DRILLING AND TESTING OF PRODUCTION WELLS 13 THROUGH 18 NORTH PORT WELL FIELD PORT ST. LUCIE, FLORIDA

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Prepared for:
General Development Utilities, Inc.
1111 South Bayshore Drive
Miami, Florida
33131

Prepared by:
Geraghty & Miller, Inc.
Ground-Water Consultants
1665 Palm Beach Lakes Blvd., Suite 604
West Palm Beach, Florida
33401

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DRILLING AND TESTING OF PRODUCTION WELLS 13 THROUGH 18 NORTH PORT WELL FIELD PORT ST. LUCIE, FLORIDA

INTRODUCTION

In October 1981, as authorized by Addendum 22 of Contract 816 from General Development Utilities, Inc., (GDUI) of Miami, Florida, Geraghty & Miller, Inc., initiated a program of production-well construction and testing in the North Port section of General Development Corporation's Port St. Lucie community. Persson Drilling Corporation, of Fort Pierce, Florida, was subcontracted by Geraghty & Miller, Inc., to construct and test six new production wells and associated sentinel wells for the program. The purpose was to increase GDUI's water-supply capacity for Port St. Lucie.

Favorable water-producing material in the shallow aquifer beneath Port St. Lucie has been discovered during previous exploratory drilling programs conducted by Geraghty & Miller, Inc. A large area south and west of the North Port Water Plant and Well Field has been proven suitable for installation of production wells. For this program, GDUI and Geraghty & Miller staff members selected production-well sites that were available and accessible to the water plant and raw water pipeline.

This report describes the drilling and construction of the production and sentinel wells and details the pumping-test procedures. Pumping-test data are evaluated and interpreted; water-quality data for the production wells are presented and reviewed; and recommendations for optimum well capacity and estimated pumping levels are given.

FINDINGS

1. Production Wells 13 through 18 (PW13 through PW18) are screened opposite water-producing material between 50 and 105 feet below land surface.

2. The recommended installed capacities of the completed wells are: PW13, 190 gpm (gallons per minute); PW14, 315 gpm; PW15, 450 gpm; PW16, 300 gpm; PW17, 450 gpm; and PW18, 100 gpm. The total recommended installed capacity for these six wells is 1805 gpm, or 2.6 mgd (million gallons per day).

3. Raw water from the production wells is potable for domestic purposes without treatment; however, to meet public water-supply standards (Chapter 17-22, Florida Administrative Code) or to provide a superior product, some parameters may require treatment.

Parameters that may have to be treated include color, corrosivity, iron, turbidity, total dissolved solids, and hardness.

4. Static and pumping water levels in the production and sentinel wells should be measured and recorded quarterly; the pumping rate and gravel pack height of each well should be noted and recorded at the same time.

5. Implementation of the monitoring program required by the South Florida Water Management District will satisfy permit conditions, aid GDUI in managing the well field, and provide data upon which future expansion plans can be based.

DRILLING AND WELL CONSTRUCTION

Six production wells were installed in the general vicinity of the North Port Well Field on parcels of land designated as public parks. Well site locations are shown on Figure 1. Well construction was permitted by the DER (Florida Department of Environmental Regulation); the sites of Wells 17 and 18 had to be re-graded to make them conform to DER requirements for public-supply wells. A sentinel well was installed adjacent to each production well to provide information on well and aquifer performance which can be used as a guide for operating and maintaining the wells. These were designated as S13 through S18 to correspond with the numbers of the adjacent production well.

Each of the production wells was constructed using the following sequence of operations:

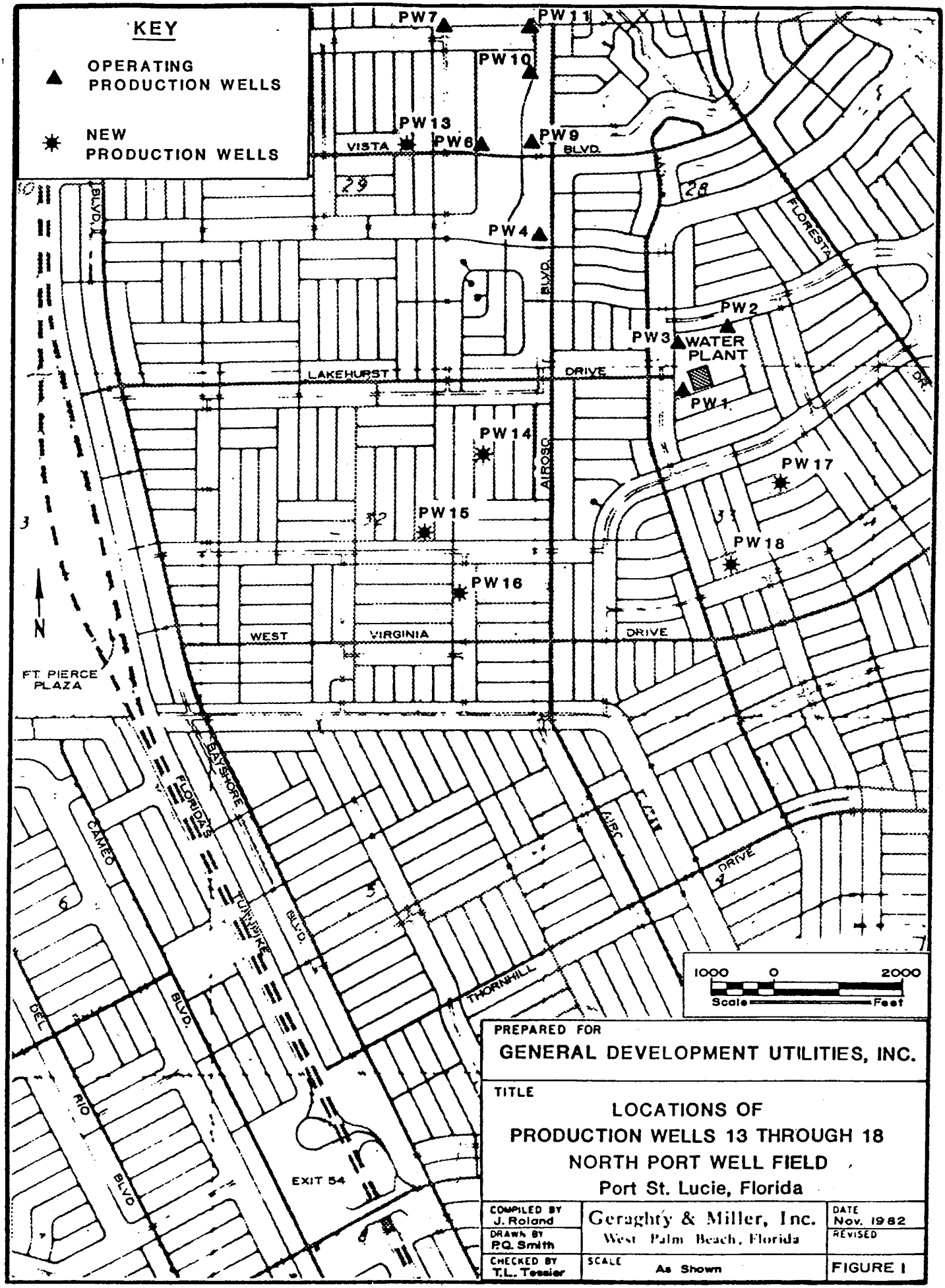
1. Drill a test hole to the top of the potential screen zone by the rotary method.

2. Obtain continuous formation samples during test-hole drilling and split-spoon samples after each five feet of drilling in the potential screen zone. Prepare a geologic log from the samples.

3. Complete the test hole to its total depth and select a potential production zone.

4. Construct a two-inch-diameter sentinel well of PVC pipe in each test hole with the screen set opposite the potential production zone.

5. Select split-spoon samples for sieve analysis and send them to a well-screen manufacturer for analysis and recommendations. Review results and select the screen zone, screen size, and gravel pack size.



PREPARED FOR
GENERAL DEVELOPMENT UTILITIES, INC.

TITLE
LOCATIONS OF
PRODUCTION WELLS 13 THROUGH 18
NORTH PORT WELL FIELD
Port St. Lucie, Florida

COMPILED BY J. Roland	Geraghty & Miller, Inc.	DATE Nov. 1982
DRAWN BY P.Q. Smith	West Palm Beach, Florida	REVISED
CHECKED BY T.L. Tessier	SCALE As Shown	FIGURE 1

6. Drill a 21-inch-diameter hole to the top of the screen zone by the rotary method, install 16-inch-diameter casing to the top of the producing zone, and seal the annulus to land surface with neat cement.

7. Drill through the cement plug at the bottom of the 16-inch-diameter casing, and drill a 15-inch-diameter hole by the rotary method to eight feet below the bottom of the selected screen zone.

8. Install a centralized 8-inch-diameter, wire-wound, stainless steel well screen opposite the production zone; an 8-inch-diameter, 5-foot-long, closed-bottom sump beneath the screen; and 8-inch-diameter steel casing from the top of the screen to above ground level.

9. Pump gravel-pack material around the screen and develop the well to a sand-free condition by pumping and with compressed air, replenishing the gravel pack as necessary.

10. Perform step- and constant-rate pumping tests.

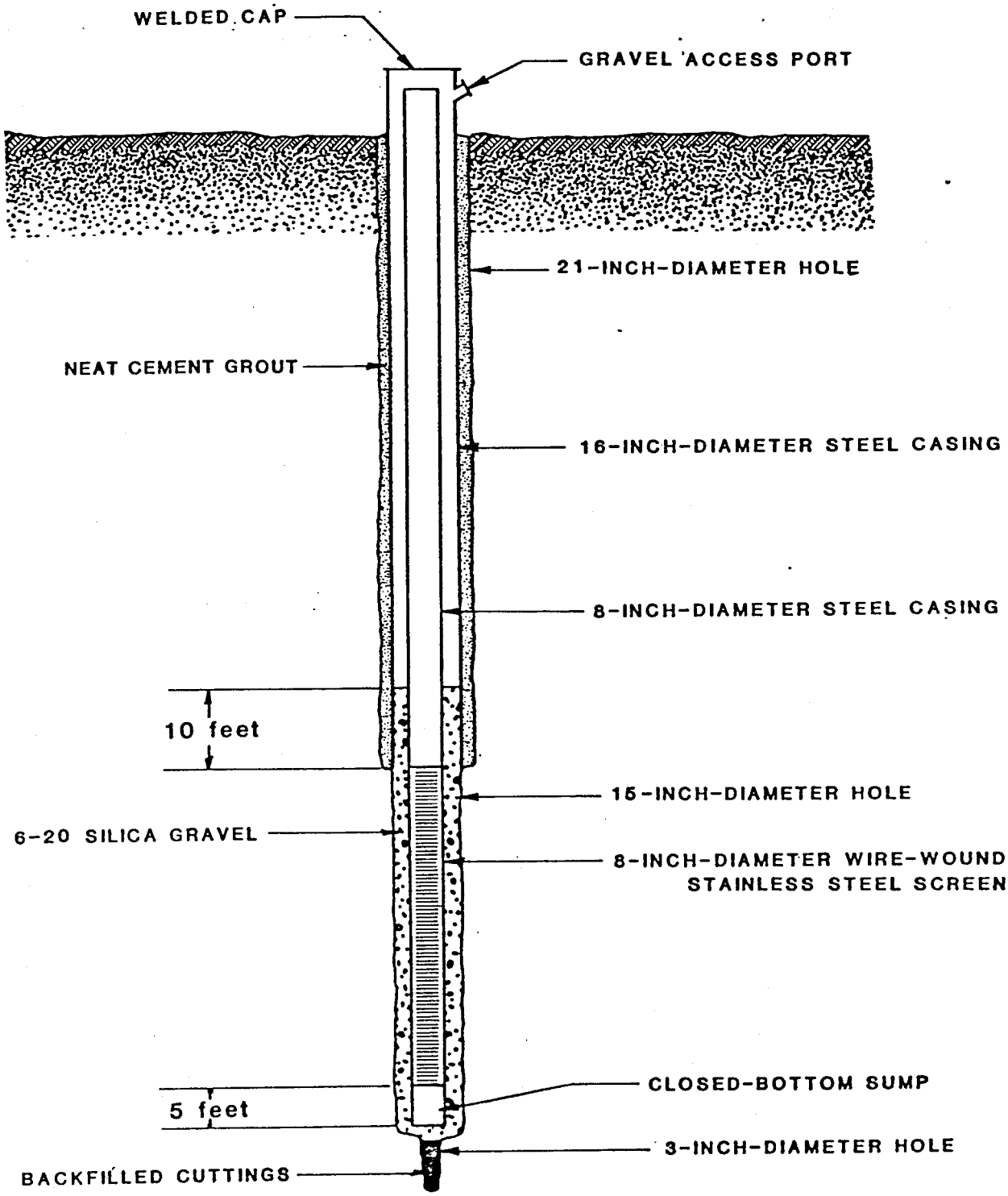
11. Complete well head with cap, gravel access tube, and cement pad.

Details of typical production-well construction are illustrated in Figure 2. Construction data for all six production wells are shown in Table 1. Construction details of the sentinel wells are given in Table 2.

HYDROGEOLOGIC CONDITIONS

Construction and testing of all six production wells were directed by Geraghty & Miller. Formation samples were collected and evaluated on site by the Geraghty & Miller, Inc., hydrogeologist. Geologic logs were compiled and are presented in Appendix A. Evaluation of the geologic logs and other data collected during the test-hole drilling indicates that fine-grained quartz sands with generally minor interbeds of clay and shell fragments exist to a depth of about 50 to 60 feet below land surface. The formation becomes more coarse grained and has a greater shell content below 50 to 60 feet, and is interbedded with a sandy, shelly limestone. The limestone, sand, and shell sequence is highly productive in the locations tested. These materials extend to depths of about 95 to 105 feet below ground level, where they grade into a much finer-grained, less productive strata. The shell content decreases and clays and silts become dominant.

Based on the results of previous exploratory drilling programs in the Port St. Lucie area, the extensive clay beds marking the base of the shallow aquifer and the top of the Hawthorn Formation are usually found at depths ranging from 140 to 160 feet. Generally, the 40 to 50 feet of



Not to Scale

PREPARED FOR
GENERAL DEVELOPMENT UTILITIES, INC.

