STATE OF NORTH CAROLINA

DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT

OFFICE OF WATER RESOURCES

GROUNDWATER RESOURCES OF THE SOUTHERN PINES AREA

A SUPPLEMENT TO THE SANDHILLS CAPACITY USE STUDY

RALEIGH, N. C. MAY, 1980

State of North Carolina
Department of Natural Resources and Community Development
Office of Water Resources

Groundwater Resources of the Southern Pines Area
A Supplement to the Sandhills Capacity Use Study

Raleigh, N.C.
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Summary

Hills and ridges composed chiefly of interbedded, unconsolidated sands and sandy clay form the Sandhills aquifer, which is the primary source of groundwater in the study area. The continuity of the aquifer is interrupted by numerous stream valleys which restrict the movement of groundwater between the interstream areas.

The thickness of the aquifer ranges from a few feet in the stream valleys to over 300 feet along ridge crests. Poorly permeable sandy clays underlie the aquifer, separating it from the crystalline rocks and consolidated sediments which form the "basement" complex.

In the vicinity of upper ridge slopes the aquifer has a transmissivity of approximately 8,000 gallons per day per foot and a storage coefficient of 0.0002. The specific capacity of municipal wells averages 4.5 gallons per minute per foot of drawdown. The average municipal well yield is about 175 gallons per minute.

The chemical quality of groundwater in the Sandhills aquifer is generally good but may be locally high in iron.

It is estimated that approximately eight to ten million gallons of groundwater per day could be withdrawn from designated areas in the region. However, the distribution of well sites and well spacing requirements could impose economic restrictions on groundwater development.

GROUNDWATER RESOURCES OF THE SOUTHERN PINES AREA, MOORE COUNTY
A SUPPLEMENT TO THE SANDHILLS CAPACITY USE STUDY

INTRODUCTION

In order to meet current demands for water and to provide for projected growth through the twenty-first century, consultants for the Town of Southern Pines identified several water supply source alternatives. These alternatives, described in a feasibility report prepared in 1977, focused chiefly on surface sources.

A report entitled, "Sandhills Capacity Use Study," published by the Department in January, o979, concluded that some surface water supply alternatives had potentially severe impacts on affected streams and that the groundwater resources of the area should be considered as a potential source of municipal supplies.

In order to assess more accurately the groundwater resources in the Southern Pines-Pinehurst-Aberdeen area, the Department began an investigation of the hydrogeology of the area. This supplement presents the results of the investigation.

PURPOSE AND SCOPE

The purpose of the investigation was to determine the potential for developing groundwater supplies sufficient to meet the long-range projected needs of municipalities in the study area.

The study area is in the southern part of Moore County. It is bounded by the Little River on the north, the Moore County line on the east and south, and longitude 79 degrees 35 minutes west, on the west. The area includes the Towns of Southern Pines, Pinehurst, Aberdeen, West End, and Pine Bluff and the communities of Seven Lakes, Foxfire Village and Whispering Pines (Figure 1).

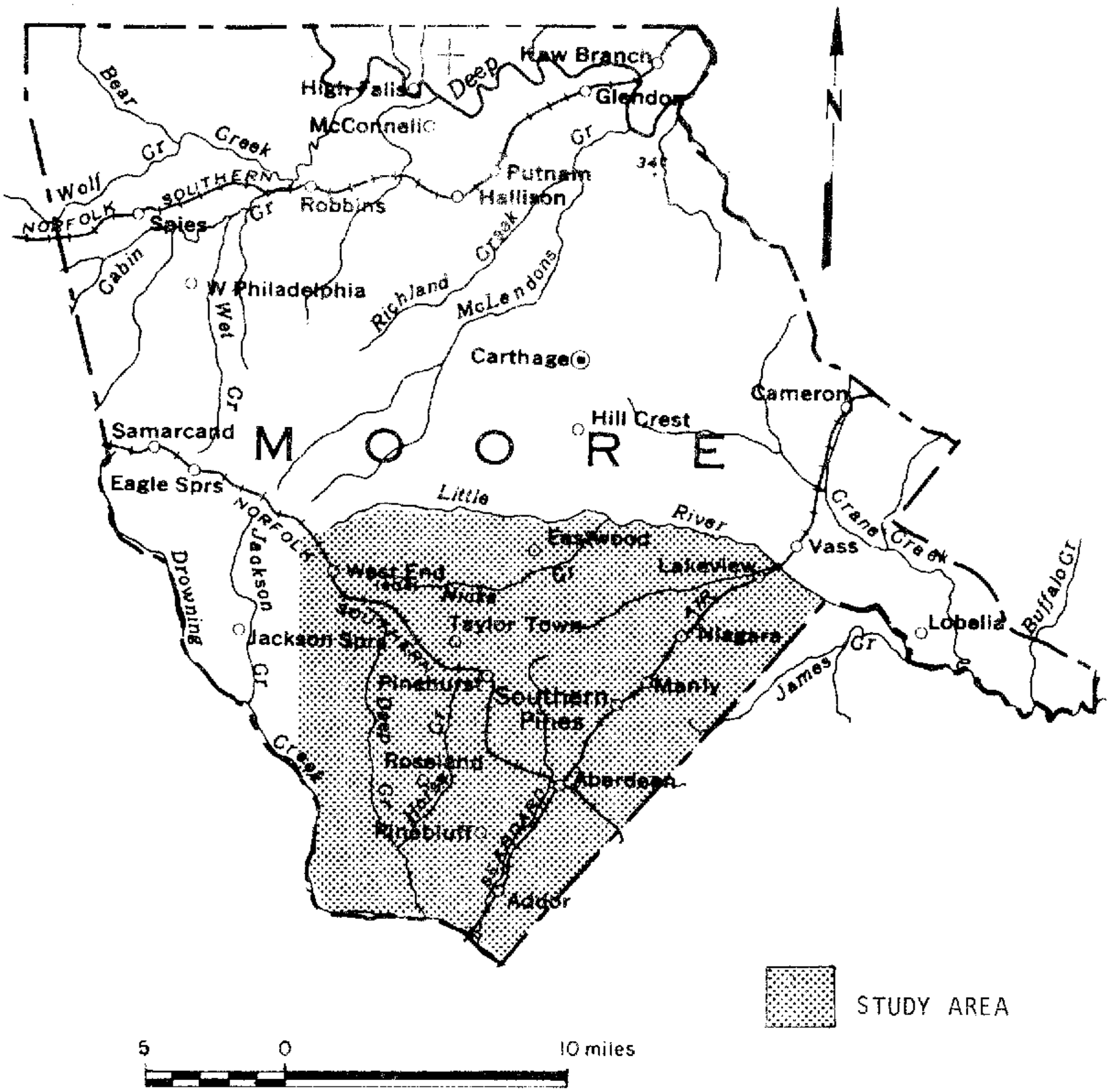


FIGURE 1

MAP OF STUDY AREA

Method of Investigation

The study utilized data on file with the Department and obtained from towns within the study area. Water well contractors serving the area contributed valuable information and cooperated with Department personnel in their data collection activities.

Test wells were constructed by the Department at eight sites for the purpose of describing the hydrogeology of the area and obtaining hydrologic data. Diagrams of these stations are shown in Appendix A. Their locations are shown in Figure 2.

Acknowledgement

Many public officials and private citizens provided information valuable to this study. In particular we wish to express appreciation to Mrs. Mildred McDonald, Town Manager of the Town of Southern Pines, and her staff; Heater Well Company, Carolina Well and Pump Company, and to Mr. Edward Burt, Geologist, N. C. Geological Survey.

HYDROGEOLOGIC FRAMEWORK

Physiography

The Southern Pines area is located in the western Coastal Plain sub-region known as the "Sandhills." The area is characterized by rolling hills ranging in elevation from 450 to 600 feet above sea level. Stream beds in the area range from 300 to 350 feet elevation, resulting in 200 to 300 feet of topographic relief. An east-west trending ridge which traverses the area forms the principal drainage divide. Runoff to the north of the divide discharges to the Little River and, to the south, to Drowning Creek. North-south trending ridges formed by a well developed, dendritic drainage pattern project from the principal divide. Ridge Crests, or divides, are typically broad and slope slightly to the east or southeast.

Precipitation and Stream flow

The area receives approximately 49 inches of precipitation per year, most of which occurs during the Spring and Summer months. Average

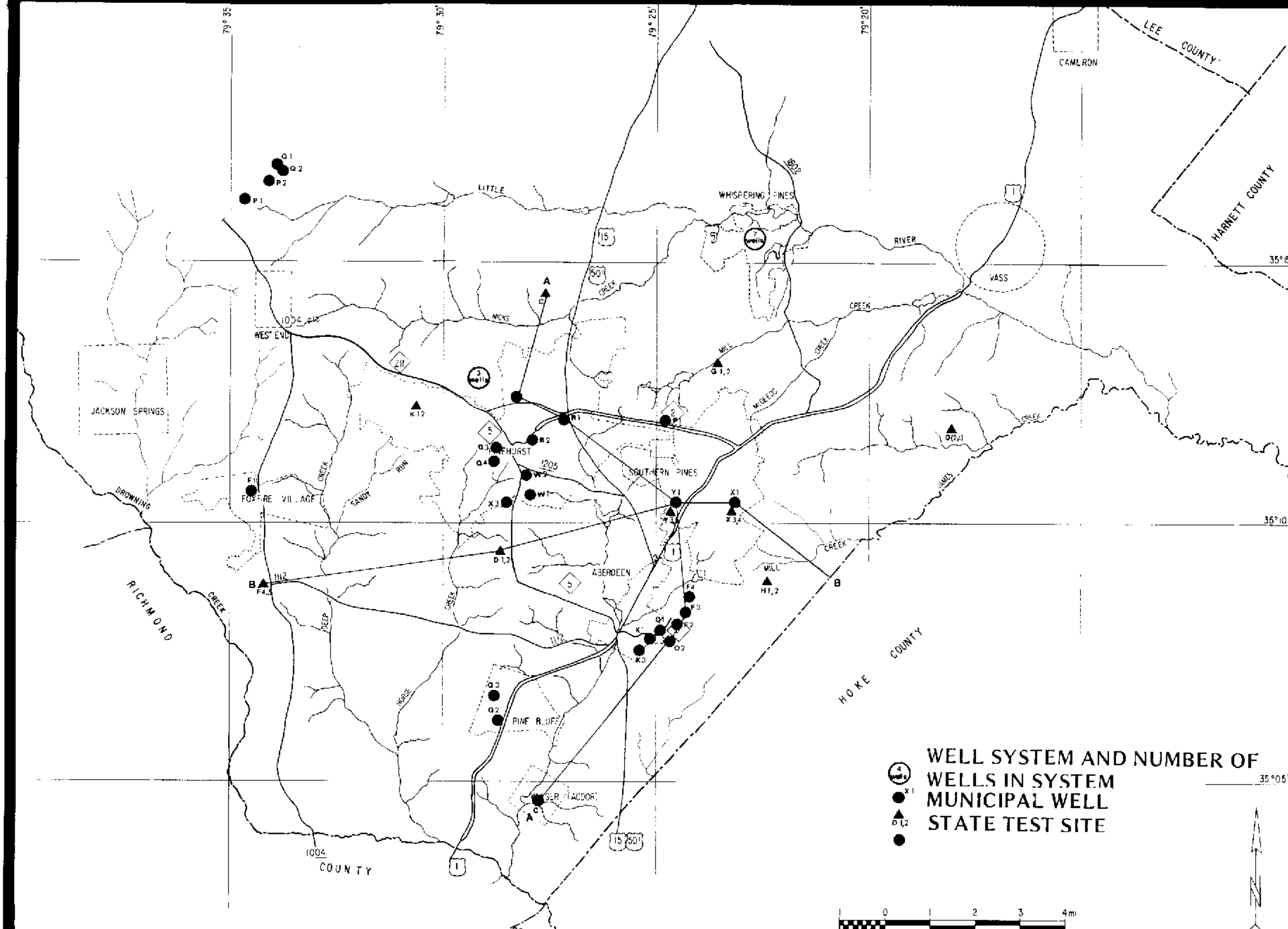


FIGURE 2

LOCATION OF MUNICIPAL WELLS OR WELL SYSTEMS, STATE TEST WELL SITES monthly rainfall at Southern Pines is shown in Figure 3.

An analysis of streamflow measurements recorded over a 20 month period at Deep Creek indicates that 45.8 inches of precipitation, overland runoff accounted for 6.7 inches (15%), groundwater runoff accounted for 10.4 inches (23%) and 28.7 inches (63%) was lost as evapotranspiration or groundwater outflow. Because of the prevailing hydrogeologic conditions, one may assume that almost the entire 28.7 inches was evaporated or transpired.

Average streamflow in the area is 1.3 cfs/mi.^{2} and average base flow is 0.78 cfs/mi.^{2} or approximately 61% of average flow.

Hydrogeologic Units

Three major hydrogeologic units underlie the area: the Carolina Slate Belt Metavolcanic unit, the Triassic unit and the Sandhills unit. The youngest of the three, the Sandhills unit, was deposited on a gently sloping peneplain composed of rocks of the Triassic and Metavolcanic unit. Subsequent subaerial erosion and eolian processes resulted in the existing landform.

Slate Belt and Triassic Units

Both metavolcanic rocks of the Carolina Slate Belt and Triassic deposits form the basement surface upon which subsequent deposition occurred.

The Triassic rocks were deposited in a structural basin within the Slate Belt complex, and were subsequently tilted and subjected to continued vertical displacement and erosion. The basin, known as the Sanford segment of the Deep River Triassic Basin, is about 10 miles wide in Moore County and trends northeast. It is bounded on the east by the Jonesboro fault and on the west by the Western Boundary fault. In that part of the basin underlying the study area, the Triassic system includes red or reddish-brown fanglomerates, red silstones and claystones.

