REPORT OF HYDROGEOLOGIC INVESTIGATION GATE MARITIME PROPERTIES BLOUNT ISLAND JACKSONVILLE, FLORIDA

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REPORT OF HYDROGEOLOGY
GATE MARITIME PROPERTIES
TABLE OF CONTENTS

Section	Title	Page
1.0	REGIONAL GEOLOGY	1
	1.1 Geology	1
	1.2 Hydrogeology	1
2.0	SITE CONDITIONS	2
	2.1 General Overview	2
	2.2 Well Construction	4
3.0	AQUIFER TEST	5
	3.1 Background Data	5
	3.2 Pump Test	5
	3.3 Changes in Water Levels	7
4.0	WELL LOGGING	7
5.0	DATA ANALYSIS	8
	5.1 Pump Test	8
6.0	DISCUSSION	14
	6.1 Pump Test	14
	6.2 Water Quality	20
	6.3 Conclusions	21
7.0	RECOMMENDATIONS	22

APPENDICES

A. Data Recorder Listings
B. Time Clock Recordings
C. USGS Cedar Point Tidal Data
D. Geophysical Well Logs and Interpretation
E. Recorded Chloride Values
F. Chemical Analyses
G. Generalized Lithology
H. Raw Data and Calculations

LIST OF FIGURES

Number	Title	Page
1	Site Location Map	3
2	Well Location Map	6
3	Observation Well-1 Drawdown Curve	9
4	Observation Well-2 Drawdown Curve	10
5	Observation Well-3 Drawdown Curve	11
6	Predicted Drawdown - 3.0 MGD	12
7	Predicted Drawdown - 3.5 MGD	13
8	Predicted Cone of Depression - 3.0 MGD	15
9	Predicted Cone of Depression - 3.5 MGD	16

1.0 REGIONAL GEOLOGY AND HYDROGEOLOGY

1.1 Geology

Northeastern Florida lies in the Atlantic Coastal Plains physiographic region of the United States, and is underlain by consolidated and unconsolidated sedimentary sequences ranging from the late Cretaeous to Holocene times.

Northeast Florida is characterized by flat plains and low rolling hills. Much of the surface geology is controlled by the Atlantic Ocean and wind. Subsurface geology ranges from sediment deposits indicating recent episodes of deposition, to sequences of carbonate rock deposits indicating shallow warm sea levels. The carbonate deposits make up the Florida Plateau, which rapidly drops off to deep Atlantic waters to the east, and extends westward into the Gulf of Mexico for approximately 100 miles. Underlying the carbonate deposits are clastic rock of the continent, which have not shown to be continuous from central Florida south (Milton, 1972).

1.2 Hydrogeology

The carbonate rock underlying the recent sediments construct the upper confining unit and the Floridan aquifer. The Floridan Aquifer and confining beds are well described in Bush and Johnston, 1988 as "...the top of the Floridan Aquifer system represents the top of highly permeable carbonate rock that is overlain by low permeable material--either clastic or carbonate rocks. Similarly, the base of the Floridan is that level having no high permeability rock below it."

Although the Floridan aquifer is considered a confined aquifer, the confining beds can be open to the overlying water table aquifer by sedimentary deposits or by sink holes (Bush, 1988). The Floridan is generally divided into two zones, the Upper and Lower Floridan, but may be subdivided into three

water bearing zones separated by semiconfining zones (Leve, 1966). The Upper Floridan aquifer consists of three carbonate units, the Suwannee Limestone, Ocala Limestone, and the Avon Park Formation (Bush, 1988). The Lower Floridan consists of Middle Eocene to Early Cretaceous carbonate units (Miller, 1986). Locally, there are subregional confining units which separate the upper Floridan from the lower (Miller, 1986).

The permeable units of the Floridan aquifer range in transmissivity depending on location. The ranges usually quoted are between 50,000 to 500,000 square feet per day (Leve, 1966), (Miller, 1986 indicates transmissivity ranges between 25,000 and 250,000 feet squared per day), but these values can range up or down with penetration of the aquifer and permeability of the confining units.

2.0 SITE CONDITIONS

2.1 General Overview

Blount Island is a partially manmade island composed of dredge spoil removed from the St. Johns River. Much of the material was deposited around Alligator Island, Vicks Island and LeBaron Island, and southward toward the main channel of the St. Johns River. Material has been deposited to depths of up to 20 feet. During the early 1940s, dredging of the main channel on the south side of Blount Island removed some soft limestone from the 40-foot cut in the channel (Corps of Engineers Jacksonville Harbor Project, 1944). This channel allows Blount Island to accommodate deep draft shipping activities as well as eliminate the difficult navigation for large ships in the Old River Channel when moving to and from the downtown area of Jacksonville. Figure 1 shows Blount Island with respect to Duval County.

Blount Island is currently the location of two major industrial operations, Gate Maritime Properties, Inc. and the Jacksonville Port

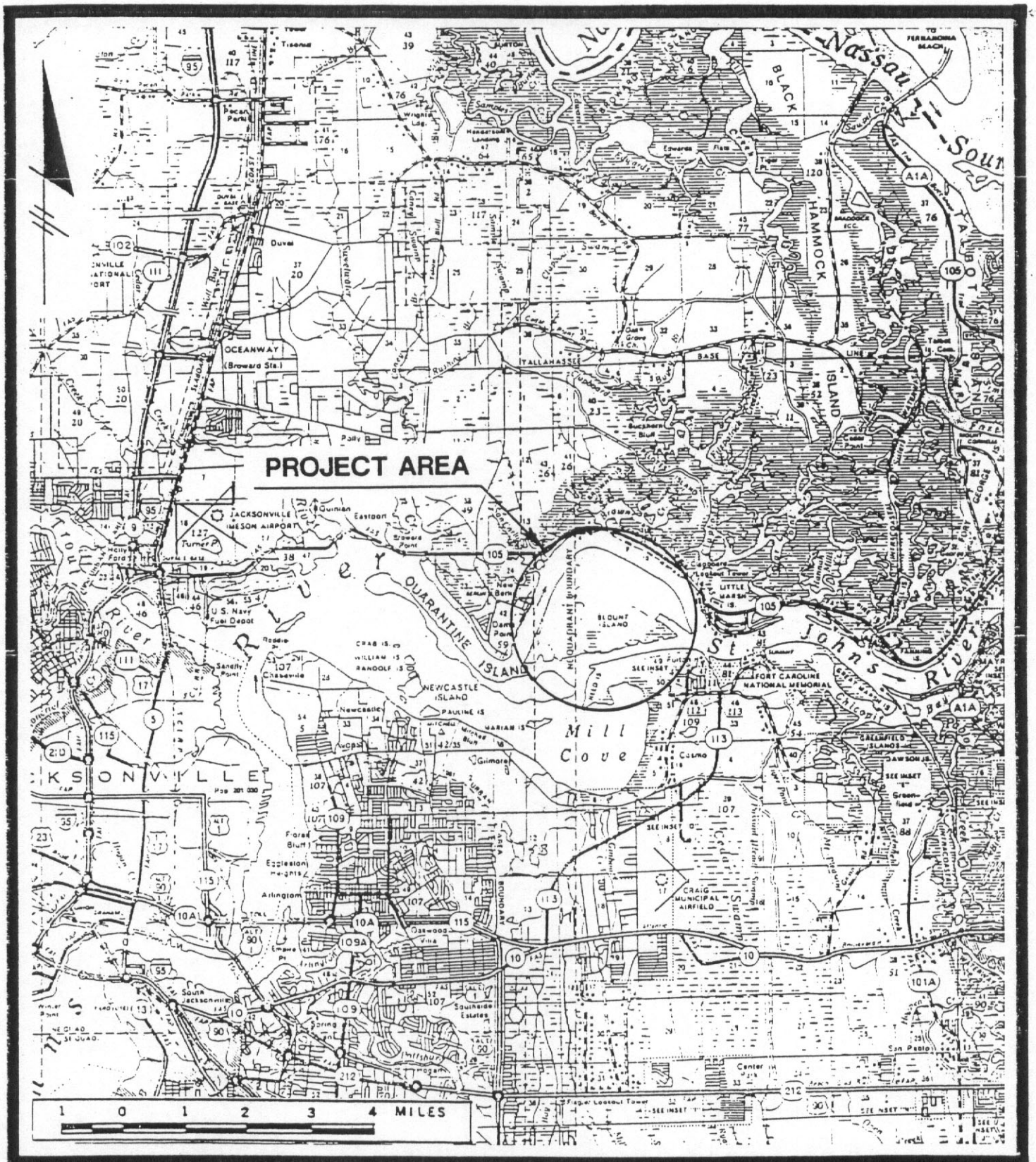

Figure 1

SITE LOCATION MAP

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Authority. Gate Maritime operates facilities on the eastern side of the island and provides services and land use to the U.S. Marine Corp, Bendix Corporation, and B.F. Goodrich Rubber Company. Gate maintains the water supply system on their portion of the island.

2.2 Well Construction

Gate Maritime Properties purchased the former Offshore Power Systems facilities in the early 1980s. To supply the expected water consumption for OPS, two deep wells had been installed. These wells both have 18-inch diameter surface casing narrowing to a 12-inch diameter open hole from the top of the Ocala Limestone to termination.

The North Well (Well 1) was fitted with a 75-horsepower turbine pump with the bowl assembly at a depth of 60 feet below the first surface flange. The north well generally pumps at 2,850 gallons per minute and is used to fill and maintain levels in a 500,000-gallon storage tank. Flow from the well is monitored on a pipe-mounted flow meter reading to the tenth of a gallon, a chart recorder, which records quantity pumped against time, and an inside flow meter which reads only when the pump is running. Flow is also calculated by the time clock on the pump control panel in the pump house.

The South Well (Well 2) was constructed for extended use in the event the north well would not meet the expected capacity. Although it is not fitted with a pump, and has never been used (except to collect samples), a similar storage tank and control building were constructed and are available for use.

