7133 U-007-303.57

TRANSMITTAL OF THE PROJECT SPECIFIC PLAN FOR THE SOUTH FIELD INJECTION TEST

08/25/95

DOE-1415-95
DOE-FN EPAS
75
PSP

Department of Energy
Fernald Environmental Management Project
P. O. Box 538705
Cincinnati, Ohio 45253-8705
(513) 648-3155

AUG 25 1995

DOE-1415-95

Mr. James A. Saric, Remedial Project Director
U.S. Environmental Protection Agency
Region V - 5HRE-8J
77 W. Jackson Boulevard
Chicago, Illinois 60604-3590

Mr. Tom Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

TRANSMITTAL OF THE PROJECT SPECIFIC PLAN FOR THE SOUTH FIELD INJECTION TEST

The purpose of this letter is to transmit the referenced document to the U.S. Environmental Protection Agency (U.S. EPA) and the Ohio Environmental Protection Agency (OEPA) for review and approval. Because this project is being funded by the Department of Energy, Environmental Management (EM-50) Office of Science and Technology with Fiscal Year 1995 funds, the injection test needs to be completed in a timely manner. Therefore, it has been tentatively scheduled to begin the week of September 18, 1995. Per discussions between my staff and representatives from both the U.S. EPA, and the OEPA, we have requested that the review of this Project Specific Plan (PSP) be expedited in order to meet the September 18, 1995, start date.

If you or your staff have any questions regarding this transmittal, please contact John Kappa at (513) 648-3149 or Robert Janke at (513) 648-3124.

Sincerely,

Johnny Reising

for Jack R. Craig
Fernald Remedial Action
Project Manager

FN:Kappa

Enclosure: As Stated

cc w/enc:

K. H. Chaney, EM-423/GTN
L. Griffin, EM-423/GTN
B. Skokan, EM-423/GTN
G. Jablonowski, USEPA-V, 5HRE-8
M. Hodnett, OEPA-Columbus, DDAGW
Manager, TSPP/DERR, OEPA-Columbus
S. McClellan, PRC
D. S. Ward, GeoTrans
F. Bell, ATSDR
R. Vandergrift, ODOH
J. Carr, FERMCO/52-2
R. D. George, FERMCO/52-2
T. Hagen, FERMCO/65-2
AR Coordinator, FERMCO

cc w/o enc:

C. Little, FERMCO
M. Yates, FERMCO

7133

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

OPERABLE UNIT 5

PROJECT-SPECIFIC PLAN FOR THE SOUTH FIELD INJECTION TEST

AUGUST 1995

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

DRAFT

000003

7133

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

OPERABLE UNIT 5

PROJECT-SPECIFIC PLAN FOR THE SOUTH FIELD INJECTION TEST

AUGUST 1995

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

DRAFT

7133

TABLE OF CONTENTS

7133

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

The Proposed Plan for Operable Unit 5 has identified groundwater extraction and treatment as the selected remedy for restoring the Great Miami Aquifer. The Operable Unit 5 Feasibility Study (DOE 1995a) concluded that a 28-well base case extraction system pumping at a net maximum rate of 4000 gallons per minute (gpm) would be sufficient to restore the aquifer in an estimated 27-year time frame (Figure 1). As part of the selected remedy, the DOE agreed to continue evaluating the benefits of applying emerging or innovative technologies to enhance aquifer recovery. One recognized technology is the possibility of reinjecting groundwater containing total uranium concentrations of less than 20 μg/L into the aquifer as a means of speeding the contaminant flushing process. The injection test presented in this work plan involves the reinjection of Great Miami Aquifer groundwater in the South Field area of the FEMP.

Modeling using the FEMP SWIFT groundwater model has been conducted to evaluate the possible benefit that injection would have on the 28-well base case extraction system. This modeling work is not presented in detail in this work plan. A separate report is being prepared that will provide details on these modeling activities. The following is a very brief summary. The flow and transport modeling was conducted using both a low uranium K_d (soil to water partition coefficient) (1.78 L/Kg) and a high uranium K_d (17.8/Kg). The low K_d is thought to represent dissolved conditions, while the high K_d is thought to represent the desorption rate of the uranium from the aquifer materials. Modeling results indicate that under low K_d conditions groundwater injection is not beneficial or practical to implement, but under high K_d conditions, significant improvement is realized in certain areas of the plume. Once the dissolved portion of the total uranium plume is flushed from the Great Miami Aquifer, desorption will become the controlling remediation factor.

Because the high K_d groundwater modeling results were favorable, evaluation of hydraulic and engineering feasibility issues surrounding injection needs to begin. The field testing proposed in this project-specific plan (PSP) is needed before the development of the remedial design work plan because present studies on the benefit of injection have relied solely on modeling. The modeling has assumed that injection at a rate of 240 to 500 gpm is feasible; this rate needs to be verified and the effects of the injection into the aquifer documented.

This PSP provides guidance for conducting an injection test in the South Field area of the FEMP site, hereinafter referred to as the South Field injection test and will address hydraulic and engineering issues through the collection of water quality and water level data. As discussed below, physical issues will be evaluated. Geochemical issues are not in the scope of this work plan.

This work plan is designed to assess issues involving the physical process of injection. For instance, possible plugging of the aquifer (the result of air entrainment or suspended solids in the injection water and/or rearrangement of the aquifer materials surrounding the injection well) also needs to be evaluated. Delivering water to the injection well without it cascading down the well needs to be demonstrated and the accuracy at which injection rates can be maintained needs to be determined. Understanding the difference caused by injection and extraction on the rise and fall of the water table will be used to assess how well the current groundwater model can simulate the effects of injection.

The general objective of the test is to provide information supportive and useful to the evaluation of innovative technology for enhanced aquifer restoration at Fernald; specific major objectives include:

- Determining if injection using Great Miami Aquifer water, with total uranium concentration below 20 μg/L, will result in any plugging problems
- Determining how much the water table of the Great Miami Aquifer will rise given several different injection rates
- Comparing actual water level rises to predicted groundwater modeling results
- Determining if a sustainable injection rate can be maintained that is close to the rate currently being modeled (i.e., between 240 to 500 gpm)
- Identifying mechanical concerns associated with actual injection operations.

A regulatory consideration for this project is the State of Ohio 5X26 Aquifer Remediation Projects Policy which states that injection through Class V wells may be appropriate for pump and treat operations conducted for remediation. The test outlined in this work plan will demonstrate the feasibility of implementing injection at the FEMP as part of a remediation strategy. Information presented in this work plan satisfies the substantive requirements of the permit to install, as mandated for on-site CERCLA response actions [Section 121(e)(1)], and OAC 3745-34-01. These are:

- A hydrogeologic site description (including groundwater flow direction), Section 4.0
- Injection well installation and construction information, Section 6.0
- A complete analysis of the fluids to be injected, Section 4.3 and Appendix B

- The volume and rate of fluid to be injected, Section 6.8, and Table 4
- Results of groundwater monitoring, Section 4.3 and Appendix B.

In addition, an injection test report will be prepared following the implementation of this workplan. The report will provide an analysis of the injected water used, the volume and rate of the injected fluids and groundwater monitoring procedures, as described in the 5X26 Aquifer Remediation Project Policy. Additional information regarding the report is provided in Section 7.0 of this plan.

2.0 OVERVIEW OF THE TEST

Details concerning the implementation of the South Field injection test are provided in Section 6.0 of this work plan. The following is a brief overview of the selection of the testing location, the source of injection water, selection of monitoring locations, and deciding on the type of test to conduct. In this work plan, the injection well is referred to as the control well.

The injection test presented in this work plan is similar to a pumping test and is comprised of a step test and a constant rate test (CRT). Instead of extracting groundwater and measuring the aquifer response, groundwater will be injected into the aquifer and the response of the aquifer will be measured. Using a site where a pumping test has already been performed facilitates the analysis of the injection test results in that the response of the aquifer to pumping has already been determined and can be easily compared to injection results. For instance, injection-specific capacity can be calculated and compared to previously calculated extraction-specific capacities for the same control well to determine the difference between the two parameters. In theory it is harder to push water into the aquifer than to extract it. By already having extraction results from the pumping test, the difference between injection and extraction at the same rate and at the same location can be readily determined; of interest is how much mounding will be created at a certain injection rate.

The injection test will involve two phases; an initial step test followed by a three- to seven-day constant pumping rate test. Results of the step test will be used to determine an injection rate for the longer constant rate test. This selected rate will be based on the specific capacity of the injection well. Data collected during the constant rate test will be used to determine if plugging is occurring due to the injection process. The water level response due to injection will be measured over time at the injection well and in the surrounding observation wells. The water level rise in both the control well and the surrounding aquifer should stabilize and remain constant. A water level that continues to rise in the control well could indicate that plugging of either the screen or surrounding aquifer is occurring.

Two locations with similar water chemistry were considered for the injection test, the South Plume (DOE 1993) and the South Field (DOE 1995c) pumping test locations (Figure 2). Both are suited for an injection test because both were formerly used for extraction tests and information concerning aquifer response and properties is available. Both locations provide an injection well and monitoring well network that are readily accessible. However, for the following reasons, the best choice is the South Field pumping test location:

- The South Field location is the current area of interest for injection
- The aquifer properties at the South Plume location are different due to depositional differences and proximity of the aquifer buried valley wall (discussed in Section 4.0)
- The South Field location is on FEMP property, providing ease of access
- The facilities to extract groundwater from the South Plume area and deliver it to the South Field area already exist (i.e., the pipeline put in for the South Plume pumping test).

As mentioned above, the South Field location is the area of interest for injection. Groundwater injection in the South Field area is expected to have the most significant impact on remediation because the uranium plume is larger and uranium concentrations are higher in the South Field than in any other areas. Groundwater injection is considered less advantageous in other areas of the site due to the smaller plume sizes, lower initial concentrations, and lower mass loading rates during soil remediation. Previous model simulations conducted during the FS process show that these other areas can be effectively remediated using groundwater extraction systems (cleanup times within 30 years). For these reasons, groundwater in the waste pit, former production and South Plume areas can be remediated using groundwater extraction wells only.

During the test, South Plume extraction Wells 3926 and 3927 (Figure 4), located outside the 20 μg/L uranium plume, will be used as a source of injection water. South Plume Wells 3924 and 3925 which have shown uranium concentrations above 20 μg/L will not be pumped during the test; the flow rate delivered by pumping Wells 3926 and 3927 will be adequate for the test. The uranium concentration of the injected water should be far below 20 μg/L (approximately 3.5 μg/L). Monitoring for total uranium in the injection water will be conducted during the test to document actual concentrations.

Water level changes monitored during the injection test will be measured to record the horizontal spread of the injected slug of clean water. Water level data collected during the remedial investigation (DOE 1995b) indicate that strong vertical gradients are not present in the Great Miami Aquifer in the test area. Drilling data collected during the installation of wells in the test area and calculations made from a pumping test conducted there indicate that the horizontal hydraulic conductivity is higher by a factor of 10 than the vertical hydraulic conductivity (DOE 1995c). Given the limited period of time that injection will occur (three to seven days), vertical movement of the injected slug of clean water should be insignificant.

3.0 MANAGEMENT AND RESPONSIBILITIES FOR THE INJECTION TEST

The project leader is responsible for:

- Completing project activities safely and promptly
- Designing the test, locating wells, and allocating responsibilities so that project objectives are met
- Assuring that data are collected and analyzed properly
- Determining the step test and constant rate test injection rates
- Completing an injection test report that details testing activities and presents results
- Procuring needed materials and funding for the testing program.

The hydrogeologist in charge is responsible for:

- Coordinating the injection test, including instrument setup in the field and data collection
- Documenting the test setup including preparation of a diagram of equipment used in the injection test (dimensions, depth of water intakes, locations of gauges, etc.)
- Determining that all test equipment is in proper working order before the start of the test
- Securing all field instruments after completion of the injection test.

4.0 BACKGROUND

4.1 GEOLOGY OF THE TEST AREA

The area selected for the South Field injection test (Figure 2) is situated over the New Haven Trough, a large buried valley whose axis roughly extends in a northeast - southwest orientation (Figures 3 and 4). The New Haven Trough is bounded by Ordovician age shale and limestone bedrock along the floor and walls. The depth to bedrock at the testing location, as measured in Well 31550, is 185 feet. The New Haven Trough was carved into the shale bedrock during the Pleistocene and subsequently filled with sand and gravel in a braided stream depositional environment. Glaciation during

Wisconsin time deposited a layer of clay-rich till over the sand and gravel outwash deposits. At the test location (Well 31550) the sand and gravel, which comprises the matrix of the Great Miami Aquifer, is 168 feet thick. The Great Miami Aquifer is an unconfined, anisotropic, heterogenous aquifer which has been designated as a sole-source aquifer.

A semiconfining clay layer divides the aquifer into an upper and lower zone across most of the FEMP site, but not at the test location (Figure 5). The clay layer is present approximately 1200 feet to the north and 900 feet to the west of the test area. As documented at Well 31550, in descending order the lithology of the test area consists of: 11.5 feet of brown clay, 5.5 feet of gray clay, 28.5 to 36.5 feet of unsaturated sand and gravel, and 131 to 139 feet of saturated sand and gravel (depending upon the seasonal elevation of the water table).

There are no surface water bodies in the immediate area of the injection test. Paddys Run is an intermittent stream located approximately 1000 feet west of the test area. The storm sewer outfall ditch is located approximately 400 feet north of the test site with a tributary to the ditch approximately 400 feet west of the site. These drainages also flow intermittently. Sections of Paddys Run and these drainages are in direct physical contact with sand and gravel in the Great Miami Aquifer and represent recharge zones to the aquifer.

Sieve analysis results on soil samples collected from seven wells drilled in the test area reveal a very low percentage of silt and clay (DOE 1995c). The percentage of silt/clay is below 10 percent in practically all of the samples sieved and generally below 5 percent. Correlation of the sieve results indicates that many shifting channels are present, as is expected in a braided stream depositional environment (DOE 1995c).

4.2 <u>HYDROLOGY OF THE TEST AREA</u>

The Great Miami Aquifer is a textbook example of a glacio-fluvial buried valley aquifer. Since 1943, 12 pumping tests have been conducted near the FEMP for the purpose of determining horizontal hydraulic conductivity (K_h) within the Great Miami Aquifer. Table 1 shows values of K_h calculated from these 12 tests. The average K_h is 397 ft/day with a minimum of 120 ft/day and a maximum of 774 ft/day. This range of K_h probably reflects textural changes which resulted from a braided stream depositional environment. The criss-crossing of channels and changing depositional energies created permeability trends that may be responsible for the range of K_h. A ratio of vertical to horizontal hydraulic conductivity of .05 to .19 was calculated from the pumping test performed for the South Plume Removal Action (DOE 1993). The coefficient of storage for the Great Miami Aquifer has been estimated to be 0.2 and transmissivity has been estimated to be approximately 300,000 gpd/ft (Spieker and Norris 1962).

Approximately four years of water elevation data exists for the test area. Data collected in 1993 reveals that flow is either to the east or southeast. The water table under the test area dips to the east in January and April (when water levels are high) and to the southeast in July and October (when water levels are low). Water table maps are provided in Appendix A. Data collected from Wells 2387, 2049, and 2390 indicate that seasonally the water table rises and falls approximately 7 feet, from a low of approximately 518 feet above mean sea level (amsl) to 525 feet amsl. Hydrographs are also provided in Appendix A.

A pumping test in the Great Miami Aquifer was conducted at one of the Albright and Wilson alternate supply wells in the fall of 1991. The well is located approximately 5940 feet west of the South Field injection test area. The test consisted of three steps, each lasting approximately 111.5 minutes. Discharge rates for each step were 130 gpm, 205 gpm, and 375 gpm (DOE 1992). A constant rate test was conducted for 72 hours at a flow rate of 380 gpm. Drawdown during the 72 hour constant rate test, in observation wells located 25 feet from the injection well, was not large enough to provide for the calculation of aquifer properties. The aquifer was not stressed enough, indicating that much higher pumping rates are required if aquifer properties are to be calculated in this area.

