REPORT

FLORIDAN AQUIFER WELL (FB-2) CONSTRUCTION AND TESTING

Fort Pierce Utilities Authority

Fort Pierce, Florida

January 1992

BLASLAND & BOUCK ENGINEERS, P.C.
BLASLAND, BOUCK & LEE
ENGINEERS & GEOSCIENTISTS

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FORT PIERCE UTILITIES AUTHORITY
FORT PIERCE, FLORIDA

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EXECUTIVE SUMMARY

Background

The Fort Pierce Utilities Authority (FPUA) provides potable water to a service area which includes the City of Fort Pierce and surrounding areas. The FPUA develops its water supply from 42 shallow, screened wells located along Belcher Canal, S. 25th Street, the Lawnwood Recreational Complex, and west of the Water Treatment Plant (WTP).

Water developed from the shallow aquifer is naturally high in quality but due to man's activities, the supply is somewhat limited. These activities relate to the discharge of flowing artesian well waters into the Belcher Canal, which results in elevated chloride concentrations in the northernmost shallow wells. Unfortunately, the most productive wells in the system are located here. Contaminants such as petroleum and solvents have in the past, and still are entering the shallow aquifer by way of leaks, spills, or past disposal practices. The FPUA has spent approximately $3 million to provide treatment for these contaminants found in the wells along S. 25th Street. This will be an ongoing problem, in that a large plume of gasoline and its constituents have been identified within the drawdown area of these wells. The water supply potential of the shallow aquifer was also documented in a report by Ruskauff et al. (April 1989). Their report suggested that the shallow aquifer in the Fort Pierce area cannot sustain a withdrawal of 12 mgd over time. Potable water requirements at buildout are projected to be 24.3 mgd maximum day flow.

In addition, the shallow aquifer is limited in areal extent. It is bounded on the east by salt water bodies. To the west, the permeable

strata which comprises the aquifer is absent. To the north and south of the present shallow wellfield the existence of old landfills, an industrial area, and the use of septic tanks limit the development of a potable water supply.

As the FPUA service area grows, and water demand increases, the only viable future source is the Floridan aquifer. This aquifer, used throughout the state, is a highly productive confined strata which produces water that lends itself to membrane treatment processes most notably those which use reverse osmosis.

Floridan Aquifer Wellfield Development

Blasland, Bouck & Lee was retained by the FPUA to perform a Floridan aquifer wellfield investigation. Phase I of this study included: 1) an assessment of the permitability of the Floridan aquifer in the vicinity of the WTP prior to proceeding with construction and testing of a test/production well; 2) a determination of the water quality in the area to assure long term water quality stability and for determining proper reverse osmosis application and blending criteria; and 3) an assessment of the available quantity of water for production and the impact of the future wellfield to adjacent legal users. Phase I results were documented in a report by Blasland, Bouck & Lee dated August 1990, containing five Technical Memoranda.

Phase II of the Floridan aquifer wellfield development program was the construction and testing of a Floridan aquifer test/production well. This report focuses on the activities involved in Phase II, and recommends further activities to be completed during Phase III.

Construction on a Floridan aquifer test/production well (FB-2) began on August 19, 1991, and was completed on September 5, 1991. The 12-inch

well was completed to a depth of 880 feet, penetrating the upper Floridan aquifer. A seven day Aquifer Performance Test (APT) was conducted to evaluate production capacity and water quality. The transmissivity of the aquifer was calculated to be approximately 350,000 gallons per day per foot. Chloride concentration remained stable at approximately 280 milligrams per liter throughout the APT. Approximately 10 million gallons of ground water were pumped during the APT which resulted in approximately 43 feet of drawdown in FB-2. A Floridan aquifer observation well (FB-1), located approximately 725 feet east of FB-2, had approximately 2.3 feet of drawdown.

Aquifer production and water quality results from this evaluation were better than previously anticipated. The high yield and good water quality indicated that the cost to FPUA to produce and treat raw water from the Floridan aquifer would be less than originally anticipated.

Development of a Floridan aquifer wellfield in conjunction with the existing surficial aquifer wellfield will allow for decreased production from the shallow aquifer wellfield, if necessary. Utilization of two aquifers for water supply can provide FPUA with significant flexibility when faced with naturally occurring phenomenon such as drought or man-induced problems such as contamination.

As the Floridan aquifer wellfield is expanded, additional testing using long term APTs should be conducted using other Floridan wells as observation points. These tests will further evaluate multiple well interferences, water quality variations, impact to existing users, and expedite future permitting activities.

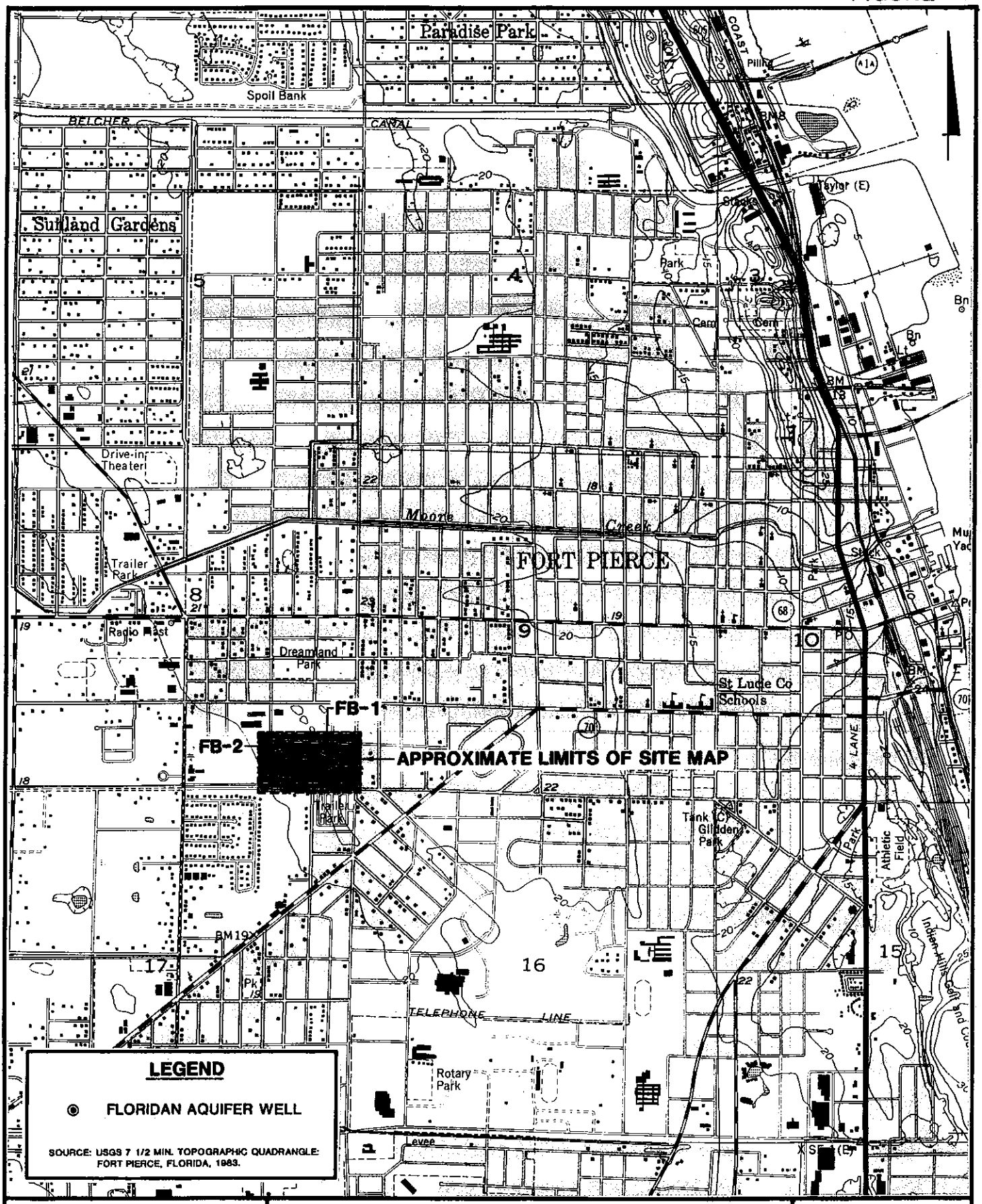
SECTION 1 - INTRODUCTION

1.1 Background

On April 18, 1990, Blasland, Bouck & Lee (BB&L) was authorized by the Fort Pierce Utilities Authority (FPUA) to provide design and hydrogeologic services for the installation of a Floridan aquifer test/production well (FB-2). A preliminary design investigation report was completed for the well on August 31, 1990, and the final design plans and specifications were completed on July 24, 1991. Following the competitive bidding process conducted by FPUA with assistance from BB&L, the well construction contract was awarded to Drilling Services, Inc., (DSI) of Fort Pierce, Florida. The bid was broken into 14 tasks. The initial bid amount per task and the amount actually invoiced per task for the well is included as Appendix A. A notice to proceed with construction was sent to DSI on August 7, 1991.

FB-2 is the second Floridan aquifer test/production well installed by FPUA. The first well, FB-1, was installed in 1988, and is currently being used as a blending well at the FPUA conventional water treatment plant (WTP) located on S. 25th Street. The location of both Floridan aquifer test/production wells is shown in Figure 1. These two Floridan aquifer wells are part of a planned, future wellfield to be used for blending purposes at the WTP, and eventually for use at an advanced reverse osmosis WTP. Development of the Floridan aquifer wellfield will provide a consistent raw water supply free from potential surface contamination sources, and at sufficient yields to offset production limitations of the surficial aquifer.

FIGURE 1



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FORT PIERCE, FLORIDA

QUADRANGLE LOCATION MAP

File No. 499.02

Date

Dwg. No.

1.2 History

The FPUA has historically produced its raw water supply from wells screened in the unconfined surficial aquifer. Currently, the FPUA uses 42 surficial aquifer wells and one Floridan aquifer well (FB-1) for its raw water supply. The surficial aquifer wells are generally located along 25th Street south of the Belcher canal. The Floridan aquifer well is located at the FPUA WTP. The production capacity of the wellfield is approximately 14 million gallons per day (mgd). The surficial aquifer wellfield can sustain a constant withdrawal rate of 12 mgd with a possible upper limit of 20 mgd, according to a ground-water flow model (Ruskauff, et al., 1989) prepared for the South Florida Water Management District (SFWMD). The projected water demand at buildout for Fort Pierce is 24.3 mgd maximum day flow. The FPUA will need to develop additional raw water capacity to meet the projected demand.

Developing the surficial aquifer further is limited for several reasons: high chloride concentrations recharging surface water from the Belcher Canal; man-made constituents in the ground water such as petroleum, solvents, and other compounds; and the limited areal extent of the aquifer. The high chloride concentrations are due to flowing artesian well water discharging into the Belcher Canal, which is adjacent to the northern end of the surficial aquifer wellfield. Other contaminants, such as petroleum and solvents, continually threaten the surficial aquifer wells due to the wellfield's proximity to commercial and industrial businesses in Fort Pierce. For example, petroleum constituents (detected in well N-5 and N-14) and commercial solvents (detected in wells N-2, N-3, N-4, N-5, N-6, N-7, N-9, and recently in N-11) have been found in wells along S. 25th Street (Hicks et al., 1988; Ebasco Environmental, 1990; and Stenberg, verbal comm., 1/15/92). Expanding

the surficial wellfield by moving away from the above described contamination sources is also not a viable alternative because the aquifer is bounded on the east by salt water bodies, the geologic strata that comprises the aquifer is absent to the west, and expansion to the north or south is limited by old landfills, an existing industrial area, and the use of septic tanks in some locations.

In comparison to the surficial aquifer, the Floridan aquifer is not affected by surface contaminants from leaks, spills or past disposal practices. The Floridan aquifer is protected by 400 feet of clay that separates it from surface sources of contamination. The clay has a very low permeability, and creates an extremely effective barrier to ground-water and contaminant movement. In addition, the Floridan aquifer water supply is more resistent to drought conditions than the surficial aquifer, because the Floridan aquifer is less dependent on local rainfall than the surficial aquifer.

Impacts to wetlands from wellfield pumping is another consideration when developing a new water source. Regulations have become much more stringent and protective of existing wetlands. Withdrawing water from the Floridan aquifer will create no wetland impacts due to the 400 feet of clay overlying the Floridan aquifer.

The natural water quality of the Floridan aquifer is not as good as the surficial aquifer. However, the Floridan aquifer water available in Fort Pierce lends itself to cost effective membrane treatment processes, assuming the process concentrate can be disposed of or reused.

Finally, the Floridan aquifer has an abundant supply of ground water which can be developed for public water supply. It is used throughout the state due to its high transmissivity, as confirmed by recent testing.

The advantages of using the Floridan aquifer, as outlined above, are numerous and make it an excellent source of raw water supply for the FPUA to meet future demands.

1.3 Scope of Work

The work performed by BB&L included, but was not limited to: preliminary design, final design, regulatory interface, assistance during bidding; observing well construction; collecting and describing well cuttings; geophysical logging and interpretation; recording background water levels; conducting a step-drawdown test; conducting a specific capacity test; conducting a seven-day aquifer performance test (APT); data evaluation/interpretation; and the development of conclusions and recommendations based on this and previous efforts. The field work was coordinated through Mr. Richard Stenberg, FPUA Department Head - Water Treatment.

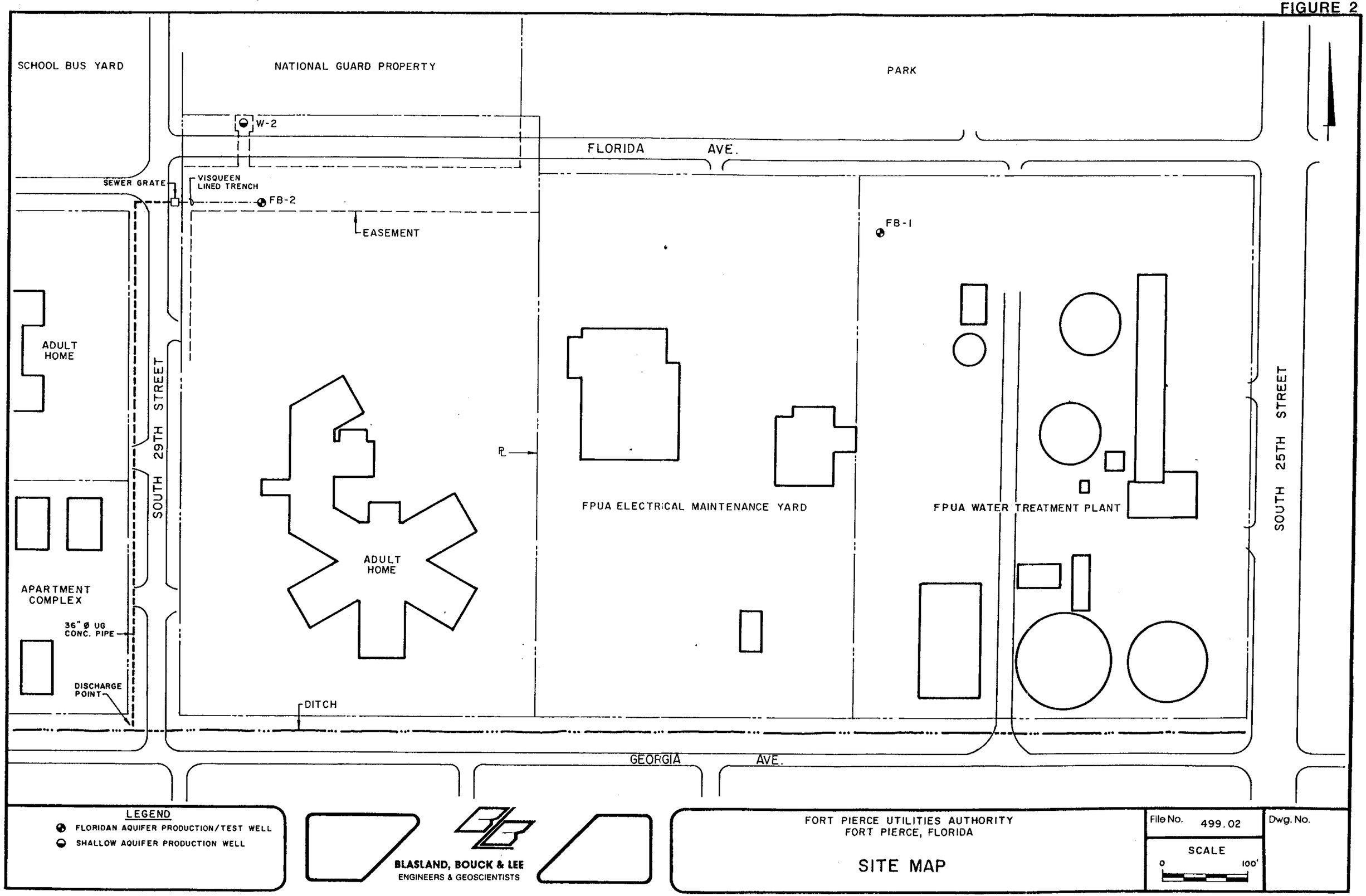
Construction of FB-2 began on August 19, 1991 and was completed on September 5, 1991. The completed well specifications are as follows:

Steel Surface Casing Depth:	115 feet, cemented in place
Steel Surface Casing Diameter:	20 inches
PVC Inner Casing Depth:	500 feet, cemented in place
PVC Inner Casing Diameter:	12 inches
Total Well Depth:	880 feet
Open Hole Interval:	500 to 880 feet below land surface
Open Hole Diameter:	12 inches (nominal)
Natural Flow Rate Upon Completion:	600 to 650 gallons per minute (gpm)

The well construction methods are described in Section 2.

FB-2 is located approximately 35 feet south of Florida Avenue and 100 feet east of S. 29th Street (Figure 2), immediately west of the FPUA-WTP on S. 25th Street. The well lies within a FPUA water main easement and is approximately 725 feet west of FB-1, which was constructed on the WTP property.

FIGURE 2



LEGEND

- FLORIDAN AQUIFER PRODUCTION/TEST WELL
- SHALLOW AQUIFER PRODUCTION WELL

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FORT PIERCE UTILITIES AUTHORITY
FORT PIERCE, FLORIDA

SITE MAP

File No. 499.02

SCALE 0 100'

Dwg. No.

SECTION 2 - WELL CONSTRUCTION

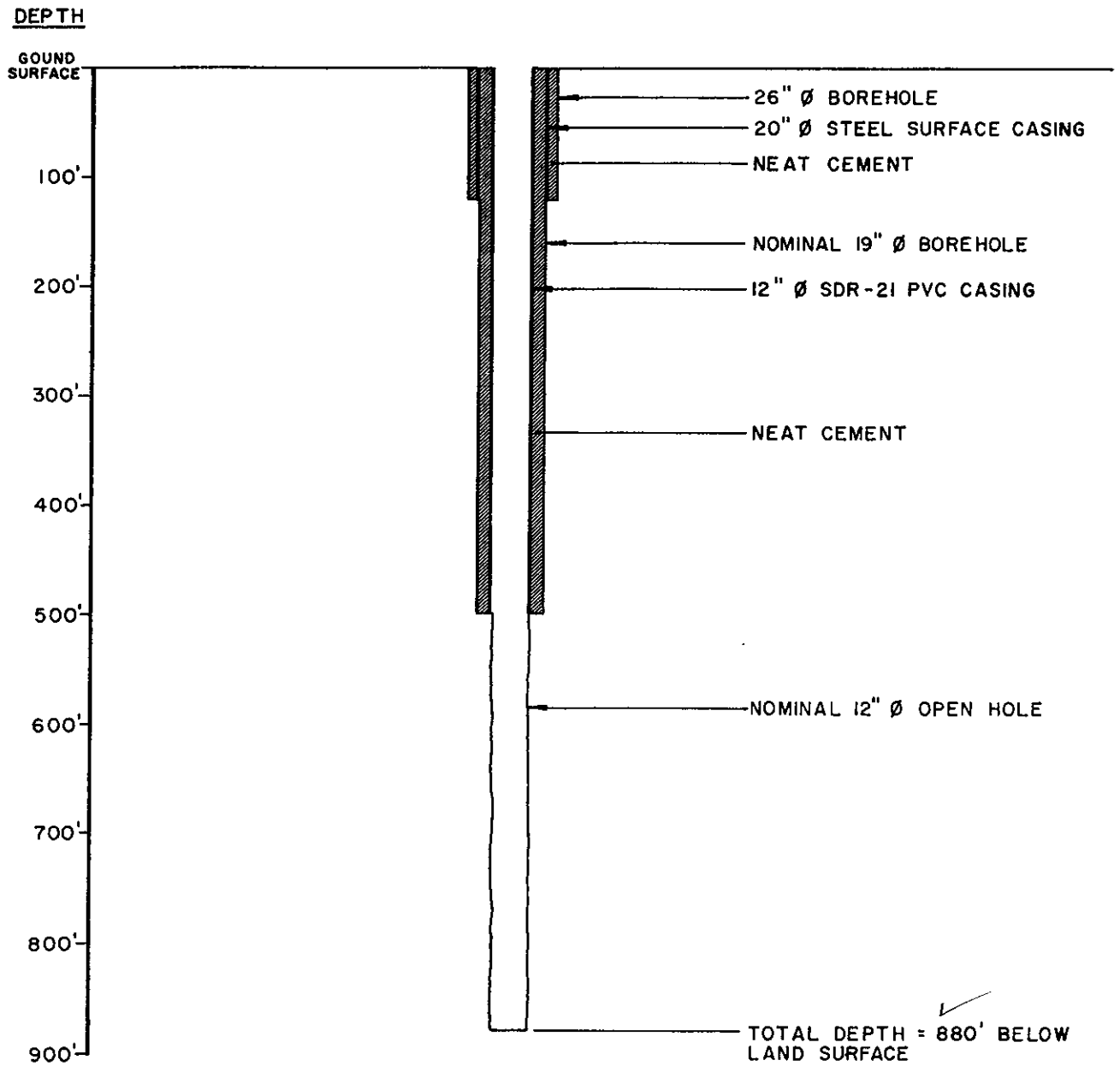
2.1 General

Installation of FB-2 began on August 19, 1991 and was completed on September 5, 1991. The well was installed using a Midway 1500 rotary drill rig, which was operated by a minimum of three DSI personnel at all times. From 0 to 500 feet below land surface (BLS), the well was installed by the mud-rotary, direct circulation technique. From 500 feet BLS to the well's final depth of 880 feet BLS, the reverse air drilling technique was used. The well consists of an outer steel surface casing, an inner PVC casing, and an open hole section (Figure 3). The South Florida Water Management District Water Well Construction Permit (#SF07089IR) is included as Appendix B.

2.2 Surface Casing

The surface casing was emplaced from 0 to 115 feet BLS to prevent formation collapse during installation of the inner PVC casing. The steel surface casing, which is 20-inches in diameter with one-quarter-inch thick walls, was installed in a 26-inch diameter borehole. The borehole was drilled using the mud-rotary, direct circulation method with a staged tricone drill bit. The drill cuttings were placed in a garbage dumpster and hauled off site by a private waste hauler.

The surface casing was set into the borehole on August 19, 1991 in three separate sections, a 27-foot and two 44-foot sections. The joints were arc-welded together as each section was lowered into the borehole. As each section was arc-welded, and the casing lowered into the borehole, precautions were taken to insure that the casing was set vertical. Two-inch PVC pipe



DATES CONSTRUCTED: 8/19/91 - 9/5/91
DRILLER: DRILLING SERVICES, INC.
WATER LEVEL UPON COMPLETION: 17.17' (ABOVE TOP OF PVC FLANGE)
DATE WATER LEVEL MEASURED: 9/12/91

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FORT PIERCE, FLORIDA

WELL CONSTRUCTION DETAILS
FB-2

File No. 499.02
Date
Dwg. No.

was installed inside the casing to the bottom, and then used to pressure grout the casing from bottom to top in one stage. ASTM C150 Type II cement was used. The cement included a curing additive, WRDA-79, which has an ASTM designation of C494 as a Type A and Type D admixture. The following day, after the cement cured, the plug was drilled through with a nominal 19-inch staged tricone drill bit to begin installation of the inner PVC casing.

2.3 Inner Casing

A nominal 19-inch staged tricone drill bit was used to extend the borehole from 115 feet BLS to the top of the Floridan aquifer which occurred at 500 feet BLS. Once the top of the Floridan aquifer was encountered, the hole was advanced carefully into the rock approximately 1 to 2 feet. This allowed a precise casing set which sealed off the clay confining strata completely, yet did not case out the upper most producing unit of the Floridan aquifer. The drill cuttings were placed in a garbage dumpster and hauled off site by a private waste hauler.

Five hundred feet of inner PVC casing was set and cemented into the borehole on August 23, 1991. The inner casing consisted of Certainteed 12-inch SDR21 PVC well casing with flared bell ends. The wall casing thickness was 0.606 inches. The casing was set in 25-20 foot sections. The sections were connected, as they were inserted into the borehole, using PVC cement (UNI-Weld 1700 PVC cement), and with 4 one-inch long, 5/16-inch diameter stainless steel bolts. Holes for the bolts were pre-drilled into the casing so as not to fully penetrate the casing. Stabilizer bars, in sets of three placed 120 degrees apart, were installed on the casing at 500, 440,

380, 320, 240, 180, 120, 60, and 10 feet BLS. A PVC header was attached to the top of the casing and bolted to the drill rig to stabilize the casing in the borehole during pressure cementing. The inner casing was pressure cemented from the bottom (500 feet BLS) to 90 feet BLS using the same technique and cement specifications used for the surface casing. By cementing the lower 410 feet of casing at one time, the integrity of the cement seal is insured so that no surface water or surface contaminants can migrate to the Floridan aquifer through the cement annulus. The upper 90 feet was not cemented on the same day to avoid excessive heat of hydration deformation of the PVC casing. The following day, the cement level around the inner casing was tagged at 90 feet BLS. The remainder of the casing was cemented by lowering a 2-inch PVC tremmie line to a depth of approximately 90 feet BLS, in the annular space between the two casings. The cement plug inside the PVC casing was then drilled out using a nominal 11-inch tricone drill bit, which was used to drill through the Floridan aquifer. Once the drill bit entered the Floridan aquifer, the drilling method was changed from direct mud rotary to the reverse air circulation method. Reverse air drilling, which creates a suction lift through the drill bit, allows water quality samples to be collected, drill cuttings to be brought rapidly to the surface, thus increasing drilling speed, and creates low pressure in the borehole thus developing the well as drilling proceeds.

2.4 Open Hole

The open hole section of the well was drilled using the reverse air circulation method into the upper Floridan aquifer extending from 500 to 880 feet BLS. A nominal 11-inch tricone drill bit was used.

The drill cuttings and formation water produced during drilling were directed into the pit used during the mud rotary drilling phase, which overflowed into a trench and diverted into an existing storm drain (Figure 2). The storm drain ran to a ditch approximately 600 feet south of the well. The ditch is oriented east-west and slopes to the west. The mud pit and trench were used to allow the heavy drill cuttings to settle out before the water was discharged to the storm drain. The trench, which was approximately 120 feet long, 3 feet wide and 2 feet deep, was lined with visqueen to prevent Floridan aquifer water from entering the surficial aquifer.

During well installation, water quality was monitored and samples were periodically collected throughout the open hole drilling phase. The results are presented in Section 6. Upon completion of the well construction, a full suite of borehole geophysical logs were run on the well, background water level data was collected, a step drawdown test was performed, and a seven-day APT was performed. These results are presented in Sections 3 and 6.

SECTION 3 - WELL CHARACTERISTICS ANALYSES

3.1 Borehole Geophysical Logging

Borehole geophysical well logging is the measurement of physical properties which can be interpreted in terms of the hydrogeologic characteristics of the strata penetrated by the well. Geophysical logging surveys conducted on FB-2 consisted of: electric - spontaneous potential and resistivity; natural gamma ray; borehole temperature; caliper; and borehole fluid velocity. All logs were run under natural, artesian flowing conditions.