Prior to construction of the deep wells, an open-ended three-inch diameter well, cased with a five-inch outer casing to 17 feet and an inner three-inch casing to 462 feet, supplied water. This well (Well 7) is currently not in use but is available for fire protection.

Three other wells are located on the facility (Figure 2). These wells are driven two-inch diameter wells with a three-inch surface casing. These wells, historically identified as Wells 3, 5 and 6 are 110-, 100- and 80-feet deep, respectively. These wells once supplied remote buildings with water, or were used either for lawn maintenance or fire control. None are currently used on a regular basis, but can be used for backup or fire fighting needs. Another well, previously known as Well 4, is no longer on Gate Maritime, Inc. property due to a real estate transfer to the Jacksonville Port Authority.

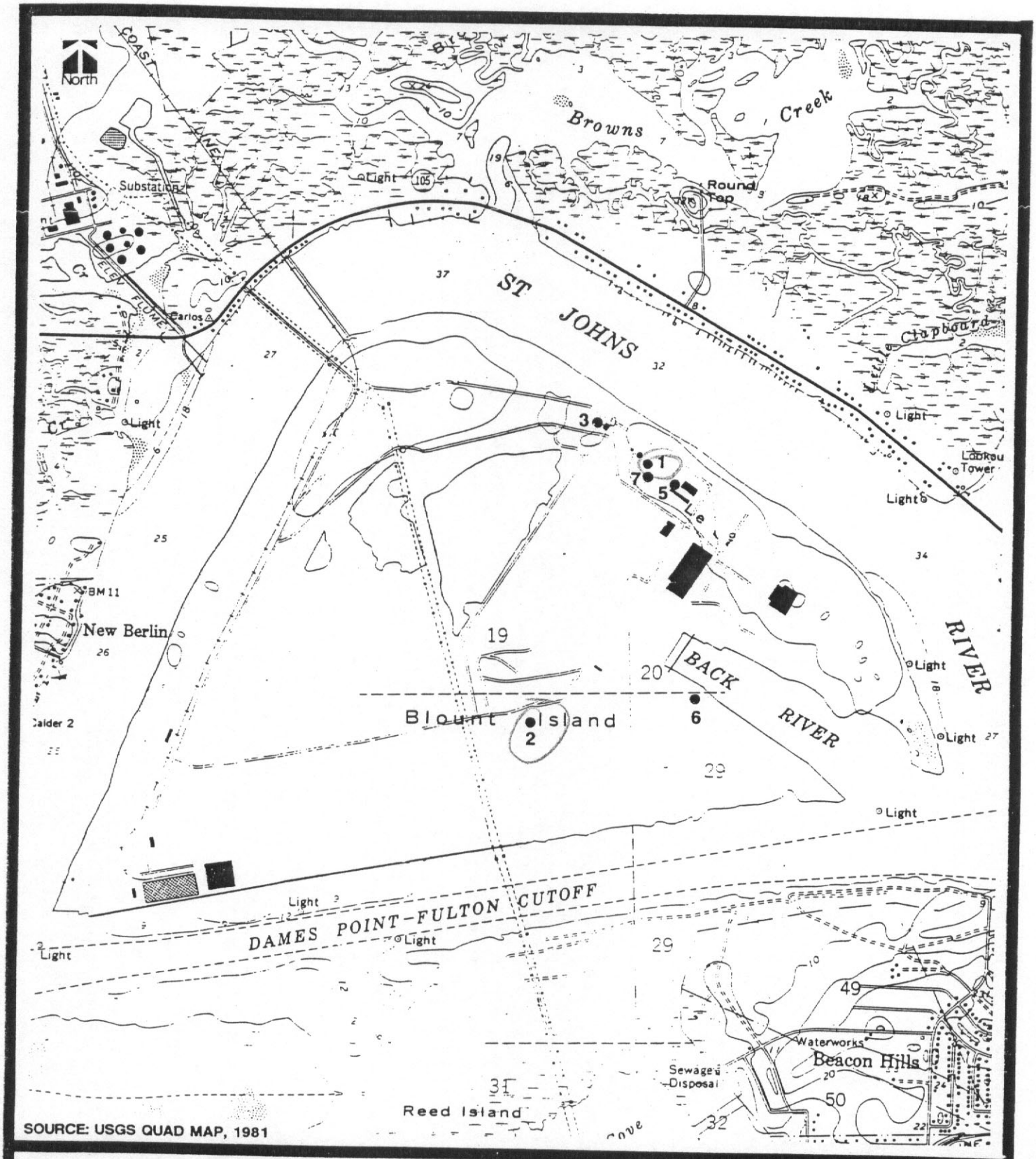
3.0 AQUIFER TEST

3.1 Background Data

Prior to the start of the 24-hour pump test, background water levels were collected on the observation wells using an electronic data logger. The three observation wells selected for the aquifer test were Well 7, 100 feet away from the pumping well (designated OB-1), Well 5, 600 feet from the pumping well (designated OB-2), and Well 2, the south well, 4,480 feet from the pumping well (designated OB-3). Each well was monitored for a period of 24 hours. Data was collected on a linear cycle ranging from two to five minutes. Recorded data is attached in Appendix A.

3.2 Pump Test

At exactly 1 PM, December 21, 1989, a 24-hour continuous flow pump test was begun at the North production well. The flow rate as measured by the pipe gauge and the pump house flow meter registered 2,850 gallons per minute. The flow from the well was piped through the 500,000-gallon storage tank and through piping to the slipway, approximately 2,000 feet away from the well. Appendix B indicates the time clock/flow recorder record and time clock reconciliation over the duration of pumping.



SOURCE: USGS QUAD MAP, 1981

WELL LOCATION MAP

Figure 2

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All of the data loggers were programmed to begin collecting data on a logarithmic cycle to two minutes, where data was collected on a linear cycle until the test finished. The data loggers were also programmed to end the test at 1 PM on December 22, 1989 and begin collecting recovery data (Appendix A) until stopped. A complete set of recovery data could not be collected as the storage tank required refilling after the test terminated.

3.3 Changes in Water Levels

Throughout the collected background data, there is a clearly defined cyclic up and down movement of the water level. Appendix C contains both a table of tidal elevations collected at the USGS Cedar Point Station located near Blount Island, and a plot of the background elevation changes in the south well. These changes appear to be related by fluctuations in the tide. Only the south well exhibited a high degree of elevation change; however, each observation well saw some tidal effect. Barometric changes did not effect the well elevations.

During the constant rate pump test, drawdown was seen immediately in the two closest wells, OB-1 and OB-2. In the south well, OB-3, drawdown did not occur until 200 minutes into the test. In OB-1 and OB-2, the drawdown was measured to 3.8 feet and 3.4 feet, respectively. The drawdown in OB-3, after tidal correction, was measured at 0.6 feet. No tidal influence was apparent on OB-1 or OB-2. As indicated, tidal effects were seen in OB-3 and, although drawdown was measurable, it was almost overcome by tidal change.

4.0 WELL LOGGING

A complete discussion of the well logging procedures and results are given in Appendix D.

5.0 DATA ANALYSIS

5.1 Pump Test

The data collected from the 24-hour constant rate pump test was evaluated using the Hantush Modified Method as described in Lohman, 1972. This method is for leaky confined aquifers with storage in the semiconfining beds. Figures 3, 4 and 5 illustrate the drawdown plotted as time (t) versus drawdown (s) in feet. Calculations are given on each for transmissivity (T) in squared feet per day and storage (S). A match point is indicated, as well as a beta value indicating the appropriate type curve used.

The values of transmissivity in OB-1 were calculated to be 109,153 square feet per day, with a storage of 2.27×10^{-2}. The values obtained for transmissivity in OB-2 and OB-3 cannot be considered accurate because OB-2 was found to be slightly greater than 100 feet deep, and OB-3 was heavily influenced by the tide. These values do not fit the hydraulics of typical Floridan aquifer wells. However, since such a great drawdown was indicated in OB-2, the upper beds must be contributing water into the Floridan aquifer system. This can be demonstrated by plotting the drawdown versus time on semilog paper for OB-1. The plotted data indicates some measure of vertical leakage, seen as a recharge effect, after approximately 50 minutes. The values given for OB-2 are within the predicted ranges for the Floridan aquifer. Values given for OB-3 should not be considered reasonable due to its distance from the pumping well.

The Hantush Modified Method was also used to estimate the drawdown away from the pumping well, for a flow rate of 3.0 million gallons a day and 3.5 million gallons per day. These flow rates are the rates previously permitted in Gate Maritime's Consumptive Use Permit and are the rates requested for the new permit. Figures 6 and 7 illustrate that the curves for both Q-values is

