GROUNDWATER ASSESSMENT

prepared for

TINKER AIR FORCE BASE
OKLAHOMA CITY, OKLAHOMA

by

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Tulsa, District
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EXECUTIVE SUMMARY

Tinker Air Force Base is located in the recharge area of the Garber-Wellington aquifer, the primary groundwater supply source for a seven county area in central Oklahoma. Being so located, Tinker AFB has the potential, along with other industries in the area, to adversely impact the groundwater quality either as a result of industrial activities or from overpumpage of the aquifer.

In order to preserve this very important natural resource, Tinker AFB has implemented a very aggressive Installation Restoration Program (IRP) to remedy historic waste sites on the Base that could potentially contaminate the groundwater. Tinker AFB has also made every effort to prevent future contamination through an environmental management program aimed at reducing, containing, and reporting spills, recycling hazardous materials, and implementing state-of-the-art industrial processes and management techniques. Although these programs are not a part of this groundwater assessment, they are an important part of providing protection to the Garber-Wellington aquifer.

The purpose of this program is to provide a long term groundwater monitoring plan for Tinker AFB. This plan, however, is not intended to monitor specific potential sources of contamination on the Base. Individual groundwater monitoring plans will be developed, as required, and presented in the remedial investigation/feasibility study reports for each IRP historic waste site. This groundwater assessment is a regional monitoring approach aimed at assessing the effects of diffuse sources and/or the combined effect of many point sources of contamination on groundwater quality. Monitoring wells which have been installed along the perimeter of the Base will monitor the quality of groundwater entering and leaving Tinker AFB. A long-term monitoring plan for the Base water supply wells is included in this report for reasons of safeguarding public health and protecting the aquifer from overpumpage.

An assessment of present groundwater quality in the vicinity of the Base is presented in this report based upon a one-time sampling of water supply wells, selected offbase privately owned wells, and the perimeter monitoring well network. Although one sampling round is insufficient for producing a reliable comparison of downgradient and upgradient wells, some conclusions can be made. Localized areas of groundwater contamination do exist on the Base. However, based on this initial sampling, there does not appear to be any contamination leaving the Base. The validity of this conclusion will be continually reviewed in future assessments. None of the offbase wells which were sampled show any contamination. Low levels of contamination are probable in Base water supply wells 15, 16, and 17, near Building 3001. At least one water supply well (14) shows apparent contamination from overpumpage. Groundwater contamination is also evident at two locations (monitoring wells 40A and 40B and monitoring well 52B) in the northwestern portion of the Base where there is no explainable source of contamination from Tinker operations. Monitoring of these wells, and others, will continue, and additional wells will be added to form a more complete network.

The recommended monitoring plan will provide the basis for an on-going assessment of groundwater quality beneath Tinker AFB. This plan is capable of determining adverse effects on groundwater quality due to industrial activities or from overpumpage of the aquifer. The recommendations contained in the report address the number and location of additional monitoring wells that are required as well as the sampling frequency and parameters to be tested.

TINKER AIR FORCE BASE
GROUNDWATER ASSESSMENT

INTRODUCTION

1. **Purpose and scope.** Operations and maintenance at Tinker Air Force Base, Oklahoma have caused localized soil and groundwater contamination. Sixteen sites are currently being investigated to define the extent and magnitude of this contamination. Contamination of the groundwater is prohibited under Oklahoma Title 82 State Statute 926.4, Pollution of Water, and 1020, Oklahoma Groundwater Law. This report assesses the effects of past Tinker operations on the groundwater supplies of the Garber-Wellington aquifer, which is the primary water source for the Base as well as surrounding communities, industry, and many residences. Groundwater quality in the area, as determined from a one-time sampling of the Base water supply wells, selected offbase privately owned wells, and a Base perimeter monitoring network is described in this report. Detailed discussion of contamination in the vicinity of individual sites including remedial plans will be discussed in the remedial investigation/feasibility study reports for each site and are beyond the scope of this report, although summary discussions are included in section 4. A long term groundwater monitoring plan which will monitor the quality of groundwater entering and leaving Tinker AFB is also presented. This plan is designed to detect any future changes in groundwater quality as a result of industrial operations on the Base or from overpumpage of the aquifer. Recommendations provided in a report prepared by the Garber-Wellington Association have been incorporated into this monitoring plan. This report is included in its entirety as Appendix E.

2. **Geohydrology.** Tinker Air Force Base is located in the Interior Lowlands physiographic province on gently westward dipping Permian redbeds. The geology, which is shown on figure 2-1, is discussed below. Figures 2-2 and 2-3 are geologic sections along the south and east perimeters respectively. They are also shown in a larger size and more detailed in plates A and B, which are in the back pocket. Geologic logs of the perimeter monitoring wells are given in Appendix A.

a. Garber-Wellington Formation.

(1) **Geology.** The Garber Sandstone and Wellington Formation are hydrologically interconnected formations which are not easily distinguished from each other based on rock type, key beds, fossils, or hydrologic properties. The Garber-Wellington is about 900 feet thick in the Tinker area, and consists of lenticular and interbedded sandstone, shale, and siltstone. Sandstone is orange-red to reddish-brown, fine-grained, and poorly cemented. The grains are sub-angular to sub-rounded and composed of quartz. Shale is reddish-brown and silty. Although present beneath all of Tinker AFB, the Garber-Wellington is overlain by the Hennessey Formation over much of the Base. Sediments of the Garber-Wellington are deltaic in origin. Stream-deposited sands interfinger with marine shales, and individual beds vary from a few feet to about 40 feet in thickness. Sandstone averages about 65% of the formation, as determined from borings drilled at the Base. Because of shifting channels and changing currents

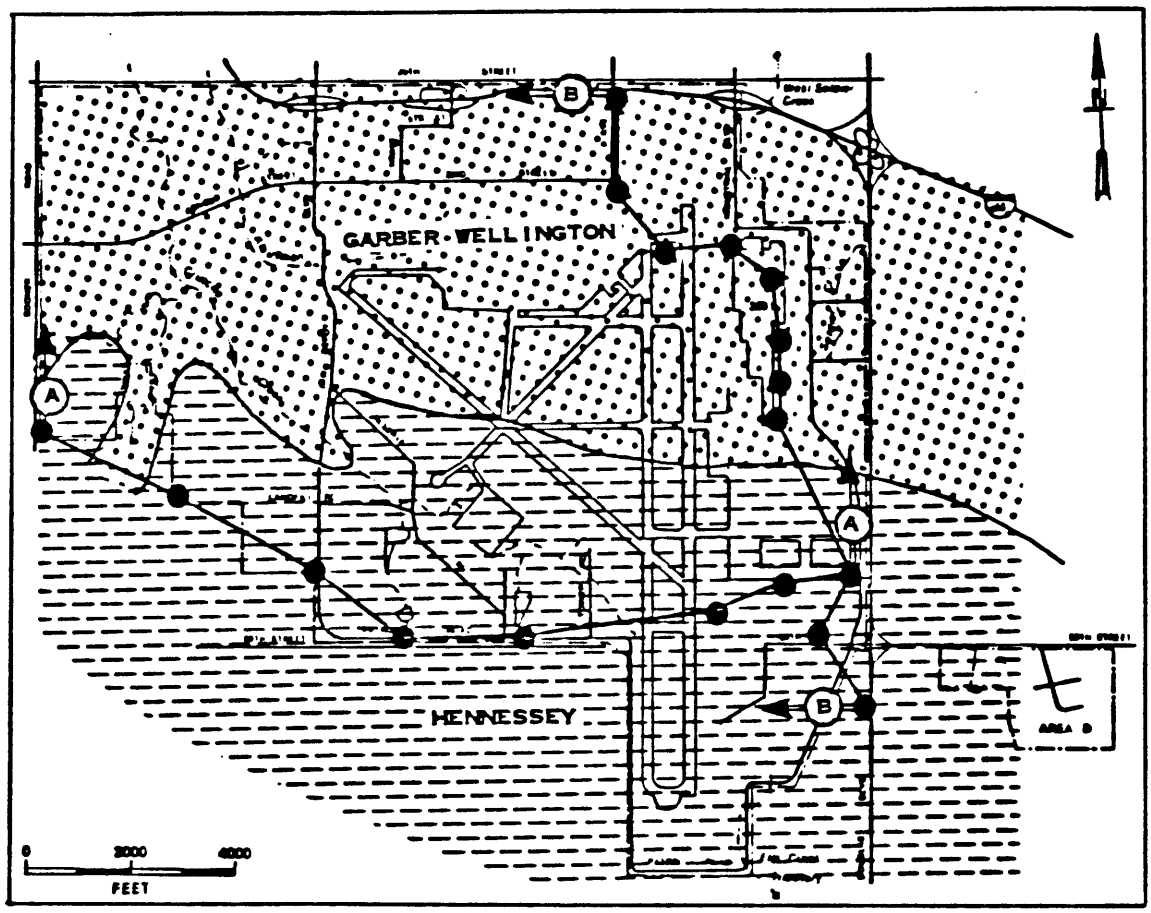

Figure 2-1. Surface geology at Tinker Air Force Base with the locations of geologic sections A-A and B-B.

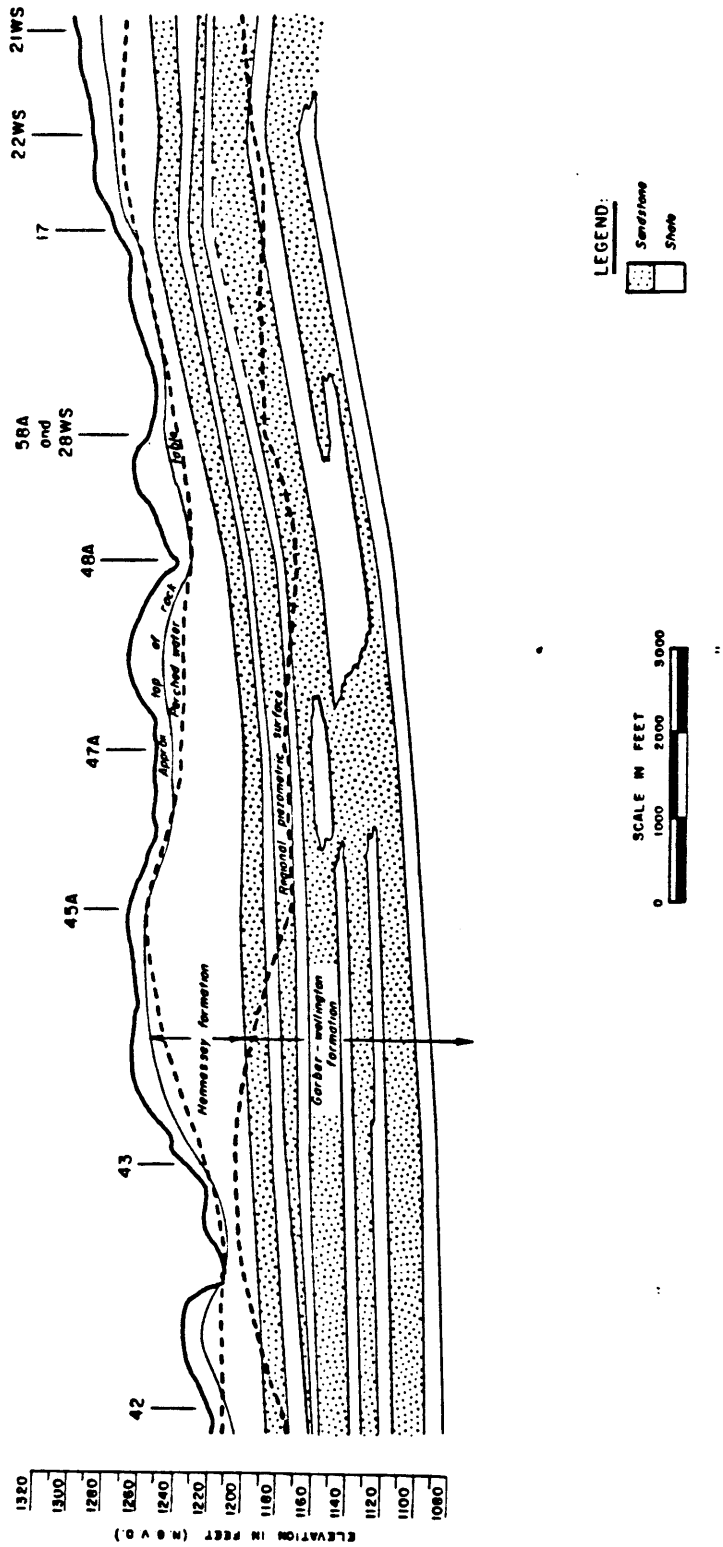

Figure 2-2. Geologic section A-A, an east-west section through the southern portion of the Base. A more detailed section is located in the back pocket.

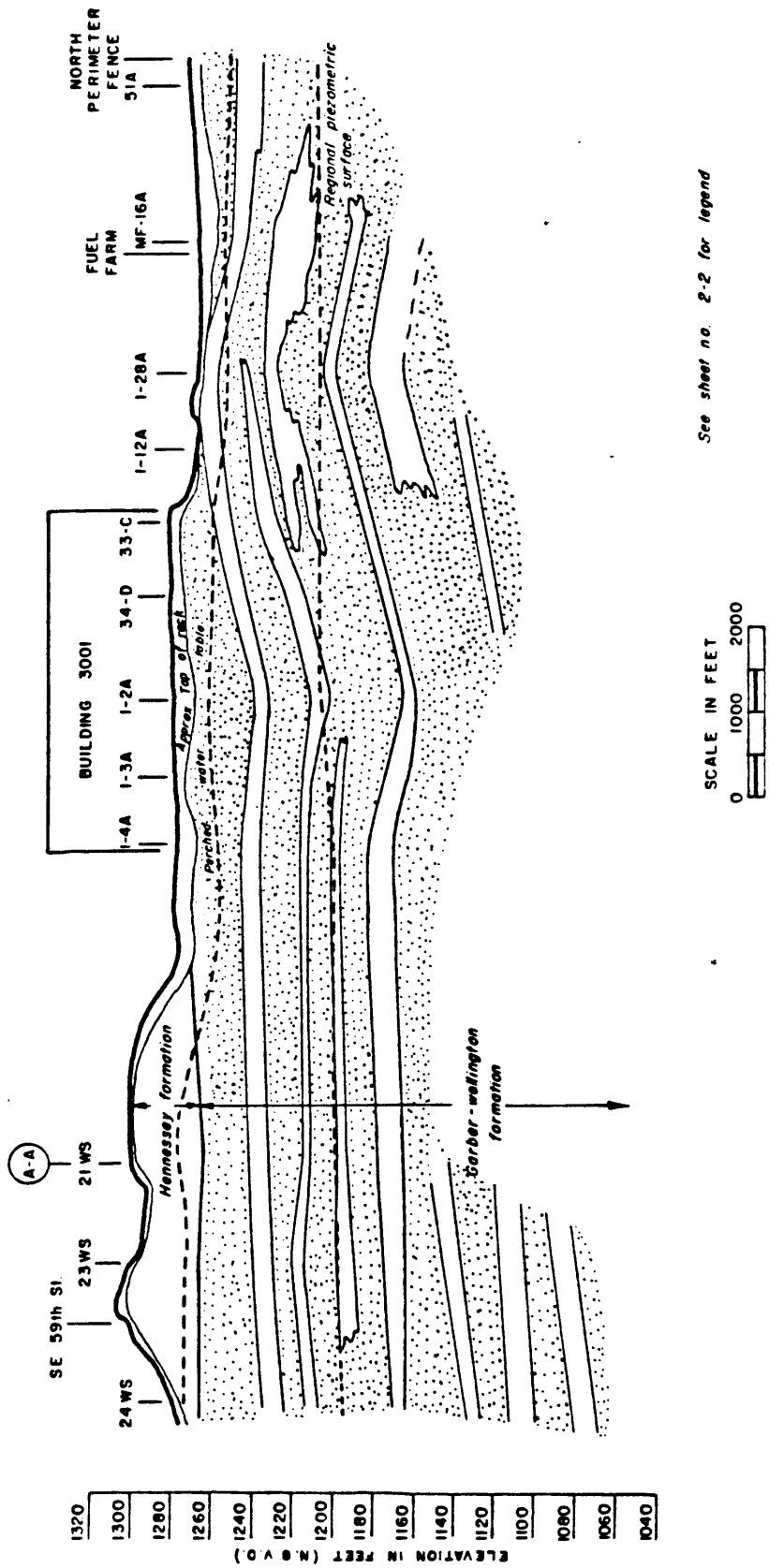

Figure 2-3. Geologic section B-B, a north-south section through the eastern portion of the Base. A more detailed section is located in the back pocket.

during deposition, detailed correlation of lithologic units is only possible over short distances. Section A-A, figure 2-2 and plate A, shows the Hennessey Formation, varying from 20 to 55 feet in thickness, continuous across the southern portion of Tinker AFB. Several of the major sandstone beds of the Garber-Wellington can be correlated for that distance, although thicknesses vary and beds do tend to pinch out. Section B-B, figure 2-3 and plate B, shows that the Hennessey does not extend as far north as Building 3001.

b. **Hennessey Formation.** The Hennessey Formation outcrops over the southern half of Tinker AFB as shown on figures 2-1 and 2-2. The Hennessey thins to the north and pinches out just south of Building 3001. It consists of reddish-brown shale with beds of siltstone and silty sandstone. The Hennessey often separates the regional water table in the Garber-Wellington from overlying perched water. There are several wells in the area producing minor amounts of water from the Hennessey which are developed from one of the thin sandstone beds or from joints and fractures in the shale.

c. **Quaternary alluvium.** Most of the streams at Tinker have some alluvial deposits unless their channels have been modified. These deposits consists of unconsolidated sediments of sand, silt, and clay. The thickness of these deposits is unknown at Tinker. The alluvial deposits are water-bearing and are hydrologically connected to the perched water table which is found over most of Tinker.

d. **Groundwater.** Groundwater exists in the Garber-Wellington under both water table and confining conditions, depending on the presence of overlying shale beds. The water becomes salty near the Base of the formation, and wells drilled through the fresh water zone have to be partially backfilled to be useable. Midwest City and Del City pump from a depth of about 550 feet with rates approximately 250 gallons per minute. Midwest City, just north of the Base, has 28 wells in their system, and, although they do not all operate simultaneously, the well system pumps about 1 million gallons per day. Residential usage is generally shallower than 200 feet, and pump rates average about 35 gallons per minute. There are 25 water supply wells located on Tinker AFB. These wells, which were drilled in the 1940's, provide 4 to 6 million gallons per day for use by the Base, making Tinker the greatest user of groundwater in the area. These wells pump an average of about 217 gallons per minute and consist of multiple screens to a total depth of about 700 feet. This producing zone is fairly permeable, and pump tests from wells in the towns of Norman and Edmond yield permeabilities about of 10^{-3} cm/sec.

The perched water table, where present, is quite distinct from the potentiometric surface of the regional aquifer. Figure 2-4 is a map of the perched water table, contoured on all available data points and showing flow toward the streams. This groundwater occurs above confining shale beds in the more permeable residual overburden and in the stream alluvial deposits. It is not necessarily continuous over all of the Base, and may occur in several strata at the same location which are separated by low permeability materials. The first encounter of groundwater below the perched water is described in this report as the regional aquifer, and is

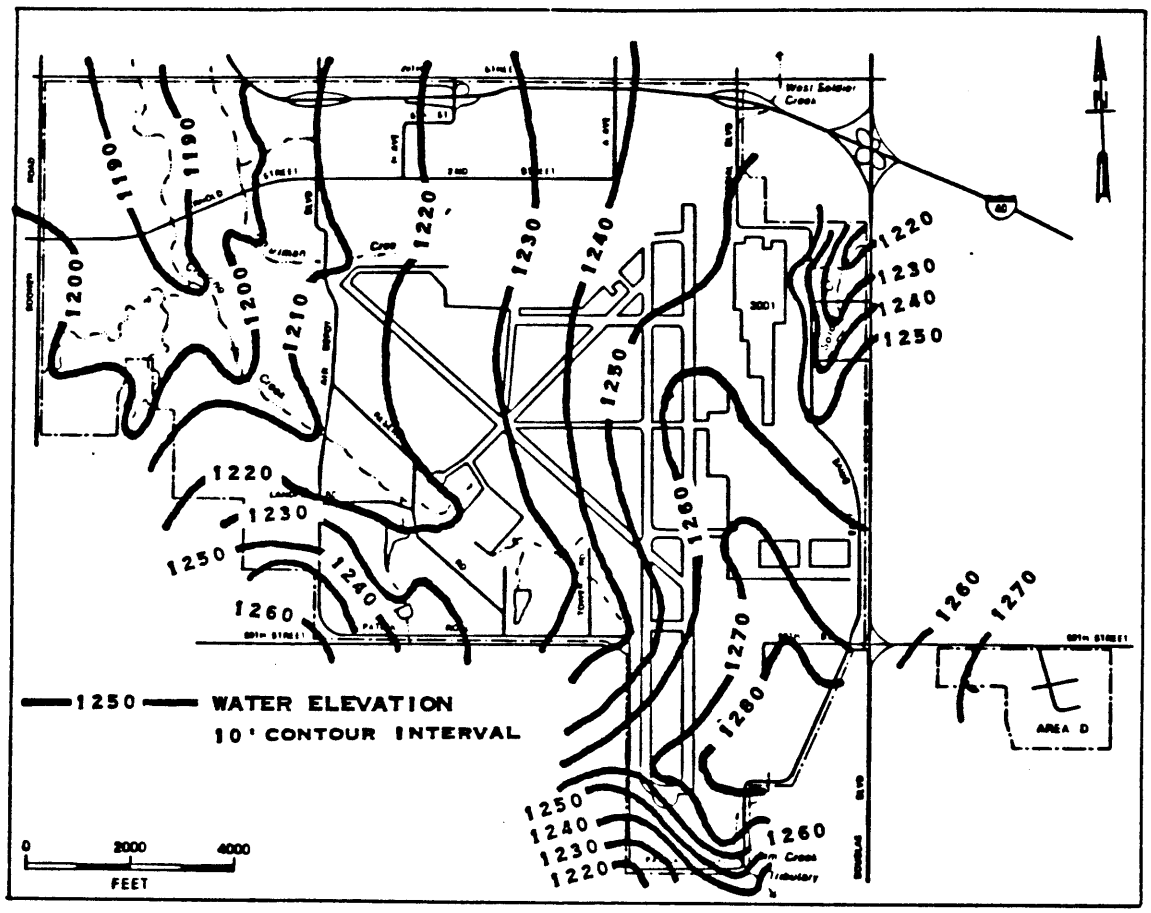

Figure 2-4. Perched water table.

contoured on figure 2-5. This map shows a southwesterly flow direction to the groundwater, and was prepared using all existing data points, which include numerous site monitoring wells not otherwise used in this assessment. The vertical gradient within the regional aquifer is downward. The deeper sandstone strata, which are thicker and more permeable, are described here as the producing zone. Attempts to contour the producing zone were not successful because of the scarcity of data points and the difficulty of interpreting cones of depression around pumping wells. The average depth to water in the producing zone is about 250 feet, which is about 200 feet lower than the regional potentiometric surface. Groundwater movement in the lenticular beds of the Garber-Wellington is very complex, and is studied in greater detail at each individual site. In this assessment for purposes of making meaningful upgradient to downgradient comparisons, the terms "perched", "regional" and "producing" are used.

3. Investigations.

a. Records search. Information on geohydrology and groundwater quality was obtained from the following sources: Tinker Air Force Base, the Oklahoma Geological Survey, The Oklahoma Water Resources Board, the Oklahoma Department of Health, the Garber-Wellington Association, and local residents and communities. Reports on geology and groundwater resources as well as geological and geophysical logs of water and monitoring wells and available chemical data were obtained. Water wells within several miles of the Base were located. Based on this records search, 11 of these offbase wells which are representative of offbase water quality conditions and the 25 Base water supply wells which are still in use were selected for a one-time sampling. These well locations are shown on figure 3-1.

b. Field investigations.

(1) Contaminated sites. Investigation of historic sites with groundwater contamination potential is in progress as part of the Base's Installation Restoration Program. Each site is being investigated primarily by auger drilling, with samples taken from the auger at 1 to 3 foot intervals for identification and chemical testing. Core drilling, downhole geophysical logging, ground penetrating radar, and surface resistivity have been used to supplement the auger drilling program. Monitoring wells have been installed at all sites which have the potential for groundwater contamination. From these studies, types and locations of contaminated materials, soil, and groundwater are being determined.

(2) Perimeter monitoring wells. Based on the available geologic and potentiometric maps, a perimeter monitoring well network was planned as shown on figure 3-1. The network was designed to monitor groundwater leaving the Base in the upper 150 feet. Coverage was provided by installing wells on the north, west, and south of the Base, and utilizing existing wells on the east. Each location is a well pair, with a shallow well (designated B) installed into the perched water to a depth of about 40 feet, and deep well (designated A) installed into the regional water table, to a depth of about 150 feet. A typical well pair is shown on figure 3-2 and a complete set of well schematics is given in Appendix B. Well location 40 consists of 3 wells, from deepest to shallowest, 40A, 40B, and 40C. The well casings of the perimeter wells are composed of stainless steel 316

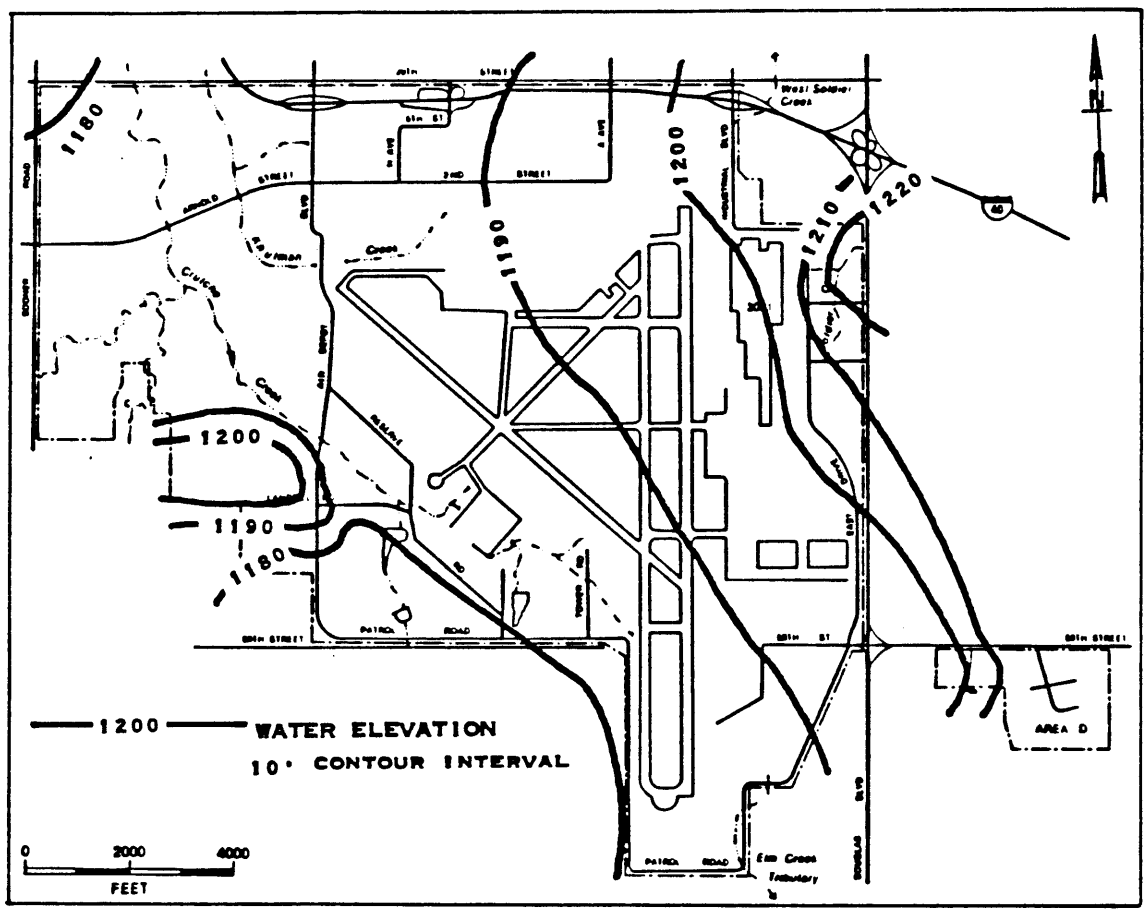

Figure 2-5. Potentiometric surface of the top of the regional aquifer.

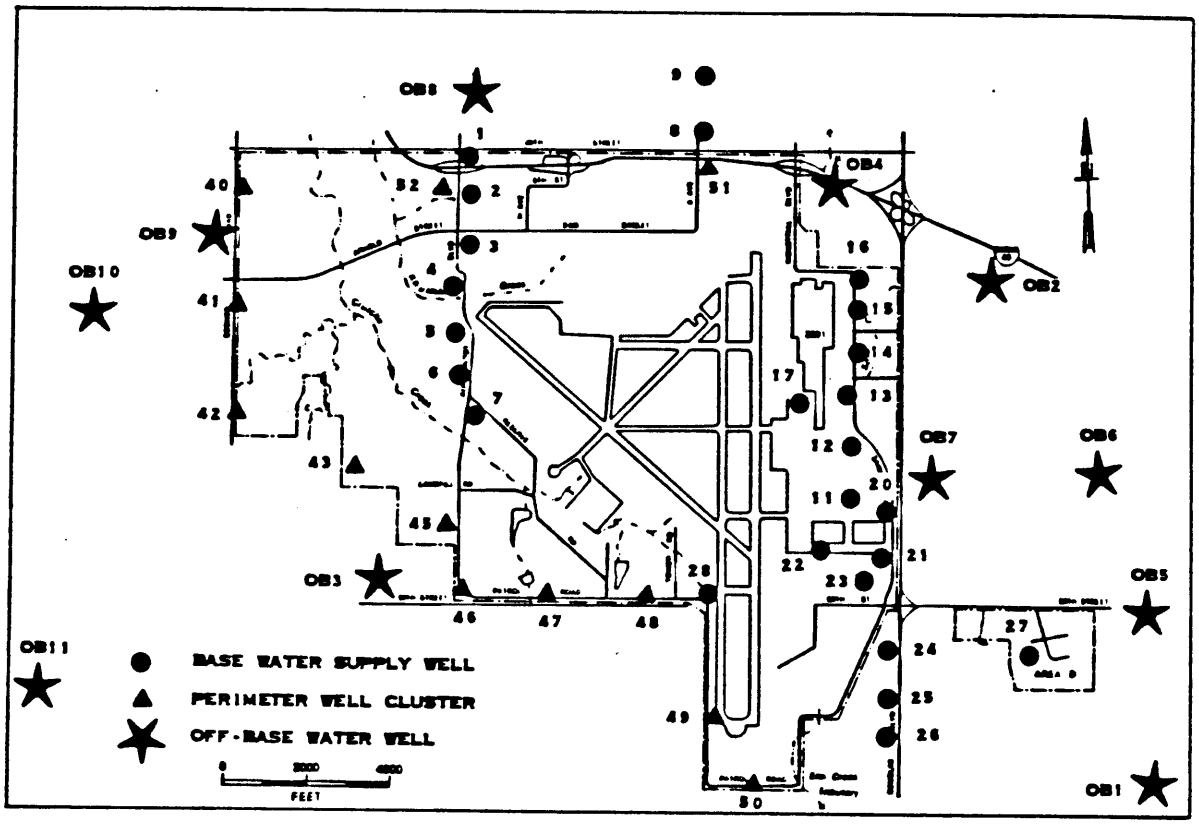

Figure 3-1. Wells used in the groundwater monitoring program.

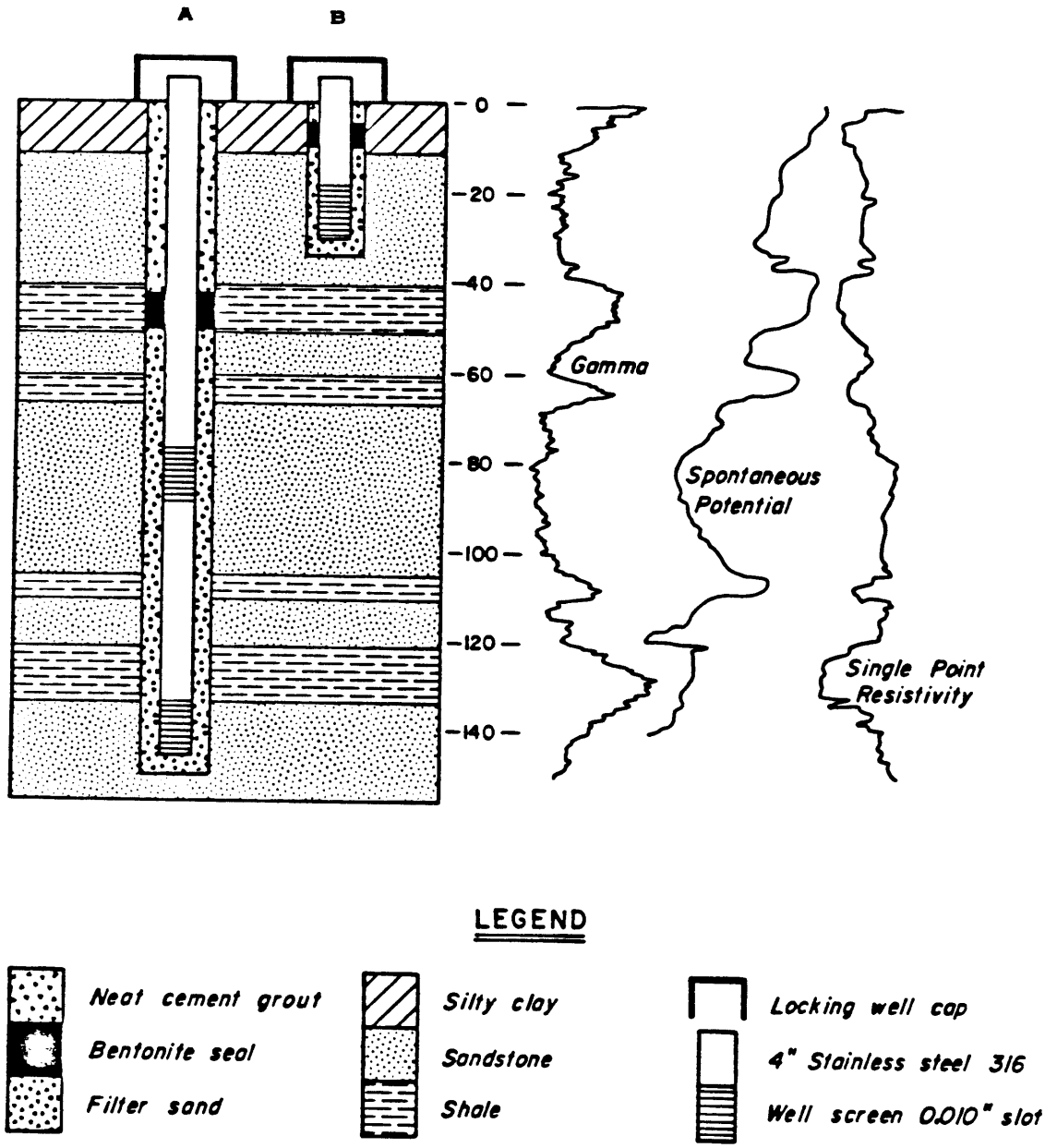

Figure 3-2. Typical perimeter monitoring well pair.

(with the exception of well 49B, which is threaded joint schedule 40 PVC). The stainless steel well screens have 0.01 inch slots. Each shallow well has a 10-foot well screen in the perched water zone, or where the zone would be if it were present. The annulus between the well casing and the boring is filled with a coarse Arkansas River sand through the entire perched water interval. A gradation and mineralogic composition of this sand is given in table 3-1. Above the filter sand is a 2 to 5 foot benton-

Table 3-1
Specifications for filter sand

mineralogy		gradation (% passing each sieve)	
quartz	80.7%		
feldspar	15.7	#4	98
granite	2.7	#8	85
chert	0.6	#16	58
sandstone	0.2	#30	27
magnitite	0.1	#50	9
shale	tr	#100	0.5
limestone	tr		
volcanic rock	tr		

ite seal, made up of bentonite pellets which were placed in the well and allowed time to hydrate and swell. Above the bentonite seal is a neat cement grout, which contains 10% by volume bentonite to retard shrinkage. Geophysical logs (gamma, single point resistance, and spontaneous potential) were run in the deep boring and were used to determine the well depth and well screen placement of the shallow well as well as the placement of the sand filter and the location and number of screens in the deep well. Each major water-bearing sand bed in the deep well had a 5 or 10 foot screen to intercept water from that bed, and each well has 1 to 3 of these screens. Filter sand, as described above, was placed from the bottom of the well up to the impervious zone separating the perched and regional water tables. The bentonite seal was placed in the impervious zone supporting the perched water table in order to isolate the regional aquifer from the perched aquifer. The purpose of the long sand filters is to detect any contamination leaving the base, and not necessarily to isolate which sandstone bed is contaminated.

c. **Groundwater sampling and analysis.** The monitoring well sampling network used in this initial assessment, and shown on figure 3-1, consists of the 25 Base water supply wells, 11 offbase wells, and 25 perimeter wells (12 well sites) for a total of 61 monitoring wells. Well numbers, depths, and names of the owners of the offbase wells are listed in table 3-2. All of the wells have been sampled and prepared for shipment in accordance with *Tinker Air Force Base Sampling and Analysis Plan,* Appendix F, prepared by the Tulsa District.

4. Contaminated site studies. Each of the sites being investigated is described below and is located on figure 4-1. Tables 4-1 through 4-3, which present maximum concentrations at 3 of these sites, show worst case situations and are not reflective of the average concentration at each site or of the concentration which would be pumped in a cleanup operation.

Table 3-2
Offbase monitoring wells

well	depth	owner
shallow wells (regional aquifer)		
OB1	160	Curtis Hall
OB2	175	Kenneth McMichael
OB3	175	Vera Bell
OB4	120	Lawrence Richards
OB5	160	Ruby York
OB6	180	Pete Choates
OB7	180	Midwest Maintanance
OB8	325	Midwest City
deep wells (producing zone)		
OB9	746	Del City
OB10	750	Del City
OB11	700	Dolese

a. Building 3001. Building 3001, located near the northeast boundary of the Base, covers approximately 50 acres and houses an industrial complex in which aircraft are repaired and upgraded. Past activities within the building have resulted in contamination of the groundwater by chlorinated solvents and heavy metals to a depth of approximately 170 feet. The primary contaminants are trichloroethylene and chromium. These and other contaminants are listed in table 4-1.

Table 4-1
Groundwater contamination from Building 3001
range of concentrations in groundwater

organic compounds ug/l		metals, total mg/l	
trichloroethylene	<5 - 330,000	chromium	<0.010 - 80.0
toluene *	<5 - 13,000	barium	<0.500 - 36.0
1,2-dichloroethylene	<5 - 4,600	lead	<0.025 - 0.58
tetrachloroethylene	<5 - 1,200		
chlorobenzene **	<5 - 940		
1,2-dichloroethane	<5 - 700		
benzene *	<5 - 580		
vinyl chloride **	<10 - 530		
xylene	<5 - 530		

* From a fuel area SW of the building ** NE of the building

b. Fuel Farm. The Fuel Farm is a two-acre site bounded by First and Second streets on the south and north and by A and B streets on the east and west. It is currently being converted from an underground to an above ground fuel storage facility. Until 1986, it had 3 groups of buried tanks containing motor fuel, JP-4 jet fuel, and avgas. Approximately

63,000,000 gallons of fuel passed through this yard annually. There are approximately 50,000 gallons of fuel product floating on the water table, and groundwater is contaminated with benzene, toluene, and xylene. An interim remedial action consisting of removing the fuel product from the groundwater with two recovery wells is currently in progress.

