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DATA SUMMARY REPORT FOR THE 1990 LANDFARM AREA SAMPLING, SOUTHERN WOOD PIEDMONT COMPANY, WILMINGTON, NORTH CAROLINA

September 1993

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Prepared for:

SOUTHERN WOOD PIEDMONT COMPANY
Spartanburg, South Carolina

Prepared by:

GERAGHTY & MILLER, INC.
Environmental Services
2840 Plaza Place - Suite 350
Raleigh, North Carolina 27612
(919) 571-1662

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DATA SUMMARY REPORT FOR THE 1990 LANDFARM AREA SAMPLING, SOUTHERN WOOD PIEDMONT COMPANY, WILMINGTON, NORTH CAROLINA

September 1993

Geraghty & Miller, Inc., is submitting this report to Southern Wood Piedmont Company for work performed at the landfarm areas in Wilmington, North Carolina. The report was prepared in conformance with Geraghty & Miller's strict quality assurance/quality control procedures to ensure that the report meets the highest standards in terms of the methods used and the information presented. If you have any questions or comments concerning this report, please contact one of the individuals listed below.

Respectfully submitted,

GERAGHTY & MILLER, INC.

Mark E. Radecke
Staff Scientist/Quality Assurance Officer

Christopher W. Lovdahl
Project Scientist/Project Manager

William H. Doucette, Jr., Ph.D., P.G.
Associate and Senior Technical Consultant
South Region

1387swp

CONTENTS

Page

1.0 INTRODUCTION 1-1

2.0 SITE HISTORY AND ENVIRONMENTAL SETTING 2-1
- 2.1 SITE HISTORY 2-1
- 2.2 HISTORY OF LANDFARMING OPERATIONS AND PREVIOUS SAMPLING 2-1
- 2.3 LANDFARM HISTORICAL DATA REVIEW 2-3
- 2.4 SURROUNDING LAND USE 2-6
- 2.5 REGIONAL AND SITE GEOLOGY AND HYDROLOGY 2-6

3.0 INVESTIGATIVE METHODS 3-1
- 3.1 SOIL SAMPLING 3-1
- 3.2 GROUND-WATER SAMPLING 3-3
- 3.3 EXPANDED LIST OF CONSTITUENTS 3-3
- 3.4 LABORATORY ANALYSES AND QUALITY ASSURANCE/QUALITY CONTROL PRACTICES 3-4
- 3.4 CHAIN OF CUSTODY 3-5
- 3.5 DATA VALIDATION 3-5

4.0 SAMPLING RESULTS 4-1
- 4.1 SOIL SAMPLE RESULTS 4-1
- 4.2 GROUND-WATER SAMPLE RESULTS 4-2

5.0 REFERENCES 5-1

TABLES

2-1. Half-Life Categories for Polycyclic Aromatic Hydrocarbons (PAHs) Monitored by the Mississippi State University Forest Product Division, Southern Wood Piedmont Landfarm Area, Wilmington, North Carolina.

2-2 List of Wood-Preserving Constituents and Nutrients Monitored by the Mississippi State University Forest Product Research Division, Southern Wood Piedmont Landfarm Area, Wilmington, North Carolina.

3-1. Expanded List of Constituents Analyzed for in Landfarm Soil and Ground-Water Samples Collected in 1990 at the Southern Wood Piedmont Landfarm Facility, Wilmington, North Carolina.

3-2. U.S. Environmental Protection Agency Methods for Analysis for Soil and Ground Water, Southern Wood Piedmont Landfarm Area, Wilmington, North Carolina.

3-3. Polychlorinated Dibenzofurans and Polychlorinated Dibenzodioxins Analyzed at the Southern Wood Piedmont Landfarm Area, Wilmington, North Carolina.

4-1. Analytical Results for Soil Samples Collected in 1990 Within the River Landfarm 1 and Underlying Substrate at the Southern Wood Piedmont Site, Wilmington, North Carolina.

4-2. Analytical Results for Soil Samples Collected in 1990 Within the River Landfarm 2 and Underlying Substrate at the Southern Wood Piedmont Site, Wilmington, North Carolina.

4-3. Dioxin and Furan Concentrations for Composite Soil Samples Collected in Landfarms 1 and 2 at the Southern Wood Piedmont Site, Wilmington, North Carolina.

4-4. Analytical Results for Ground-Water Samples Collected in 1990 From the Upgradient Monitor Well (MW-6) and Three Downgradient Monitor Wells (MW-7, MW-8, and MW-9) Located on the Perimeter of Landfarms 1 and 2 at the Southern Wood Piedmont Site, Wilmington, North Carolina.

FIGURES

2-1. Generalized Site Map, Southern Wood Piedmont, Wilmington, North Carolina.

3-1. Soil Sampling Locations within the Landfarm Areas at Southern Wood Piedmont's Former Wood-Treatment Facility, Wilmington, North Carolina.

APPENDICES

A. Historical Data
B. Soil Physical Testing Results
C. Ground-Water Sampling Logs
D. Analytical Laboratory Reports and Chain-of-Custody Forms

1.0 INTRODUCTION

Geraghty & Miller, Inc., (G&M) was retained by the Southern Wood Piedmont (SWP) company to sample the soils in the Wilmington landfarm areas. Ground-water samples were also collected from four ground-water monitor wells, one upgradient and three downgradient from the land farm areas. The purpose of the sampling was to provide baseline data with which to conduct a risk assessment. This risk assessment was to evaluate whether a "concentration of residual pentachlorophenol (PCP) and major constituents of creosote is reached which will protect public-health and the environment," according to the terms of the Administrative Order of Consent Agreement (North Carolina Department of Human Resources, 1985), paragraph 10.

This report presents a brief history of the landfarming operations at the site, a discussion of the site environmental setting, the sampling and analysis methodologies used, and a discussion of the results.

2.0 SITE HISTORY AND ENVIRONMENTAL SETTING

This section gives of brief description of the history of the site and landfarming operations and a review of historical landfarm sampling data. Land use for the surrounding area and regional/local geology and hydrogeology are also discussed.

2.1 SITE HISTORY

SWP and its predecessors leased and operated a wood-treatment facility in Wilmington, North Carolina, from approximately 1932 to 1983. In 1932 the North State Company leased the property previously operated by Liberty Shipyards. The North State Company purchased and sold non-treated wood from 1932 to 1935. In 1935, the Taylor Colquitt Company leased the property to establish a wood-preserving facility to treat piling and poles with creosote. ITT, of which SWP is a subsidiary, acquired the company in 1969. SWP added chromated copper arsenate (CCA) to the wood treatment process in the early 1970s, and PCP in the late 1970s. Each of the three preservatives (creosote, PCP, and CCA) were stored on-site in tanks adjacent to the wood treating facility. Additional creosote storage was in the southwestern property corner. In 1983, the SWP facility ceased its wood-treatment operations and began closure procedures.

2.2 HISTORY OF LANDFARMING OPERATIONS AND PREVIOUS SAMPLING

At the northwest corner of the SWP facility property, a 5-acre area was bermed and ditched following the removal of existing rails and crossties and divided into two landfarm areas: Landfarm 1 (LF1), and Landfarm (LF2). Figure 2-1 shows the landfarm areas. This area was formerly used to store treated wood.

During the period of July 1984 through April 1990, soil and material originating from the spoil pile area was applied at regular intervals. Over this period, approximately 17 different soil amendments occurred in LF1 and 20 in LF2. Each amendment consisted of a 2-inch-thick layer of spoil pile material that was added to the surface of the landfarms. During the landfarm operation, irrigation water, 10-10-10 fertilizer, and chicken and turkey manure were added to promote and enhance microbial growth and polycyclic aromatic hydrocarbon (PAH) degradation. The two landfarm areas were tilled to a depth of 4 inches weekly, promoting biological and photochemical treatment of residual chemicals.

Prior to the Geraghty & Miller sampling, soil samples were routinely collected and analyzed during the operation of the landfarm. A total of 37 sampling events occurred for LF1 and 59 for LF2. For each sampling event a composite soil sample was collected at each of the following depth intervals: 0 to 3 inches, 9 to 12 inches and 21 to 24 inches. A composite sample consisted of four subsamples, a subsample from each quadrant of a landfarm area. Soil sampling was initiated in September 1985 for LF2 and November 1985 for LF1.

The soil samples were analyzed for total nitrogen, total phosphorus, chloride, total organic carbon, soil pH, PAHs, PCP, phenol, and microbial counts by the Mississippi State University Forest Products Research Division (MSUFPRD) Laboratory in State College, Mississippi. A discussion of the results of routine soil sampling is provided in Section 2.3, Landfarm Historical Data Review.

The quality of ground water in the two landfarmed areas was monitored during the landfarm operations. Four monitor wells were installed between September 5 and 10, 1985, on the perimeter of the landfarm area. Ground water from the upgradient (MW-6) and three downgradient (MW-7, 8, and 9) monitor wells was initially collected biannually and subsequently annually and analyzed for PCP and the major constituents of creosote. Composite soil samples were also taken directly from the spoil pile and analyzed for PAH constituents.

2.3 LANDFARM HISTORICAL DATA REVIEW

The MSUFPRD analytical data of PAHs in soil taken from two landfarm areas (LF1 and LF2) between 1985 and 1990 were reviewed to determine the efficiency of the landfarm bioremediation activities. Total PAH concentrations substantially declined following applications of discolored spoil pile soil material to the two landfarm areas. As expected, the degradation rates varied between the different PAHs. PAHs with two aromatic rings were found to degrade more rapidly than PAHs with four or more aromatic rings. These findings are in agreement with the literature which showed the degradation rates to be dependent upon the molecular size and structure of the PAHs. According to MSUFPRD, PAHs detected in the landfarms can be divided into three groups based on the observed half-lives: (a) PAHs with half-lives of 10 days or less, (b) PAHs with half-lives of 10 to 100 days, and (c) PAHS with half-lives of more than 100 days (Table 2-1). PAHs with half-lives ranging from 10 to 100 days comprised the majority of the PAHs that were detected in the soil samples obtained from LF1 and LF2.

Generally the PAH concentrations measured in the surficial soil samples (i.e., 0 to 3 inches) exceeded the concentrations measured in the 9- to 12-inch and 21- to 24-inch layers within the two landfarm areas. The comparatively lower levels that were detected in the deeper layers may be explained in two ways: First during the initial period of landfarm operation the deeper soil samples were collected from the indigenous substrate soil, not soil from the spoil pile. It is also conceivable that the deepest soil sampling interval (i.e., 21- to 24-inches) consisted predominantly of indigenous substrate soil even during the final stages of the landfarm operation. The depth of the landfarm material on October 10, 1990 ranged from 12- to 30-inches. Secondly as a result of frequent spoil applications soil below 0 to 3 inch contained spoil pile material which was applied at an earlier date. These earlier applications would be subject to a longer period of bioremediation and enhanced removal of PAHs. For the above reasons, evaluation of the data for short-term degradation rates was limited to the 0- to 3-inch soil layer.

Three 4- to 6-months periods each consisting of 3 to 4 sampling events not interrupted by the addition of soil pile material were used to assess the short-term degradation of PAHs in LF1 and LF2. The first period began with the addition of affected (discolored) soil to LF1 and LF2 on June 5, 1986. The addition resulted in increased total PAH concentrations in samples collected eleven days latter on June 16, 1986. Figures A1 and A2 in Appendix A show total concentrations of PAHs grouped by their half-life spans at different sampling periods. Subsequent samples taken on August 4, October 1 and December 1, 1986, in LF1 and on August 4 and October 1, 1986, in LF2 exhibited a gradual decrease in total PAH concentrations. Total concentrations of PAHs with half-lives of less than 10 days and of PAHs with half-lives of 10 to 100 days were reduced after 2 to 4 months following June 16, 1986. Degradation of total PAHs with half-lives greater than 100 days was also observed but to a much lesser extent. Higher total PAH concentrations were detected in LF2 as compared to LF1 (Figures A1 and A2, Appendix A).

On August 25, 1986, and on August 25 and November 11, 1986, chicken and turkey manure was added to LF1 and LF2, respectively. These manure additions appeared to have enhanced the biodegradation of PAHs. An evaluation of degradation rates of individual PAHs in LF1 indicated that acenaphthene, acenapthylene and 1-methylnaphthalene were completely degraded within 2 months after June 16, 1986, (Figures A3-A5, Appendix A). Fluorene, dibenzofuran, biphenyl, 2-methylnaphthalene, naphthalene, carbazole, benzo(a)pyrene, and benzo(g,h,i)perylene were degraded within 4 months after June 16, 1986, (Figures A6-A13, Appendix A). Anthracene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene and chrysene, however, were found to persist at low concentrations after 6 months starting June 16, 1986, (Figures A14-A19, Appendix A). Although the degradation of individual PAHs in LF2 are not shown here, the trends were similar to individual PAHs in LF1.

Results for phenol and PCP in LF1 are shown in Figure A20 and A21, respectively. Figures A22 and A23 represent soil concentrations of phenol and PCP in LF2. The results in

Figures A20-A23 show persistence at low soil concentrations after 6 months starting June 16, 1986.

The second sampling period that was evaluated extended from November 9, 1987, to April 20, 1988, in LF1 and November 10, 1987, to April 28, 1988, in LF2. Soil samples were collected for laboratory analyses on November 16 (1987), January 19 (1988), March 1 (1988), and April 11 (1989) from LF1 and LF2. The soil samples that were collected on November 16, 1987 exhibited increased concentrations of total PAHs following spoil pile soil application on November 9 (1987) in LF1 and November 10 (1987) in LF2 (Figures A24 and A25, respectively, Appendix A). Total PAH concentration detected during the second sampling period were comparatively higher than those measured during the first sampling period (compare Figure A1-A2 of first sampling period and Figure A24-A25 of second sampling period). Samples collected from LF1 on November 16, 1987 and January 19, March 1 and April 11, 1988 exhibited a gradual decrease in total PAH concentrations (Figure A24, Appendix A) whereas the total PAH concentrations measured in LF2 decreased drastically (Figure A25 , Appendix A). After 6-month of landfarm treatment following spoil pile soil application, PAHs with half-lives of less than 10 days were almost completely degraded. Lower concentrations of PAHs with half-lives of 10 days or greater were detected on March 1 and April 11, 1988, in LF1 and LF2 and on January 19, 1988, in LF1 compared to the levels initially measured on November 16, 1987 in both LF1 and LF2.

Results of PCP from the second sampling period in LF1 and LF2 are presented in Figures A26 and A27, respectively. PCP was not detected in soils collected from LF1 in January and April 1988 (Figure A26, Appendix A). PCP was detected at a relatively constant concentration in every sample collected form LF2 (Figure A27, Appendix A).

The third period extended from June 15 to October 4, 1988 for LF1 and June 20 to October 4, 1988, for LF2. Soil samples were collected on June 21, August 15 and September 27, 1988. The results are shown in Figures A28 and A29, Appendix A. Total PAH

concentrations in LF1 and LF2 decreased with time, a similar trend observed in previous sampling periods. PAHs with half-lives less than 10 days were completely degraded after 3 months whereas PAHs with intermediate and long half-lives persisted throughout this period (Figures A28 and A29, Appendix A). Greater reduction in PAH concentration, however, was observed on September 27, 1988.

PCP concentrations in the third sampling period in LF1 and LF2 are depicted in Figures A30 and A31(Appendix A), respectively. PCP was not detected in soil samples collected from LF1 after 2 months but was found in soil samples taken from LF2 (Figures A30 and A31, Appendix A).

2.4 SURROUNDING LAND USE

The SWP facility, which measures approximately 1,000 feet east to west by 1,600 feet north to south, lies within an industrialized area of Wilmington, North Carolina. Industry in the vicinity includes the Hess Fuel Tank Farms separated from the SWP property by a ditch on the north side and the Poctank, Inc., plant separated by an undeveloped lot on the south side of the SWP property. The major roads in the vicinity of the plant are Greenfield and Surrey Street. Greenfield Street runs in an east-west direction and dead ends into the center of the facility. Surrey Street runs in a north-south direction and is situated east of the property. The Cape Fear River borders the property on the west.

2.5 REGIONAL AND SITE GEOLOGY AND HYDROLOGY

The Wilmington site is located in the Coastal Plain Physiographic Province of North Carolina, a region underlain by Cretaceous and Cenozoic marine and non-marine sedimentary sequences. Approximately 1500 feet of Coastal Plain sediments overlie pre-Mesozoic crystalline basement rock in the Wilmington area (NCGS, 1985). The site is directly underlain by the Cretaceous-age Pee Dee Formation (NCGS, 1985), which consists predominantly of

unconsolidated, dark green to gray, clay-rich, marine sand and which may contain calcareous sandstone ledges (Sohl and Owens, 1991).

Five soil borings were advanced at the site to a maximum depth of approximately 50 feet by Soil and Material Engineers, Inc., during 1981 and an additional four borings (to a maximum depth of 20 feet) were drilled by Law Environmental in 1985. Lithologic logs (presented in Soil and Material Engineers, 1981, and Law Environmental, 1985) indicate that a surficial layer of sandy fill material or sand is present at the site, which varies from less than 1 foot to 18 feet in thickness. This layer, which appears to be thickest in the northern part of the site, is described as consisting of fine to medium sand, with wood, roots, or other material occasionally found. Below this sandy material is a layer consisting of dark brown, organic-rich silt or peat, which may contain traces of fine sand, roots, and wood fragments. This layer ranges in thickness from 5 to 19 feet.in the soil boring locations, and apparently increases in thickness toward the Cape Fear River to the west. Fine to medium sands extend from below the organic rich layers to a depth of 42 to 45.5 feet, below which a gray marl is encountered (Soil and Material Engineers, Inc., 1981).

Based on their observations, Soil and Material Engineers (1981) concluded that the dominant direction of shallow ground-water flow at the site was to the south, parallel to the Cape Fear River. Water table maps prepared by Law Environmental (1985) indicate westward to southwestward flow (toward the river) near the Landfarm areas, and generally southward flow at the eastern part of the site. Tidal influences may cause temporary alterations or reversals in these flow directions. Hydraulic conductivities ranging from 3×10^{-5} centimeters/second (cm/sec) to 10^{-6} cm/sec were determined based on in-situ monitor well tests, and an average ground-water flow velocity of 0.10 feet/year was calculated (Law Environmental, 1985).

3.0 INVESTIGATIVE METHODS

A soil and ground-water sampling program, separate from the routine sampling described in Chapter 2.0, was designed to provide a baseline of current conditions within the two landfarmed areas (LF1 and LF2). The soil sampling locations and depths were selected to assess the presence of wood-preserving constituents (the list previously monitored by the MSUFPRD) and nutrients. The soil samples were collected in the landfarmed material and underlying substrate in accordance with standard operating procedures presented in the Work Plan (Geraghty & Miller, 1990). Ground water samples were collected from the four monitor wells bordering LF1 and LF2. All samples were analyzed by U.S. Environmental Protection Agency (USEPA) methodologies for the nutrients and selected semi-volatile organic compounds (SVOCs). In addition, two composite surficial soil samples were collected and analyzed to assess the presence of polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) and their respective chlorinated homologues and 2,3,7,8-congeners. The analytical procedures for PCDDs and PCDFs were conducted in accordance with USEPA methodologies. All field records and analytical data were reviewed and validated by a Geraghty & Miller Quality Assurance Officer.

3.1 SOIL SAMPLING

Soil samples were collected at five locations from the two landfarmed areas on October 10, 1990, as illustrated in Figure 3-1. At each location, three samples were collected within the landfarmed material and one sample was taken from the underlying substrate. Soil samples were analyzed for pH and the expanded list of wood-preserving constituents and nutrients (Table 3-1), including those previously monitored by the MSUFPRD and additional constituents (see Section 3.3, Expanded List of Constituents). Table 3-2 lists the analytical methods.

A small-diameter (<4-inch), stainless steel, hand-held bucket auger was used to determine the depth of the substrate layer at each sampling location prior to collecting soil samples. Following this preliminary activity, the auger was decontaminated with a laboratory-grade soap solution and rinsed three times with distilled water. The depth of the landfarmed material in LF1 and LF2 ranged from 12 to 30 inches and 12 to 27 inches, respectively. Three soil samples within the landfarmed material were collected at each sampling location by means of a hand-held bucket auger. Each borehole consisted of a sample taken at the surface, in the center of the landfarmed material and above the substrate layer.

The upper and lower sections of the individual soil cores were removed and discarded to prevent potential contamination between subsequent samples. The landfarmed soil was black, friable and had a moist consistency. Bricks and glass were encountered at the landfarmed material-substrate interface at several borehole locations. A faint creosote odor was also noticed at a few sample locations. The samples were placed in stainless steel bowls and thoroughly mixed prior to being stored in sample containers on ice at 4°C. Following the collection of the samples and the removal of the intermediate soil layers, the bucket auger was decontaminated with a laboratory-grade soap solution and rinsed three times with distilled water. A 3-foot length of polyvinyl chloride (PVC) pipe was inserted into the boreholes prior to the collection of the substrate samples. The upper 6 inches of the substrate were first removed using a 2-inch-diameter probe and discarded. The sampling equipment was decontaminated prior to collecting the substrate samples. The samples were thoroughly mixed in a stainless steel bowl and stored in a sample container on ice at 4°C.

Additional surficial soil samples (0- to 6-inch) were collected on October 9, 1990, for PCDD and PCDF analyses (Table 3-3). The soil cores were taken with a hand-held bucket auger at each of the five borehole locations in LF1 and LF2 and composited into two samples. The samples were thoroughly mixed and stored in containers on ice at 4°C. The bucket auger was decontaminated using the procedures previously described prior to and following the collection of each set of subsamples.

1387swp

Four surficial (0- to 6-inch) soil samples were collected with a sampling scoop on October 19, 1990, for grain- and particle-size determination and organic matter analysis. The individual soil samples were thoroughly mixed and placed in sample containers. The results of these analyses are included in Appendix B.

3.2 GROUND-WATER SAMPLING

The three downgradient (MW-7, MW-8, and MW-9) and upgradient (MW-6) monitor wells on the perimeter of LF1 and LF2 were sampled on October 9, 1990. These samples were analyzed for pH and the expanded list of wood-preserving constituents and nutrients (Table 3-1), including those previously monitored by the MSUFPRD and additional constituents (see Section 3.3, Expanded List of Constituents).

Plastic sheeting was placed around the wells to protect the sampling equipment from potential contamination prior to determining the well depth and water elevations using an electronic water-level meter. The wells were evacuated and sampled with disposable polyethylene bailers in accordance with standard operation procedures outlined in the Work Plan (Geraghty & Miller, 1990). The pH and conductance of the ground water were monitored and recorded. The ground-water samples were placed in sample containers and stored on ice at 4°C. The sampling logs completed during the ground-water sampling activities are presented in Appendix C.

3.3 EXPANDED LIST OF CONSTITUENTS

During an investigation of soil quality in the former treated and untreated wood storage area in 1991, several inorganic and semi-volatile organic constituents that were not included in the MSUFPRD list of wood preserving constituents were detected in site soils. Some of these additional constituents, included in Table 3-1 (without asterisks), were included in the analytical method used to analyze the 1990 landfarm soil and ground-water samples (EPA Method 8270),

but had not been reported by the laboratory because they had not been requested. To determine whether these additional organic constituents were also present in the landfarm soil and ground-water samples collected by Geraghty & Miller in 1990, Geraghty & Miller requested that these additional constituents be reported by Savannah Laboratories in 1991. The laboratory complied with the request.

3.4 LABORATORY ANALYSES AND QUALITY ASSURANCE/QUALITY CONTROL PRACTICES

All soil and ground-water samples collected during the 1990 sampling event were analyzed by Savannah Laboratories Environmental Services, Inc., located in Savannah, Georgia, for nutrient (total nitrogen, total phosphorus, total organic carbon, and chloride) and wood-preserving constituents in accordance with USEPA-approved methodologies (Table 3-2). Several field quality control samples were collected during the soil sampling program to assess field techniques and laboratory performance. These samples included a rinsate blank (RB-1) and a field (FB-1). Sample RB-1 was collected using the decontaminated bucket auger and stainless steel bowl following the collection of sample LF1BU. Concurrently, sample FB-1 was taken. The quality control samples were prepared in accordance with procedures described in the Work Plan and analyzed for the list of constituents presented in Table 3-1.

The two composite surficial soil samples collected for PCDD and PCDF determination and their respective tetra-, penta-, hexa-, hepta- and octa-chlorinated homologues and 2,3,7,8-congeners, including 2,3,7,8-TCDD and 2,3,7,8-tetrachlorodibenzo-p-furan (TCDF) (Table 3-3), were analyzed by Triangle Laboratories, Inc., located in Research Triangle Park, North Carolina, in accordance with the USEPA-approved methodology 8290.

The four surficial soil samples (LF1-B, LF1-D, LF2-B, and LF2-D) collected for grain- and (sieve) particle-size and organic mater (loss on ignition, American Society Testing and Materials [ASTM] method) determination were analyzed by Law Environmental, Inc., located

in Kennesaw, Georgia. The silt and clay fractions for sample LF1-D were determined using the hydrometer method.

3.4 CHAIN OF CUSTODY

Samples collected in the field remained in the presence of a project representative at all times until they were shipped to the analytical laboratory. The transfer of the samples to the laboratory was accomplished by means of chain-of-custody forms. Activity documentation logs completed during this investigation are presented in Appendix B, and chain-of-custody forns are included in Appendix D. The placement of the custody seals ensured the integrity of the samples and prevented potential tampering.

3.5 DATA VALIDATION

The purpose of this section is to evaluate the field data for its adherence to the approved sampling Work Plan and to ensure the completion of required documentation. Additionally, the analytical laboratory data were reviewed for the completeness of the data package deliverables and the achievement of project-specific data quality objectives.

All field activities were appropriately documented as illustrated by the sampling logs presented in Appendix B. Field (FB) and rinsate blanks (RB) for nutrient and wood-preserving constituent analysis were taken at a frequency of 1 for every 40 samples collected using procedures described in the Work Plan. Field and rinsate blank sample results are shown in Table 3-4 Total organic carbon was detected at a concentration of 2.4 mg/L in FB-1. This constituent was not found in RB-1.

The requested detection limits for the wood-preserving constituents analyzed in the soil samples were not achieved for 31 out of the 40 samples collected. Samples LF1DM and LF2AL were diluted due to matrix interferences whereas the dilution of the remaining samples was

attributed to PAH concentrations above the calibration range of the gas chromatography/mass spectroscopy (GC/MS) detection system. The matrix spike analyses were conducted on sample LF1AS. These dilutions accounted for the absence of surrogate recoveries. Estimated constituent concentrations were reported for levels below the detection limits where applicable. The remaining quality control (QC) data, however, were within established control limits.

The two surficial soil samples LF1 and LF2 were analyzed for PCDD and PCDF by high resolution GC/MS in accordance with the USEPA Method 8290. The samples were diluted and reanalyzed due to hexa-, hepta- and octa-chlorinated dibenzodioxin and furan isomer concentrations above the calibration range of the mass spectrometer detection system. The data reported herein represent a combination of the two analyses. The isomers 2,3,4,6,7,8-hexachlorodibenzofuran and octa-chlorodibenzodioxin were detected in the laboratory method blank. The concentrations found, however, were acceptable under TLI guidelines. Quantitative interferences were reported for a number isomers in the method blank, and samples LF1 and LF2. The concentration of the affected analytes may be considered qualitative.

All soil, ground-water, and quality control samples collected were analyzed within the required holding times. With the exception of the deviations reported herein, all quality control samples were found to be within established control limits. The enclosed data (Appendix D) are valid and met the data quality objectives stated in the Work Plan.

4.0 SAMPLING RESULTS

4.1 SOIL SAMPLE RESULTS

The wood-preserving constituent, pH, and nutrient results for soil samples collected from LF1 and LF2 are presented in Tables 4-1 and 4-2, respectively. These data tables present the expanded constituent list which includes additional semi-volatile data reported by the laboratory in 1991. Table 4-3 summarizes the PCDD and PCDF data for the two composite samples. Sample results are identified with a unique sample ID consisting of the landfarm (LF1 or LF2), the location (A through E), and the sampling depth (U [upper], M [middle], L [lower], or S [substrate]). For example, sample LF2BU was the upper sample collected from location B in LF2. Laboratory data reports and the 1991 supplemental data are included in Appendix D.

A total of 15 semi-volatile organic compounds (semi-VOCs) were detected above their respective practical quantitation limits (PQLs) in the landfarm samples. Thirteen are PAHs: naphthalene; 1-methylnaphthalene; 2-methylnaphthalene; acenaphthene; fluorene; phenanthrene; anthracene; pyrene; benzo(a)anthracene; chrysene; benzo(a)pyrene; benzo(g,h,i)perylene; and fluoranthene. Two of the constituents are heterocyclic organics: carbazole and dibenzofuran. An additional 5 constituents were detected in the landfarm samples, but the concentrations were below the PQLs: benzo(b,k)fluoranthene (the laboratory could not resolve the two isomers and reported them together); indeno(1,2,3-cd)pyrene; dibenzo(a,h)anthracene; pentachlorophenol, and tetrachlorophenols (the laboratory did not resolve the tetrachlorophenol isomers and reported them together). The first 3 constituents are PAHs. Compounds detected below PQLs are "J"-qualified on the data tables.

Anthracene, a 3-ring PAH, had the highest concentration of the semi-VOCs: 900 milligrams per kilogram on a dry weight basis (mg/kg dw) in the upper sample from location C in LF2. Fluoranthene and pyrene occurred in the second-highest concentrations: up to 500

mg/kg dw each in the lower sample from location D in LF2. Generally, there was no observable trending in constituent concentrations between the upper, middle and lower samples from the landfarm area. For example, pyrene occurred in concentrations of 51, 66, and 500 mg/kg dw for the upper, middle, and lower samples, respectively, from location D in LF2. The same constituent occurred in concentrations of 130, 36, and 41 mg/kg dw for the upper, middle, and lower samples, respectively, from location C in LF2. Analyses of variance (ANOVA) performed on the data indicate no significant difference in constituent concentrations between the upper, middle, and lower samples. Concentrations of constituents in the substrate samples, however, were significantly lower than those occurring in the overlying landfarm material samples, indicating minimal vertical migration of constituents. Five of the ten substrate samples had no detectable semi-VOCs.

Both composite samples had detectable concentrations of PCDDs and PCDFs. The concentrations for each class of PCDFs ranged from 0.09/0.10 (LF1/LF2) micrograms per kilogram (μg/kg dw) total tetrachlodibenzofurans to 147/164 (LF1/LF2) μg/kg dw total heptachlorodibenzofurans. The concentrations for each class of PCDDs ranged from 0.14/0.17 (LF1/LF2) μg/kg dw total tetrachlodibenzodioxins to 621/932 (LF1/LF2) μg/kg dw total octachlorodibenzodioxins.

4.2 GROUND-WATER SAMPLE RESULTS

The wood-preserving constituent, pH, suspended solids, and nutrient results for ground-water samples collected from monitor wells MW-6, MW-7, MW-8, and MW-9 are presented in Tables 4-4. None of the wood-preserving constituents were detected in any of the ground-water samples.

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TABLES

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Table 2-1. Half-Life Categories for Polycyclic Aromatic Hydrocarbons (PAHs) Monitored by the Mississippi State University Forest Product Division, Southern Wood Piedmont Landfarm Area, Wilmington, North Carolina.

Less Than 10 Days	10 to 100 Days	Greater Than 100 Days
Acenaphthylene	Anthracene	Benzo(a)anthracene
Acenaphthene	Carbazole	Benzo(a)pyrene
Biphenyl	Fluoranthene	Benzo(g,h,i)perylene
Dibenzofuran	Phenanthrene	Chrysene
Fluorene		Pyrene
1-Methylnaphthalene		
2-Methylnaphthalene		
Naphthalene		

Reference: USEPA, 1989.

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Table 2-2. List of Wood-Preserving Constituents and Nutrients Monitored by the Mississippi State University Forest Product Research Division, Southern Wood Piedmont Landfarm Area, Wilmington, North Carolina.

Wood Preserving Constituents
Acenapthylene
Acenaphthene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(g,h,i)perylene
Biphenyl
Carbazole
Chrysene
Dibenzofuran
Fluoranthene
Fluorene
2-Methylnaphthalene
1-Methylnaphthalene
Naphthalene
Oil
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
Nutrients/Other
Chloride
Total nitrogen
Total organic carbon
Total phosphorous

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Table 3-1. Expanded List of Constituents Analyzed for in Landfarm Soil and Ground-Water Samples Collected in 1990 at the Southern Wood Piedmont Facility, Wilmington, North Carolina.

- Base Neutral Acid Extractable Constituents

Naphthalene*
2-Methylnaphthalene*
1-Methylnaphthalene*
1,1-Biphenyl*
Acenaphthylene*
Acenaphthene*
Dibenzofuran*
Fluorene*
Phenanthrene*
Anthracene*
Carbazole*
Pyrene*
Benzo(a)anthracene*
Chrysene*
Benzo(a)pyrene*
Benzo(g,h,i)perylene*
Pentachlorophenol*
Fluoranthene*
2-Chlorophenol
Phenol
2,4-Dimethylphenol
Trichlorophenols
o-Cresol
m- & p-Creosol
p-Chloro-m-cresol
Tetrachlorophenols
2,4-Dinitrophenol
Benzo(k)fluoranthene
Indeno(1,2,3-c,d)pyrene
Dibenzo(a,h)anthracene

- Nitrogen Series

Total Kjeldahl Nitrogen-N*
Nitrate + Nitrite-N*
Total Nitrogen*

- Total Phosphorus*
Total Organic Carbon*
Chloride*

- pH*

* 1990 Mississippi State University Forest Product Research Division (MSUFPRD) Constituent List (also included polychlorinated dibenzodioxins and polychlorinated dibenzofurans). Data for other constituents (1990 sampling program) were requested in 1991.

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Table 3-2. U.S. Environmental Protection Agency Methods of Analysis for Soil and Ground Water, Southern Wood Piedmont Landfarm Area, Wilmington, North Carolina.

Constituents	Method
Polycyclic aromatic hydrocarbons	SW-846 8270
Other Semi-VOCs (phenols, furans, carbazole)	SW-846 8270
Total kjeldahl nitrogen	351.2
Nitrate and nitrite	353.1
Total phosphorus	365.1
Total suspended solids	160.2
Total organic carbon	415.1
Chloride	325.2

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Table 3-3. Polychlorinated Dibenzofurans and Polychlorinated Dibenzodioxins Analyzed at the Southern Wood Piedmont Landfarm Area, Wilmington, North Carolina.

Constituents	Abbreviations
Furans	
Tetrachlorodibenzofurans (total)	TCDFs (total)
2,3,7,8-Tetrachlorodibenzofuran	2,3,7,8-TCDF
Pentachlorodibenzofurans (total)	PeCDFs (total)
1,2,3,7,8-Pentachlorodibenzofuran	1,2,3,7,8-PeCDF
2,3,4,7,8-Pentachlorodibenzofuran	2,3,4,7,8-PeCDF
Hexachlorodibenzofurans (total)	HxCDFs (total)
1,2,3,4,7,8-Hexachlorodibenzofuran	1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-Hexachlorodibenzofuran	1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-Hexachlorodibenzofuran	2,3,4,6,7,8-HxCDF
1,2,3,7,8,9-Hexachlorodibenzofuran	1,2,3,7,8,9-HxCDF
Heptachlorodibenzofurans (total)	HpCDFs (total)
1,2,3,4,6,7,8-Heptachlorodibenzofuran	1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-Heptachlorodibenzufuran	1,2,3,4,7,8,9-HpCDF
Octachlorodibenzofurans (total)	OCDF
Dioxins	
Tetrachlorodibenzodioxins (total)	TCDDs total
2,3,7,8-Tetrachlorodibenzodioxin	2,3,7,8-TCDD
Pentachlorodibenzodioxins (total)	PeCDDs (total)
1,2,3,7,8-Pentachlorodibenzodioxin	1,2,3,7,8-PeCDD
Hexachlorodibenzodioxins (total)	HxCDDs (total)
1,2,3,4,7,8-Hexachlorodibenzodioxin	1,2,3,4,7,8-HxCDD
1,2,3,6,7,8-Hexachlorodibenzodioxin	1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-Hexachlorodibenzodioxin	1,2,3,7,8,9-HxCDD
Heptachlorodibenzodioxins (total)	HpCDDs (total)
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	1,2,3,4,6,7,8-HpCDD
Octachlorodibenzodioxins (total)	OCDD

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Table 3-4. Analytical Results for Quality Control Samples Associated with Ground-Water Samples Collected in 1990, Southern Wood Piedmont Site, Wilmington, North Carolina.

Sample Identification #:	RB-1	FB-1
Constituents (mg/L)		
Semi-Volatile Organic Constituents (8270)		
Naphthalene	ND	ND
1-Methylnaphthalene	ND	ND
2-Methylnaphthalene	ND	ND
1,1-Biphenyl	ND	ND
Acenaphthylene	ND	ND
Acenaphthene	ND	ND
Dibenzofuran	ND	ND
Fluorene	ND	ND
Phenanthrene	ND	ND
Anthracene	ND	ND
Carbazole	ND	ND
Pyrene	ND	ND
Benzo(a)Anthracene	ND	ND
Chrysene	ND	ND
Benzo(a)pyrene	ND	ND
Benzo(g,h,i)perylene	ND	ND
Pentachlorophenol	ND	ND
Fluoranthene	ND	ND
2-Chlorophenol	ND	ND
Phenol	ND	ND
2,4-Dimethylphenol	ND	ND
Trichlorophenols	ND	ND
Creosol (ortho)	ND	ND
Creosol m&p	ND	ND
P-chloro-m-cresol	ND	ND
Tetrachlorophenols	ND	ND
2,4-Dinitrophenol	ND	ND
Benzo(b,k)fluoranthene	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND
Dibenzo(a,h)anthrancene	ND	ND
Total Organic Carbon	ND	ND
Chloride	ND	2.4

RB Rinsate blank.
FB Field blank.
ND Compound was not detected.
NA pH was not analyzed.

1295swp

Table 4-1. Analytical Results for Soil Samples Collected in 1990 Within the River Landfarm 1 and Underlying Substrate at the Southern Wood Piedmont Site, Wilmington, North Carolina.

Sample Identification # /1	LF1AU 9100A	LF1AM 9100B	LF1AL 9100C	LF1AS 9100D	LF1BU 9101A	LF1BM 9101B	LF1BL 9101C	LF1BS 9101D	LF1CU 9102A	LF1CM 9102B
Constituents (mg/kg dw)										
Semi-Volatile Organic Compounds (8270)										
Naphthalene	3.8J	ND	ND	ND	4.4J	12	ND	ND	4.8J	ND
2-Methylnaphthalene	4.0J	ND	ND	ND	5.9J	15	ND	ND	ND	ND
1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	5.0J	ND	ND	ND	6.7J	11	ND	ND	6.6J	ND
Fluorene	14	ND	ND	ND	4.9J	27	ND	ND	20	ND
Phenanthrene	25	3.9J	6.2J	ND	36	41	ND	ND	130	8.1
Anthracene	88	3.4J	3.7J	ND	230	200	4.6J	ND	29	58
Carbazole	26	ND	ND	ND	46	90	ND	ND	43	9.6
Pyrene	44	13	80	ND	50	27	20	ND	150	11
Benzo(a)Anthracene	20	5.8J	39	ND	19	8.6	10	ND	32	ND
Chrysene	22	9.5	59	ND	27	15	18	ND	42	8.9
Benzo(a)pyrene	19	7.3	32	ND	20	9.4	10	ND	24	ND
Benzo(g,h,i)perylene	8.8	5.0J	16	ND	7.4	ND	3.9J	ND	10	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	58	13	80	ND	19	34	20	ND	140	8.9
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorophenols	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Creosol (ortho)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Creosol m&p	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P-chloro-m-cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachlorophenols	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b,k)fluoranthene	35J	19J	100J	ND	43J	19J	27J	ND	49J	14J
Ideno(1,2,3-cd)pyrene	10J	5.2J	17J	ND	10J	4.9J	5.2J	ND	11J	3.3J
Dibenzo(a,h)anthracene	4.2J	2.2J	7.5J	ND	4.3J	2.7J	2.3J	ND	5.0J	1.6J
Nitrogen Series										
Total Kjeldahl Nitrogen-N	1600	500	1200	58	1600	1600	7500	88	1900	1100
Nitrate + Nitrite-N	ND	6.7	ND	ND	ND	16	8.2	ND	8.1	ND
Total Nitrogen	1600	507	1200	58	1600	1616	7508	88	1908	1100
Total Phosphorous	830	560	900	40	1100	840	450	42	1000	620
Total Organic Carbon	35000	18000	25000	ND	32000	26000	15000	120	39000	23000
Chloride	ND	ND	ND	ND	29	28	26	ND	35	ND
pH	6	6.6	6.8	7.3	6.5	6.5	7.7	8	6.6	6.7
Percent Solids %	82	90	90	94	82	84	90	95	70	88

1 Represents Landfarm 1 location (A, B, C, D, or E) depth sampled (U, M, L, or S).
J Estimated concentration below the practical quantitation limit.
ND Compound was not detected.

Table 4-1. Analytical Results for Soil Samples Collected in 1990 Within the River Landfarm 1 and Underlying Substrate at the Southern Wood Piedmont Site, Wilmington, North Carolina.

Sample Identification # /1	LF1CL 9102C	LF1CS 9102D	LF1DU 9103A	LF1DM 9103B	LF1DL 9103C	LF1DS 9103D	LF1EU 9104A	LF1EM 9104B	LF1EL 9104C	LF1ES 9104D
Constituents (mg/kg dw)										
Semi-Volatile Organic Compounds (8270)										
Naphthalene	ND	ND	ND	ND	ND	ND	3.6J	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	5.0J	ND	ND	ND	6.0J	ND	ND	ND
Phenanthrene	13	ND	11	ND	14	6.5J	20	4.6J	ND	ND
Anthracene	6.8J	ND	35	4.7J	3.6J	3.0J	70	5.0J	ND	ND
Carbazole	ND	ND	ND	ND	ND	ND	23	ND	ND	ND
Pyrene	110	ND	28	9.5	68	23	41	6.0J	6.5J	ND
Benzo(a)Anthracene	42	ND	11	3.4J	18	13	21	7.4	ND	ND
Chrysene	59	ND	17	7.3	40	19	22	8.1	3.7J	ND
Benzo(a)pyrene	22	ND	16	7.3	16	5.9J	18	8.1	3.5J	ND
Benzo(g,h,i)perylene	6.5J	ND	6.3J	4.8J	7.4J	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	120	ND	29	9.5	71	24	51	4.4J	6.8J	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorophenols	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Creosol (ortho)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Creosol m&p	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P-chloro-m-cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachlorophenols	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b,k)fluoranthene	68J	ND	31J	14J	52J	18J	29J	120J	9.1J	1.1J
Ideno(1,2,3-cd)pyrene	9.3J	ND	8.0J	4.9J	8.7J	4.1J	8.1J	14J	2.0J	ND
Dibenzo(a,h)anthracene	4.7J	ND	4.3J	1.6J	3.9J	1.8J	3.2J	4.2J	0.76J	ND
Nitrogen Series										
Total Kjeldahl Nitrogen-N	1300	67	1600	1000	330	1500	1400	ND	470	ND
Nitrate + Nitrite-N	ND	ND	7	6.9	ND	ND	ND	ND	ND	ND
Total Nitrogen	1300	67	1607	1007	330	1500	1400	ND	470	ND
Total Phosphorous	250	66	630	530	240	340	980	640	320	88
Total Organic Carbon	21000	ND	34000	17000	26000	25000	30000	21000	8000	ND
Chloride	77	ND	ND	ND	ND	ND	40	27	ND	21
pH	6.5	6.8	6.3	6.3	6.6	6.9	6.4	6.7	7.1	7.3
Percent Solids %	88	90	86	90	86	87	88	88	91	97

1 Represents Landfarm 1 location (A, B, C, D, or E) depth sampled (U, M, L, or S).
J Estimated concentration below the practical quantitation limit.
ND Compound was not detected.

1387swp

Table 4-2. Analytical Results for Soil Samples Collected in 1990 Within the Office Landfarm 2 and Underlying Substrate at the Southern Wood Piedmont Site, Wilmington, North Carolina.

Sample Identification # /1	LF2AU 9105A	LF2AM 9105B	LF2AL 9105C	LF2AS 9105D	LF2BU 9106A	LF2BM 9106B	LF2BL 9106C	LF2BS 9106D	LF2CU 9107A	LF2CM 9107B
Constituents (mg/kg dw)										
Semi-Volatile Organic Compounds (8270)										
Naphthalene	ND	ND	ND	0.33J	ND	30	ND	ND	ND	5.1J
2-Methylnaphthalene	ND	10	ND	ND	ND	41	ND	ND	ND	ND
1-Methylnaphthalene	ND	ND	ND	ND	ND	20	ND	ND	ND	ND
1,1-Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	28	ND	ND	49	ND	ND	ND	ND	ND
Dibenzofuran	ND	26	ND	ND	19	20	5.6J	ND	ND	3.8J
Fluorene	22	91	ND	ND	42	57	12	ND	12	ND
Phenanthrene	34	200	ND	0.49	82	86	24	ND	99	17
Anthracene	100	280	ND	0.36J	350	400	66	ND	900	72
Carbazole	45	200	ND	ND	100	160	30	ND	270	23
Pyrene	26	200	4.7J	2.0	55	23	78	0.60	130	36
Benzo(a)Anthracene	20	110	ND	1.2	33	13	21	0.21J	43	19
Chrysene	21	120	3.6J	1.9	35	18	31	0.35J	58	22
Benzo(a)pyrene	16	46	ND	1.3	24	30	41	0.30J	41	16
Benzo(g,h,i)perylene	7.8	17	ND	0.71	12	ND	16	ND	17	13
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	35	300	5.0J	2.3	92	27	82	0.63	110	38
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorophenols	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Creosol (ortho)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Creosol m&p	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P-chloro-m-cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachlorophenols	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b,k)fluoranthene	33J	89J	6.2J	2.6J	43J	24J	17J	0.78J	43J	5.7J
Ideno(1,2,3-cd)pyrene	8.6J	18J	1.1J	ND	11J	ND	ND	0.18J	11J	14J
Dibenzo(a,h)anthracene	3.9J	ND	ND	ND	ND	ND	ND	ND	5.3J	6.2J
Nitrogen Series										
Total Kjeldahl Nitrogen-N	1400	1400	170	1100	1700	1400	900	920	2200	340
Nitrate + Nitrite-N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Nitrogen	1400	1400	170	1100	1700	1400	900	920	2200	340
Total Phosphorous	1100	290	120	800	920	970	390	61	740	90
Total Organic Carbon	37000	51000	3700	26000	36000	34000	31000	230	36000	24000
Chloride	26	51	ND	ND	ND	ND	ND	ND	ND	ND
pH	6.3	6.3	6.6	5.1	6.2	5.8	6.7	7.2	6.2	7.0
Percent Solids %	84	79	92	73	85	84	86	88	86	91

1 Represents Landfarm 2 location (A, B, C, D, or E) depth sampled (U, M, L, or S).
J Estimated concentration below the practical quantitation limit.
ND Compound was not detected.

1387mp

Table 4-2. Analytical Results for Soil Samples Collected in 1990 Within the Office Landfarm 2 and Underlying Substrate at the Southern Wood Piedmont Site, Wilmington, North Carolina.

Sample Identification # /1	LF2CL 9107C	LF2CS 9107D	LF2DU 9108A	LF2DM 9108B	LF2DL 9108C	LF2DS 9108D	LF2EU 9109A	LF2EM 9109B	LF2EL 9109C	LF2ES 9109D
Constituents (mg/kg dw)										
Semi-Volatile Organic Compounds (8270)										
Naphthalene	ND	ND	ND	3.7J	11	ND	3.5J	ND	2.1J	ND
2-Methylnaphthalene	ND	ND	9.5	ND	11	ND	ND	ND	ND	ND
1-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Biphenyl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	24	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	20	ND	3.7J	ND	ND	ND
Fluorene	ND	ND	37	ND	54	ND	ND	6.1J	ND	ND
Phenanthrene	6.0J	ND	70	12	130	0.40J	19	14	5.7	ND
Anthracene	ND	ND	170	15	290	0.97	70	50	14	ND
Carbazole	ND	ND	67	4.6J	75	ND	24	17	1.9J	ND
Pyrene	41	ND	51	66	500	2.2	34	34	30	ND
Benzo(a)Anthracene	18	ND	18	27	100	1.0	13	13	11	ND
Chrysene	32	ND	22	40	150	1.4	18	19	16	ND
Benzo(a)pyrene	11	ND	19	33	65	0.97	18	15	12	ND
Benzo(g,h,i)perylene	4.2J	ND	7.9	34	14	0.47	8.1	7.1J	8.6	ND
Pentachlorophenol	ND	ND	ND	ND	20J	0.80J	ND	ND	ND	ND
Fluoranthene	47	ND	74	65	500	2.3	36	36	32	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorophenols	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Creosol (ortho)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Creosol m&p	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P-chloro-m-cresol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachlorophenols	ND	ND	ND	ND	1.2J	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b,k)fluoranthene	38J	ND	1.4J	82J	99J	2.3J	35J	32J	31J	ND
Ideno(1,2,3-cd)pyrene	23J	ND	ND	19J	19J	0.53J	9.6J	8.3J	9.4J	ND
Dibenzo(a,h)anthracene	15J	ND	ND	8.0J	9.4J	0.23J	4.4J	3.2J	3.9J	ND
Nitrogen Series										
Total Kjeldahl Nitrogen-N	520	67	1300	1400	290	190	190	1400	520	90
Nitrate + Nitrite-N	ND	ND	ND	ND	ND	ND	ND	12	ND	ND
Total Nitrogen	520	67	1300	1400	290	190	190	1400	520	90
Total Phosphorous	200	49	910	250	130	580	1200	940	370	53
Total Organic Carbon	13000	580	36000	49000	44000	4700	35000	31000	20000	490
Chloride	ND	ND	63	99	85	64	27	ND	ND	ND
pH	7.5	7.7	6.5	5.9	5.8	5.6	6.0	6.1	6.7	7.5
Percent Solids %	87	86	83	85	78	77	88	87	80	91

1 Represents Landfarm 2 location (A, B, C, D, or E) depth sampled (U, M, L, or S).
J Estimated concentration below the practical quantitation limit.
ND Compound was not detected.

1387rwp

Table 4-3. Dioxin and Furan Concentrations for Composite Soil Samples Collected in Landfarms 1 and 2 at the Southern Wood Piedmont Site, Wilmington, North Carolina.

Parameters	Land Farm 1	Land Farm 2
Furans (µg/kg*)		
Tetrachlorodibenzofurans (total)	0.09	0.10
2,3,7,8-Tetrachlorodibenzofuran	0.02	0.02
Pentachlorodibenzofurans (total)	0.92	0.87
1,2,3,7,8-Pentachlorodibenzofuran	0.06	0.06
2,3,4,7,8-Pentachlorodibenzofuran	0.06	0.06
Hexachlorodibenzofurans (total)	31.4	34.4
1,2,3,4,7,8-Hexachlorodibenzofuran	0.71	0.76
1,2,3,6,7,8-Hexachlorodibenzofuran	0.24	0.21
2,3,4,6,7,8-Hexachlorodibenzofuran	0.16	0.14
1,2,3,7,8,9-Hexachlorodibenzofuran	0.04	0.05**
Heptachlorodibenzofurans (total)	147.0	164.0
1,2,3,4,6,7,8-Heptachlorodibenzofuran	59.5	66.0
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.77	0.96
Octachlorodibenzofurans (total)	63.2	83.3
Dioxins (µg/kg*)		
Tetrachlorodibenzodioxins (total)	0.14	0.17
2,3,7,8-Tetrachlorodibenzodioxin	0.004**	0.008
Pentachlorodibenzodioxins (total)	0.48	0.65
1,2,3,7,8-Pentachlorodibenzodioxin	0.03	0.05
Hexachlorodibenzodioxins (total)	16.4	22.5
1,2,3,4,7,8-Hexachlorodibenzodioxin	0.10	0.18
1,2,3,6,7,8-Hexachlorodibenzodioxin	1.3	1.8
1,2,3,7,8,9-Hexachlorodibenzodioxin	0.22	0.89
Heptachlorodibenzodioxins (total)	461	573
1,2,3,4,6,7,8-Heptachlorodibenzodioxin	65.5	98.7
Octachlorodibenzodioxins (total)	621	932

* µg/kg = micrograms per kilogram.
** Estimated Maximum Possible Concentration

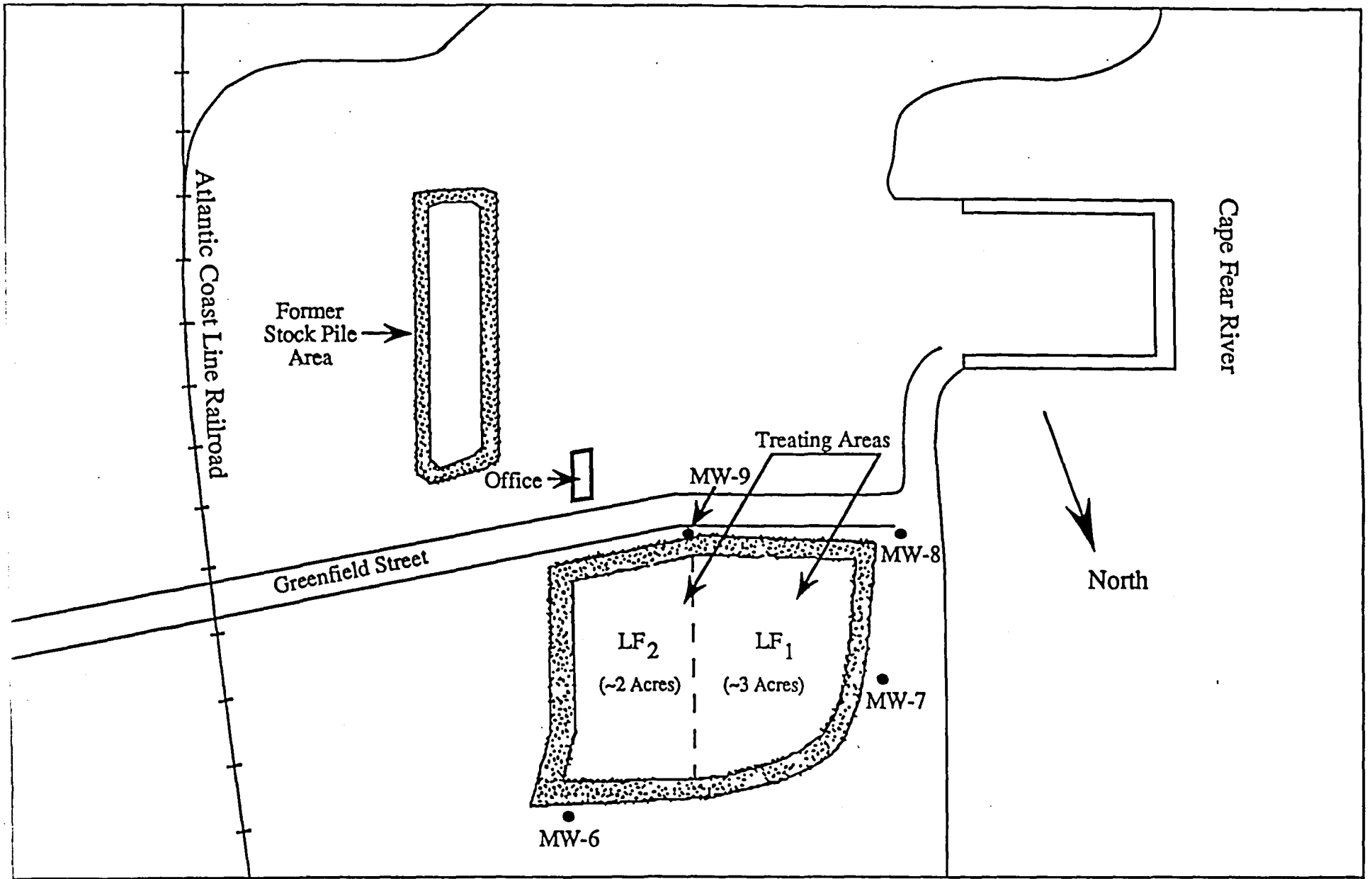
Table 4-4. Analytical Results for Ground-Water Samples Collected in 1990 From the Upgradient Monitor Well (W-6) and Three Downgradient Monitor Wells (W-7, W-8, and W-9) Located on the Perimeter of Landfarms 1 and 2 at the Southern Wood Piedmont Site, Wilmington, North Carolina.

Sample Identification #	MW-6	MW-7	MW-8	MW-9
Constituents (mg/L)				
Semi-Volatile Organic Compounds (8270)				
Naphthalene	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND
1-Methylnaphthalene	ND	ND	ND	ND
1,1-Biphenyl	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND
Carbazole	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND
Benzo(a)Anthracene	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND
Nitrogen Series				
Total Kjeldahl Nitrogen-N	11	7.2	10	6.7
Nitrate + Nitrite-N	ND	ND	ND	ND
Total Nitrogen	11	7.2	10	6.7
Total Phosphorous	1.0	0.47	0.51	0.35
Suspended Solids	68	130	220	30
Total Organic Carbon	13	22	26	20
Chloride	530	210	110	120

ND Compound was not detected.

1387rwp

FIGURES



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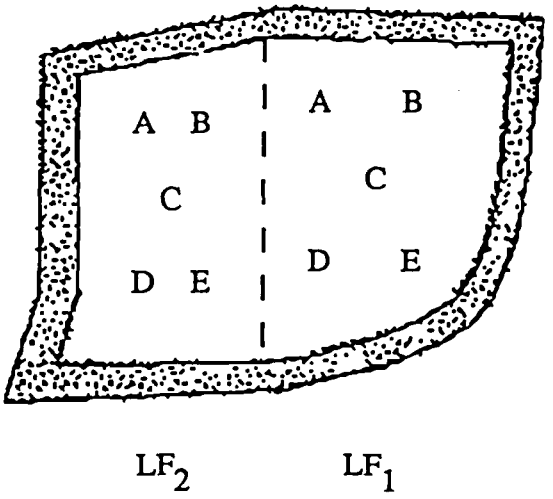
GENERALIZED SITE MAP
Southern Wood Piedmont, Wilmington, North Carolina
(Not to Scale)

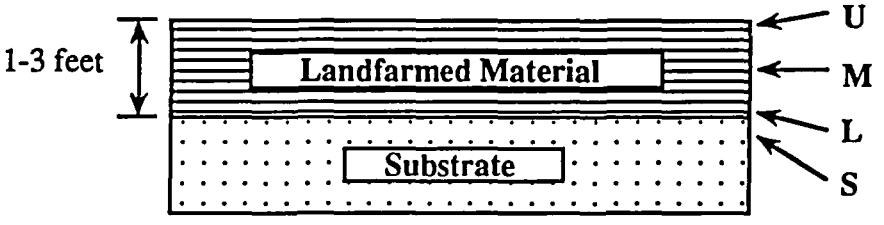
Figure 2-1

Plan View



Soil Sampling Locations in Landfarm Areas 1 and 2 Southern Wood Piedmont, Wilmington

Cross-Sectional View



U Upper soil sample taken approximately 3" below landfarm surface.

M Middle soil sample taken midway through the landfarmed material.

L Lower soil sample taken within the bottom 6" of the landfarmed material.

S Substrate sample taken approximately 6" below the base of the landfarmed material.