In the spring of 1993, a pumping test was performed on one of the South Plume Removal Action wells. The well is located approximately 2400 feet to the south of the South Field pumping test area. The test consisted of six steps, each lasting approximately 100 minutes. Discharge rates for each step were 200, 275, 350, 425, 575, and 750 gpm, respectively (DOE 1993). A constant rate test was conducted for seven days at a flow rate of 425 gpm. Drawdown of approximately 1 foot was recorded in observation wells located approximately 200 feet away.

Gamma logs collected from the pumping wells of the two sites record that the South Plume area contains more gamma-emitting sediment than the alternate water supply well area. Higher gamma readings indicate that the sand and gravel of the Great Miami Aquifer contain a higher percentage of silt and clay. A difference in silt and clay content between the two areas was not recorded in visual descriptions of the sediment which were collected when the wells were drilled.

In May 1995 a pumping test was conducted at the site of the proposed injection test. Horizontal hydraulic conductivity estimates for the six observation wells ranged from 509 to 558 feet/day with a geometric mean of 523.6 feet/day. These results are consistent with previous pumping test results for the area, with reported hydraulic conductivities ranging from 120 to 774 feet/day (Table 1). Estimated vertical hydraulic conductivity ranged from 31.9 to 66.6 feet/day with a geometric mean of 51.5 feet/day. Estimates of specific yield ranged from .089 to .2 and fall within the reported range for unconfined aquifers. The tight range of hydraulic conductivity indicates that the Great Miami Aquifer at the testing location is fairly isotropic. The injected slug of water should therefore expand uniformly.

The Albright and Wilson alternate water supply wells are located in the center of the New Haven Trough over one of the deepest areas. The South Plume Removal Action wells are located toward the edge of the New Haven Trough across the mouth of a smaller channel that runs south of and connects to the New Haven Trough (Figures 3 and 4).

It appears that the sand and gravel in the center of the New Haven Trough contain a smaller percentage of clay than the sand and gravel located along the edge of the New Haven Trough. A smaller percentage of clay would provide for larger values of hydraulic conductivity.

4.3 WATER QUALITY OF THE TEST AREA AND INJECTION WATER

Water quality in the Great Miami Aquifer within the injection test area has been characterized in detail in the Operable Unit 5 RI Report (DOE 1995b). The predominate contaminant of concern for the injection test area is uranium. Unfiltered samples collected from Type 2 wells in 1993 indicate that total uranium concentrations range up to 329 μg/L (DOE 1995b, Plate E-77). Unfiltered samples collected from Type 3 wells (approximately 50 to 60 feet beneath the water table) indicate that total uranium concentrations are less than 20 μg/L (DOE 1995b, Plate E-78). At the injection test location uranium concentrations greater than 20 μg/L appear to be limited to the upper 20 feet of the aquifer.

Injection water will be delivered by pumping two of the South Plume extraction wells (3926 and 3927). The average total uranium concentration of the injection water (approximately 3.5 μg/L) will be far below the total uranium concentration found in the groundwater in the area of the injection test. Three years of groundwater monitoring for total uranium in Wells 3926 and 3927 indicate that the average concentration of total uranium from these two South Plume wells is 3.58 and 3.2 μg/L, respectively.

A review of groundwater quality data collected in the vicinity of Wells 3926 and 3927 also indicates that concentrations of organic, inorganic, and radiological constituents in the injection water will not exceed relevant primary drinking water standards (see Appendix B).

5.0 PROCEDURES

Injection test activities are similar to aquifer/permeability testing activities. Injection test activities will be performed in accordance with requirements contained in the Sitewide CERCLA Quality Assurance Project Plan (SCQ) (DOE 1993a) for aquifer/permeability testing. Table 2 lists the guidelines that will be followed for conducting the injection test.

6.0 INJECTION TESTING PROGRAM

A seven-part testing program will be conducted:

1) Pretest monitoring
2) Slug testing of the control well
3) A step test (ST)
4) ST recovery monitoring
5) A 72-hour constant rate injection test
6) CRT recovery monitoring
7) Slug testing of the control well.

6.1 TEST SETUP

Well 31550 will be used for the injection test (Figure 6). During the test water will be injected through a pipe and exit from the pipe at a point approximately five feet beneath the water table in the surrounding aquifer, and approximately three feet above the top of the screen in the well. The delivery piping will be designed so that water will not cascade down the pipe as it enters the well. Delivering the water by this method should decrease the possibility of plugging the surrounding formation due to air entrapment within the injected water. Well 31550 has a 2-inch observation well installed within the filter pack of the well, outside of the screen, that will be monitored for water levels and water quality during the injection test.

Figure 7 shows the location of the observation wells within the immediate test area. Pressure transducers will be installed in Wells 31550, 31551, 31552, 31553, 31554, 31555, and 31556 and connected to a common 8-channel data logger system. Using this setup, water level readings at all of the observation wells can be collected uniformly at the same programmed frequency (defined in Table 4). Water quality will be monitored (as outlined in Appendix C) in each of these wells (dissolved oxygen, pH, temperature, total suspended solids and total uranium) to document the expansion of the injected slug of clean water.

Water levels will be recorded in the following monitoring wells located around the test area: 2387, 2049, 2390, 2434 and 2398 (Figure 8). Monitoring at these surrounding locations will be used to assess water table fluctuations due to recharge through precipitation during the test.

The following measurements will be taken in support of the injection test:

- Water levels in the Great Miami Aquifer (feet)
- Injection rate to the control well (gpm)
- Atmospheric pressure (inches of mercury)
- Precipitation (inches)
- Water quality (dissolved oxygen, pH, temperature, total suspended solids, total uranium of recharge water)
- Vertical flow profiling within the control well during the CRT.

Most of the measurements involve monitoring water levels in the Great Miami Aquifer to determine regional trends before the start of the testing activity, regional trends during the testing program, recharge due to precipitation, and water level responses due to injection. Pressure transducers and automatic data logger systems will be used. Data will be used to calculate an injection-specific capacity for Well 31550, document if plugging due to injection is occurring, and document the spread of the injected plume of clean water. Atmospheric pressure and precipitation data will be collected at the FEMP meteorological tower, which is located approximately 1750 feet northwest of the test area. Dissolved oxygen, pH, and temperature will be measured in the field. Total uranium and total suspended solids will be measured in the FEMP laboratory (analytical support level B).

An attempt will be made during the CRT to measure a vertical flow profile of water movement within the control well using a flow profiling tool. This measurement may be useful in determining if injection flow will preferentially move through coarser grained zones of the aquifer. As described above, injected water will be released downhole above the top of the screen. A flow profiling tool will be used to document where the majority of flow across the screen is occurring. The flow profiling spinner tool is shown in Figure 9. It consists of a stainless steel impeller attached to a shaft extending from the bottom of a magnetic head. Rotation of the magnet activates reed switches that generate electrical pulses in direct proportion to the rotation velocity, which is proportional to the flow rate. The signal is amplified and displayed on a strip chart recorder at the surface. Logging with this tool is similar to conventional logging procedures. The tool will be lowered into Well 31550 until the bottom of the screen is tagged, water will be injected, and the tool will be pulled up across the screen at a rate that is equal to the lowest velocity required to spin the impeller through still water.

6.2 TEST EQUIPMENT

The following equipment will be required to conduct the testing program:

- For the injection system -
  - Piping and necessary fittings from the water source to the injection well with a minimum capacity of 700 gpm
  - Power source for ancillary field equipment (including lighting system for night work).
  - Primary and backup gate valve to control recharge to the test well
  - Digital flow meter and totalizer to measure flow in gpm and total recharge in gallons
  - Analog flow meter and totalizer to measure flow in gpm and total recharge in gallons
  - Sampling port on the flow line for the collection of water samples
  - Lighting system for night work
- To conduct pneumatic and vacuum slug tests -
  - Wellhead apparatus for sealing well, controlling vacuum/pressure, allowing access for pressure transducers and water level indicators
  - Electric water level indicator

- High speed data logger

- 50 psi pressure transducer with 100 feet of cable

- 3500 watt portable generator

- 3500 watt portable generator (backup)

- 3/4 hp or larger air compressor with storage tank

- Vacuum pump

- Field printer

• To measure flow rates -

- Stop watch
- Field notebook and flow rate recording forms
- Flow profiling tool (see Figure 7)

• To measure Great Miami Aquifer water levels -

- Eight transducers, to be used to monitor immediate injection test area (control well, one in and one outside of screen) and 6 observation wells

- Two 8-channel data logger systems to record pressure readings from transducers in the immediate injection test area; one will serve as a backup

- Two electric water level measuring tapes

- Deionized water and disposal towels for decontaminating probes and tapes

- Field notebook and water level recording forms

- Five 1-channel data logger systems and five pressure transducers to monitor surrounding wells for recharge due to precipitation

• To collect water samples -

- Sample bottles and shipping containers (coolers)
- Turbidity meter
- pH, specific conductance, temperature, and dissolved oxygen probes and meters

• Miscellaneous -

- Two flashlights
- Indelible pens and/or pencils
- Health and safety equipment and clothing
- Portable laptop computer, equipped with Lotus 1-2-3 and WordPerfect

- Semilog and log-log graph paper for plotting injection data
- Portable phones
- Extra batteries for water level probes and flashlights
- Flow profiling tool within signal pickup.

6.3 EQUIPMENT SHAKEDOWN

To minimize unforeseen problems, all equipment will be subjected to a performance shakedown two days before initiation of the test. Power supplies, flow lines, valves, gauges, meters, lighting, recorders, data loggers, and any other equipment subject to mechanical, structural, and/or electrical failure will be inspected and field tested before start up of the injection test. The shakedown test will include a practice run that replicates the first step of the step injection test and a demonstration of a 700-gpm injection rate. Records of the shakedown will be maintained by the operator(s).

6.4 PRETEST MONITORING

Pretest monitoring will be conducted to assess local water level trends. Water levels will be measured at a minimum of once a day for a minimum period of seven days immediately before the start of the testing program to determine how water levels are trending, and predict how the trend will continue through the injection test. Trends will be established in the following wells: 31550, 31551, 31552, 31553, 31554, 3155, 31556, 2387, 2049, 2390, 2434 and 2398.

6.5 PNEUMATIC AND VACUUM SLUG TEST

A vacuum and pneumatic slug test will be conducted on the injection well before and after the injection tests. The tests will be conducted to determine if any plugging or alteration of the well and surrounding aquifer material occurred during the injection test. The slug tests will use a wellhead apparatus allowing the application of either pressure or vacuum to displace water standing in the well bore (Figures 10 and 11). A vacuum test will create a falling head slug test where the water level is raised in the well, held constant to obtain equilibrium conditions, and allowed to fall by releasing the vacuum through a ball valve. A pneumatic test creates a rising head test where the water level in the well is lowered by air pressure, held constant to obtain equilibrium conditions, and allowed to recover by releasing the pressure through a ball valve.

A high-speed data logger and pressure transducers will be used to measure recovering water levels as a function of time. The water level is expected to recover very quickly, based on results of the pumping test completed in the same well in May 1995. A rate of 5 measurements per second will be used to record water levels for the duration of each test.

Two vacuum slug tests and two pneumatic tests will be conducted during each test session, before and after injection testing. Displacements of 5 and 10 feet for each test type are anticipated during each session. Actual displacements will depend on static water levels in the well at the time of the test. Slug test displacements created during preinjection testing will be duplicated during postinjection testing.

Data collected for each test will be downloaded to a laptop computer for data processing. The data will then be uploaded into the Aqtesolv™ program for calculating aquifer parameters using the Bower and Rice method for unconfined aquifers.

6.6 STEP INJECTION TEST

A step injection test will be conducted for the purpose of determining a fixed rate for the CRT.

6.6.1 ST Procedures

The step injection test will begin with an injection rate of 100 gpm. Each step will be conducted for approximately 100 minutes. Injection will be increased by 100 gpm each step of the test. Six steps are planned, resulting in an injection rate that ranges up to 600 gpm. If all six steps are conducted as planned, approximately 210,000 gallons of water will be injected and the test will last approximately 10 hours; see Table 4.

Water levels in the control well and the six closest observation wells (31551 through 31556, Figure 7) will be monitored automatically using pressure transducers and data loggers according to the time intervals presented in Table 3. The injection rate will be recorded once every minute for the first 10 minutes of injection for each step and once every 10 minutes for the remainder of the step.

Water samples will be collected from the injected water and Wells 31550, 31551, 31552, 31553, 31554, 31555 and 31556 at the start of each step of the step test and measured for dissolved oxygen, pH and temperature and analyzed for total suspended solids total uranium (unfiltered). Well 31550 will be sampled through an observation well installed just outside the screen.

All six steps will be conducted unless the hydrogeologist in charge decides that enough data has been collected to determine a rate of injection for the constant rate injection test. If injection is disrupted the hydrogeologist in charge will determine when the test can be resumed. Restart of the test will depend upon the degree of the disruption and how fast water levels recover to preinjection conditions.

6.6.2 ST Recovery Monitoring

Water levels will continue to be monitored automatically in the control well and six closest observation wells following the step injection test until it has been determined that water levels have recovered to pretest elevations. The recovery of water levels will be recorded in the same sequence as during injection. Using the data logger system, measurements will be recorded automatically at the intervals shown in Table 3.

Monitoring will continue for approximately 24 hours or until three successive water level measurements at 1-hour intervals show less than a 0.1-foot difference in recovery at the control well. It is anticipated that recovery will be complete within a few hours. The objective of this monitoring is to document that water levels have returned to pre-ST elevations before the commencement of the CRT.

6.7 CONSTANT RATE TEST

A CRT will be conducted for the purpose of determining a sustainable injection rate for the Great Miami Aquifer in the South Field. The flow rate for the CRT will be determined from results of the step injection test. The gate valve will be adjusted before the start of the CRT test.

6.7.1 CRT Procedures

Water level buildup in the control well and Wells 31551 through 31556 will be recorded automatically using pressure transducers and data loggers; water levels will also be checked periodically with manual water level indicators to assess the accuracy of the automatic system. Data logger measurement frequencies are tabulated in Table 3. The data logger will be downloaded every 24 hours (at a minimum) during the course of the test. Water levels in the surrounding monitoring wells (2387, 2049, 2390, 2434, and 2398) will be measured every 15 minutes during the CRT using pressure transducers and data logger systems.

Water samples will be collected from the injected water and Wells 31550, 31551, 31552, 31553, 31554, 31555, 31556 at the start of the CRT and every 12 hours of the test for the measurement of dissolved oxygen, pH and temperature and analyzed for total uranium and total suspended solids. Well 31550 will be sampled through an observation well installed just outside the screen.

The injection rate will be checked and recorded every minute for the first 10 minutes, every 10 minutes for the next 100 minutes, and then every 100 minutes thereafter. The injection rate will be adjusted as needed to maintain the desired injection.

The CRT will be conducted for a minimum of 72 hours. The project leader will determine when the test can be terminated after the 72-hour minimum has been reached. Additional injection may be needed to check for delayed yield effects. The test will not extend past 7 days or 10,000 minutes.

If injection is disrupted the hydrologist in charge will determine when the test can be resumed. Restart of the test will depend upon the degree of the disruption and how fast water levels recover to preinjection conditions.

6.7.2 CRT Recovery Monitoring

Water levels will continue to be monitored automatically in the control well and six closest observation wells (31551 through 31556, Figure 7) following the CRT until it has been determined that water levels have recovered to pretest elevations. The recovery of water levels will be recorded in the same sequence as during injection. Using the data logger system, measurements will be recorded automatically at the intervals shown in Table 3.

Monitoring will continue for approximately 24 hours or until three successive water level measurements at one-hour intervals show less than 0.1-foot difference in recovery at the control well. It is anticipated that recovery will be complete within a few hours. The objective of this monitoring is to document that water levels have returned to pre-ST elevations.