Table 4-2
Groundwater contamination from the Fuel Farm
range of concentrations in groundwater

organic compounds ug/l		metals, total mg/l	
benzene	<5 - 10,080	barium	<0.500 - 6.4
xylene	<5 - 2,066	lead	<0.025 - 0.27
toluene	<5 - 892	chromium	<0.010 - 0.26

c. Landfill 6. Landfill 6 is a 20-acre site located 1/2 mile east of Douglas Blvd on S. E. 59th Street on property leased from Oklahoma City by Tinker AFB. Approximately 15 acres of the site are covered by a 2-foot thick clay cap. The site was active from 1970 to 1979 and was used for the disposal of general refuse with small quantities of industrial waste such as insecticide and paint cans. Also, some industrial waste treatment sludges were placed in the landfill. The major contaminants found in the groundwater at Landfill 6 and their maximum concentrations are given in table 4-3.

Table 4-3
Groundwater contamination from Landfill 6
maximum concentrations in groundwater

organic compounds ug/l		metals, total mg/l	
bis(2ethylhexyl)phthalate	<10 - 24,000	barium	<0.500 - 19.0
4-methylphenol	<10 - 4,000	lead	<0.025 - 0.28
acetone	<10 - 1,300	chromium	<0.010 - 0.27
total phenols	<10 - 1,100		
chlorobenzene	<5 - 190		

d. Landfills 1-4. Landfills 1, 2, 3, and 4 are located south of Crutcho Creek and east of Air Depot Road. They have a combined surface area of 45 acres, and were in use from 1942 to 1968. Because of their proximity to each other, they are being treated as a single unit. Investigations at landfills 1-4 are continuing.

e. Landfill 5. Landfill 5 is located north of Patrol Road and east of Tower Road in the southeastern portion of the Base. The landfill was in use from 1968 to 1970. Disposal at the site consisted primarily of general refuse and possibly some waste solids from the domestic wastewater treatment plant and industrial waste. Runoff from a portion of the landfill drains into Crutcho Creek. Preliminary results indicates that the type and degree of groundwater contamination is very similar to that at Landfill 6.

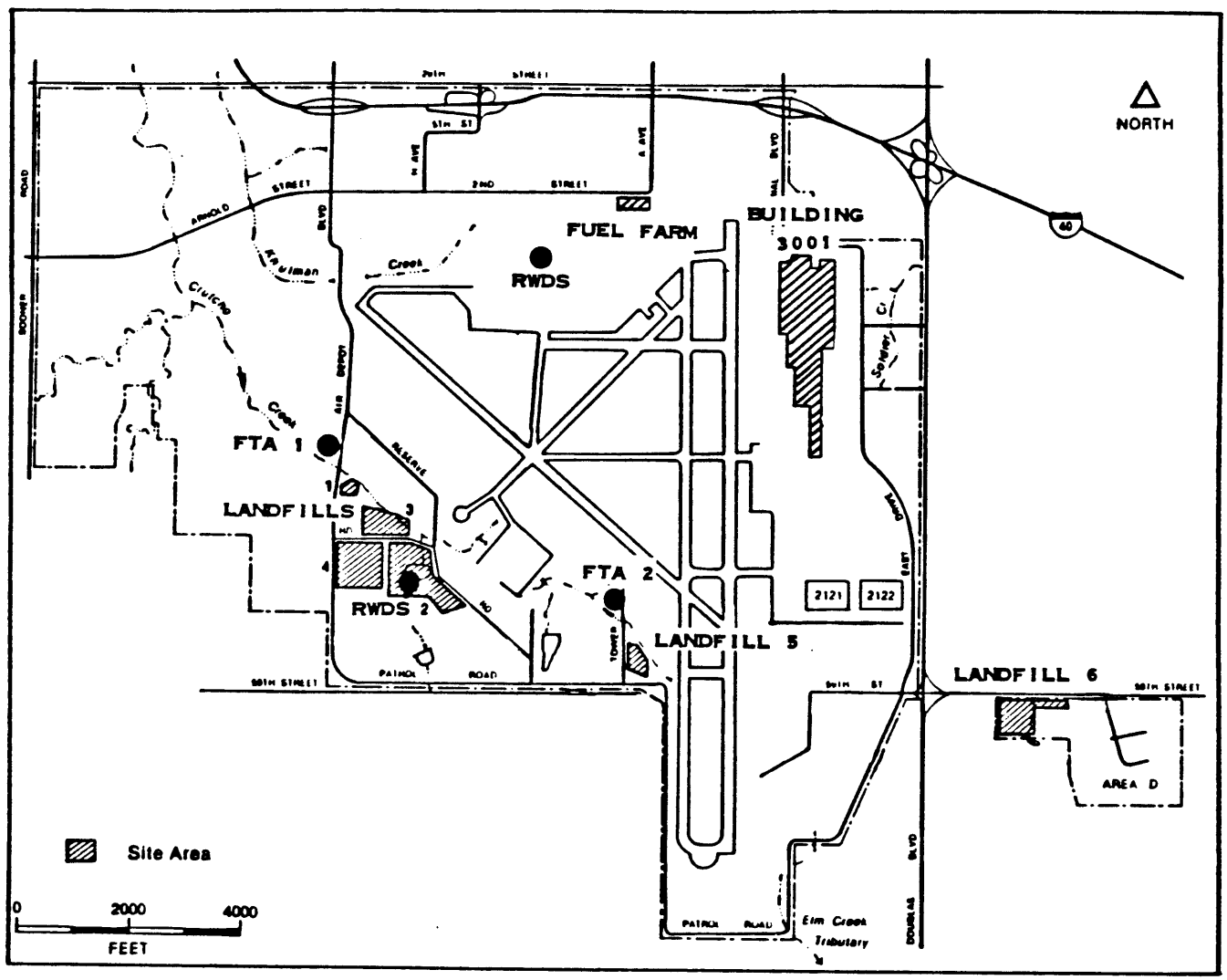

Figure 4-1. Sites under investigation.

f. **Fire training areas.** Two abandoned fire training areas exist at Tinker. One is located between Patrol Road and Air Depot Blvd just north of Crutcho Creek, and near Landfill 1, and the other is located just north and west of the airfield control tower, about 1 mile south of Building 3001. Both of these sites were in use in the 1960's. Waste fuels and solvents were poured over aircraft hulls, set on fire, and extinguished with a variety of firefighting fluids. The unburned residual materials were not always cleaned up after each training exercise. Investigation of these sites is continuing.

g. **Radiologic waste disposal sites.** Two radiologic waste disposal sites are being investigated, one adjacent to building 201, and one located in Landfill 2. Both sites were once used for disposal of radium paint dials. Material from the Building 201 site was containerized, and material at Landfill 2 was reportedly excavated and hauled to a disposal site in Mt. Kiska, NY. Investigation of these sites is continuing.

5. **Analytical procedures for the groundwater monitoring network.**

a. **Sampling parameters.** The following parameters, shown in table 5-1, were tested in all of the wells of the monitoring network. They were chosen to represent what was known to exist in the groundwater around the sites as well as what could potentially be found based on descriptions of site operations.

Table 5-1
Parameters tested in the monitoring network

total and diss. metals

- arsenic
- barium
- cadmium
- chromium
- lead
- mercury
- nickel
- selenium
- silver
- zinc

radiometrics

- gross alpha
- gross beta
- radium-226
- radium-228

misc and indicators

- chloride
- sulfate

misc and indicators (cont.)

- cyanide
- oil and grease
- total organic carbon
- pH
- conductivity

volatiles

- 1,1,2-trichloroethane
- benzene
- cis-1,3-dichloropropene
- 2-chloroethylvinylether
- bromoform
- 2-hexanone
- 4-methyl-2-pentanone
- tetrachloroethene
- 1,1,2,2-tetrachloroethene
- toluene
- chlorobenzene
- 1,1,1-trichloroethane
- 2-butanone
- 1,2-dichloroethane
- chloroform

Table 5-1 (cont.)
Parameters tested in the monitoring network

volatiles (cont.)

trans-1,2-dichloroethene
1,1-dichloroethane
1,1-dichloroethene
carbon disulfide
acetone
methylene chloride
chloroethane
vinyl chloride
bromomethane
chloromethane
ethylbenzene
styrene
total xylenes
carbon tetrachloride
vinyl acetate
bromodichloromethane
1,2-dichloropropane
trans-1,3-dichloropropene
trichloroethene
dibromochloromethane

semivolatiles

3,3-dichlorobenzidene
butyl benzyl phthalate
pyrene
fluoranthene
di-n-butyl phthalate
2-methylnaphthalene
hexachlorocyclopentadiene
2,4,6-trichlorophenol
2,4,5-trichlorophenol
2-chloronaphthalene
2-nitroaniline
dimethyl phthalate
acenaphthylene
3-nitroaniline
acenaphthene
2,4-dinitrophenol
4-nitrophenol
dibenzoufuran
2,3-dinitrotoluene
2,6-dinitrotoluene
diethyl phthalate
4-chlorophenyl phenyl ether
fluorene
4-nitroaniline

semivolatiles (cont.)

4,6-dinitro-2-methylphenol
n-nitrosodiphenylamine
4-bromophenol phenol ether
hexachlorobenzene
pentachlorophenol
phenanthrene
1,4-dichlorobenzene
benzyl alcohol
1,2-dichlorobenzene
2-methylphenol
benzo(g,h,i)perlyene
dibenzo(a,h)anthracene
bis(2-chloroisopropyl)ether
4-methylphenol
n-nitrosodipropylamine
hexachloroethane
nitrobenzene
isophorone
2-nitrophenol
2,4-dimethylphenol
benzoic acid
bis(2-chloroethoxy)methane
2,4-dichlorophenol
1,2,4-trichlorobenzene
naphthalene
4-chloroaniline
hexachlorobutadiene
p-chloro-m-cresol
benzo(b)fluoranthene
benzo(k)fluoranthene
benzo(a)pyrene
indeno(1,2,3-c,d)pyrene
anthracene
crysene
di-n-octyl phthalate
phenol
bis(2-chloroethyl)ether
2-chlorophenol
1,3-dichlorobenzene
bis(2-ethylhexyl) phthalate
benzo(a)anthracene
4,6-dinitro-2-methylphenol
n-nitrosodiphenylamine
4-bromophenol phenyl ether
hexachlorobenzene
pentachlorophenol
phenanthrene

Table 5-1 (cont.)
Parameters tested in the monitoring network

pesticides and PCBs	pesticides and PCBs (cont.)
dieldrin	endrin
aldrin	endrin aldehyde
a-BHC	heptachlor
b-BHC	heptachlor epoxide
d-BHC	toxaphene
g-BHC	PCB 1016
chlordane	PCB 1221
4,4-DDE	PCB 1232
4,4-DDT	PCB 1242
4,4-DDD	PCB 1248
endosulfan I	PCB 1254
endosulfan II	PCB 1260
endosulfan sulfate	

These wells were sampled between May and November 1986. Results of this sampling are given in Appendix C.

b. Laboratory test procedures. Laboratory test procedures, EPA test methods, and QA/QC plans are given in Appendix F. Four of the wells, OB2, OB3, OB9, and OB10 were resampled, and the samples were split with the Oklahoma State Department of Health at their request in order to verify the results for metals. The Health Department concluded that the analytical work being performed was acceptable. Their results are included in Appendix D.

c. Procedures for data analysis. All groundwater data used in this assessment is stored on EPA's STORET system. The statistics used were performed by SAS (Statistical Analysis Systems). An analysis of variance (ANOVA) was made, comparing background and downgradient wells for three groupings, perched, regional, and producing zones, as listed in table 5-2. Background wells were chosen to be representative of groundwater quality unaffected by man-made contamination. They are not necessarily upgradient. Wells set in the perched water table are shown in figure 5-1. Wells which are set at the top of the regional aquifer are shown on figure 5-2 and wells which are set in the producing zone of the regional aquifer are shown in figure 5-3. There are many statistical tests which could be used to analyze the data. Unfortunately, most of them are not very reliable in making comparisons where each well has been sampled only once. An analysis of variance was used at the 95% confidence interval to test the hypothesis that the value of each parameter for each downgradient well is significantly different from the mean of that parameter for that background grouping. An ANOVA was performed on all of the parameters listed in table 4-1, with the exception of the organics (volatiles, semivolatiles, pesticides, and PCB's), where the laboratory data was examined for the presence of organic compounds. For the metals, only total metals were examined statistically. Dissolved metals were not. Table 5-3 gives the background values used in the analyses for each grouping.

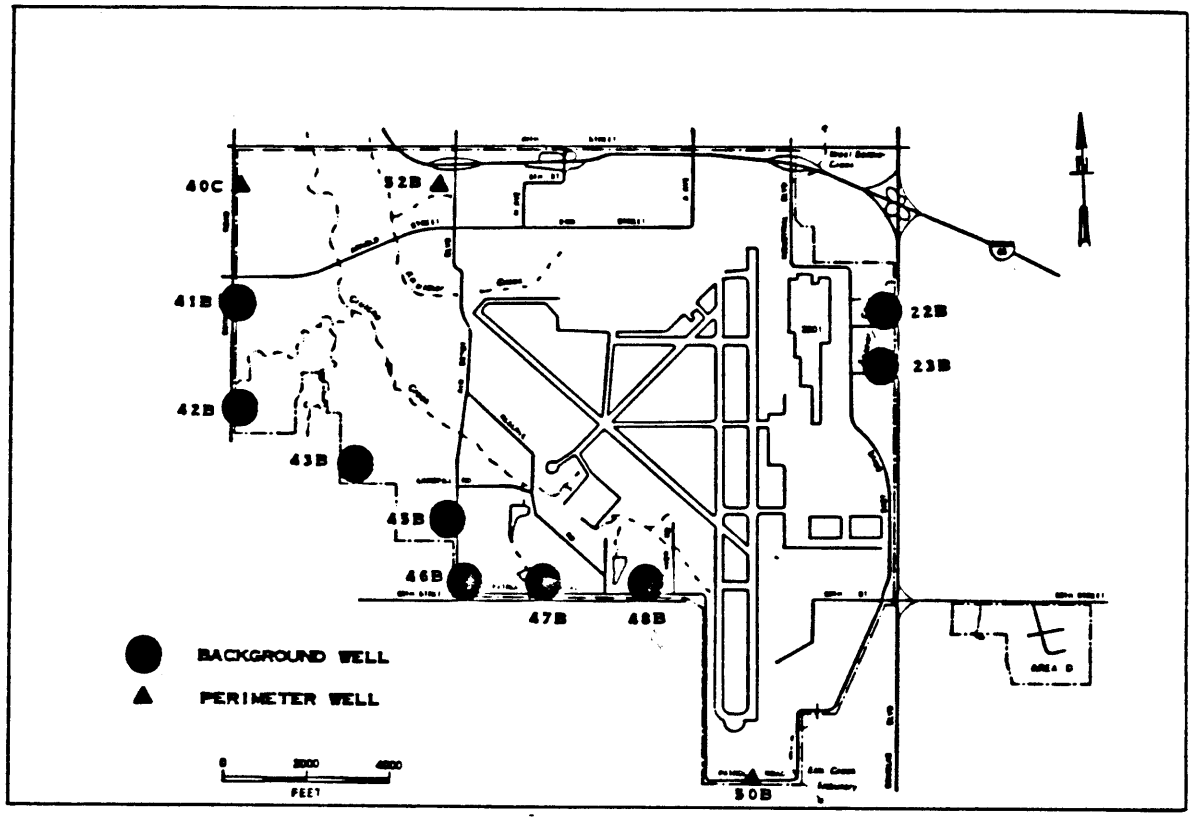

Figure 5-1. Background and downgradient wells set in the perched water table.

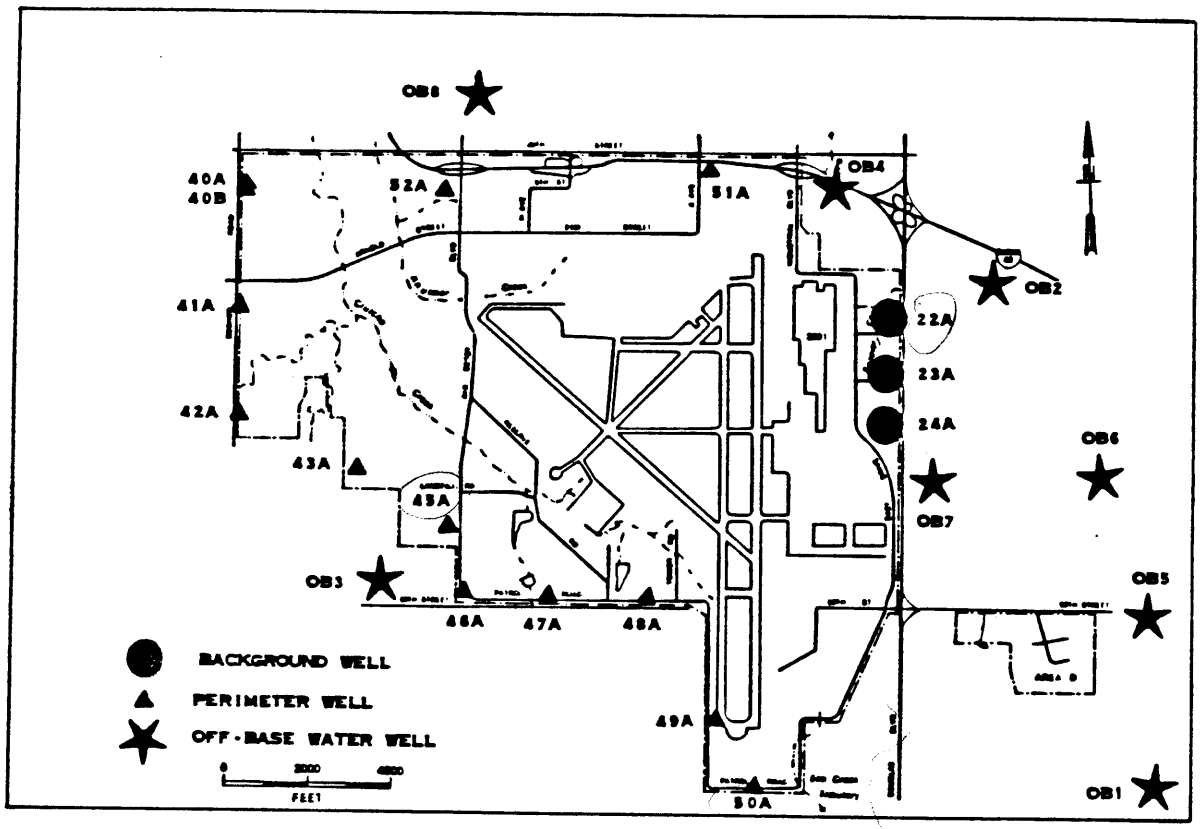

Figure 5-2. Background and downgradient wells set at the top of the regional aquifer.

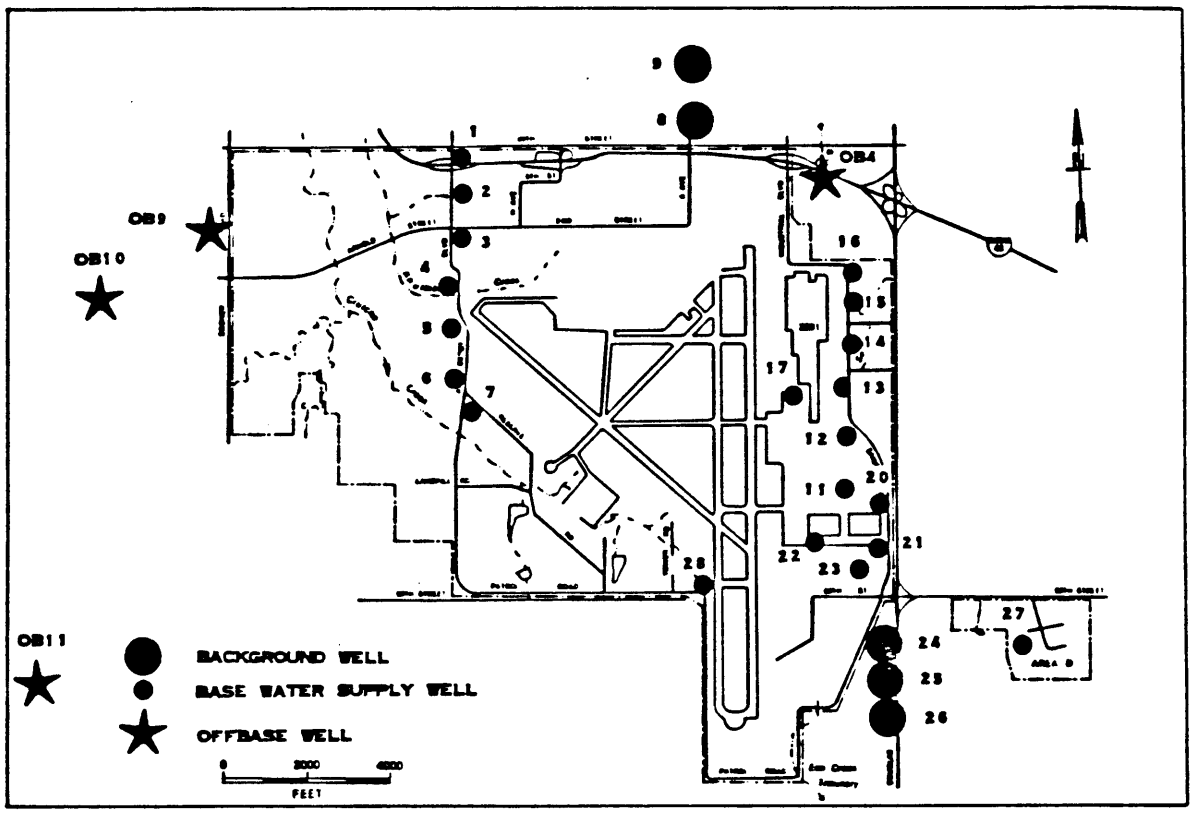

Figure 5-3. Background and downgradient wells set in the producing zone of the regional aquifer.

Table 5-2
Groupings for analysis of variance

downgradient wells	background wells
PERIMETER WELLS - PERCHED AQUIFER	
40C, 50B, 52B	41B, 42B, 43B, 45B, 46B, 47B, 48B, 22B, 23B
PERIMETER WELLS - REGIONAL AQUIFER	
40A, 40B, 41A, 42A, 43A, 45A, 46A, 47A, 48A, 49A, 50A, 51A, 52A	22A, 23A, 24A
OFFBASE WELLS - REGIONAL AQUIFER	
OB1, OB2, OB3, OB4, OB5, OB6, OB7, OB8	22A, 23A, 24A
OFFBASE WELLS - PRODUCING ZONE	
OB9, OB10, OB11	8WS, 9WS, 24WS, 25WS, 26WS
BASE WATER SUPPLY WELLS - PRODUCING ZONE	
1WS, 2WS, 3WS, 4WS, 5WS, 7WS, 11WS, 12WS, 13WS, 14WS, 15WS, 16WS, 20WS, 21WS, 27WS, 28WS	8WS, 9WS, 24WS, 25WS, 26WS

Table 5-3
Background averages, mg/l and pc/l

	producing zone	regional aquifer	perched WT
arsenic	0.002	0.002	0.010
barium	<0.500	0.663	1.11
cadmium	<0.0075	<0.0075	0.010
chromium	<0.010	<0.010	0.046
lead	0.033	0.048	0.057
mercury	<0.0004	<0.0004	<0.0004
selenium	0.0021	0.0005	0.0021
silver	<0.010	<0.010	0.010
nickel	0.019	0.033	0.101
zinc	0.44	0.12	0.11
chloride	4.9	42.1	297.4
sulfate	5.8	21.0	82.8
conductivity	442	718	684
pH	7.17	9.80	7.10
TOC	2.2	5.3	3.9
oil & grease	<1.0	<1.0	<1.0
cyanide	<0.20	<0.20	<0.20
alpha	4.2	3.7	55.2
beta	9.0	9.3	106.8

6. Results and discussion.

a. Results. Parameters which were significant in the ANOVA are shown along with the background mean in table 6-1. Organic compounds which occurred above laboratory detection limits are given in table 6-2. Three compounds, however, have been omitted from this table. Bis(2-ethylhexyl) phthalate is a common plasticizer, and occurs from field and laboratory glassware and tubing. It occurred in 8 wells in concentrations varying from 15 to 39 ug/l and in 1 well at 290 ug/l. Methylene chloride is a common constituent of laboratory atmospheres, and occurred in 6 wells in concentrations varying from 5 to 23 ug/l. Acetone is one of several rinses (along with soapy water, distilled or deionized water, and hexane) used in the cleanup of the teflon sampling bailers. It appeared in equipment blanks prepared from cleaned bailers at concentrations as high as 240 ug/l. Even after following the acetone with a double hexane rinse, and allowing the bailers to air overnight, acetone was still being detected in the blanks. The use of acetone was discontinued in the cleanup procedure. Acetone appeared in 13 samples, varying from 11 to 230 ug/l, all taken before its use was discontinued. It did not occur in any samples after that time. Chloroform, although reported in table 6-2, was found in the deionized water at 30 ug/l, which was used for bailer cleanup. Wash water is now distilled and deionized, and is free of chloroform.

Table 6-1
ANOVA results, statistically significant parameters
mg/l

PERCHED AQUIFER - PERIMETER WELLS

	background average	40C	50B
barium	0.50	4.30	
TOC	3.9		41.0

REGIONAL AQUIFER - PERIMETER AND OFFBASE WELLS

	background average	40A	40B	42A	43A	45A
arsenic	0.002		0.016			
barium	0.66	2.4	7.10			
cadmium	0.008	0.018	0.028			
chromium	0.010	0.160	0.85	0.250	0.018	
lead	0.048	0.850	0.540		0.130	
selenium	0.0005			0.0054	0.0071	0.0020
silver	0.010		0.055			
nickel	0.03		1.30			
zinc	0.12		1.00			
chloride	42.2				2300.0	

Table 6-1 (cont.)
ANOVA results, statistically significant parameters
mg/l

	background average	46A	47A	48A	49A	51A
barium	0.66				2.2	
cadmium	0.008					0.015
chromium	0.010	0.028			0.035	
nickel	0.033		0.070	0.070	0.073	
selenium	0.0005		0.0021			

	background average	52A	OB2	OB3
cadmium	0.008		0.010	0.010
chromium	0.010	0.013		0.160
lead	0.048		0.100	

PRODUCING ZONE - OFFBASE WELLS AND BASE WATER SUPPLY WELLS

	background average	OB9	OB11	1WS	3WS	5WS
chromium	0.010	14.0			0.033	
chloride	4.9		0.033			10.8
sulfate	5.8	13.0				
TOC	2.2			5.0		

PRODUCING ZONE - OFFBASE WELLS AND BASE WATER SUPPLY WELLS

	background average	7WS	13WS	14WS	15WS	16WS
arsenic	0.002			0.012		
barium	0.50					0.68
cadmium	0.008					0.013
chromium	0.010			0.030		
selenium	0.0021			0.1400		
chloride	4.9			29.0		
sulfate	5.8	16.0		4.0	8.0	
TOC	2.2		7.0			
gross alpha*	4.2	26.0		27.0		
gross beta*	9.0	28.0				
conductivity	442.0			665.0		

	background average	20WS	21WS	27WS	28WS
barium	0.50		0.51		
cadmium	0.008			0.013	
chromium	0.010	0.015	0.025		
silver	0.010			0.025	

Table 6-1 (cont.)
ANOVA results, statistically significant parameters
mg/l

zinc	0.043				0.088
chloride	4.9		12.0		
sulfate	5.8	9.0		15.0	10.0
gross alpha*	4.2	14.0			

* values are picocuries/liter (pc/l)

Table 6-2
Organic compounds detected
ug/l

PERCHED AQUIFER - PERIMETER WELLS

	52B
trichloroethylene, 6/11/86	7.0
trichloroethylene, 2/3/87	18.0

REGIONAL AQUIFER - PERIMETER WELLS AND OFFBASE WELLS

	40A	40B	46A	OB2
chloroform			13.0	
trichloroethylene	3.0	1.6		
chloroform, 8/13/86				220.0
chloroform, 11/25/86				<10.0

PRODUCING ZONE - OFFBASE WELLS AND BASE WATER SUPPLY WELLS

	OB9	15WS	16WS
chloroform*	3.9		
dichlorobromomethane*	2.2		
tetrachloroethylene			0.7
1,2-dichloroethane			1.9
trichloroethylene		0.7	1.9

* found by State Health Department

b. Discussion.

(1) **General.** All of the metals tested except mercury were significant in at least one well. Chromium was significant in 13 wells. Also chloride, sulfate, total organic carbon (TOC), alpha, beta, and conductivity were significant in at least one well. The major difficulty in doing this type of analysis with only one set of readings is determining the difference between what is significant statistically and what is truly meaningful. Several of the metals, such as cadmium and chromium, were below detection limits in all of the background wells for some groupings. Therefore, the presence of any amount of that metal in a downgradient well,

even if it were very near the detection limit, would be significant statistically, since the mean of the background wells would be the detection limit and the variance would be 1. But because of the unreliability of data in these low concentrations, this value would not necessarily be meaningful. The discrepancy between statistically significant and meaningful will lessen as more data is taken from these wells and used in the statistical comparisons. In each of the discussions below, the emphasis is placed on data which appears to be meaningful.

(2) **Perimeter wells - perched aquifer.** Only 3 wells in the perched aquifer appear to be downgradient from the Base, since the groundwater flows toward areas that are topographically low. No parameters were statistically significant in this grouping with the exception of 4.3 mg/l barium from well 40C and 41 mg/l TOC from well 50B. Since no organic compounds appeared in these 2 wells and only one parameter is significant, contamination from manmade sources is unlikely. However, trichloroethylene (TCE) appeared in well 52B at 7 ug/l. This well, which is located on the golf course near the Air Depot gate, was resampled in February 1987, and that value was 18 ug/l. TCE is not naturally occurring and is an indicator of contamination in the vicinity of the well. No heavy metals were found in this well and there is no known source of TCE in this area.

(3) **Perimeter wells - regional aquifer.** Eleven of the 12 perimeter wells had at least one statistically signigicant result, wells 40A and 43A had 4 and well 40B had 8. Two of these wells, 40A and 40B, were resampled to confirm the presence of the metals and also to test for volatile organics at lower detection limits than was performed during the original analysis. Wells 40A and 40B contained TCE at 3.0 and 1.6 ug/l respectively. These wells appear to be contaminated, although the source of the contamination is not known. These wells are located next to the jogging track in the housing area just a few feet from the perimeter fence. Well 40B, which has a sand filter from 45 to 100 feet, has the highest concentration of metals, which include arsenic, barium, cadmium, chromium, lead, silver, nickel, and zinc. Barium is high in well 49A (2.2 mg/l), chromium is high in well 42A (0.25 mg/l), and lead and chloride are high in well 43A (0.13 and 2300 mg/l). Selenium appears in 4 wells in concentrations varying from 0.002 to 0.007 mg/l and is a naturally occurring metal in groundwater, especially in areas of overpumpage. None of the wells other than 40A and 40B appear to be contaminated from manmade sources.

(4) **Offbase wells - regional aquifer.** Low levels of cadmium, chromium, and lead appeared in 2 of the shallow offbase wells, OB2 and OB3. These wells were resampled in November 1986, and samples were split with the State Department of Health. Cadmium, chromium, and lead were all below detection limits in these samples. OB2 had 220 ug/l chloroform in the original sampling but less than 10 ug/l in the resample. Chloroform may have been introduced from the deionized wash water. None of these wells show any contamination.

(5) **Offbase wells - producing zone.** OB9 contained 14 mg/l chloride and 13 mg/l sulfate, plus very low levels of chloroform and dichlorobromomethane were found in the State Health Department check of the resample. Chloride and sulfate are naturally occurring, and the chlorinated compounds are most likely a result of the deionized wash water used to

rinse the bailers and sampling equipment.

(6) **Base water supply wells - producing zone.** Wells 3, 5, 13, and 14 contain low but statistically significant levels of several heavy metals and other inorganic compounds. Most of these do not appear to be of any consequence with the exception of selenium at 0.14 mg/l in well 14. This well also has statistically significant arsenic, chromium, chloride, sulfate, and conductivity. According to studies performed by the Garber-Wellington Association, reported in Appendix E, these compounds are naturally occurring and are indicators of overpumpage rather than contamination from manmade sources. Wells 15 and 16, however, do appear to be contaminated with low levels of TCE (0.7 and 1.9 ug/l respectively) and well 16 with 1,2-dichloroethane at 1.9 ug/l. These compounds have been used in processes at Building 3001 and have been found in the groundwater beneath and near the building to a depth of approximately 170 feet. Well 17, which is near the southeast corner of the building, is very likely to contain these compounds also, but cannot be tested because it is out of service. Contamination is apparently entering these wells either through movement in the permeable, producing zone or vertically from contaminated groundwater at the top of the regional aquifer. As in the case of wells 18 and 19, which have been previously plugged, the poor condition of the well could allow for vertical migration. Figure 6-1 is a map of the Building 3001 area showing TCE contamination at the top of the regional aquifer showing wells 15, 16, and 17 within the limits of that plume.

7. Conclusions. Table 7-1 summarizes the results of the previous discussion. Contamination is probable in water supply wells near Building 3001 and in several perimeter wells in the northwestern portion of the Base where there is no readily explainable source of contaminants.

Table 7-1
Wells in which groundwater contamination is likely

	source of contamination	
	operations	overpumpage
perimeter wells - perched zone	52B	----
perimeter wells - regional aquifer	40A, 40B	----
offbase wells - regional aquifer	----	----
offbase wells - producing zone	----	----
water supply wells - producing zone	15WS, 16WS, 17WS	14WS

One sample is not enough to produce a reliable statistical comparison of downgradient and background wells. At least one well shows apparent contamination from overpumpage. Continued monitoring of offbase wells in not required.

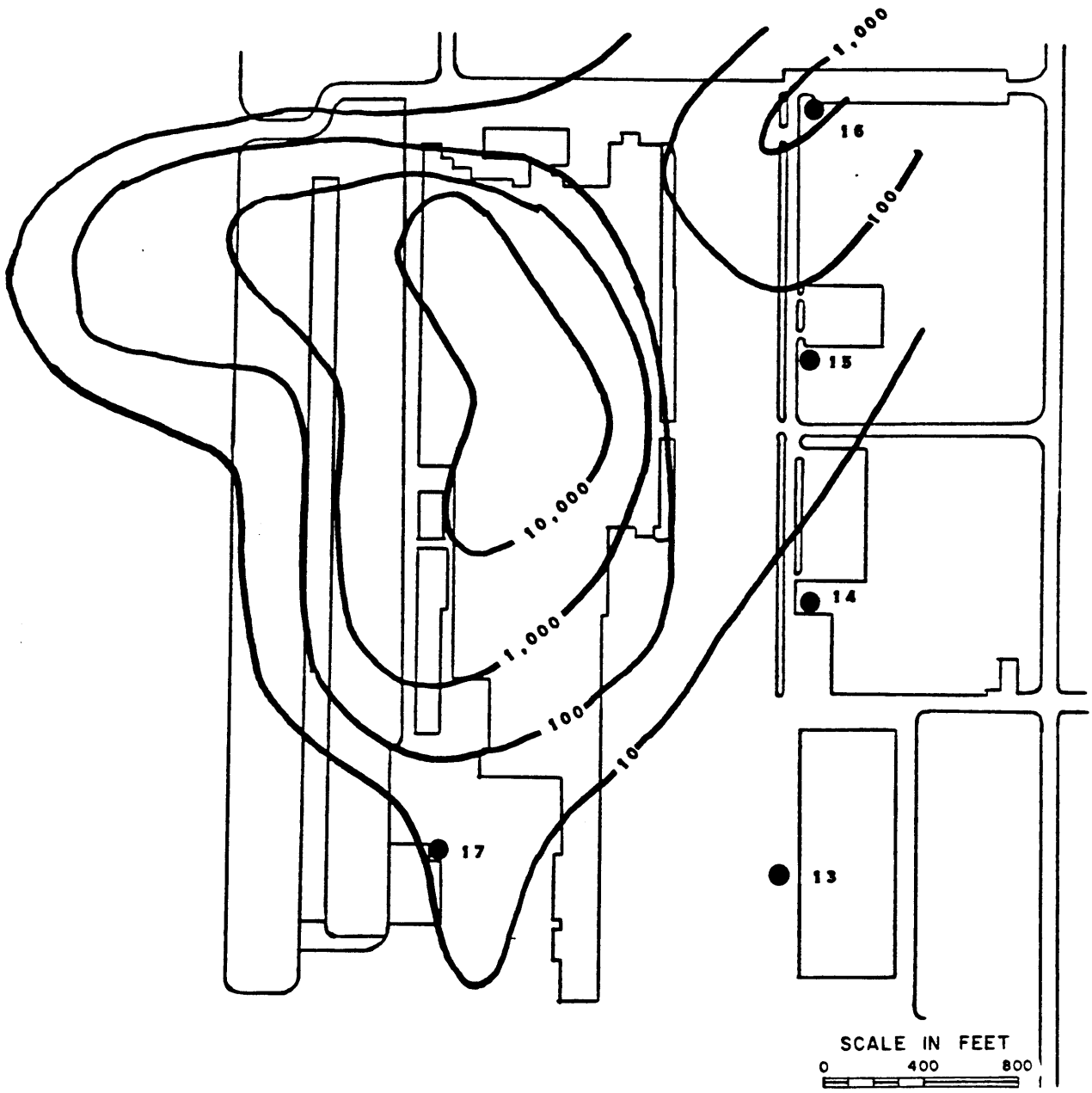

Figure 6-1. Contours of TCE concentration in ug/l at Building 3001 on top of the regional aquifer. Water supply wells 13 to 17 are shown.

8. Recommendations.

a. General. A long term Base groundwater monitoring plan is recommended which will provide the basis for an on-going assessment of groundwater quality beneath Tinker AFB. This plan is capable of determining any effects on groundwater quality due to industrial activities on the Base or from overpumpage of the aquifer. The recommendations listed below discuss the number and location of wells as well as the sampling frequency and parameters to be tested. It is not the purpose of this on-going assessment to determine the location and extent of contaminant plumes associated with each of the sites. Each site with groundwater contamination will have its own monitoring program which will be discussed in that site closure plan. A detailed discussion of the monitoring of natural water quality from heavy pumpage has been provided by the Garber-Wellington Association, and is given in Appendix E.

b. Well network. Two additional perimeter wells should be installed on the east side of the base into the regional aquifer to better define background conditions, as shown on figure 8-1. Four perimeter wells to define perched water conditions should be installed where that water exits the Base, on Crutcho Creek, Kuhlman Creek, East Soldier Creek, and West Soldier Creek. Five additional locations of perched wells will be installed on the northern and eastern boundaries of the Base to fill in gaps and form a more complete network. These locations are shown on figure 8-2. All of these wells should be stainless steel and constructed in a similar manner as the existing perimeter wells.

c. Long term monitoring plan.

