INTERIM REPORT ON GROUNDWATER CONDITIONS IN CAPACITY USE AREA NO. 1 CENTRAL COASTAL PLAIN, NORTH CAROLINA 1974 - 1975

REPORT OF INVESTIGATION NO. 13

GROUNDWATER SECTION
DIVISION OF ENVIRONMENTAL MANAGEMENT
NORTH CAROLINA
DEPARTMENT OF NATURAL AND ECONOMIC RESOURCES

RALEIGH, NORTH CAROLINA
OCTOBER 1976

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PURPOSE

The purpose of this report is to review the status of groundwater conditions in Capacity Use Area No. 1 (Fig. 1). The report includes data collected between June 1974 and December 1975 and briefly discusses developments which occurred in the area prior to May, 1976.

PREPARATION OF REPORT

This report was prepared by the staff of the Groundwater Section including, P.F. Nelson, L.L. Laymon, L.A. Register and W. C. Jeter.

PREVIOUS REPORTS

Many reports have been published concerning the hydrogeology, geology, and the physical characteristics of the Capacity Use Area. These reports are included in the bibliography of Groundwater Bulletin No. 21, "Status Report on Groundwater Conditions in Capacity Use Area No. 1 - Central Coastal Plain, North Carolina", 1974. In addition, Report of Investigation No. 11 "Potential Effects of Withdrawals from the Castle Hayne Aquifer for Expanded Phsophate Mining in Beaufort County, North Carolina" was published by the Groundwater Section in September 1975.

GROUNDWATER USE

Non-domestic groundwater use in the Capacity Use Area increased by 12.46 MGD during 1974-76 (Table 1). Withdrawals at Lee Creek increased from 56.66 MGD in 19.73 to 62.56 MGD in

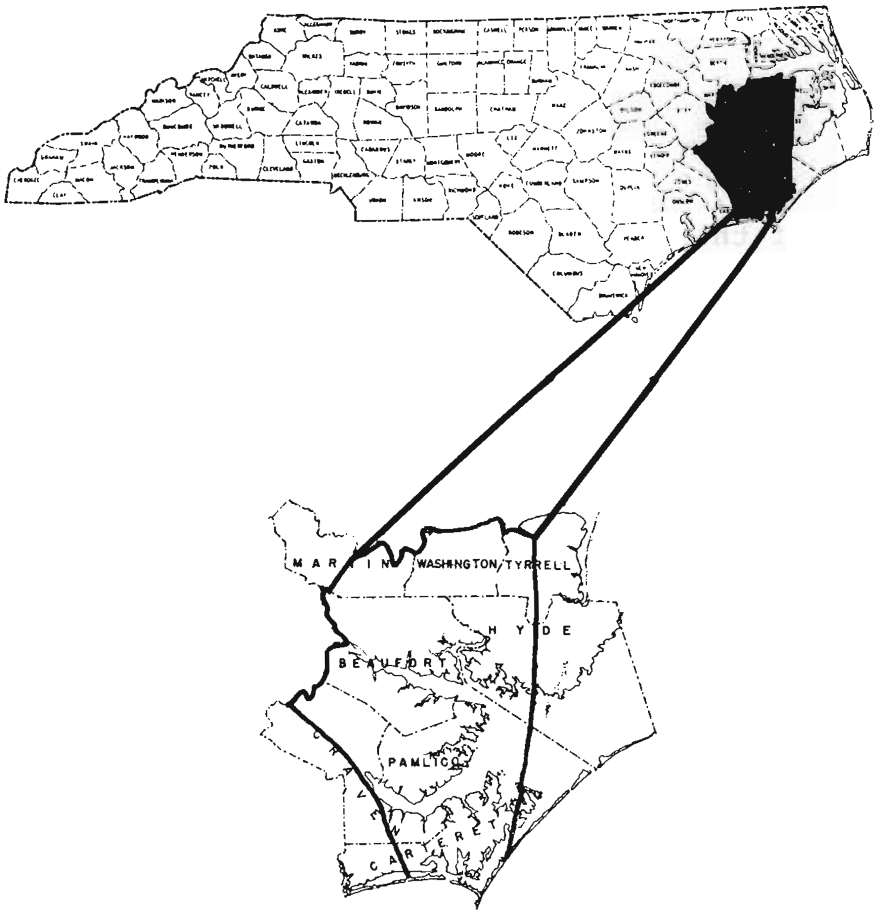


FIGURE I.— INDEX MAP SHOWING CAPACITY USE AREA I

Table 1. Estimated increase in groundwater withdrawals by use, 1974-75

	1974 (MGD)	1975 (MGD)	Total (MGD)
Domestic	.12	.12	.24
Public	1.27	2.10	3.37
Industrial	6.24	1.97	8.21
Agricultural	.72	.32	1.04
TOTALS	8.35	4.51	12.86

1974 and 63.71 MGD in 1975, a net of 7.05 MGD for the two year period. (Fig. 2)

Domestic use of groundwater, estimated from well completion reports, increased by about 0.24 MGD.

Two Water Use Permits were issued by the Environmental Management Commission during the reporting period.

Water Use Permit No. 21 (temporary) was issued in April, 1975 to First Colony Farms, Inc., a farming operation of approximately 4400 acres in Dare, Hyde, Tyrrell and Washington counties, authorizing the withdrawal of groundwater for the purpose of improving agricultural conditions in the area. The maximum amount of water which may be withdrawn shall not exceed 632,100,000 gallons per month.

Water Use Permit No. 22 was issued in June, 1975 to the Town of Oriental, Pamlico County, authorizing the withdrawal of up to 150,000 gallons per day for public supply.

WATER LEVELS

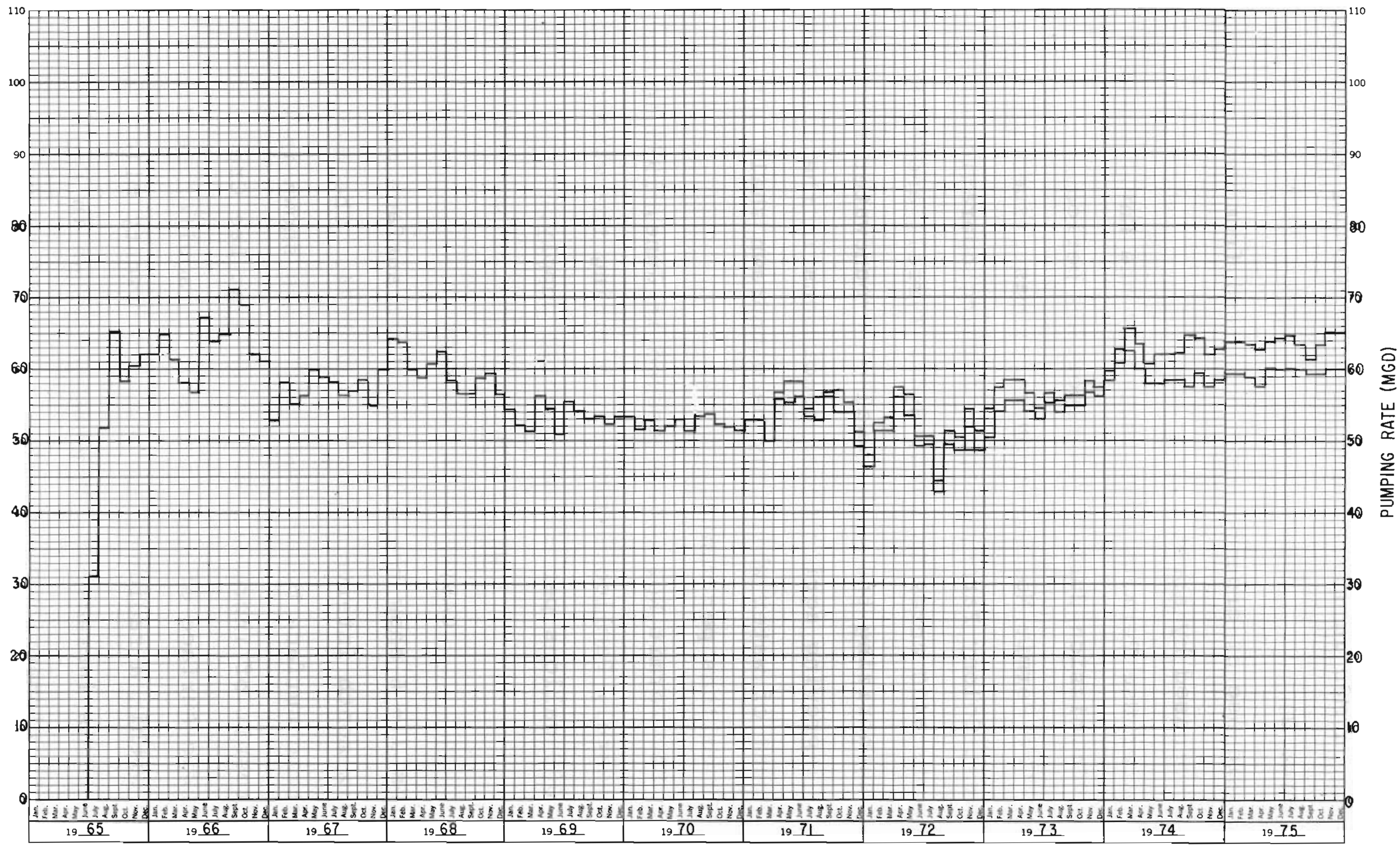
CASTLE HAYNE AQUIFER

Figures 3 - 6 show the potentiometric surface of the Castle Hayne at six month intervals from July, 1974. The depth of the potentiometric surface below land surface is shown in Fig. 7.

As a result of increased withdrawals at Lee Creek the potentiometric surface of the Castle Hayne aquifer declined measurably within a radius of from six to twenty miles from the mine site. This increase in drawdown is shown in Fig. 8.

