TECHNICAL MEMORANDUM ON THE CONSTRUCTION AND TESTING OF WELL F-2 CITY OF HOLLYWOOD, FLORIDA

prepared for

Metcalf & Eddy, Inc.
400 Sawgrass Corporate Parkway
Sunrise, Florida 33325

October, 1992

by

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Project Number
MH1-693

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February 16, 1993

Mr. Steve Kruppa
Broward County Plan Manager
Lower District Planning Division
Planning Department
South Florida Water Management District
P.O. Box 24680
West Palm Beach, FL 33416-4680

Dear Mr. Kruppa

Enclosed is a copy the technical memorandum on Well F-2, City of Hollywood, which includes the results of the aquifer performance test. If you have any questions concerning the test or our Floridan aquifer work, please do not hesitate to contact me.

Sincerely yours

Robert G. Maliva, Ph.D.

Debra,
3 copies –
1 John Lukc
1 Jose
1 Jeff Giddings
Thanks
Steve K

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October 12, 1992

Mr. Roberto S. Ortiz
Metcalf & Eddy, Inc.
400 Sawgrass Corporate Parkway
Sunrise, Florida 33325

Re: Transmittal of report entitled "Technical Memorandum on the Construction and Testing of Well F-2, City of Hollywood, Florida"

Dear Mr. Ortiz:

We are pleased to transmit the subject report for the City of Hollywood on the construction and testing of well F-2. This document contains all information on the final construction of well F-2, the aquifer test and water quality data, and the final analysis of the data.

Based on the hydrogeologic information collected during this phase of the investigation, we are very optimistic that the City of Hollywood can successfully develop a major wellfield in the Floridan Aquifer System for a new membrane treatment plant. Please review this document and if you have any questions, contact me.

Sincerely,

Thomas M. Missimer

Thomas M. Missimer, P.G.
Vice Chairman
Professional Geologist #144

TMM:lk

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued:

LIST OF FIGURES

LIST OF TABLES

I. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

A hydrogeologic investigation of the upper part of the Floridan Aquifer System was conducted for the City of Hollywood at a location adjacent to the existing water treatment plant. The investigation included well construction observation and measurement of the aquifer hydraulic characteristics and general water quality. Based on the information collected, the following conclusions were made:

1) Production wells can be successfully constructed into the Floridan Aquifer System at the City of Hollywood. In the future it will be necessary to utilize 12-inch diameter, 3/8-inch wall thickness fiberglass casing for the primary well casing. This type of casing can be successfully installed in a oversize borehole in order to avoid construction problems.

2) There is a large quantity of water available for use in the upper Floridan Aquifer System. Aquifer coefficients determined from testing are:

   Transmissivity = 180,000 gpd/ft
   Storage Coefficient = 3×10^{-4}
   Leakance = 4.7×10^{-4} gpd/ft^3

3) The height of the potentiometric surface at the well site varies between 35 and 36 feet NGVD.

4) Water quality within the upper part of the Floridan Aquifer System is density stratified to some degree. The dissolved chloride concentration remained relatively constant during the aquifer test at an

average of 2140 mg/l. However, the geophysical log of fluid resistivity showed about a 15% increase in dissolved chloride from the top to the base of the aquifer. The dissolved chloride concentration during drilling ranged from 2100 to about 2200 mg/l.

5) Most of the water entering the wellbore originates in the Suwannee Limestone from a depth of 926 feet down to 1100 feet below surface. Virtually no flow of water enters the well below a depth of 1200 feet.

2. Recommendations

1) All future production wells should be constructed using 12-inch diameter fiberglass casing with the assumption that the desired yield will be 1000 gpm. The recommended nominal annulus width is 5 inches. Therefore, the total diameter of the final borehole for the casing should be 22 inches. Because of potential construction difficulties, flexibility should be written into future well construction specifications.

2) Based on the measured aquifer hydraulic coefficients, the upper part of the Floridan Aquifer System is a viable source for a major wellfield to be used for feedwater to a membrane treatment plant. It is recommended that detailed solute transport modeling be performed to assess the optimal well spacing and to evaluate each practical wellfield configuration. The low leakance of the aquifer suggests that water quality changes caused by pumping will not be rapid, if the wellfield is properly designed.

3) Since the quality of water under the production aquifer must be known in order to properly model water quality changes in the production

aquifer, it is recommended that well F-1 be deepened to about 1600 feet below surface and a 4-inch casing be installed and cemented in place inside the existing casing. The base of the 4-inch casing should be set at about 1400 feet or a depth based on the water quality and flow data obtained during construction. Water quality data should be collected during construction and it should be geophysically logged.

4) Because there is essentially no flow of water from below a depth of 1200 feet, all new wells should be constructed to a maximum depth of 1200 feet unless local geologic conditions necessitate a greater depth.

II. INTRODUCTION

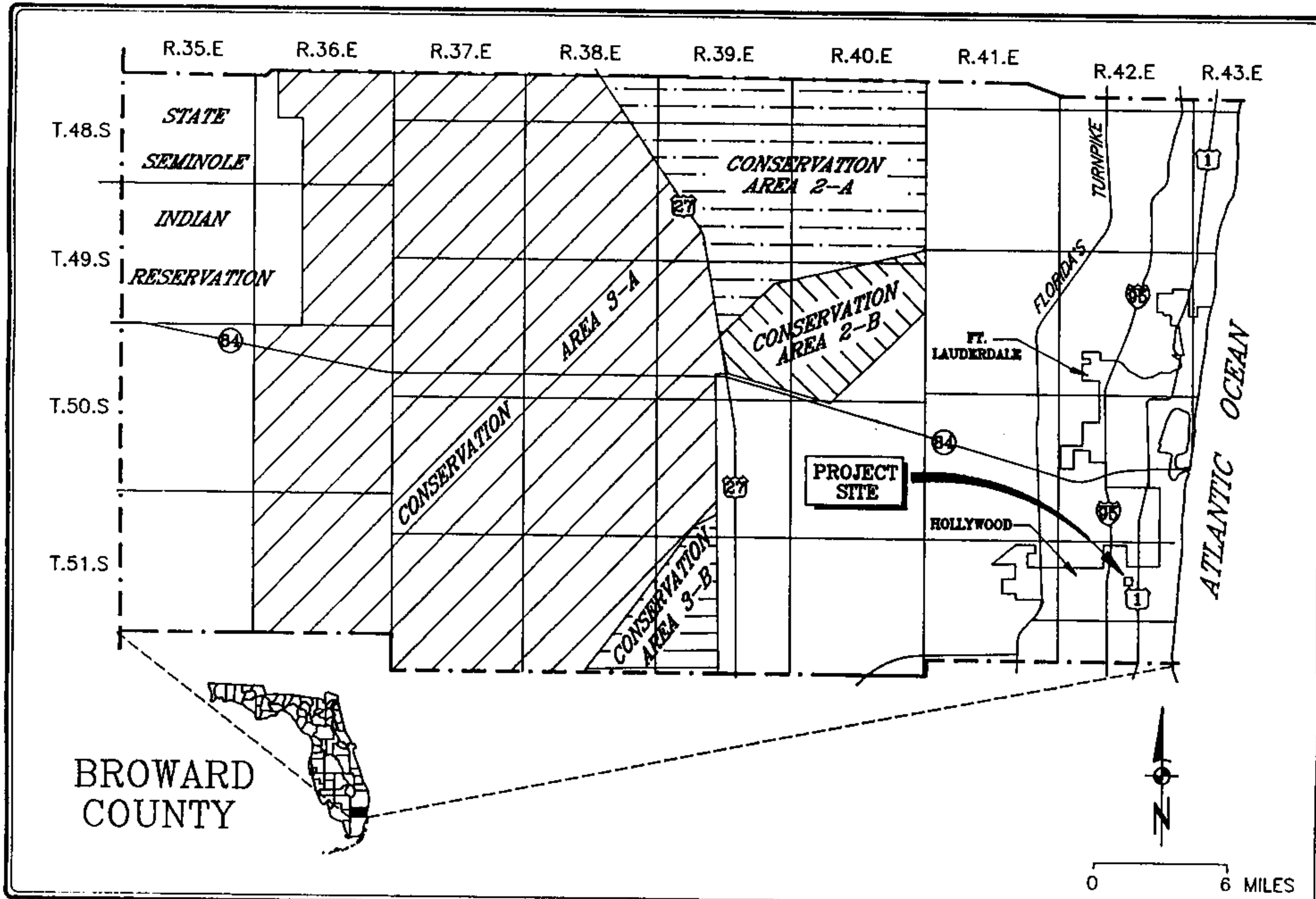
1. Authorization and Scope of Services

As part of the expansion of the City of Hollywood, Florida water supply system, Missimer & Associates, Inc. contracted with Metcalf & Eddy, Inc. to perform a hydrogeologic investigation on the Floridan Aquifer System. The investigation was formally authorized on July 19, 1992, as job number 005131, subcontract no. 31731. The ultimate purposes of this work effort were the successful completion of test production well F-2 and an assessment of the aquifer hydraulic properties. This project investigation is a part of a proposed 6 to 8 MGD wellfield for a new reverse osmosis water treatment plant (Figure 2-1, location map).

The specific scope of this phase of the overall work effort included: 1) recommendation of a modified design for production well F-2, 2) observation of the final casing installation, 3) observation of the well drillout with geologic sample collection, 4) assistance with water quality testing including chloride and conductivity measurements, 5) production of weekly field reports on construction of well F-2, 6) description of the geology from the drill cuttings and geophysical logs from wells F-1 and F-2, 7) completion of an aquifer performance test and a step-drawdown test on well F-2 using well F-1 as an observation well, 8) analysis of the aquifer test data and calculation of coefficients, 9) preparation of a technical memorandum on site conditions, and 10) project coordination and attendance of technical meetings as requested.

2. Acknowledgements

We wish to thank the following individuals for assisting Missimer & Associates, Inc. during this investigation: Ms. Ana Kembro, Utilities Engineer, and her staff,



M&A	ENVIRONMENTAL AND GROUNDWATER SERVICES	Missimer & Associates,Inc.
	DRN. BY: JCS DWG NO. A-M1693GEN-2 DATE: 10/9/92	
	PROJECT NAME: CITY OF HOLLYWOOD PROJECT NUMBER: MH1-693	

FIGURE 2-1. MAP SHOWING GENERAL SITE LOCATION.

City of Hollywood, Mr. Bob Ortiz and Mr. Don Haumann, Metcalf & Eddy, Inc., and Mr. Bob Matthews and Mr. Bill Neely, Diversified Well Drilling, Inc.

III. CONSTRUCTION OF TEST PRODUCTION WELL F-2

1. Original Specifications

Well F-2 was originally designed by Blasland, Bouck & Lee, Inc. as a Floridan Aquifer test-production well with the intention of converting it to a production well in the future. The design yield for the well was 1000 gpm.

The original specifications called for the installation of the well to be conducted as follows: "A) drill or auger a 36-inch diameter borehole using the hydraulic rotary-mud method to approximately 120 feet below land surface, and install 30-inch diameter outer steel casing. Grout space between casing and borehole wall, B) drill a minimal 30-inch diameter borehole to approximately 300 feet below land surface and install a 24-inch diameter steel casing. Grout space between casing and borehole, C) drill a 22-inch borehole to a depth approximately 930 feet below land surface. Install and grout 16-inch diameter Schedule 80 PVC casing. Initial drilling shall utilize mud rotary drilling followed by reverse air when sufficient amounts of formation water are present, D) continue open hole drilling (14-inch diameter) to an approximate depth of 1300 feet below land surface, E) collect geological samples during drilling, F) develop well by air lifting and surging, G) assist in the performance of the geophysical logging. Engineer will provide for geophysical logging and will examine logs and select intervals for water quality testing, H) perform water quality tests at selected zones, I) perform aquifer performance tests, J) install a temporary cap on well, and K) abandon well or install permanent cap on well head at direction of City/Engineer". These specifications were taken directly from Division 1 Supplementary Condition (p. 7) of a document entitled "Production well F-2 (Floridan Aquifer) at the City of Hollywood, Florida, project #913013, contract documents and specifications", May, 1991.

The original concept of well design was generally based on well F-1, located about 475 feet away from the site for F-2. A major difference between the specifications in well F-1 and F-2 was the type of primary casing, steel versus PVC, respectively. The site geology and the chosen final casing material caused some major alterations in the well design and construction.