1) Frequency of sampling. Sampling should be quarterly for the first year in order to obtain seasonal data, as well as better statistical comparisons. For the second year, sampling should be semiannual, unless a problem is found which requires more frequent monitoring at a specific location. However, quarterly sampling of water supply wells 13, 14, 15, 16, and 17 (when it becomes operational) should continue since they are part of the water supply network and either have low levels of TCE or have the potential to become contaminated. Well 17 should be sampled as soon as it is repaired. After sampling, it should be taken offline until the results are reviewed. At the end of the second year, recommendations will be made for sampling frequency for subsequent years.

2) Sampling parameters and procedures. The parameters listed in table 8-1 should be tested each time the wells are sampled. The additional parameters for the water supply wells are chosen to monitor the effects of overpumpage and are discussed in Appendix E. Sampling and preparation techniques and analytical procedures are discussed in detail in the groundwater sampling and analysis plan in Appendix F. Field data forms and chain of custody forms are also included in Appendix F.

Table 8-1
Recommended parameters to be tested

all wells

metals, total	organics	others
arsenic	total organic carbon	pH
barium	volatiles	conductivity
cadmium	semivolatiles	chloride
chromium		sulfate
lead		
mercury		
nickel		
selenium		
silver		
zinc		

additional parameters for water supply wells

potassium	total dissolved solids
sodium	alkalinity
calcium	
magnesium	

3) **Water level and production monitoring.** Water levels should be taken in all wells when they are sampled and in the water supply wells monthly. These levels should be reflective of the operational status of the well at the time, and in most cases they will be production water levels. Wells 4, 15, 26, and 28 should be shut down for a 2 week period twice a year to obtain static water levels. This information will help determine the effects of pumpage on the volume of water available for use. Also, water meters should be installed on each water supply well so that actual quantities pumped can be recorded on a monthly basis. A construction project designed by Tinker Air Force Base, Repair Water Wells, PN 850160, will provide for the installation of flow meters and water level recorders linked to a central system on all water supply wells. This project was not funded this year and is scheduled to be re-evaluated for advertisement in FY 1988.

d. Annual assessments and reporting procedure. The data should be placed on STORET, made available twice a year, and analyzed annually in a groundwater assessment. Data from water wells 13 to 17 should be included in the annual groundwater assessment, but that data should be examined as soon as available. Any water supply well which has more than 5 ug/l TCE should be shut down and resampled. If the resample confirms the presence of TCE greater than 5 ug/l, then the use of that well should be discontinued and either the well should be plugged or the water should be treated before use. Flow data and water levels from the water supply wells should be sent to the Garber-Wellington Association monthly on their forms, which are provided in Appendix E. Static water levels should be recorded biannually and sent to the Garber-Wellingon Association on the form provided in Appendix E. Results of chemical sampling should also be provided them on their form annually.

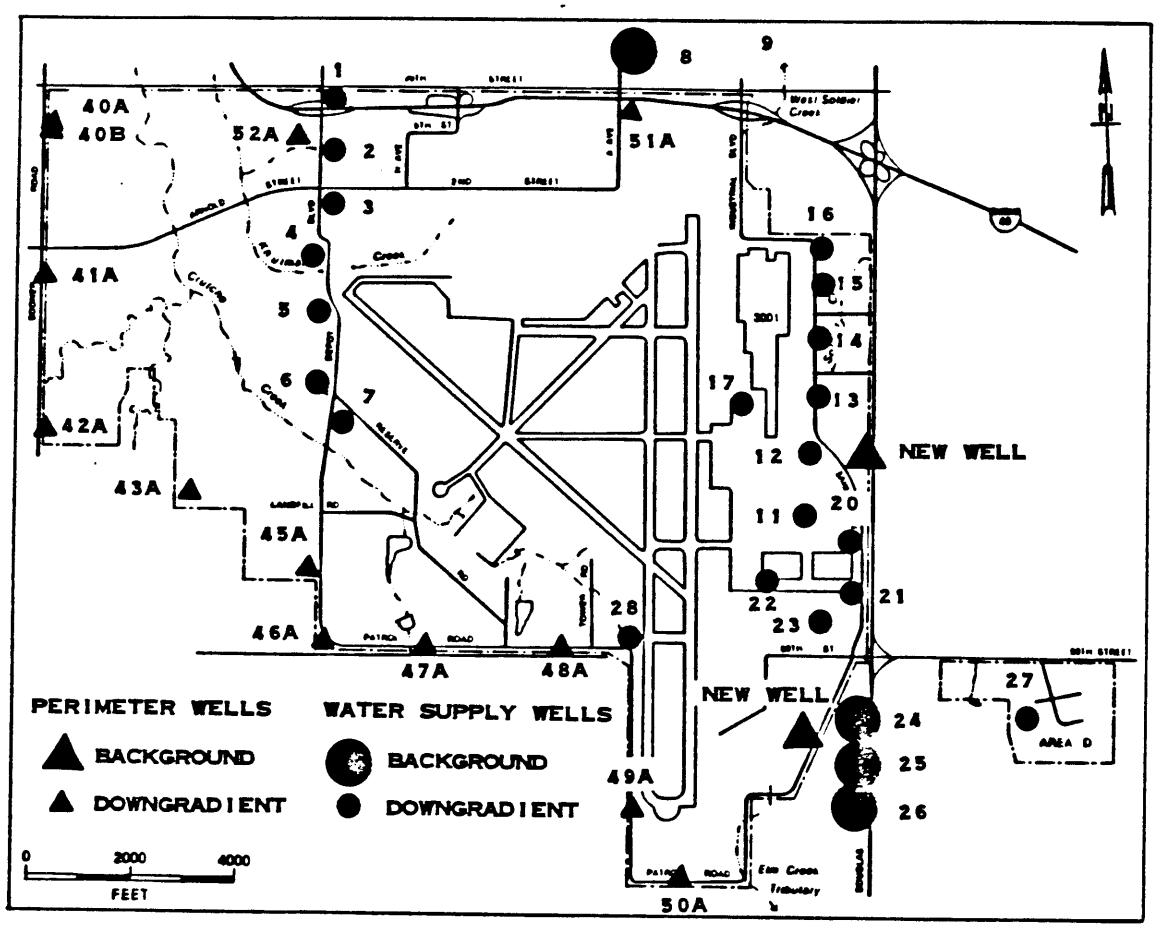

Figure 8-1. The groundwater monitoring program showing the producing zone and top of regional aquifer.

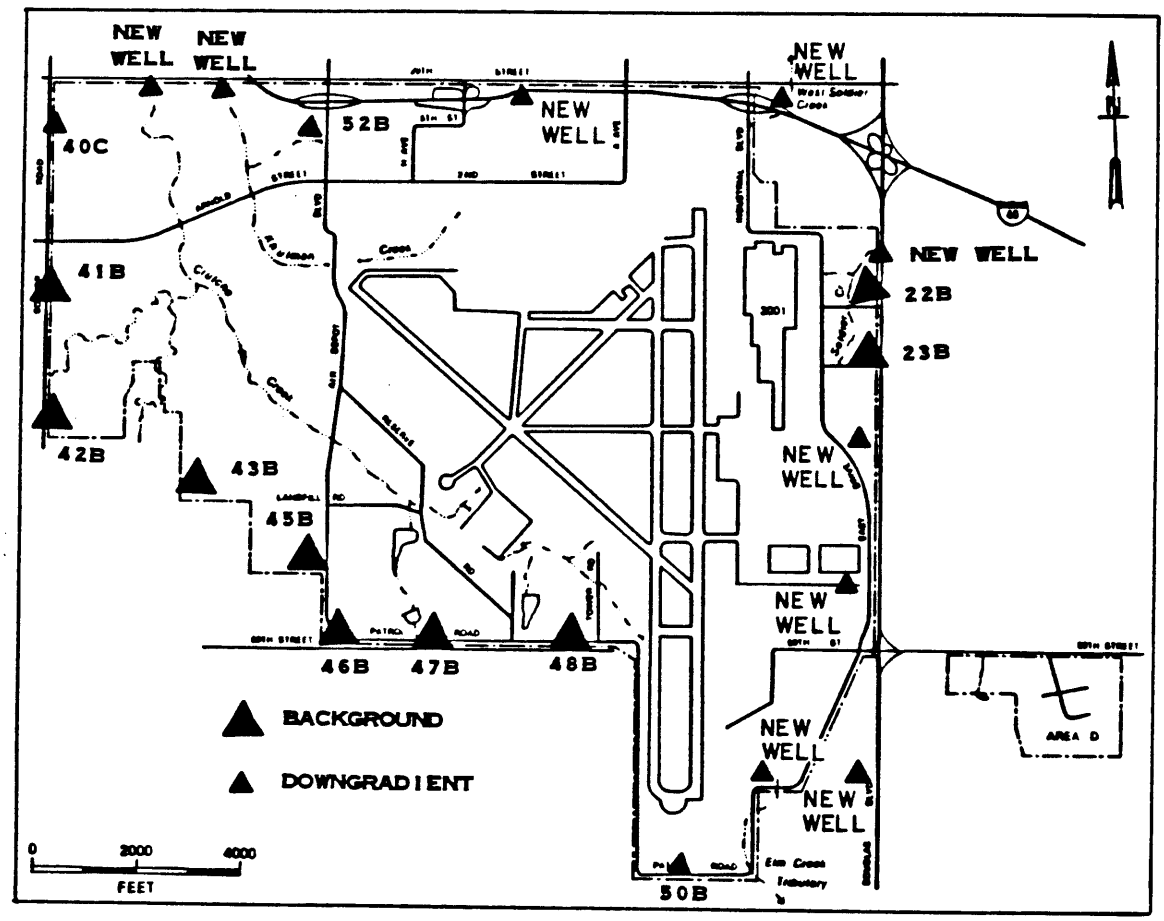

Figure 8-2. The groundwater monitoring program showing the perched zone monitoring.

APPENDIX A

GEOLOGICAL LOGS

HOLE NO. MW-40A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 1 OF 3 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER, 9.5" ROCKBIT	
2. LOCATION (Coordinates or Station) 157962.50	2171919.10	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) MW-40A		13. TOTAL NO OF OVER– DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1180.1	
		16. DATE HOLE STARTED 03/26/1986	COMPLETED 03/29/1986
7. THICKNESS OF OVERBURDEN 11.0		17. ELEVATION TOP OF HOLE 1214.8	
8. DEPTH DRILLED INTO ROCK 140.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 150.7		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1209.3	5		CLAY (CL) (0.0 – 5.5) SILTY AT 3.0–3.5, MED. STIFF, MED–LOW PLASTICITY, BROWN–RED			AUGERED 0.0–17.0, RB TO 150.7. LOGGED HOLE WITH GEOPHYSICAL TOOLS. ROCK AND SOIL DESCRIPTIONS BASED ON GEOPHYSICAL LOGS.
1203.8	10		CLAY (CL) (5.5 – 11.0) SANDY, MED. STIFF, LOW PLASTICITY, BROWN–RED			SET 4" STAINLESS STEEL WELL. WATER LEVEL IN WELL AT 37.8 ON 07/30/86.
	15		SANDSTONE (SS) (11.0 – 40.0) SHALEY, FINE, POORLY CEMENTED			NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE GENERALLY WELL CEMENTED WITH CARBONATE.
	20					
	25					
	30					
	35					
1174.8	40					
			SHALE (SH) (40.0 – 52.0) VERY SILTY, SOFT.			
	45					
1164.8	50					

DRILLING LOG

DIVISION: SOUTHWEST
INSTALLATION: TINKER
SHEET 2 OF 3 SHEETS

1. PROJECT: MONITORING WELLS – PERIMETER
2. LOCATION (Coordinates or Station): 157962.50 2171919.10
3. DRILLING AGENCY: USACE, ST. LOUIS
4. HOLE NO. (As shown on drawing title and file number): MW-40A
5. NAME OF DRILLER: C.W. HUTSON
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 11.0
8. DEPTH DRILLED INTO ROCK: 139.7
9. TOTAL DEPTH OF HOLE: 150.7
10. SIZE AND TYPE OF BIT: 4" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: 0
15. ELEVATION GROUND WATER: 1180.1
16. DATE HOLE: STARTED 03/26/1986 COMPLETED 03/29/1986
17. ELEVATION TOP OF HOLE: 1214.8
18. TOTAL CORE RECOVERY FOR BORING: 0.0 %
19. SIGNATURE OF INSPECTOR: J. KISSANE

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1162.8			SHALE (SH) (40.0 – 52.0) VERY SILTY, SOFT.			
	55		SANDSTONE (SS) (52.0 – 63.0) FINE, WEAKLY CEMENTED, SOFT			
	60					
1151.8						
	65		SHALE (SH) (63.0 – 66.0) SANDY, SOFT			
1148.8						
	70		SANDSTONE (SS) (66.0 – 106.0) FINE, WEAKLY CEMENTED, SOFT			
	75					
	80					
	85					
	90					
	95					
1114.8	100					

HOLE NO. MW-40A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 3 OF 3 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER	
2. LOCATION (Coordinates or Station) 157962.50 2171919.10		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) MW-40A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1180.1	
		16. DATE HOLE STARTED 03/26/1986	COMPLETED 03/29/1986
7. THICKNESS OF OVERBURDEN 11.0		17. ELEVATION TOP OF HOLE 1214.8	
8. DEPTH DRILLED INTO ROCK 139.7		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 150.7		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE (SS) (66.0 – 106.0) FINE, WEAKLY CEMENTED, SOFT			
1108.8	105					
			SILTSTONE (ST) (106.0 – 110.0) SHALEY, SOFT			
1104.8	110					
			SANDSTONE (SS) (110.0 – 120.0) SHALEY, FINE, SOFT, MOD. CEMENTED			
	115					
1094.8	120					
			SILTSTONE (ST) (120.0 – 125.0) SHALEY, SOFT, POORLY CEMENTED			
1089.8	125					
			SHALE (SH) (125.0 – 134.0) SOFT			
	130					
1080.8						
	135		SILTSTONE (ST) (134.0 – 147.0) SHALEY, SOFT, POORLY CEMENTED			
	140					
	145					
1067.8						
			SANDSTONE (SS) (147.0 – 150.0) SILTY, FINE, SOFT, WEAKLY CEMENTED			
1064.8	150		BOTTOM OF HOLE AT 150.7'			

HOLE NO. 41A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 1 OF 3 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 91/2" RB	
2. LOCATION (Coordinates or Station) 155256.40 2171980.60		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY TULSA DISTRICT		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 41A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER CARROLL		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1177.9	
		16. DATE HOLE STARTED 06/23/1986	COMPLETED 06/24/1986
7. THICKNESS OF OVERBURDEN 9.0		17. ELEVATION TOP OF HOLE 1222.1	
8. DEPTH DRILLED INTO ROCK 141.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 150.0		19. SIGNATURE OF INSPECTOR NARDIN	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1213.1	5		CLAY (CL) (0.0 – 9.0) MED. STIFF, LOW PLASTICITY, RED–BROWN			AUGERED 0.0–10.0, RB TO 10.0–150.0. LOGGED HOLE WITH GEOPHYSICAL TOOLS. ROCK & SOIL DESCRIPTIONS BASED ON GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 39.9 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE GENERALLY WELL CEMENTED WITH CARBONATE.
1198.1	10 15 20		SANDSTONE (SS) (9.0 – 24.0) SILTY, MED. SOFT, POORLY CEMENTED, WEATHERED			
1182.1	25 30 35 40		SHALE (SH) (24.0 – 40.0) SANDY, INTERBEDDED WITH V. THIN SILTSTONE LAYERS, SOFT			
1172.1	45 50		SANDSTONE (SS) (40.0 – 59.0) SILTY, SHALEY 49.0–53.0, V. FINE, WEAKLY CEMENTED			

HOLE NO. 41A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 3 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 91/2" RB	
2. LOCATION (Coordinates or Station) 155256.40	2171980.60	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY TULSA DISTRICT		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 41A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER CARROLL		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1177.9	
		16. DATE HOLE STARTED 06/23/1986	COMPLETED 06/24/1986
7. THICKNESS OF OVERBURDEN 9.0		17. ELEVATION TOP OF HOLE 1222.1	
8. DEPTH DRILLED INTO ROCK 141.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 150.0		19. SIGNATURE OF INSPECTOR NARDIN	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1163.1	55		SANDSTONE (SS) (40.0 – 59.0) SILTY, SHALEY 49.0–53.0, V. FINE, WEAKLY CEMENTED			
1150.1	60 65 70		SILTSTONE (ST) (59.0 – 72.0) SHALEY, SOFT, POORLY CEMENTED			
1122.1	75 80 85 90 95 100		SANDSTONE (SS) (72.0 – 110.0) SILTY, FINE, WEAKLY CEMENTED SHALE – SILTY, SOFT, 76.0–79.0			

HOLE NO. 41A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 3 OF 3 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 91/2" RB	
2. LOCATION (Coordinates or Station) 155256.40 2171980.60		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY TULSA DISTRICT		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 41A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER CARROLL		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1177.9	
		16. DATE HOLE STARTED 06/23/1986	COMPLETED 06/24/1986
7. THICKNESS OF OVERBURDEN 9.0		17. ELEVATION TOP OF HOLE 1222.1	
8. DEPTH DRILLED INTO ROCK 141.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 150.0		19. SIGNATURE OF INSPECTOR NARDIN	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE (SS) (72.0 – 110.0) SILTY, FINE, WEAKLY CEMENTED SHALE – SILTY, SOFT, 76.0–79.0			
	105					
1112.1	110		SHALE (SH) (110.0 – 118.0) SILTY, SOFT			
	115					
1104.1			SANDSTONE (SS) (118.0 – 127.5) SILTY, FINE, MOD. CEMENTED			
	120					
	125					
1094.6			SHALE (SH) (127.5 – 138.0) SOFT, SANDSTONE – V. FINE, WEAKLY CEMENTED 129.0–131.0.			
	130					
	135					
1084.1			SANDSTONE (SS) (138.0 – 150.0) FINE, WEAKLY CEMENTED			
	140					
	145					
1072.1	150		BOTTOM OF HOLE			

HOLE NO. 42A

DRILLING LOG	DIVISION: SOUTHWEST	INSTALLATION: TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT: MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT: 91/2" RB	
2. LOCATION (Coordinates or Station): 152430.70 2171952.30		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: TULSA DISTRICT		12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number): 42A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER: CARROLL		14. TOTAL NUMBER CORE BOXES: 0	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 1182.4	
7. THICKNESS OF OVERBURDEN: 4.0		16. DATE HOLE: STARTED 06/23/1986	COMPLETED 06/24/1986
8. DEPTH DRILLED INTO ROCK: 148.0		17. ELEVATION TOP OF HOLE: 1220.3	
9. TOTAL DEPTH OF HOLE: 152.0		18. TOTAL CORE RECOVERY FOR BORING: 0.0 %	
		19. SIGNATURE OF INSPECTOR: NARDIN	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1216.3			SAND (SC) (0.0 – 4.0) CLAYEY, MED. DENSE, DARK-BROWN			AUGERED 0.0–10.0, RB TO 10.0–152.0. LOGGED HOLE WITH GEOPHYSICAL TOOLS. ROCK & SOIL DESCRIPTIONS BASED ON GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 40.7 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE GENERALLY WELL CEMENTED WITH CARBONATE.
			SHALE (SH) (4.0 – 27.0) SOFT, WEATHERED			
	10					
	20					
1193.3						
	30		SANDSTONE (SS) (27.0 – 38.0) FINE, POORLY CEMENTED			
1182.3						
	40		SILTSTONE (ST) (38.0 – 44.0) SHALEY, (INTERBEDDED SHALE?), SOFT, POORLY CEMENTED			
1176.3						
			SHALE (SH) (44.0 – 52.0) SILTY, SOFT			
	50					
1168.3						
			SILTSTONE (ST) (52.0 – 59.0) SOFT, POORLY CEMENTED			
1161.3						
	60		SANDSTONE (SS) (59.0 – 78.0) V. FINE, WEAKLY CEMENTED, MED. SOFT			
	70					
1142.3						
	80		SILTSTONE (ST) (78.0 – 84.0) SOFT, POORLY CEMENTED			
1136.3						
			SANDSTONE (SS) (84.0 – 97.0) FINE, WEAKLY CEMENTED, (BECOMES SHALEY AT 90.0–97.0)			
	90					
1123.3						
1120.3	100		SHALE (SH) (97.0 – 102.0) SOFT			

HOLE NO. 42A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 91/2" RB	
2. LOCATION (Coordinates or Station) 152430.70 2171952.30		11. DATUM FOR ELEVATION SHOWN (GS or MSL) MSL	
3. DRILLING AGENCY TULSA DISTRICT		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 42A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER CARROLL		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1182.4	
		16. DATE HOLE STARTED 06/23/1986	COMPLETED 06/24/1986
7. THICKNESS OF OVERBURDEN 4.0		17. ELEVATION TOP OF HOLE 1220.3	
8. DEPTH DRILLED INTO ROCK 148.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 152.0		19. SIGNATURE OF INSPECTOR NARDIN	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1118.3			SHALE (SH) (97.0 – 102.0) SOFT			
1112.3			SILTSTONE (ST) (102.0 – 108.0) SOFT, POORLY CEMENTED			
	110		SANDSTONE (SS) (108.0 – 122.5) FINE, POORLY CEMENTED, SOFT			
1097.8	120					
1089.3			SHALE (SH) (122.5 – 131.0) SOFT			
	130					
1083.3			SILTSTONE (ST) (131.0 – 137.0) SOFT, POORLY CEMENTED			
	140		SANDSTONE (SS) (137.0 – 144.0) FINE, POORLY CEMENTED, SOFT			
1076.3			SILTSTONE (ST) (144.0 – 152.0) SOFT, POORLY CEMENTED, (SHALEY 145.0–148.0)			
	150		BOTTOM OF HOLE			
1068.3						
	160					
	170					
	180					
	190					
	200					

HOLE NO. 43A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 91/2" RB	
2. LOCATION (Coordinates or Station) 151089.10 2174544.10		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY TULSA DISTRICT		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 43A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER CARROLL		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1200.5	
		16. DATE HOLE	STARTED 06/20/1986 / COMPLETED 06/20/1986
7. THICKNESS OF OVERBURDEN 8.0		17. ELEVATION TOP OF HOLE 1229.6	
8. DEPTH DRILLED INTO ROCK 144.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 152.0		19. SIGNATURE OF INSPECTOR NARDIN	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1221.6			CLAY (CL) (0.0 – 8.0) SOFT, MED–LOW PLASTICITY, REDDISH–BROWN, SL. MOIST, (BECOMES SANDY 5.0–8.0)			RB 0.0–152.0. LOGGED HOLE WITH GEOPHYSICAL TOOLS. OFFSET BETWEEN HOLES 43A AND 43B, AUGERED 10.0. OBTAINED SOIL DESCRIPTION AND SAMPLES FOR CHEMICAL ANALYSIS, (17 NOV. 1986). ROCK DESCRIPTIONS BASED ON GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL MEASURED WATER LEVEL IN WELL AT 31.5 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE GENERALLY WELL CEMENTED WITH CARBONATE.
1207.6	10 20		SILTSTONE (ST) (8.0 – 22.0) SANDY 10.0–15.0, MED. SOFT, POORLY CEMENTED, BROWN–RED, SPECKLED WITH GRAY–GREEN SPOTS			
1196.6	30		SHALE (SH) (22.0 – 33.0) SOFT			
1181.6	40		SANDSTONE (SS) (33.0 – 48.0) FINE, POORLY CEMENTED			
1175.6	50		SHALE (SH) (48.0 – 54.0) SILTY, SOFT			
1169.6	60		SANDSTONE (SS) (54.0 – 60.0) FINE, WEAKLY CEMENTED			
1164.6			SHALE (SH) (60.0 – 65.0) SOFT			
1129.6	70 80 90 100		SANDSTONE (SS) (65.0 – 125.0) FINE, POORLY CEMENTED, (BECOMES SITLY 88.0–92.0, 105.0–109.0'.			

HOLE NO. 43A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 91/2" RB	
2. LOCATION (Coordinates or Station) 151089.10 2174544.10		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY TULSA DISTRICT		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 43A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER CARROLL		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1200.5	
		16. DATE HOLE STARTED 06/20/1986	COMPLETED 06/20/1986
7. THICKNESS OF OVERBURDEN 8.0		17. ELEVATION TOP OF HOLE 1229.6	
8. DEPTH DRILLED INTO ROCK 144.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 152.0		19. SIGNATURE OF INSPECTOR NARDIN	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE (SS) (65.0 – 125.0) FINE, POORLY CEMENTED, (BECOMES SITLY 88.0–92.0, 105.0–112.0'.			
1104.6	110					
	120					
			SILTSTONE (ST) (125.0 – 130.0) SHALEY, SOFT			
1099.6	130					
			SANDSTONE (SS) (130.0 – 136.0) SHALEY, FINE, WEAKLY CEMENTED			
1093.6						
			SHALE (SH) (136.0 – 143.0) SOFT			
	140					
1086.6						
			SANDSTONE (SS) (143.0 – 152.0) FINE, POORLY CEMENTED			
	150					
1077.6			BOTTOM OF HOLE			
	160					
	170					
	180					
	190					
	200					

HOLE NO. 45A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station) 148855.00	2177224.00	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 45A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1175.4	
		16. DATE HOLE STARTED 04/07/1986	COMPLETED 04/10/1986
7. THICKNESS OF OVERBURDEN 12.0		17. ELEVATION TOP OF HOLE 1266.5	
8. DEPTH DRILLED INTO ROCK 146.5		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 158.5		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1258.5			CLAY (CL) (0.0 – 8.0) SANDY, MOD. PLASTIC, STIFF, DAMP TO MOIST, RED-BROWN			AUGERED 0.0–8.0, RB TO 8.0–158.5. LOGGED HOLE WITH GEOPHYSICAL TOOLS. DESCRIPTION OF MATERIALS IS BASED ON INTERPRE-TATION OF GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 93.6 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE OFTEN WELL CEMENTED WITH CARBONATE.
1254.5	10		CLAY (CL) (8.0 – 12.0) MOD. PLASTIC, V. STIFF, DAMP TO DRY			
1251.5			SILTSTONE (ST) (12.0 – 15.0) V. SHALEY, SOFT, RED-BROWN TO TAN			
	20		SHALE (SH) (15.0 – 30.0) SOFT, MINOR SILTY, THIN SANDY ZONES			
1236.5	30		SILTSTONE (ST) (30.0 – 36.0) SHALEY, SOFT			
1230.5			SHALE (SH) (36.0 – 59.0) SOFT, MINOR SILT, SEVERAL THIN SANDY ZONES, SANDSTONE 55.0–57.0			
	40					
	50					
1207.5	60		SANDSTONE (SS) (59.0 – 78.0) FINE TO V. FINE, SOFT, V. SILTY AT 59.0, DECREASING SILT TO 66.0			
	70					
1188.5	80		SILTSTONE (ST) (78.0 – 87.0) SANDY, SOFT			
1179.5						
1177.5	90		SANDSTONE (SS) (87.0 – 89.0) FINE, MOD. SOFT, SILTY			
			SILTSTONE (ST) (89.0 – 101.0) SOFT, INTERBEDS OF SHALEY SAND.			
1166.5	100					

HOLE NO. 45A

DRILLING LOG	DIVISION: SOUTHWEST	INSTALLATION: TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT: MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT: 4" AUGER, 9.5" RB	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number): 45A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER: C.W. HUTSON		14. TOTAL NUMBER CORE BOXES: 0	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 1175.4	
		16. DATE HOLE: STARTED 04/07/1986	COMPLETED 04/10/1986
7. THICKNESS OF OVERBURDEN: 12.0		17. ELEVATION TOP OF HOLE: 1266.5	
8. DEPTH DRILLED INTO ROCK: 146.5		18. TOTAL CORE RECOVERY FOR BORING: 0.0 %	
9. TOTAL DEPTH OF HOLE: 158.5		19. SIGNATURE OF INSPECTOR: J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1165.5			SILTSTONE (ST) (89.0 – 101.0) SOFT, INTERBED OF SHALEY SAND			
			SANDSTONE (SS) (101.0 – 140.0) FINE TO MED., SOFT TO MOD. SOFT, SILTY 135.0–138.0			
	110					
	120					
	130					
1126.5	140		SHALE (SH) (140.0 – 146.0) MOD. SOFT			
1120.5			SANDSTONE (SS) (146.0 – 150.0) FINE TO MED., SOFT TO MOD. SOFT			
1116.5	150		SHALE (SH) (150.0 – 158.5) SOFT TO MOD. SOFT, SANDY 150.0–154.0			
1108.0			BOTTOM OF HOLE			
	160					
	170					
	180					
	190					
	200					

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PROJECT: MONITORING WELLS – PERIMETER | HOLE NO. 45A

HOLE NO. 46A

DRILLING LOG	DIVISION: SOUTHWEST	INSTALLATION: TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT: MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT: 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station): 149897.30 2177192.90		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number): 46A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER: C.W. HUTSON		14. TOTAL NUMBER CORE BOXES: 0	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 1177.2	
7. THICKNESS OF OVERBURDEN: 4.0		16. DATE HOLE: STARTED 03/30/1986	COMPLETED 04/03/1986
8. DEPTH DRILLED INTO ROCK: 155.8		17. ELEVATION TOP OF HOLE: 1255.2	
9. TOTAL DEPTH OF HOLE: 159.8		18. TOTAL CORE RECOVERY FOR BORING: 0.0 %	
		19. SIGNATURE OF INSPECTOR: J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1251.2			CLAY (CL) (0.0 – 4.0) LOW PLASTICITY, MED. STIFF, DAMP, SILTY, BROWN TO RED–BROWN			AUGERED 0.0–7.0, RB TO 7.0–159.8. LOGGED HOLE WITH GEOPHYSICAL TOOLS. DESCRIPTION OF MATERIALS BASED ON INTERPRETATION OF GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 80.5 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE OFTEN WELL CEMENTED WITH CARBONATE.
			SHALE (SH) (4.0 – 63.0) SOFT, SILTY, OCCASIONAL SOFT SILT LAYERS			
	10					
	20					
	30					
	40					
	50					
	60					
1192.2			SANDSTONE (SS) (63.0 – 88.0) FINE TO V. FINE, SOFT TO V. SOFT			
	70					
	80					
1167.2			SHALE (SH) (88.0 – 95.0) SOFT, SILTY			
	90					
1160.2			SILTSTONE (ST) (95.0 – 105.0) SHALEY, SOFT TO MOD. SOFT			
1155.2	100					

HOLE NO. 46A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station) 149897.30 2177192.90		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 46A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1177.2	
7. THICKNESS OF OVERBURDEN 4.0		16. DATE HOLE STARTED 03/30/1986	COMPLETED 04/03/1986
8. DEPTH DRILLED INTO ROCK 155.8		17. ELEVATION TOP OF HOLE 1255.2	
9. TOTAL DEPTH OF HOLE 159.8		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1150.2			SILTSTONE (ST) (95.0 – 105.0) SHALEY, SOFT TO MOD. SOFT			
	110		SANDSTONE (SS) (105.0 – 139.0) SOFT TO MOD. SOFT, FINE TO MED. SILTY 107.0–111.0, 113.0–115.0, 118.0–119.0, 130.0–131.0			
	120					
	130					
1116.2	140		SHALE (SH) (139.0 – 145.0) V. SILTY, SOFT, SANDY 141.0–144.0			
1110.2			SANDSTONE (SS) (145.0 – 159.8) FINE TO MED., SOFT TO V. SOFT			
	150					
1095.4	160		BOTTOM OF HOLE			
	170					
	180					
	190					
	200					

HOLE NO. 47A

DRILLING LOG	DIVISION: SOUTHWEST	INSTALLATION: TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT: MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT: 4" AUGER 9.5" RB.	
2. LOCATION (Coordinates or Station): 148504.50 2178843.60		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number): 47A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER: C.W. HUTSON		14. TOTAL NUMBER CORE BOXES: 0	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 1175.0	
7. THICKNESS OF OVERBURDEN: 6.0		16. DATE HOLE: STARTED 04/11/1986	COMPLETED 04/14/1986
8. DEPTH DRILLED INTO ROCK: 153.5		17. ELEVATION TOP OF HOLE: 1248.4	
9. TOTAL DEPTH OF HOLE: 159.5		18. TOTAL CORE RECOVERY FOR BORING: 0.0 %	
		19. SIGNATURE OF INSPECTOR: J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1242.4			CLAY (CL) (0.0 – 6.0) SANDY, LOW PLASTICITY, SOFT, MOIST, BROWN, STIFF, SILTY, RED–BROWN 2.0–6.0'.			AUGERED 0.0–9.5, RB TO 9.5–159.5. LOGGED HOLE WITH GEOPHYSICAL TOOLS. DESCRIPTION OF ROCK AND SOIL IS BASED ON INTERPRETATION OF GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 75.9 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE OFTEN WELL CEMENTED WITH CARBONATE.
	10		SHALE (SH) (6.0 – 47.0) SOFT, SILTY, OCCASIONAL SOFT SILTSTONE LAYERS			
	20					
	30					
	40					
1201.4						
	50		SANDSTONE (SS) (47.0 – 77.0) FINE TO V. FINE, SOFT, SHALEY 47.0–52.0, 61.0–63.0			
	60					
	70					
1171.4						
	80		SILTSTONE (ST) (77.0 – 83.0) SOFT, CLAYEY			
1165.4						
	90		SANDSTONE (SS) (83.0 – 94.0) FINE TO V. FINE, SOFT TO MOD. SOFT			
1154.4						
			SHALE (SH) (94.0 – 100.0) SOFT, SILTY			
1148.4	100					

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PROJECT: MONITORING WELLS – PERIMETER HOLE NO. 47A

HOLE NO. 47A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station) 148504.50 2178843.60		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 47A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1175.0	
		16. DATE HOLE STARTED 04/11/1986 COMPLETED 04/14/1986	
7. THICKNESS OF OVERBURDEN 6.0		17. ELEVATION TOP OF HOLE 1248.4	
8. DEPTH DRILLED INTO ROCK 153.5		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 159.5		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
1148.4	b	c	d	e	f	g
			SANDSTONE (SS) (100.0 – 143.0) FINE TO MED., SOFT TO MOD. SOFT			
	110					
	120					
	130					
	140					
1105.4			SHALE (SH) (143.0 – 146.0) SOFT, SILTY			
1102.4			SANDSTONE (SS) (146.0 – 159.5) FINE TO MED., SOFT TO MOD. SOFT			
	150					
			BOTTOM OF HOLE			
1088.9	160					
	170					
	180					
	190					
	200					

HOLE NO. 48A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station) 148510.30 2180961.40		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 48A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1179.1	
		16. DATE HOLE STARTED 04/26/1986	COMPLETED 04/30/1986
7. THICKNESS OF OVERBURDEN 12.0		17. ELEVATION TOP OF HOLE 1246.4	
8. DEPTH DRILLED INTO ROCK 147.5		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 159.5		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1234.4	10		CLAY (CL) (0.0 – 12.0) SANDY, SOFT, LOW PLASTICITY, MOIST, BROWN. RED BROWN BELOW 4.0'.			AUGERED 0.0–14.2, RB TO 14.2–159.5. LOGGED HOLE WITH GEOPHYSICAL TOOLS. DESCRIPTION OF ROCK MATERIAL BELOW 20.0 IS BASED ON INTERPRETATION OF GEOPHYSICAL LOGS. DESCRIPTION OF SOIL AND ROCK MATERIAL IS FROM ADJACENT HOLE AUGERED TO OBTAIN SAMPLES FOR CHEMICAL ANALYSIS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 39.8 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE OFTEN WELL CEMENTED WITH CARBONATE.
1229.4			SANDSTONE (SS) (12.0 – 17.0) FINE, LOOSELY CEMENTED, WEATHERED, RED.			
1211.4	20 30		SHALE (SH) (17.0 – 35.0) SOFT, SILTY, SILTSTONE 23.0–27.0'.			
1201.4	40		SANDSTONE (SS) (35.0 – 45.0) VERY FINE TO FINE, SOFT, SILTY 40.0–45.0'.			
1194.4	50		SILTSTONE (ST) (45.0 – 52.0) SOFT, MINOR SHALE.			
1182.4	60		SHALE (SH) (52.0 – 64.0) SOFT, SILTY, SILTSTONE ZONES 56.0–57.0 AND 59.0–60.0'.			
1173.4	70		SILTSTONE (ST) (64.0 – 73.0) SOFT, SHALY.			
1156.4	80 90		SANDSTONE (SS) (73.0 – 90.0) FINE TO VERY FINE, SOFT TO MOD SOFT, SILTY.			
1146.4	100		SILTSTONE (ST) (90.0 – 100.0) VERY SHALY, SOFT.			