The potentiometric surface in the immediate vicinity of the

FIGURE 2. - GRAPH OF WITHDRAWALS AT LEE CREEK MINE



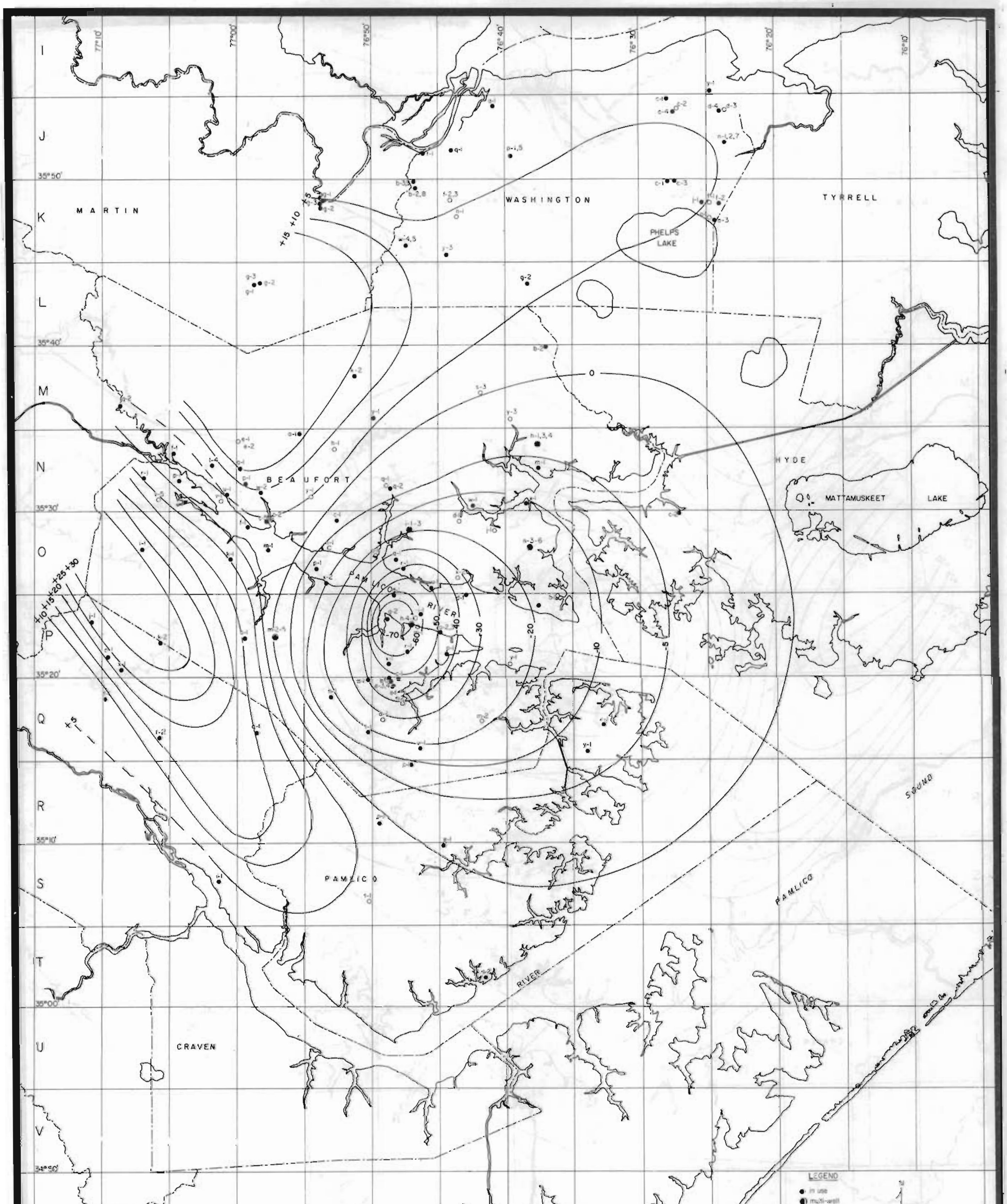


FIGURE 3.- POTENTIOMETRIC SURFACE OF CASTLE HAYNE AQUIFER - JULY 1974

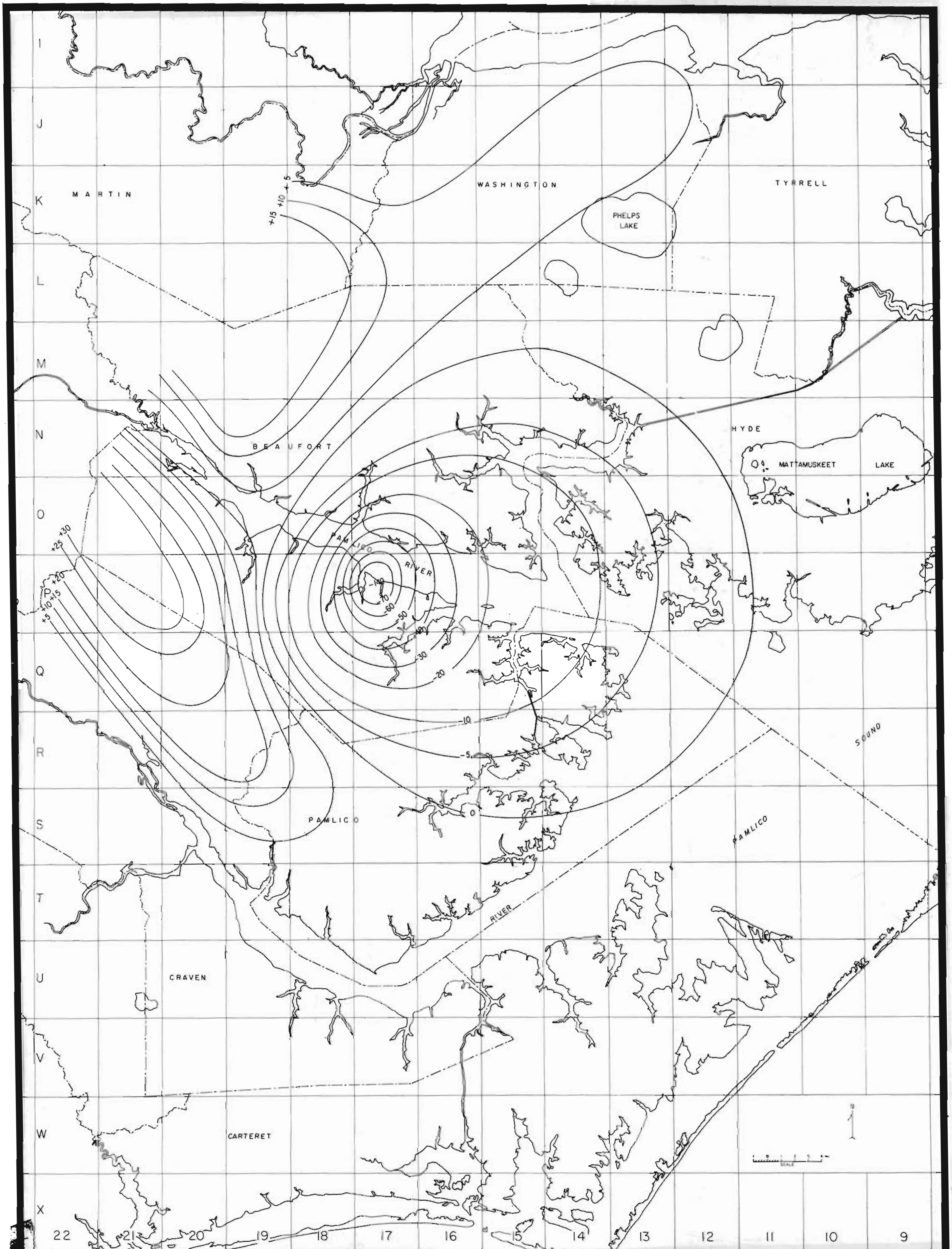


FIGURE 4.-POTENTIOMETRIC SURFACE OF CASTLE HAYNE AQUIFER - JANUARY, 1975

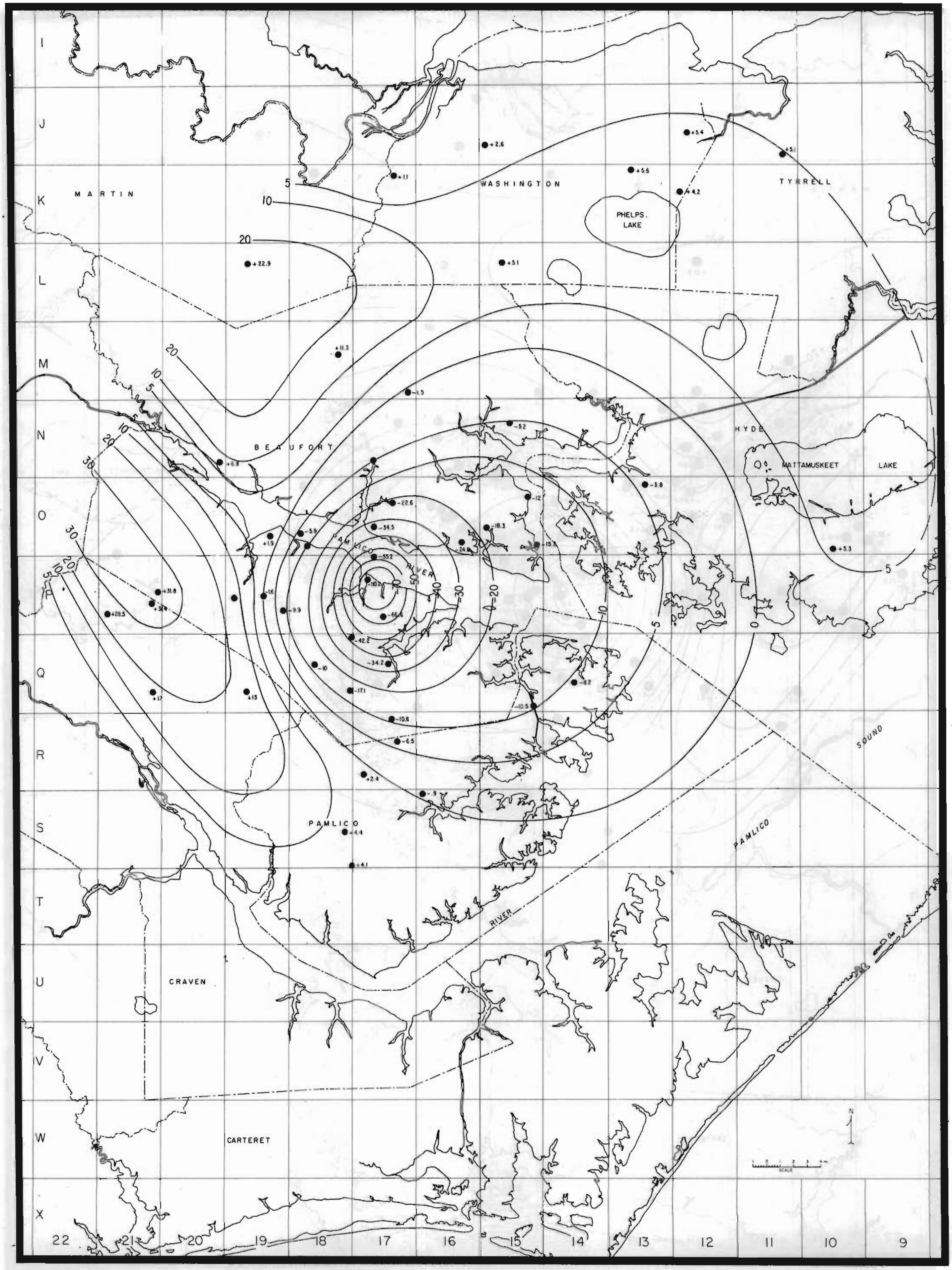


FIGURE 5.- POTENTIOMETRIC SURFACE OF CASTLE HAYNE AQUIFER, JULY 1975

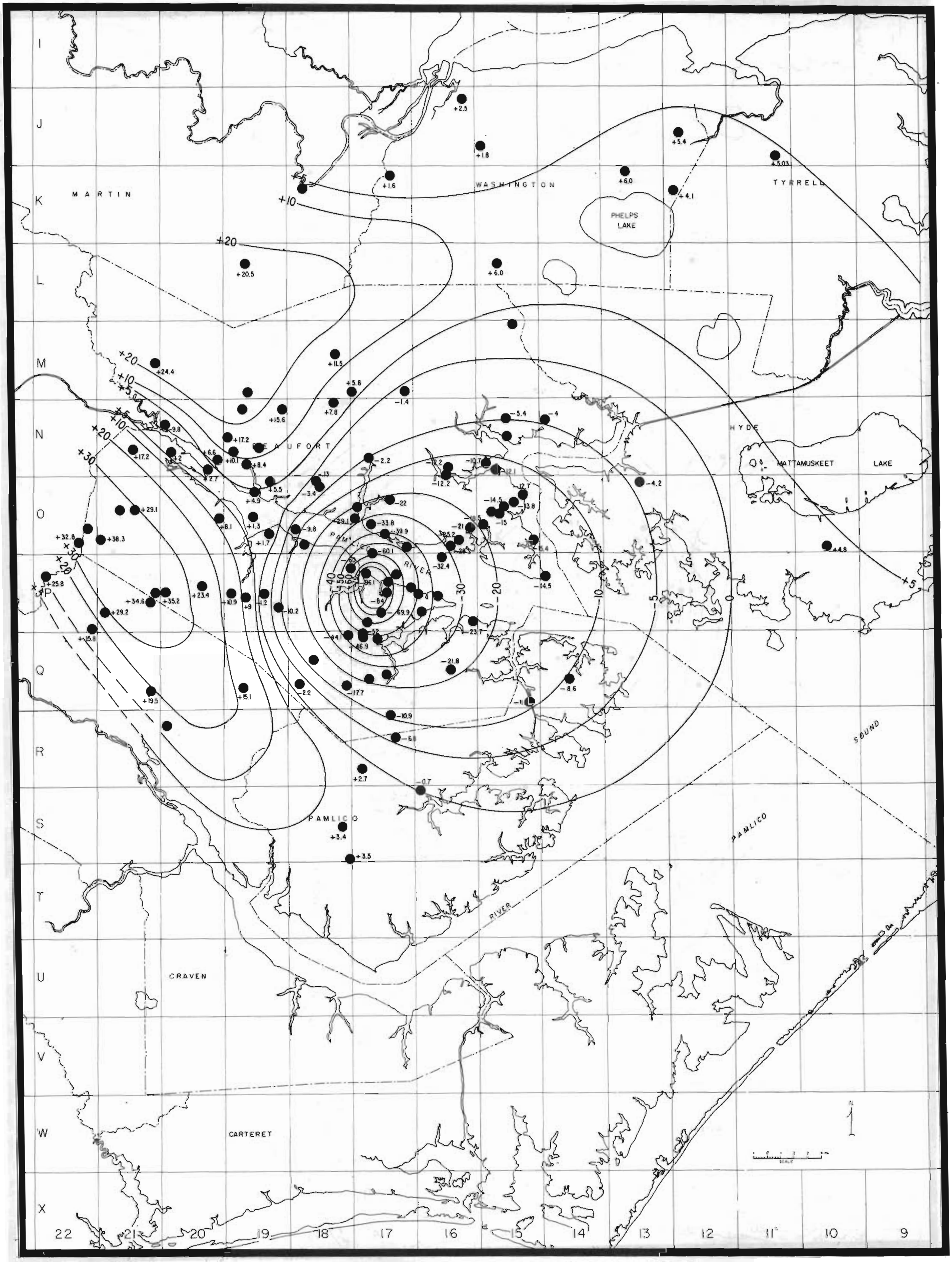


FIGURE 6.-POTENTIOMETRIC SURFACE OF CASTLE HAYNE AQUIFER, JANUARY 1976

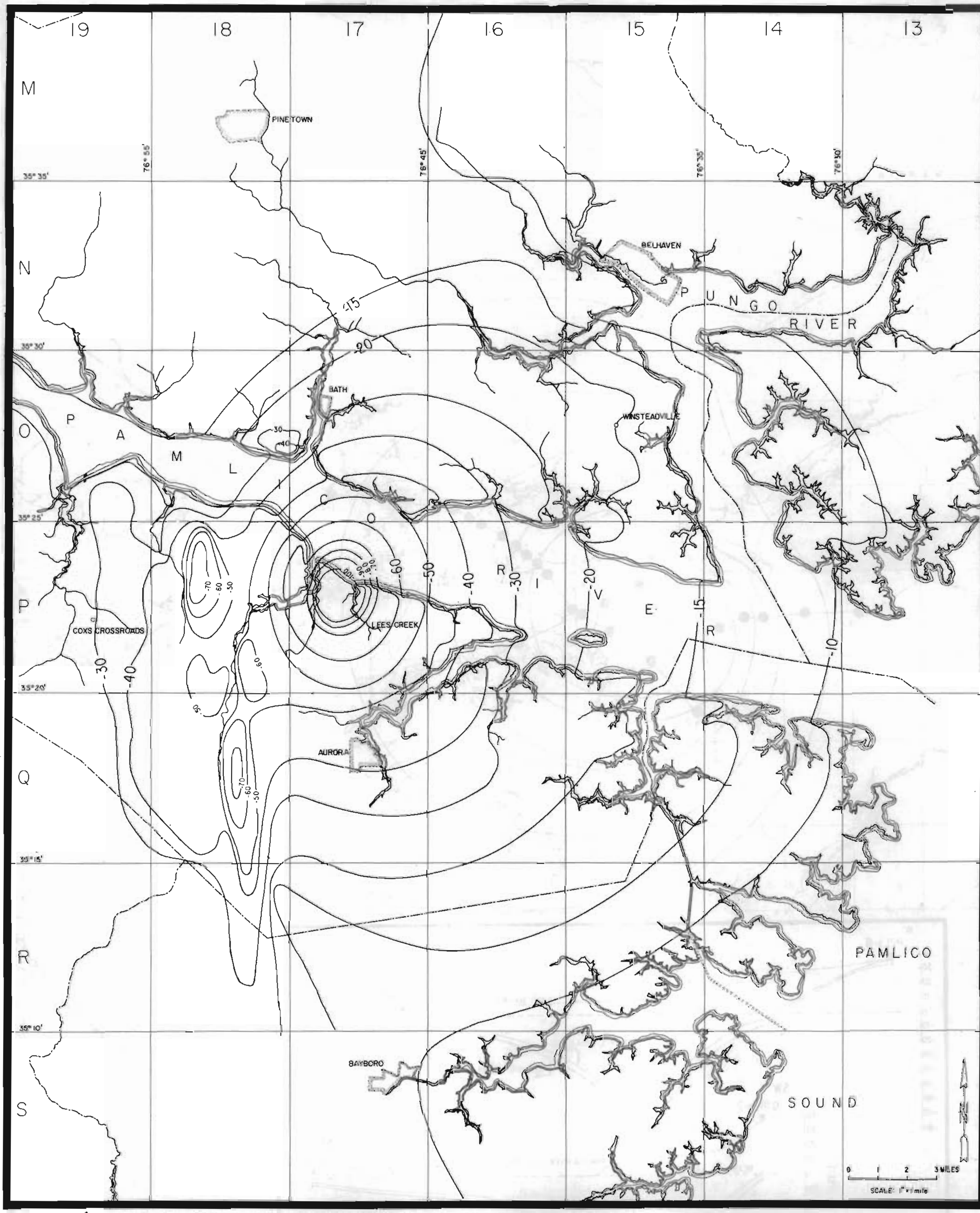


FIGURE 7. - DEPTH OF POTENTIOMETRIC SURFACE OF CASTLE HAYNE AQUIFER BELOW LAND SURFACE - JANUARY 1975

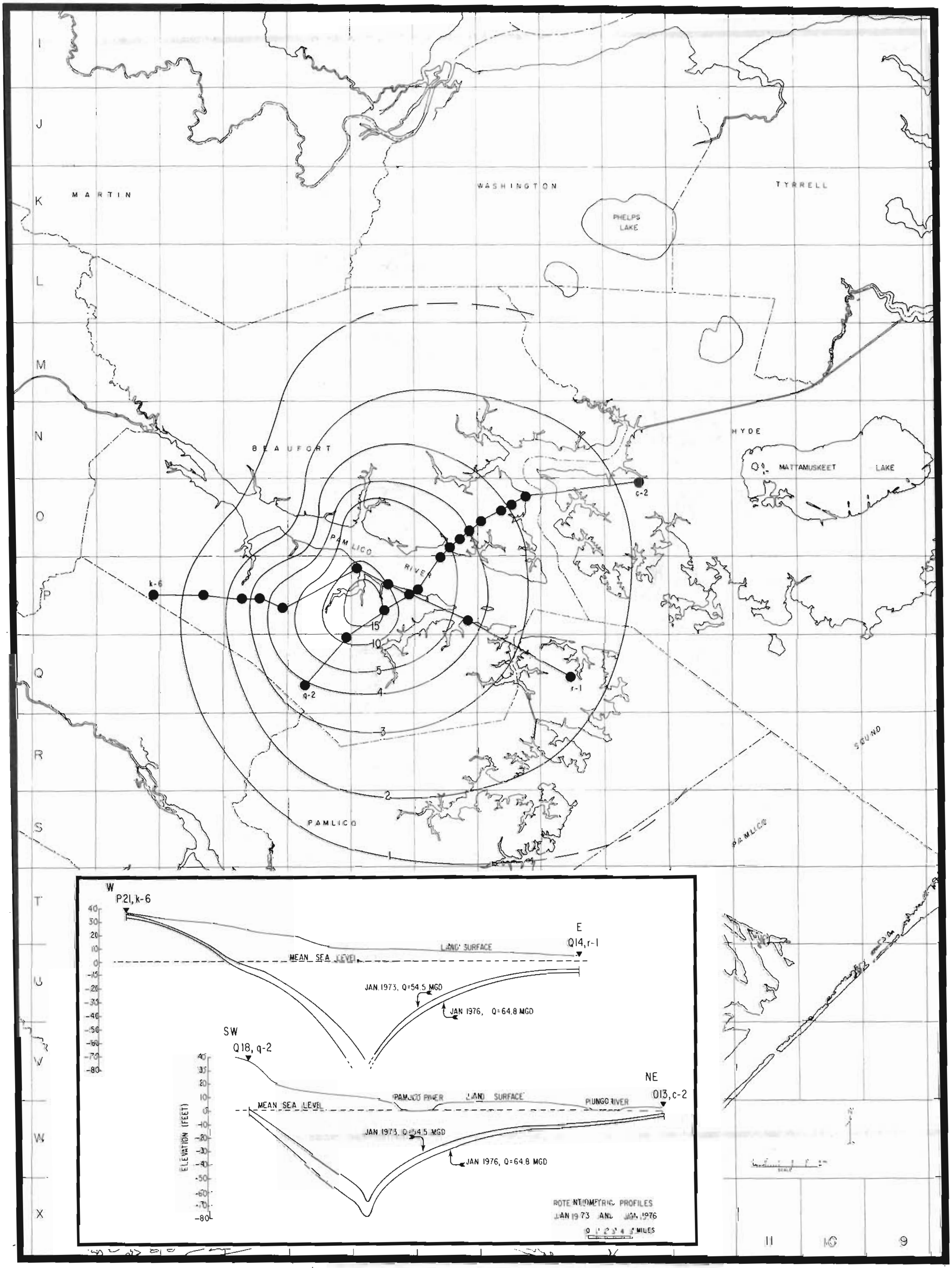


FIGURE 8.- INCREASE IN DRAWDOWN IN CASTLE HAYNE AQUIFER FROM JANUARY 1973 TO JANUARY 1976

mine is shown in Fig. 9-12. The area in which the potentiometric surface was at or below 120 feet below sea level ranged from 203 to 338 acres. The present permit limits drawdown below -120 feet to a maximum of 400 acres.

Water levels in wells completed in the Castle Hayne aquifer normally decline during the summer and early fall as a result of evapotranspiration losses, and recover during the winter and spring.

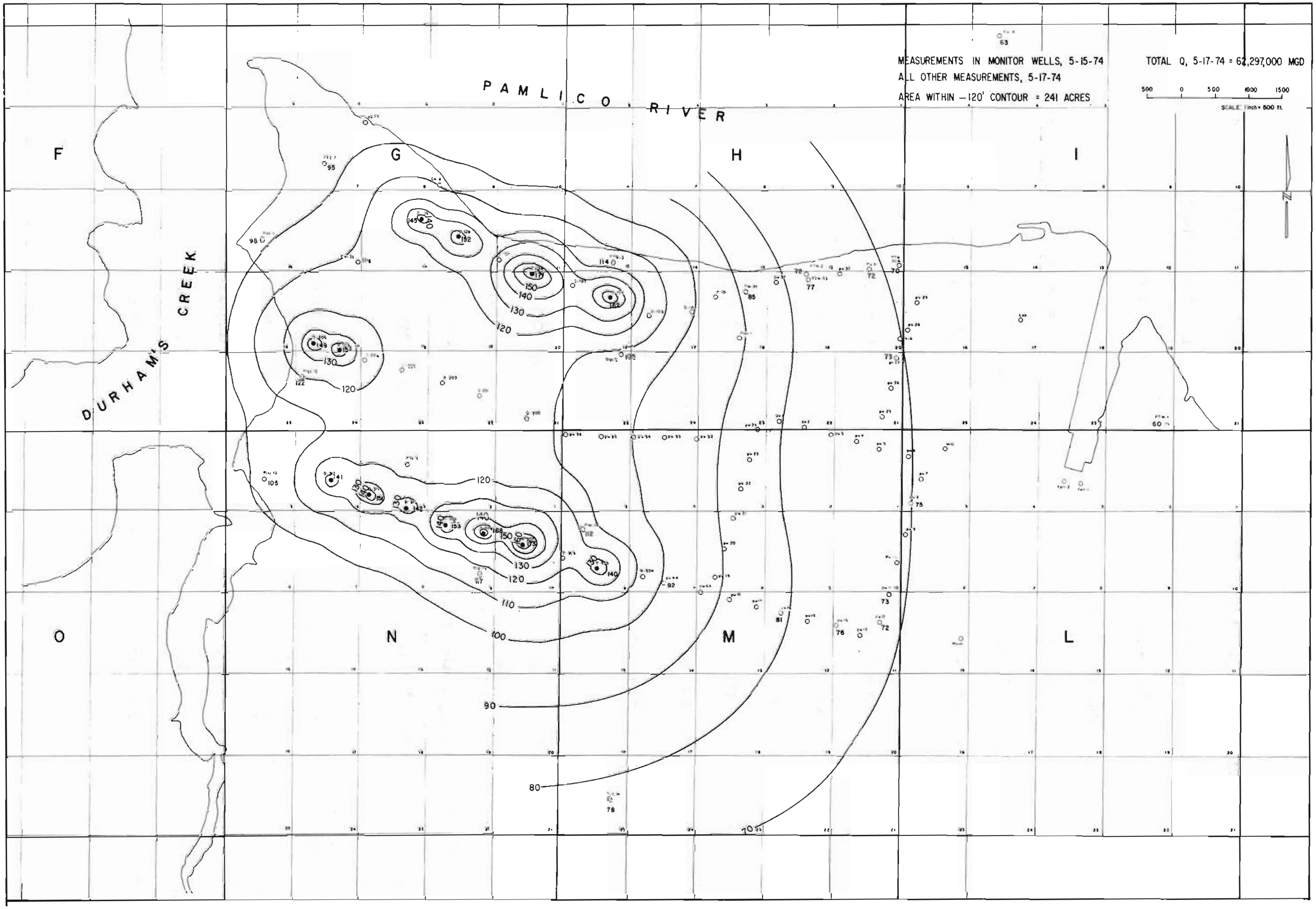
Near the center of pumping, seasonal effects are masked by the radical response of water levels to short-term changes in pumping rates. At, and beyond the western limits of the cone of depression the lack of confinement is illustrated by the manner in which water-levels rise and fall contemporaneously, and in about the same magnitude, with water levels in the unconfined aquifer.

YORKTOWN AQUIFER

The effect of withdrawals at Lee Creek on the Yorktown aquifer is difficult to analyze as the aquifer is composed of units of varying lithology, degree of confinement and hydraulic contiguity. Figure 13 shows the distribution of water levels in the Yorktown aquifer.

Water-level fluctuations in wells completed in the Yorktown aquifer illustrate various degrees of confinement and show response to rainfall and evapotranspiration, local pumping from within the aquifer, and to leakage to the underlying Castle Hayne as a result of pressure differentials created by mine depressuring. Examples of the latter are shown by the hydrograph for (Q14 y-1) in

FIGURE 9.- POTENTIOMETRIC MAP CASTLE HAYNE AQUIFER - LEE CREEK MINE - MAY 1974



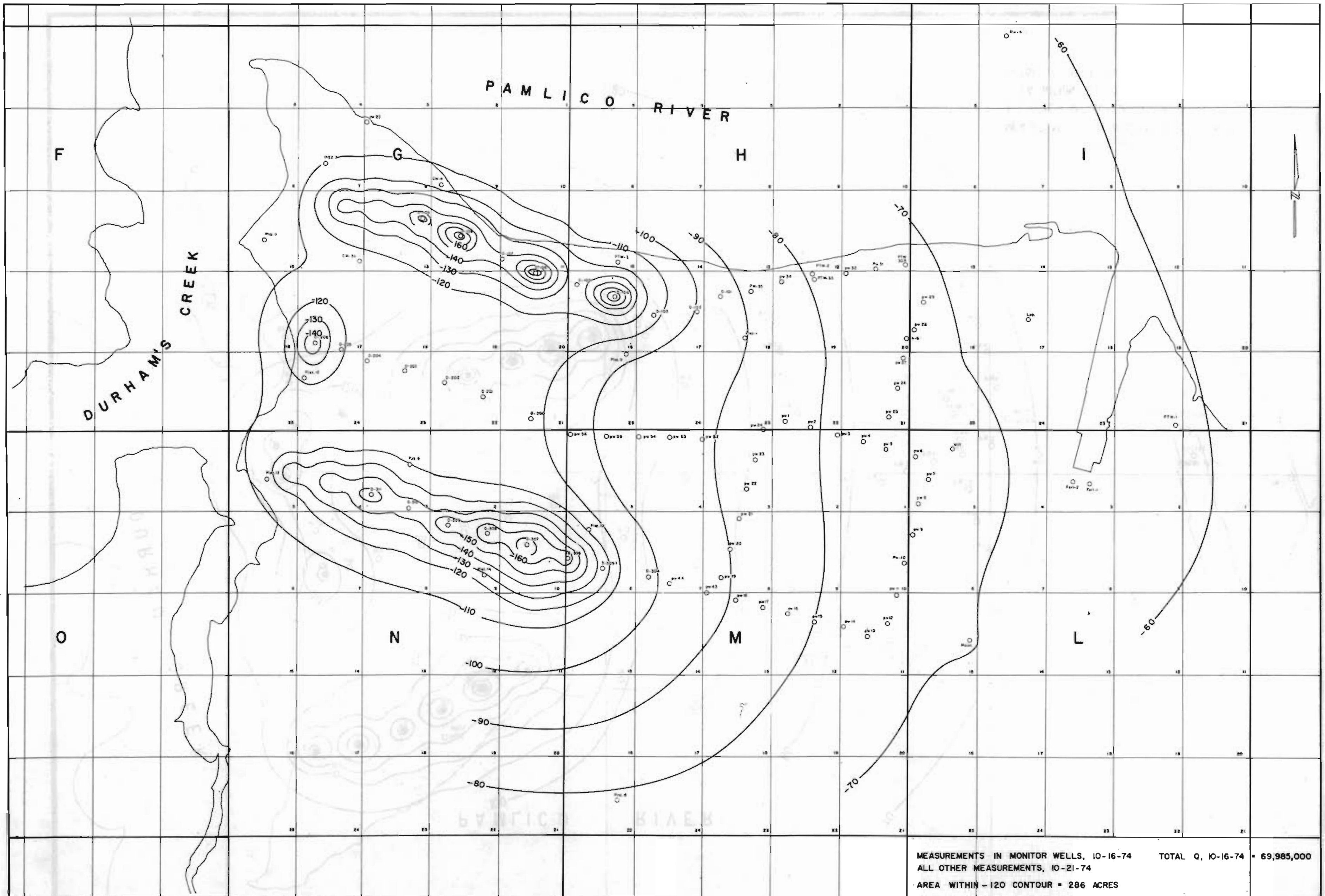
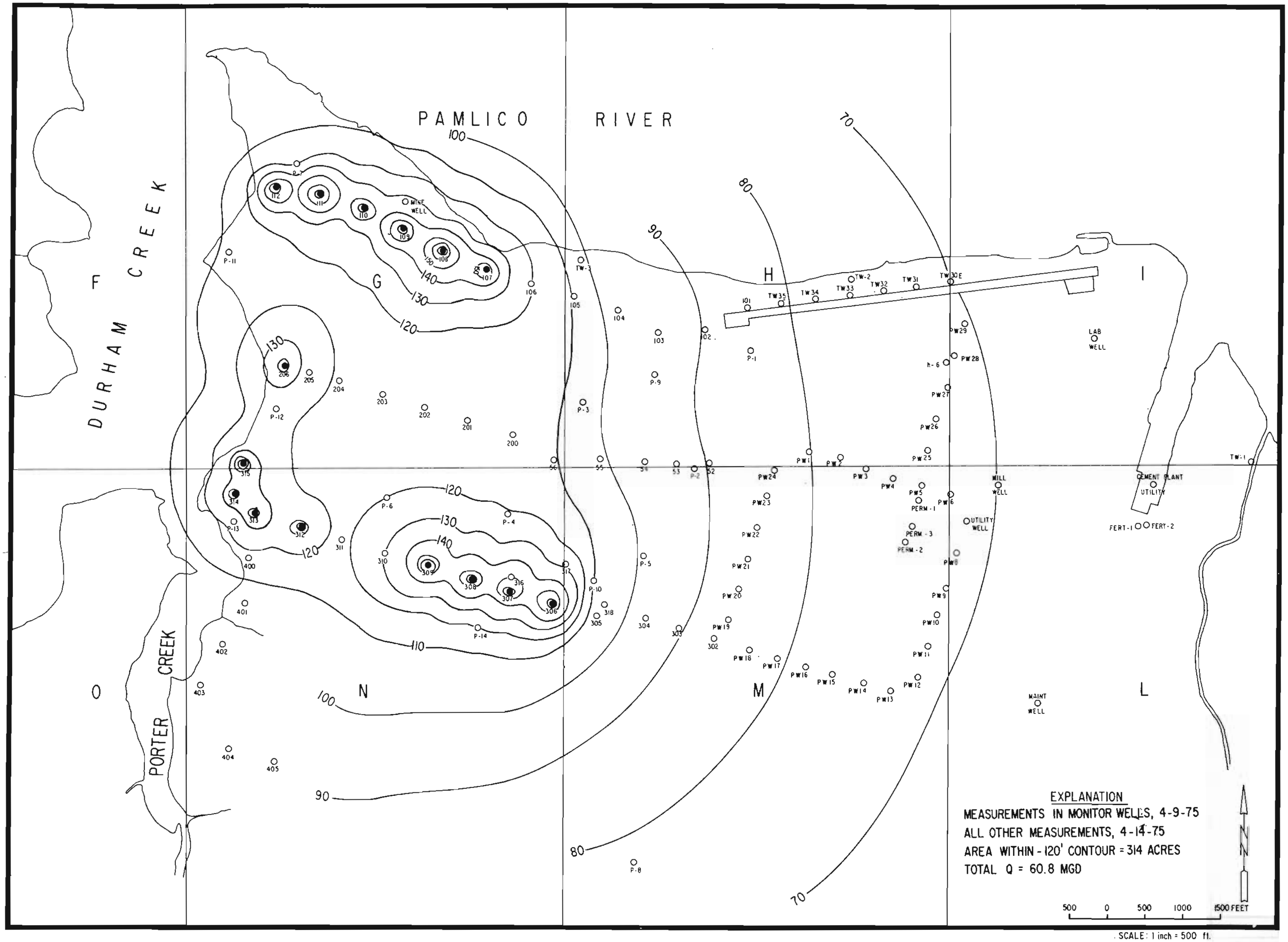