GERAGHTY & MILLER, INC. *Environmental Services*	Soil Sampling Locations within the Landfarm Areas at Southern Wood Piedmont's Former Wood-Treatment Facility - Wilmington, North Carolina (Not to Scale)	Figure 3-1

Figure A1. Total PAH Concentrations by Half-Lives in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

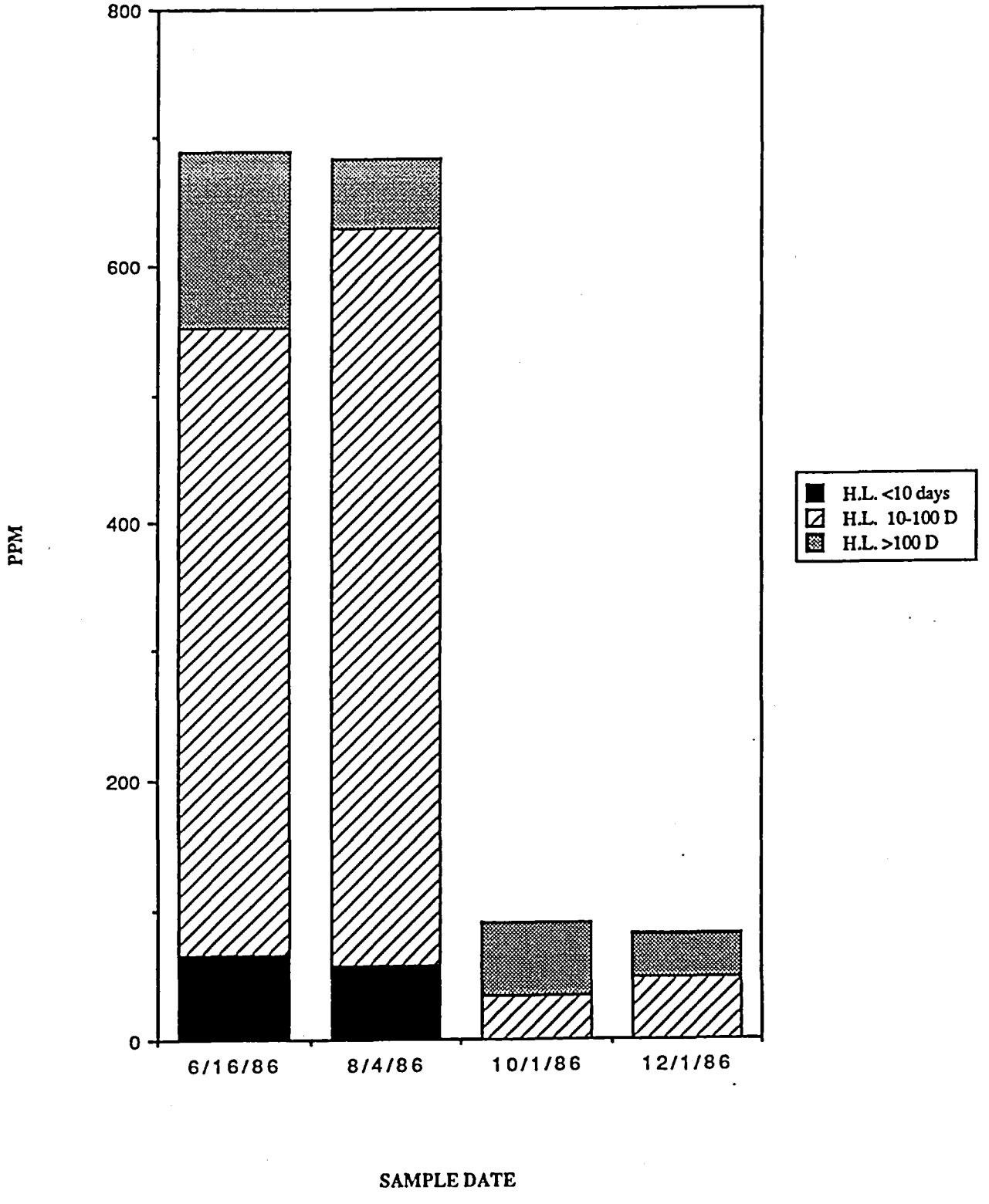


Figure A2. Total PAH Concentrations by Half-Lives in 0- to 3-Inch Soil Samples Collected in Landfarm 2 Between Subsequent Soil Applications Made on June 5 and October 30, 1986

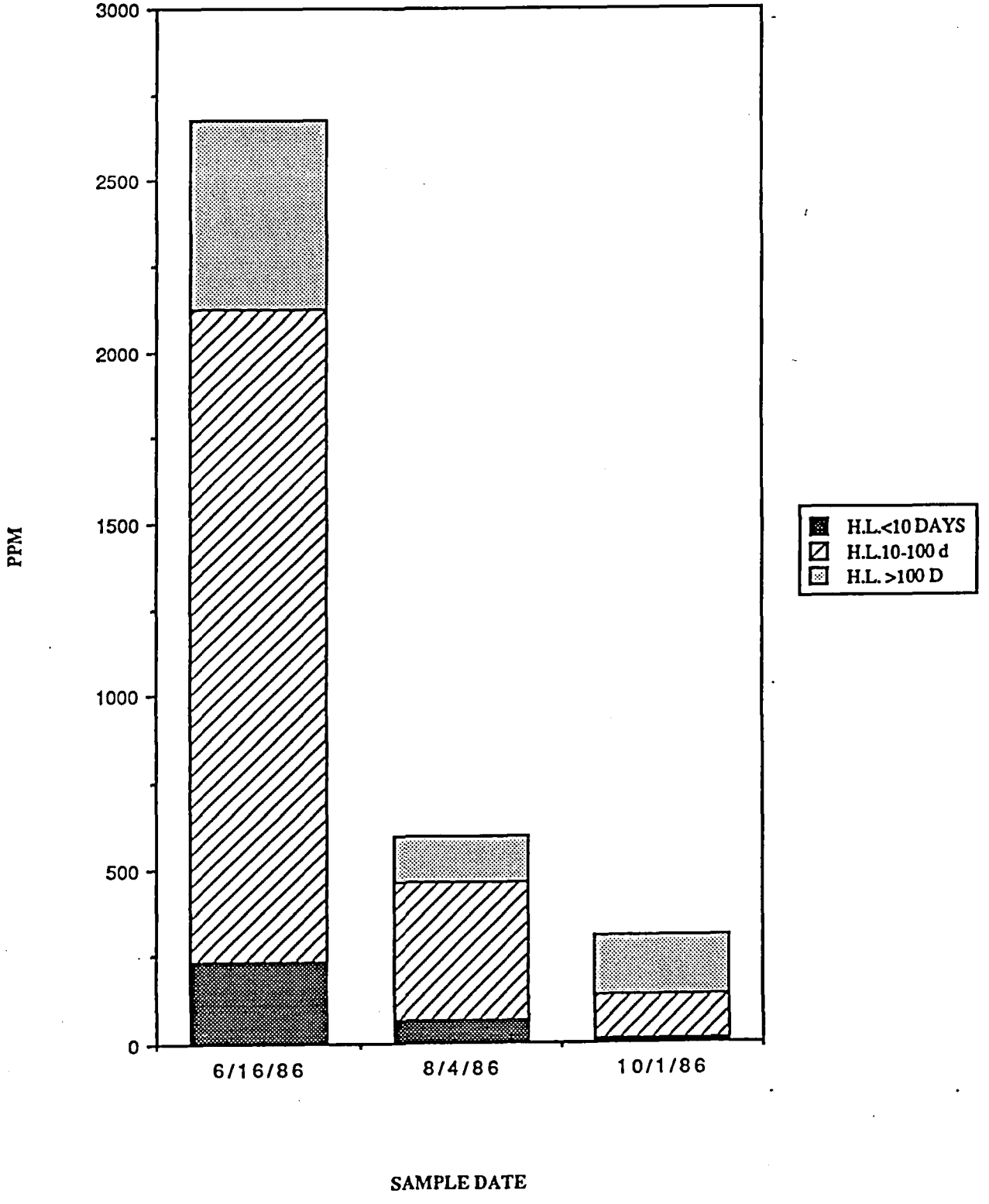


Figure A3. Acenaphthene Concentrations in 0- to 3-inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

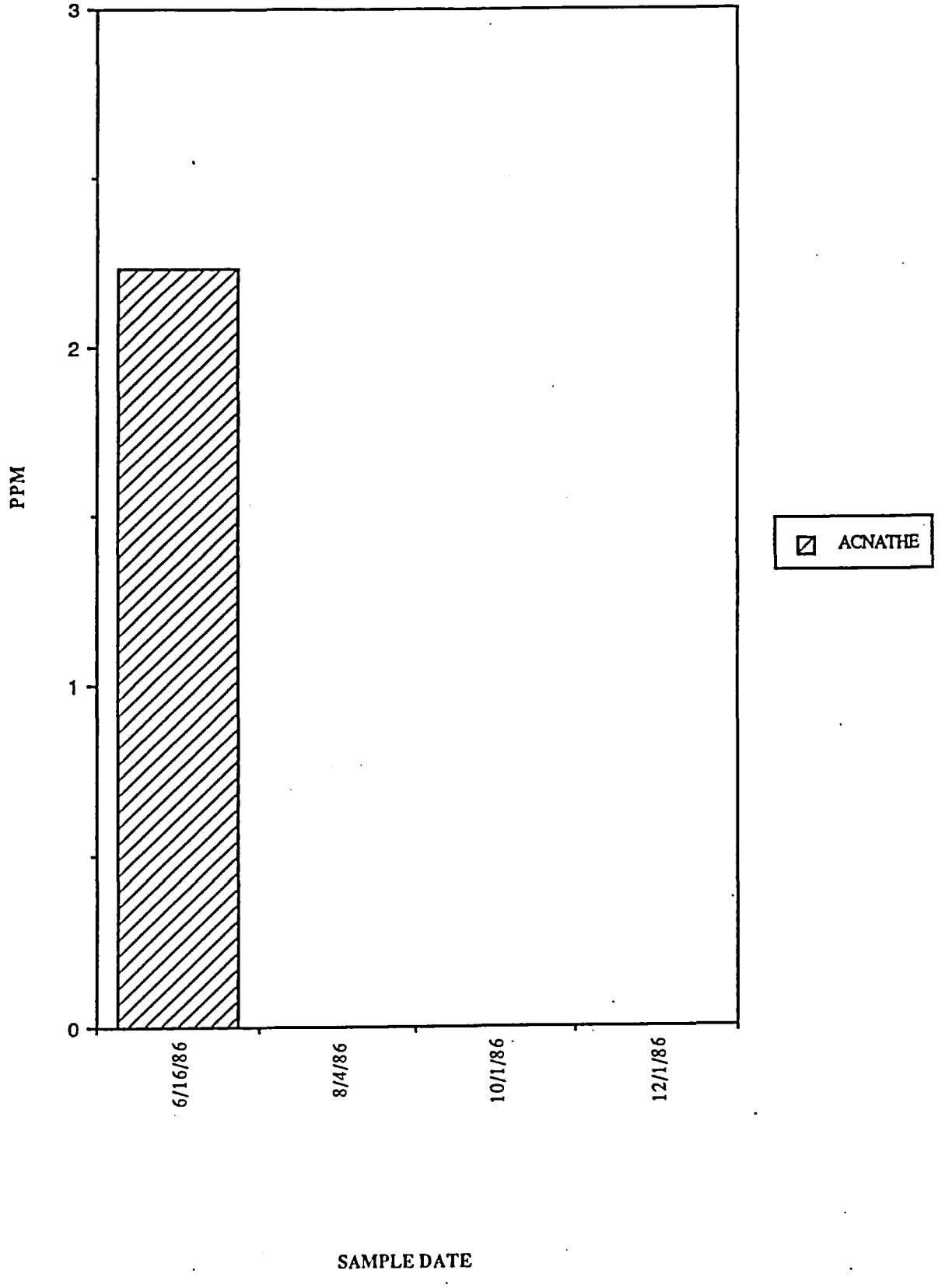


Figure A4. Acenapthylene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

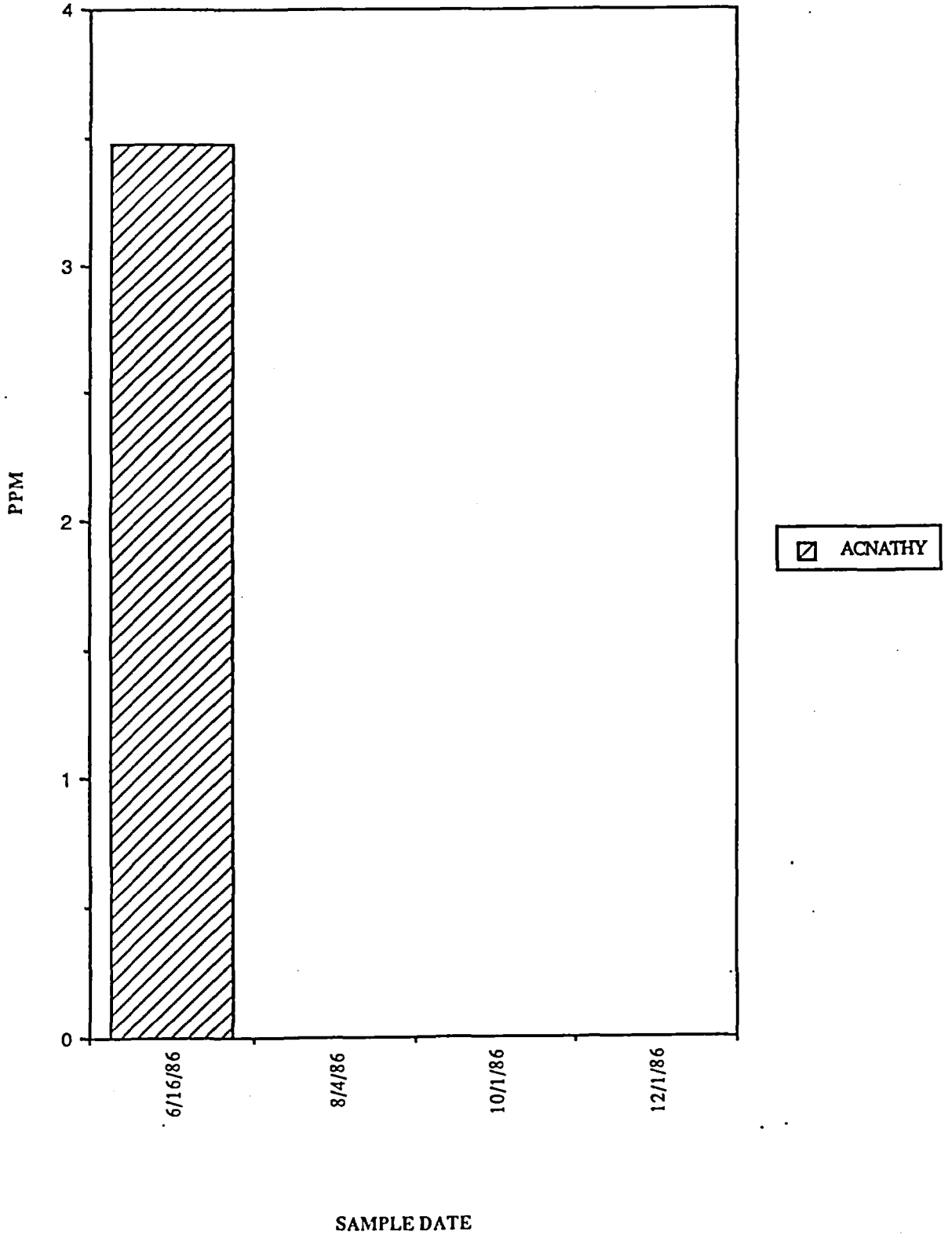


Figure A5. One-Methylnaphthalene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

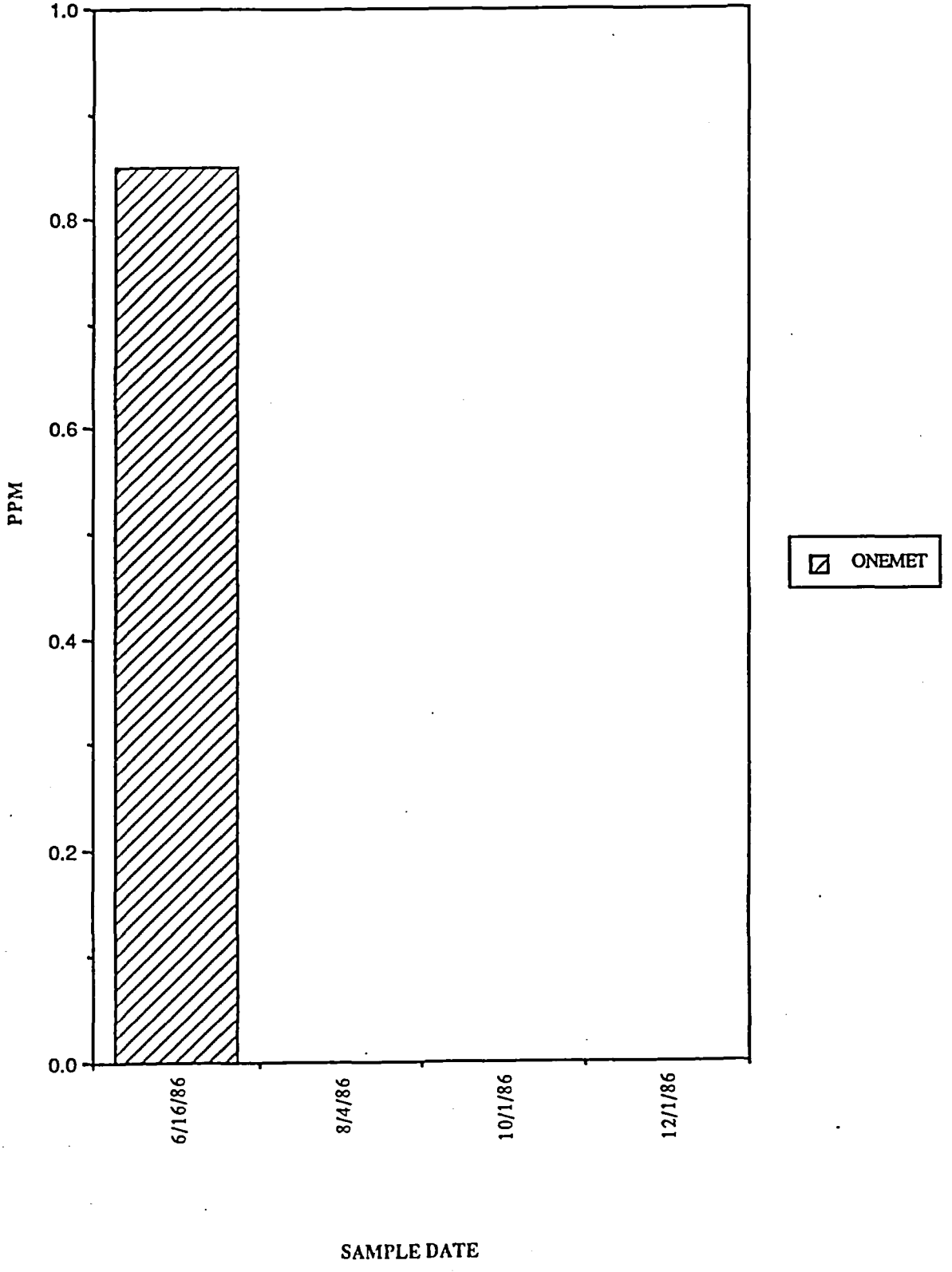


Figure A6. Fluorene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

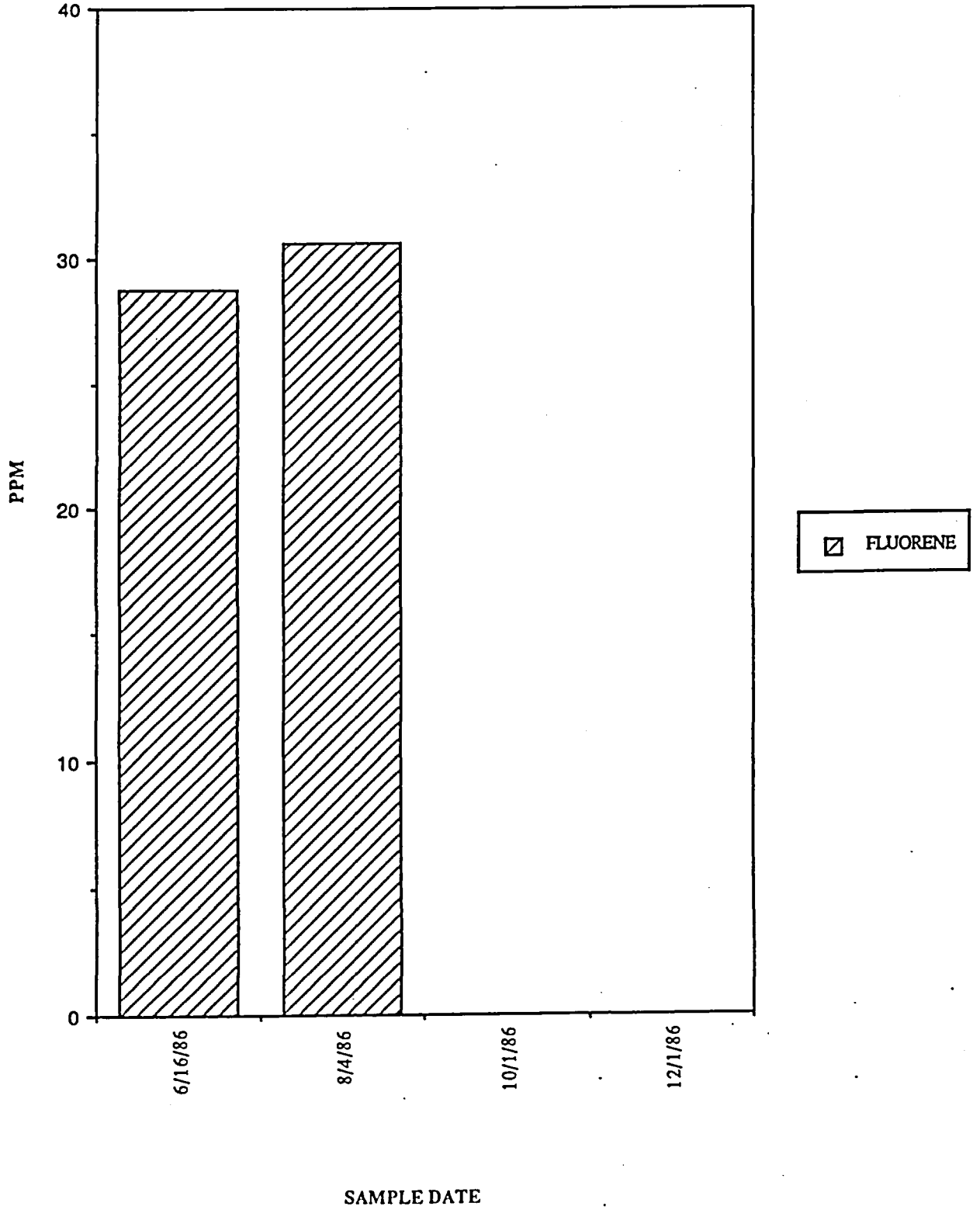


Figure A7. Dibenzofuran Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

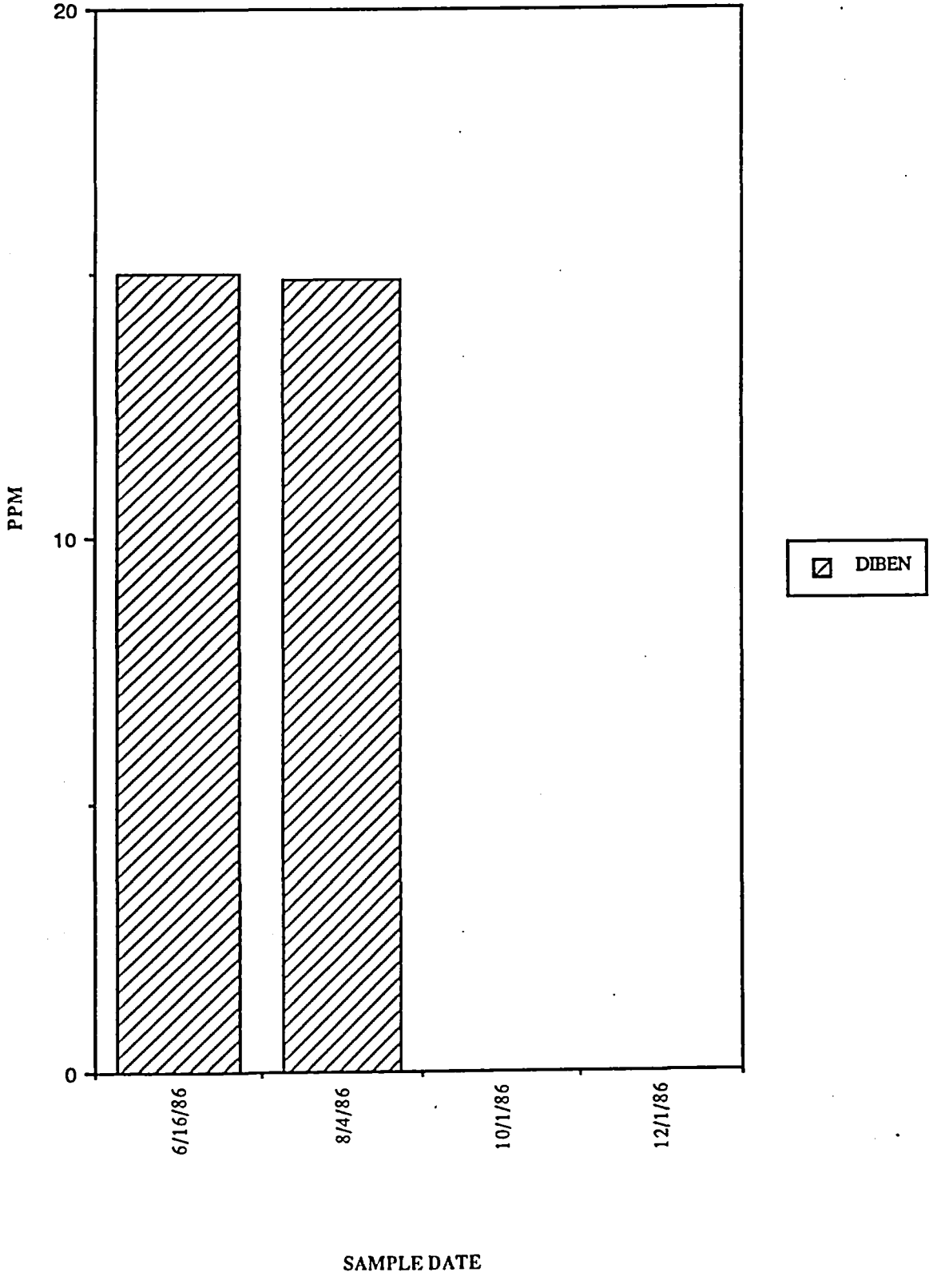


Figure A8. Biphenyl Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

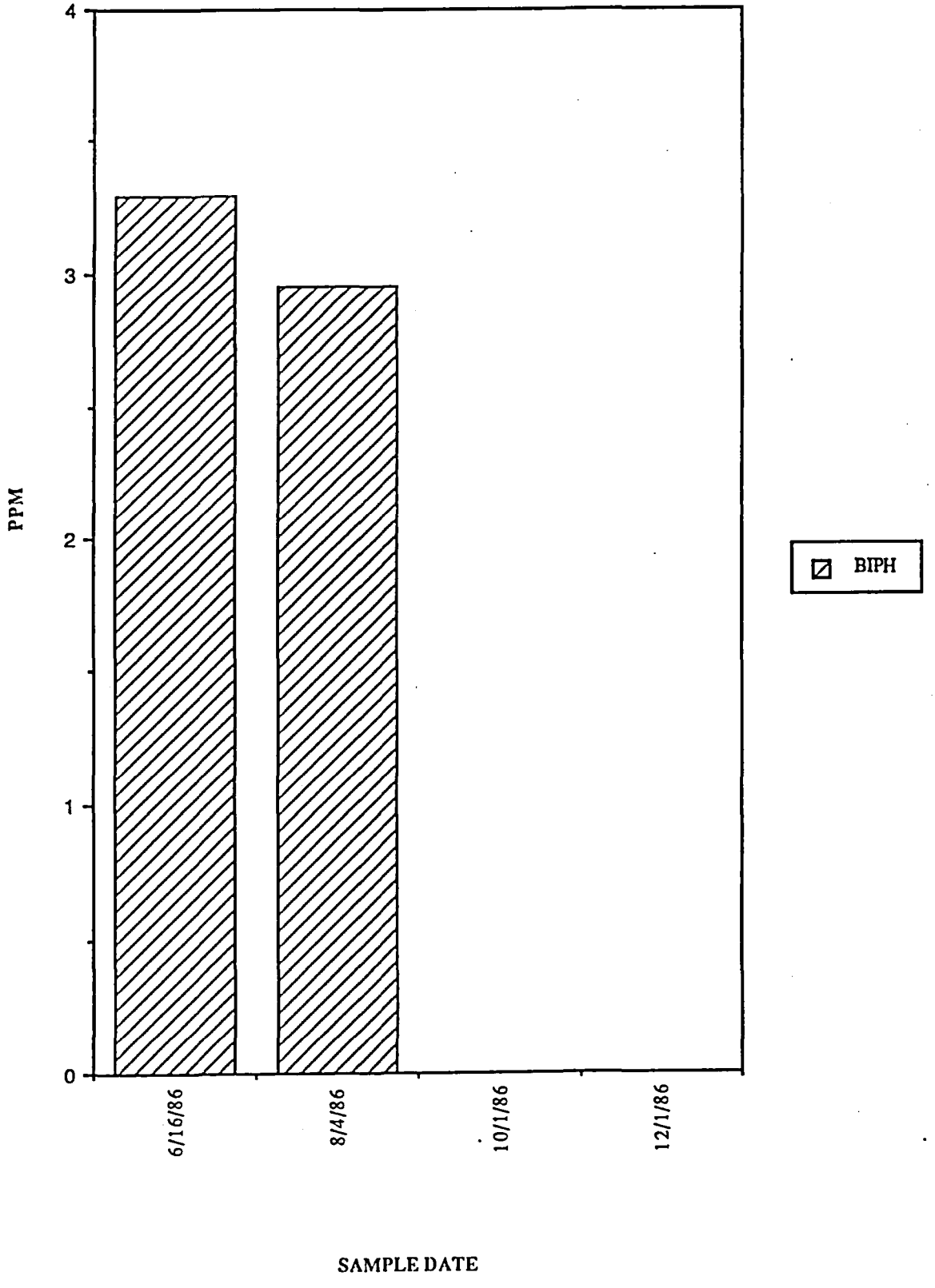


Figure A9. Two-Methylnaphthalene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

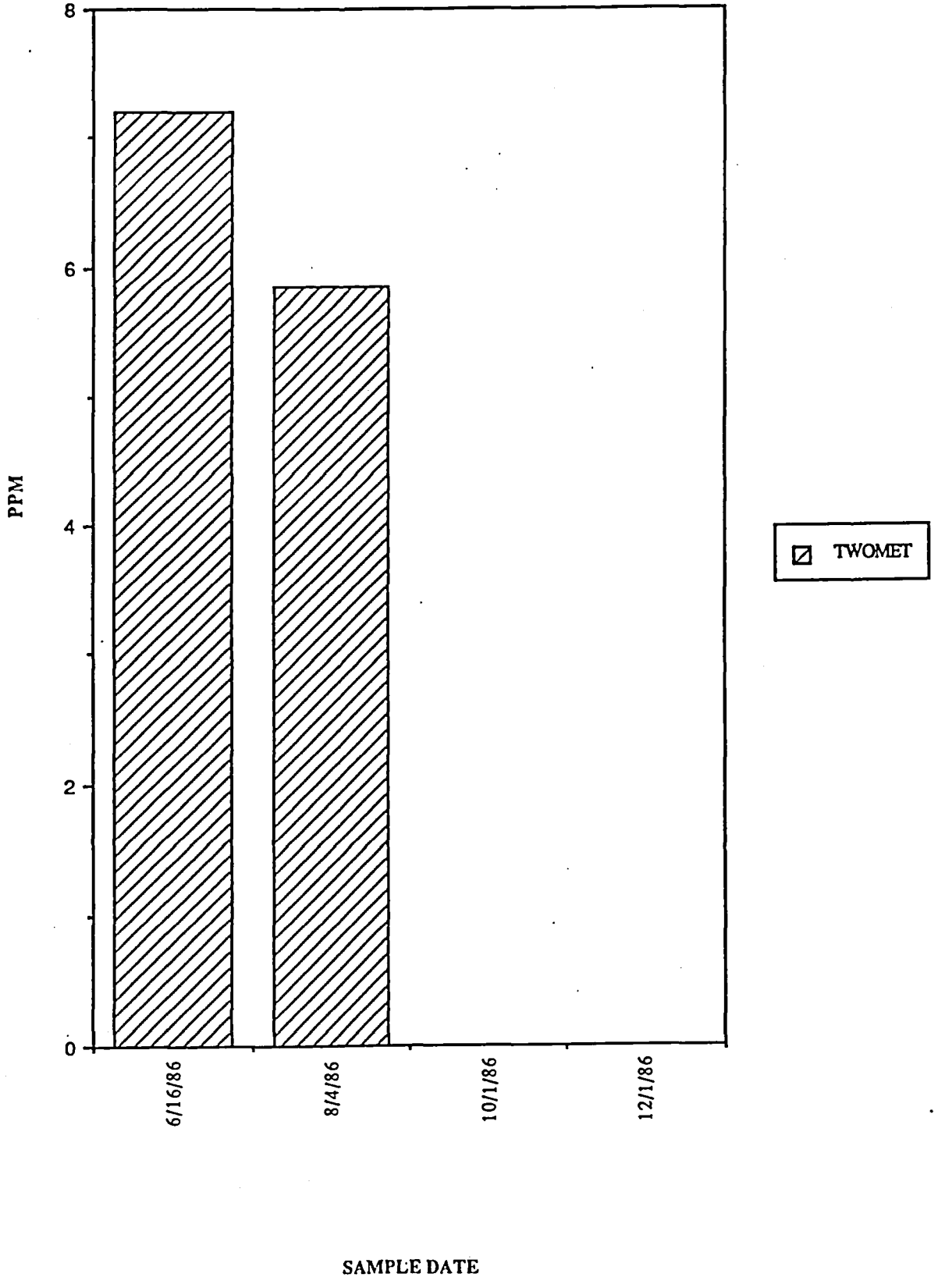


Figure A10. Naphthalene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

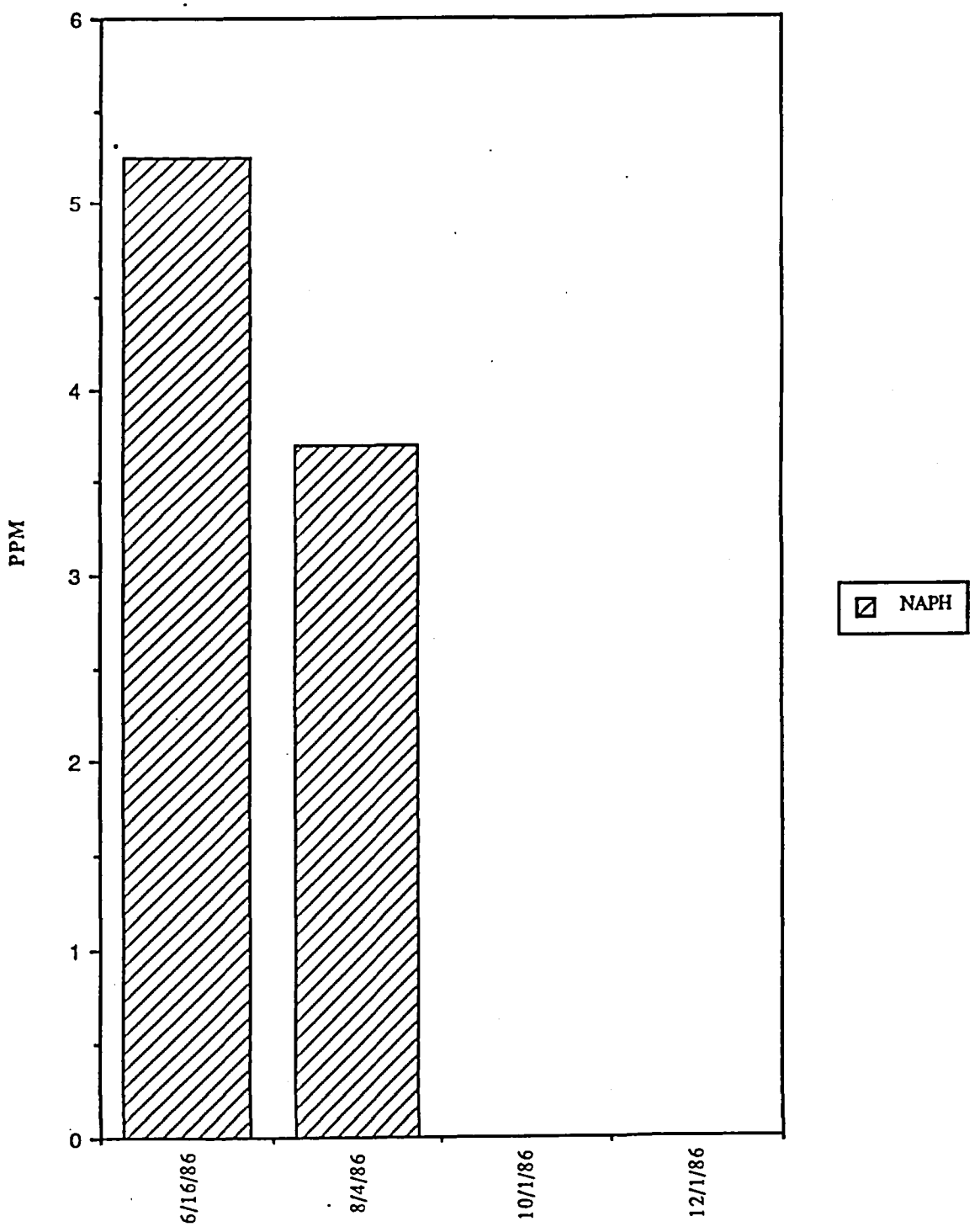


Figure A11. Carbazole Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

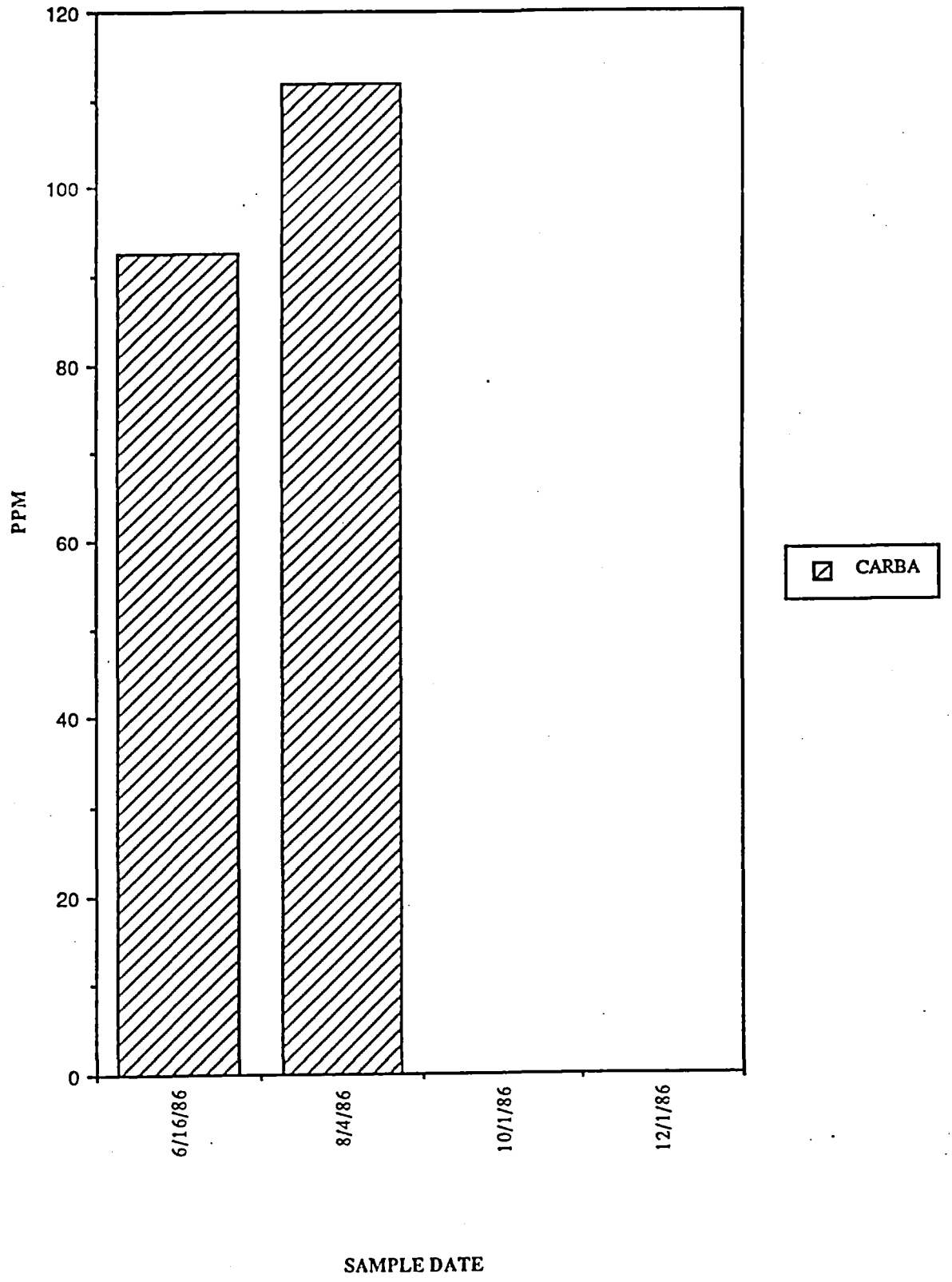


Figure A12. Benzo(a)pyrene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

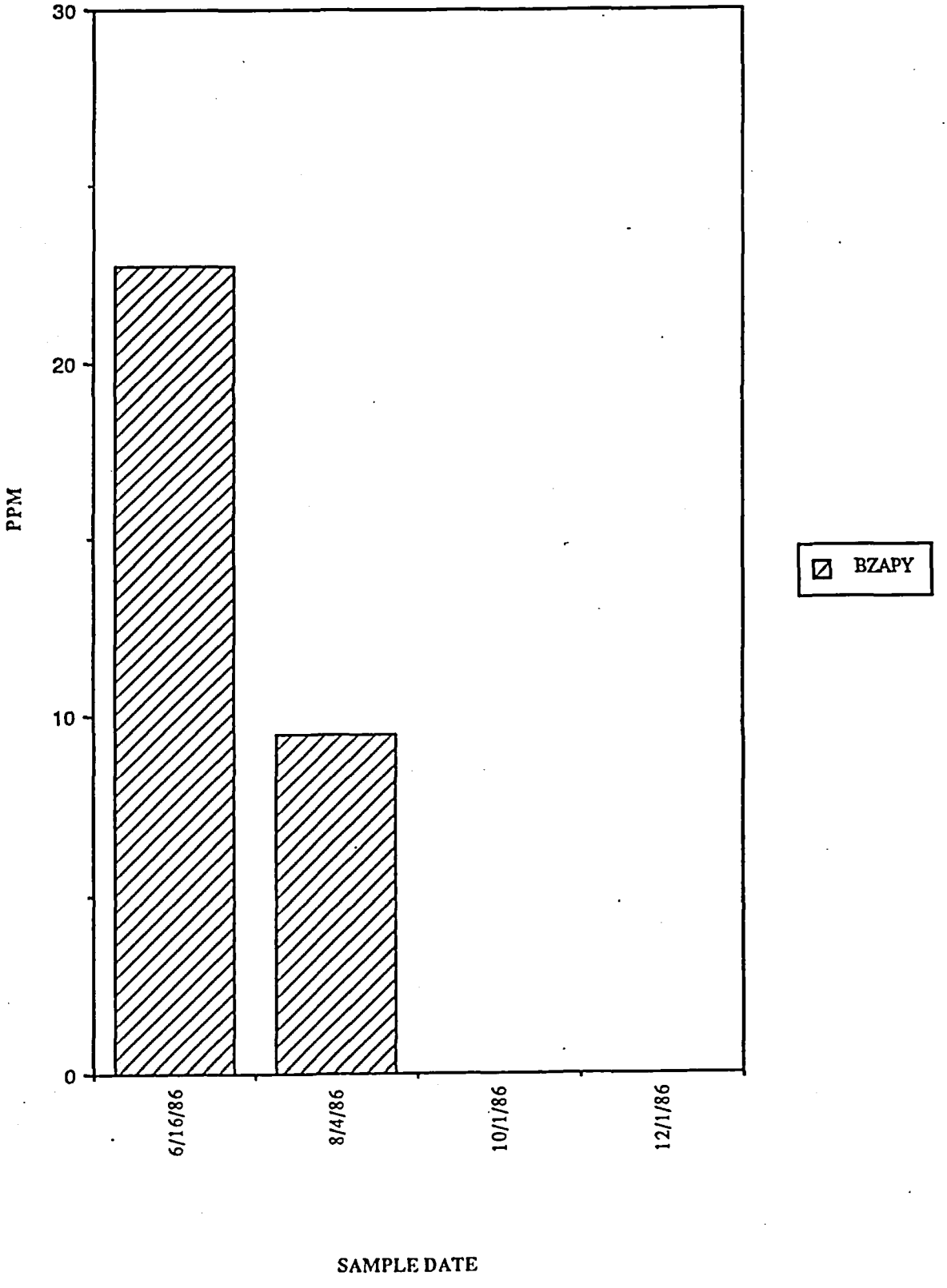


Figure A13. Benzo(g,h,i)perylene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

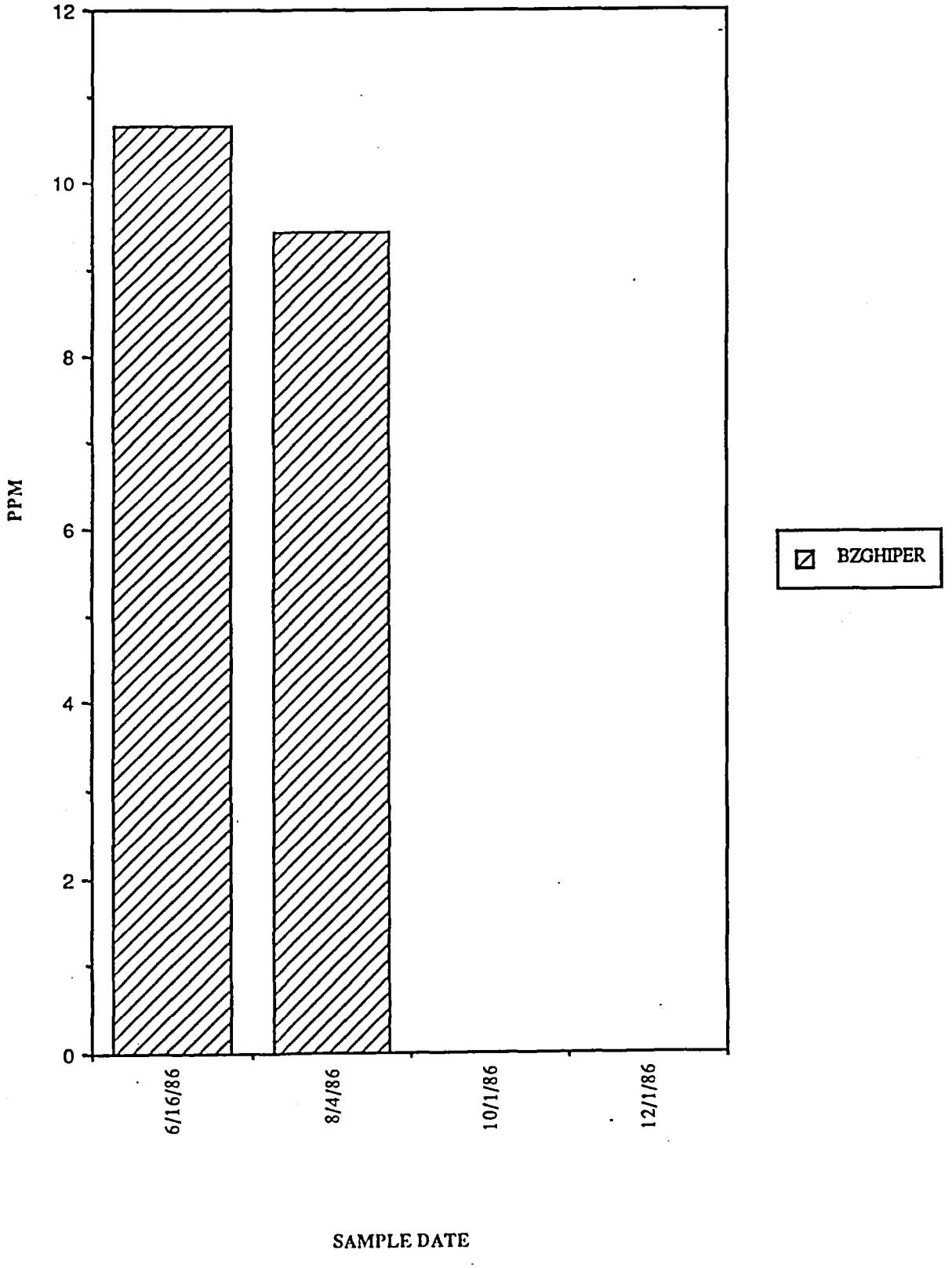


Figure A14. Anthracene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

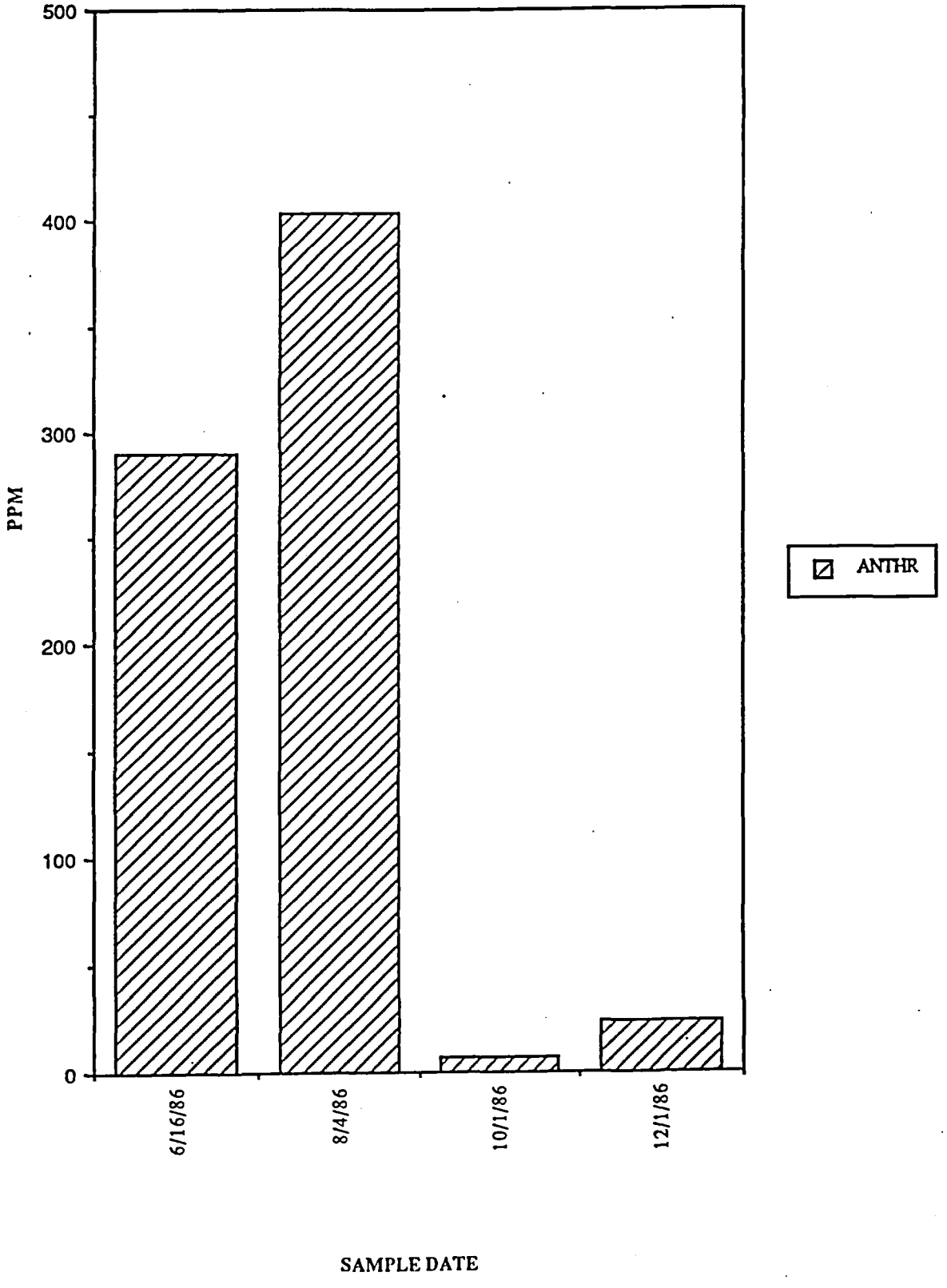


Figure A15. Phenanthrene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

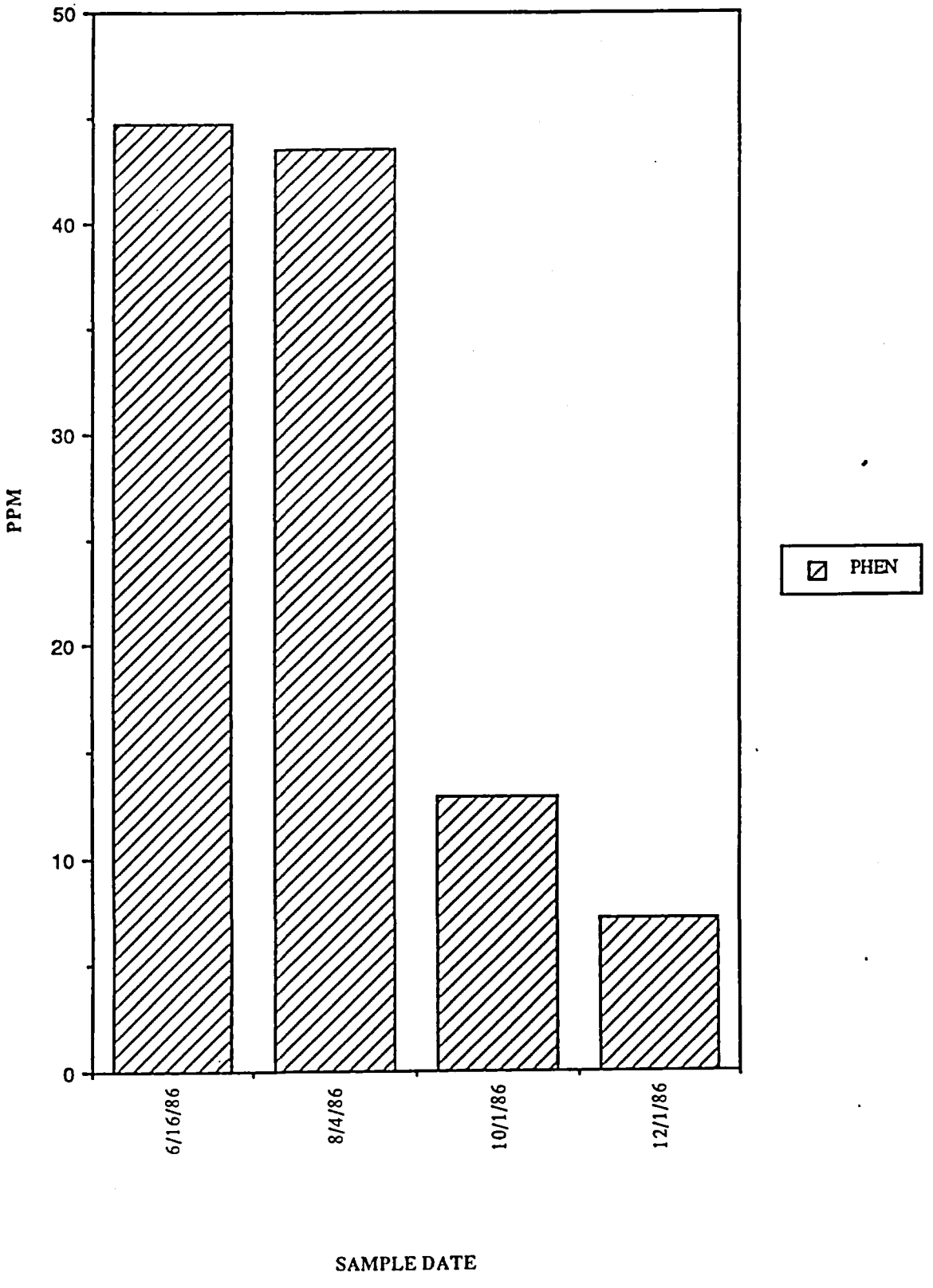


Figure A16. Fluoranthene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

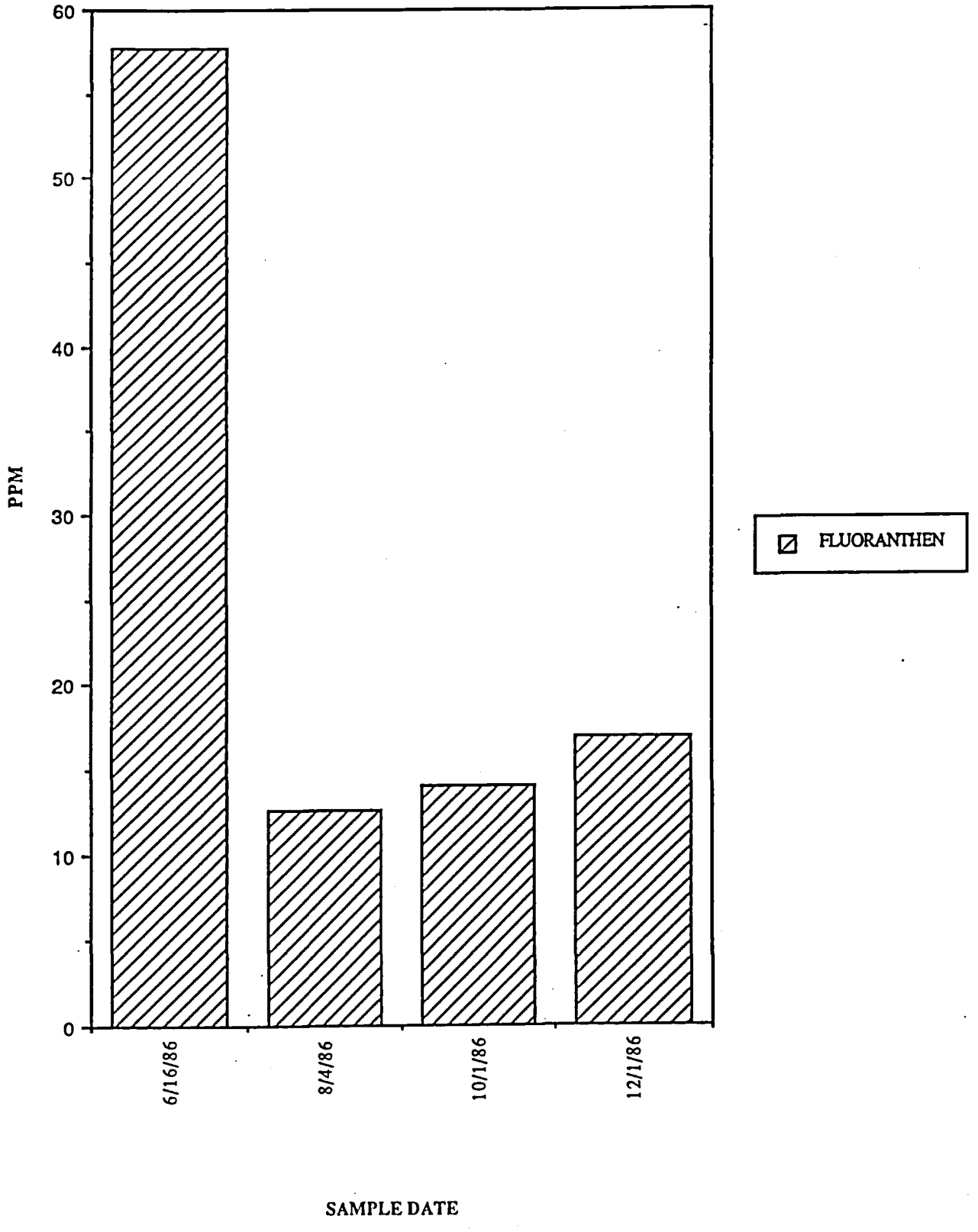


Figure A17. Pyrene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

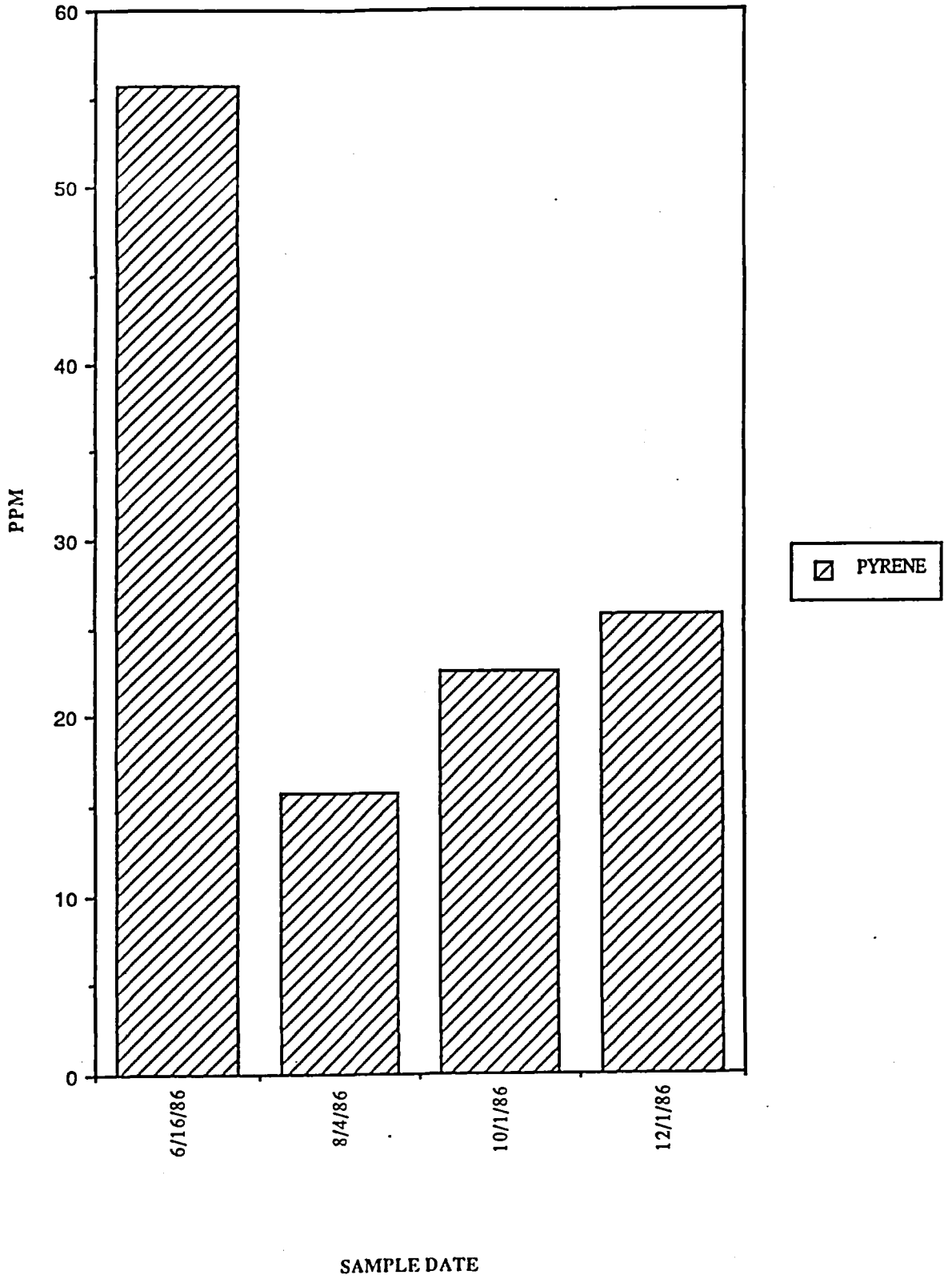


Figure A18. 1,2-Benzo(a)anthracene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