6.8 TOTAL VOLUME OF INJECTED WATER

Table 4 shows the calculated volume of water to be injected in the step injection test and constant rate injection test. Approximately 210,000 gallons will be injected during the ST and 2,100,000 gallons will be injected if the CRT is conducted for three days only.

6.9 PROPOSED PROJECT SCHEDULE

Figure 12 presents a preliminary schedule for the South Field injection test. On the basis of this schedule, the test is to be conducted by October 6, 1995. The injection test is scheduled to begin on September 18, 1995 (Run Test-Alternative 1, Figure 12). An early start date of September 11, 1995 may be possible, pending construction and concurrence on the testing plan (Run Test-Alternative 2, Figure 12). A report covering the test activities and presenting results is to be completed by November 21, 1995.

7.0 DATA MANAGEMENT ANALYSIS AND REPORTING

Data collected during the investigation will be properly managed following completion of field activities. Data and field documentation generated during the investigation shall be checked to ensure compliance with the data quality objectives for the project.

As specified in Section 5.1 of the SCQ, sampling teams shall describe daily activities on the Field Activity Log sufficient for the sampling team to reconstruct a particular situation without reliance on memory. To assure appropriate documentation was completed during field activities and that documentation was completed correctly, field documentation shall be checked for completeness and accuracy.

Data collected from the injection test will be used to assess long-term well injectivity. Data collected from the test will not be used to calculate hydraulic conductivity, as would be expected during a pumping test. All water level data and flow data will be expressed in units of feet and gallons per minute.

All measurement data collected and used for the purpose of determining well injectivity will be tabulated and presented in an injection test report. Graphs and tables of data will be used as appropriate to aid in the data reduction process. Printouts of data logger tapes and original field documentation will be maintained in project files according to procedures at the FEMP. The injection test report will contain background information on the testing activities, a description of the injection test, and an analysis of the data.

8.0 HEALTH AND SAFETY

The project-specific health and safety plan prepared for the South Field pumping test will be used for this project.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

All work will be conducted in accordance with the requirements of the overall quality assurance program at the FEMP. Injection test activities and laboratory testing shall be assigned the proper quality level. Site Policy and Procedure Number FMPC-711 provides guidelines for matching the quality program requirements to the quality levels. Specific quality items will be reviewed by FERMCO to verify that the quality requirements are adequate and consistent with the assigned quality level. Field quality control will be consistent with guidance provided in the FEMP SCQ (DOE 1993a).

10.0 REFERENCES

Dove, G. D., 1961, "A Hydrologic Study of the Valley-Fill Deposits in the Venice Area, Ohio," Technical Report No. 4, Ohio Department of Natural Resources, Division of Water, Columbus, OH.

Driscoll, F. G., 1986, Groundwater and Wells, 2nd Ed., Johnsons Division, St. Paul, MN.

Kazmann, R. G., 1950, "Memorandum Report on Hydrogeological Survey for Southwestern Ohio Water Company, Big Bend Area, Miami River, Hamilton County, Ohio."

Klaer, F. and R. G. Kazmann, 1943, "A Qualitative Study of the Well Field of the Mill Creek Valley Water Supply Project," USGS Technical Report, Butler County, Ohio.

Klaer, F. and R. G. Kazmann, 1948, "Groundwater Resources of the Cincinnati Area," USGS Water Supply Paper, Butler and Hamilton Counties, Ohio.

Kruseman, G. P., and N. A. de Ridder, 1989, "Analysis and Evaluation of Pumping Test Data," ILRI Publication 47, International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

Lewis, R. C., 1968, "An Investigation of the Potential Yield of the Big Bend Wellfield," unpublished thesis, Univ. of Cincinnati, OH.

Smith, R. C., 1960, "Results of Investigation: Available Well Water Supply at Baldwin-Lima-Hamilton, Ohio," Technical Report for Champion Paper and Fiber Co., Hamilton, Ohio.

Smith, R. D., 1962, "Groundwater Development, Miami River Area," Consultant report to the Water Works Dept., City of Cincinnati, Ohio.

Spieker, A. M. and S. E. Norris, 1962, "Groundwater Movement and Contamination at the AEC Feed Materials Production Center Located Near Fernald, Ohio," U.S. Geological Survey Technical Report for the U.S. Atomic Energy Commission, AEC, Washington, DC.

U.S. Department of Energy, 1992, "South Groundwater Contamination Plume Removal Action, Part 1, Alternate Water Supply, Installation and Test of a Test Well," Fernald Environmental Management Project, DOE, Fernald Office, Cincinnati, OH.

REFERENCES
(Continued)

U.S. Department of Energy, 1993a, "Sitewide CERCLA Quality Assurance Project Plan," Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Department of Energy, 1993b, "South Plume Removal Action Pumping Test Report," Revision 0, Fernald Environmental Management Project, DOE, Fernald Office, Cincinnati, OH.

U.S. Department of Energy, 1994, "SWIFT Great Miami Aquifer Model - Summary of Improvements Report," Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Department of Energy, 1995a, "Feasibility Study Report for Operable Unit 5," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 1995b, "Remedial Investigation Report for Operable Unit 5," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 1995c, "South Field Pumping Test Report," Draft, DOE, Fernald Area Office, Cincinnati, OH.

Watkins, J. S. and A. M. Spieker, 1971, "Seismic Refraction Survey of Pleistocene Drainage Channels in the Lower Great Miami River Valley, Ohio," U.S. Geological Survey, Professional Paper 605-B, available from U.S. Government Printing Office, Washington, DC.

TABLE 1

HYDRAULIC CONDUCTIVITY FROM PUMPING TESTS IN THE GREAT MIAMI AQUIFER NEAR THE FEMP

Reference	Location	Hydraulic Conductivity[a] (ft/day)	Hydraulic Conductivity[a] cm/s
Dove, 1961	SOWC Wells	375 to 400	1.3×10^{-1} to 1.4×10^{-1}
Smith, 1962	Bolton Wellfield	328	1.2×10^{-1}
Klaer, 1948	Bolton Wellfield	120	4.2×10^{-2}
Kazmann, 1950	SOWC Wells	318 to 369	1.1×10^{-1} to 1.3×10^{-1}
Klaer and Kazmann, 1943	Hamilton South Wellfield	313 to 324	1.1×10^{-1} to 1.1×10^{-1}
Spieker and Norris, 1962	FEMP Production Well	267	9.4×10^{-2}
Lewis, 1968	SOWC Wells	334 to 404	1.2×10^{-1} to 1.4×10^{-1}
Smith, 1960	ChemDyne - Hamilton	214 to 412	7.5×10^{-2} to 1.5×10^{-1}
DOE, 1993	Fernald - FEMP Removal Action 3	413	1.5×10^{-1}
Smith, 1962	Ross - west bank of Great Miami River	534	1.9×10^{-1}
Smith, 1960	New Miami - mouth of Four Mile Creek	774	2.7×10^{-1}
DOE, 1995	FEMP - South Field	509-558	1.8×10^{-1} to 2.0×10^{-1}

[a]Summary statistics:

Minimum K_h	=	120 ft/day	4.2×10^{-2} cm/s
Maximum K_h	=	774 ft/day	2.7×10^{-1} cm/s
Average K_h	=	397 ft/day	1.4×10^{-1} cm/s
Standard deviation	=	164 ft/day	5.8×10^{-1} cm/s

TABLE 2

TEST GUIDELINES

Guidelines	Reference
Chain-of-custody	SCQ, Section 7.1
Corrective action	SCQ, Section 15.2
Daily logs	SCQ, Section 5.1 and Appendix J, Subsection J.4.1
Variances	SCQ, Section 15.4
Field	
Groundwater level measurement	SCQ, Appendix K, Subsection K.4.2.1
Aquifer/permeability testing	SCQ, Section 5.2.5 and Appendix J, Subsection J.4.6
Groundwater sampling	SCQ, Appendix K
Field screening of samples for radioactive contamination	SCQ, Appendix K, Subsection K.5.3.2
Decontamination	SCQ, Appendix K, Subsection K.11
Field storage and shipment of samples	SCQ, Appendix K, Subsection K.10
Field calibration requirements	SCQ, Appendix I
Field analytical methods	SCQ, Appendix K, Subsection K.4.1
temperature	SCQ, Appendix K, Subsection K.4.1.1
pH	SCQ, Appendix K, Subsection K.4.1.2
specific conductance	SCQ, Appendix K, Subsection K.4.1.3
dissolved oxygen	SCQ, Appendix K, Subsection K.4.1.4
Laboratory Tests	
Total uranium	Attachment I, Volume V, Method No. FM-RAD-0120
Total suspended solids	FEMP EPM Lab method 9094/TSS-Gravimetric

TABLE 3

GROUNDWATER LEVEL MEASUREMENT SCHEDULE

Time Since Start of Pumping	Approximate Time Intervals
0-5 seconds	0.5 seconds
5-20 seconds	1 second
20-120 seconds	5 seconds
2-100 minutes	2 minutes
100-1000 minutes	20 minutes
1000 - completion of test	200 minutes

7138

TABLE 4

CALCULATED VOLUME OF WATER INJECTED

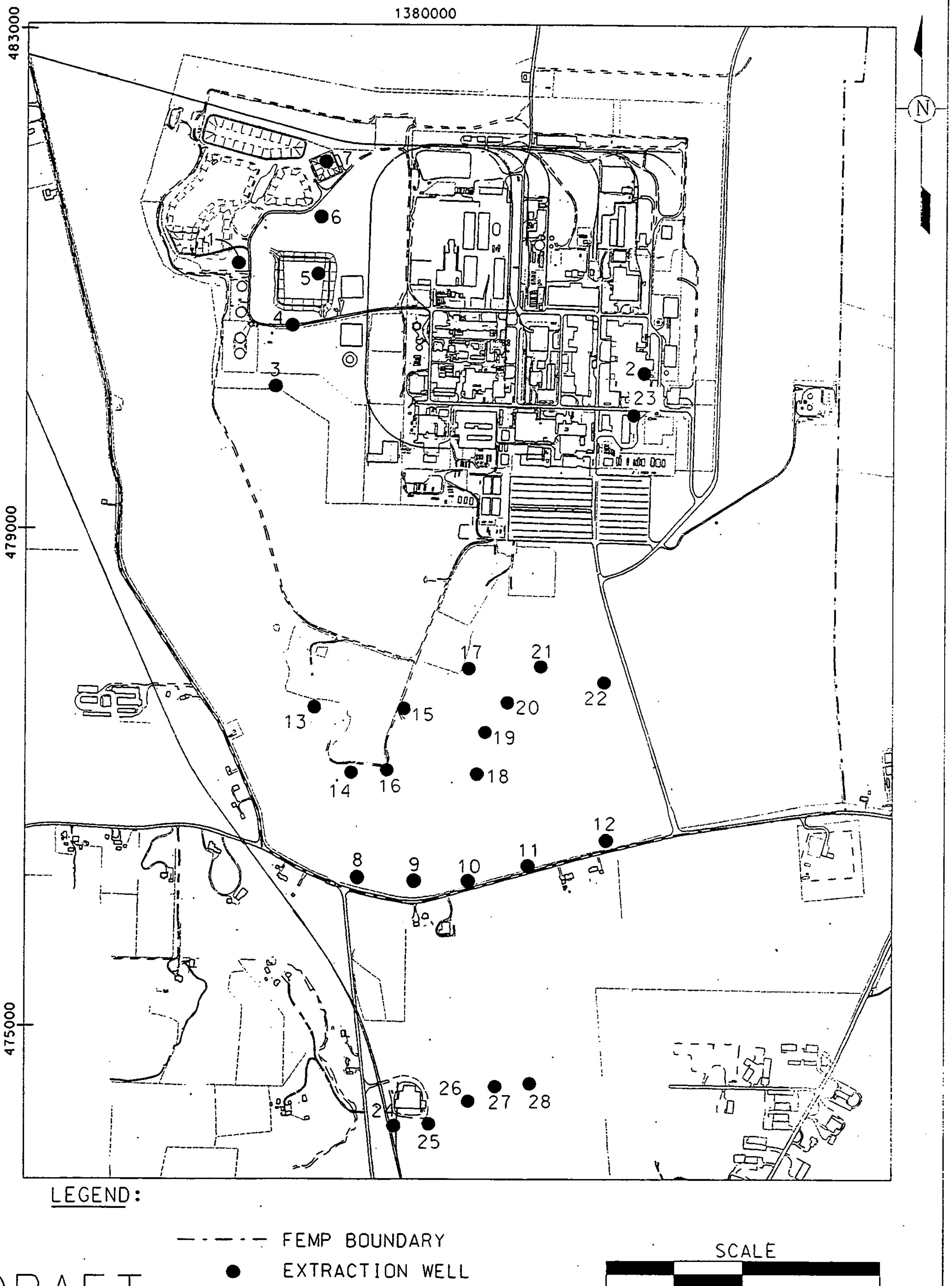
Step Injection Test Volume Estimates

Step No.	Time Period (min)	Injection Rate (gpm)	Volume (gal)
1	100	100	10,000
2	100	200	20,000
3	100	300	30,000
4	100	400	40,000
5	100	500	50,000
6	100	600	60,000
		Total Volume	210,000

Constant Rate Injection Test Volume Estimates

Scenario	Time Period (days)	Injection Rate (gpm)	Total Volume Injected (gal)
1	3	300	1,290,000
2	3	500	2,100,000

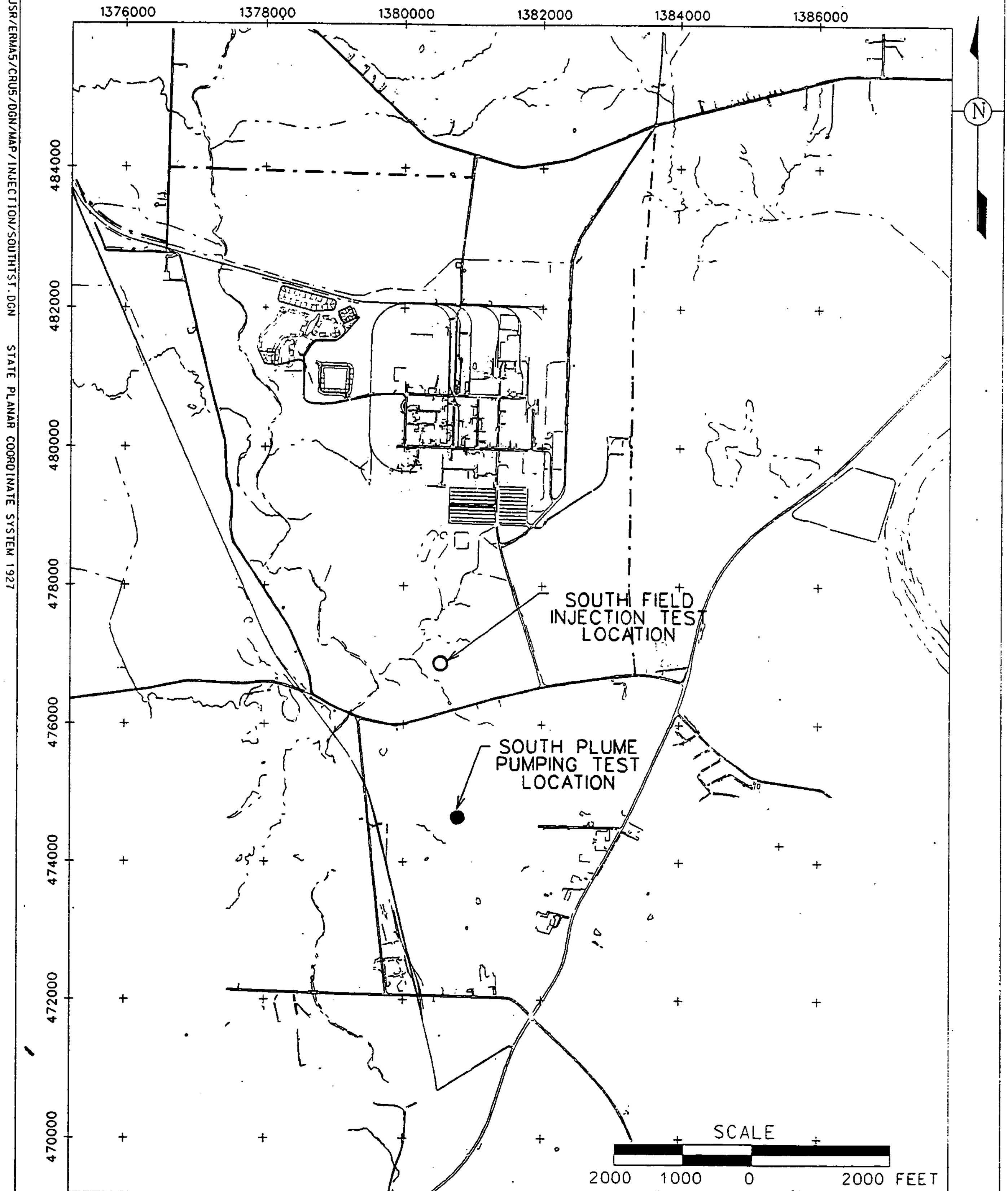
/USR/ERMA1/CRU5/DGN/INJECTION/EXTWELL.DGN FER OU5 8/13/95 STATE PLANAR COORDINATE SYSTEM 1927