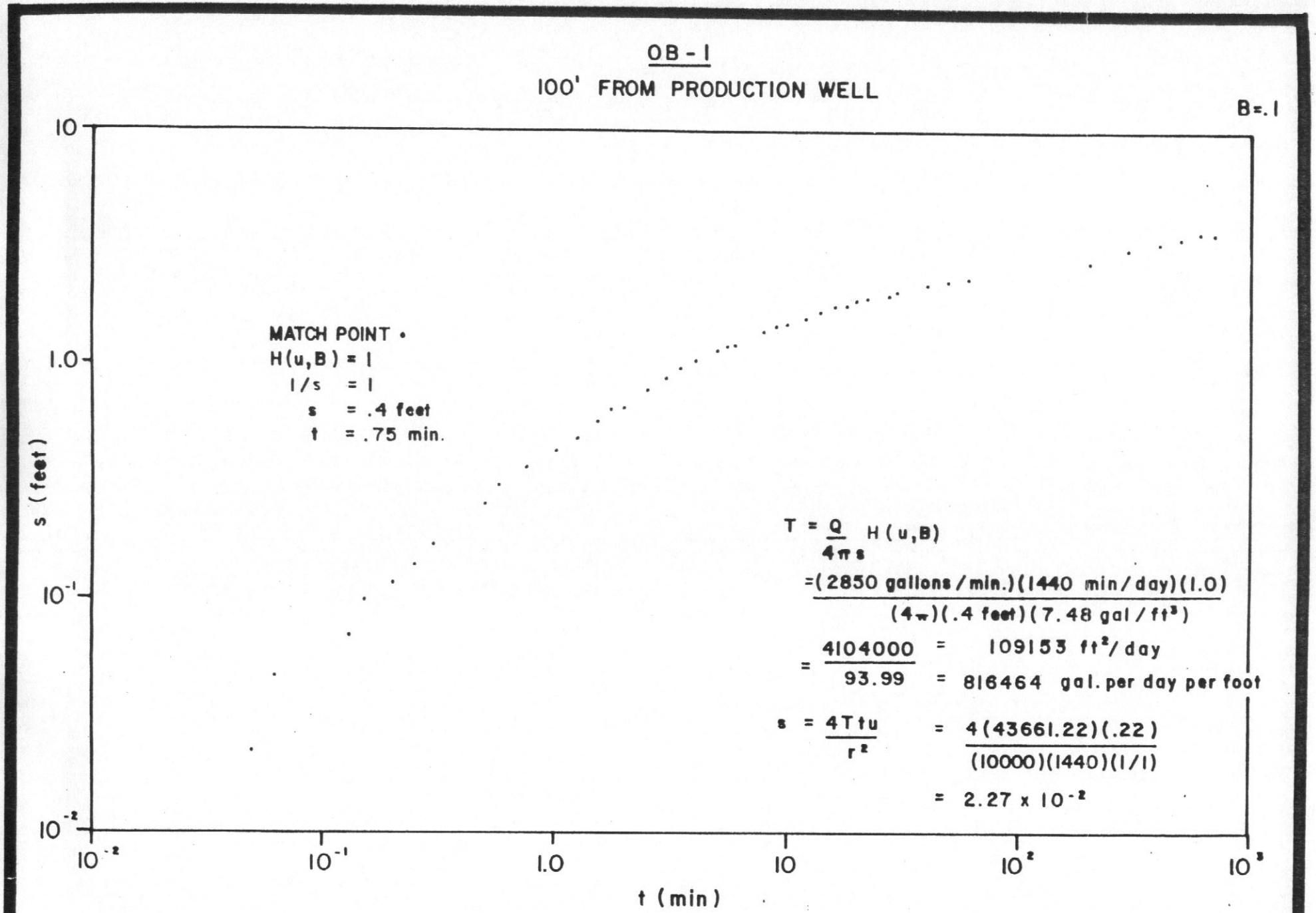

FIGURE 3

HANTUSH MODIFIED DRAWDOWN CURVE

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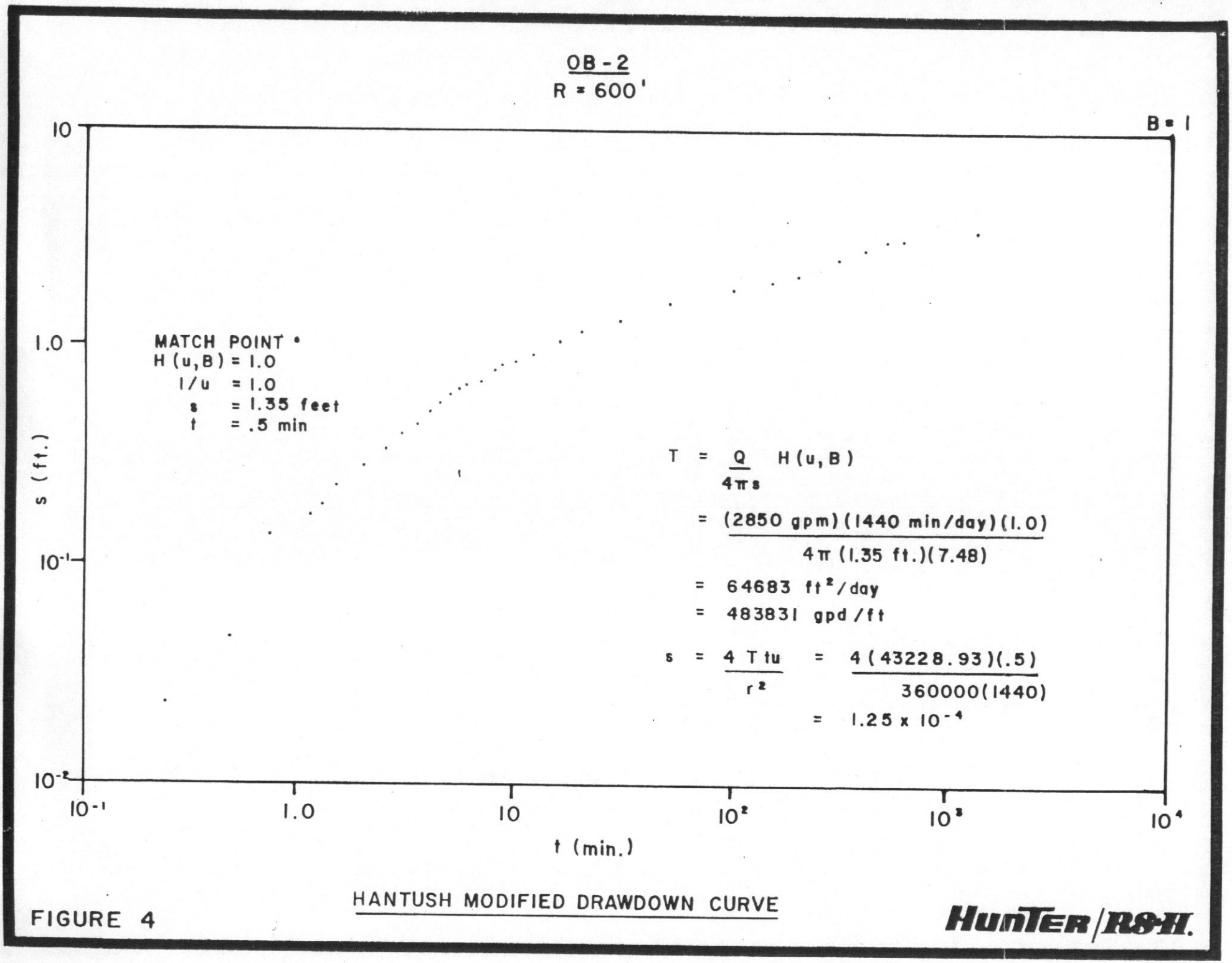


HANTUSH MODIFIED DRAWDOWN CURVE

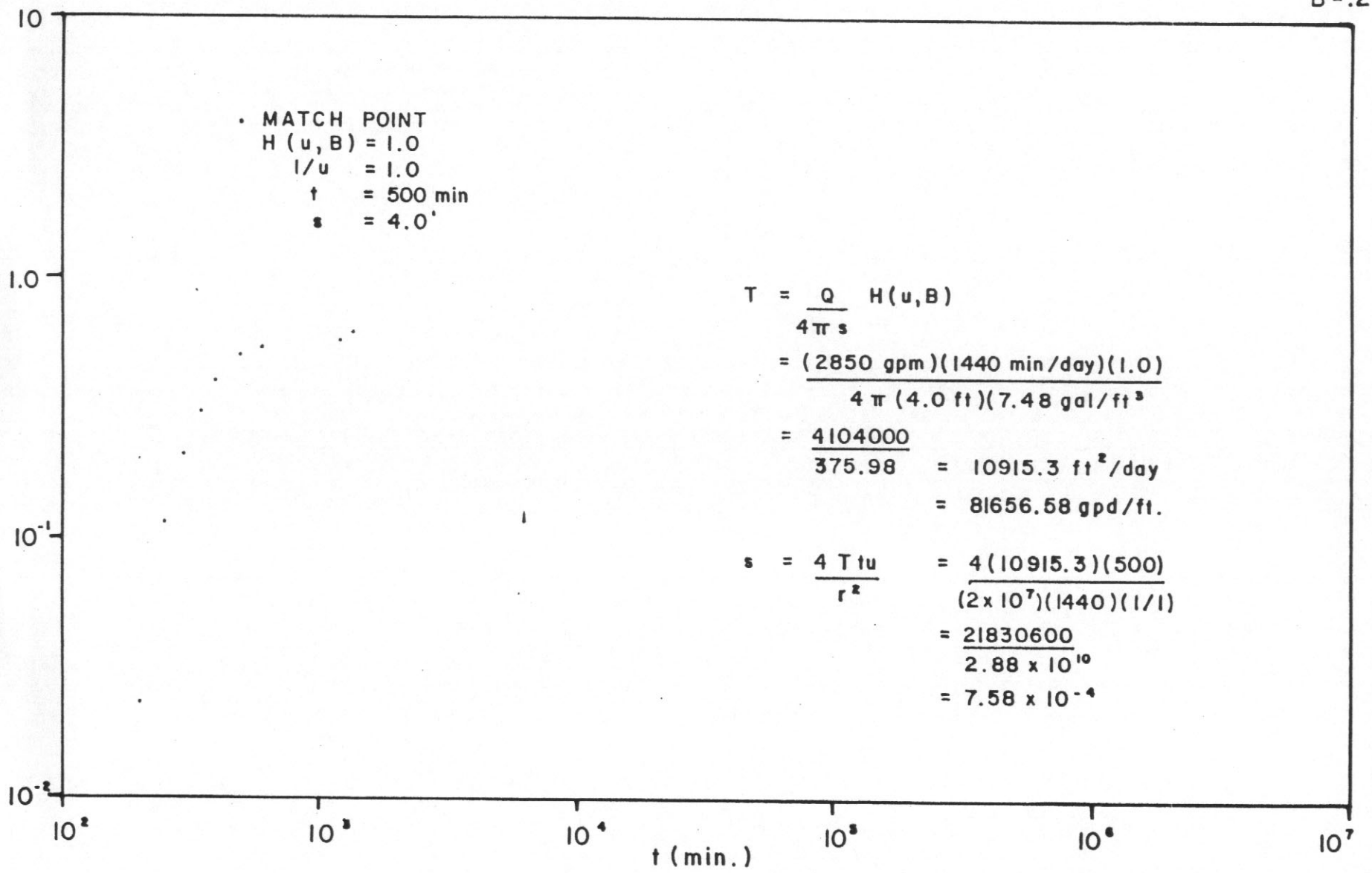
FIGURE 4

HUNTER/R&H.