3.1.1 Description of Geophysical Methods

An electric log is a record of the apparent resisitivities of the subsurface formations and the spontaneous potentials generated in the borehole. Both are plotted against depth BLS. These two properties are related to the lithology and to the quality of water found within each formation.

Natural gamma ray logging measures the emission of gamma rays from certain very low level radioactive elements that occur in very small but varying amounts in different lithologies. By measuring the emitted radiation, it is possible to identify and correlate subsurface formations penetrated by the well. Typically, due to the presence of phosphorite material, clay formations produce a noticeably higher amount of gamma ray emissions, which in turn are associated with zones of low permeability.

The temperature log is a record of water temperature within the borehole versus depth. Temperature logs may be used to locate zones of water entry into the borehole, to locate casing cement based on the

heat of hydration, to determine the direction of borehole flow, to identify geothermal gradients, etc. Producing intervals may be identified from a temperature log if the producing zones water temperature is measurably different from the water upgradient in the borehole.

The caliper log is a record of the wells inside diameter versus depth. Caliper logs locate cavities, confirm casing diameters and lengths, and are necessary for quantitative interpretation of fluid velocity logs.

Fluid velocity or flowmeter logs measure vertical flow of water in the well. Flows at various depths are measured by means of a propeller flowmeter that is lowered at a known constant velocity into the well. Data obtained from fluid velocity logs are used to calculate the quantities of water released from, or accepted by, an aquifer at different depths.

3.1.2 Results of Geophysical Logging

The importance of geophysical logging to the proper development of the Floridan aquifer at Fort Pierce cannot be overemphasized. The techniques used for this well allowed for the optimization of flow, which is directly related to the quantity of water which can ultimately be developed and quality, which directly impacts treatment costs. The geophysical logs and well construction details of FB-2 are illustrated on Figure 4. A complete set of the geophysical logs are included in Appendix C.

The gamma ray log was run to correlate stratigraphy with that recorded in the field from the well cuttings. This log was also useful in correlating geologic and geophysical logs from FB-1 as well as logs

FIGURE 4

DEPTH (FEET)

GEOLOGY / CALIPER LOG

FLUID RESISTIVITY LOG (micro-mhos/cm)

5000 2000 1500 1250 1000

TEMPERATURE LOG (° F)

75 76 77 78 79

FLUID VELOCITY LOG (RPM)

30 60 90 120 150 180 210 240

GAMMA RAY LOG (COUNTS / SEC)

10 20 30 40 50 60 70 80 90 100

DEPTH (FEET)

0 100 200 300 400 500 600 700 800 900 1000

A
B
C
D
E
F

PRODUCTION ZONE 1

PRODUCTION ZONE 2

PRODUCTION ZONE 3

DIRECTION OF LOG RUN

DIRECTION OF LOG RUN

DIRECTION OF LOG RUN

STATIONARY FLOW MEASUREMENT POINT

DIRECTION OF LOG RUN

A = Undifferentiated Deposits (SAND)
B = Anastasia Formation (Coquina LIMESTONE)
C = Tamiami Formation (Shelly LIMESTONE)
D = Hawthorn Formation (Calcareous CLAY)
E = Ocala Group (Fossiliferous LIMESTONE with interbedded chert and clay)
F = Avon Park Formation (DOLOSTONE interbedded with clay)

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FORT PIERCE, FLORIDA

WELL SUMMARY
FB-2

File No. 499.02

Dwg No.

VERTICAL SCALE
0 80'

from other wells in the region. A zone of high gamma ray emission occurs at the base of the Hawthorn formation. Underlying the lower Hawthorn formation beds is the Ocala Group, an Eocene limestone unit, which indicates the top of the Floridan aquifer. The Ocala formation is denoted by a marked decrease in gamma ray emission. This decrease indicates a formation change from a predominantly clay unit to a limestone unit, as was observed in the well cuttings.

The fluid velocity log illustrates the approximate location of three producing zones at 870 to 874, 740 to 780, and 640 to 660 feet BLS. The producing zones are indicated by significant increases in the borehole flow rate (Figure 5).

The temperature log shows little variation throughout the borehole. The lack of variation is due to the large percentage of water entering at the bottom of the borehole from production zone number 3. Production zone 3 contributes 37.5% of the water produced by the well. As this water flows up the well it blends with water from other zones, thus masking any change in water temperature in the upper two production zones.

The caliper log is best used in conjunction with the flow log to determine the producing zones. The flow rate measured in the flow log varies according to the production zones and as the borehole diameter varies (fluid velocity decreases in a larger diameter hole and vice versa). By analyzing the caliper and fluid velocity logs simultaneously, the true value of each production zone can be determined.

The fluid conductivity log indicates little change in conductivity with depth. The log results correspond to the field conductivity

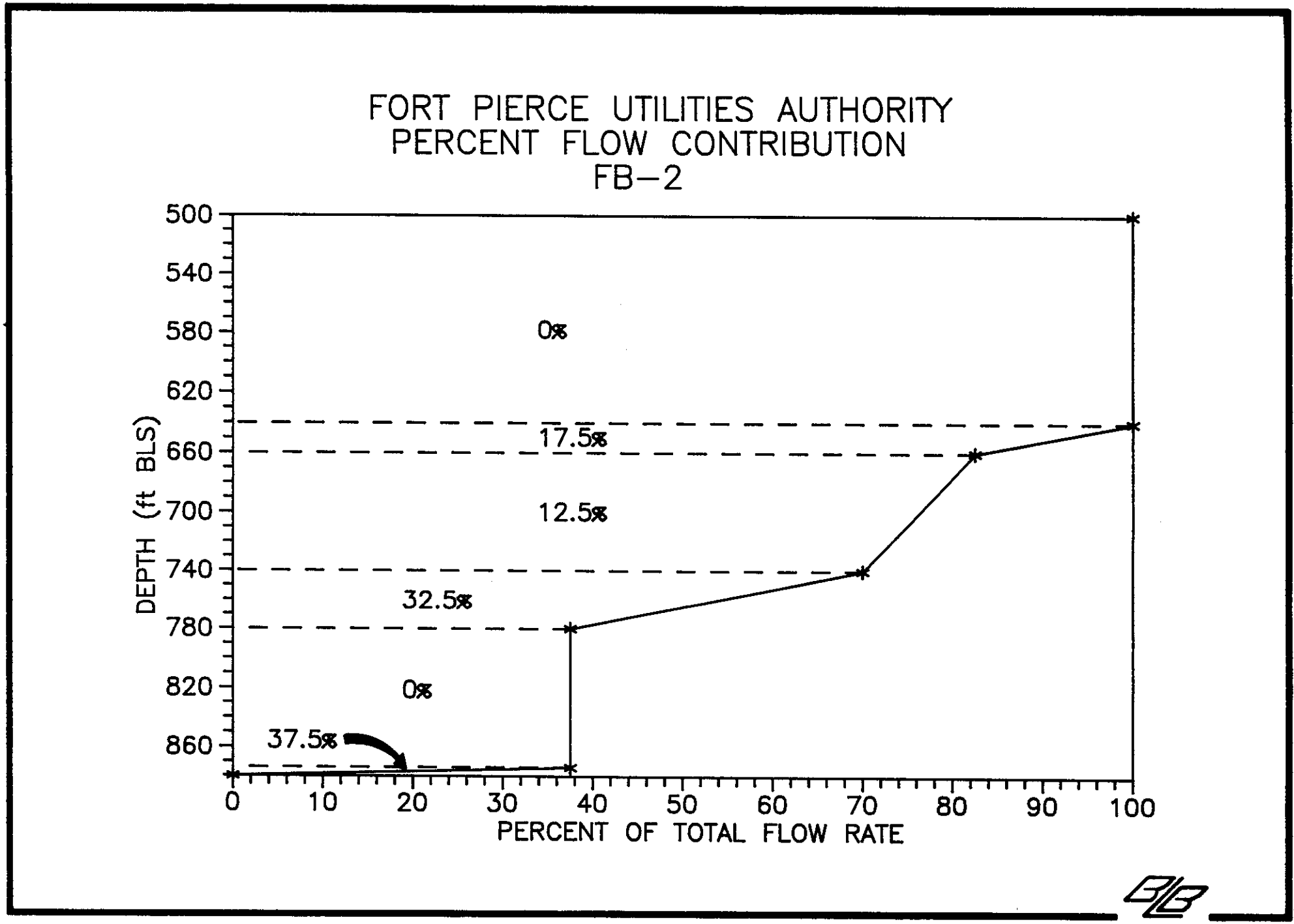

FORT PIERCE UTILITIES AUTHORITY
PERCENT FLOW CONTRIBUTION
FB-2
DEPTH (ft BLS)
500
540
580
620
660
700
740
780
820
860
0%
17.5%
12.5%
32.5%
0%
37.5%
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF TOTAL FLOW RATE

FIGURE 5

measurements collected during the reverse air drilling phase, which consistently ranged from 1,500 to 1,600 micromhos/cm.

Results from the geophysical logging were used to predict the water quality and quantity that can be expected from future Floridan aquifer wells in and around Fort Pierce.

3.2 Background Water Levels

Background water levels were measured in FB-2 and W-2 for five days from September 12 to September 17, 1991. W-2 is a shallow aquifer production well located approximately 90 feet north-northwest of FB-2 (Figure 2). The water levels were measured and recorded every 15 minutes by an In-Situ Hermit 2000 data logger. Background water levels were measured to determine natural fluctuations that might interfere with the step-drawdown test and APT that followed. Six days prior to measuring the water levels, production from W-2 and FB-1 was stopped to allow water levels to equilibrate. The natural flow from FB-2 was shut off two days before measurement of background water levels began.

The water levels in W-2 are shown in Figure 6, and indicate an overall rise during the five days of measurement. Superimposed on this rise are oscillations that occur at a regular frequency of approximately every six hours, and are probably due to a combination of natural fluctuations and the pumping schedule of other FPUA shallow aquifer production wells. Tidal charts for this time period are presented in Appendix D for comparison purposes.

The background water level fluctuations which occurred at FB-2 are presented in Figure 7. These results are characterized by a sudden rise and

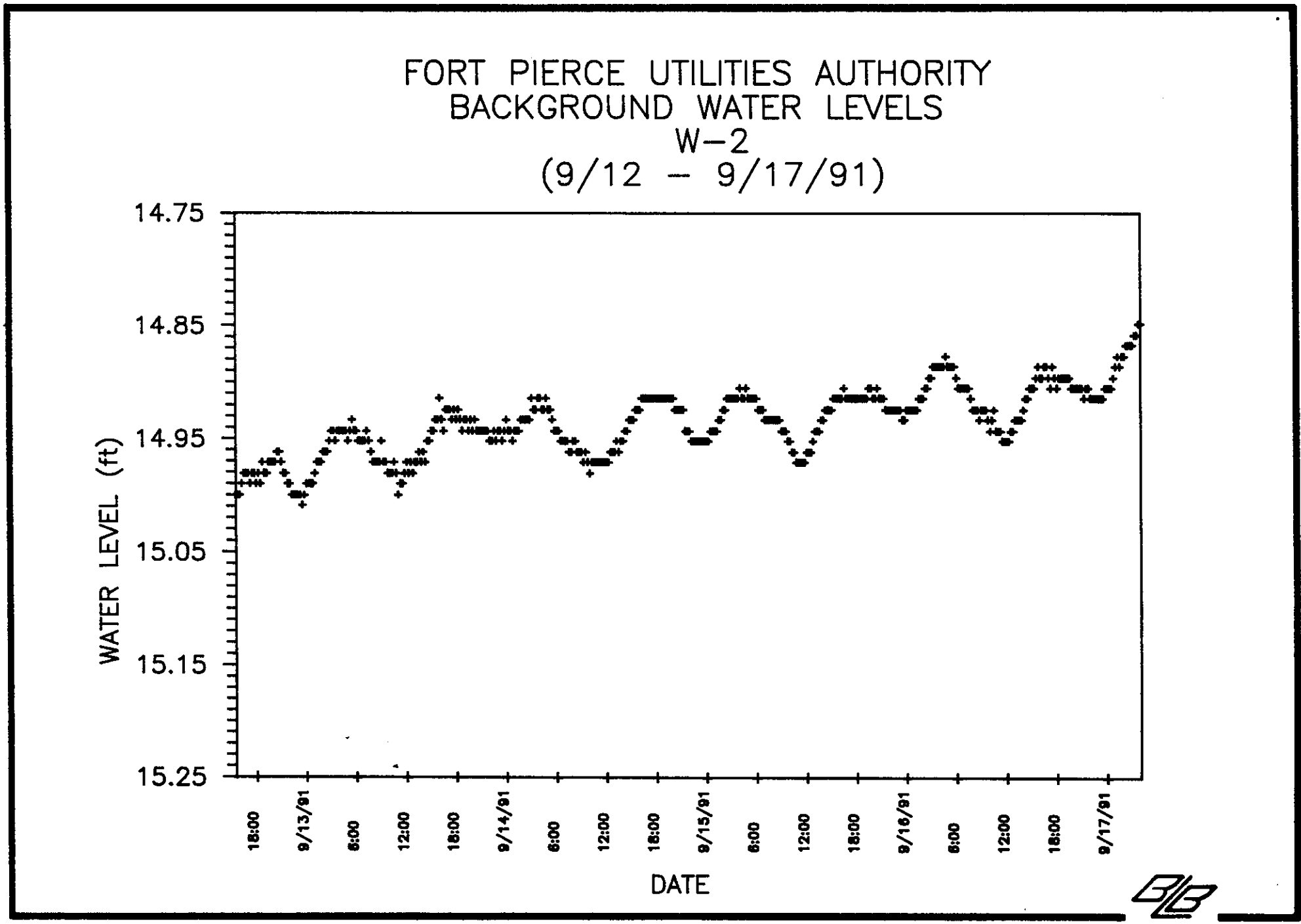

FORT PIERCE UTILITIES AUTHORITY
BACKGROUND WATER LEVELS
W-2
(9/12 - 9/17/91)
WATER LEVEL (ft)
14.75
14.85
14.95
15.05
15.15
15.25
18:00
9/13/91
6:00
12:00
18:00
9/14/91
6:00
12:00
18:00
9/15/91
6:00
12:00
18:00
9/16/91
6:00
12:00
18:00
9/17/91
DATE

FIGURE 6

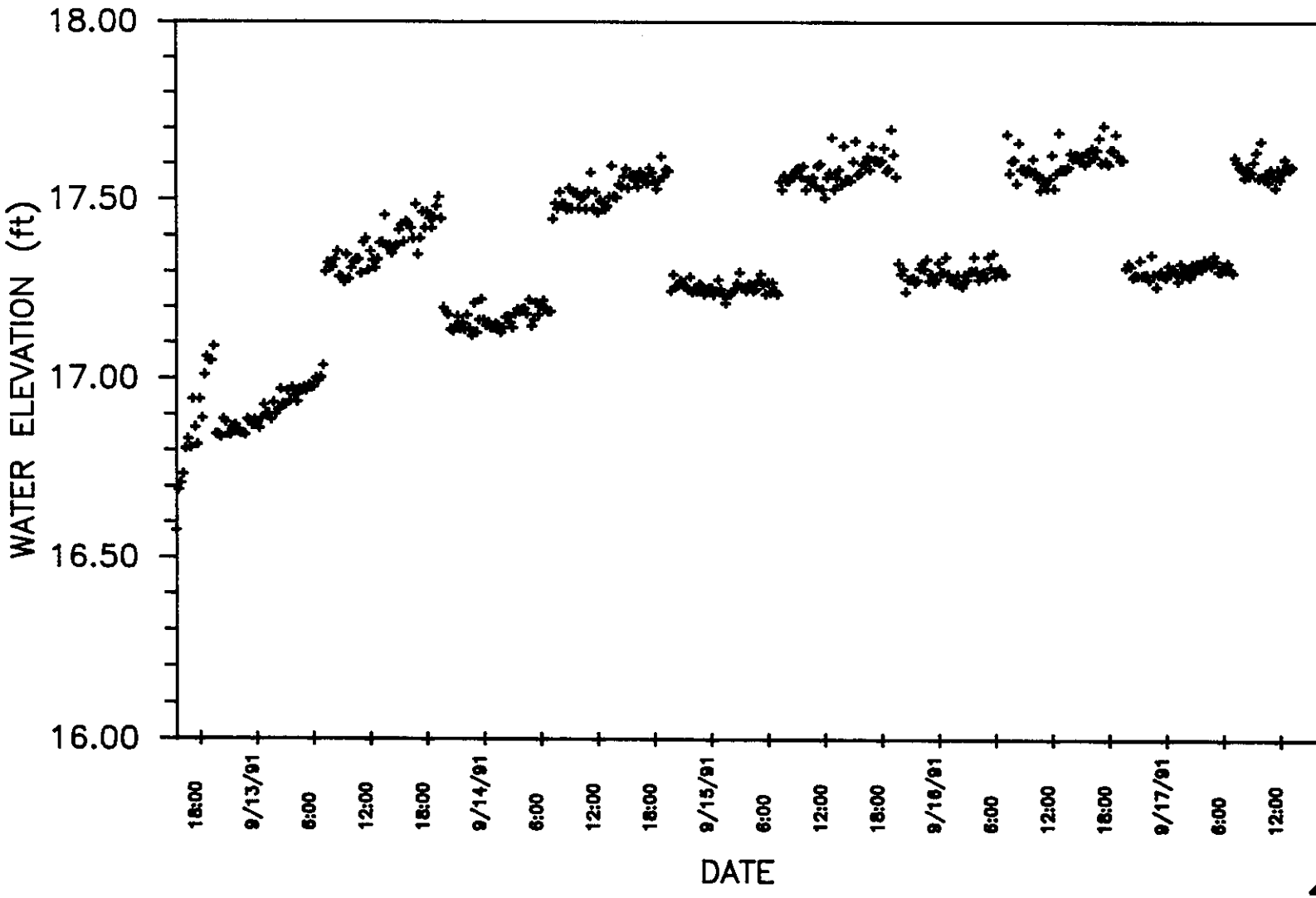

FORT PIERCE UTILITIES AUTHORITY
BACKGROUND WATER LEVELS
FB-2
(9/12 - 9/17/91)
WATER ELEVATION (ft)
18.00
17.50
17.00
16.50
16.00
18:00
9/13/91
6:00
12:00
18:00
9/14/91
6:00
12:00
18:00
9/15/91
6:00
12:00
18:00
9/16/91
6:00
12:00
18:00
9/17/91
6:00
12:00
DATE

FIGURE 7

lowering of the water levels by less than 0.3 feet every 12 hours. These sudden shifts are probably created by a nearby Floridan aquifer well (most likely an irrigation well) that is pumping 12 hours per day, timed schedule during the night. The shifts appear to be too sudden to be explained by natural events. Since the distance to the nearest permitted Floridan aquifer well from FB-2 is almost one mile (Figure 8), there may be an unpermitted well in service nearby. The overall trend of rising water levels shown in Figure 7 during the first few days is the result of the well returning to equilibrium conditions after flowing naturally during construction.

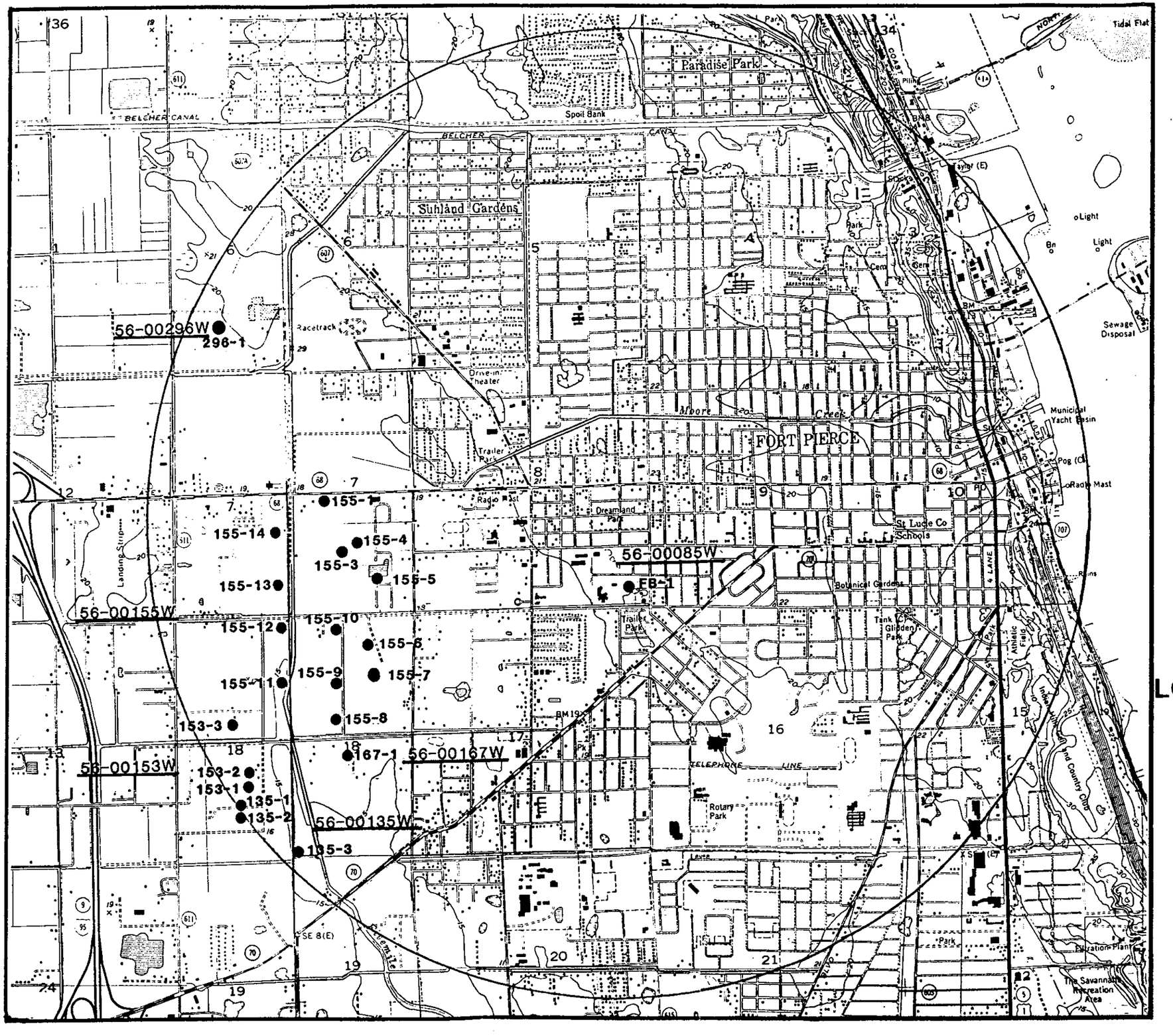
Due to the fluctuations in FB-2, background water levels were measured in FB-1 (Figure 9) after the APT (September 30 to October 4, 1991). The water levels in FB-1 do not exhibit the same daily shifts observed in FB-2. The difference between FB-1 and FB-2 may be attributed to one of two causes; 1) the pumping well that caused drawdowns in FB-2 was not operating during background water level measurements in FB-1, or 2) the pumping well is closer to FB-2, and does not create noticeable effects at FB-1.

3.3 Step Drawdown Tests

On September 20, 1991, a step-drawdown test was run on FB-2. The test was run to determine the specific capacity of FB-2, and to provide future data used to select pumping rates, size pumps, and determine pump settings.

Three steps were run during the test: step 1 at 740 gpm; step 2 at 940 gpm; and step 3 at 1,170 gpm (the maximum pump capacity). Steps 1, 2, and 3 were run for 60, 48, and 46 minutes, respectively. After step 3 was completed, water level recovery data was collected for 180 minutes.

FIGURE 8



LEGEND :

56-00085W — PERMIT NUMBER (SFWMD)

● — PERMITTED FLORIDAN AQUIFER WELL

○ — APPROXIMATE 2 MILE RADIUS

SOURCE : USGS QUADRANGLE MAP, FT.PIERCE

FORT PIERCE
UTILITIES AUTHORITY

LOCATION OF PERMITTED FLORIDAN AQUIFER WELLS

0 1/2 1
SCALE (MILES)

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FORT PIERCE UTILITIES AUTHORITY
BACKGROUND WATER LEVELS
FB-1
(9/30 - 10/4/91)

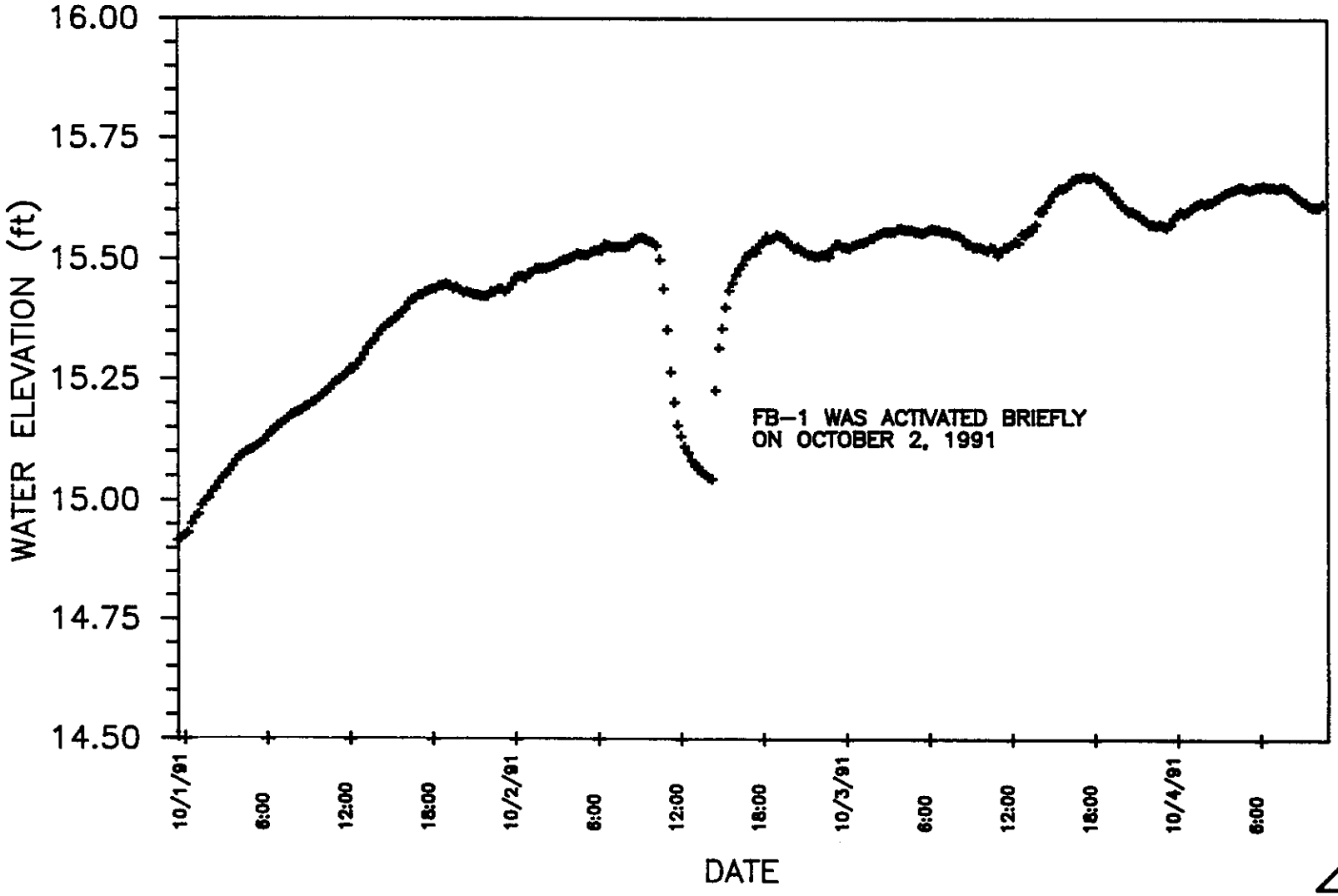

FIGURE 9

The water level was recorded with an In-Situ Hermit 2000 data logger. The specific capacities calculated for each step are presented below. The results of each step and the recovery data are presented graphically in Appendix E.