DRAFT

FIGURE 1. 28-WELL BASE CASE EXTRACTION SYSTEM

2133

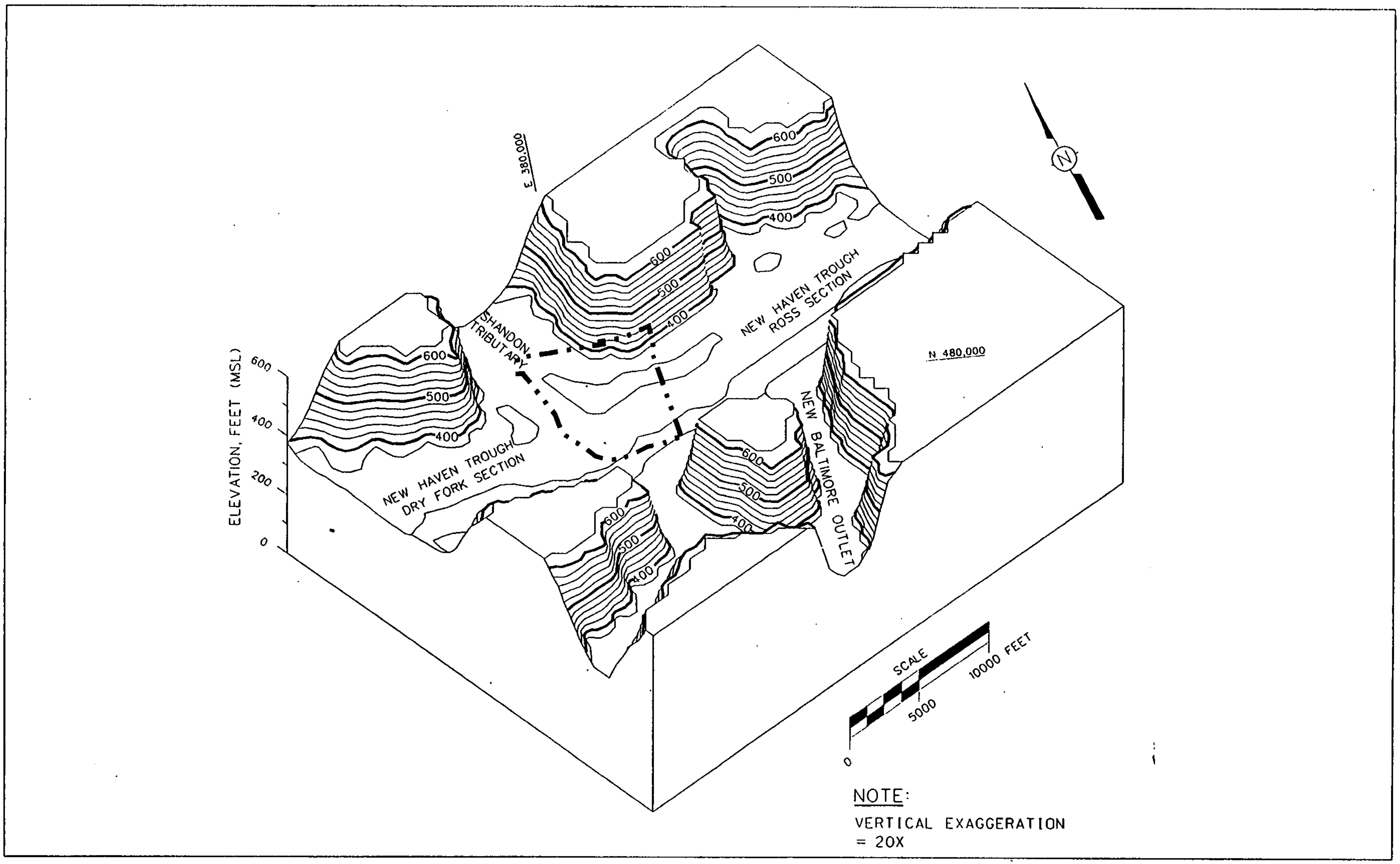


LEGEND:

- ● SOUTH PLUME TEST LOCATION
- ○ PROPOSED INJECTION TEST LOCATION
- -·-·— FEMP BOUNDARY

DRAFT

FIGURE 2. LOCATION OF SOUTH FIELD INJECTION TEST



LEGEND:
400 CONTOUR
FEMP BOUNDARY

DRAFT

FIGURE 3. 3-DIMENSIONAL BEDROCK CONFIGURATION AT THE FEMP

/USR/.../INJECTION/3DBEDROC.DGN

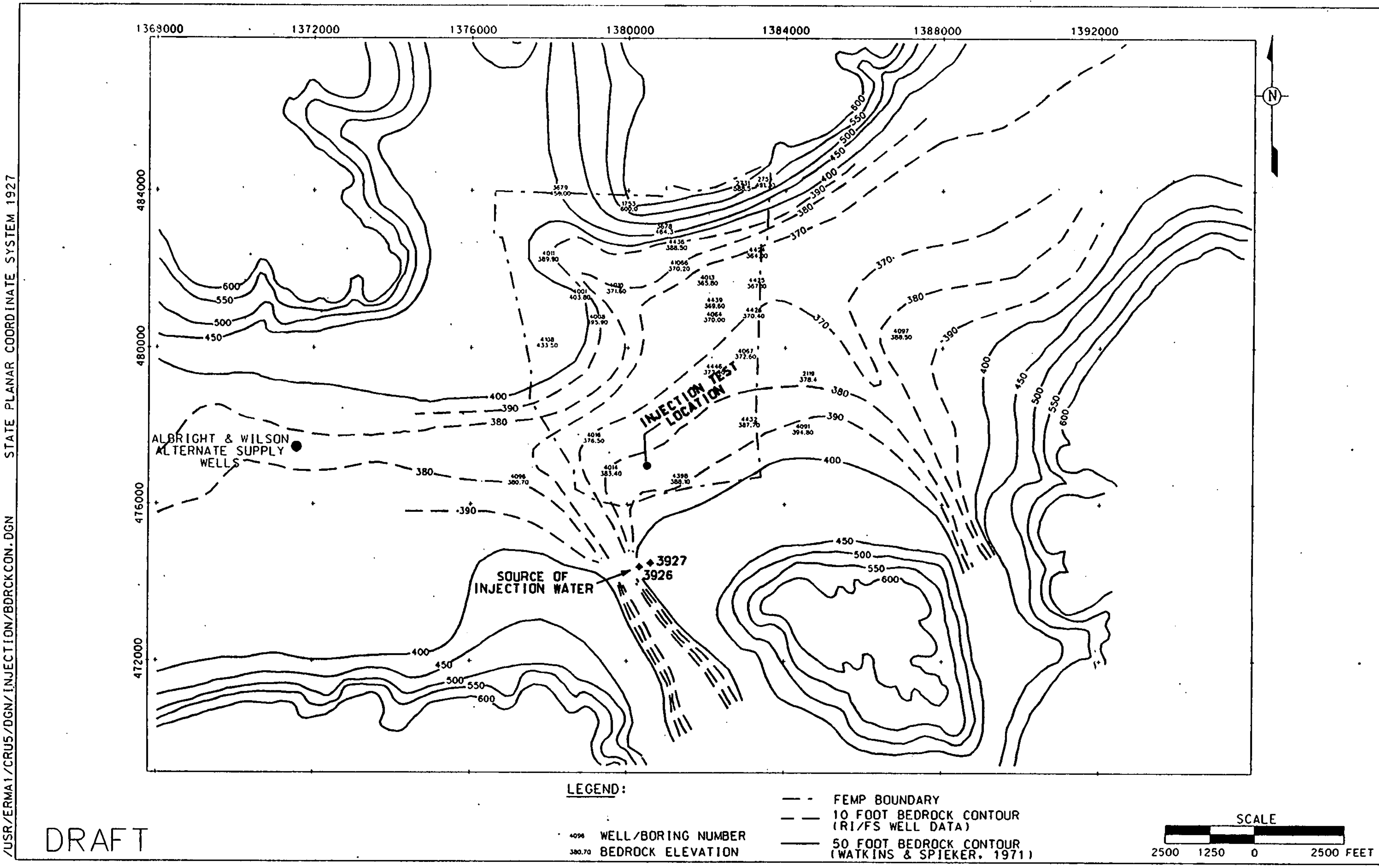


FIGURE 4. BEDROCK TOPOGRAPHIC SURFACE

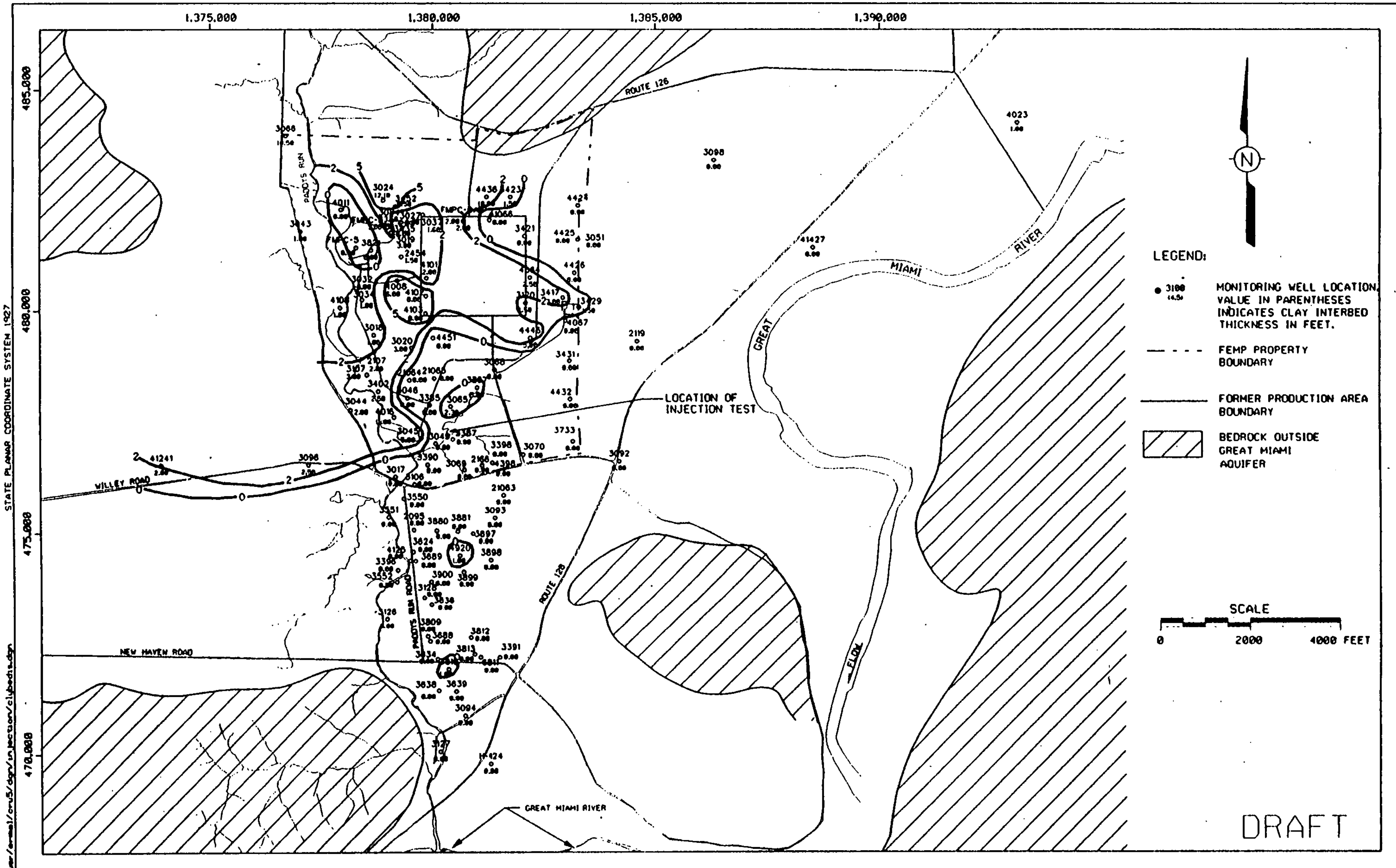


FIGURE 5. CLAY INTERBED ISOPACH

8 2 1 9

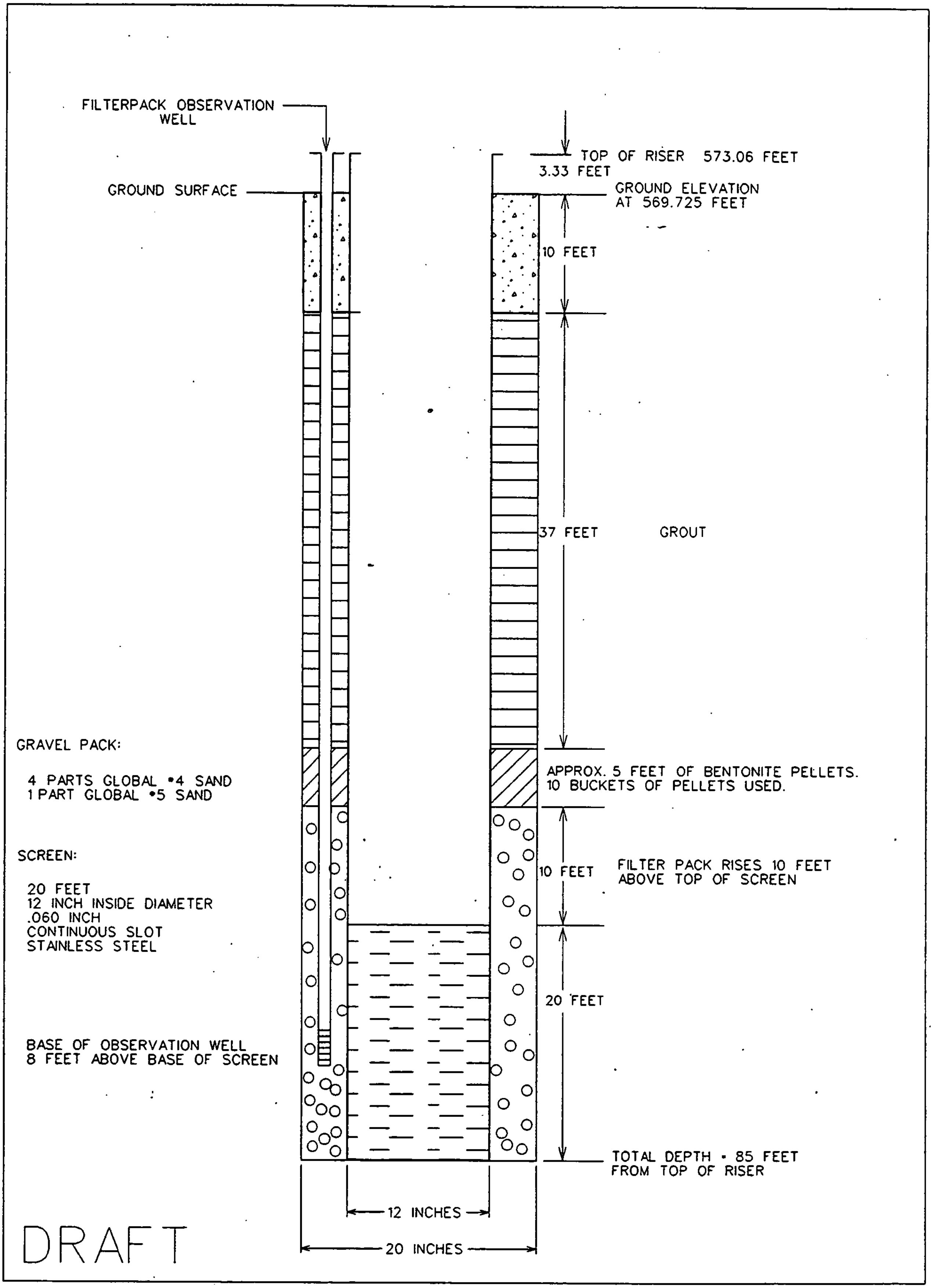
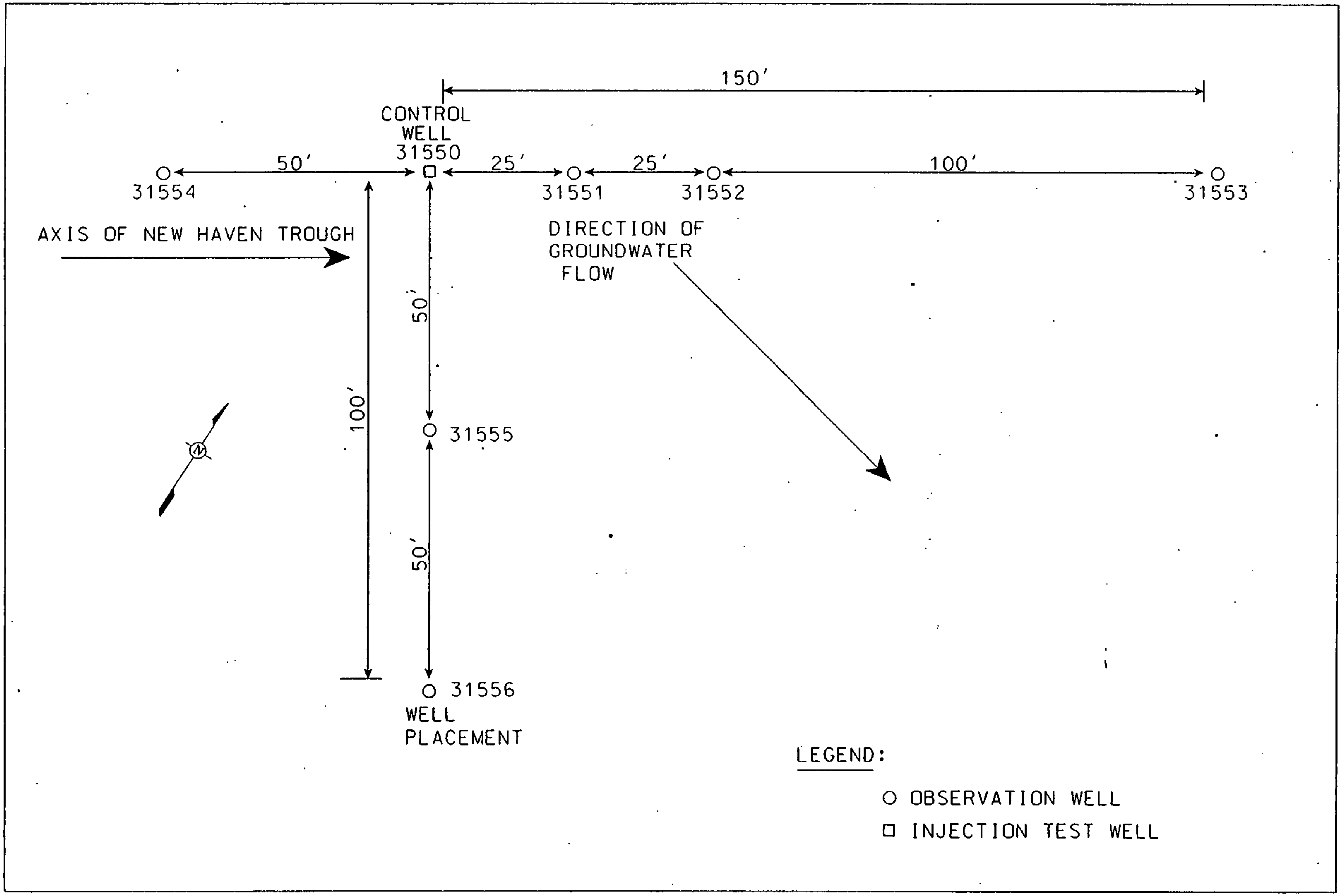