OB - 3

r = 4480'

B = .2



• MATCH POINT
H (u, B) = 1.0
1/u = 1.0
t = 500 min
s = 4.0'

$$T = \frac{Q}{4\pi s} H(u,B)$$

$$= \frac{(2850\ gpm)(1440\ min/day)(1.0)}{4\pi\,(4.0\ ft)(7.48\ gal/ft^3)}$$

$$= \frac{4104000}{375.98} = 10915.3\ ft^2/day$$

$$= 81656.58\ gpd/ft.$$

$$s = \frac{4\,T\,t\,u}{r^2} = \frac{4(10915.3)(500)}{(2 \times 10^7)(1440)(1/1)}$$

$$= \frac{21830600}{2.88 \times 10^{10}}$$

$$= 7.58 \times 10^{-4}$$

FIGURE 5

HANTUSH MODIFIED DRAWDOWN CURVE

HUNTER/R&H.

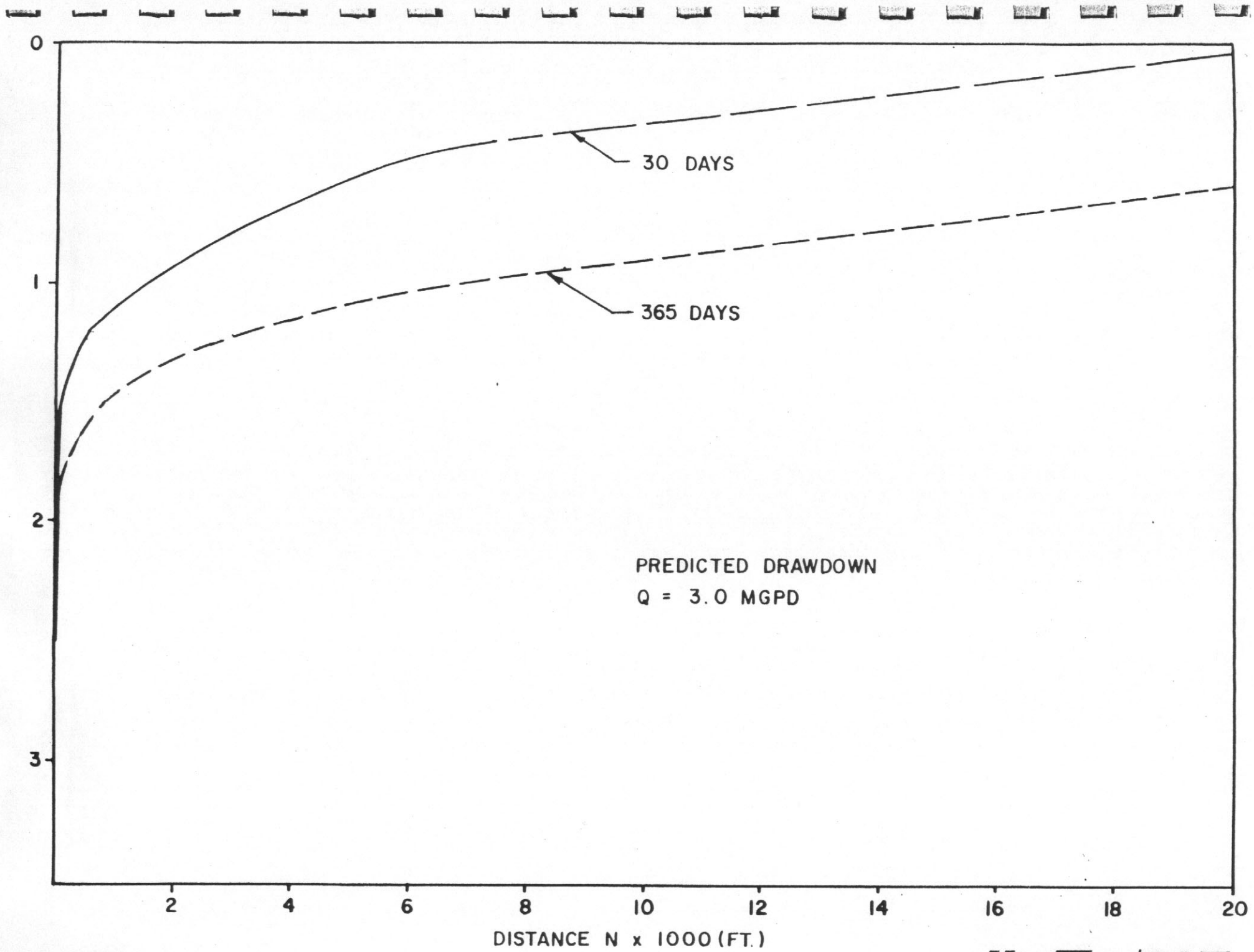


FIGURE 6

HUNTER/R&H.

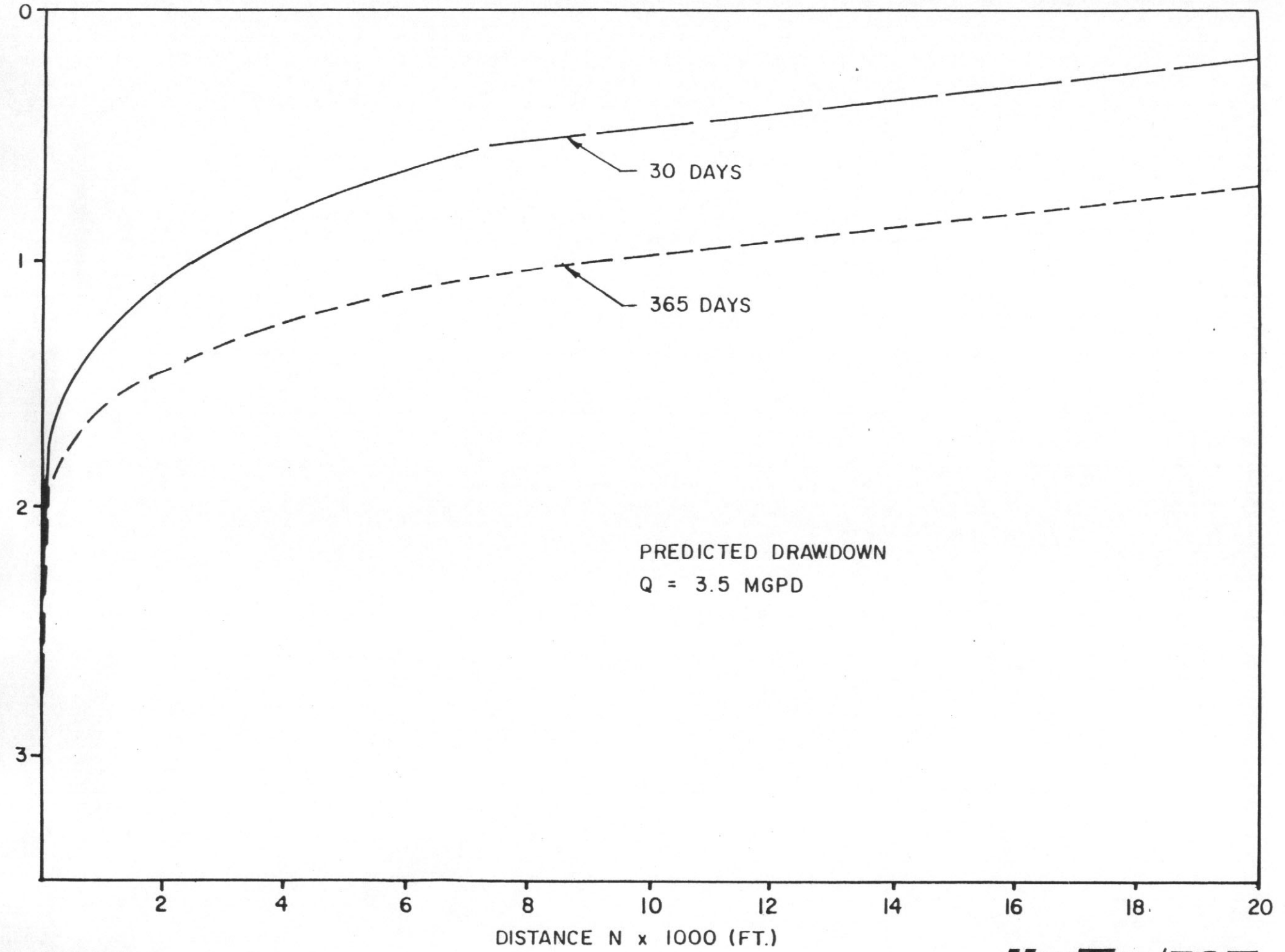


FIGURE 7

HUNTER/R&H.