2. Construction Difficulties

Prior to beginning the drilling of the specified 36-inch diameter borehole, the well drilling constructor initially drilled a smaller diameter pilot hole in order to assess geologic conditions to be encountered in the upper part of the well. A very permeable limestone was encountered in the upper 40 feet of the borehole. This unit caused the loss of circulation and drained the drilling mud from the well. No such permeable limestone was encountered or reported in well F-1, located only a short distance away. The circulation loss problem presented a major difficulty in successfully completing a 36-inch borehole to 120 feet without risking upper borehole collapse or potential loss of a drilling bit and drilling pipe. Therefore, it was prudent and necessary for the drilling contractor to install a large diameter "pit casing" in the upper part of the well. A 46-inch diameter hole was drilled to a depth of slightly greater than 40 feet (space left at bottom to allow cementing). A 40-foot string of steel casing was installed in the borehole and was grouted in place with neat cement.

Installation of the larger diameter "pit casing" allowed the successful drilling of the 36-inch diameter borehole to 120 feet and the 120 feet string of 30-inch diameter casing was installed and grouted into place with neat cement.

After installation of the 30-inch casing, a nominal 30-inch diameter borehole was drilled to a depth of approximately 300 feet. The third casing string, about 300 feet of 24-inch casing, was successfully installed and grouted into place.

Drilling of the borehole began for installation of the final or primary casing. No pilot hole was specified or drilled, probably because of the geologic data obtained from well F-1. A 22-inch borehole was drilled using the hydraulic rotary-mud method to a depth of 926 feet. Although the full diameter of the borehole was 22-inch at 926 feet, the "tree type" drill bit assembly drilled slightly below the casing depth. This extra "space" was absolutely necessary to allow grouting without abnormal pressure buildup inside of the casing. Upon completion of the borehole, the drilling mud was carefully conditioned to adjust the pH and to increase the weight and viscosity to the required levels.

After the drilling mud was conditioned, the 926-foot string of 16-inch diameter, Schedule 80 PVC casing was installed. Installation of this length of large diameter PVC casing requires a large amount of time, because of the extra work required to prevent casing failure at the joints, which can be caused by tensile loading. Therefore, each joint had to be cemented using a PVC welding component, the joints had to be pinned using stainless steel, sheet metal screws, and the PVC cement had to cure for over an hour. The overall operation took at least 40 hours just to set the casing. Centralizers also had to be added during casing installation in order to keep the casing centered in the borehole so that the cement grout would evenly surround the casing.

Because of the significant susceptibility of PVC casing to failure during grouting, when the heat of hydration can cause temperatures to rise well above 200°F, it was necessary to grout in stages. The first stage of cement grout was installed under pressure with the slurry consisting of cement and bentonite. This type of grout has a relatively slow curing time, which caused at least a 12-hour delay prior to beginning the second stage. It was during preparation for the second stage of grouting that a major problem was detected. The tremie pipe being lowered between the 22-inch borehole and the outside of the 16-inch casing bottomed on an obstruction well above the anticipated 626-foot depth to the top of the first grout stage. It was decided to grout the remaining annulus and then pressure test the casing. If the casing passed the pressure test, then the well would be acceptable to the Florida Department of Environmental Regulation, if a monitor well would be placed in the Biscayne Aquifer adjacent to the finished well.

The well casing was subsequently pressure tested and at pressures of 100 psi and less, leaks were detected in the casing. It should be noted that PVC welded joints are never perfect in terms of a high pressure seal. The welded joint and the exterior grout combine to produce a sufficient seal to prevent leakage of water into or out of the well. At this point, the well should have been acceptable to the agency without any monitoring well, because the clay in the annulus was just as effective at inhibiting water flow as is the cement. Unfortunately, lack of experience by agency personnel lead to the conclusion that the well was not acceptable. At this point, the well construction contractors decided to drill out the PVC casing and to attempt installation of the casing a second time.

Drilling out of an existing grouted casing is a tedious and time consuming exercise, which was successfully completed without losing the hole. The borehole was carefully cleared to the original nominal diameter of 22 inches. Again, the drilling mud was conditioned to the proper pH and viscosity. The drill rods were withdrawn from the hole and casing installation began. Installation of the PVC casing proceeded quite slowly and was interrupted by a severe thunder storm. The casing moved freely into place to a depth of about 550 feet, where some minor resistance was encountered. As joints of casing were added, the resistance necessary to install the casing became severe. Based on the resistance caused by the slow collapse of formation materials and knowledge that it would no longer be possible to obtain an "acceptable" grout, the drilling contractor decided to withdraw the casing. Fortunately, the string of casing was successfully extracted from the borehole. At this time, it was decided by all parties that the design of the well should be reviewed and perhaps a new approach should be taken.

Missimer & Associates, Inc. was retained to review all aspects of the well design and construction in order to make recommendations concerning how to proceed. It was concluded that the problem encountered was a "swelling" of the natural clay materials in the formation or the slumping of formation materials that was causing closure of the borehole. Based on the design pumping rate of 1000 gpm and the known diameter of a submersible pump capable of discharging this rate, it was found that a 12-inch diameter well would be sufficient to meet the demand. A second major issue was the time required to install a 926-foot string of PVC casing, which has severe strength deficiencies at this depth during cement grouting. It was recommended that 3/8-inch wall thickness, 12-inch diameter, fiberglass well casing should be used (Burgess type or equivalent). The casing was reinforced with horizontal "ribbing" every 12 inches. Also, each joint was made with a rubber O-ring in order to obtain a 100 psi rating at each joint. The manufacturer recommended that each joint be pinned with stainless steel screws. It was concluded that this casing could be installed in less than 12 hours and had better strength properties to resist failure during cement grouting. In order to provide an extra measure of time, it was also decided to clear the borehole to the original full diameter of 22-inches rather than reduce the diameter to 20-inches or the 6-inches required by state law.

3. Finished Construction of Well F-2

The third attempt to set a primary casing in well F-2 began with the cleaning of the borehole. Prior to beginning of drilling, the drilling mud was mixed to the proper pH, viscosity, and weight. The drilling bit was slowly lowered into the borehole with the assembly rotating and full mud circulation. No significant resistance was observed during the entire drillout procedure. However, circulation of the mud showed cuttings returns beginning at about 550 feet below surface. The material returned was mostly a shelly lime mud. Therefore, the problem in the borehole was not caused by "swelling" clay, but by slow slumping of mud caused by water flow through some permeable shell lenses occurring within the confining beds. Drilling to the base of the borehole at about 926 feet proceeded without incident and the drilling mud was then carefully conditioned to the proper pH, viscosity, and weight in preparation for setting of the casing.

After rapid removal of the drill rods and bit from the borehole, the 12-inch diameter fiberglass casing was installed. The threaded joints were easily assembled and the joints were pinned. Centralizers were added as specified. It took approximately 7 to 12 minutes to add each new joint of casing. The casing was installed in the borehole with no problems in about 8.5 hours.

It was decided to grout the casing in place in three stages. In order to accelerate the cement curing process, both bentonite (heat of hydration reducer) and calcium chloride (hydration accelerator) were added to the cement that would be above the base of the casing. Neat cement without any additives was added last. This cement was added to allow later compliance to membrane manufacturer warranties (bentonite is a membrane foulant) and to cause rapid curing of the cement. The first stage of cement grout was successfully implaced via pressure from the interior of the casing to the exterior using 375 sacks of cement with bentonite (no bentonite at base). The level of grout rise in the annulus was 670 feet versus the anticipated rise to 550 feet. Therefore, about 20 percent of the grout in the first stage exited into the formation. This loss rate is common in permeable limestones at a formation contact and was shown not to be a problem. Cups of cement were collected for observation of curing.

Based on the anticipated curing rate and the direct observation of the cement in the cups, the second stage of grout was pumped into the well 8 hours and 20 minutes after the first stage was completed. Approximately 308 sacks of cement with bentonite were pumped via tremie pipe into the annulus. The anticipated depth of cement in the annulus was 295 feet, but a 200 foot depth was observed. This difference shows that the slumping problem closed about half of the annulus during construction. An acceptable ring of cement grout was pumped throughout the height of the second stage. It should be noted that the tremie pipe to the top of the first stage cement passed between the outer borehole and the exterior of the 12-inch casing without obstruction.

The third stage grout was pumped about 20 hours later. The remaining 200 feet of the annulus was cemented using neat cement with no additives. The well was rested for curing for a period of several days before drilling of the open-hole was begun.

As soon as the cement grout had cured sufficiently, the cement inside the 12-inch casing was carefully drilled out. Only about 10 feet of cement was inside the casing. The mud was removed from the casing by circulation with freshwater. Next a concentrated salt brine was prepared and introduced into the casing to control flow of water from the formation between the drill stem and the casing. The open-hole portion of the well was drilled using the reverse-air rotary technique to a depth of 1314 feet below surface. The completed well is shown in Figure 3-1.

Upon completion of the borehole, the salt brine was removed from the well and the water was developed by surging with a pump at rates of up to 1200 gpm. Higher pumping rates could not be tolerated because it was not possible to dispose of the saline water produced at any higher rate.

4. Discussion

A great deal of useful information was obtained during the construction of well F-2. Based on an "after the fact" analysis of the original proposed well construction design, it is now apparent that it is not possible to construct a 16-inch well using PVC casing at this site to a depth of 926 feet. The slumping of material from the

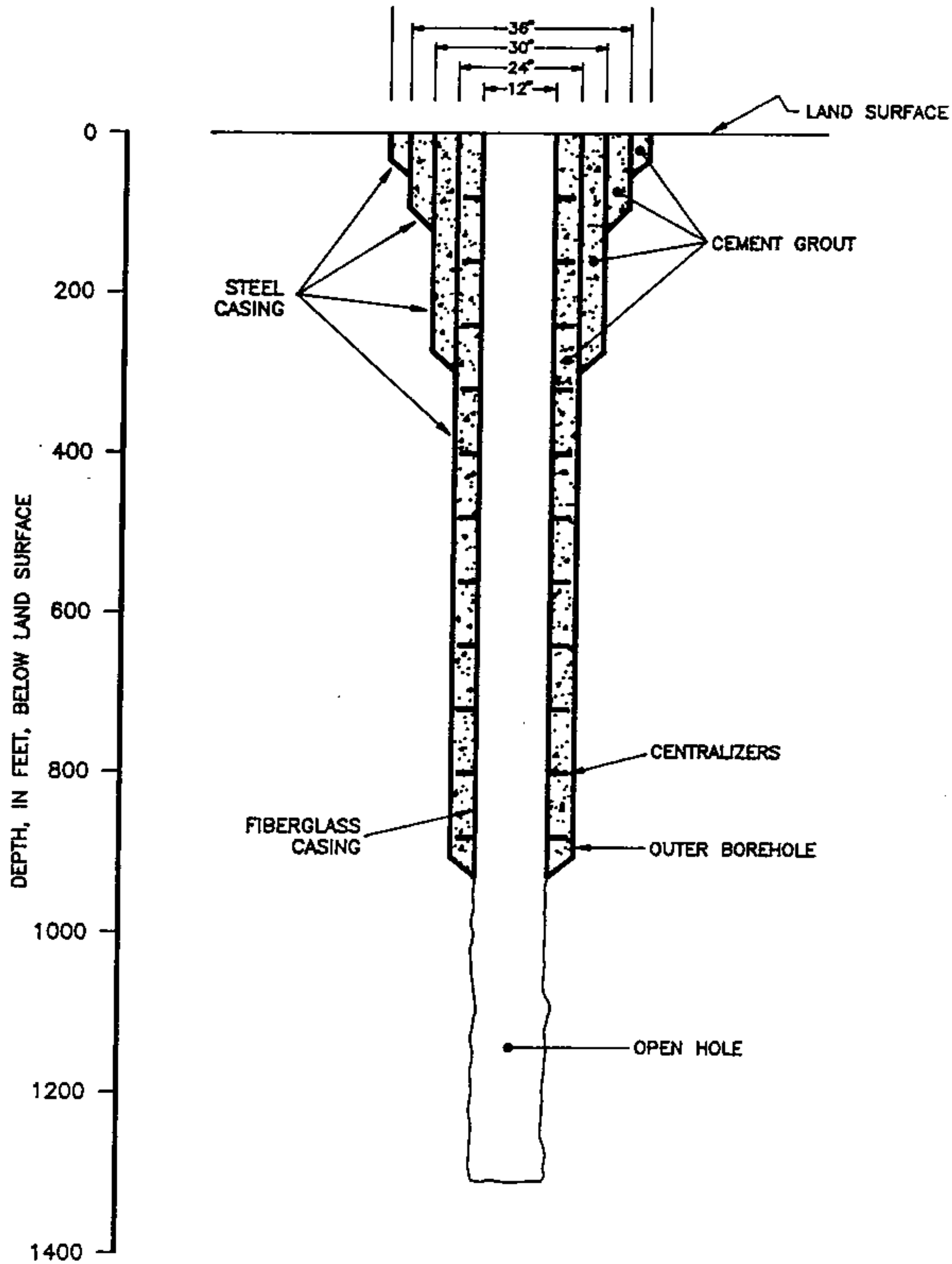


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FIGURE 3-1. DIAGRAM SHOWING THE FINAL CONSTRUCTION OF WELL F-2.

c⁻ⁿates a problem that severely limits the length of time available to install the casing. In our opinion, the slumping problem cannot be controlled ..e pH, viscosity, or weight of the drilling mud. Therefore, the problem esolved by cutting the length of time necessary to install the casing and ie nominal borehole diameter relative to the casing diameter. For a minimal nominal 3-inch annulus is normally recommended for a 16-inch ch borehole). In this case, the nominal annulus required would be inches to compensate for hole diameter loss caused by slumping (26- e).

ie observations and the successful completion of well F-2, it is ded that all future Floridan Aquifer System wells to be constructed for the vood be specified to have 12-inch diameter (I.D.) fiberglass casings for stallation and strength. The nominal borehole diameter to be used for lation should be 22-inches instead of the normal 18-inches. This diameter allows more time to be available for casing installation and more severe slumping problem would occur at a given site, the casing o be removed and the borehole enlarged to 24-inches to yield additional nstruction is not an exact science and requires flexible specifications, in the case of deep wells. Future well specifications should contain vork line items in anticipation of on-site problems caused by local anges.

e Aquifer in well ie and Pliocene of well F-2. The unconsolidated tasia Formation permost strata es belonging to categorized, with mudstones and Fort Thompson well F-1, where us quartz sands

tasia Formation, -rich limestones. -grained quartz

ation and is the collected and/or s the boundary The Anastasia- its approximate predominantly of live gray), finer- tion limestones.