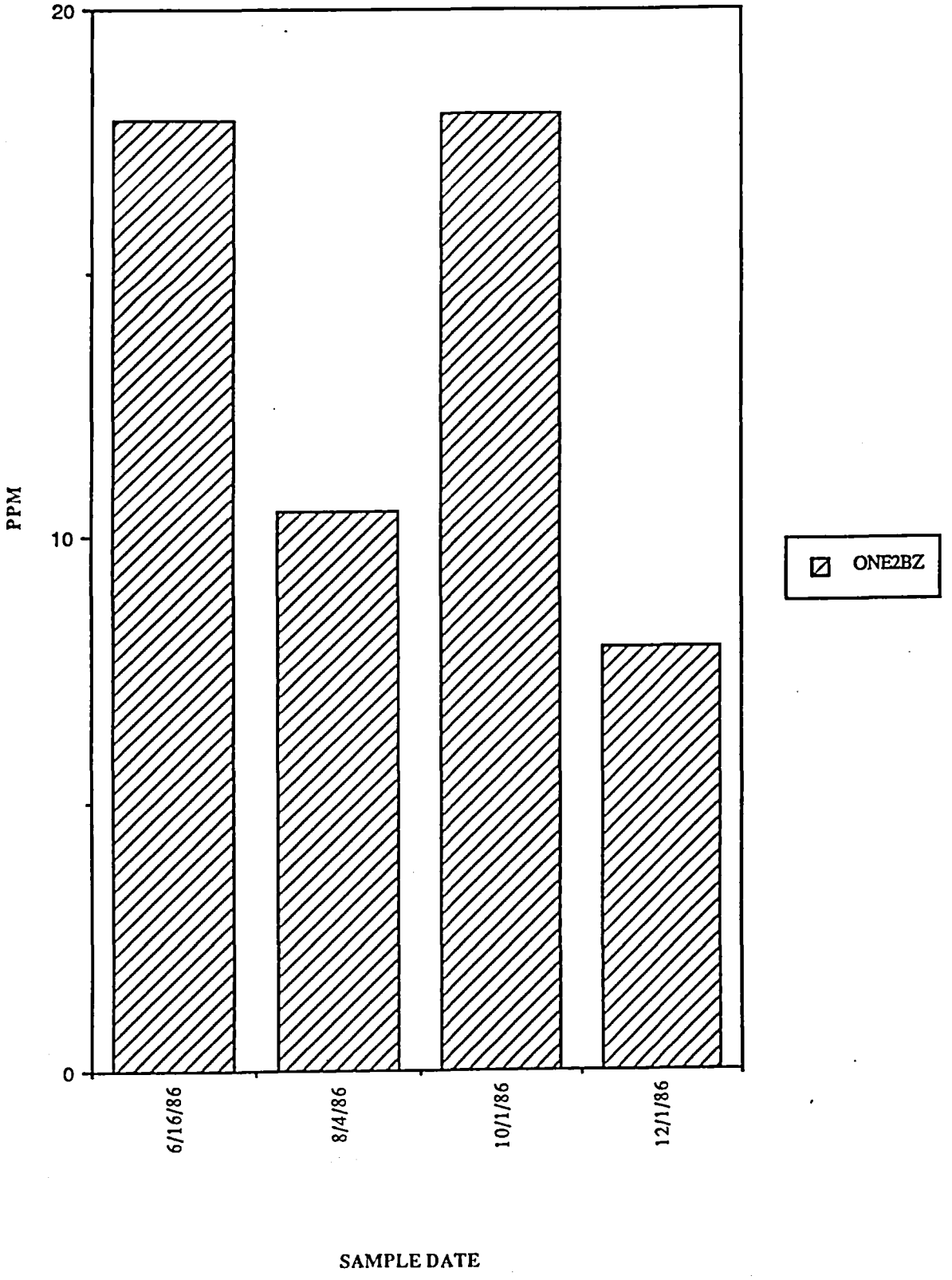


Figure A19. Chrysene Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

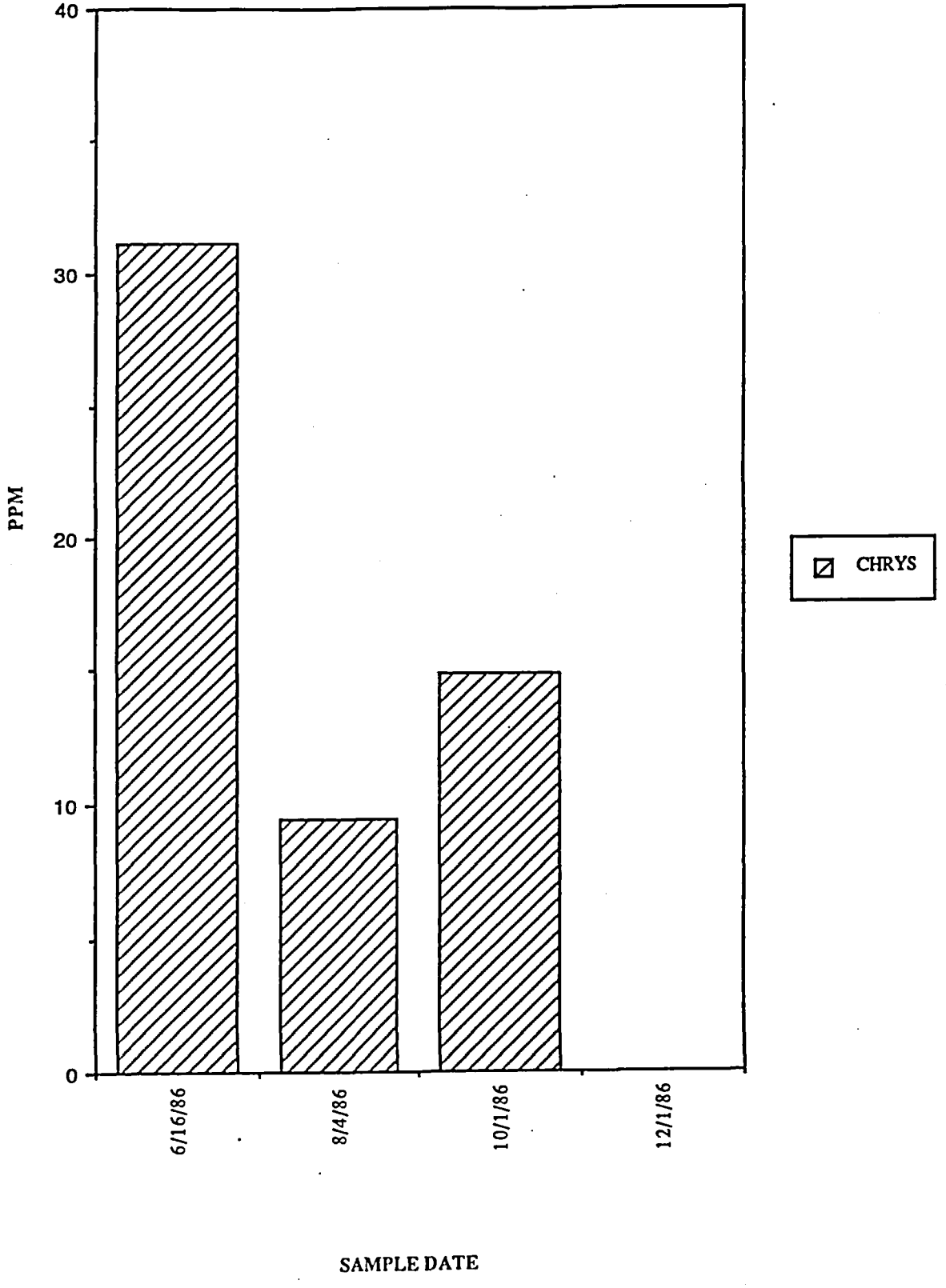


Figure A20. Phenol Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

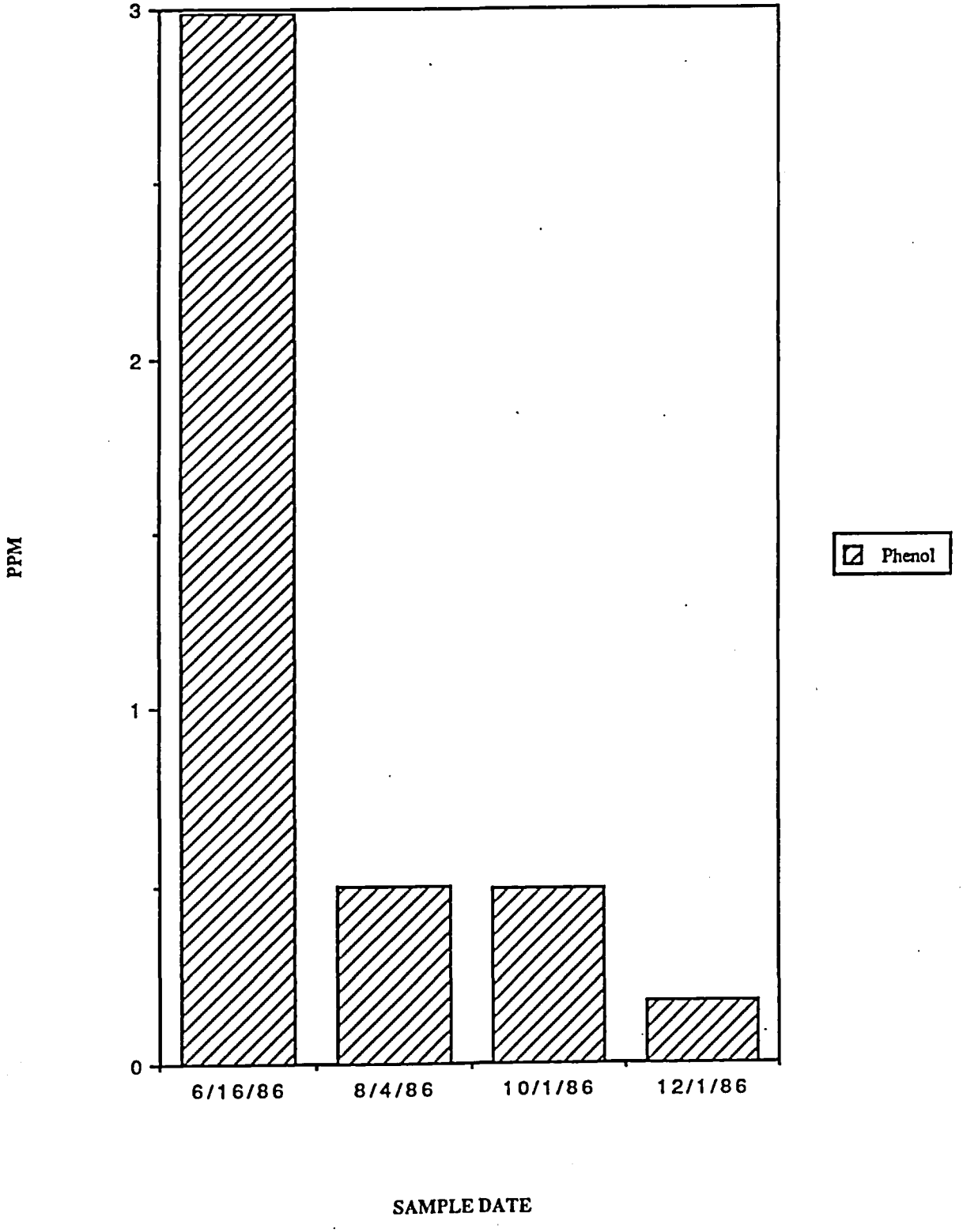


Figure A21. Pentachlorophenol Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 5 and December 16, 1986

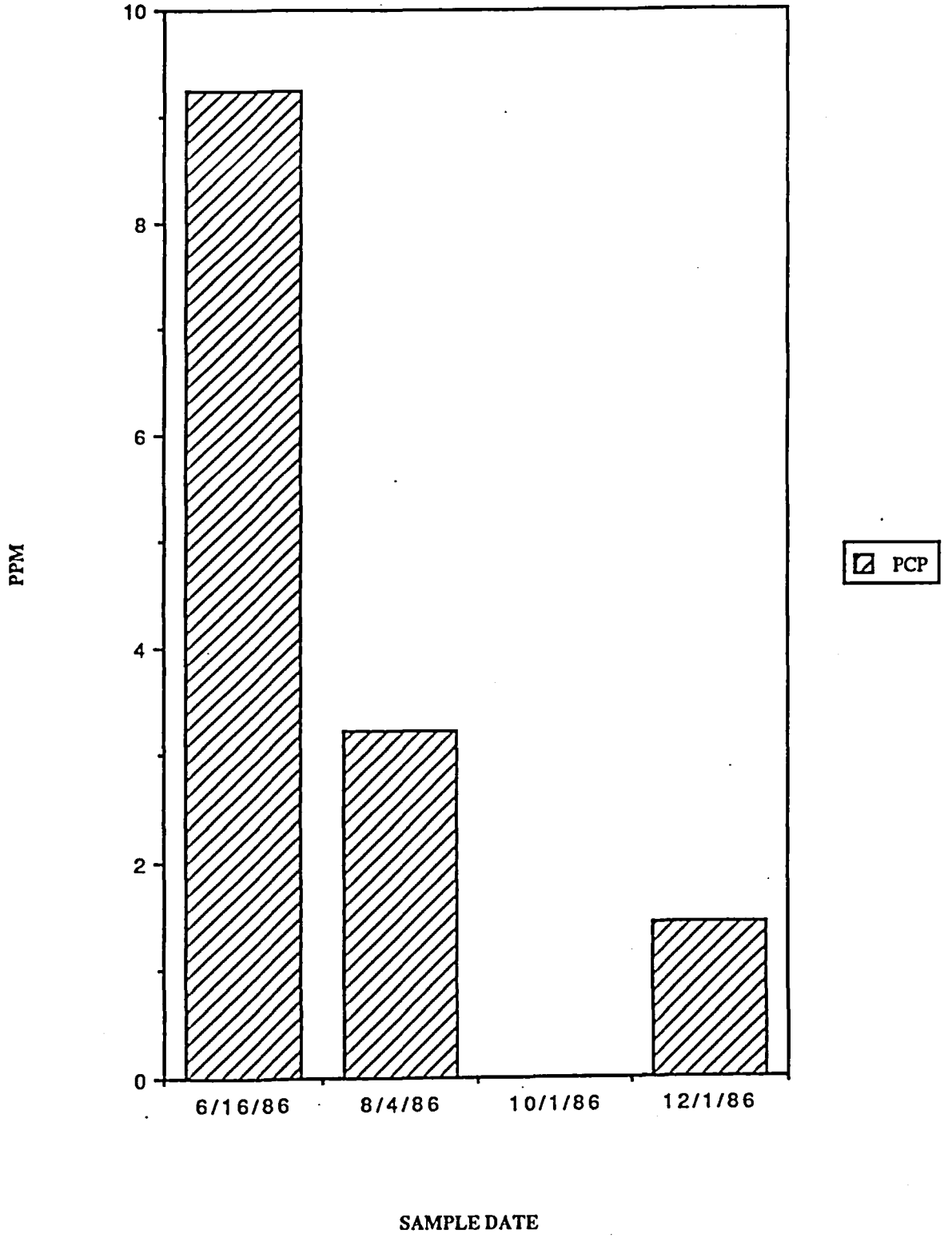


Figure A22. Phenol Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 2 Between Subsequent Soil Applications Made on June 5 and October 30, 1986

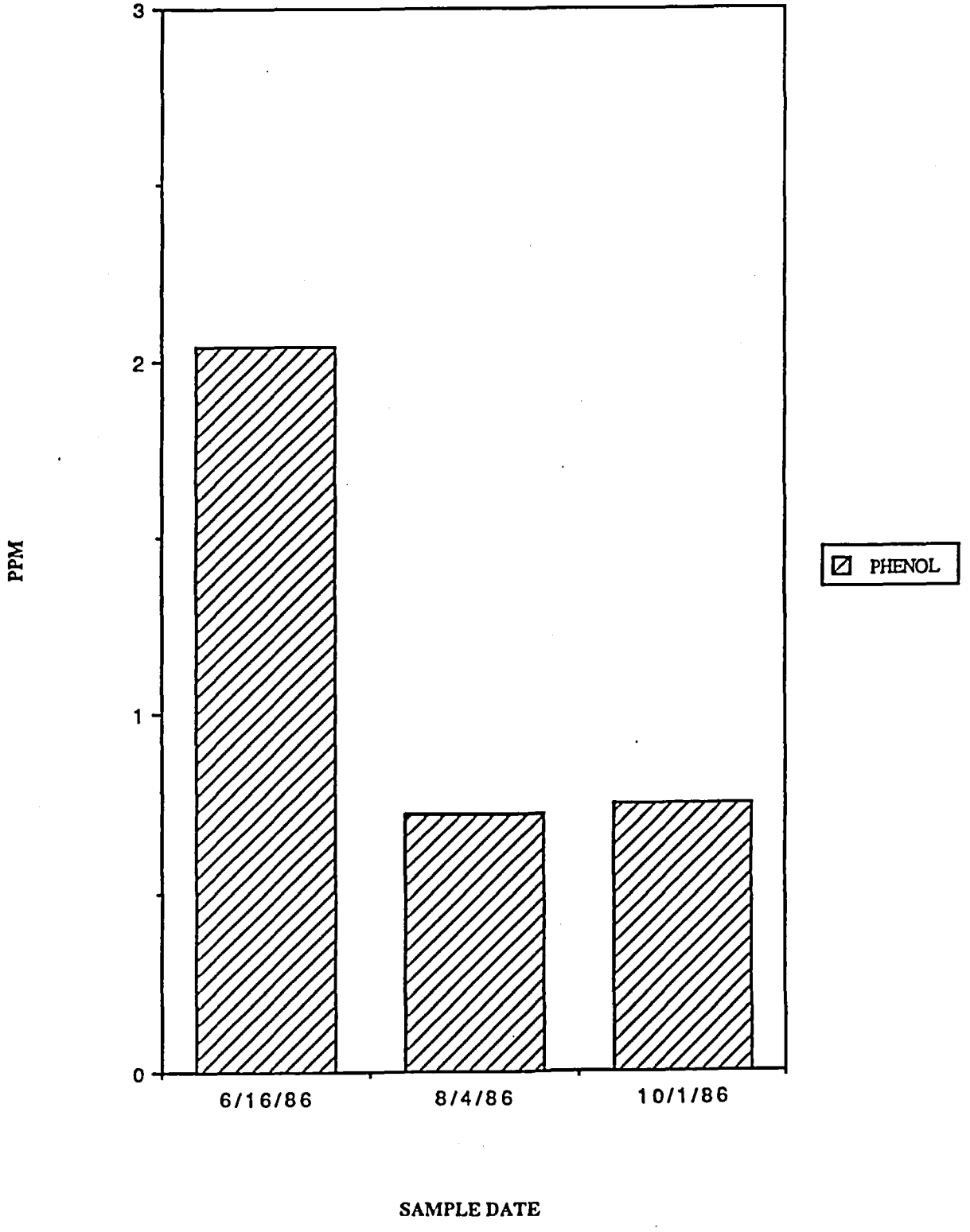


Figure A23. Pentachlorophenol Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 2 Between Subsequent Soil Applications Made on June 5 and October 30, 1986

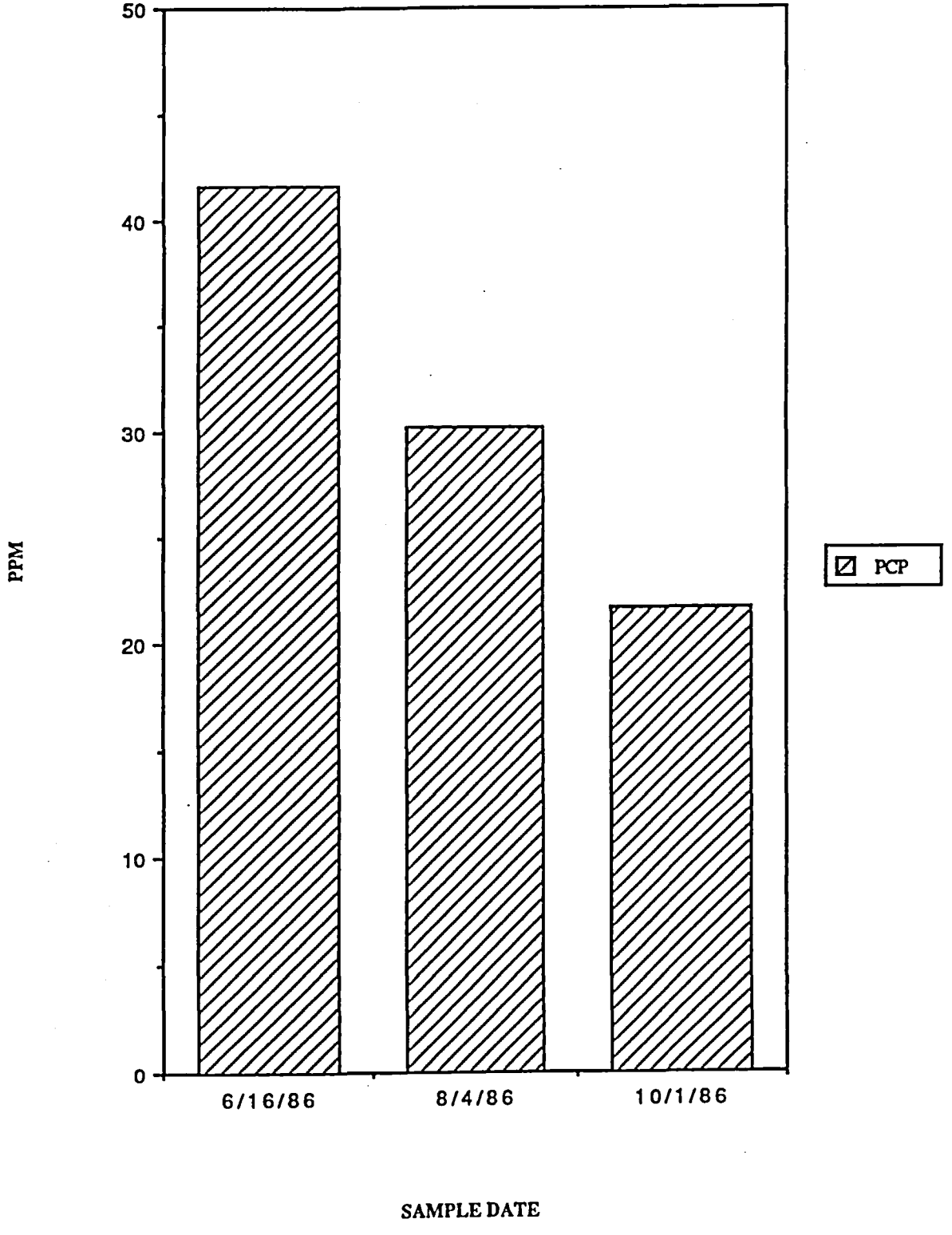


Figure A24. Total PAH Concentrations by Half-Lives in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on November 9, 1987 and April 20, 1988

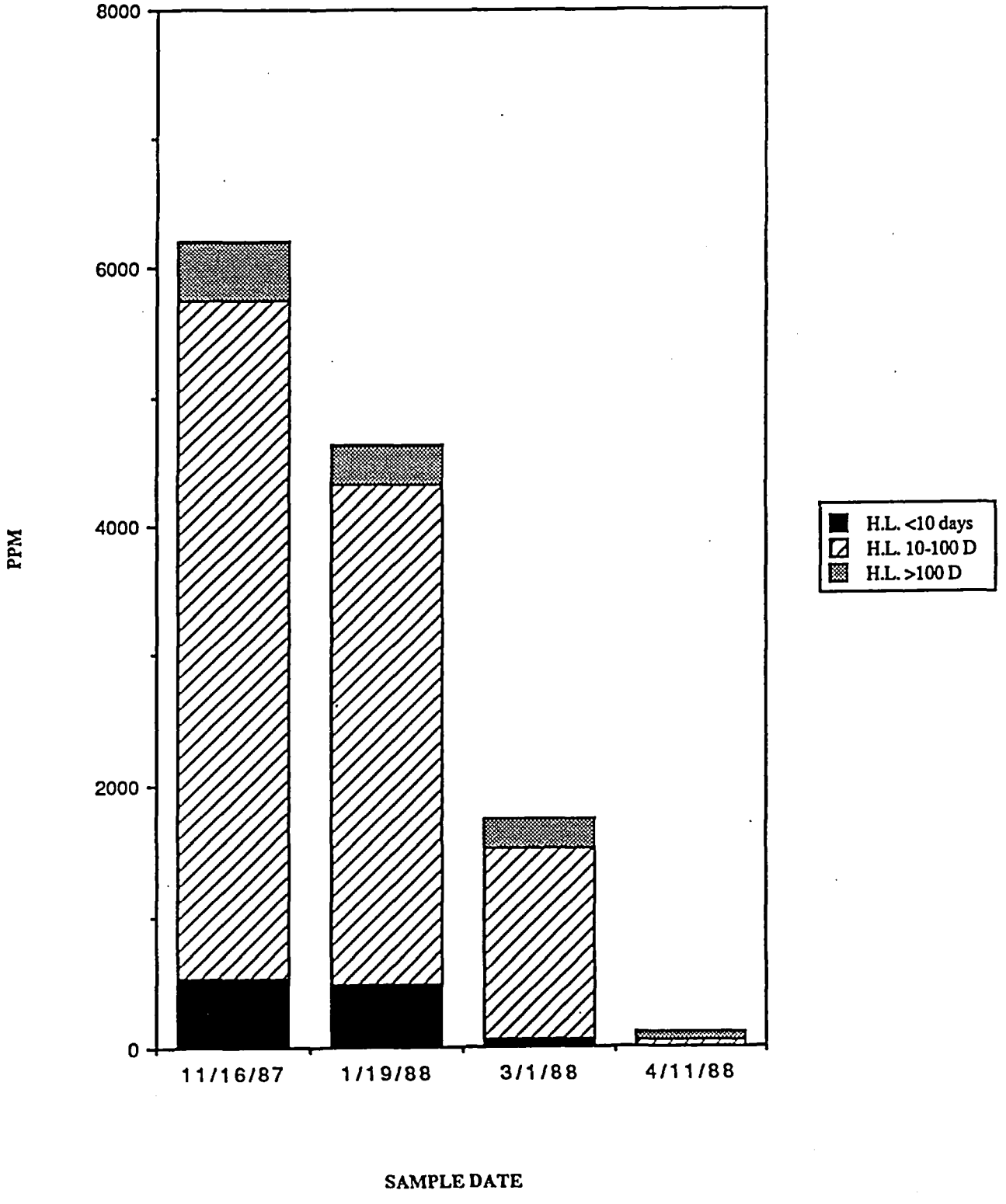


Figure A25. Total PAH Concentrations by Half-Lives in 0- to 3-Inch Soil Samples Collected in Landfarm 2 Between Subsequent Soil Applications Made on November 10, 1987 and April 28, 1988

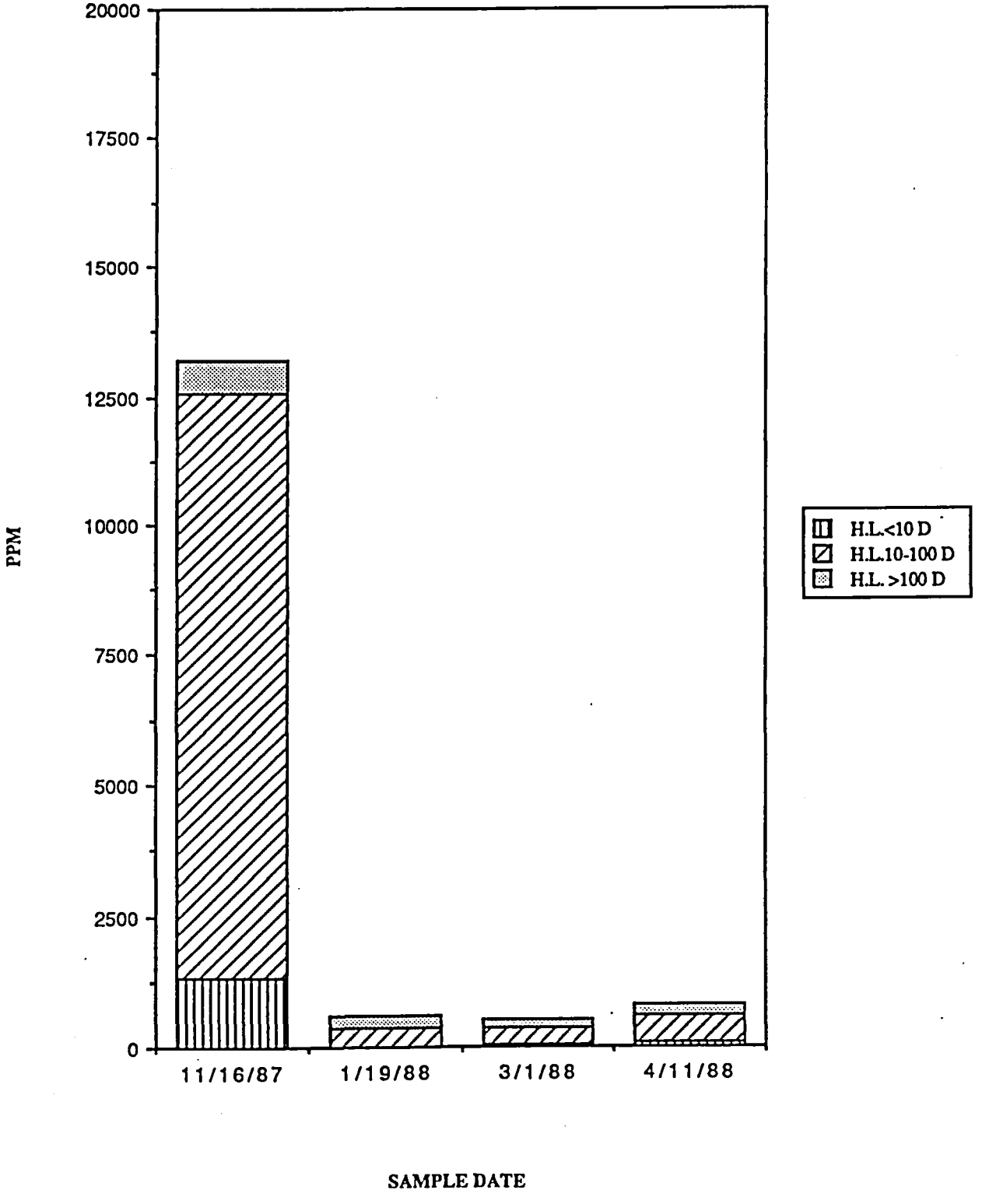


Figure A26. Pentachlorophenol Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on November 9, 1987 and April 20, 1988

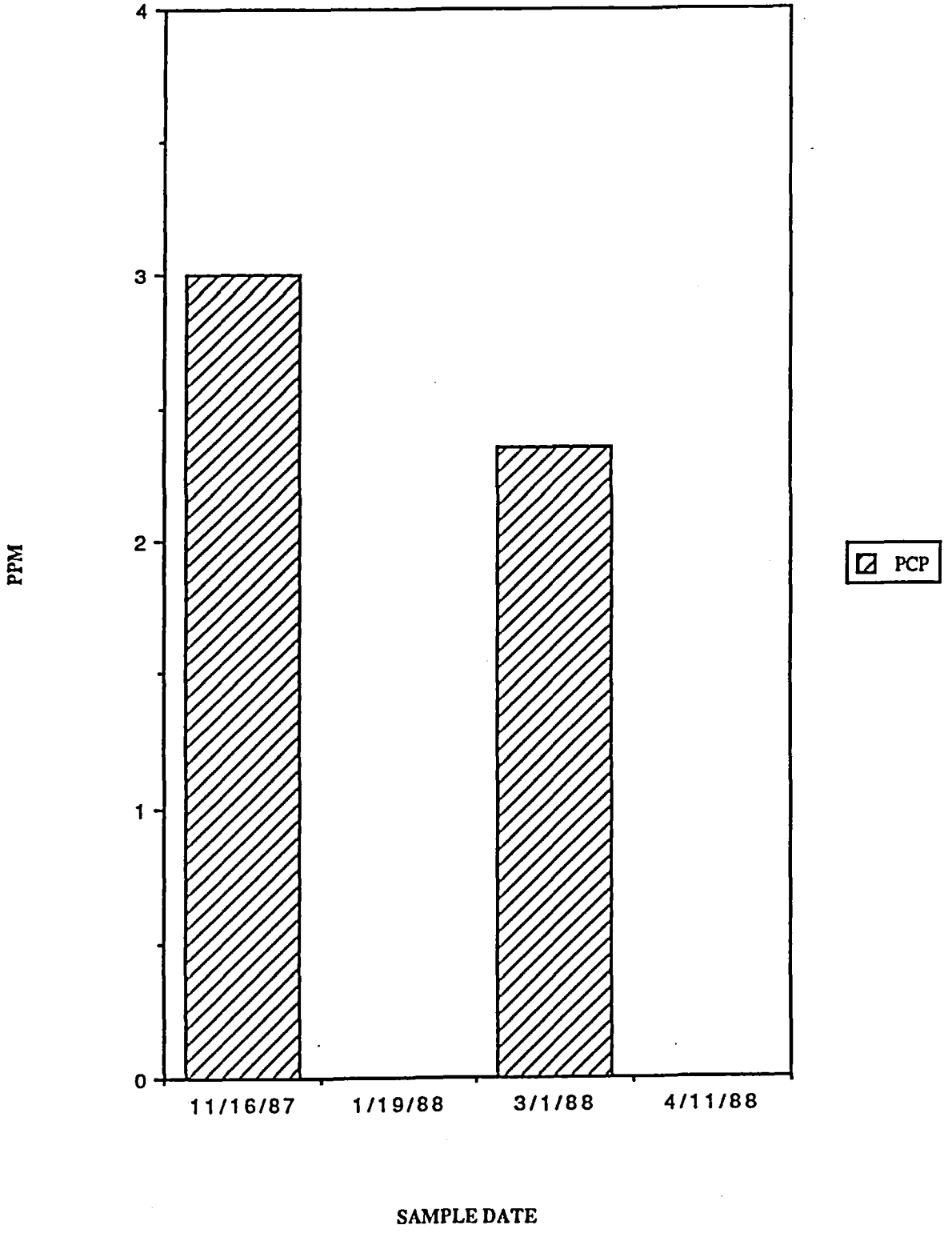


Figure A27. Pentachlorophenol Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 2 Between Subsequent Soil Applications Made on November 10, 1987 and April 28, 1988

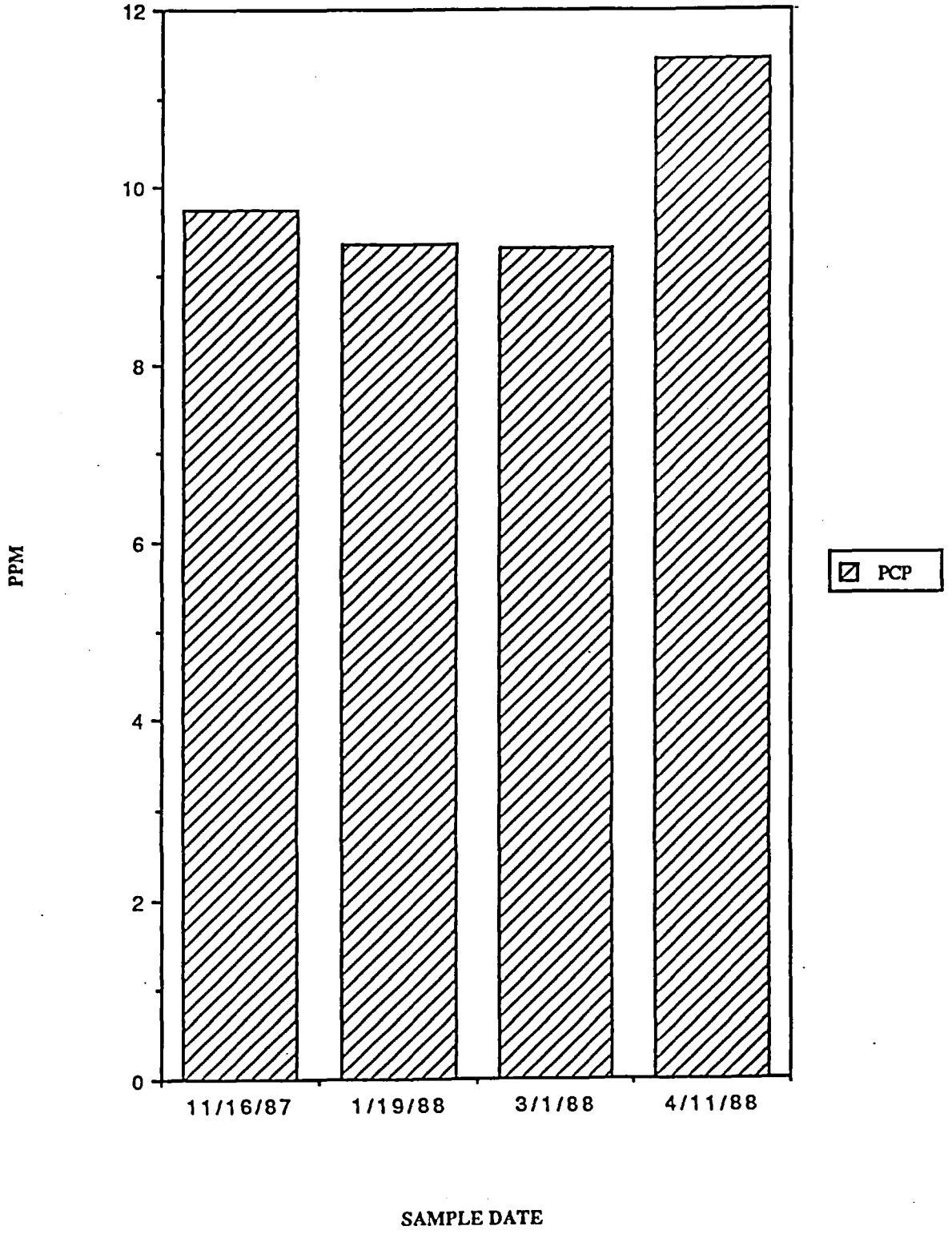


Figure A28. Total PAH Concentrations by Half-Lives in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 15 and October 4, 1988

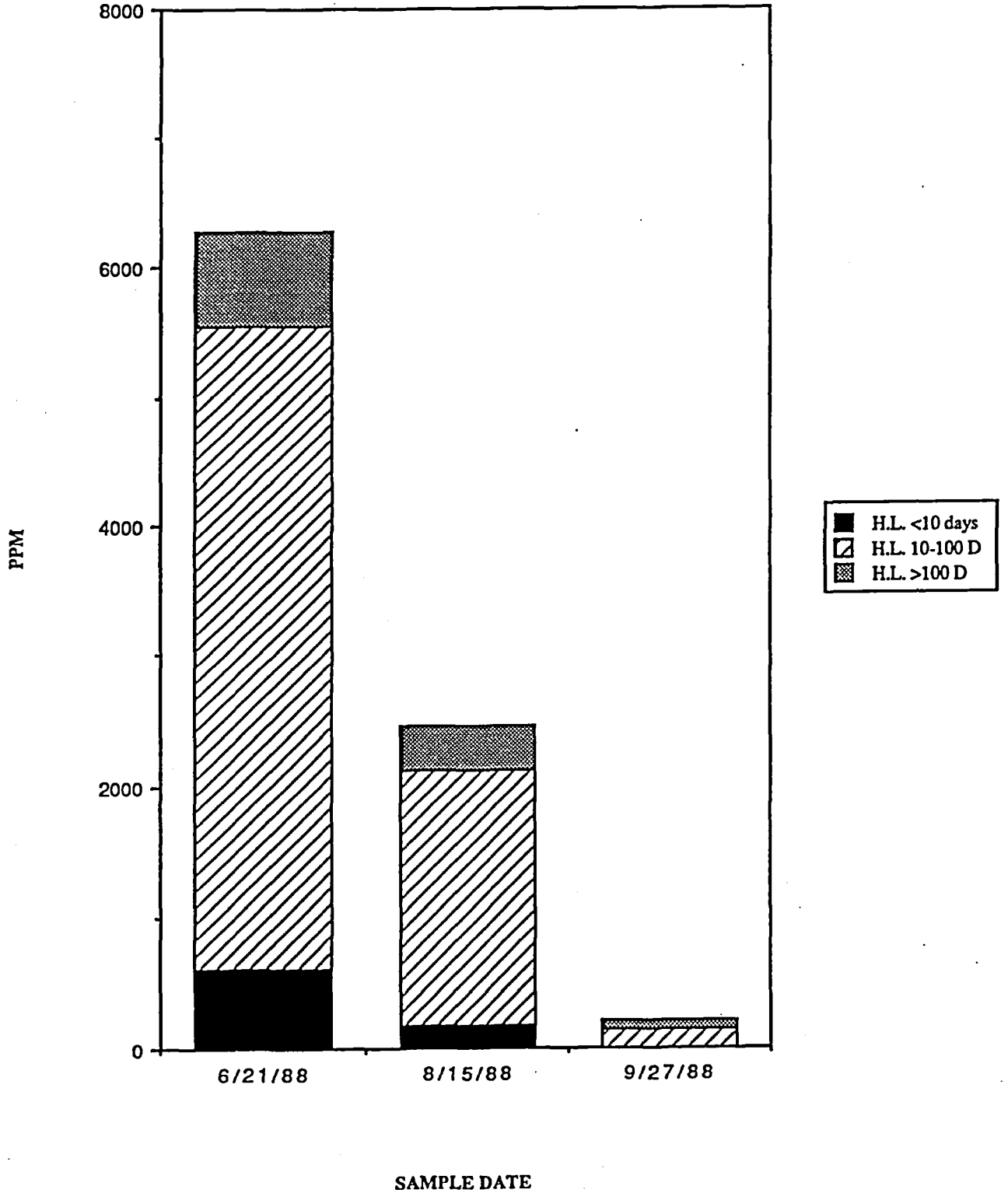


Figure A29. Total PAH Concentrations by Half-Lives in 0- to 3-Inch Soil Samples Collected in Landfarm 2 Between Subsequent Soil Applications Made on June 20 and October 4, 1988

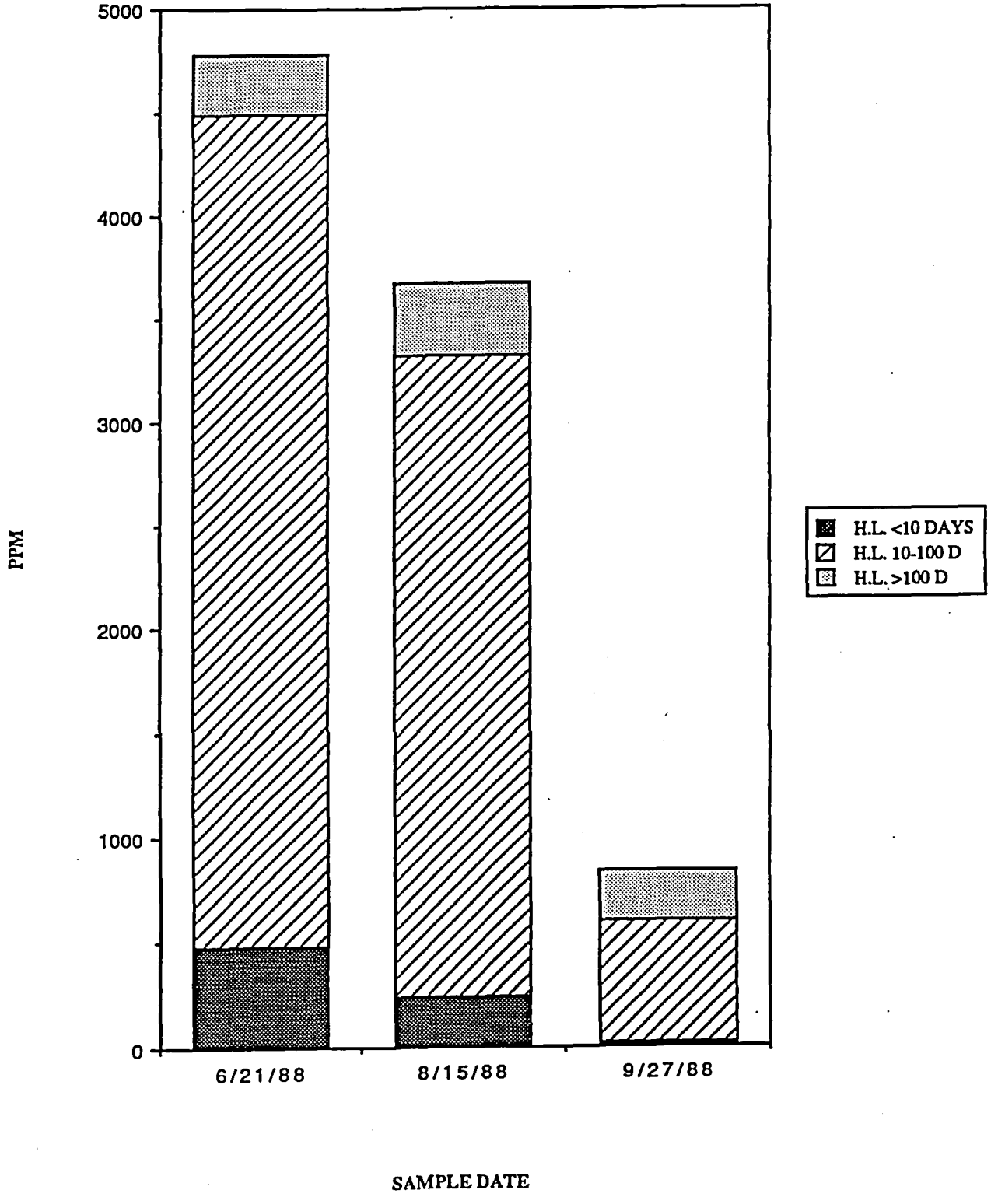


Figure A30. Pentachlorophenol Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 1 Between Subsequent Soil Applications Made on June 15 and October 4, 1988

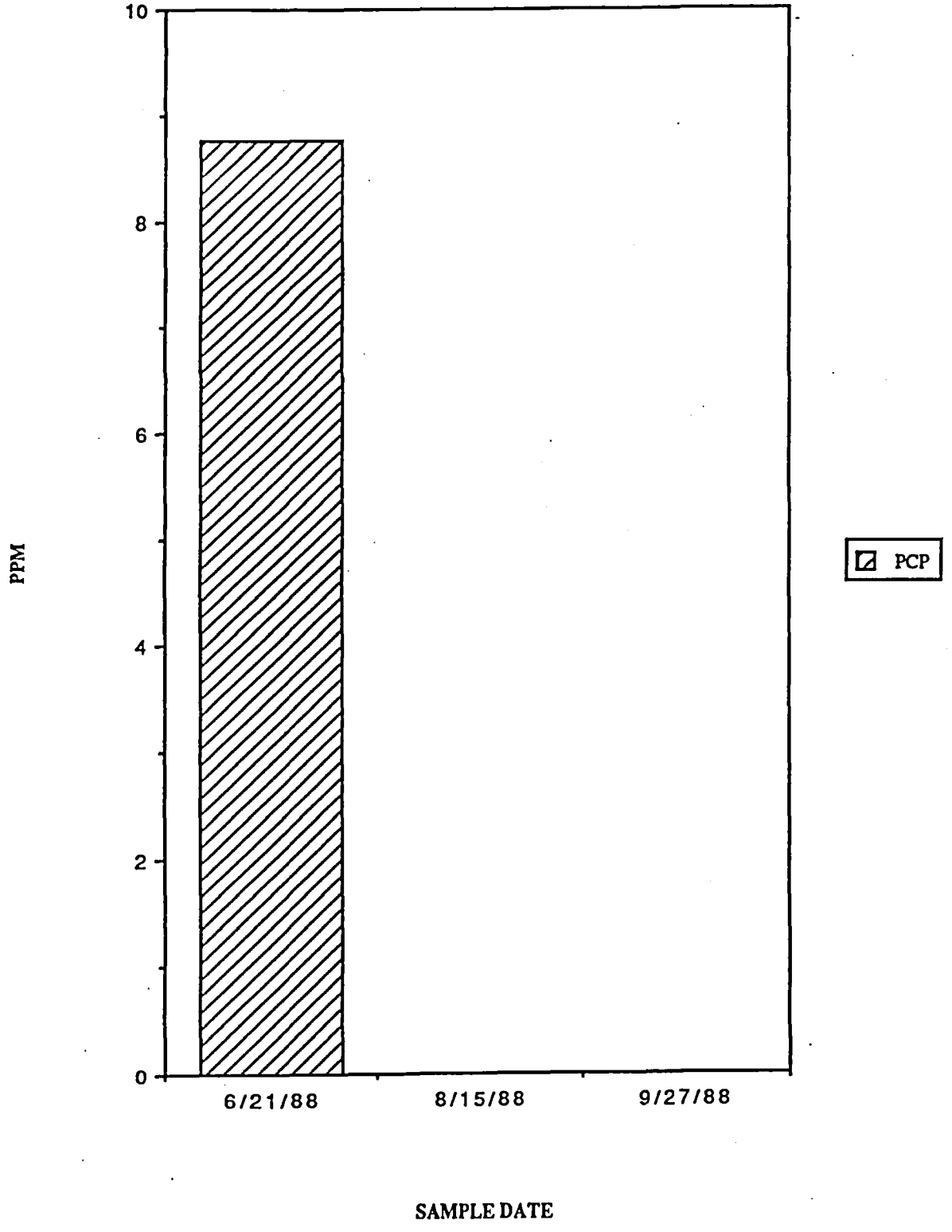
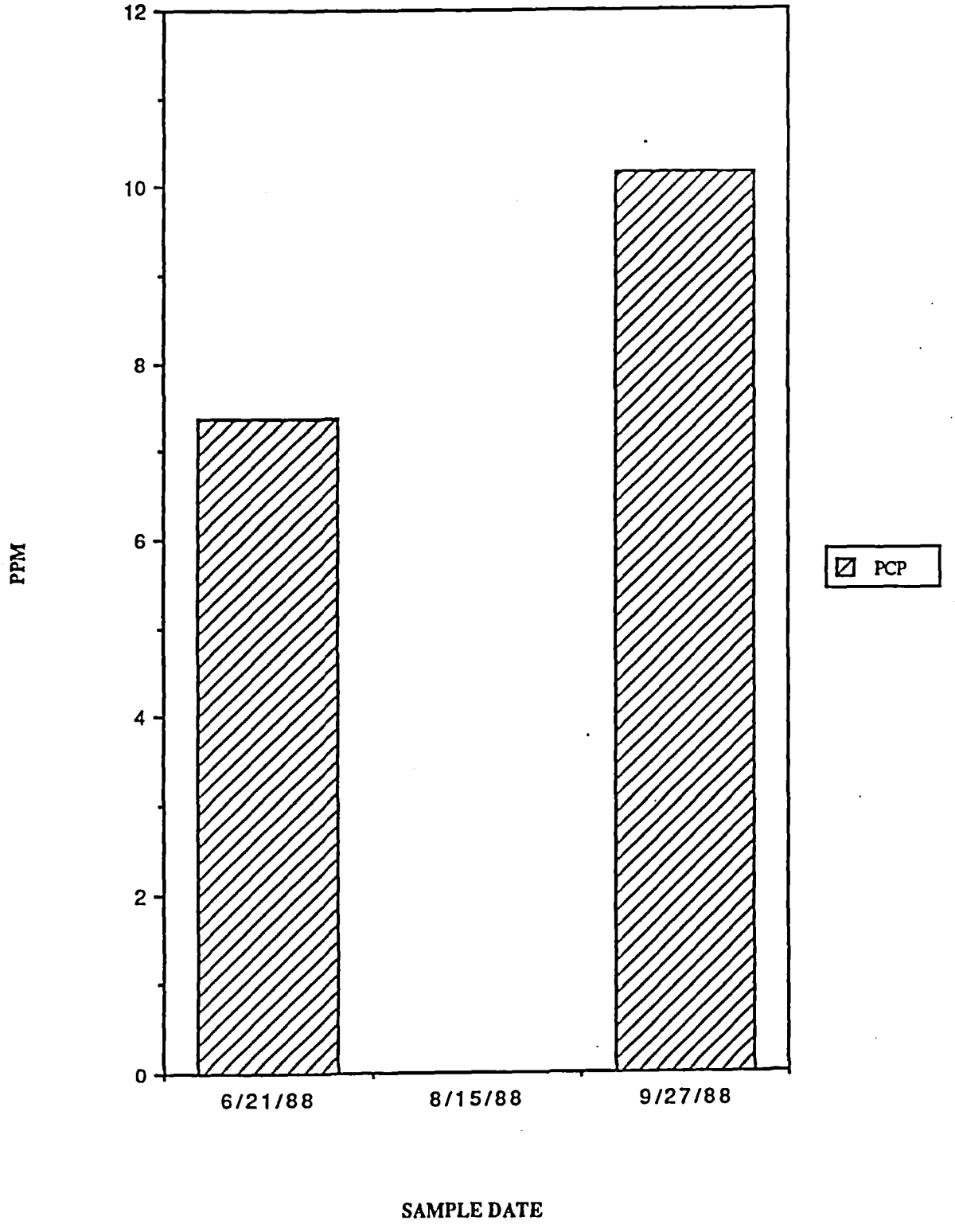


Figure A31. Pentachlorophenol Concentrations in 0- to 3-Inch Soil Samples Collected in Landfarm 2 Between Subsequent Soil Applications Made on June 20 and October 4, 1988



APPENDIX B

Soil Physical Testing Results

1387swp

LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

October 30, 1990

Geraghty & Miller, Inc.
Koger Center Glenwood
3724 National Drive
Suite 228
Raleigh, North Carolina 27612

Attention: Mr. Charles E. Whipkey

Subject: Physical Testing of Soils
Geraghty & Miller, Inc. Project NC09001
Law Environmental, Inc. Job No. 41-8935.01
Lab No(s). 00456-00459

Dear Mr. Whipkey:

Testing has been completed for the four samples received on October 24,1990. Shipment was via Federal Express.

Please find the data summarized on the attached forms. The information provided applies only to the samples tested. Reproduction of the reports in part for distribution outside of your company is permitted only with authorization from Law Environmental, Inc.

The excess samples will be returned to you.

If we can be of further assistance please contact us at (404)425-7879.

Sincerely,

LAW ENVIRONMENTAL,INC.

Michael A. O'Kelley

Michael A. O'Kelley
Physical Laboratory Supervisor

MAOK/mao
Enclosures

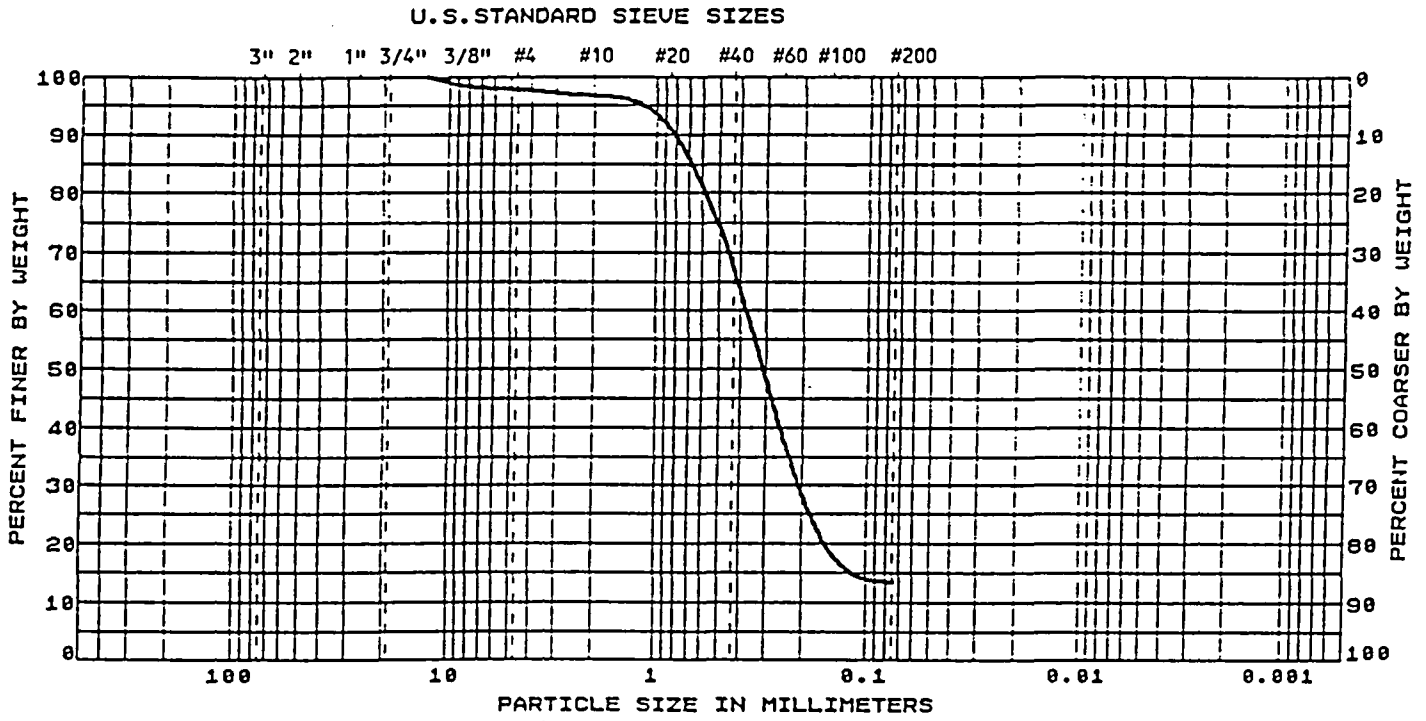
LAW ENVIRONMENTAL, INC.
300 CHASTAIN CNTR BLVD, SUITE 315
KENNESAW, GEORGIA 30144
404-425-7879

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Geraghty and Miller, Inc.
3724 National Dr., Ste. 228
Raleigh, North Carolina 27612

JOB NO. 41-8935.01
LAB NO. 00456
PROJECT GM Project NC27612
SAMPLE ID LF1-8

DATE October 30, 1990
PAGE 1



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75			0.050
2"	50			0.020
1-1/2"	37.5			0.005
1"	25			0.002
3/4"	19			0.001
1/2"	12.5	100.0		
3/8"	9.5	98.8		
#4	4.75	97.8		
#10	2.00	96.7		
#20	0.850	90.9		
#40	0.425	66.2		
#60	0.250	38.2		
#100	0.150	19.1		
#200	0.075	13.5		

POROSITY (%)
EFFECTIVE SIZE (mm)
COEFFICIENT OF UNIFORMITY
COEFFICIENT OF CURVATURE
LIQUID LIMIT NP
PLASTIC LIMIT NP
PLASTICITY INDEX NP
CLASSIFICATION SILTY SAND (SM)

WATER CONTENT (%)
DRY DENSITY (PCF)
SPECIFIC GRAVITY
HYDRAULIC CONDUCTIVITY (cm/sec - 20C)
TEST PROCEDURES: ASTM D422, D2487.