HOLE NO. 48A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER	
2. LOCATION (Coordinates or Station) 1485100.30 2180961.40		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 48A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1179.1	
		16. DATE HOLE STARTED 04/26/1985	COMPLETED 04/30/1985
7. THICKNESS OF OVERBURDEN 12.0		17. ELEVATION TOP OF HOLE 1246.4	
8. DEPTH DRILLED INTO ROCK 147.5		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 159.5		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1146.4						
			SANDSTONE (SS) (100.0 – 117.0) FINE TO MEDIUM, SOFT TO MOD. SOFT.			
	110					
1129.4						
	120		SILTSTONE (ST) (117.0 – 125.0) SOFT, INCREASING SHALE WITH DEPTH.			
1121.4						
1118.4			SHALE (SH) (125.0 – 128.0) SOFT, VERY SILTY.			
	130		SILTSTONE (ST) (128.0 – 136.0) SOFT, DECREASING SHALE WITH DEPTH.			
1110.4						
			SANDSTONE (SS) (136.0 – 159.5) FINE TO MEDIUM, SOFT TO MOD SOFT.			
	140					
	150					
			BOTTOM OF HOLE			
1086.9	160					
	170					
	180					
	190					
	200					

HOLE NO. 49A

DRILLING LOG	DIVISION: SOUTHWEST	INSTALLATION: TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT: MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT: 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station): 146233.80 2182486.30		11. DATUM FOR ELEVATION SHOWN (Tbm or MSL): MSL	
3. DRILLING AGENCY: USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number): 49A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER: C.W. HUTSON		14. TOTAL NUMBER CORE BOXES: 0	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: 1177.9	
7. THICKNESS OF OVERBURDEN: 6.0		16. DATE HOLE: STARTED 04/15/1986	COMPLETED 04/22/1986
8. DEPTH DRILLED INTO ROCK: 153.5		17. ELEVATION TOP OF HOLE: 1280.7	
9. TOTAL DEPTH OF HOLE: 159.5		18. TOTAL CORE RECOVERY FOR BORING: 0.0 %	
		19. SIGNATURE OF INSPECTOR: J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1274.7			CLAY (CL) (0.0 – 6.0) V. SILTY, MINOR SAND, FIRM TO STIFF, DAMP, BROWN			AUGERED 0.0–7.0, RB TO 7.0–159.5. LOGGED HOLE WITH GEOPHYSICAL TOOLS. DESCRIPTION OF ROCK AND SOIL IS BASED ON INTERPRETATION OF GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL MEASURED WATER LEVEL IN COMPLETED WELL AT 105.3 ON 07/29/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE OFTEN WELL CEMENTED WITH CARBONATE.
	10		SHALE (SH) (6.0 – 42.0) SOFT, SILTY, MINOR V. SOFT SILTY LAYERS			
	20					
	30					
	40					
1238.7			SILTSTONE (ST) (42.0 – 50.0) SOFT, SHALEY 47.0–50.0			
1230.7	50		SANDSTONE (SS) (50.0 – 62.0) FINE TO MED., SOFT TO MOD. SOFT			
1218.7	60		SILTSTONE (ST) (62.0 – 69.0) SOFT			
1211.7	70		SHALE (SH) (69.0 – 75.0) SOFT, OCCASIONAL INTERBEDDED SILTSTONES.			
1205.7			SILTSTONE (ST) (75.0 – 87.0) SOFT, SHALEY			
1193.7	80		SANDSTONE (SS) (87.0 – 129.0) FINE TO MED., SOFT TO MOD. SOFT, SILTY			
1180.7	90 100					

HOLE NO. 49A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station) 146233.80 2182486.30		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 49A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1177.9	
		16. DATE HOLE STARTED 04/15/1986	COMPLETED 04/22/1986
		17. ELEVATION TOP OF HOLE 1280.7	
7. THICKNESS OF OVERBURDEN 6.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
8. DEPTH DRILLED INTO ROCK 153.5		19. SIGNATURE OF INSPECTOR J. KISSANE	
9. TOTAL DEPTH OF HOLE 159.5			

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE (SS) (87.0 – 129.0) FINE TO MED., SOFT TO MOD. SOFT, SILTY			
	110					
	120					
1151.7	130		SHALE (SH) (129.0 – 133.0) V. SILTY, SOFT			
1147.7			SANDSTONE (SS) (133.0 – 148.0) FINE, V. SILTY, SOFT TO MOD. HARD			
	140					
1132.7			SHALE (SH) (148.0 – 159.5) MOD. SOFT, SILTY, SILTSTONE SEAM 154.0–156.0			
	150					
			BOTTOM OF HOLE			
1121.2	160					
	170					
	180					
	190					
	200					

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PROJECT MONITORING WELLS – PERIMETER | HOLE NO. 49A

HOLE NO. 50A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station) 144158.50 2184014.30		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 50A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1182.8	
		16. DATE HOLE STARTED 04/24/1986	COMPLETED 04/25/1986
7. THICKNESS OF OVERBURDEN 8.0		17. ELEVATION TOP OF HOLE 1250.2	
8. DEPTH DRILLED INTO ROCK 151.5		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 159.5		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1207.8			CLAY (CL) (0.0 – 8.0) SILT SAND, MED. STIFF, LOW PLASTICITY, REC–BROWN			AUGERED 0.0–12.0, RB TO 12.0–159.5. LOGGED HOLE WITH GEOPHYSICAL TOOLS. ROCK & SOIL DESCRIPTIONS BASED ON GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 69.9 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE OFTEN WELL CEMENTED WITH CARBONATE.
	10		SANDSTONE (SS) (8.0 – 38.0) FINE, SOFT, POORLY CEMENTED, BECOMES SILTY 32.0–38.0			
	20					
	30					
1177.8	40		SHALE (SH) (38.0 – 43.0) SANDY, SOFT			
1172.8			SANDSTONE (SS) (43.0 – 102.0) SILTY, FINE, POORLY CEMENTED, (SILTSTONE, – SANDY, POORLY CEMENTED, 91.0–04.0)			
	50					
	60					
	70					
	80					
	90					
1150.2	100					

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PROJECT MONITORING WELLS – PERIMETER | HOLE NO. 50A

HOLE NO. 50A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT	MONITORING WELLS – PERIMETER	10. SIZE AND TYPE OF BIT	4" AUGER 9.5" RB
2. LOCATION (Coordinates or Station)	144158.50 2184014.30	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
3. DRILLING AGENCY	USACE, ST. LOUIS	12. MANUFACTURER'S DESIGNATION OF DRILL	FAILING 1500
4. HOLE NO. (As shown on drawing title and file number)	50A	13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 UNDISTURBED 0
5. NAME OF DRILLER	C.W. HUTSON	14. TOTAL NUMBER CORE BOXES	0
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ——— DEG. FROM VERT.	15. ELEVATION GROUND WATER	1182.8
7. THICKNESS OF OVERBURDEN	8.0	16. DATE HOLE	STARTED 04/24/1986 COMPLETED 04/25/1986
8. DEPTH DRILLED INTO ROCK	151.5	17. ELEVATION TOP OF HOLE	1250.2
9. TOTAL DEPTH OF HOLE	159.5	18. TOTAL CORE RECOVERY FOR BORING	0.0 %
		19. SIGNATURE OF INSPECTOR	J. KISSANE

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE (SS) (43.0 – 102.0)			
1113.8			SHALE (SH) (102.0 – 112.0) SOFT			
	110					
1103.8			SANDSTONE (SS) (112.0 – 119.0) FINE, WEAKLY CEMENTED			
1096.8	120		SANDSTONE (SS) (119.0 – 159.5) SILTY, SHALEY, V. FINE, POORLY CEMENTED, (INTERBEDDED WITH THIN, SOFT, SHALE AT 138.0–159.5)			
	130					
	140					
	150					
			BOTTOM OF HOLE			
1090.7	160					
	170					
	180					
	190					
	200					

HOLE NO. 51A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station) 158648.80 2182821.50		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 51A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1196.8	
		16. DATE HOLE STARTED 05/05/1986	COMPLETED 05/07/1986
7. THICKNESS OF OVERBURDEN 8.0		17. ELEVATION TOP OF HOLE 1257.6	
8. DEPTH DRILLED INTO ROCK 151.5		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 159.5		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1249.6			CLAY (CL) (0.0 – 8.0) SILTY, LOW PLASTICITY, SOFT, MOIST, BROWN-GRAY, MED. STIFF, RED 4.0–8.0			AUGERED 0.0–20.0, TO GET SAMPLES FOR CHEMICAL ANALYSIS. RB 20.0–159.5. LOGGED HOLE WITH GEO-PHYSICAL TOOLS. ROCK DESCRIPTION BELOW 20.0 BASED ON INTERPRETATION OF GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 62.3 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE OFTEN WELL CEMENTED WITH CARBONATE.
	10		SANDSTONE (SS) (8.0 – 24.0) FINE, SILTY, SOFT, LOOSELY CEMENTED, RED SPECKLED WITH GREEN			
1233.6	20					
			SHALE (SH) (24.0 – 37.0) SOFT, SILTY, 31.0–34.0 SILTSTONE			
1220.6	30					
	40		SILTSTONE (ST) (37.0 – 52.0) SOFT, V. SANDY 37.0–42.0, SHALEY 50.0–52.0			
1205.6	50					
	60		SANDSTONE (SS) (52.0 – 137.0) FINE TO MED., SOFT TO V. SOFT, GRADES FROM SILTSTONE AT 52.0–60.0, SILTY ZONES 107.0–110.0, 114.0–118.0			
	70					
	80					
	90					
1157.6	100					

HOLE NO. 51A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER	
2. LOCATION (Coordinates or Station) 158648.80 2182821.50		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 51A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1196.8	
		16. DATE HOLE STARTED 05/05/1986	COMPLETED 05/07/1986
		17. ELEVATION TOP OF HOLE 1257.6	
7. THICKNESS OF OVERBURDEN 8.0		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
8. DEPTH DRILLED INTO ROCK 151.5		19. SIGNATURE OF INSPECTOR J. KISSANE	
9. TOTAL DEPTH OF HOLE 159.5			

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDSTONE (SS) (52.0 – 137.0) FINE TO MED., SOFT TO V. SOFT, GRADES FROM SILTSTONE AT 52.0–60.0, SILTY ZONES 107.0–110.0, 114.0–118.0			
1120.6	140		SILTSTONE (ST) (137.0 – 142.0) V. SHALEY, SOFT			
1115.6			SANDSTONE (SS) (142.0 – 159.5) FINE TO MED., SOFT TO MED. SOFT			
1098.1	160		BOTTOM OF HOLE			

HOLE NO. 52A

DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 1 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5" RB	
2. LOCATION (Coordinates or Station) 158045.30 2177009.20		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 52A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1182.2	
		16. DATE HOLE STARTED 05/08/1986 COMPLETED 05/09/1986	
7. THICKNESS OF OVERBURDEN 4.5		17. ELEVATION TOP OF HOLE 1215.8	
8. DEPTH DRILLED INTO ROCK 153.5		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 158.0		19. SIGNATURE OF INSPECTOR J. KISSANE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1211.3			CLAY (CL) (0.0 – 4.5) SANDY, LOW PLASTICITY, MED. STIFF, BROWN–RED, SL. MOIST			AUGERED 0.0–4.5, RB TO 4.5–158.0. LOGGED HOLE WITH GEOPHYSICAL TOOLS. ROCK DESCRIPTIONS BASED ON GEOPHYSICAL LOGS. SET 4" STAINLESS STEEL WELL. MEASURED WATER LEVEL IN WELL AT 36.3 ON 07/30/86. NOTE: SANDSTONES IMMEDIATELY ABOVE SHALES ARE OFTEN WELL CEMENTED WITH CARBONATE.
	10		SANDSTONE (SS) (4.5 – 30.0) SILTY, (HIGHLY WEATHERED 5.0–11.0), FINE, LOOSELY CEMENTED			
	20					
1185.8	30					
			SHALE (SH) (30.0 – 35.0) SILTY, SOFT			
1180.8						
1177.8			SILTSTONE (ST) (35.0 – 38.0) SHALEY, SOFT			
	40		SANDSTONE (SS) (38.0 – 47.0) FINE, SOFT, LOOSELY CEMENTED			
1168.8						
	50		SILTSTONE (ST) (47.0 – 52.0) SOFT			
1163.8						
			SANDSTONE (SS) (52.0 – 92.0) INTERBEDDED WITH THIN SHALE 50.0–80.2, SL. SILTY, FINE, WEAKLY CEMENTED			
	60					
	70					
	80					
	90					
1123.8						
			SHALE (SH) (92.0 – 105.0) SILTY, SOFT			
1115.8	100					

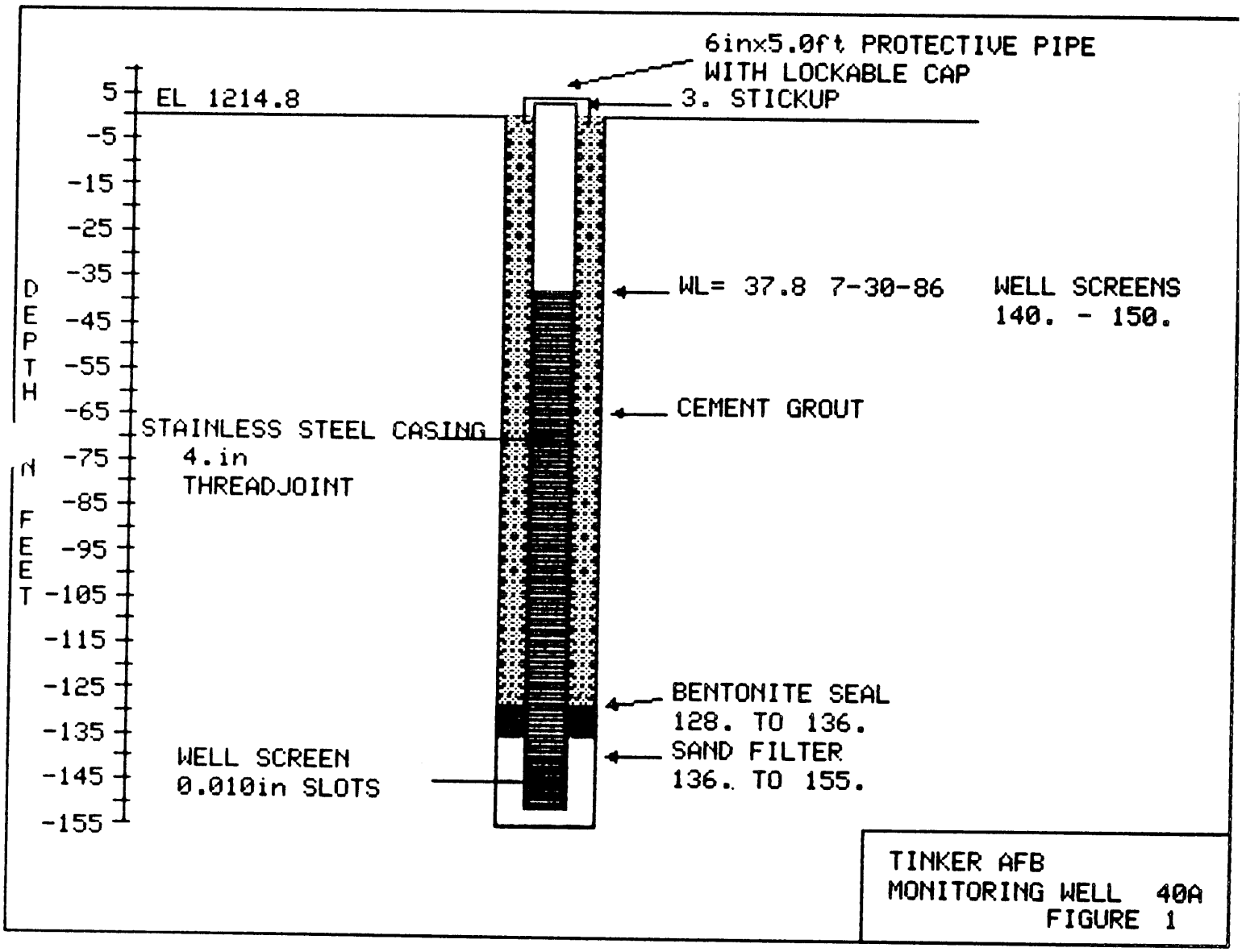
HOLE NO. 52A

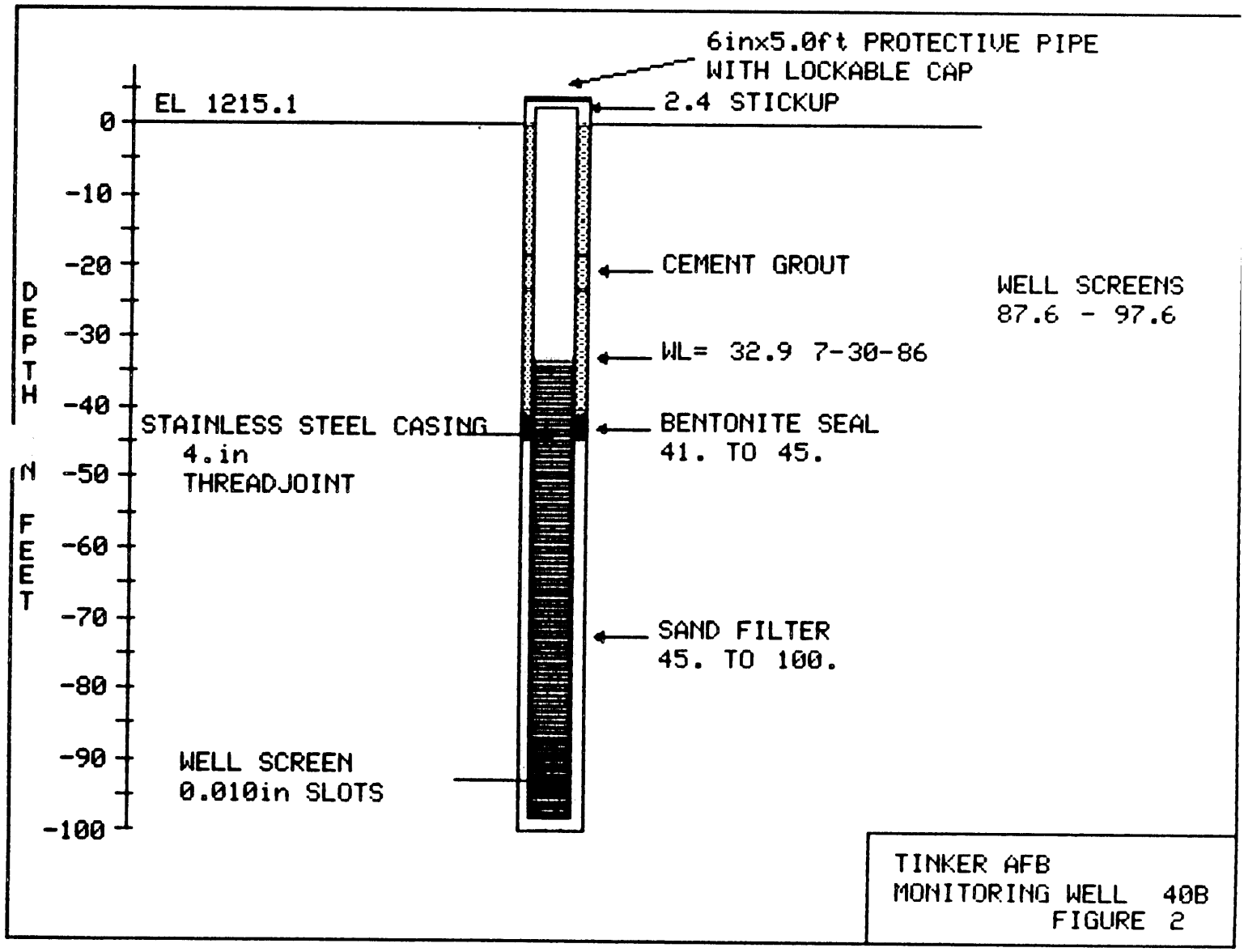
DRILLING LOG	DIVISION SOUTHWEST	INSTALLATION TINKER	SHEET 2 OF 2 SHEETS
1. PROJECT MONITORING WELLS – PERIMETER		10. SIZE AND TYPE OF BIT 4" AUGER 9.5"RB	
2. LOCATION (Coordinates or Station) 158045.30 2177009.20		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USACE, ST. LOUIS		12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number) 52A		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER C.W. HUTSON		14. TOTAL NUMBER CORE BOXES 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1182.2	
		16. DATE HOLE STARTED 05/08/1986	COMPLETED 05/09/1986
7. THICKNESS OF OVERBURDEN 4.5		17. ELEVATION TOP OF HOLE 1215.8	
8. DEPTH DRILLED INTO ROCK 153.5		18. TOTAL CORE RECOVERY FOR BORING 0.0 %	
9. TOTAL DEPTH OF HOLE 158.0		19. SIGNATURE OF INSPECTOR J. KISSANE	

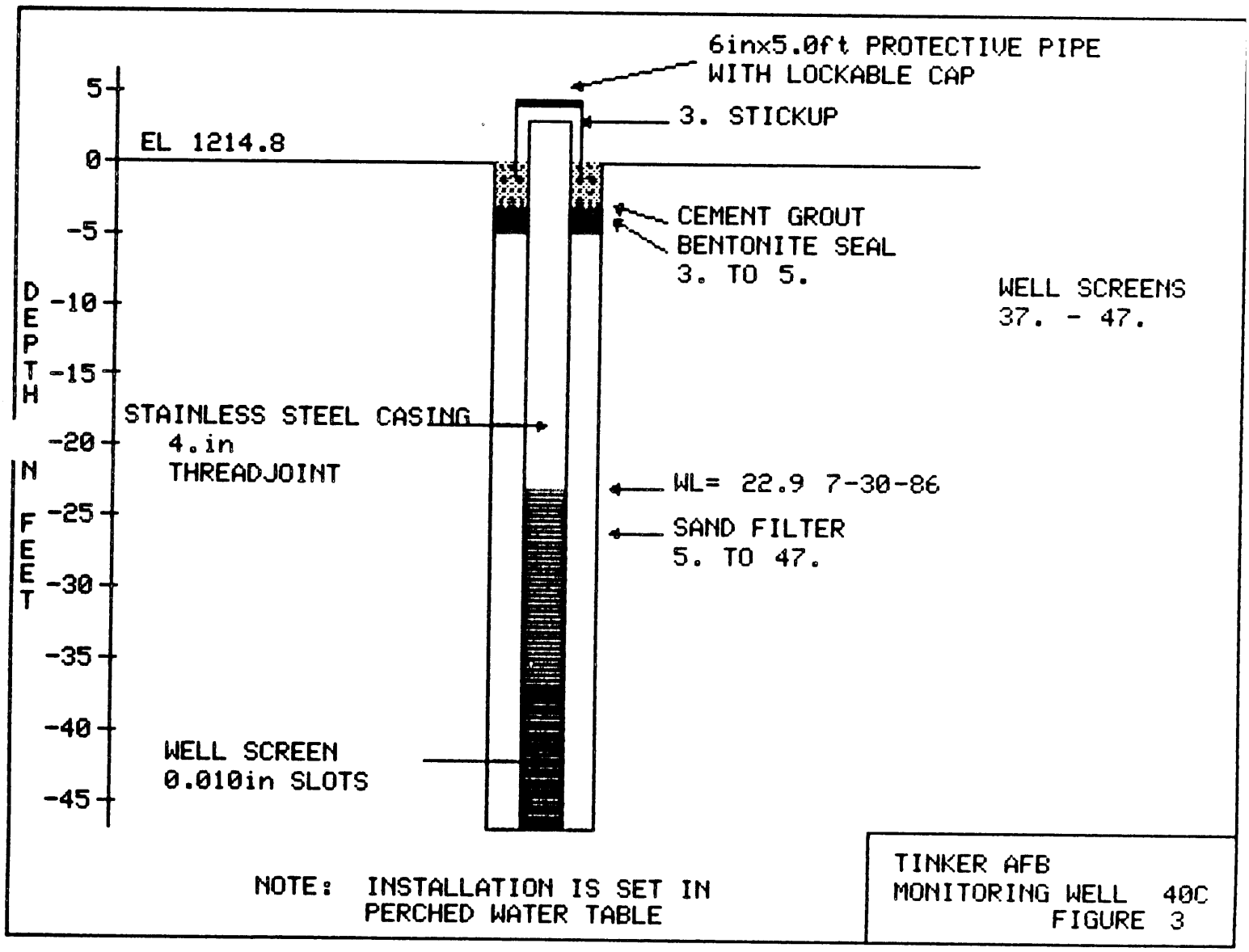
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1110.8			SHALE (SH) (92.0 – 105.0) SILTY, SOFT			
	110		SANDSTONE (SS) (105.0 – 133.0) FINE, SL. SILTY			
	120					
	130					
1082.8			SHALE (SH) (133.0 – 144.0) SOFT			
	140					
1071.8			SANDSTONE (SS) (144.0 – 158.0) FINE, LOOSELY CEMENTED, SOFT			
	150					
1057.8			BOTTOM OF HOLE			
	160					
	170					
	180					
	190					
	200					

APPENDIX B

WELL SCHEMATICS

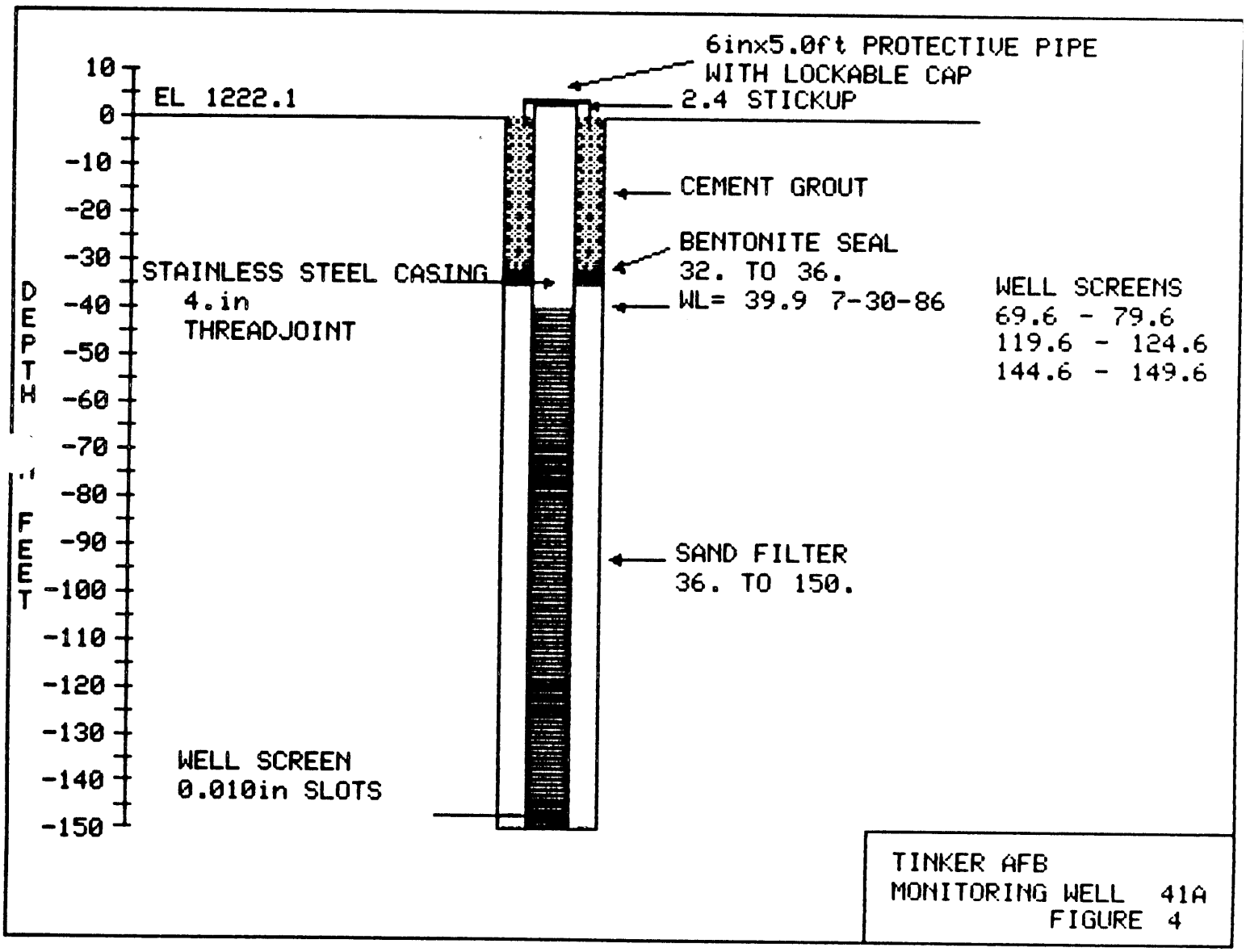

6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
3. STICKUP
EL 1214.8
5
-5
-15
-25
-35
-45
-55
-65
-75
-85
-95
-105
-115
-125
-135
-145
-155
DEPTH IN FEET
WL= 37.8 7-30-86
WELL SCREENS
140. - 150.
CEMENT GROUT
STAINLESS STEEL CASING
4.in
THREADJOINT
BENTONITE SEAL
128. TO 136.
SAND FILTER
136. TO 155.
WELL SCREEN
0.010in SLOTS
TINKER AFB
MONITORING WELL 40A
FIGURE 1

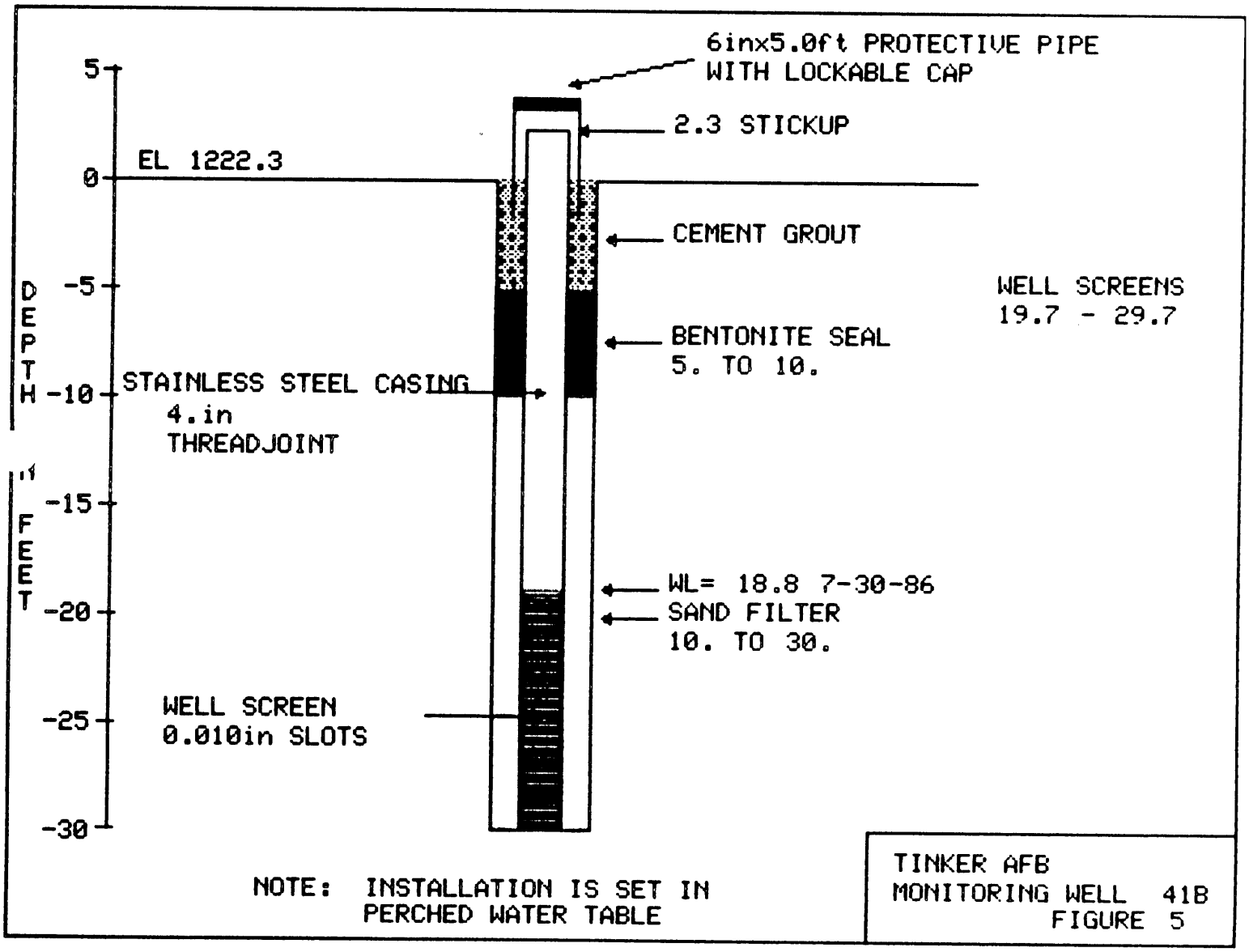

6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
EL 1215.1
2.4 STICKUP
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
DEPTH IN FEET
CEMENT GROUT
WELL SCREENS
87.6 - 97.6
WL= 32.9 7-30-86
STAINLESS STEEL CASING
4.in
THREADJOINT
BENTONITE SEAL
41. TO 45.
SAND FILTER
45. TO 100.
WELL SCREEN
0.010in SLOTS
TINKER AFB
MONITORING WELL 40B
FIGURE 2

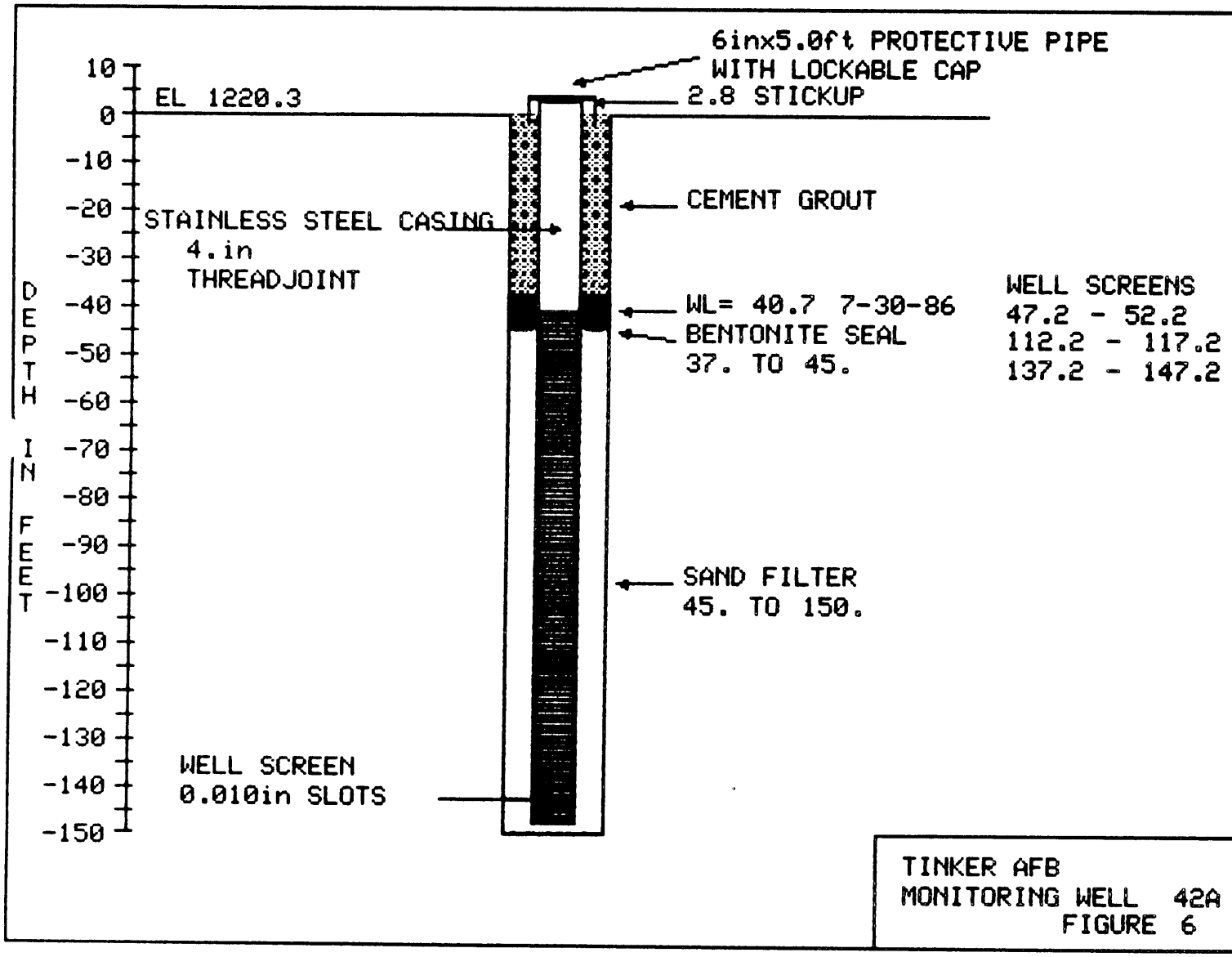


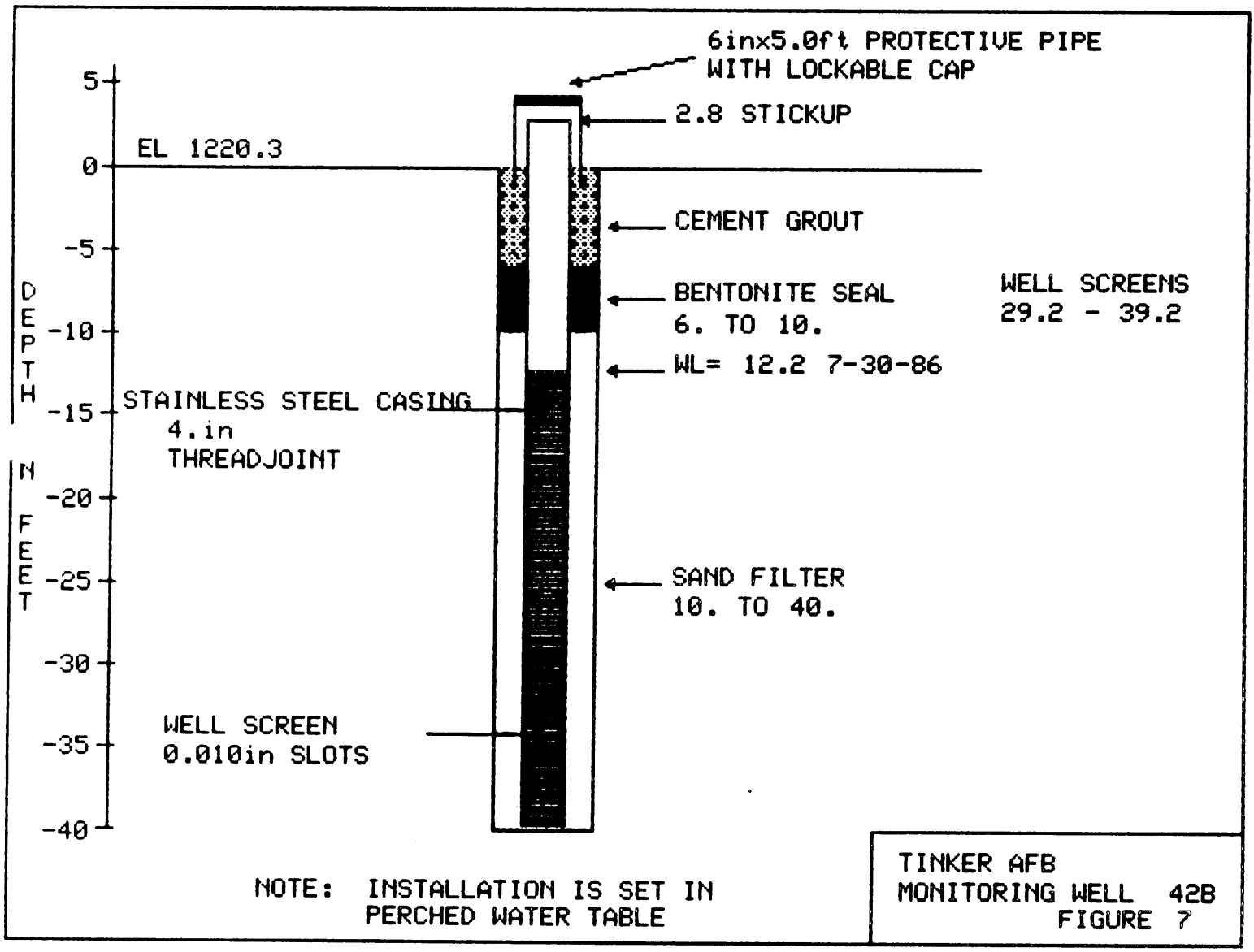
NOTE: INSTALLATION IS SET IN PERCHED WATER TABLE