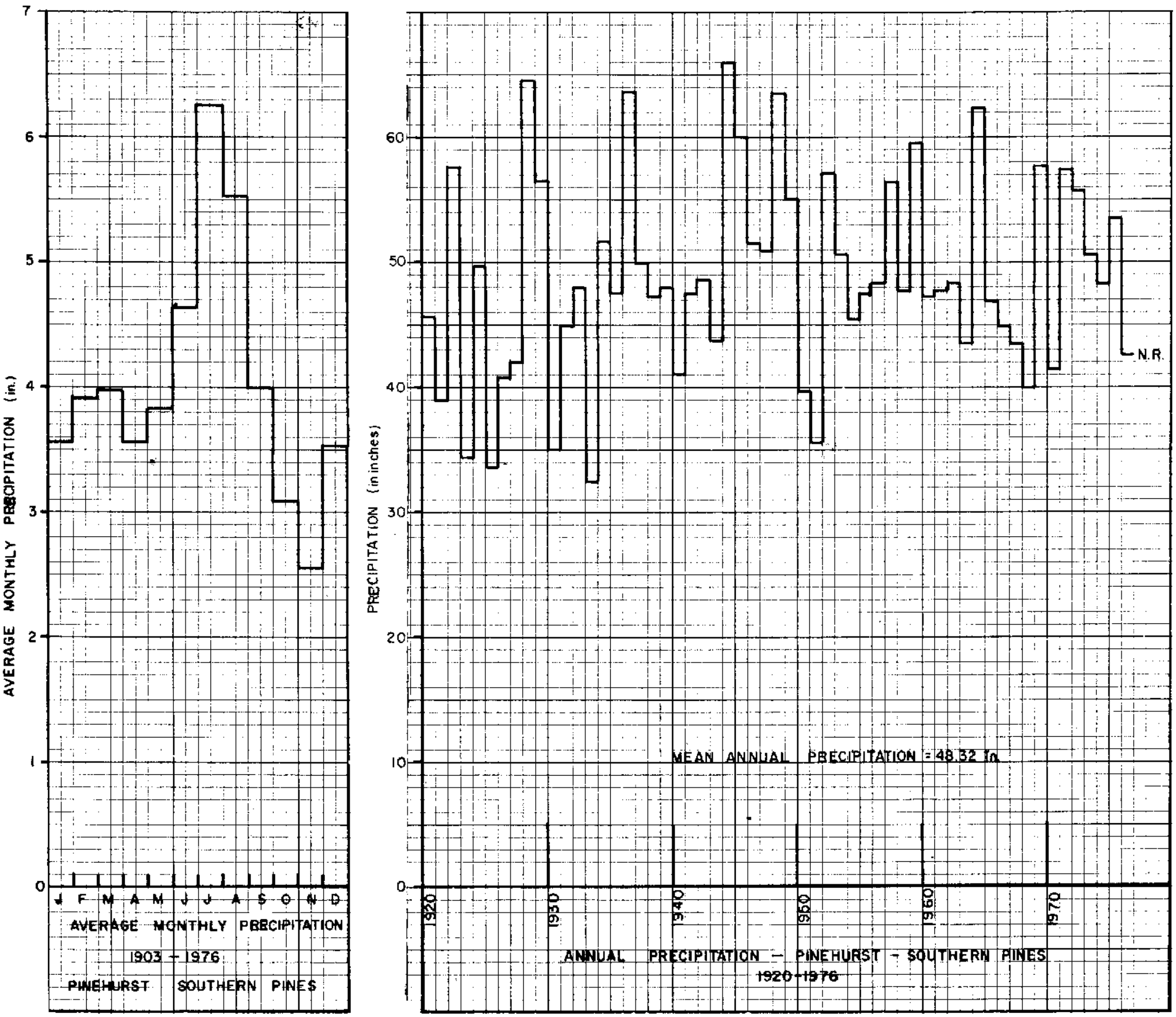


FIG. ___ GRAPHS SHOWING PRECIPITATION IN THE PINEHURST - SOUTHERN PINES AREA

East of the Jonesboro fault the basement rocks are comprised of fine-grained metavolcanics and metasediments. Granite has been reported in the area southeast of Aberdeen on evidence provided by drill cuttings from water wells. The slates and tuffs of the Metavolcanic unit dip generally to the southeast under increasingly thicker coastal plain sediments. Basement rocks are exposed along Nicks Creeek north of Pinehurst and along Little River in the northeastern part of the study area.

The elevation of the basement surface ranges from about 450 feet above sea level in the northwestern part of the area to less than 200 feet in the southeast (Figure 4).

Sandhills Unit

The Sandhills hydrogeologic unit lies unconformably on the basement surface. This unit includes the Cape Fear and Middendorf formation of Late Cretaceous age, outliers of ocene deposits and the post-Eocene surficial sands of the Pinehurst formation.

The Cape Fear formation, which overlies basement rocks throughout most of the study area, is composed of sandstones and clays in varying combinations. The unit ranges in thickness from a featheredge in the northern part of the area near Nick's Creek to more than 100 feet near Southern Pines. Because the extent and thickness have been determined principally on the basis of geophysical characteristics, some younger strata having characteristics typical of the Cape Fear may have been included.

The Middendorf and, where present, the overlying Pinehurst formation comprise the Sandhills Aquifer.

The Middendorf, of late Cretaceous age, occurs everywhere in the interstream areas in the region of study and forms the hills for which the region is named. he formation ranges in thickness from about 100 feet to 200 feet and dips gently to the southeast.

The Middendorf is composed of cross-bedded, medium-grain, micaceous quartz sand intercalated with clay or sandy-clay lenses with gravel occurring locally at its base. The formation has a mottled, orange and tan color with streaks of red and purple hematite and manganese stains. Layers of hematite cemented sandstone, or "hard-pan," occur throughout the unit.

The deposits of Eocene age are reported to occur as an outlier on "Paint Hill," east of Aberdeen. The deposits are distinctive from all others in the area in that they consist of glauconitic sandstones, chert and opal

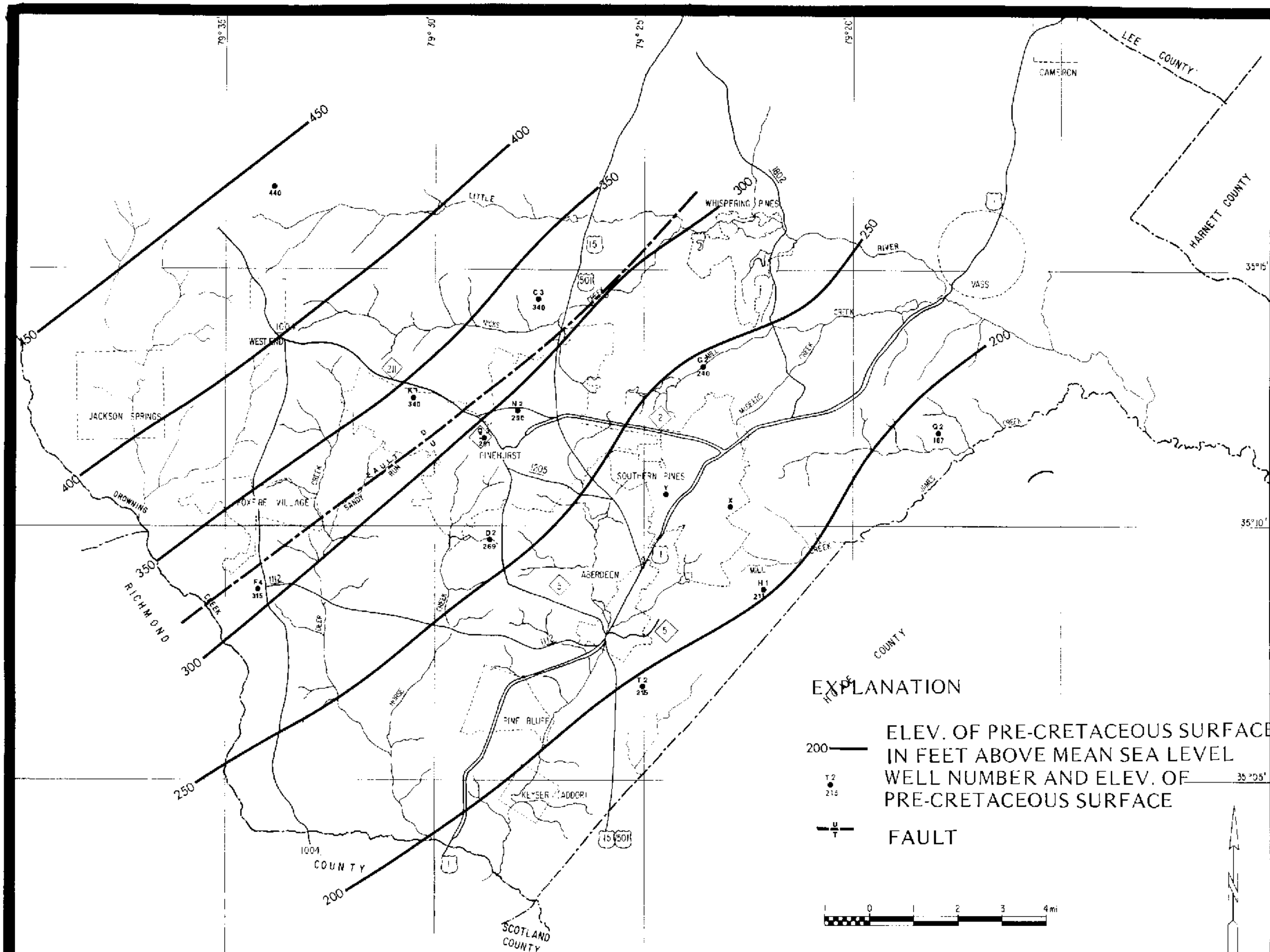


Figure 4 MAP OF PRE-CRETACEOUS SURFACE (BASEMENT)

claystone. The deposits are about 50 feet thick at this location and are not known to occur elsewhere in the study area.

The Pinehurst formation caps most of the hills in the study area and gives the area it characteristic surficial appearance. The Pinehurst formation is composed of light-brown, poorly sorted, unconsolidated quartz sand, of both eolian and fluvial origin. The sands are from 20 to 30 feet thick along the divides. Interestingly, the Pinehurst formation does not occur on the hilltops within Southern Pines.

GEOHYDROLOGY

The Sandhills Aquifer

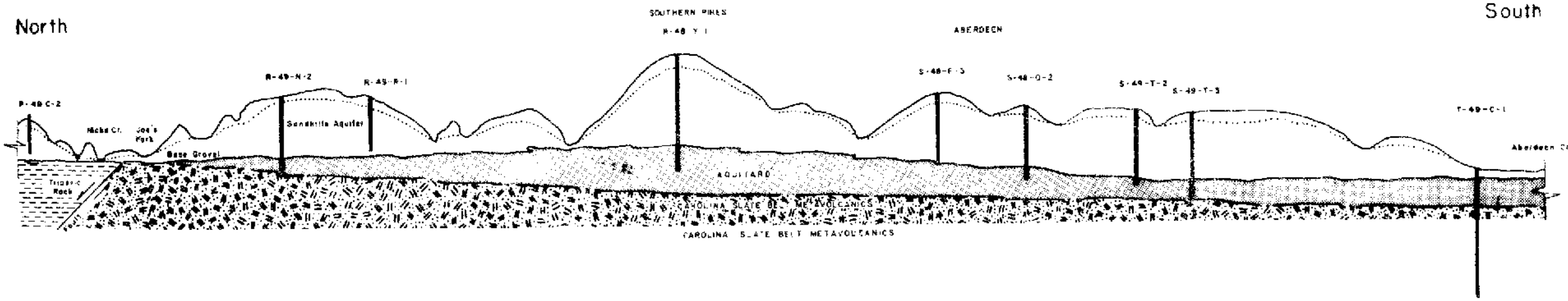
The geohydrology of the Sandhills region is somewhat unique. It is neither typical of the Piedmont and Mountain regions of North Carolina nor of the Coastal Plain. Although the aquifer itself is similar in composition and structure to those of the Coastal Plain, it lacks their permeability, continuity and areal extent.

In the study area the Sandhills aquifer consists of a system of ridges separated by stream valleys. The ridges are composed of moderately permeable strata which dip gently to the east. East of the study area the strata regain their continuity as they become more deeply buried under younger sediments. The ridges are capped, in most of the area, by relatively clean, loose sand and are underlain by the Cape Fear aquitard (Figure 5).

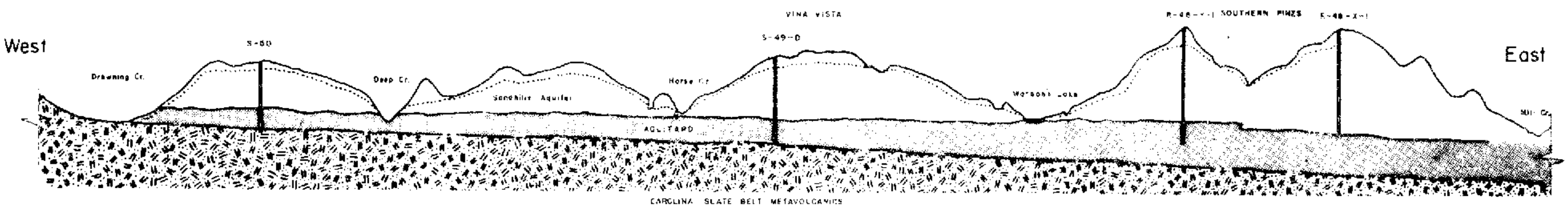
Because continuity between ridges is provided only by the poorly permeable aquitard and underlying basement rocks, groundwater inflow into the area is severely restricted. Recharge to the groundwater reservoir is almost entirely by direct precipitation.

Areal Extent and Thickness

The Sandhills aquifer occupies the inter-stream areas throughout the study area. The aquifer thickness, which is dependent on the topographic relief (Figure 6), ranges from a few feet to 300 feet. It is thickest beneath the higher ridges and thinner on the slopes. In thier lower reaches the streams are generally incised into the aquitard. The thicknesses of the aquifer shown on the map in Figure 7 are measured from land surface to the base of the aquifer (Figure 8) and do not take into account the unsaturated zone above the water-table.



CROSS-SECTION A-A'



CROSS-SECTION B-B'

Scale:

Horizontal 1" = 8300'

Vertical 1" = 430'
(approximate)

Explanation

Approximate profile of potentiometric surface

Sandhills Aquifer

Cape Fear Aquitard

Basement Rocks

FIGURE 5 HYDROGEOLOGIC CROSS-SECTION A-A' and B-B'