TITLE
TYPICAL PRODUCTION-WELL DESIGN
PRODUCTION WELLS 13 THROUGH 18
NORTH PORT WELL-FIELD
Port St. Lucie, Florida

COMPILED BY J. Roland	Geraghty & Miller, Inc.	DATE Nov. 1982
DRAWN BY P.Q. Smith	West Palm Beach, Florida	REVISED
CHECKED BY T.L. Tessler	SCALE None	FIGURE 2

TABLE 1

CONSTRUCTION DETAILS OF
PRODUCTION WELLS 13 THROUGH 18
NORTH PORT WELL FIELD
PORT ST. LUCIE, FLORIDA

Well Number	Depth of Outer Casing (feet)	Screened Interval (feet)	Total Completed Well Depth (feet) Including 5-Foot Sump
PW13	54.5	54.5- 94.5	99.5
PW14	60.0	60.0- 95.0	100.0
PW15	64.5	64.5- 94.5	99.5
PW16	55.0	55.0- 85.0	90.0
PW17	55.0	55.0-105.0	110.0
PW18	50.0	50.0- 90.0	95.0

Note: All depths are measured below existing grade.
All outer casing diameters are 16 inches (outside diameter).
All inner casing and screen diameters are 8 inches (inside diameter).
All wells were completed with 0.040-inch-slot screens and 6-20 silica gravel

TABLE 2

CONSTRUCTION DETAILS OF
SENTINEL WELLS 13 THROUGH 18
NORTH PORT WELL FIELD
PORT ST. LUCIE, FLORIDA

Well Number	Screened Interval (feet below land surface)	Distance From Production Well (feet)
S13	55 - 95	13.61
S14	60 - 95	17.55
S15	65 - 95	17.95
S16	55 - 95	14.50
S17	55 - 95	47.50
S18	50 - 90	44.50

Note: All wells are constructed of two-inch-diameter PVC casing and screen.
Screened intervals are gravel packed with 6-20 graded silica.

material overlying the clay contact consists of silty limestone, fine-grained quartz sand, and traces of sandy, gray or green clay. When these materials were found in the test-hole samples, drilling was halted. The production wells were designed to utilize the more productive upper zone of the aquifer.

PUMPING TESTS

Step-rate and constant-rate pumping tests were conducted on each production well, using a diesel-driven turbine pump which was installed after air development was completed. Prior to testing, each well was pumped and surged for a period of one to two hours to complete development and assure that the discharge was sand free. During the tests, the discharge water was conveyed from the vicinity of the well by means of a six-inch-diameter PVC pipeline. An orifice and manometer were installed at the end of the discharge pipe to measure the pumping rate and a gate valve was used to regulate the rate.

Step-Rate Tests

The step-rate test was performed prior to the constant-rate test. This type of test is useful for:

1. Predicting a well's response to pumping over a range of pumping rates
2. Selecting a suitable rate for the constant-rate test
3. Anticipating the magnitude of water-level response in the production and any nearby observation wells
4. Verifying future well efficiency by providing a basis for comparison
5. Testing the pump discharge line, and flow-measuring devices
6. Determining capacity and pumping water levels

In addition, the step-rate test is a special condition of the South Florida Water Management District water-use permits.

Table 3 summarizes the static and pumping water-level data, and the calculated specific capacity for each step of each test. Specific capacity is a measure of yield per foot of drawdown during a particular pumping period. Since each pumping period during these tests was 30 minutes long and each recovery period was 60 minutes long, specific capacity serves as a useful comparison of productivity between wells.

TABLE 3

DATA COLLECTED DURING STEP-RATE TESTS
AT NORTH PORT WELL FIELD
PORT ST. LUCIE, FLORIDA

Step	Pumping Rate (gpm)	Static Depth to Water at Start of Pumping (feet below measuring point)	Depth to Water After 30 Minutes of Pumping (feet below measuring point)	Specific Capacity (gpm/ft)
		PRODUCTION WELL 13 - January 26, 1982		
1	401	13.52	42.62	13.78
2	335	13.90	37.38	14.27
3	271	13.86	35.22	12.68
4	201	13.81	27.15	15.06
		PRODUCTION WELL 14 - January 21, 1982		
1	278	9.86	44.19	8.10
2	220	10.32	31.33	10.47
3	185	10.72	26.10	12.03
4	145	10.89	21.04	14.28
		PRODUCTION WELL 15 - February 2, 1982		
1	523	7.84	37.13	17.85
2	444	8.23	29.54	20.83
3	369	8.30	24.38	22.95
4	275	8.32	18.08	28.17
		PRODUCTION WELL 16 - March 23, 1982		
1	498	8.01	41.27	14.97
2	411	8.39	30.99	18.18
3	320	8.43	24.46	19.96
4	257	8.41	19.42	23.34
		PRODUCTION WELL 17 - May 25, 1982		
1	510	5.54	31.35	19.76
2	584	6.12	35.35	19.98
3	412	6.45	26.20	20.86
4	316	6.48	20.53	22.49
		PRODUCTION WELL 18 - May 11, 1982		
1	205	4.50	44.86	5.08
2	158	4.62	35.48	5.12
3	114	4.70	26.26	5.29
4	79	4.75	20.24	5.10

NOTES

Measuring point was 3.00 feet above land surface for Production Well 13.
Measuring point was 3.00 feet above land surface for Production Well 14.
Measuring point was 1.35 feet above land surface for Production Well 15.
Measuring point was 1.55 feet above land surface for Production Well 16.
Measuring point was 1.75 feet above land surface for Production Well 17.
Measuring point was 1.80 feet above land surface for Production Well 18.
All drawdown steps were 30 minutes.
All recovery steps were 60 minutes.

Graphical comparisons of pumping rate and specific capacity are shown in Figures 3A and 3B.

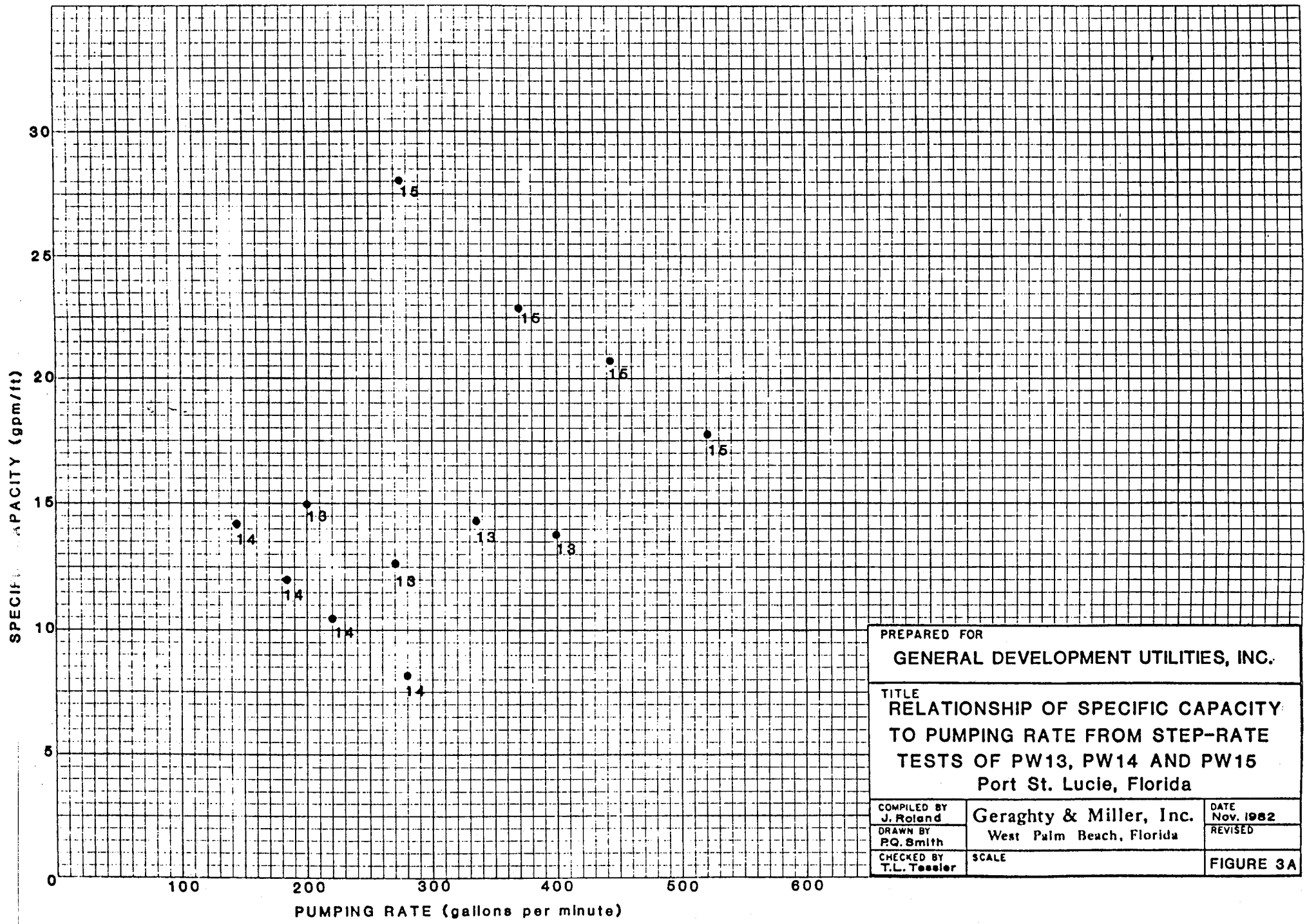
As can be seen, Wells 13 and 14 both have specific capacities that range between about 8 and 15 gpm/ft. However, the specific capacity of Well 14 declines more rapidly at higher pumping rates than does Well 13. This suggests that a greater head loss occurs in Well 14 in moving water from the aquifer into the well. Wells 15, 16, and 17 all exhibit similar patterns of specific capacity. The initial specific capacity of Well 15 is somewhat higher than Wells 16 and 17 at lower pumping rates, but it declines more rapidly at higher pumping rates. A greater head loss occurs in moving water into Well 15 than in moving water into Wells 16 and 17.

These data can be used by GDUI in the future as a basis for identifying any decline in an individual well's efficiency. By conducting a 30-minute pumping test at a well's normal rate and comparing the resulting specific capacity to those determined during these tests, it will be possible to estimate the decrease (or increase) in efficiency of individual wells. From this comparison, GDUI can decide when individual wells require redevelopment or replacement. It will be possible also to determine the improvement in efficiency of a well following redevelopment.

Constant-Rate Tests

Constant-rate tests were performed in order to establish the production-well and aquifer response to longer periods of pumping. Each test consisted of a six- to eight-hour pumping segment followed by a two-hour recovery period. Water-level data were collected from the production well, the nearby two-inch-diameter sentinel well, and from a shallow well (installed by Geraghty & Miller, Inc., personnel for test purposes) that just penetrated to the water table. Table 4 summarizes the water-level data collected during each test. The drawdown data collected from each production well during the test are graphically presented in Appendix B.

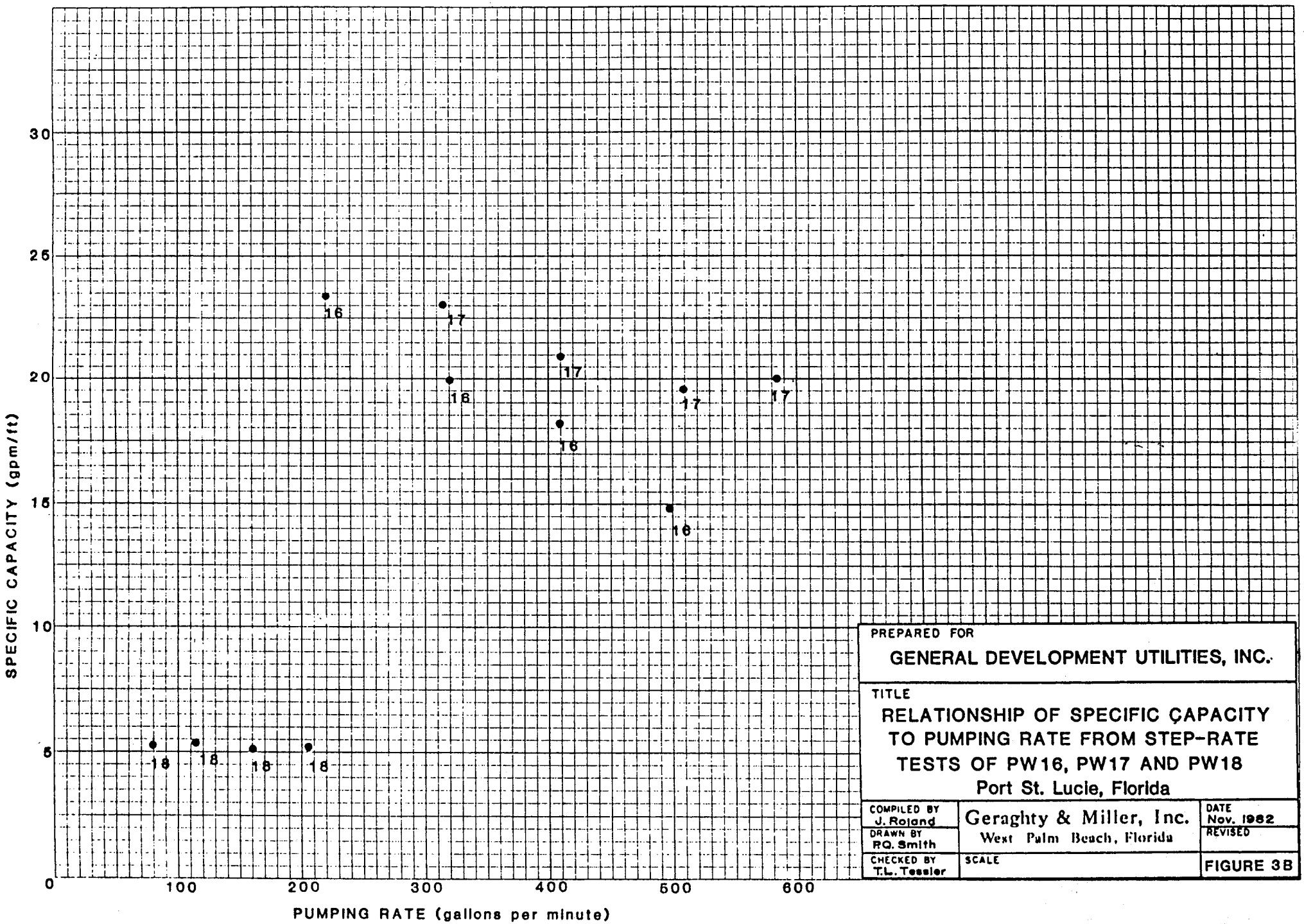
The transmissivity of the aquifer in the vicinity of each well can be estimated from an analysis of the test data. For each test, drawdown and recovery data from the pumped well and drawdown data from the sentinel well were available for analysis. The analyses were made using Jacob's modification of the Theis equation. This method was designed to permit simple graphical analysis of water-level data collected from wells penetrating a confined aquifer with no source of recharge. Although the aquifer at Port St. Lucie receives recharge from rainfall at the surface and through leakage from the water table, the influence of leakage in the vicinity of a pumped well is insignificant during short-term pumping tests. Therefore, the transmissivity values derived using Jacob's method are considered to be reasonable approximations of



PREPARED FOR
GENERAL DEVELOPMENT UTILITIES, INC.