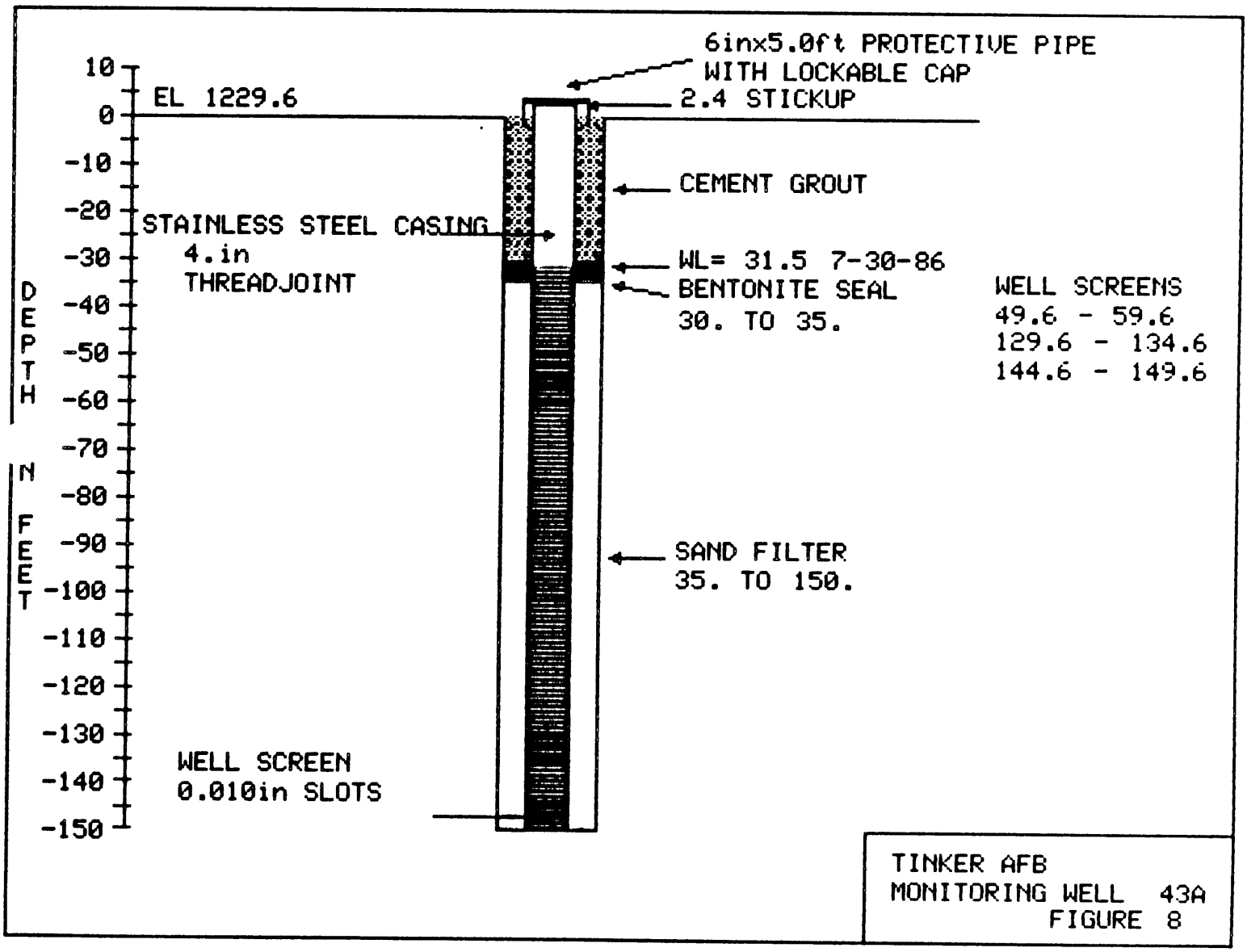
TINKER AFB
MONITORING WELL 40C
FIGURE 3

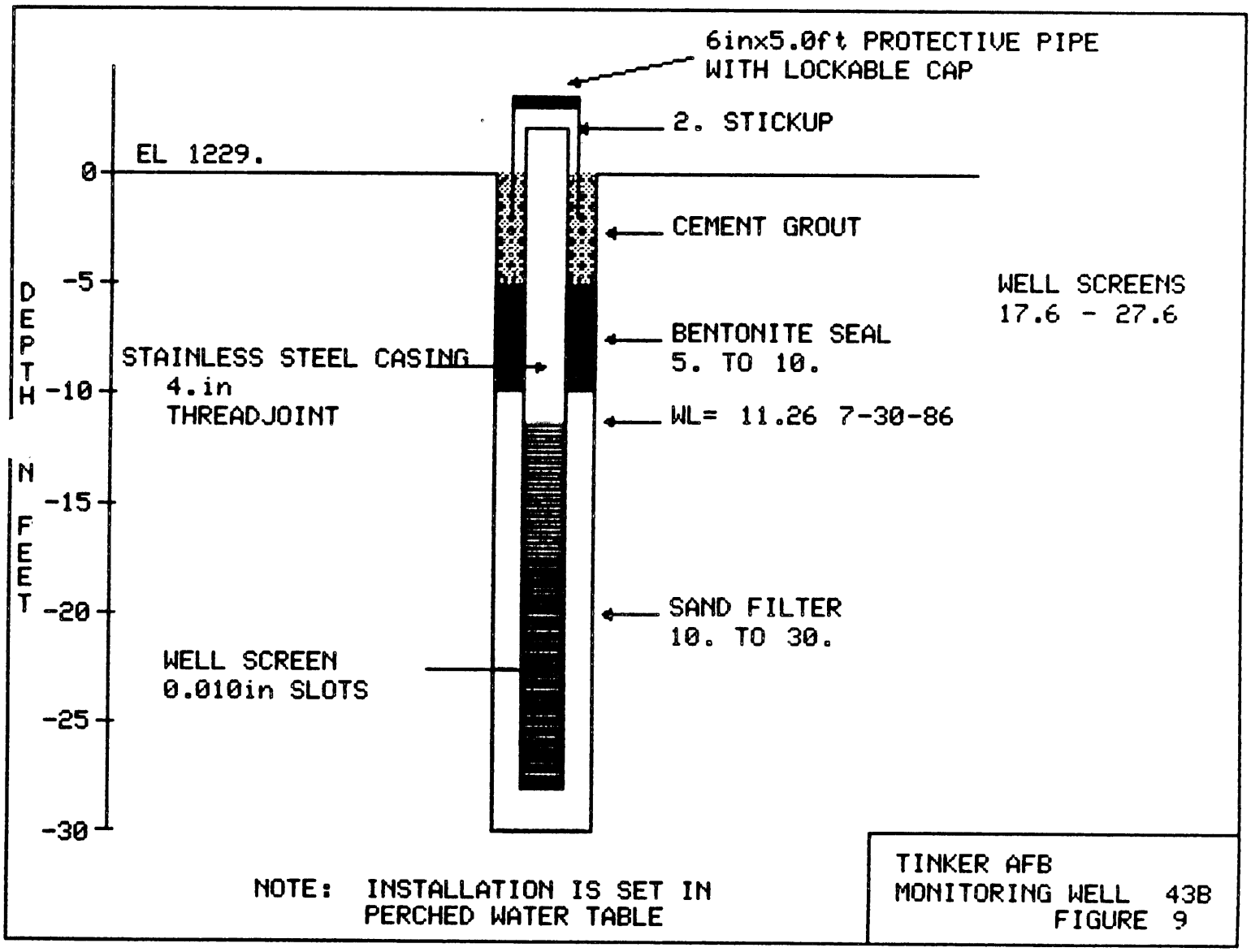

6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.4 STICKUP
EL 1222.1
CEMENT GROUT
BENTONITE SEAL
32. TO 36.
WL= 39.9 7-30-86
STAINLESS STEEL CASING
4.in
THREADJOINT
WELL SCREENS
69.6 - 79.6
119.6 - 124.6
144.6 - 149.6
SAND FILTER
36. TO 150.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
TINKER AFB
MONITORING WELL 41A
FIGURE 4


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.3 STICKUP
EL 1222.3
CEMENT GROUT
WELL SCREENS
19.7 - 29.7
BENTONITE SEAL
5. TO 10.
STAINLESS STEEL CASING
4.in
THREADJOINT
WL= 18.8 7-30-86
SAND FILTER
10. TO 30.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
0
-5
-10
-15
-20
-25
-30
NOTE: INSTALLATION IS SET IN
PERCHED WATER TABLE
TINKER AFB
MONITORING WELL 41B
FIGURE 5


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.8 STICKUP
EL 1220.3
CEMENT GROUT
STAINLESS STEEL CASING
4.in
THREADJOINT
WL= 40.7 7-30-86
BENTONITE SEAL
37. TO 45.
WELL SCREENS
47.2 - 52.2
112.2 - 117.2
137.2 - 147.2
SAND FILTER
45. TO 150.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
TINKER AFB
MONITORING WELL 42A
FIGURE 6

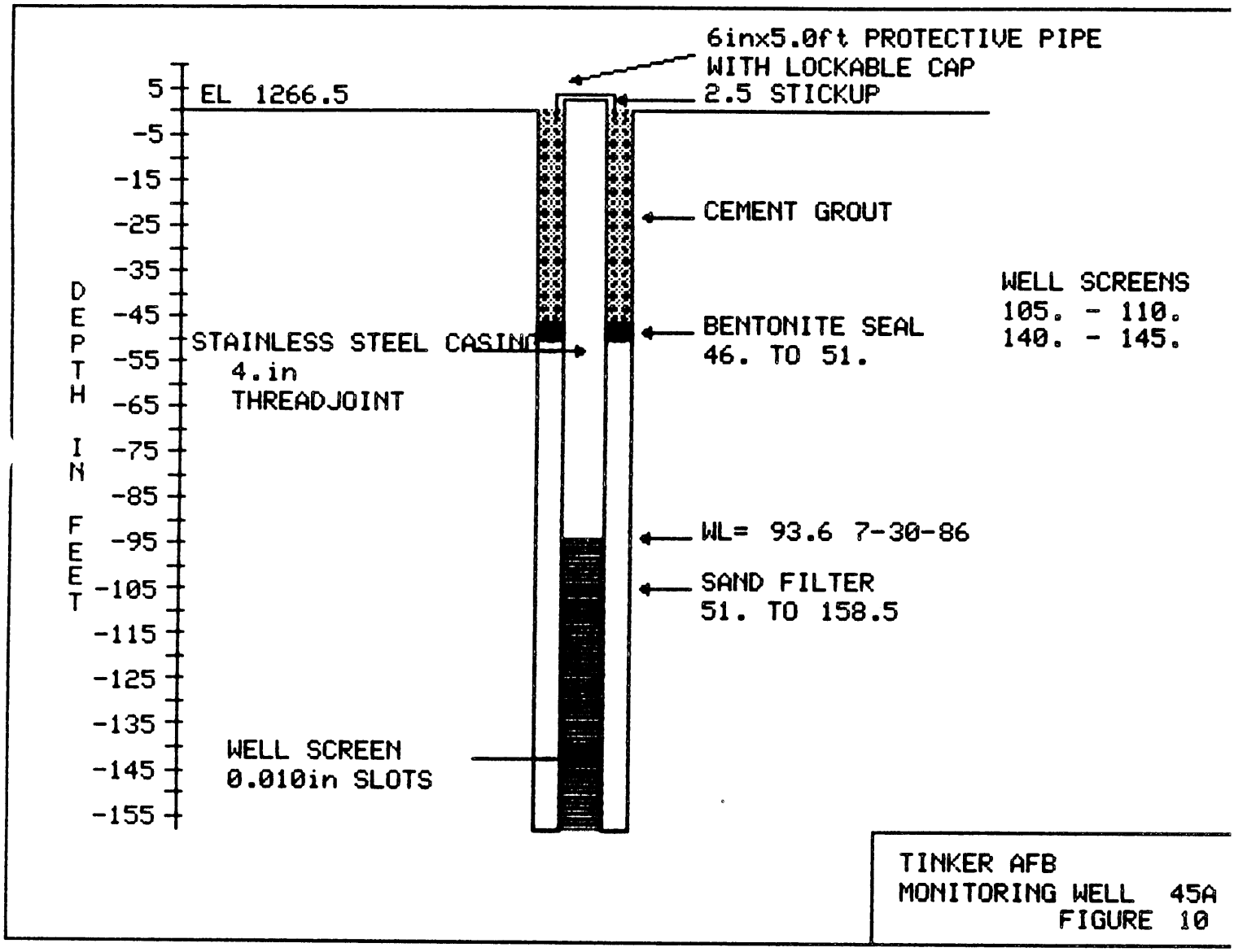

6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.8 STICKUP
EL 1220.3
CEMENT GROUT
BENTONITE SEAL
6. TO 10.
WL= 12.2 7-30-86
WELL SCREENS
29.2 - 39.2
STAINLESS STEEL CASING
4.in
THREADJOINT
SAND FILTER
10. TO 40.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
0
-5
-10
-15
-20
-25
-30
-35
-40
NOTE: INSTALLATION IS SET IN
PERCHED WATER TABLE
TINKER AFB
MONITORING WELL 42B
FIGURE 7


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.4 STICKUP
EL 1229.6
CEMENT GROUT
STAINLESS STEEL CASING
4.in
THREADJOINT
WL= 31.5 7-30-86
BENTONITE SEAL
30. TO 35.
WELL SCREENS
49.6 - 59.6
129.6 - 134.6
144.6 - 149.6
SAND FILTER
35. TO 150.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
TINKER AFB
MONITORING WELL 43A
FIGURE 8

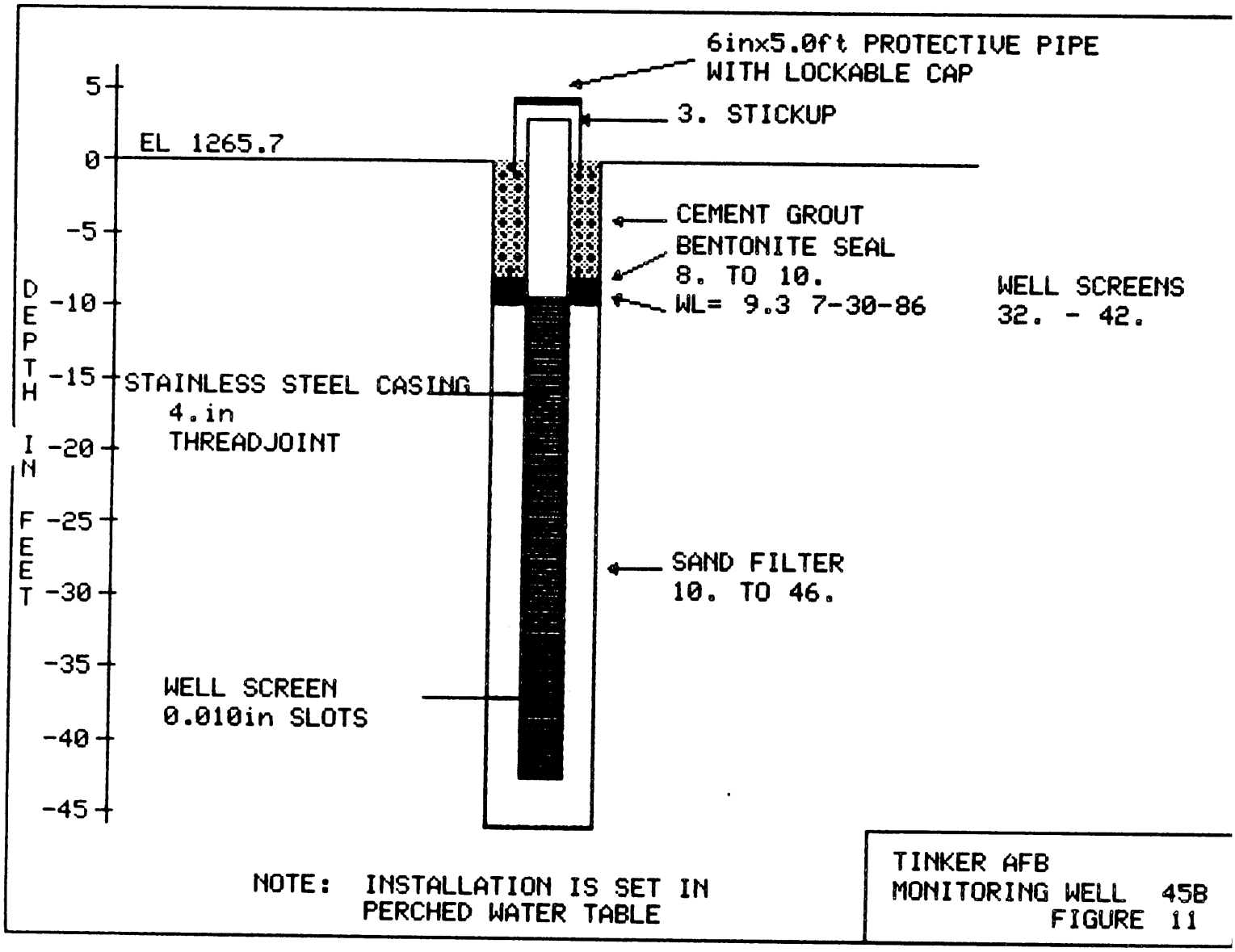


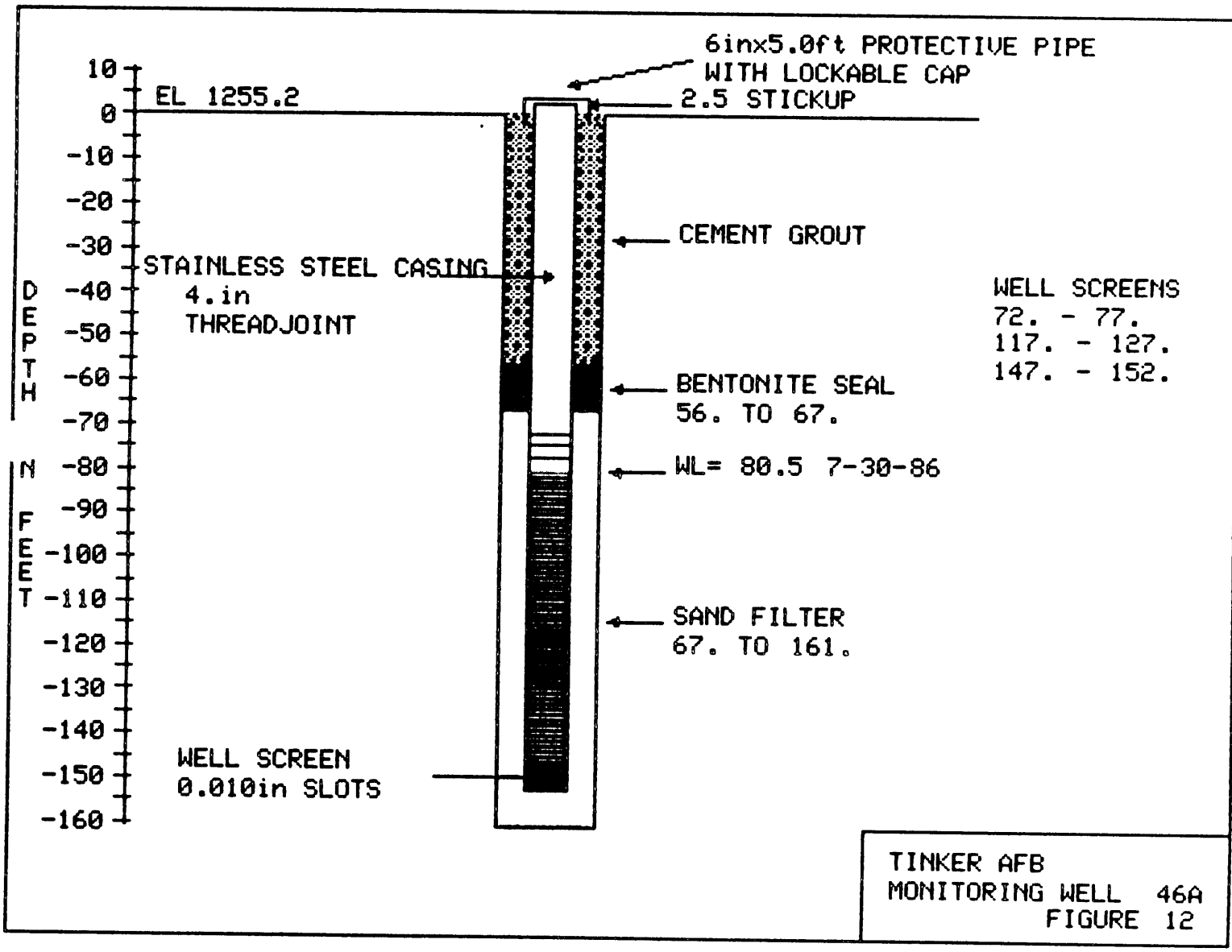
NOTE: INSTALLATION IS SET IN PERCHED WATER TABLE

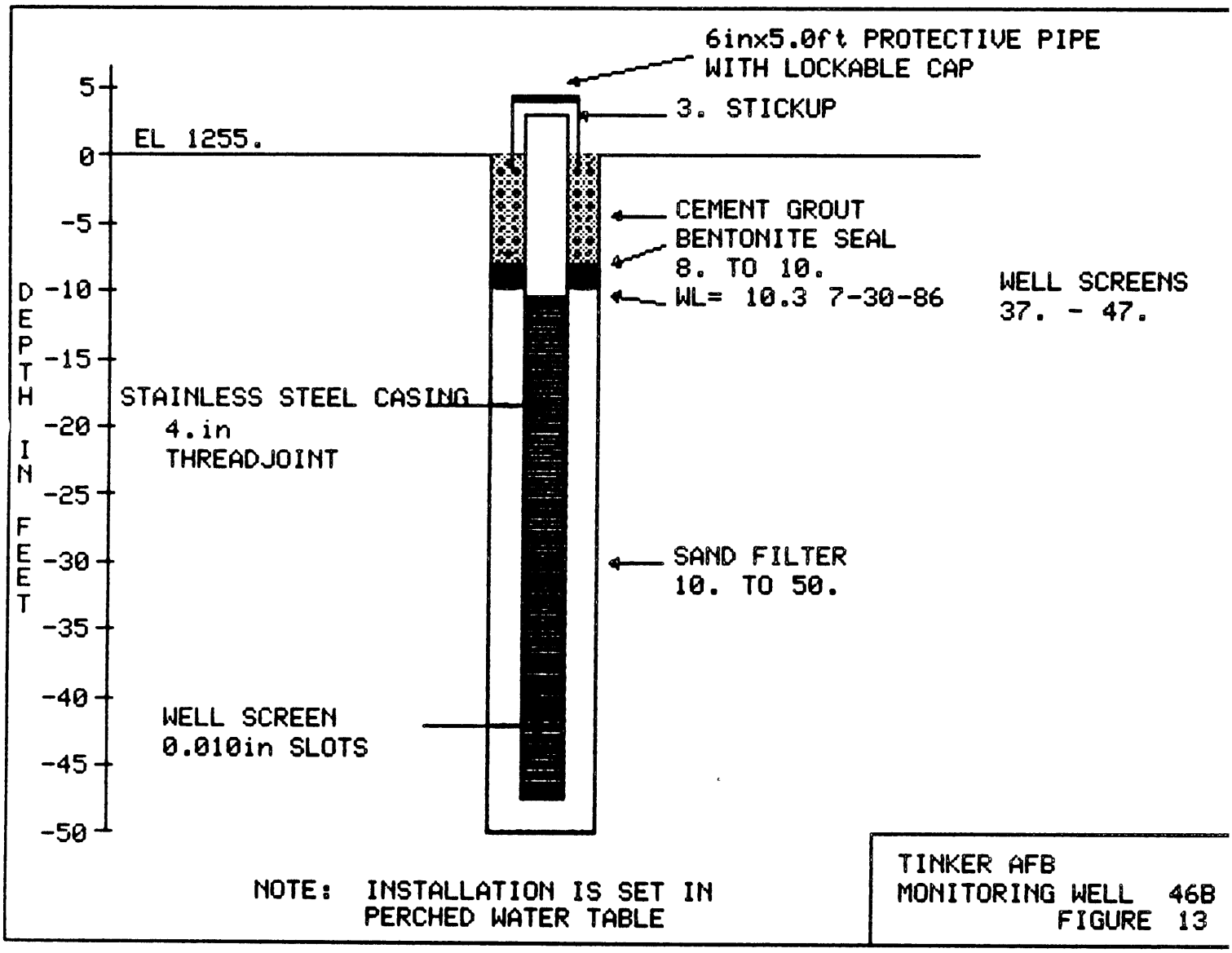
TINKER AFB
MONITORING WELL 43B
FIGURE 9

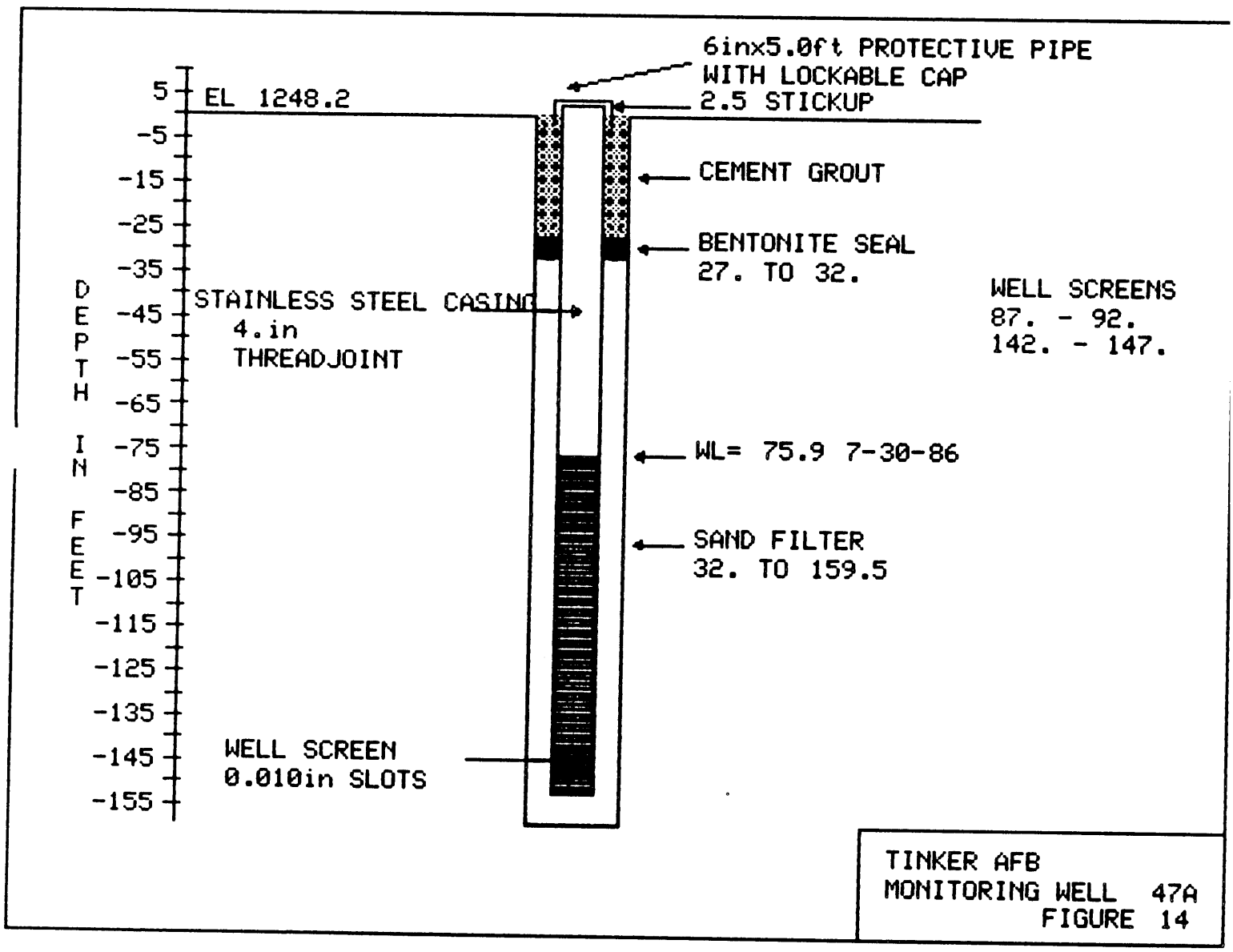


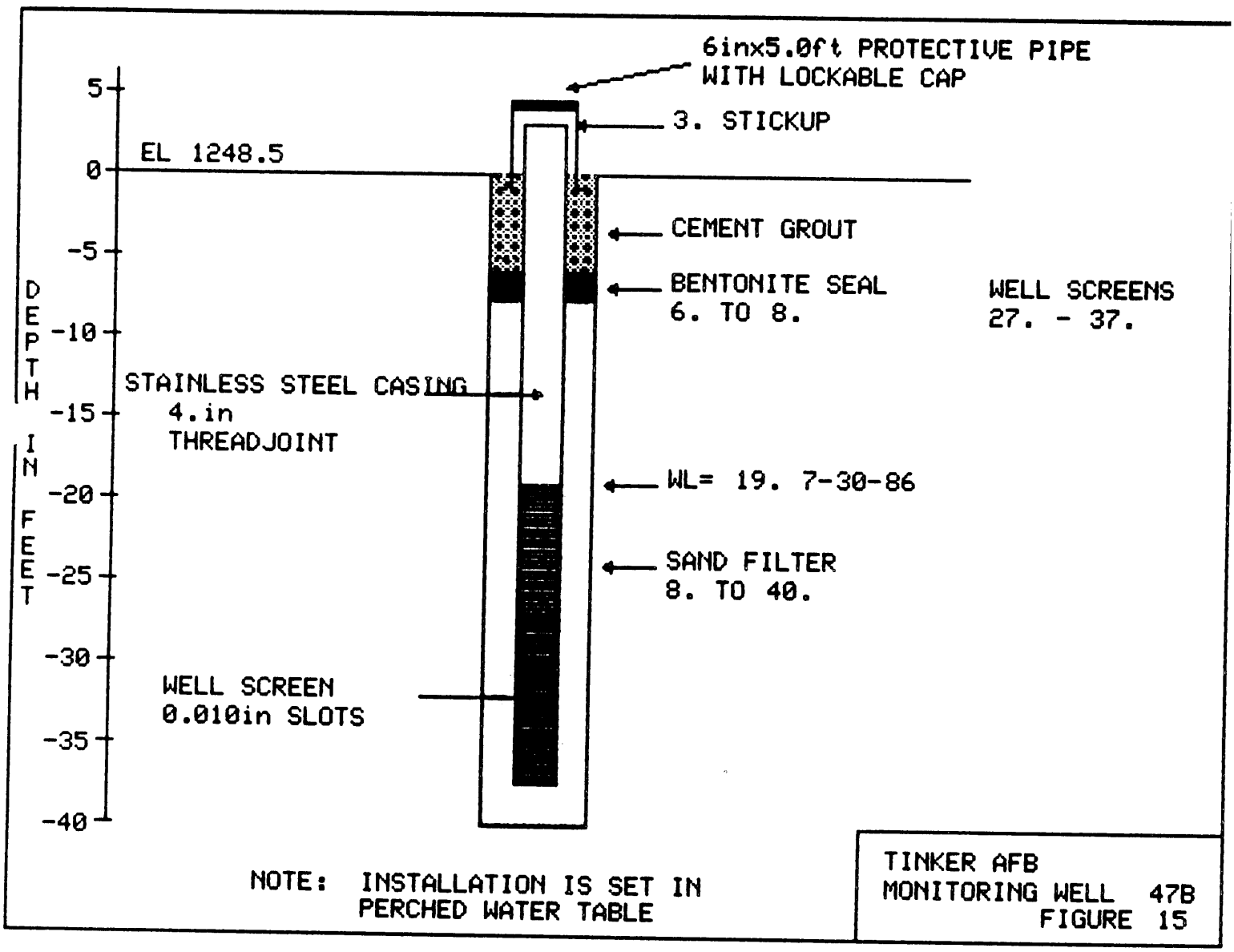
TINKER AFB
MONITORING WELL 45A
FIGURE 10


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
3. STICKUP
EL 1265.7
CEMENT GROUT
BENTONITE SEAL
8. TO 10.
WL= 9.3 7-30-86
WELL SCREENS
32. - 42.
STAINLESS STEEL CASING
4.in
THREADJOINT
SAND FILTER
10. TO 46.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
NOTE: INSTALLATION IS SET IN
PERCHED WATER TABLE
TINKER AFB
MONITORING WELL 45B
FIGURE 11


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.5 STICKUP
EL 1255.2
CEMENT GROUT
STAINLESS STEEL CASING
4.in
THREADJOINT
WELL SCREENS
72. - 77.
117. - 127.
147. - 152.
BENTONITE SEAL
56. TO 67.
WL= 80.5 7-30-86
SAND FILTER
67. TO 161.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
TINKER AFB
MONITORING WELL 46A
FIGURE 12

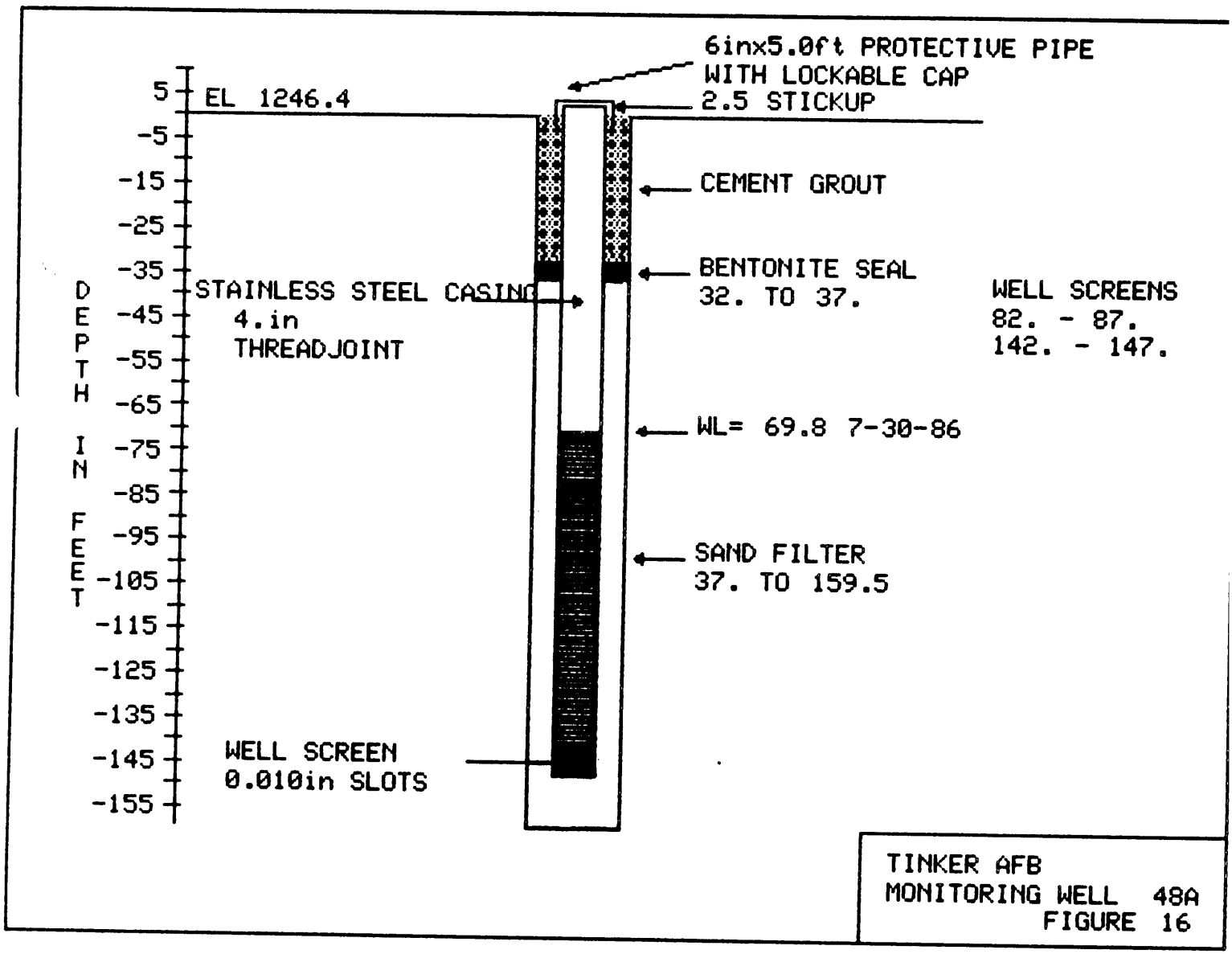

6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
3. STICKUP
EL 1255.
CEMENT GROUT
BENTONITE SEAL
8. TO 10.
WL= 10.3 7-30-86
WELL SCREENS
37. - 47.
STAINLESS STEEL CASING
4.in
THREADJOINT
SAND FILTER
10. TO 50.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
NOTE: INSTALLATION IS SET IN
PERCHED WATER TABLE
TINKER AFB
MONITORING WELL 46B
FIGURE 13


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.5 STICKUP
EL 1248.2
CEMENT GROUT
BENTONITE SEAL
27. TO 32.
WELL SCREENS
87. - 92.
142. - 147.
STAINLESS STEEL CASING
4.in
THREADJOINT
WL= 75.9 7-30-86
SAND FILTER
32. TO 159.5
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
-5
-15
-25
-35
-45
-55
-65
-75
-85
-95
-105
-115
-125
-135
-145
-155
TINKER AFB
MONITORING WELL 47A
FIGURE 14