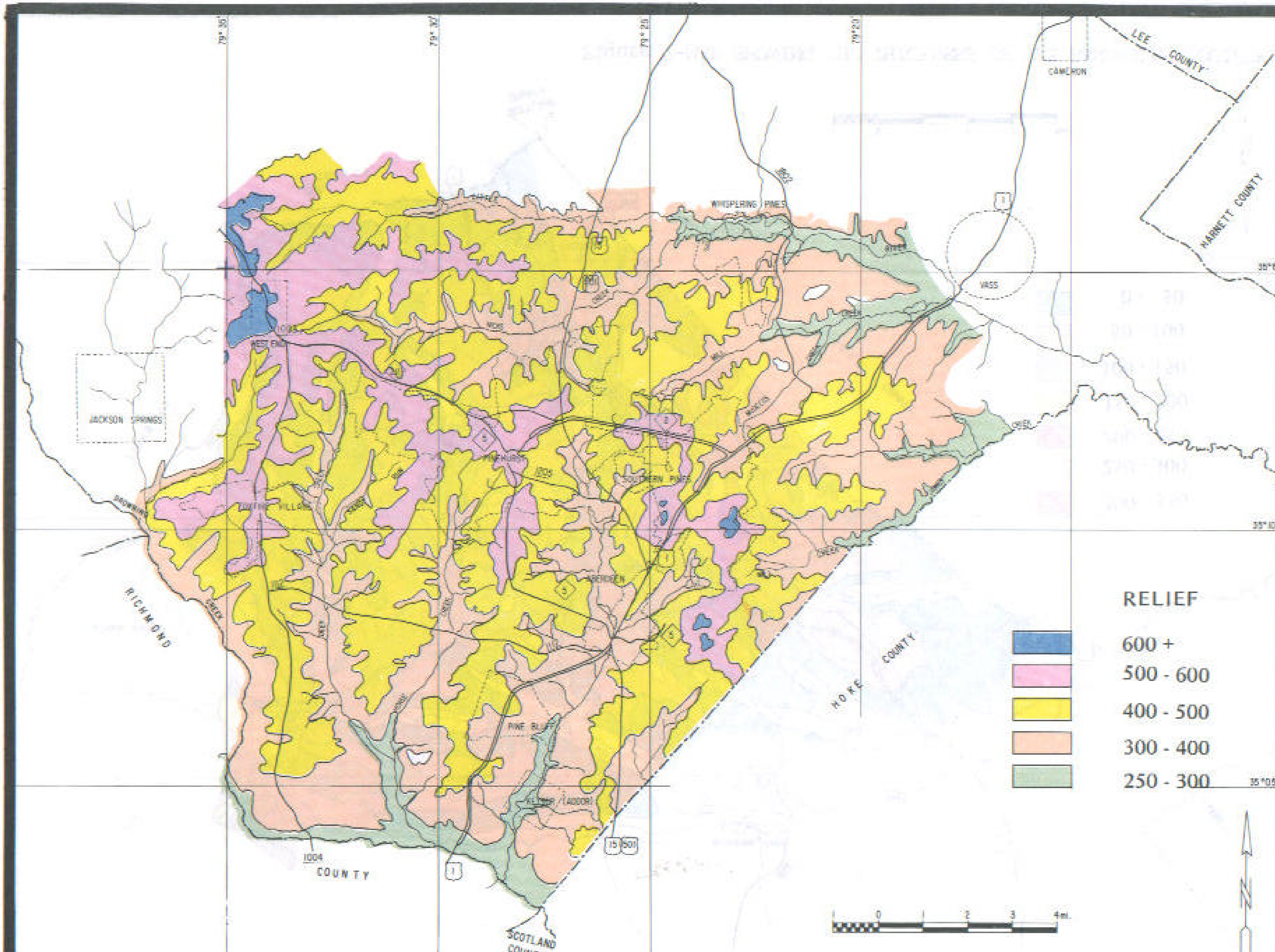


Figure 6-TOPOGRAPHIC RELIEF IN THE STUDY AREA

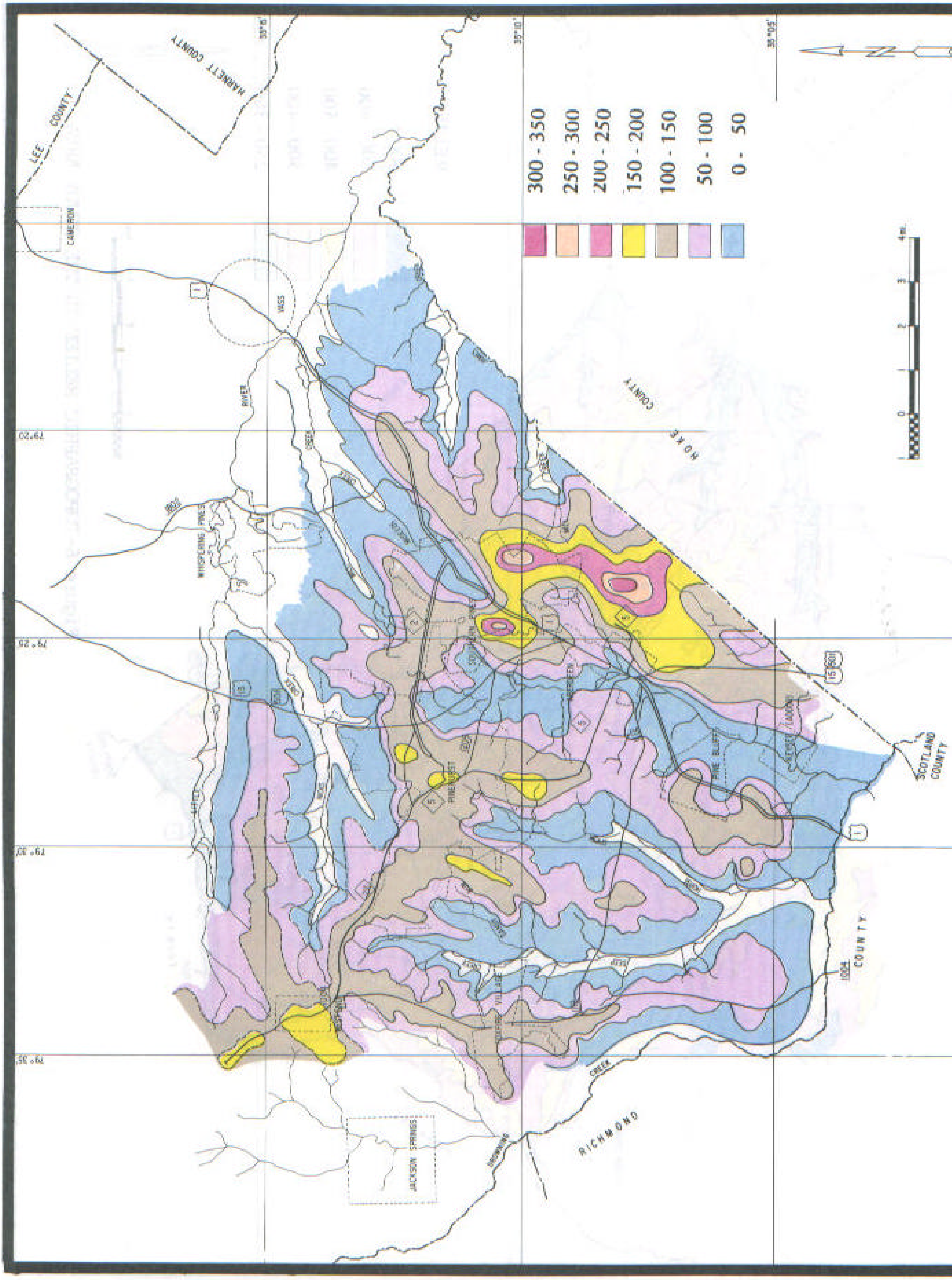


Figure 7–MAP SHOWING THE THICKNESS OF THE SANDHILLS AQUIFER

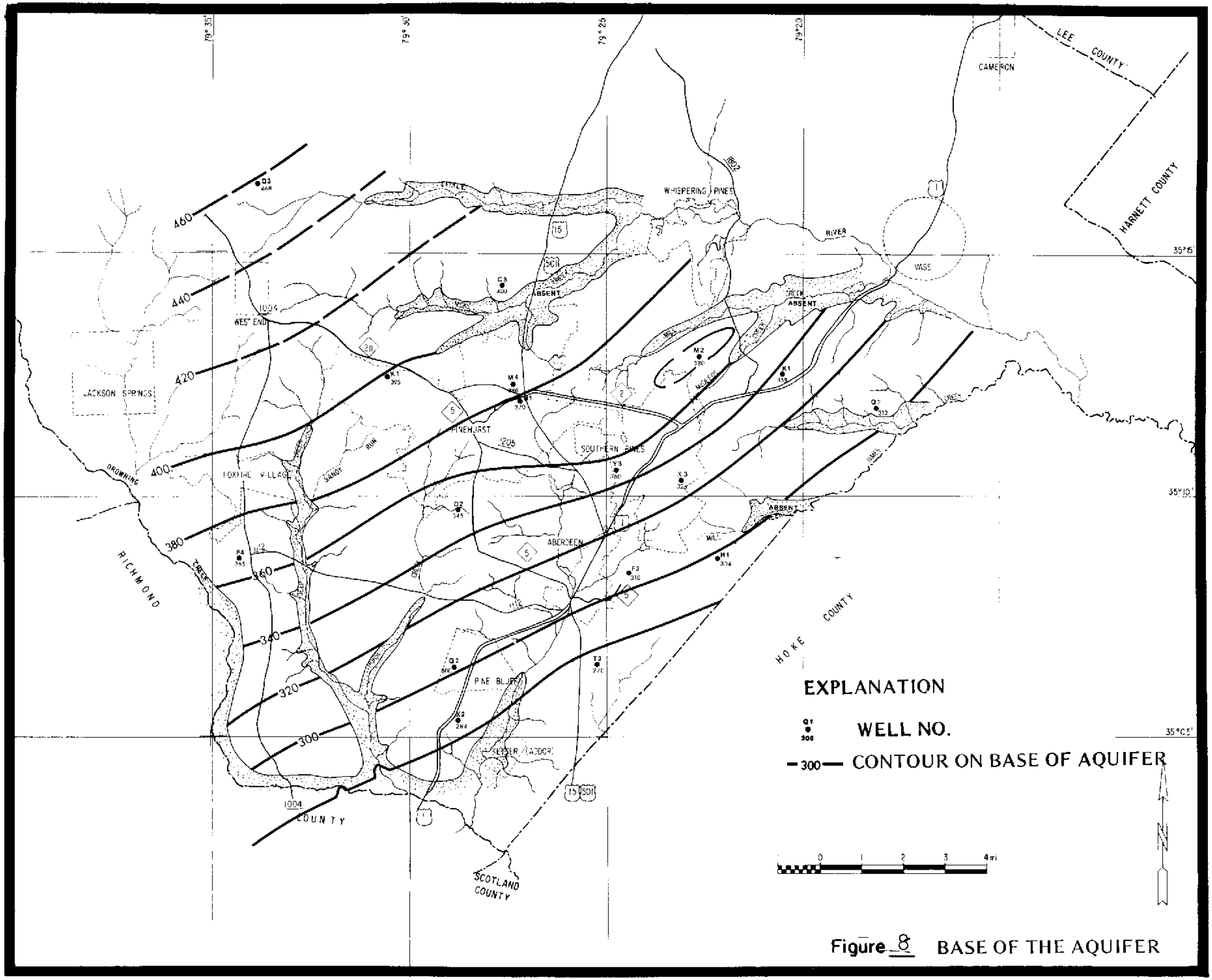


Figure 8 BASE OF THE AQUIFER

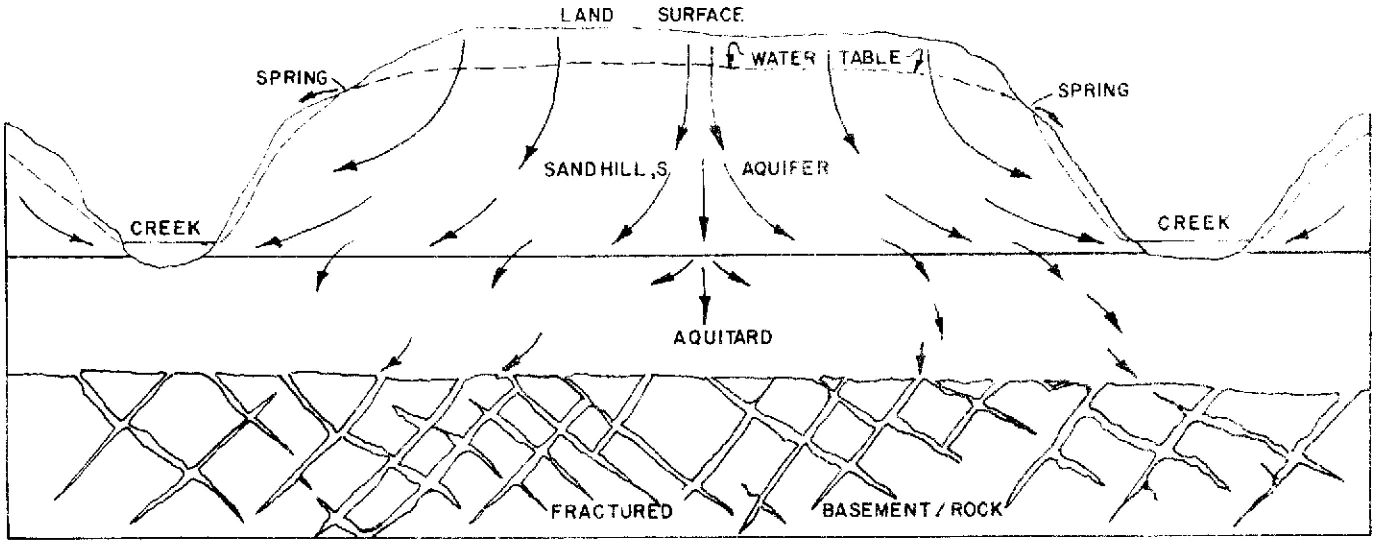
Movement of Groundwater

The water-table is the upper surface of the zone of saturation and is, in profile, a subdued expression of the topography. Its depth varies from a few feet along the lower valley slopes to more than thirty feet beneath the ridge crests. The loose, friable surficial sands allow rapid infiltration of precipitation to the water-table. The thickness and permeability of the sands result in the rapid drainage of the unit and a moderately deep water-table. Water in the upper part of the saturated zone moves laterally towards natural areas of discharge along the upper reaches of tributary streams and creeks, and downward, (Figure 9) to the top of the Middendorf formation, which comprises the greater part of the total aquifer thickness.

The Middendorf, because of its partial cementation, poor sorting and considerable silt and clay content, is much less permeable than the overlying surficial sands and offers increased resistance to the vertical movement of water. Because the Middendorf member of the aquifer transmits water at a slower rate, lateral flow in the upper unit is increased. Lateral flow which reaches the intersection of the plane of the aquifer boundary and land surface discharges in the form of springs.

The aquitard and underlying basement rocks allow little underflow between ridges. Any underflow through the more permeable zones of the aquitard is intercepted by streams. Rainfall occurring during the growing season is returned to the atmosphere by evaporation and transpiration, thus limiting recharge to infiltration occurring during the winter and spring.

The hydrograph of well S49, Q-1 (USGS NC-122) in Pine Bluff shows the seasonal variation in water levels in the upper part of the aquifer (Figure 10). Water levels typically decline from June through October and recover during the winter and spring to their previous high levels. Although seasonal water levels may decline dramatically during drought years, no general declining trend has been recognized.