TITLE
RELATIONSHIP OF SPECIFIC CAPACITY TO PUMPING RATE FROM STEP-RATE TESTS OF PW13, PW14 AND PW15
Port St. Lucie, Florida

COMPILED BY J. Roland	Geraghty & Miller, Inc.	DATE Nov. 1982
DRAWN BY P.Q. Smith	West Palm Beach, Florida	REVISED
CHECKED BY T.L. Tessier	SCALE	FIGURE 3A



PREPARED FOR

GENERAL DEVELOPMENT UTILITIES, INC.

TITLE

RELATIONSHIP OF SPECIFIC CAPACITY TO PUMPING RATE FROM STEP-RATE TESTS OF PW16, PW17 AND PW18

Port St. Lucie, Florida

COMPILED BY J. Roland	Geraghty & Miller, Inc.	DATE Nov. 1982
DRAWN BY RQ. Smith	West Palm Beach, Florida	REVISED
CHECKED BY T.L. Tessler	SCALE	FIGURE 3B

TABLE 4

SUMMARY OF CONSTANT-RATE PUMPING TEST DATA
PRODUCTION WELLS 13 THROUGH 18
NORTH PORT WELL FIELD
PORT ST. LUCIE, FLORIDA

Well Measured	Distance From Pumped Well (feet)	Screened Depth (feet below land surface)	Static Water Level (feet below land surface)	Maximum Water Level Change
PRODUCTION WELL 13 - January 27, 1982 (pumping for 8 hours at 380 gpm)				
PW13	0	54.5-94.5	10.10	30.09
S13	13.61	55-95	12.38	17.76
WT13	10.33	1.0-2.0	0.89	0.08
PRODUCTION WELL 14 - January 20, 1982 (pumping for 8 hours at 257 gpm)				
PW14	0	60-95	6.92	37.71
S14	17.55	60-95	8.02	4.88
PRODUCTION WELL 15 - February 5, 1982 (pumping for 8 hours at 472 gpm)				
PW15	0	64.5-94.5	6.59	26.46
S15	17.95	65-95	8.14	5.07
WT15	11.68	3-4	6.36	+0.02
PRODUCTION WELL 16 - March 24, 1982 (pumping for 8 hours at 473 gpm)				
PW16	0	55-85	6.28	38.05
S16	14.50	55-95	5.93	7.32
WT16	6.80	2.5-3.5	2.70	0.02
PRODUCTION WELL 17 - May 26, 1982 (pumping for 6 hours at 548 gpm)				
PW17	0	55-105	3.37	30.28
S17	47.50	55-95	7.23	16.13
WT17	20.00	2.5-3.5	0.83	0.19
PRODUCTION WELL 18 - May 12, 1982 (pumping for 6 hours at 205 gpm)				
PW18	0	50-90	2.52	43.28
S18	44.50	50-90	3.36	8.62
WT18	18.00	3.5-4.5	3.42	0.10

the true aquifer transmissivities. The estimated transmissivities are presented in Table 5. To obtain more precise values, longer pumping tests and more distant observation wells would be required. The values derived from these pumping tests are consistent with those established for this area during previous investigations. Consequently, detailed testing was considered to be unnecessary for this program.

Data from the test of PW15 suggest that a hydrologic boundary exists near that site. It is apparent as a two-fold increase in the slope of the drawdown-data curve in PW15 after about 40 minutes of pumping. This corresponds with knowledge about areal geologic conditions. Previous investigations southwest of PW15 have shown that the formation material in the production zone is not productive enough to warrant the installation of public-supply wells. Therefore, it appears that expanding the North Port Well Field into that area will be undesirable. However, productive material suitable for water-supply development was identified during previous studies to the south near Airoso Boulevard and north near Prima Vista Boulevard and adjacent to Florida's Turnpike. If the North Port Well Field is expanded, these areas contain potential well sites.

Recommended capacities and estimated pumping levels for each new production well are shown in Table 6. These recommendations were sent to GDUI previously in a series of letters as information on each individual well became available following testing. The capacities and pumping levels allow for seasonal fluctuations of water levels, for interference from Wells 1 through 12 at their design capacities, and for interference effects from Wells 13 through 18 pumping at their recommended capacities. In order to estimate pumping levels, it was assumed that all production wells would be pumped continuously for a minimum of 7 days, or until stabilization. It is likely that continuous pumpage from all the wells will occur only rarely, so that the average interference effects will be less than predicted. The total capacity for the six new production wells is 1805 gpm, or 2.6 million gallons per day.

WATER QUALITY

Prior to the end of each constant-rate test, a water sample was collected. Analyses for constituents listed in the Florida primary and secondary drinking water standards (Florida Administrative Code, Chapter 17-22) and those that affect treatability (such as alkalinity and hardness) were performed by Orlando Laboratories, Inc. The results are presented in Appendix C.

Concentrations of the various constituents are generally typical of ground water from this area. Based on these data, the water could be used without treatment by domestic systems. Total dissolved solids, bicarbonate and bicarbonate alkalinity, total and calcium hardness, and

TABLE 5

ESTIMATES OF TRANSMISSIVITIES
FROM PUMPING TESTS CONDUCTED
ON PRODUCTION WELLS 13 THROUGH 18
NORTH PORT WELL FIELD
PORT ST. LUCIE, FLORIDA

Test of	Well Measured	Data Used	Transmissivity (gpd/ft)
PW13	PW13	Drawdown	23,300
	PW13	Recovery	24,000
	S13	Drawdown	33,440
PW14	PW14	Drawdown	29,500
	PW14	Recovery	56,000
	S14	Drawdown	61,700
PW15	PW15	Drawdown	54,700
	PW15	Recovery	78,900
	S15	Drawdown	75,500
PW16	PW16	Drawdown	71,400
	PW16	Recovery	69,400
	S16	Drawdown	73,500
PW17	PW17	Drawdown	35,900
	PW17	Recovery	36,600
	S17	Drawdown	38,700
PW18	PW18	Drawdown	10,400
	PW18	Recovery	11,600

TABLE 6

RECOMMENDED WELL CAPACITIES
AND ESTIMATED PUMPING LEVELS
PRODUCTION WELLS 13 THROUGH 18
NORTH PORT WELL FIELD
PORT ST. LUCIE, FLORIDA

Well	Recommended Capacity (gallons per minute)	Estimated Pumping Water Level (feet below land surface)
PW13	190	45.0
PW14	315	49.0
PW15	450	44.5
PW16	300	45.0
PW17	450	45.0
PW18	100	40.0

iron concentrations are high enough, however, to make treatment desirable. The water also has a high color level and is alkaline.

Water provided by community supply systems must meet primary and secondary drinking water standards as specified in Chapter 17-22 of the Florida Administrative Code. The raw water from PW13 through PW18 meets these standards except as follows:

PW13 - color, corrosivity, iron
PW14 - color, corrosivity, iron
PW15 - color, corrosivity, iron, turbidity
PW16 - color, iron, turbidity, total dissolved solids
PW17 - color, turbidity
PW18 - color, turbidity

All the other constituents evaluated, which include inorganic elements and organic compounds, were found in concentrations below the limits specified in the primary and secondary drinking water standards. It should be noted that the report forms from Orlando Laboratories list a maximum contaminant level of 150 mg/l (milligrams per liter) for total hardness. This level is exceeded in all six wells. However, the State of Florida does not have a standard for total hardness; 150 mg/l is a guideline only.

WELL FIELD MONITORING AND MANAGEMENT

The sentinel wells were left in place for future water-level monitoring. Static and pumping water levels should be measured and recorded quarterly from each production well and adjacent sentinel well. When local ground-water levels are stable, declines in a production well's specific capacity indicate a lowering of the well's efficiency. Continued decline in a well's specific capacity will indicate to GDUI when a well requires redevelopment. Monitoring each well's efficiency will provide data that can be used by GDUI to maintain the well field and insure that it will continue to produce an adequate supply of water.

At the same time that the quarterly water-level measurements are made, the height of the gravel pack should be measured in each well also. If the pack declines to a level of less than ten feet above the top of the screen, it should be replenished with fresh pack material.

In order to comply with the conditions of the water-use permit issued by the South Florida Water Management District (SFWMD), GDUI will be required to initiate both a Salt-Water Intrusion Monitoring and Management Program (SWIMM) and a Multi-Depth Potentiometric Head Monitoring Program (MUD-POHMP). As was discussed with SFWMD

representatives at the meeting on July 29, 1982, these programs will require monitoring as described below.

SALT-WATER INTRUSION MONITORING AND MANAGEMENT PROGRAM

1. Monitor and report water levels and chloride concentrations in well clusters SW2 (2 wells), SW3 (2 wells), and SW4 (3 wells).

2. Monitor and report water levels and chloride concentrations in North Port Production Well 4.

MULTI-DEPTH POTENTIOMETRIC HEAD MONITORING PROGRAM

1. Remove the water-level recorder from South Port Production Well 7 and install it in North Port Production Well 4. Continue to measure and report water-level measurements on South Port Production Well 7. Provide charts from North Port Production Well 4 to SFWMD.

2. Install a shallow water-table well to a depth of 8 to 10 feet adjacent to North Port Production Well 4; survey both well elevations.

3. Install a shallow water-table well to a depth of 8 to 10 feet adjacent to Wells 80-7 and WI2; survey for elevation.

4. Measure and report water levels from the three shallow wells to be installed and from Wells WI2, WI5, WI17, WI18, 80-7, North Port Production Well 4, and South Port Production Well 7. Plate 1 shows all of the mentioned well locations as well as the six new production well sites.

Initially, SFWMD will require that all monitoring be performed monthly so that a data base can be developed. After one year, it is likely that the monitoring will be reduced to a quarterly interval. Semi-annual wet and dry season water-table maps also will be necessary.

In addition to fulfilling the special conditions of GDUI's water-use permit, this program will provide valuable data that can be used by GDUI to manage the Port St. Lucie water-supply system.

Respectfully submitted,
GERAGHTY & MILLER, INC.

John J. Roland, Jr.
Hydrogeologist

Thomas L. Tessier

Thomas L. Tessier
Senior Scientist

Vincent P. Amy
Principal

2 March 1983

APPENDIX A

Geologic Logs of Production Wells
13 Through 18
North Port Well Field
Port St. Lucie, Florida

GEOLOGIC LOG OF PRODUCTION WELL 13 PORT ST. LUCIE, FL

Sample Description	Depth Interval (feet)	Thickness (feet)
SAND - Sand, 100%, quartz, clear to frosted, fine-grained, sub-angular to sub-rounded.	0- 4	4
SAND - Sand, 90%, quartz, clear to grayish orange, fine-grained, sub-angular to sub-rounded; Organics, 10%, moderate brown, very fine-grained, semi-consolidated.	4- 6	2
CLAYEY SAND - Sand, 75%, quartz, clear to frosted, very fine- to fine-grained, sub-angular to sub-rounded; Clay, 25%, moderate yellowish brown, soft pliable.	6- 14	8
SAND - Sand, 90%, quartz, clear, very fine-grained, well sorted; Shell, 10%, very pale orange, very fine fragments.	14- 17	3
SHELLY SAND - Sand, 50%, quartz, clear to frosted, very fine- to medium-grained, sub-angular to sub-rounded, phosphatic; Shell, 50%, medium dark gray, fine to medium fragments and whole shells.	18- 39	21
SANDY SHELL - Shell Fragments, 50%, very pale orange to medium light gray, fine to medium fragments; Sand, 40%, quartz, very fine-grained, sub-angular, phosphatic; Limestone, 10%, medium light gray, fine-grained, soft; Clay, trace, gray.	39- 59	20

Sample Description	Depth Interval (feet)	Thickness (feet)
SANDY CLAY - Clay, 50%, light olive gray, soft, plastic; Sand, 50%, quartz, clear, very fine-grained; Trace, shell fragments.	59-61	2
SANDY CLAY, LIMESTONE AND SHELL (interbedded) - Clay, 50%, light olive gray, soft, plastic, with fine quartz sand grains in matrix; Limestone, 30%, medium dark gray, medium-grained, fine quartz sand and shell fragments, apparent good porosity; Shell, 20% very pale orange, medium fragments.	61-69	8
SANDY LIMESTONE AND SHELLY SAND (interbedded) - Limestone, 40%, medium dark to medium light gray, fine-grained, moderately hard, fine quartz grains and shell in matrix; Sand, 40%, quartz, very fine- to medium-grained, sub-rounded, phosphatic; Shell, 20%, very pale orange to light brown, medium fragments.	69-78	9
SANDY LIMESTONE, SAND AND SHELL (interbedded) - Limestone, 40%, medium dark gray, very fine-grained, soft, with quartz sand and shell in matrix; Sand, 40%, quartz, very fine- to medium-grained, sub-rounded, phosphatic; Shell, 20%, very pale orange to medium dark gray, very fine to medium fragments; Clay, trace, gray.	78-89	11

Geologic Log of
Production Well 13
Port St. Lucie, FL - 3 -

Sample Description	Depth Interval (feet)	Thickness (feet)
SANDY CLAY AND LIMESTONE (interbedded) - Clay, 60%, yellowish gray, soft, plastic, fine quartz and phosphate grains in matrix; Limestone, 40%, medium light gray, medium-grained, soft, quartz sand and shell in matrix.	89-91	2
SANDY LIMESTONE, SAND AND SHELL (interbedded) - Limestone, 40%, medium dark gray, very fine-grained, soft, with quartz sand and shell in matrix; Sand, 40%, quartz, subrounded to rounded, phosphatic; Shell, 20%, very pale orange to medium dark gray, very fine to medium fragments; Clay, trace, gray.	91-107	16
LIMESTONE, SANDY CLAY AND SHELL (interbedded) - Limestone, 50%, medium light gray, very fine-grained, hard, apparent low porosity; Clay, 30%, yellowish gray, soft, plastic, with quartz, and phosphate grains in matrix; Shell, 20%, very pale orange to light gray, medium fragments.	107- SAB	4+
TOTAL DEPTH:	111	

Geraghty & Miller, Inc.