FIGURE 10.- POTENTIOMETRIC MAP, CASTLE HAYNE AQUIFER-LEE CREEK MINE - OCTOBER 1974

FIGURE 11.- POTENTIOMETRIC MAP CASTLE HAYNE AQUIFER - LEE CREEK MINE - APRIL 1975



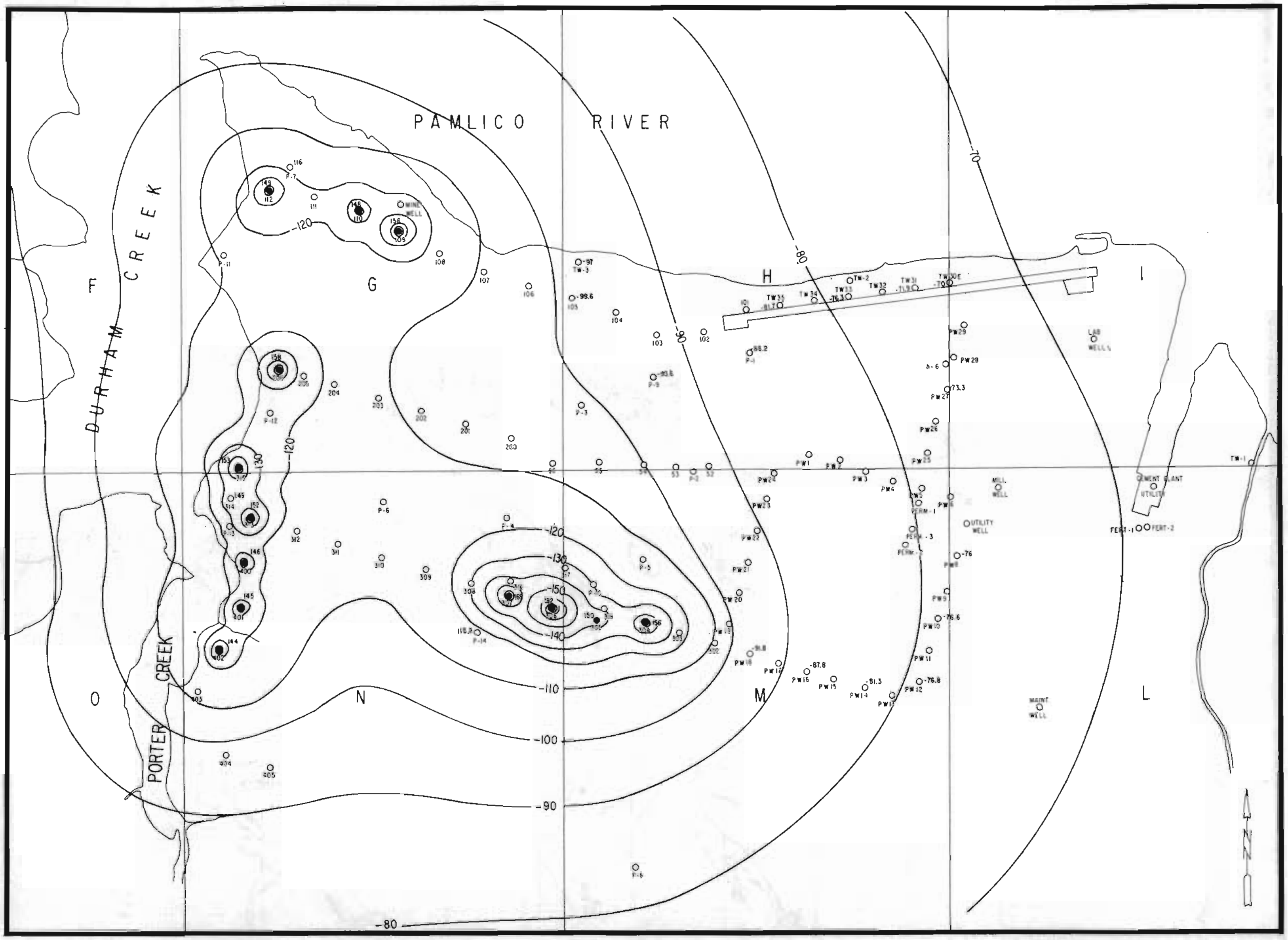


FIGURE 12.- POTENTIOMETRIC MAP OF CASTLE HAYNE AQUIFER, LEE CREEK MINE, SEPTEMBER 1975

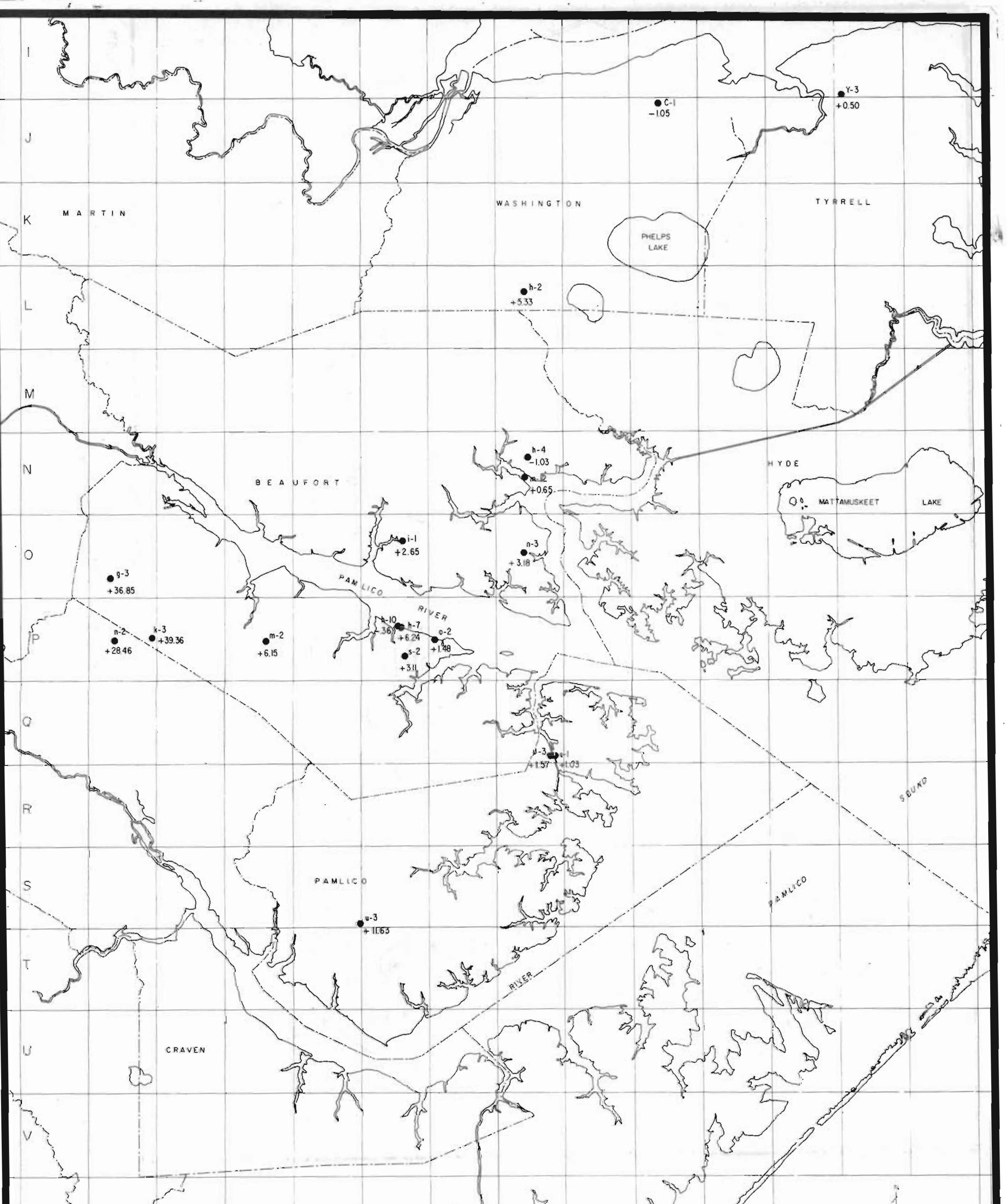


FIGURE 13.- DISTRIBUTION OF WATER LEVELS IN YORKTOWN AQUIFER - 1975

Pamlico County (Fig. 14). The sharp decline in late 1965 is coincident with the beginning of depressuring operations at Lee Creek. Water levels rose gradually til 1973, then began to decline as a result of increased withdrawals at Lee Creek.

Taken as one hydrologic unit, the Yorktown serves as a transmission zone for recharge to the Castle Hayne, either by fairly rapid infiltration of rainfall where geologic and hydrologic conditions are optimal, or by very slow and probably circuitous leakage in those areas in which depth of burial and interference of water movement by zones of low permeability are significant. Leakage from the Yorktown to the Castle Hayne is replaced by water from the overlying unconfined (water table)aquifer or from surface sources such as the Pamlico or Pungo River.

UNCONFINED AQUIFER

Water levels in wells completed in the unconfined (water-table) aquifer fluctuated in response to local precipitation and evapotranspiration. Water levels are typically high from December through May and decline throughout the summer and fall when evapotranspiration rates are highest. The water table fluctuates through a range of 3 to 6 feet. The aquifer serves as a source of recharge to the underlying, confined aquifer in areas in which the water-table stands at a higher elevation than the potentiometric surface of the confined aquifers.

Hydrographs in Fig. 15 - 22 show the hydrologic relationship between aquifers at Research Station sites. Hydrographs of other monitor wells are shown in Fig. 23 - 25.

FIGURE 14. - HYDROGRAPH OF WELL Q14 R-1, LOWLAND, N.C.

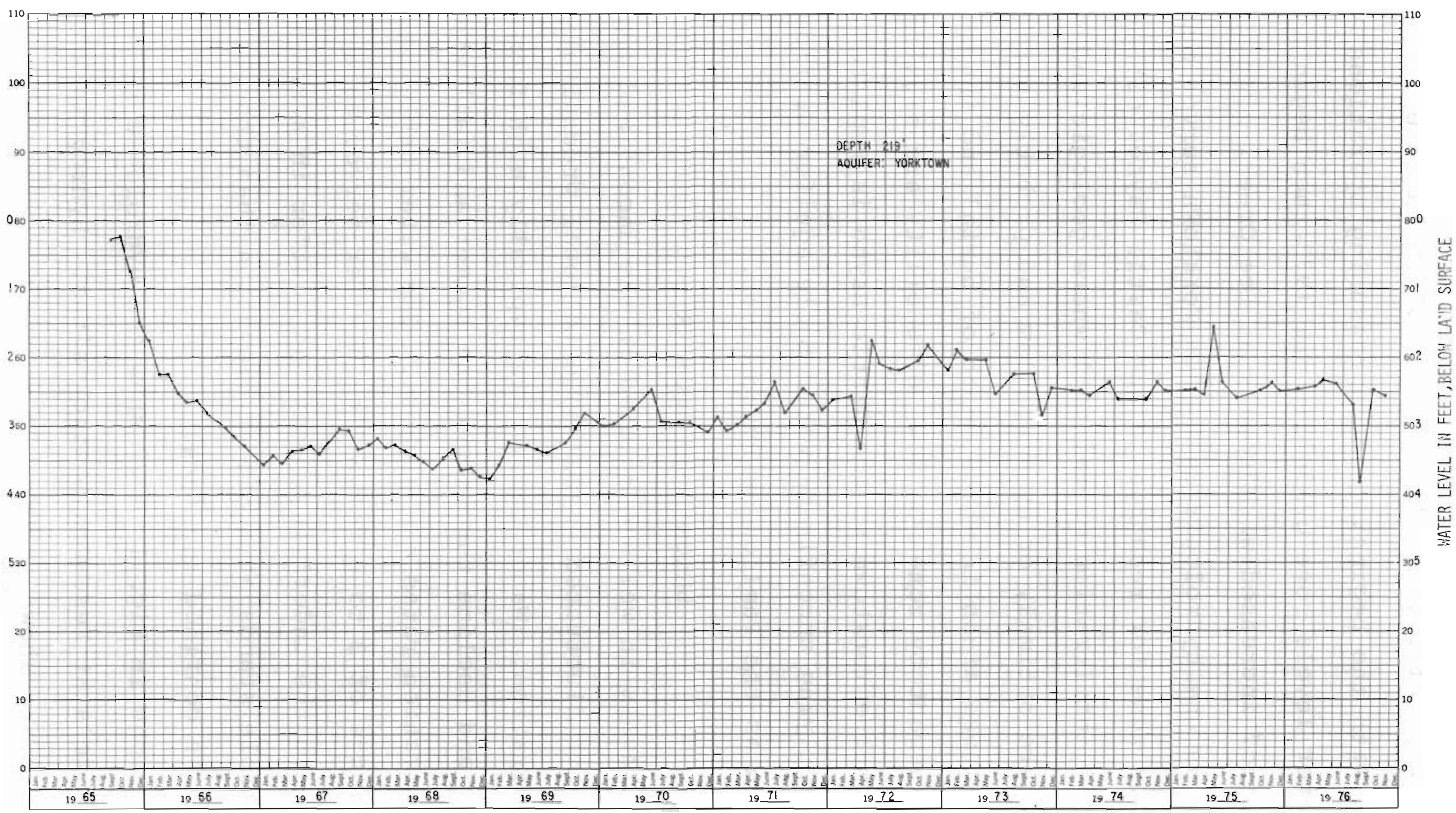
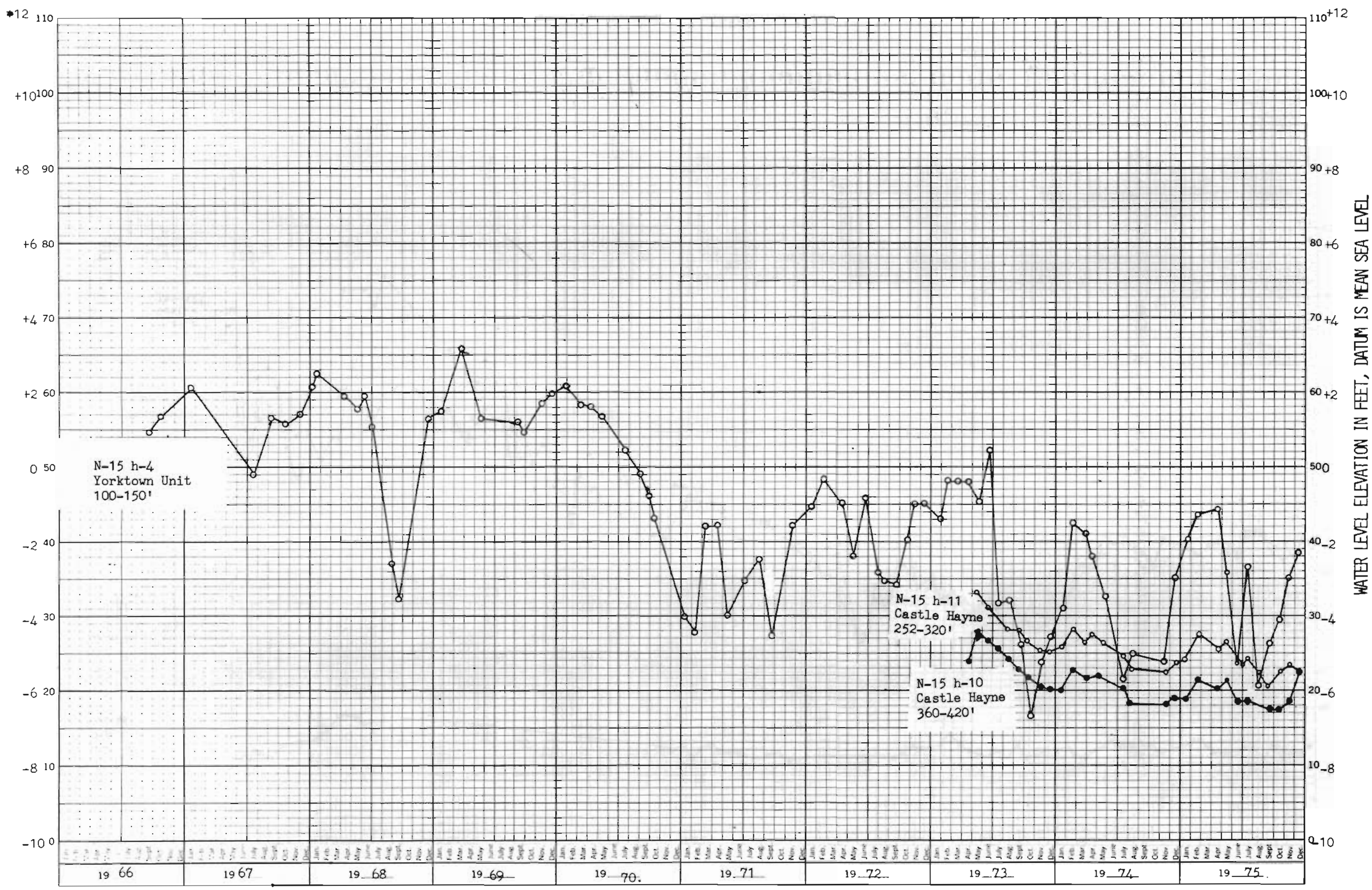


FIGURE 15. - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT LEE CREEK, N.C.

FIGURE 16. - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT BELHAVEN, N.C.



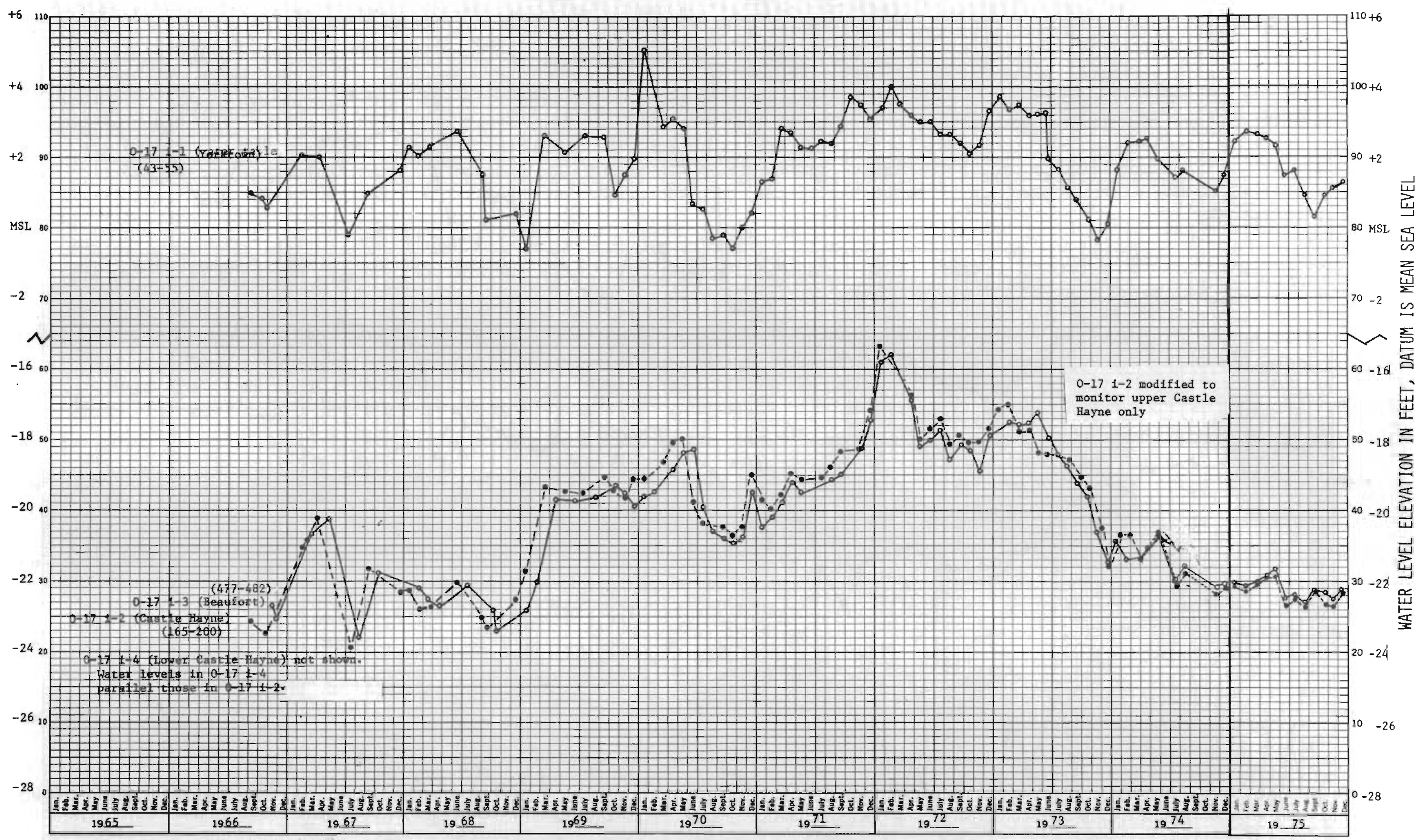
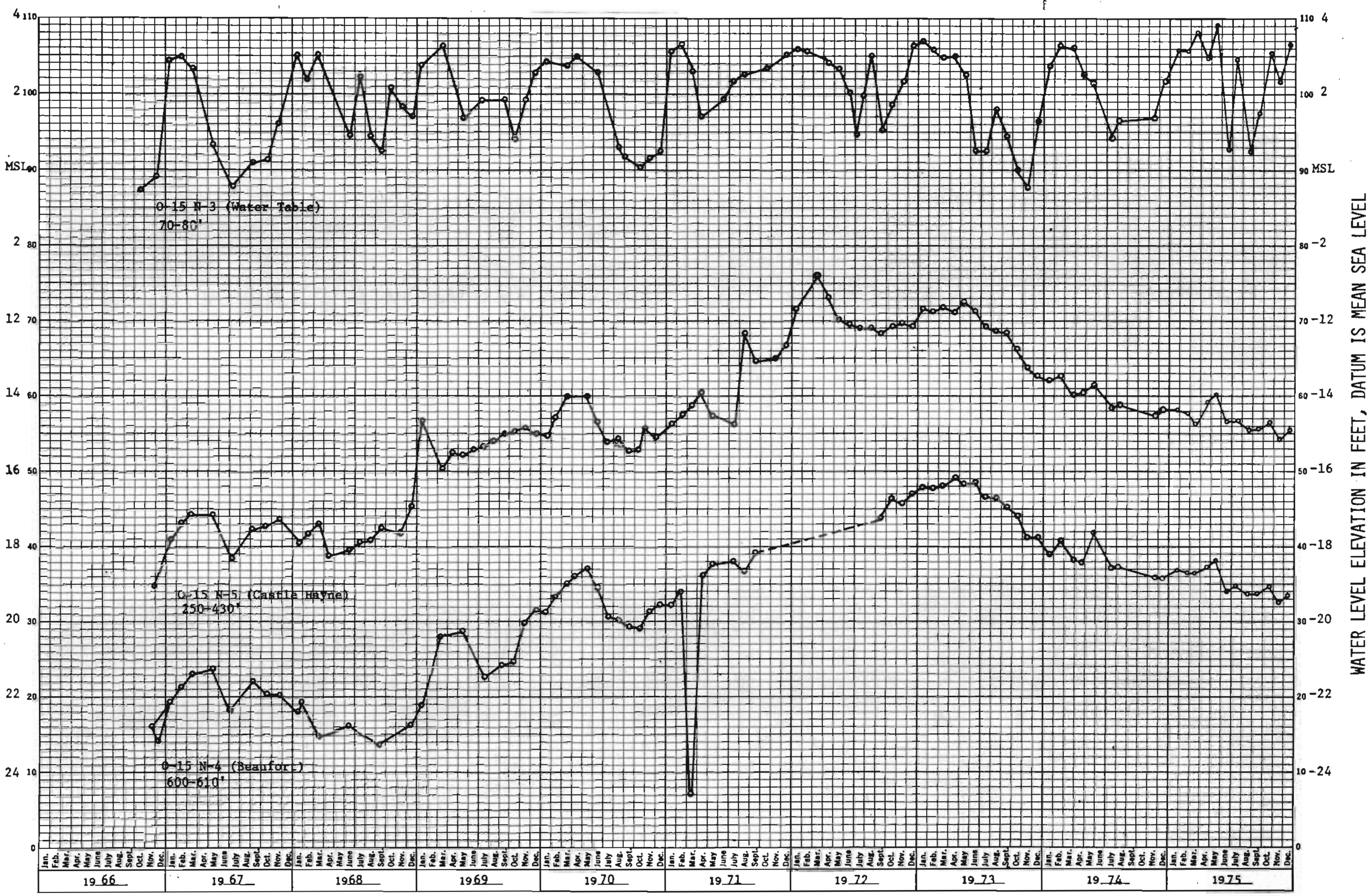