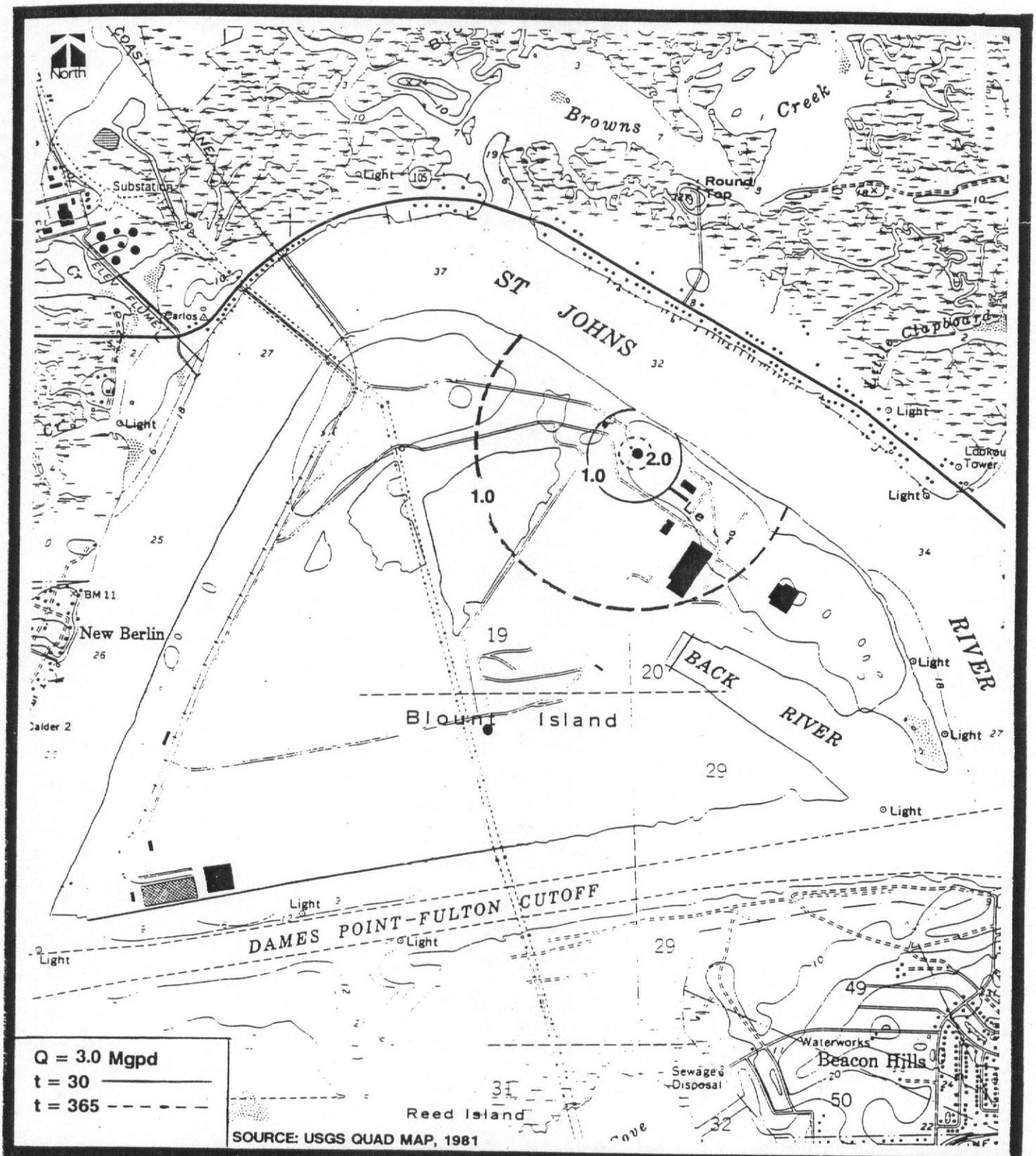
steep toward the pumped well, but shallows rapidly. Both curves indicate that a broad, shallow cone of depression would be formed at these rates. Figures 8 and 9 give a topographic view of the cone of depression.

6.0 DISCUSSION

6.1 Pump Test

The results of the constant rate pump test show that the north production well fits the typical Northeast Floridan aquifer well as far as transmissivity and storage are concerned. As indicated on Table 1, the chlorides are moderately high, and fluctuate in this well. Only during the well logging operations on February 1, 1990, when the well was allowed to flow freely, did the chloride values stabilize to around 125 ppm (chloride values in the south well (Well 2) dropped from an initial 150 ppm to 123 ppm during well logging, Table 2.) Well boring log descriptions and an examination of other area wells (from St. Johns River Water Management District Consumptive Use records) indicate both wells penetrate shallower zones than the majority of industrial use wells. It can also be shown from the fluid resistivity log from the south well that a zone of high quality water exists at a depth of 1,160 feet to termination at 1,209 feet. A water sample collected at this interval gave a 14-ppm chloride value. Further, wells on JPAs portion of the island, the west side, are deeper and yield a higher water quality (20 ppm chloride). From this series of information, it can be inferred that Gate's production well is not deep enough to penetrate the zone of very high quality water.

Furthermore, as shown on the SJRWMD consumptive use files for areas around Blount Island, other industrial wells are permitted to pump a continuous 25 million gallons per day which would create a broad cone of depression, and would certainly include most, if not all of Blount Island.

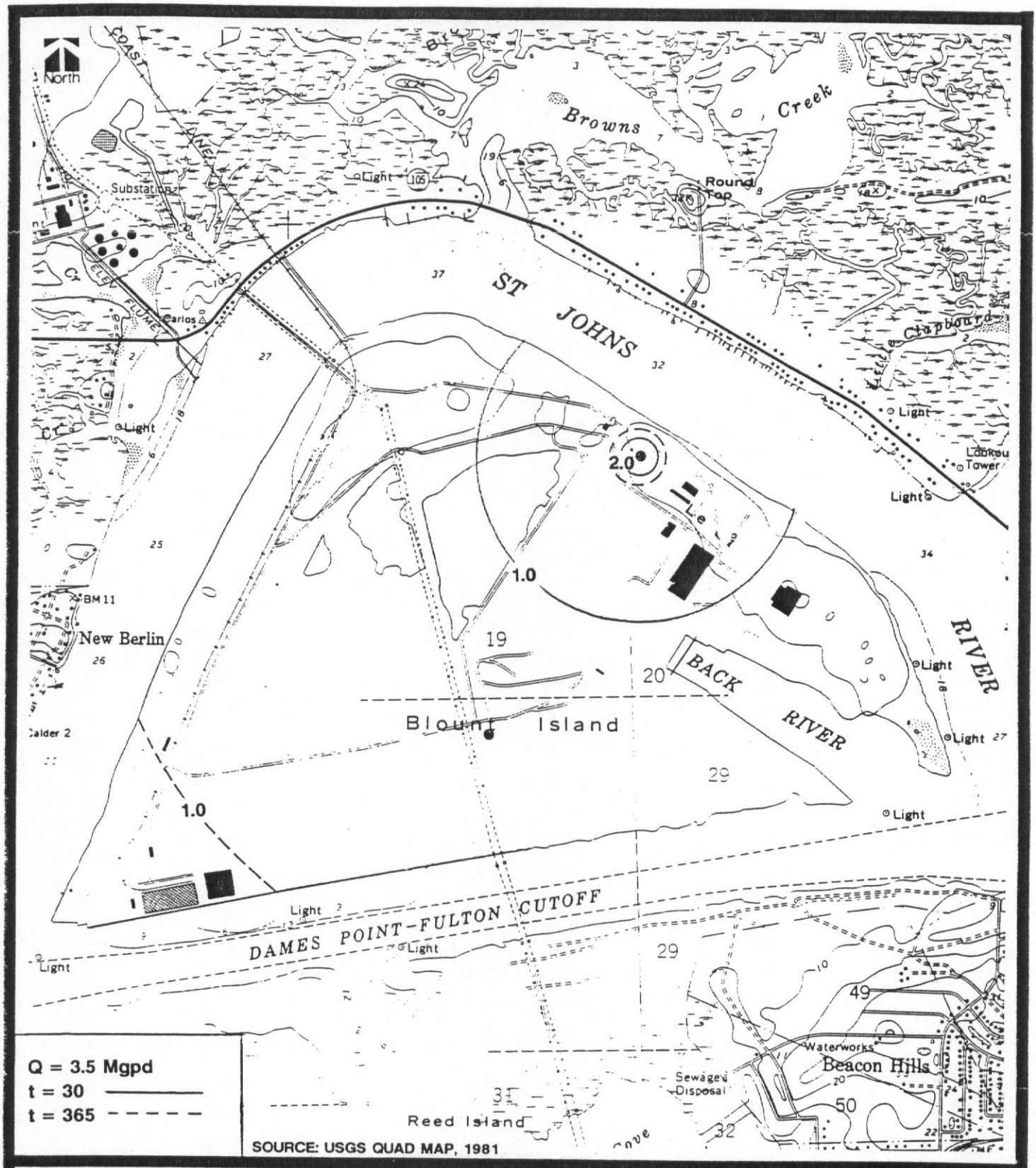


DRAWDOWN CONTOURS

NORTH WELL

Figure 8

HUNTER/RS+H



DRAWDOWN CONTOURS

NORTH WELL

Figure 9

HUNTER/RSH.

Table 1. Chloride Values at North Production Well
Gate Maritime Properties, Blount Island, Jacksonville, Florida

Date	Time	Chloride Concentration PPM
10/3/89	11:15	127.5
	11:20	130.0
	11:25	113.0
	11:30	125.0
	11:40	129.9
	11:45	122.9
	11:50	124.9
	11:55	114.4
10/10/89	19:53	131.5
10/11/89	7:40	131.4
	10:10	127.5
	11:13	132.9
	15:25	135.9
	16:40	137.5
	17:19	105.9
10/12/89	9:28	122.9
	10:45	119.9
	14:36	126.5
	15:35	116.5
	15:50	117.9
	16:14	113.5
11/28/89	12:15	134.0
	12:30	135.5
	12:55	115.1
	13:30	130.0
	14:00	113.6
	14:10	102.7
	14:30	113.6
	15:00	116.6
	15:30	114.1
11/29/89	11:25	125.6
	11:45	123.1
	12:30	115.6
11/30/89	9:00	101.2
12/21/89	21:24	121.6
	22:13	119.1

Table 1. Chloride Values at North Production Well
Gate Maritime Properties, Blount Island, Jacksonville, Florida
(Continued)

Date	Time	Chloride Concentration PPM
12/22/89	11:47	121.6
	12:25	113.7
	12:45	108.2
2/01/89	9:00	124.6
	9:30	131.5
	10:00	133.0
	10:30	128.0
	11:00	129.0
	11:30	127.0
	12:00	126.0
	12:30	129.0
	13:00	126.0
	13:30	125.6
	14:00	126.0
	14:30	125.6
	15:00	126.0
	15:30	126.0
	16:00	122.6
	16:30	120.6
	17:00	124.0
	18:00	130.5

Note: Testing was conducted in the field using Standard Methods 407A, Argentometric Method.