GEOLOGIC LOG OF
PRODUCTION WELL 14
PORT ST. LUCIE, FL

Sample Description	Depth Interval (feet)	Thickness (feet)
SAND - Sand, 95%, quartz, clear to dusky yellow, fine-grained, sub-angular to sub-rounded; Silt, 5%, light brown.	0-5	5
CLAYEY SAND - Sand, 80%, quartz, clear to frosted, very fine-to medium-grained; Clay, 20%, medium light gray to dark yellowish orange, soft, plastic.	5-14	9
SANDY SHELL - Shell, 60%, very pale orange, fine to medium fragments; Sand, 40%, quartz, clear, very fine-grained, sub-angular, phosphatic.	14-20	6
SANDY SHELL - Shell, 70%, medium dark gray, fine to medium fragments; Sand, 30%, quartz, clear, very fine-grained, phosphatic.	20-44	24
SHELLY SAND - Sand, 60%, quartz, very fine-to medium-grained, sub-angular to sub-rounded, phosphatic; Shell, 35%, dark gray, fine fragments; Clay, 5%, greenish gray.	44-55	9
SANDY CLAY - Clay, 50%, greenish gray, soft, plastic; Sand, 40%, calcareous, very pale orange, very fine-grained; Shell, 10%, very pale orange, medium-to whole shells.	55-57	2

Sample Description	Depth Interval (feet)	Thickness (feet)
SHELLY SAND - Sand, 70%, quartz, clear to frosted, very fine-to medium coarse-grained, sub-angular to sub-rounded, phosphatic; Shell, 30%, very pale orange to medium dark gray, fine fragments; Clay, trace, greenish gray; Limestone, trace, medium light gray.	57-65	18
SILTY SAND and LIMESTONE (inter-bedded) - Sand, 50%, quartz, very fine- to medium-grained, sub-angular to sub-rounded, phosphatic; Limestone, 30%, medium dark gray, fine-grained, moderately hard, quartz sand and fine shell in matrix; Silt,20%, very pale orange to white.	65-67	2
SHELLY SAND - Sand, 80% , quartz, clear, very fine-grained, sub-angular to sub-rounded, phosphatic; Shell, 20% , very pale orange to medium dark gray, very fine frag-ments; Limestone, trace, light gray.	67-75	8
SAND AND SANDY LIMESTONE - Limestone, 65%, medium dark gray, fine-grained, moderately hard, quartz sand and fine shell in matrix; Sand, 25%, quartz, clear, fine-grained; Silt, 10%, very pale orange to white.	75-77	2

Geologic Log of
Production Well 14
Port St. Lucie, FL

Sample Description	Depth Interval (feet)	Thickness (feet)
SAND and SANDY LIMESTONE - Sand, 60%, quartz, clear to frosted, very fine- to medium-grained, sub-angular to sub-rounded, phosphatic; Limestone, 25%, medium light gray, fine-grained, soft, fine quartz grains and fine shell in matrix; Shell, 15%, very pale orange to medium dark gray, fine fragments.	77-96	19
SAND - Sand, 100%, quartz, clear, very fine-grained, sub-angular to sub-rounded, phosphatic.	96-98	2
SAND and SANDY LIMESTONE (inter-bedded) - Sand, 60%, quartz, clear to frosted, very fine- to medium-grained, sub-angular to sub-rounded, phosphatic; Limestone, 25%, medium light gray, fine-grained, soft, fine quartz grains and fine shell in matrix; Shell, 15%, very pale orange to medium dark gray, fine fragments.	98-109	11
CLAYEY SAND - Sand, 60%, clear, fine-grained, sub-angular, phosphatic; Clay, 40%, light olive gray, soft, plastic.	109-	2+
TOTAL DEPTH:	111	

Geraghty & Miller, Inc.

GEOLOGIC LOG OF
PRODUCTION WELL 15
PORT ST. LUCIE, FL

Sample Description	Depth Interval (feet)	Thickness (feet)
SAND - Sand, quartz, clear to frosted, very fine- to fine-grained, phosphatic.	0- 3	3
LIMEY SAND - Sand, 85%, clear to frosted, fine- to medium-grained, sub-angular to rounded, phosphatic; Clay 15%, moderate yellowish brown, soft, plastic.	3- 6	3
CLAYEY SAND - Sand, 70%, quartz, clear to frosted, fine- to medium-grained, sub-rounded to rounded; Clay, 30%, medium light gray, soft, plastic, with quartz sand in matrix.	6- 11	5
SANDY SHELL - Shell, 60%, very pale orange, fine- to medium fragments; Sand, 40%, quartz, clear, fine-grained, sub-angular, phosphatic.	11- 16	5
SANDY SHELL - Shell, 50%, very pale orange to medium dark gray, fine- to medium fragments; Sand, 50%, quartz, clear to frosted, very fine- to medium coarse-grained, sub-rounded, phosphatic; Clay, trace, dusky yellow green, soft, plastic.	16- 34	18
SANDY SHELL - Sand, 40%, quartz, clear to frosted, very fine- to medium-grained, sub-rounded, phosphastic; Shell, 40%, very pale orange to medium dark gray, fine- to medium fragments; Limestone, 20%, medium light gray, very fine-grained, soft, fine quartz grains and fine shell in matrix.	34- 41	7

Sample Description	Depth Interval (feet)	Thickness (feet)
CLAYEY SHELLY SAND - Sand, 60%, quartz, clear to frosted, fine- to medium-grained, sub-angular to sub-rounded, phosphatic; Shell, 20%, very pale orange to medium dark gray, fine fragments; Clay, 20%, dusky yellow green, soft, plastic.	41- 57	16
SHELLY CLAY - Clay, 80%, grayish green, soft, plastic; Shell, 20%, very pale orange to light brown, medium fragments.	57- 63	6
SANDY LIMESTONE, SAND AND SHELL, (interbedded) - Sand, 50%, quartz, clear to frosted, fine- to medium-grained, sub-rounded, phosphatic; Limestone, 35%, medium light gray, fine-grained, fine shell, quartz, and phosphate in matrix, apparent fair porosity; Shell, 15%, very pale orange, medium fragments.	63- 80	17
SANDY LIMESTONE - Limestone, 60%, quartz, clear to frosted, very fine- to medium-fine-grained, sub-rounded, phosphatic; Limestone, 25%, medium dark gray, very fine-grained, only slightly consolidated; Shell, 15%, very pale orange to light brown, fine- to medium fragments.	80- 83	3
SANDY LIMESTONE - Limestone, 60%, medium light gray, fine-grained, moderately hard, fine quartz, phosphatic and shell in matrix; Sand, 25%, quartz, clear, very fine- to fine-grained, phosphatic; Shell, 15%, very pale orange to light brown, fine- to medium fragments; Clay, trace, medium light gray.	83- 98	15

Sample Description	Depth Interval (feet)	Thickness (feet)
SAND - Sand, quartz, clear, very fine-grained to micro-granular, well sorted, phosphatic; Silt, trace.	99-103	4
SAND AND SANDY LIMESTONE (inter-bedded) - Sand, 75%, quartz, clear, very fine-grained to micro-granular, well-sorted, phosphatic; Limestone, 25%, medium light gray, fine-grained, soft, apparent low porosity.	103-	8+
TOTAL DEPTH:	111	

Geraghty & Miller, Inc.

GEOLOGIC LOG OF PRODUCTION WELL 16 PORT ST. LUCIE, FL

Sample Description	Depth Interval (feet)	Thickness (feet)
SAND - Sand, 90%, quartz, clear to frosted, fine-grained, sub-angular to sub-rounded; Silt, 10%, dusky brown.	0- 5	5
SAND - Sand, 95%, quartz, clear to frosted, fine- to medium-grained; Organics, 5%, brownish black, silty.	5- 10	5
SAND - Sand, 85%, clear to dusky yellow, fine- to medium-grained; Shell, 15%, very pale orange, fine fragments.	10- 25	15
SANDY CLAY - Clay, 80%, medium gray, soft, plastic; Sand, 20%, quartz, clear to dusky yellow, fine-grained.	25- 29	4
LIMEY SHELL - Shell, 60%, very pale orange to medium gray, fine to medium fragments; Limestone, 40%, medium gray, fine-grained, moderately hard, fine phosphate grains in matrix.	29- 40	11
SANDY CLAY - Clay, 70%, pale green to medium gray, soft, plastic; Sand, 30%, quartz, clear, fine-grained, sub-angular to sub-rounded, phosphatic.	40- 44	4
SHELLY SANDY CLAY - Clay, 50%, pale green to medium gray, soft, plastic; Shell, 30%, very pale orange to moderate brown, medium fragments; Sand, 20%, quartz, clear to light gray, fine-grained, phosphatic.	44- 50	6

Sample Description	Depth Interval (feet)	Thickness (feet)
SANDY LIMESTONE - Limestone, 70%, medium dark gray, fine-grained, moderately hard, with fine quartz grains and shell in matrix; Sand, 30%, quartz, clear to medium light gray, fine- to medium-grained, phosphatic.	50-60	10
SHELLY SANDY LIMESTONE - Limestone, 60%, medium dark gray, fine- to medium fine-grained, with fine shell and quartz grains in matrix; Shell, 25%, white to medium dark gray, fine fragments; Sand, 15%, clear to frosted, medium-grained.	60-86	26
CLAYEY LIMESTONE - Limestone, 60%, medium dark gray, fine-grained; Clay, 20%, medium gray, soft, plastic; Shell, 20%, very pale orange to light gray, fine to medium fragments.	86-90	4
SANDY LIMESTONE - Limestone, 75%, medium gray, fine-grained, moderately hard, with fine quartz sand and fine shell fragments in matrix; Sand, 25%, quartz, clear, fine- to medium-grained, poorly sorted.	90-96	6
SANDY CLAY - Clay, 60%, medium light gray to medium gray, soft, plastic; Sand, 40%, quartz, clear to light gray, fine-grained.	96-105	9

Sample Description	Depth Interval (feet)	Thickness (feet)
SANDY LIMESTONE - Limestone, 75%, medium light gray, medium-grained, moderately hard, fine shell in matrix; Sand, 25%, quartz, fine- to medium-grained, phosphatic.	105-	10+
TOTAL DEPTH:	115	

Geraghty & Miller, Inc.

GEOLOGIC LOG OF PRODUCTION WELL 17 PORT ST. LUCIE, FL

Sample Description	Depth Interval (feet)	Thickness (feet)
SAND - Sand, 85%, quartz, clear to frosted, fine-grained, sub-angular to sub-rounded; Silt, 15%, grayish orange.	0- 5	5
CLAYEY SAND - Sand, 75%, quartz, fine- to medium-grained; sub-angular to sub-rounded; Clay, 25%, dark yellowish brown, silty.	5- 20	15
SAND - Sand, 90%, quartz, very fine- to fine-grained, sub-angular; Silt, 10%, grayish orange.	20- 30	10
SHELLY SAND - Sand, 60%, quartz, clear to frosted, fine- to coarse-grained, sub-rounded; Shell, 35%, very pale orange to dark gray, very fine to fine fragments; Clay, 5%, medium dark gray.	30- 50	20
SHELLY SAND - Sand, 80%, quartz, clear, very fine-grained, sub-angular to sub-rounded; Shell, 20%, white to medium gray, very fine to fine fragments; Limestone, trace, medium gray, fine-grained.	50- 60	10
SAND - Sand, 85%, quartz, dark yellowish brown to clear, medium- to coarse-grained, sub-angular to sub-rounded; Shell, 15%, fine to medium fragments.	60- 65	5

Sample Description	Depth Interval (feet)	Thickness (feet)
SANDY SHELL - Shell, 60%, medium gray to white, fine to medium fragments; Sand, 40%, clear to dark yellowish brown to black, quartz and phosphate, medium- to coarse-grained, sub-angular to sub-rounded.	65-75	10
SHELLY SAND - Sand, 70%, quartz, clear to light yellowish brown to black, fine-to medium-grained, sub-angular to sub-rounded, phosphatic; Shell, 30%, medium gray to pale yellowish orange, fine fragments.	75-78	3
SHELL AND SANDSTONE (Interbedded) - Shell, 65%, very pale orange to medium gray, medium to coarse fragments and whole shells; Sandstone, 30%, pale yellowish brown, fine-grained, moderately hard, with fine shell fragments and fine-grained quartz and phosphate in matrix; Sand, 5%, quartz, clear to pale yellowish orange, fine- to medium-grained, sub-angular to sub-rounded, phosphatic.	78-105	27
SAND - Sand, 85%, quartz, clear to dark yellowish brown, fine-grained, sub-angular to sub-rounded, phosphatic; Shell, 15%, very pale orange to medium light gray, fine fragments.	105-111	6

Geologic Log of
Production Well 17
Port St. Lucie, FL

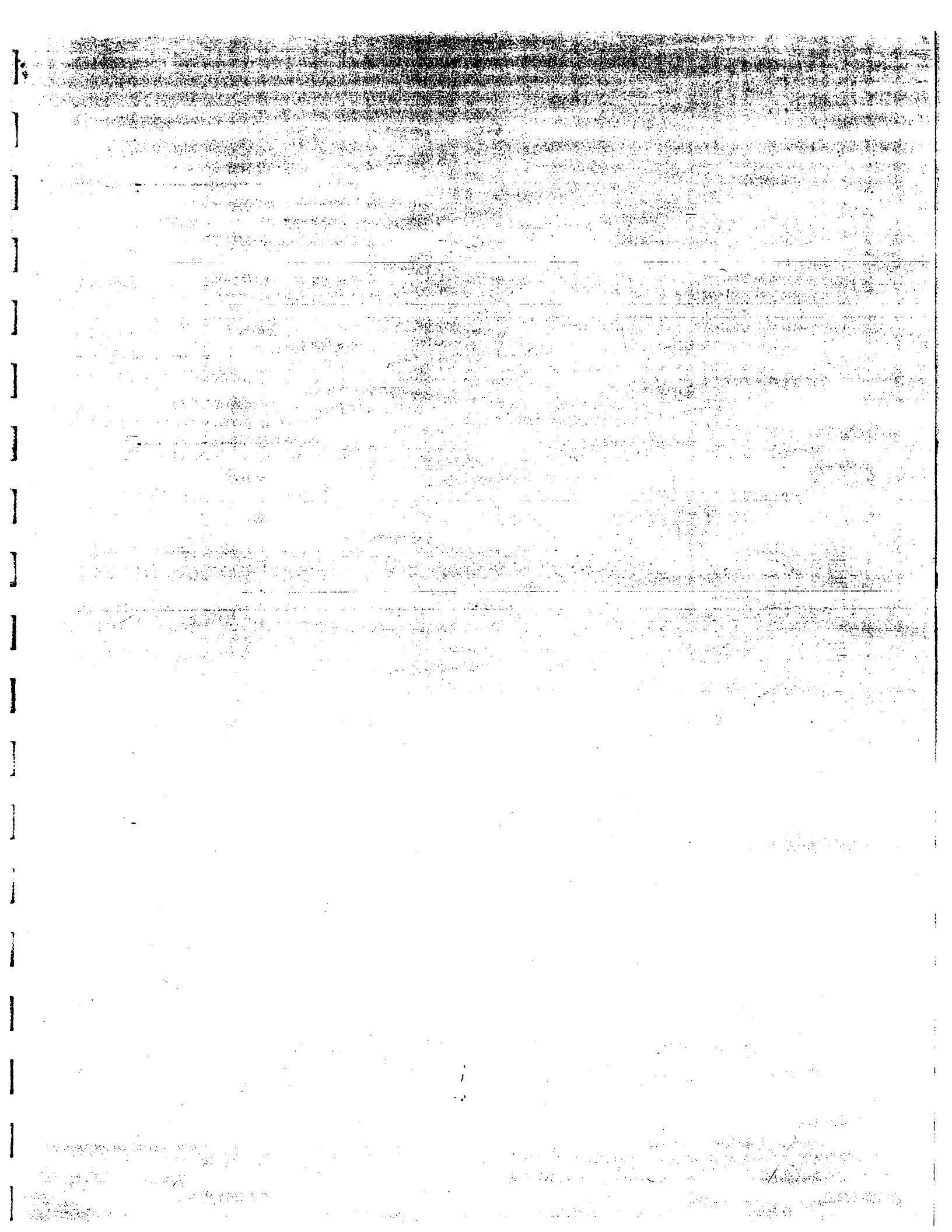
Sample Description	Depth Interval (feet)	Thickness (feet)
SHELL AND LIMESTONE - Limestone, 60%, dark yellowish brown, fine-grained, moderately hard, with fine quartz and phosphate grains in matrix; Shell, 40%, very pale orange to medium gray, fine to coarse fragments.	111-	4+
TOTAL DEPTH:	115	

Geraghty & Miller, Inc.