FIGURE 17. - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT BATH, N.C.

FIGURE 18. - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT WINSTEADVILLE, N.C.



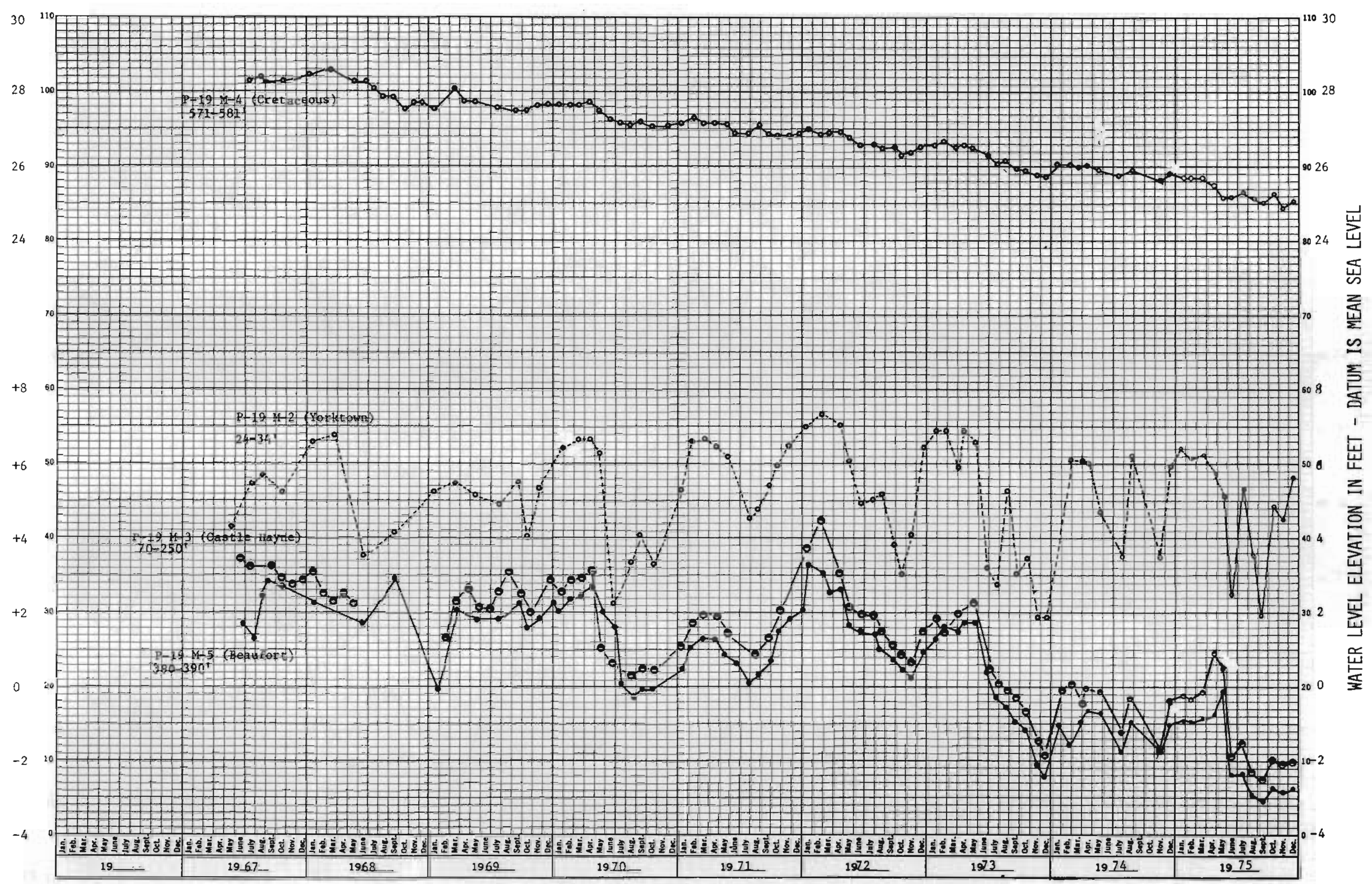
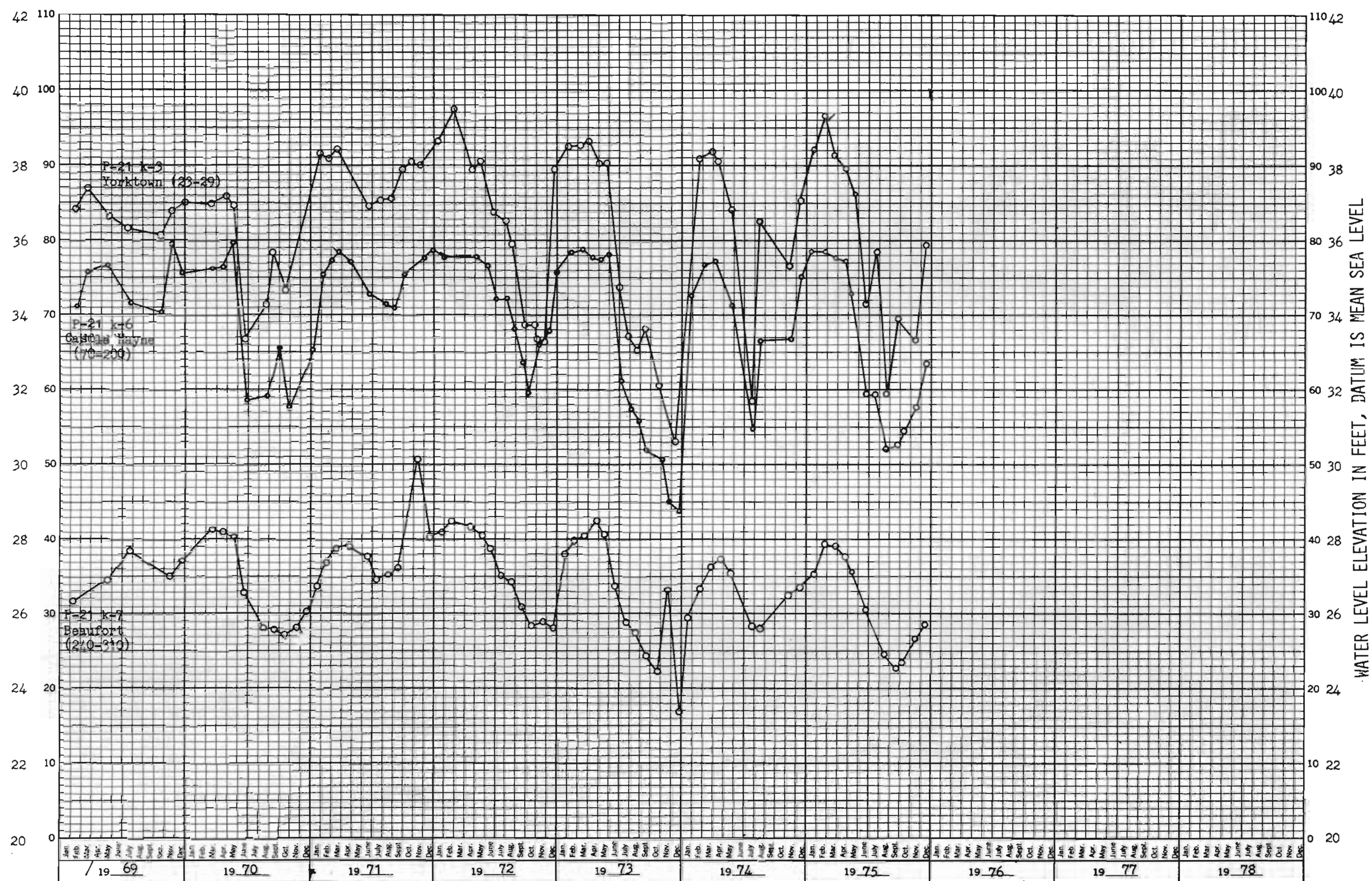


FIGURE 19. - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT COX CROSSROADS, N.C.

FIGURE 20. A - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT WILMAR, N.C.



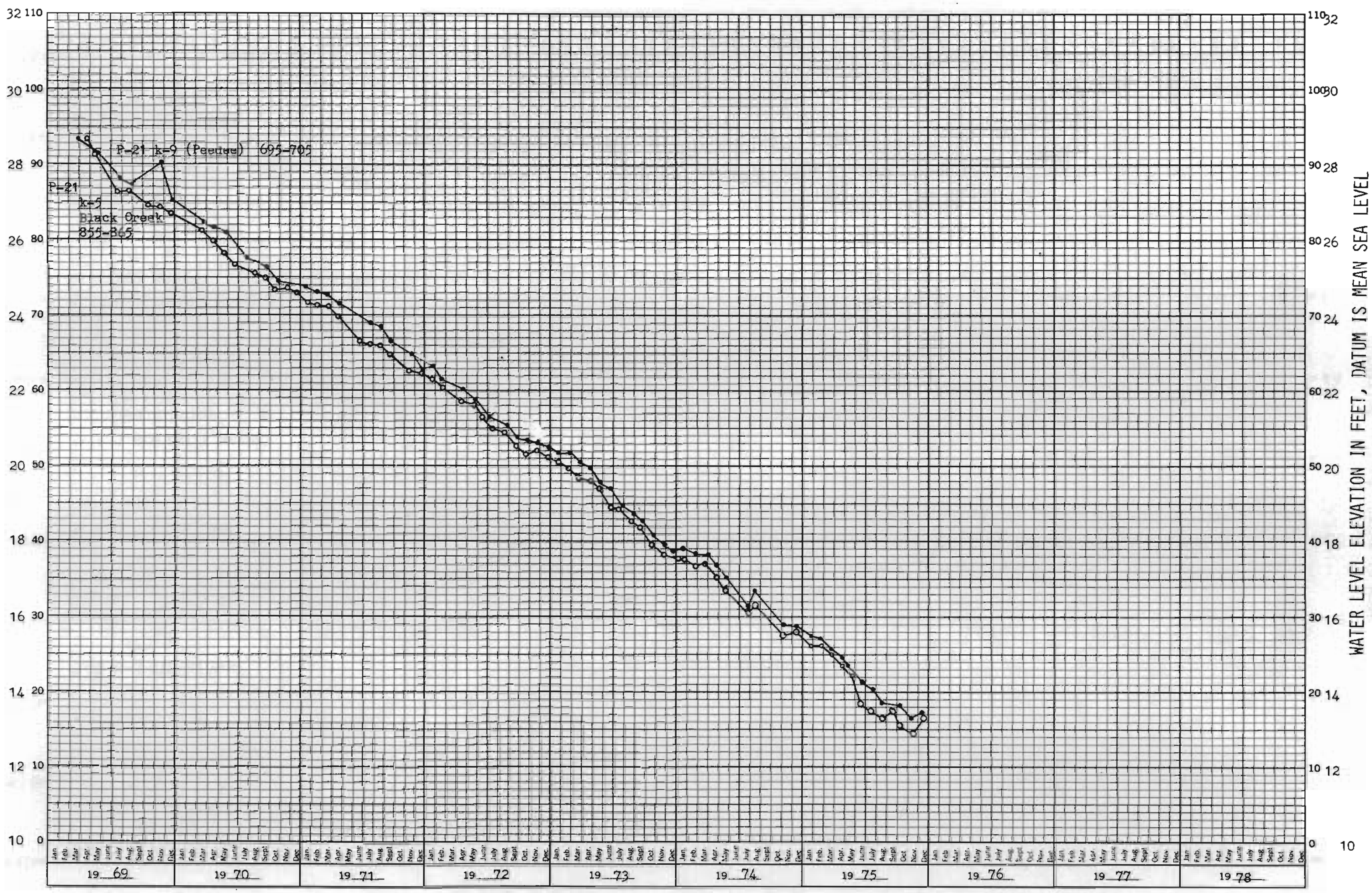
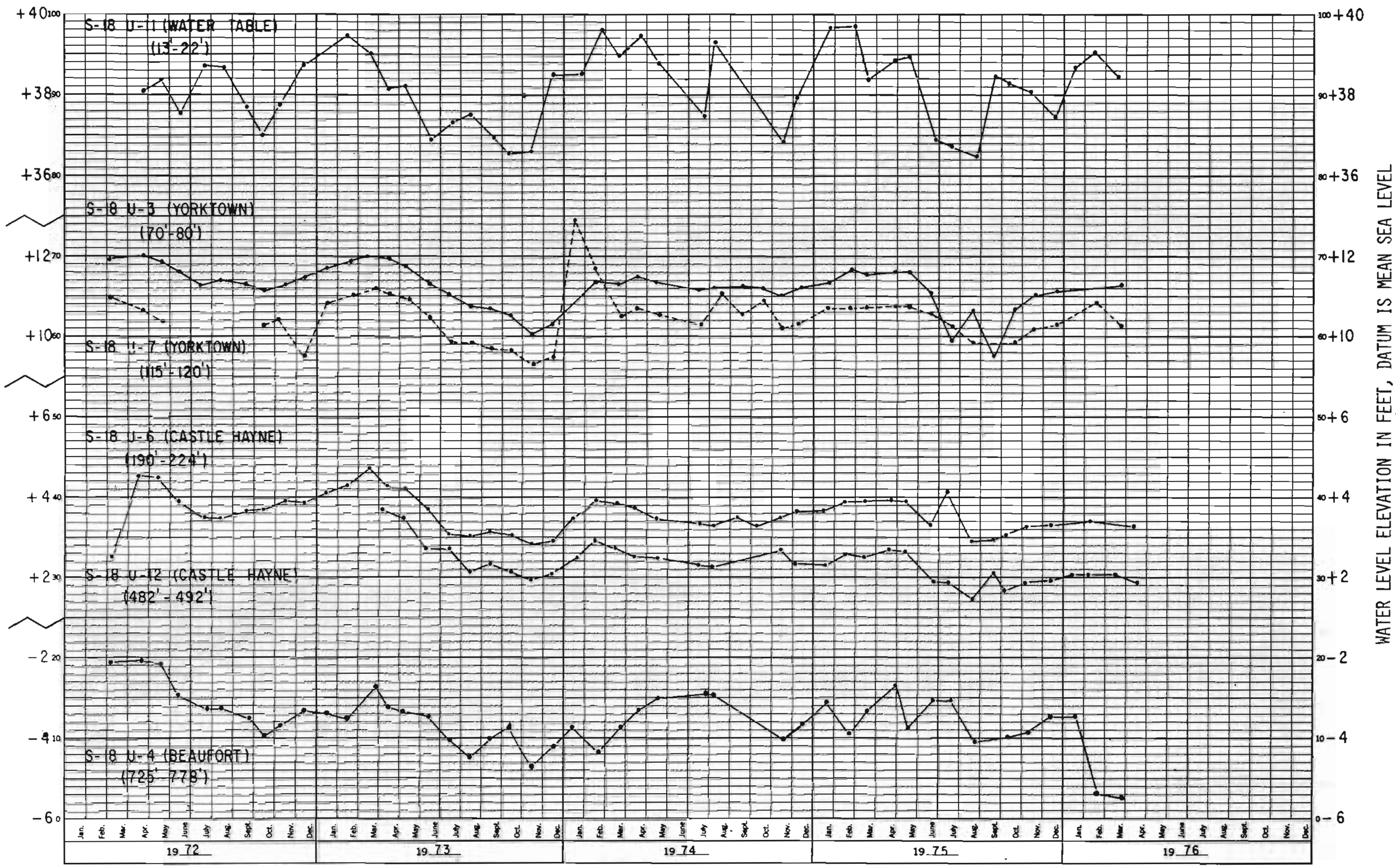


FIGURE 20. B - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT WILMAR, N.C.

FIGURE 21. - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT ARAPAHOE, N.C.



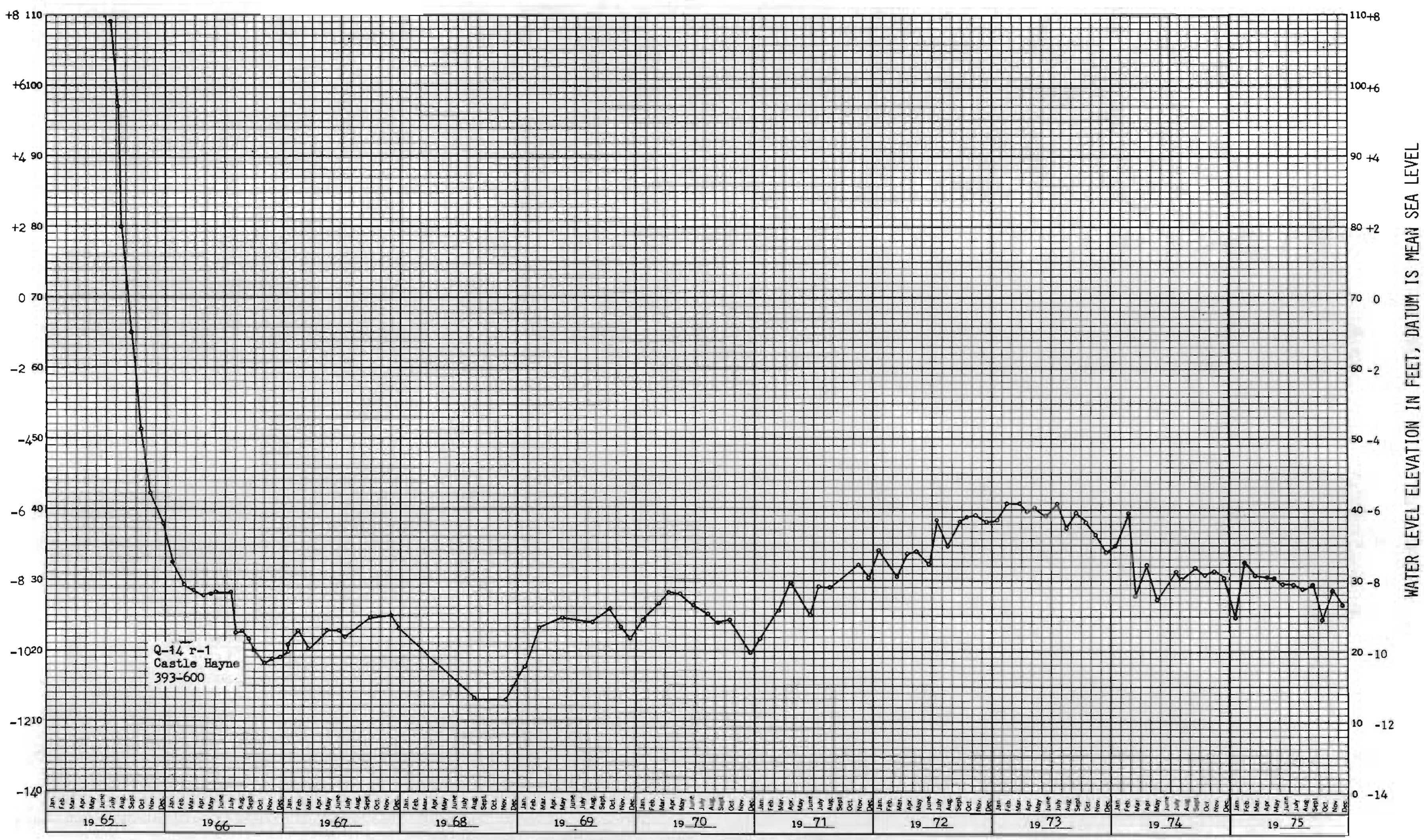


FIGURE 22. - HYDROGRAPHS OF WELLS AT RESEARCH STATION AT LOWLAND, N.C.