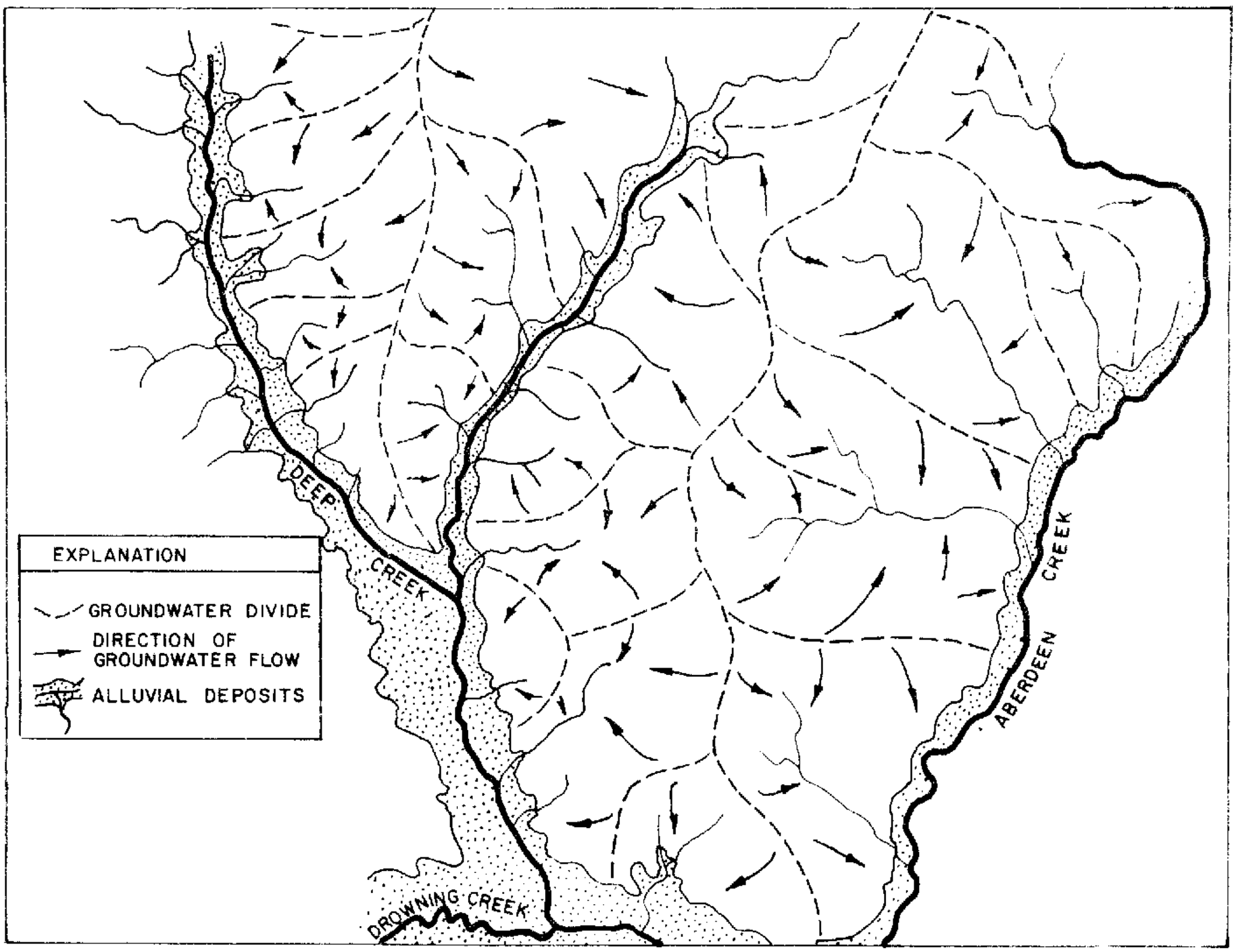


FIGURE 9 IDEALIZED SECTION AND MAP SHOWING DIRECTION OF GROUNDWATER MOVEMENT

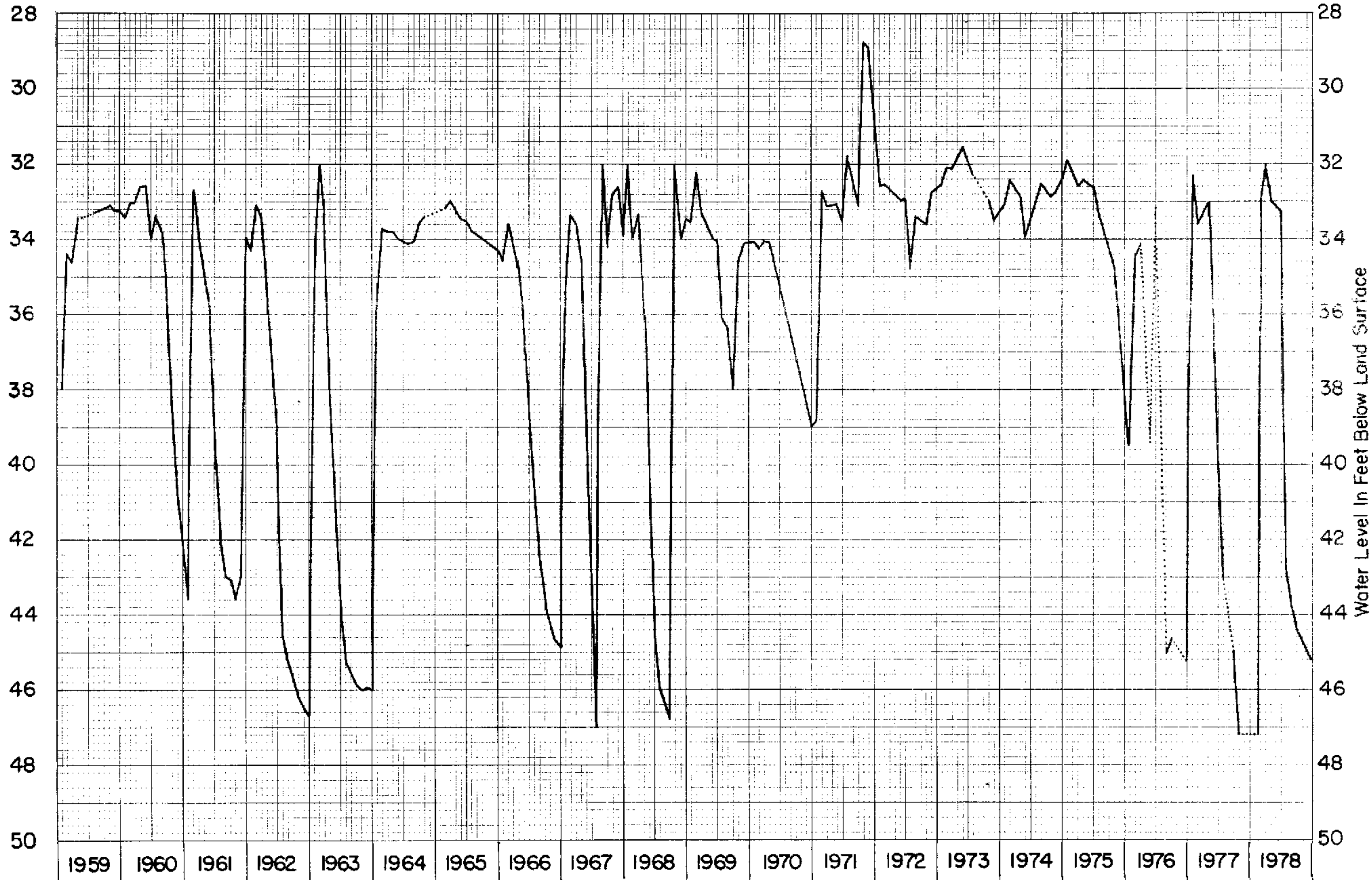


Figure 10 Graph Showing Water Levels in Well S49 Q-1 (USGS, NC-122). Pine Bluff, N.C.

Hydraulic Characteristics

The fundamental quantitative characteristics of an aquifer are transmissivity (T) and storage (S). The transmissivity of an aquifer is the rate at which water will flow from a vertical column equal to the full thickness of aquifer one unit wide under a hydraulic gradient of 1.00 (100%). The coefficient of storage is the volume of water released from storage per unit surface area of the aquifer per unit change in head. It is a dimensionless term. Transmissivities of aquifers range from about 1,000 gallons per day per foot to over 1,000,000 GPD/Ft. Transmissivity values less than 10,000 GPD/Ft. are relatively low, particularly when the aquifer is to be used as a source of municipal supply, from 10,000 to 50,000 GPD/Ft., moderate, and over 50,000 GPD/Ft., high. Values of storage vary from 0.01 to 0.3 for water-table (unconfined) aquifers and from .00001 to .001 for artesian (confined) aquifers.

Although several municipal wells have been drilled in the Southern Pines-Pinehurst-Aberdeen area, usable pumping test data exist for only a few. Analysis of the best available data has determined that the transmissivity of the Sandhills aquifer in the study area is approximately 8,000 GPD/Ft. and the coefficient of storage about 0.0002. Because the degree of confinement is expected to change after prolonged pumping and some dewatering of the aquifer is expected to occur, the coefficient of storage may increase as a result of continuous pumping.

Aquifer coefficients may be used in well design for predicting specific capacities of wells of varying diameters and periods of pumping, determining drawdowns at various distances from the pumping well so that interference effects may be calculated, calculating the drawdown within the pumping well at any time after pumping begins so as to insure the proper pump setting and for many other purposes.

The distance-drawdown graph in Figure 11 shows the distribution of drawdown within the radius of the cone of depression of a well pumping 150 GPM for different periods of time. Figure 12 is a profile through adjacent cones of depression illustrating the increased drawdown resulting from overlapping cones of depression. Excessive intereference reduces the maximum yield of the well and increases pumping costs.

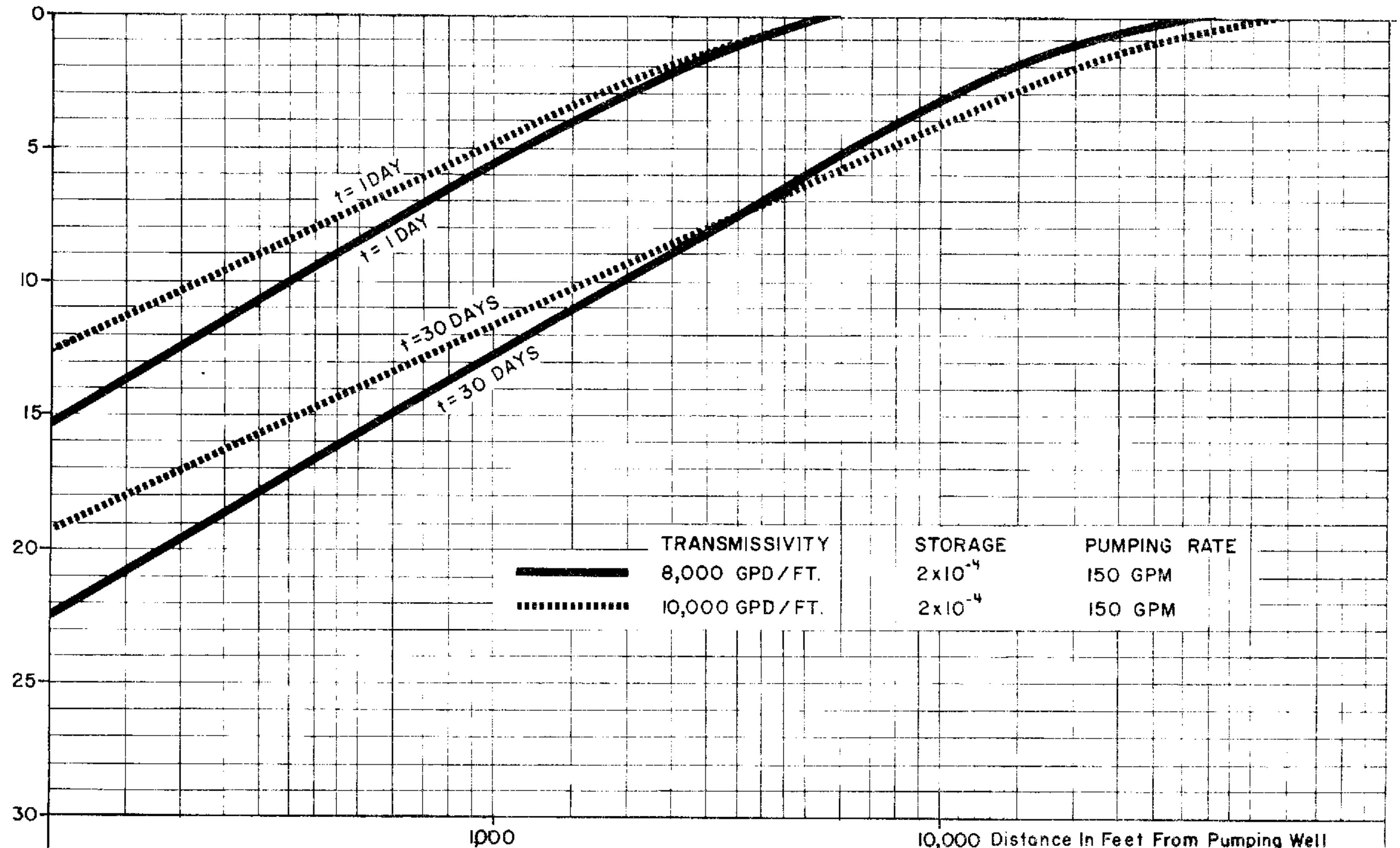


FIGURE 11 DISTANCE – DRAWDOWN GRAPH - SANDHILLS AQUIFER

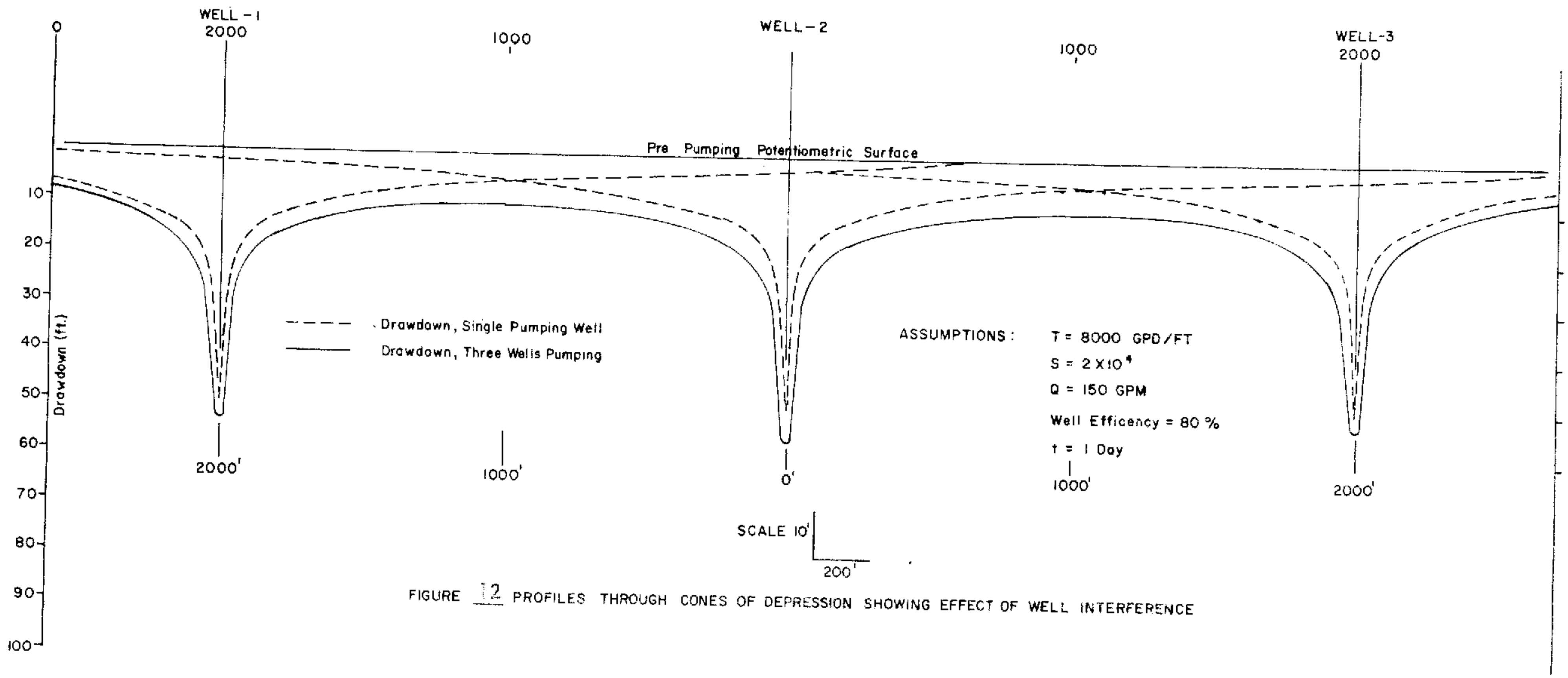


FIGURE 12 PROFILES THROUGH CONES OF DEPRESSION SHOWING EFFECT OF WELL INTERFERENCE

Aquifer test data were analyzed using the Theis non-equilibrium and modified non-equilibrium formulas. These methods include a number of assumptions which are rarely found in nature such as aquifer homogeneity and isotropy, and infinite areal extent. Although none of these assumptions are valid in the Sandhills area, the technique is not rendered invalid but, as an analytical tool, must be applied with caution. Values derived from aquifer or well performance tests may have limited areal application until substantiated by additional testing.