GEOLOGIC LOG OF
PRODUCTION WELL 18
PORT ST. LUCIE, FL

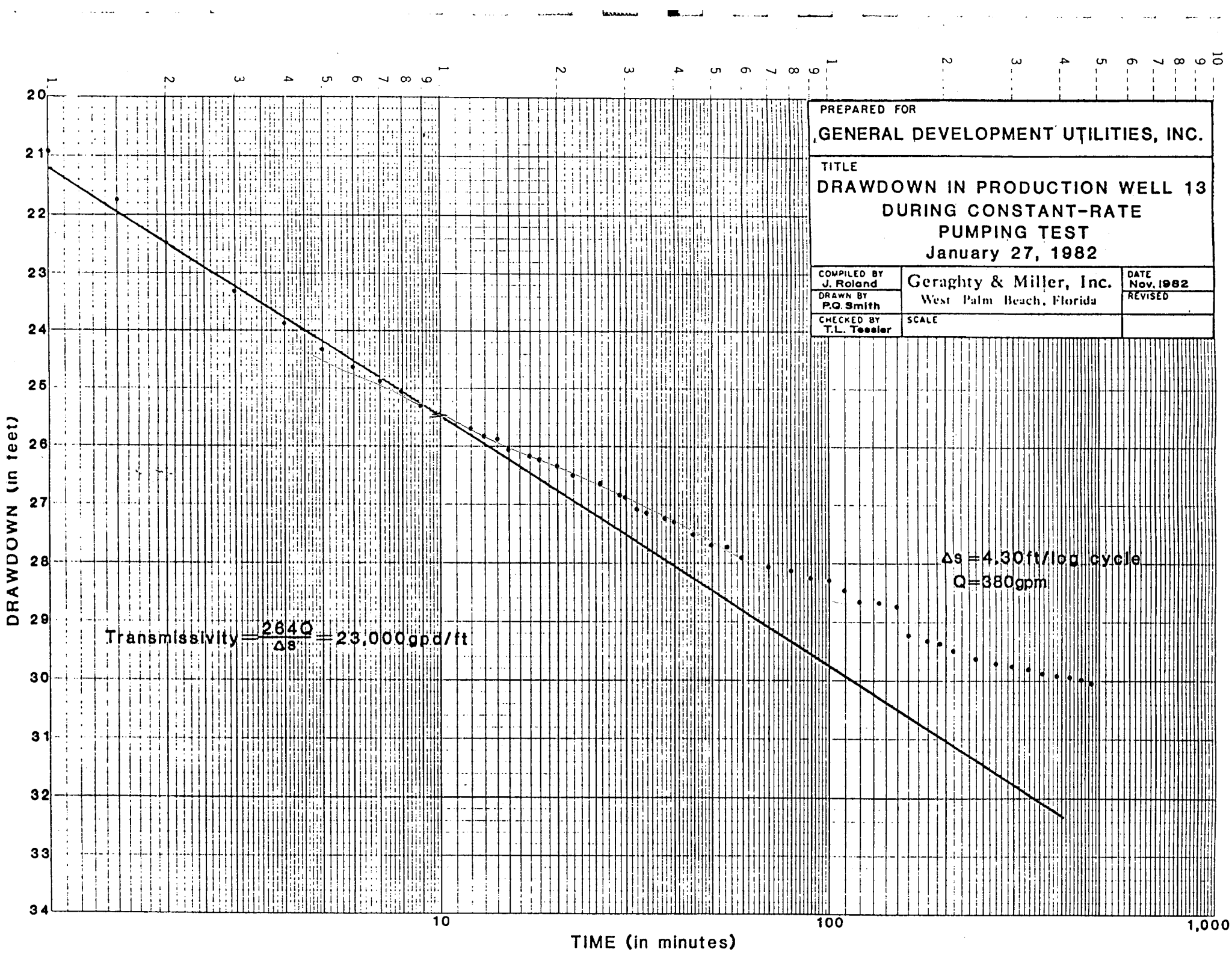
Sample Description	Depth Interval (feet)	Thickness (feet)
CLAYEY SAND - Sand, 70%, quartz, clear, fine-grained, sub-angular to sub-rounded, well-sorted; Clay, 30%, yellowish brown, soft, silty, plastic.	0-10	10
SHELLY SAND - Sand, 60%, quartz, clear to frosted, very fine- to fine-grained, well-sorted; Shell, 40%, very pale orange, fine fragments.	10-18	8
SANDY SHELL - Shell, 60%, very pale orange to medium dark gray, very fine to medium fragments; Sand, 40%, quartz, clear to frosted, fine-grained, sub-rounded, phosphatic.	18-40	17
SHELLY SAND - Sand, 80%, quartz, clear to very light gray, very fine- to fine-grained; Shell, 20%, very pale orange to medium dark gray, fine to medium fragments; Clay, trace, yellowish brown.	40-50	10
SANDY LIMESTONE - Limestone, 60%, medium dark gray, fine-grained, moderately soft with fine sand and shell in matrix; Sand, 25%, quartz, clear to frosted, fine- to medium coarse-grained, sub-rounded; Shell, 15%, very pale orange to medium light gray, fine to medium fragments.	50-75	25

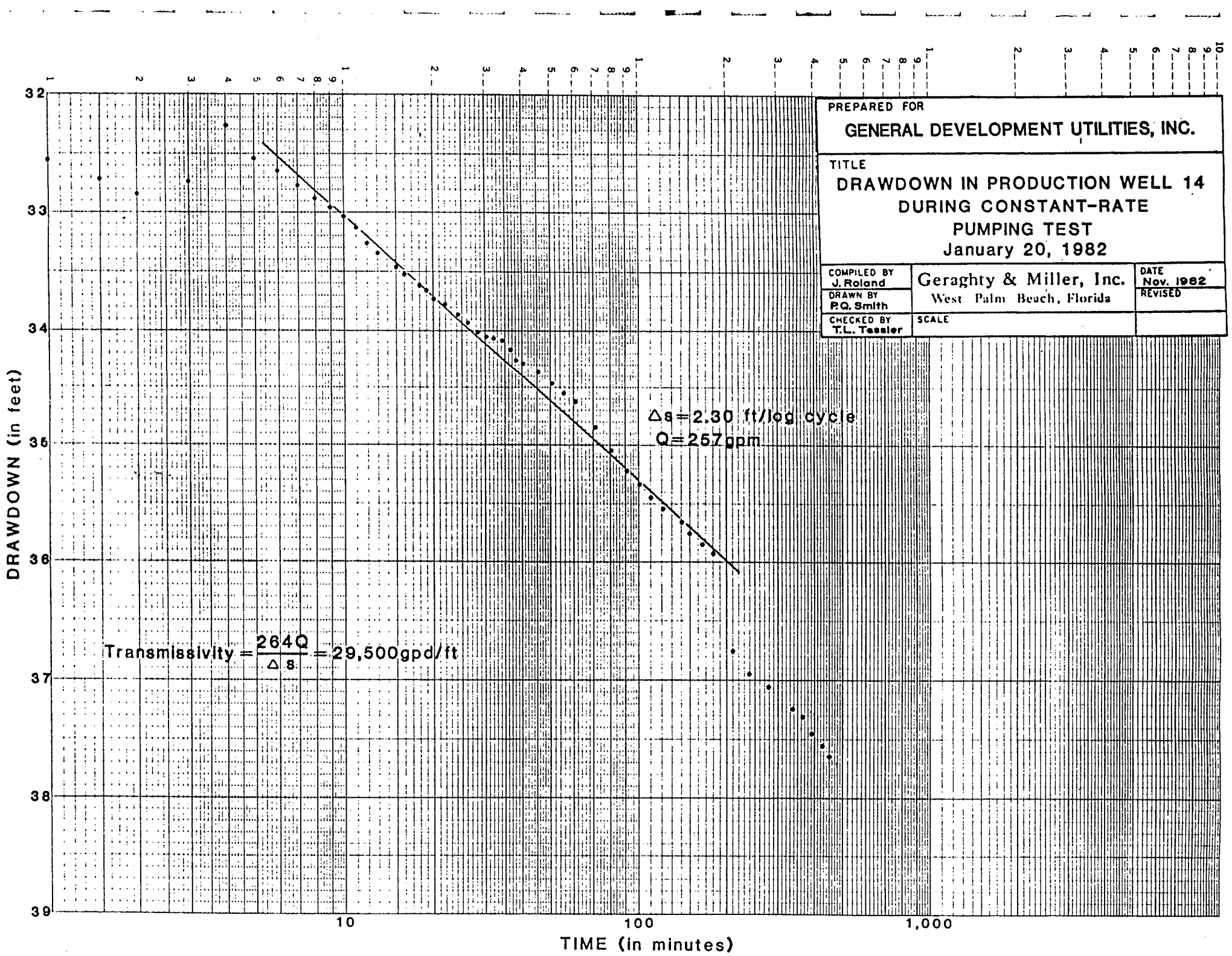
Sample Description	Depth Interval	Thickness (feet)
SHELLY SAND - SAND, 75%, quartz, clear to frosted, very fine- to medium-grained, sub-angular to sub-rounded, phosphatic; Shell, 15%, pale yellowish orange to medium light gray, fine fragments; Silt, 10%, yellowish brown.	75-85	15
SHELLY SAND - Sand, 70%, quartz, clear to frosted, fine-to coarse-grained, sub-rounded; Shell, 20%, very pale orange to medium light gray, very fine to medium fragments; Limestone, 10%, medium light gray, fine-grained, soft.	85-105	20
CLAYEY SHELLY SAND - Sand, 60%, quartz, clear to black, very fine-grained, sub-rounded, phosphatic; Shell, 20%, very pale orange to medium gray, very fine to fine fragments; Clay, 20%, pale olive, soft, silty, plastic.	105-	15+
TOTAL DEPTH:	120	