LAW ENVIRONMENTAL, INC.
M.A. O'Kelley

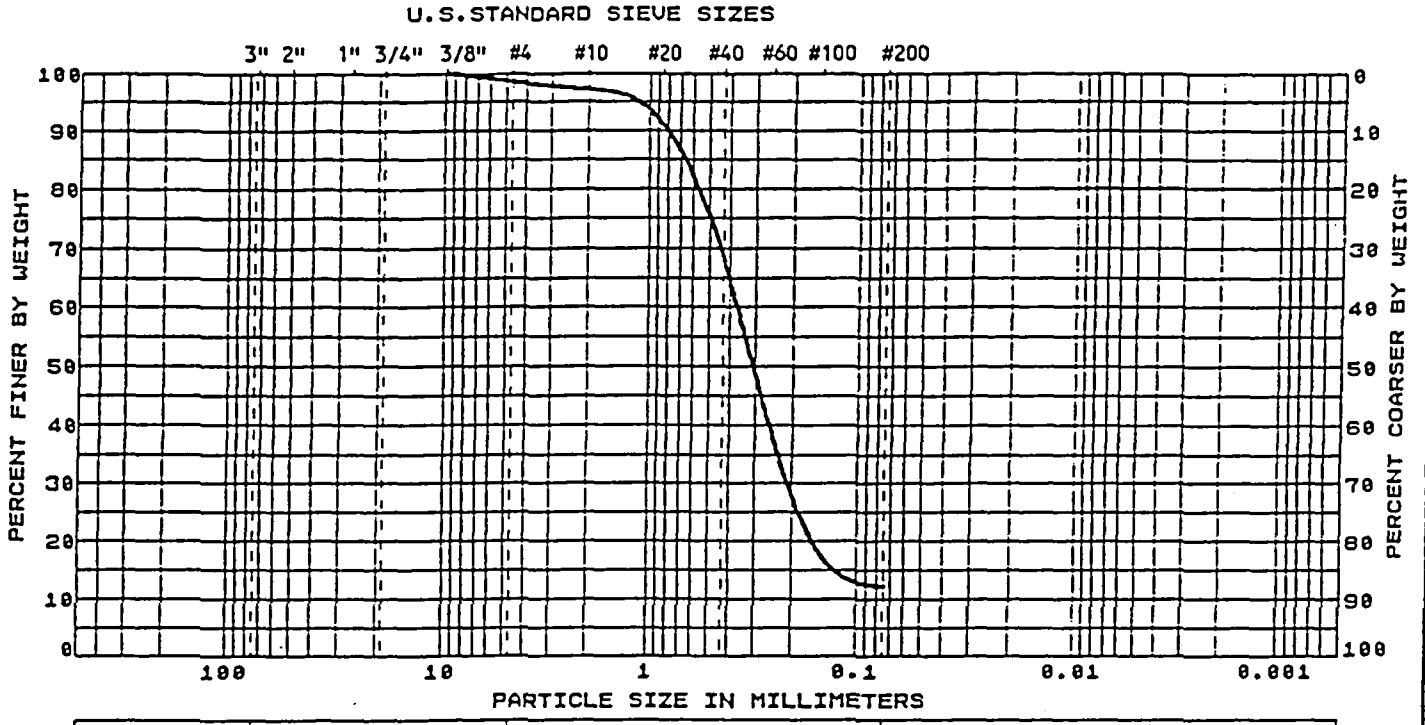
LAW ENVIRONMENTAL, INC.
300 CHASTAIN CNTR BLVD, SUITE 315
KENNESAW, GEORGIA 30144
404-425-7879

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Geraghty and Miller, Inc.
3724 National Dr., Ste. 228
Raleigh, North Carolina 27612

JOB NO. 41-8935.01
LAB NO. 00457
PROJECT GM Project NC27612
SAMPLE ID LF2-8

DATE October 30, 1990
PAGE 2



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75			0.050
2"	50			0.020
1-1/2"	37.5			0.005
1"	25			0.002
3/4"	19			0.001
1/2"	12.5			
3/8"	9.5	100.0		
#4	4.75	98.6		
#10	2.00	97.2		
#20	0.850	91.2		
#40	0.425	67.3		
#60	0.250	38.0		
#100	0.150	18.2		
#200	0.075	12.1		

POROSITY (%)
EFFECTIVE SIZE (mm)
COEFFICIENT OF UNIFORMITY 5.3
COEFFICIENT OF CURVATURE 1.6
LIQUID LIMIT NP
PLASTIC LIMIT NP
PLASTICITY INDEX NP
CLASSIFICATION POORLY GRADED SAND with SILT (SP-SM)
WATER CONTENT (%)
DRY DENSITY (PCF)
SPECIFIC GRAVITY
HYDRAULIC CONDUCTIVITY (cm/sec - 20C)
TEST PROCEDURES: ASTM D422, D2487.

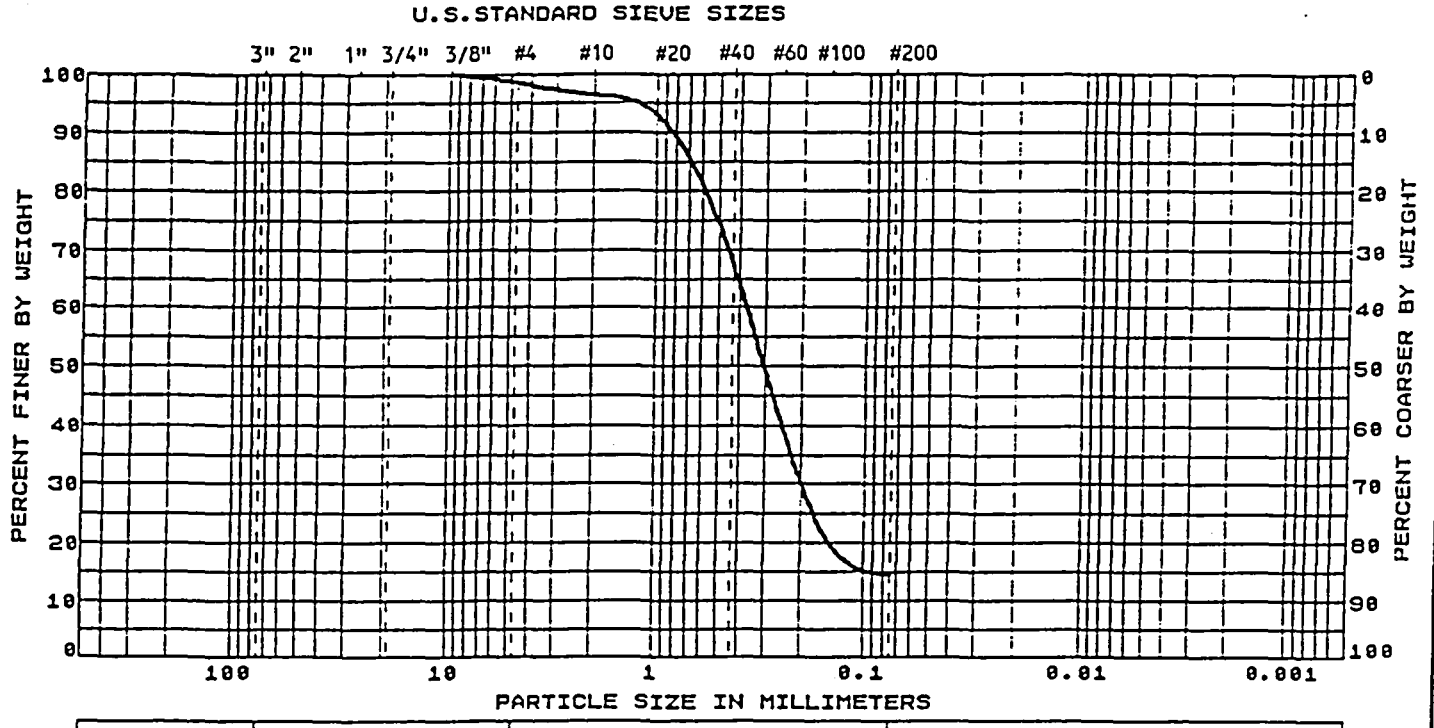
LAW ENVIRONMENTAL, INC.
M.A. O'Kelly

LAW ENVIRONMENTAL, INC.
300 CHASTAIN CNTR BLVD, SUITE 315
KENNESAW, GEORGIA 30144
404-425-7879

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Geraghty and Miller, Inc.
3724 National Dr., Ste. 228
Raleigh, North Carolina 27612

JOB NO. 41-8935.01 DATE October 30, 1990
LAB NO. 00458 PAGE 3
PROJECT GM Project NC27612
SAMPLE ID LF1-D



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75			0.050
2"	50			0.020
1-1/2"	37.5			0.005
1"	25			0.002
3/4"	19			0.001
1/2"	12.5			
3/8"	9.5	100.0		
#4	4.75	98.5		
#10	2.00	96.4		
#20	0.850	90.5		
#40	0.425	66.5		
#60	0.250	39.7		
#100	0.150	20.7		
#200	0.075	14.5		

POROSITY (%)
EFFECTIVE SIZE (mm)
COEFFICIENT OF UNIFORMITY
COEFFICIENT OF CURVATURE
LIQUID LIMIT NP
PLASTIC LIMIT NP
PLASTICITY INDEX NP
CLASSIFICATION SILTY SAND (SM)

WATER CONTENT (%)
DRY DENSITY (PCF)
SPECIFIC GRAVITY
HYDRAULIC CONDUCTIVITY (cm/sec - 20C)
TEST PROCEDURES: ASTM D422, D2487.

LAW ENVIRONMENTAL, INC.
M.A. O'Kelley

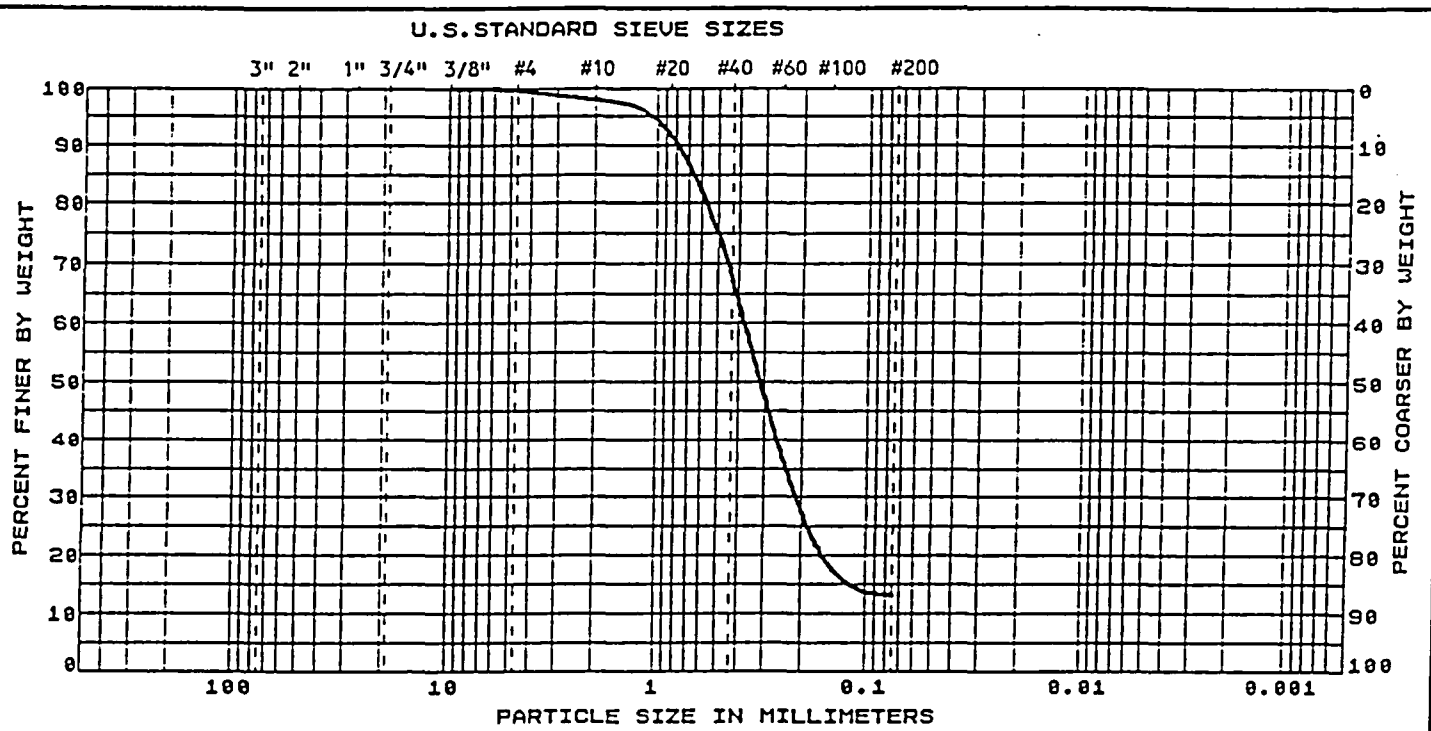
LAW ENVIRONMENTAL, INC.
300 CHASTAIN CNTR BLVD, SUITE 315
KENNESAW, GEORGIA 30144
404-425-7879

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Geraghty and Miller, Inc.
3724 National Dr., Ste. 228
Raleigh, North Carolina 27612

JOB NO. 41-8935.01
LAB NO. 00459
PROJECT GM Project NC27612
SAMPLE ID LF2-D

DATE October 30, 1990
PAGE 4



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75			0.050
2"	50			0.020
1-1/2"	37.5			0.005
1"	25			0.002
3/4"	19			0.001
1/2"	12.5			
3/8"	9.5	100.0		
#4	4.75	99.6		
#10	2.00	97.9		
#20	0.850	91.7		
#40	0.425	66.5		
#60	0.250	37.1		
#100	0.150	18.6		
#200	0.075	13.1		

POROSITY (%)
EFFECTIVE SIZE (mm)
COEFFICIENT OF UNIFORMITY
COEFFICIENT OF CURVATURE
LIQUID LIMIT NP
PLASTIC LIMIT NP
PLASTICITY INDEX NP
CLASSIFICATION SILTY SAND (SM)

WATER CONTENT (%)
DRY DENSITY (PCF)
SPECIFIC GRAVITY
HYDRAULIC CONDUCTIVITY (cm/sec - 20C)
TEST PROCEDURES: ASTM D422, D2487.

LAW ENVIRONMENTAL, INC.
M. A. O'Kelley

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 10/31/90
Page 1

--- Project Information ---

Lab Number : 90-7131-01
Project No. : 4142 Cust. No. :
Project Name : GERAGHTY & MILLER NCO-9001

Manager: MIKE O'KELLY

--- Sample Information ---

Station ID : LF1-B
Matrix : SO
Type : GRAB
Collector : C

Sampled Date/Time : / /
Received Date/Time : 10/24/90 12:45
Received From/By : JM/KOP
Chain of Custody : 0
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Analy
-- INORGANIC CHEMISTRY RESULTS --						
Loss on Ignition	ASTM	wt %		4.8	10/29/90	GW

Signed

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 10/31/90
Page 1

--- Project Information ---

Lab Number : 90-7131-02
Project No. : 4142
Cust. No. :
Project Name : GERAGHTY & MILLER NCO-9001

Manager: MIKE O'KELLY

--- Sample Information ---

Station ID : LF2-B
Matrix : SO
Type : GRAB
Collector : C

Sampled Date/Time : / /
Received Date/Time : 10/24/90 12:45
Received From/By : JM/KOP
Chain of Custody : 0
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Analy
-- INORGANIC CHEMISTRY RESULTS --						
Loss on Ignition	ASTM	wt %		5.7	10/29/90	GW

Signed

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 10/31/90
Page 1

--- Project Information ---

Lab Number : 90-7131-03
Project No. : 4142 Cust. No. :
Project Name : GERAGHTY & MILLER NCO-9001

Manager: MIKE O'KELLY

--- Sample Information ---

Station ID : LF1-D
Matrix : SO
Type : GRAB
Collector : C

Sampled Date/Time : / /
Received Date/Time : 10/24/90 12:45
Received From/By : JM/KOP
Chain of Custody : 0
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Analy
-- INORGANIC CHEMISTRY RESULTS --						
Loss on Ignition	ASTM	wt %		4.8	10/29/90	GW

Signed

LAW ENVIRONMENTAL NATIONAL LABORATORIES
TEST DATA REPORT

Date 10/31/90
Page 1

--- Project Information ---

Lab Number : 90-7131-04
Project No. : 4142 Cust. No. :
Project Name : GERAGHTY & MILLER NCO-9001

Manager: MIKE O'KELLY

--- Sample Information ---

Station ID : LF2-D
Matrix : SO
Type : GRAB
Collector : C

Sampled Date/Time : / /
Received Date/Time : 10/24/90 12:45
Received From/By : JM/KOP
Chain of Custody : 0
Number of Containers : 1

Remarks :

--- Test Data ---

Parameter	Method	Units	PQL	Results	Test Date	Analy
-- INORGANIC CHEMISTRY RESULTS --						
Loss on Ignition	ASTM	wt %		46	10/29/90	GW

Signed

LAW ENVIRONMENTAL, INC.
112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

November 8, 1990

Geraghty & Miller, Inc.
Koger Center Gleenwood
Suite 228
3724 National Drive
Raleigh, North Carolina 27612

Attention: Mr. Charles E. Whipkey

Subject: Physical Testing of Soils
Geraghty & Miller, Inc. Project NC09001
Law Environmental, Inc. Job No. 41-8935.01
Lab No(s). 00458

Dear Mr. Whipkey

We have completed the hydrometer analysis for your sample. Please find the report form attached. Because we have already performed a sieve analysis on this sample the cost will only be for the hydrometer portion, $58.00. The invoice will be prepared shortly.

The information provided applies only to the samples tested. Reproduction of the reports in part for distribution outside of your company is permitted only with authorization from Law Environmental, Inc.

The excess samples will be returned to you.

If we can be of further assistance please contact us at (404)425-7879.

Sincerely,

LAW ENVIRONMENTAL, INC.

Michael A. O'Kelley

Michael A. O'Kelley
Physical Laboratory Supervisor

MAOK/mao
Enclosures

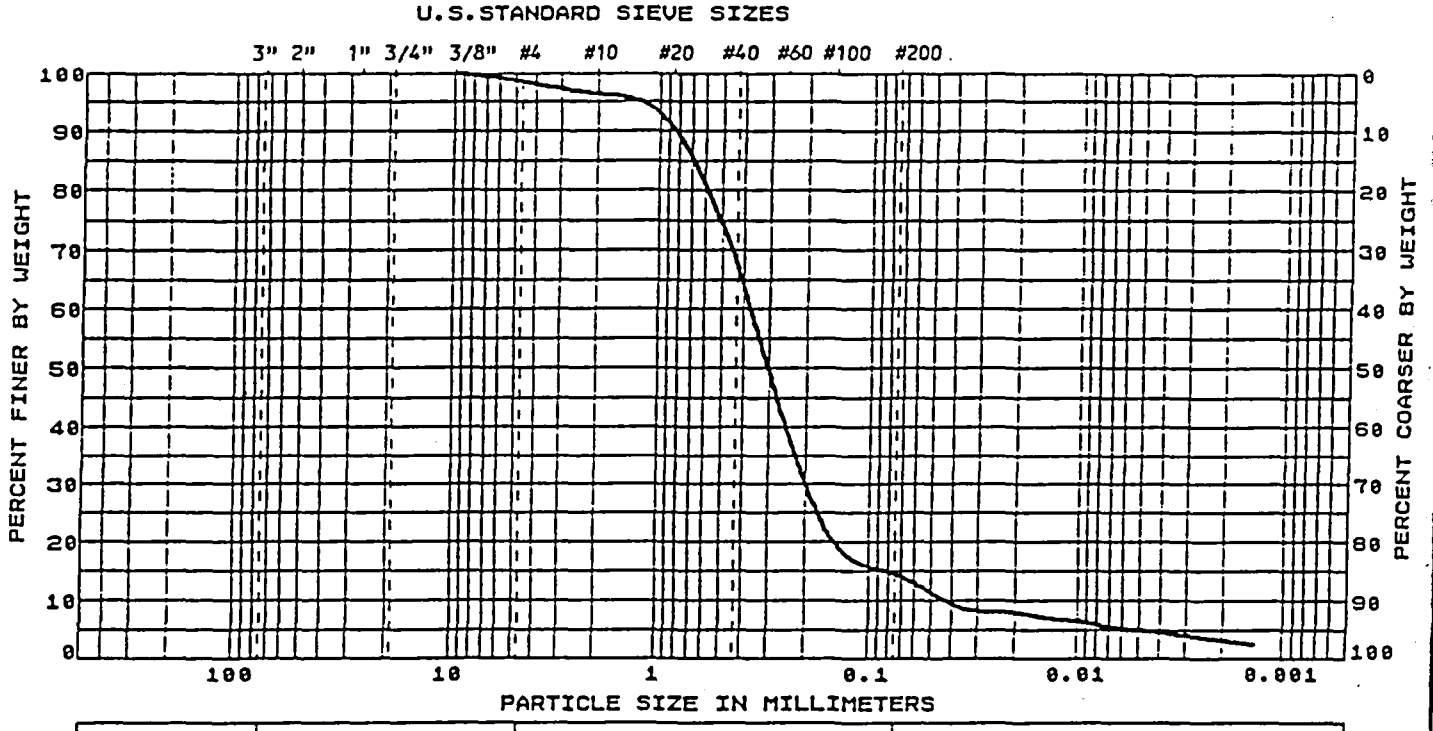
LAW ENVIRONMENTAL, INC.
300 CHASTAIN CNTR BLVD, SUITE 315
KENNESAW, GEORGIA 30144
404-425-7879

PARTICLE SIZE DISTRIBUTION & PHYSICAL PROPERTIES

CLIENT Geraghty and Miller, Inc.
3724 National Dr., Ste. 228
Raleigh, North Carolina 27612

JOB NO. 41-8935.01
LAB NO. 00458
PROJECT GM Project NC27612
SAMPLE ID LF1-D

DATE November 8, 1990
PAGE 1



COBBLES	GRAVEL		SAND			SILT & CLAY
	COARSE	MEDIUM	CO.	MEDIUM	FINE	

U.S.STANDARD SIEVE SIZE		PERCENT PASSING		HYDROMETER
SIEVE NO.	SIEVE SIZE (MILLIMETERS)			PARTICLE DIAMETER (MILLIMETERS)
3"	75		11.5	0.050
2"	50		7.7	0.020
1-1/2"	37.5		4.9	0.005
1"	25		3.2	0.002
3/4"	19			0.001
1/2"	12.5			
3/8"	9.5	100.0		
#4	4.75	98.5		
#10	2.00	96.4		
#20	0.850	90.5		
#40	0.425	66.5		
#60	0.250	39.7		
#100	0.150	20.7		
#200	0.075	14.5		

POROSITY (%)
EFFECTIVE SIZE (mm)
COEFFICIENT OF UNIFORMITY
COEFFICIENT OF CURVATURE
LIQUID LIMIT NP
PLASTIC LIMIT NP
PLASTICITY INDEX NP
CLASSIFICATION SILTY SAND (SM)

WATER CONTENT (%)
DRY DENSITY (PCF)
SPECIFIC GRAVITY
HYDRAULIC CONDUCTIVITY (cm/sec - 20C)
TEST PROCEDURES: ASTM D422, D2487.

LAW ENVIRONMENTAL, INC.
M.A. O'Kelley

APPENDIX C

Ground-Water Sampling Logs

1387swp

GERAGHTY & MILLER, INC.
Environmental Services

Page ___ of ___

WATER SAMPLING LOG

Project/No. NC09001 Date 10/9/90
Site Location SWP - Wilmington
Site/Well No. MW-6 (~~MW-4~~) PK Rep./Field Blank No. ___
Weather Cloudy Sampling Began 1640 Ended 1730
Description of Measuring Point (MP) TOC
MP Elevation 5.12 'msl Water Level Elevation 1.82

Evacuation Data

Height of MP ___
Depth of Well Below MP 21.40
Held ___ Depth to Water Below MP - 3.30
Wet ___ Water Column in Well = 18.10
Casing Diameter ___ Gal./ft. x 0.16
Gallons in Well = 2.90 ~ 3.0
Evacuation Volume x 3 = ___

Gallons	3.0	6.0	9.0			
pH	6.02	6.04	6.09			
Spec. Conductance	1350	1950	2050			
Temperature (°C/°F)	23	23	22.5			

Sampling Data/Field Parameters

Color ___ Odor ___ Appearance Slightly Cloudy 1730
Comments: ___
Spec. Cond. (umhos/cm) 2100 pH 6.12 T(°C/°F) 23
Sampling Method Disposable Bailer

Analyses	Container Type (Lab ✓ G&M ___)	Preservative
Kool	1 Liter Amber Glass	4°c
TN TP	250 ml Plastic	H_2SO_4
TSS	100 ml Plastic	4°c
TOC	250 ml Plastic	H_2SO_4
Cl^-	250 ml Plastic	4°c

Remarks: ___

Sampling Personnel: G. D. Rumford

GERAGHTY & MILLER, INC.
Environmental Services

WATER SAMPLING LOG

Project/No. NCO 9001 Date 10/9/90
Site Location SWP - Wilmington
Site/Well No. MW-9 (MW-1) Rep./Field Blank No.
Weather Sunny 80's Sampling Began 1300 Ended 1430
Description of Measuring Point (MP) TOC
MP Elevation 6.49 Water Level Elevation 2.01

Evacuation Data

Height of MP			
Depth of Well Below MP			21.42
Held ____	Depth to Water Below MP	-	4.48
Wet ____	Water Column in Well	=	16.94
Casing Diameter ____	Gal./ft.	x	0.16
Gallons in Well		=	2.71 ~ 3.0
Evacuation Volume	x ____	=	

Gallons	2.0	4	6			
pH	5.72	5.76	5.86			
Spec. Conductance	550	600	600			
Temperature (°C/°F)	24	23	23			

Sampling Data/Field Parameters

1430

Color None Odor Sulfide Appearance Cloudy
Comments:
Spec. Cond. (umhos/cm) 700 pH 6.05 T (°C/°F) ~~20~~ 25
Sampling Method Disposable Bailer

Analyses	Container Type (Lab ___ G&M ___)	Preservative
KOOL	1 Liter Amber Glass	4°C
TN TP	250 ml Plastic	H_2SO_4
TSS	100 ml Plastic	4°C
TOC	250 ml Plastic	H_2SO_4
Cl^-	250 ml Plastic	4°C

Remarks:

Sampling Personnel: G.D. Rumford

GERAGHTY & MILLER, INC.
Environmental Services

WATER SAMPLING LOG

Project/No. NCO 9001 Date 10/9/90
Site Location SWP - Wilmington
Site/Well No. MW-8 (~~MW-2~~) Rep./Field Blank No.
Weather Cloudy Sampling Began 1445 Ended 1530
Description of Measuring Point (MP) TOC
MP Elevation 6.86' msl Water Level Elevation 2.12' msl

Evacuation Data

Height of MP			
Depth of Well Below MP			21.42
Held _____ Depth to Water Below MP		-	4.74
Wet _____ Water Column in Well		=	16.68
Casing Diameter _____	Gal./ft.	x	.16
Gallons in Well		=	2.67 ~2.6
Evacuation Volume	x 3	=	

Gallons	2.0	4.0	6.0			
pH	5.76	5.73	5.81			
Spec. Conductance	600	600	600			
Temperature (°C/°F)	24	23	23			

Sampling Data/Field Parameters

Color _____ Odor Sulfide Appearance _____ 1530
Comments: organic Coloration
Spec. Cond. (umhos/cm) 600 pH 5.87 T (°C/°F) 23
Sampling Method Disposable Bailer

Analyses	Container Type (Lab __G&M__)	Preservative
KOOL	1 Liter Amber Glass	4°c
TN TP	250 ml Plastic	H_2SO_4
TSS	100 ml Plastic	4°c
TOC	250 ml Plastic	H_2SO_4
Cl^-	250 ml Plastic	4°c

Remarks:

Sampling Personnel: G.D. Rumford

GERAGHTY & MILLER, INC.
Environmental Services

WATER SAMPLING LOG

Project/No. NC09001 Date 10/4/90
Site Location SWP - Wilmington
Site/Well No. MW-7 (~~MW-3~~) Rep./Field Blank No. _____
Weather overcast 70° Sampling Began 1550 Ended 1630
Description of Measuring Point (MP) TOC
MP Elevation 6.09 Water Level Elevation 1.79

Evacuation Data

Height of MP			
Depth of Well Below MP			21.38
Held _____	Depth to Water Below MP	-	4.30
Wet _____	Water Column in Well	=	17.08
Casing Diameter _____	Gal./ft.	x	0.16
Gallons in Well		=	2.73
Evacuation Volume	x 3	=	

Gallons	2.0	4.0	6.0				1630
pH	5.92	5.84	6.08				
Spec. Conductance	800	800	850				
Temperature (°C/°F)	24	23	23				

Sampling Data/Field Parameters

Color Brown Odor Sulfide Appearance Cloudy 1630
Comments: Sandy
Spec. Cond. (umhos/cm) 1000 pH 6.15 T(°C/°F) 24
Sampling Method Disposable Bailer

Analyses	Container Type (Lab __G&M__)	Preservative
VOC	1 Liter Amber Glass	4°c
TN TP	250 ml Plastic	H_2SO_4
TSS	100 ml Plastic	4°c
TOC	250 ml Plastic	H_2SO_4
Cl^-	250 ml Plastic	4°c

Remarks:

Sampling Personnel: G.D. Rumford

APPENDIX D

Analytical Laboratory Reports and Chain-of-Custody Forms

1387swp

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S0-12806

Received: 10 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12806-1	MW-9 (# 9112) 10-9-90	Client
12806-2	MW-8 (# 9113) 10-9-90	
12806-3	MW-7 (# 9114) 10-9-90	
12806-4	MW-6 (# 9115) 10-9-90	
12806-5	TB-1 10-9-90	

ARAMETER	12806-1	12806-2	12806-3	12806-4	12806-5
Semi Volatiles					
Naphthalene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
1-Methylnaphthalene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
1,1-Biphenyl, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenzofuran, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Carbazole, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)Anthracene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
Pentachlorophenol, mg/l	<0.050	<0.050	<0.050	<0.050	<0.050
Fluoranthene, mg/l	<0.010	<0.010	<0.010	<0.010	<0.010
% R Surrogate-2FP (CL 21-100)	46 %	36 %	42 %	25 %	30 %

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S0-12806

Received: 10 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12806-1	MW-9 (# 9112) 10-9-90	Client
12806-2	MW-8 (# 9113) 10-9-90	
12806-3	MW-7 (# 9114) 10-9-90	
12806-4	MW-10 (# 9115) 10-9-90	
12806-5	TB-1 10-9-90	

PARAMETER	12806-1	12806-2	12806-3	12806-4	12806-5
% R Surrogate-PHL (CL 10-94)	26 %	22 %	64 %	38 %	34 %
% R Surrogate-NBZ (CL 35-114)	46 %	50 %	65 %	56 %	54 %
% R Surrogate-2FBP (CL 43-116)	46 %	45 %	64 %	59 %	50 %
% R Surrogate-TBP (CL 10-123)	58 %	55 %	50 %	72 %	67 %
% R Surrogate-TPH (CL 33-141)	60 %	46 %	66 %	65 %	69 %
Date Extracted	10.16.90	10.16.90	10.16.90	10.16.90	10.16.90
Date Analyzed	10.18.90	10.18.90	10.18.90	10.18.90	10.18.90
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	6.7	10	7.2	11	<0.10
Nitrate + Nitrite-N, mg/l	<0.050	<0.050	<0.050	<0.050	<0.050
Total Nitrogen, mg/l	6.7	10	7.2	11	<0.10
Total Phosphorus, mg/l	0.35	0.51	0.47	1.0	<0.050
Suspended Solids, mg/l	30	220	130	68	<5.0
Total Organic Carbon, mg/l	20	26	22	13	<1.0
Chloride, mg/l	120	110	210	530	<1.0

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Received: 10 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12806-6	Method Blank (MB) Result	Client
12806-7	Lab Control Standard (LCS) Result	
12806-8	LCS Expected Value	
12806-9	LCS % Recovery	
12806-10	LCS % Recovery Limits	

PARAMETER	12806-6	12806-7	12806-8	12806-9	12806-10
Semi Volatiles					
Naphthalene, mg/l	<0.010	71	100	71 %	39-140 %
2-Methylnaphthalene, mg/l	<0.010	---	---	---	---
1-Methylnaphthalene, mg/l	<0.010	---	---	---	---
1,1-Biphenyl, mg/l	<0.010	---	---	---	---
Acenaphthylene, mg/l	<0.010	103	100	103 %	36-140 %
Acenaphthene, mg/l	<0.010	101	100	101 %	46-118 %
Dibenzofuran, mg/l	<0.010	---	---	---	---
Fluorene, mg/l	<0.010	---	---	---	---
Phenanthrene, mg/l	<0.010	114	100	114 %	54-140 %
Anthracene, mg/l	<0.010	105	100	105 %	40-140 %
Carbazole, mg/l	<0.010	---	---	---	---
Pyrene, mg/l	<0.010	---	---	---	---
Benzo(a)Anthracene, mg/l	<0.010	118	100	118 %	29-140 %
Chrysene, mg/l	<0.010	105	100	105 %	17-168 %
Benzo(a)pyrene, mg/l	<0.010	119	100	119 %	25-160 %
Benzo(g,h,i)perylene, mg/l	<0.010	---	---	---	---
Pentachlorophenol, mg/l	<0.050	77	100	77 %	9-103 %
Fluoranthene, mg/l	<0.010	96	100	96 %	26-140 %

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LOG NO: S0-12806

Received: 10 OCT 90

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Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12806-6	Method Blank (MB) Result	Client
12806-7	Lab Control Standard (LCS) Result	
12806-8	LCS Expected Value	
12806-9	LCS % Recovery	
12806-10	LCS % Recovery Limits	

PARAMETER	12806-6	12806-7	12806-8	12806-9	12806-10
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	<0.10	5.0	5.0	100 %	90-110 %
Nitrate + Nitrite-N, mg/l	<0.050	0.89	0.93	96 %	90-110 %
Total Nitrogen, mg/l	<0.10	---	---	---	---
Total Phosphorus, mg/l	<0.050	10.4	10	104 %	75-125 %
Suspended Solids, mg/l	<5.0	360	399	90 %	60-140 %
Total Organic Carbon, mg/l	<1.0	6.3	6.1	104 %	60-140 %
Chloride, mg/l	<1.0	211	222	95 %	90-110 %

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Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12806-11	Matrix Spike (MS) Result/Dup	Client
12806-12	MS Expected Value	
12806-13	MS % Recovery/Duplicate	
12806-14	MS % Recovery Limit	
12806-15	MS % RPD (Limit)	

PARAMETER	12806-11	12806-12	12806-13	12806-14	12806-15
Semi Volatiles					
Naphthalene, mg/l	103/98	100	103/98 %	39-140 %	5.0(<40)%
Acenaphthylene, mg/l	118/120	100	118/120 %	36-140 %	1.7(<40)%
Acenaphthene, mg/l	105/109	100	105/109 %	46-118 %	3.7(<31)%
Phenanthrene, mg/l	115/116	100	115/116 %	54-140 %	0.87(<40)%
Anthracene, mg/l	113/111	100	113/111 %	40-140 %	1.8(<40)%
Carbazole, mg/l	157/175	100	157/175 %	---	---
Benzo(a)Anthracene, mg/l	121/120	100	121/120 %	29-140 %	0.83(<40)%
Chrysene, mg/l	112/111	100	112/111 %	17-168 %	0.90(<48)%
Benzo(a)pyrene, mg/l	119/122	100	119/122 %	25-160 %	2.5(<40)%
Pentachlorophenol, mg/l	127/125	100	127/125 %	9-103 %	1.6(<50)%
Fluoranthene, mg/l	100/112	100	100/112 %	26-140 %	11(<40)%
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	4.18/4.18	4.0	105/105 %	75-125 %	0(<40)%
Nitrate + Nitrite-N, mg/l	.183/.184	0.20	91/92 %	75-125 %	1.1(<30)%
Total Nitrogen, mg/l	---	---	---	---	---
Total Phosphorus, mg/l	.514/.509	0.50	103/102 %	75/125 %	0.98(<30)%
Suspended Solids, mg/l	---	---	---	---	---
Total Organic Carbon, mg/l	124/126	100	124/126 %	60-140 %	1.6(<40)%
Chloride, mg/l	4.65/4.93	5.0	93/99 %	75-125 %	6.3(<30)%

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LOG NO: S0-12806

Received: 10 OCT 90

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Spartanburg, SC 29304

CC: Mark Radecke

Project: Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12806-16	Methods	Client

PARAMETER	12806-16
Semi Volatiles	
Naphthalene	8270
2-Methylnaphthalene	8270
1-Methylnaphthalene	8270
1,1-Biphenyl	8270
Acenaphthylene	8270
Acenaphthene	8270
Dibenzofuran	8270
Fluorene	8270
Phenanthrene	8270
Anthracene	8270
Carbazole	8270
Pyrene	8270
Benzo(a)Anthracene	8270
Chrysene	8270
Benzo(a)pyrene	8270
Benzo(g,h,i)perylene	8270
Pentachlorophenol	8270
Fluoranthene	8270
Nitrogen Series	
Total Kjeldahl Nitrogen-N	351.2
Nitrate + Nitrite-N	353.1
Total Phosphorus	365.1
Suspended Solids	160.2
Total Organic Carbon	415.1
Chloride	325.2

Methods: EPA SW-846 & 40 CFR Part 136

J. W. Andrews

J. W. Andrews, Ph. D.

GAUGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Project Number NC09001

Project Location WILMINGTON, NC

Laboratory SAVANNAH LABORATORIES

Sampler(s)/Affiliation M. RADECKE G&M
D. RUMFORD, III G&M

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	1 Liter amber glass 4°C *KOOL PAH's	250ml plastic 4°C Total N TOTAL P H2SO4	100ml plastic 4°C TSS	250ml amber glass 4°C TOC	250ml plastic 4°C H2SO4 Cl-					TOTAL
TB-1	L	10/9/90		1	1	1	1	1					5
MW9 / 9112	L	10/9/90 14:20		1	1	1	1	1					5
MW8 / 9113	L	10/9/90 15:30		1	1	1	1	1					5
MW7 / 9114	L	10/9/90 16:30		1	1	1	1	1					5
/ 9115	L	10/9/90		1	1	1	1	1					5
12806													

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 25

Relinquished by: Mark E. Radecke	Organization: Gaughty & Miller, Inc	10/9/90 19:00	Seal Intact? Yes No N/A
Received by: K. Bonds	Organization: Sav. Labs	Date 10/10/90 Time 10:30 am	
Relinquished by:	Organization:		Seal Intact? Yes No N/A
Received by:	Organization:	Date / / Time	

Special Instructions/Remarks: ~~*KOOL~~ PAH's Site Specific list + PCP

Kool changed to PAH's per Mark Radecke 10/24/90. GF

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other _____ (SPECIFY)

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: SO-12822

Received: 11 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-1	LF1BL (# 9101C) 10-10-90	Client
12822-2	LF1BU (# 9101A) 10-10-90	
12822-3	LF1BM (# 9101B) 10-10-90	
12822-4	LF1BS (# 9101D) 10-10-90	
12822-5	LF1ES (# 9104D) 10-10-90	

PARAMETER	12822-1	12822-2	12822-3	12822-4	12822-5
Semi Volatiles					
Naphthalene, mg/kg dw	<7.3	4.4J	12	<0.35	<0.34
2-Methylnaphthalene, mg/kg dw	<7.3	5.9J	15	<0.35	<0.34
1-Methylnaphthalene, mg/kg dw	<7.3	<7.4	<7.8	<0.35	<0.34
1,1-Biphenyl, mg/kg dw	<7.3	<7.4	<7.8	<0.35	<0.34
Acenaphthylene, mg/kg dw	<7.3	<7.4	<7.8	<0.35	<0.34
Acenaphthene, mg/kg dw	<7.3	<7.4	<7.8	<0.35	<0.34
Dibenzofuran, mg/kg dw	<7.3	6.7J	11	<0.35	<0.34
Fluorene, mg/kg dw	<7.3	4.9J	27	<0.35	<0.34
Phenanthrene, mg/kg dw	<7.3	36	41	<0.35	<0.34
Anthracene, mg/kg dw	4.6J	230	200	<0.35	<0.34
Carbazole, mg/kg dw	<7.3	46	90	<0.35	<0.34
Pyrene, mg/kg dw	20	50	27	<0.35	<0.34
Benzo(a)Anthracene, mg/kg dw	10	19	8.6	<0.35	<0.34
Chrysene, mg/kg dw	18	27	15	<0.35	<0.34
Benzo(a)pyrene, mg/kg dw	10	20	9.4	<0.35	<0.34
Benzo(g,h,i)perylene, mg/kg dw	3.9J	7.4	<7.8	<0.35	<0.34
Pentachlorophenol, mg/kg dw	<37	<37	<39	<1.8	<1.7
Fluoranthene, mg/kg dw	20	19	34	<0.35	<0.34
% R Surrogate-2FP (CL 21-100)	*	*	*	97 %	88 %

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S0-12822

Received: 11 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-1	LF1BL (# 9101C) 10-10-90	Client
12822-2	LF1BU (# 9101A) 10-10-90	
12822-3	LF1BM (# 9101B) 10-10-90	
12822-4	LF1BS (# 9101D) 10-10-90	
12822-5	LF1ES (# 9104D) 10-10-90	

PARAMETER	12822-1	12822-2	12822-3	12822-4	12822-5
% R Surrogate-PHL (CL 10-94)	*	*	*	87 %	80 %
% R Surrogate-NBZ (CL 35-114)	*	*	*	94 %	91 %
% R Surrogate-2FBP (CL 43-116)	*	*	*	104 %	101 %
% R Surrogate-TBP (CL 10-123)	*	*	*	81 %	90 %
% R Surrogate-TPH (CL 33-141)	*	*	*	103 %	89 %
Date Extracted	10.23.90	10.23.90	10.23.90	10.23.90	10.23.90
Date Analyzed	11.01.90	11.01.90	11.01.90	11.01.90	11.01.90
pH, units	7.7	6.5	6.5	8.0	7.3
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	7500	1600	1600	88	<15
Nitrate + Nitrite-N, mg/kg dw	8.2	<2.0	16	<2.0	<2.0
Total Nitrogen, mg/kg dw	7500	1600	1600	88	<15
Total Phosphorus, mg/kg dw	450	1100	840	42	88
Total Organic Carbon, mg/kg dw	15000	32000	26000	120	<0.50
Chloride, mg/kg dw	26	29	28	<20	21
Percent Solids, %	90 %	82 %	84 %	95 %	97 %

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Received: 11 OCT 90

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Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-6	LF1EM (# 9104B) 10-10-90	Client
12822-7	LF1EL (# 9104C) 10-10-90	
12822-8	LF1EU (# 9104A) 10-10-90	
12822-9	LF1CU (# 9102A) 10-10-90	
12822-10	LF1CM (# 9102B) 10-10-90	

PARAMETER	12822-6	12822-7	12822-8	12822-9	12822-10
Semi Volatiles					
Naphthalene, mg/kg dw	<7.4	<7.2	3.6J	4.8J	<7.4
2-Methylnaphthalene, mg/kg dw	<7.4	<7.2	<7.5	<9.4	<7.4
1-Methylnaphthalene, mg/kg dw	<7.4	<7.2	<7.5	<9.4	<7.4
1,1-Biphenyl, mg/kg dw	<7.4	<7.2	<7.5	<9.4	<7.4
Acenaphthylene, mg/kg dw	<7.4	<7.2	<7.5	<9.4	<7.4
Acenaphthene, mg/kg dw	<7.4	<7.2	<7.5	<9.4	<7.4
Dibenzofuran, mg/kg dw	<7.4	<7.2	<7.5	6.6J	<7.4
Fluorene, mg/kg dw	<7.4	<7.2	6.0J	20	5.8J
Phenanthrene, mg/kg dw	4.6J	<7.2	20	130	8.1
Anthracene, mg/kg dw	5.0J	<7.2	70	29	58
Carbazole, mg/kg dw	<7.4	<7.2	23	43	9.6
Pyrene, mg/kg dw	6.0J	6.5J	41	150	11
Benzo(a)Anthracene, mg/kg dw	7.4	<7.2	21	32	3.7J
Chrysene, mg/kg dw	8.1	3.7J	22	42	8.9
Benzo(a)pyrene, mg/kg dw	8.1	3.5J	18	24	6.5J
Benzo(g,h,i)perylene, mg/kg dw	<7.4	<7.2	<7.5	10	<7.4
Pentachlorophenol, mg/kg dw	<37	<36	<38	<47	<37
Fluoranthene, mg/kg dw	4.4J	6.8J	51	140	8.9
% R Surrogate-2FP (CL 21-100)	*	*	*	*	*

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LOG NO: S0-12822

Received: 11 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-6	LF1EM (# 9104B) 10-10-90	Client
12822-7	LF1EL (# 9104C) 10-10-90	
12822-8	LF1EU (# 9104A) 10-10-90	
12822-9	LF1CU (# 9102A) 10-10-90	
12822-10	LF1CM (# 9102B) 10-10-90	

PARAMETER	12822-6	12822-7	12822-8	12822-9	12822-10
% R Surrogate-PHL (CL 10-94)	*	*	*	*	*
% R Surrogate-NBZ (CL 35-114)	*	*	*	*	*
% R Surrogate-2FBP (CL 43-116)	*	*	*	*	*
% R Surrogate-TBP (CL 10-123)	*	*	*	*	*
% R Surrogate-TPH (CL 33-141)	*	*	*	*	*
Date Extracted	10.23.90	10.23.90	---	---	---
Date Analyzed	11.01.90	11.01.90	---	---	---
pH, units	6.7	7.1	6.4	6.6	6.7
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	<15	470	1400	1900	1100
Nitrate + Nitrite-N, mg/kg dw	<2.0	<2.0	<2.0	8.1	<2.0
Total Nitrogen, mg/kg dw	<15	470	1400	1900	1100
Total Phosphorus, mg/kg dw	640	320	980	1000	620
Total Organic Carbon, mg/kg dw	21000	8000	30000	39000	23000
Chloride, mg/kg dw	27	<20	40	35	<20
Percent Solids, mg/kg dw	88 %	91 %	88 %	70 %	88 %

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LOG NO: S0-12822

Received: 11 OCT 90

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Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-11	LF1CL (# 9102C) 10-10-90	Client
12822-12	LF1CS (# 9102D) 10-10-90	
12822-13	LF1AU (# 9100A) 10-10-90	
12822-14	LF1AM (# 9100B) 10-10-90	
12822-15	LF1AL (# 9100C) 10-10-90	

PARAMETER	12822-11	12822-12	12822-13	12822-14	12822-15
Semi Volatiles					
Naphthalene, mg/kg dw	<7.5	<0.36	3.8J	<7.3	<7.3
2-Methylnaphthalene, mg/kg dw	<7.5	<0.36	4.0J	<7.3	<7.3
1-Methylnaphthalene, mg/kg dw	<7.5	<0.36	<8.0	<7.3	<7.3
1,1-Biphenyl, mg/kg dw	<7.5	<0.36	<8.0	<7.3	<7.3
Acenaphthylene, mg/kg dw	<7.5	<0.36	<8.0	<7.3	<7.3
Acenaphthene, mg/kg dw	<7.5	<0.36	<8.0	<7.3	<7.3
Dibenzofuran, mg/kg dw	<7.5	<0.36	5.0J	<7.3	<7.3
Fluorene, mg/kg dw	<7.5	<0.36	14	<7.3	<7.3
Phenanthrene, mg/kg dw	13	<0.36	25	3.9J	6.2J
Anthracene, mg/kg dw	6.8J	<0.36	88	3.4J	3.7J
Carbazole, mg/kg dw	<7.5	<0.36	26	<7.3	<7.3
Pyrene, mg/kg dw	110	<0.36	44	13	80
Benzo(a)Anthracene, mg/kg dw	42	<0.36	20	5.8J	39
Chrysene, mg/kg dw	59	<0.36	22	9.5	59
Benzo(a)pyrene, mg/kg dw	22	<0.36	19	7.3	32
Benzo(g,h,i)perylene, mg/kg dw	6.5J	<0.36	8.8	5.0J	16
Pentachlorophenol, mg/kg dw	<38	<1.8	<40	<37	<37
Fluoranthene, mg/kg dw	120	<0.36	58	13	80
% R Surrogate-2FP (CL 21-100)	*	92 %	*	*	*

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LOG NO: S0-12822

Received: 11 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-11	LF1CL (# 9102C) 10-10-90	Client
12822-12	LF1CS (# 9102D) 10-10-90	
12822-13	LF1AU (# 9100A) 10-10-90	
12822-14	LF1AM (# 9100B) 10-10-90	
12822-15	LF1AL (# 9100C) 10-10-90	

PARAMETER	12822-11	12822-12	12822-13	12822-14	12822-15
% R Surrogate-PHL (CL 10-94)	*	83 %	*	*	*
% R Surrogate-NBZ (CL 35-114)	*	91 %	*	*	*
% R Surrogate-2FBP (CL 43-116)	*	107 %	*	*	*
% R Surrogate-TBP (CL 10-123)	*	82 %	*	*	*
% R Surrogate-TPH (CL 33-141)	*	87 %	*	*	*
Date Extracted	10.23.90	10.23.90	10.23.90	10.23.90	10.23.90
Date Analyzed	11.01.90	11.01.90	11.01.90	11.01.90	11.01.90
pH, units	6.5	6.8	6.0	6.6	6.8
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	1300	67	1600	500	1200
Nitrate + Nitrite-N, mg/kg dw	<2.0	<2.0	<2.0	6.7	<2.0
Total Nitrogen, mg/kg dw	1300	67	1600	500	1200
Total Phosphorus, mg/kg dw	250	66	830	560	900
Total Organic Carbon, mg/kg dw	21000	<0.50	35000	18000	25000
Chloride, mg/kg dw	77	<20	<20	<20	<20
Percent Solids, %	88 %	90 %	82 %	90 %	90 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-16	LF1AS (# 9100D) 10-10-90	Client
12822-17	LF2BU (# 9106A) 10-10-90	
12822-18	LF2BM (# 9106B) 10-10-90	
12822-19	LF2BL (# 9106C) 10-10-90	
12822-20	LF2BS (# 9106D) 10-10-90	

PARAMETER	12822-16	12822-17	12822-18	12822-19	12822-20
Semi Volatiles					
Naphthalene, mg/kg dw	<0.35	<7.7	30	<7.6	<0.37
2-Methylnaphthalene, mg/kg dw	<0.35	<7.7	41	<7.6	<0.37
1-Methylnaphthalene, mg/kg dw	<0.35	<7.7	20	<7.6	<0.37
1,1-Biphenyl, mg/kg dw	<0.35	<7.7	<7.8	<7.6	<0.37
Acenaphthylene, mg/kg dw	<0.35	<7.7	<7.8	<7.6	<0.37
Acenaphthene, mg/kg dw	<0.35	49	<7.8	<7.6	<0.37
Dibenzofuran, mg/kg dw	<0.35	19	20	5.6J	<0.37
Fluorene, mg/kg dw	<0.35	42	57	12	<0.37
Phenanthrene, mg/kg dw	<0.35	82	86	24	<0.37
Anthracene, mg/kg dw	<0.35	350	400	66	<0.37
Carbazole, mg/kg dw	<0.35	100	160	30	<0.37
Pyrene, mg/kg dw	<0.35	55	23	78	0.60
Benzo(a)Anthracene, mg/kg dw	<0.35	33	13	21	0.21J
Chrysene, mg/kg dw	<0.35	35	18	31	0.35J
Benzo(a)pyrene, mg/kg dw	<0.35	24	30	41	0.30J
Benzo(g,h,i)perylene, mg/kg dw	<0.35	12	<7.8	16	<0.37
Pentachlorophenol, mg/kg dw	<1.8	<39	<39	<38	<1.9
Fluoranthene, mg/kg dw	<0.35	92	27	82	0.63
% R Surrogate-2FP (CL 21-100)	97 %	*	*	*	96 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-16	LF1AS (# 9100D) 10-10-90	Client
12822-17	LF2BU (# 9106A) 10-10-90	
12822-18	LF2BM (# 9106B) 10-10-90	
12822-19	LF2BL (# 9106C) 10-10-90	
12822-20	LF2BS (# 9106D) 10-10-90	

PARAMETER	12822-16	12822-17	12822-18	12822-19	12822-20
% R Surrogate-PHL (CL 10-94)	86 %	*	*	*	86 %
% R Surrogate-NBZ (CL 35-114)	95 %	*	*	*	92 %
% R Surrogate-2FBP (CL 43-116)	101 %	*	*	*	98 %
% R Surrogate-TBP (CL 10-123)	92 %	*	*	*	98 %
% R Surrogate-TPH (CL 33-141)	100 %	*	*	*	94 %
Date Extracted	10.23.90	10.23.90	10.23.90	10.23.90	10.23.90
Date Analyzed	11.01.90	11.01.90	11.01.90	11.01.90	11.01.90
pH, units	7.3	6.2	5.8	6.7	7.2
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	58	1700	1400	900	920
Nitrate + Nitrite-N, mg/kg dw	<2.0	<2.0	<2.0	<2.0	<2.0
Total Nitrogen, mg/kg dw	58	1700	1400	900	920
Total Phosphorus, mg/kg dw	40	920	970	390	61
Total Organic Carbon, mg/kg dw	<0.50	36000	34000	31000	230
Chloride, mg/kg dw	<20	<20	<20	<20	<20
Percent Solids, %	94 %	85 %	84 %	86 %	88 %

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-21	LF2EU (# 9109A) 10-10-90	Client
12822-22	LF2EM (# 9109B) 10-10-90	
12822-23	LF2EL (# 9109C) 10-10-90	
12822-24	LF2ES (# 9109D) 10-10-90	
12822-25	LF2AU (# 9105A) 10-10-90	

PARAMETER	12822-21	12822-22	12822-23	12822-24	12822-25
Semi Volatiles					
Naphthalene, mg/kg dw	3.5J	<7.5	2.1J	<0.36	<7.8
2-Methylnaphthalene, mg/kg dw	<7.4	<7.5	<4.1	<0.36	<7.8
1-Methylnaphthalene, mg/kg dw	<7.4	<7.5	<4.1	<0.36	<7.8
1,1-Biphenyl, mg/kg dw	<7.4	<7.5	<4.1	<0.36	<7.8
Acenaphthylene, mg/kg dw	<7.4	<7.5	<4.1	<0.36	<7.8
Acenaphthene, mg/kg dw	<7.4	<7.5	<4.1	<0.36	<7.8
Dibenzofuran, mg/kg dw	3.7J	<7.5	<4.1	<0.36	<7.8
Fluorene, mg/kg dw	<7.4	6.1J	<4.1	<0.36	22
Phenanthrene, mg/kg dw	19	14	5.7	<0.36	34
Anthracene, mg/kg dw	70	50	14	<0.36	100
Carbazole, mg/kg dw	24	17	1.9J	<0.36	45
Pyrene, mg/kg dw	34	34	30	<0.36	26
Benzo(a)Anthracene, mg/kg dw	13	13	11	<0.36	20
Chrysene, mg/kg dw	18	19	16	<0.36	21
Benzo(a)pyrene, mg/kg dw	18	15	12	<0.36	16
Benzo(g,h,i)perylene, mg/kg dw	8.1	7.1J	8.6	<0.36	7.8
Pentachlorophenol, mg/kg dw	<37	<38	<21	<1.8	<39
Fluoranthene, mg/kg dw	36	36	32	<0.36	35
% R Surrogate-2FP (CL 21-100)	*	*	*	106 %	*

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-21	LF2EU (# 9109A) 10-10-90	Client
12822-22	LF2EM (# 9109B) 10-10-90	
12822-23	LF2EL (# 9109C) 10-10-90	
12822-24	LF2ES (# 9109D) 10-10-90	
12822-25	LF2AU (# 9105A) 10-10-90	

PARAMETER	12822-21	12822-22	12822-23	12822-24	12822-25
% R Surrogate-PHL (CL 10-94)	*	*	*	87 %	*
% R Surrogate-NBZ (CL 35-114)	*	*	*	99 %	*
% R Surrogate-2FBP (CL 43-116)	*	*	*	97 %	*
% R Surrogate-TBP (CL 10-123)	*	*	*	103 %	*
% R Surrogate-TPH (CL 33-141)	*	*	*	101 %	*
Date Extracted	10.23.90	10.23.90	10.23.90	10.23.90	10.23.90
Date Analyzed	11.01.90	11.01.90	11.01.90	11.01.90	11.01.90
pH, units	6.0	6.1	6.7	7.5	6.3
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	190	1400	520	90	1400
Nitrate + Nitrite-N, mg/kg dw	<2.0	12	<2.0	<2.0	<2.0
Total Nitrogen, mg/kg dw	190	1400	520	90	1400
Total Phosphorus, mg/kg dw	1200	940	370	53	1100
Total Organic Carbon, mg/kg dw	35000	31000	20000	490	37000
Chloride, mg/kg dw	27	<20	<20	<20	26
Percent Solids, %	88 %	87 %	80 %	91 %	84 %

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-26	LF2AM (# 9105B) 10-10-90	Client
12822-27	LF2AL (# 9105C) 10-10-90	
12822-28	LF2AS (# 9105D) 10-10-90	
12822-29	LF2CM (# 9107B) 10-10-90	
12822-30	LF2CU (# 9107A) 10-10-90	

PARAMETER	12822-26	12822-27	12822-28	12822-29	12822-30
Semi Volatiles					
Naphthalene, mg/kg dw	<8.3	<7.1	0.33J	5.1J	<7.6
2-Methylnaphthalene, mg/kg dw	10	<7.1	<0.44	<7.3	<7.6
1-Methylnaphthalene, mg/kg dw	<8.3	<7.1	<0.44	<7.3	<7.6
1,1-Biphenyl, mg/kg dw	<8.3	<7.1	<0.44	<7.3	<7.6
Acenaphthylene, mg/kg dw	<8.3	<7.1	<0.44	<7.3	<7.6
Acenaphthene, mg/kg dw	28	<7.1	<0.44	<7.3	<7.6
Dibenzofuran, mg/kg dw	26	<7.1	<0.44	3.8J	<7.6
Fluorene, mg/kg dw	91	<7.1	<0.44	<7.3	12
Phenanthrene, mg/kg dw	200	<7.1	0.49	17	99
Anthracene, mg/kg dw	280	<7.1	0.36J	72	900
Carbazole, mg/kg dw	200	<7.1	<0.44	23	270
Pyrene, mg/kg dw	200	4.7J	2.0	36	130
Benzo(a)Anthracene, mg/kg dw	110	<7.1	1.2	19	43
Chrysene, mg/kg dw	120	3.6J	1.9	22	58
Benzo(a)pyrene, mg/kg dw	46	<7.1	1.3	16	41
Benzo(g,h,i)perylene, mg/kg dw	17	<7.1	0.71	13	17
Pentachlorophenol, mg/kg dw	<42	<36	<2.2	<37	<38
Fluoranthene, mg/kg dw	300	5.0J	2.3	38	110
% R Surrogate-2FP (CL 21-100)	*	*	84 %	*	*

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-26	LF2AM (# 9105B) 10-10-90	Client
12822-27	LF2AL (# 9105C) 10-10-90	
12822-28	LF2AS (# 9105D) 10-10-90	
12822-29	LF2CM (# 9107B) 10-10-90	
12822-30	LF2CU (# 9107A) 10-10-90	

PARAMETER	12822-26	12822-27	12822-28	12822-29	12822-30
% R Surrogate-PHL (CL 10-94)	*	*	74 %	*	*
% R Surrogate-NBZ (CL 35-114)	*	*	76 %	*	*
% R Surrogate-2FBP (CL 43-116)	*	*	92 %	*	*
% R Surrogate-TBP (CL 10-123)	*	*	83 %	*	*
% R Surrogate-TPH (CL 33-141)	*	*	72 %	*	*
Date Extracted	10.23.90	10.23.90	10.23.90	10.23.90	10.23.90
Date Analyzed	11.01.90	11.01.90	11.01.90	11.01.90	11.01.90
pH, units	6.3	6.6	5.1	7.0	6.2
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	1400	170	1100	340	2200
Nitrate + Nitrite-N, mg/kg dw	<2.0	<2.0	<2.0	<2.0	<2.0
Total Nitrogen, mg/kg dw	1400	170	1100	340	2200
Total Phosphorus, mg/kg dw	290	120	800	90	740
Total Organic Carbon, mg/kg dw	51000	3700	26000	24000	36000
Chloride, mg/kg dw	51	<20	<20	<20	<20
Percent Solids, %	79 %	92 %	73 %	91 %	86 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-31	LF2CL (# 9107C) 10-10-90	Client
12822-32	LF2CS (# 9107D) 10-10-90	
12822-33	LF2DS (# 9108D) 10-10-90	
12822-34	LF2DU (# 9108A) 10-10-90	
12822-35	LF2DL (# 9108C) 10-10-90	