FIGURE 6. DESIGN OF WELL 31550



DRAFT

FIGURE 7. INJECTION TEST WELL NETWORK

/usr/ermal/cru5/dgn/INJECTION/TSTNET.dgn

8214

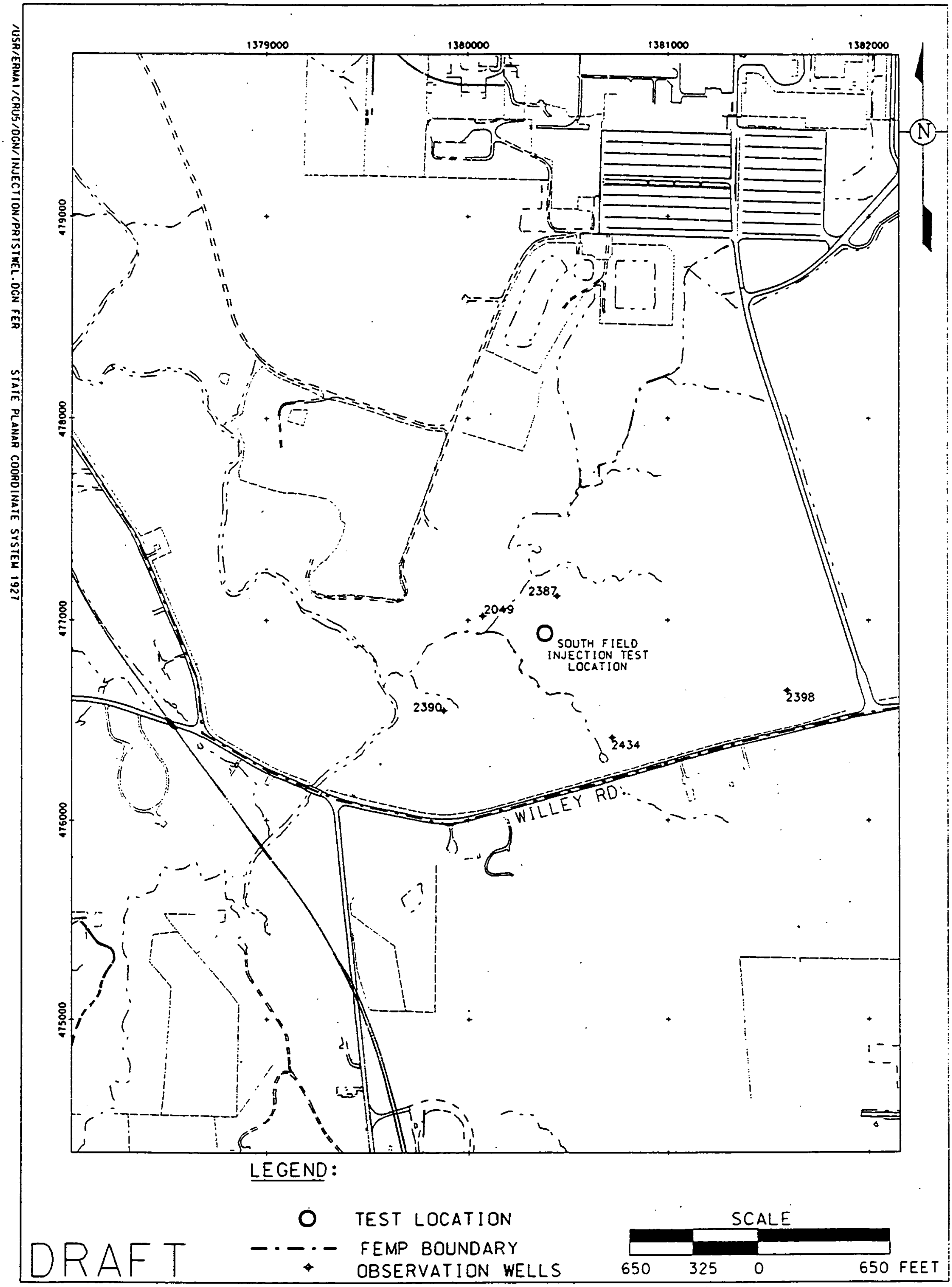


FIGURE 8. INJECTION TEST AREA SHOWING EXISTING OBSERVATION WELLS

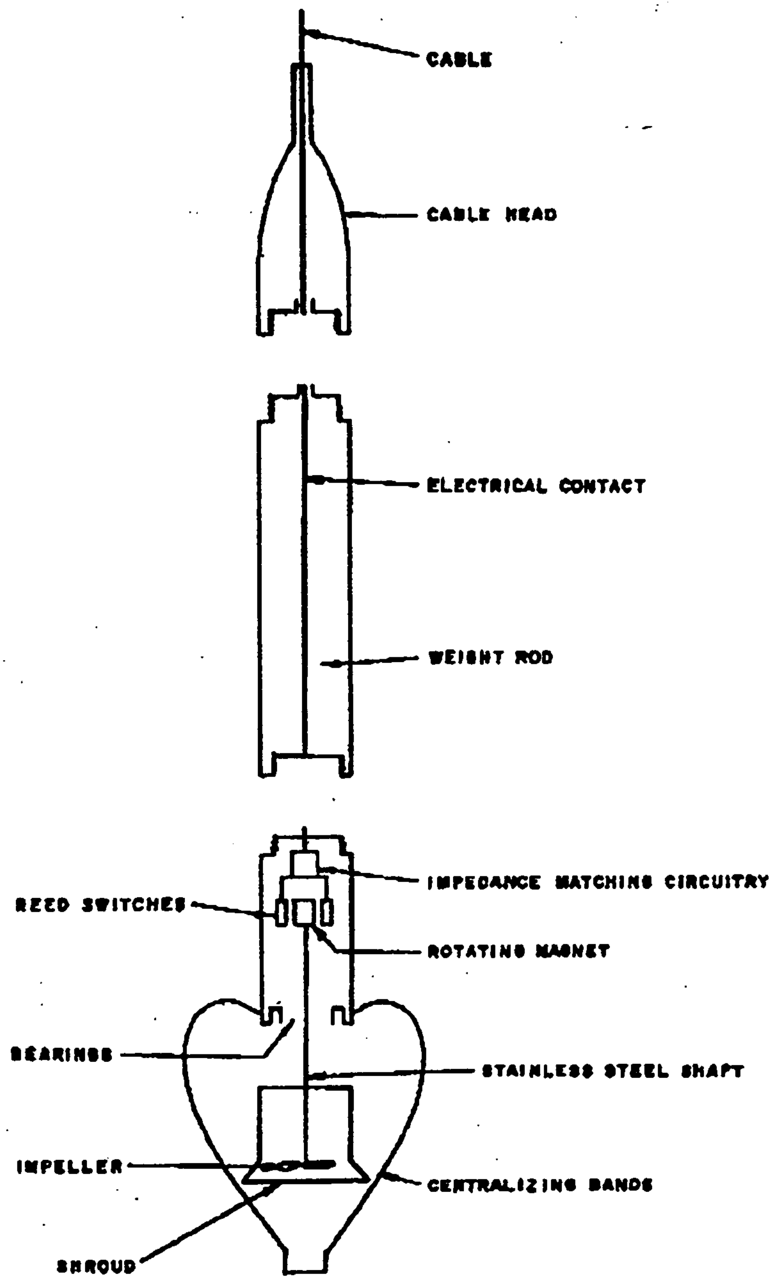


FIGURE 9. SCHEMATIC DIAGRAM OF FLOW PROFILING TOOL

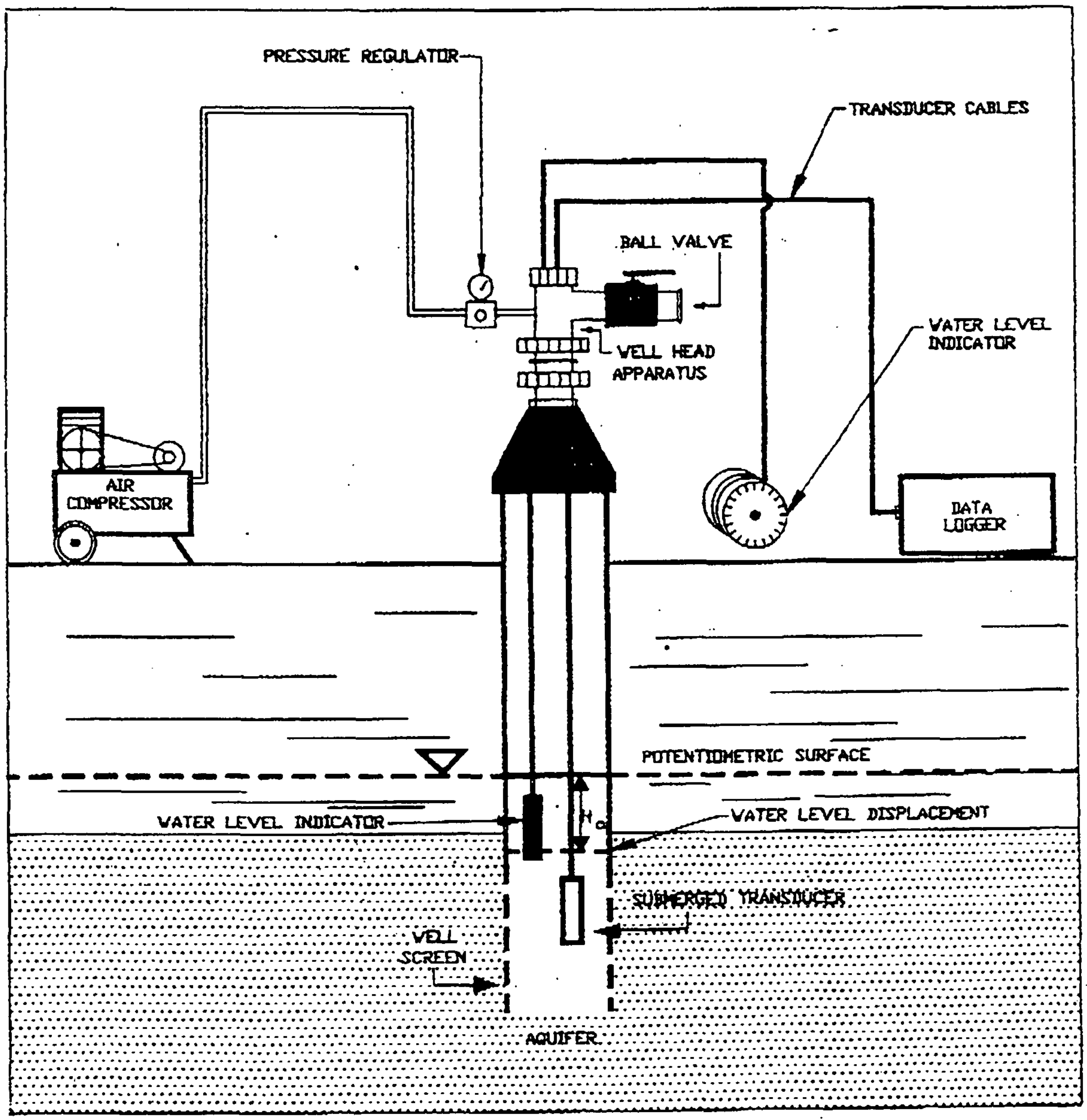


FIGURE 10. PNEUMATIC SLUG TEST EQUIPMENT SETUP

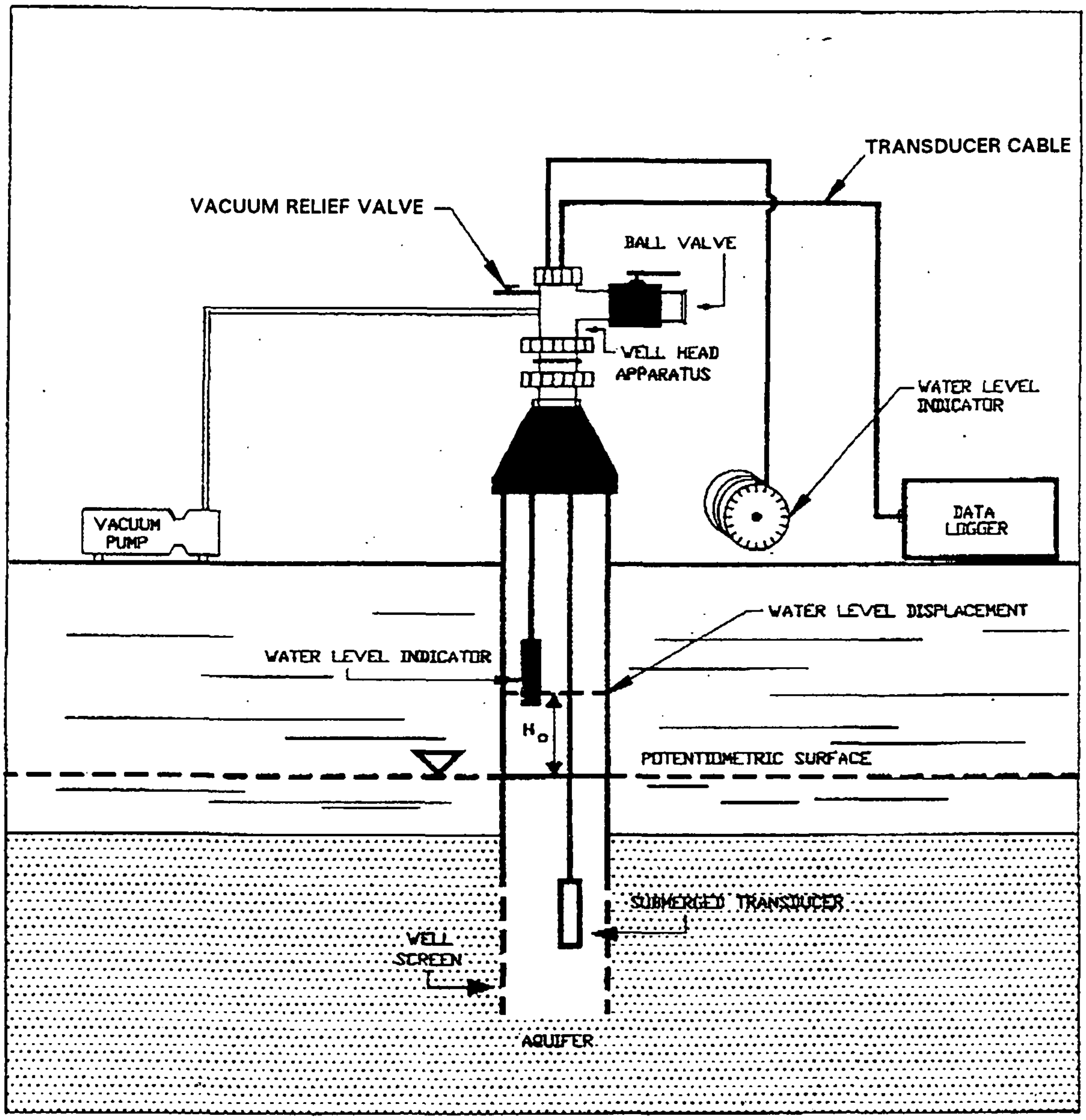
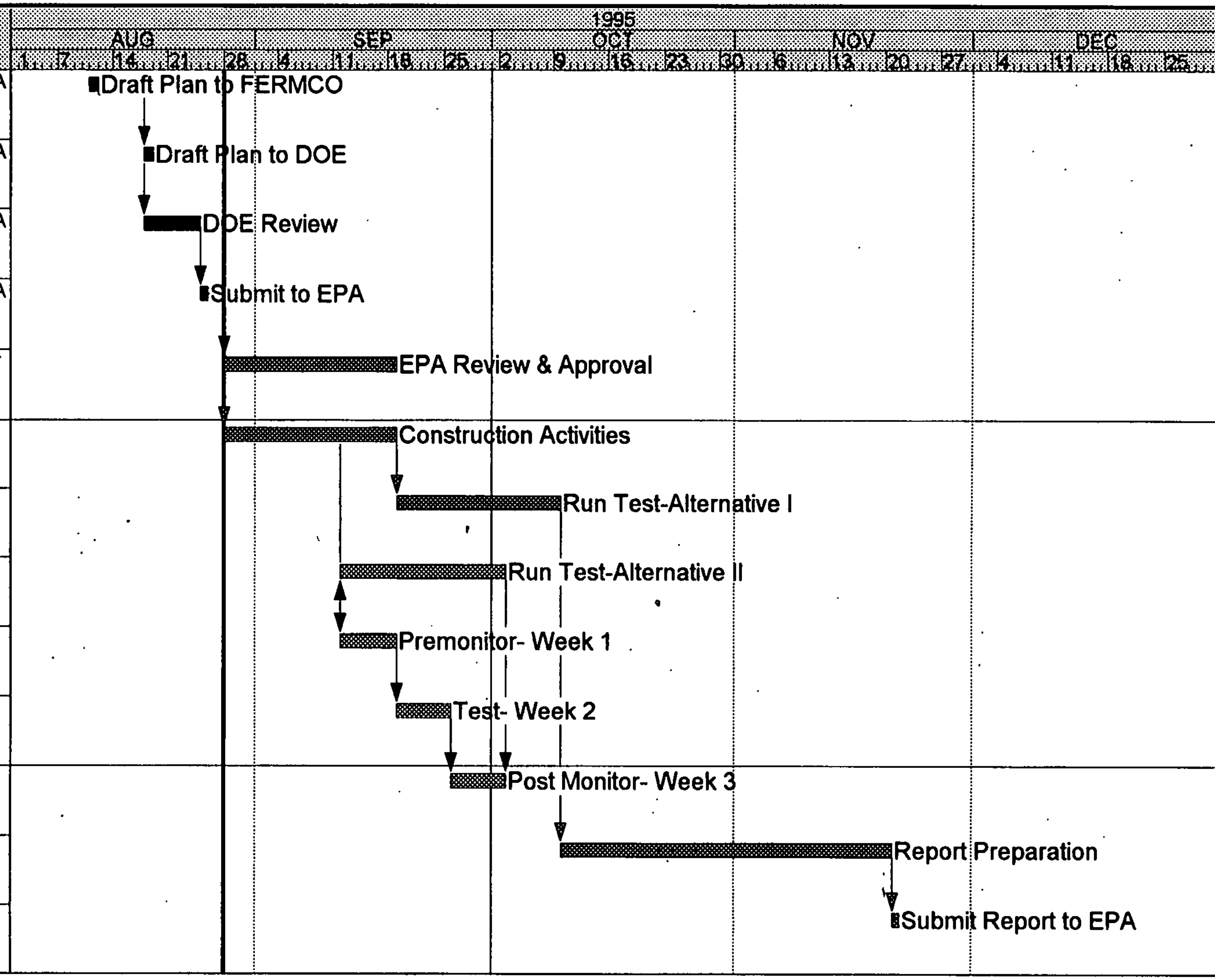


FIGURE 11. VACUUM SLUG TEST EQUIPMENT SETUP

Activity ID	OD	Rem Dur	%	Early Start	Early Finish
5CGW20100	1	0	100	11AUG95A	11AUG95A
5CGW20200	1	0	100	18AUG95A	18AUG95A
5CGW20300	5	0	100	18AUG95A	24AUG95A
5CGW20400	1	0	100	25AUG95A	25AUG95A
5CGW20500	15	15	0	28AUG95	18SEP95
5CGW20600	15	15	0	28AUG95	18SEP95
5CGW20700	15	15	0	19SEP95	09OCT95
5CGW20800	15*	15*	0	12SEP95	02OCT95
5CGW20900	5	5	0	12SEP95	18SEP95
5CGW21000	5	5	0	19SEP95	25SEP95
5CGW21100	5	5	0	26SEP95	02OCT95
5CGW21200	29	29	0	10OCT95	20NOV95
5CGW21300	1	1	0	21NOV95	21NOV95



Project Start	01JAN90	Early Bar
Project Finish	21NOV95	Progress Bar
Data Date	28AUG95	Critical Activity
Plot Date	24AUG95	

© Primavera Systems, Inc.