FIGURE 23. - HYDROGRAPH OF WELL L-19 G-2, WENONA, N.C.

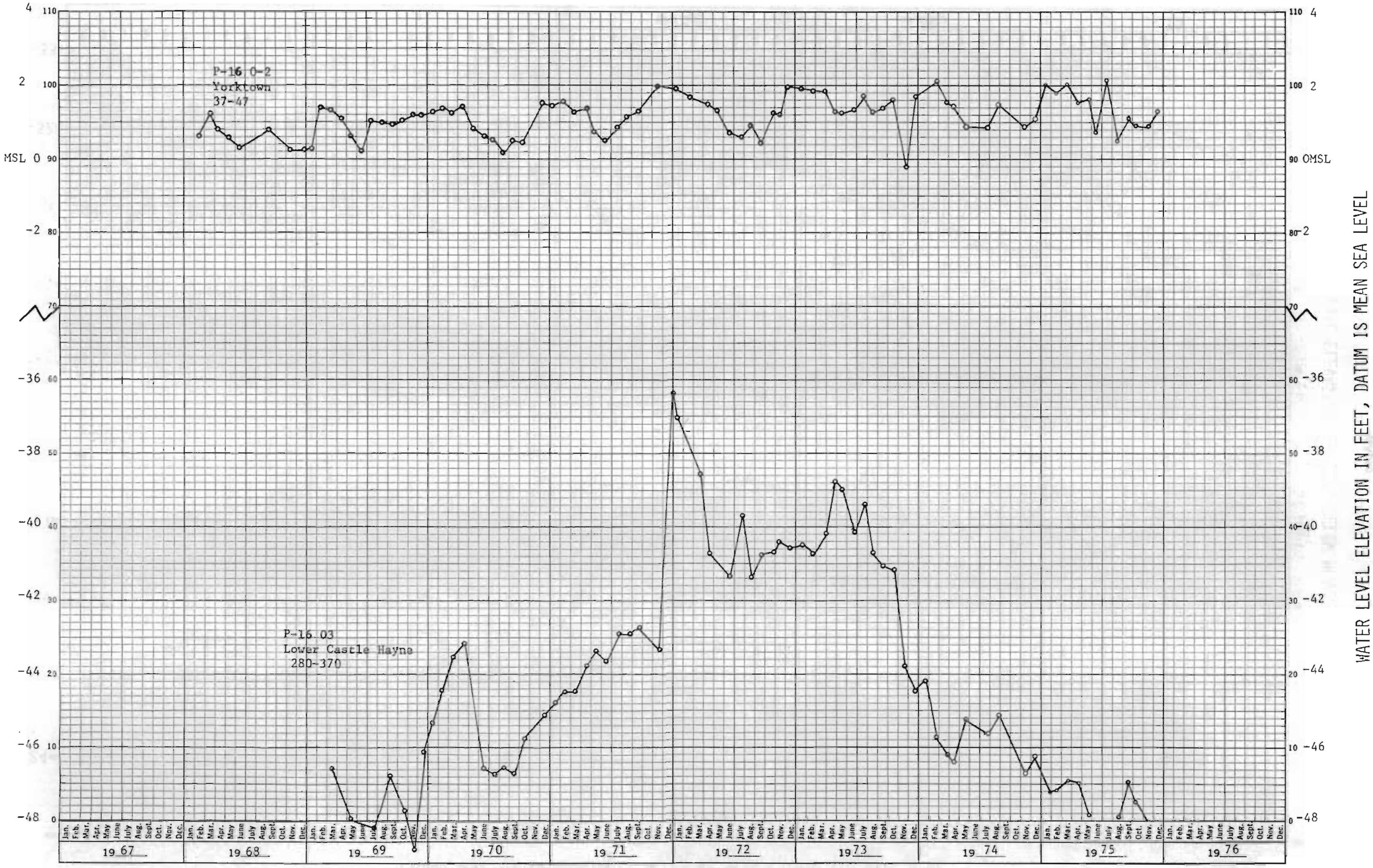
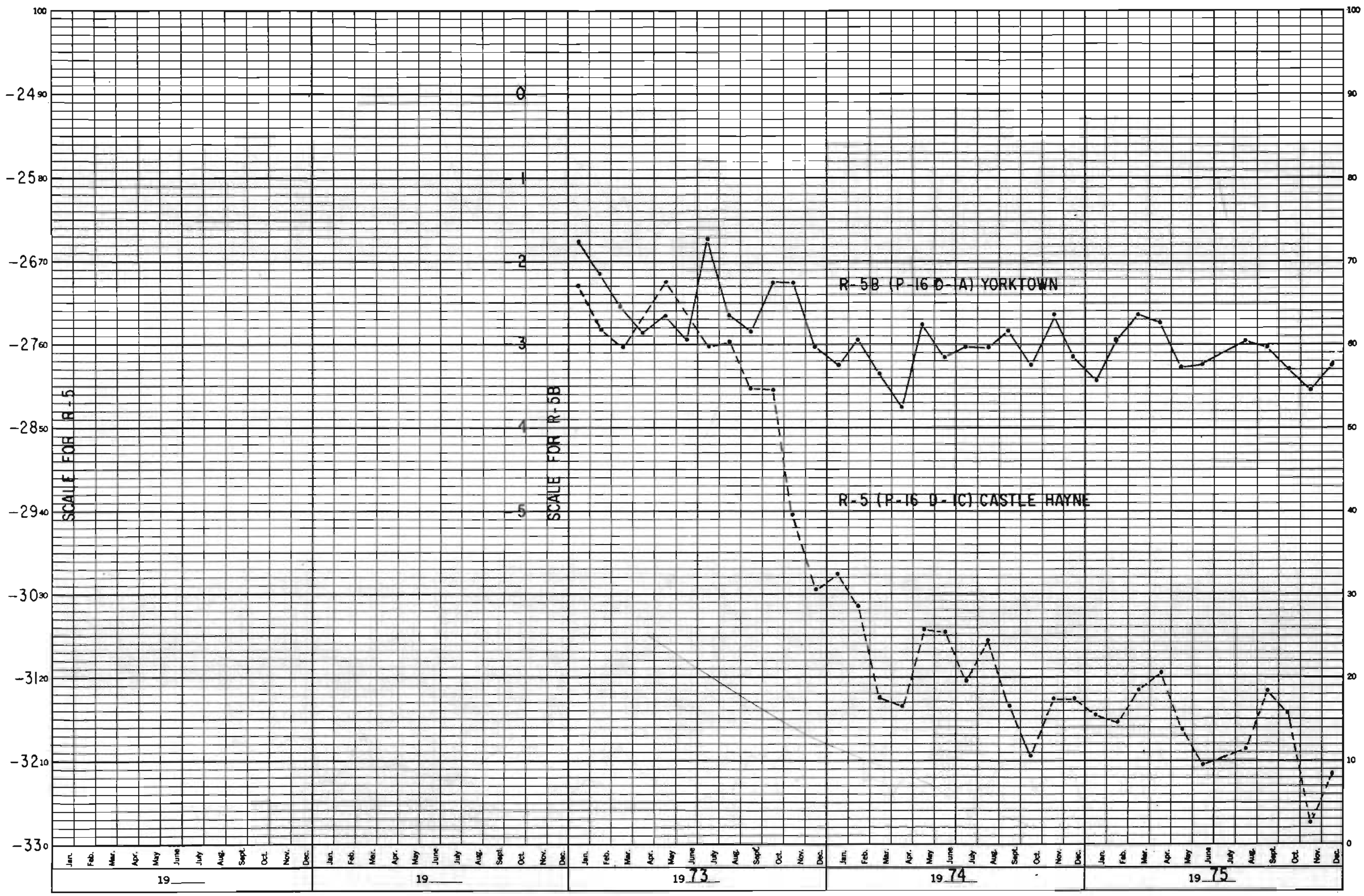


FIGURE 24. - HYDROGRAPHS OF WELLS P-16 0-2 AND P-16 0-3.

FIGURE 25. - HYDROGRAPHS OF WELLS AT SITE P-16 D (TG SITE R-5)



GROUNDWATER QUALITY

A water-quality monitor well system has been established in the Capacity Use Area to detect and observe changes in the concentration of chloride ions in each of the aquifers or aquifer systems in the area.

Monitoring is conducted at regular intervals by the State and Texasgulf, Inc. Existing and planned monitor well locations are shown in Fig. 26. Graphs showing the chloride content of water from wells at research stations and other localities are shown in Figures 27 - 36.

CASTLE HAYNE AQUIFER SYSTEM

Upper Castle Hayne Unit

Figure 37 shows the distribution of chloride content of water in the upper Castle Hayne unit in 1975 and the changes which have been observed since 1965. Data do not indicate any significant regional changes in salinity. Changes in the configuration of the isochlors result from the use of additional control obtained from recently constructed monitor wells.

Figures 38 - 40 show the salinity of the aquifer in the vicinity of the Texasgulf plant area. Higher salinities in this area are primarily the result of upward movement of more saline water from the lower units and, to a lesser extent, lateral inflow from a more brackish zone of the upper unit underlying the Pamlico River.

Lower Castle Hayne Unit

Because of its relatively lower permeability, the lower

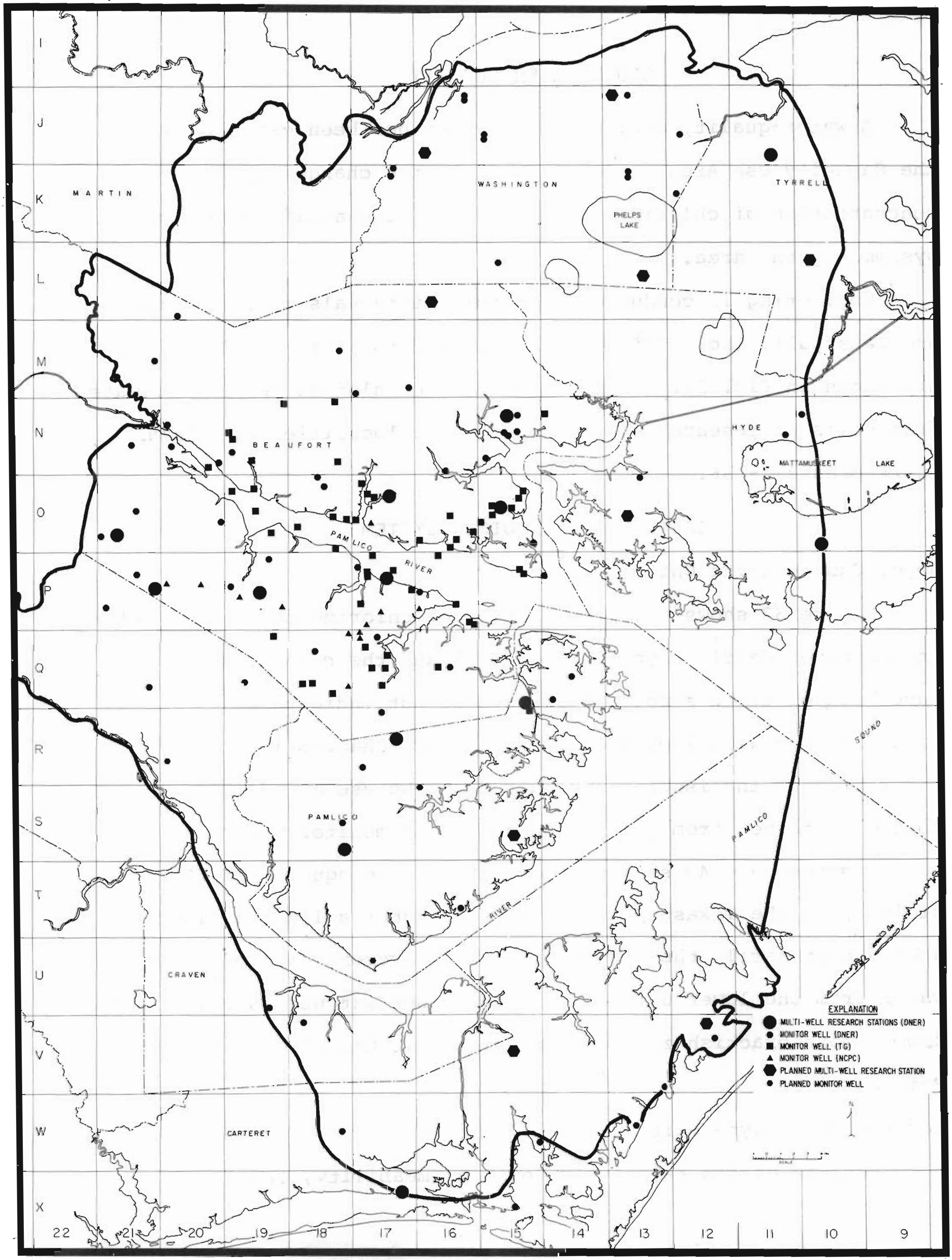


FIGURE 26.- LOCATION OF EXISTING AND PLANNED MONITORING SITES

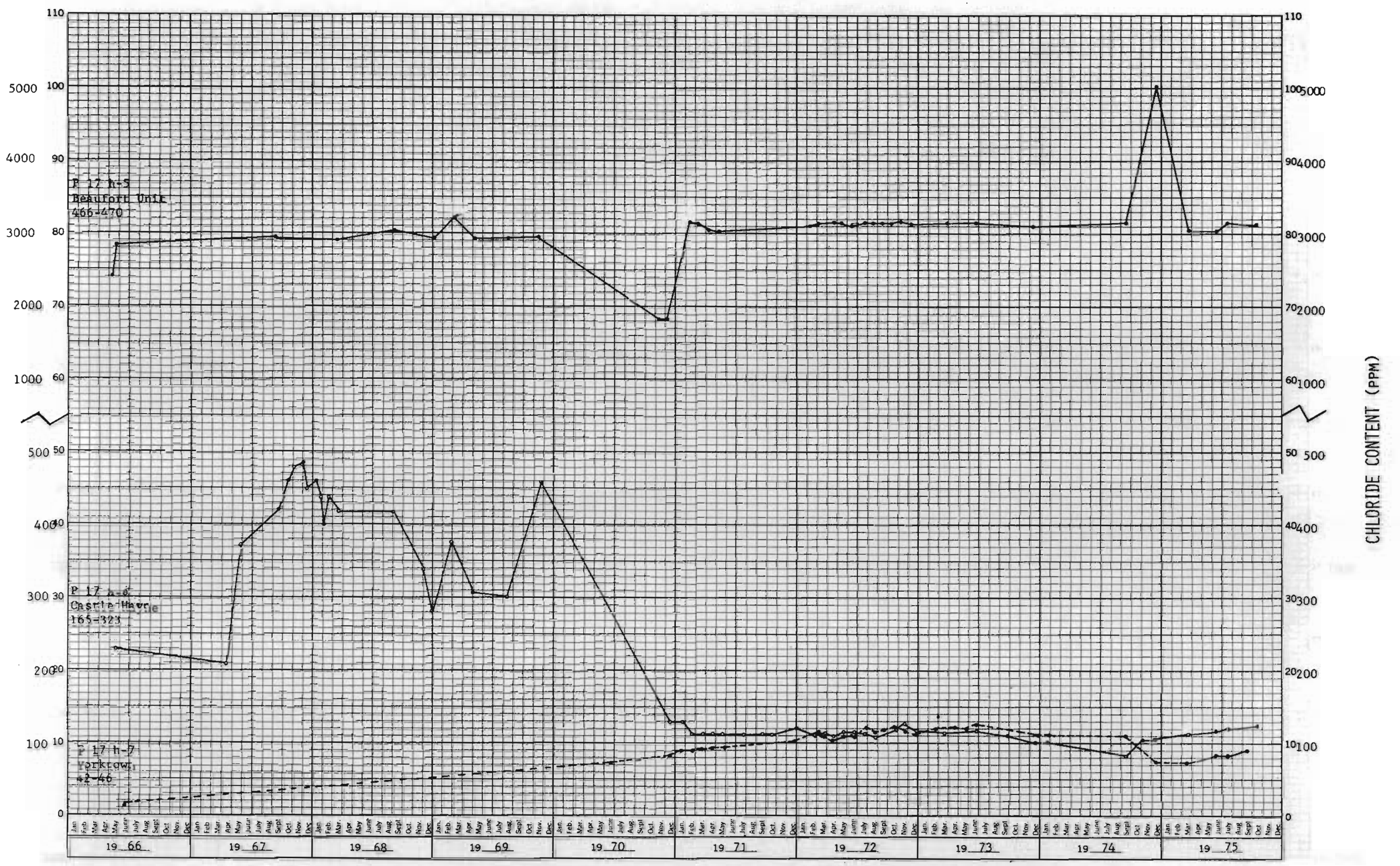


FIGURE 27, - CHLORIDE CONTENT OF WATER FROM WELLS AT THE LEE CREEK RESEARCH STATION

FIGURE 28. - CHLORIDE CONTENT OF WATER FROM WELLS AT THE BATH RESEARCH STATION

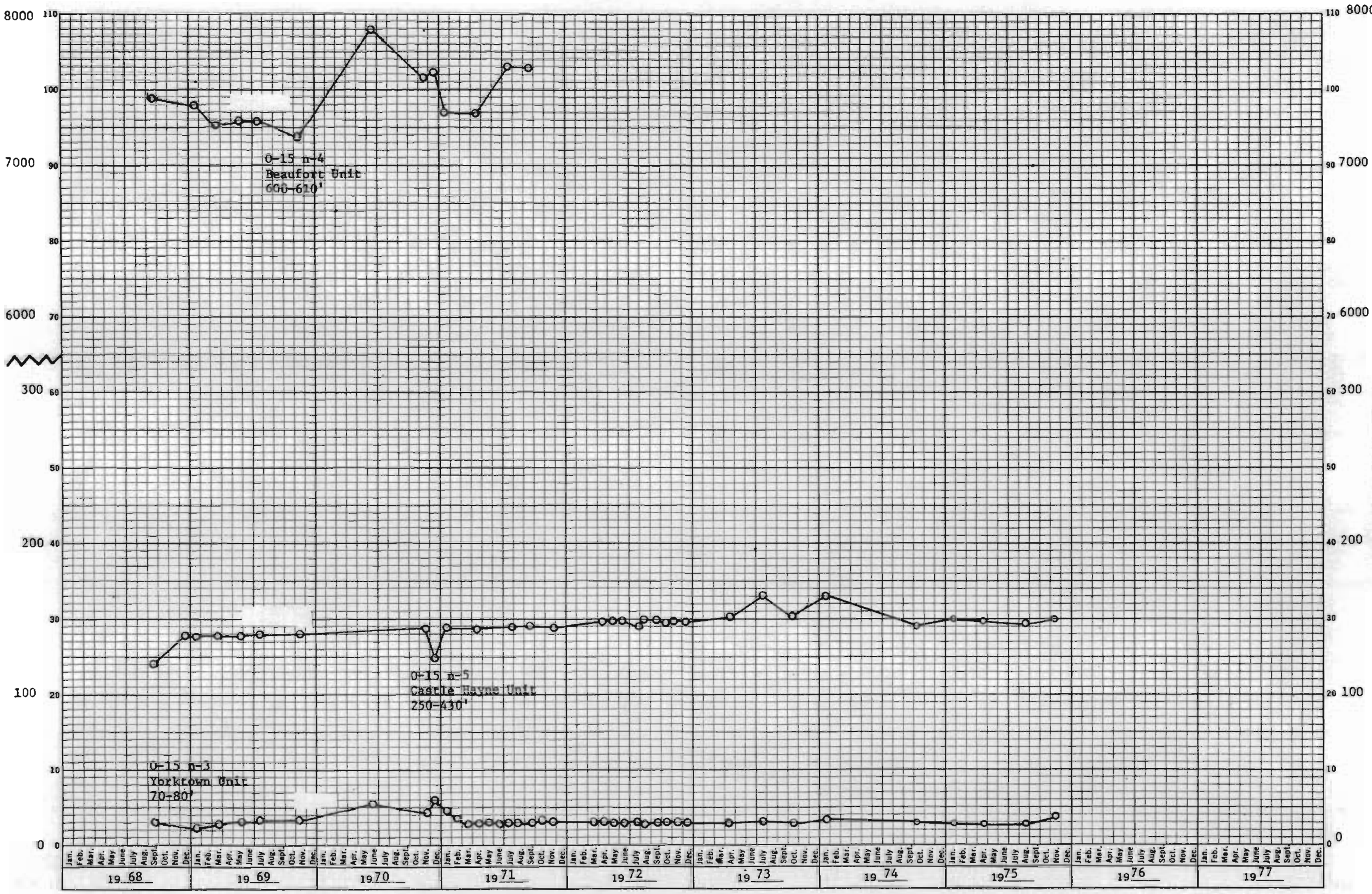
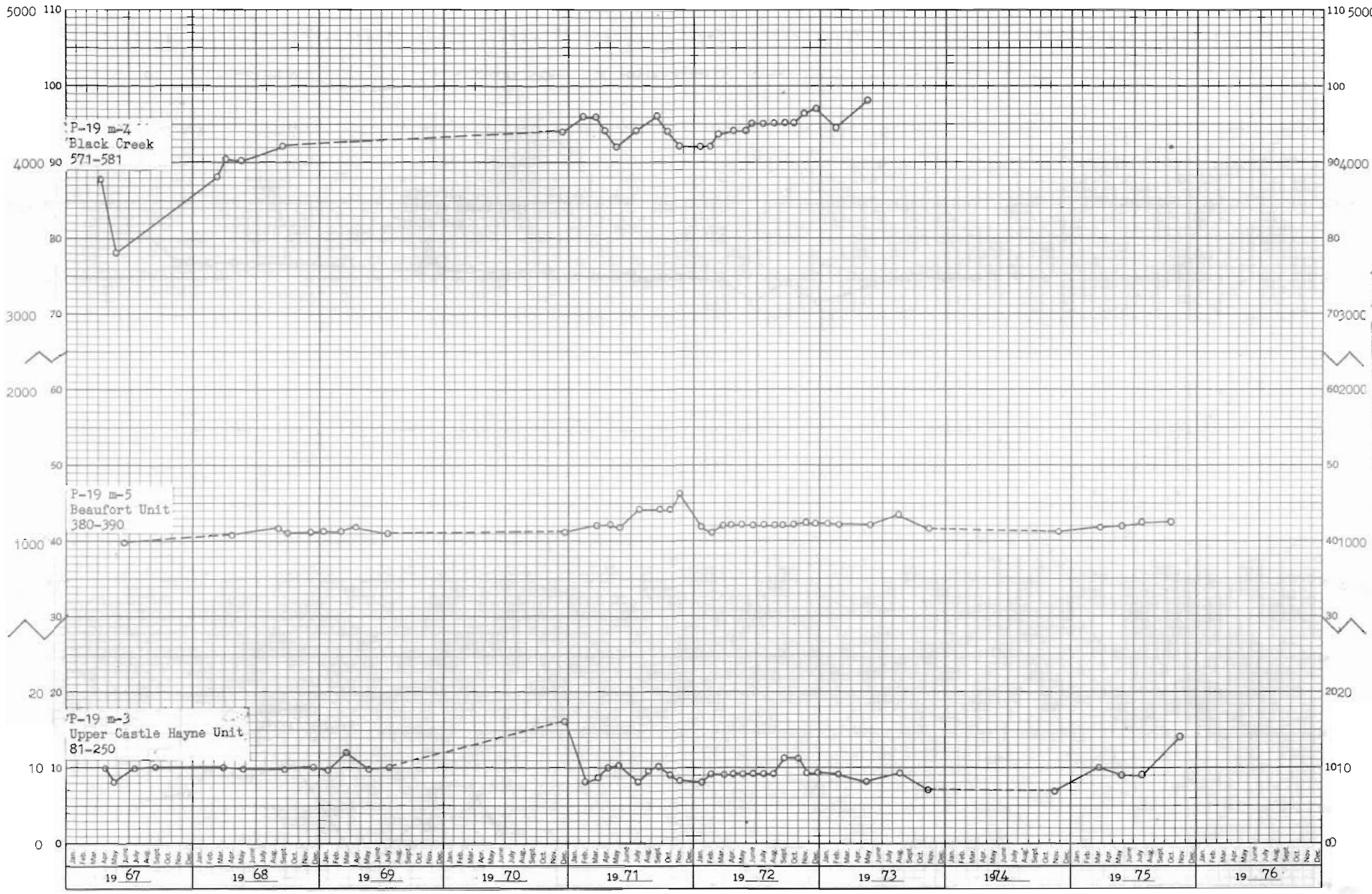