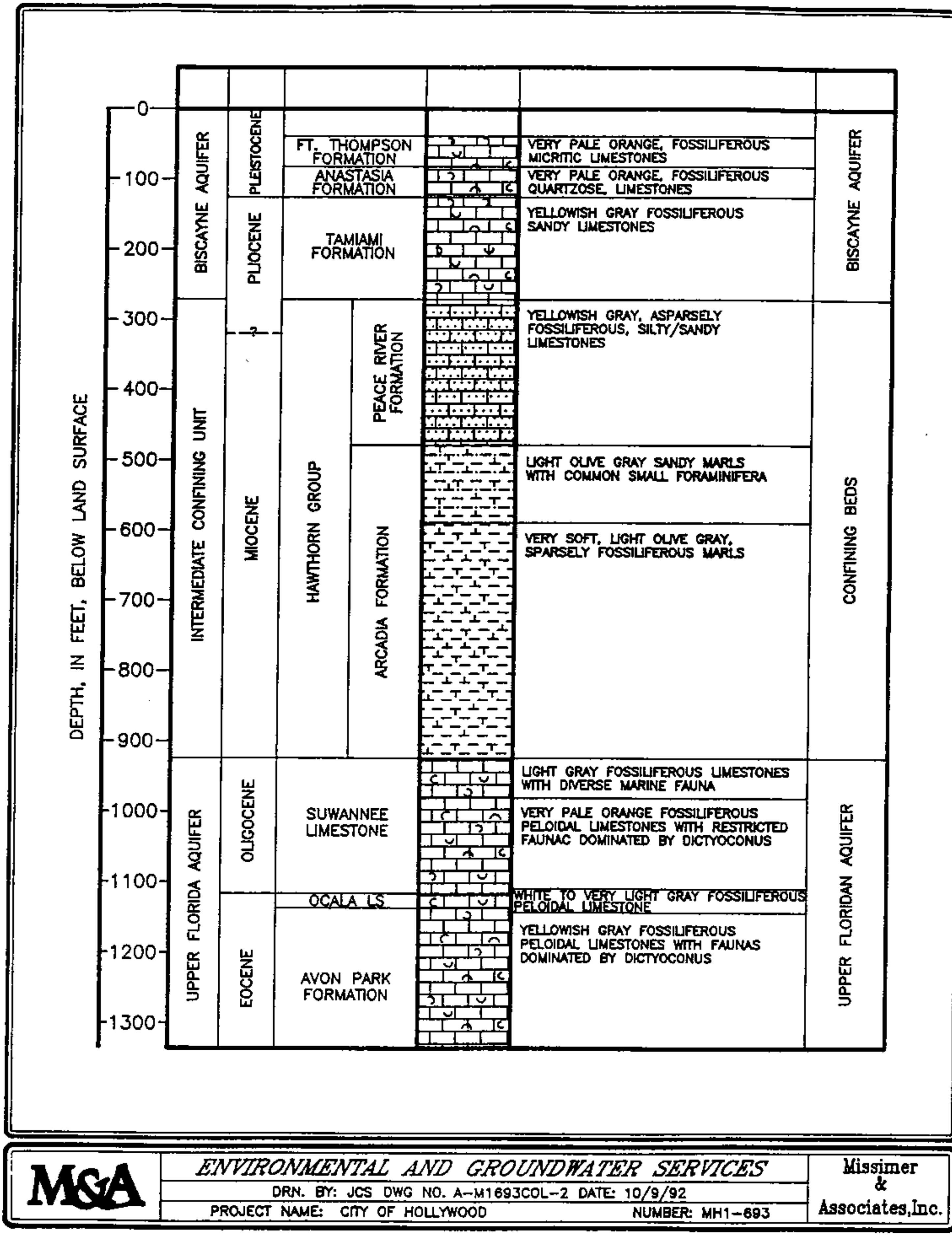


FIGURE 4-1. GEOLOGY OF AQUIFER LOCATIONS IN WELL F-2.

The Hawthorn Group (Miocene) constitutes the Intermediate Confining Unit, which separates the Biscayne Aquifer from the Upper Floridan Aquifer. The Hawthorn Group contains two formations, which are, in ascending order, the Peace River Formation and the Arcadia Formation. The change from the Tamiami Formation to the Peace River Formation is marked by a downhole decrease in grain size, detrital quartz concentration, and fossil abundance. The Peace River Formation in well F-2 consists mostly of sparsely fossiliferous, light olive gray, silty limestones. The Tamiami Formation-Hawthorn Group boundary is not distinguishable on the gamma ray log.

The transition from the Peace River Formation to the Arcadia Formation is marked by a decrease in hardness. The Peace River Formation consists of relatively well-indurated limestone, whereas the Arcadia Formation consists mostly of very soft, poorly lithified marls. There is a slight increase in gamma ray emissions from the Peace River to the Arcadia Formation. The Arcadia Formation can be informally subdivided in well F-2 into two members, an upper unit (480 to 545 feet) that consists of poorly lithified sandy marls that are highly friable, and a lower unit (545 to 926 feet) that consists of finer grained marls that are cohesive (due to a high clay content) rather than friable.

The upper Arcadia Formation marls are light olive gray to yellowish gray, contain abundant very fine-grained quartz sand, and have a fauna dominated by small benthonic foraminifera. The lower Arcadia Formation marls are light olive gray (5 Y 6/2), sparsely fossiliferous, and appear to have very low porosities. The boundary between the upper and lower Arcadia Formations is marked (at about 545 feet) by a large sharp peak in gamma ray emissions and the beginning of a 6 to 7 inch decrease in borehole diameter (the borehole diameter decreases from 20 to 13 inches on the X-caliper log and from 17 to 11 inches on the Y-caliper log over the interval 545 to 555 feet). Slumping of sediments within the lower Arcadia Formation marls are the main cause of this decrease in borehole diameter. The lower Arcadia

Formation has lower gamma ray emissions than the upper Arcadia Formation despite its higher clay content. Phosphate grains and shell fragments are common in both the upper and lower Arcadia Formation. The lower Arcadia formation marls are the principal barrier to vertical flow between the Upper Floridan and Biscayne Aquifers.

The section of the Upper Floridan Aquifer penetrated in well F-2 consists predominantly of fossiliferous limestones that belong, in ascending order, to the Suwannee Limestone (Oligocene), Ocala Limestone (Late Eocene), and Avon Park Formation (Middle Eocene). These limestones consist mostly of fossiliferous grainstones, and fossil peloid packstones and grainstones. The transition from the clay and phosphate-rich marls and limestones of the Hawthorn Group to the comparatively clean limestones of the Suwannee Limestone, Ocala Limestone, and upper Avon Park Formation is marked by a decrease in gamma ray emissions. The exact position of the boundary is masked by three large gamma ray peaks at 919, 924, and 946 feet, which presumably mark horizons containing abundant phosphate. The boundary between the Hawthorn Group and Suwannee Limestone, which approximately marks the top of the Floridan Aquifer, is placed at 926 feet, the shallowest depth at which relatively clean fossiliferous limestone was recorded in the cuttings.

The Suwannee Limestone can be informally subdivided into two members based on fauna and lithology. The upper 55 feet of the Suwannee Limestone (926 to 982 feet) consist of light gray to yellowish gray fossiliferous limestones that contain a diverse marine fauna (gastropods, echinoderms, bivalves, foraminifera, etc.). The lower Suwannee Limestone (982 to 1123 feet), as well as the Ocala Limestone and the cored part of the Avon Park Formation, consists predominantly of fossil peloid grainstones and packstones with low diversity faunas dominated by the distinctive large cone-shaped foraminifera of the genus Dictyoconus. The upper Suwannee Limestone consists of interbedded limestones with variable, but usually low visible (macro) porosity, whereas the lower Suwannee Limestone usually has medium to high intergranular porosity. There is a broad 4-inch peak in borehole diameter (from 14" to 18") and a decrease in gamma ray response over the interval 1005 to 1085 feet. This interval of the lower Suwannee Limestone appears to consist of relatively clean soft, porous limestone. Gamma ray emissions increase in the basal Suwannee limestone (1095 to 1123 feet).

The Ocala Limestone is lighter-colored (white to very pale orange) and less fossiliferous than both the lower Suwannee Limestone and the upper Avon Park Formation. The upper and lower boundaries of the Ocala Limestone are placed, respectively, at 1123 and 1139 feet, based on the decrease in gamma ray log response. The Ocala Limestone has a low gamma ray emission because of its relative purity. There is about a 2.5-inch peak in borehole diameter in the Ocala Limestone, reflecting its greater erodability (softness) than the overlying and underlying limestones. The upper Avon Park Formation is darker colored (yellowish gray) than bulk of the overlying Upper Floridan Aquifer limestones. There is a gradual decrease in borehole diameter through the drilled part of the Avon Park Formation, indicating a downhole increase in hardness (resistance to erosion).

Detailed geologist logs for both wells F-1 and F-2 are given in the Appendix in Tables A-1 and A-2.

V. HYDROLOGY

There are four basic types of aquifers in nature according to the Dutch definitions (Kruseman and DeRidder, 1970). These types are defined on the basis of the degree of confinement and are: 1) unconfined aquifers, 2) semi-unconfined aquifers, 3) semi-confined aquifers, and 4) confined aquifers. The upper part of the Floridan Aquifer System is a semi-confined type of aquifer.

Semi-confined aquifers occur where continuous beds of low permeability bound the aquifer both above and below and confine it from the atmosphere and other aquifers. Although the aquifer is fully confined, water can still move vertically through the confining beds. When a semi-confined aquifer is pumped, water is withdrawn not only from the aquifer, but also through the adjacent confining beds. Since pumping reduces the pressure in the aquifer, groundwater in the adjacent aquifer moves vertically into the aquifer through the confining beds. During long term pumping of a semi-confined aquifer, an equilibrium between the discharge rate of the pump and the recharge rate through the confining beds will occur. Since the upper part of the Floridan Aquifer is confined by over 500 feet of material, all vertical leakage will come from below the aquifer. In order to properly assess the effects of pumping a semi-confined aquifer, it is necessary to determine three hydraulic coefficients from aquifer test data. These coefficients are:

Transmissivity (T) -	The ability of an aquifer to transmit water, reported in gallons/day/foot (gpd/ft).
Storage Coefficient (S) -	The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head, reported as a dimensionless number.
Leakance (K'/b') -	The effective permeability of a confining bed divided by the thickness of the confining bed, reported in gallons/day/cubic foot (gpd/ft^3).

Preliminary and primary aquifer tests were performed on the upper part of the Floridan Aquifer System. A step-drawdown test was conducted on test-production well F-2 on August 20, 1992. Individual steps lasted between 30 and 50 minutes depending on the time required to reach equilibrium. The four steps completed were at discharge rates of 755, 940, 1020, and 1180 gpm. A fifth step was attempted at above 1200 ppm, but the discharge line could only accept 1140 gpm at the time and the fifth step was abandoned. From the data collected (Table A-3), it was determined that the primary aquifer test could be conducted at a discharge rate of 1000 gpm.