Table 2. Chloride Values at South Production Well
Gate Maritime Properties, Blount Island, Jacksonville, Florida

Date	Time	Chloride Concentration PPM
12/22/89	12:01 12:15	156.3 161.0*
1/29/90	13:55 15:00 16:15 17:30	150.0 138.0 139.0 140.0
1/30/90	10:40 11:35 12:30	126.5 127.0 123.5
2/2/90	12:55 13:55	14.7 1190′ 111.7 960′

*Sample analyzed by TSI Laboratory.
1190′ and 960′ are depths where discrete samples were collected.

Although Gate's well is capable of pumping 3.5 million gallons a day, the historical average usage over the past five years has been approximately 50,000 gallons per day, with an average pumping time of under two hours per day, sporadically. This conservative usage has not contribute to any decline in water quality in the well.

6.2 Water Quality

Since 1985, Gate has been required to monitor the water quality in both the north and south wells. Over that period of time, the water quality monitoring data has shown the chloride content to increase from 90 ppm to the present 120 ppm chloride. During this time, Gate chose to sample the wells with on-site personnel. The on-site staff was unaware of the extended flushing times necessary to relieve these deep wells of cased water in order to obtain a representative chloride sample. The results have been higher than expected, and are subject to the sampling technique. In several instances the water quality in the south well has shown increases up to 167 ppm chloride.

Trilinear diagrams are typically used to judge water quality trends. Appendix H contains trilinear analyses using quarterly water quality data from the north well, and a moving average of diagram of trends. It can be seen that there is a slight upward trend in chloride values, but it is neither as steep as previously thought, nor does the water quality tend to be in the high chloride range.

Table 1 and Table 2 show values obtained during testing of both the north and south wells. As previously mentioned, when water is allowed to freely flow from both wells, the chloride content stabilizes around 120 ppm for both wells sampled at the surface. This indicates that the sampling techniques previously used do not allow a complete flushing of the wells prior to sampling, and that the suspected poorer water quality in the south well is

actually increasing at a much lower rate than the previous monitoring data has shown and that the general chloride content is approximately the same as the north well. Although a decrease in the quality of water for both wells has occurred, a suspected source of lower quality water in the south well area has been identified and can possibly be eliminated.

Overall, the fluid resistivity logs for both wells indicate neither a zone of poor water quality nor increased zonal flow from the well bottom. Rather, the fluid resistivity logs indicate, with the exception of the high water quality in the bottom of the south well, that the water quality throughout both the wells is not high quality.

It has been suggested that a fault in the lower part of the aquifer (Miller, 1986; Leve, 1966) has displaced beds which allow saline water to enter from the lower known (Brown, et. al., 1985) zones into the fresh water zones of the aquifer. Although there is some displacement of the upper Hawthorne Formation, this could be contributed to erosional or depositional surfaces. There is, however, no confirmed evidence from past researchers of a fault in this area, or that one exists in the lower Floridan from the data collected by this study. The fluid resistivity logs for the south well suggest that the water quality in the lower beds, which the well encounters, is very good.

6.3 Conclusions

The results of the study of the declining water quality at the Gate Maritime facility on Blount Island is not limited to just the north well. The problem is a regional problem probably due to the high quantity pumpage of users and industrial processors tapping the aquifer. Gate is located in an area of heavy industry which requires large volumes of water for production use. To imply that the poor water quality in the area is due to one or two

wells which have had a periodic use of several million gallons per day versus daily use of tens of millions of gallons per day is a broad misinterpretation.

The north well at Gate is a typical Floridan aquifer well, as it fits the typical construction, and hydraulic parameters. The drawback of the north well is that it is not deep enough to tap higher quality water, as documented in the south well, which must contribute to the overall high water quality in the surrounding wells if it is tapped. The declining water quality in the Gate wells is largely due to the broad cone of depression created by heavy industrial users to the northwest of Blount Island, and not due to speculated geological anomalies.

7.0 RECOMMENDATIONS

Since 1985, the water quality on the east side of Blount Island has declined, which can be attributed, wholly or in part, to the over pumpage of the Floridan aquifer by industry to the northwest. The well used by Gate does not appear to be deep enough to tap a higher water quality zone which averages 200 feet deeper in surrounding wells. However, the water quality in the well is still below the state secondary water quality standard of 250 ppm chloride, and the quantity of water pumped by Gate is minimal compared to its neighbors.

It cannot be justified for Gate to deepen or construct a new well at this time, as the expense of the construction outweighs the usage of the water. Gate should continue to monitor chloride levels in the north well. Until such a time occurs that the water quality in Gate's well approaches or exceeds the 250 ppm chloride level, no action is recommended.

Borehole Geophysical Investigation Report

Blount Island

Jacksonville, Florida

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February 1990

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WCC File No: 90C5032

TABLE OF CONTENTS

	PAGE
INTRODUCTION	1
WELL CONSTRUCTION DATA	1
LITHOLOGY AND HYDROGEOLOGY FROM GEOPHYSICAL LOGS	2
FLOWMETER LOG INTERPRETATION	3
BOREHOLE WATER QUALITY	4
CONCLUSIONS	6

INTRODUCTION

In January 1990, Woodward-Clyde Consultants (WCC) was contracted to perform borehole geophysical services for Reynolds, Smith and Hills on Blount Island in Jacksonville, Florida. Beginning January 29th through February 3, 1990, WCC logged two deep wells and four shallow wells at the Gate Marine Terminal on Blount Island. The primary purpose of this investigation was to assess formation water quality, and the secondary purpose was to determine lithology and provide well construction data. A suite of logs consisting of the natural gamma, caliper, electric log, flow meter and fluid resistivity were run on the two deep wells #1 and #2 (Figure 1). The temperature log was run on well #2, and fluid samples were taken from both deep wells. Natural gamma and fluid resistivity logs were run on the shallow wells, and the caliper was run on wells #5 and #7. The two deep wells were drilled in 1977. Well #1 was reported to be cased to 457' and drilled to a depth of 1192'. Well #2 was reportedly cased to 516' and drilled to 1209'. Wells #3, 5 and 6 were reported to be cased to 450', with an additional 100' of open hole. The original depth of well #7 was unknown.

WELL CONSTRUCTION DATA AS DETERMINED FROM BOREHOLE GEOPHYSICAL LOGS

Blount Island

Well #	Casing Depths/Diameter		Total Depth Logged
1	0 - ?	18"	
	? - 457'	12"	457' - 1100' (open hole)
2	0 - 85'	18"	
	85 - 415'	12"	
	415 - 517'	10"	517' - 1209' (open hole)
3	0 - 96'	3"	96'

WELL CONSTRUCTION DATA AS DETERMINED FROM BOREHOLE GEOPHYSICAL LOGS

Blount Island
(continued)

Well #	Casing Depths/Diameter		Total Depth Logged
5	0 - 100'	3"	100'
6	0 - 80'	3"	80'
7	0 - 17'	5"	
	17 - 455'	3"	465'

LITHOLOGY AND HYDROGEOLOGY FROM GEOPHYSICAL LOGS

Three distinct lithologic units are observed on the natural gamma logs. The uppermost unit consists of surficial sand, underlain by the clayey Hawthorn Formation, which is in turn underlain by carbonates of the Floridan aquifer. The Floridan is a relatively thick sequence of limestones and dolomites, which have been separated into hydrogeologic units as identified from the logs and listed below.

Unit	Lithology/ Hydrogeology	Well #1 Depths (feet below land surface)	Well #2 Depths (feet below land surface)
1	Unconsolidated surficial sands	0-105	0-162
2	Hawthorn-type confining unit	105-468	162-508
3a	Uniform carbonate, moderate permeability	468-850	508-855
3b	Hard dolomite, high permeability	850-945	855-985
3c	Semi-confining, low permeability	945-1065	985-1130

Unit	Lithology/ Hydrogeology	Well #1 Depths (feet below land surface)	Well #2 Depths (feet below land surface)
3d	Hard dolomite, high permeability Brown Dolomite	1030-1100 (TD)	1130-1180 1180-1209 (TD)

In well #7 adjacent to well #1, the top of the Hawthorn is also noted at 105'. Wells #3, 5 and 6 (all less than 100' in depth) are located in the unconsolidated surficial sand unit with stringers of clay, sand, and clayey sands.

FLOWMETER LOG INTERPRETATION

Flowmeter logs were run on wells #1 and #2. The borehole walls on well #1 are extremely irregular as evidenced by numerous attempts to reach the bottom of the borehole with the logging tools. The caliper was damaged in well #1 due to the rugosity of the hole. This roughness and the irregular changes in borehole diameter render the interpretation from the flowmeter of limited usefulness in well #1. Although there is no caliper log available on well #1, two conclusions can be drawn from the flowmeter log. At a depth of 850', the borehole diameter appears to be smaller (drilled with smaller diameter drill bit), and a significant amount of flow appears to be coming from the lower portion of the borehole due to the high flow rate maintained to the total depth.

The flowmeter log from well #2 identified four producing zones within the borehole, as indicated in the table below.