Step	Pump Rate (gpm)	Maximum Drawdown (ft)	Specific Capacity (gpm/ft)
1	740	27.263	27.1
2	940	37.079	25.4
3	1,170	46.546	25.1

Consistency of the specific capacity values calculated from pump rates of 740, 940, and 1,170 gpm indicate the well is efficient with little production loss due to well turbulence. The well efficiency of FB-2 was calculated as 51%. The formula and calculations used are presented in Appendix F.

On October 4, 1991 a specific capacity test was run on FB-1. FB-1 was allowed to flow at 250 gpm for 62 minutes. The maximum drawdown measured by an In-Situ Hermit 2000 data logger was 7.401 feet. The specific capacity at 250 gpm was, therefore, 33.8 gpm/ft.

3.4 Aquifer Performance Test (APT)

An APT was conducted on FB-2 to determine distance-drawdown relationships, boundary effects, long-term safe sustained yields, and most importantly to determine the aquifer characteristics; transmissivity, storativity and leakance factor. This data will form the basis for well field design.

The APT was completed by pumping FB-2 continuously at 1,000 gpm for 9,700 minutes (161.6 hours or 6.7 days). A Goulds 10DHL pump powered by a 62 horsepower diesel engine was used. The flow rate was measured by both a digital totalizing flowmeter and a manometer (Appendix G). The discharge water was diverted into the visqueen-lined trench (Figure 2), and directed into the storm drain which flows into the ditch south of FB-2.

Water levels in two observation wells (FB-1 and W-2) were monitored during the APT in addition to the pumping well. Recovery data was collected for 660 minutes (11 hours) in FB-1 and FB-2, and for 300 minutes (5 hours) in W-2. FB-1 served as the Floridan aquifer observation well during the APT. W-2 served as the surficial aquifer observation well. FB-1 has an open hole interval between 509 and 904 feet BLS (similar to FB-2). W-2 is screened between 70 and 105 feet BLS. Water levels in FB-2 and W-2 were measured by an In-Situ Hermit 2000 data logger. Levels in FB-1 were measured by an In-Situ Hermit 1000C data logger.

The pressure transducer in W-2 was lowered through a port in the header to approximately 13 feet below static water level. The pressure transducer in FB-2 was lowered approximately 35 feet BLS into a water-tight port in the header and through a one-inch PVC pipe that extended approximately 40 feet BLS. The pressure transducer in FB-1 was inserted a few inches into a horizontal port at the base of the header, and was clamped to the port with a water-tight rubber washer. Water level tubes taped to scaffolding erected next to each well were attached to both FB-1 and FB-2 to record water levels in the wells. Steel measuring tapes were taped to each tube to visually measure water levels in FB-1 and FB-2 during the APT and recovery period.

As expected, no visible effects were measured in the surficial aquifer well (W-2) during the APT. Approximately 400 feet of low permeability clay separates the Floridan aquifer from the surficial aquifer, effectively separating the water resources of each aquifer. This is important since it allows both sources to be developed simultaneously with no impact on the other. The maximum drawdowns measured in FB-1 and FB-2 were 2.353 and 43.128 feet,

respectively. The approximate elevations at FB-1 and FB-2 are 21 feet above sea level, National Geodetic Vertical Datum (NGVD). The approximate elevation of the water surface at maximum drawdowns in FB-1 and FB-2, during the APT, were 13.1 and -4.8 feet NGVD, respectively. The APT drawdown and recovery results for FB-1 were analyzed using the Theis curve-matching method and the Jacob straight-line method to determine the transmissivity, storativity, and leakance factor of the Floridan aquifer. The average transmissivity, storativity, and leakance is 47,350 ft^2/day (354,190 gpd/ft), $8.5x10^{-4}$, and 0 day^{-1}, respectively. The plotted results are presented in Appendix H. The drawdown and recovery data for FB-2 is also presented in Appendix H. However, FB-2 was not analyzed for aquifer characteristics since values from the observation well are more accurate than those from the pumping well.

Transmissivity is a measure of an aquifers ability to transmit water. The transmissivity measured at FB-2 (354,190 gpd/ft) is an above average value for a Floridan aquifer well in this area (see Table 1 and Figure 10). A high transmissivity indicates that when pumped, the drawdown near the well will be relatively small, and drawdown decreases slowly at distance from the well.

Storativity is a measure of an aquifers ability to store water. As the storativity of an aquifer increases, its ability to produce water per volume of aquifer also increases. The storativity of FB-2 was measured as $8.5x10^{-4}$ (storativity is a dimensionless parameter). Storativities within confined aquifers, such as the Floridan aquifer, are typically between $5x10^{-3}$ and $5x10^{-5}$. The storativity of the Floridan aquifer in Fort Pierce is, therefore, within the expected range of values for a confined aquifer.

TABLE 1
FORT PIERCE UTILITIES AUTHORITY

FLORIDAN AQUIFER WELL FB-2
AQUIFER TEST RESULTS
FOR SELECTED FLORIDAN AQUIFER WELLS
IN ST. LUCIE COUNTY

Well Number	Total Depth (ft)	Cased Depth (ft)	Transmissivity (gpd/ft)	Storage Coefficient
FB-1	508 <⟷>	904	* 72,000	**.00183
FB-2	880	500	354,190	.00085
SLF-4	993	482	461,700	----
SLF-9	1,058	263	956,700	----
SLF-21	700	156	49,000	----
SLF-24A	---	---	208,500	.000183
SLF-20	896	311	44,600	----
SLF-17	1,286	320	166,600	----
SLF-15	---	---	629,200	.000955

Source: CH2M Hill 1989 and Brown 1980

* Transmissivity estimated based on empirical formula using the well's specific capacity.

**Storage coefficient based on average values available from literature.

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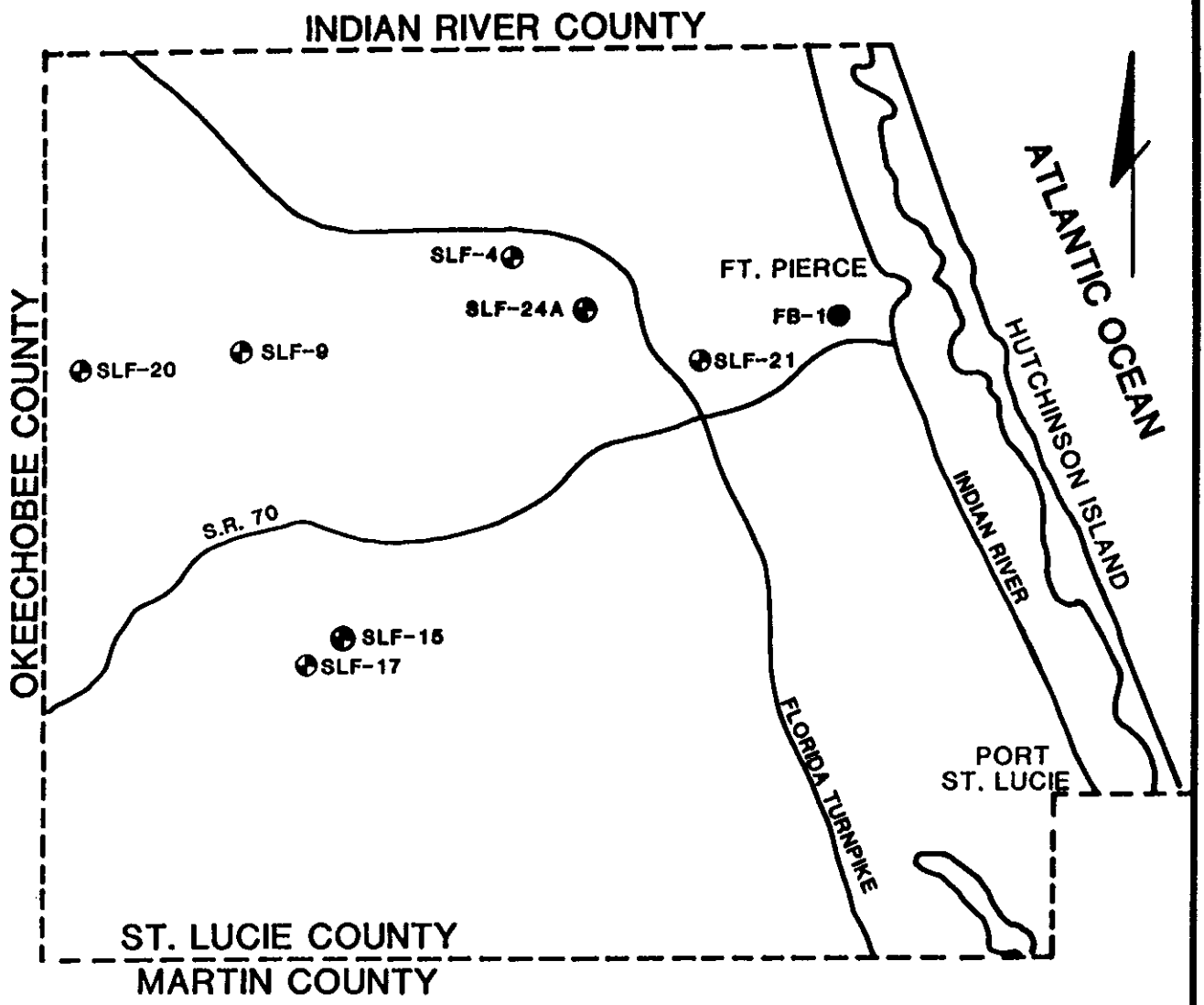
FIGURE 10



FORT PIERCE UTILITIES AUTHORITY

APPROXIMATE LOCATIONS OF SELECTED FLORIDAN AQUIFER WELLS (ST. LUCIE COUNTY)

LEGEND:

- ● FLORIDAN AQUIFER BLENDING WELL
- ◔ DATA COLLECTION SITE AND TEST WELL NUMBER

0 5
SCALE(MILES)

SOURCE: Modified from SFWMD Technical Publication 80-1

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Leakance is the measure of the amount of water entering a pumping well from above or below the aquifer being pumped. At FB-2 no leakance was measured, indicating that little or no water was being drawn from the overlying Hawthorn Formation and, more importantly, little or no water was drawn from the lower Floridan aquifer which contains lower quality water. In essence, all the water produced by FB-2 during the APT came from the upper 380 feet of the Floridan aquifer. FB-2, therefore, appears to be isolated from water quality problems in the surficial aquifer and Lower Floridan aquifer.

SECTION 4 - GEOLOGY

4.1 Regional Geology

The regional geology of Southeastern Florida consists primarily of interlayered sand, limestone, and clay formations. These formations were deposited primarily in a shallow sea environment.

The upper 100 to 200 feet consists of interlayered sand, sandy limestone, limestone and coquina limestone. Beneath that is the Hawthorn Formation, which consists of approximately 400 feet of calcareous clay. Underlying the clay is several thousand feet of carbonates (limestones and dolostones) comprising the Lake City, Avon Park, Ocala, and Suwannee Formations.

4.2 Site Geology

The major stratigraphic units encountered in FB-2 are presented in Figure 4. The units encountered were the Avon Park formation, Ocala Group, Hawthorn formation, Tamiami formation, Anastasia formation, and undifferentiated deposits which range in age from middle Eocene to Recent. The units are described below in order of deposition, from oldest to youngest.

4.2.1 Avon Park Formation

The Avon Park formation is of middle to late Eocene age (approximately 45 million years ago). It was encountered between 770 and 880 feet BLS. At FB-2, the Avon Park consists of white/gray/tan limestone and dolostone with interbedded clay. Various shell fragments occur continuously between 770 and 840 feet BLS with no dolostone.

Below 840 feet BLS there are little or no shell fragments and dolostone is interbedded with limestone from 850 to 880 feet BLS.

4.2.2 Ocala Group

The Ocala group is of late Eocene age (approximately 40 million years ago). It was encountered between 500 and 770 feet BLS. At FB-2, the Ocala Group consists primarily of gray/tan fossiliferous limestone. Interbedded throughout the Ocala Group are minor layers of chert and clay. Also found scattered throughout the formation are sharks teeth and coral fragments. Black phosphatic nodules occur near the top of the formation. Some of the fossils present are indistinguishable shell fragments, however, many of the shells are distinguishable as Lepidocyclina ocalana. Also present are Heterostegina ocalana and Nummulites ocalanus. Dolostone occurs in minor amounts between 590 and 700 feet BLS.

4.2.3 Hawthorn Formation

The Hawthorn formation is of Miocene age (approximately 15 million years ago). It was encountered between 120 and 500 feet BLS. At FB-2, it consists predominantly of green calcareous clay with minor shell fragments intermixed. From 360 to 450 feet BLS, the clay contains varying amounts of interbedded chert, limestone/dolostone, sharks teeth, and black phosphate nodules. Chert is also interbedded between 450 and 500 feet BLS. Minor fine sand was encountered between 270 and 280 feet BLS. The clay that comprises this unit creates an impermeable barrier to movement of ground-water between the underlying and overlying geological units.

4.2.4 Tamiami Formation

The Tamiami formation is of Pliocene age (approximately 4 million years ago). It was encountered between 100 and 120 feet BLS. At FB-2, it consists of gray/tan silty, shelly limestone.

4.2.5 Anastasia Formation

The Anastasia formation is of Pleistocene age (approximately 1 million years ago). It was encountered between 42 and 100 feet BLS. At FB-2, it consists of a gray/tan silty coquina interbedded with varying percentages of limestone.

4.2.6 Undifferentiated Recent Deposits

The upper 42 feet of FB-2 consists of fine- to medium-grained brown sand. It has been deposited in the past 10,000 years.

SECTION 5 - HYDROGEOLOGY

5.1 Regional Hydrogeology

The regional hydrogeology consists of three units. The Floridan Aquifer System, the Intermediate Confining System, and the Surficial Aquifer System. The "Floridan aquifer" as defined by Parker and others (1955), includes all or parts of the Lake City Limestone, Avon Park Limestone, Ocala Group, Suwannee Limestone, and "permeable parts of the Hawthorn Formation that are in hydrologic contact with the rest of the aquifer."

The terminology used in this report coincides with that of the Florida Geological Survey Special Publication No. 28 on "Hydrogeological Units of Florida" (1986). Here the Floridan aquifer system is defined as a "thick carbonate sequence which includes all or part of the Paleocene and early Miocene Series and functions regionally as a water-yielding hydraulic unit." The top of the aquifer system coincides with the top of the Suwannee Limestone, where present, or the top of the Ocala Group. The publication also allows for the designation of one or more aquifers within the Floridan aquifer system based on vertical variations in water bearing properties.

Numerous authors have sub-divided the Floridan aquifer. Meyer (1989) defines three zones in southern Florida that comprise the Floridan aquifer system.

These divisions are based on the geology, hydrochemistry, and hydraulic data. They are:

1. The Upper Floridan aquifer, which contains brackish ground water. Specific conductance of the ground water ranges from about 2,500

to 25,000 micromhos per centimeter (umhos/cm) and averages about 5,000 umhos/cm.

2. The middle confining unit, which contains salty ground water. The specific conductance is approximately 36,000 umhos/cm.
3. The Lower Floridan aquifer, which contains ground water that is similar in composition to sea water. The specific conductances averages about 49,000 umhos/cm.

This report is concerned only with the high quality water in the upper Floridan aquifer.

5.1.1. Upper Floridan Aquifer

The occurrence of a less permeable carbonate unit of sub-regional extent found particularly in south Florida separates the system into the two aquifers. The less permeable units may be very leaky to virtually non-leaky, depending upon the lithologic character of the rock comprising the unit (Miller, 1986). Meyer (1989) describes the Upper Floridan aquifer in southern Florida as consisting chiefly of permeable zones in the Tampa, Suwannee, Ocala Limestone and the upper part of the Avon Park Formation. The ground water is brackish, and the salinity generally increases with increasing depth and with distance downgradient and southward from central Florida.

The most significant ground-water movement occurs at or near the top of each formation. Ground-water movement is generally southward from the area of highest head near Polk City in central Florida to the Gulf of Mexico and to the Atlantic Ocean.

5.1.2 Intermediate Confining Unit

Overlying the Upper Floridan aquifer is a thick sequence of low permeability clays. The confining unit is up to 700 feet thick (400 feet locally) and retards the vertical movement of water between the surficial aquifer and the Floridan aquifer systems. An additional benefit of this thick confining unit is that contaminants in the surficial aquifer cannot migrate to the Upper Floridan aquifer. The low permeability beds are Miocene in age and consist primarily of clays and clayey sands of the Hawthorn formation.

5.1.3 Surficial Aquifer System

A surficial aquifer, which contains water under unconfined conditions is present throughout the region. The surficial aquifer in the region is comprised of a number of Plio-Pleistocene aged units. These vary in thickness from 0 to greater than 200 feet thick. The bottom of the surficial aquifer is denoted by the presence of fine grained clastic material of Miocene age. The FPUA wellfield is located in a highly permeable zone of this aquifer. However, due to increasing water demands, surface sources of contamination, and susceptibility to droughts, further development of this aquifer is limited.

5.2 Site Hydrogeology

The hydrogeology of the area consists of three units, the upper Floridan aquifer, the intermediate Hawthorn confining formation, and the surficial aquifer. The units are described below in order of deposition, from oldest to youngest.

5.2.1 Floridan Aquifer System

The Floridan artesian aquifer is up to 3,000 feet thick in this region. The aquifer is highly productive, but water quality degrades with depth. FB-2 was drilled 380 feet into the upper Floridan aquifer, which contains the highest quality water in the aquifer. The water producing zones in the Floridan are characteristically narrow zones and occur at formation contacts known as non-conformities. Weathering processes at the tops of formations creates a secondary permeability which often produce highly transmissive zones of narrow thickness relative to overlying and underlying strata, which are much lower in permeability. FB-2 receives water from three of these zones at approximately 870 to 874, 740 to 780, and 640 to 660 feet BLS (Figure 5). Approximately 87.5 percent of the water FB-2 produces is generated from those three zones, which comprise only 17 percent (64 feet) of the wells open hole thickness of 380 feet.

The transmissivity of the Floridan aquifer can vary significantly from well to well due to natural variations of the producing zones (i.e., formation contacts). At FB-2 the transmissivity based on the APT performed is 47,350 ft^2/day, which is an above average value in this location for a well within a few miles of the coast (SFWMD, 1980).

5.2.2 Intermediate Confining Unit

The Hawthorn clay formation separates the Floridan aquifer and surficial aquifers, and is known as the Floridan Aquiclude. Due to its thickness (380 feet at FB-2) and low permeability (several orders of magnitude lower than either aquifer), the formation serves as a confining unit between the two aquifers. Due to its low permeability, the

Hawthorn formation excludes the movement of water from the surficial aquifer to the Floridan aquifer, thus protecting the Floridan aquifer from surface contamination. In addition, due to the Hawthorn formation, the Floridan aquifer is not as dependant upon local rainfall for recharge as the surficial aquifer, and is, therefore, less susceptible to drought.

5.2.3 Surficial Aquifer System

The surficial aquifer contains an upper sand unit and a lower, highly transmissive sand and shell zone which is used extensively for private and municipal production wells. The FPUA develops most of its present water supply from this aquifer. As described in Section 1.2, the estimated production limit of the FPUA surficial aquifer wellfield is between 12 and 20 mgd (Ruskauff, et al., 1989), and the estimated maximum water needs at buildout will be 24.3 mgd. Since the surficial aquifer is limited by man's activities in addition to its natural limitations (salt-water to the east, decreasing aquifer thickness to the west, and susceptibility to droughts), the Floridan aquifer is an ideal choice to supplement the existing raw water supply.

SECTION 6 - WATER QUALITY

6.1 Introduction

The water quality within the Floridan aquifer generally decreases with depth. Therefore, it is necessary to periodically monitor water quality during installation of a Floridan well. Water quality was monitored at least every 60 feet during the installation of FB-2. Water quality was also monitored during the step-drawdown test and the seven-day APT as outlined below.

Water quality parameters analyzed in the field consisted of pH, temperature and conductivity. Water samples collected for chloride analysis were delivered to the FPUA WTP laboratory. Water samples collected for total dissolved solids (TDS) were analyzed by the FPUA wastewater treatment plant laboratory. Analyses conducted for sulfate, sulfide, and turbidity, as requested by the Florida Department of Environmental Regulation (FDER), were performed by Savannah Laboratories.

6.1.1 Well Construction Water Quality

As drilling progressed in the Floridan aquifer, water quality was monitored every 60 feet from 500 to 780 feet BLS and every 20 feet thereafter. Water samples were analyzed for pH, temperature, conductivity, and chloride. The water quality samples were collected from the reverse air discharge pipe. Drilling was stopped for 5 to 10 minutes at each sampling point to allow the well to flush and obtain a representative sample from each depth.

The water quality results (Table 2) indicated that water quality did not vary significantly with depth in FB-2. The range of values recorded for pH, temperature, and conductivity were 7.62 to 8.80, 26.5 to 29°C,

TABLE 2
FORT PIERCE UTILITIES AUTHORITY

FLORIDAN AQUIFER WELL FB-2
WELL CONSTRUCTION WATER QUALITY RESULTS

DATE	TIME	DEPTH (ft. BLS)	pH	TEMPERATURE (oC)	CONDUCTIVITY (umhos/cm)	CHLORIDE (1) (mg/l)	TDS (2) (mg/l)
8/28/91	13:20	515	8.72	29.0	1,850	255	N/A
8/29/91	8:50	540	8.80	27.5	1,200	204	N/A
8/29/91	11:50	600	8.05	27.0	1,650	271	N/A
8/29/91	15:20	660	8.06	27.0	1,600	267	N/A
8/30/91	9:00	720	8.10	26.5	1,500	275	N/A
8/30/91	11:20	780	8.00	27.0	1,500	280	N/A
8/30/91	13:00	800	7.62	27.0	1,550	280	N/A
8/30/91	15:10	820	7.96	27.0	1,500	290	N/A
8/30/91	16:25	840	7.85	27.0	1,500	305	N/A
9/5/91	14:40	860	8.20	27.0	1,525	298	N/A
9/5/91	16:05	880	8.08	27.0	1,500	315	N/A
9/5/91	16:50	880(3)	7.64	26.5	1,500	N/A	N/A
9/9/91	14:20	880(3)	7.78	27.0	1,500	308	915
9/9/91	14:10	880(4)	7.79	27.5	1,600	312	872
9/11/91	12:55	880(3)	7.73	27.0	1,550	303	N/A

0391409M

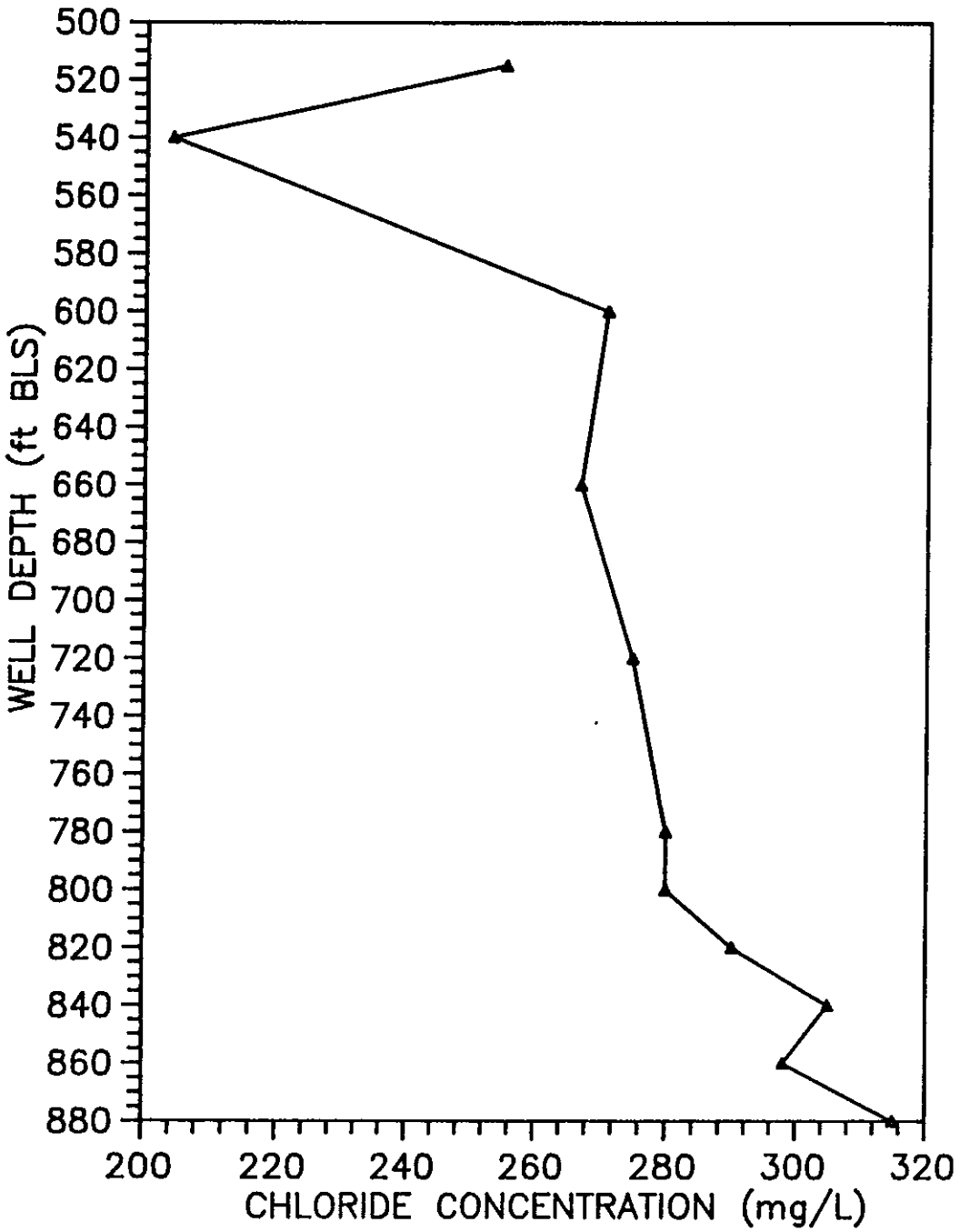
N/A - Not analyzed
(1) - Analyzed by FPUA water treatment plant laboratory.
(2) - Analyzed by FPUA wastewater treatment plant laboratory.
(3) - Composite sample taken from the flowing wellhead.
(4) - Point sample taken by depth sampler.
BLS - Below Land Surface.
TDS - Total Dissolved Solids.
mg/l - milligrams per liter
umhos/cm - micromhos per centimeter

and 1,200 to 1,850 micromhos/cm, respectively. Chloride concentrations ranged from 204 to 315 mg/L. A graph showing changes in chloride concentrations with depth is shown in Figure 11. Table 2 and Figure 11 indicate an anomolously low chloride concentration (204 mg/L) at 540 feet BLS. This low value is probably not representative of formation water quality. Water samples were taken from the reverse air discharge water except for those labeled as composites. Composites were taken at the flowing wellhead when drilling was not in progress. The composite sample represents a "weighted" blend from all producing zones encountered.

6.1.2 Background Water Quality

During drilling in the Floridan aquifer, discharge water from FB-2 was diverted to a visqueen lined trench and into an existing storm drain which flows to the ditch south of the site. Water discharged to that ditch flowed westward into 5-Mile Creek, which is approximately 1.25 miles west of the discharge point in the ditch. The water in 5-Mile Creek and the discharge water from FB-2 were sampled on September 19, 1991 for sulfide and turbidity as requested by the FDER (see Appendix I). 5-Mile Creek was identified as the receiving water for the FB-2 discharge, and was assumed to be indicative of naturally occurring background levels. In addition, water at the discharge point was analyzed for sulfide. The results are summarized below and the lab results are presented in Appendix J.