The primary aquifer test was performed on the upper part of the Floridan Aquifer System beginning on August 31, 1992 and ending on September 5, 1992. Well F-2 was pumped continuously at a rate of about 1010 gpm for a period of 5 days. Aquifer pressures were measured in test-production well F-2 using a calibrated wellhead pressure gage. Aquifer pressures were measured in observation well F-1 using a recording pressure transducer system. The aquifer test setup is shown in Figure 5-1. The time and drawdown data for the test production well and the observation well are given in Tables A-4 and A-5, respectively. Time and recovery data for observation well F-1 are given in Table A-6.

Since the upper part of the Floridan Aquifer System is considered to be a leaky confined or semi-confined aquifer, the method of Hantush and Jacob (1955) as discussed in Lohman (1979) was used to analyze the data. The analysis method was applied to the log curves of time vs. drawdown for both the primary test data set and the recovery data set as given in Figures 5-2 and 5-3. The match points between each observed curve and the corresponding type curve were substituted into the following equations:

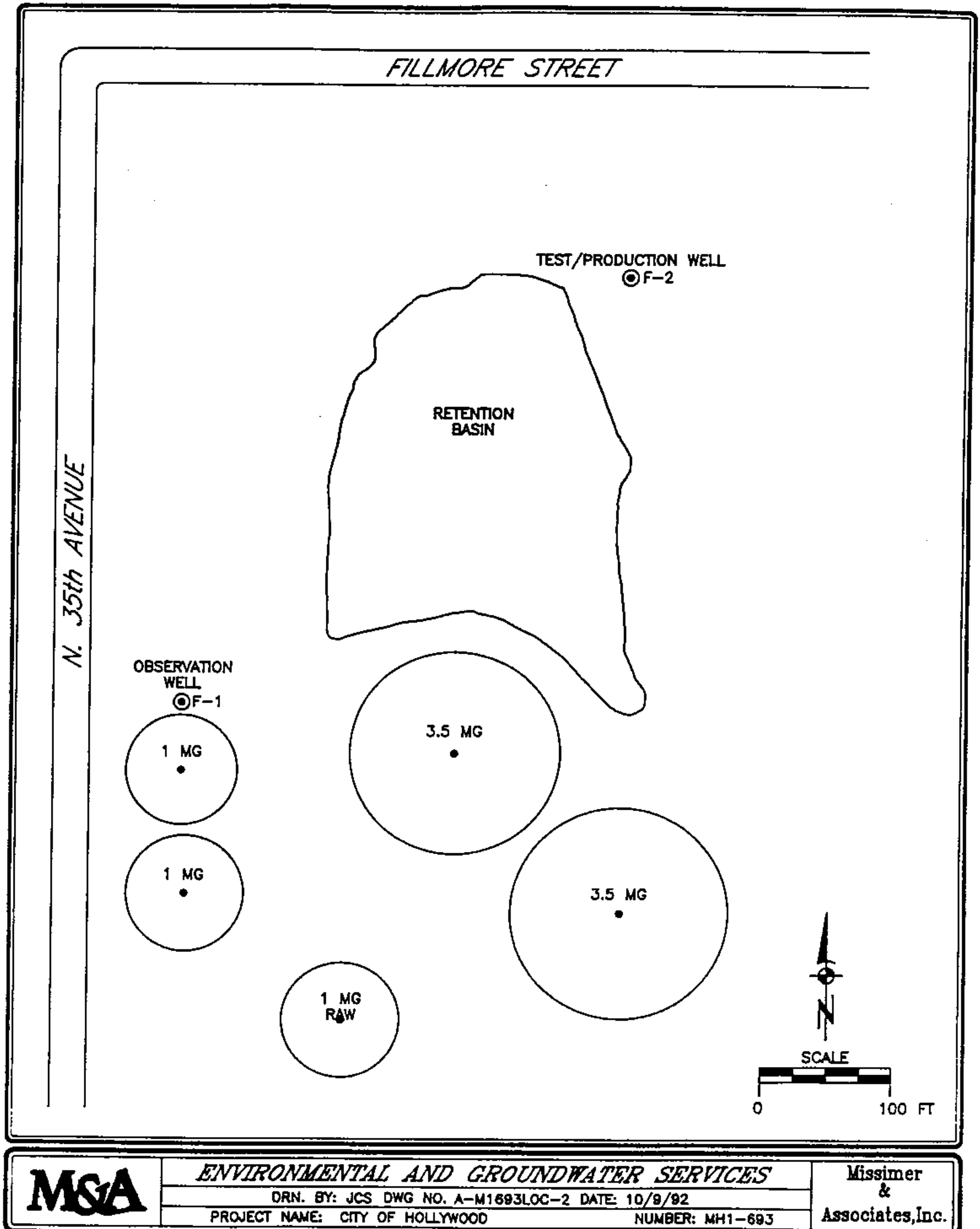
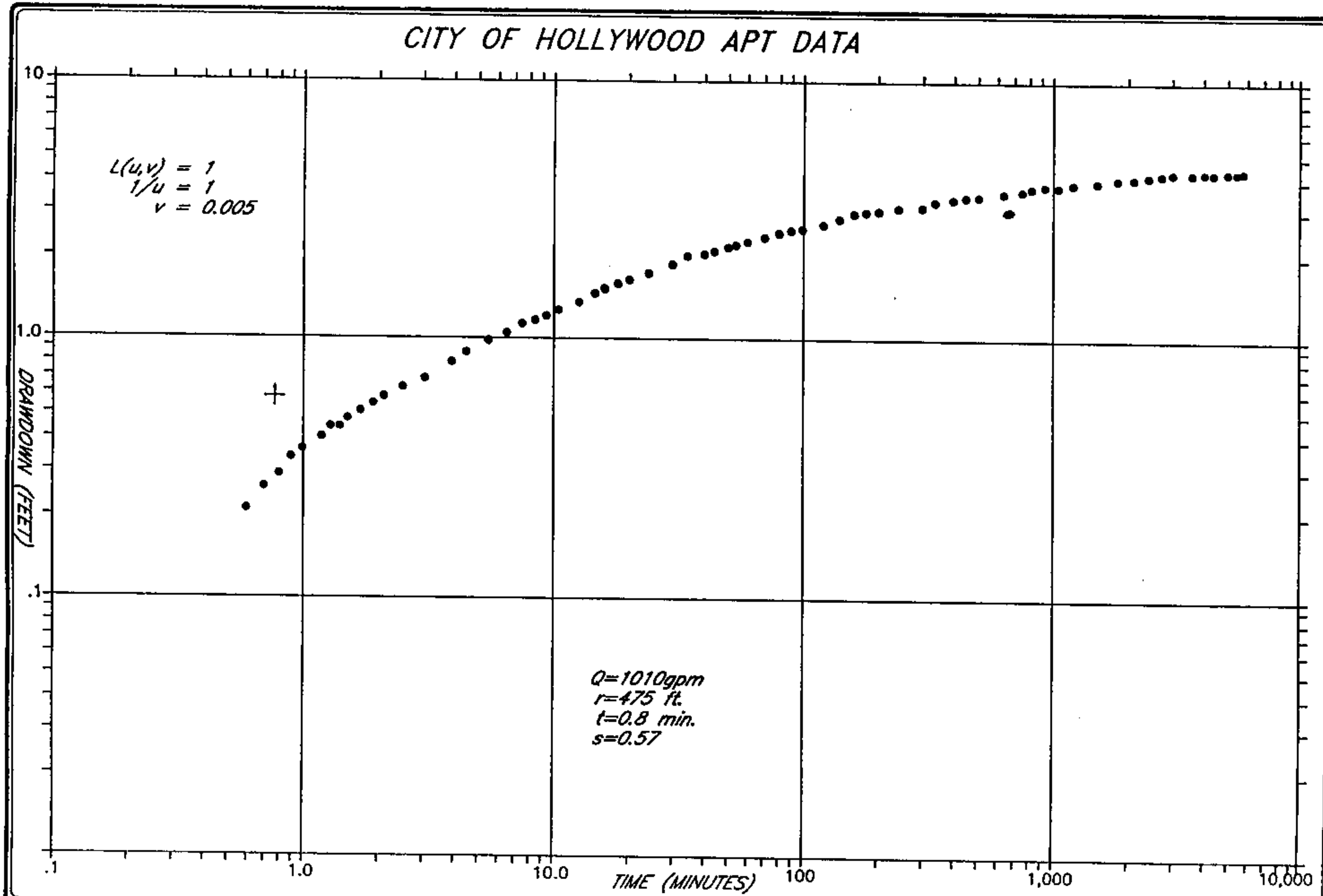


FIGURE 5-1. AQUIFER TEST SET-UP.

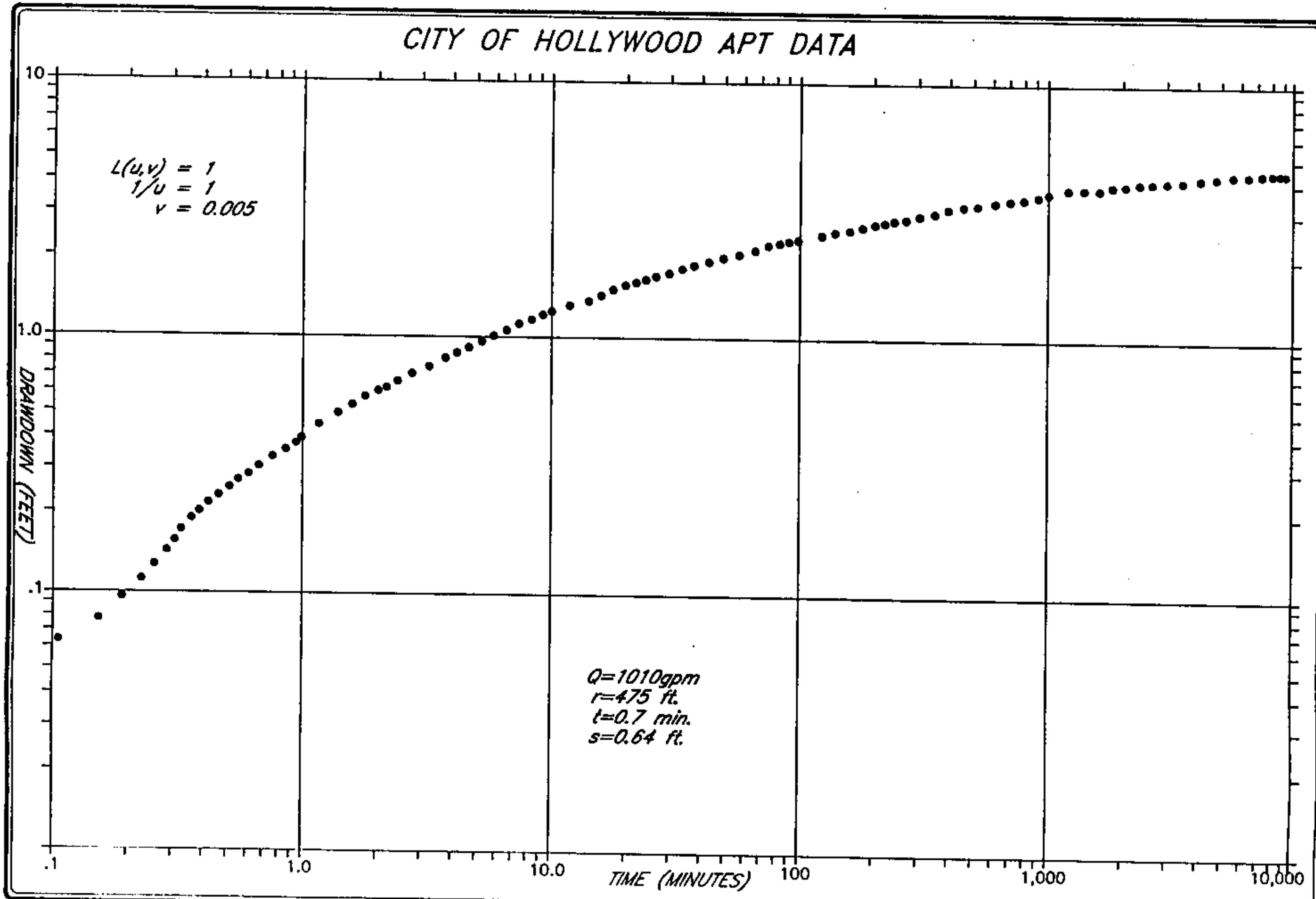


ENVIRONMENTAL AND GROUNDWATER SERVICES

M&A | DRN. BY: JCS DWG NO. A-M1693APT-4 DATE: 10/9/92 | Missimer & Associates,Inc.