PRODUCING ZONES IN WELL #2

Zone	Depth (feet)	Percent of Measurable Flow In Wellbore
Bottom of Casing	517	0
Zone 1	517-545	7
2	585-610	27
3	925-985	50
4	1130-1165	16

It should be noted that additional flow is being contributed from adjacent areas to these four zones; however, the amount of flow is less than the sensitivity of the flow meter.

BOREHOLE WATER QUALITY

The primary purpose of this investigation is to determine the source of poor-quality formation water. To assess water quality in each of the wells the fluid resistivity tool was used. Although the fluid resistivity tool does not directly indicate water quality, a strong correlation exists between the resistivity of water (Rw) and the dominant ions in groundwater (Kwader, 1982)[1]. Chloride values at the wellhead averaged about 125 and 120 mg/l in wells #1 and #2, respectively. Water quality as determined by the fluid resistivity tool is similar in well #7, which is approximately 100 feet from well #1. Water quality in wells #3, 5 and 6 is considerably better and is recorded between 46 and 56 ohm-m versus recordings between 24 and 28 ohm-m in well #7 and the deep wells. Water quality increases with higher resistivity values. Water quality is between 27 and 28 ohm-m in well #1, with

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[1] Kwader, Thomas, Ph.D. December 1982. Interpretation of Borehole Geophysical Logs in Shallow Carbonate Environments and Their Application to Groundwater Resources Investigation, Doctorate dissertation, p 110.

a slight decrease at 992' to about 26 ohm-m. In well #2, water quality is between 26 and 28 ohm-m, with a noticeable decrease at 1078' to about 24 ohm-m and then a significant increase at 1165' to about 46 ohm-m. Figure 2 shows the relationship between temperature, chlorides, and Rw. Overall fluid resistivity values decrease slightly with depth in wells #1 and #2.

Two fluid samples were taken in well #2. The first sample taken in the zone of high resistivity at 1190' had a chloride value of 14.8 mg/l. The second sample taken at 960' had a chloride value of 111 mg/l. Only one sample was taken in well #1 due to the lack of time available to keep this well off-line. This sample was taken at 1092' and the chloride value was 143 mg/l. Overall water quality was fairly uniform in wells #1 and 2, the exception being the higher water quality in the zone from 1165' to 1209' in well #2. Water quality in well #7 was uniform and Rw was very similar to those values found in well #1. In shallow wells #3, 5 and 6 water quality was fairly uniform. Overall water quality was much better in wells #3, 5 and 6 than in wells #1, 2 and 7, as illustrated in the following table.

CHLORIDE VALUES FOR WATER SAMPLES IN WELLS #1 AND WELL #2

Blount Island (Figure 3)

Well #1	Chlorides (mg/l)	Rw (ohm-m)
wellhead	average 125	
1092'	143	26
Well #2		
wellhead	average 120	
960'	111	27
1190'	14	48

CONCLUSIONS

It has been noted that water quality has slightly deteriorated since wells #1 and 2 were installed. Particular focus in this study was directed at the quality of the water from the lower sections of the boreholes.

It is concluded that water quality actually improved towards the bottom of the borehole as seen in well #2. Although well #1 is not quite as deep it is anticipated the same water quality and hydrogeologic conditions exist in both wells. The source of the "poor water quality" is primarily in the carbonates above 1165 in well #2. The poor water quality is due to long-term pumping and lateral movement of poorer water quality from downgradient as opposed to upcoming water from a lower depth. Based upon results of the geophysical logs and related experience in similar wells in the Southeast Coastal Plain of the U.S., plugging of the bottom of the wells will not significantly improve the composite water quality and will slightly decrease the well yield.

Woodward-Clyde Consultants

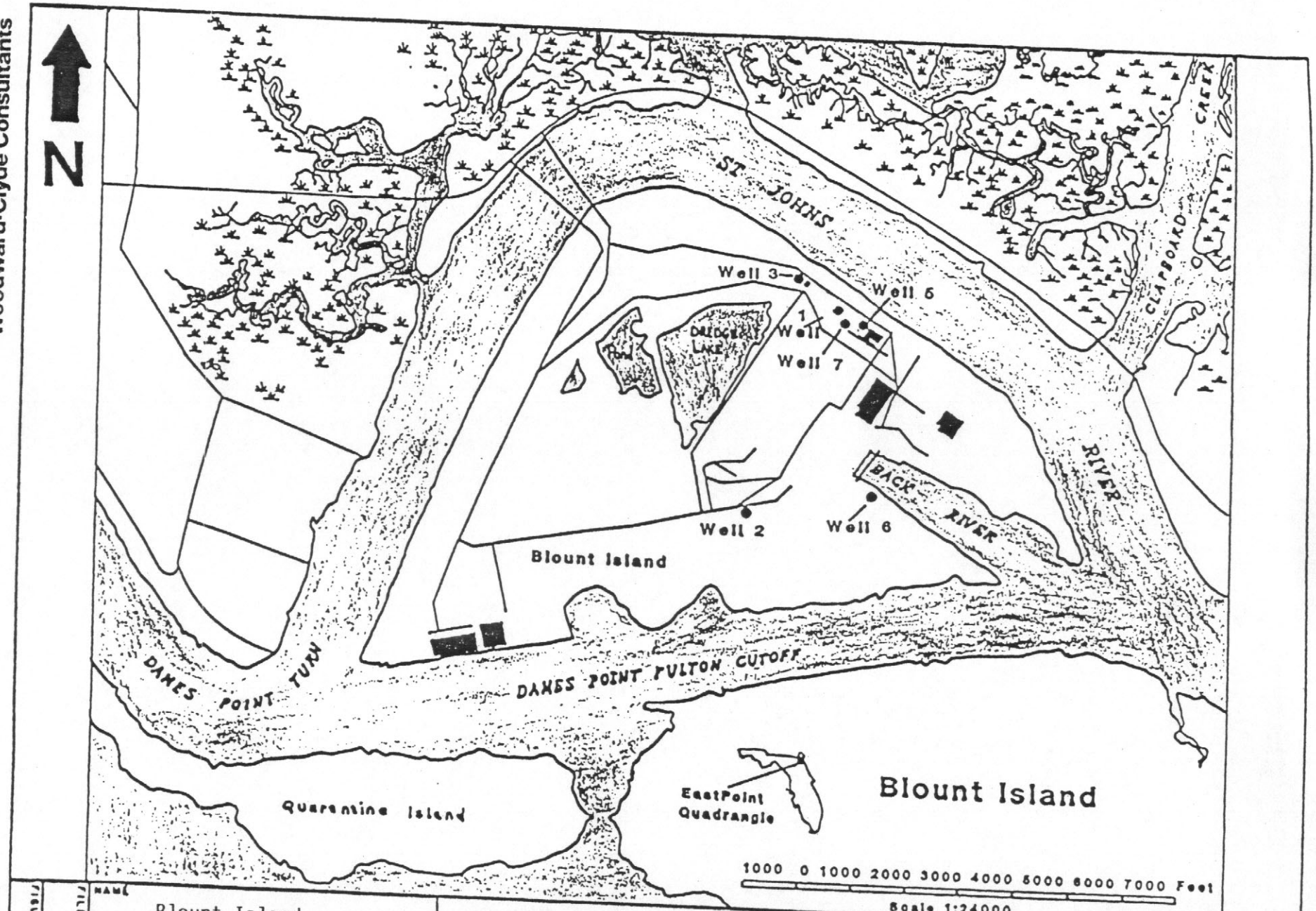


FIGURE	FILE NO.	NAME: Blount Island	Woodward-Clyde Consultants	TITLE: Well Location Map	FILE NO.
		FOR: Reynolds, Smith and Hills	MADE BY: JH DATE: 2-16-90		
			CHECKED BY: GM DATE: 2-19-90	Base Map Source: USGS EastPoint Quadrangle 1981	FIGURE 1