FORT PIERCE UTILITIES AUTHORITY
WELL CONSTRUCTION
CHLORIDE CONCENTRATIONS
FB-2



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Sampling Point	Turbidity (NTU)	Sulfide (mg/L)
FB-2	18	<0.10
5-Mile Creek	5	<0.10
Discharge canal	---	<0.10

The FDER ordered that the turbidity of the receiving water (5-Mile Creek) must not be increased 29 NTUs above background levels. The turbidity data from FB-2 indicates that the discharge water was only 13 NTUs above 5-Mile Creek.

Additional water samples were also collected during the geophysical logging of FB-2. A point sample was taken from the bottom of the well (880 feet BLS) using a stainless steel depth sampler. The sample was tested in the field for pH, temperature, conductivity, and laboratory analyzed for chloride and TDS. The results are summarized in Table 2.

6.1.3 Step-Drawdown Test Water Quality

During the step-drawdown test performed on FB-2 on September 20, 1991, water samples were collected for water quality analysis at the start of the test and immediately after each step. The samples were collected from the visqueen-lined discharge trench. The water was analyzed for pH, temperature, conductivity, chloride, TDS, and sulfate. The results are summarized in Table 3. The sulfate laboratory results are presented in Appendix K. None of the parameters tested varied significantly during the test.

6.1.4 Aquifer Performance Test Water Quality

During the seven-day APT, water samples were collected from the discharge trench every hour for the first seven hours and every four hours thereafter. The water was analyzed for pH, temperature,

TABLE 3
FORT PIERCE UTILITIES AUTHORITY

FLORIDAN AQUIFER WELL FB-2
STEP-DRAWDOWN TEST WATER QUALITY RESULTS

DATE	TIME	SAMPLE I.D.	pH	TEMPERATURE (C)	CONDUCTIVITY (umhos)	CHLORIDE (1) (mg/l)	TDS (2) (mg/l)	SULFATE (3) (mg/l)
9/20/91	10:20	Before Test	7.79	27.0	1,525	300	945	130
9/20/91	11:17	End of Step 1	7.82	27.0	1,600	285	920	180
9/20/91	12:05	End of Step 2	7.79	27.0	1,600	284	940	160
9/20/91	12:50	End of Step 3	7.75	27.0	1,600	285	950	170

0491409M

(1) - Analysis performed by FPUA water treatment plant laboratory.
(2) - Analysis performed by FPUA wastewater treatment plant laboratory.
(3) - Analysis performed by Savannah Laboratories
TDS - Total Dissolved Solids.
mg/l - milligrams per liter

conductivity, chloride, TDS, and sulfate. The parameters tested did not vary significantly during the APT. The results are summarized in Table 4. Compared to nearby Floridan aquifer wells (Figure 12), the chloride concentrations in FB-2 are extremely good. The change in chloride concentration with time during the APT is presented graphically in Figure 13. During the last 64 hours of the APT, the chloride levels did not exceed 280 mg/L. The sulfate laboratory results are presented in Appendix L. Sulfide and turbidity samples were also analyzed during the APT at 0, 43, 99, and 163 (end of test) hours after the test began. The results are summarized in Table 5. The laboratory results are presented in Appendix L. The sulfide concentrations increased steadily during the APT from <0.1 mg/L at the start, to 6.8 mg/L at the end. The sulfide concentrations recorded near the end of the APT are probably indicative of natural background levels in the Floridan aquifer as compared to the earlier data which was affected by fluids entering the formation during well construction. The sulfate concentrations were equal to or below 200 mg/L, and did not vary significantly during the test. The turbidity values decreased rapidly between the 43- and 99-hour samples. The turbidity values for the 0- and 43-hour samples were 28 and 31 NTUs, respectively. However, the 99 and 163 hour values were 0.32 and 0.29 NTUs, respectively. This large turbidity decrease indicates the APT helped develop the well and removed much of the remaining fine material around the borehole.

The combined results of all water quality analyses strongly suggests that the water quality in FB-2 is stable even at high (1,000 gpm) pumping rates.

TABLE 4

FORT PIERCE UTILITIES AUTHORITY

FLORIDAN AQUIFER WELL FB-2
APT WATER QUALITY RESULTS

DATE	ELASPED TIME (TIME)	pH	TEMP (C)	CONDUCTIVITY (umhos)	1 TDS (mg/l)	2 CHLORIDE (mg/l)	3 SULFATE (mg/l)
9/23/91	0.0 Hr. (15:00)	7.87	27.0	1,550	860	305	130
9/23/91	1.0 Hr. (16:00)	7.75	27.0	1,600	880	284	160
9/23/91	2.0 Hrs. (17:00)	7.82	27.0	1,600	840	287	160
9/23/91	3.0 Hrs. (18:00)	7.83	27.0	1,600	900	287	170
9/23/91	4.0 Hrs. (19.00)	7.77	26.5	1,600	890	278	160
9/23/91	5.0 Hrs. (20:00)	7.81	26.0	1,600	890	277	160
9/23/91	6.0 Hrs. (21:00)	7.72	26.0	1,600	930	285	160
9/23/91	7.0 Hrs. (22:00)	7.74	26.0	1,550	920	280	170
9/24/91	11.0 Hrs. (2:00)	7.76	26.0	1,550	930	288	190
9/24/91	15.0 Hrs. (6:00)	7.74	26.0	1,575	940	282	180
9/24/91	19.0 Hrs. (10:00)	7.61	26.0	1,550	930	285	180
9/24/91	23.0 Hrs. (14:00)	7.32	26.0	1,600	930	294	170
9/24/91	27.0 Hrs. (18:00)	7.81	27.0	1,600	950	234	170
9/24/91	31.0 Hrs. (22:00)	8.06	26.0	1,400	930	282	170
9/25/91	35.0 Hrs. (2:00)	7.97	26.0	1,400	950	282	190
9/25/91	39.0 Hrs. (6:00)	8.00	26.0	1,350	925	285	180
9/25/91	43.0 Hrs. (10.00)	8.09	26.5	1,375	930	278	180
9/25/91	47.0 Hrs. (14:00)	8.02	27.0	1,400	910	293	170
9/25/91	51.0 Hrs. (18:00)	8.04	26.0	1,375	900	290	200
9/25/91	55.0 Hrs. (22:00)	8.01	26.0	1,350	905	287	190
9/26/91	59.0 Hrs. (2:00)	8.10	26.0	1,350	905	290	190
9/26/91	63.0 Hrs. (6:00)	8.02	26.0	1,350	900	287	170
9/26/91	67.0 Hrs. (10:00)	8.13	26.0	1,400	910	284	180

4391409L

1. Analysis performed by Ft. Pierce wastewater treatment plant
2. Analysis performed by Ft. Pierce water treatment plant
3. Analysis performed by Savannah Laboratories

TABLE 4 (continued)
FORT PIERCE UTILITIES AUTHORITY

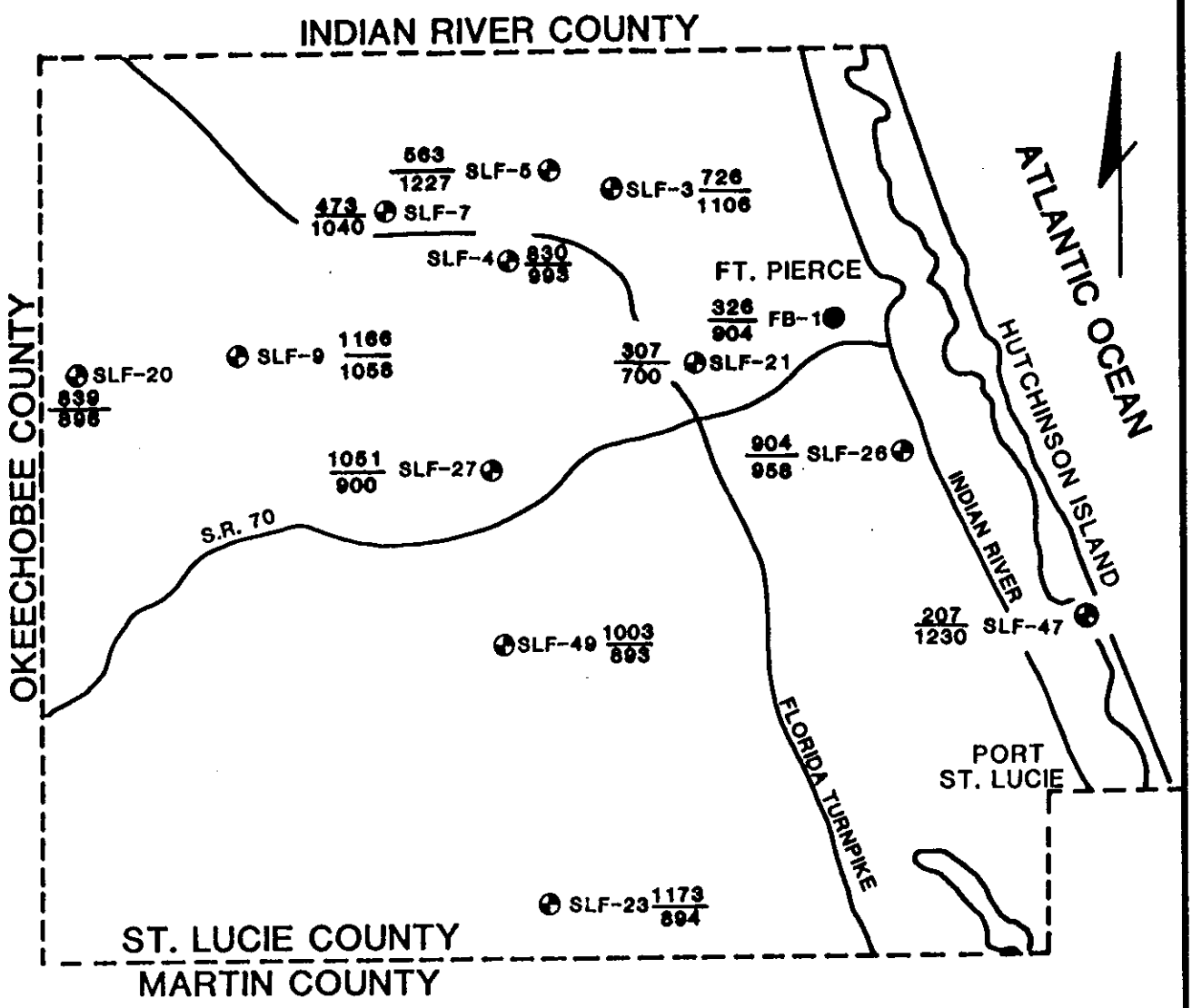
FLORIDAN AQUIFER WELL FB-2
APT WATER QUALITY RESULTS

DATE	ELASPED TIME (TIME)	pH	TEMP (C)	CONDUCTIVITY (umhos)	1 TDS (mg/l)	2 CHLORIDE (mg/l)	3 SULFATE (mg/l)
9/26/91	71.0 Hrs. (14:00)	7.80	26.5	1,500	920	285	170
9/26/91	75.0 Hrs. (18:00)	7.79	26.5	1,500	910	292	150
9/26/91	79.0 Hrs. (22:00)	7.83	26.0	1,500	935	299	180
9/27/91	83.0 Hrs. (2:00)	7.78	29.0	1,500	935	280	190
9/27/91	87.0 Hrs. (6.00)	7.83	25.5	1,450	N/A	303	180
9/27/91	91.0 Hrs. (10:00)	7.85	26.0	1,500	950	293	180
9/27/91	95.0 Hrs. (14:00)	7.85	26.5	1,500	940	290	190
9/27/91	99.0 Hrs. (18:00)	7.73	26.0	1,500	915	280	180
9/27/91	103.0 Hrs. (22:00)	7.84	25.5	1,475	910	272	180
9/28/91	107.0 Hrs. (2:00)	7.72	26.0	1,475	940	271	170
9/28/91	111.0 Hrs. (6:00)	7.85	25.5	1,450	935	275	170
9/28/91	115.0 Hrs. (10:00)	7.75	26.0	1,500	925	272	170
9/28/91	119.0 Hrs. (14:00)	7.79	26.5	1,550	920	272	160
9/28/91	123.0 Hrs. (18:00)	7.84	26.5	1,575	920	271	160
9/28/91	127.0 Hrs. (22:00)	7.84	26.0	1,550	920	271	170
9/29/91	131.0 Hrs. (2.00)	7.80	26.0	1,550	925	275	160
9/29/91	135.0 Hrs. (6:00)	7.74	26.0	1,500	940	280	160
9/29/91	139.0 Hrs. (10:00)	7.83	26.5	1,500	900	280	180
9/29/91	143.0 Hrs. (14:00)	7.78	27.0	1,600	910	280	190
9/29/91	147.0 Hrs. (18:00)	7.80	27.0	1,600	880	280	170
9/29/91	151.0 Hrs. (22:00)	7.75	26.0	1,525	890	278	180
9/30/91	155.0 Hrs. (2:00)	7.75	26.0	1,525	870	277	160
9/30/91	159.0 Hrs. (6:00)	7.80	26.0	1,525	910	278	160
9/30/91	163.0 Hrs. (10:00)	____*	26.0	1,550	915	274	160

Stopped Test @ 10:17 am * - pH meter broke

4591409L

1. Analysis performed by Ft. Pierce wastewater treatment plant
2. Analysis performed by Ft. Pierce water treatment plant
3. Analysis performed by Savannah Laboratories



FORT PIERCE UTILITIES AUTHORITY

CHLORIDE CONCENTRATIONS AND TOTAL DEPTH OF SELECTED FLORIDAN AQUIFER WELLS (ST. LUCIE COUNTY)

LEGEND :

326/904 CHLORIDE (MG/L) / TOTAL DEPTH (FT)

● FLORIDAN AQUIFER BLENDING WELL

⊕ DATA COLLECTION SITE AND TEST WELL NUMBER

0 5
SCALE(MILES)

SOURCE: Modified from SFWMD Technical Publication 80-5 and 89-1

BLASLAND, BOUCK & LEE
ENGINEERS & GEOSCIENTISTS

FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
CHLORIDE CONCENTRATIONS
FB–2

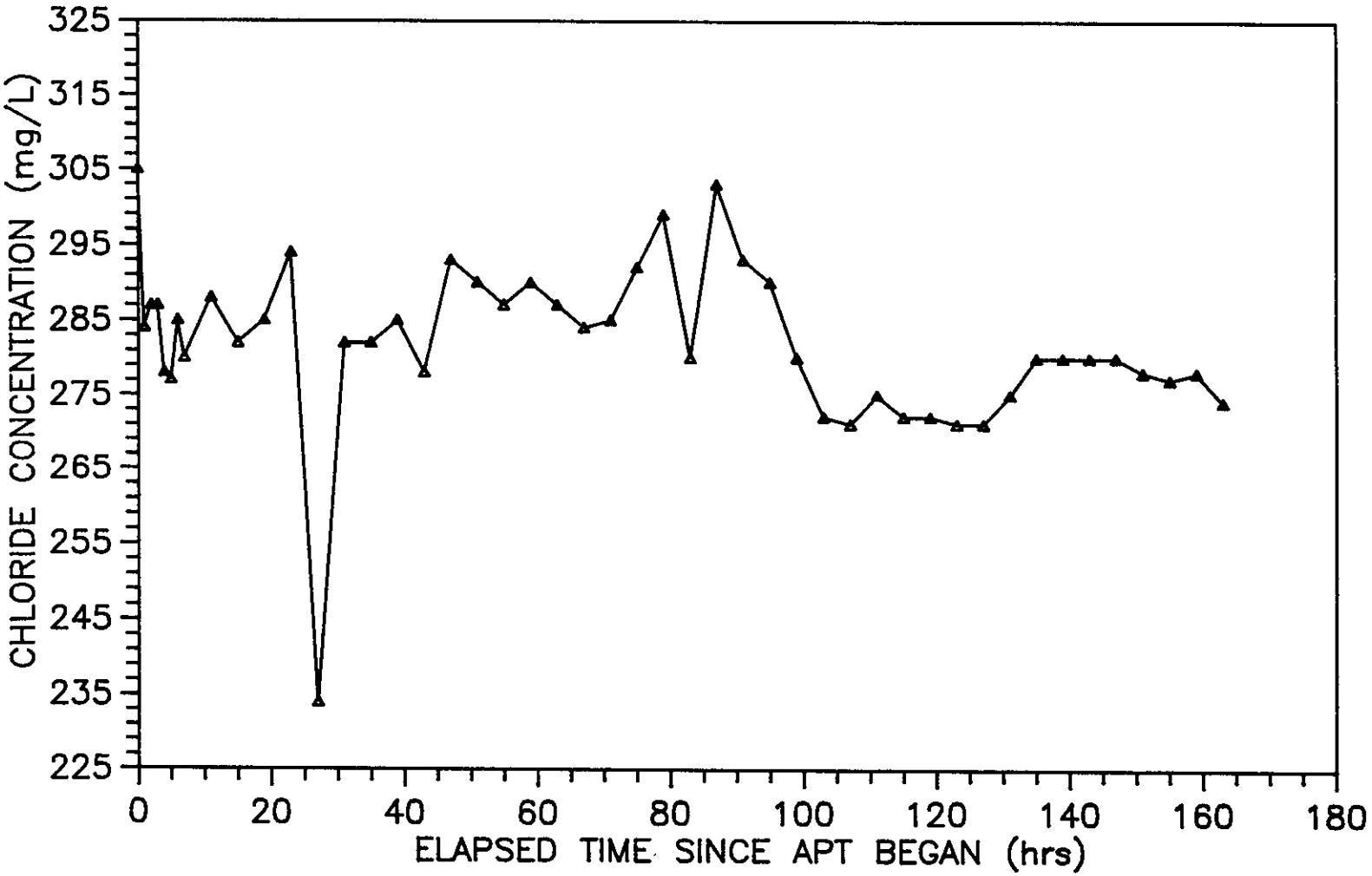


FIGURE 13

TABLE 5
FORT PIERCE UTILITIES AUTHORITY

FLORIDAN AQUIFER WELL FB-2
APT WATER QUALITY

DATE	ELAPSED TIME (TIME)	TURBIDITY (NTU)	SULFIDE (mg/l)
9/23/91	0.0 Hr. (15:00)	28	<0.1
9/25/91	43.0 Hrs. (10:00)	31	2.1
9/27/91	99.0 Hrs. (18:00)	0.32	6.0
9/30/91	1630.0 Hrs. (10:00)	0.29	6.8

1791409M

SECTION 7 - CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Based on the information gathered during construction and testing of well FB-2, the following conclusions can be drawn:

- The reverse-air drilling method was used to construct FB-2 in the Floridan aquifer. The flow rate from FB-2 (approximately 600 gpm upon well completion) is higher than that from FB-1 (approximately 500 gpm), which suggests that the reverse air method produces a more productive well than the straight air method used to construct FB-1.
- Approximately 87.5% of the water flowing from FB-2 is produced from three narrow zones in the well with a combined thickness of 64 feet. These zones are the three upper producing zones in the Floridan aquifer, and contain the best quality water in the aquifer.
- The maximum drawdowns at FB-1 and FB-2 were 2.353 and 43.128 feet, respectively, during the seven-day APT (1,000 gpm pump rate). Those drawdowns correspond to elevations in FB-1 and FB-2 of 13.1 and -4.8 feet NGVD, respectively. Since the water elevation at FB-2 is only 4.8 below NGVD at 1,000 gpm, it should be well above the NGVD during naturally flowing conditions, and therefore, also above mean sea level. The low drawdown at FB-1 during the APT indicates only minor well interference will occur during normal well use.

- The transmissivity of FB-2 is 47,350 ft^2/day (354,190 gpd/ft). This is above average for this area, and indicates the aquifer can safely provide large quantities of water.
- The storativity of FB-2 is $8.5x10^{-4}$. This is below average for this area, but is well within the typical values for a confined aquifer ($5x10^{-3}$ to $5x10^{-5}$).
- The leakance is 0 day^{-1}, which indicates water from the surficial aquifer and lower Floridan aquifer was not entering the Upper Floridan aquifer during the APT. Therefore, lower quality water will not enter the Floridan aquifer from above or below during well production.
- The average specific capacity of FB-2, as determined by the step-drawdown test, is approximately 25.9 gpm/ft.
- The water quality of FB-2 (temperature, pH, conductivity, chloride and TDS) is relatively high for a Floridan aquifer well, and did not vary significantly with depth or during the step drawdown test and the APT. This suggests water quality will remain high and stable during normal well usage.
- Chloride levels exceeded 300 mg/L twice during the seven-day APT. The chloride concentration at the start of the test and 87 hours into the test were 305 mg/L and 303 mg/L, respectively. The chloride levels did not exceed 280 mg/L during the last 64 hours of the APT. Again, these results suggest the water quality of FB-2 is generally good, and is stable under stressed aquifer conditions.

- o Sulfide was the only constituent tested for during the APT that increased significantly. During the APT, the sulfide levels increased steadily from <0.1 mg/L at the start of the test to 6.8 mg/L at the end. This indicates sulfide concentrations may have been decreased near the well due to well construction activities.

7.2 Recommendations

Based on the above conclusions, the following recommendations should be implemented in the following order:

1) To determine optimal well spacing and well location for future Floridan aquifer wells with respect to hydrogeological and raw water distribution, a ground-water flow model should be developed. The model should provide a prediction of safe yields as well as predict impacts on existing legal users. Modeling will also be extremely helpful when water use permit modifications are requested from the SFWMD.
2) Apply for a water use permit modification/renewal which identifies the Floridan aquifer and the surficial aquifer as the source of water supply.
3) Construct and test three (3) additional production/test wells at more remote locations to evaluate a greater area within the Floridan aquifer.

Other recommendations that should be considered during the Floridan aquifer wellfield development include:

- Develop future water supply from the upper Floridan aquifer, which is an excellent source of raw water in terms of quality, quantity, and isolation from surficial sources of contamination.
- To obtain the highest well yield, future Floridan aquifer production wells should be drilled using the reverse air method through the Floridan aquifer.
- Future Floridan aquifer production wells should be completed into and include the third producing interval, which is approximately between 850 and 880 feet BLS in this area according to wells FB-1 and FB-2. Based on other deep Floridan aquifer wells, the next producing interval is well below the third zone, and water quality is reportedly much lower than observed at FB-2.
- Future Floridan aquifer production wells should be constructed in a similar manner to FB-2 by using similar drilling methods and casing emplacement techniques.
- Long term APTs, with multiple observation wells, should be performed on future Floridan aquifer wells to determine irregularities in the aquifer characteristics and to determine the highest producing locations. This information will be extremely useful when water use permit modifications are requested from the SFWMD.

SECTION 8 - REFERENCES

Blasland, Bouck & Lee, "Pre-Design Investigation Floridan Aquifer Wellfield Development." for FPUA, 1990.

Blasland, Bouck & Lee "Reverse Osmosis Potential of the Floridan Aquifer Lower East Coast Water Supply Planning Area." for the SFWMD, 1991.

Brown, M.P. "Aquifer Recovery Test Data and Analyses for the Floridan Aquifer System in the Upper East Coast Planning Area, South Florida Water Management District." South Florida Water Management District, Technical Publication 80-1, January 1980.

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Driscoll, Fletcher, G., "Ground Water and Wells," Johnson Division, 1986.

Ebasco Environmental "Site 10: Amoco-Reddick Service Station, Fort Pierce, St. Lucie County, Florida, Final Contamination Assessment Report for Task 10H," May 1990.

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Hicks, Richard W., William A. Martin, Jr., and Allan M. Stodghill, "Fort Pierce Utility Authority 25th Street Wellfield Contamination, St.Lucie County," Florida Department of Environmental Regulation, January 1988.

Meyer, F.W. "Hydrogeology, Ground Water Movement, and Subsurface Storage in the Floridan Aquifer System in Southern Florida." U.S. Geological Survey Professional Paper 1403-G, 1989.

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Parker, G.G., Ferguson, G.E., Love, S.K., and others, "Water Resources of Southeastern Florida." U.S. Geological Survey, Water Supply Paper 1255, 1955.

Ruskauff, Gregory, J., Dean M. Mades, and Michael L. Voorhees, "Martin and St. Lucie County Ground-Water Modeling Study," for the South Florida Water Management District, April 1989.

SFWMD, "Aquifer Recovery Test Data and Analyses for the Floridan Aquifer System in the Upper East Coast Planning Area, South Florida Water Management District," January 1980.

APPENDIX A

BID PROPOSAL PRICES AND ACTUAL

MATERIALS AND PRICES

FORT PIERCE UTILITIES AUTHORITY

FLORIDAN AQUIFER WELL (FB-2)
BID PROPOSAL PRICES
AND
ACTUAL MATERIALS AND PRICES

Item Description	Unit Price	Contract Specified Quantity	Contract Specified Price	Actual Quantity Used	Price Invoiced
1. Mob and demob/Site cleanup	Lump Sum	1	$6,000.00	1	$6,000.00
2. Drill nominal 26″ diameter hole to approx. 115' depth.	$35.00/ft.	115	$4,025.00	115 ft.	$4,025.00
3. Ream pilot hole to nominal 19″ diameter to approx. 500' depth.	$16.00/ft.	385	$6,160.00	385 ft.	$6,160.00
4. Drill nominal 12″ diameter open hole to approx. 900' depth.	$15.00/ft.	400	$6,000.00	380 ft.	$5,700.00
5. Furnish and install 20″ casing.	$45.00/ft.	115	$5,175.00	115 ft.	$5,175.00
6. Furnish and install 12″ casing.	$17.50/ft.	500	$8,750.00	500 ft.	$8,750.00
7. Furnish and install ASTM C150, Type II cement with max. 8% bentonite by total volume.	$12.50/sk.	minimum 473	$5,912.50	580 sacks	$7,250.00
8. Develop open hole by air lifting and surging.	$112.00/hr.	12	$1,344.00	0 hrs.	$0.00
9. Standby time.	$25.00/hr.	40	$1,000.00	6 hrs.	$150.00
10. Extra work.	$40.00/hr.	40	$1,600.00	0 hrs.	$0.00
11. Wellhead, valves, appurtenances including pad.	Lump Sum		$1,580.00	---	$1,580.00
12. Assistance during geophysical logging on reamed holes.	Lump Sum	5	$1,500.00	---	$1,500.00
13. Assistance during interval sampling	Lump Sum	5	$890.00	---	$890.00
14. Pump Test	Lump Sum	7	$8,300.00	---	$8,300.00
TOTALS			$58,236.50		$55,480.00

APPENDIX B

WATER WELL CONSTRUCTION PERMIT

South Florida Water Management District

P.O. Box 24680 • 3301 Gun Club Road • West Palm Beach, FL 33416-4680 • (407) 686-8800 • FL WATS 1-800-432-2045

CON 24-06

August 6, 1991

WATER WELL CONSTRUCTION PERMIT # SF070891R

PERMITTEE

Ft. Pierce Utilities Authority
P.O. Box 3191
Ft. Pierce, FL 34948

CONTRACTOR

David E. Webb
3504 Industrial 33rd Street
Ft. Pierce, FL 34946
(License Number 21456)

PROJECT: Floridan Aquifer Test Well FB-2
TYPE OF USE: Test Well
COUNTY: St. Lucie
SEC: 8 TWP: 35S RGE: 40E

WELL CONSTRUCTION SPECIFICATIONS

CASING DIAMETER:	12.00" (inner) 20.00" (outer)
CASING DEPTH:	500.00' (inner) 115.00' (outer)
SCREENED INTERVAL:	N/A
OPEN HOLE INTERVAL:	500.00' - 900.00'
TOTAL DEPTH OF WELL:	900.00'

GROUT REQUIREMENT (INNER):
CASING SHALL BE GROUTED BOTTOM TO TOP.
GROUT REQUIREMENT (OUTER):
CASING SHALL BE GROUTED BOTTOM TO TOP.