Groundwater Quality

The chemical quality of groundwater in the study area is generally good. Analyses of selected wells are shown in Table 1. Although some of these wells are located outside of the study area, they derive water from rock types common to it. A comparison of analyses shows that water in the principal aquifer (Sandhills hydrogeologic unit) is generally of better chemical quality than that in the underlying basement rock. This can be explained by the greater mineralogic homogeneity, better circulation and shorter time of retention in the Sandhills aquifer.

Groundwater in the Sandhills aquifer is low in dissolved solids and hardness, is slightly acidic and, in the shallow surficial unit, may be high in iron.

The Carolina Slate Belt and Triassic hydrogeologic units contain water that may be moderately hard and locally may contain objectionable amounts of iron.

POTENTIAL FOR GROUNDWATER DEVELOPMENT

Proposed Areas of Future Development

Within the areas delineated on the map in Figure 13, approximately eight to ten million gallons of groundwater per day could be withdrawn for municipal water supply. An increase in well density within this area would result in an increased hydrologic impact on the efficiency and productivity of all wells.

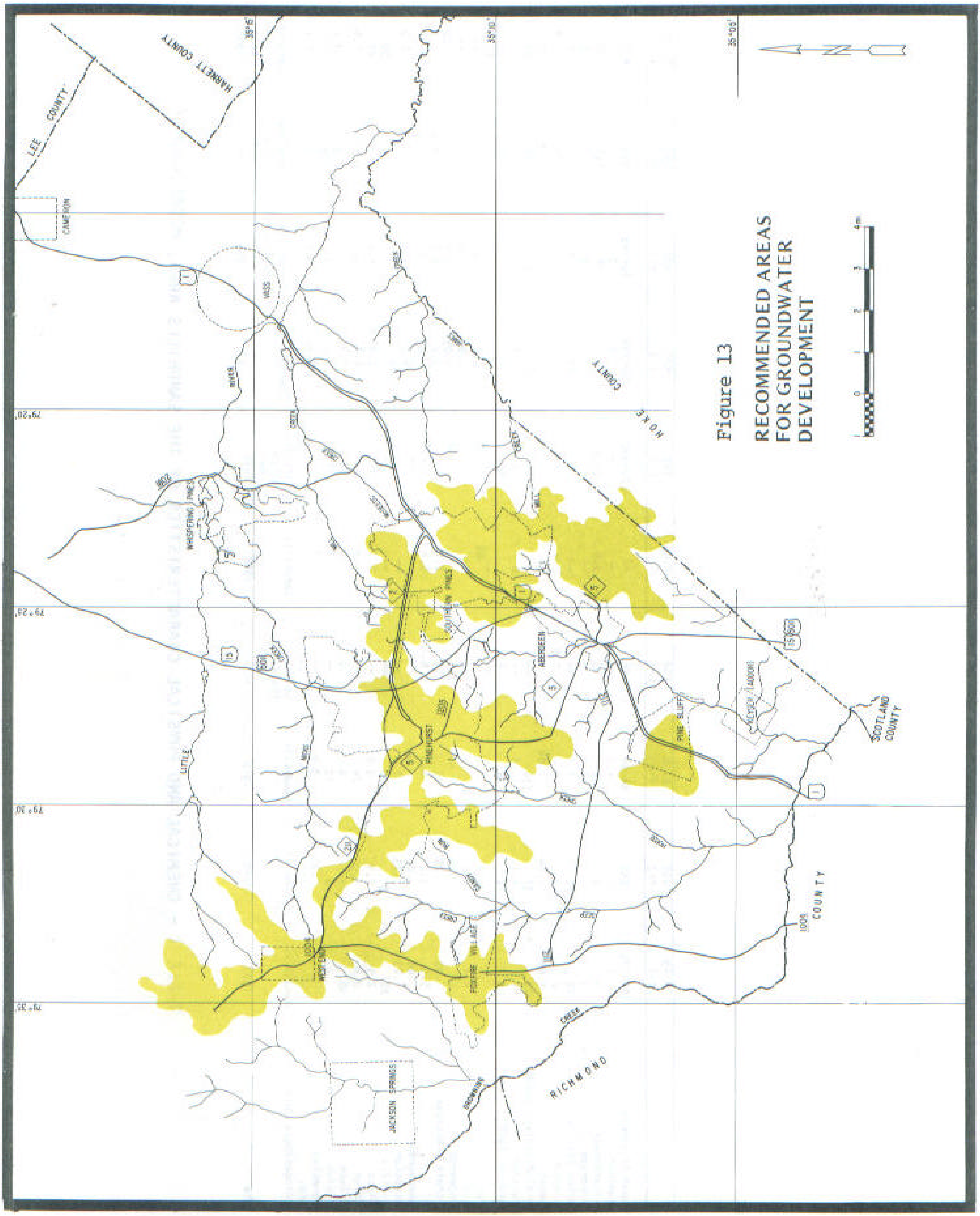


Figure 13
RECOMMENDED AREAS FOR GROUNDWATER DEVELOPMENT

	R-49 K-2	R48 Y-3	S-50 F-6	R48 L-1	Spring	T49 C-1	R48 X-3	R51 M-1	Q47 V-1	Q-47 V-2	P48 W-2
Depth of Sample	140-175	250	84-94	26	--	120-340	230-240	Spring	250	475	779
Aluminum	.2	<.1	<.1	--	--	--	<.1	0	--	.3	--
Bircarbonate	4	8	32	15	3.0	97.6	6	6	152	70	9
Carbonate	<1	<1	<1	0	--	0	<1	0	0	0	0
Carbon Dioxide	20	20	8.1	--	--	6	24	--	--	--	--
Chloride	2	2	9	2.5	2.1	2	3	5.6	4	1.9	5.6
Copper	<.04	<.04	<.04	--	--	--	<.04	--	--	--	--
Total Dissolved Solids	23	37	136	--	16	146	39	28	183	90	32
Fluoride	<1	<.1	.1	--	0	0.75	<.1	.0	.2	0	0
Hardness $CaCO_3$	4	12	36	6	--	65	6	8	107	47	4
Iron	.1	<.1	<.1	.7	.06	.38	<.1	.23	.22	11	.7
Lead	<.1	<.1	<.1	--	--	--	<.1	--	--	--	--
Manganese	--	<.05	--	--	--	.19	<.05	.00	0	--	--
Nitrate & Nitrite	.05	.38	13	55.7	2.0	Nil	<.05	5.7	.9	.2	4.9
pH	5.5	5.8	6.8	6.2	5.6	7.35	5.6	5.7	7.4	6.4	6.3
Phosphorous	.68	<.05	<.05	--	--	--	.05	--	--	--	--
Potassium	.23	.25	2.0	--	--	--	6.7	1.2	--	2.0	7.5
Specific	20	30	220	--	--	--	30	37	--	108	49
Silica	2.9	2.8	3.9	--	3.7	36	2.9	4.6	40	29	2.7
Sodium	2.6	3.0	24	--	1.9	13.6	4.8	3.0	--	[illegible].6	--
Sulfate	<5	<5	6	2	.4	12.3	<.5	--	9.3	[illegible]	1.5
Calcium	.27	2	12	--	.8	18.2	.47	2.2	28	[illegible]	8
Magnesium	.17	.27	3.4	--	.3	--	0.42	.6	9.1	5.6	6
Temp.	--	--	--	74			--	--	--	--	--
Hydrogeologic Unit	Sandhills	Sandhills	Sandhills	Sandhills (Surficial Unit)	Sandhills	Carolina Slate Belt	Sanchills	Sandhills (Surficial)	Carolina Slate Belt	Carolina Slate Belt	Triassic
Date	1978	1978	1978	1954	1948	1976	1978	1958	1947	1958	1950

T[illegible] - CHEMICAL AND PHYSICAL CHARACTERISTICS OF THE SANDHILLS AREA, MOORE COUNTY

In the Southern Pines area approximately ten additional wells could be completed within an area of approximately six to seven miles using a spacing pattern of 2,000 feet. The total yield of all wells, pumped continuously at an average pumping rate of 150 GPM, would be about 2 million gallons per day. However, the increased drawdown resulting from well interference and boundary conditions encountered after extended pumping might necessitate a staggered pumping schedule or a reduction in pumping rates.

Approximately six additional wells could be constructed in the Pinehurst area on the ridge east of Horse Creek and another four on the ridge to the west of the creek. Assuming the same criteria as proposed for Southern Pines, an additional one to two MGD could be developed.

Aberdeen currently has plans to extend its well field to the south of town. Additional wells could be constructed along the ridge extending generally southward of "Paint Hill."

Problems associated with the development of municipal well fields are both real and imaginary. Good management practices demand adequate well spacing and site location which, in turn, require costly land purchase, site accessibility, protective structures, water transmission lines and increased operation and maintenance costs. Public acceptance of a system in which projections and calculations regarding performance and longevity are not always precise must also be considered. These factors must be weighed against the cost and environmental impact of the construction of surface impoundments, pipelines and costly water treatment. Although cost/benefit analyses are not within the scope of this study, it is generally true that where the groundwater resources are adequate for anticipated future needs, they offer an attractive alternative on the basis of their low treatment cost alone.

Potential Effect of Groundwater Withdrawals on Streamflow

Waste treatment for Southern Pines, Pinehurst, Aberdeen, Pine Bluff area is based on anticipated low flows in Aberdeen Creek. A reduction flow in the creek below design limits could result from the diversion of groundwater discharge to wells. The extent to which streamflow would be diminished by groundwater withdrawals is a factor limiting groundwater development.

The base flow of streams in the area is considered to be the groundwater contribution to streamflow. The water budget for the Deep Creek watershed places base flow at 61 percent of average flow which is typical of the area.

Design parameters of the wastewater treatment plant near Aberdeen are based on a low flow (7Q10) of 17 cfs. As the average base flow in the watershed is approximately 31 cfs, additional diversion of groundwater to wells of approximately 4.6 cfs (3 MGD) would affect the waste treatment criteria for Aberdeen Creek only during those periods when the streamflow approached the 7Q10.

The withdrawal of an additional 3 MGD from wells would not reduce streamflow by that amount if the wells are properly located. Placing the wells near the ridge crests (basin divides) would reduce the effect on any basin by half. Also, the drawdown within the cone of depression caused by the pumping well would, during the winter and early spring, provide additional storage for infiltrating precipitation.

Well Design and Testing

The specific design criteria for a municipal supply well in the Sandhills area should be established only after evaluation of the hydrogeologic and geophysical data obtained through the test drilling phase.

Although the size and type of casing and screen to be used can be determined prior to test drilling, the amount, location and slot size of the well screen and size and volume of the gravel pack should be determined on the basis of the test data.

Because of the generally low permeability of the aquifer material, the productivity of a well depends to a large degree upon the aggregate thickness of the saturated sands and the degree to which they are segregated by strata of lower permeability. Massive bedding of aquifer sands allows screens to be concentrated in one zone while thinner, vertically dispersed beds would dictate multiple screened zones separated by blank sections of casing.

If low pumping levels are predicted, screens should be concentrated in the lower part of the aquifer. The upper sands, which, if screened, would be exposed by the low pumping water level, could be connected hydraulically to the lower screened zones by means of a highly permeable gravel envelope surrounding the casing in the annulus between the borehole wall and the casing and screens. Gravel size should be carefully selected on the basis of the effective grain size of the aquifer sand and the slot size of well screens should be based on the grain size of the gravel pack.

The completed well should be tested for at least 24 hours at a constant pumping rate and utilizing an observation well so constructed and located as to provide optimum data for evaluation of the aquifer characteristics. Ideally, following recovery, a step-drawdown test should be conducted to determine the optimum pumping rate for maximum sustainable yield.