PARAMETER	12822-31	12822-32	12822-33	12822-34	12822-35
Semi Volatiles					
Naphthalene, mg/kg dw	<7.5	<0.39	<0.42	<7.9	11
2-Methylnaphthalene, mg/kg dw	<7.5	<0.39	<0.42	9.5	11
1-Methylnaphthalene, mg/kg dw	<7.5	<0.39	<0.42	<7.9	<8.5
1,1-Biphenyl, mg/kg dw	<7.5	<0.39	<0.42	<7.9	<8.5
Acenaphthylene, mg/kg dw	<7.5	<0.39	<0.42	<7.9	<8.5
Acenaphthene, mg/kg dw	<7.5	<0.39	<0.42	<7.9	24
Dibenzofuran, mg/kg dw	<7.5	<0.39	<0.42	<7.9	20
Fluorene, mg/kg dw	<7.5	<0.39	<0.42	37	54
Phenanthrene, mg/kg dw	6.0J	<0.39	0.40J	70	130
Anthracene, mg/kg dw	<7.5	<0.39	0.97	170	290
Carbazole, mg/kg dw	<7.5	<0.39	<0.42	67	75
Pyrene, mg/kg dw	41	<0.39	2.2	51	500
Benzo(a)Anthracene, mg/kg dw	18	<0.39	1.0	18	100
Chrysene, mg/kg dw	32	<0.39	1.4	22	150
Benzo(a)pyrene, mg/kg dw	11	<0.39	0.97	19	65
Benzo(g,h,i)perylene, mg/kg dw	4.2J	<0.39	0.47	7.9	14
Pentachlorophenol, mg/kg dw	<38	<2.0	0.80J	<40	20J
Fluoranthene, mg/kg dw	47	<0.39	2.3	74	500
% R Surrogate-2FP (CL 21-100)	*	97 %	94 %	*	*

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-31	LF2CL (# 9107C) 10-10-90	Client
12822-32	LF2CS (# 9107D) 10-10-90	
12822-33	LF2DS (# 9108D) 10-10-90	
12822-34	LF2DU (# 9108A) 10-10-90	
12822-35	LF2DL (# 9108C) 10-10-90	

PARAMETER	12822-31	12822-32	12822-33	12822-34	12822-35
% R Surrogate-PHL (CL 10-94)	*	90 %	76 %	*	*
% R Surrogate-NBZ (CL 35-114)	*	92 %	90 %	*	*
% R Surrogate-2FBP (CL 43-116)	*	95 %	94 %	*	*
% R Surrogate-TBP (CL 10-123)	*	107 %	96 %	*	*
% R Surrogate-TPH (CL 33-141)	*	101 %	92 %	*	*
Date Extracted	10.23.90	10.23.90	10.23.90	10.23.90	10.23.90
Date Analyzed	11.01.90	11.01.90	11.01.90	11.01.90	11.01.90
pH, units	7.5	7.7	5.6	6.5	5.8
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	520	67	190	1300	290
Nitrate + Nitrite-N, mg/kg dw	<2.0	<2.0	<2.0	<2.0	<2.0
Total Nitrogen, mg/kg dw	520	67	190	1300	290
Total Phosphorus, mg/kg dw	200	49	580	910	130
Total Organic Carbon, mg/kg dw	13000	580	4700	36000	44000
Chloride, mg/kg dw	<20	<20	64	63	85
Percent Solids, %	87 %	86 %	77 %	83 %	78 %

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LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-36	LF2DM (# 9108B) 10-10-90	Client
12822-37	LF1DL (# 9103C) 10-10-90	
12822-38	LF1DU (# 9103A) 10-10-90	
12822-39	LF1DM (# 9103B) 10-10-90	
12822-40	LF1DS (# 9103D) 10-10-90	

PARAMETER	12822-36	12822-37	12822-38	12822-39	12822-40
Semi Volatiles					
Naphthalene, mg/kg dw	3.7J	<7.6	<7.6	<7.3	<7.6
2-Methylnaphthalene, mg/kg dw	<7.8	<7.6	<7.6	<7.3	<7.6
1-Methylnaphthalene, mg/kg dw	<7.8	<7.6	<7.6	<7.3	<7.6
1,1-Biphenyl, mg/kg dw	<7.8	<7.6	<7.6	<7.3	<7.6
Acenaphthylene, mg/kg dw	<7.8	<7.6	<7.6	<7.3	<7.6
Acenaphthene, mg/kg dw	<7.8	<7.6	<7.6	<7.3	<7.6
Dibenzofuran, mg/kg dw	<7.8	<7.6	<7.6	<7.3	<7.6
Fluorene, mg/kg dw	<7.8	<7.6	5.0J	<7.3	<7.6
Phenanthrene, mg/kg dw	12	14	11	<7.3	6.5J
Anthracene, mg/kg dw	15	3.6J	35	4.7J	3.0J
Carbazole, mg/kg dw	4.6J	<7.6	<7.6	<7.3	<7.6
Pyrene, mg/kg dw	66	68	28	9.5	23
Benzo(a)Anthracene, mg/kg dw	27	18	11	3.4J	13
Chrysene, mg/kg dw	40	40	17	7.3	19
Benzo(a)pyrene, mg/kg dw	33	16	16	7.3	5.9J
Benzo(g,h,i)perylene, mg/kg dw	34	7.4J	6.3J	4.8J	<7.6
Pentachlorophenol, mg/kg dw	<39	<38	<38	<37	<38
Fluoranthene, mg/kg dw	65	71	29	9.5	24
% R Surrogate-2FP (CL 21-100)	*	*	*	*	*

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LOG NO: S0-12822

Received: 11 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , SOLID OR SEMISOLID SAMPLES	SAMPLED BY
12822-36	LF2DM (# 9108B) 10-10-90	Client
12822-37	LF1DL (# 9103C) 10-10-90	
12822-38	LF1DU (# 9103A) 10-10-90	
12822-39	LF1DM (# 9103B) 10-10-90	
12822-40	LF1DS (# 9103D) 10-10-90	

PARAMETER	12822-36	12822-37	12822-38	12822-39	12822-40
% R Surrogate-PHL (CL 10-94)	*	*	*	*	*
% R Surrogate-NBZ (CL 35-114)	*	*	*	*	*
% R Surrogate-2FBP (CL 43-116)	*	*	*	*	*
% R Surrogate-TBP (CL 10-123)	*	*	*	*	*
% R Surrogate-TPH (CL 33-141)	*	*	*	*	*
Date Extracted	10.23.90	10.23.90	10.23.90	10.23.90	10.23.90
Date Analyzed	11.01.90	11.01.90	11.01.90	11.01.90	11.01.90
pH, units	5.9	6.6	6.3	6.3	6.9
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	1400	330	1600	1000	1500
Nitrate + Nitrite-N, mg/kg dw	<2.0	<2.0	7.0	6.9	<2.0
Total Nitrogen, mg/kg dw	1400	330	1600	1000	1500
Total Phosphorus, mg/kg dw	250	240	630	530	340
Total Organic Carbon, mg/kg dw	49000	26000	34000	17000	25000
Chloride, mg/kg dw	99	<20	<20	<20	<20
Percent Solids, %	85 %	86 %	86 %	90 %	87 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12822-41	RB-1	Client
12822-42	FB-1	

PARAMETER	12822-41	12822-42
Semi Volatiles		
Naphthalene, mg/l	<0.010	<0.010
2-Methylnaphthalene, mg/l	<0.010	<0.010
1-Methylnaphthalene, mg/l	<0.010	<0.010
1,1-Biphenyl, mg/l	<0.010	<0.010
Acenaphthylene, mg/l	<0.010	<0.010
Acenaphthene, mg/l	<0.010	<0.010
Dibenzofuran, mg/l	<0.010	<0.010
Fluorene, mg/l	<0.010	<0.010
Phenanthrene, mg/l	<0.010	<0.010
Anthracene, mg/l	<0.010	<0.010
Carbazole, mg/l	<0.010	<0.010
Pyrene, mg/l	<0.010	<0.010
Benzo(a)Anthracene, mg/l	<0.010	<0.010
Chrysene, mg/l	<0.010	<0.010
Benzo(a)pyrene, mg/l	<0.010	<0.010
Benzo(g,h,i)perylene, mg/l	<0.010	<0.010
Pentachlorophenol, mg/l	<0.050	<0.050
Fluoranthene, mg/l	<0.010	<0.010
% R Surrogate-2FP (CL 21-100)	45 %	40 %
% R Surrogate-PHL (CL 10-94)	53 %	51 %
% R Surrogate-NBZ (CL 35-114)	87 %	91 %
% R Surrogate-2FBP (CL 43-116)	92 %	83 %
% R Surrogate-TBP (CL 10-123)	62 %	71 %
% R Surrogate-TPH (CL 33-141)	83 %	81 %
Date Extracted	10.23.90	10.23.90
Date Analyzed	11.01.90	11.01.90

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12822-41	RB-1	Client
12822-42	FB-1	

PARAMETER	12822-41	12822-42
Suspended Solids, mg/l	<5.0	<5.0
Total Organic Carbon, mg/l	<1.0	2.4
Chloride, mg/l	<1.0	<1.0

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12822-43	TB-2 10-10-90	Client

PARAMETER	12822-43
Semi Volatiles	
Naphthalene, mg/l	<0.010
2-Methylnaphthalene, mg/l	<0.010
1-Methylnaphthalene, mg/l	<0.010
1,1-Biphenyl, mg/l	<0.010
Acenaphthylene, mg/l	<0.010
Acenaphthene, mg/l	<0.010
Dibenzofuran, mg/l	<0.010
Fluorene, mg/l	<0.010
Phenanthrene, mg/l	<0.010
Anthracene, mg/l	<0.010
Carbazole, mg/l	<0.010
Pyrene, mg/l	<0.010
Benzo(a)Anthracene, mg/l	<0.010
Chrysene, mg/l	<0.010
Benzo(a)pyrene, mg/l	<0.010
Benzo(g,h,i)perylene, mg/l	<0.010
Pentachlorophenol, mg/l	<0.050
Fluoranthene, mg/l	<0.010
% R Surrogate-2FP (CL 21-100)	52 %
% R Surrogate-PHL (CL 10-94)	61 %
% R Surrogate-NBZ (CL 35-114)	92 %
% R Surrogate-2FBP (CL 43-116)	87 %
% R Surrogate-TBP (CL 10-123)	41 %
% R Surrogate-TPH (CL 33-141)	87 %
Date Extracted	10.23.90
Date Analyzed	11.01.90

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	SAMPLED BY
12822-43	TB-2 10-10-90	Client

PARAMETER	12822-43
Nitrogen Series	
Total Kjeldahl Nitrogen-N, mg/l	<0.10
Nitrate + Nitrite-N, mg/l	<0.050
Total Nitrogen, mg/l	<0.10
Total Phosphorus, mg/l	<0.10
Suspended Solids, mg/l	<5.0
Total Organic Carbon, mg/l	<1.0
Chloride, mg/l	<1.0

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
12822-44	Method Blank (MB) Result (Soil)	Client
12822-45	Lab Control Standard (LCS) Result (Soil)	
12822-46	LCS Expected Value (Soil)	
12822-47	LCS % Recovery (Soil)	
12822-48	LCS % Recovery Limits (Soil)	

PARAMETER	12822-44	12822-45	12822-46	12822-47	12822-48
Semi Volatiles					
Naphthalene, mg/kg dw	<0.33	2.6	3.3	79 %	39-127 %
2-Methylnaphthalene, mg/kg dw	<0.33	---	---	---	---
1-Methylnaphthalene, mg/kg dw	<0.33	---	---	---	---
1,1-Biphenyl, mg/kg dw	<0.33	---	---	---	---
Acenaphthylene, mg/kg dw	<0.33	---	---	---	---
Acenaphthene, mg/kg dw	<0.33	3.0	3.3	91 %	31-137 %
Dibenzofuran, mg/kg dw	<0.33	---	---	---	---
Fluorene, mg/kg dw	<0.33	3.3	3.3	100 %	25-150 %
Phenanthrene, mg/kg dw	<0.33	2.7	3.3	82 %	54-120 %
Anthracene, mg/kg dw	<0.33	2.6	3.3	79 %	40-125 %
Carbazole, mg/kg dw	<0.33	---	---	---	---
Pyrene, mg/kg dw	<0.33	2.6	3.3	79 %	20-150 %
Benzo(a)Anthracene, mg/kg dw	<0.33	3.5	3.3	106 %	29-112 %
Chrysene, mg/kg dw	<0.33	3.5	3.3	106 %	17-168 %
Benzo(a)pyrene, mg/kg dw	<0.33	3.8	3.3	115 %	25-160 %
Benzo(g,h,i)perylene, mg/kg dw	<0.33	4.1	3.3	124 %	10-130 %
Pentachlorophenol, mg/kg dw	<1.7	12.6	17	74 %	17-109 %
Fluoranthene, mg/kg dw	<0.33	2.6	3.3	79 %	26-137 %
% R Surrogate-2FP (CL 21-100)	93 %	---	---	96 %	25-121 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
12822-44	Method Blank (MB) Result (Soil)	Client
12822-45	Lab Control Standard (LCS) Result (Soil)	
12822-46	LCS Expected Value (Soil)	
12822-47	LCS % Recovery (Soil)	
12822-48	LCS % Recovery Limits (Soil)	

PARAMETER	12822-44	12822-45	12822-46	12822-47	12822-48
% R Surrogate-PHL (CL 10-94)	91 %	---	---	90 %	24-113 %
% R Surrogate-NBZ (CL 35-114)	101 %	---	---	101 %	23-120 %
% R Surrogate-2FBP (CL 43-116)	104 %	---	---	120 %	30-115 %
% R Surrogate-TBP (CL 10-123)	99 %	---	---	106 %	19-122 %
% R Surrogate-TPH (CL 33-141)	97 %	---	---	71 %	18-137 %
Date Extracted	10.23.90	---	---	---	---
Date Analyzed	11.01.90	---	---	---	---
pH, units	---	6.1	6.1	100 %	90-110 %
Chloride, mg/kg dw	<20	4600	4440	105 %	90-110 %
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	<15	4.79	5.0	96 %	90-110 %
Nitrate + Nitrite-N, mg/kg dw	<2.0	18.7	20	94 %	75-125 %
Total Nitrogen, mg/kg dw	<15	---	---	---	---
Total Phosphorus, mg/kg dw	<25	389	375	104 %	90-110 %
Total Organic Carbon, mg/kg dw	<0.50	270000	230000	117 %	52-134 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
12822-49	Matrix Spike (MS) Result/Dup (Soil)	Client
12822-50	MS Expected Value (Soil)	
12822-51	MS % Recovery/Duplicate (Soil)	
12822-52	MS % Recovery Limit (Soil)	
12822-53	MS % RPD (Soil)	

PARAMETER	12822-49	12822-50	12822-51	12822-52	12822-53
Semi Volatiles					
Naphthalene, mg/kg dw	2.8/2.7	3.3	85/82 %	39-127 %	3.6(<32)%
Acenaphthene, mg/kg dw	2.9/3.0	3.3	88/91 %	31-137 %	3.4(<19)%
Fluorene, mg/kg dw	3.1/2.9	3.3	94/88 %	25-150 %	6.6(<33)%
Phenanthrene, mg/kg dw	3.1/2.9	3.3	94/88 %	54-120 %	6.6(<21)%
Anthracene, mg/kg dw	2.7/2.8	3.3	82/85 %	40-125 %	3.6(<25)%
Pyrene, mg/kg dw	3.4/3.2	3.3	103/97 %	20-150 %	6.0(<36)%
Benzo(a)Anthracene, mg/kg dw	3.3/3.1	3.3	100/94 %	29-112 %	6.2(<32)%
Chrysene, mg/kg dw	3.1/2.9	3.3	94/88 %	17-168 %	6.6(<48)%
Benzo(a)pyrene, mg/kg dw	3.1/3.2	3.3	94/97 %	25-160 %	3.1(<38)%
Benzo(g,h,i)perylene, mg/kg dw	3.1/3.1	3.3	94/94 %	10-130 %	0(<56)%
Pentachlorophenol, mg/kg dw	18/18	17	105/105 %	17-109 %	0(<47)%
Fluoranthene, mg/kg dw	3.4/3.2	3.3	103/97 %	26-137 %	6.0(<33)%
% R Surrogate-2FP (CL 21-100)	---	---	95/93 %	25-121 %	---
% R Surrogate-PHL (CL 10-94)	---	---	85/86 %	24-113 %	---
% R Surrogate-NBZ (CL 35-114)	---	---	98/99 %	23-120 %	---
% R Surrogate-2FBP (CL 43-116)	---	---	97/103 %	30-115 %	---
% R Surrogate-TBP (CL 10-123)	---	---	103/103 %	19-122 %	---
% R Surrogate-TPH (CL 33-141)	---	---	106/105 %	18-137 %	---
pH, units	---	---	---	---	---
Chloride, mg/kg dw	108/109	100	108/109 %	75-125 %	0.92(<30)%

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Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
12822-49	Matrix Spike (MS) Result/Dup (Soil)	Client
12822-50	MS Expected Value (Soil)	
12822-51	MS % Recovery/Duplicate (Soil)	
12822-52	MS % Recovery Limit (Soil)	
12822-53	MS % RPD (Soil)	

PARAMETER	12822-49	12822-50	12822-51	12822-52	12822-53
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/kg dw	5.04/4.9	5.0	101/98 %	99 %	3.0(<30)%
Nitrate + Nitrite-N, mg/kg dw	22.7/22.7	20	114/114 %	75-125 %	0(<30)%
Total Phosphorus, mg/kg dw	103/108	125	82/86 %	75-125 %	4.8(<40)%
Total Organic Carbon, mg/kg dw	---	---	---	---	---

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12822-54	Method Blank (MB) Result (Liquid)	Client
12822-55	Lab Control Standard (LCS) Result	
12822-56	LCS Expected Value (Liquid)	
12822-57	LCS % Recovery (Liquid)	
12822-58	LCS % Recovery Limits (Liquid)	

PARAMETER	12822-54	12822-55	12822-56	12822-57	12822-58
Semi Volatiles					
Naphthalene, mg/l	<0.010	---	---	---	---
2-Methylnaphthalene, mg/l	<0.010	---	---	---	---
1-Methylnaphthalene, mg/l	<0.010	---	---	---	---
1,1-Biphenyl, mg/l	<0.010	---	---	---	---
Acenaphthylene, mg/l	<0.010	---	---	---	---
Acenaphthene, mg/l	<0.010	0.050	0.050	100 %	46-118 %
Dibenzofuran, mg/l	<0.010	---	---	---	---
Fluorene, mg/l	<0.010	---	---	---	---
Phenanthrene, mg/l	<0.010	---	---	---	---
Anthracene, mg/l	<0.010	---	---	---	---
Carbazole, mg/l	<0.010	---	---	---	---
Pyrene, mg/l	<0.010	0.060	0.050	120 %	26-127 %
Benzo(a)Anthracene, mg/l	<0.010	---	---	---	---
Chrysene, mg/l	<0.010	---	---	---	---
Benzo(a)pyrene, mg/l	<0.010	---	---	---	---
Benzo(g,h,i)perylene, mg/l	<0.010	---	---	---	---
Pentachlorophenol, mg/l	<0.050	0.090	0.10	90 %	9-103 %
Fluoranthene, mg/l	<0.010	---	---	---	---
% R Surrogate-2FP (CL 21-100)	56 %	---	---	42 %	25-121 %
% R Surrogate-PHL (CL 10-94)	47 %	---	---	27 %	24-113 %
% R Surrogate-NBZ (CL 35-114)	82 %	---	---	103 %	23-120 %
% R Surrogate-2FBP (CL 43-116)	83 %	---	---	101 %	30-115 %
% R Surrogate-TBP (CL 10-123)	59 %	---	---	105 %	19-122 %
% R Surrogate-TPH (CL 33-141)	83 %	---	---	118 %	18-137 %

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Southern Wood Piedmont (SP)
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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12822-54	Method Blank (MB) Result (Liquid)	Client
12822-55	Lab Control Standard (LCS) Result	
12822-56	LCS Expected Value (Liquid)	
12822-57	LCS % Recovery (Liquid)	
12822-58	LCS % Recovery Limits (Liquid)	

PARAMETER	12822-54	12822-55	12822-56	12822-57	12822-58
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	<0.10	5.45	5.00	109 %	90-110 %
Nitrate + Nitrite-N, mg/l	<0.050	0.191	0.20	96 %	75-125 %
Total Nitrogen, mg/l	<0.10	---	---	---	---
Total Phosphorus, mg/l	<0.10	1.58	1.50	105 %	90-110 %
Suspended Solids, mg/l	<5.0	380	399	95 %	60-140 %
Total Organic Carbon, mg/l	<1.0	6.5	6.12	106 %	60-140 %
Chloride, mg/l	<1.0	230	222	104 %	90-110 %

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REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12822-59	Matrix Spike (MS) Result/Dup (Liquid)	Client
12822-60	MS Expected Value (Liquid)	
12822-61	MS % Recovery/Duplicate (Liquid)	
12822-62	MS % Recovery Limit (Liquid)	
12822-63	MS % RPD (Limit) (Liquid)	

PARAMETER	12822-59	12822-60	12822-61	12822-62	12822-63
Semi Volatiles					
Acenaphthene, mg/l	0.05/0.05	0.050	100/100 %	46-118 %	0(<31)%
Pyrene, mg/l	0.06/0.06	0.050	120/120 %	26-127 %	0(<31)%
Pentachlorophenol, mg/l	0.09/0.10	0.10	90/100 %	9-103 %	11(<50)%
% R Surrogate-2FP (CL 21-100)	---	---	42/47 %	25-121 %	---
% R Surrogate-PHL (CL 10-94)	---	---	27/30 %	24-113 %	---
% R Surrogate-NBZ (CL 35-114)	---	---	103/112 %	103/112 %	---
% R Surrogate-2FBP (CL 43-116)	---	---	101/99 %	30-115 %	---
% R Surrogate-TBP (CL 10-123)	---	---	105/108 %	19-122 %	---
% R Surrogate-TPH (CL 33-141)	---	---	118/134 %	18-137 %	---
Nitrogen Series					
Total Kjeldahl Nitrogen-N, mg/l	3.95/4.34	4.00	99/109 %	75-125 %	9.6(<30)%
Nitrate + Nitrite-N, mg/l	0.19/0.19	0.20	95/95 %	75-125 %	0(<25)%
Total Phosphorus, mg/l	0.43/0.42	0.50	86/84 %	75-125 %	2.4(<25) %
Suspended Solids, mg/l	---	---	---	---	---
Total Organic Carbon, mg/l	100/99	102.5	98/97 %	60-140 %	1.0(<40) %
Chloride, mg/l	4.74/4.63	5.0	95/93 %	75-125 %	2.3(<25) %

SL SAVANNAH · LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S0-12822

Received: 11 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , REPORT FOR LIQUID SAMPLES	SAMPLED BY
12822-64	Report Completion Date	Client

PARAMETER	12822-64
Date Reported	11.13.90

Methods: EPA SW-846
* Because of high levels of components, these samples had to be diluted. Thus, surrogates were not recovered.

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

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LOG NO: S0-12822

Received: 11 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
12822-65	Methods	Client

PARAMETER	12822-65
Semi Volatiles	
Naphthalene	8270
2-Methylnaphthalene	8270
1-Methylnaphthalene	8270
1,1-Biphenyl	8270
Acenaphthylene	8270
Acenaphthene	8270
Dibenzofuran	8270
Fluorene	8270
Phenanthrene	8270
Anthracene	8270
Carbazole	8270
Pyrene	8270
Benzo(a)Anthracene	8270
Chrysene	8270
Benzo(a)pyrene	8270
Benzo(g,h,i)perylene	8270
Pentachlorophenol	8270
Fluoranthene	8270
pH	150.1
Nitrogen Series	
Total Kjeldahl Nitrogen-N	351.2
Nitrate + Nitrite-N	353.1
Total Phosphorus	365.1
Total Organic Carbon	415.1
Chloride	325.2

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S0-12822

Received: 11 OCT 90

Ms. Sandra Watson
Southern Wood Piedmont (SP)
P. O. Box 5447
Spartanburg, SC 29304

CC: Mark Radecke

Project: NC09001 Wilmington, NC

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR SOLID/SEMISOLID	SAMPLED BY
12822-65	Methods	Client

PARAMETER	12822-65
Suspended Solids	160.2

Methods: EPA SW-846
ND = Not Detected

J. W. Andrews

J. W. Andrews, Ph. D.

PA TY & M LER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Number NC09001

Project Location ~~NC09001~~ Wilmington, NC

Laboratory Savannah Laboratories

Sampler(s)/Affiliation M. RADECKE G&M
D. RUMFORD III G&M

SAMPLE BOTTLE / CONTAINER DESCRIPTION

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	1 Liter amber glass ~~TCCP~~ + PAH's 4°C	250 ml plastic Total N Total P 4°C H_2SO_4	160 ml plastic TSS 4°C	250 ml amber glass TOC 4°C H_2SO_4	250 ml plastic Cl⁻ 4°C	500 ml glass Cl⁻ TN TP TOC KOOH + pH 4°C				TOTAL
RB-1	L	10/10/90 16:20	12822	1		1	1	1					4
FB-1	L	10/10/90 16:25		1		1	1	1					4
TB-2	L	10/10/90		1	1	1	1	1					5
LF1BL/9101C	S	10/10/90 16:45							1				1
LF1BU/9101A	S	10/10/90 16:15							1				1
LF1BM/9101B	S	10/10/90 16:40							1				1
LF1BS/9101D	S	10/10/90 17:00							1				1
LF1ES/9104D	S	10/10/90 14:00							1				1
LF1EM/9104B	S	10/10/90 13:45							1				1
LF1EU/9104C	S	10/10/90 13:50							1				1
LF1EU/9104A	S	10/10/90 13:40							1				1

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 23

Relinquished by: Mark E Radecke Organization: Geraghty & Miller, Inc 10/10/90 19:00
Received by: Carla Longworth Organization: Savannah LAB Date 10/11/90 Time 10:00
Seal Intact? Yes No N/A

Relinquished by: Organization:
Received by: Organization: Date / / Time
Seal Intact? Yes No N/A

Special Instructions/Remarks: * ~~TCCP~~ PAH's site specific constituents
* Analyze for GS per Mark Radecke 10/15/90 - GF
Kool changed to PAH's per Mark Radecke 10/24/90. GF

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other (SPECIFY)

GERAGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Number NC0900)

Project Location Wilmington, NC

Laboratory Savannah laboratories,

Sampler(s)/Affiliation M. RADECKE G&M
D. RUMFORD III G&M

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	SOIL PH, Grain Size, PAH's, KOOT, TP, TOC, Cl-4a									TOTAL
LF2CM/9107B	S	10/10/90 11:30	12822	1									1
LF2CU/9107A	S	10/10/90 11:15		1									1
LF2CL/9107C	S	10/10/90 11:25		1									1
LF2CS/9107D	S	10/10/90 11:41		1									1
LF2DS/9108D	S	10/10/90 12:35		1									1
* LF2DU/9108A	S	10/10/90 12:16	12822	1									1
LF2DL/9108C	S	10/10/90 12:30		1									1
LF2DM/9108B	S	10/10/90 12:20		1									1
LF1DL/9103C	S	10/10/10 13:15		1									1
* LF1DU/9103A	S	10/10/90 13:05		1									1
LF1DM/9103B	S	10/10/90 13:10		1									1
LF1DS/9103D	S	10/10/90 13:20		1									1

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 12

Relinquished by: Mark E Radecke	Organization: Geraghty & Miller, Inc	10/10/90 19:00	Seal Intact? Yes No N/A
Received by: Carla Longworth	Organization: Savannah LAB	Date 10/11/90 Time 10:00	
Relinquished by:	Organization:		Seal Intact? Yes No N/A
Received by:	Organization:	Date / / Time	

Special Instructions/Remarks: ~~x KOOT~~ PAH's Site specific list KOOI changed to PAH's per Mark Radecke 10/24/90. GF
& Analyze for Grain Size per Mark Radecke 10/15/90. GF

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other _____ (SPECIFY)

GERAGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Project Number NC09001

Project Location Wilmington, NC

Laboratory Savannah Laboratories

Sampler(s)/Affiliation M. RADECKE G&M
D. RUMFORD III G&M

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	SAMPLE BOTTLE / CONTAINER DESCRIPTION: 500 ml Glass PAH's TN TP TOC PH Cl⁻ 4°C									TOTAL
* LF2BU/9106A	S	10/10/90	12822	1									1
LF2BM/9106B	S	10/10/90		1									1
LF2BL/9106C	S	10/10/90		1									1
LF2BS/9106D	S	10/10/90		1									1
LF2EU/9109A	S	10/10/90		1									1
LF2EM/9109B	S	10/10/90		1									1
LF2EL/9109C	S	10/10/90		1									1
LF2ES/9109D	S	10/10/90		1									1
LF2AU/9105A	S	10/10/90		1									1
LF2AM/9105B	S	10/10/90		1									1
LF2AL/9105C	S	10/10/90		1									1
LF2AS/9105D	S	10/10/90		1									1

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers: 12

Relinquished by: Mark E. Radecke	Organization: Geraghty & Miller Inc	10/10/90 19:00	Seal Intact? (Yes) No N/A
Received by: Carla Longworth	Organization: Savannah LAB	Date 10/11/90 Time 10:00	
Relinquished by:	Organization:		Seal Intact? Yes No N/A
Received by:	Organization:	Date / / Time	

Special Instructions/Remarks: PAH's Food Site Specific list
* Analyze for Grain Size per Mark Radecke 10/15/90. GF
KOOL changed to PAH's per Mark Radecke 10/24/90. GF

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express ☐ Lab Courier ☐ Other _____

GEOGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Number NC09001

Project Location Wilmington, NC

Laboratory Savannah Laboratories

Sampler(s)/Affiliation D. RUMFORD III G&M
M. RADECKE G&M

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	500ml Glass PAH + Cl- TD TP TOC pH 4°C									TOTAL
LFICU/9102A	S	10/10/90 14:20	12822	1									1
LFICM/9102B	S	10/10/90 14:30		1									1
LFICL/9102C	S	10/10/90 14:35		1									1
LFICS/9102D	S	10/10/90 14:50		1									1
LFIAU/9100A	S	10/10/90 15:20		1									1
LFIAM/9100B	S	10/10/90 15:28		1									1
LFIAL/9100C	S	10/10/90 15:34		1									1
LFIAS/9100D	S	10/10/90 15:42		1									1

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 8

Relinquished by: Mark E Radecke Organization: Geoghity & Miller, Inc 10/10/90 19:00
Received by: Carla Longworth Organization: Savannah LAB Date 10/11/90 Time 10:00
Seal Intact? (Yes) No N/A

Relinquished by: Organization:
Received by: Organization: Date / / Time
Seal Intact? Yes No N/A

Special Instructions/Remarks: ~~TCLP~~ Site specific list
Kool charged PAH's per Mark Radecke 10/24/90. GF

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other _____ (SPECIFY)

SWP

TRIANGLE LABORATORIES, INC.

RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

DOCUMENT
CONTROL

NOV 1 9 1990

TRIANGLE LABORATORIES, INC.

[PSTHF 1]

PCDD/PCDF/PBDD/PBDF SAMPLE TRACKING & MANAGEMENT FORM

GENERAL INFORMATION

TLI PROJECT NUMBER: 1 66661

OTHER TLI PROJECTS: 1_____, 1_____ Client Code: DX-H

Detection limits req. 1-10ppt

CUSTOMER Name: Southern Wood Piedmont P.O. No.: 5145

RECEIVING DATE: 10 / 10 / 90 Client's Project No: NC09001

Collection Date: 10-9-90

TURN-AROUND TIME: Hardcopy 30 Days Sample Orgin: Wilmington, NC

Circle one: TSCA/FIFRA/FDA/other GLP/non GLP

DUE DATE: 11 / 09 / 90

10/10/90

SAMPLE PREPARATION LABORATORY INSTRUCTIONS

2 soil

NUMBER/TYPE of SAMPLES: ___ A ___ AA 2 B ___ C

MATRIX TYPE [No Samples]:

Soil	[2]	Water	[ ]	Ash	[ ]
Sludge	[ ]	Pulp	[ ]	Paper	[ ]
Wipes	[ ]	Oil	[ ]	Chemical	[ ]
Fish	[ ]	Blood	[ ]	Adipose	[ ]
Milk	[ ]	MMS	[ ]	Other:	____

NA% of original extract sent to GC/MS

Portion (unspiked) given to Organics (amount/initial/date) NA

ORGANICS TLI PROJECT NUMBER: 1 NA

SAMPLE FORTIFICATION

Solution ID:	USB-I	USB-S	USB-C	USB-A
Before Extraction:	[✓]	[ ]	[ ]	[ ]
Before Cleanup:	[ ]	[✓]	[✓]	[✓]

13C-DBF BS-1 Other: _____

Concentration: 0.1 ng/µL Volume: 100 µL

The XAD-2 resins or the PUF cartridges were prespiked with 1 ng/of the surrogate carbon-labeled standards (USB-S & USB-C; TLI 1 NA).

ISOLATION PULP LOW (HIGH) (DB-5) DB-225 Others _____

(Tetra-Octa) Mono-Octa Tetra only Unchlorinated Others _____

INFORMATION ENTERED BY: PROJECT COORDINATOR INITIALS/DATE: KKC 10-10-90

REV 104 8/27/90

NOV 19 1990

[PSTMF 10]

TRIANGLE LABORATORIES, INC.

166661

PROJECT COMMUNICATION TRACKING SHEET

Use this form to record all exchanges of information between production units as well as personnel handling this project. Decisions, corrective actions and recommendations must also appear on this tracking document.

Date	Name	Comment / Decision / Resolution / Action / Observation
10/23/90	Em	Run dilutions on 2 samples
		Extra charge @ $515 per sample
		FAX original analysis to Sandra Watson
		803-599-1087. Ship whole
		package when dilutions complete.
15 Nov 90	B	Data Review:
		① 123478 HxCDF should have been
		detected (S903791)
		② 123789 HxCDD - AC or flag
		PR (S904212)
		- Remarks here. -
16 Nov 90	A	Data to SWP per Ed Martin

REV 102 4/15/90

NOV 19 1990

TRIANGLE LABORATORIES, INC. [PSTMF 3]

PCDD/PCDF/PBDD/PBDF SAMPLE TRACKING & MANAGEMENT FORM

SAMPLE PREPARATION LABORATORY INSTRUCTIONS

(continued)

TLI PROJECT NUMBER: 166661

ample Size(To be extracted): 10 g ___ L Other: ___

Sample Extraction: Soxhlet Toluene EtOH Tol/EtOH
Sep. Fun. Jar SDS Lyoph/Soxhlet Fish

ASME Front/Back Halves Combined yes no

Filter Sample after Fortification yes no

Extract Solid and Filtrate Separately yes no

Combine both Extracts before Cleanup yes no

Other: _____ (see Special Instructions)

GS 10/15/96

Sample Fractionation: Acid/Base Large Acid
BioSil A Impregnated: yes no
Piggy Back
A540: 12g 50g A950
AX-21 Celite Silica Gel
Other: _____

Percent Moisture: yes no Percent Lipids: yes no

Quality Assurance / Quality Control Samples

Laboratory Method Blank (TLI Blank): yes no L

Duplicate (DUP): ID _____ yes no ___
ID _____

Matrix Spike (MS): ID _____ yes no ___

Matrix Spike Duplicate (MSD): ID _____ yes no ___

MS Solution ID: USB-MX BS-MX Other: ___

MS Solution Conc.: ___ ng/uL

MS Solution Vol.: ___ uL

INFORMATION ENTERED BY: PROJECT COORDINATOR INITIALS/DATE KKC 10-10-90

NOV 1 9 1990

TRIANGLE LABORATORIES, INC.

[PSTMF 4]

PCDD/PCDF/PBDD/PBDF SAMPLE TRACKING & MANAGEMENT FORM

HIGH-RESOLUTION MASS SPECTROMETRY LABORATORY INSTRUCTIONS

TLI PROJECT NUMBER: 16661

Recovery Standards

Solution ID: (USB-RS) 13C-DBD Others: _____

Concentration: 100 pg/uL Volume: 100 uL

Volume of Pure Solvent : NA uL

HRGC/HRMS Method

(2378X) 551 1613 BROMO DD/DF Other: _____

System Definition

Mono-Octa Tri-Octa (Tetra-Octa) Tetra Other: _____

Confirmation Analyses Required (yes) no

Duplicate Injection required on : NA

INFORMATION ENTERED BY: PROJECT COORDINATOR INITIALS/DATE: KKC 10-10-90

RUN TYPE	FULL-SCREEN ANALYSES	CONFIRMATION ANALYSES
I-CAL date	10 / 13 / 90	___ / ___ / ___
CON-CAL File	3903783	_____
RETCHECK File	3903784	_____
For GC/MS Files	3903789 to 3903791	_____ to _____
CON-CAL File	_____	_____
RETCHECK File	_____	_____
For GC/MS Files	_____ to _____	_____ to _____
CON-CAL File	_____	_____
RETCHECK File	_____	_____
For GC/MS Files	_____ to _____	_____ to _____

INFORMATION ENTERED BY: GC/MS CLERK INITIALS / DATE: M. Smith 10/19/90

NOV 1 9 1990

TRIANGLE LABORATORIES, INC. ENVIRONMENTAL SERVICES

PCDD/PCDF/PBDD/PBDF SAMPLE TRACKING & MANAGEMENT FORM

REPORT GENERATION AND DATA REVIEW INSTRUCTIONS

TLI PROJECT NUMBER: 16661

Report Results on Dry-Weight Basis: (yes) no Type: A AA (B) C

Analyte Concentration Units: ppt pg (ppb) ng ppq

Toxic Equivalent Factors: yes (no)

NCASI Report Format: yes (no)

QUALITY ASSURANCE / QUALITY CONTROL REQUIREMENTS

INFORMATION ENTERED BY: PROJECT COORDINATOR INITIALS / DATE: KLC 10-10-96

NOV 1 9 1990

TRIANGLE LABORATORIES, INC.

[PSTMF 7]

PCDD/PCDF/PBDD/PBDF SAMPLE PREPARATION TRACKING & MANAGEMENT FORM

SWP

- 166661

EXTRACTION DATE: 10/10/90 Spiking Dates: 10/10/90 _/_/_ _/_/_ CB 10/15/90 _/_/_

SAMPLE INFORMATION

WET LAB No:	TLI Sample ID	Gross Weight	Sample Size g / mL	USB-I Vol. µL	USB-I Ex/Cl Init.	USB-S Vol. µL	USB-S Ex/Cl Init.	USB-C Vol. µL	USB-C Ex/Cl Init.	USB-AC Vol. µL	USB-AC Ex/Cl Init.	USB-MX Volume µL	USB-MX Extr. Init.	Sple left y/n	Dry Wght g	Mst Lipd (%)
0	TLI Blank			95 100µl	WK					100µl	MH					
1	37-26-1	531.0	11.02	95 100µl	WK					100µl	MH			Y	9.46	14.19
2	37-26-2	450.1	11.10g	95 100µl	WK					100µl	MH			Y	9.40	15.28

*Gross weight of sample container plus sample before a liquot removal.

LABORATORY ID: High Level Lab

(B)- Blank Thimble

(1)- Dark brown Sandy Soil, some rocks

(2) " " " " "

INITIALS OF BOTH THE SPIKER AND OBSERVER MUST BE ENTERED.

Indicate Below the TLI Identification Number of the Sample Fortification Solutions:

USB-I : $11-7-1A WK (0.1ng/µl) Exp 3/11/91

USB-AC S $11-13-1B (0.1ng/µl) Exp 11 Mar 91 MH

USB-S : _____

USB-MX : _____

USB-C : _____

Other : _____

LOT # (solvents): Toluene Lot # 904956

for extraction _____

fractionation: _____

REV 104 8/27/90

NOV 1 9 1990

TRIANGLE LABORATORIES, INC.

[PSTMF 8]

PCDD/PCDF/PBDD/PBDF SAMPLE TRACKING & MANAGEMENT FORM

16661

SWP

SAMPLE INFORMATION

WET LAB No:	TLI Sample ID	Client Sample ID	GC/MS File Name Column: DB5	S	Confirm (yes)/no	Confirm File Name Column: DB225	S	USB-RS volume soln ID	USB-RS Initial date	ANALYSIS COMMENTS
0	TLI Blank		$9037891	✓	NO			100 ml $12-14-3C	C.P. 10/18/90	
1	37-26-1	LF1/9110	* S904212 $903790	✓	YES	U902306		↓	↓	
2	37-26-2	LF1/9111	* T904958 $903791	✓	YES	U902307		↓	↓	
		ec 10/15/90 NOV 15 LB								

S = DATA ARCHIVED/SHIPPED *Reshoot, saturation, process these, DR 10/23/90.

Reason for Reextraction:

REV 104 8/27/90

NOV 19 1990

TRIANGLE LABORATORIES, INC.

[PSTMF 9]

PCDD/PCDF/PBDD/PBDF SAMPLE TRACKING & MANAGEMENT FORM

SWP ENVIRONMENTAL

1 606061

SAMPLE EXTRACT INFORMATION

WET LAB No:	TLI Sample ID	EXTRACT CHAIN OF CUSTODY						
		FROM WET LAB		TO MASS SPEC LAB		TO ARCHIVE		
		DATE AND TIME SAMPLE RELEASED	INITIAL	DATE AND TIME SAMPLE ACCEPTED	INITIAL	DATE AND TIME SAMPLE ARCHIVED	INITIAL	COMMENTS
0	TLI Blank	10/17/90 22:00	JS	10/17/90 2330	SB			
1	37-26-1	↓	↓	↓	↓			
2	↓ 2	↓	↓	↓	↓			

REV 104 8/27/90

TRIANGLE LABORATORIES, INC
MASS SPECTROMETER RUN SHEET

FULL SCREEN ANALYSES

CASE ID: Southern Wood Piedmont	TLI PROJECT ID: 166661	
DATE :	SPECTROSCOPIST:	MS #707

SAMPLE ID:	FILE NAME:	OPERATOR:	DATE	TIME	COMMENTS
RTCHK	$903784	CP	10/18/90	712	
C.Cal	$903783	VC		430	
TLI Blank	$903789	CP		1224	
LF1/9110	90			1328	
LF1/9111	91	HSK		1434	

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ENVIRONMENTAL AFFAIRS

REV 2 12/1/88

TRIANGLE LABORATORIES, INC

MASS SPECTROMETER RUN SHEET

CONFIRMATION ANALYSES

CASE ID: JWP	TLI PROJECT ID: 16661
DATE : 10/21/90	SPECTROSCOPIST: MS # 70W

SAMPLE ID:	FILE NAME:	OPERATOR:	DATE	TIME	COMMENTS
RTCHK	U902297	JA	10/31/90	921	
C-Cal	98	↓	↓	1013	
LF1/9110	U902306	JA	10-21-90	1642	
LF1/9111	07	JA	↓	1732	

RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

REV 2 12/1/88

RECEIVED
NOV 19 1990
ENVIRONMENTAL

% Moisture Calculation
Project Number: 6661

Sample Number	Client ID	Vial + Moisture Sample Weight	Empty Vial Weight	Dry Vial + Moisture Sample Weight	% Moisture	Actual Sample Weight	Dry Actual Sample Weight
1	LF1/9110	27.4108	13.2100	25.3972	14.18	11.0200	9.46
2	LF1/9111	27.2169	13.6488	25.1431	15.28	11.1000	9.40

SWP

PERCENT MOISTURE FORM

NOV 19 1990

PROJECT ENVIRONMENTAL AFFAIRS

6666

SAMPLE I.D.	A VIAL+SAMPLE	B MT VIAL	C WET WT.	<-- D --> FIRST DRY	SECOND	THIRD	(A-D) H2O LOST	(A-D)/CX100 %H2O
	10/10/90 gs	10/10/90 gs		10/4/90 wk	10/12/90 wk	10/13/90 wk		
1	27.4108	13.2100		25.4200	25.4021	25.3972		
2	27.2169	13.6488		25.1633	25.1484	25.1431		

GERAGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No. N/A

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Project Number NC09001

Project Location WILMINGTON, NC

Laboratory TRIANGLE LABORATORIES INC

Sampler(s)/Affiliation M. RADECKE G&M
D. RUMFORD III G&M

SAMPLE-BOTTLE / CONTAINER DESCRIPTION

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	250ml amber glass PCB/Pesticide Cl4-Cl & with 2,3,7,8 confirmation									TOTAL
LF1 / 9110	S	10/9/90		1									1
LF2 / 9111	S	10/9/90		1									1

Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/Containers 2

Relinquished by: Mark E. Radecke Organization: Geraghty & Miller, Inc 10/9/90 19:00
Received by: Organization: Date / / Time

Seal Intact? Yes No N/A

Relinquished by: Organization:
Received by: Brian Hunt Organization: TRIANGLE LABS Inc Date 10/10/90 Time 12:45PM

Seal Intact? Yes No N/A

Special Instructions/Remarks:

Delivery Method: ☐ In Person ☒ Common Carrier Federal Express (SPECIFY) ☐ Lab Courier ☐ Other (SPECIFY)

Custody Seal: Present / Absent // Intact / Not Intact
Chain of Custody: Present / Absent
Sample Tags: Present / Absent
Sample Tag Numbers: Listed / Not listed on Chain of Custody
SHO Forms: Present / ~~Absent~~

TLI Project Number: 16661
Client: Geraghty & Miller Inc
Date Received at TLI: 10/10/90 By Rick Hunt
Carrier and Number: Fed X 806181516

Book: 37
Page: 21

Packaging: Styro foam Cooler
Ice Present: Yes / No

TLI	Sample ID Client	Matrix	Storage Location	To Lab Date/ Initial	To Storage Date/ Initial	To Lab Date/ Initial	To Storage Date/ Initial	To Lab Date/ Initial	To Storage Date/ Initial	To Archive Date/ Initial
37.26.1	LF1/9110	Soil	Cooler #1							
37.26.2	LF2/9111	↓	↓							

Receiving Remarks: (2) Samples Received In good Condition.

Archive Remarks:

TRIANGLE LABORATORIES, INC. CHAIN OF CUSTODY REVISED 9/25/90

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ENVIRONMENTAL AFFAIRS

NOV 20 1990

TRIANGLE LABORATORIES, INC.
801-10 CAPITOLA DRIVE
RESEARCH TRIANGLE PARK, NC 27713

Phone: (919) 544-5729
Fax: (919) 544-5491

DATE :	* 16 NOVEMBER 1990
CLIENT ID :	* SOUTHERN WOOD PIEDMONT
P.O. NUMBER :	* 5145
TLI PROJECT No. :	* 16661

CASE NARRATIVE
MODEL 8290X

ANALYSIS OF SAMPLES FOR THE PRESENCE OF

POLYCHLORINATED DIBENZO-p-DIOXINS

AND

DIBENZOFURANS

BY

HIGH-RESOLUTION GAS CHROMATOGRAPHY /
HIGH-RESOLUTION MASS SPECTROMETRY

Two soil samples were received from SOUTHERN WOOD PIEDMONT in good condition October 10, 1990 and stored in a refrigerator at 4°C. The samples were extracted and analyzed according to procedures described in the Triangle Labs User Manual provided with this data package. Any particular difficulties encountered during the sample handling by Triangle Labs will be discussed in the QA/QC remark section below.

Quality Assurance/Quality Control Samples

A laboratory method blank -- identified as the TLI Blank -- is prepared along with the batch of samples.

QA/QC Remarks

The release of this particular set of SOUTHERN WOOD PIEDMONT analytical data by Triangle Labs was authorized by the Quality Assurance Officer who has reviewed each sample data package individually following a series of inspections/reviews conducted at two other levels of the data production line. When applicable, general deviations from acceptable QA/QC requirements are identified below. Comments on the effect of these deviations upon the validity and reliability of the results can be obtained from the User Manual (Data Quality Objectives; Section 5). Specific QA/QC Problems Associated with this Particular Project are:

Sample Preparation Laboratory: None

Mass Spectrometry: None

Data Review:

The 234678-HxCDF and OCDD isomers were found in the TLI Blank at levels less than one-third the calculated theoretical method quantitation limit (TMQL) for the associated samples. Blank contamination levels of one-third TMQL or less are acceptable under TLI guidelines, as discussed in section 5.1.3.2 of the Data User's Manual.

TLI Blank, Samples LF1/9110 (TLI # 37-26-1) and LF2/9111 (TLI # 37-26-2) present QC ion instabilities as a result of quantitative interferences (on DB-5 and DB-225 analyses). The affected isomers are flagged "Q" on the report. Affected analytes may be overestimated or underestimated due to this interference. Quantitative interference is described in section 5.1.2.4.1 of the Data User's Manual.

These samples have been diluted and reanalyzed on DB-5 column due to saturation in the original analysis.

Sample LF2/9111 (DIL) (TLI # 37-26-2) has been reanalyzed on DB-5 column due to arcing, present in the HpCDF mass channel.

NOV 19 1990

Environmental ...

Addendum to Section 4.6 of the Data User's Manual

Effective December 15, 1989, Triangle Laboratories has adopted a new procedure for calculating the analyte specific detection limits. Under this new policy two representative noise height determinations are summed and multiplied by an empirically determined factor before the detection limit equation given in Section 4.6 of the Data User's Manual is applied. The effect of this procedure is to increase DB-225 analyses detection limits by a factor of 3.5, and DB-5 analyses detection limits by a factor of 5. This procedure will result in a more accurate estimate of detection limits.

The revised formula for DB-225 analyses is:

$$DL_{ai}^{DB-225} = \frac{2.5 * (3.5 * H_{ai}) * Q_{Bj}}{A_{Bj} * \overline{RRF} * W}$$

$$3.5 * H_{ai} = A_{noise}$$

The revised formula for DB-5 analyses is:

$$DL_{ai}^{DB-5} = \frac{2.5 * (5 * H_{ai}) * Q_{Bj}}{A_{Bj} * \overline{RRF} * W}$$

$$5 * H_{ai} = A_{noise}$$

The symbols are defined in Section 4.6 of the Data User's Manual.

As an example, consider a DB-225 confirmation analysis of a 10 g sample. The internal standard spike is 2000 pg, the 13C12-2,3,7,8-TCDF internal standard area is 12000 area units, the RRF is 1.215 and the noise height is 11 units. The 2,3,7,8-TCDF detection limit is:

$$DL_{TCDF}^{DB-225} = \frac{2.5 * (3.5 * 11) * 2000}{12000 * 1.215 * 10.0} = 1.3 \text{ ppt}$$

Should SOUTHERN WOOD PIEDMONT have any questions or comments to formulate regarding this data package please feel free to contact us.

For Triangle Laboratories,

Analyst	QA Project Officer	Laboratory Manager

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12822	-1	-2	-3	-4	-5
	9101C	9101A	9101B	9101D	9104D
2-Chlorophenol	<7.3	<7.4	<7.8	<0.35	
Phenol	↓	↓	↓	↓	
2,4-Dimethylphenol					
Trichlorophenols					
p-chloro-m-cresol					
Tetrachlorophenols	↓	↓	↓	↓	
2,4-Dinitrophenol	<37	<7	<39	<1.8	
Benzo(b,k)Fluoranthene	27J	43J	19J	<0.35	
Indeno(1,2,3-cd)pyrene	5.2J	10J	4.9J	↓	
Dibenzo(a,h)anthracene	2.3J	4.3J	2.7J		
o-cresol	<7.3	<7.4	<7.8		
m+p-cresol	↓	↓	↓	↓	

12822	-6	-7	-8	-9	-10
	9104B	9104C	9104A	9102A	9102B
2-Chlorophenol	<7.4	<7.2	<7.5	<9.4	<7.4
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<37	<36	<38	<47	<37
Benzo(b,k)Fluoranthene	120J	9.1J	29J	49J	14J
Indeno(1,2,3-cd)pyrene	14J	2.0J	8.1J	11J	3.3J
Dibenzo(a,h)anthracene	4.2J	0.76J	3.2J	5.0J	1.6J
o-cresol	<7.4	<7.4	<7.5	<9.4	<7.4
m+p-cresol	↓	↓	↓	↓	↓

12822	-11	-12	-13	-14	-15
	9102C	9102D	9100A	9100B	9100C
2-Chlorophenol	<7.5	<0.36	<8.0	<7.3	<7.3
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-Chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<38	<1.8	<40	<37	<37
Benzo(b,k)Fluoranthene	68 J	<0.36	35 J	19 J	100 J
Indeno(1,2,3-cd)pyrene	9.3 J	↓	10 J	5.2 J	17 J
Dibenzo(a,h)anthracene	4.7 J	↓	4.2 J	2.2 J	7.5 J
o-cresol	<7.5	↓	<8.0	<7.3	<7.3
m+p cresol	↓	↓	↓	↓	↓

12822	-16	-17	-18	-19	-20
	9100D	9106A	9106B	9106C	9106D
2-Chlorophenol	<0.35	<7.7	<7.8	<7.6	<0.37
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-Chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<1.8	<39	<39	<38	<1.9
Benzo(b,k)fluoranthene	<0.35	43 J	24 J	17 J	0.78 J
Indeno(1,2,3-cd)pyrene	↓	11 J	<7.8	<7.6	0.18 J
Dibenzo(a,h)anthracene	↓	<7.7	↓	↓	<0.37
o-cresol	↓	↓	↓	↓	↓
m+p cresol	↓	↓	↓	↓	↓

12822	-26	-27	-28 *	-29	-30
	9105B	9105C	9105D	9107B	9107A
2-Chlorophenol	<8.3	<7.1		<7.3	<7.6
Phenol	↓	↓		↓	↓
2,4-Dimethylphenol	↓	↓		↓	↓
Trichlorophenols	↓	↓		↓	↓
p-chloro-m-cresol	↓	↓		↓	↓
Tetrachlorophenols	↓	↓		↓	↓
2,4-Dinitrophenol	<42	<36		<37	<38
Benzo(b,k)Fluoranthene	89 J	6.2 J		5.7 J	43 J
Indeno(1,2,3-cd)pyrene	18 J	1.1 J		14 J	11 J
Dibenzo(a,h)anthracene	<8.3	<7.1		6.2 J	5.3 J
o-cresol	↓	↓		<7.3	<7.6
m+p cresol	↓	↓		↓	↓

	-31	-32	-33	-34	-35
	9107C	9107D	9108D		9108C
2-Chlorophenol	<7.5	<0.39	<0.42		<8.5
Phenol	↓	↓	↓		↓
2,4-Dimethylphenol					
Trichlorophenols					
p-chloro-m-cresol					
Tetrachlorophenols					1.2 J
2,4-Dinitrophenol	<38	<2.0	<2.1		<43
Benzo(b,k)Fluoranthene	38 J	<0.39	2.3 J		99 J
Indeno(1,2,3-cd)pyrene	23 J		0.53 J		19 J
Dibenzo(a,h)anthracene	15 J		0.23 J		9.4 J
o-cresol	<7.5		<0.42		<8.5
m+p-cresol	↓	↓	↓		↓

12822	-36	-37	-38	-39	-40
	9108B	9108C	9103A	9103B	9103D
2-Chlorophenol	<7.8	<7.6	<7.6	<7.3	<7.6
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol					
Trichlorophenols					
p-Chloro-m-cresol					
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<39	<38	<38	<37	<38
Benzo(b,k)Fluoranthene	82J	52J	31J	14J	18J
Indeno(1,2,3-cd)pyrene	19J	8.7J	8.0J	4.9J	4.1J
Dibenzo(a,h)anthracene	8.0J	3.9J	4.3J	1.6J	1.8J
o-cresol	<7.8	<7.6	<7.6	<7.3	<7.6
m+p-cresol	↓	↓	↓	↓	↓

	-41	-42	-43		
	RB1	FB-1	TB-2		
2-Chlorophenol	<0.010	<0.010	<0.010		
Phenol	↓	↓	↓		
2,4-Dimethylphenol	↓	↓	↓		
Trichlorophenols	↓	↓	↓		
p-chloro-m-cresol	↓	↓	↓		
Tetrachlorophenols	↓	↓	↓		
2,4-Dinitrophenol	<0.050	<0.050	<0.050		
Benzo(b,k)Fluoranthene	<0.010	<0.010	<0.010		
Indeno(1,2,3-cd)pyrene	↓	↓	↓		
Dibenzo(a,h)anthracene	↓	↓	↓		
o-cresol	↓	↓	↓		
m+p-cresol	↓	↓	↓		

12822	-21	-22	-23	-24	-25
	9109A	9109B	9109C	9109D	9105A
2-Chlorophenol	<7.4	<7.5	<4.1	<0.36	<7.8
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<37	<38	<21	<1.8	<39
Benzo(b,k)Fluoranthene	35J	32J	31J	<0.36	33J
Indeno(1,2,3-cd)pyrene	9.6J	8.3J	9.4J	↓	8.6J
Dibenzo(a,h)anthracene	4.4J	3.2J	3.9J	↓	3.9J
o-cresol	<7.4	<7.5	<4.1	↓	<7.8
m+p cresol	↓	↓	↓	↓	↓

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

Mark,

Additional compound results for 12822 # 5 # 28 # 34.

Thanks,
Gloria

THE ENCLOSURE IS BEING SENT TO YOU WITHOUT A PERSONAL LETTER SO THAT IT MAY REACH YOU EXPEDITIOUSLY.

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G

12822	-1	-2	-3	-4	-5
	9101C	9101A	9101B	9101D	9104D
2-Chlorophenol	<7.3	<7.4	<7.8	<0.35	<0.34
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<37	<7	<39	<1.8	<1.7
Benzo(b,k)Fluoranthene	27J	43J	19J	<0.35	1.1J
Indeno(1,2,3-cd)pyrene	5.2J	10J	4.9J	↓	<0.34
Dibenzo(a,h)anthracene	2.3J	4.3J	2.7J	↓	↓
o-cresol	<7.3	<7.4	<7.8	↓	↓
m+p-cresol	↓	↓	↓	↓	↓

12822	-26	-27	-28	-29	-30
	9105B	9105C	9105D	9107B	9107A
2-Chlorophenol	<8.3	<7.1	<0.45	<7.3	<7.6
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	↓
2,4-Dinitrophenol	<42	<36	<2.3	<37	<38
Benzo(b,k)Fluoranthene	89J	6.2J	2.6J	5.7J	43J
Indeno(1,2,3-cd)pyrene	18J	1.1J	<0.45	14J	11J
Dibenzo(a,h)anthracene	<8.3	<7.1	↓	6.2J	5.3J
o-cresol	↓	↓	↓	<7.3	<7.6
m+p-cresol	↓	↓	↓	↓	↓

39

	-31	-32	-33	-34	-35
	9107C	9107D	9108D	9108A	9108C
2-Chlorophenol (128)	<7.5	<0.39	<0.42	<0.39	<8.5
Phenol	↓	↓	↓	↓	↓
2,4-Dimethylphenol	↓	↓	↓	↓	↓
Trichlorophenols	↓	↓	↓	↓	↓
p-chloro-m-cresol	↓	↓	↓	↓	↓
Tetrachlorophenols	↓	↓	↓	↓	1.2 J
2,4-Dinitrophenol	<38	<2.0	<2.1	<2.0	<43
Benzo(b,k)fluoranthene	38 J	<0.39	2.3 J	1.4 J	99 J
Indeno(1,2,3-cd)pyrene	23 J	↓	0.53 J	<0.39	19 J
Dibenzo(a,h)anthracene	15 J	↓	0.23 J	↓	9.4 J
o-cresol	<7.5	↓	<0.42	↓	<8.5
m+p-cresol	↓	↓	↓	↓	↓

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G & M RALEIGH

March 12, 1992

Mr. Mark Radecke
GERAGHTY & MILLER, INC.
3724 National Drive
Suite 228
Raleigh, NC 27612

Dear Mark:

Benzo(b,k)fluoranthene cannot be separated for orders SO-12822 and SO-12806.