PROJECT NAME: CITY OF HOLLYWOOD PROJECT NUMBER: MH1-693

FIGURE 5-2. LOG PLOT OF TIME vs. DRAWDOWN FOR WELL F-2.



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DRN. BY: JCS DWG NO. A-M1693AP2-1 DATE: 10/9/92

PROJECT NAME: CITY OF HOLLYWOOD PROJECT NUMBER: MH1-693

FIGURE 5-3. LOG PLOT OF TIME vs. RECOVERY IN WELL F-1.

$$T = \frac{Q\,L\,(u,v)}{4\ s} \qquad (1)$$

$$S = \frac{4Tt/r^2}{l/u} \qquad (2)$$

$$k'/b' = \frac{4Tv^2}{r^2} \qquad (3)$$

where,

T = transmissivity, in feet^2/day
Q = discharge, in feet^3/day
L (u, v) = Hantush curve function
s = drawdown, in feet
S = storage coefficient, dimensionless
u = Hantush curve function
t = time, in days
r = distance from pumped well, in feet
k' = permeability of confining layers, in ft/day
b' = thickness of confining layers, in feet
v = Hantush curve function
(7.48 g/ft^3) (ft^2/day) = 1 gpd/ft
(7.48 g/ft^3) (1/days) = 1 gpd/ft^3

The analyses of the aquifer test data showed that the aquifer transmissivity is about 180,000 gpd/ft with the primary and recovery data yielding very similar values (Table 5-1). There is a small problem with the first 7 minutes of time and drawdown data, which falls ~~below~~ above the Thesis curve. This departure of the early data ~~below~~ above the Thesis curve is common for the first 1 to 2 minutes because of the sudden removal of the water stored in the borehole. However, the reason for the departure on both

TABLE 5-1. AQUIFER COEFFICIENTS CALCULATED FOR THE UPPER PART OF THE FLORIDAN AQUIFER FOR WELL F-1

Parameter	Primary Test	Recovery
Discharge	1010 gpm	1010 gpm
Distance (r)	475 feet	475 feet
Match Points L (u,v) 1/u	 1 1	 1 1
Drawdown (s)	0.65 feet	0.65 feet
Time (T)	0.096 minutes	0.7 minutes
Transmissivity	178,000 gpd/ft	181,000 gpd/ft
Storage Coefficient	3×10^{-4}	2×10^{-4}
Leakance	7×10^{-4} gpd/ft^3	8×10^{-5} gpd/ft^3

the drawdown and recovery phases is not known. This departure problem does not have any significant impact on the data analysis, but is noted.

The storage coefficient calculated from both data sets ranged from 2×10^{-4} to 3×10^{-4}. This shows internal agreement and consistency of the data.

Leakance values varied widely between the test data sets from 7×10^{-4} gpd/ft^3 to 8×10^{-5} gpd/ft^3. From the test curves, it is quite clear that the leakance of the aquifer is a small number. However, there is a general problem with the selection of the departure point from the Thesis curve. Based on previous testing of the Floridan Aquifer System and past experience, it is appropriate to estimate the leakance at the higher value.

Based on the aquifer test data and analysis, the appropriate hydraulic coefficients to be used for future modeling of the aquifer are:

Transmissivity = 180,000 gpd/ft
Storage Coefficient = 3×10^{-4}
Leakance = 4.7×10^{-4} gpd/ft^3

The height of the potentiometric surface at well F-2 ranged from 23 to 24 feet above the measuring point on the wellhead. The measuring point was located about 4 feet above land surface. Assuming the land surface has an altitude of about 8 feet NGVD, the potentiometric surface of the upper part of the Floridan Aquifer System lies between 35 and 36 feet NGVD. This altitude will vary seasonally.

Prior to conducting the aquifer test, pressure fluctuations were recorded in well F-1 using the pressure transducer system. Tidal fluctuations of pressure were recorded with amplitudes of 0.1- to 0.2-foot. These fluctuations did not create any significant problem in the analysis of the drawdown or recovery data. The tidal fluctuation data will be used to evaluate regional aquifer properties during the next phase of the wellfield project.

VI. WATER QUALITY

Water quality samples were collected during the drilling of the open-hole portion of well F-2 and during the aquifer performance test. Fluid resistivity logs were also run on the well under a static and a flowing condition. This information was used to evaluate the existing water quality in the aquifer. The water quality data collected during drilling are given in Table A-7 and the data collected during the aquifer test are given in Table A-8.

The water samples collected during drilling provided the general pattern of water quality variation with depth. The dissolved chloride concentration measurements ranged from 1900 to 2600 mg/l. During drilling, there were some problems with leakage of brine from inside the casing into the flow inside the drill stem. This "contamination" of the samples caused the concentration of 2600 mg/l at 1024 feet. The overall pattern of water quality variation was confirmed by the geophysical logging (fluid resistivity). Based on the geophysical log and drilling data, it is concluded that the dissolved chloride concentration at 926 feet is 1900 mg/l and at a depth of about 1200 feet, the concentration is about 2200 mg/l. It is difficult to accurately assess the water quality at the base of the well because there is no flow into the borehole. It is recommended that a bottom hole sample, a sample at 1200 feet, a sample at 1100, and one at 940 feet be collected in the future using a cable-mounted grab samples.

During the aquifer performance test, the dissolved chloride concentration of the discharge water was relatively constant. Measured chloride concentrations ranged from 2100 to 2200 mg/l. The mean concentration was about 2140 mg/l. The range of values is within the error range of the titration method. There was no significant trend or change of water quality with time.

VII. DISCUSSIONS ON WELL DEPTHS

Both wells F-1 and F-2 were constructed with similar casing and total depths. Geophysical logging performed on well F-2 showed that no significant flow of water comes from below a depth of 1200 feet. Since there is a general increase in the salinity of water with depth, it is prudent to construct future production wells to depths less than 1200 feet in order to provide a greater level of protection against upward leakage of saline water with time.

The exact nature of the confining beds separating the upper and lower parts of the Floridan Aquifer is not known. Since there is a substantial increase in salinity between the upper and lower portions of the aquifer system, it is quite important to measure the salinity of water immediately below the confining beds. Therefore, it is recommended that well F-1 be drilled down to a depth of about 1600 feet in order to obtain deeper water quality data. A 4-inch casing should be cemented in place at a depth of about 1400 feet. This 4-inch casing should be continued to land surface. This would make well F-1 a dual piezometer with the ability to gather information on both the upper and lower parts of the aquifer. Both potentiometric pressure and water quality could be monitored.

VIII. REFERENCES

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IX. APPENDICES

1. Geologist's Logs

TABLE A-1. GEOLOGY LOG OF THE CITY OF HOLLYWOOD WELL F-1

Depth (feet)	Lithology
0-10	Sand, quartz, coarse-grained, sub-rounded. Very light gray (N8) to very pale orange (10 YR 8/2). Common fossils, 10% large bivalve fragments. Common (10%) limestone, ooid grainstone. 1% loose, uncemented ooids.
10-20	Sand, quartz, coarse-grained, similar to 0-10'. Minor (1%) limestone, ooid grainstone, and sandstone, quartz, very fine to fine-grained, poorly cemented with calcite. 1% loose, uncemented ooids.
20-30	Sand, quartz, similar to 10-20'. 1-2% loose, uncemented ooids.
30-40	Sand, quartz, similar to 10-20'.
40-50	Sand, quartz, coarse-grained, sub-rounded. 30% Sandstone, quartz, very fine to fine-grained, calcite cement.
50-60	Sand, quartz, coarse-grained, rounded. Minor sandstone, quartz, very fine to fine-grained, calcite cement. Minor limestone, oolitic grainstone. Common fossils (5%), mostly large bivalve fragments.
60-70	Sand, quartz, similar to 50-60'.
70-80	Sandstone, quartz, very-fine to coarse-grained, calcite cement. Very light gray (N8) to very pale orange (10 YR 8/2), poorly cemented (friable), high porosity. Common (3-5%) large bivalves. 20% limestone, micritic (mudstone), less common oolitic grainstone. 1% shiny brown sand grains, which are probably phosphate.
80-90	Sandstone, quartz, and subsidiary limestone, similar to 70-80'. Medium friability and intergranular porosity. Limestone includes mudstone (most abundant), oolitic grainstone, peloid grainstone, and bioclast grainstone.
90-100	Sandstone, quartz, and subsidiary limestone, similar to 70-80'.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-1

Depth (feet)	Lithology
100-110	Sandstone, quartz, and subsidiary limestone, similar to 70-80'. Fine to coarse-grained, varying degrees of calcite cementation, mostly poorly cemented--very friable.
110-120	Sandstone, quartz, and subsidiary limestone, similar to 70-80'. 5% fossils, mostly bivalves and echinoderms. The bivalves have a chalky appearance.
120-130	Sandstone, quartz, and subsidiary limestone, similar to 70-80'.
130-140	Limestone, micritic, fossiliferous, several lithologies present ranging from mudstone to grainstone. Mostly very pale orange (10 YR 8/2), hard, low porosity. Common bivalves and echinoderms. 10% limestone, sandy (quartz), pale yellowish brown (10 YR 6/2). 5% limestone, silty, light medium gray (N6).
140-150	Sandstone, quartz, medium to coarse-grained, calcite cement, gradational to a limestone. Light olive gray (5 Y 6/1) to (5 Y 5/2), medium hardness/friability, medium visible porosity. Common (10%) fossils including gastropods and bivalves. 10% limestone, micritic, similar to 130-140'.
150-160	Sandstone, quartz, (gradational to a sandy limestone), fossiliferous, medium-grained, calcite cement. Medium friability, medium visible porosity. Two color types are present: (1) dark--light olive gray (5 Y 5/2), similar to 140-150', and (2) light--very pale orange (10 YR 8/2).
160-170	Sandstone, quartz, similar to 150-160'.
170-180	Sandstone, quartz, medium-grained, calcite cement, very pale orange (10 YR 8/2). Hard, not friable, medium visible porosity. Common (5%) fossils, some bivalves, but mostly unidentifiable fragments. Minor limestone, micritic.
180-190	Limestone, sandy (medium-grained quartz), fossiliferous, predominantly a grainstone. Very pale orange (10 YR 8/2), medium friability and porosity. Fossils include echinoderms, gastropods, and bivalves.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-1

Depth (feet)	Lithology
190-200	Limestone, sandy, similar to 180-190'.
200-210	Limestone, sandy, quartz, (close to a sandstone), fine to medium-grained, grainstone. Yellowish gray (5 Y 7/2). Medium friability, visible porosity varies (low to high). Common (10%) fossils including bivalves and echinoderms.
210-220	Limestone, sandy, fine quartz and carbonate grains, textural a grainstone, similar to 200-210, except darker colored. Very light olive gray (5 Y 6/2), salt and pepper appearance from dark phosphate grains. Medium friability and porosity. Common fossils including bivalves and echinoderms.
220-230	Limestone, sandy, similar to 210-220'.
230-240	Limestone, sandy, similar to 210-220'. The limestone below 230' has a more uniform color (less speckled) than above, very light olive gray (5 Y 6/2).
240-250	Limestone, sandy, similar to 210-220'.
250-260	Limestone, sandy, similar to 210-220'. Fine to medium-grained, high intergranular porosity.
260-270	Limestone, sandy, similar to 210-220'.
270-280	Limestone, sandy, similar to 210-220'.
280-290	Limestone, sandy, fine-grained (quartz and carbonate) packstone. Limestone has less quartz (10-20%), fewer large fossils (1%), a finer grain size, and a somewhat darker color than the overlying limestones. Light olive gray (5 Y 5/2), medium hardness (friability), low visible porosity. Limestone also appears to be more clay rich than above. 1-2% coarse quartz sand.
290-300	Limestone, sandy, similar to 280-290'.
300-310	Limestone, sandy, similar to 280-290'.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-1

Depth (feet)	Lithology
310-320	Limestone, sandy, quartz (=>20%), medium-grained, texturally a packstone. Medium hardness/friability, somewhat harder than above. Common (3-5%) large fossils, mostly bivalves. Minor siltstone, calcareous, medium dark gray (N4), strong HCl reaction.
320-330	Limestone, sandy, similar to 280-290'.
330-340	Limestone, sandy, similar to 280-290'.
340-350	Limestone, sandy, similar to 280-290'.
350-360	Limestone, sandy, (quartz and carbonate), fine-grained, poorly sorted, packstone/wackestone. Very light olive gray (5 Y 6/2). Common (1-2%) large fossils including bivalves and echinoids, 1-2% phosphate sand grains. Minor medium gray (N5) calcareous siltstone.
360-370	Limestone, sandy, similar to 350-360'.
370-380	Limestone, sandy, similar to 350-360'.
380-390	Limestone, sandy, similar to 350-360'.
390-400	Limestone, sandy, similar to 350-360'.
400-410	Limestone, sandy, similar to 350-360'.
410-420	Limestone, sandy, similar to 350-360'.
420-430	Limestone, sandy, similar to 350-360'.
430-440	Limestone, sandy, similar to 350-360'.
440-450	Limestone, sandy, similar to 350-360'.
450-460	Limestone, sandy, similar to 350-360'. Common (1-2%) small foraminifera.
460-470	Limestone, sandy, similar to 350-360'. Common (1-2%) small foraminifera.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-1