SFIT

Sheet 1 of 1

FERMCO

South Field Injection Test

FIGURE 12. SOUTH FIELD INJECTION TEST SCHEDULE

000042

APPENDIX A

WATER TABLE MAPS AND HYDROGRAPHS

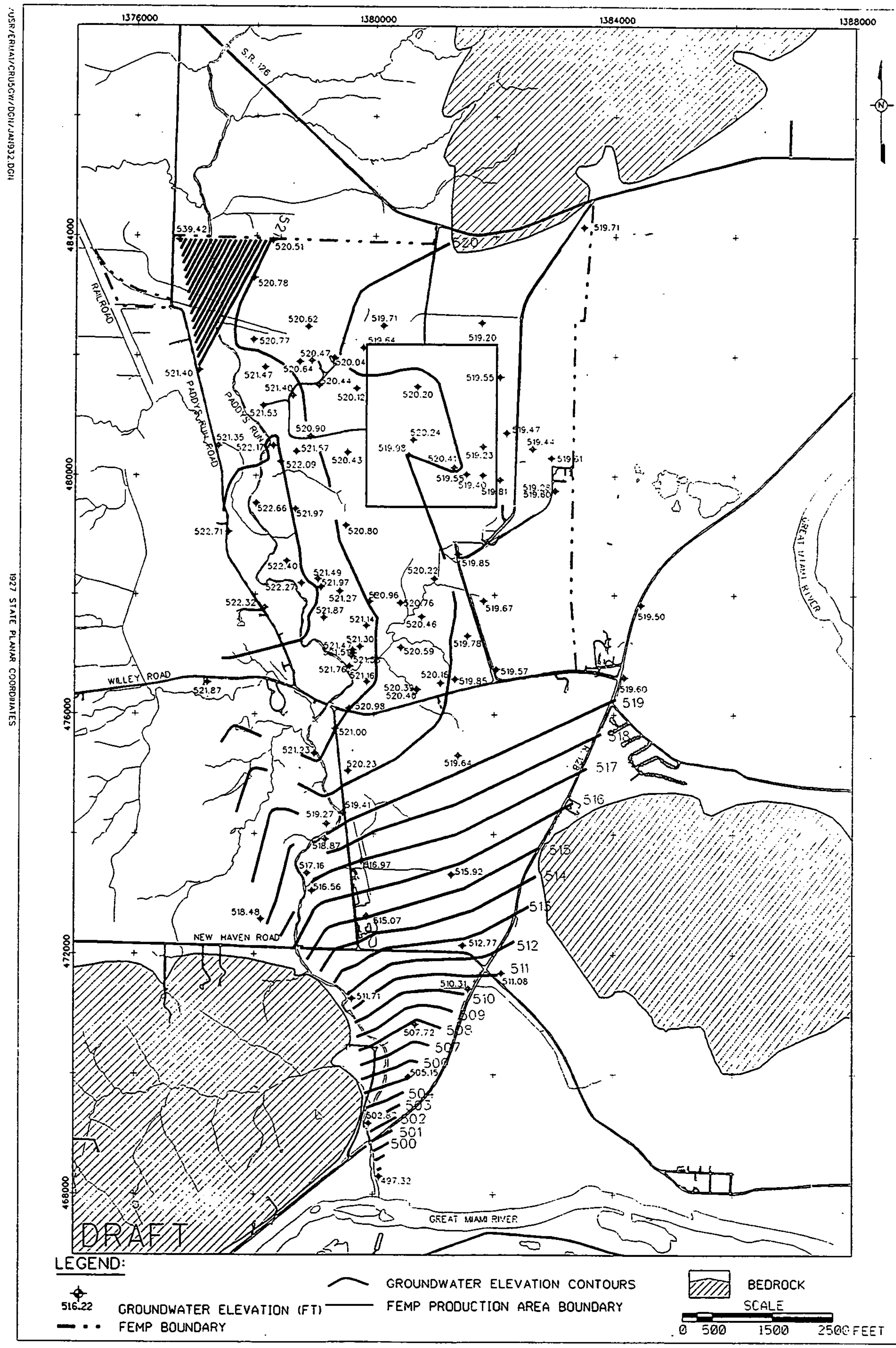


FIGURE A-1. GROUNDWATER ELEVATIONS, TYPE 2 WELLS, JANUARY 1993

7153

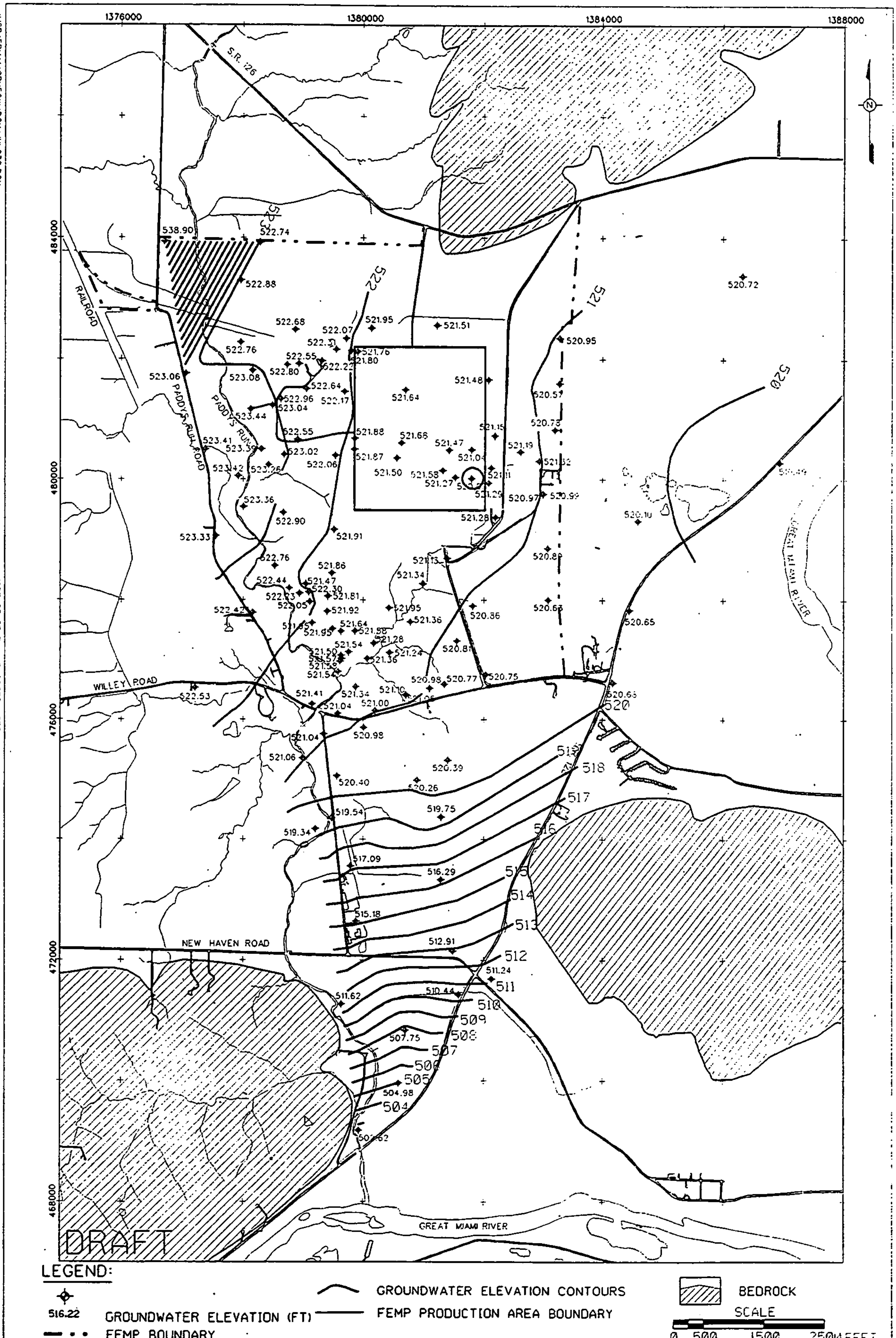


FIGURE A-2. GROUNDWATER ELEVATIONS, TYPE 2 WELLS, JULY 1993

000045

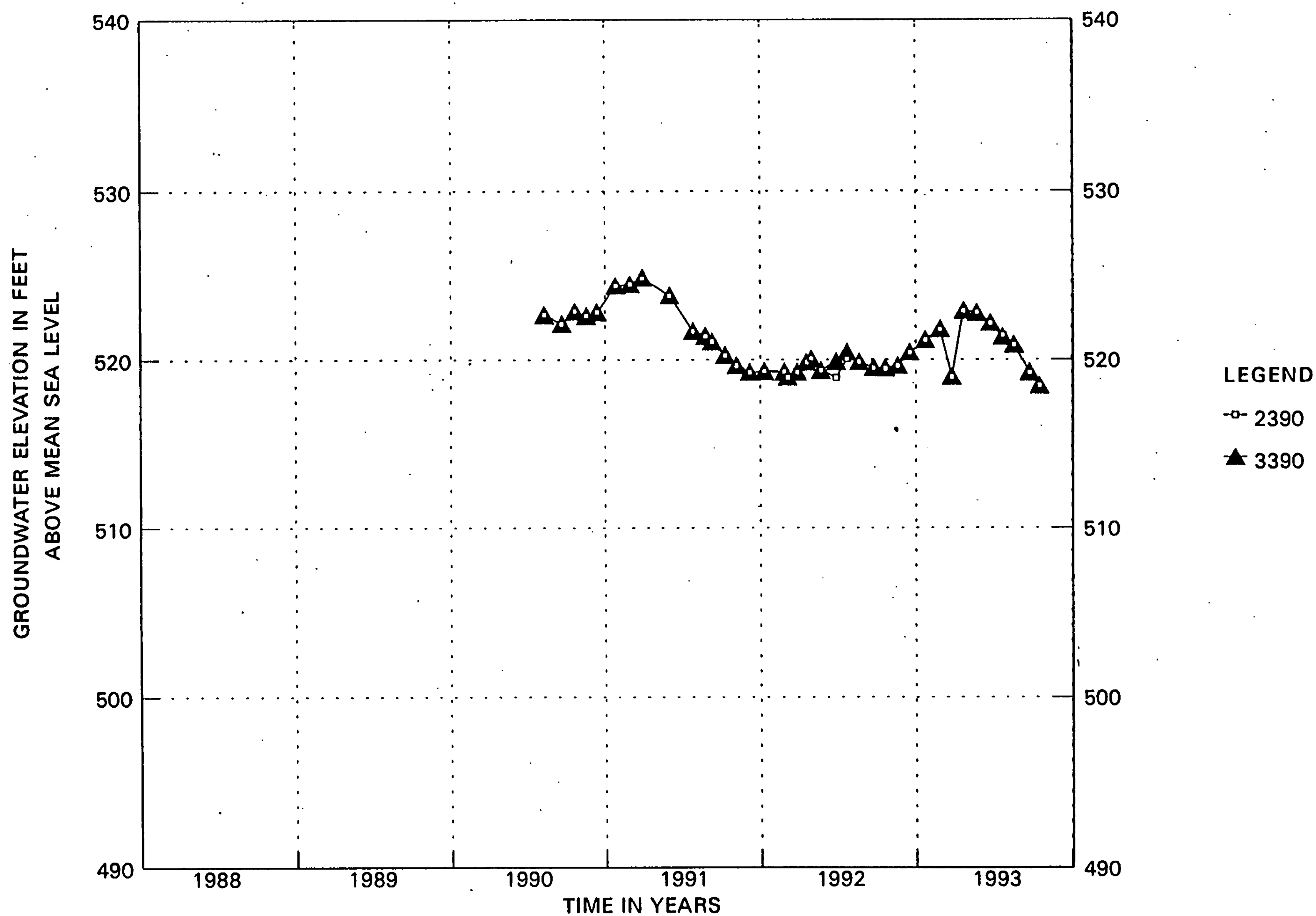


FIGURE A-3. HYDROGRAPH FOR WELL CLUSTER 390

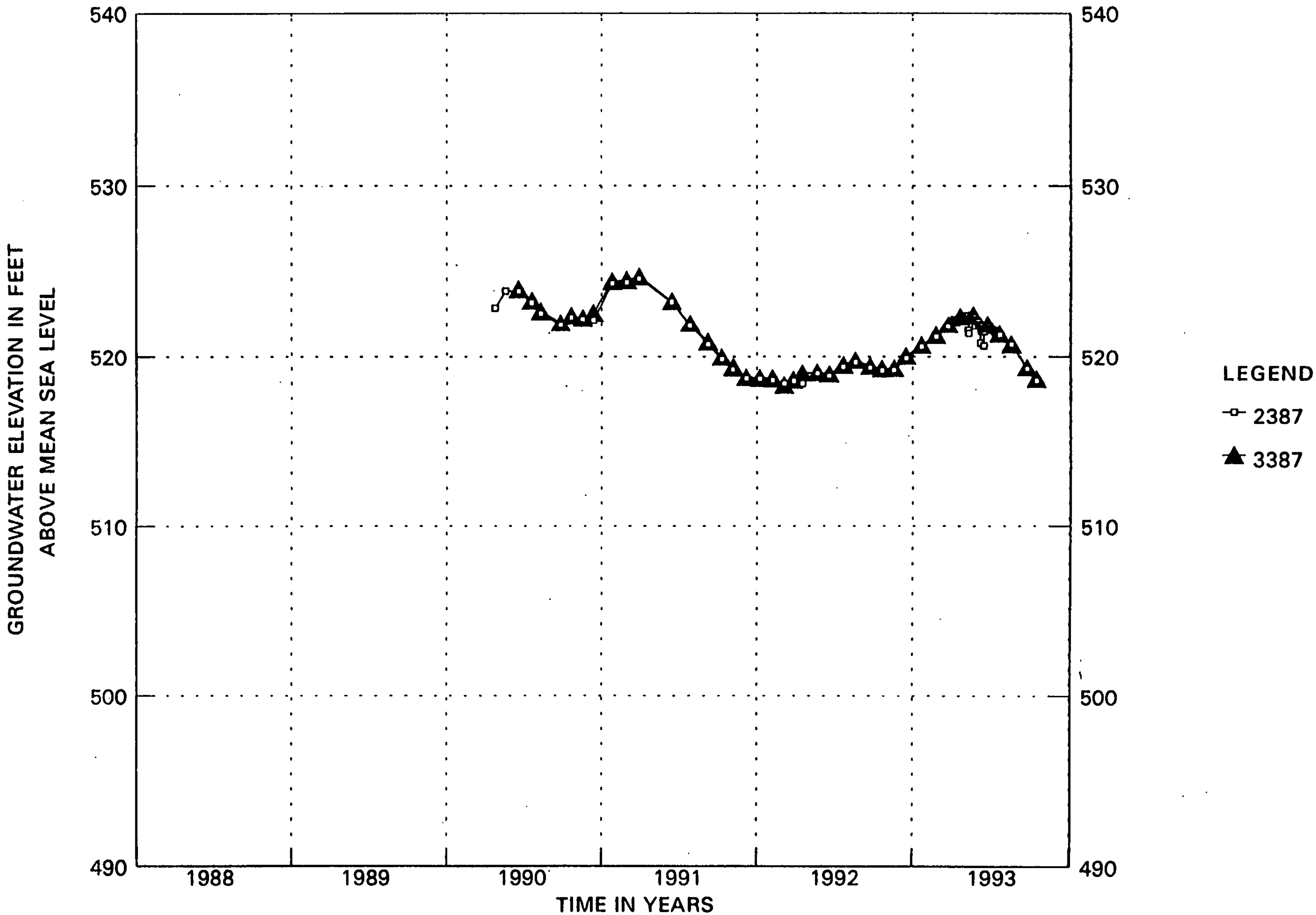


FIGURE A-4. HYDROGRAPH FOR WELL CLUSTER 387

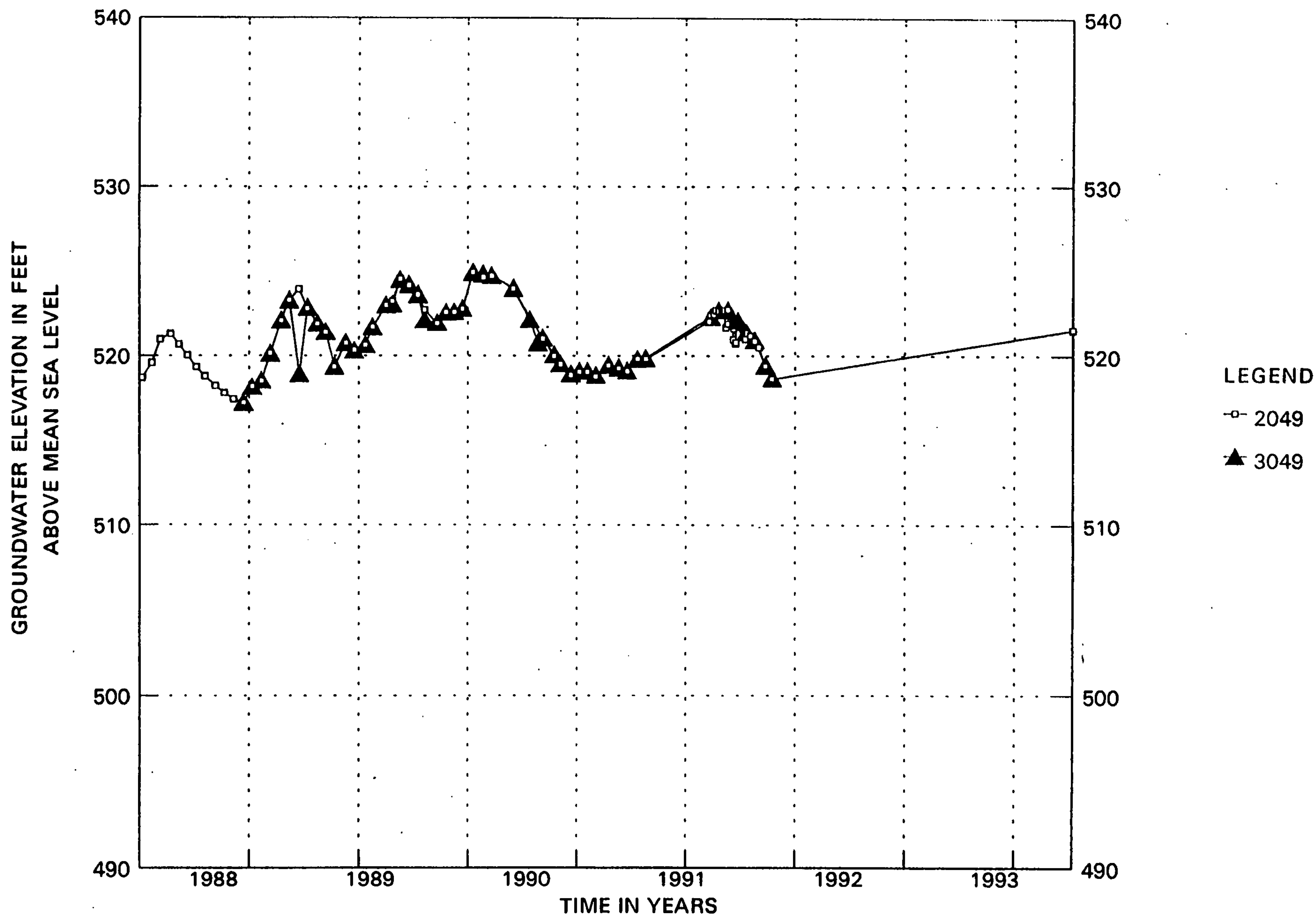


FIGURE A-5. HYDROGRAPH FOR WELL CLUSTER 049

APPENDIX B

Summary of Detections
Organic, Inorganic and
Radiochemical Parameters
Select Monitor Wells in the South Plume Area
(Vicinity of Recovery Wells 3926 and 3927)