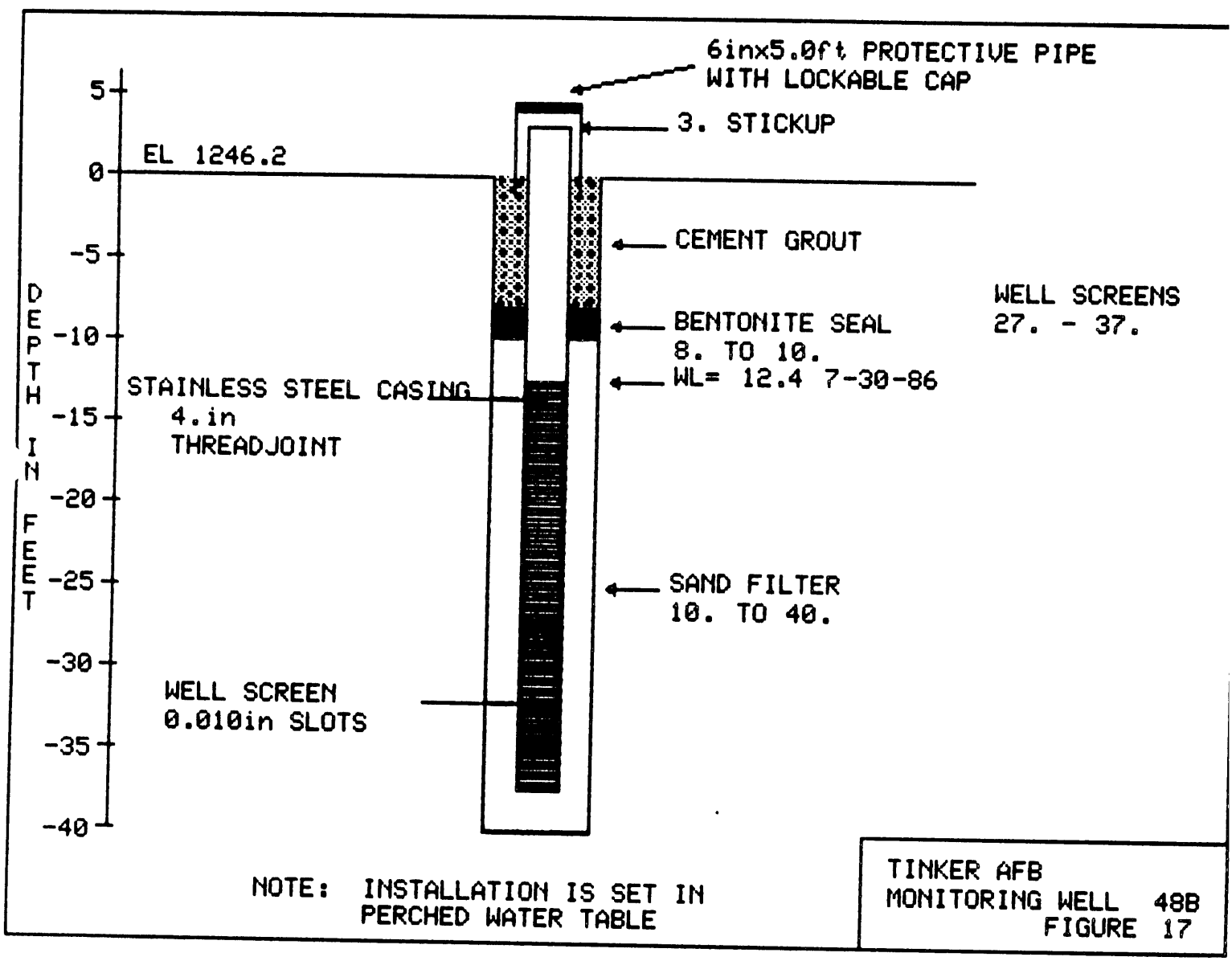


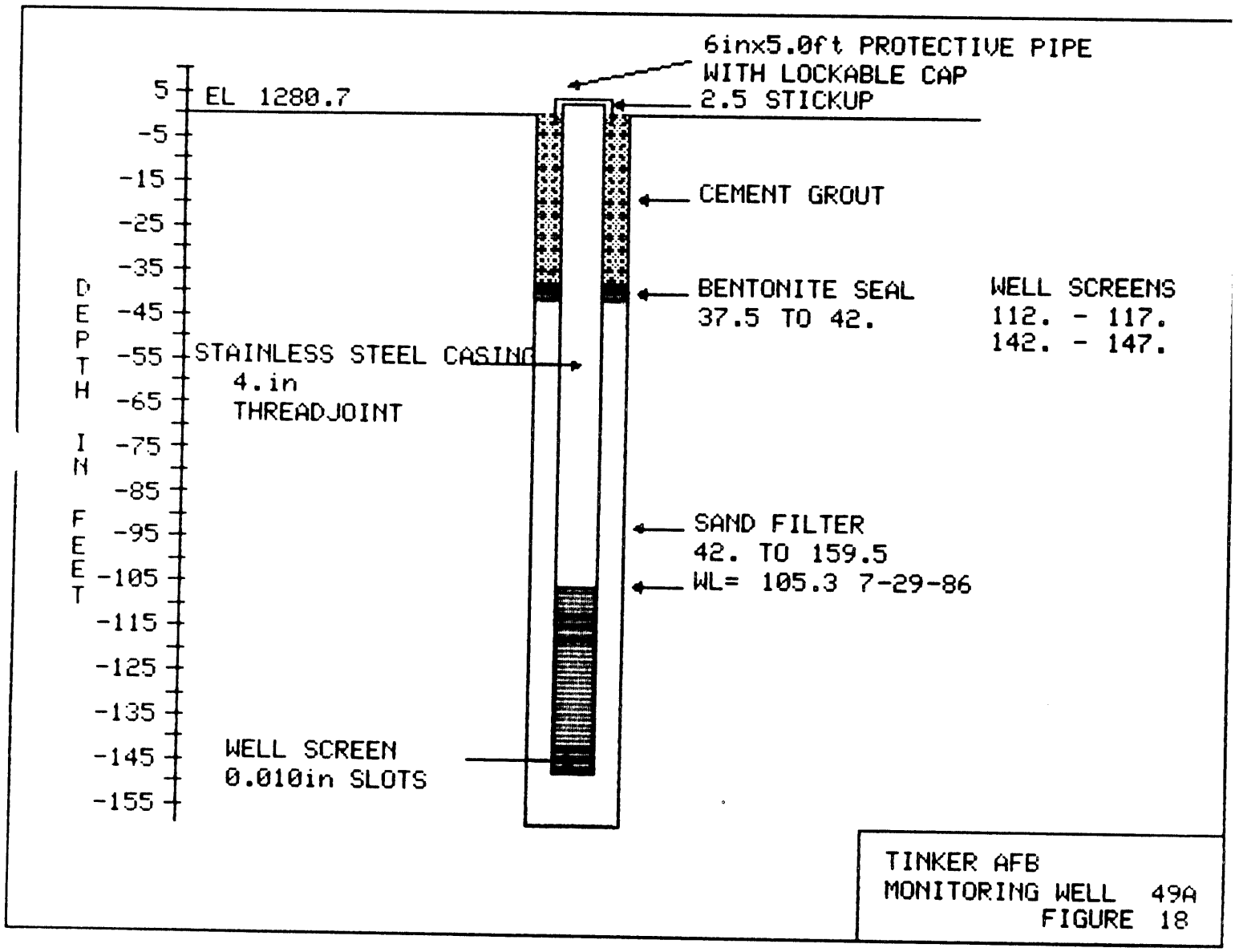
NOTE: INSTALLATION IS SET IN PERCHED WATER TABLE

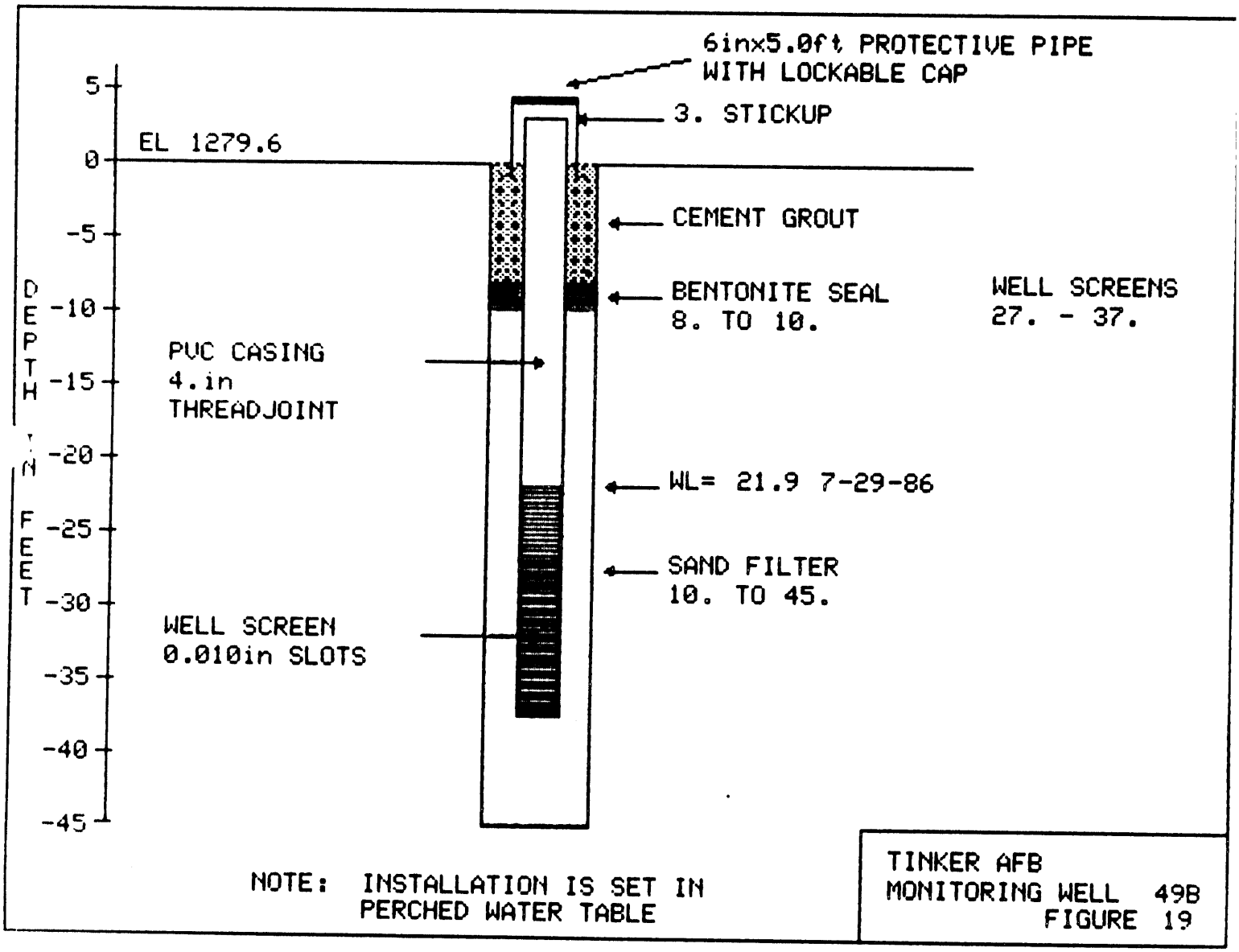
TINKER AFB
MONITORING WELL 47B
FIGURE 15

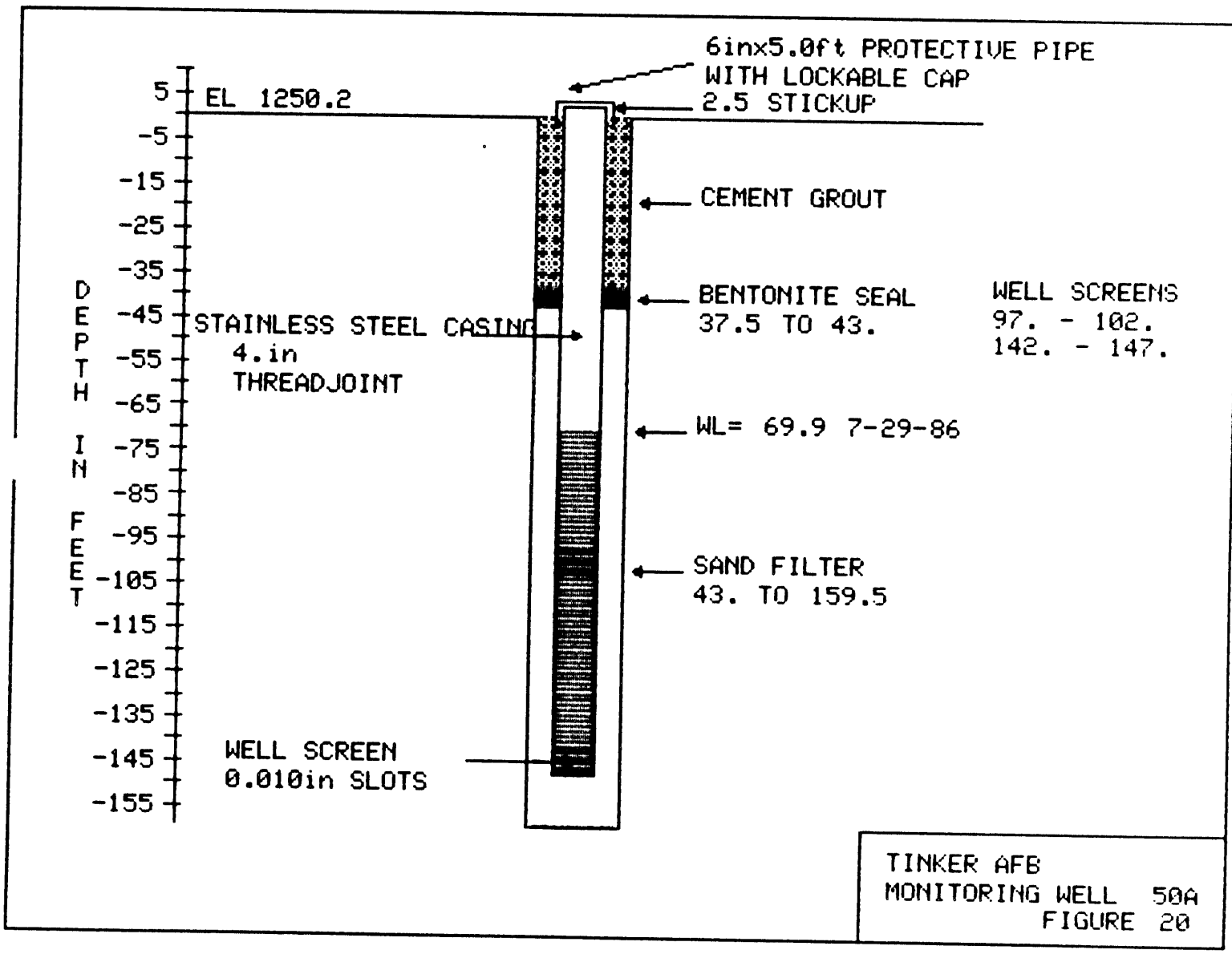


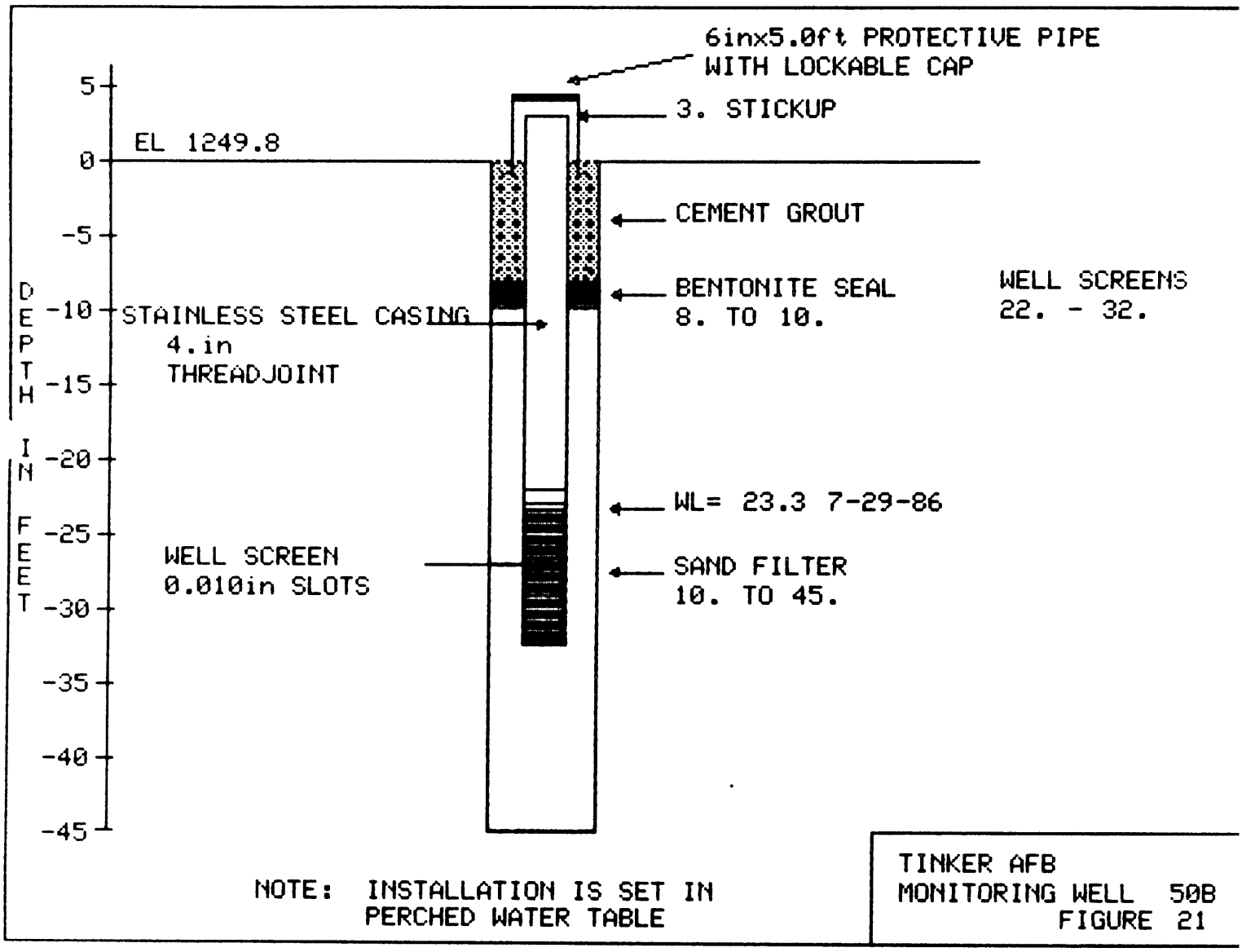
TINKER AFB
MONITORING WELL 48A
FIGURE 16


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
3. STICKUP
EL 1246.2
CEMENT GROUT
WELL SCREENS
27. - 37.
BENTONITE SEAL
8. TO 10.
WL= 12.4 7-30-86
STAINLESS STEEL CASING
4.in
THREADJOINT
SAND FILTER
10. TO 40.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
0
-5
-10
-15
-20
-25
-30
-35
-40
NOTE: INSTALLATION IS SET IN
PERCHED WATER TABLE
TINKER AFB
MONITORING WELL 48B
FIGURE 17


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.5 STICKUP
EL 1280.7
CEMENT GROUT
BENTONITE SEAL
37.5 TO 42.
WELL SCREENS
112. - 117.
142. - 147.
STAINLESS STEEL CASING
4.in
THREADJOINT
SAND FILTER
42. TO 159.5
WL= 105.3 7-29-86
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
-5
-15
-25
-35
-45
-55
-65
-75
-85
-95
-105
-115
-125
-135
-145
-155
TINKER AFB
MONITORING WELL 49A
FIGURE 18

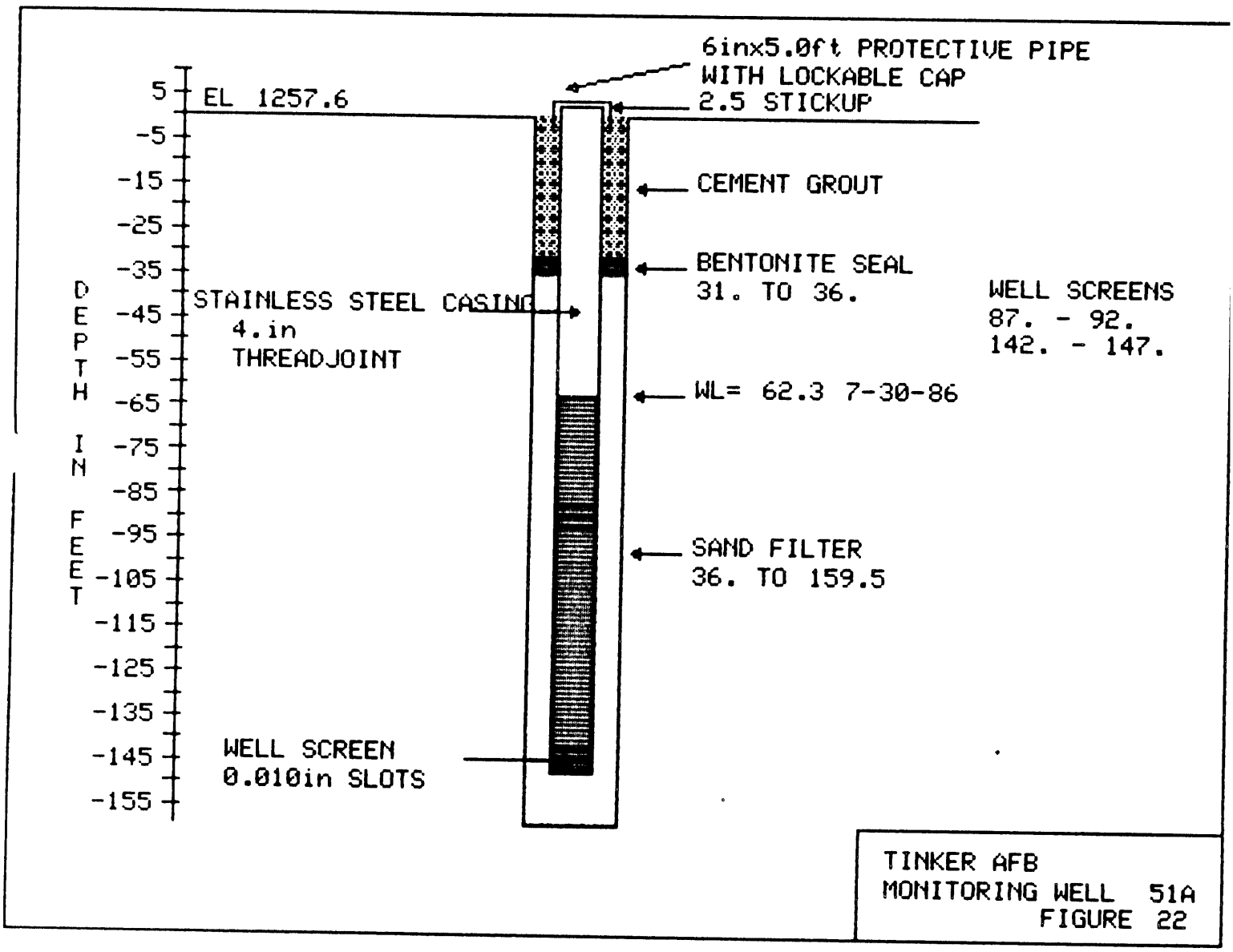

6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
3. STICKUP
EL 1279.6
CEMENT GROUT
BENTONITE SEAL
8. TO 10.
WELL SCREENS
27. - 37.
PVC CASING
4.in
THREADJOINT
WL= 21.9 7-29-86
SAND FILTER
10. TO 45.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
NOTE: INSTALLATION IS SET IN
PERCHED WATER TABLE
TINKER AFB
MONITORING WELL 49B
FIGURE 19

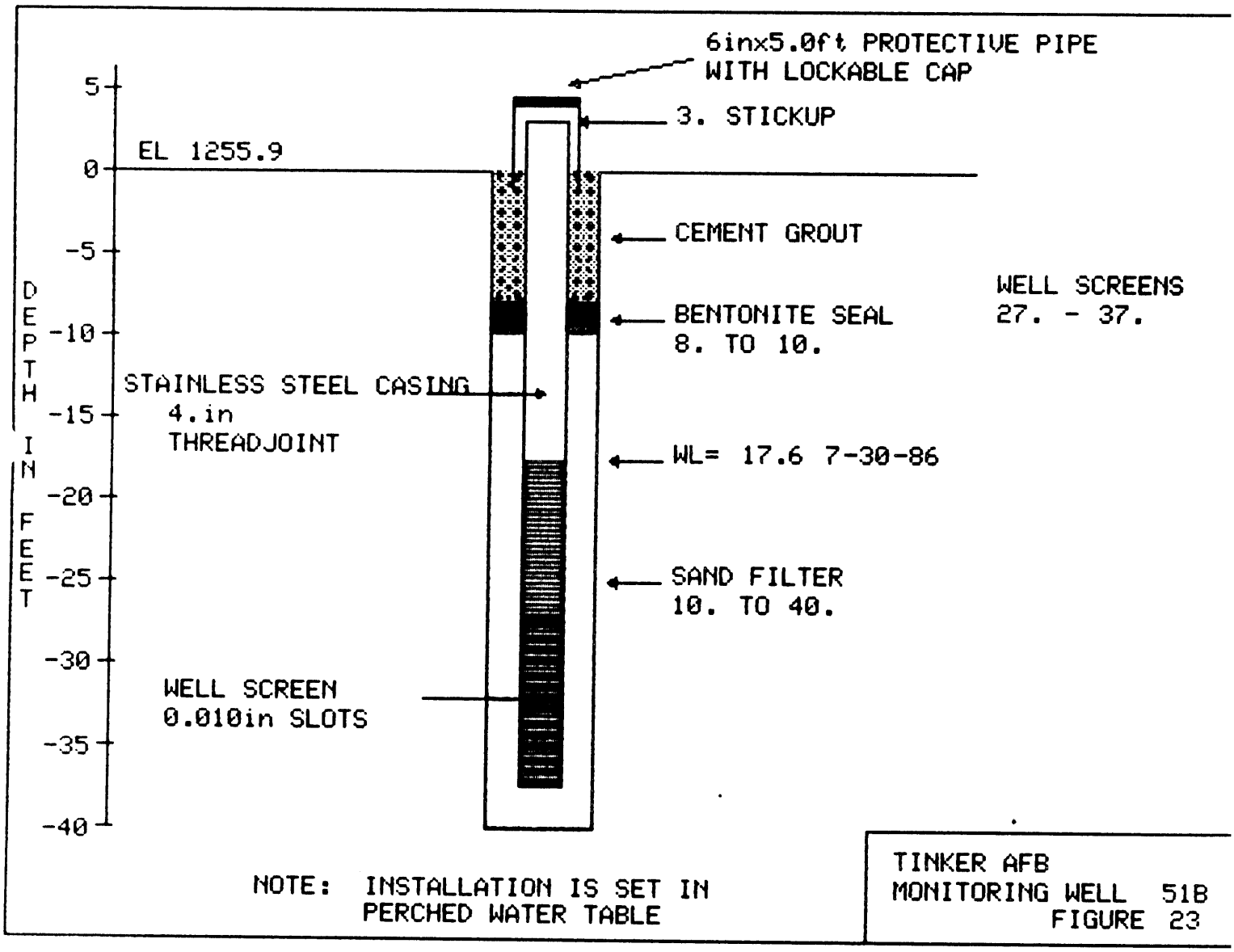

6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.5 STICKUP
EL 1250.2
CEMENT GROUT
BENTONITE SEAL
37.5 TO 43.
WELL SCREENS
97. - 102.
142. - 147.
STAINLESS STEEL CASING
4.in
THREADJOINT
WL= 69.9 7-29-86
SAND FILTER
43. TO 159.5
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
-5
-15
-25
-35
-45
-55
-65
-75
-85
-95
-105
-115
-125
-135
-145
-155
TINKER AFB
MONITORING WELL 50A
FIGURE 20

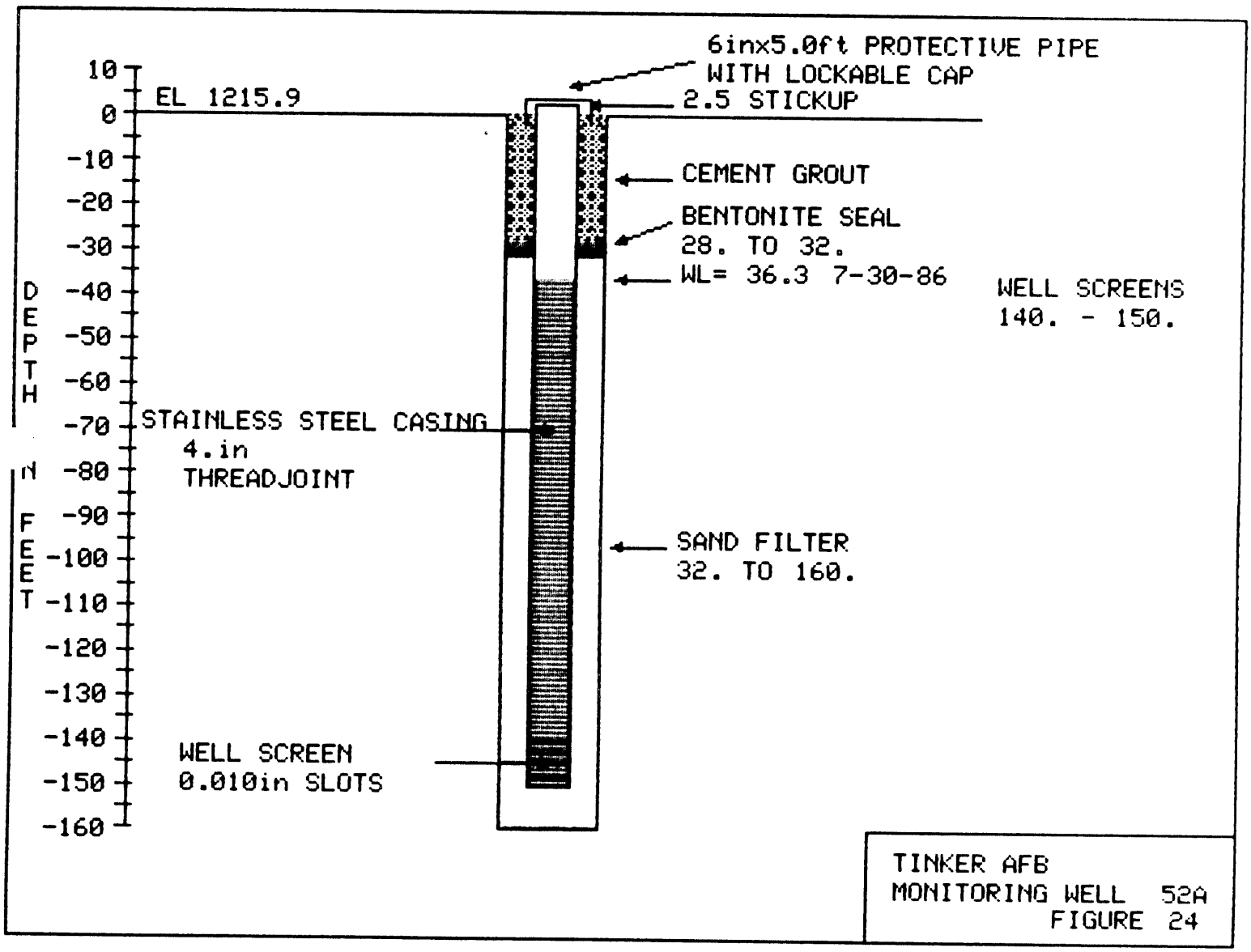


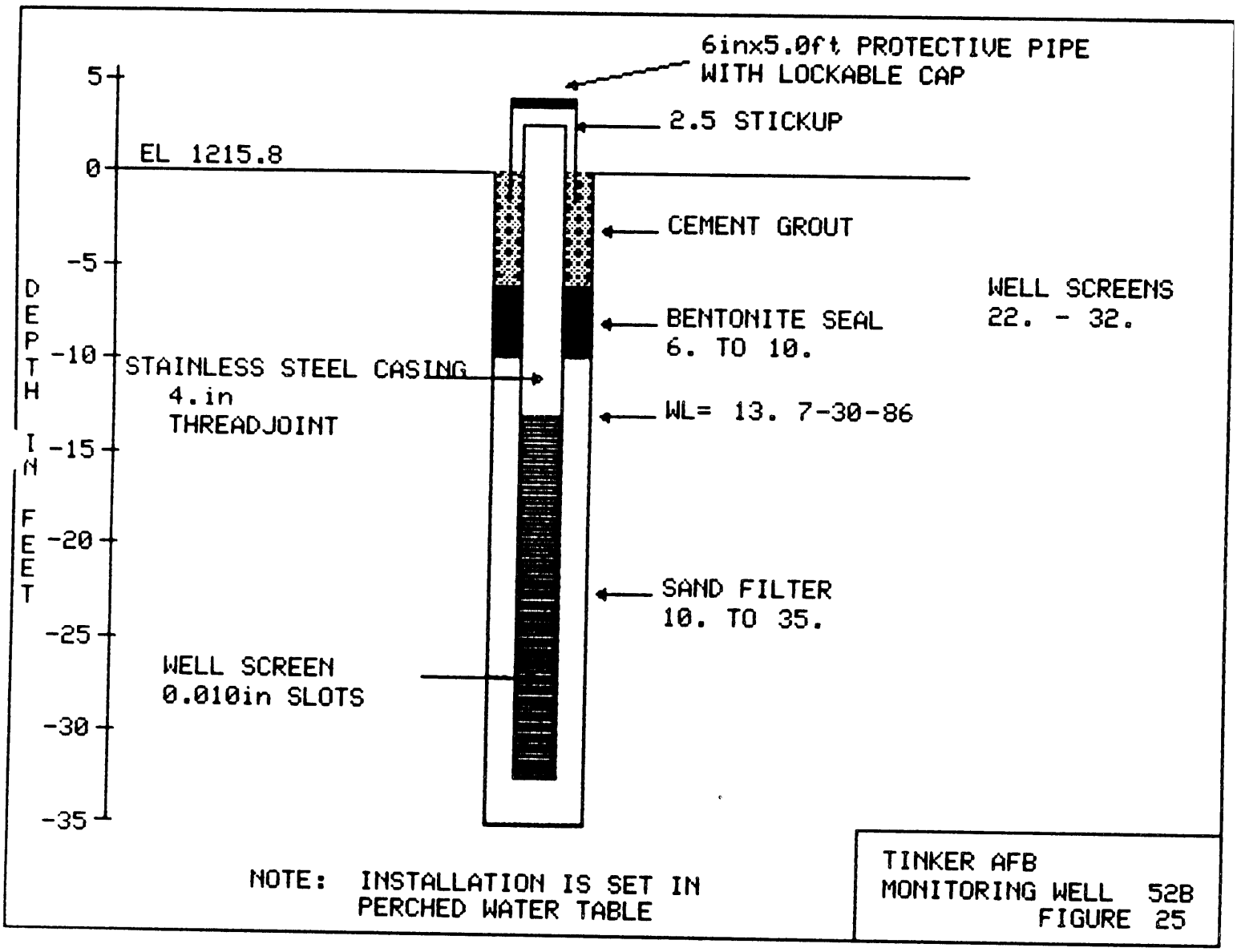
NOTE: INSTALLATION IS SET IN PERCHED WATER TABLE

TINKER AFB
MONITORING WELL 50B
FIGURE 21


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.5 STICKUP
EL 1257.6
CEMENT GROUT
BENTONITE SEAL
31. TO 36.
WELL SCREENS
87. - 92.
142. - 147.
STAINLESS STEEL CASING
4.in
THREADJOINT
WL= 62.3 7-30-86
SAND FILTER
36. TO 159.5
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
-5
-15
-25
-35
-45
-55
-65
-75
-85
-95
-105
-115
-125
-135
-145
-155
TINKER AFB
MONITORING WELL 51A
FIGURE 22


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
3. STICKUP
EL 1255.9
CEMENT GROUT
WELL SCREENS
27. - 37.
BENTONITE SEAL
8. TO 10.
STAINLESS STEEL CASING
4.in
THREADJOINT
WL= 17.6 7-30-86
SAND FILTER
10. TO 40.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
0
-5
-10
-15
-20
-25
-30
-35
-40
NOTE: INSTALLATION IS SET IN
PERCHED WATER TABLE
TINKER AFB
MONITORING WELL 51B
FIGURE 23


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.5 STICKUP
EL 1215.9
CEMENT GROUT
BENTONITE SEAL
28. TO 32.
WL= 36.3 7-30-86
WELL SCREENS
140. - 150.
STAINLESS STEEL CASING
4.in
THREADJOINT
SAND FILTER
32. TO 160.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
TINKER AFB
MONITORING WELL 52A
FIGURE 24


6inx5.0ft PROTECTIVE PIPE
WITH LOCKABLE CAP
2.5 STICKUP
EL 1215.8
CEMENT GROUT
WELL SCREENS
22. - 32.
BENTONITE SEAL
6. TO 10.
STAINLESS STEEL CASING
4.in
THREADJOINT
WL= 13. 7-30-86
SAND FILTER
10. TO 35.
WELL SCREEN
0.010in SLOTS
DEPTH IN FEET
5
0
-5
-10
-15
-20
-25
-30
-35
NOTE: INSTALLATION IS SET IN
PERCHED WATER TABLE
TINKER AFB
MONITORING WELL 52B
FIGURE 25

APPENDIX C

LABORATORY DATA
SOUTHWESTERN DIVISION LABORATORY

arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.05
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.05
total organic carbon		mg/l	1.10
oil and grease		mg/l	<1.00
chloride		mg/l	6.00
sulfate		mg/l	7.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	7.72
conductivity		umhos/cm	493.00

WELL OB10
11/25/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.02
arsenic	total	mg/l	0.00
barium	total	mg/l	0.51
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.02
pH, field		pH	7.55
conductivity		umhos/cm	353.00

WELL OB11
8/6/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00

barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.03
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	<0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.03
lead	total	mg/l	0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	tttal	mg/l	0.04
total organic carbon		mg/l	1.30
oil and grease		mg/l	<1.00
chloride		mg/l	2.50
sulfate		mg/l	7.00
cyanide		mg/l	<0.20
gross alpha		pc/l	7.00
alpha counting error		pc/l	3.00
gross beta		pc/l	5.00
beta counting error		pc/l	3.00
pH, field		pH	7.98
conductivity		umhos/cm	401.00

WELL OB2
8/13/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.65
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.06
mercrry	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.04
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.00
barium	total	mg/l	0.96
cadmium	total	mg/l	0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.10
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.04
selenium	total	mg/l	<0.00

silver	total	mg/l	<0.01
zinc	total	mg/l	0.06
total organic carbon		mg/l	1.20
oil and grease		mg/l	<1.00
chloride		mg/l	13.00
sulfate		mg/l	4.00
cyanide		mg/l	<0.20
pH, field		pH	6.89
conductivity		umhos/cm	503.00

WELL OB2
11/25/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.97
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.01
arsenic	total	mg/l	0.00
barium	total	mg/l	1.10
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.02
pH, field		pH	6.71
conductivity		umhos/cm	341.00

WELL OB3
8/8/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	0.00

barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.16
lead	total	mg/l	0.04
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.05
total organic carbon		mg/l	0.77
oil and grease		mg/l	<1.00
chloride		mg/l	45.00
sulfate		mg/l	14.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	5.00
beta counting error		pc/l	3.00
pH, field		pH	7.29
conductivity		umhos/cm	952.00

WELL OB3
11/25/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.04
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.02
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.05
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
pH, field		pH	7.29
conductivity		umhos/cm	766.00

WELL OB4
8/7/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00

barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.03
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.04
total organic carbon		mg/l	1.30
oil and grease		mg/l	<1.00
chloride		mg/l	43.00
sulfate		mg/l	33.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	7.02
conductivity		umhos/cm	449.00

WELL OB5
8/7/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.56
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.0
arsenic	total	mg/l	0.00
barium	total	mg/l	0.65
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03

total organic carbon	mg/l	0.67
oil and grease	mg/l	<1.00
chloride	mg/l	9.30
sulfate	mg/l	6.00
cyanide	mg/l	<0.20
gross alpha	pc/l	<2.00
gross beta	pc/l	<3.00
pH, field	pH	7.37
conductivity	umhos/cm	1037.00

WELL OB6
8/7/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.62
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.03
arsenic	total	mg/l	0.00
barium	total	mg/l	0.63
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.04
total organic carbon		mg/l	0.51
oil and grease		mg/l	<1.00
chloride		mg/l	13.00
sulfate		mg/l	9.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	4.00
beta counting error		pc/l	3.00
pH, field		pH	7.09
conductivity		umhos/cm	449.00

WELL OB7
8/7/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.68
cadmium	dissolved	mg/l	<0.01

chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.02
arsenic	total	mg/l	0.00
barium	total	mg/l	0.74
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	<0.00
silver	toaal	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	0.58
oil and grease		mg/l	<1.00
chloride		mg/l	4.00
sulfate		mg/l	4.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	5.00
beta counting error		pc/l	3.00
pH, field		pH	7.51
conductivity		umhos/cm	506.00