Depth (feet)	Lithology
470-480	Limestone, sandy, similar to 350-360'. Common (3-5%) bivalve and/or brachiopod fragments.
480-490	Marl, sandy, abundant very fine quartz, light olive gray (5 Y 5/2) to medium olive gray (5 Y 4/2). Very soft (unlithified) highly friable, plastically deformable when wet. Common sand-sized phosphatic grains, small foraminifera (1-2%) and bivalve fragments.
490-500	Marl, sandy, similar to 480-490'.
500-510	Marl, sandy, similar to 480-490'.
510-520	Marl, sandy, similar to 480-490'.
520-530	Marl, sandy, similar to 480-490'.
530-540	Marl, sandy, similar to 480-490'.
540-550	Marl, sandy, similar to 480-490'.
550-560	Marl, very soft (unlithified), plastically deformable, but less much friable than above due to a higher clay content. Varying abundances of quartz silt. Color ranges from light olive gray (5 Y 5/2) to medium olive gray (5 Y 4/2). Low visible porosity. Common (3-5%) phosphate pebbles/fragments. Foraminifera are less abundant than above.
560-570	Marl, similar to 550-560'.
570-580	Marl, similar to 550-560'. Very light olive gray (5 Y 6/2).
580-590	Marl, similar to 550-560'. Very light olive gray (5 Y 6/2).
590-600	Marl, similar to 550-560'. Very light olive gray (5 Y 6/2).
600-610	Marl, similar to 550-560'.

Continued:

GEOLOGY LOG OF THE CITY OF HOLLYWOOD WELL F-1

Depth (feet)	Lithology
610-620	Marl, similar to 550-560'.
620-630	Marl, similar to 550-560'.
630-640	Marl, similar to 550-560'.
640-650	Marl similar to 550-560'.
650-660	Marl, similar to 550-560'.
660-670	Marl, similar to 550-560'.
670-680	Marl, similar to 550-560'.
680-690	Marl, similar to 550-560'.
690-700	Limestone, coquina, very poorly cemented, >80% large fossils fragments that are covered with marly material. Light olive gray (5 Y 5/2). Fauna is dominated by echinoderms and bivalves and/or brachiopods.
700-710	Limestone, fossiliferous wackestone/packstone. Large fossils (mostly echinoderms) in a very fine-grained marly matrix. Very light olive gray (5 Y 6/2), soft, high porosity.
720-730	Marl, fossiliferous, very light olive gray (5 Y 6/2). Very soft (unlithified), plastically deformable, low visible porosity. Very abundant sand-sized fossil fragments, large fossils are less abundant than above. Common (2-4%) phosphate fragments.
730-740	Marl, fossiliferous, similar to 720-730'.
740-750	Marl, fossiliferous, similar to 720-730'.
750-760	Marl, fossiliferous, similar to 720-730'.
760-770	Marl, fossiliferous, similar to 720-730'.
770-780	Marl, fossiliferous, similar to 720-730'.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-1

Depth (feet)	Lithology
780-790	Marl, fossiliferous, similar to 720-730'. 1-2% phosphate fragments.
790-800	Marl, similar to 650-660'. Sand-sized fossil fragments are less abundant than above.
800-810	Marl, similar to 650-660'.
810-820	Marl, similar to 650-660'. < 1% phosphate fragments.
820-830	Marl, similar to 650-660'.
830-840	Marl, similar to 650-660'. Sand-sized fossil fragments are common.
840-850	Marl, fossiliferous, similar to 720-730'. Abundant very fine to fine sand-sized fossil fragments, some (< 1%) coarse fossil fragments. Very light olive gray (5 Y 6/2). Common phosphate fragments.
850-860	Marl, similar to 650-660'.
860-870	Marl, similar to 650-660'. Abundant very fine sand-sized fossil fragments. Common (5-10%) phosphate fragments.
870-880	Marl, similar to 650-660'. Common phosphate fragments.
880-890	Marl, varying abundances of silt and very fine sand-sized carbonate (fossil?) grains. Very light olive gray (5 Y 6/2), very soft, plastically deformable, low visible porosity. Common (1-3%) phosphate fragments, including trace fish teeth.
890-900	Marl, similar to 880-890'. Abundant very fine sand-sized carbonate grains. 2-5% phosphate fragments, trace large fossils.
900-910	Marl, similar to 880-890', 3-5% olive gray (5 Y 4/1) phosphate fragments. Large fossils are rare.
910-920	Marl, similar to 880-890'.

GEOLOGY LOG OF THE CITY OF HOLLYWOOD WELL F-1

Depth (feet)	Lithology
920-930	Marl, sandy, similar to 880-890' except somewhat more coarse grained. Very light olive gray (5 Y 6/2), very fine salt and pepper appearance from common phosphate sand grains. Large fossils are rare.
930-940	Limestone, sandy, quartz (40+%), very fine-grained (compositionally approaches a calcareous sandstone). Yellowish gray (5 Y 8/1) to very pale orange (10 YR 8/2), salt and pepper appearance. Soft, moderately friable, not plastically deformable, low visible porosity. Common (1-2%) large fossils (echinoids, gastropods, bivalves/brachiopods) in a very fine sand-rich (quartz and carbonate) matrix.
940-950	Limestone, sandy, very fossiliferous, similar to 930-940' except large fossils are much more abundant (=> 40%). Common (2-3%) phosphate fragments, some of which are skeletal. Low visible porosity.
950-960	Limestone, sandy, very fossiliferous, similar to 940-950'.
960-970	Limestone, peloid fossil wackestone/packstone, lighter colored than above, yellowish gray (5 Y 7/2). Medium hardness, low to medium visible porosity. Diverse marine fauna including gastropods, echinoderms, bivalves/brachiopods, and bryozoans.
970-980	Limestone, sandy, fossiliferous, packstone/grainstone. Light gray (N7) to very pale orange (10 YR 8/2). Limestone consists of large fossils (gastropods, bivalves) in a matrix that contains abundant very fine-grained quartz and carbonate sand grains. Medium hardness, low visible porosity.
980-990	Limestone, fossiliferous, grainstone, coarse-grained. Yellowish gray (5 Y 8/1), hard, variable visible porosity, mostly low. Limestone consists of coarse sand-sized bioclasts with larger included fossil fragments, including bryozoans, echinoderms, and bivalves/brachiopods.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-1

Depth (feet)	Lithology
990-1000	Limestone, fossiliferous grainstone, Very pale orange (10 YR 8/2). Medium hardness/friability, high intergranular porosity. Coarse-grained bioclastic sand with included larger fossil fragments (echinoderms, bryozoans, bivalves/brachiopods, foraminifera). 5-10% well-cemented grainstone, very light gray (N8) to light gray (N7).
1000-1010	Limestone, peloid fossil grainstone, very pale orange (10 YR 8/2). Medium hardness and porosity. Large fossil fragments (echinoderms, bryozoans, bivalves/brachiopods, gastropods) in a carbonate sand matrix.
1010-1020	Limestone, fossil peloid grainstone/packstone. Very pale orange (10 YR 8/2). Medium hardness/friability, high porosity. Fauna is dominated by Dictyoconus foraminifera (10-15%), with much less common ostracods, gastropods, and echinoderms.
1020-1030	Limestone, fossil peloid grainstone/packstone, similar to 1010-1020. 5-10% Dictyoconus, minor (<5%) very fine-grained sandy limestone (very light gray {N8}).
1030-1040	Limestone, fossil peloid grainstone, similar to 1010-1020.
1040-1050	Limestone, fossil peloid grainstone, similar to 1010-1020.
1050-1060	Limestone, fossil peloid grainstone, similar to 1010-1020. Very fossiliferous (30-40%), abundant Dictyoconus and much less common echinoderms.
1060-1070	Limestone, fossil peloid packstone/grainstone. White (N9) to very pale orange (10 YR 8/2), chalky appearance. Somewhat harder and less friable than above, medium porosity. Dictyoconus is less abundant than above (1-2%). Minor medium light gray (N6) sandy limestone.
1070-1080	Limestone, fossil peloid grainstone/packstone. White (N9) to very pale orange (10 YR 8/2), chalky appearance. Medium hardness/friability and porosity, somewhat softer than 1060-1070'. Common Dictyoconus (2-5%), minor echinoderms and gastropods. 15-20% medium gray (N4) silty/sandy micritic limestone.

Continued:

GEOLOGY LOG OF THE CITY OF HOLLYWOOD WELL F-1

Depth (feet)	Lithology
1080-1090	Limestone, fossil peloid grainstone/packstone, similar to 1070-1080. 1-3% Dictyoconus.
1090-1100	Limestone, fossil peloid grainstone/packstone, similar to 1070-1080. Common Dictyoconus.
1100-1110	Limestone, fossil peloid grainstone/packstone, similar to 1070-1080. 5% Dictyoconus. 5-10% medium light gray (N5) silty limestone.
1110-1120	Limestone, mixed lithologies, common Dictyoconus, trace phosphatic fragments (skeletal). A) Pelodial grainstone, very pale orange (10 YR 8/2), medium to high intergranular porosity. B) (5-10%) Micritic limestone (mudstone) very pale orange (10 YR 8/2), harder (less friable) than grainstone.
1120-1130	Limestone, similar to 1110-1120'. Micritic limestone is less abundant than above.
1130-1150	No samples. Sample bags disintegrated mixing their contents.
1150-1160	Limestone, fossil peloid grainstone, yellowish gray (5 Y 7/2) to very pale yellowish brown (10 YR 7/2). Limestone is darker than above. Soft/friable, high intergranular porosity. Low diversity fauna dominated by Dictyoconus foraminifera (5%) and echinoderms (1%).
1160-1170	Limestone, fossil peloid grainstone, similar to 1150-1160'. Minor white (N9) micritic limestone (mudstone/wackestone). Common Dictyoconus (1-3%).
1170-1180	Limestone, mudstone (micritic) and fossil peloid packstone/grainstone, very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4). Limestone is harder and less porous than above. Common Dictyoconus (1-2%), and echinoderms (1%).
1180-1190	Limestone, similar to 1170-1180'.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-1

Depth (feet)	Lithology
1190-1200	Limestone, several lithologies present. 1-2% Dictyoconus. A) Peloid grainstone, grayish orange (10 YR 7/4), medium hardness, high intergranular porosity. B) Well-cemented peloid grainstone. C) Mudstone, white (N9) to very pale orange (10 YR 8/2).
1200-1250	Sample bags disintegrated mixing their contents. Limestone, fossil peloid grainstone, subsidiary micritic lithologies. Very pale orange (10 YR 8/2) to very pale yellowish brown (10 YR 7/2). Medium to high porosity, common Dictyoconus and echinoderms.
1250-1310(T.D).	Sample bags disintegrated mixing their contents. Limestone, similar to 1200-1250'. Abundant Dictyoconus (20-25%).Peloid grainstone is the main lithology. Grayish orange (10 YR 7/4), very pale yellowish brown (10 YR 7/2) and very pale orange (10 YR 8/2) limestones are present. Minor dense, hard micritic limestone (mudstone), very pale yellowish brown (10 YR 7/2). No dolomite was observed in the cuttings, as evaluated by reaction with dilute HCl.

TABLE A-2. GEOLOGY LOG OF THE CITY OF HOLLYWOOD WELL F-2

Depth (feet)	Lithology
40-50	Limestone, micritic, very pale orange (10 YR 8/2) to pale yellowish orange (10 YR 8/6). Moderately fossiliferous (< = 10%), mostly unidentifiable fragments. Hard, low porosity. 5-10% medium gray (N5) impure limestone with very fine black (phosphate) grains. Rare very coarse quartz sand.
50-60	Limestone, similar to 40-50'.
60-70	Limestone, similar to 40-50'.
70-80	Limestone, similar to 40-50'. Rare peloid grainstone cuttings (< 1%).
80-90	Limestone, sandy, medium-grained, grainstone/packstone, quartz and carbonate grains. Very pale orange (10 YR 8/2) to very pale yellowish brown (10 YR 7/2), medium hardness/friability, low porosity, 2-5% fossil fragments, < = 1% rounded very coarse quartz sand grains.
90-100	Limestone, sandy, similar to 80-90'.
100-110	Limestone, sandy, similar to 80-90'. 1-3% rounded quartz sand grains, <1% phosphatic sand grains, <2% fossil fragments.
110-120	Limestone, sandy, similar to 80-90'. 2-3% rounded coarse sand grains.
120-190	No samples.
190-200	Limestone, sandy, fine to medium grained grainstone/packstone, quartz and carbonate grains (fossil fragments), medium olive gray (5 Y 5/1), salt and pepper appearance, medium hardness/friability, medium porosity. Echinoids, shell (bivalve?) fragments, 1% subrounded coarse to very coarse quartz sand grains.