EXPIRATION DATE: February 6, 1992

See additional conditions of permit on attached page.

We appreciate your assistance and cooperation in better managing the water resources of the District. If you have any questions on this matter, please call Ann Marie Superchi at extension 6929.

Sincerely,

Steve Lamb, Director
Water Use Division

ATTACHMENT: ADDITIONAL CONDITIONS OF PERMIT
c: Mr. Wesley Upham
Mr. Bob Callino

ADDITIONAL CONDITIONS OF PERMIT

This well is presently approved for testing purposes only. Modifications to this permit and to Water Use Permit #56-00085-W, will be necessary if this well is converted to a Public Water Supply use.

Unless this well is converted to other use, it shall be properly abandoned according to Chapter 40E-3, Florida Administrative Code, once testing is complete.

Test results shall be submitted to the District within 30 days of completion of testing.

COMPLETION REPORT REQUIRED

A Water Well Completion Report (Form 0124) must be filed with the District within 30 days of completion of work.

APPENDIX C

GEOPHYSICAL LOGS

SOUTHERN RESOURCE EXPLORATION
P.O. Box 14311
Gainesville, FL 32604
904-372-5950

GEOPHYSICAL WELL SURVEY

Sheet 1 of 5

Electric
- ☐ 16" Normal
- ☐ 64" Normal
- ☑ Single Point
- ☑ S.P.

- ☐ Caliper
- ☐ Fluid Resistivity
- ☐ Fluid Velocity
- ☑ Gamma Ray
- ☐ Temperature

CLIENT: Bluelend, Bouck, And Lee Date: 9/9/91
Well No.: FB-2 Project No.:

Location: State: Florida County: St. Lucie
¼ ¼ ¼ Sec. T R ☐ N ☐ E ☐ S ☐ W
Logged by: M. Fried Observer: E. Roggenbarger

Owner: Fort Pierce Utilities Authority
Well: FB-2
Driller: Drilled Services Date Drilled: 9/91
Surface Elevation: ft. ☐ Estimated ☐ Measured Above MSL
T.D. Logged: 882' T.D. Drilled: 882'
Hole Dia.: 12"
Casing Dia.: 12" PVC to 500'
Finish: ☐ Open Hole ☐ Screen ☐ Gravel ☐ Other
Water Level: ft. ☐ Above ☐ Below MP, ☐ Above ☐ Below Land Surface
Yield: Flow gpm Pump gpm

Remarks: 0' at 12" Flange

Log Scales

Electric Log
SP 100 millivolts/5 inches
Res ohm-meters/inch
Res 25 ohms/5 inches

Fluid Resistivity/Conductivity
ohm meters/inch
500 to 8000 m mho/cm.
@ °F

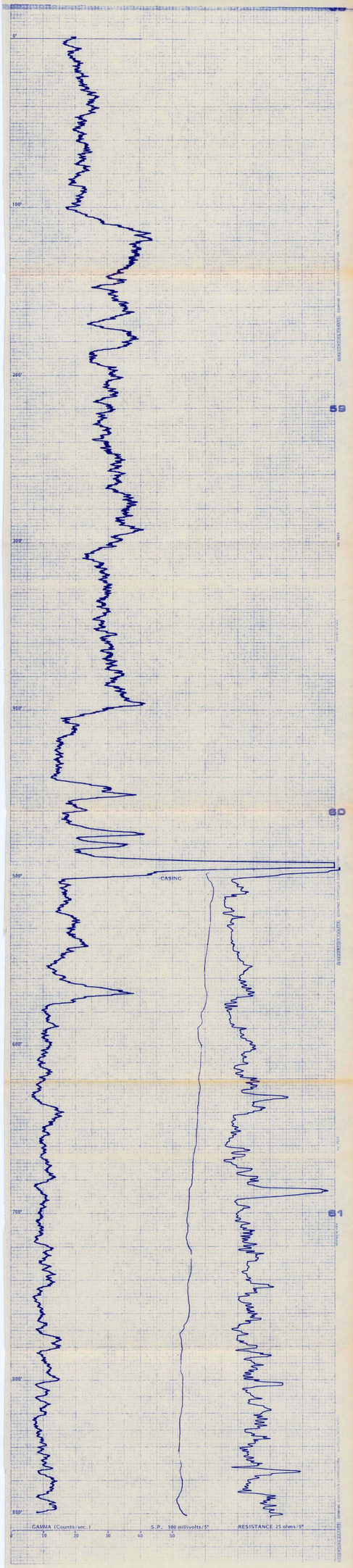
Gamma Ray Log
10 Counts/sec/inch
Time Constant 4 sec
Logging speed 30 FPM

Fluid Velocity
30 Rev./min/inch
40 FPM (Continuous)
0 = gpm

Temperature
70 °F to 90 °F
Logging speed 30 FPM

Caliper
4 inches to 24 inches
Logging speed 30 FPM

Water Samples
Depths sampled: @70'



GEOPHYSICAL WELL SURVEY

Sheet 2 of 5

SOUTHERN RESOURCE EXPLORATION
P.O. Box 14311
Gainesville, FL 32604
904-372-5950

Electric
- ☐ 16" Normal
- ☐ 64" Normal
- ☐ Single Point
- ☐ S.P.

Caliper
- ☒ Caliper
- ☐ Fluid Resistivity
- ☐ Fluid Velocity
- ☐ Gamma Ray
- ☐ Temperature

CLIENT Blanland, Roark, And Lee Date 9/9/91
Well No. FB-2 Project No.

Location: State Florida County St. Lucie
¼ ¼ ¼ Sec T ☐ N. ☐ E ☐ S. R. ☐ W.

Logged by M. Erlad Observer E. Regensburger

Owner Fort Pierce Utilities Authority
Well FB-2 Date Drilled 9/91
Driller Drilling Services
☐ Estimated ☐ Measured
Surface Elevation ft. Above MSL
T.D. Logged 882' T.D. Drilled 882'
Hole Dia. 12"
Casing Dia. 12" PVC to 500'
Finish: ☐ Open Hole ☐ Screen ☐ Gravel ☐ Other
☐ Above ☐ Above
Water Level: ft. ☐ Below MP. ☐ Below Land Surface
Yield: Flow gpm Pump gpm

Remarks 0' at 12" Flange

Log Scales

Electric Log
SP 100 millivolts/5 inches
Res ohm-meters/inch
Res 25 ohms/5 inches

Fluid Resistivity/Conductivity
ohm-meters/inch
500 to 5000 m.mhos/cm.
@ °F

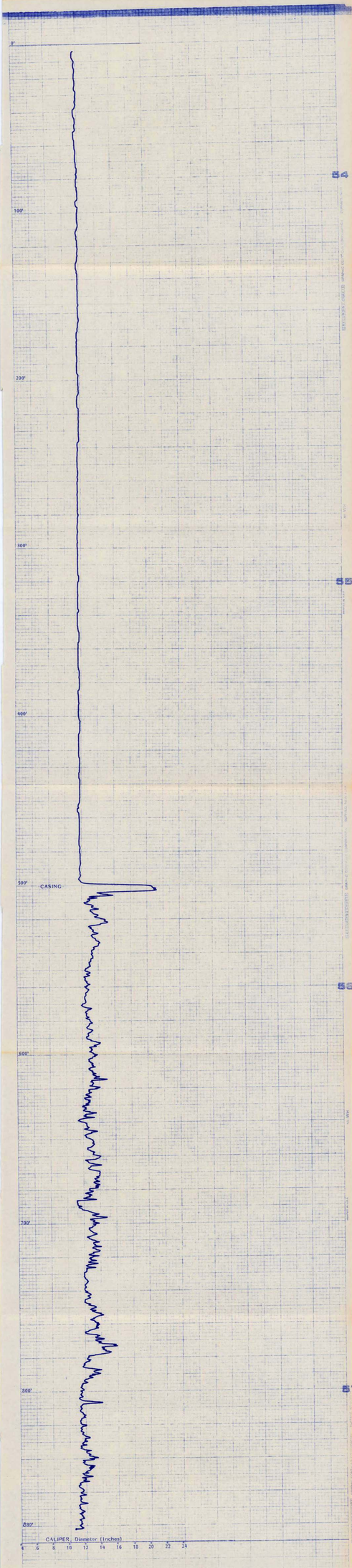
Gamma Ray Log
10 Counts/sec/inch
Time Constant 4 sec.
Logging speed 50 FPM

Fluid Velocity
50 Rev./min/inch
40 FPM (Continuous)
Q = gpm

Temperature
20 °F to 80 °F
Logging speed 30 FPM

Caliper
4 inches to 24 inches
Logging speed 30 FPM

Water Samples
Depths sampled 870'



SOUTHERN RESOURCE EXPLORATION
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904-372-5950

GEOPHYSICAL WELL SURVEY

Sheet 3 of 5

Electric
- ☐ 16" Normal
- ☐ 64" Normal
- ☐ Single Point
- ☐ S.P.

- ☐ Caliper
- ☒ Fluid Resistivity
- ☐ Fluid Velocity
- ☐ Gamma Ray
- ☐ Temperature

CLIENT Blasland, Bouck, And Lee Date 9/9/91
Well No. FB-2 Project No.

Location: State Florida County St. Lucie
☐ N ☐ E
¼ ¼ ¼ Sec. T ☐ S R ☐ W
Logged by M Fried Observer E Regensburger

Owner: Fort Pierce Utilities Authority
Well FB-2
Driller: Drilling Services Date Drilled: 9/91

☐ Estimated
Surface Elevation: ft. ☐ Measured Above MSL
T.D. Logged 882' T.D. Drilled 882'
Hole Dia. 12"
Casing Dia. 12" PVC to 500'
Finish: ☐ Open Hole ☐ Screen ☐ Gravel ☐ Other
☐ Above ☐ Above
Water Level: ft. ☐ Below MP, ☐ Below Land Surface
Yield: Flow gpm Pump gpm

Log Scales

Electric Log
SP 100 millivolts/5 inches
Res. ohm-meters/inch
Res. 25 ohms/5 inches

Fluid Resistivity/Conductivity
ohm meters/inch
500 to 5000 m.mhos/cm.
@ °F

Gamma Ray Log
10 Counts/sec/inch
Time Constant 4 sec.
Logging speed 50 FPM

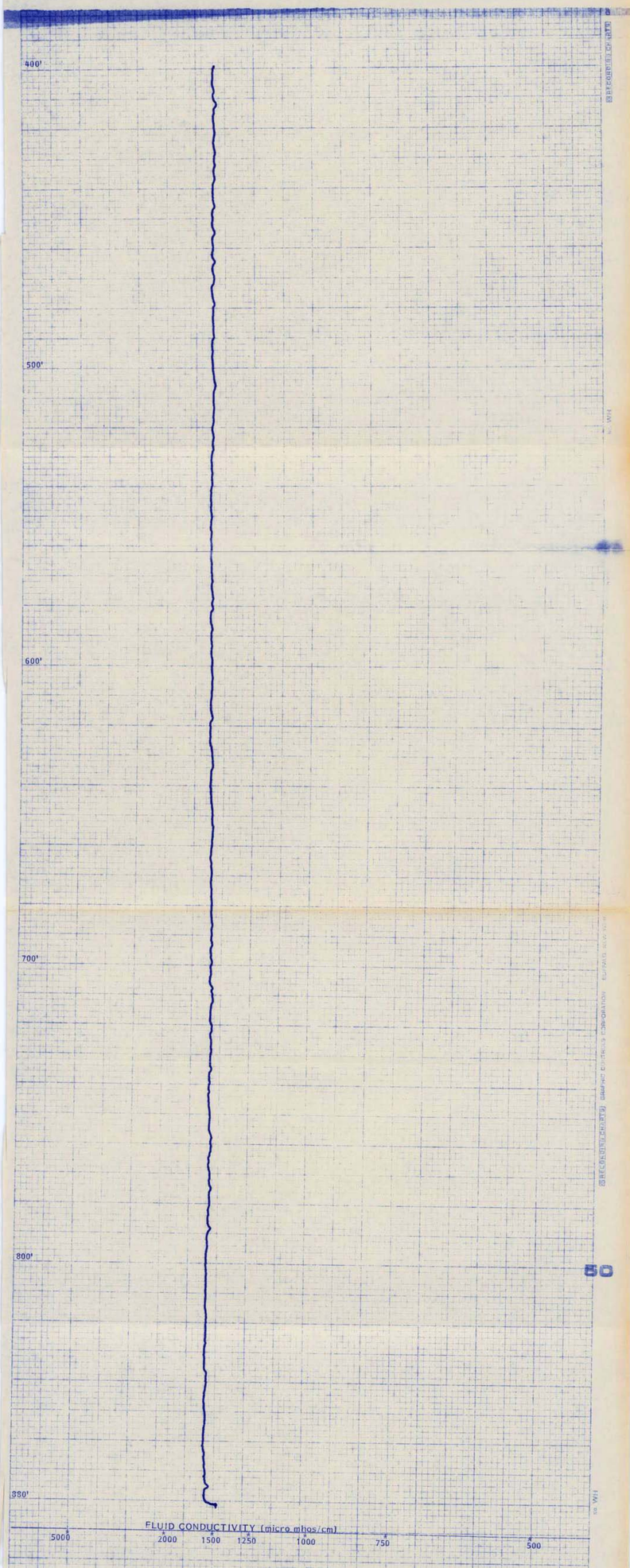
Fluid Velocity
30 Rev./min/inch
40 FPM (Continuous)
Q = gpm

Temperature
70 °F to 80 °F
Logging speed 30 FPM

Caliper
4 inches to 24 inches
Logging speed 30 FPM

Water Samples
Depths sampled: 870'

Remarks: 0' at 12" Flange



SOUTHERN RESOURCE EXPLORATION
P.O. Box 14311
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904-372-5950

GEOPHYSICAL WELL SURVEY

Sheet 4 of 5

Electric
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- ☐ 64" Normal
- ☐ Single Point
- ☐ S.P.

- ☐ Caliper
- ☐ Fluid Resistivity
- ☒ Fluid Velocity
- ☐ Gamma Ray
- ☐ Temperature

CLIENT: Blasland, Bouck, And Lee Date: 9/9/91
Well No.: FB-2 Project No.:

Location: State: Florida County: St. Lucie
☐ N ☐ E
¼ ¼ ¼ Sec. T. ☐ S R. ☐ W
Logged by: M. Fried Observer: E. Ragensburger

Owner: Fort Pierce Utilities Authority.
Well: FB-2
Driller: Drilling Services Date Drilled: 9/91
☐ Estimated
Surface Elevation: ft. ☐ Measured Above MSL
T.D. Logged: 882' T.D. Drilled: 882'
Hole Dia.: 12"
Casing Dia.: 12" PVC to 500'
Finish: ☐ Open Hole ☐ Screen ☐ Gravel ☐ Other
☐ Above ☐ Above
Water Level: ft. ☐ Below MP, ☐ Below Land Surface
Yield: Flow gpm Pump gpm

Remarks: 0' at 12" Flange

Log Scales

Electric Log
SP: 100 millivolts/5 inches
Res.: ohm-meters/inch
Res.: 25 ohms/5 inches

Fluid Resistivity/Conductivity
ohm meters/inch
300 to 3000 m.mhos/cm.
0 °F

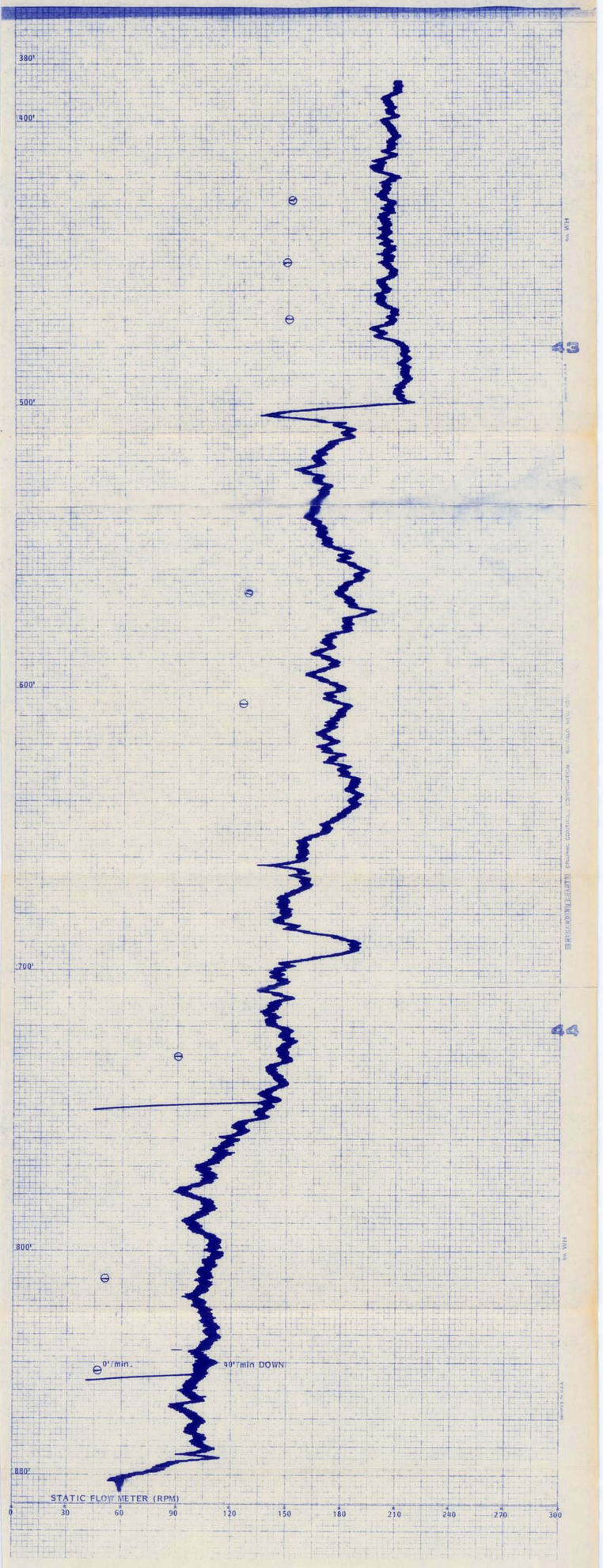
Gamma Ray Log
10 Counts/sec/inch
Time Constant 4 sec.
Logging speed 50 FPM

Fluid Velocity
20 Rev./min/inch
40 FPM (Continuous)
0 = gpm

Temperature
70 °F to 80 °F
Logging speed 30 FPM

Caliper
4 inches to 24 inches
Logging speed 30 FPM

Water Samples
Depths sampled: 870'



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904-372-5950

GEOPHYSICAL WELL SURVEY

Sheet 5 of 5

Electric
- ☐ 16" Normal
- ☐ 64" Normal
- ☐ Single Point
- ☐ S.P.

- ☐ Caliper
- ☐ Fluid Resistivity
- ☐ Fluid Velocity
- ☐ Gamma Ray
- ☒ Temperature

CLIENT Blasland, Bouck, And Lee. Date 9/9/91
Well No. FB-2 Project No.

Location: State Florida County St. Lucie
☐ N ☐ E
¼ ¼ ¼ Sec. T ☐ S R ☐ W
Logged by M. Fried Observer E. Regensburger

Owner: Fort Pierce Utilities Authority.
Well: FB-2
Driller: Drilling Services Date Drilled 9/91
☐ Estimated
Surface Elevation: ft. ☐ Measured Above MSL
T.D. Logged 882' T.D. Drilled 882'
Hole Dia. 12"
Casing Dia. 12" PVC to 500'
Finish: ☐ Open Hole ☐ Screen ☐ Gravel ☐ Other
☐ Above ☐ Above
Water Level: ft. ☐ Below MP, ☐ Below Land Surface
Yield: Flow gpm Pump gpm

Log Scales

Electric Log
SP 100 millivolts/5 inches
Res. ohm-meters/inch
Res. 25 ohms/5 inches

Fluid Resistivity/Conductivity
ohm meters/inch
500 to 5000 m.mhos/cm.
@ °F

Gamma Ray Log
10 Counts/sec/inch
Time Constant 4 sec.
Logging speed 30 FPM

Fluid Velocity
30 Rev./min/inch
40 FPM (Continuous)
Q = gpm

Temperature
70 °F to 90 °F
Logging speed 30 FPM

Caliper
4 inches to 24 inches
Logging speed 30 FPM

Water Samples
Depths sampled: 870'

Remarks: 0' at 12" Flange

400'
500'
600'
700'
800'
880'

TEMPERATURE (°F)
70 71 72 73 74 75 76 77 78 79 80

APPENDIX D

TIDAL CHARTS

DATE 1/10/91

DATUM REFERENCE

STATION NUMBER = 8722670

STATION NAME = Lake Worth, FL

DATES DATUM(S) APPLIES TO:

FROM: Sept 1 1991 TO Oct 2 1991

EPOCH = 1960-78

SUBTRACT 29.73 FEET TO REFER VALUES TO MLLW.

SUBTRACT 29.89 FEET TO REFER VALUES TO MLW.

SUBTRACT 32.86 FEET TO REFER VALUES TO MHHW.

SUBTRACT 32.71 FEET TO REFER VALUES TO MHW.

SUBTRACT 31.30 FEET TO REFER VALUES TO MTL.

SUBTRACT 31.30 FEET TO REFER VALUES TO MSL.

SUBTRACT 30.87 FEET TO REFER VALUES TO NGVD.

MLLW = MEAN LOWER LOW WATER
MLW = MEAN LOW WATER
MHHW = MEAN HIGHER HIGH WATER
MHW = MEAN HIGH WATER
MTL = MEAN TIDE LEVEL
MSL = MEAN SEA LEVEL
NGVD = NATIONAL GEODETIC VERTICAL DATUM OF 1929
(FORMERLY THE SEA LEVEL DATUM OF 1929)

ELEVATIONS ARE: ✓ PRELIMINARY

___ FINAL

ID# 219

VER# _____

NATIONAL OCEAN SERVICE (NOAA)
TIDES, HIGH AND LOW WATERS (FEET)
TM 75W N

FILE COPY

8722670 LAKE WORTH FL
SEP, 1991

DAY	HIGH TIME	HIGH HEIGHT		LOW TIME	LOW HEIGHT
1	0.4	32.55	>	6.3	29.96
	> 13.0	32.90		19.2	30.64
2	1.3	32.59	>	7.2	30.09
	> 14.2	33.24		20.0	30.79
3	2.2	32.97	>	8.4	30.26
	> 14.9	33.46		21.5	30.85
4	3.3	33.27	>	9.6	30.38
	> 16.5	33.80		22.4	31.05
5	4.5	33.54	>	10.8	30.43
	> 17.2	34.00		23.5	30.83
6	5.5	33.74	>	11.7	30.34
	> 18.1	34.09			
7	6.6	33.72		0.4	30.25
	> 19.1	34.03	>	12.7	30.20
8	7.5	34.02		1.3	30.33
	> 19.9	34.09		13.7	30.39
9	> 8.2	34.06	>	2.0	30.25
	20.5	33.69		14.4	30.31
10	> 9.1	33.94	>	2.7	30.23
	21.2	33.63		15.2	30.51
11	> 9.8	33.60	>	3.7	30.08
	21.7	33.30		15.9	30.61
12	> 10.7	33.51	>	4.2	30.30
	22.8	33.02		16.8	30.76
13	> 11.3	33.30	>	4.9	30.43
	23.6	32.78		17.8	30.72
14	> 12.3	33.01	>	6.0	30.39
				18.7	30.85
15	0.4	32.59	>	6.7	30.52
	> 13.4	32.83		19.3	30.96
16	1.2	32.57	>	7.8	30.71
	> 14.3	32.81		20.3	30.96
17	2.4	32.48	>	8.8	30.68
	> 15.5	32.89		21.6	31.13
18	3.4	32.61	>	9.6	30.66
	> 16.3	32.85		22.2	30.93
19	4.3	32.61	>	10.4	30.59
	> 16.9	32.93		23.2	30.78
20	5.0	32.70	>	11.3	30.51
	> 17.8	33.05		23.8	30.61
21	5.0	32.96	>	12.0	30.47
	18.3	33.10			
22	> 6.3	33.31	>	0.2	30.51
	18.7	33.32		12.8	30.51
23	> 7.2	33.60	>	0.8	30.60
	19.4	33.45		13.4	30.70
24	> 7.8	33.50	>	1.5	30.37
	20.1	33.33		13.9	30.46
25	> 8.4	33.74	>	2.1	30.27
	20.6	33.46		14.7	30.67
26	> 9.1	33.65	>	2.8	30.25
	21.3	33.22		15.4	30.45
27	> 9.7	33.53	>	3.6	30.07
	22.1	33.07		16.2	30.61
28	> 10.8	33.40	>	4.3	30.06
	22.8	33.02		16.9	30.50
29	> 11.8	33.36	>	5.2	30.16
				17.8	30.89
30	0.0	33.10	>	6.0	30.46
	> 12.7	33.52		19.2	30.99

MEANS FOR SEP 1, 1991 - SEP 30, 1991

MHW	33.28	HTL-MSL	-0.02	GT	3.09	
MLW	30.53	MHHW	33.45	(DRL)TL	31.70	
MSL	31.92	MLLW	30.36	(DRL)TL-MSL	-0.02	
MN	2.75	DHQ	0.17	GMHWI	0.45	HRS
MTL	31.91	DLQ	0.17	GMLWI	6.65	HRS

KEY
> HIGHER HIGH/LOWER LOW

HIGHEST TIDE 34.09 18.1 HRS SEP 6, 1991
19.9 HRS SEP 8, 1991

LOWEST TIDE 29.96 6.3 HRS SEP 1, 1991

ARCHIVED	TID	EID	VID	START	STOP	SETTING	CNST	KPT
91 10 4	251	251	206	91 8 2 14	91 9 3 15	16	-19	366
91 10 4	251	251	206	91 9 3 15	91 9 4 9	16	-19	366
91 10 31	251	251	206	91 9 4 9	91 10 2 14	-7	0	343

DATUM IS .....