WELL OB8
8/5/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.03
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	<0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.08
total organic carbon		mg/l	1.70

oil and grease	mg/l	<1.00
chloride	mg/l	180.00
sulfate	mg/l	76.00
cyanide	mg/l	<0.20
gross alpha	pc/l	<2.00
gross beta	pc/l	<3.00
pH, field	pH	7.30
conductivity	umhos/cm	1446.00

WELL OB9
8/6/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.03
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.05
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.23
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	14.00
sulfate		mg/l	13.00
cyanide		mg/l	<0.20
gross alpha		pc/l	3.00
alpha counting error		pc/l	2.00
gross beta		pc/l	4.00
beta counting error		pc/l	3.00
pH, field		pH	7.64
conductivity		umhos/cm	449.00

WELL OB9
11/25/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01

chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0001
zinc	dissolved	mg/l	0.01
arsenic	total	mg/l	0.00
barium	total	mg/l	0.56
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.02
pH, field		pH	7.48
conductivity		umhos/cm	401.00

WELL 40A
6/6/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.04
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.06
arsenic	total	mg/l	0.00
barium	total	mg/l	2.40
cadmium	total	mg/l	0.02
chromium	total	mg/l	0.16
lead	total	mg/l	0.08
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.11
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.14
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	12.00
sulfate		mg/l	50.00
cyanide		mg/l	<0.20
gross alpha		pc/l	10.00
alpha counting error		pc/l	5.00
gross beta		pc/l	5.00
beta counting error		pc/l	3.00

pH, field		pH	7.63
conductivity		umhos/cm	485.00

WELL 40B
8/1/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.06
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.02
barium	total	mg/l	7.10
cadmium	total	mg/l	0.03
chromium	total	mg/l	0.85
lead	total	mg/l	0.54
mercury	total	mg/l	<0.00
nickel	total	mg/l	1.30
selenium	total	mg/l	<0.00
silver	total	mg/l	0.05
zinc	total	mg/l	1.00
total organic carbon		mg/l	3.50
oil and grease		mg/l	<1.00
chloride		mg/l	43.00
sulfate		mg/l	33.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	9.00
beta counting error		pc/l	3.00
pH, field		pH	7.69
conductivity		umhos/cm	743.00

WELL 40C
6/5/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.55
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.04
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.03
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.10

arsenic	total	mg/l	0.00
barium	total	mg/l	4.30
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.15
lead	total	mg/l	0.07
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.08
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.21
total organic carbon		mg/l	5.00
oil and grease		mg/l	<1.00
chloride		mg/l	58.00
sulfate		mg/l	11.00
cyanide		mg/l	<0.20
gross alpha		pc/l	23.00
alpha counting error		pc/l	11.00
gross beta		pc/l	40.00
beta counting error		pc/l	4.00
pH, field		pH	6.96
conductivity		umhos/cm	1060.00

WELL 41A
6/27/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.52
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.03
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.04
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.06
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.04
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.04
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.06
total organic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	110.00
sulfate		mg/l	7.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	14.00

beta counting error		pc/l	6.00
pH, field		pH	6.60
conductivity		umhos/cm	1272.00

WELL 41B
6/26/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	0.67
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	0.04
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.03
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.09
arsenic	total	mg/l	0.00
barium	total	mg/l	0.90
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.01
lead	total	mg/l	0.05
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.04
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.26
total organic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	440.00
sulfate		mg/l	20.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	12.00
beta counting error		pc/l	6.00
pH, field		pH	7.00
conductivity		umhos/cm	2.69

WELL 42A
7/2/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	0.08
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	0.01
silver	dissolved	mg/l	<0.01

zinc	dissolved	mg/l	0.03
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.02
lead	total	mg/l	0.07
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	0.01
silver	total	mg/l	<0.01
zinc	total	mg/l	0.02
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	260.00
sulfate		mg/l	13.00
cyanide		mg/l	<0.20
gross alpha		pc/l	9.00
alpha counting error		pc/l	8.00
gross beta		pc/l	20.00
beta counting error		pc/l	6.00
radium-226		pc/l	5.40
Ra-226 counting error		pc/l	2.00
radium-228		pc/l	<1.00
pH, field		pH	6.80
conductivity		umhos/cm	1535.00

WELL 42B
7/2/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	1.20
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	0.09
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.03
arsenic	total	mg/l	0.00
barium	total	mg/l	3.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.16
lead	total	mg/l	0.14
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.04
selenium	total	mg/l	0.00
silver	total	mg/l	0.01
zinc	total	mg/l	0.11
total organic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	78.00

sulfate	mg/l	30.00
cyanide	mg/l	<0.20
gross alpha	pc/l	41.00
alpha counting error	pc/l	20.00
gross beta	pc/l	47.00
beta counting error	pc/l	8.00
radium-226	pc/l	<0.60
radium-228	pc/l	<1.00
pH, field	pH	6.90
conductivity	umhos/cm	827.00

WELL 43A
7/2/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.12
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.03
selenium	dissolved	mg/l	0.01
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.02
lead	total	mg/l	0.13
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	0.01
silver	total	mg/l	<0.01
zinc	total	mg/l	0.05
total organic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	38.00
sulfate		mg/l	35.00
cyanide		mg/l	<0.20
gross alpha		pc/l	12.00
alpha counting error		pc/l	7.00
gross beta		pc/l	21.00
beta counting error		pc/l	6.00
pH, field		pH	7.10
conductivity		umhos/cm	923.00

WELL 43B
7/1/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00

barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	0.05
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	0.01
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.01
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.07
lead	total	mg/l	0.09
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	0.00
silver	total	mg/l	0.01
zinc	total	mg/l	0.08
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	10.00
sulfate		mg/l	53.00
cyanide		mg/l	<0.20
gross alpha		pc/l	27.00
alpha counting error		pc/l	13.00
gross beta		pc/l	38.00
beta counting error		pc/l	7.00
radium-226		pc/l	2.90
Ra-226 counting error		pc/l	1.00
radium-228		pc/l	<1.00
pH, field		pH	7.40
conductivity		umhos/cm	834.00

WELL 45A
5/29/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.03
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03

mercury	total	mg/l	<0.00
nickel	total	mg/l	0.04
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.07
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	2300.00
sulfate		gg/l	13.00
cyanide		mg/l	<0.20
gross alpha		pc/l	4.00
alpha counting error		pc/l	3.00
gross beta		pc/l	9.00
beta counting error		pc/l	3.00
radium-226		pc/l	2.30
Ra-226 counting error		pc/l	1.50
radium-228		pc/l	<1.00
pH, field		pH	7.00
conductivity		umhos/cm	908.00

WELL 45B
5/29/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.23
selenium	dissolved	mg/l	0.01
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.07
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.26
selenium	total	mg/l	0.01
silver	total	mg/l	<0.01
zinc	total	mg/l	0.07
oil and grease		mg/l	<1.00
chloride		mg/l	510.00
sulfate		mg/l	64.00
cyanide		mg/l	<0.20
gross alpha		pc/l	10.00
alpha counting error		pc/l	9.00
gross beta		pc/l	13.00
beta counting error		pc/l	3.00
radium-226		pc/l	1.70

Ra-226 counting error	pc/l	1.40
radium-228	pc/l	<1.00
pH, field	pH	7.03
conductivity	umhos/cm	2.48

WELL 46A
5/29/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.03
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.03
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.03
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.05
selenium	total	mg/l	0.00
silver	toaal	mg/l	<0.01
zinc	total	mg/l	0.05
total organic carbon		mg/l	5.00
oil and grease		mg/l	<1.00
chloride		mg/l	6.30
sulfate		mg/l	14.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	19.00
beta counting error		pc/l	4.00
radium-228		pc/l	<1.00
pH, field		pH	10.48
conductivity		umhos/cm	701.00

WELL 46B
5/29/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.05

selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.09
arsenic	total	mg/l	0.00
barium	total	mg/l	0.65
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.08
lead	total	mg/l	0.06
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.10
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.14
total organic carbon		mg/l	5.00
oil and grease		mg/l	<1.00
chloride		mg/l	53.00
sulfate		mg/l	75.00
cyanide		mg/l	<0.20
gross alpha		pc/l	16.00
alpha counting error		pc/l	14.00
gross beta		pc/l	52.00
beta counting error		pc/l	14.00
radium-226		pc/l	2.00
Ra-226 counting error		pc/l	1.80
radium-228		pc/l	7.00
Ra-228 counting error		pc/l	5.00
pH, field		pH	7.16
conductivity		umhos/cm	1153.00

WELL 47A
6/4/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.05
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.07
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.07
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.02

total organic carbon	mg/l	6.00
oil and grease	mg/l	<1.00
chloride	mg/l	21.00
sulfate	mg/l	16.00
cyanide	mg/l	<0.20
gross alpha	pc/l	<2.00
gross beta	pc/l	<3.00
pH, field	pH	6.62
conductivity	umhos/cm	812.00

WELL 1WS
6/10/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.02
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.05
total organic carbon		mg/l	5.00
oil and grease		mg/l	<1.00
chloride		mg/l	6.00
sulfate		mg/l	5.00
cyanide		mg/l	<0.20
gross alpha		pc/l	5.00
alpha counting error		pc/l	3.00
gross beta		pc/l	10.00
beta counting error		pc/l	3.00
pH, field		pH	7.38
conductivity		umhos/cm	420.00

WELL 2WS
6/10/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01

chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.03
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	6.80
sulfate		mg/l	5.00
cyanide		mg/l	<0.20
gross alpha		pc/l	9.00
alpha counting error		pc/l	4.00
gross beta		pc/l	6.00
beta counting error		pc/l	3.00
pH, field		pH	7.24
conductivity		umhos/cm	413.00

WELL 3WS
6/10/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.03
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	<0.01
selenium	dissolved	mg/l	0.01
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.03
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.03
lead	total	mg/l	0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03

total organic carbon	mg/l	3.00
oil and grease	mg/l	<1.00
chloride	mg/l	6.00
sulfate	mg/l	6.00
cyanide	mg/l	<0.20
gross alpha	pc/l	9.00
alpha counting error	pc/l	4.00
gross beta	pc/l	7.00
beta counting error	pc/l	3.00
pH, field	pH	7.67
conductivity	umhos/cm	394.00

WELL 47B
5/29/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.05
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.06
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.06
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.08
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.10
total organic carbon		mg/l	6.00
oil and grease		mg/l	<1.00
chloride		mg/l	50.00
sulfate		mg/l	130.00
cyanide		mg/l	<0.20
gross alpha		pc/l	325.00
alpha counting error		pc/l	143.00
gross beta		pc/l	657.00
beta counting error		pc/l	66.00
radium-226		pc/l	3.90
Ra-226 counting error		pc/l	1.70
radium-228		pc/l	<1.00
pH, field		pH	8.20
conductivity		umhos/cm	864.00

WELL 48A
6/4/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.03
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	<0.00
barium	total	mg/l	0.61
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.07
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	5.00
oil and grease		mg/l	<1.00
chloride		mg/l	45.00
sulfate		mg/l	110.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	6.96
conductivity		umhos/cm	985.00

WELL 48B
5/29/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	0.06
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.06
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.07
arsenic	total	mg/l	0.08
barium	total	mg/l	0.73
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.02

lead	total	mg/l	0.07
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.07
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.10
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	38.00
sulfate		mg/l	130.00
cyanide		mg/l	<0.20
gross alpha		pc/l	12.00
alpha counting error		pc/l	8.00
gross beta		pc/l	28.00
beta counting error		pc/l	7.00
radium-226		pc/l	3.40
Ra-226 counting error		pc/l	2.00
radium-228		pc/l	<1.00
pH, field		pH	6.82
conductivity		umhos/cm	1361.00

WELL 49A
6/4/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.04
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	<0.00
barium	total	mg/l	2.20
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.03
lead	total	mg/l	0.05
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.07
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.16
total organic carbon		mg/l	5.00
oil and grease		mg/l	<1.00
chloride		mg/l	26.00
sulfate		mg/l	5.00
cyanide		mg/l	<0.20
gross alpha		pc/l	10.00
alpha counting error		pc/l	8.00
gross beta		pc/l	11.00

beta counting error	pc/l	3.00
pH, fie	pH	7.04
conductivity	umhos/cm	758.00

WELL 49B
6/3/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	0.64
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	0.05
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.08
selenium	dissolved	mg/l	0.01
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	<0.00
barium	total	mg/l	0.84
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.01
lead	total	mg/l	0.04
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.06
selenium	total	mg/l	0.01
silver	total	mg/l	<0.01
zinc	total	mg/l	0.10
total organic carbon		mg/l	6.00
oil and grease		mg/l	<1.00
chloride		mg/l	1200.00
sulfate		mg/l	160.00
cyanide		mg/l	<0.20
gross alpha		pc/l	325.00
alpha counting error		pc/l	143.00
gross beta		pc/l	318.00
beta counting error		pc/l	55.00
radium-226		pc/l	3.10
Ra-226 counting error		pc/l	1.80
radium-228		pc/l	<1.00
pH, field		pH	6.60
conductivity		umhos/cm	4.99

WELL 50A
6/5/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02

mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.08
arsenic	total	mg/l	0.00
barium	total	mg/l	0.52
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.04
total organic carbon		mg/l	6.00
oil and grease		mg/l	<1.00
chloride		mg/l	4.80
sulfate		mg/l	12.00
cyanide		mg/l	<0.20
gross alpha		pc/l	5.00
alpha counting error		pc/l	4.00
gross beta		pc/l	7.00
beta counting error		pc/l	3.00
pH, field		pH	7.08
conductivity		umhos/cm	704.00

WELL 50B
6/3/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	1.50
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.05
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.06
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	<0.00
barium	total	mg/l	3.20
cadmium	total	mg/l	0.01
chromium	total	mg/l	0111
lead	total	mg/l	0.08
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.10
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.15
total organic carbon		mg/l	41.00
oil and grease		mg/l	<1.00

chloride	mg/l	2.80
sulfate	mg/l	59.00
cyanide	mg/l	<0.20
gross alpha	pc/l	<2.00
gross beta	pc/l	147.00
beta counting error	pc/l	46.00
radium-228	pc/l	<1.00
pH, field	pH	7.07
conductivity	umhos/cm	911.00

WELL 51A
6/6/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.08
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.07
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	31.00
sulfate		mg/l	16.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	7.25
conductivity		umhos/cm	612.00

WELL 51B
6/5/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01

lead	dissolved	mg/l	0.03
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.03
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.06
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.04
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.04
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	150.00
sulfate		mg/l	130.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	6.85
conductivity		umhos/cm	1640.00

WELL 52A
6/11/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.02
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.03
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.06
total organic carbon		mg/l	7.00
oil and grease		mg/l	<1.00
chloride		mg/l	5.80

sulfate	mg/l	14.00
cyanide	mg/l	<0.20
gross alpha	pc/l	<2.00
gross beta	pc/l	27.00
beta counting error	pc/l	4.00
pH, field	pH	10.56
conductivity	umhos/cm	3.59

WELL 52B
6/11/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.04
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.04
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	0.01
zinc	dissolved	mg/l	0.08
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.04
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.05
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.08
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	130.00
sulfate		mg/l	4.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	5.00
beta counting error		pc/l	3.00
pH, field		pH	7.18
conductivity		umhos/cm	1256.00

WELL 11WS
6/6/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.03

mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.02
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.07
total organic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	6.30
sulfate		mg/l	5.00
cyanide		mg/l	<0.20
gross alpha		pc/l	4.00
alpha counting error		pc/l	3.00
gross beta		pc/l	<3.00
pH, field		pH	7.16
conductivity		umhos/cm	424.00

WELL 12WS
6/4/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	<0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.02
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	<0.01
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	5.30

sulfate	mg/l	5.00
cyanide	mg/l	<0.20
gross alpha	pc/l	<2.00
gross beta	pc/l	<3.00
pH, field	pH	7.27
conductivity	umhos/cm	470.00

WELL 13WS
6/4/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.03
mercury	dissolved	mg/l	<0.00
nickel	dsssolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.04
mercury	total	mg/l	<0.00
nickel	total	mg/l	<0.01
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	7.00
oil and grease		mg/l	<1.00
chloride		mg/l	4.50
sulfate		mg/l	5.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	6.95
conductivity		umhos/cm	425.00

WELL 14WS
6/4/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.01
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.02
lead	dissolved	mg/l	0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	<0.01

selenium	dissolved	mg/l	0.13
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.01
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.03
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	<0.01
selenium	total	mg/l	0.14
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	4.00
oil and grease		mg/l	<1.00
chloride		mg/l	29.00
sulfate		mg/l	2.00
cyanide		mg/l	<0.20
gross alpha		pc/l	27.00
alpha counting error		pc/l	7.00
gross beta		pc/l	7.00
beta counting error		pc/l	3.00
pH, field		pH	7.78
conductivity		umhos/cm	655.00

WELL 15WS
6/4/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	0.58
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.06
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	8.00
oil and grease		mg/l	<1.00
chloride		mg/l	5.30
sulfate		mg/l	6.00

cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	7.54
conductivity		umhos/cm	448.00

WELL 16WS
9/24/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.90
cadmium	dissolved	mg/l	0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.01
arsenic	total	mg/l	<0.00
barium	total	mg/l	0.68
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.01
lead	total	mg/l	0.04
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.04
total organic carbon		mg/l	0.86
cyanide		mg/l	<0.20
pH, field		pH	7.88
conductivity		umhos/cm	470.00

WELL 20WS
6/12/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.52
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	<0.01
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	0.01
zinc	dissolved	mg/l	0.06
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01

chromium	total	mg/l	0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.07
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	5.80
sulfate		mg/l	9.00
cyanide		mg/l	<0.20
gross alpha		pc/l	14.00
alpha counting error		pc/l	6.00
gross beta		pc/l	11.00
beta counting error		pc/l	6.00
radium-226		pc/l	3.30
Ra-226 counting error		pc/l	1.00
radium-228		pc/l	<1.00
pH, field		pH	7.76
conductivity		umhos/cm	428.00

WELL 21WS
6/12/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.52
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.02
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.07
arsenic	total	mg/l	0.00
barium	total	mg/l	0.51
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.02
lead	total	mg/l	0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.08
total organic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	12.00
sulfate		mg/l	5.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	7.00

beta counting error	pc/l	6.00
pH, field	pH	8.16
conductivity	umhos/cm	440.00

WELL 4WS
6/11/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	0.01
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.05
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	0.01
silver	total	mg/l	<0.01
zinc	total	mg/l	0.04
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	7.00
sulfate		mg/l	7.00
cyanide		mg/l	<0.20
gross alpha		pc/l	6.00
alpha counting error		pc/l	3.00
gross beta		pc/l	9.00
beta counting error		pc/l	3.00
pH, field		pH	7.27
conductivity		umhos/cm	419.00

WELL 7WS
6/12/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	<0.01
selenium	dissolved	mg/l	<0.00

silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.09
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.01
lead	total	mg/l	<0.02
mercur	total	mg/l	<0.00
nickel	total	mg/l	<0.01
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.06
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	6.00
sulfate		mg/l	16.00
cyanide		mg/l	<0.20
gross alpha		pc/l	26.00
alpha counting error		pc/l	8.00
gross beta		pc/l	28.00
beta counting error		pc/l	7.00
pH, field		pH	7.01
conductivity		umhos/cm	497.00

WELL 8WS
6/26/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.03
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissllved	mg/l	0.01
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	0.01
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	3.80
sulfate		mg/l	6.00
cyanide		mg/l	<0.20

gross alpha	pc/l	6.00
alpha counting error	pc/l	3.00
gross beta	pc/l	10.00
beta counting error	pc/l	3.00
pH, field	pH	7.59
conductivity	umhos/cm	381.00

WELL 9WS
6/26/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.02
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chromium	total	mg/l	0.01
lead	total	mg/l	0.06
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.05
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	5.80
sulfate		mg/l	5.00
cyanide		mg/l	<0.20
gross alpha		pc/l	9.00
alpha counting error		pc/l	6.00
gross beta		pc/l	15.00
beta counting error		pc/l	7.00
pH, field		pH	6.25
conductivity		umhos/cm	405.00

WELL 22A
3/20/86

-3305

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.05

mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.03
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.12
arsenic	total	mg/l	0.00
barium	total	mg/l	0.58
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.05
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.04
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.10
total organic carbon		mg/l	6.00
oil and grease		mg/l	2.20
chloride		mg/l	21.00
sulfate		mg/l	9.00
cyanide		mg/l	<0.20
gross alpha		pc/l	7.00
alpha counting error		pc/l	5.00
gross beta		pc/l	<3.00
radium-226		pc/l	<0.60
pH, field		pH	11.36
conductivity		umhos/cm	711.00

WELL 22B
5/9/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	0.56
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.12
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.06
arsenic	total	mg/l	<0.00
barium	total	mg/l	0.66
cadmium	total	mg/l	<0.01
chromium	total	mg/l	0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.17
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.08
total organic carbon		mg/l	1.80
pH, field		pH	7.13

conductivity	umhos/cm	1141.00

WELL 23A
3/24/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.78
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.06
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.04
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.64
arsenic	total	mg/l	0.00
barium	total	mg/l	0.74
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.04
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.14
total organic carbon		mg/l	1.90
oil and grease		mg/l	<1.00
chloride		mg/l	9.50
sulfate		mg/l	5.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	14.00
beta counting error		pc/l	6.00
radium-228		pc/l	<1.00
pH, field		pH	8.68
conductivity		umhos/cm	551.00

WELL 23B
5/9/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	1.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.12
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.06

arsenic	total	mg/l	<0.00
barium	total	mg/l	2.30
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.13
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.06
total organic carbon		mg/l	2.20
pH, field		pH	6.80
conductivity		umhos/cm	655.00

WELL 24A
3/24/86

PARAMETRR		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.92
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.06
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.05
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.58
arsenic	total	mg/l	0.00
barium	total	mg/l	0.67
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.05
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.12
total organic carbon		mg/l	7.90
oil and grease		mg/l	<1.00
chloride		mg/l	96.00
sulfate		mg/l	49.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	11.00
beta counting error		pc/l	4.00
radium-228		pc/l	<1.00
pH, field		pH	9.37
conductivity		umhos/cm	893.00

WELL 24WS
6/12/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	0.57
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	0.03
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.07
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.06
total oraanic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	4.00
sulfate		mg/l	6.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	14.00
beta counting error		pc/l	6.00
pH, field		pH	7.60
conductivity		umhos/cm	469.00

WELL 25WS
6/6/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.04
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01

chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.04
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	8.00
sulfate		mg/l	6.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	7.22
conductivity		umhos/cm	481.00

WELL 26WS
6/6/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.02
selenium	dissolved	mg/l	0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.02
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01
chromium	total	mg/l	<0.01
lead	total	mg/l	<0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.02
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.03
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	3.00
sulfate		mg/l	6.00
cyanide		mg/l	<0.20
gross alpha		pc/l	<2.00
gross beta		pc/l	<3.00
pH, field		pH	7.19
conductivity		umhos/cm	474.00

WELL 27WS
6/11/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	0.05
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	0.01
zinc	dissolved	mg/l	0.03
arsenic	total	mg/l	<0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	0.01
chrmmium	total	mg/l	0.01
lead	total	mg/l	0.03
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.01
selenium	total	mg/l	0.00
silver	total	mg/l	0.02
zinc	total	mg/l	0.03
total organic carbon		mg/l	3.00
oil and grease		mg/l	<1.00
chloride		mg/l	4.50
sulfate		mg/l	15.00
cyanide		mg/l	<0.20
gross alpha		pc/l	4.00
alpha counting error		pc/l	3.00
gross beta		pc/l	<3.00
pH, field		pH	7.70
conductivity		umhos/cm	418.00

WELL 28WS
6/12/86

PARAMETER		UNITS	VALUE
arsenic	dissolved	mg/l	<0.00
barium	dissolved	mg/l	<0.50
cadmium	dissolved	mg/l	<0.01
chromium	dissolved	mg/l	<0.01
lead	dissolved	mg/l	<0.02
mercury	dissolved	mg/l	<0.00
nickel	dissolved	mg/l	<0.01
selenium	dissolved	mg/l	<0.00
silver	dissolved	mg/l	<0.01
zinc	dissolved	mg/l	0.07
arsenic	total	mg/l	0.00
barium	total	mg/l	<0.50
cadmium	total	mg/l	<0.01

chromium	total	mg/l	<0.01
lead	total	mg/l	0.02
mercury	total	mg/l	<0.00
nickel	total	mg/l	0.03
selenium	total	mg/l	<0.00
silver	total	mg/l	<0.01
zinc	total	mg/l	0.09
total organic carbon		mg/l	2.00
oil and grease		mg/l	<1.00
chloride		mg/l	5.80
sulfate		mg/l	10.00
cyanide		mg/l	<0.20
gross alpha		pc/l	10.00
alpha counting error		pc/l	6.00
gross beta		pc/l	13.00
beta counting error		pc/l	6.00
pH, field		pH	7.85
conductivity		umhos/cm	432.00

APPENDIX D

LABORATORY DATA
OKLAHOMA STATE DEPARTMENT OF HEALTH

AMPLE NUMBER 133535 SAMP 00019
ATE COLLECTED 11/25/86 TIME 08:00
DATE RECEIVED 12/15/86
ATE COMPLETED 12/15/86
TATION DEPTH CODE
CO ECTED BY RDM

OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

DWAIN FARLEY, CHIEF
WASTE MANAGEMENT SERVICE
OSDH ROOM 503
OKLAHOMA CITY OK 73152

COPY

GENERAL PROJECTS

		CONCENTRATION IN SAMPLE				CONCENTRATION IN SAMPLE	
ETH ETH KETONE WTR	N		UG/L	STYRENE IN WATER	N		UG/L
YLENE IN WATER	N		UG/L	ACETONE TOTAL	N		UG/L
TYLISOBTYLKETONE W	N		UG/L	CARBON DISULFIDE WTR	N		UG/L
THYLENE CHLORIDE W	N		UG/L	1,1-DICHLOROETHENE W	N		UG/L
2-DICHLROETHANE W	N		UG/L	TRN1,2DICHLRETHENE W	N		UG/L
LOROFORM IN WATER		3.9	UG/L	1,2-DICHLOROETHANE W	N		UG/L
1,1-TRICLRETHANE W	N		UG/L	CARBON TETRACHLRIE W	N		UG/L
ICLOROBRMOMETHANE W		2.2	UG/L	1,2-DICHLORPROPANE W	N		UG/L
-1,3-DICLROPRPENE W	N		UG/L	TRICHLOROETHENE W	N		UG/L
LORDIBROMOMETHNE W	N		UG/L	C-1,3-DICLROPRPENE W	N		UG/L
2-TRICLOROETHANE W	N		UG/L	BENZENE IN WATER	N		UG/L
ROMOFORM IN WATER	N		UG/L	TETRACLOROETHLENE W	N		UG/L
22-TETRACLETHANE W	N		UG/L	TOLUENE IN WATER	N		UG/L
LOROBENZENE IN WTR	N		UG/L	ETHYLBENZENE IN WTR	N		UG/L
ETHYL CHLORIDE WTR	N		UG/L	METHYL BROMIDE WTR	N		UG/L
CHLORIDE W	N		UG/L	CHLOROETHANE IN WTR	N		UG/L
ROETHLVNLETHR W	N		UG/L	2-HEXANONE WATER	N		UG/L
NYL ACETATE WATER	N		UG/L				

25965A CODE EXPLANATIONS

N NOT DETECTED

URCE TINKER 169 GROUND CITY TINKER
OGRAM WASTE MGMT SER GENERAL PROJECT
NTY OKLAHOMA

LEGAL

SEC T R W

FS DEL CITY WELL #2
MMENTS

ALYST'S
MMENTS

FORM NO 8144-C Rev

Rocky D. McElveny
ENVIRONMENTAL LABORATORY SERVICE

REQUISITIONER COPY

ANALYST

SAMPLE NUMBER 133559 SAMP 00002
DATE COLLECTED 11/25/86 TIME 08:00
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DATE COMPLETED 12/15/86
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OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY
REPORT OF ANALYSIS

DWAIN FARLEY, CHIEF
WASTE MANAGEMENT SERVICE
OSDH ROOM 803
OKLAHOMA CITY OK 73152

COPY

GENERAL PROJECTS

	CONCENTRATION IN SAMPLE						
ETH ETH KETONE WTR	N		UG/L	STYRENE IN WATER	N		UG/L
YLENE IN WATER	N		UG/L	ACETONE TOTAL	N		UG/L
ETYLISOBTYLKETONE W	N		UG/L	CARBON DISULFIDE WTR	N		UG/L
THYLENE CHLORIDE W	N		UG/L	1,1-DICHLOROETHENE W	N		UG/L
1-DICHLOROETHANE W	N		UG/L	TRN1,2DICHLRETHENE W	N		UG/L
LOROFORM IN WATER	N		UG/L	1,2-DICHLOROETHANE W	N		UG/L
1,1,1-TRICLRETHANE W	N		UG/L	CARBON TETRACHLRDE W	N		UG/L
ICLOROBRMOMETHANE W	N		UG/L	1,2-DICHLORPROPANE W	N		UG/L
-1,3-DICLROPRPENE W	N		UG/L	TRICHLOROETHENE W	N		UG/L
LORODIBROMOMETHNE W	N		UG/L	C-1,3-DICLROPRPENE W	N		UG/L
L2-TRICLOROETHANE W	N		UG/L	BENZENE IN WATER	N		UG/L
ROMOFORM IN WATER	N		UG/L	TETRACLOROETHLENE W	N		UG/L
L22-TETRACLETHANE W	N		UG/L	TOLUENE IN WATER	N		UG/L
LOROBENZENE IN WTR	N		UG/L	ETHYLBENZENE IN WTR	N		UG/L
THYL CHLORIDE WTR	N		UG/L	METHYL BROMIDE WTR	N		UG/L
NYL CHLORIDE W	N		UG/L	CHLOROETHANE IN WTR	N		UG/L
CHLROETHLVNLETHR W	N		UG/L	2-HEXANONE WATER	N		UG/L
NYL ACETATE WATER	N		UG/L				

REMARK CODE EXPLANATIONS

N NOT DETECTED

URCE TINKER D62 GROUND CITY TINKER
OGRAM WASTE MGMT SER(GENERAL PROJECT
UNTY OKLAHOMA

LEGAL

/4 4 4 SEC T R M

MPLERS MCMICHAEL PRIVATE WELL
MMENTS

ALYSTS
MMENTS

E FORM NO 8AA 1183

Rocky D. McElwain
ENVIRONMENTAL LABORATORY SERVICE

ANALYST

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SAMPLE NUMBER 136540 00000
DATE COLLECTED 11/25/86 TIME 10:00
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OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

		CONCENTRATION IN SAMPLE				CONCENTRATION IN SAMPLE	
SENIC-DISSOLVED	K	10	UG/L	BARIUM DISSOLVED		737	UG/L
ADMIUM DISSOLVED	K	2	UG/L	CHROMIUM DISSOLVED	<	10	UG/L
AD-DISSOLVED	K	20	UG/L	NICKEL-DISSOLVED	<	25	UG/L
LENIUM-DISSOLVED	K	5	UG/L	SILVER-DISSOLVED	<	7.0	UG/L
INC-DISSOLVED		28	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

JRCE TINKER OB2
OBE TINKER AIR FORCE BASE
TY OKLAHOMA

CITY TINKER

LEGAL

4 4 4 SEC T R M

TES TINKER CONTAINER
NTS DISSOLVED METALS

LYST S
MMENTS

FORM NO 8144-10 88

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ENVIRONMENTAL LABORATORY SERVICE

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ANALYST

SAMPLE NUMBER 138541 00900
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OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

ARSENIC-DISSOLVED	<	10	UG/L	BARIUM DISSOLVED		706	UG/L
CADMIUM DISSOLVED	<	2	UG/L	CHROMIUM DISSOLVED	<	10	UG/L
LEAD-DISSOLVED	<	20	UG/L	NICKEL-DISSOLVED	<	25	UG/L
SELENIUM-DISSOLVED	<	5	UG/L	SILVER-DISSOLVED	<	7.0	UG/L
ZINC-DISSOLVED		29	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

SOURCE TINKER DB2
PROGRAM TINKER AIR FORCE BASE
COUNTY OKLAHOMA

TINKER

LEGAL

4 4 4 SEC T R M

SAMPLERS OSDH CONTAINER
COMMENTS DISSOLVED METALS

ANALYST'S
COMMENTS

Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

ANALYST

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PLE NUMBER 138542 00002

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STATE ENVIRONMENTAL LABORATORY SERVICE

REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

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SPECIAL PROJECTS

		CONCENTRATION IN SAMPLE				CONCENTRATION IN SAMPLE	
SENIC-TOTAL	<	10	UG/L	BARIUM TOTAL		684	UG/L
DMIUM-TOTAL	<	2	UG/L	CHROMIUM-TOTAL	<	10	UG/L
D-TOTAL	<	20	UG/L	NICKEL-TOTAL	<	25	UG/L
ENIUM-TOTAL	<	5	UG/L	SILVER-TOTAL	<	7	UG/L
NC-TOTAL		35	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

CODE TINKER 082

CITY TINKER

TINKER AIR FORCE BASE

OKLAHOMA

LEGAL

4 4 SEC T R M

PS TINKER CONTAINER

MENTS TOTAL METALS

LYSTS

MMENTS

Rocky D. McElvany

ENVIRONMENTAL LABORATORY SERVICE

ANALYST

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SAMPLE NUMBER 138543 00003
DATE COLLECTED 11/25/86 TIME 08:00
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OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

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SPECIAL PROJECTS

	CONCENTRATION IN SAMPLE				
ARSENIC-TOTAL	<	10 UG/L	BARIUM TOTAL		706 UG/L
CADMIUM-TOTAL	<	2 UG/L	CHROMIUM-TOTAL	<	10 UG/L
LEAD-TOTAL	<	20 UG/L	NICKEL-TOTAL	<	25 UG/L
SELENIUM-TOTAL	<	5 UG/L	SILVER-TOTAL	<	7 UG/L
ZINC-TOTAL		23 UG/L			

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

SOURCE TINKER 082
PROGRAM TINKER AIR FORCE BASE
UNIT OKLAHOMA

TINKER

LEGAL

¼ ¼ ¼ SEC T R M

SAMPLE OSDH CONTAINER
COMMENTS TOTAL METALS

ANALYSTS
COMMENTS

PERFORMING AREA NUMBER

Rocky D. McElvany
Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

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ANALYST

SAMPLE NUMBER 136544 CC0GC
DATE COLLECTED 11/25/86 TIME 08:00
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STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
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OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

		CONCENTRATION IN SAMPLE				CONCENTRATION IN SAMPLE	
ARSENIC-DISSOLVED	<	10	UG/L	BARIUM DISSOLVED		239	UG/L
CADMIUM DISSOLVED	<	2	UG/L	CHROMIUM DISSOLVED	<	10	UG/L
LEAD-DISSOLVED	<	20	UG/L	NICKEL-DISSOLVED	<	25	UG/L
SELENIUM-DISSOLVED	<	5	UG/L	SILVER-DISSOLVED	<	7.0	UG/L
ZINC-DISSOLVED		31	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

SOURCE TINKER OBS
DEPT TINKER AIR FORCE BASE
CNTY OKLAHOMA
CITY TINKER

LEGAL
¼ ¼ ¼ SEC T R M

PROJECTS TINKER CONTAINER
COMMENTS DISSOLVED METALS

ANALYSTS
COMMENTS

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Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

FORM NO. 8744-1086

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ANALYST

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STATE ENVIRONMENTAL LABORATORY SERVICE

REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

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SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

SENIC-DISSOLVED	<	10	UG/L	BARIUM DISSOLVED		241	UG/L
DMIUM DISSOLVED	<	2	UG/L	CHROMIUM DISSOLVED	<	10	UG/L
AD-DISSOLVED	<	20	UG/L	NICKEL-DISSOLVED	<	25	UG/L
LENIUM-DISSOLVED	<	5	UG/L	SILVER-DISSOLVED	<	7.0	UG/L
NC-DISSOLVED		17	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

URCE TINKER OB3 CITY TINKER

OGRAM TINKER AIR FORCE BASE

UNTY OKLAHOMA

LEGAL

/4 /4 /4 SEC T R M

AMPLER'S OSDH CONTAINER

OMMENTS DISSOLVED METALS

ALYST'S

OMMENTS

Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

D FORM NO. 8448 (5-81)

ANALYST

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OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

ARSENIC-TOTAL	<	10	UG/L	BARIUM TOTAL		238	UG/L
CADMIUM-TOTAL	<	2	UG/L	CHROMIUM-TOTAL	<	10	UG/L
LEAD-TOTAL	<	20	UG/L	NICKEL-TOTAL	<	25	UG/L
SELENIUM-TOTAL	<	5	UG/L	SILVER-TOTAL	<	7	UG/L
ZINC-TOTAL		26	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

SOURCE TINKER OB3 GROUND CITY TINKER
REFERENCE TINKER AIR FORCE BASE
COUNTY OKLAHOMA

LEGAL

¼ ¼ ¼ SEC T R M

SAMPLE TINKER CONTAINER
COMMENTS TOTAL METALS

ANALYSTS
COMMENTS

Rocky D. McElvany
Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

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ANALYST

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TE COMPLETED 12/04/86
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OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

ENIC-TOTAL	<	10	UG/L	BARIUM TOTAL		233	UG/L
MIUM-TOTAL	<	2	UG/L	CHROMIUM-TOTAL	<	10	UG/L
D-TOTAL	<	20	UG/L	NICKEL-TOTAL	<	25	UG/L
ENIUM-TOTAL	<	5	UG/L	SILVER-TOTAL	<	7	UG/L
C-TOTAL		14	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

CE TINKER UB3 GROUND CITY TINKER
TINKER AIR FORCE BASE
TY OKLAHOMA

LEGAL
A 1/4 SEC T R M

ERS OSDH CONTAINER
NTS TOTAL METALS

YSTS
MENTS

Rocky D. McElvany
Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

ANALYST

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SAMPLE NUMBER 138545 00000

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DATE RECEIVED 12/02/86

DATE COMPLETED 12/05/86

LOCATION DEPTH CODE

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OKLAHOMA STATE DEPARTMENT OF HEALTH

STATE ENVIRONMENTAL LABORATORY SERVICE

REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

	CONCENTRATION IN SAMPLE				
ENIC-DISSOLVED	<	10 UG/L	BARIUM DISSOLVED		363 UG/L
DMIUM DISSOLVED	<	2 UG/L	CHROMIUM DISSOLVED	<	10 UG/L
D-DISSOLVED	<	20 UG/L	NICKEL-DISSOLVED	<	25 UG/L
ENIUM-DISSOLVED	<	5 UG/L	SILVER-DISSOLVED	<	7.0 UG/L
NC-DISSOLVED		29 UG/L			

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

SITE TINKER 089 GROUND CITY TINKER

PROJECT TINKER AIR FORCE BASE

COUNTY OKLAHOMA

LEGAL

¼ ¼ ¼ SEC T R M

MATRIX TINKER CONTAINER

COMMENTS DISSOLVED METALS

ANALYSTS

COMMENTS

Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

FORM NO 8164 1086

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ANALYST

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STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

RSENIC-DISSOLVED	<	10	UG/L	BARIUM DISSOLVED		370	UG/L
ADMIUM DISSOLVED	<	2	UG/L	CHROMIUM DISSOLVED	<	10	UG/L
EAD-DISSOLVED	<	20	UG/L	NICKEL-DISSOLVED	<	25	UG/L
ELENIUM-DISSOLVED	<	5	UG/L	SILVER-DISSOLVED	<	7.0	UG/L
INC-DISSOLVED		17	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

URCE TINKER OBY GROUND CITY TINKER
OGRAM TINKER AIR FORCE BASE
UNTY OKLAHOMA

LEGAL

/4 /4 /4 SEC T R M

MPLE'S OSDH CONTAINER
)MMENTS DISSOLVED METALS

ALYSTS
)MMENTS

Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

E FORM NO. 8AA-1-88

ANALYST

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OKLAHOMA STATE DEPARTMENT OF HEALTH

STATE ENVIRONMENTAL LABORATORY SERVICE

REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

		CONCENTRATION IN SAMPLE				
SENIC-TOTAL	<	10	UG/L	BARIUM TOTAL		376 UG/L
ADMIUM-TOTAL	<	2	UG/L	CHROMIUM-TOTAL	<	10 UG/L
AD-TOTAL	<	20	UG/L	NICKEL-TOTAL	<	25 UG/L
ENIUM-TOTAL	<	5	UG/L	SILVER-TOTAL	<	7 UG/L
INC-TOTAL		17	UG/L			

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

RCE TINKER OB9 GROUND

GRAM TINKER AIR FORCE BASE CITY TINKER

NTY OKLAHOMA

LEGAL

/4 /4 /4 SEC T R M

ES TINKER CONTAINER

NTS TOTAL METALS

LYSTS

MMENTS

FORM NO. [illegible]

Rocky D. McElvany

Environmental Lab Service

ANALYST

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STATE ENVIRONMENTAL LABORATORY SERVICE

REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

SENIC-TOTAL	<	10	UG/L	BARIUM TOTAL		327	UG/L
DMIUM-TOTAL	<	2	UG/L	CHROMIUM-TOTAL	<	10	UG/L
AD-TOTAL	<	20	UG/L	NICKEL-TOTAL	<	25	UG/L
LENIUM-TOTAL	<	5	UG/L	SILVER-TOTAL	<	7	UG/L
NC-TOTAL		20	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

URCE TINKER OB9 GROUND CTY TINKER

OGRAM TINKER AIR FORCE BASE

UNTY OKLAHOMA

LEGAL

¼ ¼ ¼ SEC T R M

MPLER'S OSDH CONTAINER

OMMENTS TOTAL METALS

NALYST'S

OMMENTS

Rocky D. McElvany

Rocky D. McElvany
ENVIRONMENTAL LABORATORY SERVICE

HD FORM NO. E-44 (REV.)