Continued:

GEOLOGY LOG OF THE CITY OF HOLLYWOOD WELL F-2

Depth (feet)	Lithology
200-210	Limestone, sandy, similar to 190-200'.
210-220	Limestone, sandy, similar to 190-200'. Uncommon foraminifera, trace coarse quartz sand.
220-230	Limestone, sandy, similar to 190-200'.
230-240	Limestone, sandy, similar to 190-200'.
240-250	Limestone, sandy, similar to 190-200'.
250-260	Limestone, sandy, similar to 190-200'.
260-270	Limestone, sandy, similar to 190-200'. Medium olive gray (5 Y 5/1) to light olive gray (5 Y 5/2).
270-280	Limestone, silty (impure), fresh broken surface; medium light gray (N6) to medium gray (N5), "weathered" light gray (N7) to light olive gray (5 Y 7/1), very fine salt and pepper appearance. Soft, fossils uncommon (< 1%), strong HCl reaction.
280-290	Limestone, silty, similar to 270-280'.
290-300	Limestone, silty, similar to 270-280'.
300-310	No sample.
310-320	Limestone, silty, similar to 270-280'.
320-330	Limestone, silty, similar to 270-280'. 20% silty/sandy limestone, yellowish gray (5 Y 7/2), grains (quartz and carbonate) < = 0.25 mm.
330-340	Limestone, sandy, very fine-grained, quartz and carbonate grains, yellowish gray (5 Y 7/2) to dusky yellow (5 Y 6/4), soft, highly friable, high porosity, >30% quartz, < 1% fossils.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-2

Depth (feet)	Lithology
340-350	Limestone, sandy, similar to 330-340'.
350-360	Limestone, sandy, similar to 330-340'. 1-2% mudstone (micrite), medium light gray (N6) to medium gray (N5), salt and pepper appearance, strong HCl reaction.
360-370	Limestone, sandy, similar to 330-340'.
370-380	Limestone, sandy, similar to 330-340'.
380-390	Limestone, sandy, similar to 330-340'. No mudstone.
390-400	Limestone, sandy, similar to 330-340'. 2-3% mudstone.
400-410	Limestone, sandy, similar to 330-340'. 1% fossil fragments, < = 1% rounded coarse quartz sand.
410-420	No samples.
420-430	Limestone, sandy, similar to 330-340'.
430-440	Limestone, sandy, similar to 330-340'.
440-450	Limestone, sandy, similar to 330-340'. Common shell fragments (3-5%).
450-460	Limestone, sandy, very fine-grained, > = 20% quartz, light olive gray (5 Y 6/2), soft/friable, high porosity, abundant fossil fragments (15-25%), mostly bivalves and/or brachipods, foraminifera are present at lower abundances then above. Strong HCl reaction. Minor siltstone, medium light gray (N6), No HCl reaction.
460-480	No samples.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-2

Depth (feet)	Lithology
480-490	Marl, sandy, very soft (highly friable), silt to very fine-grained quartz is abundant, light olive gray (5 Y 5/2) to yellow gray (5 Y 7/2), common foraminifera (1-4%), including common narrow spiral form, strong HCl reaction. 1-2% rounded coarse quartz sand.
490-500	Marl, sandy, similar to 480-490'.
500-510	Marl, sandy, similar to 480-490'.
510-520	Marl, sandy, similar to 480-490'.
520-530	Marl, sandy, similar to 480-490'.
530-540	Marl, sandy, similar to 480-490'.
540-550	Marl, sandy, similar to 480-490'. Rare phosphatic fragments.
550-560	Marl, sandy similar to 480-490'.
560-590	No samples.
590-600	Marl, plastically deformable (unlithified), variable abundances of silt and very fine sand-sized carbonate grains. Light olive gray (5 Y 6/2), low porosity, strong HCl reaction. Fossils, particularly foraminifera, are less abundant (< 1%) than in overlying strata. 1-2% silt to very fine sand-sized black (phosphatic?) grains. Finer-grained, more clay-rich, and less friable than overlying strata.
600-610	Marl, similar to 590-600'.
610-620	Marl, similar to 590-600'. Rare non-calcareous mudstone cuttings.
620-630	Marl, similar to 590-600'.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-2

Depth (feet)	Lithology
630-640	Marl, similar to 590-600'.
640-650	Marl, similar to 590-600'. < 1% dark olive gray (5 Y 3/1) chips that react with HCl (phosphate?).
650-660	Marl, similar to 590-600'.
660-670	Marl, similar to 590-600'.
670-680	Marl, similar to 590-600'.
680-690	Marl, similar to 590-600'.
690-700	Marl, similar to 590-600'.
700-710	Marl, similar to 590-600'.
710-720	No samples.
720-730	Marl, similar to 590-600'.
730-740	No samples.
740-750	Marl, similar to 590-600'.
750-790	No samples.
790-800	Marl, similar to 590-600'.
800-810	Marl, similar to 590-600'.
810-820	No samples.
820-830	Marl, similar to 590-600'.
830-840	Marl, similar to 590-600'.
840-850	Marl, similar to 590-600'.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-2

Depth (feet)	Lithology
850-860	Marl, similar to 590-600'.
860-870	No samples.
870-880	Marl, similar to 590-600'.
880-890	Marl, similar to 590-600'.
890-900	Marl, similar to 590-600'.
900-926	No samples.
926-927	Limestone, fossiliferous packstone/wackestone, medium gray (N5) to medium dark gray (N4), salt and pepper appearance, hard, low visible porosity. Abundant (50%) large bivalve, echinoderm, and coral fragments in a silty carbonate matrix.
927-930	No samples.
930-940	Limestone, sandy, fossiliferous, very light olive gray (5 Y 6/2), salt and pepper appearance, very fine sand-sized grains (quartz, carbonate), poor sorting, hard, low visible porosity. Limestone consists of abundant (10-20%) large fossils, including bivalves/brachiopods, echinoids, fish teeth, in a very fine carbonate and quartz sand matrix. Common sand-sized phosphate grains. Trace rounded coarse quartz sand.
940-950	No samples.
950-960	Limestone, sandy, fossiliferous, micritic, (wackestone to packstone), light gray (N7) to medium light gray (N6), hard, low visible porosity. Abundant fossils including, bivalves, gastropods, echinoderms, in a silty micritic matrix. Minor medium gray (N5) micritic limestone.

Continued:

GEOLOGY LOG OF THE CITY OF HOLLYWOOD WELL F-2

Depth (feet)	Lithology
960-974	Limestone, very fossiliferous interval (echinoids, bivalves), 2 main lithologies. 1) Micrite with very fine sand-sized grains, medium light gray (N6) salt and pepper appearance, medium hard, low visible porosity. 2) Fossiliferous grainstone, medium grained, yellowish gray (5 Y 7/2), high porosity.
974-982	Limestone, fossiliferous grainstone (bioclastic), yellowish gray (5 Y 7/2), chalky appearance, hard-medium friability, high intergranular porosity, very abundant echinoderms, less common foraminifera. Minor light gray (N7) cuttings.
982-992	Limestone, micritic, fossiliferous, yellowish gray (5 Y 8/1), chalk appearance, medium hardness, low visible porosity, very common (2-5%) Dictyoconus foraminifera, trace echinoderms.
992-1024	Limestone, fossil peloid packstone/grainstone, white (N9) to very pale orange (10 YR 8/2), chalky appearance, hard-medium friability, high intergranular porosity, common Dictyoconus foraminifera (2-5%).
1024-1030	Limestone, fossil peloid packstone/grainstone, similar to 992-1024'. 2-5% Dictyoconus foraminifera, trace large (13 mm in diameter) discoidal foraminifera.
1030-1040	Limestone, fossil peloid packstone/grainstone, similar to 992-1024'.
1040-1050	No samples.
1050-1060	Limestone, fossil peloid packstone/grainstone, similar to 992-1024'.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-2

Depth (feet)	Lithology
1060-1070	Limestone, fossil peloid packstone/grainstone, similar to 992-1024'. Dictyoconus present, but at lower abundances than above. Other fossils present include: foraminifera (various types), ostracods, echinoderms, gastropods.
1070-1080	Limestone, 1% Dictyoconus, 2 lithologies present. 1) (80-90%) fossil peloid packstone/grainstone, similar to 992-1024'. 2) (10-20%) mudstone, very pale orange (10 YR 8/2).
1080-1090	Limestone, fossiliferous mudstone, very pale orange (10 YR 8/2), hard, low visible porosity. Low diversity fauna consisting of common (2-4%) Dictyoconus foraminifera and minor small gastropods. 10-20% peloid packstone/grainstone.
1090-1100	Limestone, mudstone, similar as 1080-1090'.
1100-1110	Limestone, fossil peloid packstone/grainstone, very pale orange (10 YR 8/2), medium hardness, medium-high intergranular porosity, common Dictyoconus (1-5%), fauna dominated by foraminifera. Minor fossiliferous mudstone (< 10%).
1110-1120	Limestone, fossil peloid packstone/grainstone, similar as 1100-1110'. Very pale orange (10 YR 8/2), low diversity fauna dominated by Dictyoconus foraminifera, 20% mudstone/micrite.
1120-1130	Limestone, fossil peloid mudstones to grainstones, white (N9) to very pale orange (10 YR 8/2) medium hardness. Lighter-colored and harder than overlying limestone. Low diversity fauna dominated by Dictyoconus foraminifera (2-3%).
1130-1140	Limestone, fossil peloid mudstones to grainstones, similar to 1120-1130.

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-2

Depth (feet)	Lithology
1140-1150	Limestone, fossil peloid packstone/grainstone, yellow gray (5 Y 7/2), medium hardness and friability, abundant (10+%) Dictyoconus foraminifera. Limestone is somewhat darker and more friable than overlying limestone. Some large cuttings (1%) of limestone similar to 1130-1140'.
1150-1160	Limestone, fossil peloid packstone/grainstone, similar as 1140-1150'. Dictyoconus is less abundant (1-2%) than above. Trace gastropods and bivalves.
1160-1170	Limestone, fossil peloid packstone/grainstone, similar as 1140-1150'.
1170-1180	Limestone, fossil peloid packstone/grainstone, light pale yellowish brown (10 YR 7/2), medium hardness, high intergranular porosity, common (1-2%) Dictyoconus foraminifera, minor echinoids.
1180-1190	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'.
1190-1200	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Abundant, but low diversity fauna dominated by Dictyoconus foraminifera (5-8%). About 10% mudstone (micrite).
1200-1210	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus (2-5%), variable porosity, 2 different colored chips are present (1) yellowish gray (5 Y 7/2) and (2) white (N9) to very pale orange (10 YR 8/2).
1210-1220	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus and ostracods, 10% mudstone (micrite).
1220-1230	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus and ostracods.

Continued:

GEOLOGY LOG OF THE
CITY OF HOLLYWOOD
WELL F-2

Depth (feet)	Lithology
1230-1240	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus and ostracods, 5-10% mudstone (micrite).
1240-1250	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus and ostracods.
1250-1260	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus and ostracods.
1260-1270	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus and ostracods.
1270-1280	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. common Dictyoconus and ostracods, 5% mudstone cuttings.
1280-1290	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Abundant Dictyoconus (10-20%).
1290-1300	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus (3-5%).
1300-1314	Limestone, fossil peloid packstone/grainstone, similar as 1170-1180'. Common Dictyoconus (3-5%), and other fossil fragments (bivalves, echinoids, ostracods), 5% mudstone.

2. Aquifer Test Data

TABLE A-3.