NATIONAL OCEAN SERVICE (NOAA)
TIDES, HIGH AND LOW WATERS (FEET)
TK 75W N

FILE COPY

8722670 LAKE WORTH FL
OCT. 1991

DAY	HIGH TIME	HIGH HEIGHT		LOW TIME	LOW HEIGHT
1	1.0	33.22	>	7.5	30.63
	> 13.8	33.64		20.3	31.06
2	2.1	33.31		9.5	30.70
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

LAST TIDE INTERVAL EXCEEDS MAXT 91 10 2 05 8722670

KEY
> HIGHER HIGH/LOWER LOW

INCOMPLETE HIGH/LOW DATA FOR REQUESTED TIME PERIOD
HH MISSING AT 8722670 91 10 2 15

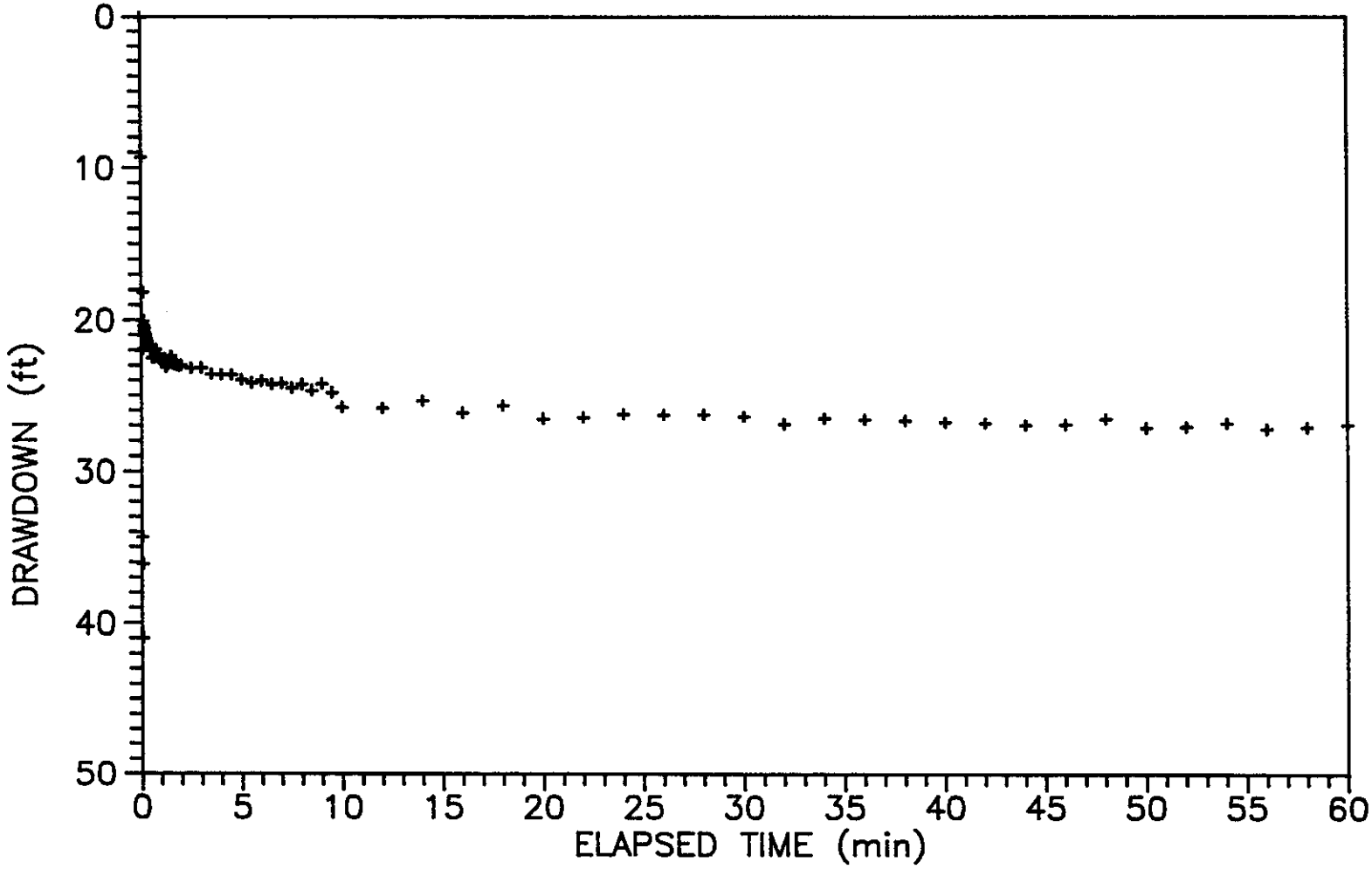
ARCHIVED	TID	EID	VID	START	STOP	SETTING	CHST	KPT
91 10 31	251	251	206	91 9 4 9	91 10 2 14	-7	0	343

DATUM IS .....

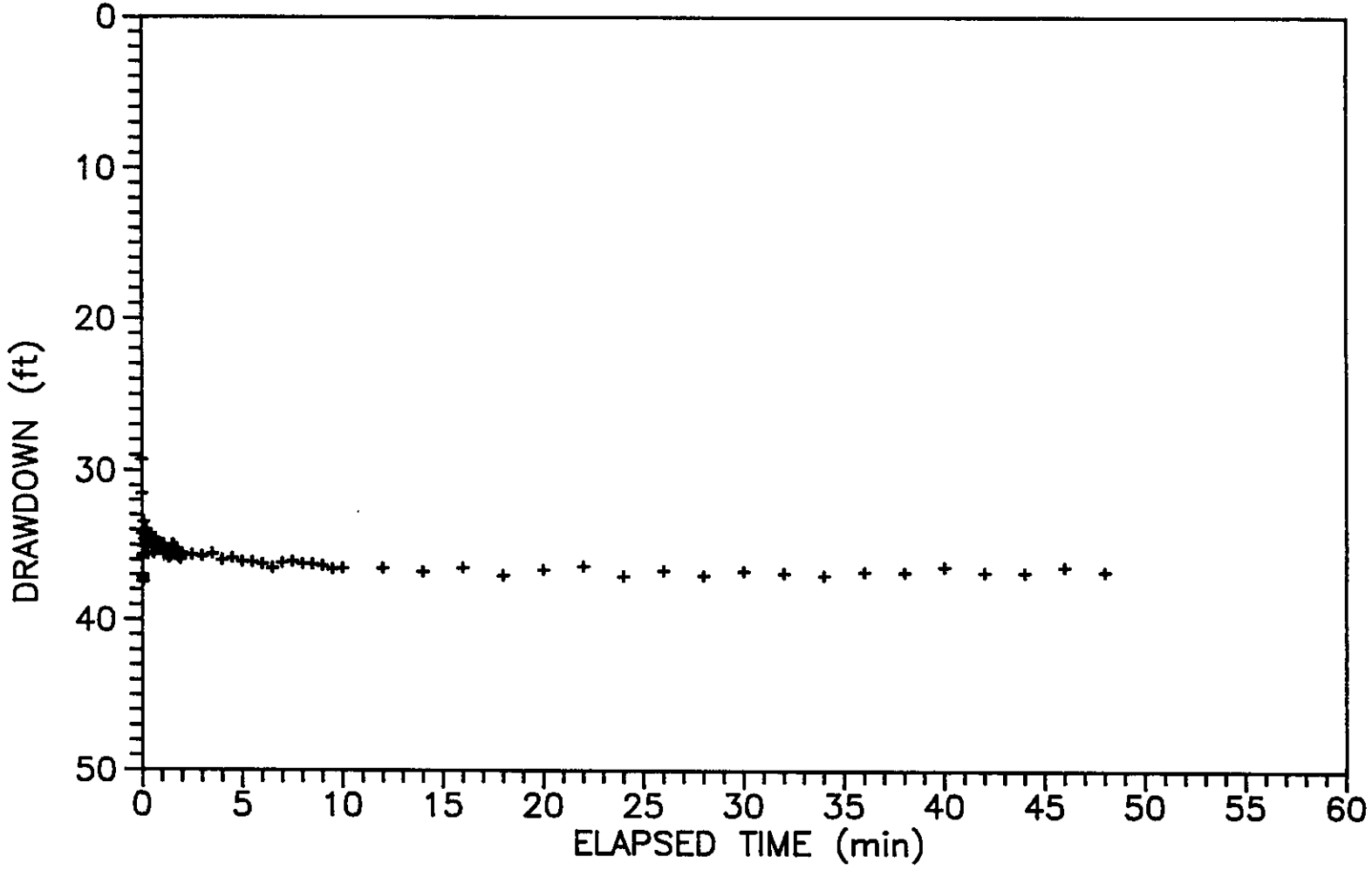
APPENDIX E

STEP-DRAWDOWN TEST RESULTS

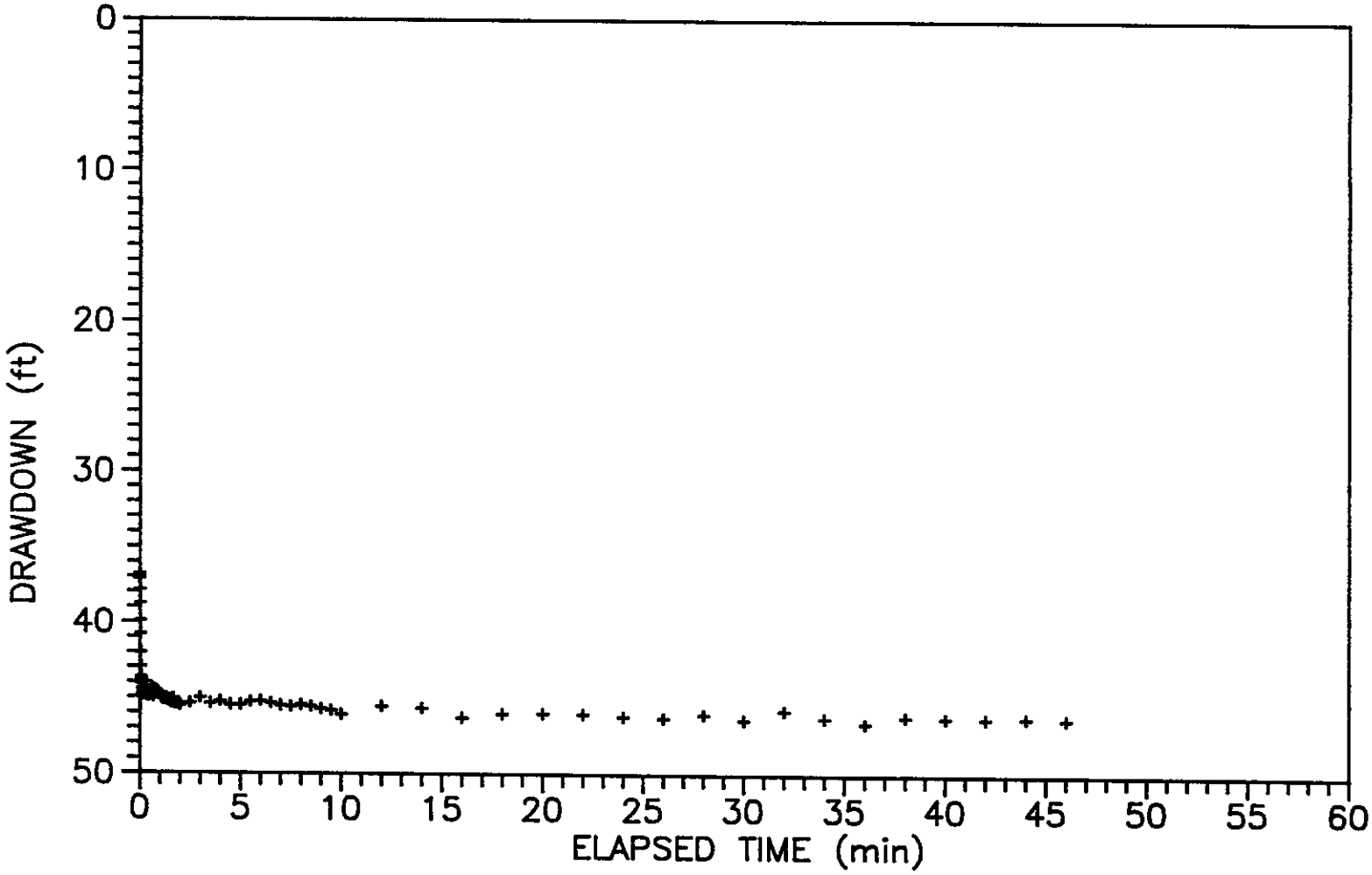
FORT PIERCE UTILITIES AUTHORITY
STEP DRAWDOWN TEST CURVE
STEP 0 (740 GPM)
FB-2



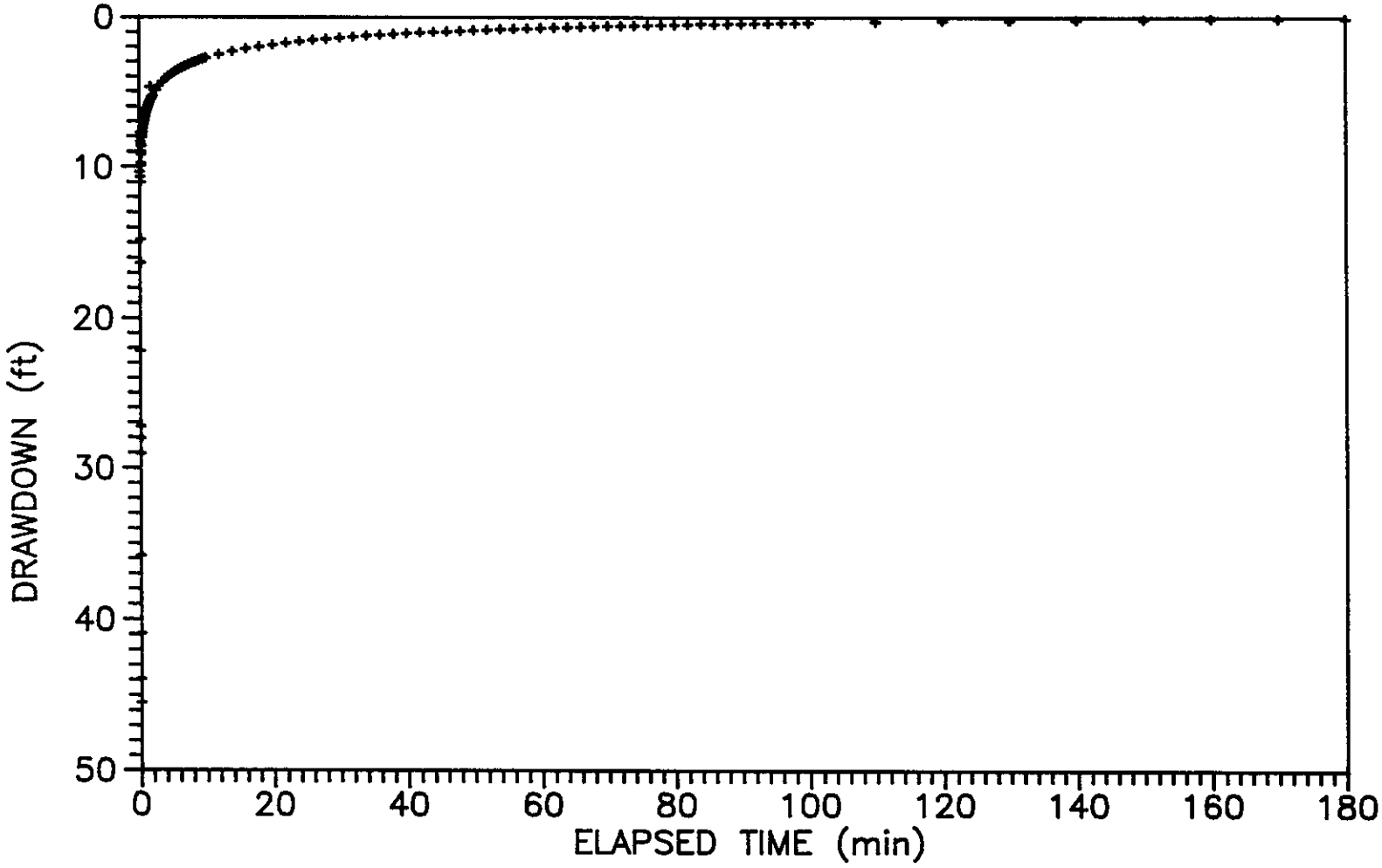
FORT PIERCE UTILITIES AUTHORITY
STEP DRAWDOWN TEST CURVE
STEP 1 (940 GPM)
FB-2



FORT PIERCE UTILITIES AUTHORITY
STEP DRAWDOWN TEST CURVE
STEP 2 (1,170 GPM)
FB-2



FORT PIERCE UTILITIES AUTHORITY
STEP DRAWDOWN TEST CURVE
STEP 3 (RECOVERY)
FB-2



APPENDIX F

WELL EFFICIENCY CALCULATIONS (FB-2)

FORT PIERCE UTILITIES AUTHORITY

FLORIDAN AQUIFER WELL FB-2
WELL EFFICIENCY CALCULATIONS*

The theoretical specific capacity (Q/s) of the well is calculated first:

$$(Q/s)_{THEORETICAL} = T/2{,}000 = \frac{91{,}550 \text{ gpd/ft}}{2{,}000}$$

$$= 45.78 \text{ gpm/ft of drawdown}$$

Where:

T = Transmissivity of aquifer at FB-2 as determined by APT (gpd/ft)

2,000 = Empirical conversion factor

The actual specific capacity is then calculated:

$$(Q/s)_{ACTUAL} = Q/s = \frac{1{,}000 \text{ gpm}}{43.128 \text{ ft}} = 23.19 \text{ gpm/ft of drawdown}$$

Where:

Q = APT withdrawal rate (gpm)
s = Maximum drawdown in FB-2 during APT.

The true well efficiency is the ratio of the actual to theoretical specific capacity.

$$\text{Well Efficiency} = \frac{(Q/s)_{ACTUAL}}{(Q/s)_{THEORETICAL}} = \frac{23.19}{45.78} = 51\%$$

* Equations are from "Ground Water and Wells", 1986 on page 558.

APPENDIX G

APT FLOW RATE AND WATER LEVEL RECORDS

FORT PIERCE UTILITIES AUTHORITY

FLORIDAN AQUIFER WELL FB-2
APT FLOW RATE DATA

DATE	ELAPSED TIME (TIME)	TOTALIZING FLOW METER		MANOMETER READING (FB-2)	
		Total Flow (gal)	Flow Rate (gpm)	Height (in.)1	Flow (gpm)2
9/23/91	0.0 Hr. (15:00)	-----	-----	67.5	997
9/23/91	1.0 Hr. (16:00)	-----	-----	67.5	997
9/23/91	2.0 Hrs. (17:00)	-----	-----	67.0	995
9/23/91	3.0 Hrs. (18:00)	-----	-----	67.0	995
9/23/91	4.0 Hrs. (19:00)	221,500	1,000	68.0	1,002
9/23/91	5.0 Hrs. (20:00)	285,200	998	68.5	1,005
9/23/91	6.0 Hrs. (21:00)	347,400	1,000	68.5	1,005
9/23/91	7.0 Hrs. (22:00)	402,000	1,000	69.0	1,009
9/24/91	11.0 Hrs. (2:00)	637,100	1,000	68.5	1,005
9/24/91	15.0 Hrs. (6:00)	875,800	998	68.5	1,005
9/24/91	19.0 Hrs. (10:00)	1,120,000	1,005	68.5	1,005
9/24/91	23.0 Hrs. (14:00)	1,360,000	1,000	68.0	1,002
9/24/91	27.0 Hrs. (18:00)	1,605,000	996	68.0	1,002
9/24/91	31.0 Hrs. (22:00)	1,842,000	1,002	68.0	1,002
9/25/91	35.0 Hrs. (2:00)	2,073,000	1,002	68.5	1,005
9/25/91	39.0 Hrs. (6:00)	2,328,000	1,001	68.5	1,005
9/25/91	43.0 Hrs. (10:00)	2,546,000	996	68.0	1,002
9/25/91	47.0 Hrs. (14:00)	2,776,000	1,001	68.5	1,005
9/25/91	51.0 Hrs. (18:00)	3,041,000	1,002	68.5	1,005
9/25/91	55.0 Hrs. (22:00)	3,280,000	1,001	68.0	1,002
9/26/91	59.0 Hrs. (2:00)	3,522,000	1,001	68.0	1,002
9/26/91	63.0 Hrs. (6:00)	3,772,000	1,002	68.0	1,002
9/26/91	67.0 Hrs. (10:00)	4,050,000	999	68.0	1,002

4791409L

gpm - gallons per minute

1. Height of water column in manometer tube.
2. Values determined from tables in "Missouri Water Well Handbook", page 152.

FORT PIERCE UTILITIES AUTHORITY

FLORDIAN AQUIFER WELL FB-2
APT FLOW RATE DATA

DATE	ELAPSED TIME (TIME)	TOTALIZING FLOW METER		MANOMETER READING (FB-2)	
		Total Flow (gal)	Flow Rate (gpm)	Height (in.)1	Flow (gpm)2
9/26/91	71.0 Hrs. (14:00)	4,239,000	992	68.0	1,002
9/26/91	75.0 Hrs. (18:00)	4,479,000	1,005	68.5	1,005
9/26/91	79.0 Hrs. (22:00)	4,729,000	1,000	68.0	1,002
9/27/91	83.0 Hrs. (2:00)	4,956,100	998	68.0	1,002
9/27/91	87.0 Hrs. (6:00)	5,220,000	1,001	68.5	1,005
9/27/91	91.0 Hrs. (10:00)	5,450,000	1,005	68.5	1,005
9/27/91	95.0 Hrs. (14:00)	5,679,000	998	68.0	1,002
9/27/91	99.0 Hrs. (18:00)	5,930,000	1,002	69.0	1,009
9/27/91	103.0 Hrs (22:00)	6,171,000	999	68.0	1,002
9/28/91	107.0 Hrs (2:00)	6,422,800	1,002	68.0	1,002
9/28/91	111.0 Hrs (6:00)	6,050,000	1,002	68.5	1,005
9/28/91	115.0 Hrs (10:00)	6,887,600	995	68.0	1,002
9/28/91	119.0 Hrs (14:00)	7,125,400	1,002	69.0	1,009
9/28/91	123.0 Hrs (18:00)	7,367,700	1,001	68.75	1,007
9/28/91	127.0 Hrs (22:00)	7,608,900	1,004	69.0	1,009
9/29/91	131.0 Hrs (2:00)	7,865,300	1,005	69.0	1,009
9/29/91	135.0 Hrs (6:00)	8,090,400	1,003	68.0	1,002
9/29/91	139.0 Hrs (10:00)	8,333,200	999	68.5	1,005
9/29/91	143.0 Hrs (14:00)	8,560,400	1,000	68.5	1,005
9/29/91	147.0 Hrs (18:00)	8,813,600	1,002	68.5	1,005
9/29/91	151.0 Hrs (22:00)	9,040,400	1,002	68.5	1,005
9/30/91	155.0 Hrs (2:00)	9,267,200	1,002	68.5	1,005
9/30/91	159.0 Hrs (6:00)	9,522,800	1,003	68.5	1,005
9/30/91	163.0 Hrs (10:00)	9,787,600	998	68.0	1,002

gpm - gallons per minute

4991409L

1. Height of water colum in manometer tube.
2. Values determined from tables in "Missouri Water Well Handbook", page 15

Stopped Test @ 10:17

APPENDIX H

APT RESULTS

AQUIFER PERFORMANCE TEST -- EQUATIONS

FORT PIERCE UTILITIES CORPORATION
499.02

Test Date: 11/17/91

EQUATIONS USED

TRANSMISSIVITY

EQUATION 1: THEIS METHOD

T = ((Q)(W(u)))/((4)(pi)(ho-h)

where:
T = Transmissivity (ft2/day)
Q = Pump Rate (ft3/day)
W(u) = Well Function
4 = Conversion Factor
pi = 3.14
ho-h = Drawdown at Match Point (ft)

EQUATION 2: JACOB METHOD

T = (((264)(Q))/delta(s))/7.48

where:
T = Transmissivity (ft2/day)
264 = Conversion Factor
Q = Pump Rate (gpm)
delta(s) = Drawdown Between One Log Cycle of Time (ft)
7.48 = Units Conversion Factor

STORATIVITY

EQUATION 3: THEIS METHOD

S = ((4)(u)(T)(t))/(r)(r)

where:
S = Storativity
4 = Conversion Factor
u = Well Function
T = Transmissivity (ft2/day)
t = Time at Match Point (days)
r = Distance between Observation Well and Pumping Well (ft)

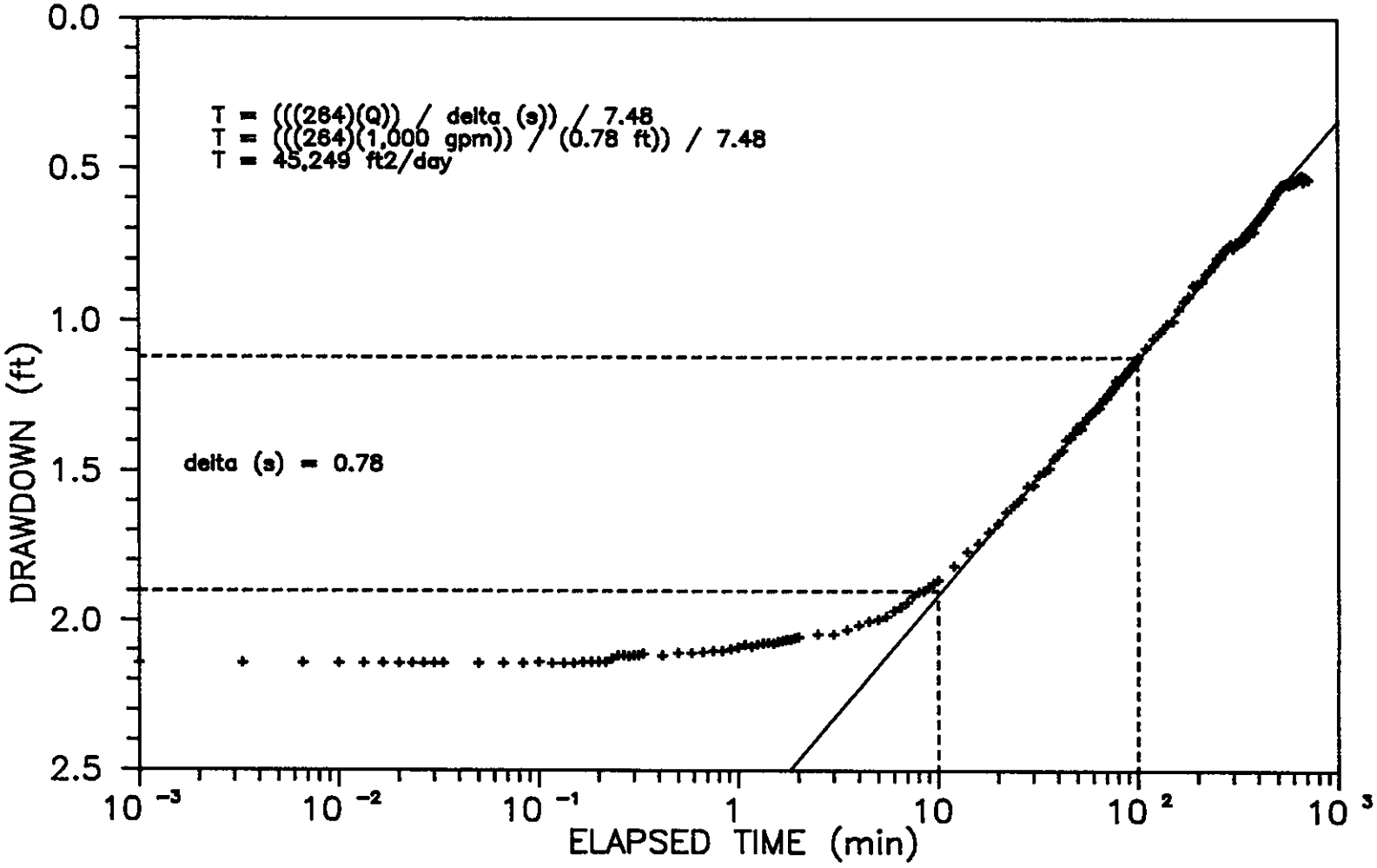
EQUATION 4: JACOB METHOD

S = ((2.25)(T)(to))/(r)(r)