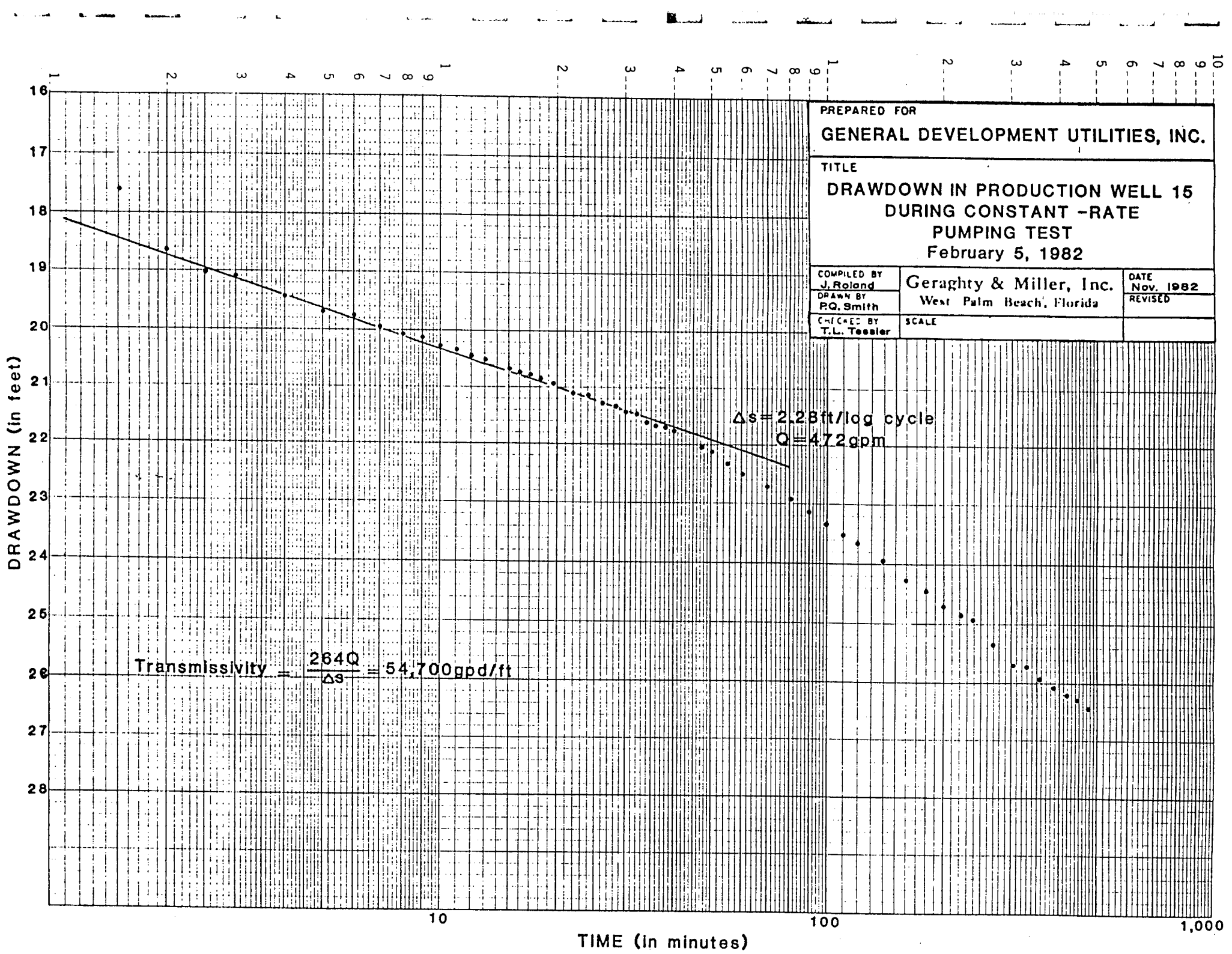


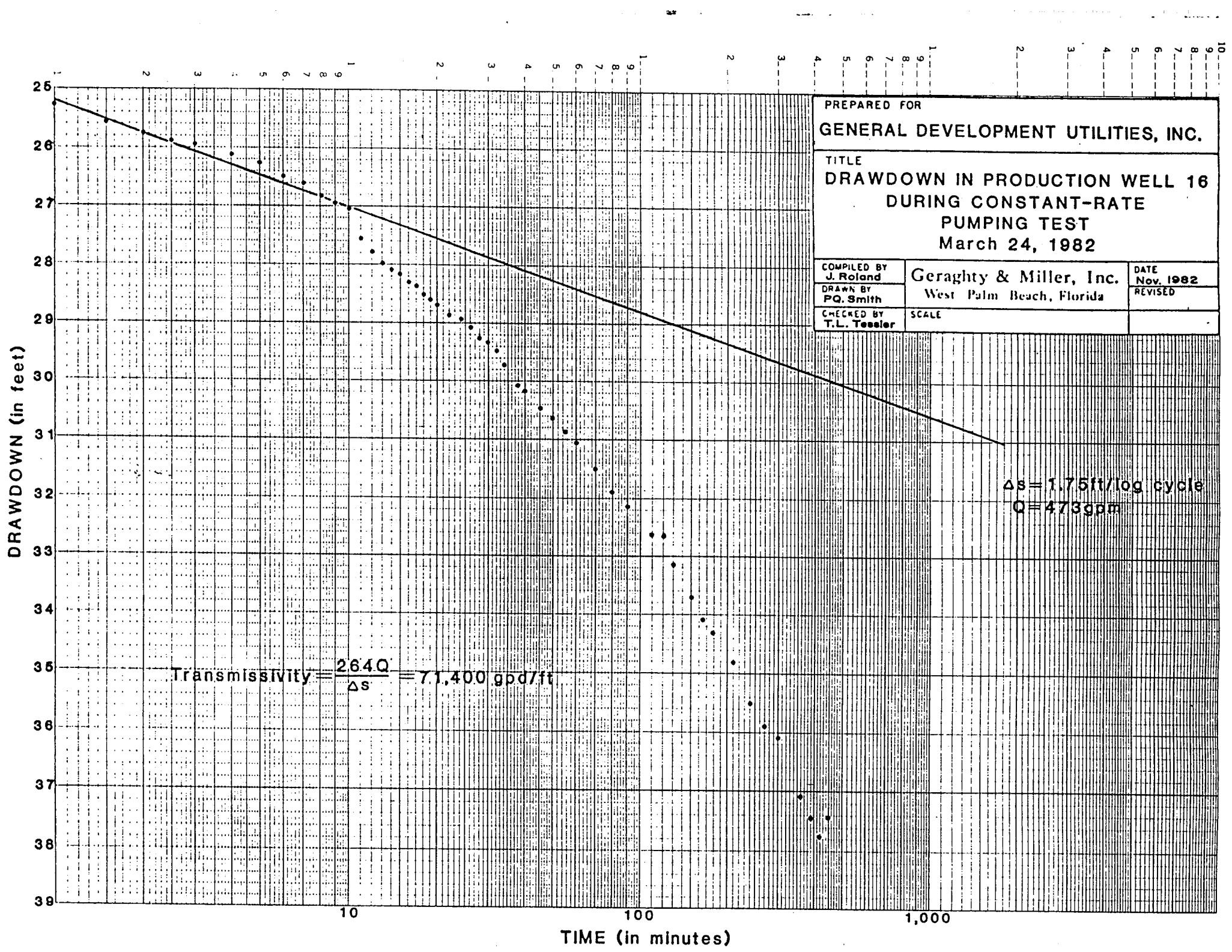
APPENDIX B

Graphs of Drawdown Data
From Production Wells 13 Through 18
During Constant-Rate Pumping Tests
North Port Well Field
Port St. Lucie, Florida


PREPARED FOR
GENERAL DEVELOPMENT UTILITIES, INC.
TITLE
DRAWDOWN IN PRODUCTION WELL 13
DURING CONSTANT-RATE
PUMPING TEST
January 27, 1982
COMPILED BY
J. Roland
DRAWN BY
P.Q. Smith
CHECKED BY
T.L. Tessler
Geraghty & Miller, Inc.
West Palm Beach, Florida
SCALE
DATE
Nov. 1982
REVISED
DRAWDOWN (in feet)
TIME (in minutes)
Δs =4.30ft/log cycle
Q=380gpm
Transmissivity = 264Q/Δs = 23,000gpd/ft


PREPARED FOR
GENERAL DEVELOPMENT UTILITIES, INC.
TITLE
DRAWDOWN IN PRODUCTION WELL 14
DURING CONSTANT-RATE
PUMPING TEST
January 20, 1982
COMPILED BY J. Roland
DRAWN BY P.Q. Smith
CHECKED BY T.L. Tessier
Geraghty & Miller, Inc.
West Palm Beach, Florida
DATE Nov. 1982
REVISED
SCALE
Δs=2.30 ft/log cycle
Q=257gpm
Transmissivity = 264Q/Δs = 29,500gpd/ft
DRAWDOWN (in feet)
TIME (in minutes)
32
33
34
35
36
37
38
39
10
100
1,000


PREPARED FOR
GENERAL DEVELOPMENT UTILITIES, INC.
TITLE
DRAWDOWN IN PRODUCTION WELL 15
DURING CONSTANT -RATE
PUMPING TEST
February 5, 1982
COMPILED BY
J. Roland
DRAWN BY
P.Q. Smith
CHECKED BY
T.L. Tessier
Geraghty & Miller, Inc.
West Palm Beach, Florida
DATE
Nov. 1982
REVISED
SCALE
Δs = 2.28ft/log cycle
Q = 472gpm
Transmissivity = 264Q/Δs = 54,700gpd/ft
DRAWDOWN (in feet)
TIME (in minutes)
16
17
18
19
20
21
22
23
24
25
26
27
28
10
100
1,000


PREPARED FOR
GENERAL DEVELOPMENT UTILITIES, INC.
TITLE
DRAWDOWN IN PRODUCTION WELL 16
DURING CONSTANT-RATE
PUMPING TEST
March 24, 1982
COMPILED BY
J. Roland
DRAWN BY
PQ. Smith
CHECKED BY
T.L. Tessier
Geraghty & Miller, Inc.
West Palm Beach, Florida
DATE
Nov. 1982
REVISED
SCALE
Δs = 1.75ft/log cycle
Q = 473gpm
Transmissivity = 264Q/Δs = 71,400 gpd/ft
DRAWDOWN (in feet)
TIME (in minutes)
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
10
100
1,000

PREPARED FOR

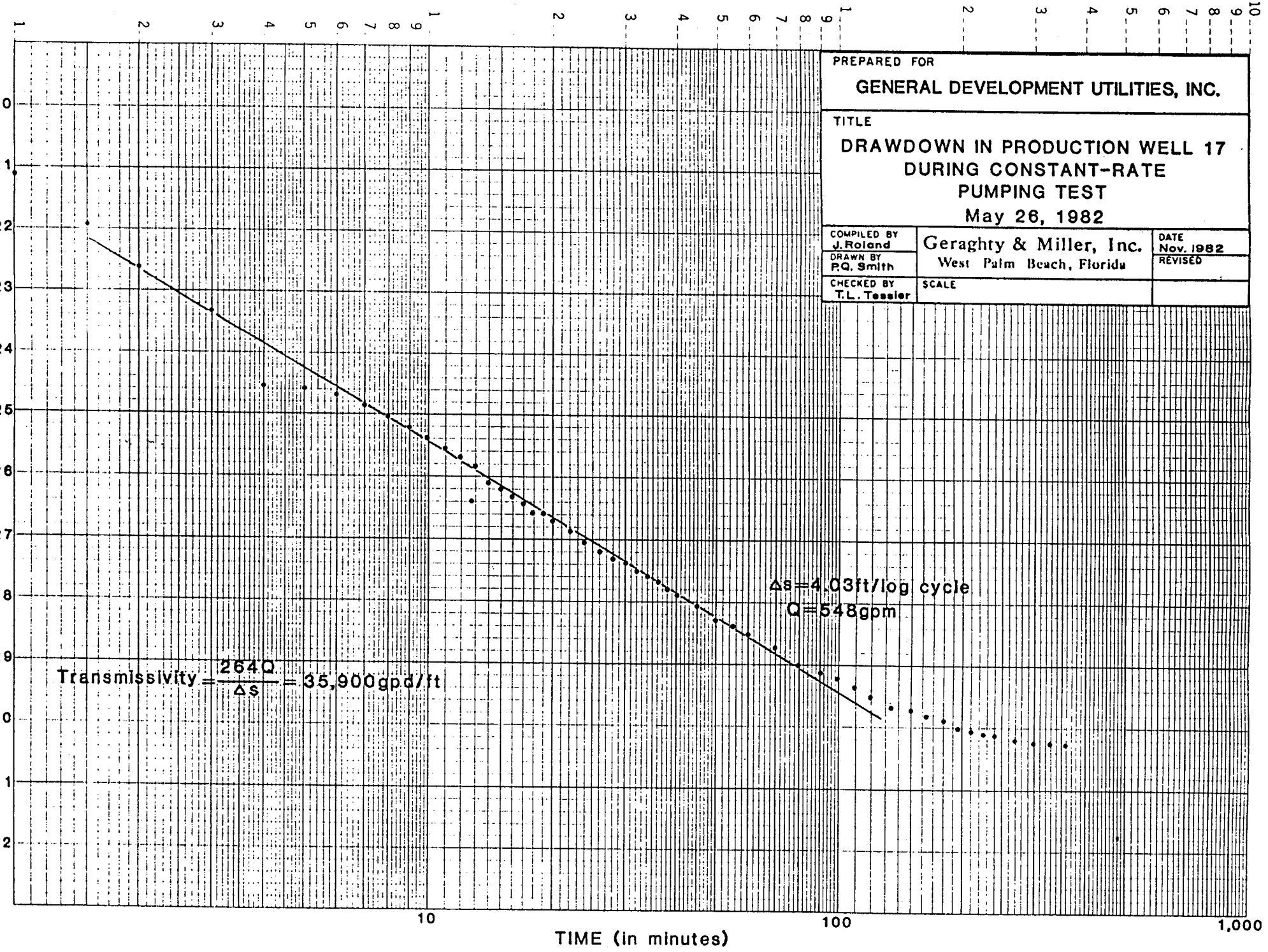
GENERAL DEVELOPMENT UTILITIES, INC.