FIGURE 29. - CHLORIDE CONTENT OF WATER FROM WELLS AT THE WINSTEADVILLE RESEARCH STATION

FIGURE 30. - CHLORIDE CONTENT OF WATER FROM WELLS AT THE COX CROSSROAD'S RESEARCH STATION



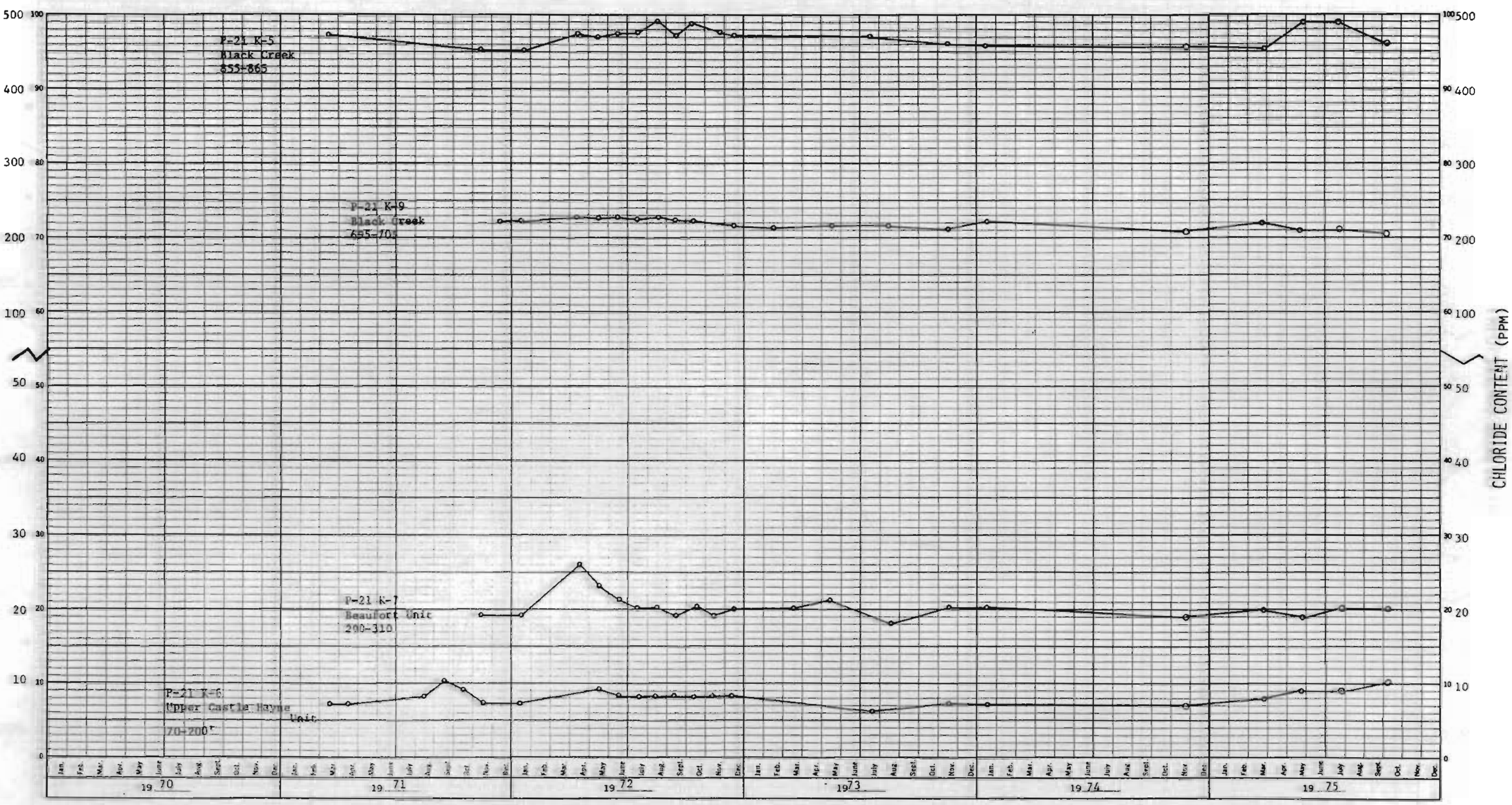
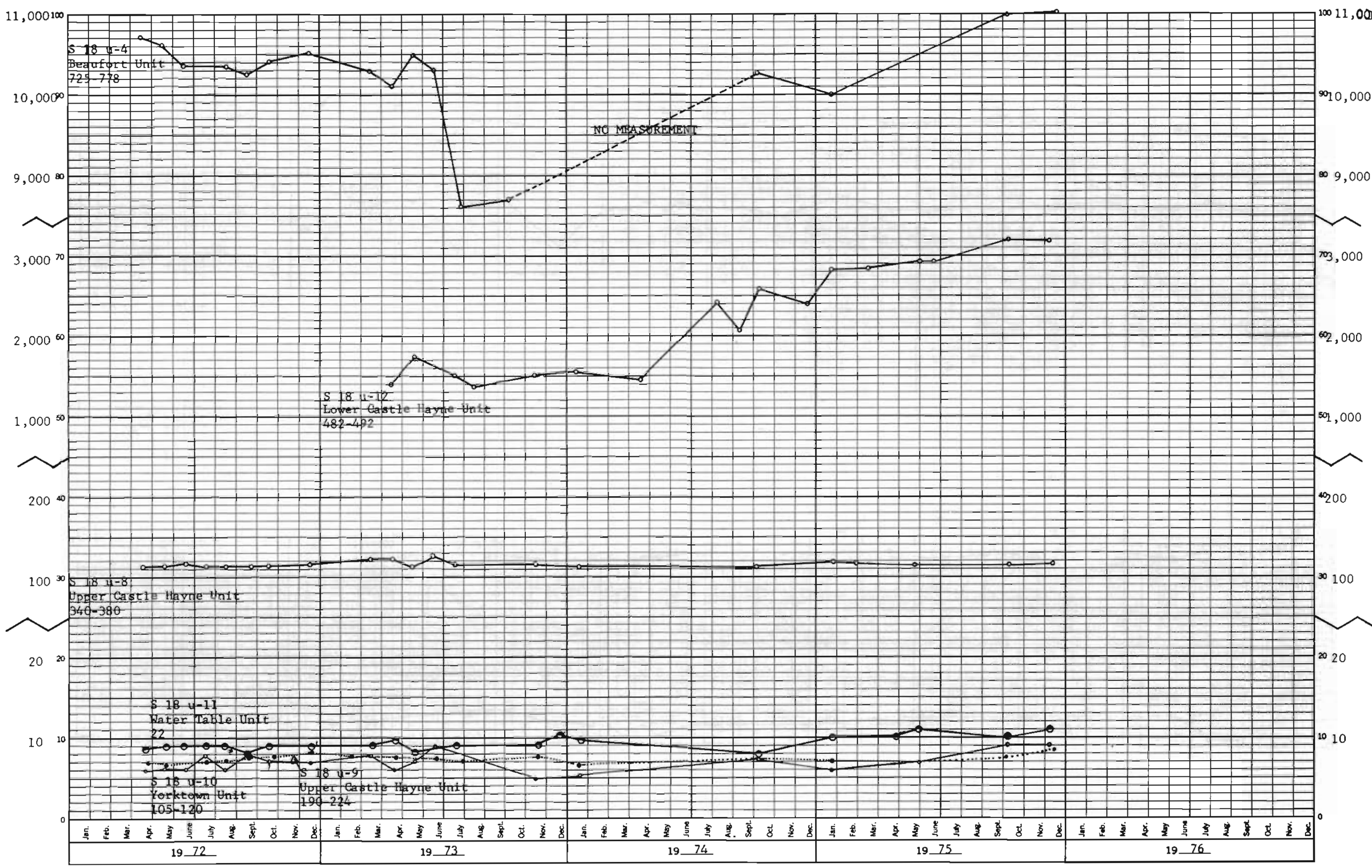


FIGURE 31. - CHLORIDE CONTENT OF WATER FROM WELLS AT THE WILMAR RESEARCH STATION

FIGURE 32, - CHLORIDE CONTENT OF WATER FROM WELLS AT THE ARAPAHOE RESEARCH STATION



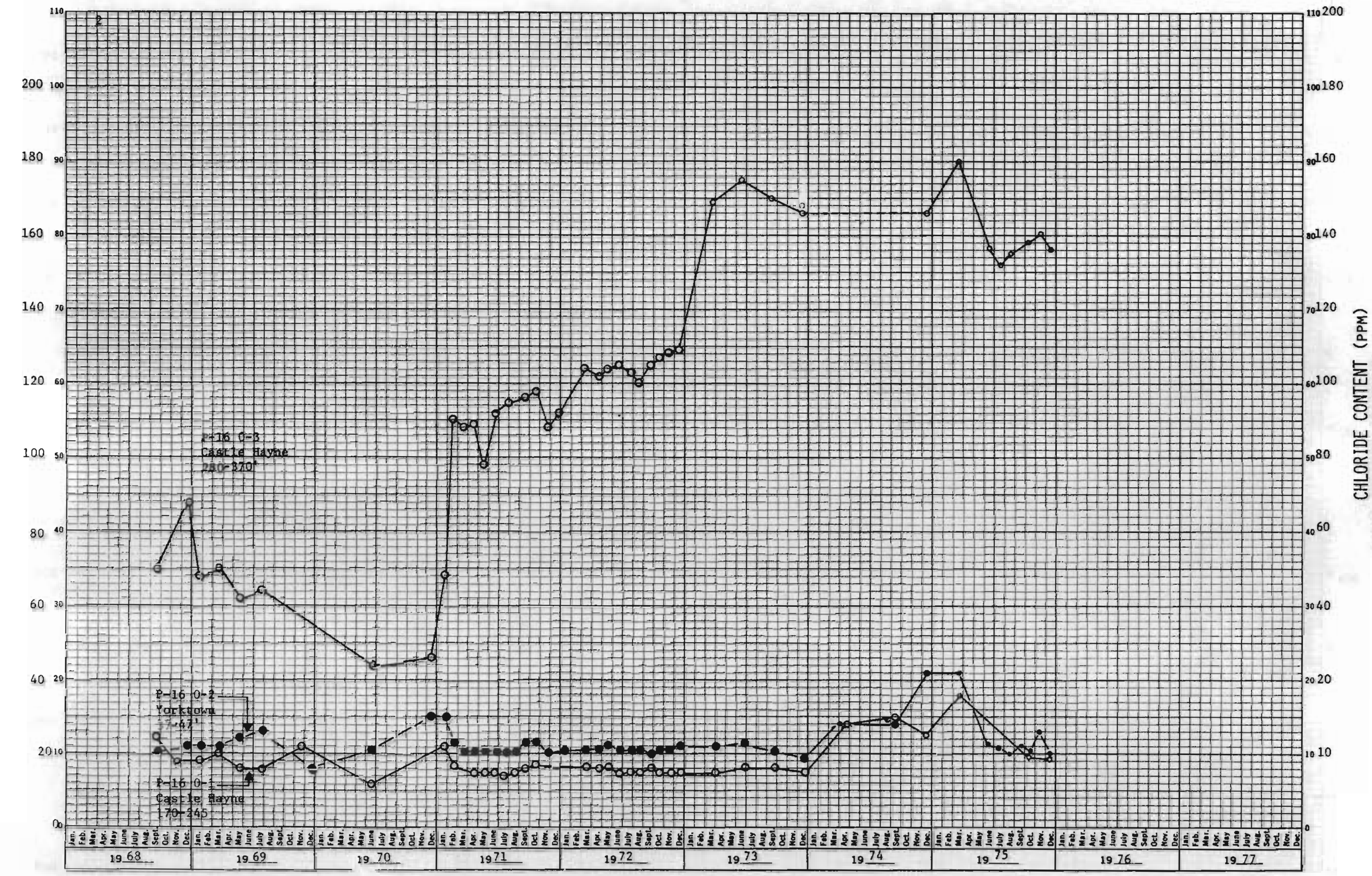
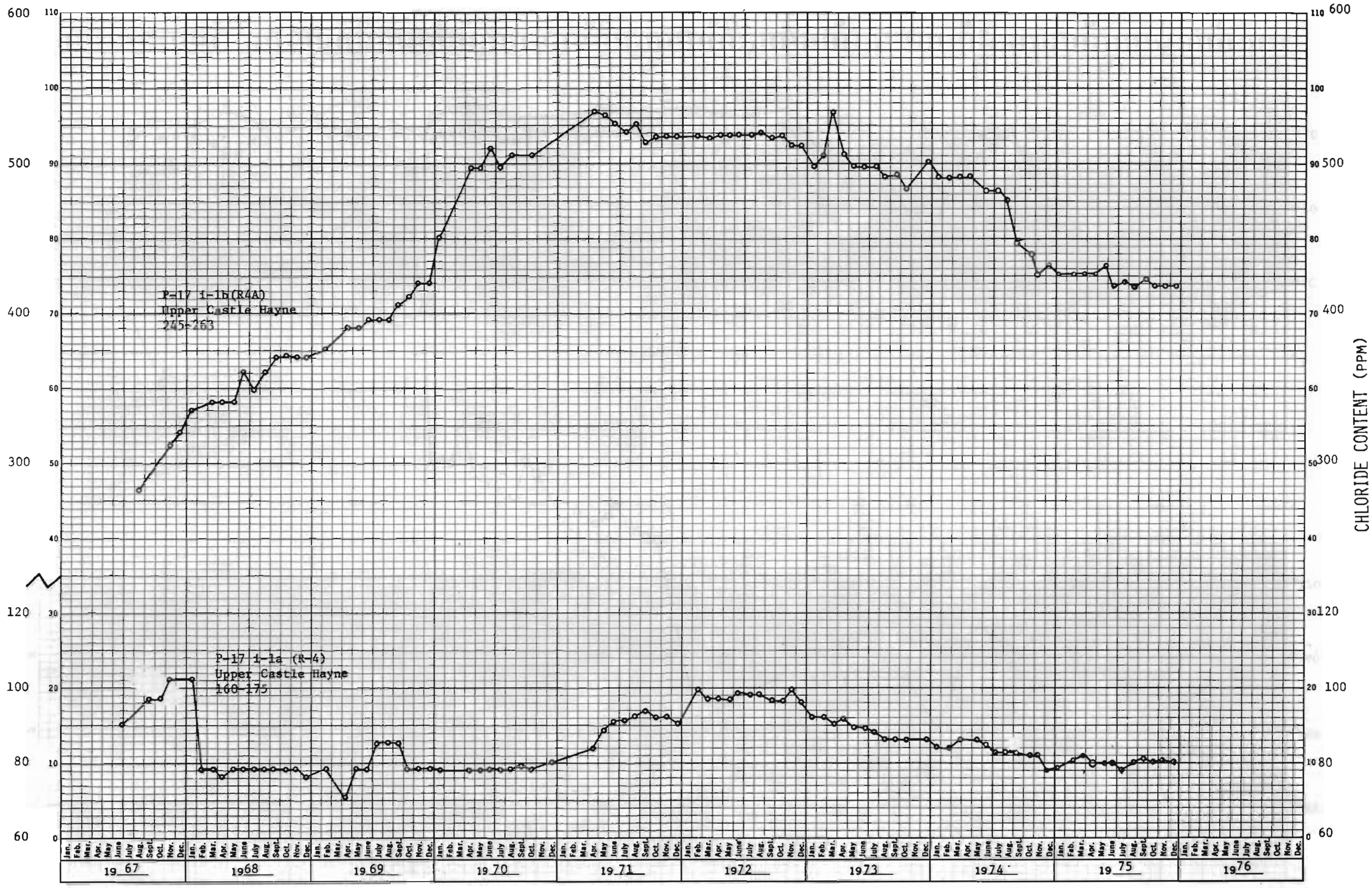


FIGURE 33. - CHLORIDE CONTENT OF WATER FROM WELLS AT SITE P-16, O

FIGURE 34. - CHLORIDE CONTENT OF WATER FROM WELLS AT SITE P-17, I



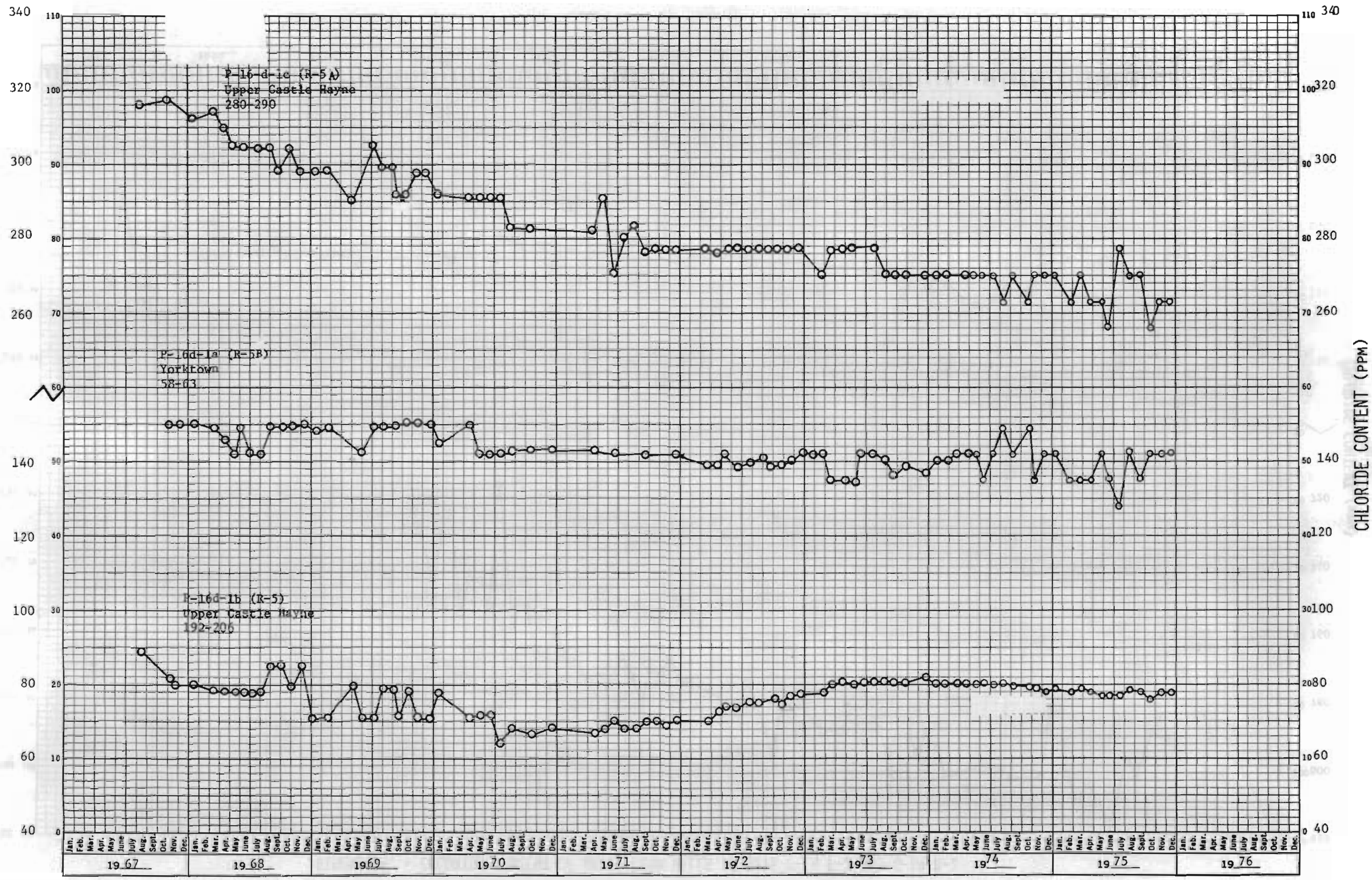
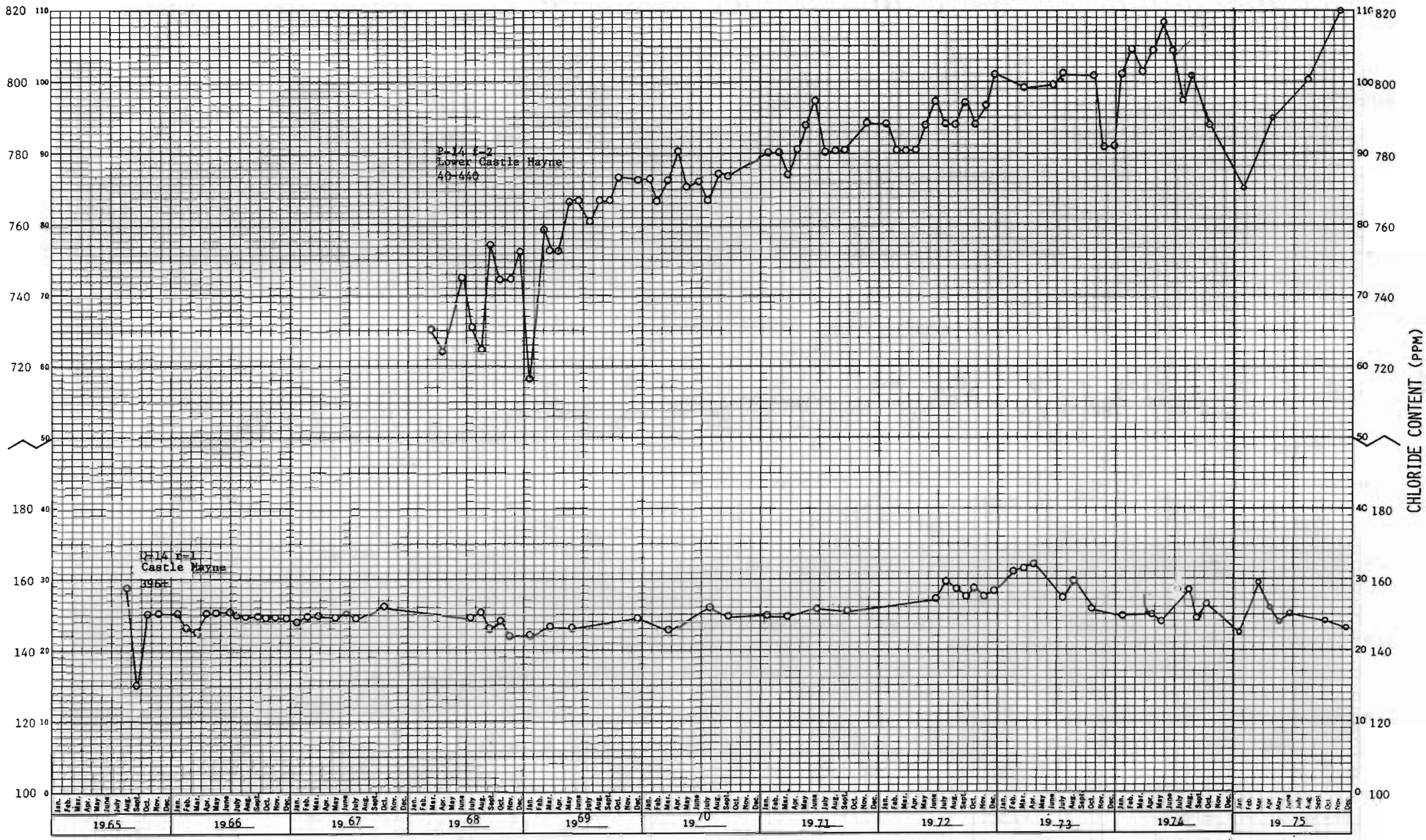