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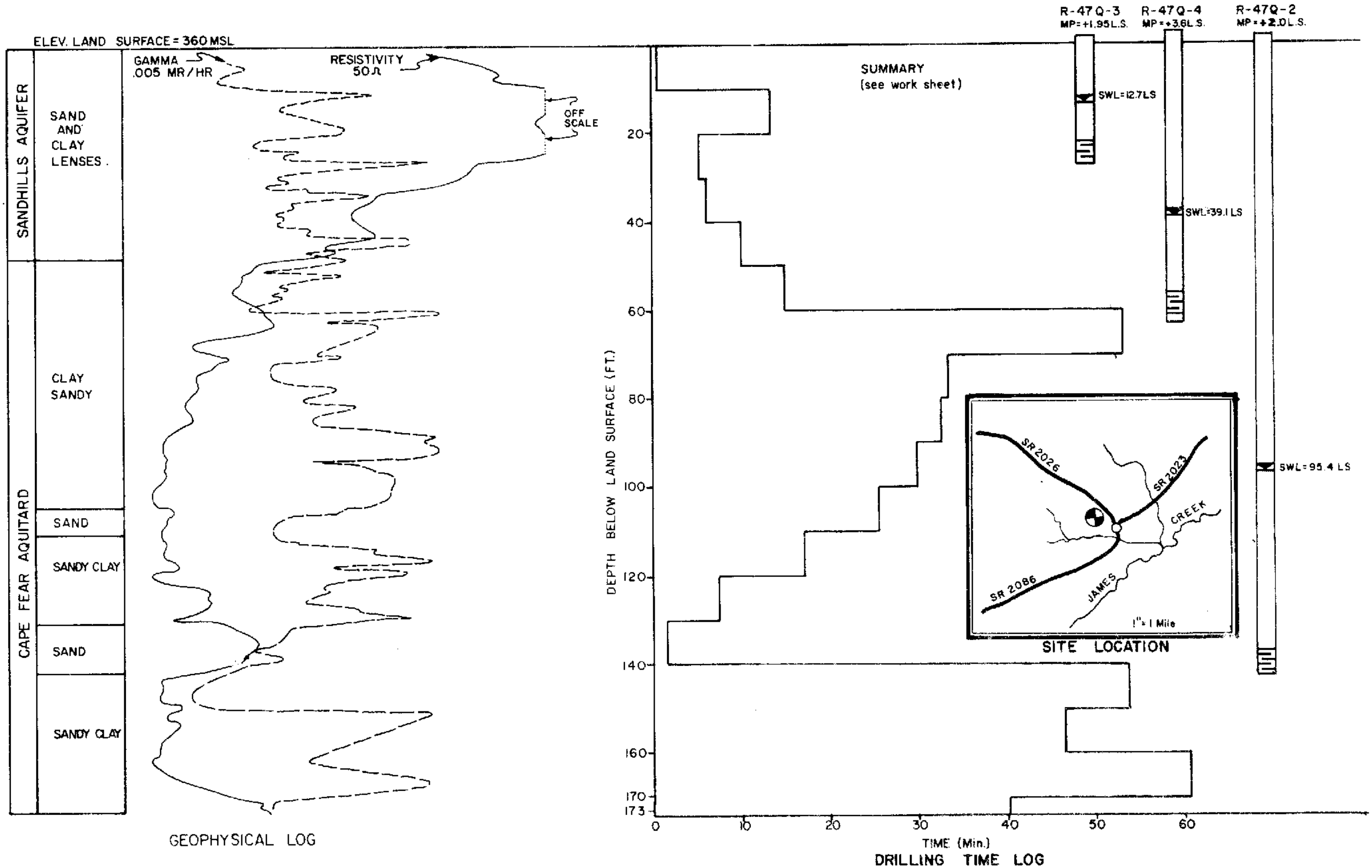
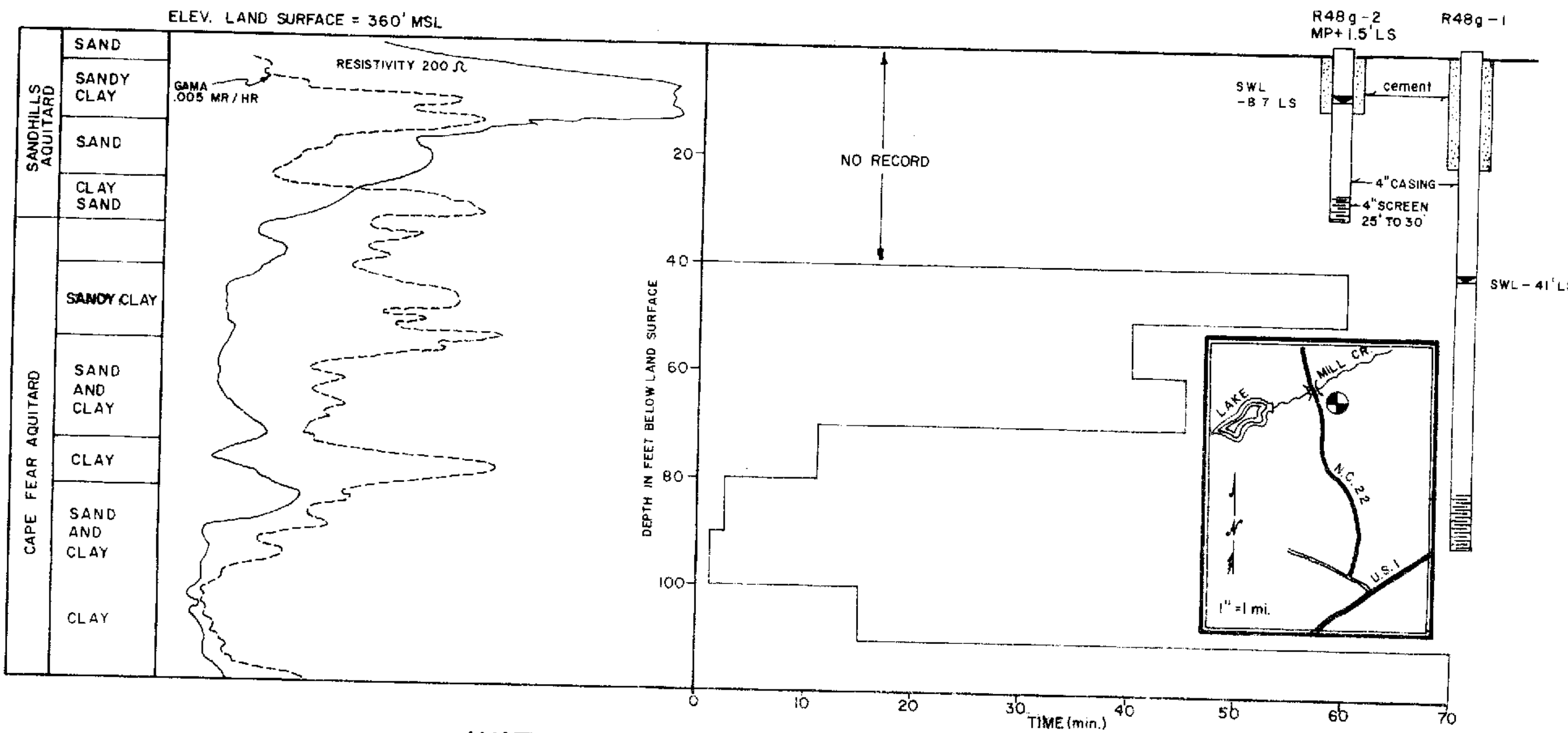
Yonts, W. L. 1971. Low-Flow Measurement of North Carolina Streams. N. C. Department of Water and Air Resources.

Appendix A

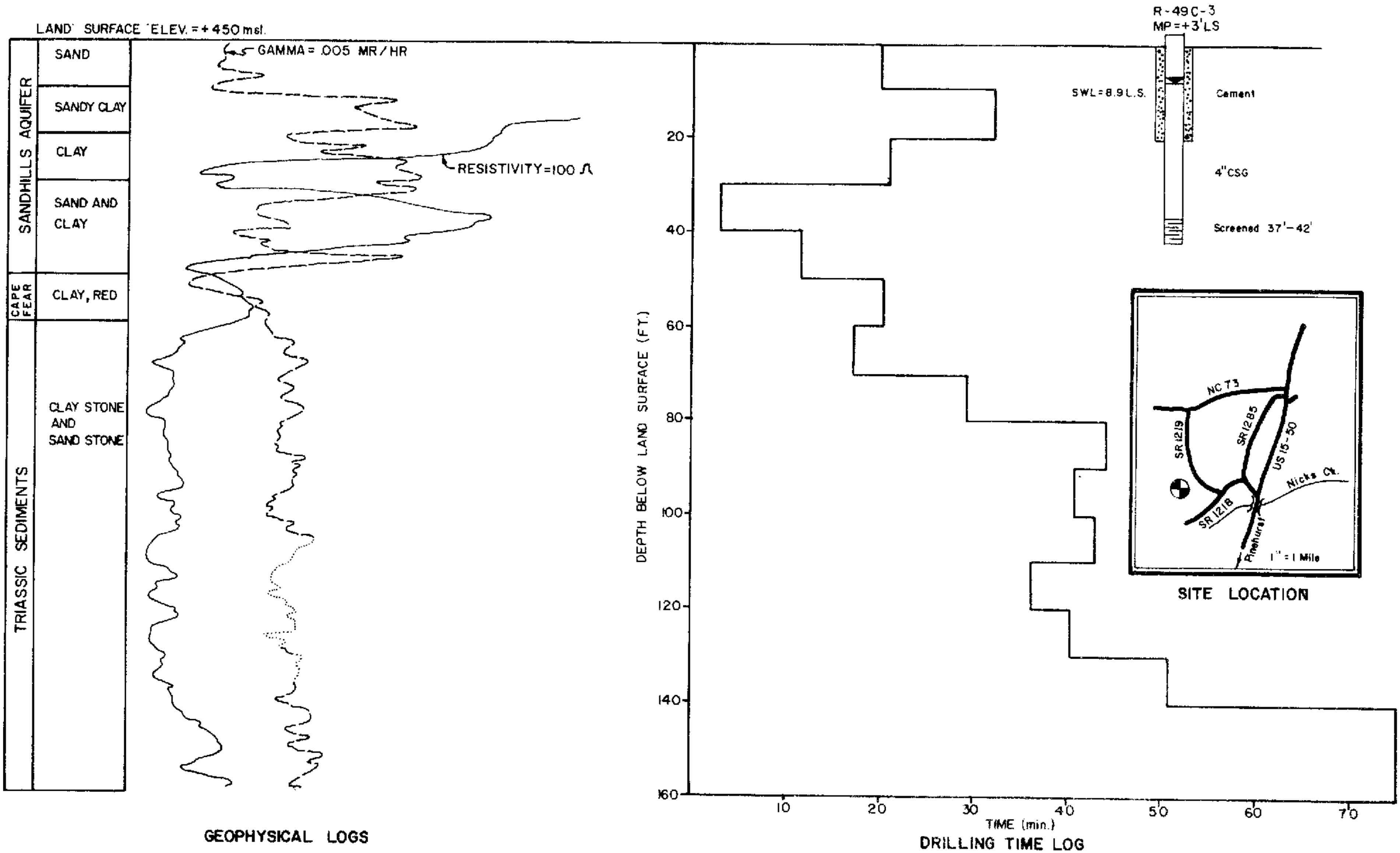
Diagrams of Test Wells In The Sandhills Area



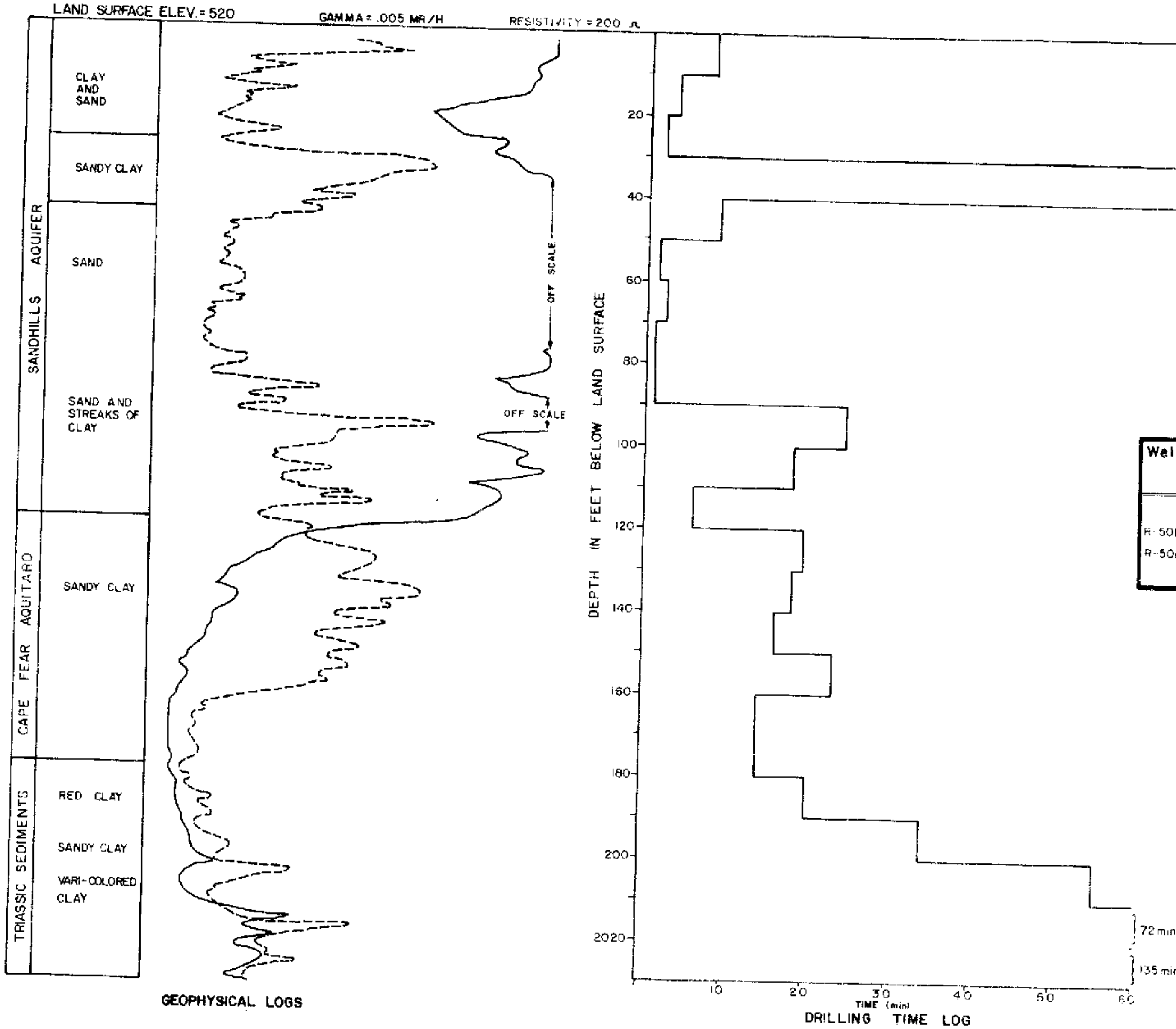
HOG ISLAND TEST SITE

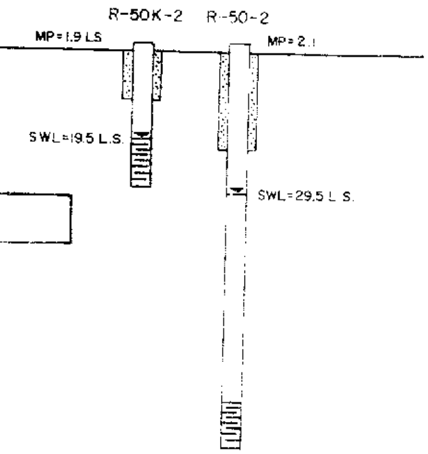


WATER PLANT TEST SITE

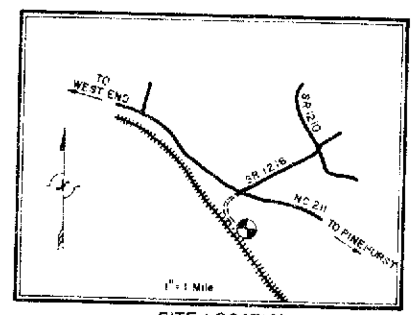


EASTWOOD TEST SITE



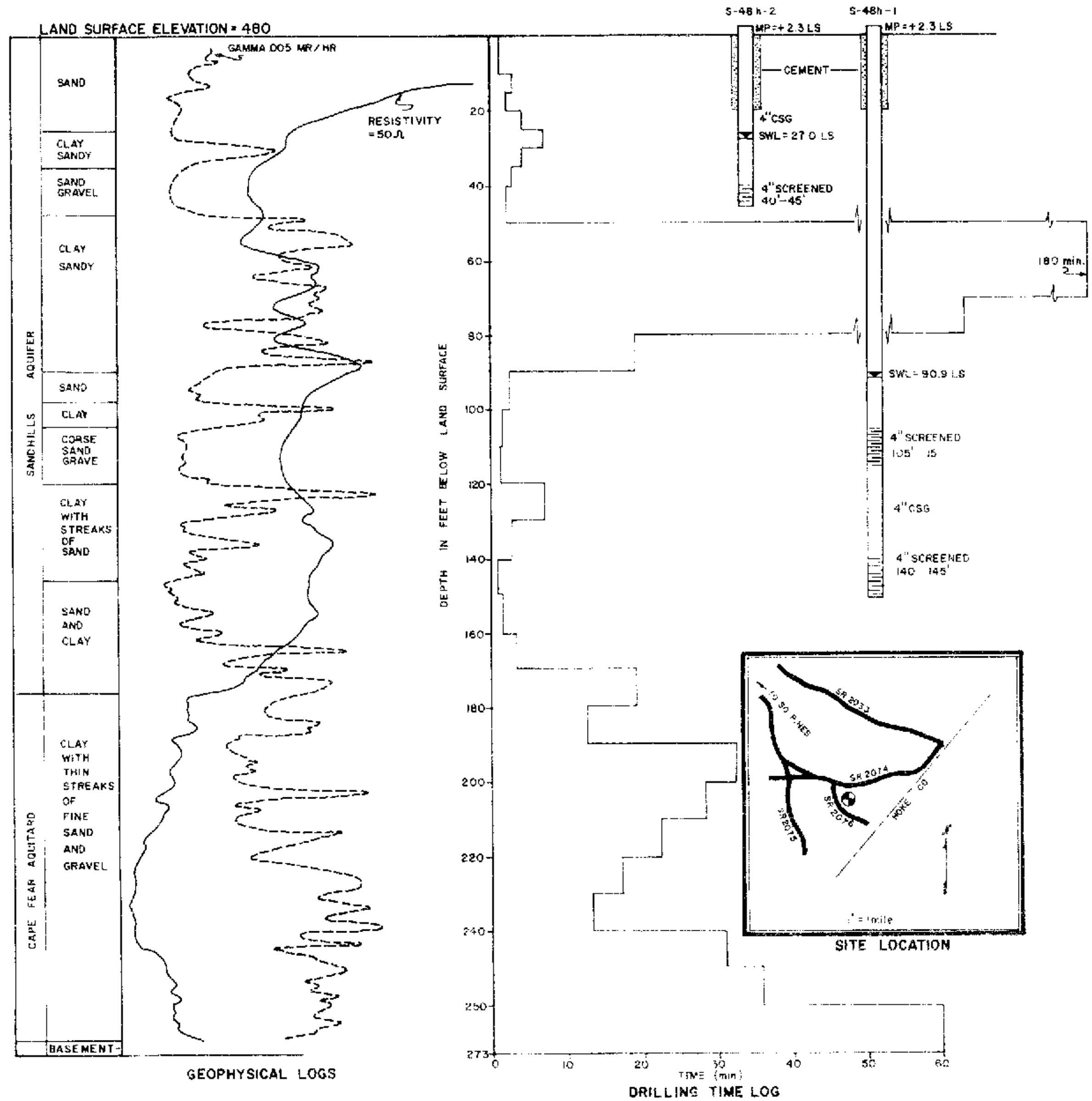


Well	Depth	DIAM.	Screened Interval	SWL Below Land Surface	Date	Q
R-50K-1	82'	4"	72'-82	29.5	2-20-79	5
R-50K-2	28'	4"	18'-28'	19.5	2-15-79	1