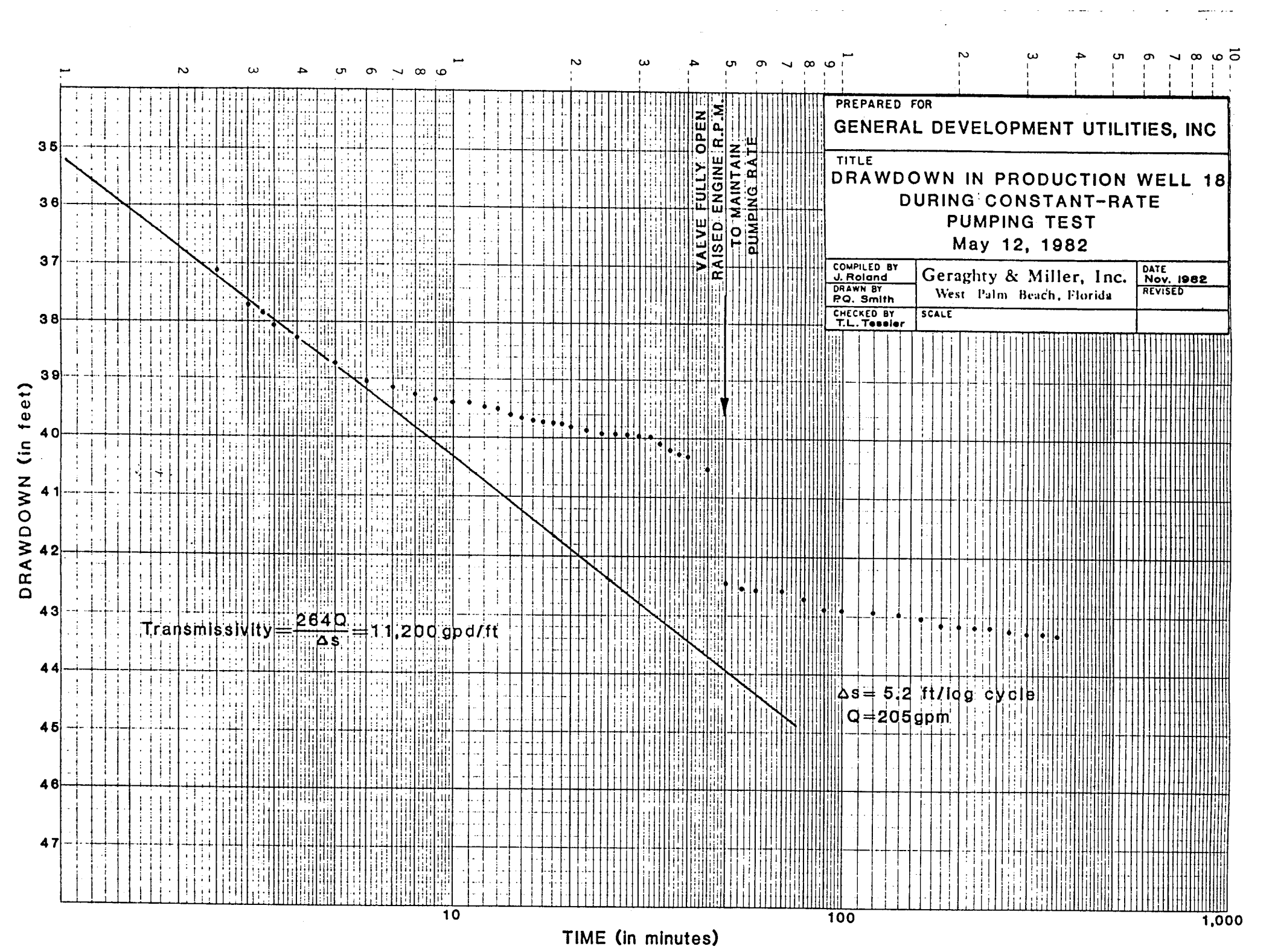
TITLE

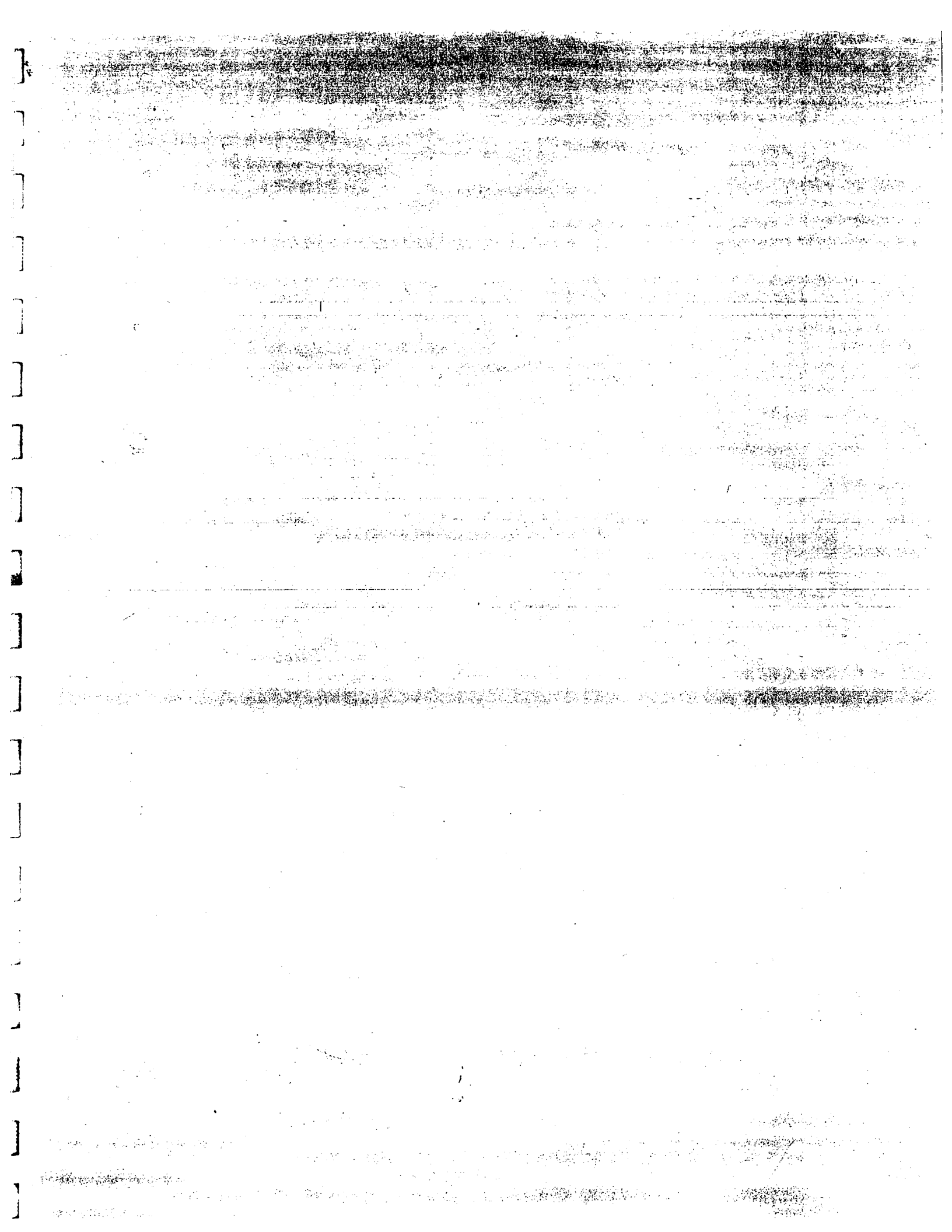
DRAWDOWN IN PRODUCTION WELL 17 DURING CONSTANT-RATE PUMPING TEST

May 26, 1982

COMPILED BY J. Roland	Geraghty & Miller, Inc. West Palm Beach, Florida	DATE Nov. 1982
DRAWN BY P.Q. Smith		REVISED
CHECKED BY T.L. Tessier	SCALE	




PREPARED FOR
GENERAL DEVELOPMENT UTILITIES, INC
TITLE
DRAWDOWN IN PRODUCTION WELL 18
DURING CONSTANT-RATE
PUMPING TEST
May 12, 1982
COMPILED BY J. Roland
DRAWN BY P.Q. Smith
CHECKED BY T.L. Tessier
Geraghty & Miller, Inc.
West Palm Beach, Florida
DATE Nov. 1982
REVISED
SCALE
VALVE FULLY OPEN
RAISED ENGINE R.P.M.
TO MAINTAIN
PUMPING RATE
Transmissivity = 264Q/Δs = 11,200 gpd/ft
Δs = 5.2 ft/log cycle
Q = 205gpm
DRAWDOWN (in feet)
TIME (in minutes)
35
36
37
38
39
40
41
42
43
44
45
46
47
10
100
1,000



APPENDIX C

Water Quality in Production Wells 13 Through 18 North Port Well Field Port St. Lucie, Florida

ANALYSIS FOR NATIONAL PRIMARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P. O. Box 8008 • Orlando, Florida 32856 • 305/843-1661

TO:
Geraghty & Miller
Attn: Tom Tessier, Suite 604
1665 Palm Beach Lakes Blvd.
West Palm Beach, Florida 33401

Report # 25399 (7979)
Sampled by: Client-J. Roland
Date Sampled: 1-27-82
Date Received: 1-29-82
Date Reported: 2-04-82

IDENTIFICATION: PW-13 Raw Water. Port St. Lucie, Florida.

INORGANIC

CONTAMINANT	MCL*	FOUND	CONTAMINANT	MCL*	FOUND
Arsenic, As	0.05	<0.01	Lead, Pb	0.05	<0.01
Barium, Ba	1.0	<0.10	Mercury, Hg	0.002	<0.0005
Cadmium, Cd	0.010	<0.005	Nitrate, NO_3-N	10	<0.02
Chromium, Cr	0.05	<0.01	Selenium, Se	0.01	<0.005
Fluoride, F	1.4-2.4	0.2	Silver, Ag	0.05	<0.01
Turbidity, NTU		0.8			

ORGANIC

Endrin	0.0002	<0.0001	Toxaphene	0.005	<0.001
Lindane	0.004	<0.001	2, 4-D	0.1	<0.01
Methoxychlor	0.1	<0.01	2, 4, 5-TP (Silvex)	0.01	<0.001

RESULTS EXPRESSED IN mg/l (ppm) UNLESS OTHERWISE DESIGNATED *MCL — MAXIMUM CONTAMINANT LEVELS

Respectfully submitted,

ORLANDO LABORATORIES, INC.

Gene Efferson

Chemist

Our Florida Department of Health & Rehabilitative Services Laboratory Identification No. is #83141

Methods & Limits: In accordance with Federal Register - Vol. 40, No. 248, Part IV - Wednesday, December 24, 1975. U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations.

METHOD: "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF and/or other EPA approved methods unless otherwise designated.

GENERAL WATER ANALYSIS FOR
SECONDARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P.O. Box 19127 • Orlando, Florida 32814 • 305/896-6645

Report to: Geraghty & Miller

Appearance: Yellow

Date: February 4, 1982

Sampled by: Client-J. Roland

Report Number: 25399 (7979)

Identification: PW-13 Raw water.
Port St. Lucie, FL

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	MCL*	mg/l	Determination	MCL*	mg/l
Total Dissolved Solids	500	500	Total Hardness, as $CaCO_3$	150	198
Phenolphthalein Alkalinity, as $CaCO_3$		0	Calcium Hardness, as $CaCO_3$		150
Total Alkalinity, as $CaCO_3$		180	Magnesium Hardness, as $CaCO_3$		48
Carbonate Alkalinity, as $CaCO_3$		0	Calcium, as Ca		60
Bicarbonate Alkalinity, as $CaCO_3$		180	Magnesium, as Mg		11
Carbonates, as CO_3		0	Sodium, as Na		74
Bicarbonates, as HCO_3		219	Iron, as Fe	0.3	0.7
Hydroxides, as OH		0	Manganese, as Mn	0.05	<0.05
Carbon Dioxide, as CO_2		14.6	Copper, as Cu	1.0	<0.03
Chloride, as Cl	250	40	Hydrogen Sulfide, H_2S (field-fixed)		<0.01
Sulfate, as SO_4	250	6	Specific Conductance, micromhos		725
Fluoride, as F		0.2	Nitrates, as N	10	<0.02
pH (Laboratory)	6.5-8.5	7.4	Foaming Agents (MBAS)	0.5	<0.01
pHs		8.3	Zinc, as Zn	5	0.02
Stability Index		9.2			
Saturation Index (corrosivity)	±1.0	-0.9			
Color, PCU	15	30			
Odor Threshold	3	0			
Turbidity, NTU	1	0.8			

Signed: Gene Wedeking
Chemist

*MCL — MAXIMUM CONTAMINANT LEVELS

ANALYSIS FOR NATIONAL PRIMARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P. O. Box 8008 • Orlando, Florida 32856 • 305/843-1661

TO:
Geraghty & Miller
Attn: Tom Tessier, Suite 604
1665 Palm Beach Lakes Blvd.
West Palm Beach, Florida 33401

Report # 25378 (7929)
Sampled by: Client-J. Roland
Date Sampled: 1-20-82 (1545 hrs)
Date Received: 1-21-82
Date Reported: 2-02-82

IDENTIFICATION: PW-14, Port St. Lucie, Florida.
Project #P157NW1

INORGANIC

CONTAMINANT	MCL*	FOUND	CONTAMINANT	MCL*	FOUND
Arsenic, As	0.05	<0.01	Lead, Pb	0.05	<0.01
Barium, Ba	1.0	<0.10	Mercury, Hg	0.002	<0.0005
Cadmium, Cd	0.010	<0.005	Nitrate, NO_3-N	10	0.02
Chromium, Cr	0.05	<0.01	Selenium, Se	0.01	<0.005
Fluoride, F	1.4-2.4	0.3	Silver, Ag	0.05	<0.01
Turbidity, NTU		0.9			

ORGANIC

Endrin	0.0002	<0.0001	Toxaphene	0.005	<0.001
Lindane	0.004	<0.001	2, 4-D	0.1	<0.01
Methoxychlor	0.1	<0.01	2, 4, 5-TP (Silvex)	0.01	<0.001

RESULTS EXPRESSED IN mg/l (ppm) UNLESS OTHERWISE DESIGNATED *MCL — MAXIMUM CONTAMINANT LEVELS

Respectfully submitted,

ORLANDO LABORATORIES, INC.

Gene Wedrick

Chemist

Our Florida Department of Health & Rehabilitative Services Laboratory Identification No. is #83141

Methods & Limits: In accordance with Federal Register - Vol. 40, No. 248, Part IV - Wednesday, December 24, 1975. U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations.

METHOD: "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF and/or other EPA approved methods unless otherwise designated.

GENERAL WATER ANALYSIS FOR
SECONDARY DRINKING WATER REGULATIONS*

Orlando Laboratories, Inc.

P.O. Box 19127 • Orlando, Florida 32814 • 305/896-6645

Report to: Geraghty & Miller

Date: 2 February 1982

Report Number: 25378 (7929)
Page 2 of 2

Appearance: Yellowish

Sampled by: Client-J. Roland

Identification: PW 14, Port St. Lucie, Florida
Sampled on 1-20-82 at 1545 hrs.
P157NW1

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	MCL*	mg/l	Determination	MCL*	mg/l
Total Dissolved Solids	500	500	Total Hardness, as $CaCO_3$	150	294
Phenolphthalein Alkalinity, as $CaCO_3$		0	Calcium Hardness, as $CaCO_3$		240
Total Alkalinity, as $CaCO_3$		323	Magnesium Hardness, as $CaCO_3$		54
Carbonate Alkalinity, as $CaCO_3$		0	Calcium, as Ca		96
Bicarbonate Alkalinity, as $CaCO_3$		323	Magnesium, as Mg		13
Carbonates, as CO_3		0	Sodium, as Na		35
Bicarbonates, as HCO_3		394	Iron, as Fe	0.3	0.9
Hydroxides, as OH		0	Manganese, as Mn	0.05	< 0.05
Carbon Dioxide, as CO_2		26	Copper, as Cu	1.0	< 0.03
Chloride, as Cl	250	87	Hydrogen Sulfide, H_2S (field-fixed)		0.01
Sulfate, as SO_4	250	7	Specific Conductance, micromhos		755
Fluoride, as F		0.3	Nitrates, as N	10	0.02
pH (Laboratory)	6.5-8.5	7.4	Foaming Agents (MBAS)	0.5	< 0.01
pHs		7.0	Zinc, as Zn	5	0.01
Stability Index		6.6			
Saturation Index (corrosivity)	±1.0	0.4			
Color, PCU	15	40			
Odor Threshold	3	0			
Turbidity, NTU	1	0.9			

Signed: [signature]
Chemist

*MCL — MAXIMUM CONTAMINANT LEVELS

ANALYSIS FOR NATIONAL PRIMARY DRINKING WATER REGULATIONS

RECEIVED

Orlando Laboratories, Inc.

P. O. Box 19127 • Orlando, Florida 32814 • 305/ 896-6645

GERAGHTY & MILLER, INC.

TO:
General Development Corporation
Attention: J.R. Peralta
1111 South Bayshore Drive
Miami, Florida 33131

Report # 25533 (8033)
Sampled by: Client-John Roland
Date Sampled: 2-05-82 (1500 hrs)
Date Received: 2-08-82
Date Reported: 2-23-82
Page 1 of 2

IDENTIFICATION: PW 15, Port St. Lucie Field -----, Raw Water.
Project # P157NW1

INORGANIC

CONTAMINANT	MCL*	FOUND	CONTAMINANT	MCL*	FOUND
Arsenic, As	0.05	<0.01	Lead, Pb	0.05	<0.01
Barium, Ba	1.0	<0.10	Mercury, Hg	0.002	<0.0005
Cadmium, Cd	0.010	<0.005	Nitrate, NO_3-N	10	<0.02
Chromium, Cr	0.05	<0.01	Selenium, Se	0.01	<0.005
Fluoride, F	1.4-2.4	0.3	Silver, Ag	0.05	<0.01
Turbidity, NTU		2.0			

ORGANIC

Endrin	0.0002	<0.0001	Toxaphene	0.005	<0.001
Lindane	0.004	<0.001	2, 4-D	0.1	<0.01
Methoxychlor	0.1	<0.01	2, 4, 5-TP (Silvex)	0.01	<0.001

RESULTS EXPRESSED IN mg/l (ppm) UNLESS OTHERWISE DESIGNATED *MCL — MAXIMUM CONTAMINANT LEVELS

Respectfully submitted,

ORLANDO LABORATORIES, INC.