FIGURE 35. - CHLORIDE CONTENT OF WATER FROM WELLS AT SITE P-16, D (TG R-5)

FIGURE 36. - CHLORIDE CONTENT OF WATER FROM WELLS AT SITE P-14 F-2 AND Q-14 R-1



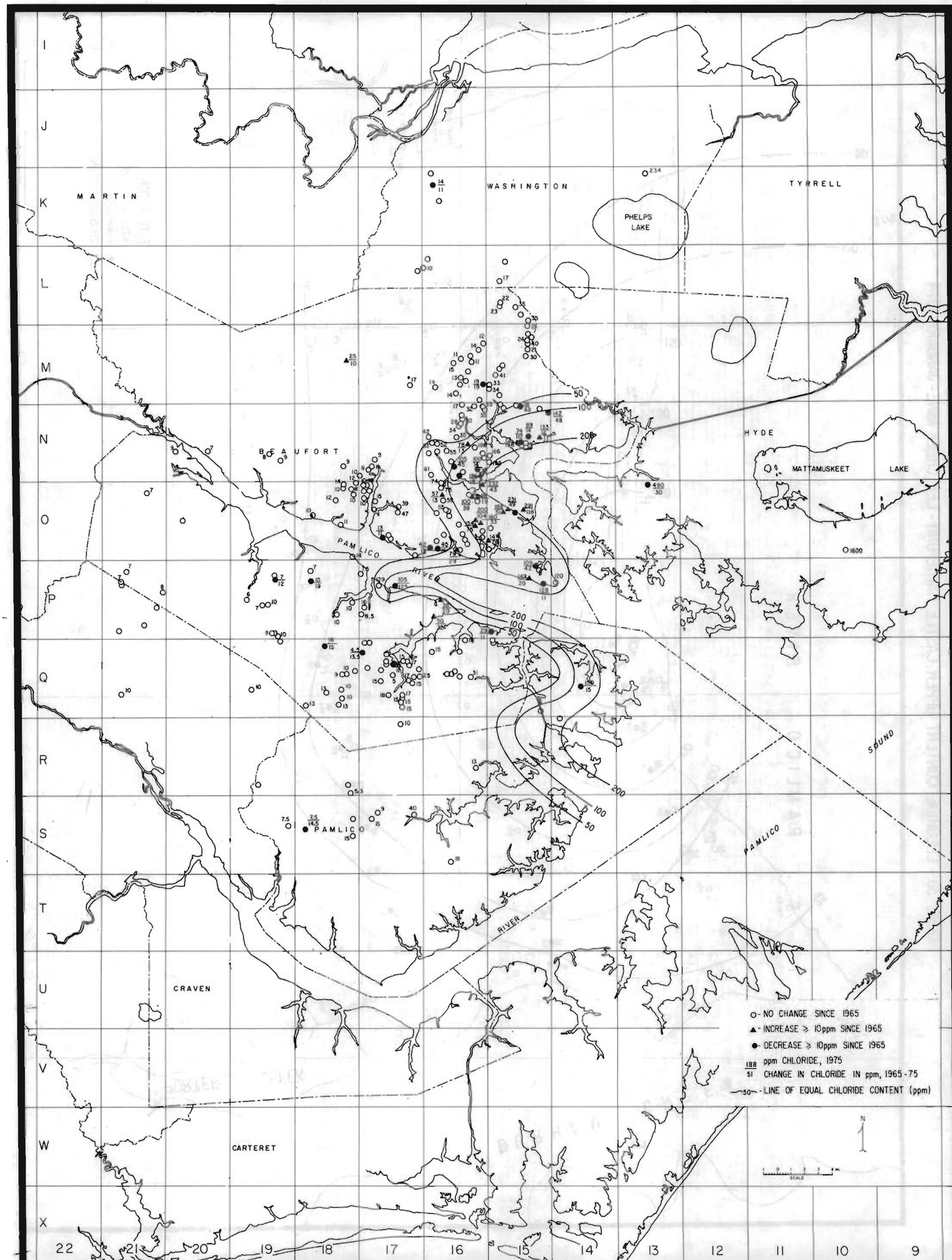
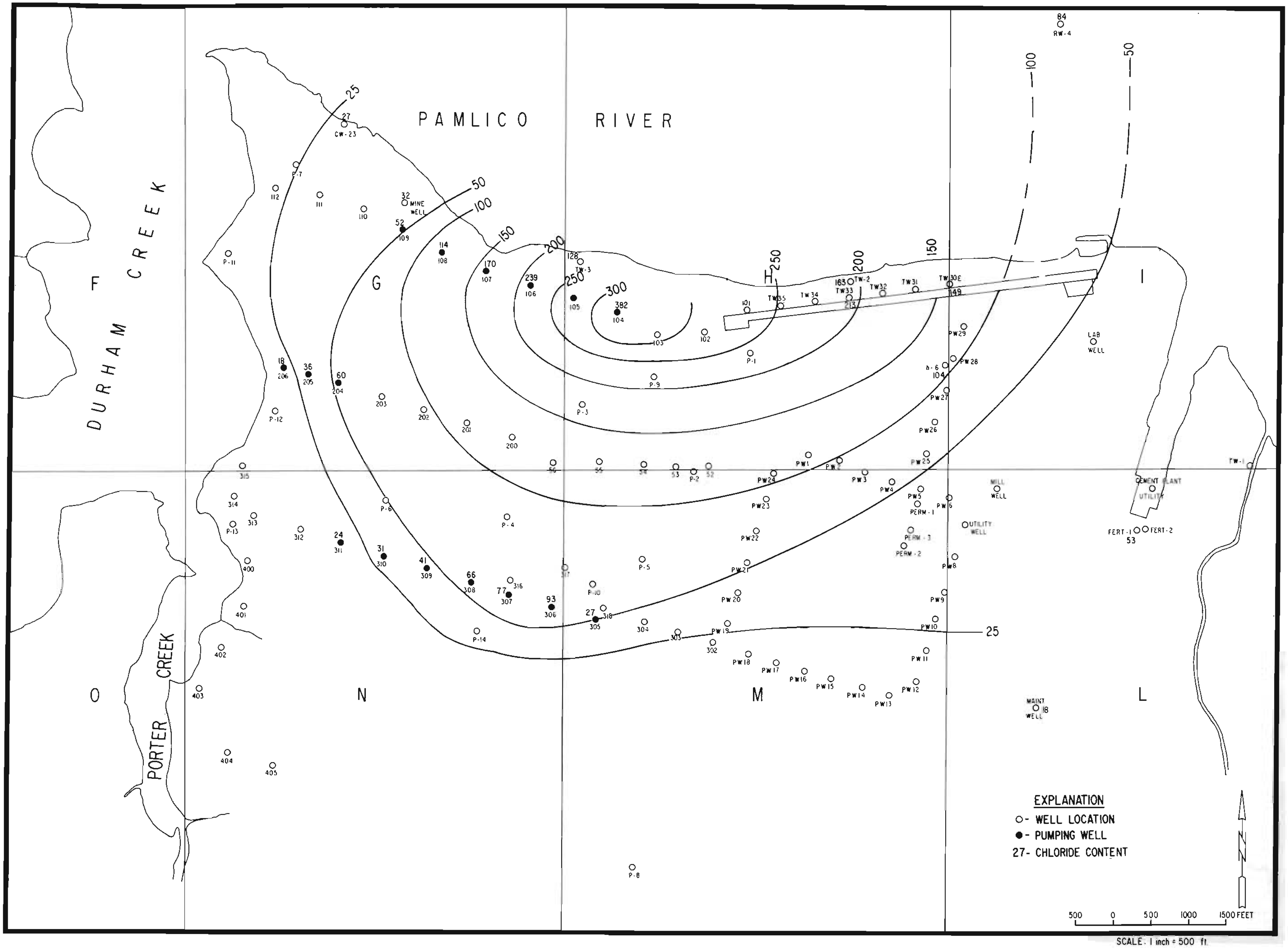


FIGURE 37.- CHLORIDE CONTENT OF WATER IN UPPER CASTLE HAYNE AQUIFER UNIT, JANUARY- FEBRUARY 1975 AND CHANGES SINCE 1965.

FIGURE 38.- CHLORIDE CONTENT UPPER CASTLE HAYNE UNIT- LEE CREEK MINE- JANUARY 1974



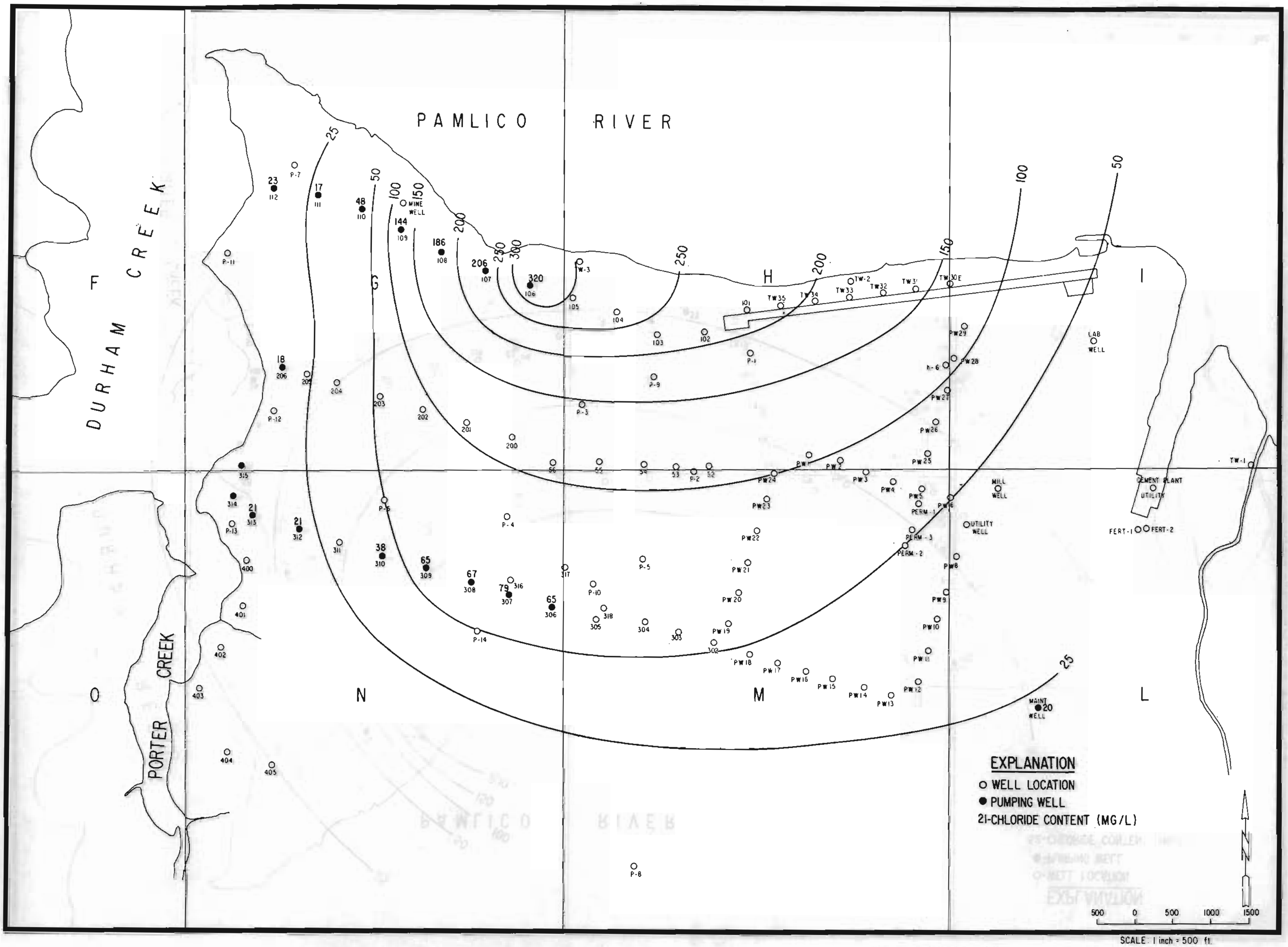
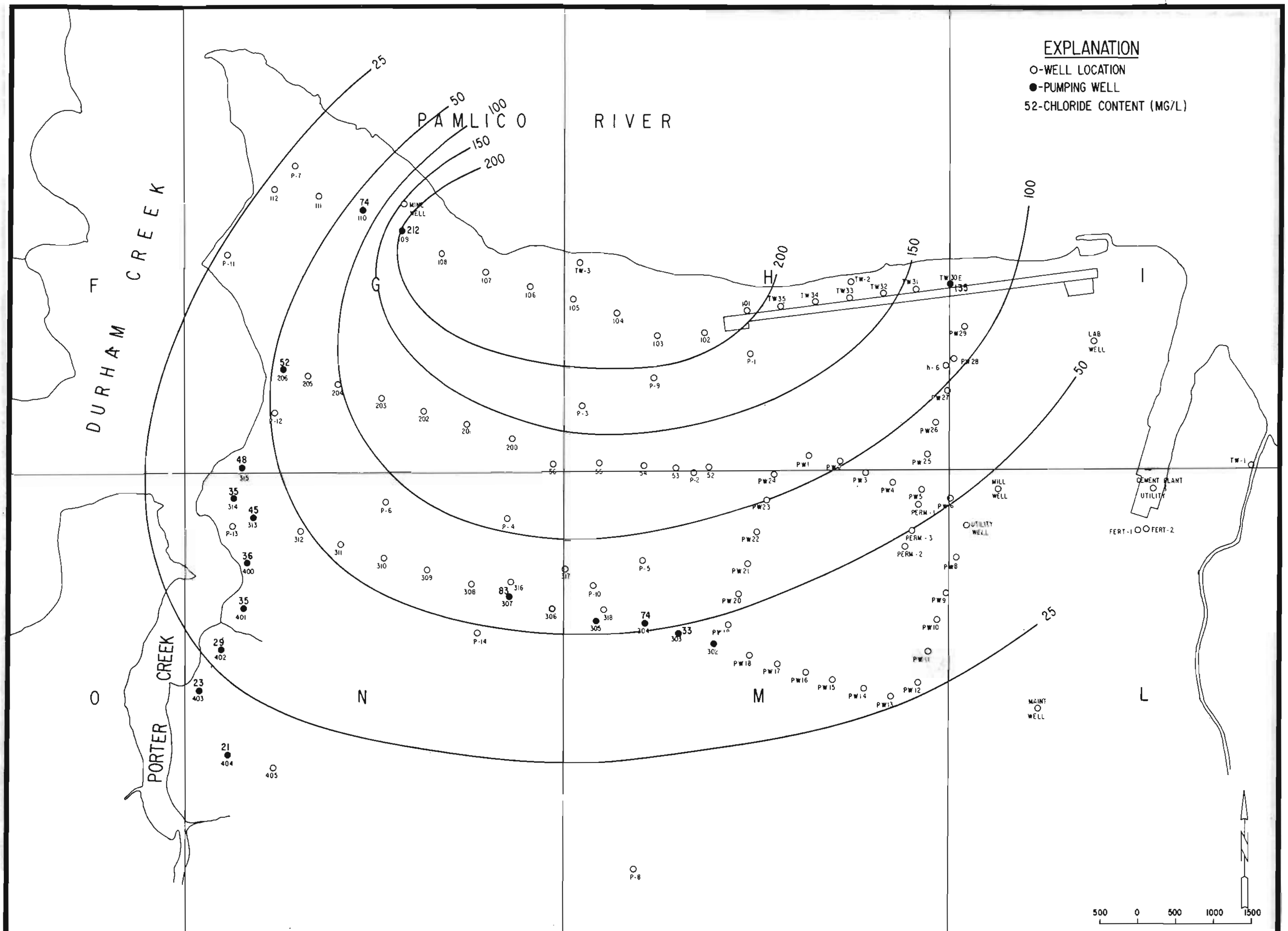


FIGURE 39.- CHLORIDE CONTENT OF UPPER CASTLE HAYNE UNIT, LEE CREEK MINE, JANUARY 1975

FIGURE 40.- CHLORIDE CONTENT OF UPPER CASTLE HAYNE UNIT, LEE CREEK MINE, DECEMBER 1975



Castle Hayne unit has not been as completely flushed of residual saline water as the upper unit. For this reason, at a given locality, chlorides in the lower unit are considerably higher than in the upper limestone unit.

Use of new data obtained from the construction of research stations in the area resulted in a change in the configuration of the regional isochlors for the lower unit (Fig. 41).

YORKTOWN AQUIFER

Water in the Yorktown aquifer is generally fresh. As water from the Yorktown moves downward as recharge to the underlying aquifers in response to the head differential within the cone of depression, it is replaced by water from the unconfined aquifer or from surface water bodies. Yorktown wells located near and down gradient from the Pamlico River may show an increase in chloride content.

Unconfined Aquifer

No changes in the chemical quality of groundwater in the unconfined aquifer have been detected.

The effect of heavy withdrawals from the artesian aquifer system on the unconfined aquifer is to accelerate the rate of vertical movement of water down into the artesian system. The degree to which the increased rate of water movement effects the potential for mineralization, or contamination from surface pollution sources, is not well known.

RECENT INVESTIGATIONS

Following the announcement by NCPC of plans for dry-pit phosphate mining operations in Beaufort County, the Groundwater Section prepared projections of the effects of the proposed increases in withdrawals on the groundwater system. These projections were presented as Report of Investigation No. 11 entitled, "Potential Effects of Withdrawals from the Castle Hayne Aquifer for Expanded Phosphate Mining in Beaufort County, North Carolina".

FUTURE DEVELOPMENT AND INVESTIGATIONS

Within the next few years North Carolina Phosphate Corporation plans to open a dry-pit phosphate mine north of Aurora, in Beaufort County. The mine will be located about 2 miles southeast of the Texasgulf mine at Lee Creek. Under existing Water Use Permits, the two phosphate mining companies may withdraw a total of 102 million gallons per day from the Castle Hayne aquifer for depressuring and processing purposes.

The proposed drainage of several thousand acres of farmland by First Colony Farms in Washington and Tyrrell counties will result in a substantial lowering of the water table over an extensive area and consequently will reduce the potential for local recharge to the Castle Hayne aquifer. Although the aquifer is deeply buried in this area, potentiometric data indicate that it receives recharge from overlying aquifers by vertical leakage. The driving force for the leakage (recharge) is the difference in head between the water table and the Castle Hayne. As this difference is reduced by lowering of the water table, the potential for recharge is reduced proportionally.