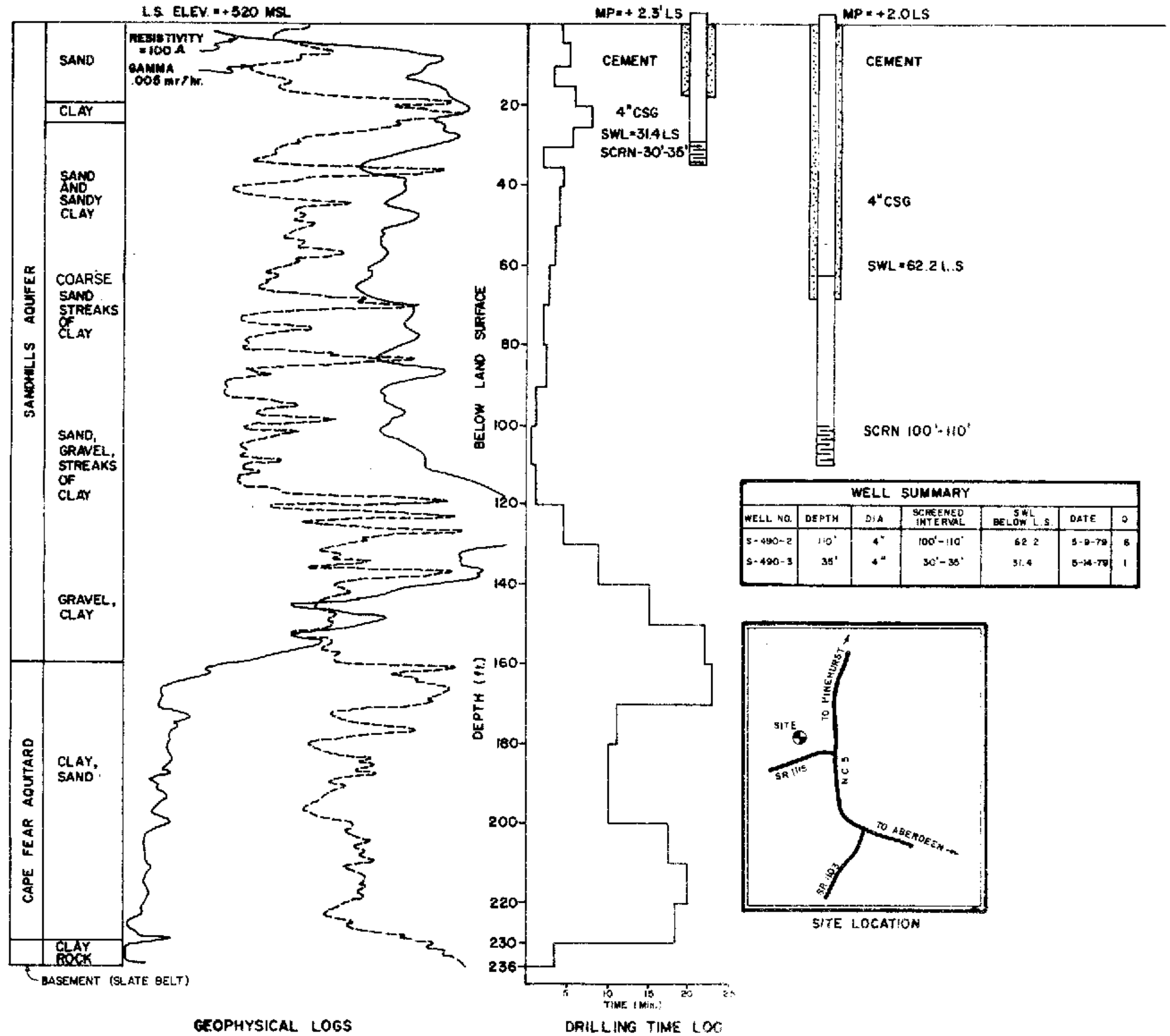


SITE LOCATION

PINEWILD TEST SITE



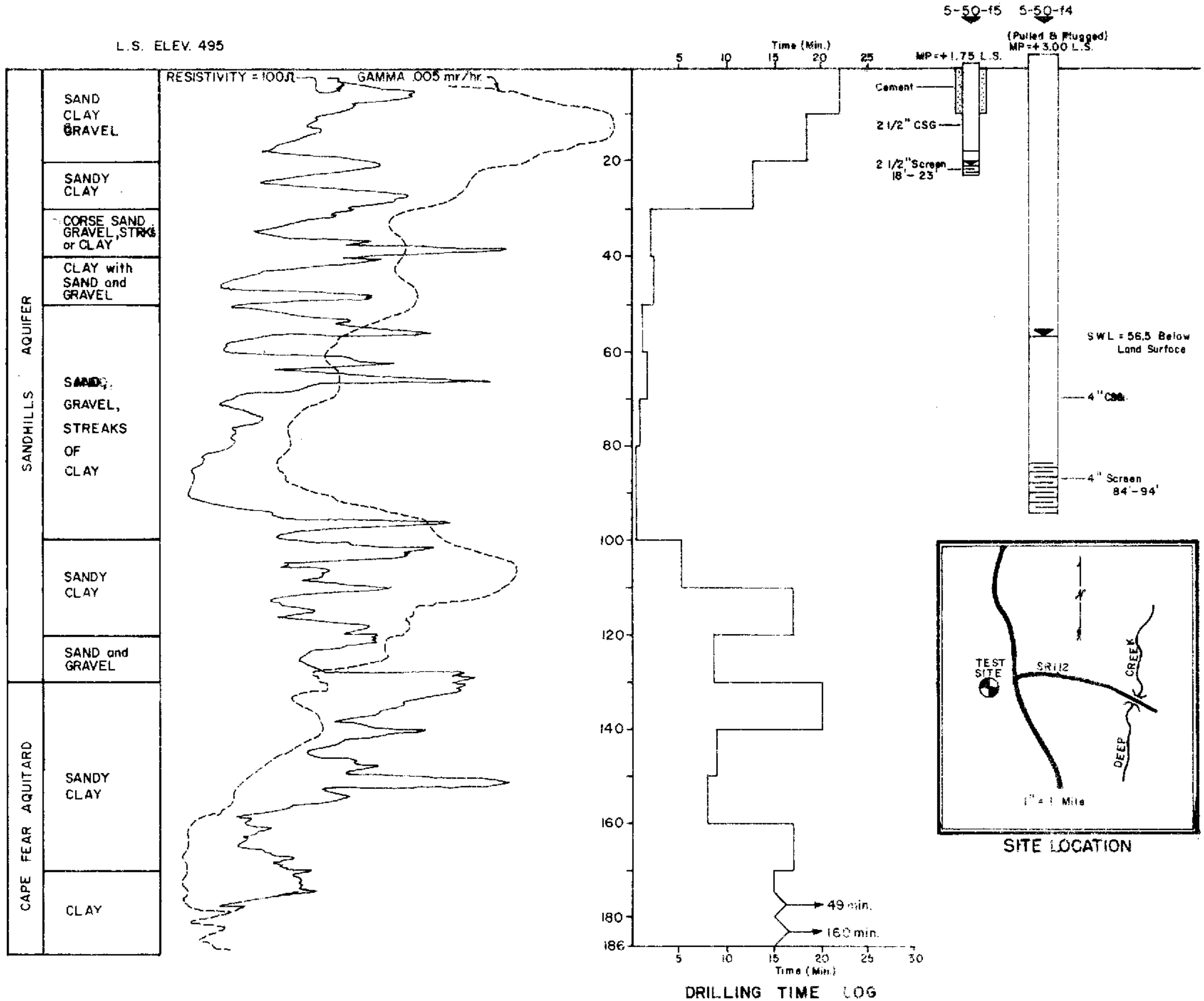
WEYMOUTH WOODS TEST SITE



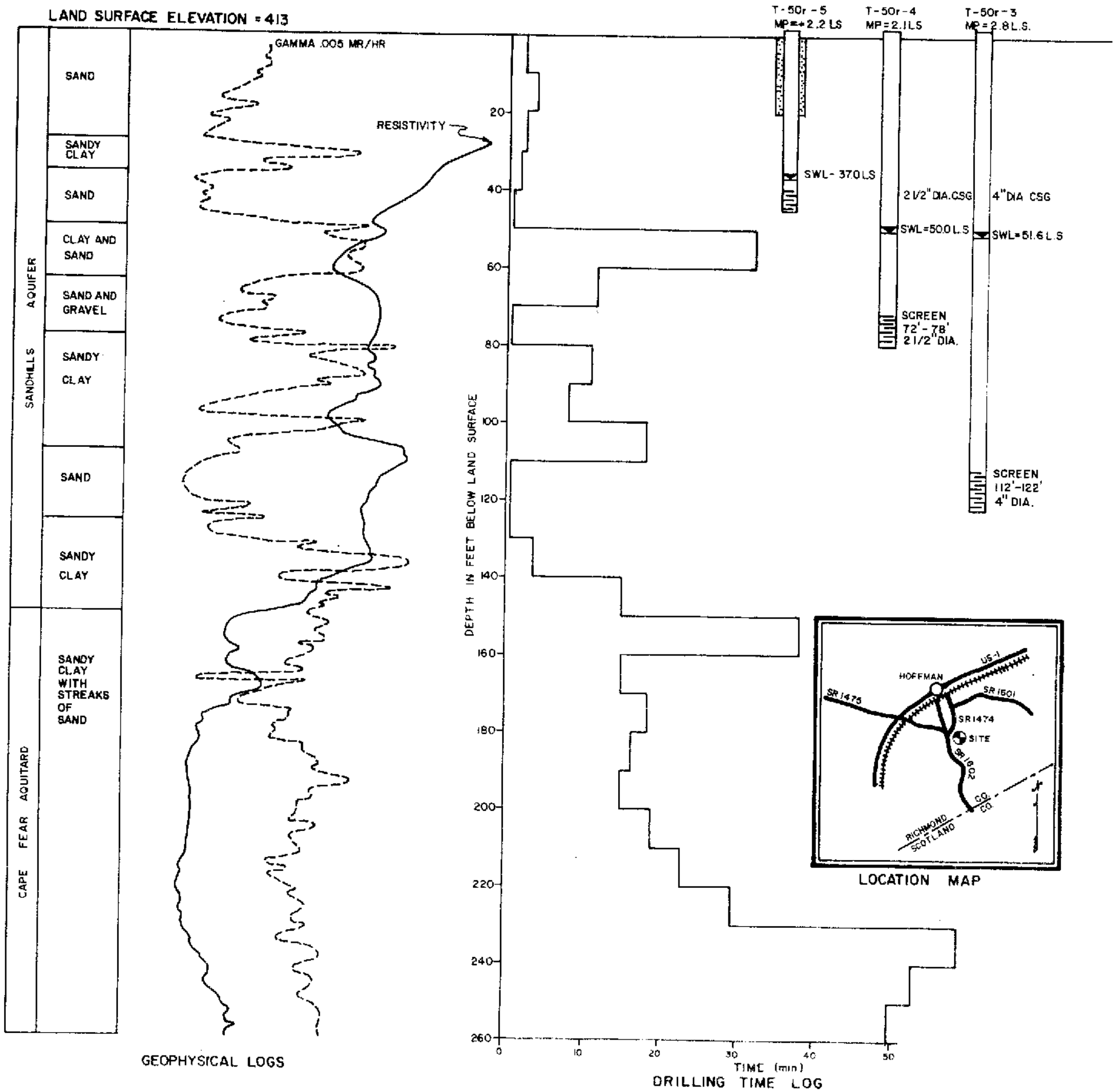
WELL SUMMARY

WELL NO.	DEPTH	DIA	SCREENED INTERVAL	SWL BELOW L.S.	DATE	Q
S-490-2	110'	4"	100'-110'	62.2	5-9-79	6
S-490-3	35'	4"	30'-35'	31.4	5-14-79	1