Chemist

Our Florida Department of Health & Rehabilitative Services Laboratory Identification No. is #83141

Methods & Limits: In accordance with Federal Register - Vol. 40, No. 248, Part IV - Wednesday, December 24, 1975. U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations.

METHOD: "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF and/or other EPA approved methods unless otherwise designated.

GENERAL WATER ANALYSIS FOR
SECONDARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P.O. Box 19127 • Orlando, Florida 32814 • 305/896-6645

Report to: General Development Corporation

Date: 23 February 1982

Report Number: 25533 (8033)

Appearance: Yellowish

Sampled by: Client-John Roland

Identification: PW15 Port St. Lucie Field ------
Raw water sampled 2-5-82 @ 1500
Project #P157NW1

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	MCL*	mg/l	Determination	MCL*	mg/l
Total Dissolved Solids	500	400	Total Hardness, as $CaCO_3$	150	270
Phenolphthalein Alkalinity, as $CaCO_3$		0	Calcium Hardness, as $CaCO_3$		222
Total Alkalinity, as $CaCO_3$		255	Magnesium Hardness, as $CaCO_3$		48
Carbonate Alkalinity, as $CaCO_3$		0	Calcium, as Ca		88
Bicarbonate Alkalinity, as $CaCO_3$		255	Magnesium, as Mg		11.6
Carbonates, as CO_3		0	Sodium, as Na		39
Bicarbonates, as HCO_3		311	Iron, as Fe	0.3	1.1
Hydroxides, as OH		0	Manganese, as Mn	0.05	<0.05
Carbon Dioxide, as CO_2		16	Copper, as Cu	1.0	<0.01
Chloride, as Cl	250	52	Hydrogen Sulfide, H_2S (field-fixed)		0.16
Sulfate, as SO_4	250	6	Specific Conductance, micromhos		640
Fluoride, as F		0.3	Nitrates, as N	10	<0.02
pH (Laboratory)	6.5-8.5	7.5	Foaming Agents (MBAS)	0.5	<0.01
pHs		7.2	Zinc, as Zn	5	0.04
Stability Index		6.9			
Saturation Index (corrosivity)	±1.0	0.3			
Color, PCU	15	40			
Odor Threshold	3	0			
Turbidity, NTU	1	2.0			

Signed: C. Keyes
Chemist

*MCL — MAXIMUM CONTAMINANT LEVELS

ANALYSIS FOR NATIONAL PRIMARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P. O. Box 19127 • Orlando, Florida 32814 • 305/ 896-6645

TO: General Development Utilities Corporation
Attention: Mr. Sanchez
1111 Bayshore Drive
Miami, Florida 33131

Report # 25908 (8355)
Sampled by: Client-J. Roland
Date Sampled: 3-24-82 (1600 hrs)
Date Received: 3-26-82
Date Reported: 4-15-82
Page 1 of 2

#16 SW

IDENTIFICATION: Raw Water-P.W. (Production Well) New Well Field for Port St. Lucie Water Plant. Primvale Road. G & M Project No.: P157NWI.

INORGANIC

CONTAMINANT	MCL*	FOUND	CONTAMINANT	MCL*	FOUND
Arsenic, As	0.05	<0.01	Lead, Pb	0.05	<0.01
Barium, Ba	1.0	<0.10	Mercury, Hg	0.002	<0.0005
Cadmium, Cd	0.010	<0.005	Nitrate, NO_3-N	10	0.02
Chromium, Cr	0.05	<0.01	Selenium, Se	0.01	<0.005
Fluoride, F	1.4-2.4	0.36	Silver, Ag	0.05	<0.01
Turbidity, NTU		2.0			

ORGANIC

Endrin	0.0002	<0.0001	Toxaphene	0.005	<0.001
Lindane	0.004	<0.001	2, 4-D	0.1	<0.01
Methoxychlor	0.1	<0.01	2, 4, 5-TP (Silvex)	0.01	<0.001

RESULTS EXPRESSED IN mg/l (ppm) UNLESS OTHERWISE DESIGNATED *MCL — MAXIMUM CONTAMINANT LEVELS

Respectfully submitted,

ORLANDO LABORATORIES, INC.

Chemist BB CK

Our Florida Department of Health & Rehabilitative Services Laboratory Identification No. is #83141

Methods & Limits: In accordance with Federal Register - Vol. 40, No. 248, Part IV - Wednesday, December 24, 1975. U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations.

METHOD: "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF and/or other EPA approved methods unless otherwise designated.

GENERAL WATER ANALYSIS FOR
SECONDARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P.O. Box 19127 • Orlando, Florida 32814 • 305/896-6645

Report to: General Development Utilities Corporation

Date: April 15, 1982

Report Number: 25908 (8355)

Appearance: Yellow

Sampled by: Client-J. Roland

Identification: Raw Water-P.W.#6 (Production Well) New Well Field for Port St. Lucie Water Plant. Primvale Road. G&M Project No. P157NWI.

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	MCL*	mg/l	Determination	MCL*	mg/l
Total Dissolved Solids	500	555	Total Hardness, as $CaCO_3$	150	282
Phenolphthalein Alkalinity, as $CaCO_3$		0	Calcium Hardness, as $CaCO_3$		264
Total Alkalinity, as $CaCO_3$		286	Magnesium Hardness, as $CaCO_3$		18
Carbonate Alkalinity, as $CaCO_3$		0	Calcium, as Ca		105
Bicarbonate Alkalinity, as $CaCO_3$		286	Magnesium, as Mg		4.3
Carbonates, as CO_3		0	Sodium, as Na		44
Bicarbonates, as HCO_3		349	Iron, as Fe	0.3	1.55
Hydroxides, as OH		0	Manganese, as Mn	0.05	<0.05
Carbon Dioxide, as CO_2		40	Copper, as Cu	1.0	<0.01
Chloride, as Cl	250	67	Hydrogen Sulfide, H_2S (field-fixed)		0.15
Sulfate, as SO_4	250	9.9	Specific Conductance, micromhos		800
Fluoride, as F		0.36	Nitrates, as N	10	0.02
pH (Laboratory)	6.5-8.5	7.2	Foaming Agents (MBAS)	0.5	<0.01
pHs		7.1	Zinc, as Zn	5	0.03
Stability Index		7.0			
Saturation Index (corrosivity)	±1.0	0.1			
Color, PCU	15	60			
Odor Threshold	3	0			
Turbidity, NTU	1	2.0			

Signed: C Keyes
Chemist

B.R.
GB

*MCL — MAXIMUM CONTAMINANT LEVELS

ANALYSIS FOR NATIONAL PRIMARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P. O. Box 19127 • Orlando, Florida 32814 • 305/ 896-6645

TO:
General Development Utilities Corporation
Attention: Mr. Sanchez
1111 Bayshore Drive
Miami, Florida 33131

Report # 26356 (8823)
Sampled by: Client-Madeksho
Date Sampled: 5-26-82 (1412)
Date Received: 5-28-82
Date Reported: 6-21-82

IDENTIFICATION: Raw water, production well #17, new well field for Port St. Lucie Water Plant. Primvale Road. G & M Project No.: P157NW1.

INORGANIC

CONTAMINANT	MCL*	FOUND	CONTAMINANT	MCL*	FOUND
Arsenic, As	0.05	<0.01	Lead, Pb	0.05	<0.01
Barium, Ba	1.0	<0.10	Mercury, Hg	0.002	<0.0005
Cadmium, Cd	0.010	<0.005	Nitrate, NO_3-N	10	<0.02
Chromium, Cr	0.05	<0.01	Selenium, Se	0.01	<0.005
Fluoride, F	1.4-2.4	0.30	Silver, Ag	0.05	<0.01
Turbidity, NTU		23			

ORGANIC

Endrin	0.0002	<0.0001	Toxaphene	0.005	<0.001
Lindane	0.004	<0.001	2, 4-D	0.1	<0.01
Methoxychlor	0.1	<0.01	2, 4, 5-TP (Silvex)	0.01	<0.001

RESULTS EXPRESSED IN mg/l (ppm) UNLESS OTHERWISE DESIGNATED *MCL — MAXIMUM CONTAMINANT LEVELS

Respectfully submitted,

ORLANDO LABORATORIES, INC.

Chemist

Our Florida Department of Health & Rehabilitative Services Laboratory Identification No. is #83141

Methods & Limits: In accordance with Federal Register - Vol. 40, No. 248, Part IV - Wednesday, December 24, 1975. U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations.

METHOD: "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF and/or other EPA approved methods unless otherwise designated.

GENERAL WATER ANALYSIS FOR
SECONDARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P.O. Box 19127 • Orlando, Florida 32814 • 305/896-6645

Report to: General Development Utilities Corporation

Date: June 21, 1982

Report Number: 26356 (8823)

Appearance: Turbid

Sampled by: Client-Madeksho

Identification: Raw water, production well #17, new well field for Port St. Lucie water plant. Primvale Road. G & M Project No.: P157NW1.

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	MCL*	mg/l
Total Dissolved Solids	500	356
Phenolphthalein Alkalinity, as $CaCO_3$		0
Total Alkalinity, as $CaCO_3$		267
Carbonate Alkalinity, as $CaCO_3$		0
Bicarbonate Alkalinity, as $CaCO_3$		267
Carbonates, as CO_3		0
Bicarbonates, as HCO_3		325
Hydroxides, as OH		0
Carbon Dioxide, as CO_2		42
Chloride, as Cl	250	44
Sulfate, as SO_4	250	22
Fluoride, as F		0.30
pH (Laboratory)	6.5-8.5	7.1
pHs		7.2
Stability Index		7.3
Saturation Index (corrosivity)	±1.0	-01
Color, PCU	15	140
Odor Threshold	3	1
Turbidity, NTU	1	23

Determination	MCL*	mg/l
Total Hardness, as $CaCO_3$	150	264
Calcium Hardness, as $CaCO_3$		228
Magnesium Hardness, as $CaCO_3$		36
Calcium, as Ca		91
Magnesium, as Mg		8.7
Sodium, as Na		23
Iron, as Fe	0.3	0.26
Manganese, as Mn	0.05	< 0.05
Copper, as Cu	1.0	< 0.01
Hydrogen Sulfide, H_2S (field-fixed)		0.24
Specific Conductance, micromhos		460
Nitrates, as N	10	< 0.02
Foaming Agents (MBAS)	0.5	< 0.01
Zinc, as Zn	5	0.01

Signed: C Keyes
Chemist

GB
BR

*MCL — MAXIMUM CONTAMINANT LEVELS

ANALYSIS FOR NATIONAL PRIMARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P. O. Box 19127 • Orlando, Florida 32814 • 305/ 896-6645

TO:

General Development Utilities Corporation
Attention: Mr. Sanchez
1111 Bayshore Drive
Miami, Florida 33131

Report# 26255 (8720)
Sampled by: Client-Roland/Madeksho
Date Sampled: 5-12-82 (1430)
Date Received: 5-14-82
Date Reported: 6-02-82

IDENTIFICATION: Raw water, P.W. 18 (production well #), New well Field for Port St. Lucie Water Plant. G&M Project No.: P157NW1

INORGANIC

CONTAMINANT	MCL*	FOUND	CONTAMINANT	MCL*	FOUND
Arsenic, As	0.05	<0.01	Lead, Pb	0.05	<0.01
Barium, Ba	1.0	<0.10	Mercury, Hg	0.002	<0.0005
Cadmium, Cd	0.010	<0.005	Nitrate, NO_3-N	10	<0.02
Chromium, Cr	0.05	<0.01	Selenium, Se	0.01	<0.005
Fluoride, F	1.4-2.4	0.27	Silver, Ag	0.05	<0.01
Turbidity, NTU		1.52			

ORGANIC

Endrin	0.0002	<0.0001	Toxaphene	0.005	<0.001
Lindane	0.004	<0.001	2, 4-D	0.1	<0.01
Methoxychlor	0.1	<0.01	2, 4, 5-TP (Silvex)	0.01	<0.001

RESULTS EXPRESSED IN mg/l (ppm) UNLESS OTHERWISE DESIGNATED *MCL — MAXIMUM CONTAMINANT LEVELS

Respectfully submitted,

ORLANDO LABORATORIES, INC.

Chemist

Our Florida Department of Health & Rehabilitative Services Laboratory Identification No. is #83141

Methods & Limits: In accordance with Federal Register - Vol. 40, No. 248, Part IV - Wednesday, December 24, 1975. U.S. Environmental Protection Agency, National Interim Primary Drinking Water Regulations.

METHOD: "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF and/or other EPA approved methods unless otherwise designated.

GENERAL WATER ANALYSIS FOR
SECONDARY DRINKING WATER REGULATIONS

Orlando Laboratories, Inc.

P.O. Box 19127 • Orlando, Florida 32814 • 305/896-6645

Report to: General Development Utilities Corp.

Date: June 2, 1982

Report Number: 26255 (8720)

Appearance: Yellow

Sampled by: Client-Roland/Madeksho

Identification: (Production well #) Raw water sample, P.W. 18
New well field for Water Plant. G&M Project No.: P157NW1

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	MCL*	mg/l
Total Dissolved Solids	500	450
Phenolphthalein Alkalinity, as $CaCO_3$		0
Total Alkalinity, as $CaCO_3$		286
Carbonate Alkalinity, as $CaCO_3$		0
Bicarbonate Alkalinity, as $CaCO_3$		286
Carbonates, as CO_3		0
Bicarbonates, as HCO_3		348
Hydroxides, as OH		0
Carbon Dioxide, as CO_2		30
Chloride, as Cl	250	64
Sulfate, as SO_4	250	7.5
Fluoride, as F		0.27
pH (Laboratory)	6.5-8.5	7.3
pHs		7.1
Stability Index		6.9
Saturation Index (corrosivity)	±1.0	0.2
Color, PCU	15	30
Odor Threshold	3	0
Turbidity, NTU	1	1.52

Determination	MCL*	mg/l
Total Hardness, as $CaCO_3$	150	276
Calcium Hardness, as $CaCO_3$		258
Magnesium Hardness, as $CaCO_3$		18
Calcium, as Ca		103
Magnesium, as Mg		4.3
Sodium, as Na		42
Iron, as Fe	0.3	0.28
Manganese, as Mn	0.05	< 0.05
Copper, as Cu	1.0	< 0.01
Hydrogen Sulfide, H_2S (field-fixed)		< 0.01
Specific Conductance, micromhos		650
Nitrates, as N	10	< 0.02
Foaming Agents (MBAS)	0.5	< 0.01
Zinc, as Zn	5	0.08

Signed: C. Keyes
B.R. Chemist

*MCL — MAXIMUM CONTAMINANT LEVELS