ANALYST

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SAMPLE NUMBER 133552 00000

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STATE ENVIRONMENTAL LABORATORY SERVICE

REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

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SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

ARSENIC-DISSOLVED	<	10	UG/L	BARIUM DISSOLVED		333	UG/L
CADMIUM DISSOLVED	<	2	UG/L	CHROMIUM DISSOLVED	<	10	UG/L
LEAD-DISSOLVED	<	20	UG/L	NICKEL-DISSOLVED	<	25	UG/L
SELENIUM-DISSOLVED	<	5	UG/L	SILVER-DISSOLVED	<	7.0	UG/L
ZINC-DISSOLVED		50	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

SOURCE TINKER DS12 GROUND CITY TINKER

DESC TINKER AIR FORCE BASE

CO. OKLAHOMA

LEGAL

¼ ¼ ¼ SEC T R M

PROJECTS TINKER CONTAINER

COMMENTS DISSOLVED METALS

ANALYSTS

COMMENTS

FORM NO 8322 (OSE)

Rocky D. McElvany

Rocky D. McElvany
ENVIRONMENTAL LAB SUPERVISOR

ANALYST

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SAMPLE NUMBER 136553 00000
DATE COLLECTED 11/25/86 TIME 08:00
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DATE COMPLETED 12/05/86
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OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

RSENIC-DISSOLVED	<	10	UG/L	BARIUM DISSOLVED		348	UG/L
ADMIUM DISSOLVED	<	2	UG/L	CHROMIUM DISSOLVED	<	10	UG/L
EAD-DISSOLVED	<	20	UG/L	NICKEL-DISSOLVED	<	25	UG/L
ELENIUM-DISSOLVED	<	5	UG/L	SILVER-DISSOLVED	<	7.0	UG/L
INC-DISSOLVED		22	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

URCE TINKER 0810 GROUND
OGRAM TINKER AIR FORCE BASE
UNTY OKLAHOMA
CITY TINKER

LEGAL

/4 4 /4 SEC T R M

MPLERS OSDH CONTAINER
MMENTS DISSOLVED METALS

ALYSTS
MMENTS

D FORM NO. E-4A 10-85

Rocky D. McElvany
ANALYST

REQUISITIONER COPY

SAMPLE NUMBER 13554 00001
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OKLAHOMA STATE DEPARTMENT OF HEALTH
STATE ENVIRONMENTAL LABORATORY SERVICE
REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB.
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

	CONCENTRATION IN SAMPLE					
ENIC-TOTAL	<	10	UG/L	BARIUM TOTAL		354 UG/L
DMIUM-TOTAL	<	2	UG/L	CHROMIUM-TOTAL	<	10 UG/L
D-TOTAL	<	20	UG/L	NICKEL-TOTAL	<	25 UG/L
ENIUM-TOTAL	<	5	UG/L	SILVER-TOTAL	<	7 UG/L
NC-TOTAL		12	UG/L			

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

SOURCE TINKER 0810 GROUND CITY TINKER
PROGRAM TINKER AIR FORCE BASE
COUNTY OKLAHOMA

LEGAL

¼ ¼ ¼ SEC T R M

MATRIX TINKER CONTAINER
COMMENTS TOTAL METALS

ANALYSTS
COMMENTS

Rocky D. McElvany

FORM NO. [illegible]

ANALYST

REQUISITIONER COPY

SAMPLE NUMBER 138555 OCCOO

DATE COLLECTED 11/25/86 TIME 08:00

DATE RECEIVED 12/02/86

DATE COMPLETED 12/04/86

STATION DEPTH CODE

COLLECTED BY RDM

OKLAHOMA STATE DEPARTMENT OF HEALTH

STATE ENVIRONMENTAL LABORATORY SERVICE

REPORT OF ANALYSIS

ROCKY MCELVANY
STATE ENVIRONMENTAL LAB
OKLA. STATE DEPT. OF HEALTH
OKLAHOMA CITY, OK 73152

COPY

SPECIAL PROJECTS

CONCENTRATION IN SAMPLE

SENIC-TOTAL	<	10	UG/L	BARIUM-TOTAL		316	UG/L
DMIUM-TOTAL	<	2	UG/L	CHROMIUM-TOTAL	<	10	UG/L
AD-TOTAL	<	20	UG/L	NICKEL-TOTAL	<	25	UG/L
LENIUM-TOTAL	<	5	UG/L	SILVER-TOTAL	<	7	UG/L
NC-TOTAL		9	UG/L				

REMARK CODE EXPLANATIONS

< LESS THAN DETECTION LIMIT

RCE TINKER 0810 GROUND CITY TINKER

GRAM TINKER AIR FORCE BASE

NTY OKLAHOMA

LEGAL

/4 /4 /4 SEC T R M

MPLER'S OSDH CONTAINER

MMENTS TOTAL METALS

LYSTS

MMENTS

Rocky D. McElvany

Rocky D. McElvany
ENVIRONMENTAL LAB SPECIALIST

FORM NO. 614A-10-86

ANALYST

REQUISITIONER COPY

APPENDIX E

GARBER–WELLINGTON ASSOCIATION
MONITORING PLAN

LONG TERM MONITORING PLAN FOR WATER QUALITY CHANGES IN TINKER AIR FORCE BASE WELL FIELD DUE TO USAGE OF THE WELL FIELD

Introduction

During the early phase of the federally funded Garber-Wellington Research Project, investigators were concerned about possible effects of overpumpage of a well or well field on the quality of water produced, i.e. saltwater intrusion. During the past six years (since 1980), the Garber-Wellington Association has monitored the water quality in Garber-Wellington Aquifer municipal wells through a yearly sampling program. Results of the sampling program have indicated that overpumpage of a well or well field contributes to localized increased levels of some naturally occuring regulated water quality parameters, in particular, chromium, selenium and arsenic. In general only slight increases in chloride concentrations have occured in well fields during the six years of monitoring indicating that perhaps saltwater intrusion is not as critical an issue as the increased levels of trace elements.

In the Midwest City well field just north of TAFB, wells were pumped extensively through 1985. Based on results of ACOG/GWA's water quality sampling program, the percentage of wells in the well field with detectable chromium concentrations increased from 22% in 1981 to 50% in 1984. One of the wells exceeded the MCL for selenium in 1984. From 1980 to 1984 the percentage of wells with detectable chloride went from 11% to 41%. In 1980, 61% of the wells had a pH above 7.5; in 1984, 84% of the wells had a pH above 7.5.

In 1985, a water sample of a Garber-Wellington Aquifer municipal well indicated extremely high selenium concentrations, well above the MCL. The well was taken out of service for 6 months and then turned back on to discharge to waste for six weeks. During the six week period, the well was sampled weekly and the water level was measured at the beginning and at the end of the six week period. The sample results indicated that through time the pH and selenium concentrations increased significantly. Selenium concentrations increased from non-detectable in the first 48 hours of operation, to fourteen times the MCL by the fifth week. Alkalinity, sulfate, and sodium concentrations also increased during the six week period.

During the six years of ACOG/GWA's water quality sampling program, several interesting relationships between pH levels and concentrations of regulated trace elements have been noted. 82% of the groundwater samples analyzed during the six year period, with non-detectable selenium had a pH less than 8.5. Only 45% of the samples analyzed with detectable selenium had a pH less than 8.5. 82% of the samples analyzed with non-detectable chromium had a pH less than 8.0. 22% of the samples analyzed with detectable chromium had pH less than 8.0.

Using a combination of ACOG/GWA's Municipal Well Records Keeping System and yearly sampling of municipal wells, wells and well fields can be monitored to ensure maximum production from wells with minimum effect on produced water quality.

Monitoring Well Program

The wells to be monitored at TAFB include all the base water supply wells (whether currently in use or not) and all monitor or observation wells screened at depths of 250 feet or greater (Figure 1). The base water supply wells are the wells which affect the water quality and water level in the aquifer in the immediate vicinity of TAFB. Monitor wells screened in zones between 250 feet and 400 feet may reflect what effect if any, the deeper production wells are having on the shallower zones of the aquifer. Domestic wells are generally shallower than 150 feet, however, some areas around TAFB have domestic wells that range from 150 feet to 350 feet.

Water Level Monitoring

Water levels are essential to determine whether the cause of water quality changes are due to overpumpage or loss of well integrity. Overpumpage will cause consistantly lower water levels. Changes in well integrity caused by holes in the casing, or plugging of perforations or screens, may cause higher or lower water levels unrelated to usage of the well.

Currently TAFB water supply wells each have an access port to accomodate an electric sounder. Water levels will be measured monthly in each well. Each production well will be measured at least twice each year, preferable at six month intervals, for a static water level (other levels may be pumping levels). The spacing of TAFB wells is close enough to cause interference between wells. A static level in a shut-in well will reflect the interference of surrounding wells. Nearby wells in operation at the time of a static level measurement in a shut-in well will be noted. A relationship between the static level in each well and the locations of wells in operation at the time of the static measurement can be developed to get an idea of the radius of influence of each well. To obtain a true static water level in the wellfield, selected wells within the wellfield will be monitored. Each of the selected wells will be out of use for approximately two weeks (only one well will be out of service at a time). After this period, the depth to water will be measured. Water levels will be recorded on the forms provided (see end of chapter). Changes in water levels through time will be compared to the water quality and water production data to determine the influence of the well field on the aquifer.

Water Production Monitoring

Actual water production per well will be recorded on a monthly basis for all production wells. The volume of water produced per well will be determined from a water meter installed on the well. TAFB wells are currently not equipped with water meters. These meters will be a

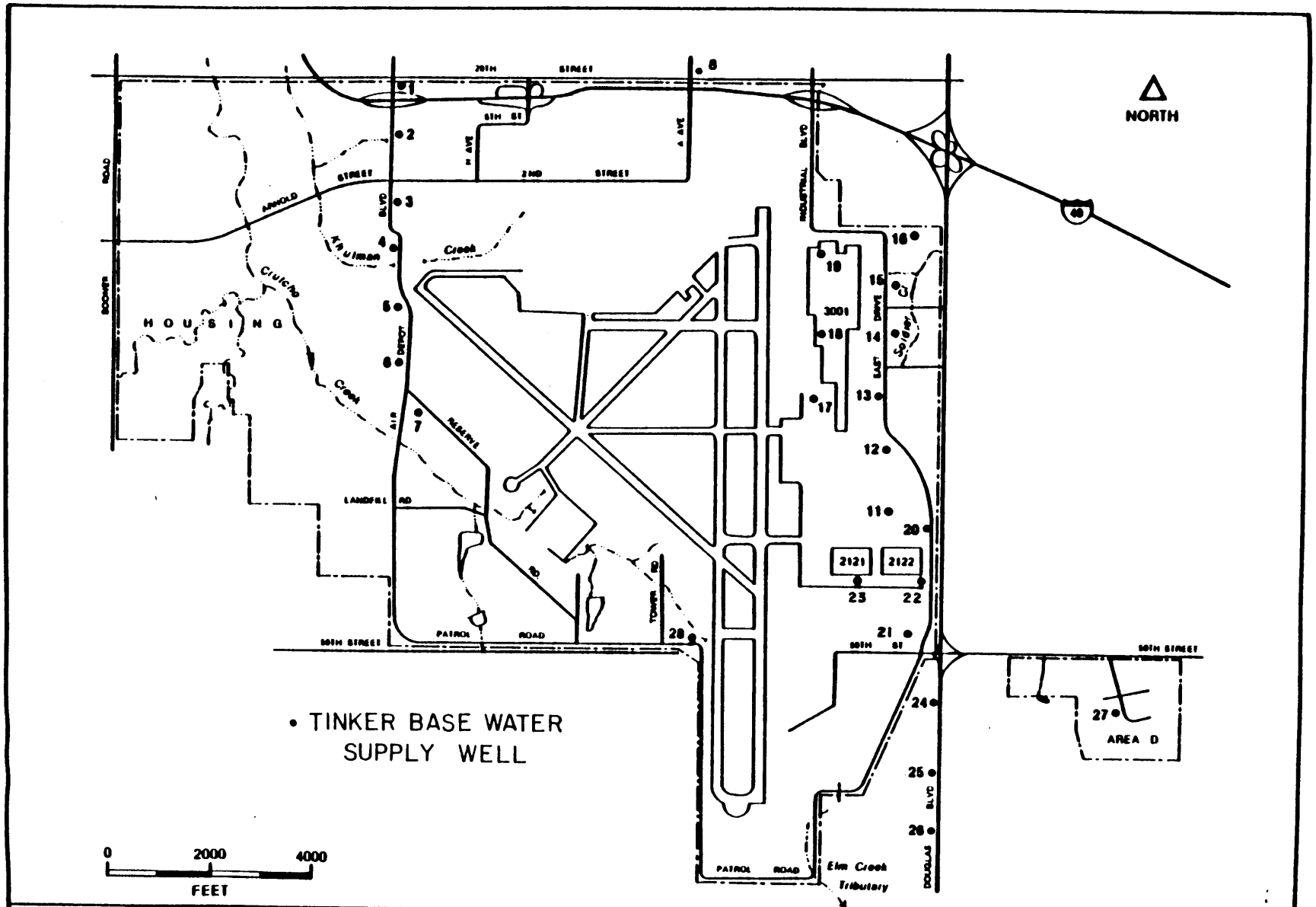

Figure 1. Base Water Supply Wells

continuous recording meter permenantly installed at each well head. Water production will be recorded on the forms provided (see end of chapter). Comparisons of total water production to changes in water quality will be used to determine if quality changes are occuring in the aquifer as a result of pumping in the well field.

Water Quality Sampling Program

All wells will be sampled yearly for changes in water quality. A water quality change may indicate a change in the well construction, i.e. a loss of well integrity, an actual change in aquifer water quality or perhaps a change due to pollution or biological activity in the well. The minimum parameters to be analyzed are chloride, specific conductance, total dissolved solids, alkalinity, sulfates, pH, chromium, selenium, arsenic, potassium, sodium, calcium and magnesium. Water quality testing is necessary to monitor changes in concentrations of naturally occuring regulated parameters and changes in overall water character. Results from these analyses will be used to aid in determining the source of the changes i.e. overpumpage, loss of well integrity, outside pollution source(s).

At each well site a water sample, water level, and a field check of the well site will be performed. During the sampling process, each well will be pumped for a specified time prior to sampling (long enough to empty about 5 well volumes from the well). If the well is currently in operation, the sample will be taken immediately. Samples will be collected and preserved according to methods described in Chapter ___.

Reporting Requirements

ACOG/GWA will collect the information, complete the forms for TAFB and keep one copy. If another agency collects the information, they will provide TAFB with the completed forms and will provide one copy of the forms to ACOG/GWA.

Water Level Measurement Methods - APPENDIX A

Water level measurements may be made using an airline, steel tape, or electric sounder. Using an airline, the basic premise is that the air pressure needed to push all the water out of the submerged portion of the airline is equal to the water pressure of a water column the height of the submerged portion of the airline (Figure 1). An airline is generally a small diameter, rigid, PVC or steel pipe which extends from the top of the well to a depth at least 5 feet above or below the point where water enters the pump to avoid disturbances caused by the pump. The airline may be installed at the time the pump is installed or it may be lowered into place when the pump is already in place but not operating. To measure the water level, the upper end of the airline is connected to a compressor. A pressure gauge is connected to a tee in the airline to measure the air pressure in the line. A pressure gauge reads in psi., additional calculations must be made to determine the feet of water. The airline is pressured up until pressure ceases to build, indicating that all the water has been forced out of the airline. The gauge reading is taken. If the reading is in feet of water, it is subtracted from the length of the airline. If the reading is in psi, the reading is multiplied by 2.31 feet /psi, and subtracted from the length of airline. Depth to water using an airline is accurate to about 0.2 feet.

The steel tape method is the most practical method to use in non-pumped or observation wells. A lead weight is attached to the bottom of the tape. The lower two or three feet of the tape are covered with carpenter chalk before measuring. The tape is let down in the well until part of the chalked section is immersed (experience is necessary to determine the "feel" of the tape when the weight hits the water surface). The length of tape let down the well must be recorded. When the tape is brought up, the wetted section of the tape is subtracted from the total length of tape let down the well to obtain the actual depth to water.

An electric sounder consists of a probe, a conducting wire and a light or ammeter at the surface which indicates a closed current when the probe touches the water. The amount of tape lowered into the well must be measured to record the depth to water.

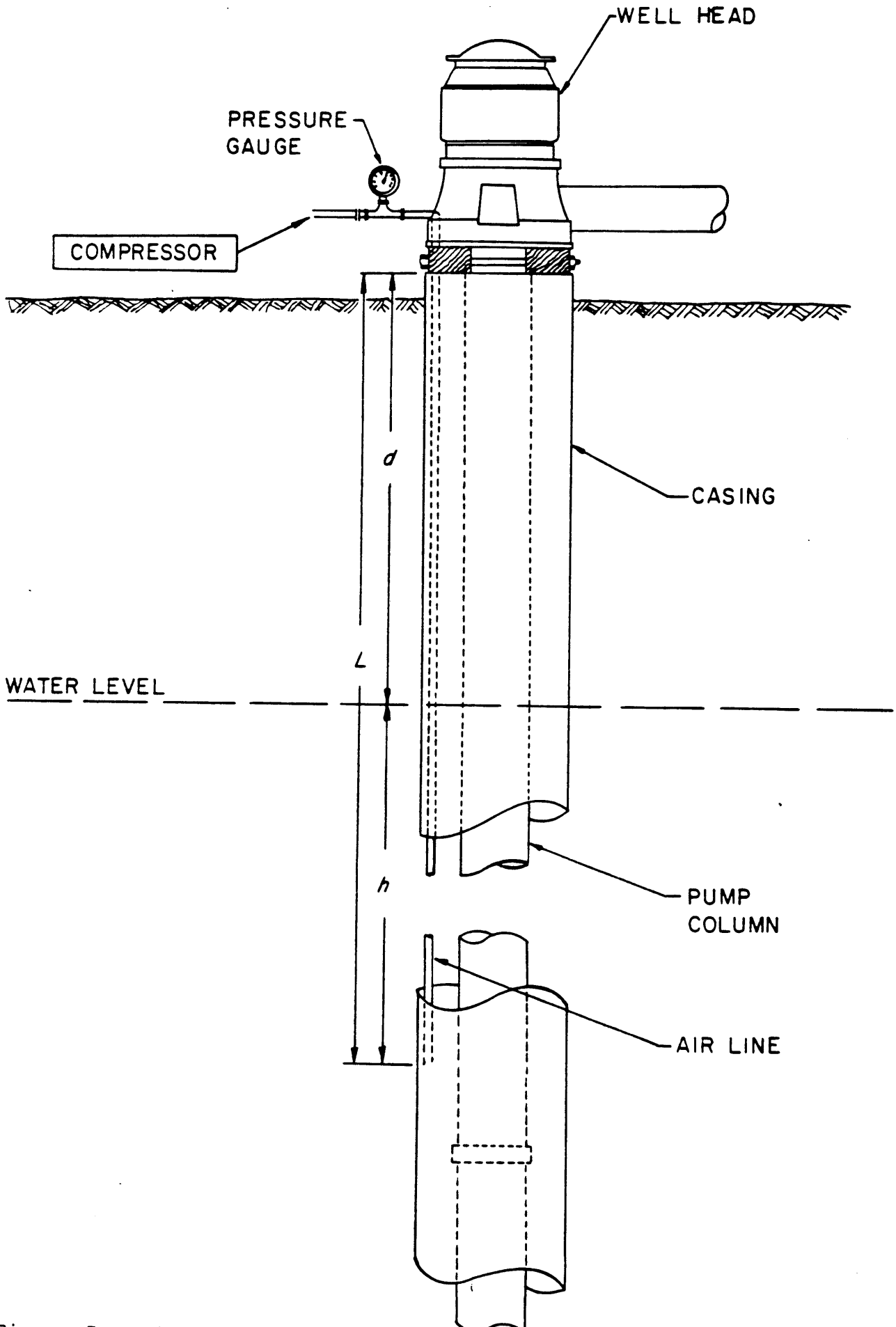

Figure 1. Airline Installation Method (modified from "Groundwater and Wells")

MONITORING FORMS

ASSOCIATION OF CENTRAL OKLAHOMA GOVT's.
4801 CLASSEN BLVD., SUITE 200
OKLAHOMA CITY, OKLAHOMA 73118

ACOG MUNICIPAL WELL RECORDS
WELL FIELD MONITORING DATA SHEET

CITY_____

MONTH and YEAR_____ FORM COMPLETED BY_____

Well #	Monthly Usage In Gallons	Depth to Water In Feet	Water Level Status At Measurement				Method of Measurement	Measured By
			Date	Pumping	Static	Time-off		

INSTRUCTIONS ON COMPLETING THE ACOG MUNICIPAL WELL RECORDS WELL FIELD MONITORING DATA SHEET

CITY: Fill in your city's name.

MONTH AND YEAR: Fill in the month and year the water level measurements were taken.

FORM COMPLETED BY: Fill in your name and write your work telephone number below it.

WELL NUMBER: Write the well's designated number.

MONTHLY USAGE IN GALLONS: Write the total number of gallons pumped from that well during the month of interest. If the well has not been in use during the month of interet, fill in blank with a "0".

DEPTH TO WATER IN FEET: Write the water level measured in that well regardless of whether the well was in use or not in use.

WATER LEVEL STATUS AT MEASUREMENT

DATE: Write the date the water level measurement was taken.

PUMPING: If the well was pumping for 48 hours or longer prior to taking the water level measurement, write "x" in the space in the pumping column. If the well had not been pumping for 48 hours or more prior to taking the water level measurement leave the space in the pumping column blank.

STATIC: If the well had not been in use for 48 hours or more when the water level measurement was taken, write "x" in the space in the static column. If the well had pumped in 48 hours or less, leave the space in the static column blank.

TIME-OFF: If the well was in use when the water level measurement was taken write the date the well was turned on. If the well was not in use when the water level measurement was taken, write the date the well was last used.

METHOD OF MEASUREMENT: Write the method used to take the water level measurement. For example; airline, electric probe, acoustic probe, steel tape, etc.

MEASURED BY: Write the name of the person or persons who actually measured the water level in the well.

ACOG/GWA WELL RECORDS SYSTEM

ENTITY_____

Bi-Annual Measurement of the Static
Water Levels

Well #	Date	Date the Well Was Last Pumped	Depth to Water	Production Wells on at the Time of the Measurement

* To be made after the pump has been off for at least two weeks)

ACOG/GWA WELL RECORDS SYSTEM

ENTITY_____

WELL FIELD MONITORING

MONITORING WELLS STATIC WATER LEVELS

WELL NUMBER ___

ELEVATION OF MARKER POINT _____

Date	Recorded By	Depth to Water	Evaluation of Water Table	Remarks

INSTRUCTIONS FOR
ACOG GARBER-WELLINGTON ANALYSIS FORM

All samples submitted for analysis on this form must be approved by the Association of Central Oklahoma Governments. If copies are requested, please so indicate at the time samples are delivered to the State Environmental Laboratory.

1. Sample number will be completed by the analytical laboratory.
2. Use only formal name; no nicknames for collector initials.
3. Source: Is the name of the well associated with the sample.
4. Depth: Is the total depth of the well.
   Note: Sample depth can be included in the sampler's comments.
5. Date collected 09/29/1983 is September 29, 1983 (month,day,year).
6. Time - use military clock.
   Example: If the time is 2:00 p.m.; record 1400. If the sample is a composite record, beginning time and ending time.
7. City - closest to the well should be used.
8. Legal description should be to the nearest 10 acres.
9. Use the sampler's comments to add any pertinent information regarding the sample.
10. Place an "X" in the "Check Parameter" column for each parameter requested.
11. All analytical final reports will be returned to ACOG/GWA per Suzanne Moore.

WATER SAMPLE LOG IN FORM

GARBER-WELLINGTON ANALYSIS

Sample Number: _____

Collector Initials: _____ Source: _____ Depth: _____

Date Collected: ____/____/19____ Time: ___:___ Well Pumped: _____hours

City: _____

County: _____: ___1/4 ___1/4 ___1/4 Sec. ___ TWP ___ Rge___ _M

Samplers Comments: _____

Check Parameter	Parameters	Values
_____	calcium (0916)	_____
_____	magnesium (0927)	_____
_____	sodium (0929)	_____
_____	potassium (0937)	_____
_____	sulfate (0945)	_____
_____	chloride (0940)	_____
_____	alkalinity (0410)	_____
_____	pH (0400)	_____
_____	spec cond (0095)	_____
_____	total hardness (0900)	_____
_____	TD solids (0515)	_____
_____	nitrate (620)	_____
_____	iron (1045)	_____
_____	manganese (1055)	_____
_____	selenium (1147)	_____
_____	chromium (1034)	_____
_____	aluminum (1105)	_____
_____	arsenic (1002)	_____

Review Comments: _____

Return to: ACOG/GWA, Suzanne Moore
4801 Classen Boulevard, Suite 200
Oklahoma City, Oklahoma 73118 Phone: (405)848-8961

APPENDIX F

TINKER AIR FORCE BASE
SAMPLING AND ANALYSIS PLAN

GROUNDWATER SAMPLING AND ANALYSIS PLAN
TINKER AIR FORCE BASE, OKLAHOMA
TULSA DISTRICT, CORPS OF ENGINEERS

I. Overview.

A. Purpose and scope. This sampling and analysis plan presents the methodology for collection, preparation, shipment, testing, and quality control for groundwater samples taken at Tinker Air Force Base by Tulsa District sampling personnel. Detailed sampling procedures are given in Section II, and transmittal forms used in sampling are given in Section III.

B. References. The following references were used in the preparation of this plan:

1. American Public Health Association and American Waterworks Association, *Standard Methods for the Examination of Water and Wastewater,* 16th ed., 1985.

2. U. S. Environmental Protection Agency, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document,* draft,August, 1985.

3. U. S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste,* SW 846, July, 1982.

4. U. S. Environmental Protection Agency, *Methods for Chemical Analysis of Water and Wastes,* EPA-600/4-79-020, 1979.

5. U. S. Environmental Protection Agency, *Handbook for Sampling and Sample Preservation of Water and Wastewater,* EPA-600/4-82-029, 1982.

6. U. S. Environmental Protection Agency, *Volatile organic compounds in water by purge and trap GC/MS,* Environmental Monitoring and Support Laboratory, 1983.

C. Field procedures. Field procedures are discussed in detail in Section II. Samples should be collected by a sampling team using a teflon bailer. Filtering, preservation, and refrigeration should be performed in a laboratory at Tinker. Samples should be shipped daily by bus or other conveyance in ice-packed ice chests to the testing laboratories with a field data form and a chain of custody form. These forms are shown in Section III. Sampling personnel should be thoroughly trained in collection and preparation techniques. As much of the sample preparation as possible should be performed in the field laboratory where controlled and clean conditions exist. Equipment and travel blanks should be taken weekly. Field blanks are discussed in Section II.

D. Parameters to be tested. Table F-1 lists the parameters and test methods which will be included in the testing program.

Table F-1
Parameters to be tested in groundwater samples

parameter	EPA method	reference	notes
pH	150.1	4	A
conductivity	205	1	A
arsenic	7060	3	B
barium	7080	3	B
cadmium	7130	3	B
chromium	7190	3	B
lead	7421	3	B
mercury	7470	3	B
nickel	7520	3	B
selenium	7740	3	B
silver	7760	3	B
zinc	7950	3	B
potassium	258.1	4	B
sodium	273.1	4	B
calcium	215.1	4	B
magnesium	242.1	4	B
total dissolved solids	209B	1	
total organic carbon	415.1	4	
alkalinity	403	4	
chloride	325.3	4	
sulfate	375.4	4	
volatile organics	524.1	6	C
semi-volatiles	8270	3	

A. To be performed in the field
B. Use a 10-fold concentration for water supply well samples
C. Obtain a detection limit of at least 0.5 ug/l for TCE

E. Laboratory qualifications. Testing laboratories should be certified by the Oklahoma Water Resources Board and should use the Environmental Protection Agency's Contract Laboratory Program protocol. A copy of the lab's QA/QC plan should be on file.

II. Groundwater sample collection, preparation, and shipment.

A. General. The objective of collecting groundwater for analysis is to provide a sample to the laboratory which represents the same geochemical conditions which occur in the aquifer. Because certain parameters are more susceptible to change than others, various techniques are needed depending on what will be tested. The purpose of this sampling plan is to discuss sample collection techniques for all of the parameters recommended for long term monitoring at Tinker Air Force Base. The best sequence of operations for sampling is as follows:

1. Evacuate slow recharge wells at the outset of the sampling day.
2. Evacuate and sample other wells.
3. Sample slow rechargers, if possible.
4. Return to lab to preserve samples.

5. Prepare samples for shipment.
6. Deliver samples to bus station.

Do not sample more wells than you can filter and prepare for shipment in one day. Refrigerate samples as soon as sampling is complete or more frequently if sampling is not proceeding expeditiously. Most of the wells should recharge quickly.

B. Collection

1) Static water levels. Before any other work is done at the well, the water level should be taken with an electric probe, and measured from the top of the casing or water level port. Record the water level to the nearest hundredth of a foot in the logbook (described in Section III) as well as any problems noted with the general condition of the well. An engineer's rule will be required to measure from the probe's tic marks. Rinse the probe in distilled water immediately before lowering it into the well and after removing it from the well. If the well is heavily contaminated, then additional rinses may be required.

2) Well evacuation procedures. Standing water within the well should be removed and fresh formation water should be sampled. Well water can be pumped onto the ground unless it has been specifically forbidden. For slowly recharging wells, pump them dry. Plan to sample as soon as there is sufficient recharge to fill the sample containers. For wells which cannot be evacuated to dryness, pump them for a sufficient period of time to remove 3 casing volumes of water. Sample immediately after evacuation. Operational water supply wells do not need to evacuated.

3) Types of setups used at TAFB.

a. Perimeter wells. All of the perimeter wells at Tinker are open wells. These wells, which do not contain dedicated equipment, should be evacuated with a teflon bailer, a portable purge pump, or a portable sample pump. The purge and sample pumps are operated by a portable gasoline-driven compressor mounted on a driver-controller unit, which provides a pressurized air supply. The pump and tubing should be thoroughly washed with water and rinsed with distilled water after each use. The bailer should be taken to the field laboratory and cleaned as described in Section C) 3. Enough bailers should be available so that field cleaning will not be necessary. For heavily contaminated wells, purge pumps and tubing should be cleaned in a similar manner.

b. Base water supply wells. There are 25 water wells which pump from the Garber-Wellington at Tinker. The water levels in these wells is about 200 feet deep, and the pumps are about 600 to 700 feet deep. Sampling can only be done when the well is operational.

4. Well sampling.

a. General procedures. The only equipment which may be used to remove a sample is a dedicated bladder pump or a teflon bailer. Each sample container should be filled directly from the spout or discharge tube of the well. A common container should not be used. Care should be

taken to prevent sample contamination through carelessness. Sampling equipment or containers should not be placed on the bare ground for any reason. Plastic sheets will be available to provide a clean working surface. You will be given a list of parameters for each well to be sampled and labels provided by the laboratory. These labels will have printed on them the type and size of container, preservation instructions, and parameters. Affix them to the appropriate containers before leaving the field lab, and when the sample is taken, write the well ID and date on them with a permanent marker. Table F-2 lists the requirements for all of the parameters in this monitoring program.

Table F-2
Sampling procedures for parameters to be tested

parameter	container size	container type	refrigeration required	preparation
pH and cond.	1/2 pt	either	no	do in field
TOC	40 ml	glass**	yes	fill to brim, hydrochloric acid to pH <2
metals, total	liter	plastic	no	nitric acid to pH <2
volatile organics	2, 40 ml	glass**	yes	brim full, no air bubbles or agitation
semivolatile organics	2, liter	glass**	yes	brim full, no air bubbles or agitation
chloride, sulfate, TDS, alkalinity	liter	plastic	yes	none required

** All glass containers have teflon-lined caps.

b. PH and specific conductance. These two parameters should be determined in the field with pH and conductivity meters before additional sample is taken. Enough sample should be collected and put into a beaker to allow the electrodes to be immersed. Calibrate the meter with two of the buffer solutions, either pH 4.0 and 7.0 or pH 7.0 and 9.0, and then measure and record the pH of the sample to the nearest 0.05 unit. The electrodes should be rinsed with distilled water between each sample or buffer solution. After the pH measurements, determine the specific conductance in a similar manner, following the directions with the conductivity meter. The approximate temperature must be known, which can be determined from the pH meter. Rinse the probe between samples. Discard this sample when pH and specific conductance measurements are completed.

C. **Preparation techniques.**

1) **Sample preparation.**

a. Refrigeration. Samples must be kept under refrigeration as much as possible. After collection is complete, put the samples into the refrigerator. Remove them to filter and preserve them, and return them to the refrigerator until they are put into the ice chests for shipment. Refrigerate all of the samples if space permits. Otherwise refrigerate only those so indicated in table F-2.

b. Adding acids. Acids (hydrochloric and nitric) are added to adjust the pH of the sample to prevent chemical reactions which would change the concentration of the parameter to be tested. Add acids with a dropper bottle, testing the pH with a meter until it is at the required level.

2) **Blanks.** Blanks are used to verify that the sample collection and handling processes have not resulted in cross contamination. The two types of blanks you will prepare are described below.

a. Travel blanks. Once a week, fill two containers, one for organics and one for inorganics, with distilled water and carry them around with you during the day. Prepare them as though they were an actual sample, affix travel blank labels, and ship them in in a separate ice chest. Rotate the containers so that different parameters are tested each week.

b. Equipment blanks. Also on that day, fill two containers, one organic and one inorganic, with distilled water drawn by one of the bailers to be used that day after it has been cleaned and rinsed. Use the same preservation and filtering procedures as described above. Ship these in the ice chest with the trip blanks. Rotate the containers so that different parameters are tested each week.

3) **Cleaning.** Sampling equipment should be cleaned using one of the following procedures:

a. Sampling for inorganic compounds. Sampling equipment not used for organics may be cleaned with dilute hydrochloric acid and distilled water as described above.

b. Sampling for organic compounds. Bailers and other equipment used in organics sampling must be cleaned with a non-phosphate detergent. The equipment should then be rinsed with tap water, distilled water, and hexane. The hexane rinse should be done under the hood. No smoking during the hexane rinses. It is very flammable.

D. Shipment. Cover each label with a strip of wide tape to protect it. Pack the samples for each well in a separate ice chest. Fit the glass containers into the styrofoam contours and the plastic containers into the spaces between the glass containers. Fill the chest with ice and insert the data sheet and chain of custody form (described in Section III) into the ziplock bag taped to the inside lid of the ice chest. Close the ice

chest and seal with duct tape or fiber tape. Drop off the ice chests at the Greyhound station at the end of each workday. Do not ship samples on Friday unless the laboratory is aware of it.

E. Paperwork.

1) **Fieldbook.** Keep a field book of all operations and record the following: well number, date, water level, well evacuation procedure and rate of recharge, sample method, pH and conductivity readings, any unusual conditions noted (odor or color of water, well damage, etc), time of collection, time of preservation, time dropped off at bus station, your names, and any information regarding blanks. The information from the field book will be transferred to the two forms described below.

2) **Field data form.** This form includes selected information transferred from the log book such as water level, pH, conductivity, and unusual observations. It is shipped in the ice chest. A copy of this form is found in Section III.

3) **Chain of custody form.** The chain of custody form is required to establish possession of the samples from their collection to their final receipt in the laboratory. Fill it out from the logbook, as shown by the enclosed sample, and enclose in the ice chest. Two signatures are required before it leaves your possession: the sample collector and the sample preparer. A copy of this form is found in Section III.

SECTION III

FIELD DATA FORM AND CHAIN OF CUSTODY FORM

GROUNDWATER MONITORING WELL FIELD DATA FORM

Location _____ Date ____ ____ ____
Y Y M M D D

Site _____

Well number _____ Csg diameter _____ Csg type _____

Rate of recharge _____

Riser elevation _____

Depth to water from top of casing _____ Time of measurement _____

Water table _____ Measuring device _____

PH Measurements

_____ Time of measurement _____

_____ Meter type and model _____

_____

_____

Specific conductance, mhos/cm

_____ Time of measurement _____

_____ Meter type and model _____

_____ Temperature _____

_____

Notes concerning condition of well, odor, color, and any problems:

_____

_____

_____

Sample collector _____

GROUNDWATER MONITORING WELL CHAIN OF CUSTODY RECORD

TULSA DISTRICT, CORPS OF ENGINEERS

Location _____ Date _____

Site _____ Well number _____

Number of containers in shipment

	glass	plastic
liter	_____	_____
40 ml	_____	

Parameters sampled

pH	____
conductivity	____
metals, total	____
metals, total, plus K, Mg, Na, Ca	____
chloride, sulfate, TDS, alkalinity	____
TOC	____
purgeables	____
semivolatiles	____

CUSTODY RECORD
signature and title

Relinquished by	Received by	Date	Time
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____