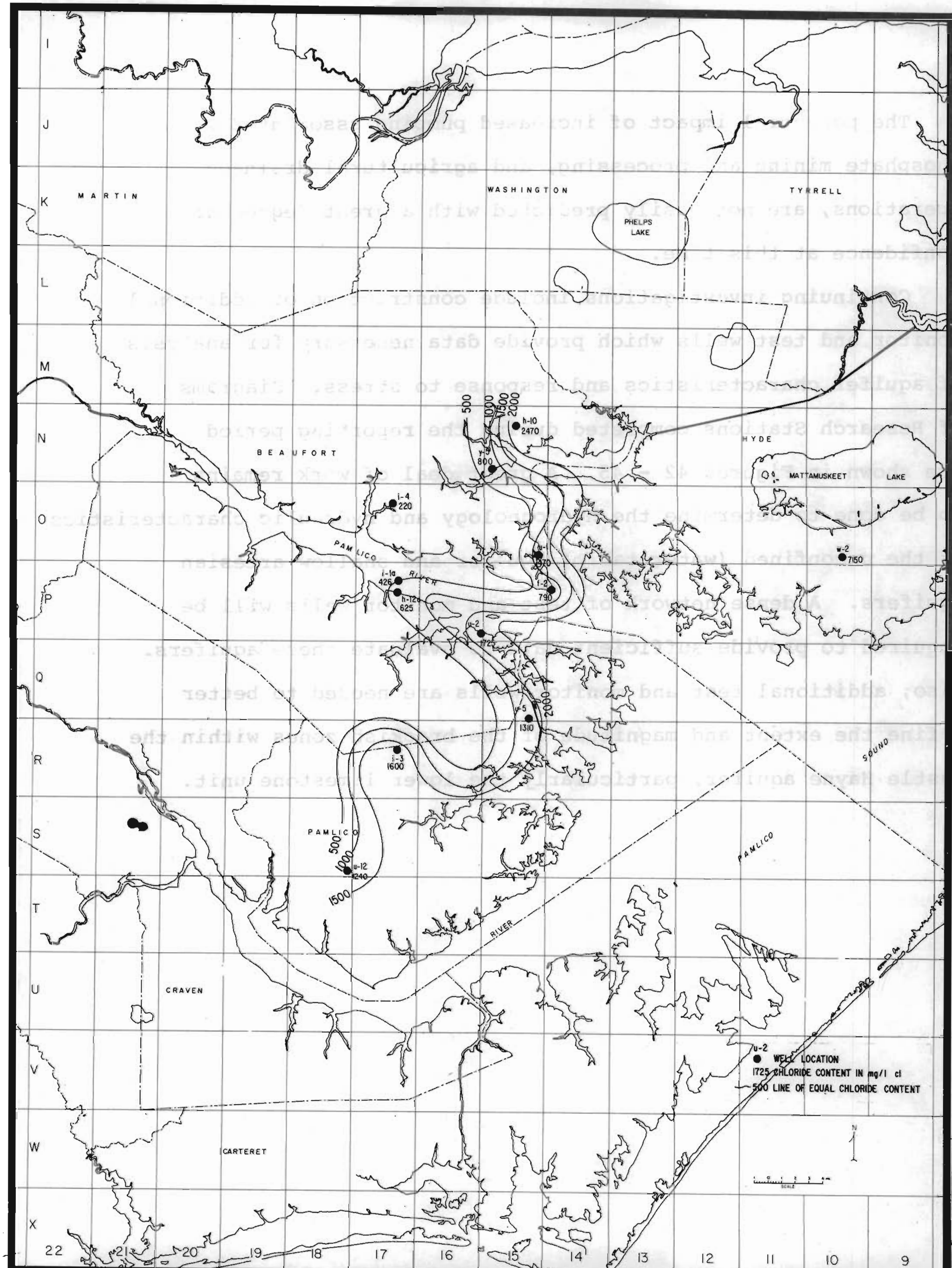
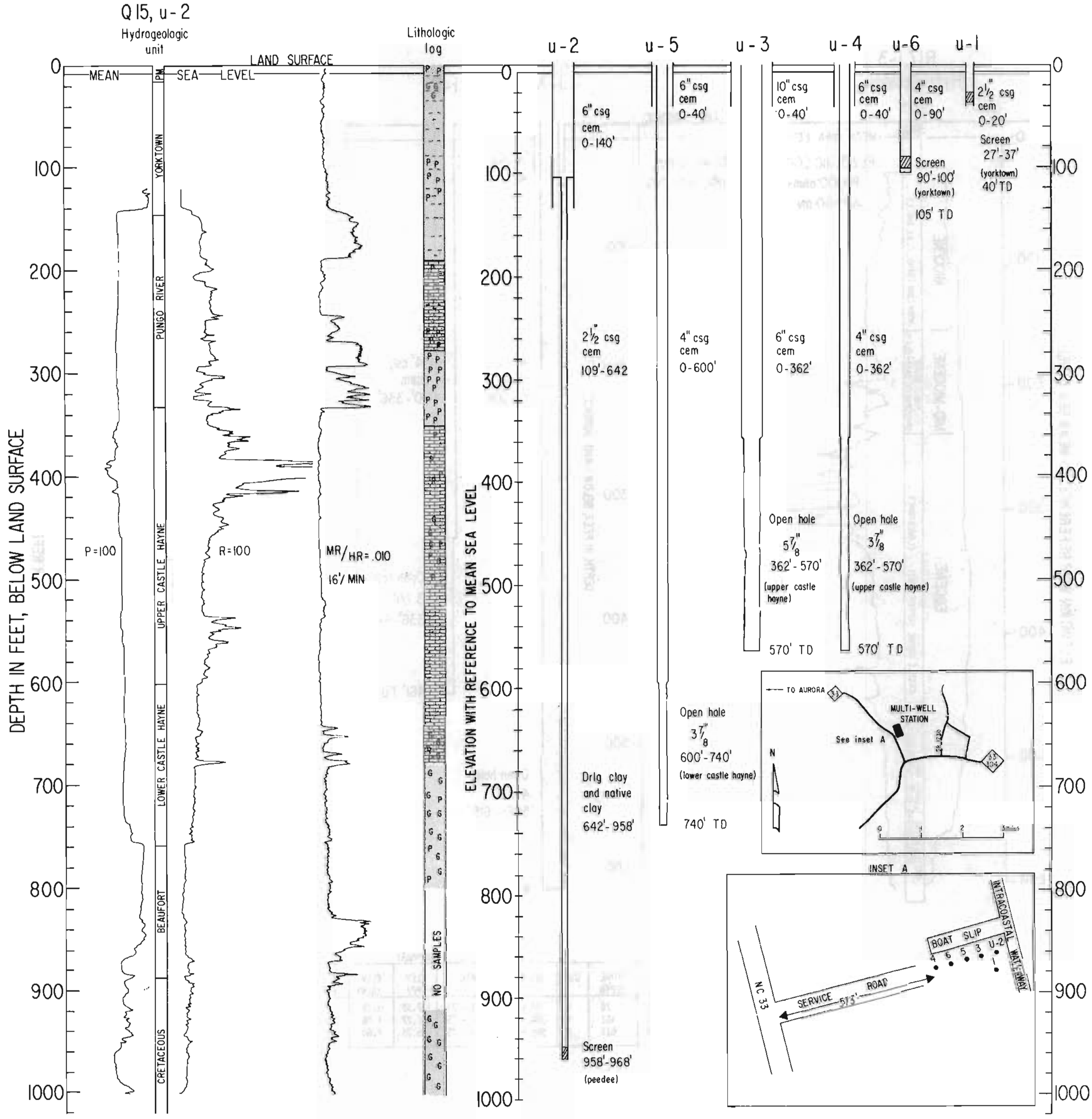
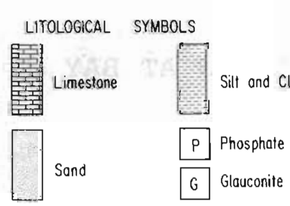


FIGURE 41- CHLORIDE CONTENT OF WATER IN LOWER CASTLE AQUIFER UNIT, 1975

The potential impact of increased pumping associated with phosphate mining and processing, and agricultural drainage operations, are not easily predicted with a great degree of confidence at this time.

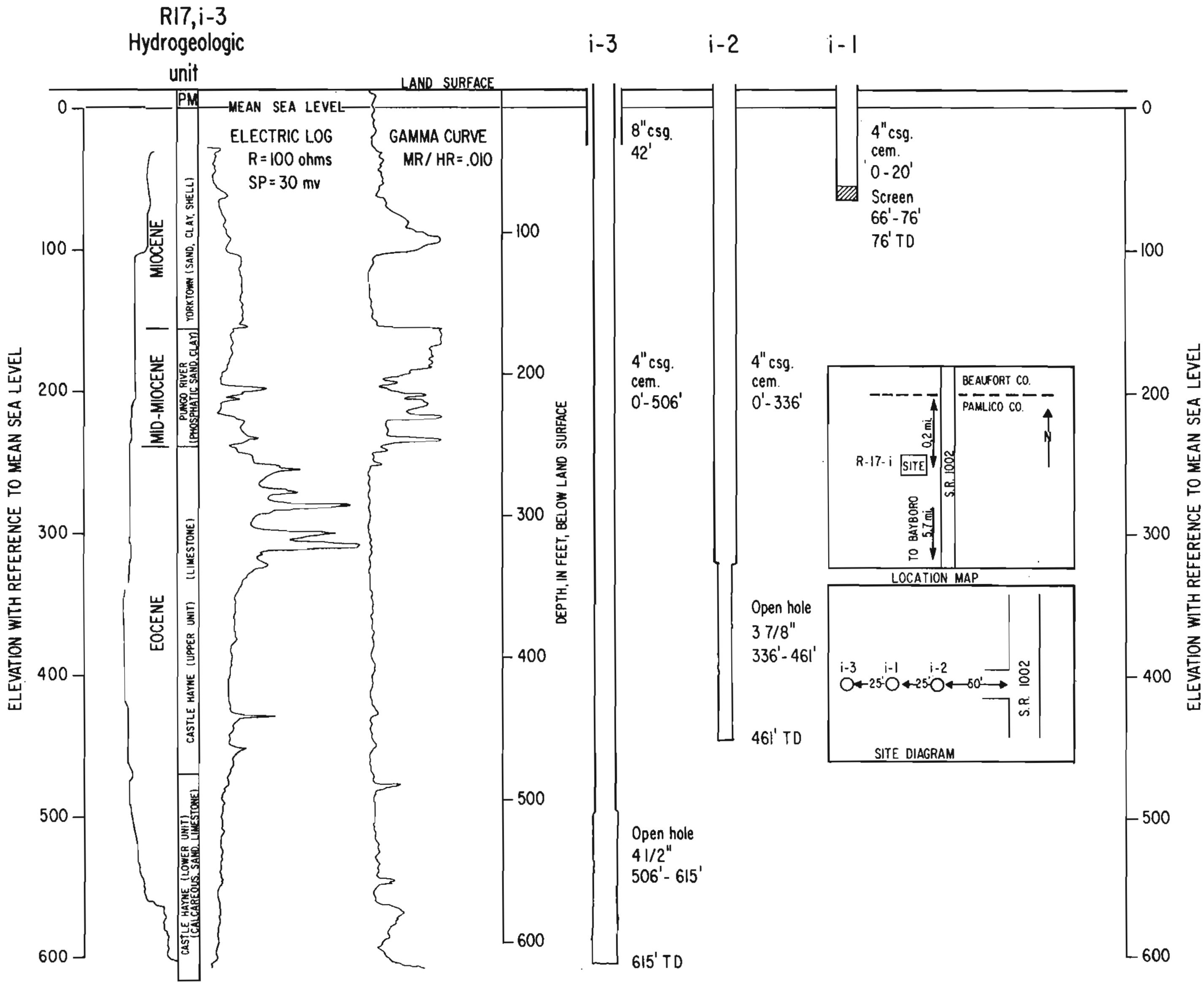
Continuing investigations include construction of additional monitor and test wells which provide data necessary for analysis of aquifer characteristics and response to stress. Diagrams of Research Stations completed during the reporting period are shown in Figures 42 - 45. A great deal of work remains to be done to determine the hydrogeology and hydraulic characteristics of the unconfined (water-table) aquifer and shallow artesian aquifers. A dense network of test and monitor wells will be required to provide sufficient data to evaluate these aquifers. Also, additional test and monitor wells are needed to better define the extent and magnitude of the brackish zones within the Castle Hayne aquifer, particularly the lower limestone unit.





Well Number	Total Depth	Well Dia	Screen or OH	SWL (MP)	Date	Elev (MP)	MP (LS)	Q (GPM)	Cl (PPM)
Q-15, u-1	40	2 1/2	27-37	8.38	7-74	8.75	2.0	15	45
u-2	1003	6	958-968	32.30	10-74	8.73	2.0	25	15,400
u-3	570	6	362-570	19.10	8-74	9.54	2.0	500	102
u-4	570	4	362-570	18.34	9-74	8.30	2.0	280	125
u-5	740	4	600-740	19.98	10-74	8.89	1.9	200	1,370
u-6	100	4	90-100	9.65	11-74	9.30	2.0	12.5	414

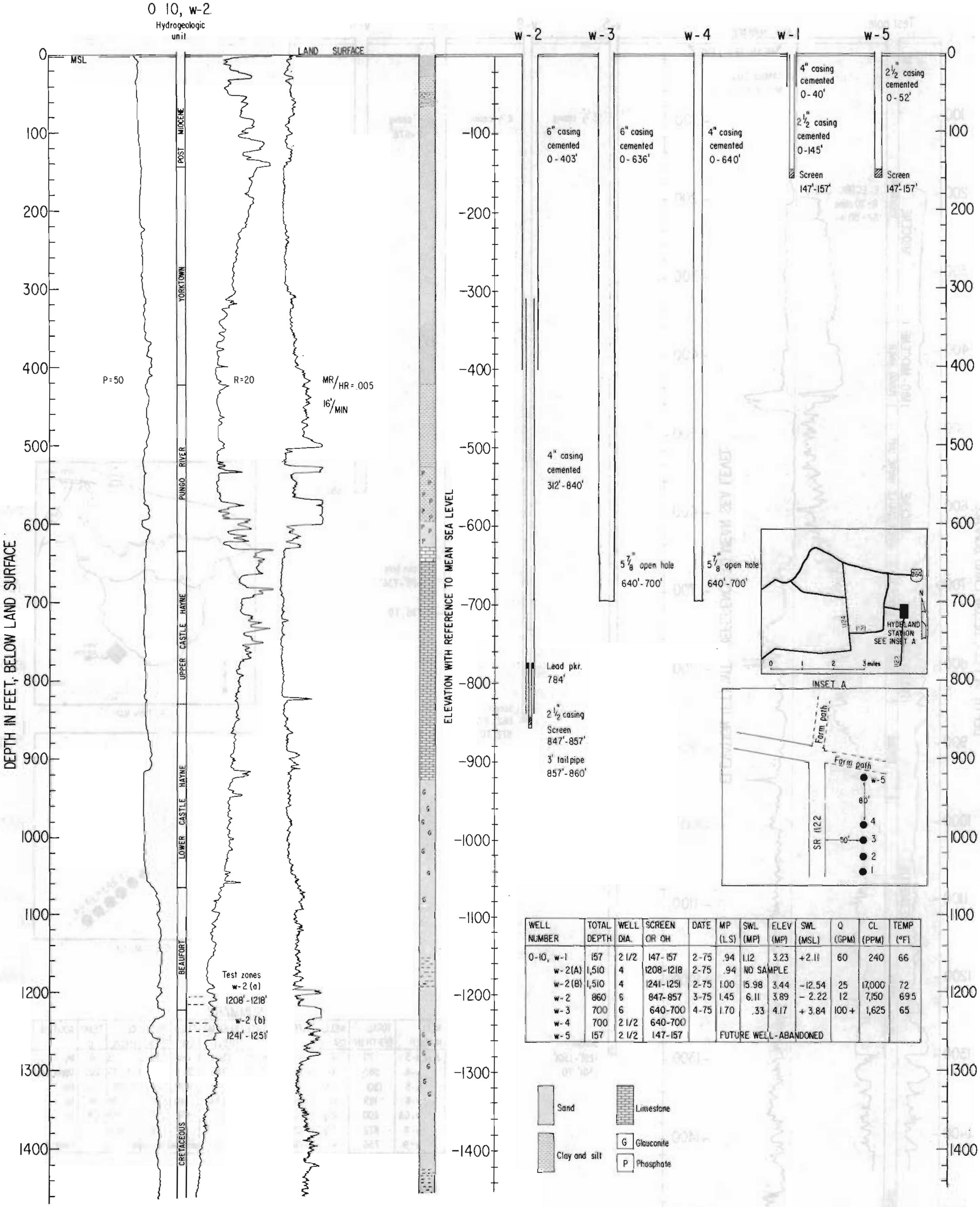
FIGURE 42.-DIAGRAM OF RESEARCH STATION AT HOBUCKEN, PAMLICO COUNTY



SUMMARY

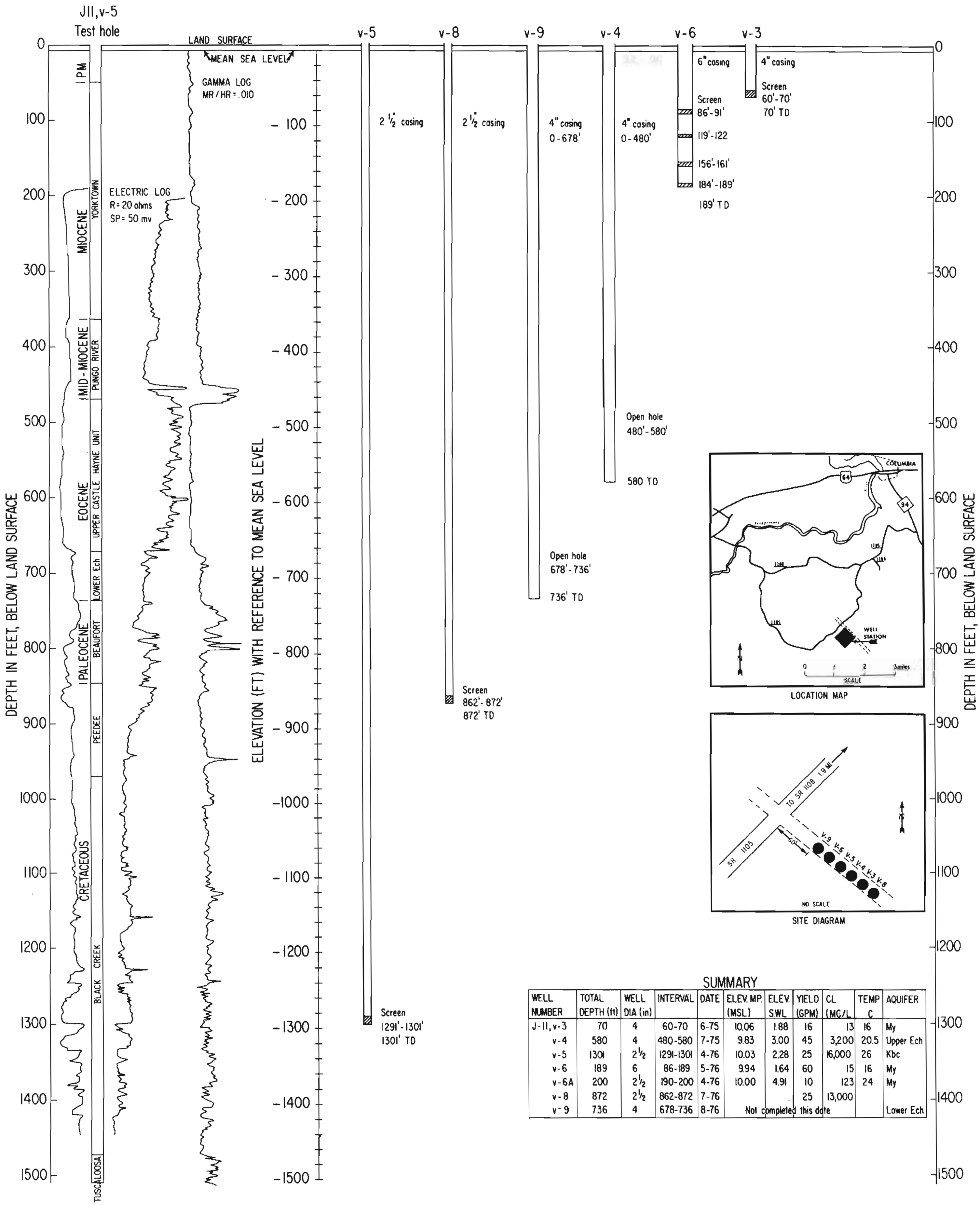
WELL NUMBER	TOTAL DEPTH	DIA	INTERNAL	DATE	ELEV (MP)	ELEV (SLW)	YIELD (GPM)	CI MG/L	TEMP C	AQUIFER
R - 17 - 1	76	4	66 - 76	1 - 75	17.33	8.18	15	8	15.5	YORKTOWN
1 - 2	461	4	336 - 461	2 - 75	16.27	4.08	150	170	18	UPPER CASTLE HAYNE
1 - 3	615	4	506 - 615	10 - 75	15.83	7.60	100	1700	20	LOWER CASTLE HAYNE

FIGURE 43.-DIAGRAM OF RESEARCH STATION AT BAY CITY, PAMLICO COUNTY .



WELL NUMBER	TOTAL DEPTH	WELL DIA.	SCREEN OR OH	DATE	MP (LS)	SWL (MP)	ELEV (MP)	SWL (MSL)	Q (GPM)	CL (PPM)	TEMP (°F)
0-10, w-1	157	2 1/2	147-157	2-75	.94	1.12	3.23	+2.11	60	240	66
w-2(A)	1,510	4	1208-1218	2-75	.94	NO SAMPLE					
w-2(B)	1,510	4	1241-1251	2-75	1.00	15.98	3.44	-12.54	25	17,000	72
w-2	860	6	847-857	3-75	1.45	6.11	3.89	- 2.22	12	7,150	69.5
w-3	700	6	640-700	4-75	1.70	.33	4.17	+ 3.84	100 +	1,625	65
w-4	700	2 1/2	640-700								
w-5	157	2 1/2	147-157		FUTURE WELL-ABANDONED						

FIGURE 44.-DIAGRAM OF RESEARCH STATION AT HYDELANDS, HYDE COUNTY



SUMMARY

WELL NUMBER	TOTAL DEPTH (ft)	WELL DIA (in)	INTERVAL	DATE	ELEV. MP. (MSL)	ELEV. S.W.L.	YIELD (GPM)	CL (MG/L	TEMP C	AQUIFER
J-11, v-3	70	4	60-70	6-75	10.06	1.88	16	13	16	My
v-4	580	4	480-580	7-75	9.83	3.00	45	3,200	20.5	Upper Ech
v-5	1301	2 1/2	1291-1301	4-76	10.03	2.28	25	16,000	26	Kbc
v-6	189	6	86-189	5-76	9.94	1.64	60	15	16	My
v-6A	200	2 1/2	190-200	4-76	10.00	4.91	10	123	24	My
v-8	872	2 1/2	862-872	7-76			25	13,000		
v-9	736	4	678-736	8-76	Not completed this date					Lower Ech

FIGURE 45.- DIAGRAM OF RESEARCH STATION AT NEW LANDS, TYRRELL COUNTY

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