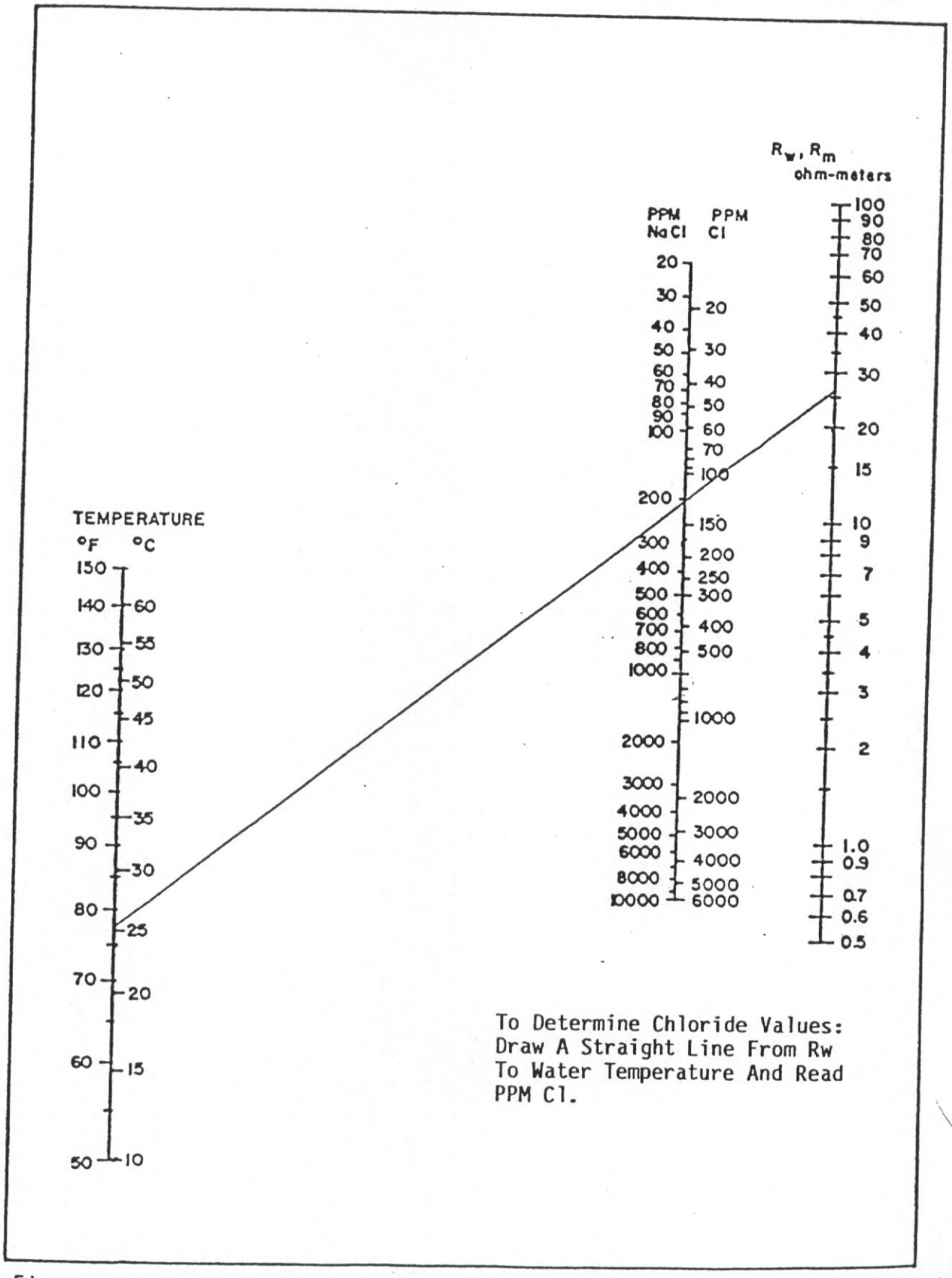
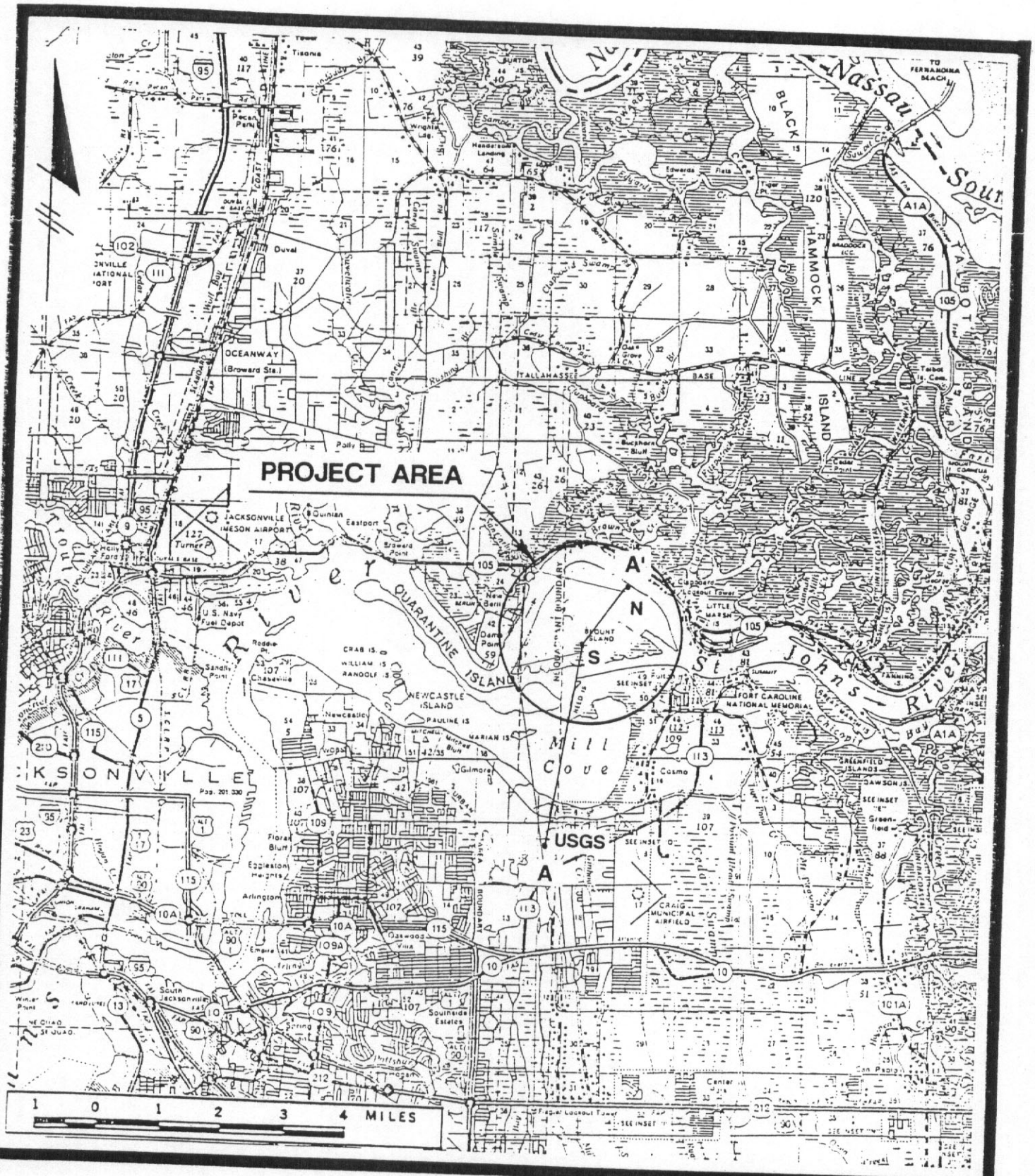


Figure 2 --Resistivity of saline solutions nomograph based upon temperature and chloride ion concentration. (Modified from Dresser Atlas, 1975).

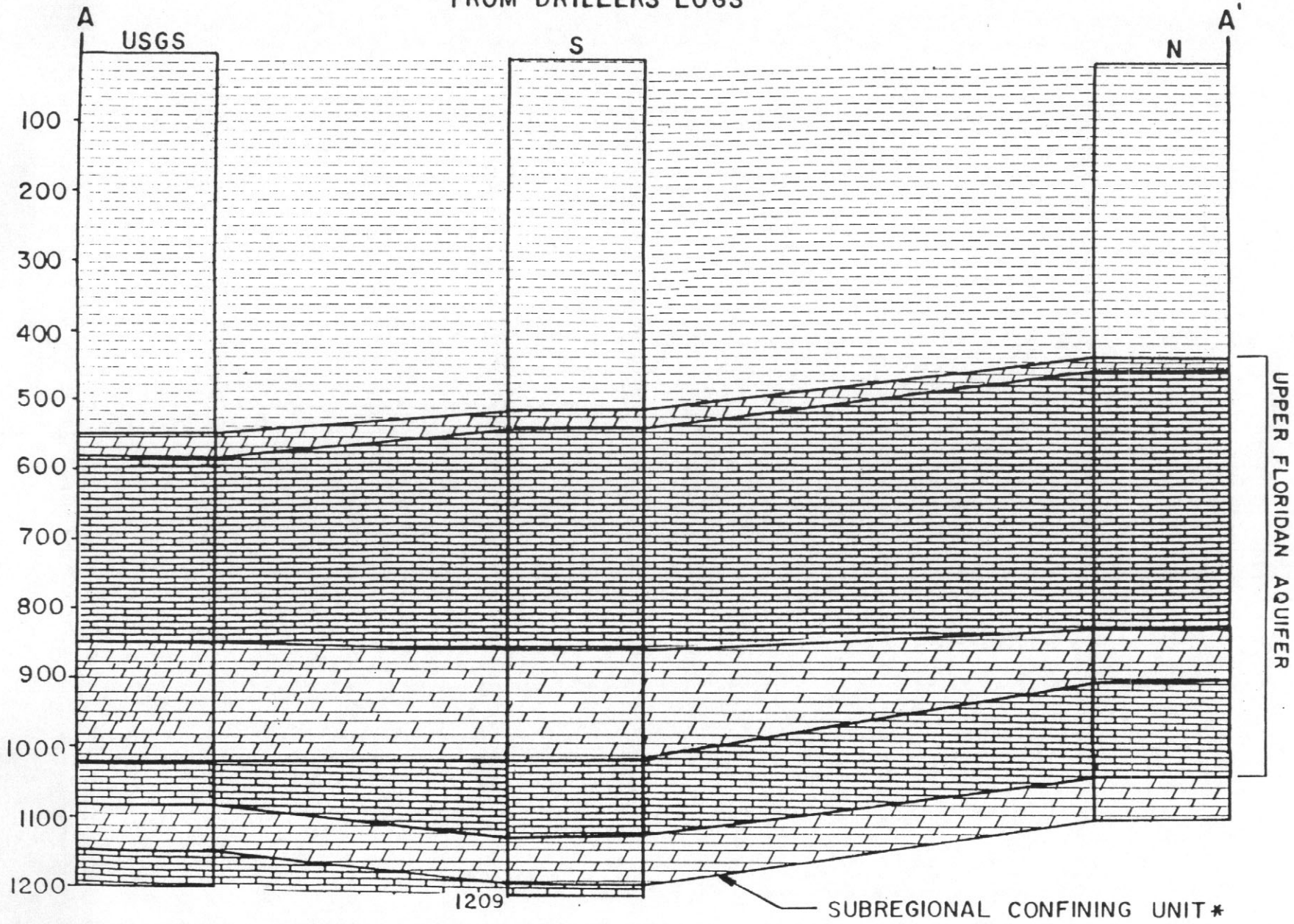


GENERALIZED CROSS SECTION

A - A'

HUNTER/RS+H

GENERALIZED LITHOLOGY FROM DRILLERS LOGS



SCALE : 1" = 20'

* AS DESCRIBED IN MILLER, 1986

SEDIMENT

LIMESTONE

DOLOMITE LIMESTONE

HUNTER/R&H.