Sincerely,

Gloria Fulwood

Gloria Fulwood

NOV 19 1990

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b)

10/31/90

FILE NAME....: S903789 CLIENT ID....: SWP TLI NUMBER....: n/a
CONCAL (VER).: S903783 SAMPLE ID....: TLI BLANK
PROJECT NUMBER: 16661 ICAL DATE....: 10/13/90
ANALYST.....: CP ANALYSIS DATE: 10/18/90
SAMPLE SIZE..: 9.000 g SAMPLE MATRIX: n/a SAMPLE ORIGIN: n/a
DATE RECEIVED.: / / DATE COLLECTED: / /
SPIKE FILE...: SPX23710 SHIPMENT NO...: n/a

NAME	CONC(ppb)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND		0.008				—
12378-PeCDD	ND		0.005				—
123478-HxCDD	ND		0.005				—
123678-HxCDD	ND		0.003				—
123789-HxCDD	ND		0.005				—
1234678-HpCDD	ND		0.005				—
OCDD	0.01				0.94	51:49	—
2378-TCDF	ND		0.005				—
12378-PeCDF	ND		0.005				—
23478-PeCDF	ND		0.005				—
123478-HxCDF	ND		0.003				—
123678-HxCDF	ND		0.003				—
234678-HxCDF	0.002				1.15	41:15	Q
123789-HxCDF	ND		0.005				—
1234678-HpCDF	ND		0.003				—
1234789-HpCDF	ND		0.005				—
OCDF	ND		0.01				—
TOTAL TCDD	ND		0.008				—
TOTAL PeCDD	EMPC			0.002			—
TOTAL HxCDD	ND		0.005				—
TOTAL HpCDD	EMPC			0.002			—
TOTAL TCDF	ND		0.005				—
TOTAL PeCDF	ND		0.005				—
TOTAL HxCDF	0.002	1			1.15		Q
TOTAL HpCDF	ND		0.003				—

KU 10/31/90

X237_RPT rev:3.03

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b) QA/QC SUMMARY
10/31/90

FILE NAME....: S903789 CLIENT ID....: SWP TLI NUMBER....: n/a
CONCAL (VER).: S903783 SAMPLE ID....: TLI BLANK
PROJECT NUMBER: 16661 ICAL DATE....: 10/13/90
ANALYST.....: CP ANALYSIS DATE: 10/18/90
SAMPLE SIZE..: 9.000 g SAMPLE MATRIX: n/a SAMPLE ORIGIN: n/a
DATE RECEIVED.: / / DATE COLLECTED: / /
SPIKE FILE...: SPX23710 SHIPMENT NO...: n/a

SURROGATE RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
37Cl-TCDD	0.57	50.9		31:13	—
13C12-PeCDF 234	0.96	86.2	1.54	36:09	—
13C12-HxCDF 478	0.84	75.3	0.53	40:17	—
13C12-HxCDD 478	1.0	90.8	1.20	41:26	—
13C12-HpCDF 789	0.90	80.8	0.44	47:07	—

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	0.92	82.8	0.53	42:24	—
13C12-HxCDF 234	1.2	110	0.51	41:14	Q

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	0.57	51.1	0.80	30:24	—
13C12-2378-TCDD	0.58	52.6	0.84	31:12	—
13C12-PeCDF 123	0.84	75.6	1.57	35:11	—
13C12-PeCDD 123	1.1	98.5	1.55	36:38	—
13C12-HxCDF 678	0.81	73.3	0.52	40:26	—
13C12-HxCDD 678	1.1	102	1.18	41:34	Q
13C12-HpCDF 678	0.83	75.1	0.46	44:53	—
13C12-HpCDD 678	0.87	78.0	1.05	46:26	—
13C12-OCDD	1.4	63.1	0.90	51:49	—

KU 10/31/90

X237_RPT rev:3.03

2

	Initial	Date
B-File/Header Changes	G.A.	10/31/90
Manual Integrations	KU	10/31/90
Transcription	KU	10/31/90
Dbase Corrections	KU	10/31/90

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Page No. 1 Listing of S903789B.dbf
10/26/90

Matched GC Peaks / Ratio / Ret. Time

noise=1691 (320)

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
304		0.49	27:22	104.87	F	F	0.900	
		0.50	27:44	49.36	F	F	0.912	
		1.54	29:02	41.47	F	F	0.955	
	D	1.29	29:42	75.01	F	F	0.977	S:N
		0.95	30:16	53.55	F	F	0.996	
		0.80	30:26	113.20	T	T	1.001	
		1.57	30:43	73.37	F	F	1.010	
		0.37	31:01	47.10	F	F	1.020	
		1.27	31:25	40.22	F	F	1.033	
	D	2.24	33:48	78.17	F	F	1.112	Rw
		3.87	34:22	33.52	F	F	1.130	
304		*** Total ***		709.84	# of Peaks:		11	
316		0.70	29:58	566.91	T	F	0.986	
		0.80	30:24	103609.61	T	T	1.000	
		0.76	30:54	823.99	T	F	1.016	
316		*** Total ***		105000.51	# of Peaks:		3	
320		2.73	28:54	63.49	F	F	0.926	
	D	0.52	29:46	26.44	F	F	0.954	S:N
		0.53	30:22	44.28	F	F	0.973	
		1.16	31:56	100.13	F	F	1.024	
		0.48	33:02	33.84	F	F	1.059	
	D	1.88	33:49	36.08	F	F	1.084	Rw
		0.73	34:54	53.29	T	F	1.119	
		0.71	35:11	447.37	T	F	1.128	
320		*** Total ***		804.92	# of Peaks:		8	
328		0.00	31:13	62641.29	T	T	1.001	
328		*** Total ***		62641.29	# of Peaks:		1	
332		0.83	31:00	112842.11	T	T	0.994	
		0.84	31:12	61556.12	T	T	1.000	
332		*** Total ***		174398.23	# of Peaks:		2	
340	D →	0.43	31:37	52.33	F	F	0.899 ←	Rw
		0.97	33:54	15.50	F	F	0.964	
	D	3.37	34:05	69.16	F	F	0.969	S:N
		0.66	36:29	25.08	F	F	1.037	
340		*** Total ***		162.07	# of Peaks:		4	
352		1.48	34:03	934.43	T	F	0.968	
		1.63	34:41	590.58	T	F	0.986	
		1.57	35:11	61925.59	T	T	1.000	
		1.73	35:34	2445.00	T	F	1.011	
		1.54	36:09	82596.86	T	T	1.027	
		1.66	37:30	1228.90	T	F	1.066	
352		*** Total ***		149721.36	# of Peaks:		6	

3

NOV 1 9 1990

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/Why
356	D	3.02	35:10	34.55	F	F	0.960	S:N
		0.77	35:22	148.33	F	F	0.965	
356		*** Total ***		182.88	# of Peaks:		2	
368		0.71	35:22	129.01	F	F	0.965	
		1.55	36:38	42342.85	T	T	1.000	
		1.87	37:18	294.25	F	F	1.018	
368		*** Total ***		42766.11	# of Peaks:		3	
374	D	0.93	39:42	22.82	F	F	0.982	S:N
	ck	~~1.00~~ 1.15	41:15	~~293.86~~ 286.4	~~F~~ T	T	1.020	
	D	1.47	41:22	23.87	F	T	1.023	S:N
		0.54	41:35	17.62	F	F	1.028	
374		*** Total ***		358.17	# of Peaks:		4	
384		0.58	38:47	229.31	T	F	0.959	
		0.59	38:59	453.68	T	F	0.964	
		0.53	40:17	105800.51	T	T	0.996	
		0.52	40:26	116899.36	T	T	1.000	
		0.51	41:14	154126.85	T	T	1.020	Q
		0.53	42:24	97789.58	T	T	1.049	
384		*** Total ***		475299.29	# of Peaks:		6	
390	D	2.94	41:15	50.22	F	F	0.992	S:N
		0.66	41:36	35.04	F	T	1.001	
		2.35	42:00	32.82	F	T	1.010	
	D	1.02	42:24	15.38	F	F	1.020	Rw
390		*** Total ***		133.46	# of Peaks:		4	
402		1.20	41:26	70009.15	T	T	0.997	
		1.18	41:34	102028.43	T	T	1.000	Q
		1.21	42:03	101557.82	T	T	1.012	
402		*** Total ***		273595.40	# of Peaks:		3	
408	D	0.78	44:53	80.45	F	T	1.000	S:N
		2.06	45:32	53.58	F	F	1.014	
408		*** Total ***		134.03	# of Peaks:		2	
418		0.46	44:53	88238.21	T	T	1.000	
		0.56	46:26	70.58	F	F	1.035	
		0.44	47:07	72427.26	T	T	1.050	
		1.26	48:45	186.40	F	F	1.086	
418		*** Total ***		160922.45	# of Peaks:		4	
424	D	4.39	44:54	69.46	F	F	0.967	not Rept a
		1.38	45:21	165.17	F	F	0.977	
	D	1.94	46:27	85.06	F	T	1.000	S:N not Rept a
	D	3.31	47:07	61.93	F	F	1.015	
		1.11	49:24	29.33	T	F	1.064	
424		*** Total ***		410.95	# of Peaks:		5	4
436		1.05	46:26	66155.25	T	T	1.000	

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
436		*** Total ***		66155.25	# of Peaks:		1	
458		2.31	49:51	32.99	F	F	0.962	
		1.40	50:43	25.26	F	F	0.979	
		0.94	51:49	480.25	T	T	1.000	
458		*** Total ***		538.50	# of Peaks:		3	
470		0.90	51:49	50926.01	T	T	1.000	
470		*** Total ***		50926.01	# of Peaks:		1	

*** End of Report ***

NOV 1 9 1990

Listing of S9037891.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
202	10:28	9.41	13:31	22.40	16:50	15.03	18:41	9.94
	10:49	12.81	14:14	22.83	16:57	20.48	18:49	7.06
	10:57	48.91	14:31	16.09	17:12	17.65	19:02	32.32
	11:13	21.12	14:52	60.14	17:22	20.66	19:15	39.76
	11:24	19.79	15:25	16.31	17:30	71.13	19:23	44.53
	12:04	27.31	15:50	32.55	17:55	38.35	19:32	7.08
	12:18	9.59	16:22	25.01	18:12	33.06	20:12	24.94
	12:27	11.00	16:34	10.54	18:18	46.88	20:20	137.88
	12:50	18.83	16:42	7.65	18:33	36.56	20:35	18.29
204	10:28	49.50	13:26	33.30	16:40	18.83	18:56	29.08
	10:50	46.07	13:42	22.08	16:47	13.99	19:24	30.28
	11:12	38.39	14:09	39.59	17:11	68.68	19:33	17.73
	11:25	7.14	14:21	14.25	17:22	48.70	19:42	9.42
	11:37	23.78	14:31	30.17	17:31	42.07	19:51	11.73
	12:12	44.31	14:55	25.02	17:41	11.02	20:08	13.36
	12:24	14.93	15:25	46.20	17:59	48.67	20:56	38.37
	12:35	16.20	15:49	9.38	18:08	17.22	21:16	16.96
	12:52	38.83	16:04	10.33	18:27	12.89		
	13:08	26.96	16:14	12.66	18:50	22.51		
238	17:29	75.80	18:34	64.87	20:33	19.63	21:50	29.21
	17:43	10.87	18:44	63.15	20:59	73.96	22:03	39.31
	17:59	7.24	18:58	7.76	21:09	27.95	22:23	45.48
	18:11	21.31	19:11	19.27	21:27	28.37		
	18:19	11.73	19:21	32.88	21:38	51.02		
240	17:28	67.42	18:45	101.78	20:57	167.79	21:59	93.14
	17:41	110.04	19:03	69.86	21:05	266.25	22:08	131.06
	18:13	16.66	19:19	37.13	21:19	36.65		
	18:29	118.87	19:33	83.37	21:36	111.88		
	18:38	30.60	20:35	200.87	21:43	86.80		
252	18:34	125.08	20:35	102.27	21:28	46.29	22:08	65.57
	18:47	46.04	20:55	38.16	21:37	57.01	22:53	69.23
	19:03	104.30	21:03	164.91	21:46	9.40	23:01	31.37
	19:32	98.17	21:20	41.21	22:00	100.20	23:11	57.27
254	18:32	14.11	19:31	13.82	20:49	13.63	22:53	8.22
	18:42	8.85	19:39	21.62	21:16	16.47	23:12	13.91
	18:54	19.83	20:14	15.39	22:09	28.82		
	19:10	12.07	20:41	13.89	22:40	17.53		
270	22:01	7.67	23:18	12.44	24:51	14.23		
	22:10	9.07	23:31	15.54	24:58	19.65		
	22:53	10.52	24:25	11.82	25:08	17.68		
272	21:50	11.38	22:36	9.05	25:04	17.13	25:41	16.93
	22:16	11.36	23:28	18.40	25:16	32.48	26:08	10.21
286	23:32	23.90	24:44	12.92	25:14	35.56	26:20	8.21
	23:56	14.16	24:57	11.86	25:44	20.19	26:38	21.84
	24:10	18.27	25:07	7.60	26:04	13.71	26:44	19.85

Listing of S903789I.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
288	25:30	9.74						
218	11:14	12.15	13:34	40.55	15:14	34.80	18:32	42.91
	11:29	13.73	14:04	21.86	15:45	42.37	18:39	76.79
	11:59	34.45	14:15	17.58	17:22	55.35	19:26	69.66
	12:10	19.35	14:36	34.95	17:32	22.26	19:45	8.83
	12:30	43.21	14:47	31.82	18:00	45.59	20:12	63.24
	12:47	63.18	15:06	48.19	18:14	55.68		
220	11:19	18.05	14:26	45.09	16:31	27.67	18:35	19.76
	12:22	13.06	14:36	51.73	16:57	44.23	19:55	39.34
	13:03	45.24	14:52	47.91	17:25	60.46	20:15	38.00
	13:49	49.74	15:26	46.40	17:29	26.59	21:23	16.23
	14:00	19.12	15:47	20.92	17:44	54.39		
	14:11	51.44	16:14	16.36	18:11	69.46		
304	27:22	34.33	29:17	38.36	31:13	35.71	33:08	9.44
	27:35	11.90	29:42	42.29	31:18	11.81	33:38	12.46
	27:44	16.55	30:00	26.86	31:25	22.53	33:48	54.08
	28:09	10.26	30:16	26.10	31:59	8.67	34:07	12.54
	28:19	15.15	30:26	50.28	32:25	7.37	34:22	26.63
	28:34	10.18	30:43	44.80	32:36	17.36		
	29:02	25.17	31:01	12.61	32:57	9.25		
306	27:22	70.54	29:09	51.87	30:56	27.12	32:40	24.49
	27:39	9.92	29:30	13.03	31:03	34.49	33:05	21.94
	27:46	32.81	29:36	25.49	31:26	17.69	33:20	37.33
	28:05	22.86	29:41	32.72	31:36	48.70	33:30	79.28
	28:15	12.08	29:47	32.17	31:49	20.41	33:50	24.09
	28:37	24.61	30:17	27.45	32:02	9.27	34:12	114.28
	28:56	17.29	30:27	62.92	32:16	71.52	34:22	6.89
	29:02	16.30	30:45	28.57	32:22	32.17		
320	27:23	14.89	29:39	22.86	31:56	53.74	33:49	23.56
	27:31	15.56	29:46	9.10	32:07	46.43	34:03	34.43
	27:41	26.72	30:22	15.32	32:42	9.03	34:24	8.33
	28:17	19.12	30:45	54.36	33:02	11.05	34:34	18.46
	28:38	6.80	31:00	19.15	33:20	10.98	34:45	32.59
	28:54	46.48	31:27	37.43	33:28	7.04	34:54	22.57
	29:14	6.05	31:47	20.08	33:37	10.24	35:11	185.79
322	27:16	46.49	29:11	25.77	31:19	75.42	33:32	47.65
	27:47	29.01	29:32	10.29	31:33	23.87	33:44	17.92
	28:22	26.18	29:47	17.34	31:54	46.39	33:51	12.52
	28:30	11.59	29:57	30.24	32:02	26.84	34:13	22.57
	28:42	27.74	30:08	9.48	32:51	9.61	34:37	33.18
	28:46	15.25	30:23	28.96	33:01	22.79	34:56	30.72
	28:54	17.01	30:35	46.68	33:08	37.35	35:11	261.58
	29:03	17.58	30:41	23.33	33:25	47.09		
340	31:24	8.72	33:36	19.25	35:04	20.61	37:36	7.41
	31:37	15.69	33:54	7.62	35:26	31.15		
	32:04	8.46	34:05	53.32	36:29	9.97		
	32:33	7.60	34:16	12.15	36:38	8.32		

Listing of S903789I.dbf File
Raw Mass, Retention Time and Data Area

NOV 1 9 1990

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
342	31:38	36.64	33:53	7.88	35:21	7.68	36:29	15.11
	31:58	7.82	34:05	15.84	35:38	19.93		
	32:07	10.05	34:45	10.14	36:08	10.38		
356	33:26	7.58	35:10	25.95	36:09	7.55	36:38	13.43
	34:14	26.41	35:22	64.46	36:19	8.78	37:39	9.47
	34:37	6.83	35:46	10.30	36:29	6.85		
358	34:26	13.07	35:11	8.60	35:38	6.62	37:16	6.03
	34:42	6.38	35:22	83.87	36:00	11.26		
316	29:36	76.64	29:58	234.05	30:24	46044.15	30:54	356.98
318	29:58	332.86	30:24	57565.46	30:54	467.01		
328	31:13	62641.29						
332	31:00	51051.07	31:12	28029.69				
334	31:00	61791.04	31:12	33526.43				
352	34:03	557.41	35:11	37873.31	36:09	50114.24	37:30	766.68
	34:41	365.95	35:34	1550.25	36:38	203.45		
354	34:03	377.02	35:11	24052.28	35:49	28.85	37:13	62.36
	34:42	224.63	35:34	894.75	36:09	32482.62	37:30	462.22
368	35:22	53.38	36:38	25738.52	37:18	191.69		
370	34:05	30.60	35:22	75.63	36:38	16604.33	37:18	102.56
374	38:54	11.32	39:42	11.02	41:00	8.51	41:41	6.83
	39:05	8.64	39:50	11.86	41:05	6.07	42:04	19.60
	39:12	17.39	39:57	10.94	41:15	146.92	42:25	9.68
	39:26	11.06	40:19	8.75	41:22	14.21		
	39:31	7.81	40:25	21.89	41:35	6.18		
376	39:00	16.82	41:15	146.94	41:31	6.55	42:40	6.47
	39:43	11.80	41:24	9.66	41:34	11.44		
390	39:07	6.50	40:25	23.40	41:15	37.47	42:00	23.03
	40:17	28.02	40:48	6.34	41:36	13.87	42:24	7.76
392	38:15	6.16	40:35	7.81	41:34	21.17	42:22	7.62
	39:51	6.93	41:15	12.75	41:55	9.30	42:49	10.53
	40:28	17.57	41:20	10.79	42:00	9.79		
384	38:47	84.38	40:17	36559.46	40:52	309.08	42:24	33751.59
	38:59	168.29	40:26	39837.25	41:14	52311.55		
386	38:48	144.93	40:17	69241.05	41:14	101815.30		
	38:59	285.39	40:26	77062.11	42:24	64037.99		

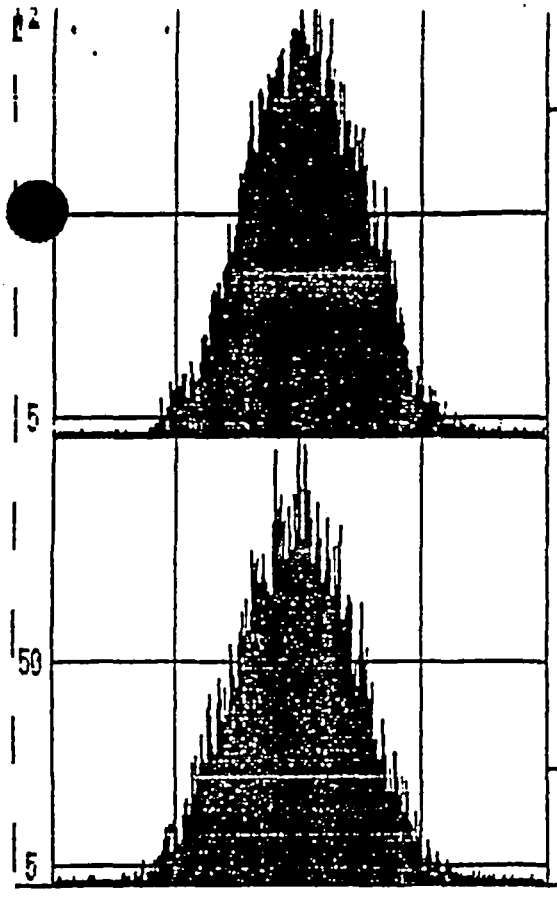
8

Listing of S903789I.dbf File
Raw Mass, Retention Time and Data Area

NOV 19 1990

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
402	41:26	38239.94	41:34	55327.00	42:03	55527.58		
404	40:35	34.33	41:26	31769.21	41:34	46701.43	42:02	46030.24
408	43:42	13.51	45:32	36.08	47:33	15.26		
	44:53	35.16	45:52	14.99	48:09	10.72		
410	43:17	22.72	44:26	23.41	45:30	17.50	47:48	10.94
	43:46	16.12	44:54	45.29	46:42	21.75	48:01	9.25
	44:00	12.83	45:13	9.59	47:25	12.48		
418	43:26	13.82	45:54	62.87	46:44	9.77	47:50	221.01
	44:53	27789.44	46:26	25.39	47:07	22050.70	48:45	104.08
420	43:35	11.00	46:02	47.93	47:07	50376.56		
	44:53	60448.77	46:17	50.70	48:31	63.05		
	45:31	804.60	46:26	45.19	48:46	82.32		
424	44:01	14.93	45:21	95.79	47:07	47.57		
	44:54	56.58	46:27	56.12	49:24	15.45		
426	44:54	12.88	45:33	20.44	47:07	14.36	49:25	13.88
	45:21	69.38	46:27	28.94	48:40	15.07		
436	46:26	33871.35						
438	46:02	13.57	46:26	32283.90	47:07	272.23		
442	50:12	9.29	52:03	18.63	53:58	11.66		
	51:45	11.91	53:17	9.19				
444	49:07	23.92	50:41	10.48	54:09	11.03		
	49:48	26.22	52:08	19.67				
458	49:51	23.01	51:49	232.14	54:57	15.50		
	50:43	14.73	53:42	19.65				
460	49:52	9.98	50:43	10.53	51:50	248.11		
470	51:49	24087.58	52:33	390.41	53:15	60.16		
472	49:53	12.48	50:54	12.43	53:06	146.68	53:37	21.88
	50:35	11.64	51:49	26838.43	53:19	34.83		

*** End of Report ***



Ref. mass 292.9825 Peak top
Height 6.34 volts Span 200 ppm

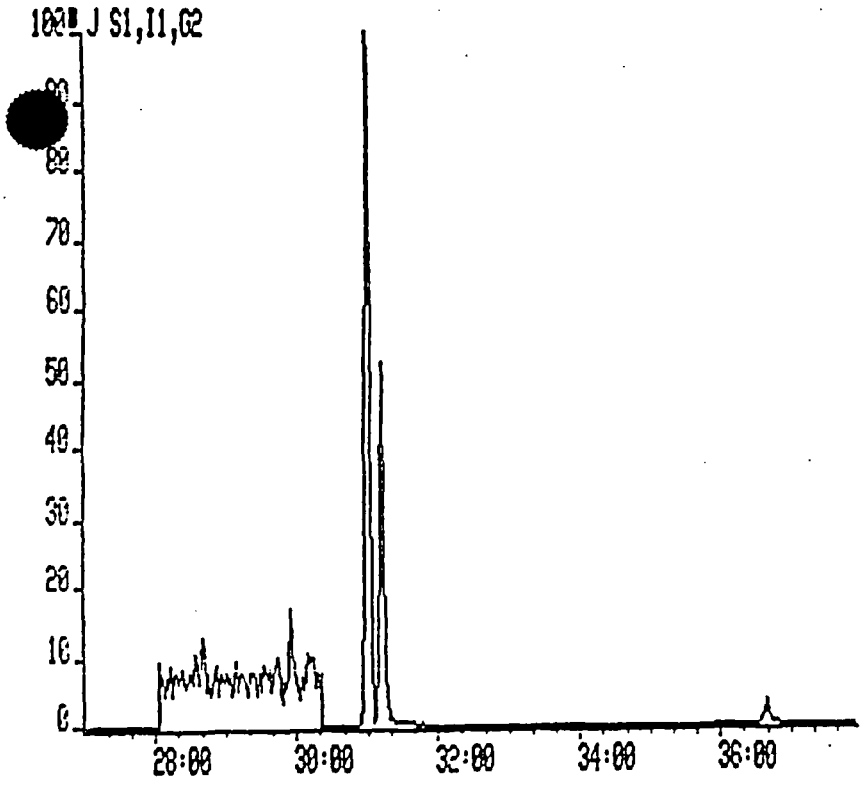
System file name	D85US
Data file name	D:S983789
Resolution	10000
Group number	2
Ionization mode	EI+
Switching	VOLTAGE
Ref. masses	292.9825, 416.9760

A	293	J	332	S	368
B	304	K	334	T	370
C	306	L	338	U	376
D	316	M	340	V	410
E	318	N	342		
F	320	O	352		
G	322	P	354		
H	328	Q	356		
I	331	R	358		

Channel I 330.9792 Peak top
Height 3.97 volts Span 200 ppm

RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

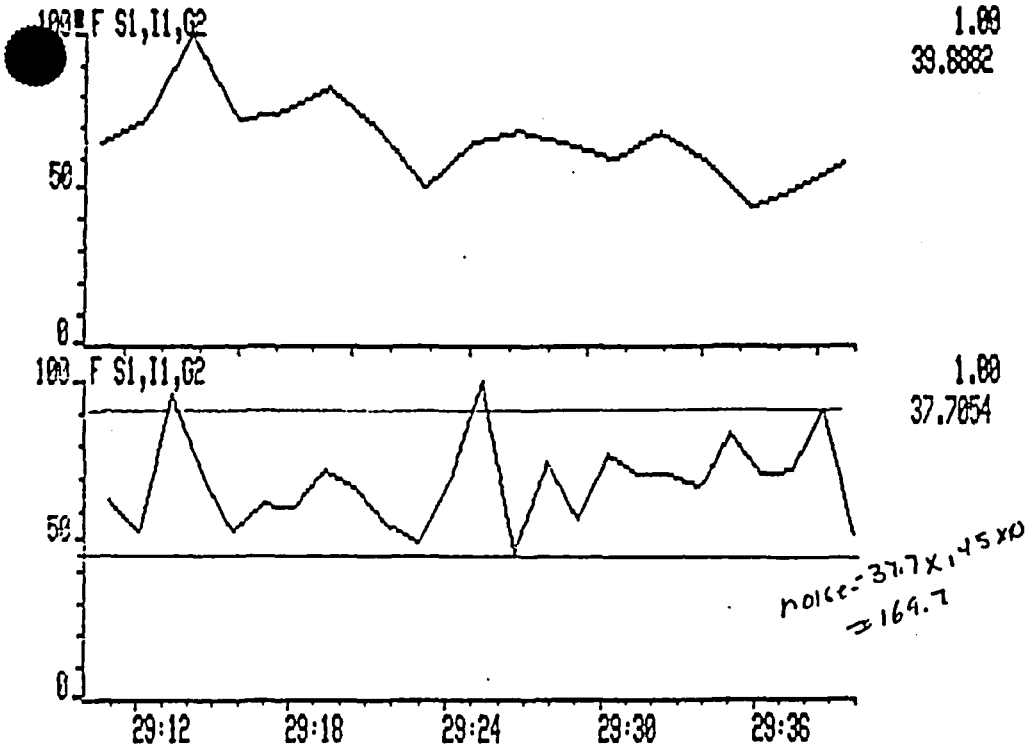
MGH 2' A: 292.9825 B: 303.9816 C: 305.8987 D: 315.9419 E: 317.9389
Text:TLI BLANK TLI#16661



50.00
12228

RECEIVED
NOV 19 1990
ENVIRONMENTAL ANALYS

[illegible] 16-OCT-90 12:24 /65 (CI+) 545:06505
GR: 2' F: 319.8965 G: 321.8936 H: 327.8847 I: 330.9732 J: 331.9368
Text: TLI BLANK TLI#16661



noise = 37.7 x 4.5 x 10 = 169.7

RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

Verified by (GC/MS) : MTB 10-18-90

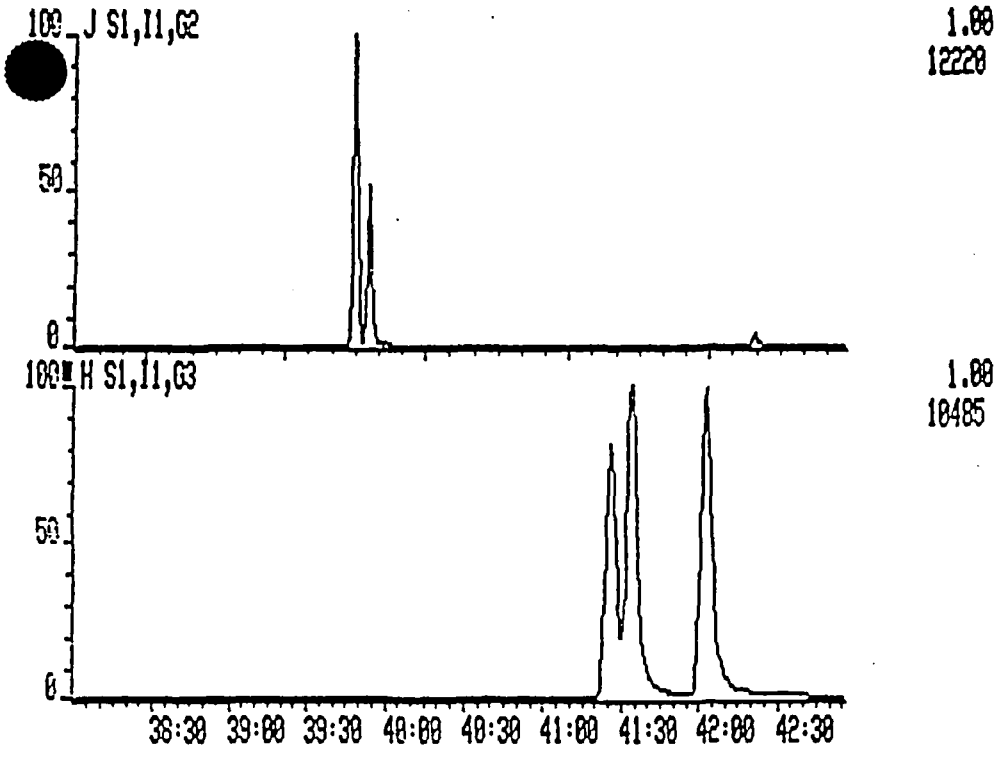
Verified by (Int. QC) : [illegible] 10/20/9

HxCDF contamination < 1/3 TMQL

[illegible] 10/20/90

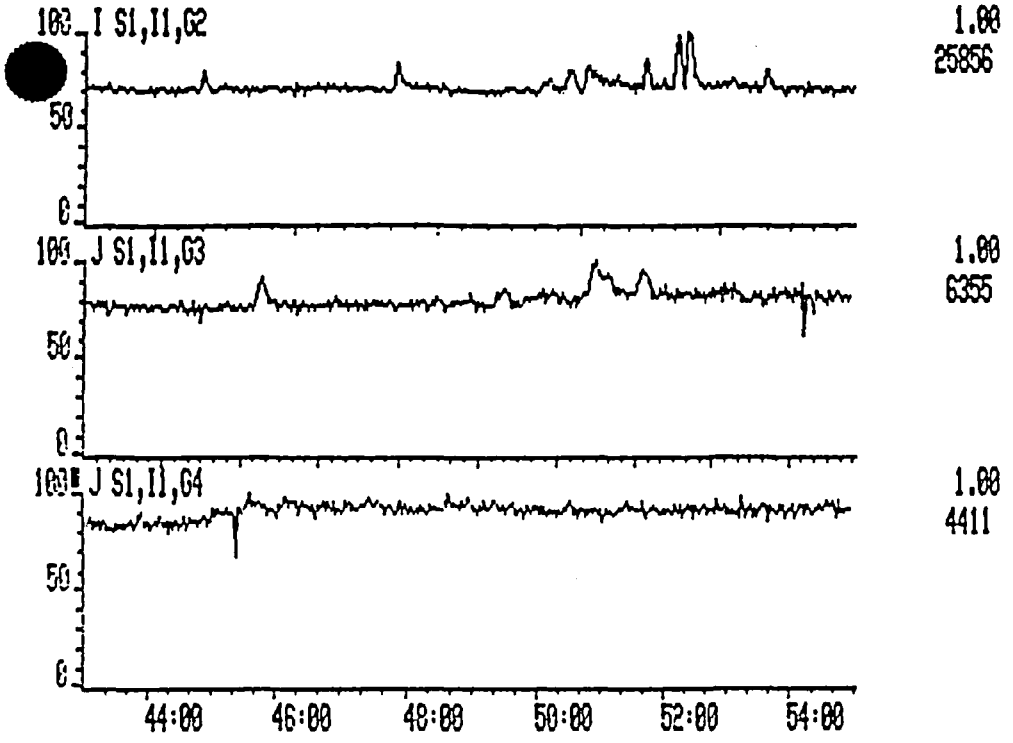
1c

GR 3 F: 331.8127 G: 392.9768 H: 401.8558 I: 403.8529 J: 430.9729
Text:TLI BLANK TLI#16661



RECEIVED
NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

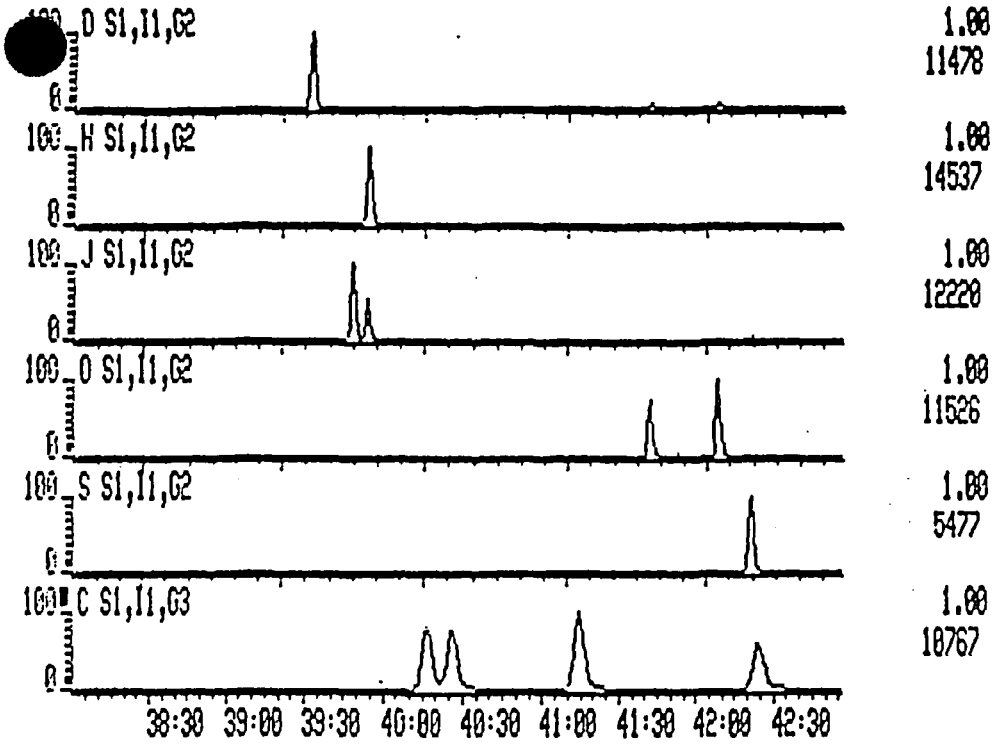
GR: 4 D: 419.8220 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8163
Text: TLI BLANK TLI#16661



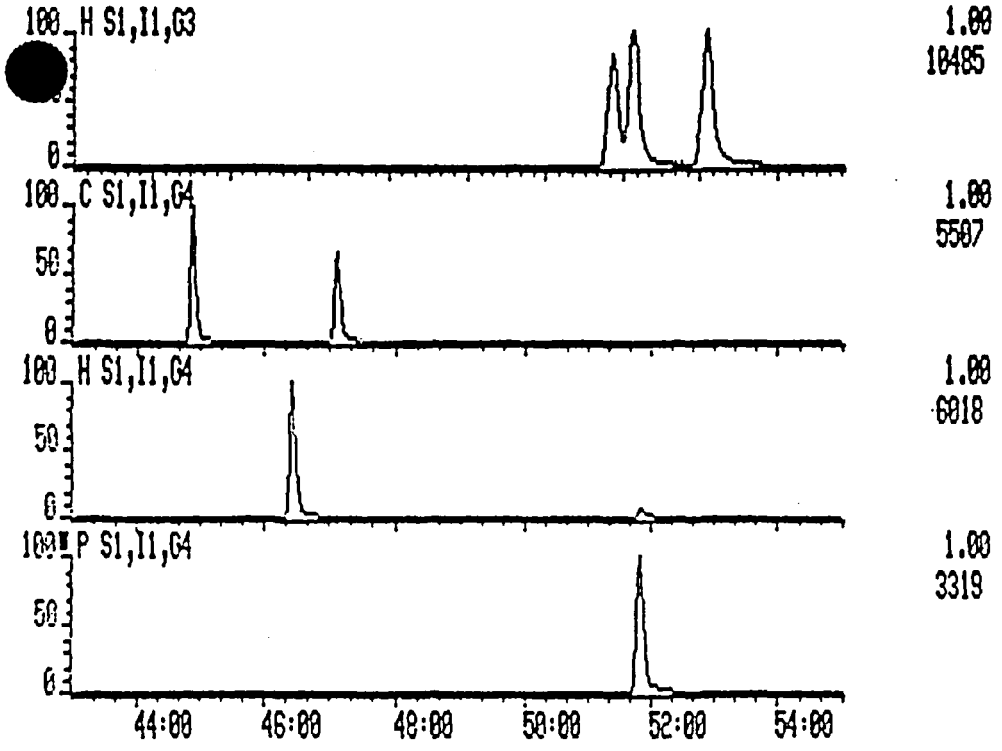
RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

[illegible] 18-OCT-90 12:24 705 (EI+) Sus:DESUS
GR 3' D: 385.8610 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558
Text:TLI BLANK TLI#16661

RECEIVED
NOV 19 1990

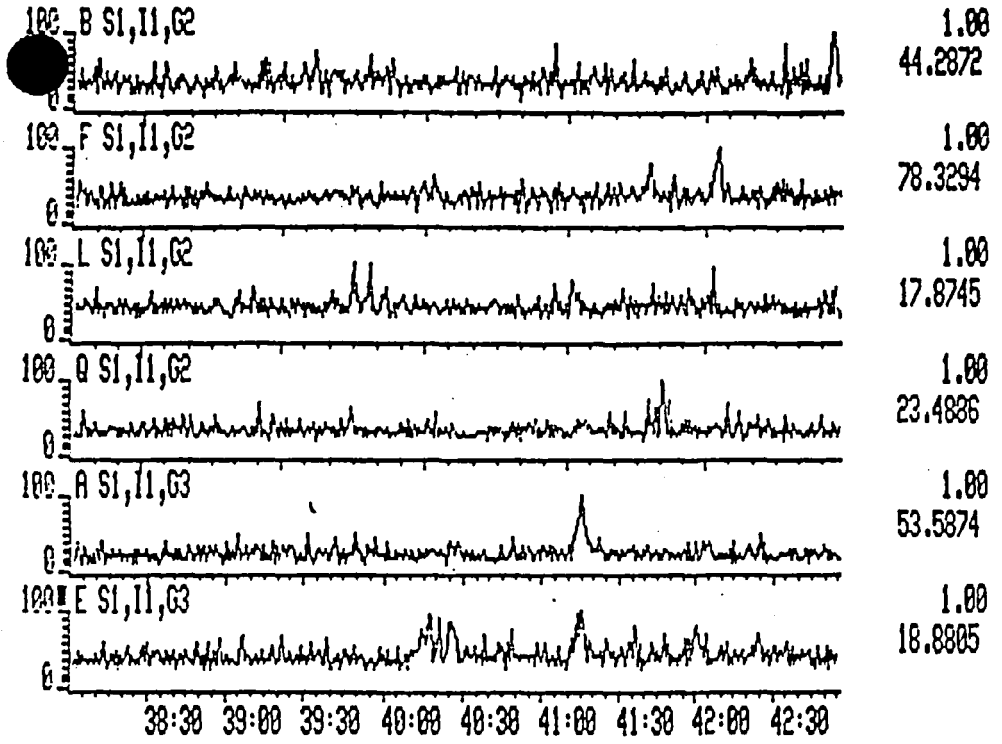


4' D: 419.8220 E: 423.7765 F: 425.7737 G: 430.9729 H: 435.8169
Text:TLI BLANK TLI#16551



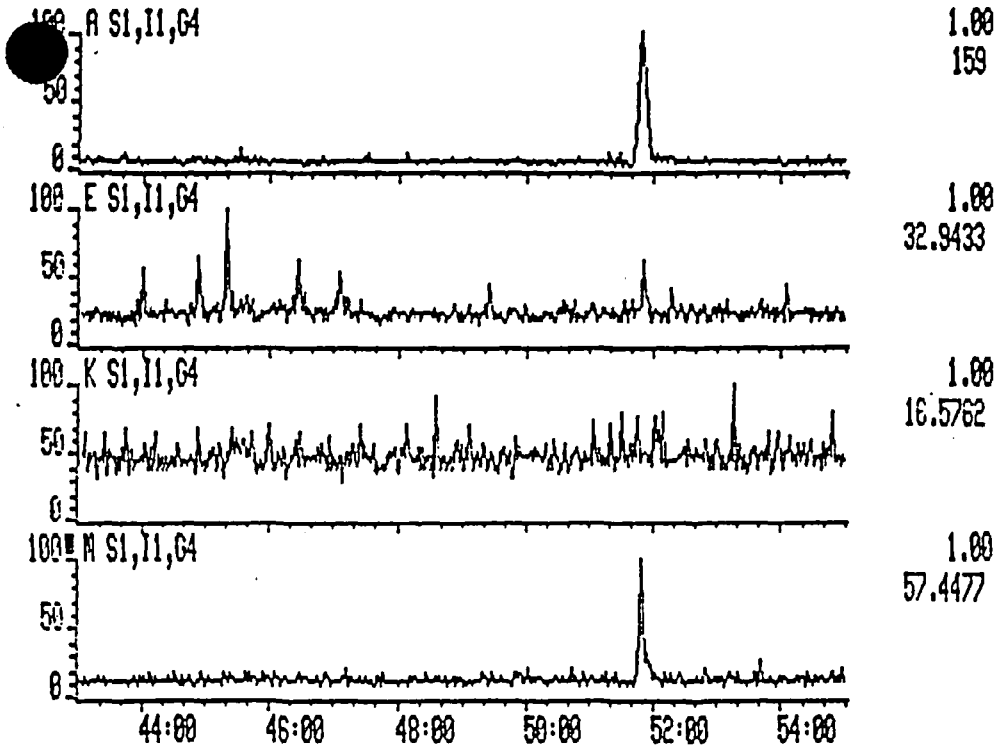
RECEIVED
NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

3: D: 385.8610 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558
Text: TLI BLANK TLI#16661



RECEIVED
NOV 19 1990
ENVIRONMENTAL ANALS

[illegible] 18-OCT-90 12:24 70S (EI+) Sub:DBSUS
GF 4 D: 419.6220 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text:TLI BLANK TLI#16661

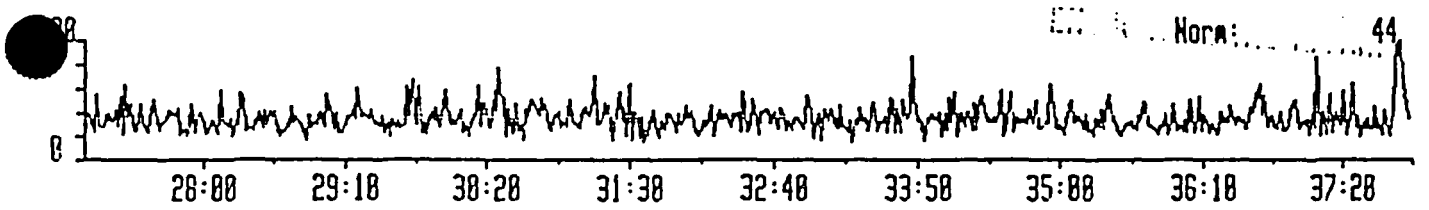


RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

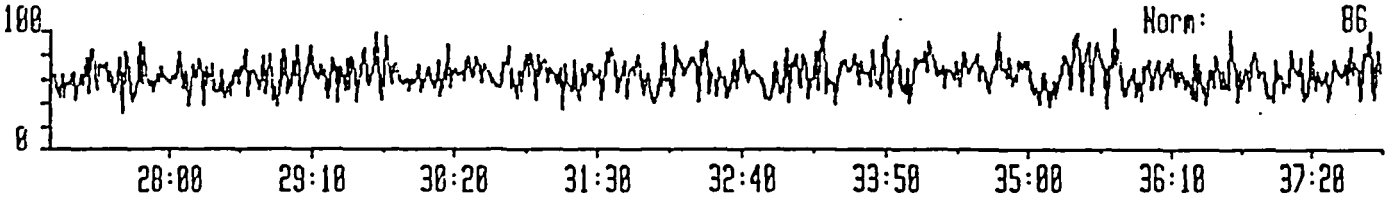
21

S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 303.9016
Text:TLI BLANK TLI#16661

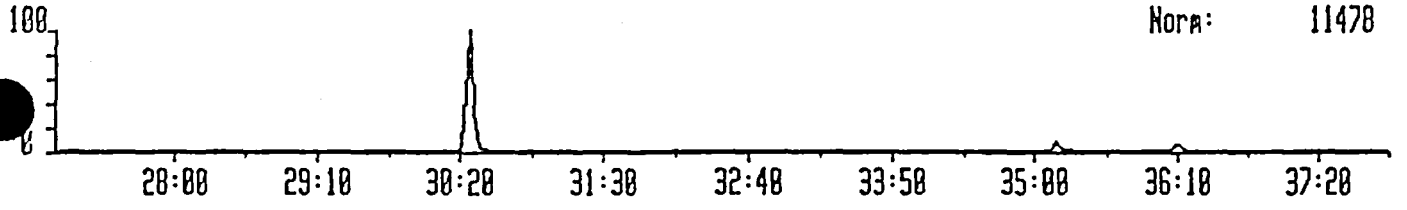
NOV 1 9 1990



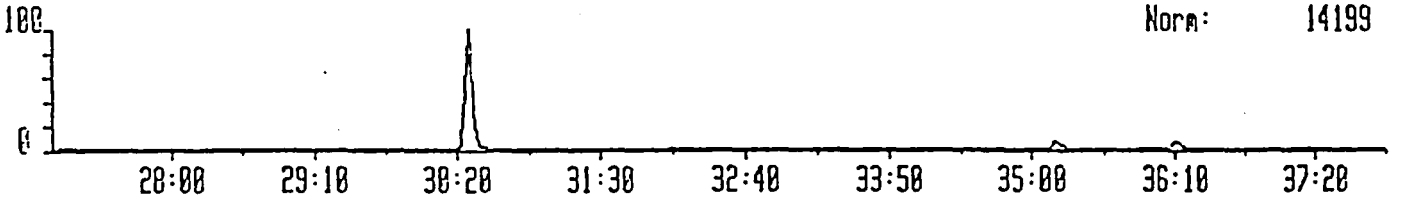
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 305.8987
Text:TLI BLANK TLI#16661



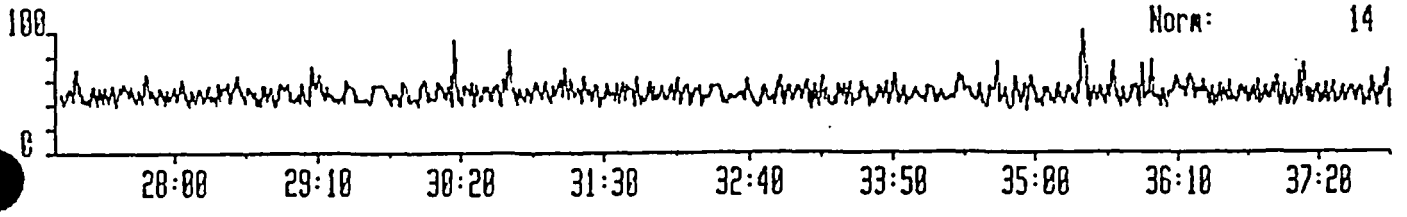
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 315.9419
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 317.9389
Text:TLI BLANK TLI#16661

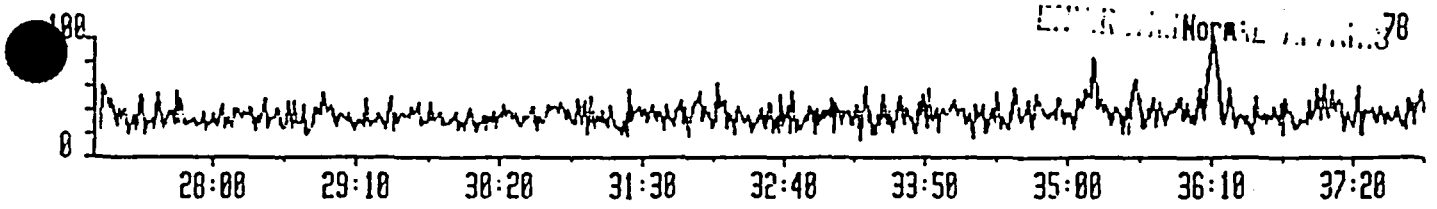


S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 375.8364
Text:TLI BLANK TLI#16661

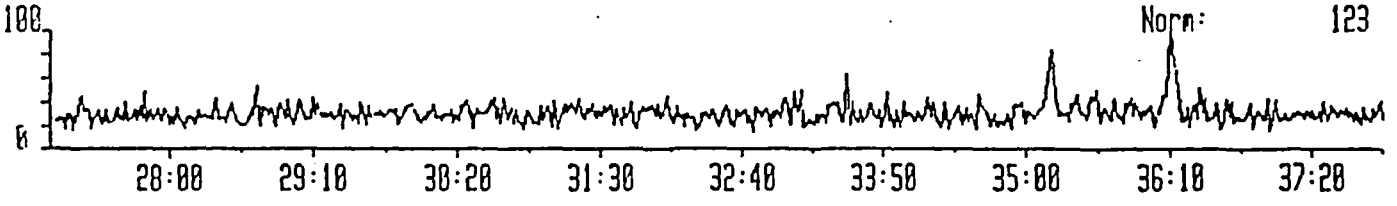


S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 319.8965
Text:TLI BLANK TLI#16661

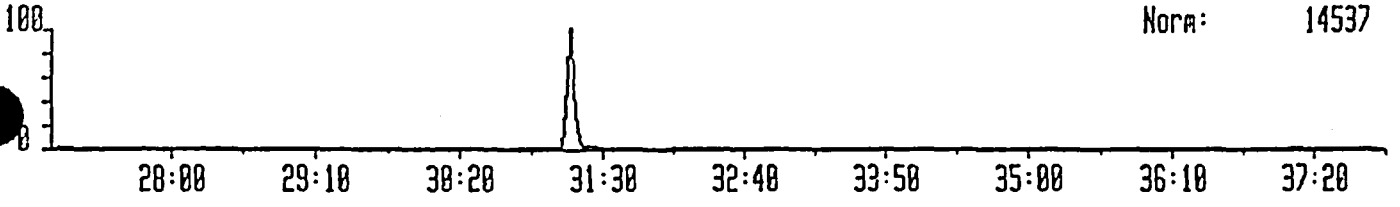
NOV 1 9 1990



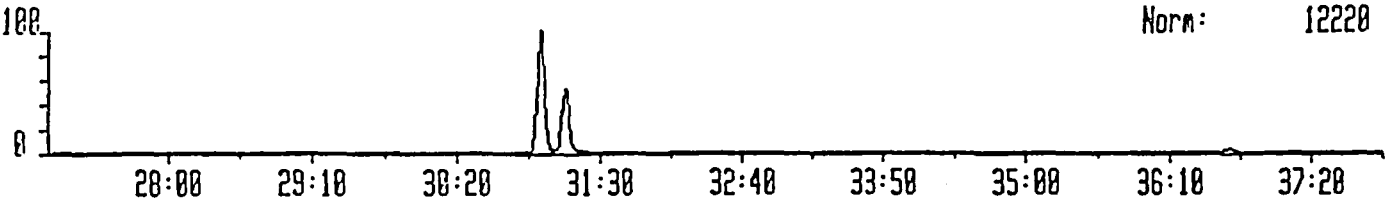
S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 321.8936
Text:TLI BLANK TLI#16661



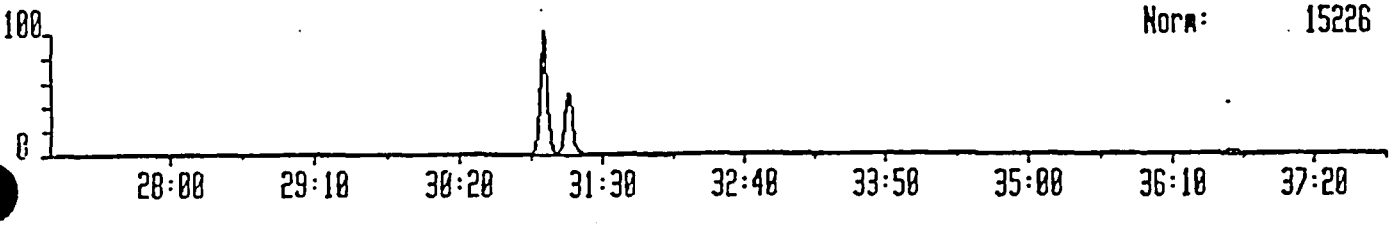
S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 327.8847
Text:TLI BLANK TLI#16661



S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 331.9368
Text:TLI BLANK TLI#16661



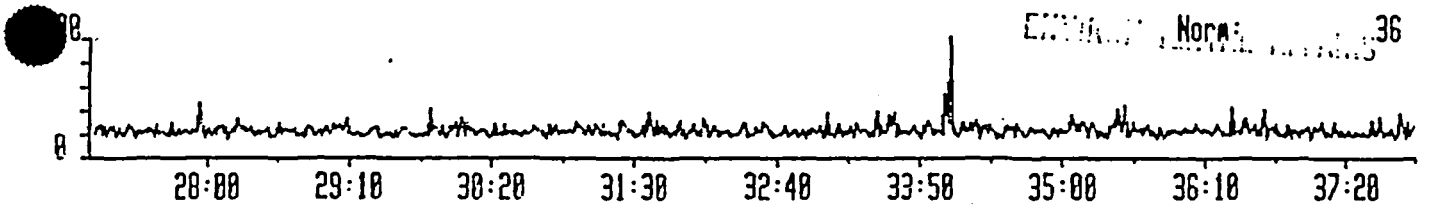
S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 333.9338
Text:TLI BLANK TLI#16661



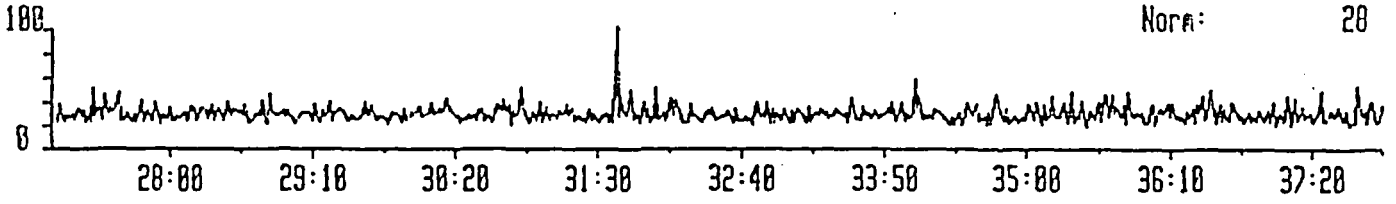
2

S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 339.8597
Text:TLI BLANK TLI#16661

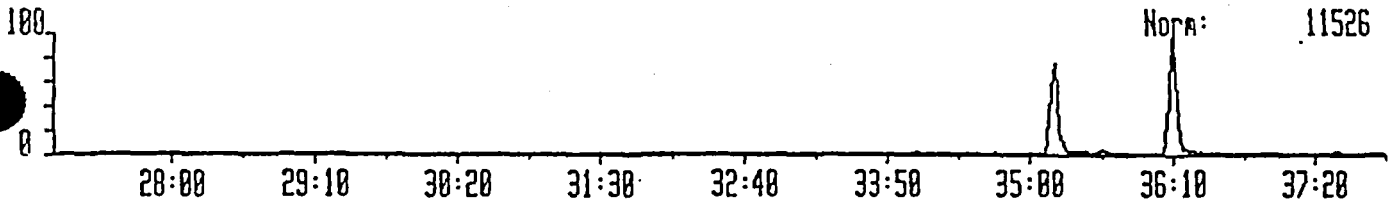
NOV 19 1990



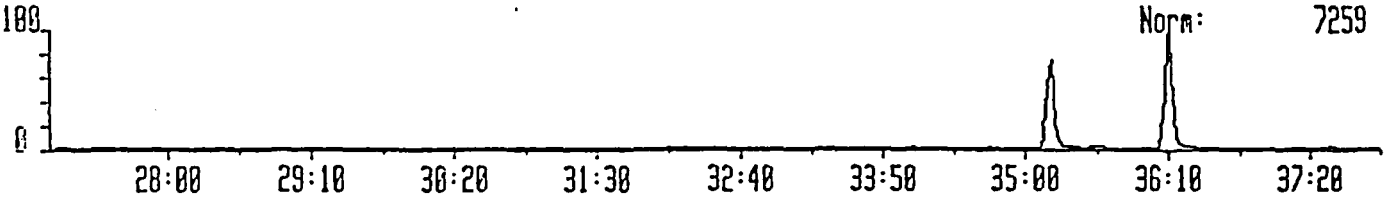
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 341.8567
Text:TLI BLANK TLI#16661



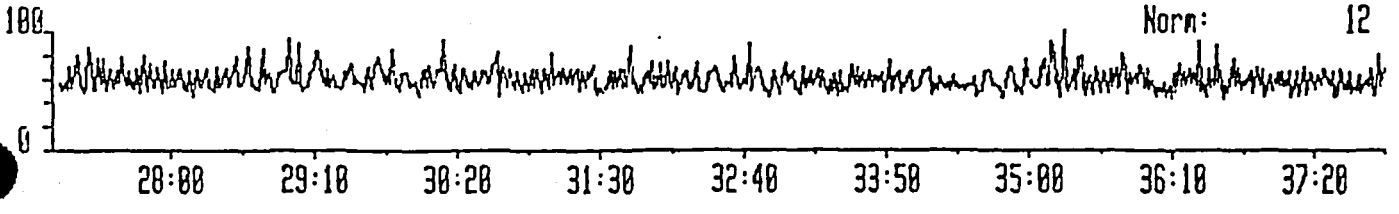
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 351.9000
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 353.8970
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 409.7974
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 355.8546
Text:TLI BLANK TLI#16661

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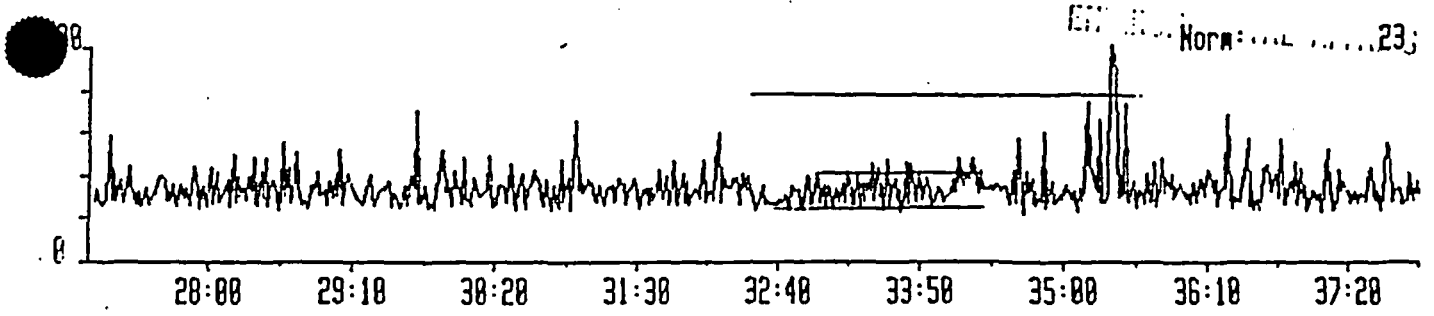
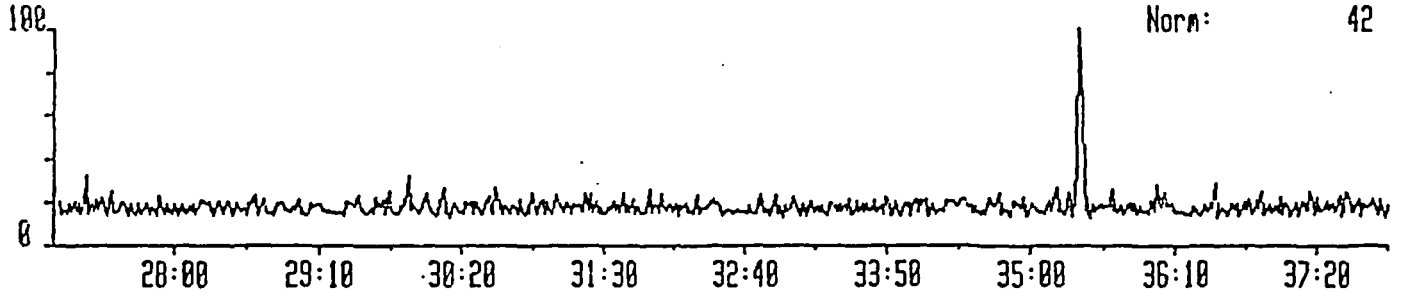
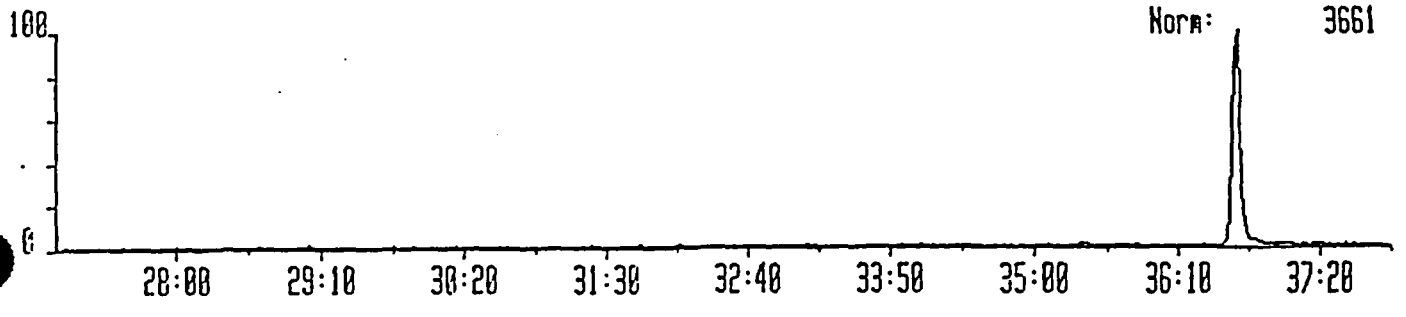