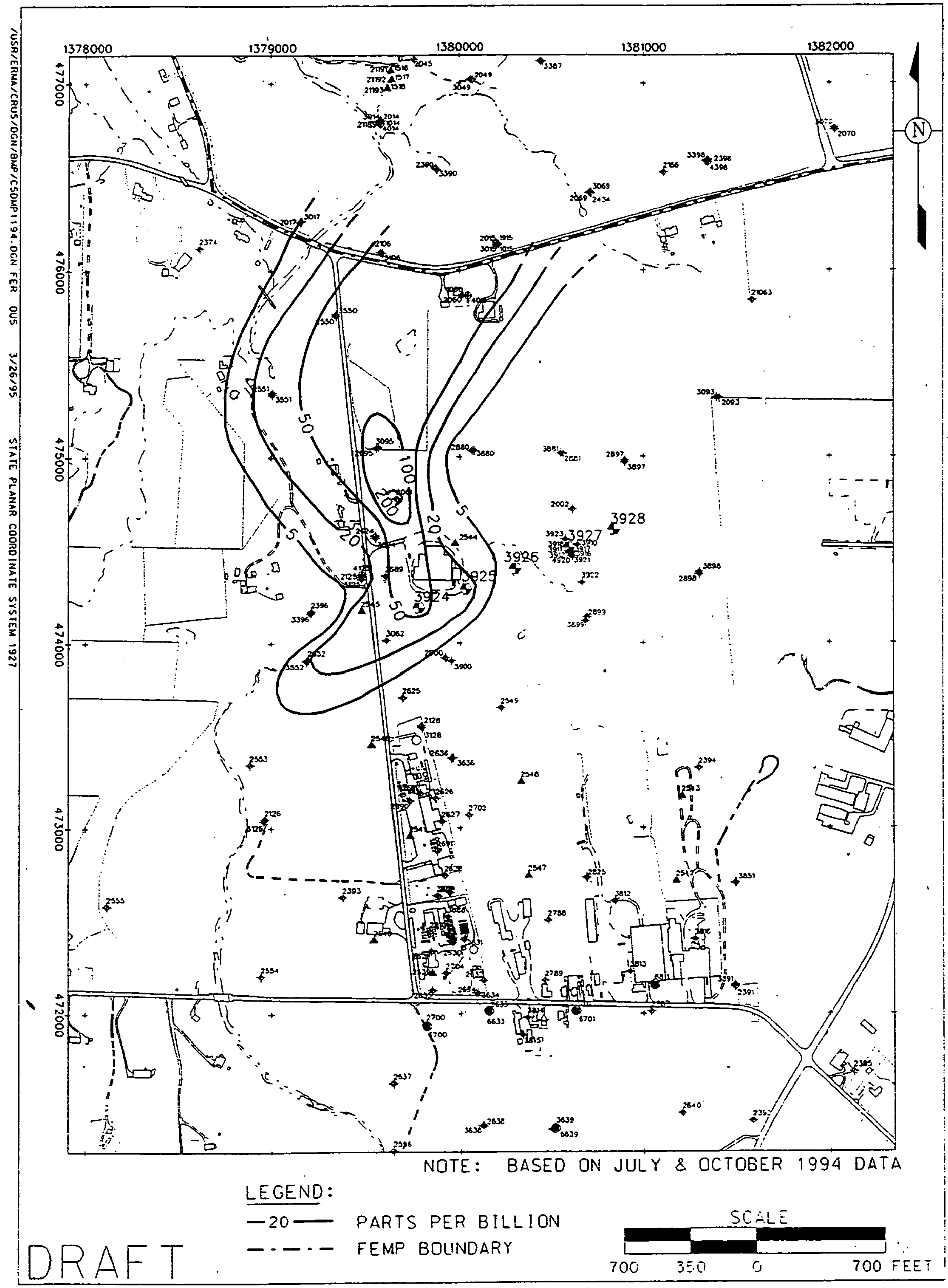


FIGURE B-1. 1994 TOTAL URANIUM PLUME AND MONITORING WELL LOCATIONS

Parameter	Result	Units	Qual.	QA Type	Suffix	Filter	Lab Qual.	Lab. Result	DL	Lab	Matrix
2002 03/29/93 GW930329-8											
Acetone	460.0000	ug/L	J	NORMAL	DL	UNFILTER	E	460.00		DATAC	GROUND WATER
03/29/93 GW930329-9											
Acetone	570.0000	ug/L	NV	DUPLICAT	NONE	UNFILTER	E	570.00		LOCKH	GROUND WATER
05/11/93 GW930511-1											
Arsenic	2.9000	ug/L	J	NORMAL	NONE	UNFILTER	BW	2.90		LOCKH	GROUND WATER
Barium	60.6000	ug/L	J	NORMAL	NONE	UNFILTER	B	60.60		LOCKH	GROUND WATER
Potassium	2930.0000	ug/L	J	NORMAL	NONE	UNFILTER	B	2930.00		LOCKH	GROUND WATER
2880 08/05/93 109965											
Barium	52.6000	ug/L	-	NORMAL	NONE	UNFILTER	B	52.60		DATAC	GROUND WATER
Lead	1.4000	ug/L	J	NORMAL	NONE	UNFILTER	B	1.40		DATAC	GROUND WATER
Potassium	3450.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3450.00		DATAC	GROUND WATER
Zinc	6.5000	ug/L	-	NORMAL	NONE	UNFILTER	BE	6.50		DATAC	GROUND WATER
Manganese	50.4000	ug/L	J	NORMAL	NONE	UNFILTER	E	50.40		DATAC	GROUND WATER
Iron	191.0000	ug/L	J	NORMAL	NONE	UNFILTER	E	191.00		DATAC	GROUND WATER
Calcium	101000.0000	ug/L	J	NORMAL	NONE	UNFILTER	E*	101000.00		DATAC	GROUND WATER
Butyl benzyl phthalate	0.9000	ug/L	J	NORMAL	NONE	UNFILTER	J	0.90		DATAC	GROUND WATER
Copper	12.5000	ug/L	-	NORMAL	NONE	UNFILTER	B	12.50		DATAC	GROUND WATER
Chromium	6.8000	ug/L	-	NORMAL	NONE	UNFILTER	BE	6.80		DATAC	GROUND WATER
2881 08/09/93 109996											
Barium	47.8000	ug/L	-	NORMAL	NONE	UNFILTER	B	47.80		DATAC	GROUND WATER
Potassium	3570.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3570.00		DATAC	GROUND WATER
Nickel	28.3000	ug/L	-	NORMAL	NONE	UNFILTER	B	28.30		DATAC	GROUND WATER
Butyl benzyl phthalate	1.0000	ug/L	J	NORMAL	NONE	UNFILTER	J	1.00		DATAC	GROUND WATER
Copper	4.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	4.00		DATAC	GROUND WATER
Lead	5.8000	ug/L	J	NORMAL	NONE	UNFILTER	W	5.80		DATAC	GROUND WATER
2899 08/09/93 109992											
Aluminum	24.8000	ug/L	-	NORMAL	NONE	UNFILTER	B	24.80		DATAC	GROUND WATER
Potassium	3390.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3390.00		DATAC	GROUND WATER
Zinc	17.2000	ug/L	-	NORMAL	NONE	UNFILTER	B	17.20		DATAC	GROUND WATER
Selenium	2.9000	ug/L	J	NORMAL	NONE	UNFILTER	BW	2.90		DATAC	GROUND WATER
Barium	51.4000	ug/L	-	NORMAL	NONE	UNFILTER	B	51.40		DATAC	GROUND WATER

Parameter	Result	Units	Qual.	QA Type	Suffix	Filter	Lab Qual.	Lab. Result	DL	Lab	Matrix
2899 09/07/93 GW930907-24											
Barium	58.4000	ug/L	-	NORMAL	NONE	UNFILTER	B	58.40		DATAC	GROUND WATER
Potassium	3500.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3500.00		DATAC	GROUND WATER
11/18/93 200020229											
Potassium	3.7000	mg/L	-	NORMAL	NONE	UNFILTER	-	3.70		NET	GROUND WATER
Sodium	14.1000	mg/L	-	NORMAL	NONE	UNFILTER	-	14.10		NET	GROUND WATER
02/11/94 200037508											
Acetone	21.0000	ug/L	NV	NORMAL	NONE	UNFILTER	B	21.00		WESTO	GROUND WATER
Methylene chloride	1.0000	ug/L	NV	NORMAL	NONE	UNFILTER	J	1.00		WESTO	GROUND WATER
02/11/94 200037509											
Barium	56.9000	ug/L	NV	NORMAL	NONE	UNFILTER	B	56.90		WESTO	GROUND WATER
Cobalt	6.2000	ug/L	NV	NORMAL	NONE	UNFILTER	B	6.20		WESTO	GROUND WATER
Nickel	14.0000	ug/L	NV	NORMAL	NONE	UNFILTER	B	14.00		WESTO	GROUND WATER
Potassium	4420.0000	ug/L	NV	NORMAL	NONE	UNFILTER	B	4420.00		WESTO	GROUND WATER
Vanadium	4.8000	ug/L	NV	NORMAL	NONE	UNFILTER	B	4.80		WESTO	GROUND WATER
04/26/94 200053533											
Barium	61.7000	ug/L	-	NORMAL	NONE	UNFILTER	B	61.70		ITAS-	GROUND WATER
Potassium	3820.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3820.00		ITAS-	GROUND WATER
Vanadium	24.9000	ug/L	-	NORMAL	NONE	UNFILTER	B	24.90		ITAS-	GROUND WATER
10/05/94 200100185											
Arsenic	2.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2.00		WESTO	GROUND WATER
Potassium	3340.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3340.00		WESTO	GROUND WATER
02/08/95 200131048											
Methylene chloride	3.0000	ug/L	NV	NORMAL	NONE	UNFILTER	BJ	3.00		QUANT	GROUND WATER
02/08/95 200131049											
Potassium	3020.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3020.00		QUANT	GROUND WATER
05/01/95 200149877											
Potassium	3560.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3560.00		DATAC	GROUND WATER
06/20/95 200160458											
Potassium	3500.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	3500.00		DATAC	GROUND WATER

000053

Parameter	Result	Units	Qual.	QA Type	Suffix	Filter	Lab Qual.	Lab. Result	DL	Lab	Matrix
3880 08/07/93 109970											
Arsenic	1.6000	ug/L	-	NORMAL	NONE	UNFILTER	B	1.60		DATAC	GROUND WATER
Barium	90.4000	ug/L	-	NORMAL	NONE	UNFILTER	B	90.40		DATAC	GROUND WATER
Potassium	2650.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2650.00		DATAC	GROUND WATER
Selenium	2.2000	ug/L	J	NORMAL	NONE	UNFILTER	BW	2.20		DATAC	GROUND WATER
08/07/93 109974											
Barium	88.1000	ug/L	-	DUPLICAT	NONE	UNFILTER	B	88.10		DATAC	GROUND WATER
Butyl benzyl phthalate	1.0000	ug/L	J	DUPLICAT	NONE	UNFILTER	J	1.00		DATAC	GROUND WATER
Potassium	2500.0000	ug/L	-	DUPLICAT	NONE	UNFILTER	B	2500.00		DATAC	GROUND WATER
bis(2-Ethylhexyl)phthalate	0.4000	ug/L	J	DUPLICAT	NONE	UNFILTER	J	0.40		DATAC	GROUND WATER
3881 08/09/93 110000											
Aluminum	14.5000	ug/L	-	NORMAL	NONE	UNFILTER	B	14.50		DATAC	GROUND WATER
Zinc	9.1000	ug/L	-	NORMAL	NONE	UNFILTER	B	9.10		DATAC	GROUND WATER
bis(2-Ethylhexyl)phthalate	0.7000	ug/L	J	NORMAL	NONE	UNFILTER	J	0.70		DATAC	GROUND WATER
Potassium	2030.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2030.00		DATAC	GROUND WATER
Arsenic	3.1000	ug/L	J	NORMAL	NONE	UNFILTER	BN	3.10		DATAC	GROUND WATER
Barium	77.1000	ug/L	-	NORMAL	NONE	UNFILTER	B	77.10		DATAC	GROUND WATER
Butyl benzyl phthalate	2.0000	ug/L	J	NORMAL	NONE	UNFILTER	J	2.00		DATAC	GROUND WATER
3899 08/08/93 109979											
Aluminum	142.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	142.00		DATAC	GROUND WATER
Barium	54.2000	ug/L	-	NORMAL	NONE	UNFILTER	B	54.20		DATAC	GROUND WATER
Copper	4.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	4.00		DATAC	GROUND WATER
Nickel	23.9000	ug/L	-	NORMAL	NONE	UNFILTER	B	23.90		DATAC	GROUND WATER
Potassium	2610.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2610.00		DATAC	GROUND WATER
Toluene	8.0000	ug/L	J	NORMAL	NONE	UNFILTER	J	8.00		DATAC	GROUND WATER
09/08/93 GW930908-20											
Aluminum	1100.0000	ug/L	J	NORMAL	NONE	UNFILTER	E	1100.00		DATAC	GROUND WATER
Barium	63.3000	ug/L	-	NORMAL	NONE	UNFILTER	B	63.30		DATAC	GROUND WATER
Calcium	107000.0000	ug/L	J	NORMAL	NONE	UNFILTER	E	107000.00		DATAC	GROUND WATER
Iron	3290.0000	ug/L	J	NORMAL	NONE	UNFILTER	EN	3290.00		DATAC	GROUND WATER
Lead	2.4000	ug/L	J	NORMAL	NONE	UNFILTER	BW	2.40		DATAC	GROUND WATER
Magnesium	27900.0000	ug/L	J	NORMAL	NONE	UNFILTER	E	27900.00		DATAC	GROUND WATER
Manganese	284.0000	ug/L	J	NORMAL	NONE	UNFILTER	E	284.00		DATAC	GROUND WATER
Potassium	2400.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2400.00		DATAC	GROUND WATER

000054

7133

Parameter	Result	Units	Qual.	QA Type	Suffix	Filter	Lab Qual.	Lab. Result	DL	Lab	Matrix
3899 10/27/93 200019942											
Potassium	3.3000	mg/L	J	NORMAL	NONE	UNFILTER	J	3.30		NET	GROUND WATER
Sodium	12.8000	mg/L	-	NORMAL	NONE	UNFILTER	-	12.80		NET	GROUND WATER
10/27/93 200019945											
Potassium	3.3000	mg/L	J	DUPLICAT	NONE	UNFILTER	J	3.30		NET	GROUND WATER
Sodium	14.6000	mg/L	-	DUPLICAT	NONE	UNFILTER	-	14.60		NET	GROUND WATER
02/11/94 200037518											
Acetone	13.0000	ug/L	NV	NORMAL	NONE	UNFILTER	B	13.00		WESTO	GROUND WATER
02/11/94 200037519											
Aluminum	94.0000	ug/L	NV	NORMAL	NONE	UNFILTER	B	94.00		WESTO	GROUND WATER
Barium	57.3000	ug/L	NV	NORMAL	NONE	UNFILTER	B	57.30		WESTO	GROUND WATER
Nickel	36.0000	ug/L	NV	NORMAL	NONE	UNFILTER	B	36.00		WESTO	GROUND WATER
Potassium	3220.0000	ug/L	NV	NORMAL	NONE	UNFILTER	B	3220.00		WESTO	GROUND WATER
Zinc	9.4000	ug/L	NV	NORMAL	NONE	UNFILTER	B	9.40		WESTO	GROUND WATER
04/26/94 200053548											
Barium	56.3000	ug/L	-	NORMAL	NONE	UNFILTER	B	56.30		ITAS-	GROUND WATER
Potassium	2800.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2800.00		ITAS-	GROUND WATER
Vanadium	18.2000	ug/L	-	NORMAL	NONE	UNFILTER	B	18.20		ITAS-	GROUND WATER
07/19/94 200076894											
Potassium	2860.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2860.00		ITAS-	GROUND WATER
10/04/94 200099697											
Arsenic	2.2000	ug/L	-	NORMAL	NONE	UNFILTER	B	2.20		WESTO	GROUND WATER
Potassium	2470.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2470.00		WESTO	GROUND WATER
02/08/95 200131058											
Methylene chloride	3.0000	ug/L	NV	NORMAL	NONE	UNFILTER	BJ	3.00		QUANT	GROUND WATER
02/08/95 200131063											
Methylene chloride	3.0000	ug/L	NV	DUPLICAT	NONE	UNFILTER	BJ	3.00		QUANT	GROUND WATER
05/01/95 200149887											
Potassium	2580.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2580.00		DATAC	GROUND WATER
06/20/95 200160468											
Potassium	2240.0000	ug/L	-	NORMAL	NONE	UNFILTER	B	2240.00		DATAC	GROUND WATER

Parameter	Result	Units	Qual.	QA Type	Suffix	Filter	Lab Qual.	Lab. Result	DL	Lab	Matrix
3899 06/20/95 200160478											
Potassium	1690.0000	ug/L	-	DUPLICAT	NONE	UNFILTER	B	1690.00		DATAC	GROUND WATER

APPENDIX C

SAMPLING MATRIX

APPENDIX C

SOUTH FIELD INJECTION TEST SAMPLING MATRIX

Analyte	Number of Samples	Frequency	Matrix	Lab/Field	Turnaround Time
Total suspended solids	13-21	Each step of step test Start of CRT[a]; one every 12 hours during CRT	Injection GW[b] and Monitoring Wells 31550-31556	Lab (on site)	1 week
Dissolved oxygen	13-21	Each step of step test Start of CRT; one every 12 hours during CRT	Injection GW and Monitoring Wells 31550-31556	Field	N/A
Uranium-total	13-21	Each step of step test Start of CRT; one every 12 hours during CRT	Injection GW and Monitoring Wells 31550-31556	Lab (on site)	24 hr
pH	13-21	Each step of step test Start of CRT; one every 12 hours during CRT	Injection GW and Monitoring Wells 31550-31556	Field	N/A
Temperature	13-21	Each step of step test Start of CRT; one every 12 hours during CRT	Injection GW and Monitoring Wells 31550-31556	Field	N/A

[a] CRT is constant rate test
[b] GW is groundwater