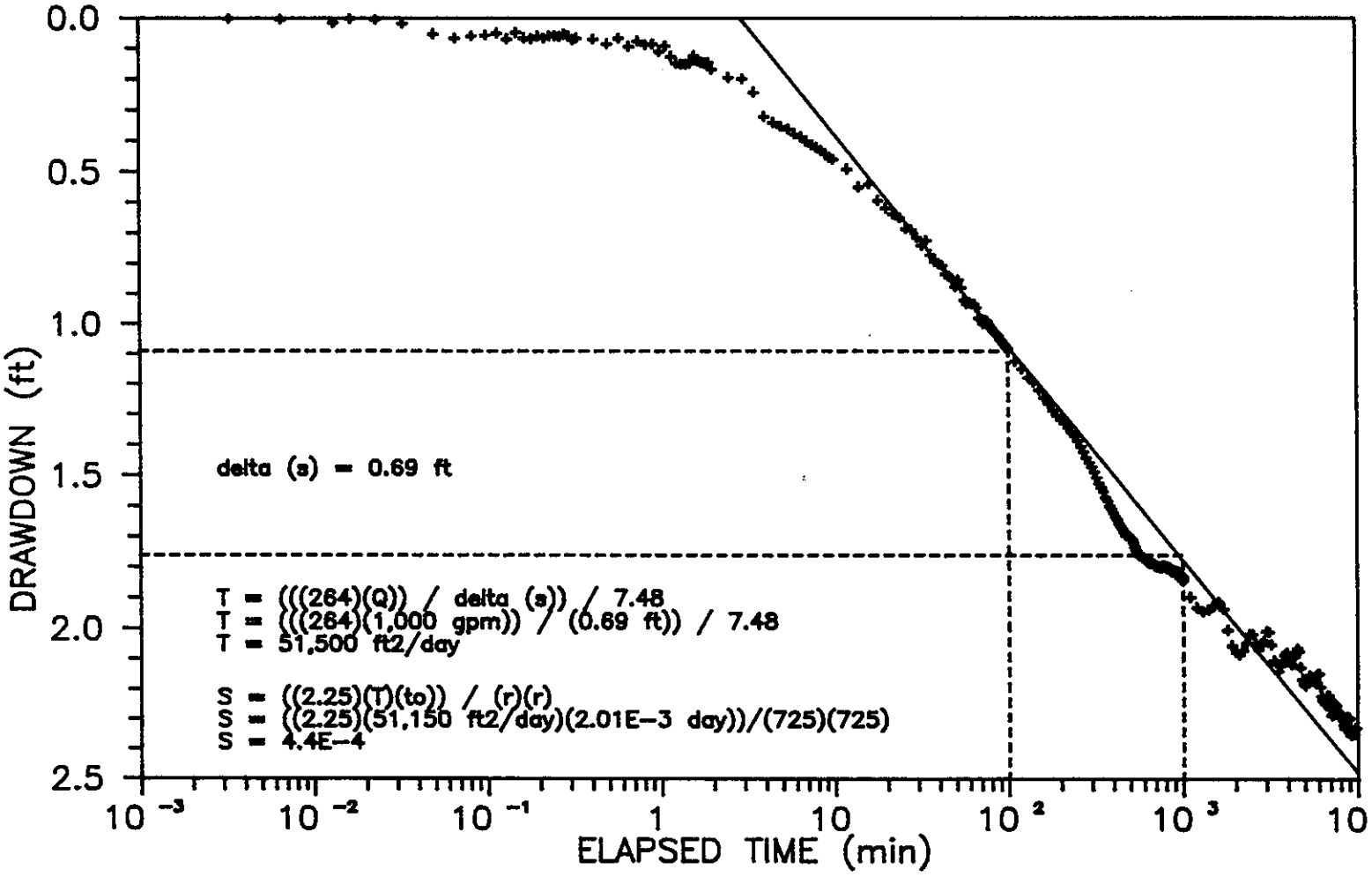
where:
S = Storativity
2.25 = Conversion Factor
T = Transmissivity (ft2/day)
to = Time at Zero Drawdown (days)
r = Distance between Observation Well and Pumping Well (ft)

BLASLAND, BOUCK & LEE
ENGINEERS & GEOSCIENTISTS

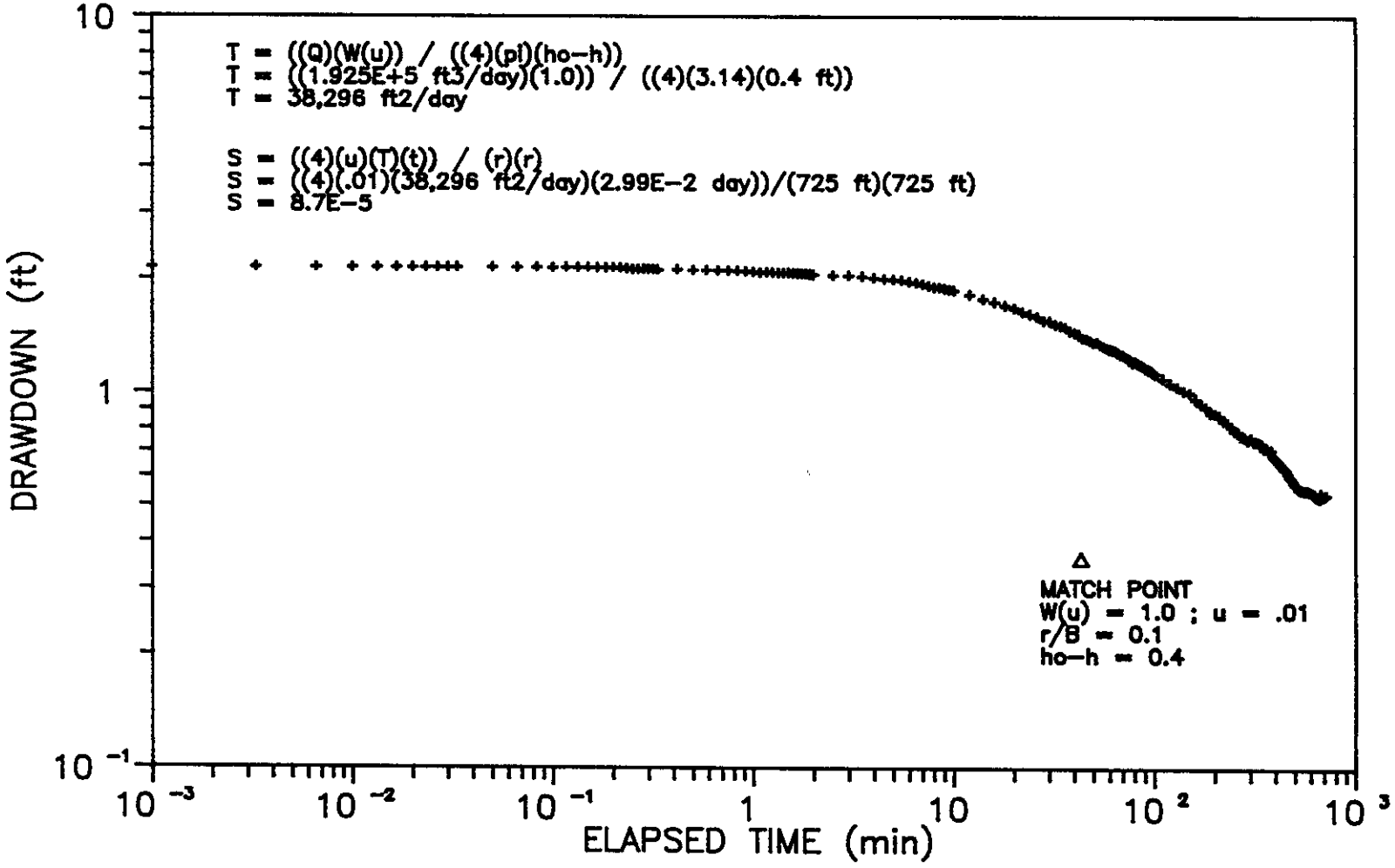
FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
FB–1 (RECOVERY)
(9/23 – 9/30/91)



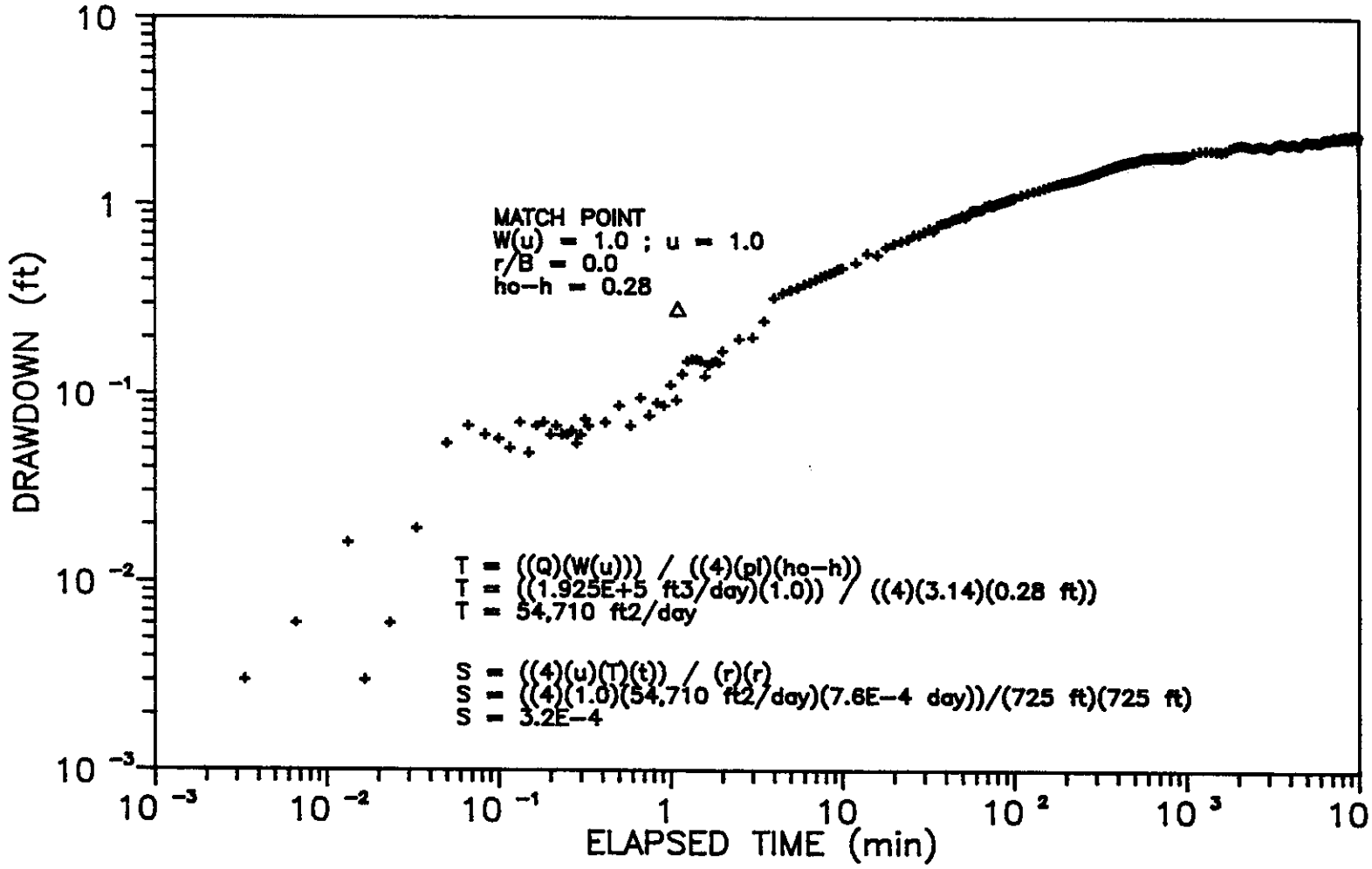
FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
FB–1 (DRAWDOWN)
(9/23 – 9/30/91)



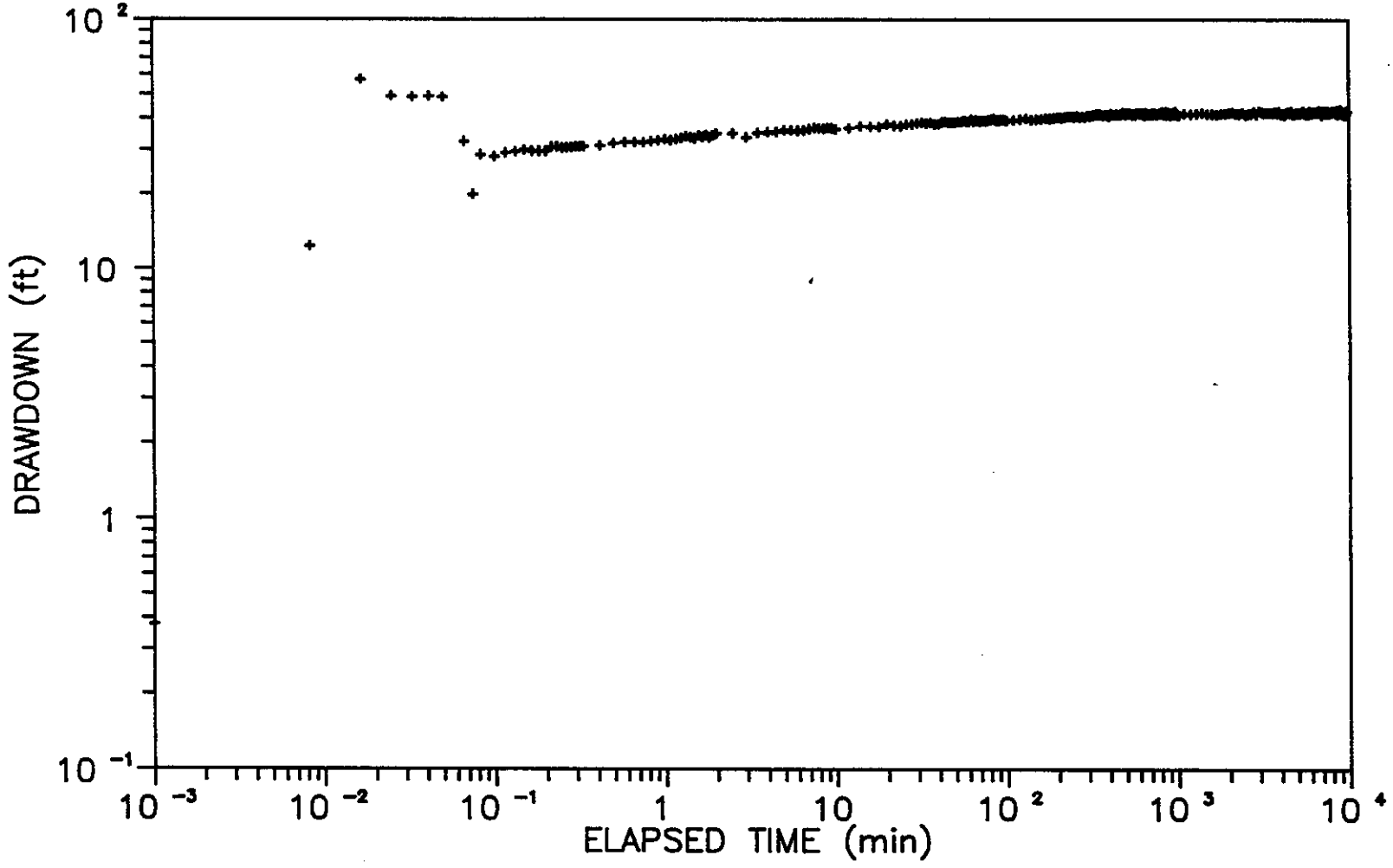
FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
FB–1 (RECOVERY)
(9/23 – 9/30/91)



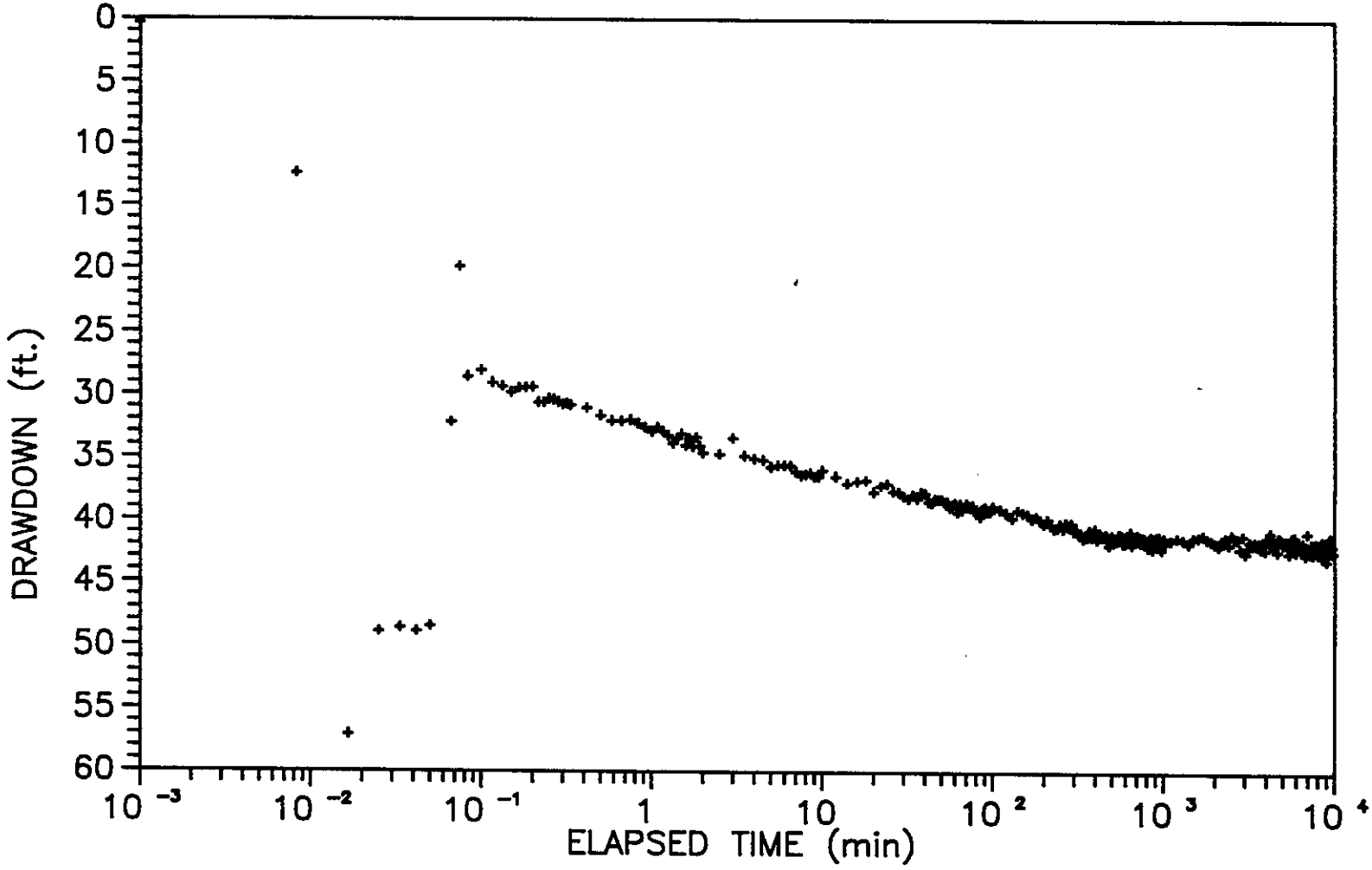
FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
FB-1 (DRAWDOWN)
(9/23 - 9/30/91)



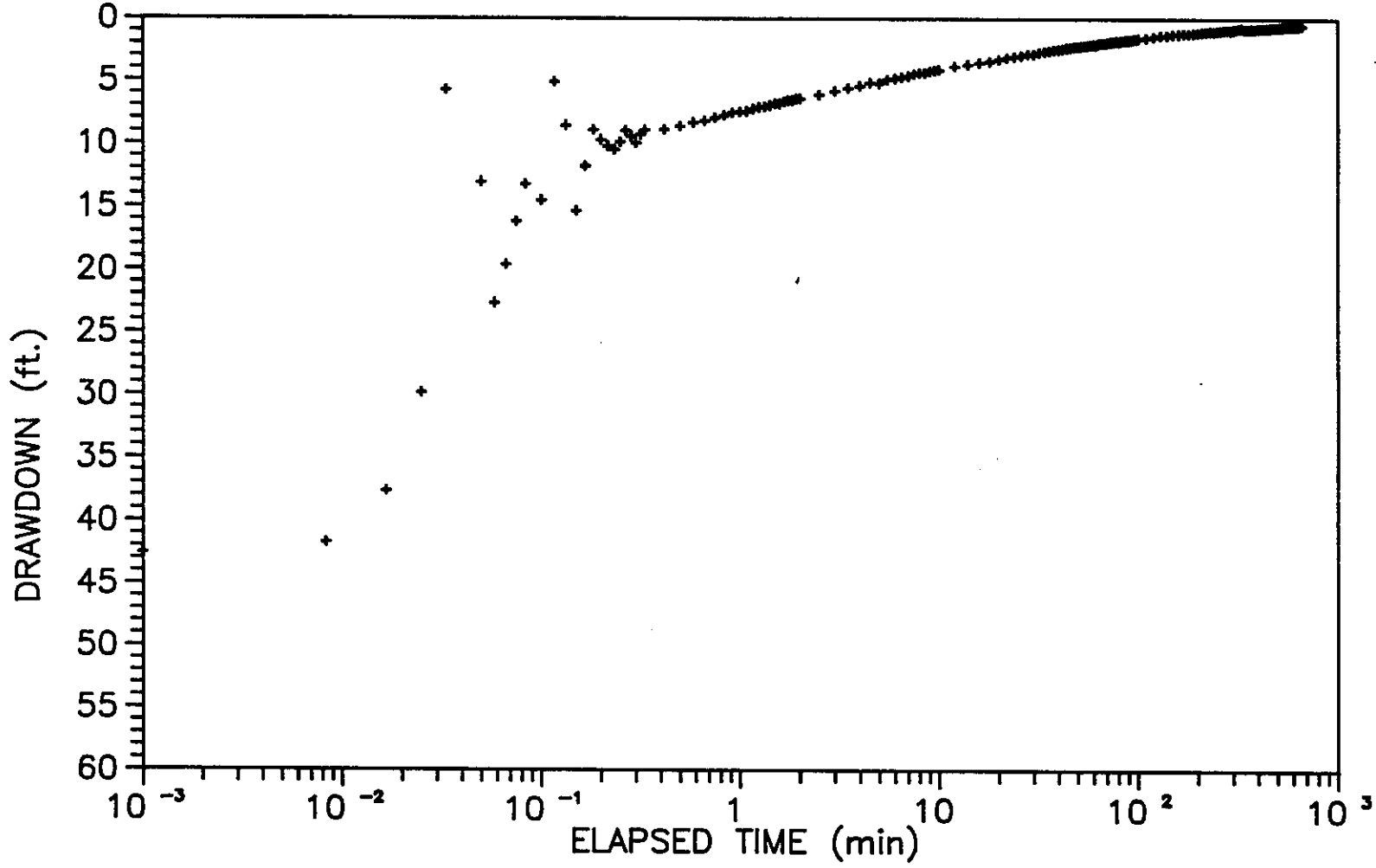
FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
FB-2 (DRAWDOWN)
(9/23 - 9/30/91)



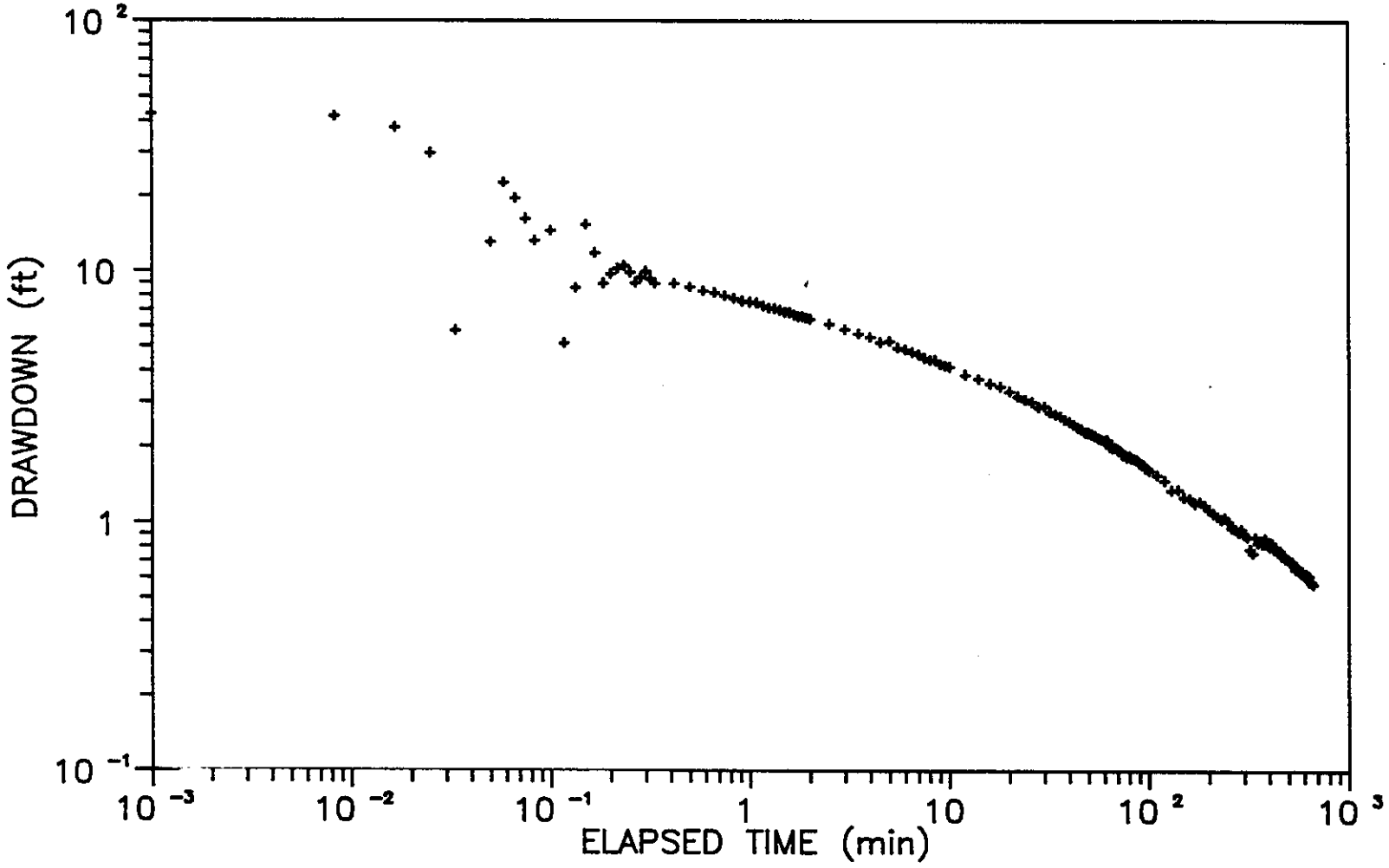
FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
FB-2 (DRAWDOWN)
(9/23 - 9/30/91)