S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 357.8516
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 367.8949
Text:TLI BLANK TLI#16661

S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 369.8919
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 373.8288
Text:TLI BLANK TLI#16661

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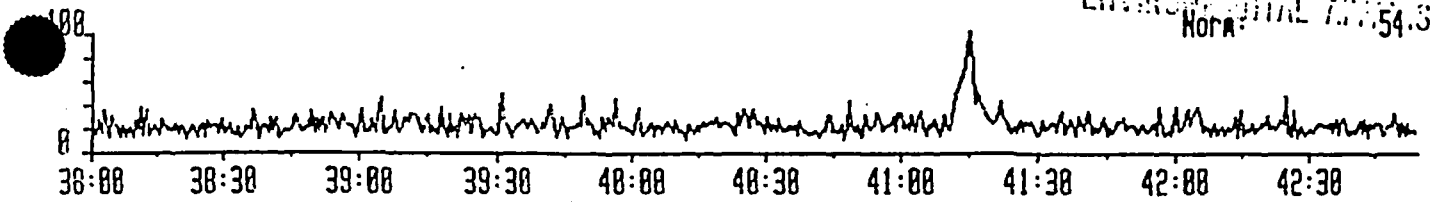
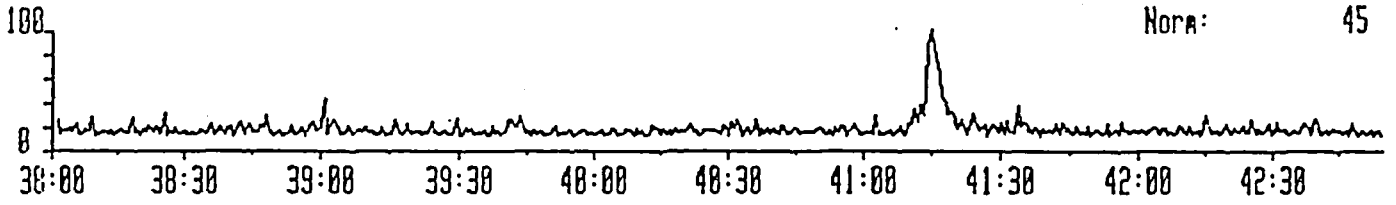
ENVIRONMENTAL ...54.3



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 375.8178
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 383.8639
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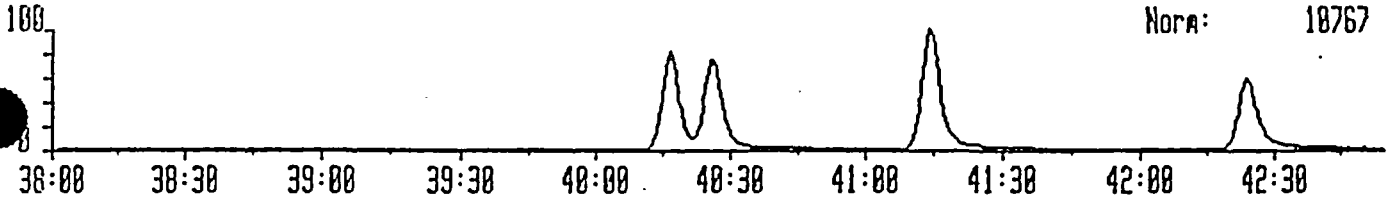
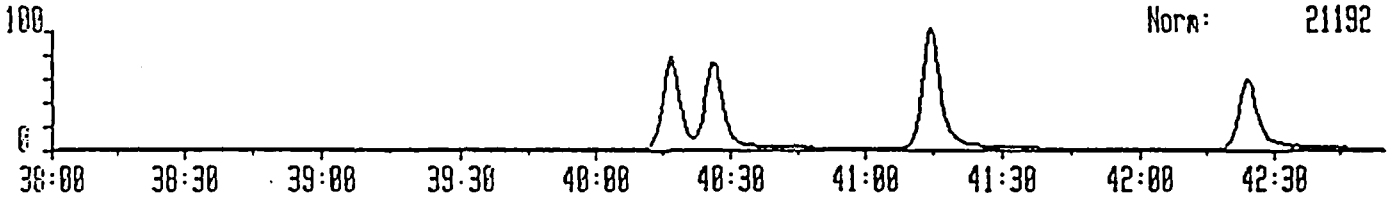


S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 385.8610
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 445.7555
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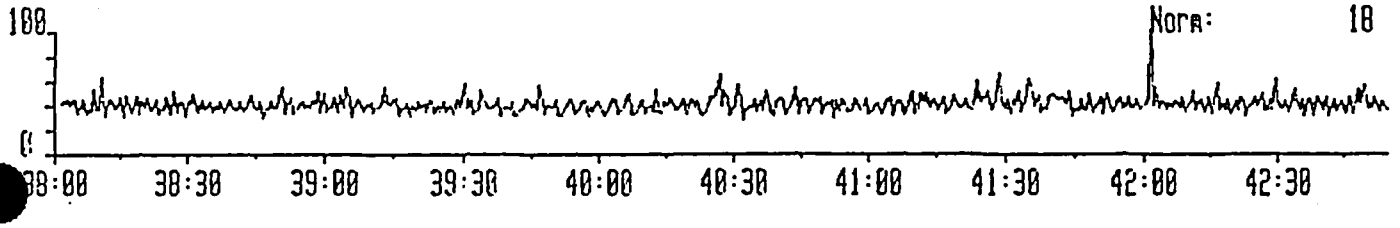

S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 389.8156
Text:TLI BLANK TLI#16661

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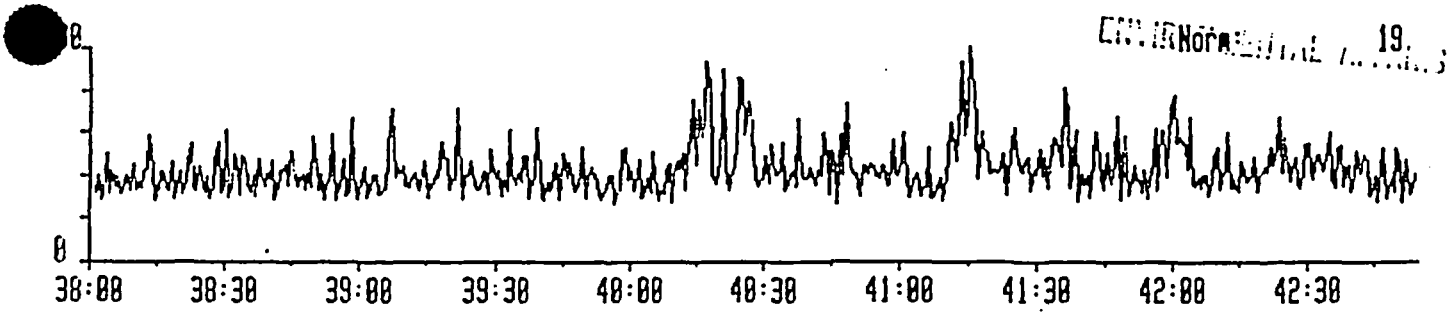

S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 391.8127
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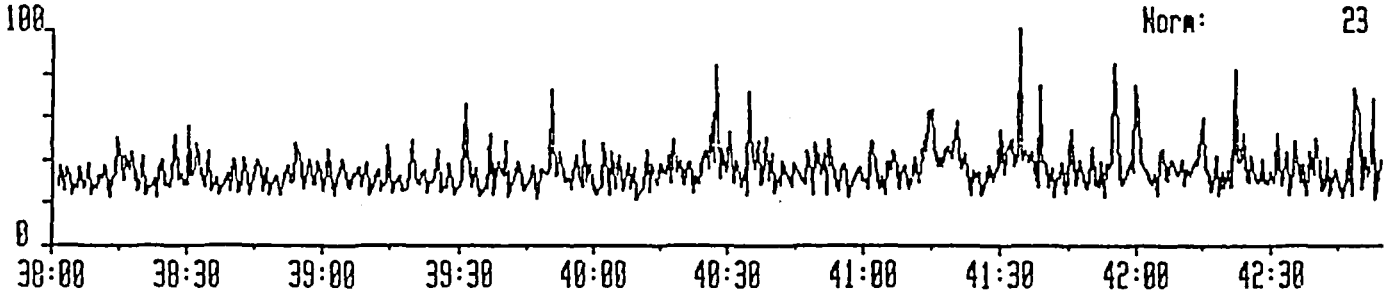
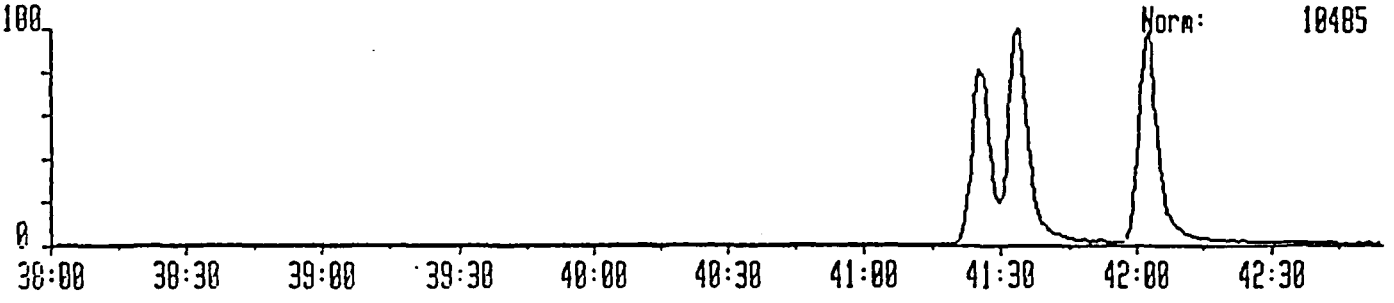
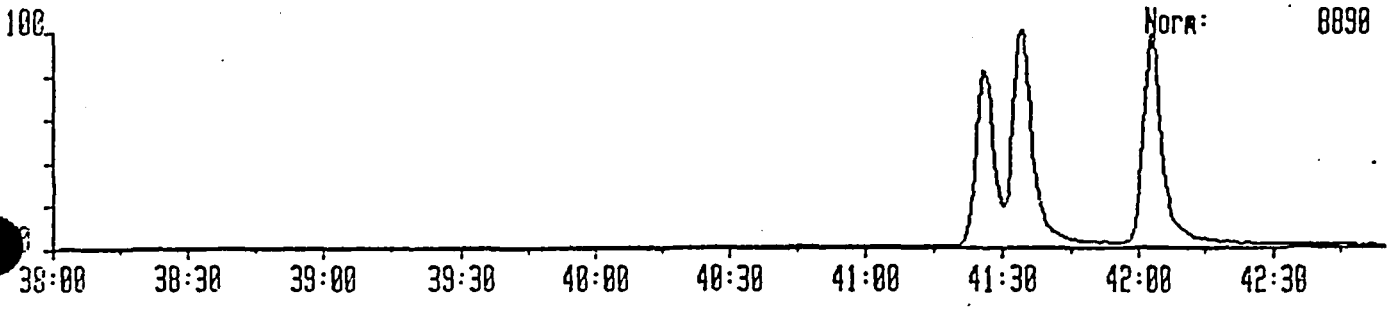


S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 401.8558
Text:TLI BLANK TLI#16661



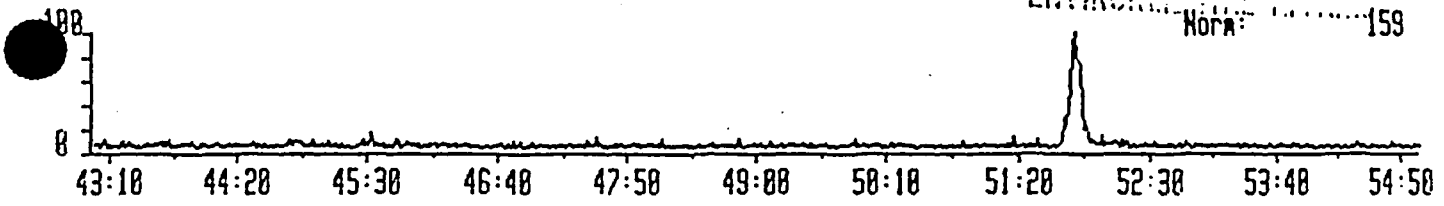
S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 403.8529
Text:TLI BLANK TLI#16661



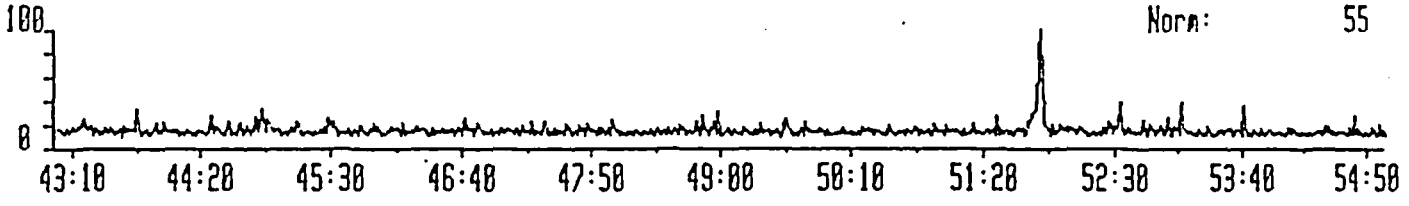
21

S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 407.7818
Text:TLI BLANK TLI#16661

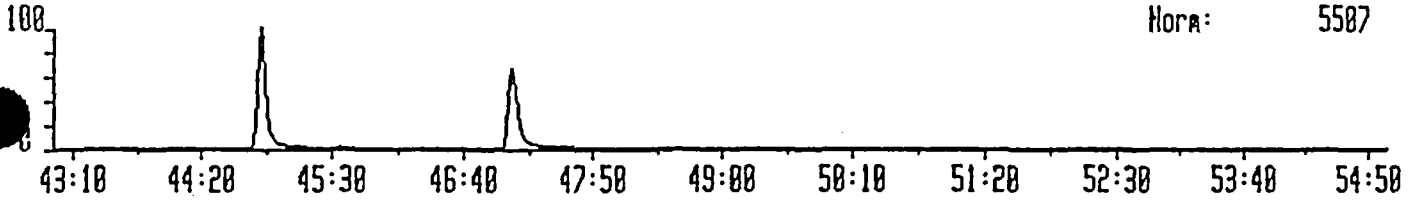
NOV 19 1990



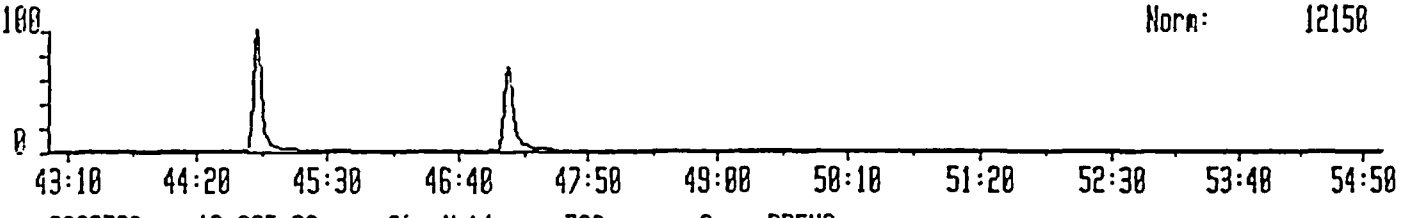
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 409.7789
Text:TLI BLANK TLI#16661



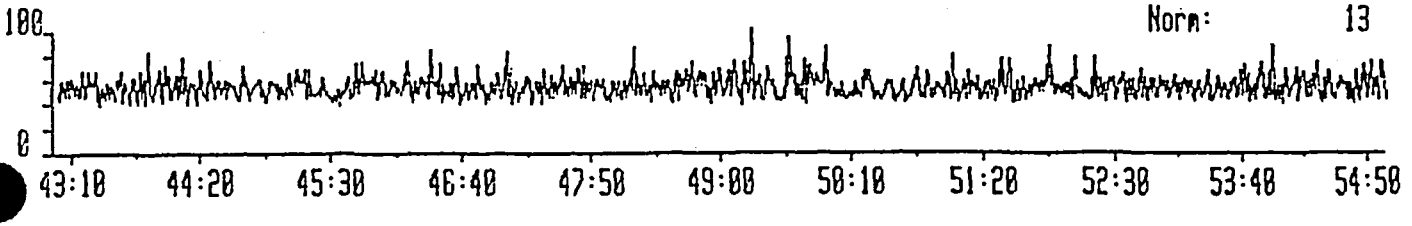
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 417.8253
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 419.8220
Text:TLI BLANK TLI#16661



S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 479.7165
Text:TLI BLANK TLI#16661

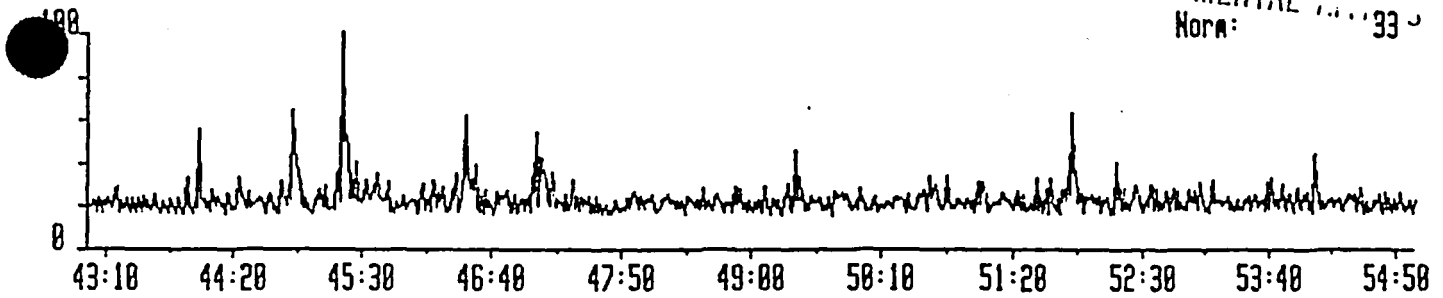


S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 423.7766
Text:TLI BLANK TLI#16661

NOV 19 1990

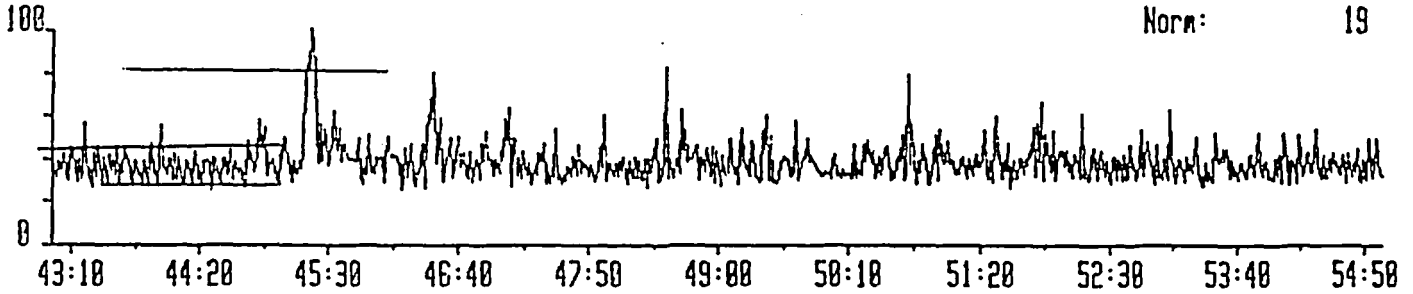
ENVIRONMENTAL ...

Norm: ...33



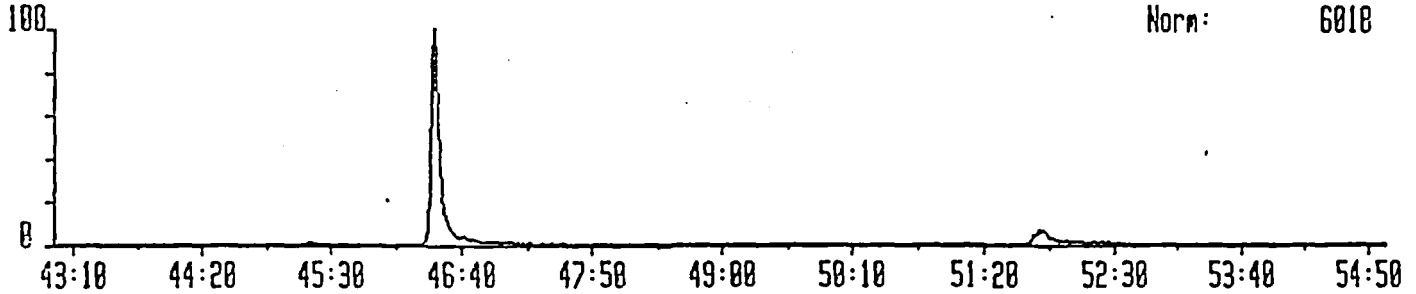
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 425.7737
Text:TLI BLANK TLI#16661

Norm: 19



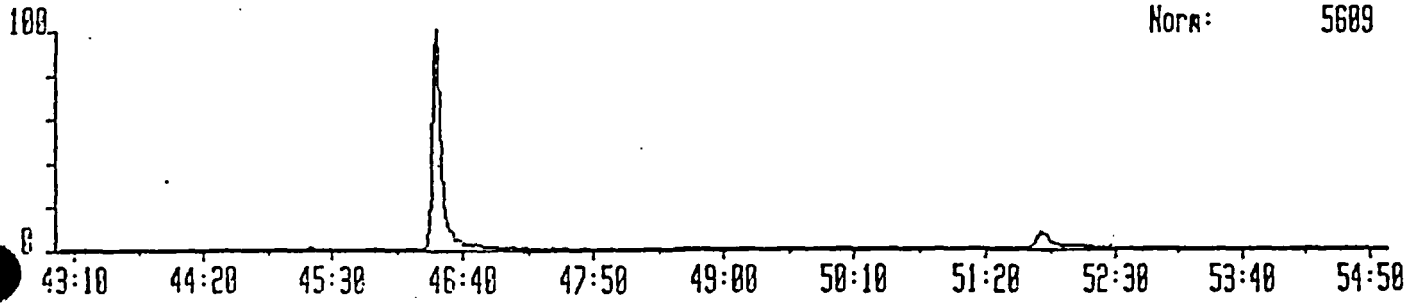
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 435.8169
Text:TLI BLANK TLI#16661

Norm: 6018



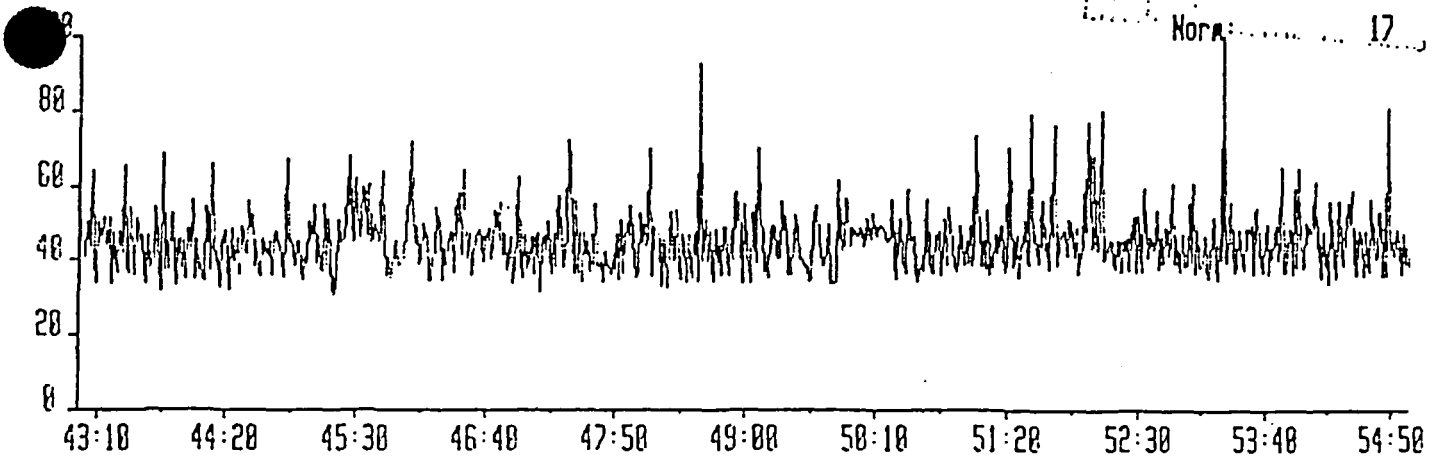
S903789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 437.8140
Text:TLI BLANK TLI#16661

Norm: 5609

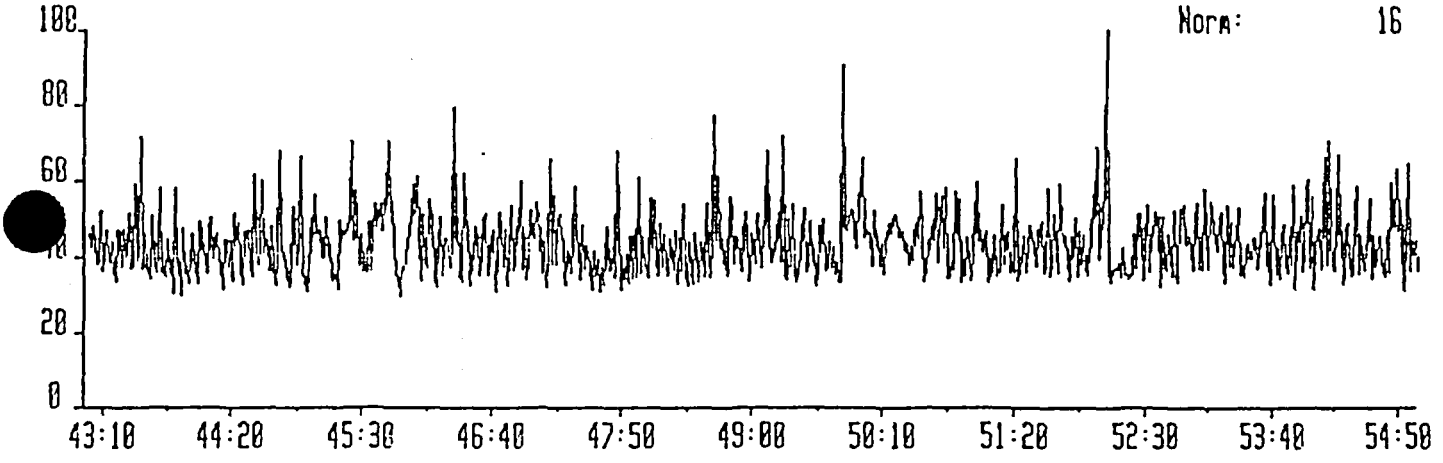


S903789 18-OCT-90 Str:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 441.7428
Text:TLI BLANK TLI#16661

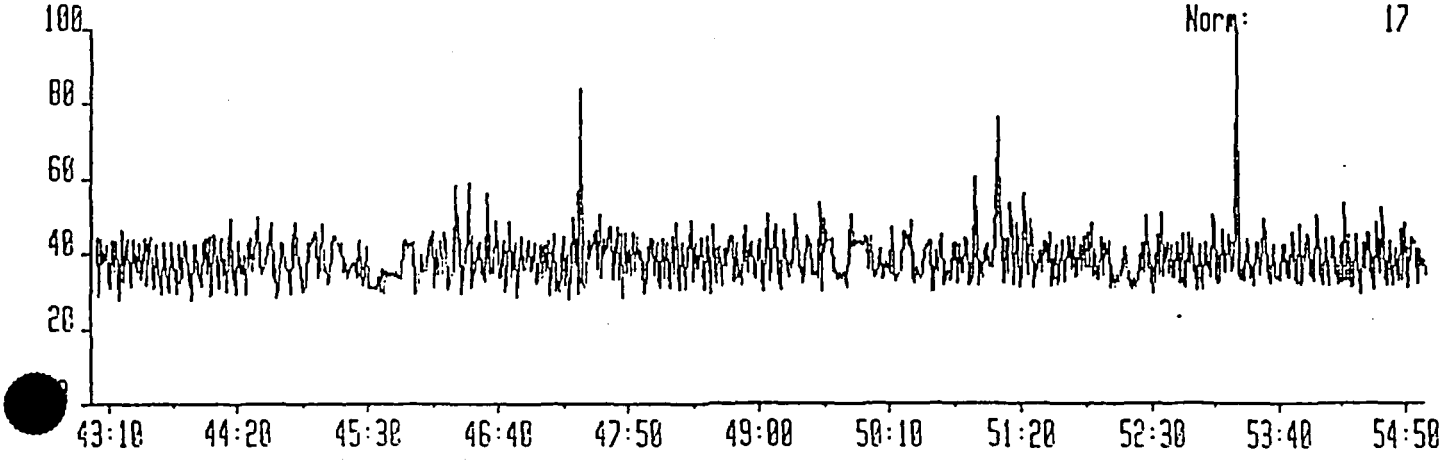
NOV 19 1990



S903789 18-OCT-90 Str:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 443.7399
Text:TLI BLANK TLI#16661

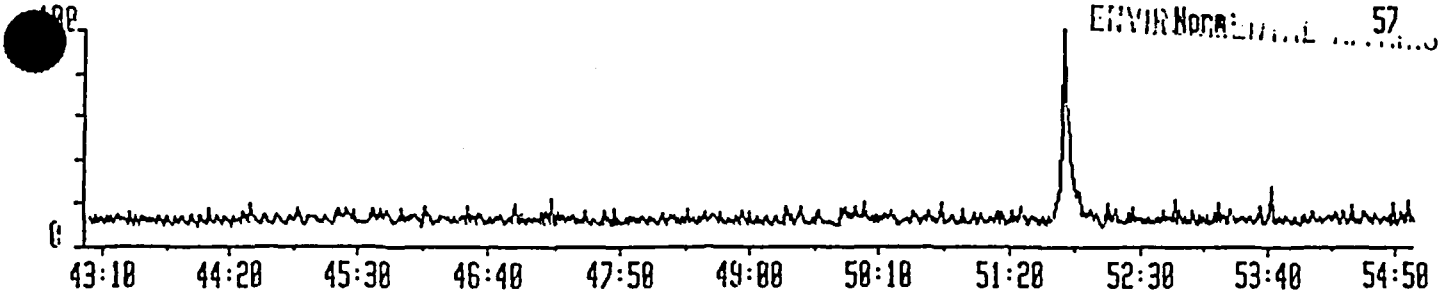


S903789 18-OCT-90 Str:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 513.6775
Text:TLI BLANK TLI#16661

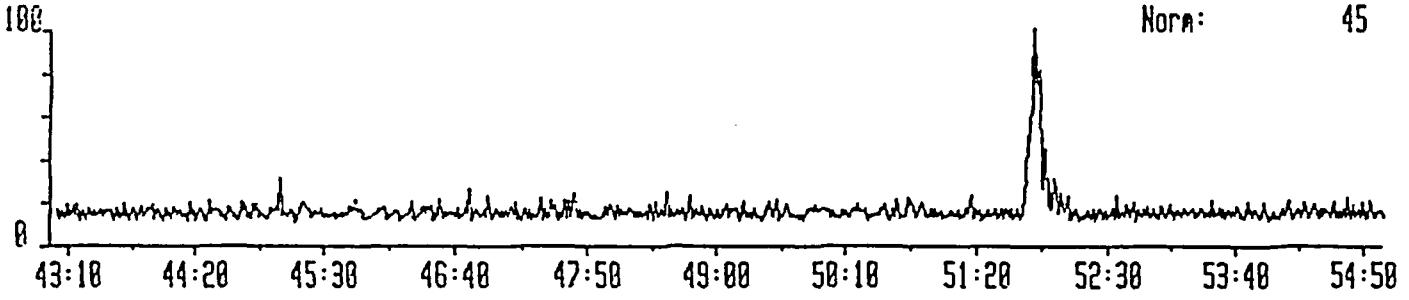


S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 457.7377
Text:TLI BLANK TLI#16661

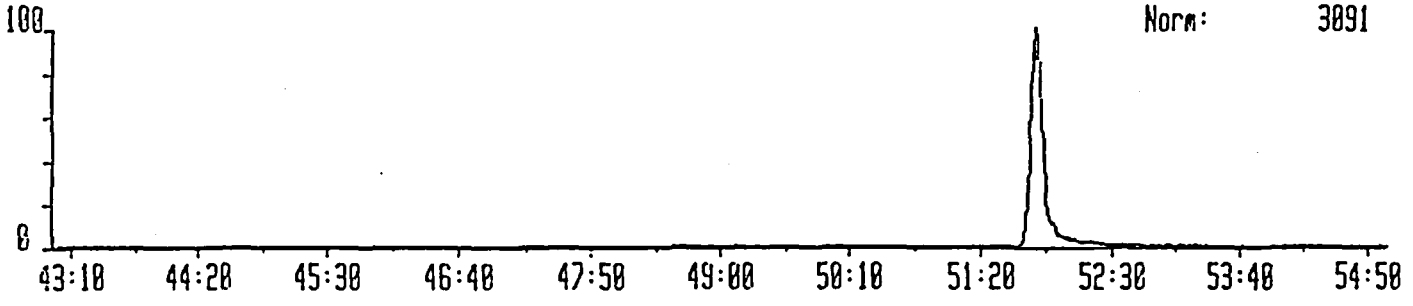
NOV 1 9 1990



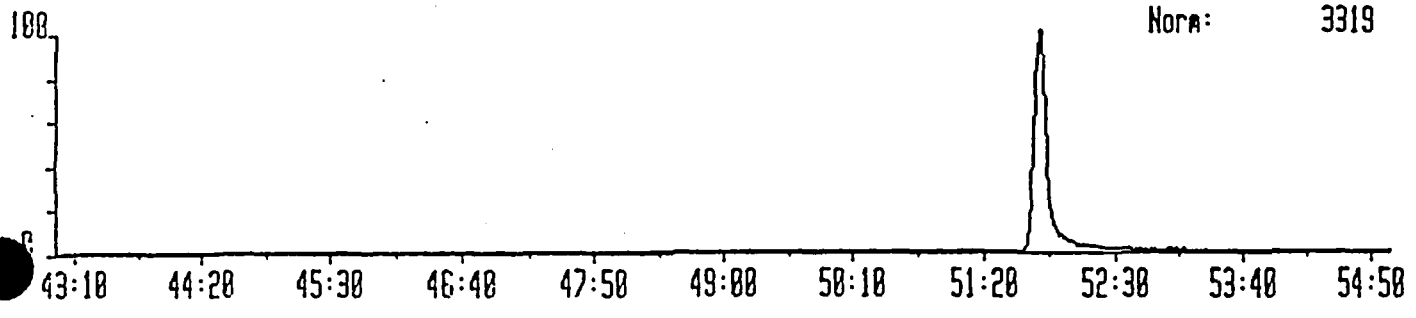
S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 459.7348
Text:TLI BLANK TLI#16661



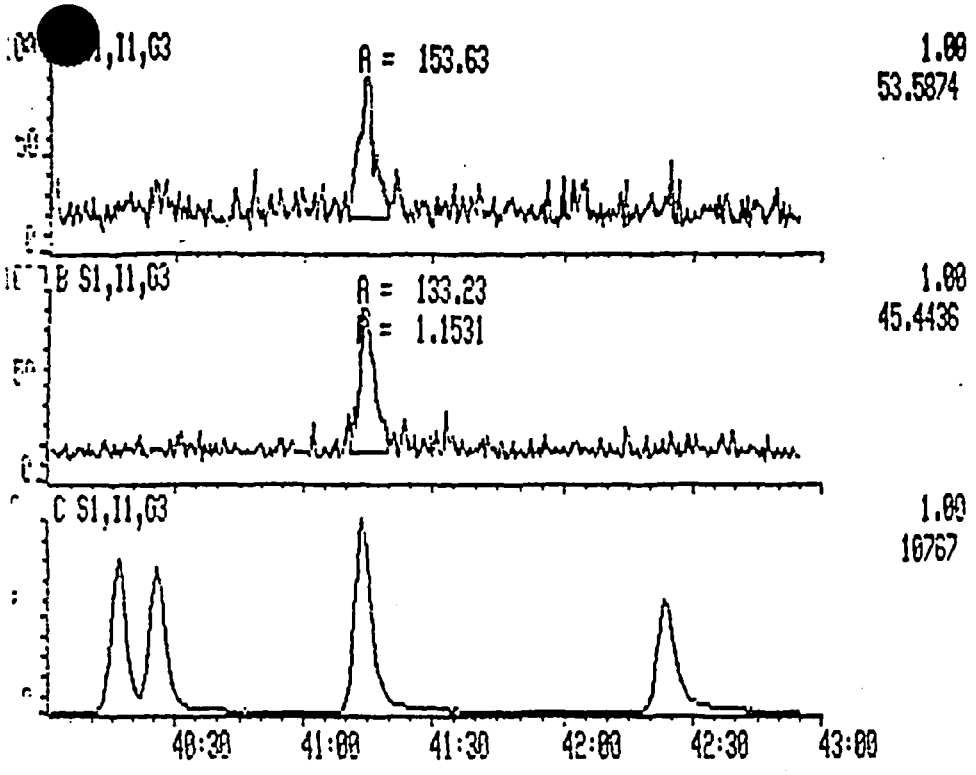
S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 469.7779
Text:TLI BLANK TLI#16661



S983789 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 471.7750
Text:TLI BLANK TLI#16661



89 -18-OCT-98 12:24 70S (EI+) Sus:D25US
A: 373.8200 B: 375.8178 C: 383.8639 D: 385.8610 E: 389.8156
TLI BLANK TLI#16661



RECEIVED
NOV 19 1998
ENVIRONMENTAL AFFAIRS

Summer Analyses

RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

TRIANGLE LABORATORIES, INC.

SAMPLE DATA

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b)

11/16/90

FILE NAME....: S903791
CONCAL (VER).: S903783
PROJECT NUMBER: 16661
ANALYST.....: HSK
SAMPLE SIZE..: 9.400 g
DATE RECEIVED.: 10/10/90
SPIKE FILE...: SPX23710

CLIENT ID....: SWP
SAMPLE ID....: LF2/9111
ICAL DATE....: 10/13/90
ANALYSIS DATE: 10/18/90
SAMPLE MATRIX: SOIL
DATE COLLECTED: 10/09/90

TLI NUMBER....: 37-26-2
SAMPLE ORIGIN: WILMINGTO
SHIPMENT NO...: NC09001

NAME	CONC(ppb)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	0.008				0.75	31:31	
12378-PeCDD	0.05				1.53	36:49	
123478-HxCDD	0.18				1.29	41:35	
123678-HxCDD	1.8				1.21	41:43	
123789-HxCDD	0.89				1.22	42:10	PR
1234678-HpCDD	48.7				1.01	46:31	S
OCDD	137				0.93	51:57	S B
2378-TCDF	0.02				0.80	30:40	
12378-PeCDF	0.06				1.54	35:23	
23478-PeCDF	0.06				1.53	36:20	
123478-HxCDF	0.76				1.12	40:26	
123678-HxCDF	0.21				1.12	40:36	
234678-HxCDF	0.14				1.22	41:24	B
123789-HxCDF	EMPC			0.05			
1234678-HpCDF	21.3				0.93	45:00	S
1234789-HpCDF	0.96				0.93	47:11	
OCDF	52.1				0.97	52:10	S
TOTAL TCDD	0.17	9		0.21	0.77		
TOTAL PeCDD	0.65	10		0.76	1.55		Q
TOTAL HxCDD	22.5	7		22.5	1.24		
TOTAL HpCDD	118	2			1.01		S
TOTAL TCDF	0.10	8		0.12	0.78		Q
TOTAL PeCDF	0.87	9			1.58		
TOTAL HxCDF	11.1	9		24.1	1.16		S
TOTAL HpCDF	56.4	4			0.92		S

MSB 11/16/90

X237_RPT rev:3.03

NOV 19 1990

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b) QA/QC SUMMARY

11/16/90

FILE NAME....: S903791
CONCAL (VER).: S903783
PROJECT NUMBER: 16661
ANALYST.....: HSK
SAMPLE SIZE..: 9.400 g
DATE RECEIVED.: 10/10/90
SPIKE FILE...: SPX23710

CLIENT ID....: SWP
SAMPLE ID....: LF2/9111
ICAL DATE....: 10/13/90
ANALYSIS DATE: 10/18/90
SAMPLE MATRIX: SOIL
DATE COLLECTED: 10/09/90

TLI NUMBER....: 37-26-2
SAMPLE ORIGIN: WILMINGTO
SHIPMENT NO...: NC09001

SURROGATE RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
37Cl-TCDD	0.57	53.1		31:30	___
13C12-PeCDF 234	0.67	62.7	1.53	36:19	___
13C12-HxCDF 478	0.62	58.4	0.53	40:25	___
13C12-HxCDD 478	0.72	67.9	1.19	41:34	___
13C12-HpCDF 789	0.41	38.3	0.46	47:10	___

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	0.58	54.1	0.52	42:32	___
13C12-HxCDF 234	0.65	61.0	0.51	41:24	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	0.54	51.0	0.78	30:39	___
13C12-2378-TCDD	0.60	56.5	0.84	31:29	Q
13C12-PeCDF 123	0.69	64.4	1.56	35:22	___
13C12-PeCDD 123	0.75	70.9	1.58	36:49	___
13C12-HxCDF 678	0.62	57.9	0.51	40:35	___
13C12-HxCDD 678	0.68	63.9	1.17	41:42	___
13C12-HpCDF 678	0.48	44.7	0.47	44:59	___
13C12-HpCDD 678	0.50	46.7	1.03	46:30	___
13C12-OCDD	1.3	59.5	1.02	51:57	___

MBS	11/16/90

X237_RPT rev:3.03

2

	Initial	Date
B-File/Header Changes	KU	10/31/90
Manual Integrations	KU	10/31/90
Transcription	KU	10/31/90
Dbase Corrections	KU	10/31/90

NOV 19 1990

Page No. 1 Listing of S903791B.dbf
10/26/90

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
304		0.87	27:54	884.08	T	F	0.910	-Q
		0.75	28:11	1615.07	T	F	0.920	
		0.91	28:30	1955.42	F	F	0.930	
		0.72	28:49	2229.67	T	F	0.940	
		0.81	29:07	1766.73	T	F	0.950	-Q
		0.86	29:31	1021.37	T	F	0.963	
		0.77	29:53	2071.00	T	F	0.975	
		0.69	30:09	757.60	T	F	0.984	
		0.80	30:40	2146.10	T	T	1.001	
		1.00	31:10	220.73	F	F	1.017	SV
		1.17	31:24	160.75	F	F	1.024	
	D	1.88	32:04	96.06	F	F	1.046	
		0.10	32:50	75.83	F	F	1.071	
	B	0.71	33:05	2168.23	T	F	1.079	RV
304		*** Total ***		17168.64	# of Peaks:		14	
316		0.40	29:46	204.05	F	F	0.971	
		0.77	30:06	601.07	T	F	0.982	
		0.78	30:39	119376.82	T	T	1.000	-Q
		0.73	31:08	1085.25	T	F	1.016	
316		*** Total ***		121267.19	# of Peaks:		4	
320		0.41	27:45	146.99	F	F	0.881	-Q
	S	0.33	28:04	117.92	F	F	0.891	-Q RV
		1.83	28:15	50.69	F	F	0.897	
		1.31	28:42	636.31	F	F	0.912	
		0.63	29:05	505.60	F	F	0.924	
		0.76	29:24	686.90	T	F	0.934	
		0.77	30:06	4811.74	T	F	0.956	
		0.77	30:20	3032.84	T	F	0.963	
		0.82	30:51	519.05	T	F	0.980	
		0.88	31:13	1704.44	T	F	0.992	
		0.78	31:21	2130.59	T	F	0.996	
		CK ~~1.30~~ 1.75	31:31	~~435.11~~ 668	~~F~~ T	T	1.001	
		0.99	31:40	607.66	F	F	1.006	
		0.69	31:53	815.04	T	F	1.013	
		0.14	32:06	249.67	F	F	1.020	SV
	D	0.35	32:15	166.16	F	F	1.024	
		2.26	32:35	90.67	F	F	1.035	
		2.07	34:00	158.02	F	F	1.080	
		2.16	34:33	98.00	F	F	1.097	RV
	D	0.85	35:02	296.38	T	F	1.113	
320		*** Total ***		17259.78	# of Peaks:		20	
320		.72	31:46	9304	T	F	1.034	KU 10/31/90
328		0.00	31:30	75491.82	T	T	1.001	-Q
		0.00	32:18	116.44	T	F	1.026	
328		*** Total ***		75608.26	# of Peaks:		2	

noise = 166 (304)

3

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
332		0.81	31:13	130087.96	T	T	0.992	
		0.84	31:29	76227.81	T	T	1.000	-Q
332		*** Total ***		206315.77	# of Peaks:		2	
340		1.29	35:15	1534.9	F	F	.996	
340	P	3.56	32:50	55.22	F	F	0.928	SN
		1.59	33:04	42107.40	T	F	0.935	
		1.56	34:30	5979.54	T	F	0.975	-Q
		ck ~~1.59~~ 1.54	35:23	~~8004.19~~ 5614.5	T	T	1.000	
		1.71	35:35	285.55	T	F	1.006	
		1.55	35:45	4407.19	T	F	1.011	
		1.53	36:20	5244.03	T	T	1.027	
		1.60	36:36	7716.21	T	F	1.035	
	D	3.20	36:58	92.42	F	F	1.045	SN
		1.60	37:40	463.45	T	F	1.065	
340		*** Total ***		74355.20	# of Peaks:		10	
340		1.54	35:00	4081.9	T	F	.989	
352		1.12	34:52	379.62	F	F	0.986	
		1.56	35:22	60807.82	T	T	1.000	
		1.39	35:44	1181.89	T	F	1.010	
		1.53	36:19	69208.41	T	T	1.027	
		1.58	37:40	1251.33	T	F	1.065	
352		*** Total ***		132829.07	# of Peaks:		5	
356		1.45	34:31	3808.63	T	F	0.938	-Q
		1.61	35:02	6198.99	T	F	0.952	-Q
		1.31	35:21	5384.48	F	F	0.960	
		1.44	35:32	4902.36	T	F	0.965	
		1.44	35:46	3409.65	T	F	0.971	
		1.67	36:00	2567.99	T	F	0.978	
		1.53	36:08	8812.14	T	F	0.981	-Q
		1.28	36:23	1243.89	F	F	0.988	
		1.54	36:34	653.86	T	F	0.993	
		1.53	36:49	3078.92	T	T	1.000	
		1.63	37:01	3266.94	T	F	1.005	
		1.63	37:29	1928.61	T	F	1.018	
356		*** Total ***		45256.46	# of Peaks:		12	
368		0.24	35:26	987.79	F	F	0.962	
		1.58	36:49	35149.19	T	T	1.000	
		0.57	37:28	397.58	F	F	1.018	
368		*** Total ***		36534.56	# of Peaks:		3	
374		1.27	38:05	481.50	T	F	0.938	
		1.14	38:56	146350.10	T	F	0.959	
		1.16	39:08	478782.90	T	F	0.964	
		1.03	39:36	4672.70	F	F	0.976	
		0.99	39:50	863106.69	F	F	0.982	-S
		1.12	40:26	60412.52	T	T	0.996	
	ck	~~0.99~~ 1.12	40:36	~~22009.06~~ 17485.0	~~F~~ T	T	1.000	
		1.10	41:01	2005.59	T	F	1.011	
	plot	~~1.12~~ 1.16	41:20	~~15385.60~~ 14989.5	T	~~F~~	1.018 ~~7~~	
		~~1.16~~ 1.22	41:24	~~11062.92~~ 8453.4	T	T	1.020	
	D	0.27	41:52	53.59	F	F	1.032	SN
~~374~~		~~1.16~~		~~14989.5~~	~~T~~	Not needed		

KU 10/31/12

4

NOV 19 1990

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/Why
374	RD CF	~~1.03~~ .97	42:32	2367.22	F	T	1.048	
		1.13	42:40	14228.76	T	~~T~~ F	1.052 R	
374		*** Total ***		1620939.15	# of Peaks:		13	
384		0.63	38:56	90.79	F	F	0.959	
		0.49	39:07	174.47	T	F	0.964	
		2.01	39:51	226.17	F	F	0.982	
		2.13	40:11	85.26	F	F	0.990	
		0.53	40:25	49546.74	T	T	0.996	
		0.51	40:35	55874.32	T	T	1.000	
		0.51	41:24	51622.85	T	T	1.020	
		0.52	42:32	38633.03	T	T	1.048	
384		*** Total ***		196253.63	# of Peaks:		8	
390		1.23	39:42	417629.96	T	F	0.952	
		2.59	40:11	579.02	F	F	0.964	
		1.26	40:25	39139.85	T	F	0.969	
		1.24	40:45	290338.51	T	F	0.977	
		1.21	41:00	89612.28	T	F	0.983	
		1.29	41:35	7940.94	T	T	0.997	
		1.21	41:43	82202.74	T	T	1.000	
		1.22	42:10	35164.71	T	T	1.011	PR
		3.84	42:30	75.64	F	F	1.019	
		1.75	42:36	27.29	F	F	1.022	
	D	1.40	42:50	42.44	T	F	1.027	RV
390		*** Total ***		962753.38	# of Peaks:		11	
402		2.06	39:17	175.50	F	F	0.942	
		1.19	41:34	31650.90	T	T	0.997	
		1.17	41:42	38490.56	T	T	1.000	
		1.20	42:10	61378.22	T	T	1.011	
		3.05	42:35	321.89	F	F	1.021	
402		*** Total ***		132017.07	# of Peaks:		5	
408		0.93	45:00	1249245.57	T	T	1.000	- S
		0.92	45:34	1354849.00	T	F	1.013	- S
		0.88	46:31	11938.44	T	F	1.034	
		0.93	47:11	33932.54	T	T	1.049	
408		*** Total ***		2649965.55	# of Peaks:		4	
418		0.47	44:59	31730.63	T	T	1.000	
		1.34	45:34	1806.47	F	F	1.013	
		0.59	45:54	2729.12	F	F	1.020	
		0.46	47:10	20718.06	T	T	1.049	
		3.96	48:06	188.94	F	F	1.069	
418		*** Total ***		57173.22	# of Peaks:		5	
424		1.00	45:25	1853232.19	T	F	0.977	S
		1.01	46:31	1302374.31	T	T	1.000	S
	D	2.29	50:18	274.10	F	F	1.082	NH
424		*** Total ***		3155880.60	# of Peaks:		3	
436		1.34	45:26	1269.40	F	F	0.977	

5

NOV 1 9 1990

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
436		1.03	46:30	23947.27	T	T	1.000	
		0.91	47:06	86.19	T	F	1.013	
436		*** Total ***		25302.86	# of Peaks:		3	
442		0.97	52:10	1407661.81	T	T	1.004	-S
442		*** Total ***		1407661.81	# of Peaks:		1	
458		0.93	51:57	3130535.76	T	T	1.000	-S
458		*** Total ***		3130535.76	# of Peaks:		1	
470		0.45	50:24	46.46	F	F	0.970	
		1.02	51:57	28978.41	T	T	1.000	
		0.64	53:37	70.91	F	F	1.032	
470		*** Total ***		29095.78	# of Peaks:		3	

*** End of Report ***

6

NOV 1 9 1990

Listing of S903791I.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
202	10:44	106.60	15:31	336.48	18:19	153.84	19:51	366.33
	11:25	48.95	15:39	171.72	18:30	280.04	20:03	233.47
	13:32	227.80	16:21	271.83	18:38	499.25	20:23	32719.90
	14:03	32.60	17:14	1382.78	19:15	3721.38		
	14:45	41.33	18:07	94.01	19:27	920.52		
204	11:41	12.41	13:40	22.06	17:34	36.62	20:12	104.39
	11:53	13.61	13:56	13.95	17:44	14.10	20:23	1048.53
	12:31	22.85	16:18	62.06	18:36	8.72	20:32	19.14
	13:19	24.36	17:15	25.55	19:15	85.94		
	13:31	36.64	17:26	8.38	19:28	234.16		
238	17:30	23.00	18:28	123.73	19:21	33.54	20:20	24.39
	17:48	14.77	18:42	175.18	19:30	70.17	21:27	32.49
	17:56	19.39	18:59	89.83	19:46	59.39		
	18:05	28.15	19:11	39.20	20:00	90.11		
240	17:25	87.86	18:19	98.34	19:21	100.08	20:00	97.30
	17:31	124.19	18:29	85.87	19:29	56.65	20:07	36.18
	17:43	23.19	18:39	193.22	19:37	78.03	20:20	55.59
	18:03	106.65	19:11	42.02	19:44	80.80		
252	18:17	22.68	19:30	132.77	20:48	27.65	22:37	146.51
	18:40	91.23	19:39	550.87	21:19	21.94	22:53	568.62
	18:47	168.79	19:57	52.76	21:30	119.05		
	19:00	41.38	20:05	58.41	21:57	84.82		
	19:21	96.86	20:25	134.41	22:03	72.60		
254	18:16	7.37	19:47	52.11	20:57	9.20	22:34	11.35
	18:40	22.25	20:01	30.05	21:13	8.34	22:53	37.73
	18:59	20.86	20:22	39.55	21:37	28.83		
	19:26	45.14	20:33	65.33	21:52	22.07		
	19:39	59.85	20:44	8.19	22:25	29.15		
270	22:47	11.02	24:01	276.35	24:53	105.45	25:31	11.60
	23:33	4548.43	24:23	210.26	25:05	220.17	25:48	11.49
	23:51	195.87	24:38	153.94	25:22	30.99	26:17	17.80
272	22:43	40.75	24:09	79.26	24:52	100.91	25:42	47.27
	23:35	4216.58	24:23	167.68	25:04	217.26	26:00	7.41
	23:59	203.21	24:36	221.08	25:26	22.36		
286	23:33	3328.22	24:26	260.57	25:06	63.18	25:49	42.24
	23:56	109.65	24:45	107.88	25:14	19.83	26:01	133.24
	24:04	74.47	24:51	115.53	25:34	181.73	26:28	30.66
288	23:34	3003.92	24:26	223.85	25:18	63.34	26:27	26.83
	23:57	161.49	24:44	125.82	25:34	152.84		
	24:07	64.77	24:51	136.91	25:44	58.25		
	24:17	46.55	25:06	83.41	26:02	146.02		
218	11:40	49.96	16:10	8.70	18:40	60.19	20:24	72.04
	14:27	36.03	16:24	44.20	18:58	42.79	20:42	63.83
	15:41	97.70	17:44	8.82	19:47	35.55		

Listing of S903791I.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
220	11:41	17.51	15:36	37.90	17:18	48.51	19:25	136.00
	12:33	85.33	15:45	41.01	18:07	34.80	20:31	92.59
	14:23	29.92	16:10	28.23	18:27	9.56	21:04	33.01
	14:58	24.38	16:23	29.08	18:50	63.93	21:28	79.61
304	27:44	7.13	29:07	788.31	30:40	956.95	32:36	31.16
	27:54	410.98	29:31	472.08	31:10	110.52	32:50	7.04
	28:11	690.98	29:53	901.09	31:24	86.53	33:05	901.85
	28:30	933.83	30:09	308.80	32:04	62.65	33:27	28.62
	28:49	933.83	30:26	142.84	32:12	68.36		
306	27:07	27.42	29:30	549.29	31:12	110.21	32:51	68.79
	27:56	473.10	29:53	1169.91	31:24	74.22	33:05	1266.38
	28:10	924.09	30:08	448.80	31:52	37.47	33:54	15.59
	28:30	1021.59	30:22	178.56	32:02	33.41	34:11	24.07
	28:49	1295.84	30:40	1189.15	32:18	12.17		
	29:07	978.42	30:58	18.13	32:44	11.96		
320	27:38	22.93	29:05	195.48	30:51	234.19	32:06	30.64
	27:45	42.59	29:24	295.73	31:13	797.12	32:15	42.72
	28:04	29.51	29:48	9.99	31:21	935.67	32:35	62.88
	28:15	32.79	30:06	2094.84	31:31	246.22	34:00	106.49
	28:27	23.13	30:20	1319.13	31:40	301.91	34:33	66.98
	28:42	361.42	30:38	37.33	31:53	332.40	35:02	135.96
322	27:46	104.40	29:24	391.17	31:31	188.89	34:01	51.53
	28:05	88.41	30:06	2716.90	31:40	305.75	34:34	31.02
	28:14	17.90	30:20	1713.71	31:53	482.64	34:53	10.78
	28:32	14.31	30:51	284.86	32:06	219.03	35:02	160.42
	28:43	274.89	31:13	907.32	32:16	123.44		
	29:06	310.12	31:21	1194.92	32:36	27.79		
340	31:42	15.13	34:30	3640.26	35:45	2680.46	37:40	284.86
	32:50	43.11	34:59	3733.56	36:20	3169.65		
	33:04	25871.13	35:23	4909.01	36:36	4753.99		
	33:38	6.92	35:35	180.10	36:58	70.40		
342	31:50	11.81	33:42	14.71	34:53	2195.79	36:36	2962.22
	32:07	10.81	33:53	6.82	35:22	3095.18	37:00	22.02
	32:23	9.36	34:01	12.59	35:35	105.45	37:10	20.85
	32:48	12.11	34:10	6.77	35:45	1726.73	37:40	178.59
	33:04	16236.27	34:30	2339.28	36:20	2074.38		
356	32:40	17.90	35:21	3055.09	36:08	5330.94	37:01	2024.86
	34:08	16.90	35:32	2890.55	36:23	697.73	37:12	31.32
	34:31	2251.98	35:46	2011.36	36:34	396.27	37:29	1193.91
	35:02	3826.34	36:00	1605.57	36:49	1862.24	37:46	7.17
358	32:44	63.00	35:02	2372.65	36:00	962.42	36:49	1216.68
	33:20	9.63	35:21	2329.39	36:08	3481.20	37:01	1242.08
	34:31	1556.65	35:32	2011.81	36:23	546.16	37:28	734.70
	34:49	29.98	35:46	1398.29	36:34	257.59		