STEP DRAWDOWN TEST
R.O. TEST WELL F-2
8-20-92

Time (minutes)	Water Level (feet above measuring point)	Drawdown (feet)	Specific Capacity (gpm)
Step 1 Static Water Level = 22.95 feet above measuring point Q = 755 gpm			
5	14.00	8.95	84.4
10	14.00	8.95	84.4
20	12.00	10.95	68.9
30	11.75	11.20	67.4
50	11.75	11.20	67.4
Step 2 Static Water Level = 22.95 feet above measuring point Q = 940 gpm			
5	8.20	14.75	63.7
10	7.60	15.35	61.2
15	7.60	15.35	61.2
20	7.60	15.35	61.2
25	7.60	15.35	61.2
30	7.60	15.35	61.2
40	7.60	15.35	61.2
Step 3 Static Water Level 22.95 feet above measuring point Q = 1020 gpm			
5	6.10	16.85	60.5
10	6.00	16.95	60.2
20	5.90	17.05	59.8
30	5.90	17.05	59.8
40	5.90	17.05	59.8
Step 4 Static Water Level = 22.95 feet above measuring point Q = 1180 gpm			
5	3.00	19.95	59.1
10	2.60	20.35	58.0
15	2.40	20.55	57.4
20	2.40	20.55	57.4
25	2.25	20.70	57.0
30	2.25	20.70	57.0
Step 5 Static Water Level = 22.95 feet above measuring point Q = 1140 gpm			
5	3.0	19.95	57.1
10	3.0	19.95	57.1
20	3.0	19.95	57.1
30	3.0	19.95	57.1

TABLE A-4. TIME AND DRAWDOWN DATA FOR TEST/PRODUCTION WELL F-2

Static Water Level = 24.9 Feet Above Measuring Point

TIME (minutes after test start)	PUMPING WATER LEVEL (feet above MP)	TIME (minutes after test start)	PUMPING WATER LEVEL (feet above MP)
0.5	11.50	660	5.80
1.0	11.00	720	5.80
1.2	10.75	780	5.70
1.6	10.60	1200	5.50
2.0	10.40	1620	5.40
2.4	10.00	1980	5.20
3.2	9.75	2160	5.00
5	9.00	2640	4.90
7	8.50	2880	4.90
10	8.25	3120	4.80
20	7.75	3360	4.80
26	7.60	3600	4.80
50	7.00	4080	4.80
54	6.90	4320	4.70
90	6.50	4620	4.70
150	6.25	5160	4.70
210	6.10	5580	4.70
480	5.80	6240	4.70
540	5.90	6600	4.70
600	5.80	7140	4.70

MP = Measuring Point

TABLE A-5.

TIME AND DRAWDOWN DATA FROM OBSERVATION WELL F-1

Time (Minutes)	Drawdown (Feet)	Time (Minutes)	Drawdown (Feet)
0.6	.217	200	3.121
0.7	.280	240	3.216
0.8	.296	300	3.326
0.9	.343	340	3.373
1.0	.359	400	3.484
1.1	.375	450	3.531
1.2	.422	510	3.579
1.3	.438	570	3.642
1.4	.454	630	3.705
1.5	.486	690	3.768
1.7	.517	750	3.831
1.9	.564	810	3.878
2.1	.596	870	3.910
2.3	.628	930	3.926
2.5	.643	990	3.957
2.9	.706	1050	3.973
3.9	.817	1110	4.005
4.5	.896	1200	4.052
5.5	.990	1290	4.083
6.5	1.053	1380	4.115
7.5	1.132	1500	4.162
8.5	1.180	1620	4.194
9.5	1.243	1710	4.210
10.5	1.290	1800	4.225
12	1.401	2100	4.304
14	1.480	2250	4.352
16	1.559	2400	4.383
18	1.622	2700	4.431
20	1.685	3000	4.494
24	1.795	4200	4.557
30	1.937	4800	4.557
34	2.016	5400	4.573
40	2.111	5700	4.620
44	2.174	6480	4.652
50	2.253	6930	4.667
54	2.300	7140	4.699
60	2.363		
70	2.458		
80	2.537		
90	2.616		
100	2.663		
120	2.774		
140	2.916		
160	3.010		
180	3.058		

TABLE A-6. TIME AND RECOVERY DATA FROM OBSERVATION WELL F-1

Time (minutes)	Head (feet)						
0.0000	0.000	0.1333	0.078	0.2666	0.142	0.6666	0.299
0.0033	0.015	0.1366	0.078	0.2700	0.142	0.6833	0.315
0.0066	0.015	0.1400	0.078	0.2733	0.142	0.7000	0.315
0.0100	0.015	0.1433	0.094	0.2766	0.142	0.7166	0.315
0.0133	0.015	0.1466	0.094	0.2800	0.142	0.7333	0.331
0.0166	0.015	0.1500	0.094	0.2833	0.157	0.7500	0.331
0.0200	0.031	0.1533	0.078	0.2866	0.142	0.7666	0.331
0.0233	0.031	0.1566	0.078	0.2900	0.157	0.7833	0.331
0.0266	0.031	0.1600	0.094	0.2933	0.157	0.8000	0.347
0.0300	0.031	0.1633	0.094	0.2966	0.157	0.8166	0.347
0.0333	0.031	0.1666	0.094	0.3000	0.157	0.8333	0.347
0.0366	0.031	0.1700	0.094	0.3033	0.157	0.8500	0.363
0.0400	0.047	0.1733	0.094	0.3066	0.157	0.8666	0.363
0.0433	0.047	0.1766	0.094	0.3100	0.173	0.8833	0.363
0.0466	0.047	0.1800	0.094	0.3133	0.157	0.9000	0.378
0.0500	0.047	0.1833	0.094	0.3166	0.173	0.9166	0.378
0.0533	0.047	0.1866	0.094	0.3200	0.173	0.9333	0.394
0.0566	0.047	0.1900	0.094	0.3233	0.173	0.9500	0.394
0.0600	0.047	0.1933	0.094	0.3266	0.173	0.9666	0.394
0.0633	0.047	0.1966	0.110	0.3300	0.173	0.9833	0.394
0.0666	0.047	0.2000	0.110	0.3333	0.173	1.0000	0.394
0.0700	0.047	0.2033	0.110	0.3500	0.189	1.2000	0.457
0.0733	0.047	0.2066	0.110	0.3666	0.189	1.4000	0.505
0.0766	0.047	0.2100	0.110	0.3833	0.205	1.6000	0.536
0.0800	0.047	0.2133	0.110	0.4000	0.205	1.8000	0.583
0.0833	0.063	0.2166	0.110	0.4166	0.220	2.0000	0.615
0.0866	0.063	0.2200	0.110	0.4333	0.220	2.2000	0.631
0.0900	0.063	0.2233	0.110	0.4500	0.236	2.4000	0.662
0.0933	0.063	0.2266	0.110	0.4666	0.236	2.6000	0.694
0.0966	0.063	0.2300	0.110	0.4833	0.236	2.8000	0.725
0.1000	0.063	0.2333	0.126	0.5000	0.252	3.0000	0.757
0.1033	0.063	0.2366	0.126	0.5166	0.252	3.2000	0.773
0.1066	0.063	0.2400	0.126	0.5333	0.268	3.4000	0.789
0.1100	0.063	0.2433	0.126	0.5500	0.268	3.6000	0.804
0.1133	0.063	0.2466	0.126	0.5666	0.284	3.8000	0.820
0.1166	0.078	0.2500	0.126	0.5833	0.284	4.0000	0.852
0.1200	0.078	0.2533	0.126	0.6000	0.284	4.2000	0.867
0.1233	0.078	0.2566	0.126	0.6166	0.284	4.4000	0.883
0.1266	0.078	0.2600	0.126	0.6333	0.299	4.6000	0.899
0.1300	0.078	0.2633	0.142	0.6500	0.299	4.8000	0.915

Continued:

TIME AND RECOVERY DATA
FROM OBSERVATION WELL F-1

5.0000	0.931	52.0000	2.114	540.000	3.503	5600.00	4.655
5.2000	0.946	54.0000	2.146	560.000	3.519	5800.00	4.623
5.4000	0.962	56.0000	2.161	580.000	3.535	6000.00	4.671
5.6000	0.978	58.0000	2.177	600.000	3.535	6200.00	4.702
5.8000	0.994	60.0000	2.193	620.000	3.550	6400.00	4.702
6.0000	1.009	62.0000	2.225	640.000	3.550	6600.00	4.686
6.2000	1.025	64.0000	2.240	660.000	3.598	6800.00	4.734
6.4000	1.041	66.0000	2.240	680.000	3.598	7000.00	4.734
6.6000	1.057	68.0000	2.288	700.000	3.613	7200.00	4.686
6.8000	1.073	70.0000	2.288	720.000	3.629	7400.00	4.686
7.0000	1.088	72.0000	2.303	740.000	3.629	7600.00	4.781
7.2000	1.104	74.0000	2.319	760.000	3.661	7800.00	4.765
7.4000	1.104	76.0000	2.367	780.000	3.661	8000.00	4.860
7.6000	1.120	78.0000	2.351	800.000	3.692	8200.00	4.607
7.8000	1.136	80.0000	2.351	820.000	3.708	8400.00	4.702
8.0000	1.151	82.0000	2.367	840.000	3.724	8600.00	4.686
8.2000	1.167	84.0000	2.398	860.000	3.724	8800.00	4.671
8.4000	1.183	86.0000	2.398	880.000	3.755		
8.6000	1.183	88.0000	2.430	900.000	3.755		
8.8000	1.199	90.0000	2.430	920.000	3.771		
9.0000	1.215	92.0000	2.430	940.000	3.803		
9.2000	1.230	94.0000	2.461	960.000	3.818		
9.4000	1.230	96.0000	2.445	980.000	3.834		
9.6000	1.246	98.0000	2.524	1000.00	3.850		
9.8000	1.246	100.000	2.461	1200.00	3.960		
10.0000	1.262	120.000	2.588	1400.00	3.992		
12.0000	1.341	140.000	2.682	1600.00	4.055		
14.0000	1.404	160.000	2.745	1800.00	4.165		
16.0000	1.483	180.000	2.840	2000.00	4.213		
18.0000	1.546	200.000	2.872	2200.00	4.213		
20.0000	1.609	220.000	2.966	2400.00	4.292		
22.0000	1.641	240.000	2.982	2600.00	4.355		
24.0000	1.688	260.000	3.061	2800.00	4.355		
26.0000	1.767	280.000	3.077	3000.00	4.355		
28.0000	1.783	300.000	3.140	3200.00	4.418		
30.0000	1.814	320.000	3.171	3400.00	4.450		
32.0000	1.862	340.000	3.203	3600.00	4.450		
34.0000	1.893	360.000	3.250	3800.00	4.466		
36.0000	1.940	380.000	3.298	4000.00	4.544		
38.0000	1.956	400.000	3.329	4200.00	4.529		
40.0000	1.988	420.000	3.345	4400.00	4.497		
42.0000	2.019	440.000	3.376	4600.00	4.544		
44.0000	2.035	460.000	3.408	4800.00	4.607		
46.0000	2.051	480.000	3.424	5000.00	4.592		
48.0000	2.083	500.000	3.455	5200.00	4.607		
50.0000	2.130	520.000	3.471	5400.00	4.655		

3. Water Quality Data

TABLE A-7.

CITY OF HOLLYWOOD RO TEST WELL F-2
WATER QUALITY DURING REVERSE AIR DRILLING
926 TO 1314' TOTAL DEPTH

DEPTH (feet)	DISSOLVED CHLORIDE CONCENTRATION (mg/l)	SPECIFIC CONDUCTIVITY (umhos/cm)
927	1900	6800
957	2200	8000
992	2000	7000
1024	2600	7950
1054	2000	7100
1087	2040	8800
1118	2100	7900
1148	2100	7800
1180	2180	7800
1211	2160	7800
1240	2160	7390
1272	2200	9000
1300	2140	8900
1314	2120	8100

Water quality variation possibly due to temperature variations and reverse air drilling while well is salt plugged.

TABLE A-8.

CITY OF HOLLYWOOD
WELL F-2
AQUIFER PERFORMANCE TEST
WATER QUALITY DATA

Sample No.	Time (minutes)	Conductivity (corrected)	Chloride (mg/l)
5a	6	7390	2160
656	60	7440	2180
185	120	7220	2120
H1106	180	7390	2140
H2009	240	7460	2200
14a	300	7390	2140
69	360	7390	2140
72	420	7350	2120
7a	480	7350	2120
600	720	7320	2160
1500	960	7350	2100
1466	1200	7350	2160
H-1007	1680	7350	2120
542	2160	7300	2120
H-1073	2400	7350	2100
2007	2640	?	2140
H-1524	2880	7350	2100
H-1468	3120	7300	2120
3a	3360	7250	2120
64	3600	7250	2100
H-1101	3840	7250	2100
6A	4080	7250	2120
B-154	4320	7250	2100
4A	4560	7250	2100
12A	4800	7250	2100
H-1077	5040	7250	2100
H-1024	5280	7300	2140
H-1052	5520	7250	2100
97	5820	7250	2120
H-1018	6120	7300	2160
598	6360	7250	2100
H-1082	6600	7250	2100
H-1517	6840	7250	2100
(A6)	6960	7250	2140