JACKSON HAMLET TEST SITE



ROSELAND TEST SITE



HOFFMAN TEST SITE

Appendix B

Data From Selected Wells in the Sandhills Areas

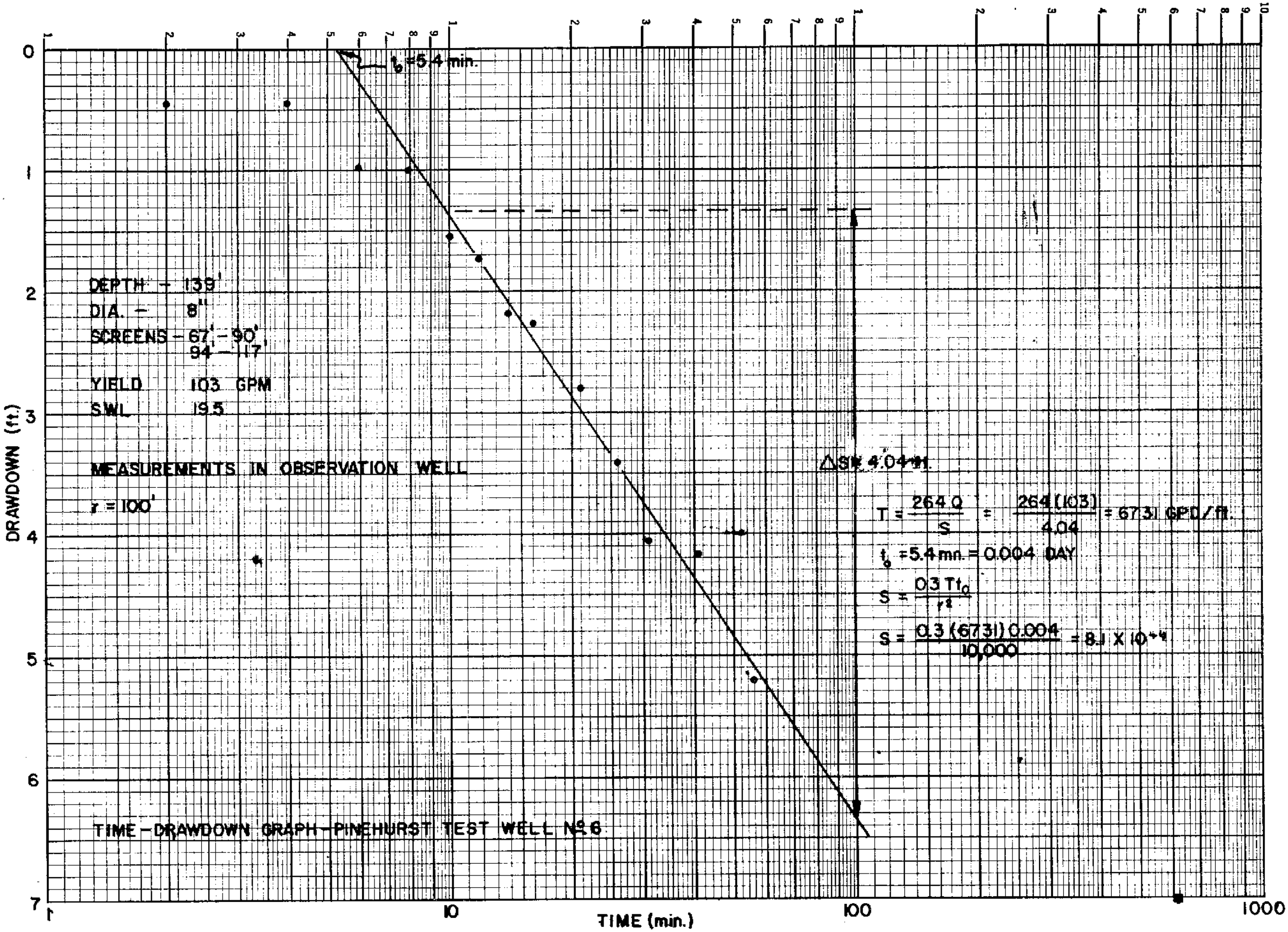
APPENDIX B - DATA FROM SELECTED WELLSIN THE SANDHILLS AREA

GRID LOCATION	OWNER	OTHER NO.	DEPTH (FT.)	DIAMETER CASING/SCREEN (IN.)	SCREENED OR OPEN HOLE INTERVAL(S)	TOTAL SCREEN (FT.)	DEPTH GRAVELED INTERVAL (FT.)
R-48,B-1	Whispering Pines		641	6/-	112-641	--	--
R-48,X-1	Southern Pines	No. 1	269	8/8	144-154 174-179 184-214 223-243 254-264	75	78-269
R-48,Y-1	Southern Pines	No. 2	249	8/8	140-150 160-170 181-186 202-207 212-217 224-244	65	61-249
R-49,W-2	Pinehurst	No. 1	158	8/8	74- 89 98-104	21	--
R-49,Q-3	Pinehurst	No. 2	172	8/8	71- 76 98-103 108-116 122-140 160-165	38	0-172
R-49,W-1	Pinehurst	No. 3	155	8/8	68- 80 86- 96 101-121 127-132	47	68-132
R-49,Q-4	Pinehurst	No. 4	--	--	--	--	--
R-49,R-2	Pinehurst	No. 5	165	8/8	95-107 112-140 150-155	45	95-165
R-49,X-3	Pinehurst	No. 6	140	8/8	67- 90 94-117	46	67-117
R-49,R-1	Pinehurst	No. 7	--	--	--	--	--
S-49,K-1	Aberdeen	No. 1	210	10/10	71- 81 100-110 131-136 201-206	30	
S-48,O-1	Aberdeen	No. 2	153	8/8	94- 99 104-140	35	--
S-48,F-2	Aberdeen	No. 3	154	8/8	96-101 111-142	36	--
S-48,O-2	Aberdeen	No. 4	165	8/8	95-115 125-150	35	--
S-49,K-3	Aberdeen	No. 5	171	8/8	72- 82 97-102 107-112 127-148 167-179	54	
S-48,F-1	Aberdeen	No. 6	136	10/10	75-115	40	--
S-48,F-4	Aberdeen	No. 7	205	10/10	101-111 128-138 150-155 173-193	45	--
S-49,Q-2	Pinebluff	No. 1	58	8/8	40- 45 46-51	10	--
S-49,Q-3	Pinebluff	No. 2	110	8/8	70-20	20	--

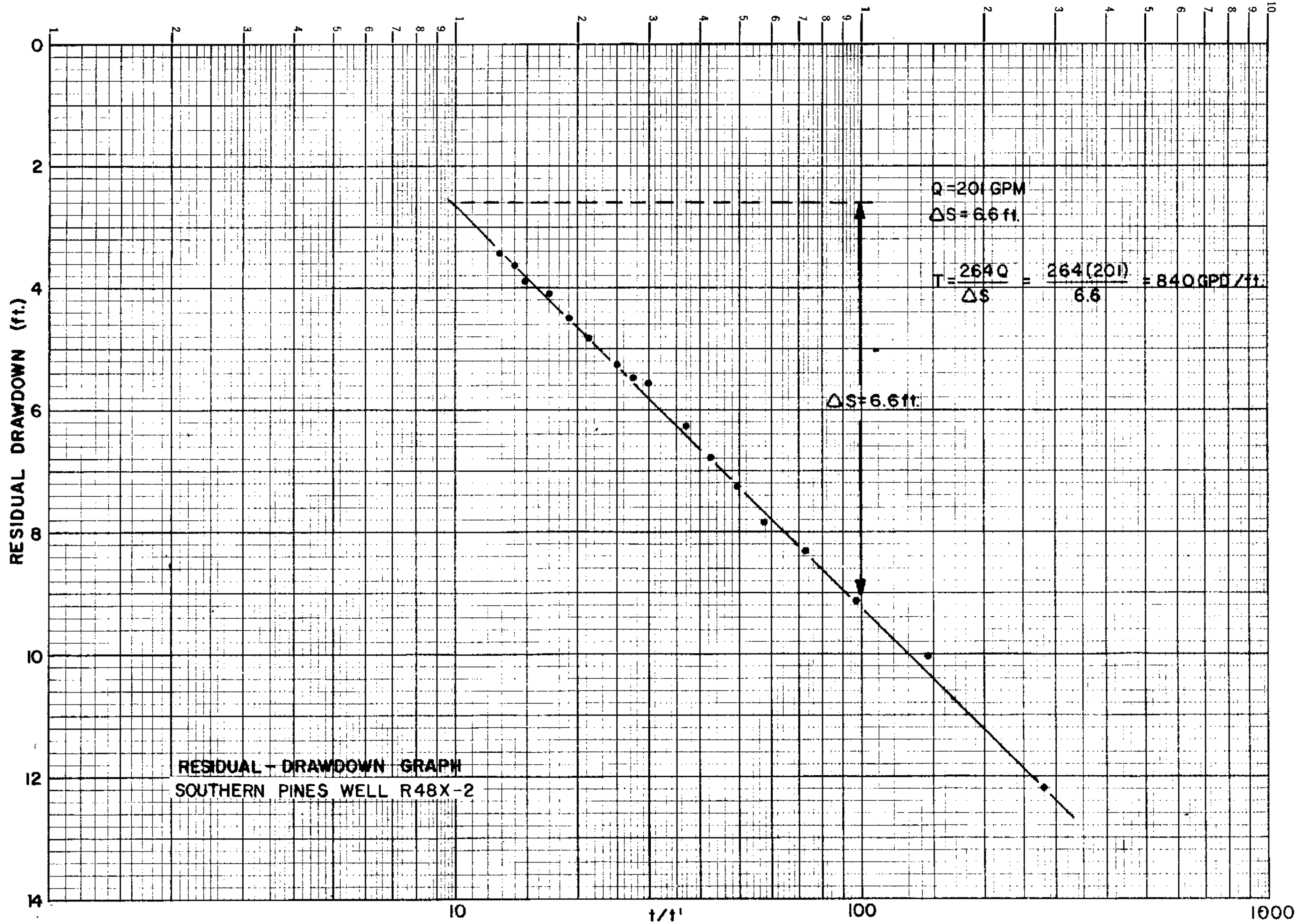
IELD (Q) GPM)	DEPTH, STATIC WATER LEVEL (FT.)	DEPTH, PUMPING WATER LEVEL (FT.)	SPECIFIC CAPACITY (GPM/FT.DD)	YIELD TOTAL SCREEN (GPM/FT.)	PUMPING RATE 1978	DATE DRILLED	REMARKS
30	87	240	0.2	--	--	1971	Completed in Bec
201	167	211	4.5	2.7	--	1978	
158	162	220	2.7	2.4	--	1978	
243	45	75	8.1	11.6	150	1969	
115	69	117	2.4	3.0	80	1969	
204	47	102	3.7	4.3	110	1972	
--	--	--	--	--	160	--	
210	50	94	4.6	4.7	200	1972	
208	20	71	4.2	4.5	150	1972	
150	--	--	--	--	--	--	
200	51	178	1.6	6.7	--	1954	
123	20	94	1.7	6.3	--	1967	
275	75	84	27.0	7.6	--	1967	
234	78	104	9.0	6.7	--	1968	
217	88	126	8.3	5.7	--	1968	
162	49	80	5.2	4.1	--	1971	
200	98	129	6.3	4.4	--	1971	
60	20	46	2.3	6.0	--	1972	
175	38	68	5.8	7.5	--	1977	

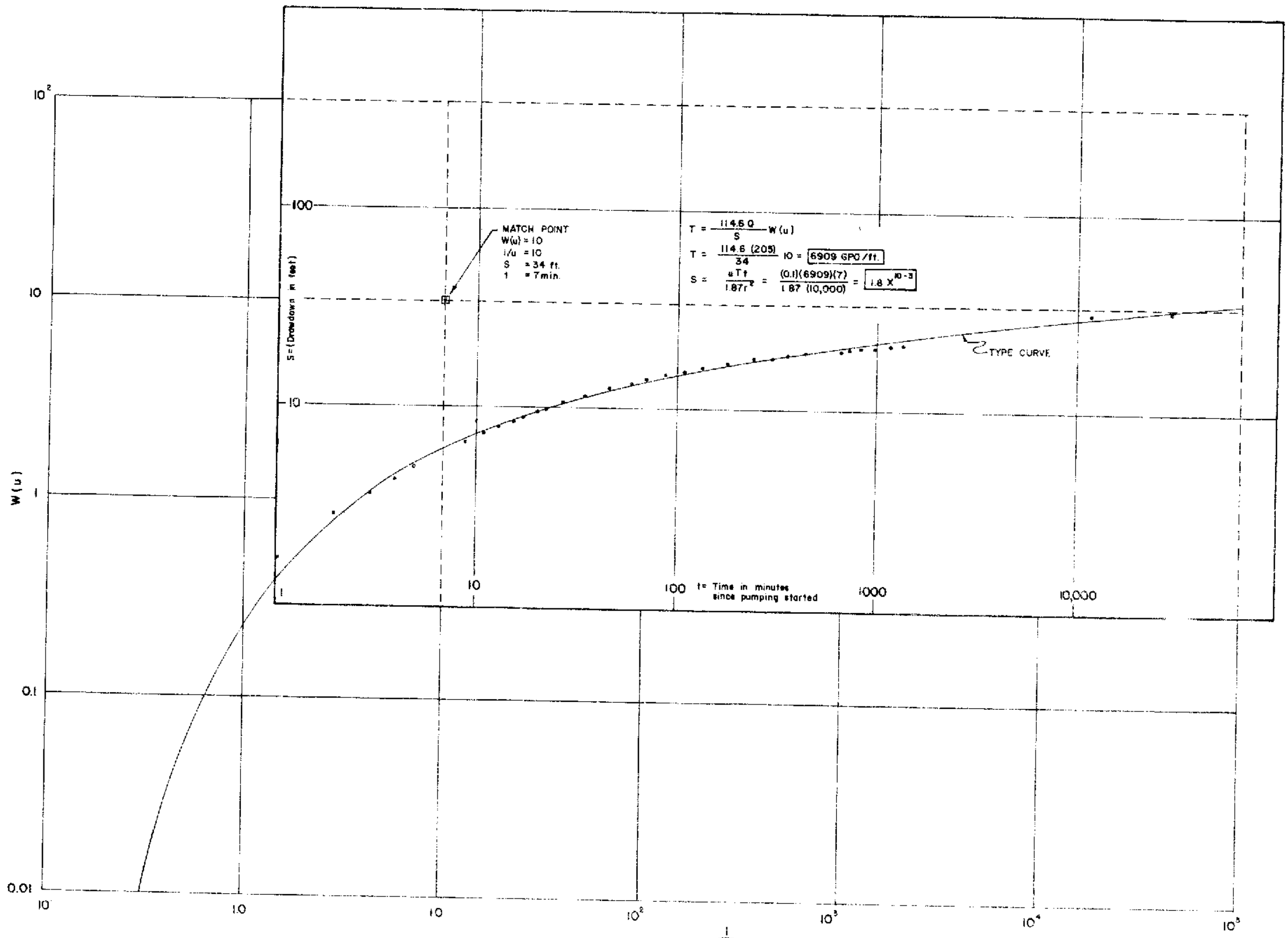
Appendix C

Well and Aquifer Test Analyses



t_o =5.4 min.
DEPTH – 139'
DIA. – 8"
SCREENS – 67' – 90'
94' – 117'
YIELD 103 GPM
SWL 19.5
MEASUREMENTS IN OBSERVATION WELL
r = 100'
ΔS = 4.04 ft.
T = 264 Q / S = 264 (103) / 4.04 = 6731 GPD/ft.
t_o = 5.4 mn. = 0.004 DAY
S = 0.3 T t_o / r²
S = 0.3 (6731) 0.004 / 10,000 = 8.1 X 10⁻⁴
TIME – DRAWDOWN GRAPH – PINEHURST TEST WELL No. 6
DRAWDOWN (ft.)
TIME (min.)


RESIDUAL DRAWDOWN (ft.)
t/t'
Q = 201 GPM
ΔS = 6.6 ft.
$T = \frac{264Q}{\Delta S} = \frac{264(201)}{6.6} = 840$ GPD/ft.
ΔS = 6.6 ft.
RESIDUAL - DRAWDOWN GRAPH
SOUTHERN PINES WELL R48X-2



GRAPHICAL SOLUTION OF PUMPING TEST-WELL R48X-2-SOUTHERN PINES

APPENDIX C-3 WELL AND AQUIFER TEST ANALYSIS

STATE OF NORTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
OFFICE OF WATER RESOURCES

GROUNDWATER RESOURCES OF THE SOUTHERN PINES AREA

ERRATA

Page 1	2nd paragraph, 2nd line:	Change 0979 to 1979
Page 7	3rd paragraph, 3rd line:	Change ocene to Eocene
Page 7	6th paragraph, 3rd line:	Change he to the
Page 9	6th paragraph, 4th line:	Change thier to their
Page 13	Figure 8,	The southern-most contour should be labeled 280 feet; disregard the stippling, which denotes absence of the aquifer, south of the 280 feet contour.
Page 24	1st paragraph, 1st line:	The line should begin with the word "in".
Page 28	Appendix A,	diagram of Hog Island test site: Delete "summary (see worksheet) at top center."
Page 32	Appendix A,	diagram of Weymouth Woods test site: Change corse to coarse and grave to gravel in lithologic description
Page 34	Appendix A,	diagram of Roseland test site: Change corse to coarse in lithologic description.
Page 40	Appendix C,	Residual drawdown graph: change value of T from 840 GPD/ft to 8040 GPD/ft