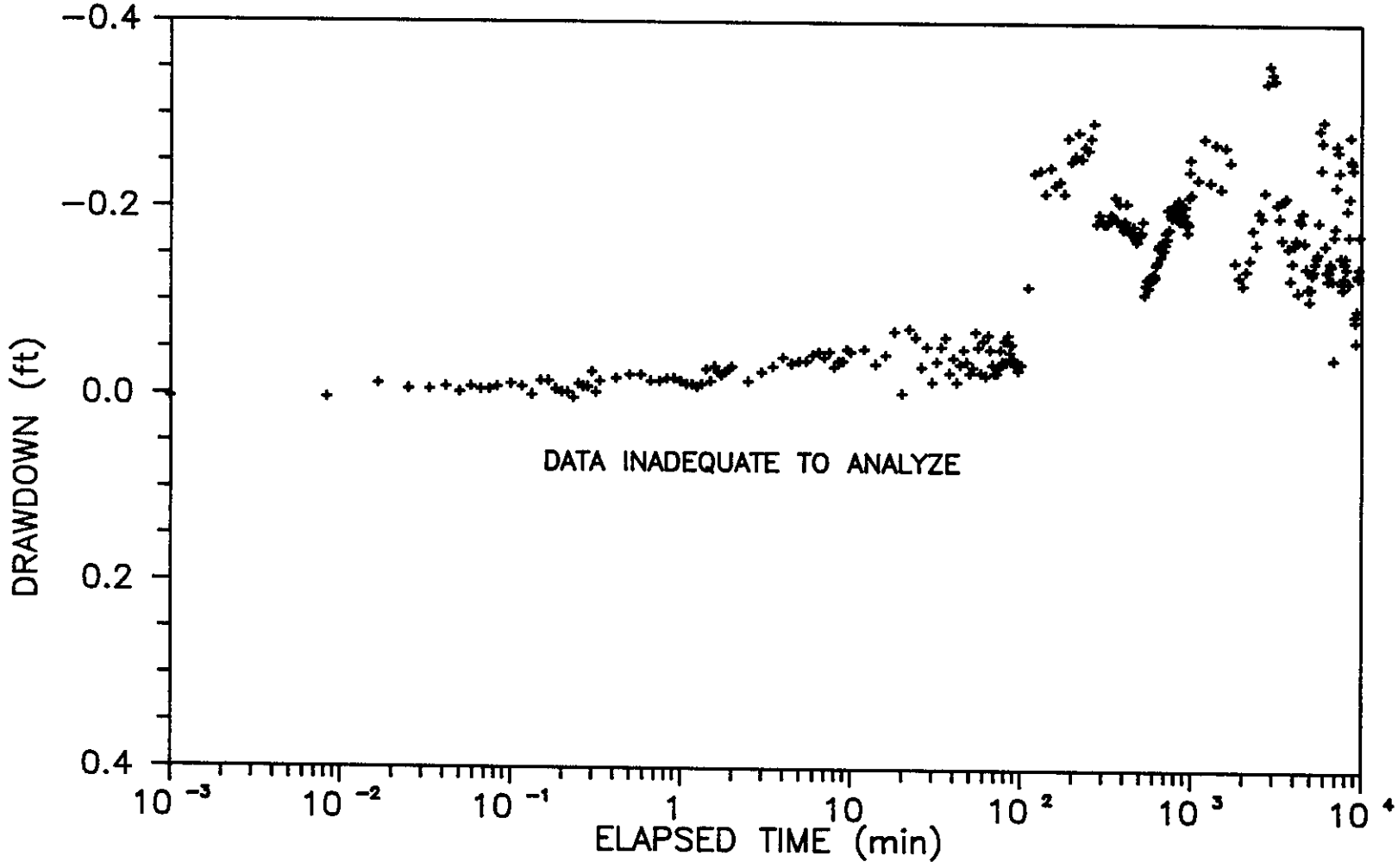
FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
FB-2 (RECOVERY)
(9/23 - 9/30/91)



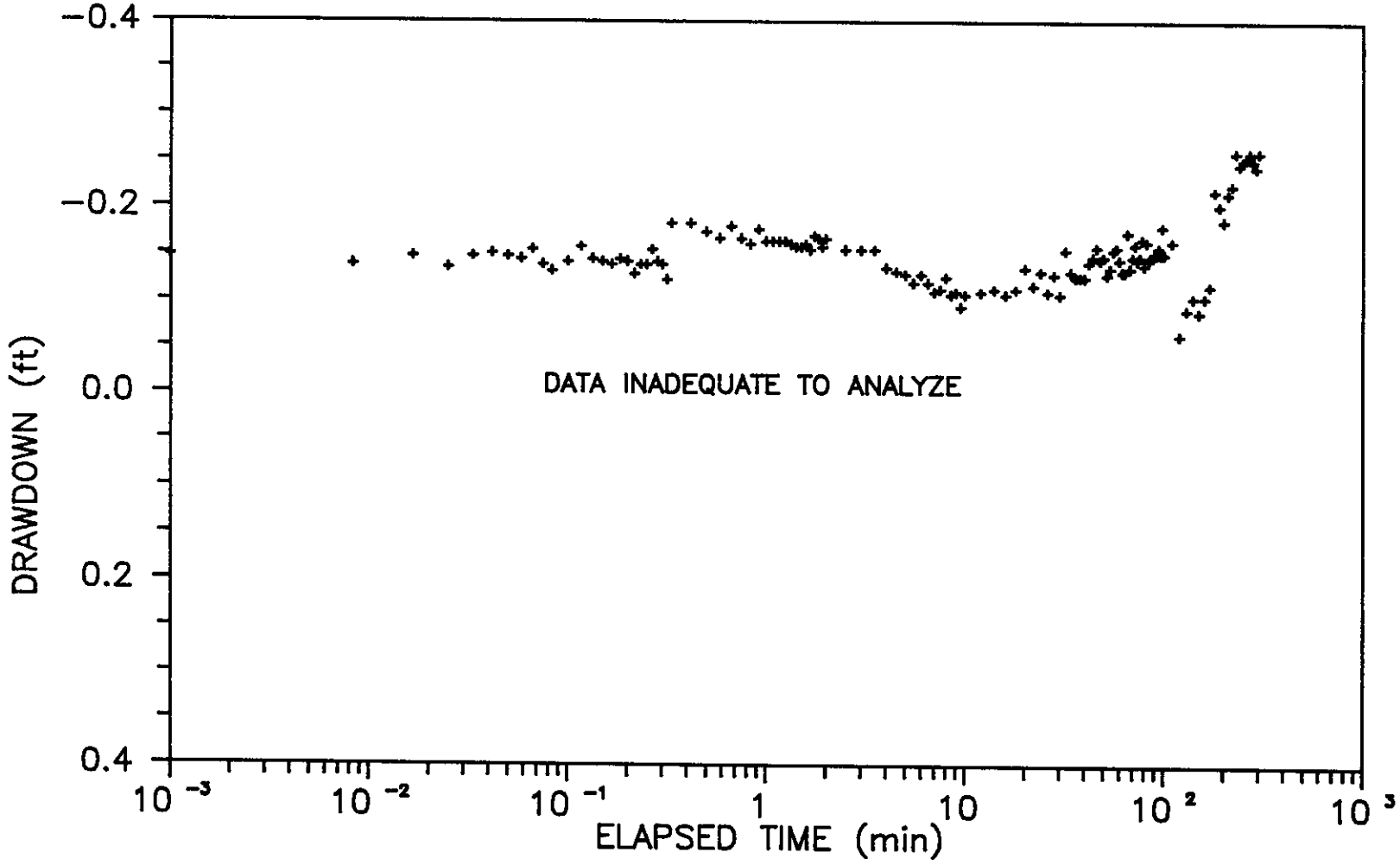
FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
FB-2 (RECOVERY)
(9/23 - 9/30/91)



FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
W-2 (DRAWDOWN)
(9/23 - 9/30/91)



FORT PIERCE UTILITIES AUTHORITY
AQUIFER PERFORMANCE TEST
W-2 (RECOVERY)
(9/23 - 9/30/91)



APPENDIX I

LETTER FROM FDER TO FPUA REQUESTING WATER QUALITY DATA

Florida Department of Environmental Regulation

Southeast District • 1900 S. Congress Ave., Suite A • West Palm Beach, Florida 33406

Lawton Chiles, Governor

Telephone: 407/433-2650
Fax: 407/433-2666

Carol M. Browner, Secretary

Mr. Richard Stenberg
Director of Water Treatment
Ft. Pierce Utilities Authority
P. O. Box 3191
Ft. Pierce, FL 34948

RE: Discharge of Flordian Aquifer Test Product Well Water

Dear Mr. Stenberg:

The Department is in receipt of the information submitted by you dated June 14, 1991, and your consultant dated August 14, 1991. Based on the information available and the temporary nature of the discharge, the Department will not require a discharge permit, provided that the following requirements are met:

1. Contact the Deparment at least 48 hours in advance of the test so that a department representative may schedule an inspection.

2. Test the treated effluent for hydrogen sulfide and turbidity and submit the test results to the Department within seven (7) days of the test. A detection limit of at least 0.01 mg/l is required to detect toxic concentrations of hydrogen sulfide.

3. Within seven (7) days after the test ends, notify the Department as to the total hours and volume (gallons) of the discharge.

The turbidity must not be increased more than 29 NTU's above background. Therefore it may be necessary to obtain a background analysis in the receiving water.

Please call Tim Powell of this office should you have any questions.

Sincerely

Donald B. White, P.E.
Water Facilities Administrator

DBW:tps/228

cc: Mr. Frederick W. Blickle, P.E., Blasland, Bouck & Lee
SFWMD

APPENDIX J

BACKGROUND WATER QUALITY LABORATORY RESULTS

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12095

Received: 19 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12095-1	FB-2 (09.19.91)	Client
12095-2	Five Mile Creek (09.19.91)	

PARAMETER	12095-1	12095-2
Sulfide, mg/l	<0.10	<0.10
Turbidity, NTU	18	6.5

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12095

Received: 19 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12095-3	Canal Discharge (09.19.91)	Client

PARAMETER	12095-3
Sulfide, mg/l	<0.10

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12095

Received: 19 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12095-4	Lab Blank	Client
12095-5	Accuracy - % Recovery	
12095-6	Precision - Relative % Difference	

PARAMETER	12095-4	12095-5	12095-6
Sulfide, mg/l	<0.10	98 %	0 %

Method Reference: EPA 600/4-79-020.

Marianne J. Walker

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO.	P.O. NO.	PROJECT NAME
499.02		Floridan Well

CLIENT NAME: B B + L — TELEPHONE: 407/994-2711

CLIENT ADDRESS: 4730 NW Boca Raton Blvd, 33431

CLIENT PROJECT MANAGER: Eric F. Regensburger

PAGE 1 OF 1

STANDARD ☐ RUSH ☒

DATE REPORT REQUESTED 9/20/91

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	REQUIRED ANALYSES: Turbidity	REQUIRED ANALYSES: Hydrogen Sulfide	REMARKS
9/14/91	15:30	FB-2	X		X	X	
9/19/91	15:45	Canal Discharge	X			X	
9/19/91	16:15	Five Mile Creek	X		X	X	

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
[signature]	9/19/91 1910				
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES NO	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
[signature]	9/16 15:10			112094	

PC

0112095

APPENDIX K

STEP-DRAWDOWN TEST WATER QUALITY

LABORATORY RESULTS

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

BLASLAND, BOUCK & LEE 12112

Received: 20 SEP 91

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Florida Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12112-1	FB-2 Step 0 (09.20.91)	Client
12112-2	FB-2 Step 1 (09.20.91)	
12112-3	FB-2 Step 2 (09.20.91)	
12112-4	FB-2 Step 3 (09.20.91)	

PARAMETER	12112-1	12112-2	12112-3	12112-4
Sulfate as SO4, mg/l	130	180	160	170

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12112

Received: 20 SEP 91

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Florida Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
		Client
12112-5	Lab Blank	
12112-6	Accuracy - % Recovery	
12112-7	Precision - Relative % Difference	

PARAMETER	12112-5	12112-6	12112-7
Sulfate as SO4, mg/l	<1.0	93 %	8.2 %

Method Reference: EPA 600/4-79-020.

Marianne J. Walker

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO.	P.O. NO.	PROJECT NAME	PAGE	OF
444.02		Floridan well	1	1

CLIENT NAME: B B+L — TELEPHONE: 407/994-2741

CLIENT ADDRESS: 4730 NW Boca Raton Blvd. 33431

CLIENT PROJECT MANAGER: Eric F. Regensburger

STANDARD ☒ RUSH ☐

DATE REPORT REQUESTED: 10/4/91

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	REQUIRED ANALYSES: Solute	REMARKS
9/20/91	10:20	FB-2 Step 0	X		X	
9/20/91	11:17	FB-2 Step 1	X		X	
9/20/91	12:05	FB-2 Step 2	X		X	
9/20/91	12:50	FB-2 Step 3	X		X	

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
Eric F. Regensburger	9/20/91 18:15				
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES NO	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
O. Phillip Doughton, Jr.	9/20/91 18:15			D11212	

APPENDIX L

APT WATER QUALITY LABORATORY RESULTS

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

BLASLAND, BOUCK & LEE

LOG NO: D1-12121

Received: 24 SEP 91

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Aquifer (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12121-1	FB-2 (t=0 hours) (09.23.91)	Client

PARAMETER	12121-1
Sulfate as SO4, mg/l	130
Sulfide, mg/l	<0.10
Turbidity, NTU	28

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12121

Received: 24 SEP 91

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Aquifer (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12121-2	Lab Blank	Client
12121-3	Accuracy - % Recovery	
12121-4	Precision - Relative % Difference	

PARAMETER	12121-2	12121-3	12121-4
Sulfate as SO4, mg/l	<1.0	93 %	8.2 %
Sulfide, mg/l	<0.10	102 %	0 %

Method Reference: EPA 600/4-79-020.

Marianne J. Walker

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

REMIT TO: P.O. Box 13548, Savannah, Georgia 31416-0548

PROJECT NO: Floridan Aquifer (#499.02)

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

INVOICE NO: D11899

INVOICE DATE: 01 OCT 1991

TERMS: Net 30 Days

LOG NO: D112121 INVOICE CODE: BB&L-BOCA$-D-OMW

ITEM	SAMPLE IDENTIFICATION	QTY	ANALYSIS	PRICE	AMOUNT
1	FB-2 (t=0 hours) (09.23.91)	1	Sulfate as SO4	$45.00	45.00
		1	Sulfide		
		1	Turbidity		
2	Lab Blank	3	Sulfate as SO4		
	Accuracy - % Recovery		Sulfide		
	Precision - Relative % Difference				

TOTAL $45.00

REPORTED TO: Mr. Eric F. Regensburger
For Proper Credit, please show INVOICE NUMBER on your remittance.
After 30 days, service charges of 1.5% per 30 days will be applied to unpaid balance.

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO. 91.02 | P.O. NO. | PROJECT NAME: Floridan Aquifer

CLIENT NAME: B B+L | TELEPHONE:

CLIENT ADDRESS: 4730 NW Boca Raton Blvd 33431 ~~33487~~

CLIENT PROJECT MANAGER: Eric F. Regensburger

PAGE | OF

STANDARD ☒ RUSH ☐

DATE REPORT REQUESTED 10/6/91

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	REQUIRED ANALYSES: H_2S	Turbidity	Sulfate	REMARKS
9/23	15:30	FB-2 (t = 0 hours)	X		X	X	X	

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
S. Lovelace	9/24 9:15 am				
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES NO	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
S. Supan	9-24-91 915			D1 12121	

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12148

Received: 25 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12148-1	FB-2 (t=1 hour) (09.23.91)	Client
12148-2	FB-2 (t=2 hours) (09.23.91)	
12148-3	FB-2 (t=3 hours) (09.23.91)	
12148-4	FB-2 (t=4 hours) (09.23.91)	
12148-5	FB-2 (t=5 hours) (09.23.91)	

PARAMETER	12148-1	12148-2	12148-3	12148-4	12148-5
Sulfate as SO4, mg/l	160	160	170	160	160

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12148

Received: 25 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12148-6	FB-2 (t=6 hours) (09.23.91)	Client
12148-7	FB-2 (t=7 hours) (09.23.91)	
12148-8	FB-2 (t=11 hours) (09.24.91)	
12148-9	FB-2 (t=15 hours) (09.24.91)	
12148-10	FB-2 (t=19 hours) (09.24.91)	

PARAMETER	12148-6	12148-7	12148-8	12148-9	12148-10
Sulfate as SO4, mg/l	160	170	190	180	180

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12148

Received: 25 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
		Client
12148-11	FB-2 (t=23 hours) (09.24.91)	
12148-12	FB-2 (t=27 hours) (09.24.91)	
12148-13	FB-2 (t=31 hours) (09.24.91)	
12148-14	FB-2 (t=35 hours) (09.25.91)	
12148-15	FB-2 (t=39 hours) (09.25.91)	

PARAMETER	12148-11	12148-12	12148-13	12148-14	12148-15
Sulfate as SO4, mg/l	170	170	170	190	180

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12148

Received: 25 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12148-16	FB-2 (t=43 hours) (09.25.91)	Client

PARAMETER	12148-16
Sulfate as SO4, mg/l	180
Sulfide, mg/l	2.1
Turbidity, NTU	31

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12148

Received: 25 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
		Client
12148-17	Lab Blank	
12148-18	Accuracy - % Recovery	
12148-19	Precision - Relative % Difference	

PARAMETER	12148-17	12148-18	12148-19
Sulfate as SO4, mg/l	<1.0	85 %	2.0 %
Sulfide, mg/l	<0.10	102 %	0 %

Method Reference: EPA 600/4-79-020.

Marianne J. Walker

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO.: 494.02 | P.O. NO.: | PROJECT NAME: Floridan well

CLIENT NAME: B B + L | TELEPHONE: 407-494-2711

CLIENT ADDRESS: 4730 NW Boca Raton Blvd 33431

CLIENT PROJECT MANAGER: Eric Regensburger

PAGE 1 OF 2

STANDARD ☒ RUSH ☐

DATE REPORT REQUESTED 10/9/91

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	REQUIRED ANALYSES: Sulfate	REMARKS
9/23	16:00	FB-2 (t = 1 hour)	X		X	
9/23	17:00	FB-2 (t = 2 hours)	X		X	
9/23	18:00	FB-2 (t = 3 hours)	X		X	
9/23	19:00	FB-2 (t = 4 hours)	X		X	
9/23	20:00	FB-2 (t = 5 hours)	X		X	
9/23	21:00	FB-2 (t = 6 hours)	X		X	
9/23	22:00	FB-2 (t = 7 hours)	X		X	
9/24	2:00	FB-2 (t = 11 hours)	X		X	
9/24	6:00	FB-2 (t = 15 hours)	X		X	

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
[signature]	9/25 1100				
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES (NO)	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
S. Scipan	9/25/1205			D1 12148	

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO. 499.02 | P.O. NO. | PROJECT NAME Florida well

CLIENT NAME BB&L | TELEPHONE 407-444-2711

CLIENT ADDRESS

CLIENT PROJECT MANAGER Eric Reisenburger

REQUIRED ANALYSES | PAGE 2 OF 2

STANDARD ☒ RUSH ☐

DATE REPORT REQUESTED 10/4/91

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	Sulfate	H_2S	Turbidity	REMARKS
9/24	10:00	FB-2 (t = 19 hours)	X		X			
9/24	14:00	FB-2 (t = 23 hours)	X		X			
9/24	18:00	FB-2 (t = 27 hours)	X		X			
9/24	22:00	FB-2 (t = 31 hours)	X		X			
9/25	2:00	FB-2 (t = 35 hours)	X		X			
9/25	6:00	FB-2 (t = 39 hours)	X		X			
9/25	10:00	FB-2 (t = 43 hours)	X		X	X	X	

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
	9/25 12:00				
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES NO	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
S. Supan	9/25/1201	YES		01 12148	

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12192

Received: 28 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12192-1	FB-2 (47 hours) (09.25.91)	Client
12192-2	FB-2 (51 hours) (09.25.91)	
12192-3	FB-2 (55 hours) (09.25.91)	
12192-4	FB-2 (59 hours) (09.26.91)	
12192-5	FB-2 (63 hours) (09.26.91)	

PARAMETER	12192-1	12192-2	12192-3	12192-4	12192-5
Sulfate as SO4, mg/l	170	200	190	190	170

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12192

Received: 28 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12192-6	FB-2 (67 hours) (09.26.91)	Client
12192-7	FB-2 (71 hours) (09.26.91)	
12192-8	FB-2 (75 hours) (09.26.91)	
12192-9	FB-2 (79 hours) (09.26.91)	
12192-10	FB-2 (83 hours) (09.27.91)	

PARAMETER	12192-6	12192-7	12192-8	12192-9	12192-10
Sulfate as SO4, mg/l	180	170	150	180	190

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12192

Received: 28 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12192-11	FB-2 (87 hours) (09.27.91)	Client
12192-12	FB-2 (91 hours) (09.27.91)	
12192-13	FB-2 (95 hours) (09.27.91)	
12192-14	FB-2 (103 hours) (09.27.91)	
12192-15	FB-2 (107 hours) (09.28.91)	

PARAMETER	12192-11	12192-12	12192-13	12192-14	12192-15
Sulfate as SO4, mg/l	180	180	190	180	170

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12192

Received: 28 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12192-16	FB-2 (111 hours) (09.28.91)	Client

PARAMETER	12192-16
Sulfate as SO4, mg/l	170

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12192

Received: 28 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12192-17	FB-2 (99 hours) (09.27.91)	Client

PARAMETER	12192-17
Sulfate as SO4, mg/l	180
Sulfide, mg/l	6.0
Turbidity, NTU	0.32

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

414 SW 12th Avenue • Deerfield Beach, Florida 33442 • (305) 421-7400 • Fax (305) 421-2584

LOG NO: D1-12192

Received: 28 SEP 91

Mr. Eric Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12192-18	Lab Blank	Client
12192-19	Accuracy - % Recovery	
12192-20	Precision - Relative % Difference	

PARAMETER	12192-18	12192-19	12192-20
Sulfate as SO4, mg/l	<1.0	91 %	8.5 %
Sulfide, mg/l	<0.10	94 %	0 %

Method Reference: EPA 600/4-79-020.

Marianne J. Walker

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.
ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO.	P.O. NO.	PROJECT NAME	PAGE	OF
799.02		Floridan Well	1	3

CLIENT NAME: BB+L — TELEPHONE: 407-994-2711

CLIENT ADDRESS: 4730 NW Boca Raton Blvd 33431

CLIENT PROJECT MANAGER: Eric Regensburger

STANDARD ☒ RUSH ☐ DATE REPORT REQUESTED 10/14

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	REQUIRED ANALYSES: Sulfate	REMARKS
9/25	14:00	FB-2 (47 hours)	X		X	
9/25	18:00	FB-2 (51 hours)	X		X	
9/25	22:00	FB-2 (55 hours)	X		X	
9/26	2:00	FB-2 (59 hours)	X		X	
9/26	6:00	FB-2 (63 hours)	X		X	
9/26	10:00	FB-2 (67 hours)	X		X	
9/26	14:00	FB-2 (71 hours)	X		X	
9/26	18:00	FB-2 (75 hours)	X		X	
9/26	22:00	FB-2 (79 hours)	X		X	

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
(BB+L)	9/28 13:20		9/28/11 13:20		
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES NO	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
	9/28/11 13:20			12197	

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO. 449.02 | P.O. NO. | PROJECT NAME Florida Well

CLIENT NAME BBL | TELEPHONE 407-994-2711

CLIENT ADDRESS

CLIENT PROJECT MANAGER Eric Regensburger

PAGE 2 OF 2

STANDARD ☒ RUSH ☐

DATE REPORT REQUESTED 10/14

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	REQUIRED ANALYSES: Sulfide	H_2S	Turbidity	REMARKS
9/27	2:00	FB-2 (83 hours)	X		X			
9/27	6:00	FB-2 (87 hours)	X		X			
9/27	10:00	FB-2 (91 hours)	X		X			
9/27	14:00	FB 2 (95 hours)	X		X			
9/27	18:00	FB-2 (99 hours)	X		X	X	X	need by 10/5
9/27	22:00	FB-2 (103 hours)	X		X			
9/28	2:00	FB-2 (107 hours)	X		X			
9/28	6:00	FB-2 (111 hours)	X		X			

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
Eric S. Regensburger (BBL)	9/28 13:00	Kimberly Lastinger	9/29 13:20		
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES NO	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
Kimberly Lastinger	9/29 13:20			12192	

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

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LOG NO: D1-12197

Received: 30 SEP 91

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12197-1	FB-2 (115 hours) (09.28.91)	Client
12197-2	FB-2 (119 hours) (09.28.91)	
12197-3	FB-2 (123 hours) (09.28.91)	
12197-4	FB-2 (127 hours) (09.28.91)	
12197-5	FB-2 (131 hours) (09.29.91)	

PARAMETER	12197-1	12197-2	12197-3	12197-4	12197-5
Sulfate as SO4, mg/l	170	160	160	170	160

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LOG NO: D1-12197

Received: 30 SEP 91

Mr. Eric F. Regensburger
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951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12197-6	FB-2 (135 hours) (09.29.91)	Client
12197-7	FB-2 (139 hours) (09.29.91)	
12197-8	FB-2 (143 hours) (09.29.91)	
12197-9	FB-2 (147 hours) (09.29.91)	
12197-10	FB-2 (151 hours) (09.29.91)	

PARAMETER	12197-6	12197-7	12197-8	12197-9	12197-10
Sulfate as SO4, mg/l	160	180	190	170	180

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& ENVIRONMENTAL SERVICES, INC.

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LOG NO: D1-12197

Received: 30 SEP 91

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12197-11	FB-2 (155 hours) (09.30.91)	Client
12197-12	FB-2 (159 hours) (09.30.91)	

PARAMETER	12197-11	12197-12	
Sulfate as SO4, mg/l	160	160	

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LOG NO: D1-12197

Received: 30 SEP 91

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12197-13	FB-2 (163 hours) (09.30.91)	Client

PARAMETER	12197-13
Sulfate as SO4, mg/l	160
Sulfide, mg/l	6.8
Turbidity, NTU	0.29

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& ENVIRONMENTAL SERVICES, INC.

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LOG NO: D1-12197

Received: 30 SEP 91

Mr. Eric F. Regensburger
Blasland, Bouck & Lee
951 Broken Sound Pkwy NW, Suite 185
Boca Raton, Florida 33487

Project: Floridan Well (#499.02)

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
		Client
12197-14	Lab Blank	
12197-15	Accuracy - % Recovery	
12197-16	Precision - Relative % Difference	

PARAMETER	12197-14	12197-15	12197-16
Sulfate as SO4, mg/l	<1.0	86 %	6.6 %
Sulfide, mg/l	<0.10	94 %	0 %

Method Reference: EPA 600/4-79-020.

Marianne J. Walker

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.
ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO.	P.O. NO.	PROJECT NAME	PAGE	OF
444.02		Florida Well	1	2

CLIENT NAME: B B + L — TELEPHONE: (407) 994-2711

CLIENT ADDRESS: 4730 Boca Raton Blvd. Boca Raton 33431

CLIENT PROJECT MANAGER: Eric F. Regensburger

STANDARD ☒ PUSH ☐ DATE REPORT REQUESTED 10/15/91

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	REQUIRED ANALYSES: Sulfate	REMARKS
9/27	12:00	FB-2 (115 hours)	X		X	
9/28	14:00	FB-2 (119 hours)	X		X	
9/28	18:00	FB-2 (123 hours)	X		X	
9/28	22:00	FB-2 (127 hours)	X		X	
9/29	2:00	FB-2 (131 hours)	X		X	
9/29	6:00	FB-2 (135 hours)	X		X	
9/29	10:00	FB-2 (139 hours)	X		X	
9/29	14:00	FB-2 (143 hours)	X		X	
9/29	18:00	FB-2 (147 hours	X		X	

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
Hillary E Hollister	9/30/91 1805				
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES NO	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
L Teel	9/30/1805			12197	

SL SAVANNAH LABORATORIES AND ENVIRONMENTAL SERVICES, INC.
ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Deerfield Beach Division
414 S.W. 12th Avenue
Deerfield Beach, FL 33442
Phone: (305) 421-7400

JOB NO. 499.02 | P.O. NO. | PROJECT NAME Florida Well

CLIENT NAME BB+L | TELEPHONE (407)994-2711

CLIENT ADDRESS

CLIENT PROJECT MANAGER Eric F. Roegnsburger

PAGE 2 OF 2

STANDARD [X]

RUSH [ ]

DATE REPORT REQUESTED 10/15/91

SAMPLING DATE	SAMPLING TIME	SAMPLE ID	AQUEOUS MATRIX	NONAQUEOUS MATRIX	REQUIRED ANALYSES: Sulfide	H_2S	Turbidity	REMARKS
9/29	22:00	FB 2 (151 hours)	X		X			
9/30	2:00	FB-2 (155 hours)	X		X			
9/30	6:00	FB 2 (159 hours)	X		X			
9/30	10:00	FB-2 (163 hours)	X		X	X	X	please submit these results by 10/4/91

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME
Hillary E. Holtsclaw	9/30/91 1806				
	DATE/TIME	RECEIVED BY: (SIGNATURE)	DATE/TIME	RELINQUISHED BY: (SIGNATURE)	DATE/TIME

LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE/TIME	CUSTODY INTACT YES NO	CUSTODY SEAL NO.	SL LOG NO.	LABORATORY REMARKS:
L Teich	9/30/1806			12197	