Listing of S9037911.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
316	29:46	57.88	30:06	262.33	30:39	52319.58	31:08	459.29
318	29:46	146.17	30:08	338.74	30:39	67057.24	31:09	625.96
328	31:30	75491.82	32:18	116.44				
332	31:13	58204.81	31:29	34714.20				
334	31:13	71883.15	31:29	41513.61				
352	34:52	200.94	35:44	686.63	37:40	767.25		
	35:22	37093.67	36:19	41902.18				
354	34:53	178.68	35:44	495.26	37:03	51.49		
	35:22	23714.15	36:19	27306.23	37:39	484.08		
368	35:26	194.38	35:52	37.92	36:49	21535.06	37:28	144.45
370	35:26	793.41	36:15	46.31	37:28	253.13		
	35:40	28.63	36:49	13614.13				
374	38:05	268.92	39:36	2368.67	41:01	1049.60	42:02	15.22
	38:15	6.83	39:50	428708.56	41:10	50.31	42:10	33.63
	38:22	15.86	40:26	31880.60	41:20	8124.92	42:32	1199.76
	38:56	78110.41	40:36	10972.46	41:24	5953.82	42:40	7549.41
	39:08	257426.84	40:46	1117.89	41:52	11.37		
376	38:07	212.58	40:16	857.97	41:20	7260.68	42:32	1167.46
	38:56	68239.69	40:26	28531.92	41:25	5129.10	42:39	6679.35
	39:08	221356.06	40:36	11036.60	41:39	152.09		
	39:36	2304.03	40:54	176.03	41:43	66.98		
	39:51	434398.13	41:01	955.99	41:52	42.22		
390	38:11	10.88	40:11	417.76	41:35	4471.75	42:30	60.00
	38:17	13.41	40:25	21857.85	41:43	45073.86	42:36	17.38
	38:42	9.55	40:45	160810.16	41:59	229.89	42:41	19.70
	39:42	230509.58	41:00	49001.40	42:10	19337.95	42:46	11.06
	40:06	281.24	41:21	567.16	42:27	66.84	42:50	24.76
392	38:25	10.25	40:11	161.26	41:00	40610.88	42:10	15826.76
	38:28	8.25	40:16	128.72	41:28	110.82	42:31	15.64
	38:46	8.08	40:25	17282.00	41:35	3469.19	42:37	9.91
	39:42	187120.38	40:45	129528.35	41:43	37128.88	42:49	17.68
384	38:56	35.00	40:11	58.01	41:24	17519.22		
	39:07	57.76	40:25	17118.90	41:49	55.27		
	39:51	151.05	40:35	18845.52	42:32	13263.28		
386	38:07	46.46	39:07	116.71	40:25	32427.84	42:00	55.64
	38:33	41.42	39:51	75.12	40:35	37028.80	42:32	25369.75
	38:54	55.79	40:09	27.25	41:24	34103.63		
402	39:17	118.24	41:42	20715.17	42:35	242.32		
	41:34	17224.32	42:10	33416.81				

Listing of S903791I.dbf File
Raw Mass, Retention Time and Data Area

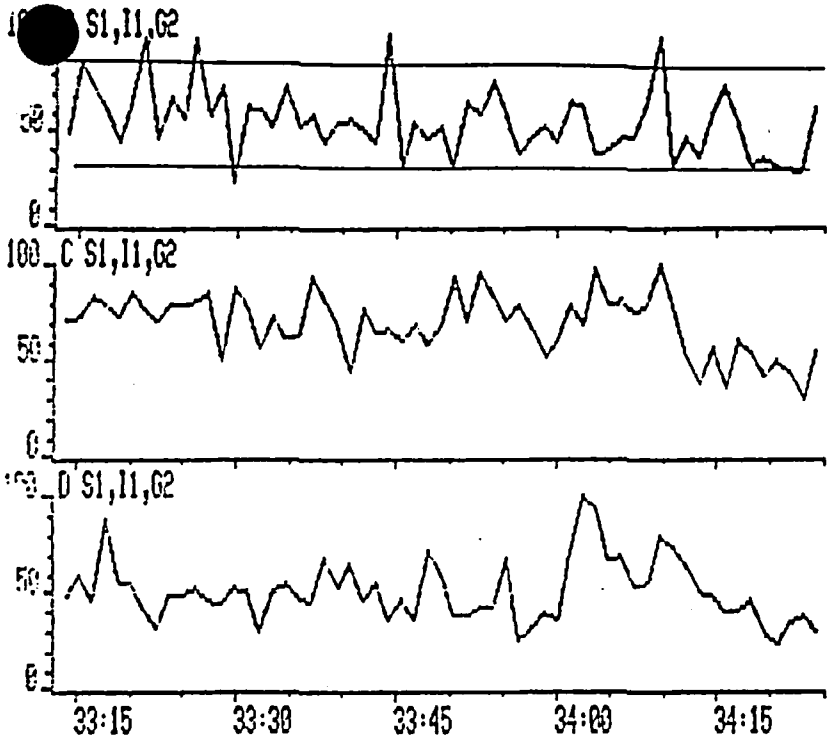
NOV 19 1990
ENVIRONMENTAL ANALYSIS

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
404	39:17	57.26	41:42	17775.39	42:35	79.57		
	41:34	14426.58	42:10	27961.41				
408	44:11	31.41	45:34	649227.06	47:11	16359.05		
	45:00	601292.44	46:31	5574.38				
410	45:00	647953.13	45:34	705621.94	46:31	6364.06	47:11	17573.49
418	43:09	13.50	44:59	10182.37	46:38	56.31	48:06	150.88
	43:27	23.54	45:34	1036.11	47:10	6539.16		
	44:32	12.23	45:54	1015.59	47:39	34.16		
420	43:35	21.11	45:54	1713.53	47:56	20.98		
	44:58	21548.26	46:31	74.84	48:05	38.06		
	45:34	770.36	47:10	14178.90	48:27	10.57		
424	45:25	926831.25	46:31	653660.31	49:53	51.29	50:18	190.81
426	43:14	51.48	46:31	648714.00	49:58	150.84		
	45:25	926400.94	47:37	2651.67	50:16	83.29		
436	45:26	726.48	45:56	24.99	46:30	12169.86	47:06	41.15
438	45:26	542.92	46:09	9.00	47:07	45.04		
	45:52	42.75	46:30	11777.41	47:15	37.11		
442	52:10	692202.81	53:35	1087.37	53:53	811.43		
444	52:09	715459.00	54:14	209.86	54:32	220.64		
458	51:57	1504856.38						
460	51:55	1625679.38						
470	50:24	14.33	51:28	16.92	53:00	51.97	53:37	27.59
	51:10	14.11	51:57	14638.56	53:28	23.29		
472	50:22	32.13	52:53	43.01	53:35	43.32		
	51:57	14339.85	53:09	25.84				

*** End of Report ***

3791 18-OCT-90 14:34 70S (EI+) Sus:D85US
2 B: 303.9816 C: 305.8987 D: 315.9419 E: 317.9389 F: 319.8965
Text:LF2/9111-TLI#16661

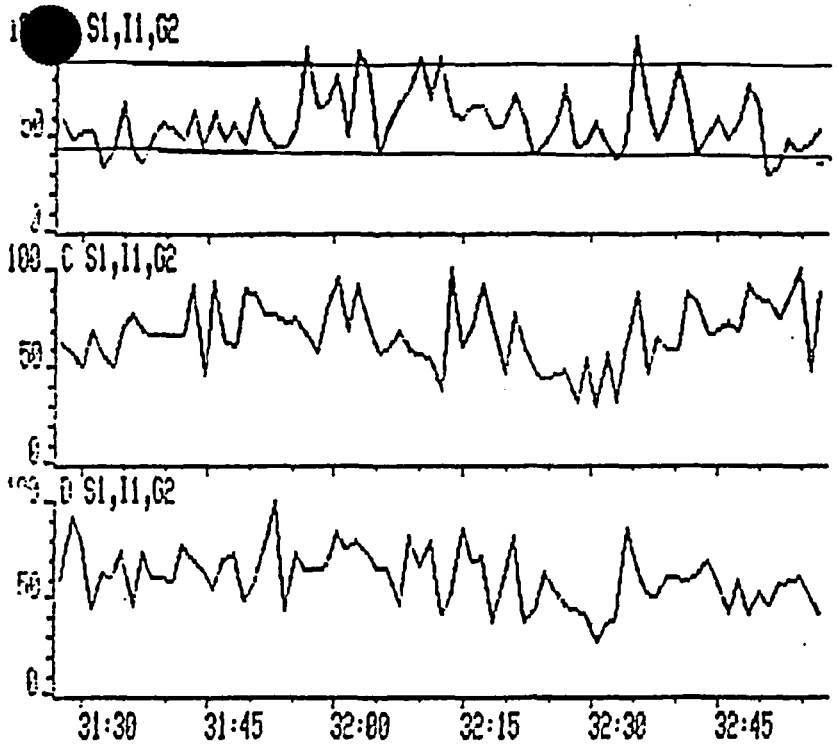
NOV 1 0 1990



noise = 34.6 x 10 x .45
= 155.7
KU 10/31/90

0731 18-OCT-90 14:34 70S (EI+) SLE:D05U6
2 B: 303.9016 C: 305.8987 D: 315.9419 E: 317.9389 F: 319.8965
Text:LF2/9111 TLI#16661

NOV 1 9 1990



ENVIRONMENTAL DETAILS

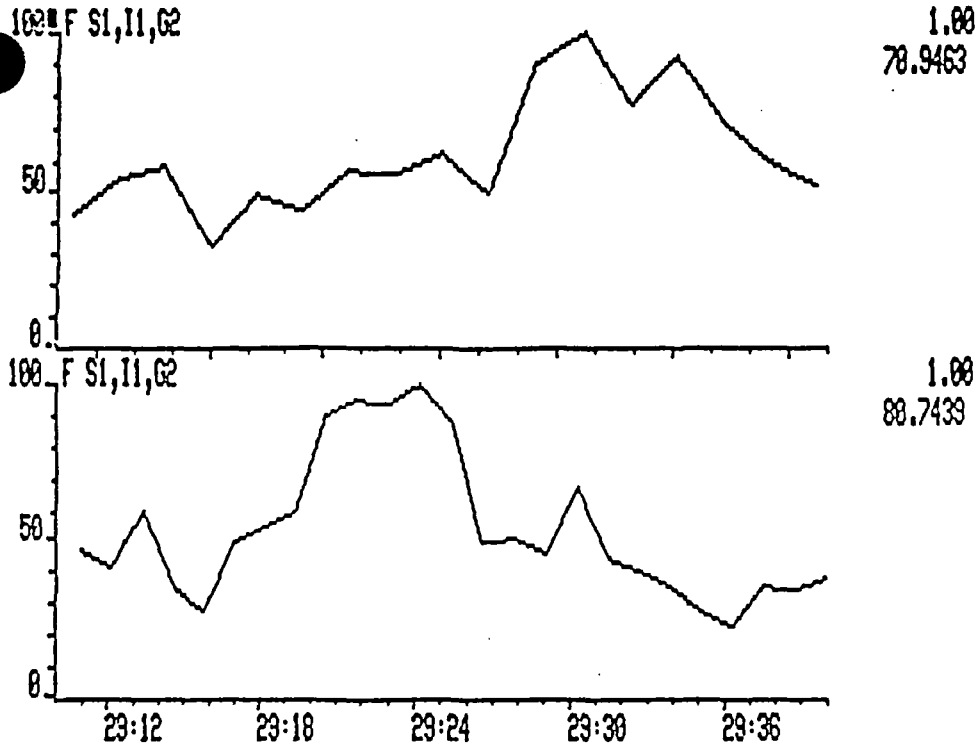
noise = 36.9 x .45 x 10
= 166.0

KU 10/31/90

12

GF: 2 F: 319.8965 G: 321.8936 H: 327.8847 I: 330.9792 J: 331.9368
Text:LF2/9111 TLI#16661

NOV 19 1990



Verified by (GC/MS): JP 10-18-90

Verified by (Int. QC): TR 10/[redacted]/90

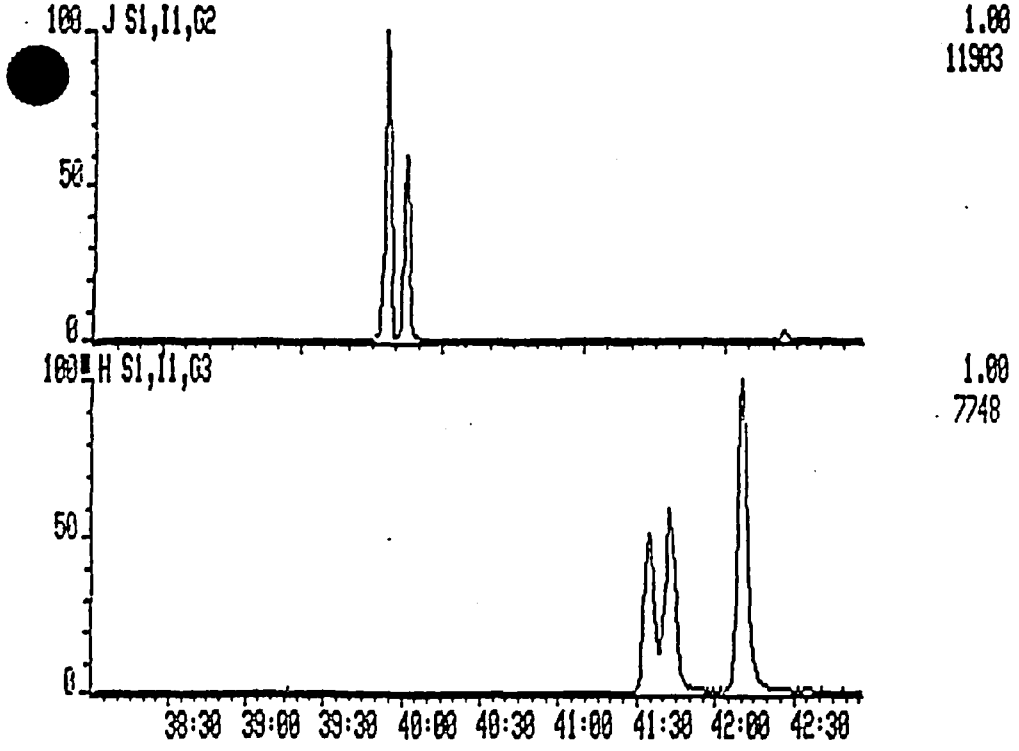
Saturated
- JP

Group 3+4 saturation except HxCDD,
TR 10/20/90

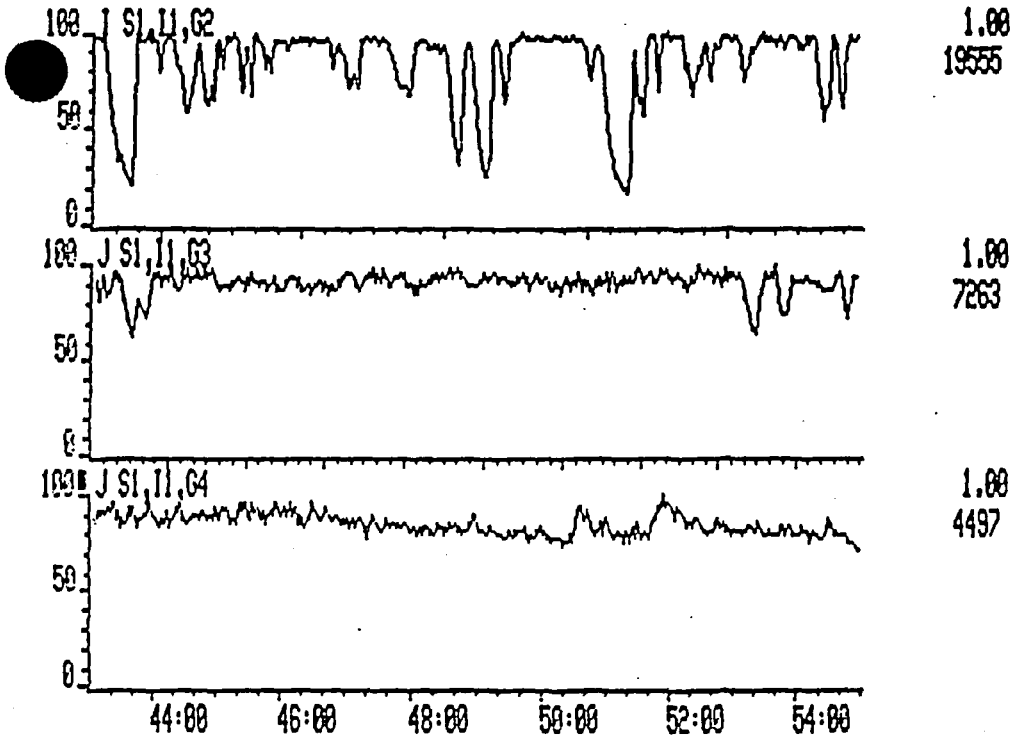
Process, dilute + reshoot. TR 10/23/9

GR 3 F: 391.8127 G: 392.9768 H: 401.6558 I: 403.8529 J: 430.9729
Text:LF2/9111 TLI#16661

RECEIVED
NOV 1 9 1990
ENVIRONMENTAL ...

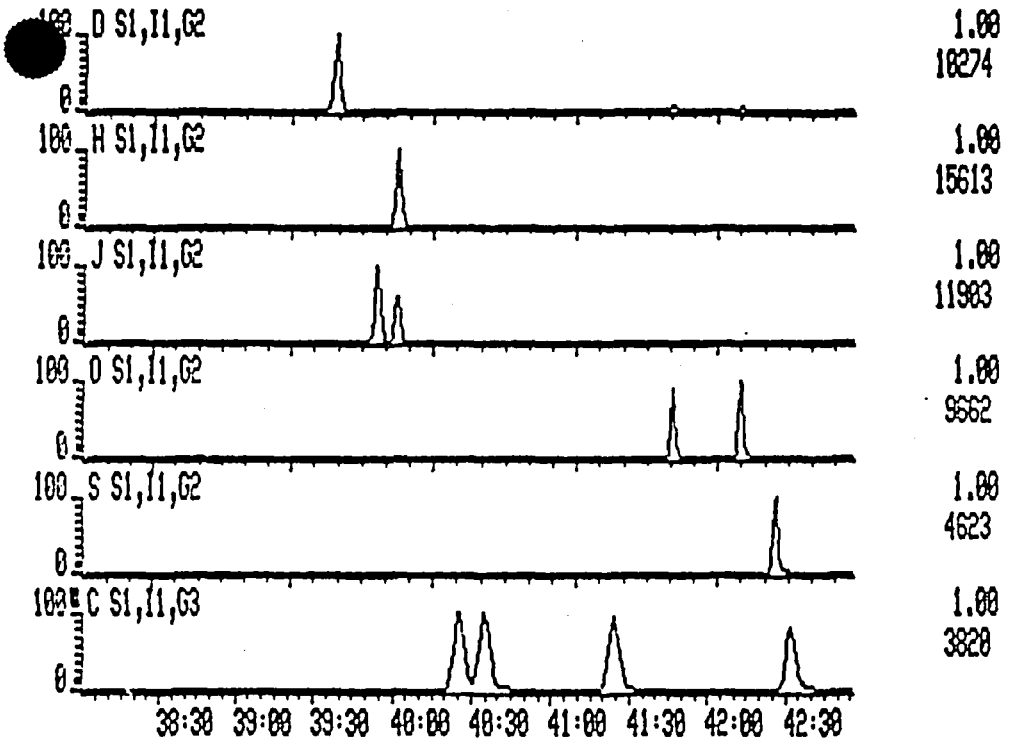


GF: 4 D: 419.8220 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Test:LF2/9111 TL1#16661



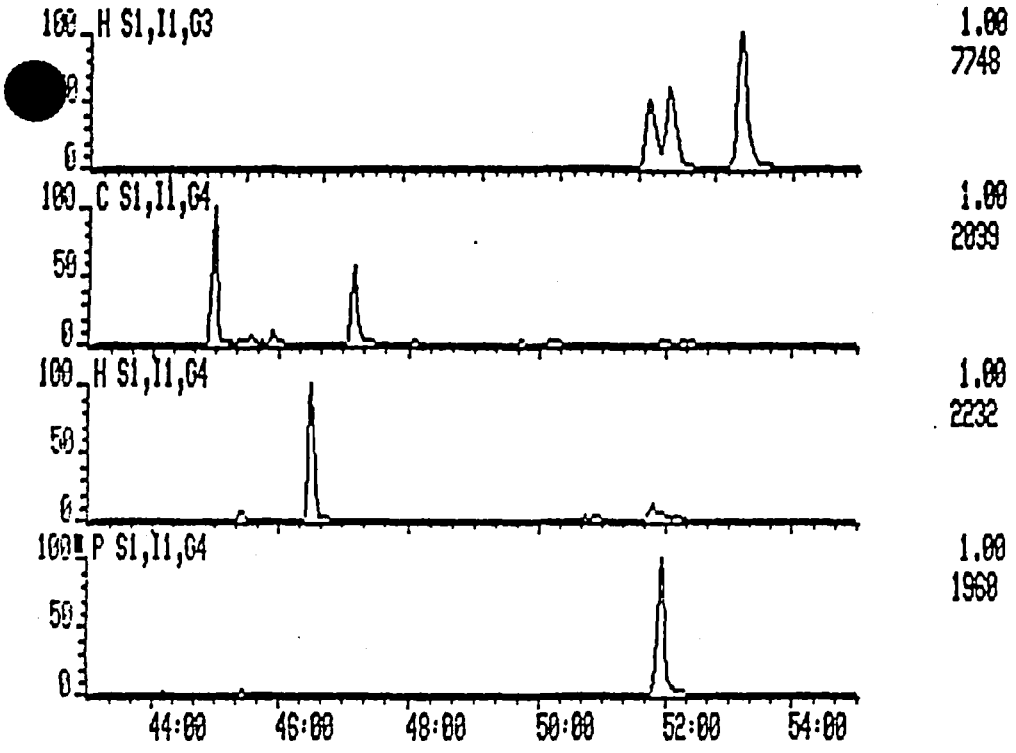
NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

[5503/91 16-OCT-90 14:54 /06 (EI+) Sub:06005
GR: 3 D: 385.8610 E: 388.8156 F: 391.8127 G: 392.9760 H: 401.8558
Text:LF2/9111 TLI#16661



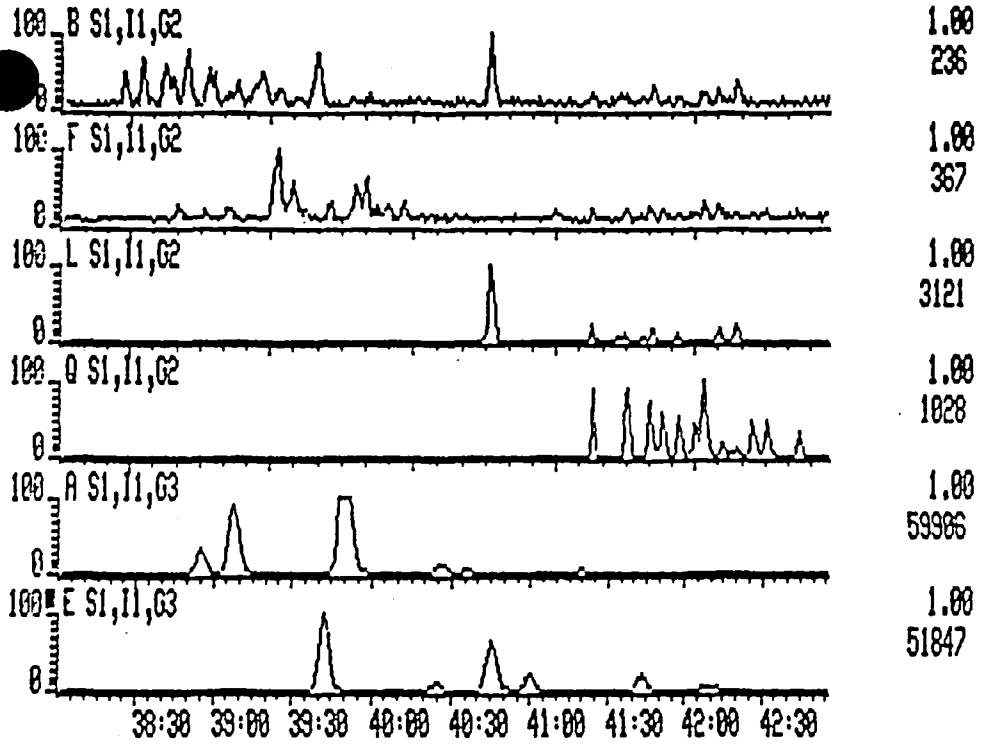
RECEIVED
NOV 19 1990
ENVIRONMENTAL LABS

GR: 4 D: 419.8226 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text:LF2/9111 TLI#16661



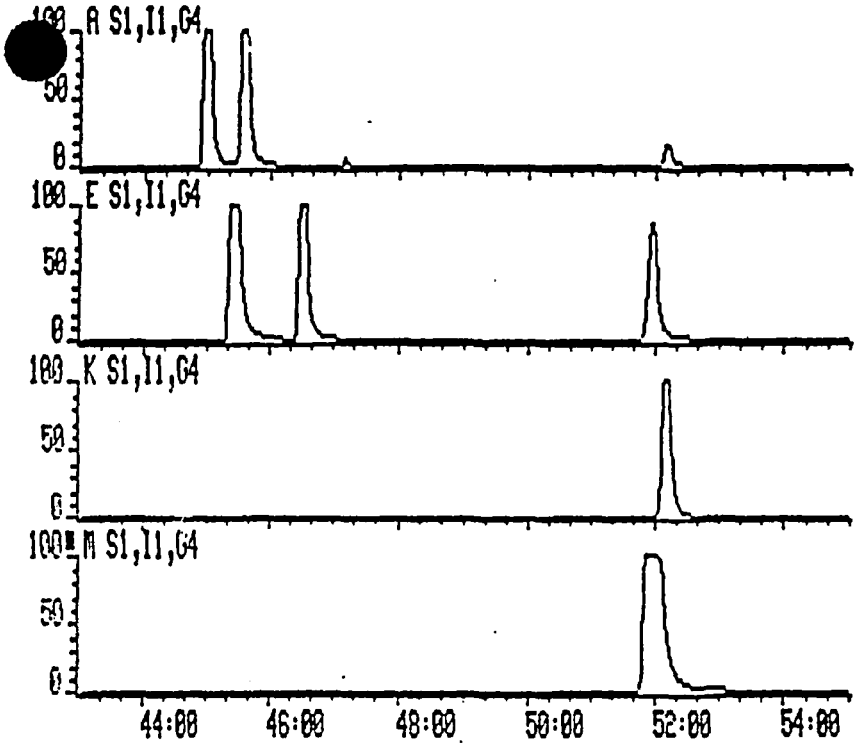
NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

C: GR 3 D: 385.8610 E: 383.8156 F: 391.8127 G: 392.9760 H: 401.8558
Text:LF2/9111 TLI#16661



RECEIVED
NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

[illegible] 16-OCT-90 14:34 70[illegible] (CI+) SQ5:06505
GR 4 D: 419.8220 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text: LF2/9111 TLI#16661



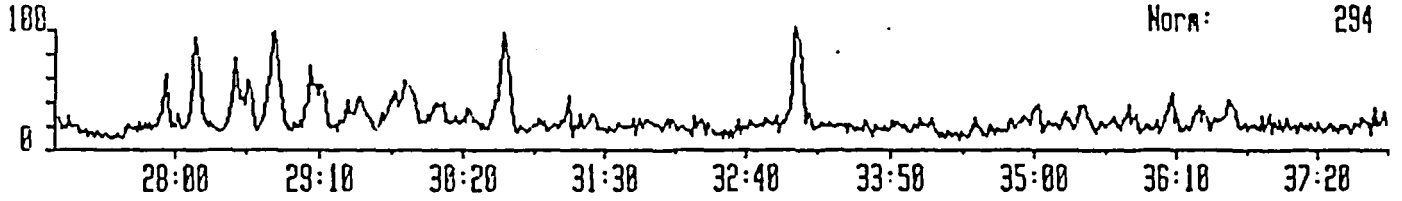
RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

10

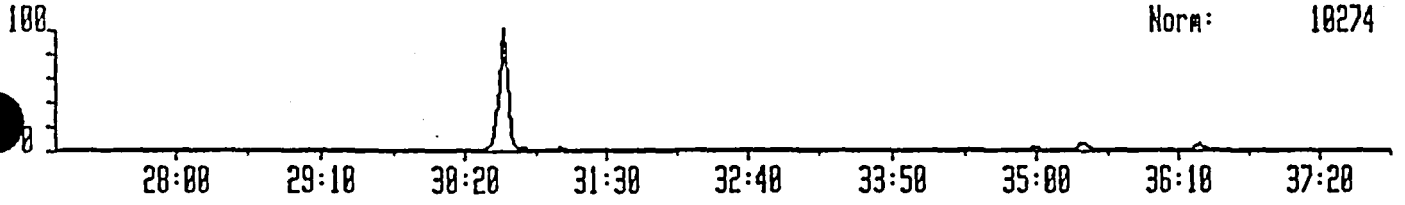
S903791 18-OCT-90 Str:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 303.9016
Text:LF2/9111 TLI#16661

NOV 1 9 1990

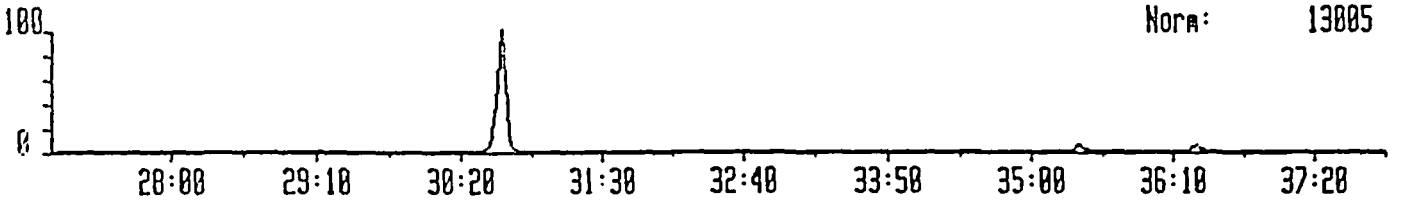
S903791 18-OCT-90 Str:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 305.8987
Text:LF2/9111 TLI#16661



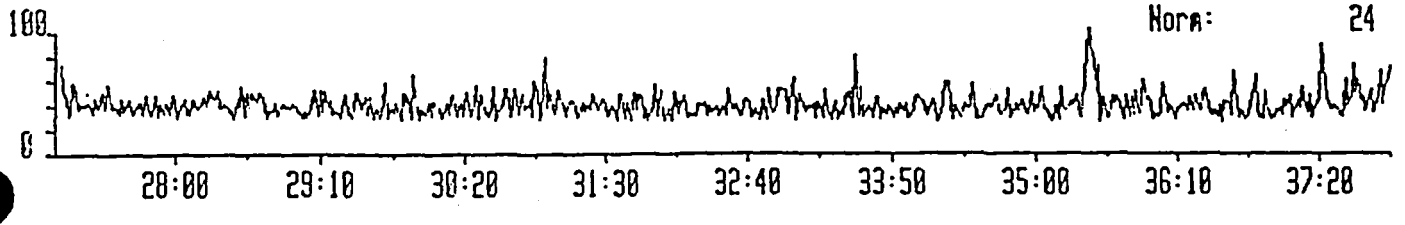
S903791 18-OCT-90 Str:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 315.9419
Text:LF2/9111 TLI#16661



S903791 18-OCT-90 Str:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 317.9389
Text:LF2/9111 TLI#16661

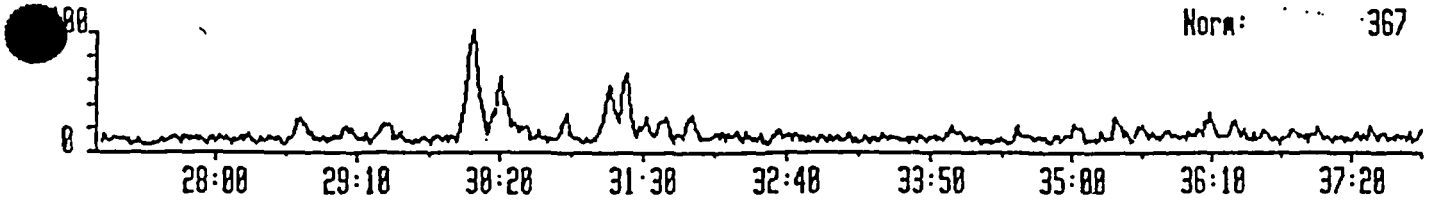


S903791 18-OCT-90 Str:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 375.8364
Text:LF2/9111 TLI#16661

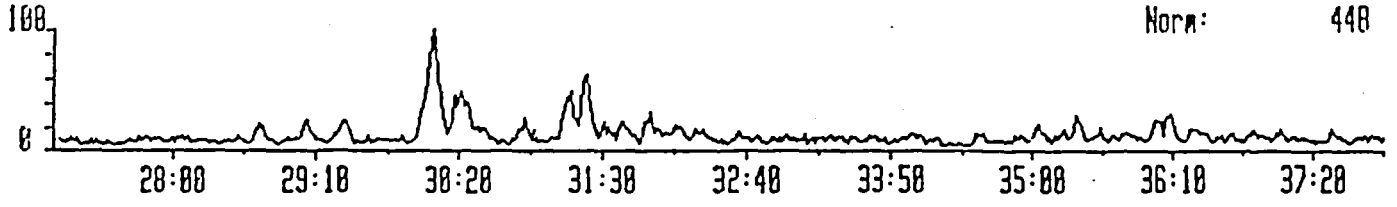


S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 319.8965
Text:LF2/9111 TLI#16661

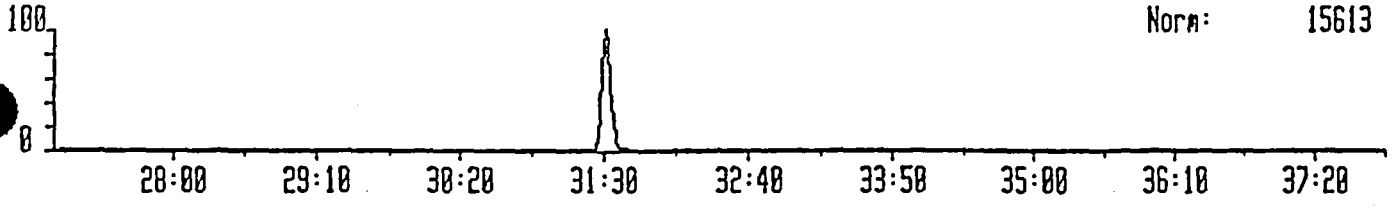
NOV 1 9 1990



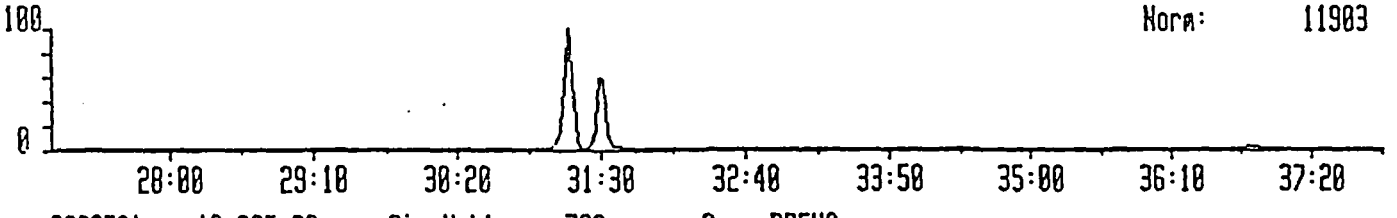
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 321.8936
Text:LF2/9111 TLI#16661



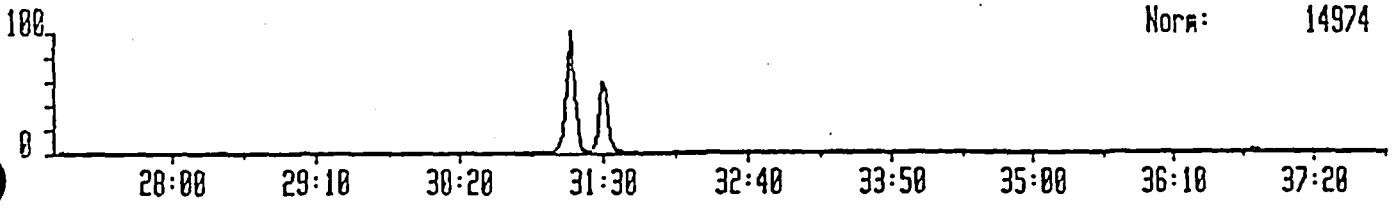
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 327.8847
Text:LF2/9111 TLI#16661



S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 331.9368
Text:LF2/9111 TLI#16661



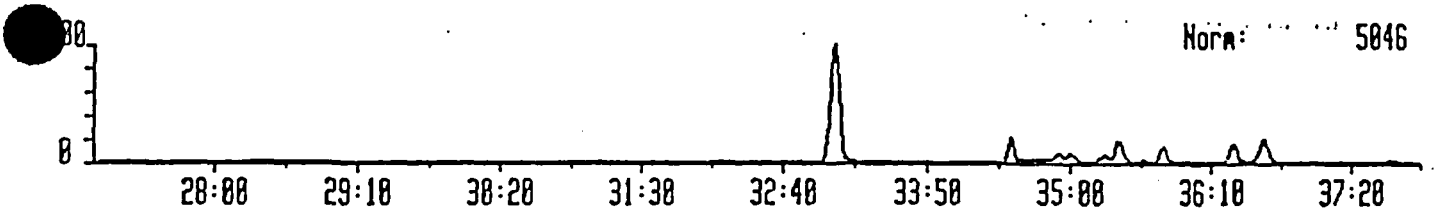
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 333.9338
Text:LF2/9111 TLI#16661



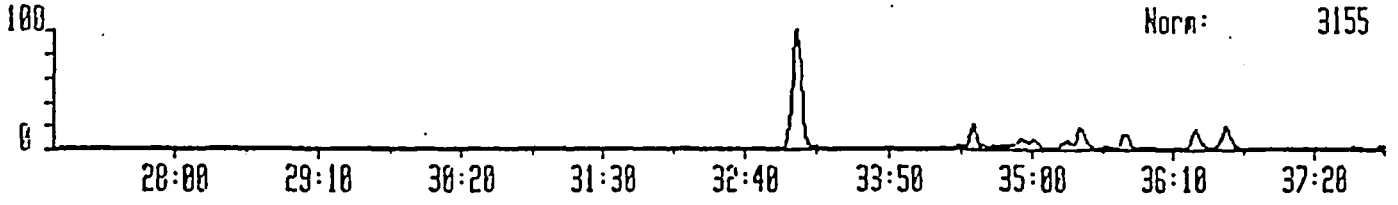
2'

S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 339.8597
Text:LF2/9111 TLI#16661

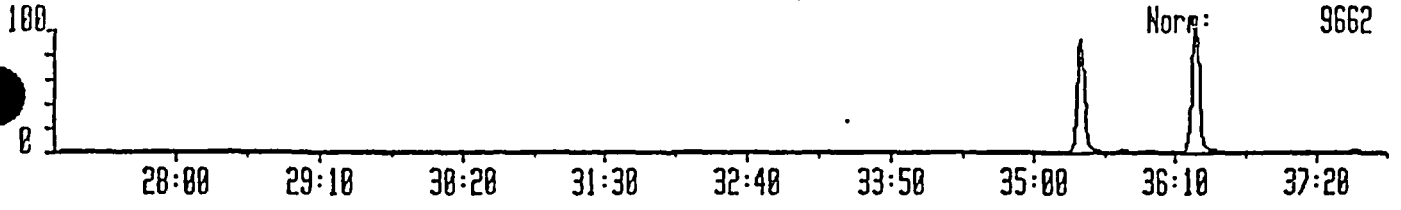
NOV 1 0 1990



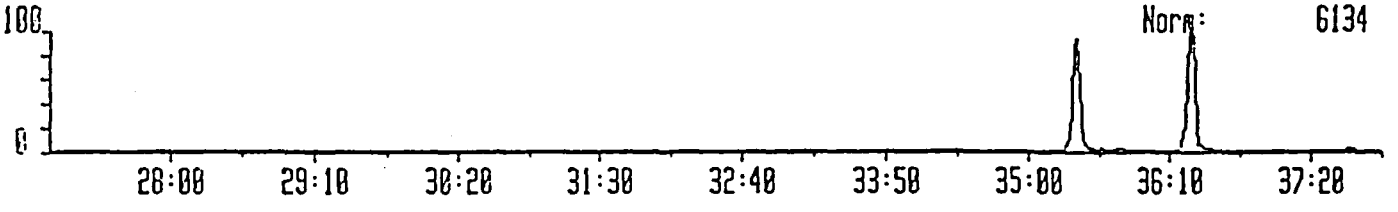
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 341.8567
Text:LF2/9111 TLI#16661



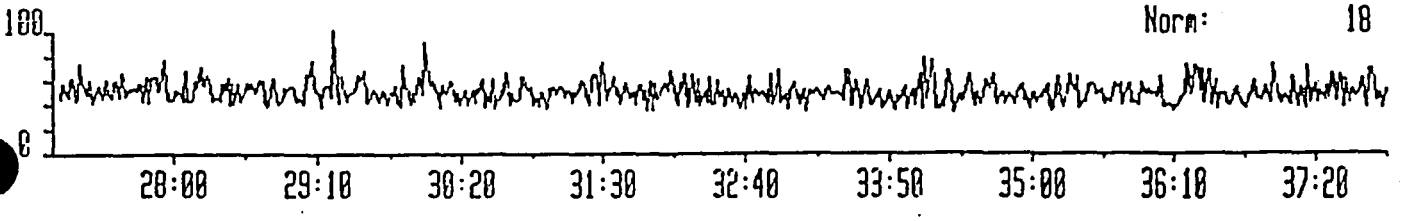
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 351.9000
Text:LF2/9111 TLI#16661



S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 353.8970
Text:LF2/9111 TLI#16661



S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 409.7974
Text:LF2/9111 TLI#16661



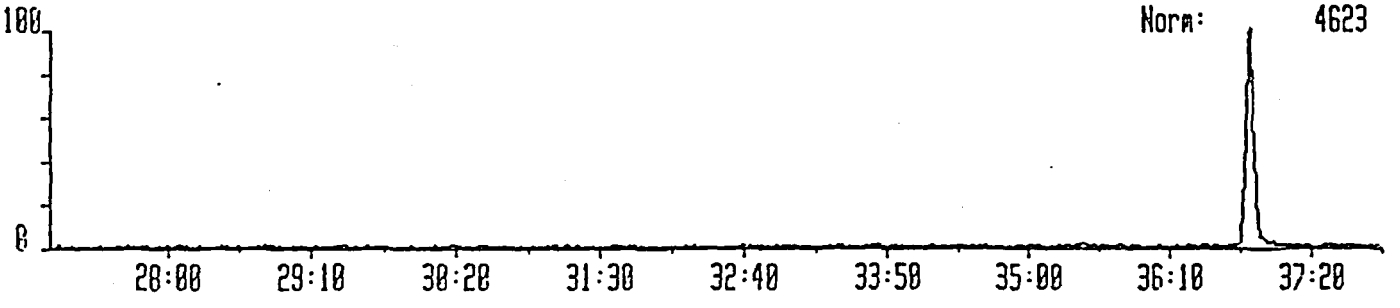
22

S983791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 355.8546
Text:LF2/9111 TLI#16661

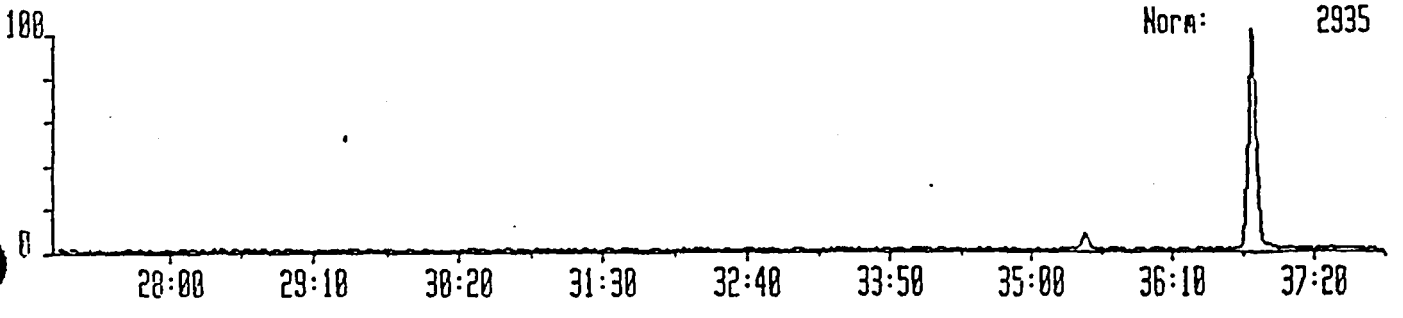
NOV 1 0 1990

S983791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 357.8516
Text:LF2/9111 TLI#16661

S983791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 367.8949
Text:LF2/9111 TLI#16661



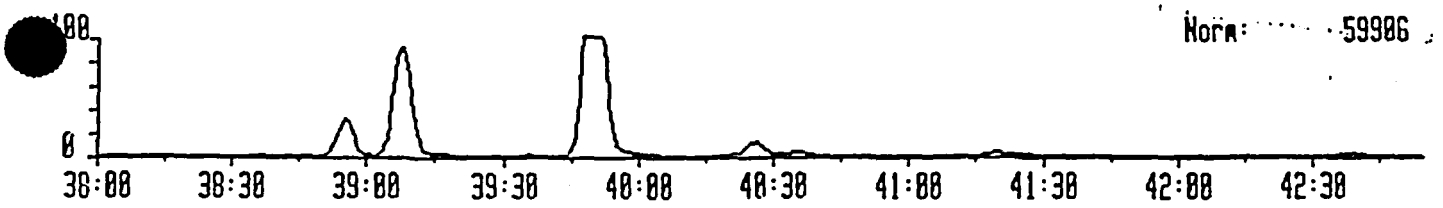
S983791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 369.8919
Text:LF2/9111 TLI#16661



22

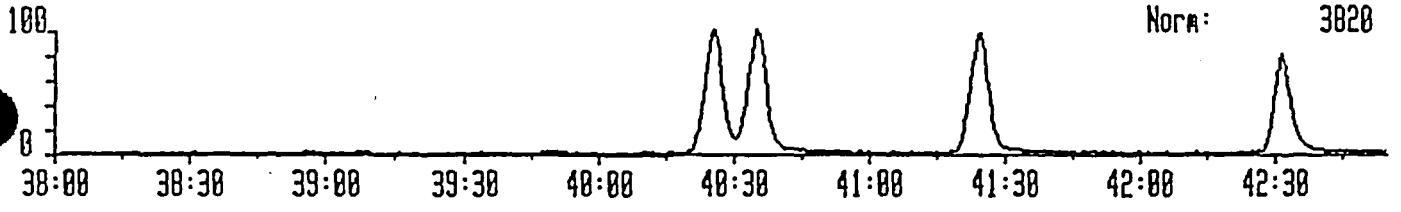
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 373.8208
Text:LF2/9111 TLI#16661

NOV 1 0 1993

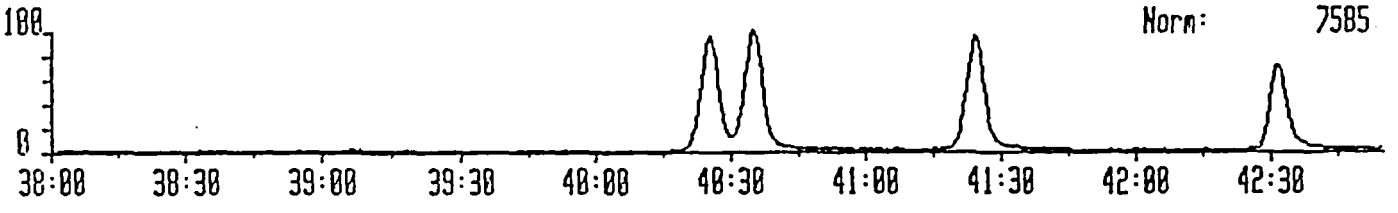


S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 375.8178
Text:LF2/9111 TLI#16661

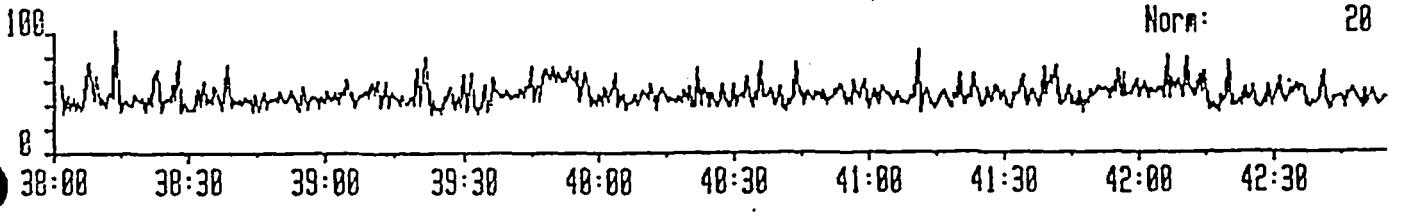
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 383.8639
Text:LF2/9111 TLI#16661



S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 385.8610
Text:LF2/9111 TLI#16661



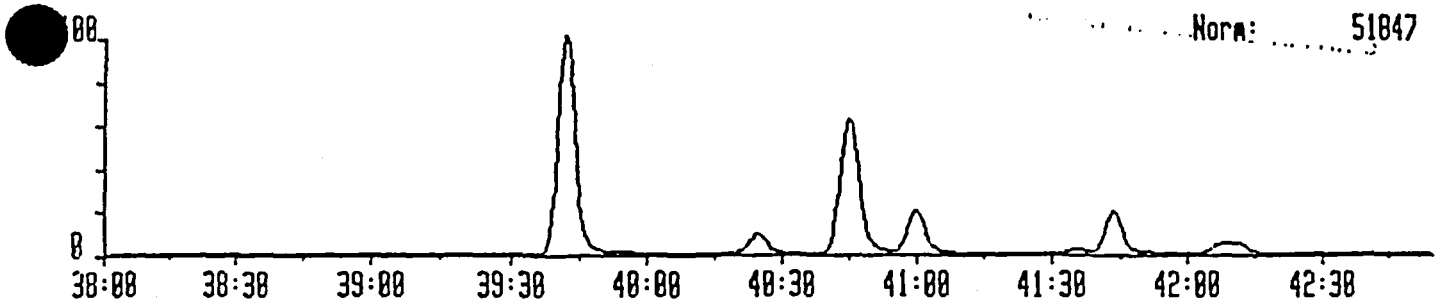
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 445.7555
Text:LF2/9111 TLI#16661



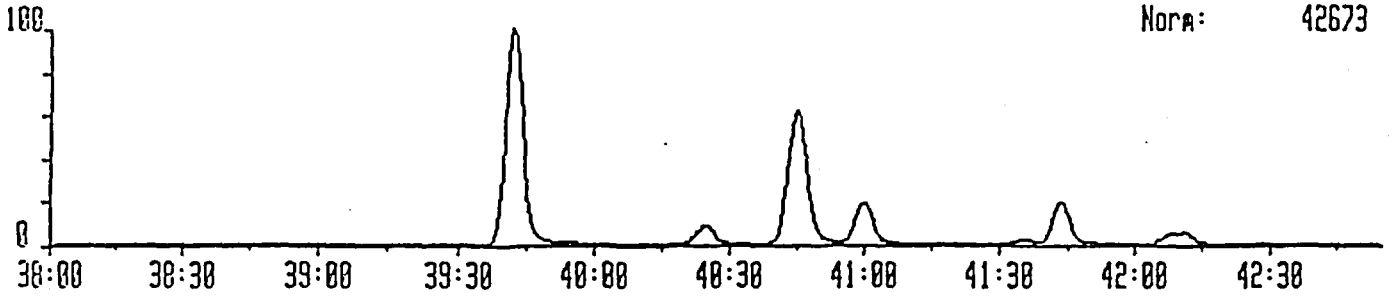
21

S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 389.8156
Text:LF2/9111 TLI#16661

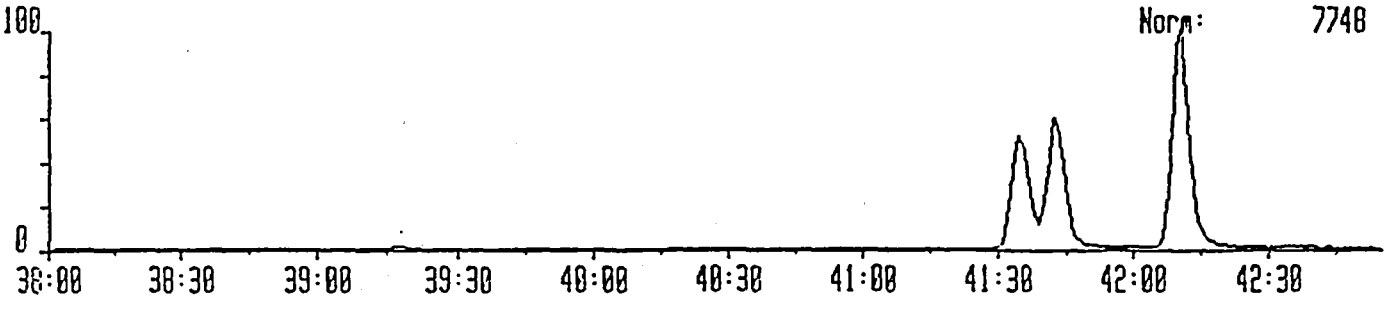
NOV 1 0 1990



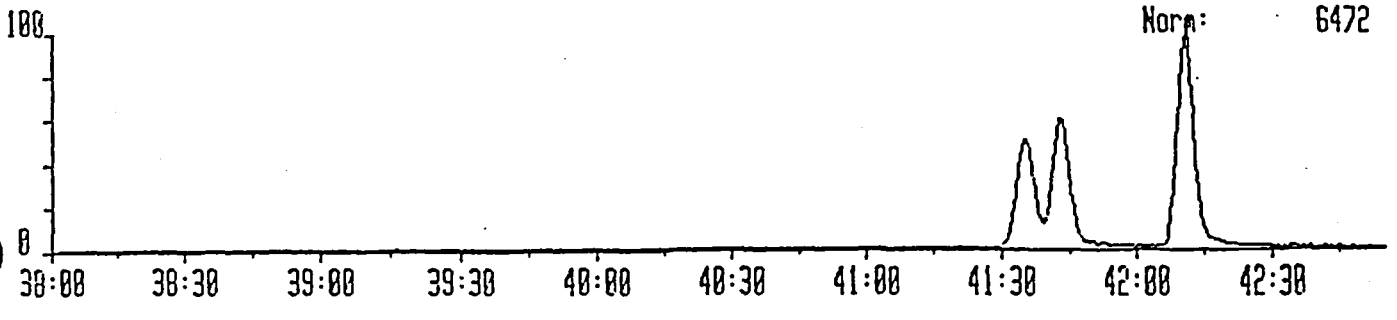
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 391.8127
Text:LF2/9111 TLI#16661



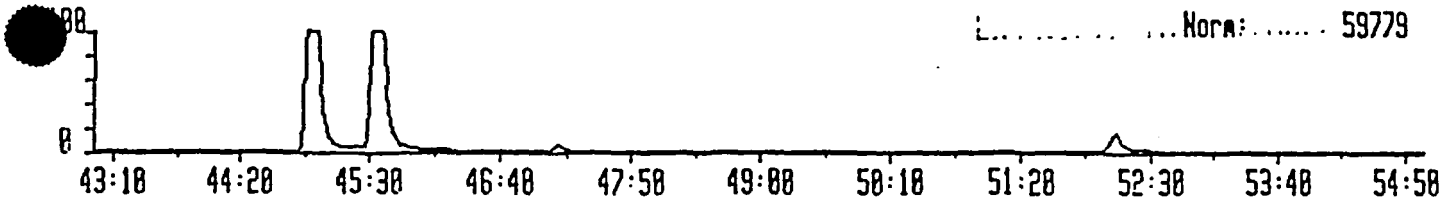
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 401.8558
Text:LF2/9111 TLI#16661



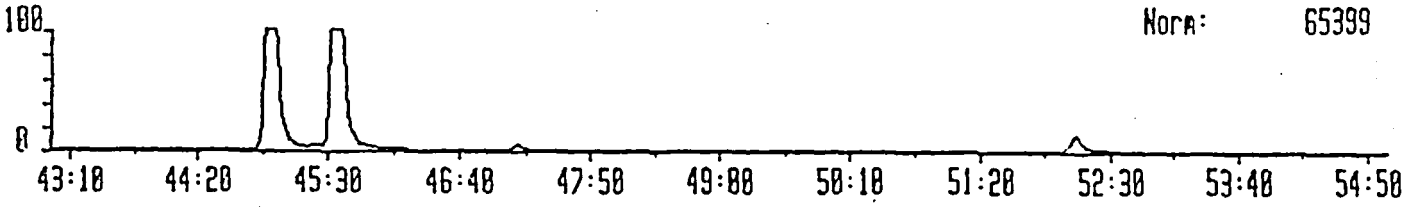
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 403.8529
Text:LF2/9111 TLI#16661



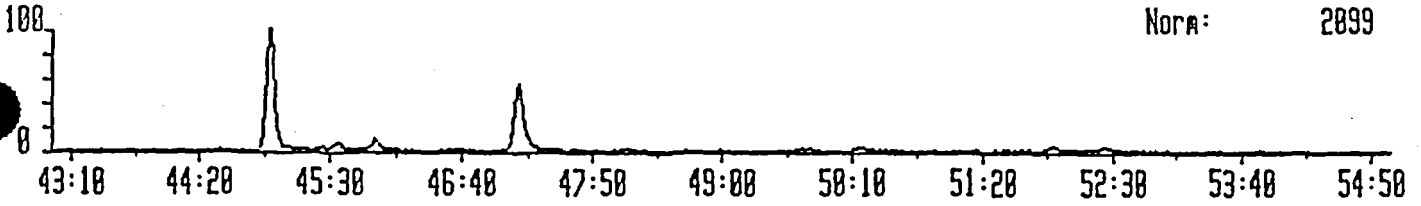
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 407.7818
Text:LF2/9111 TLI#16661



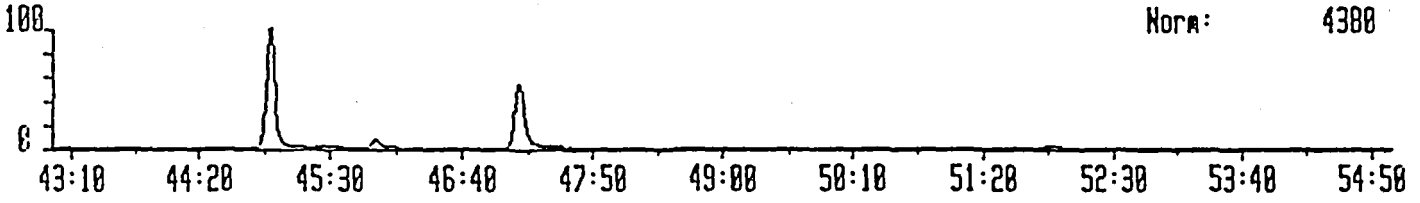
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 409.7789
Text:LF2/9111 TLI#16661



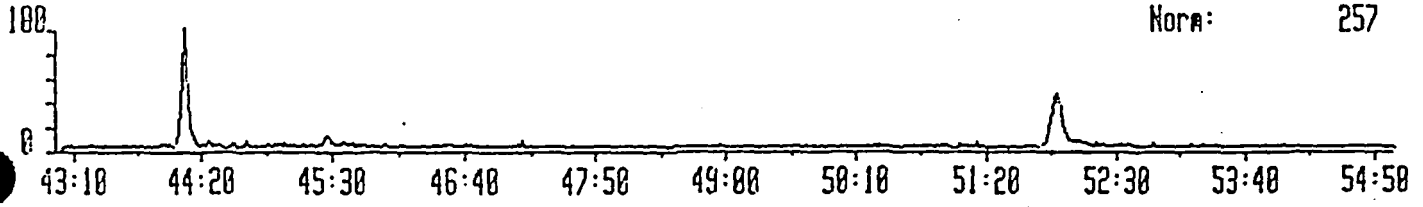
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 417.8253
Text:LF2/9111 TLI#16661



S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 419.8220
Text:LF2/9111 TLI#16661



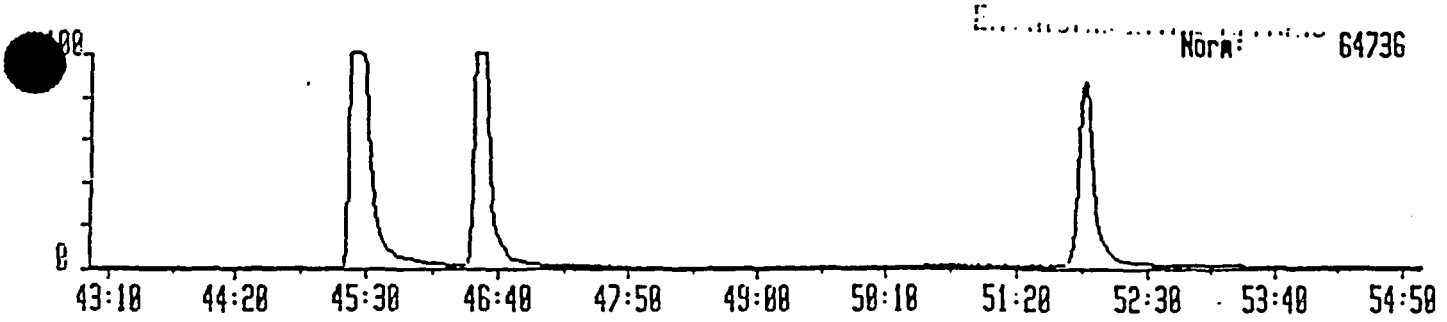
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 479.7165
Text:LF2/9111 TLI#16661



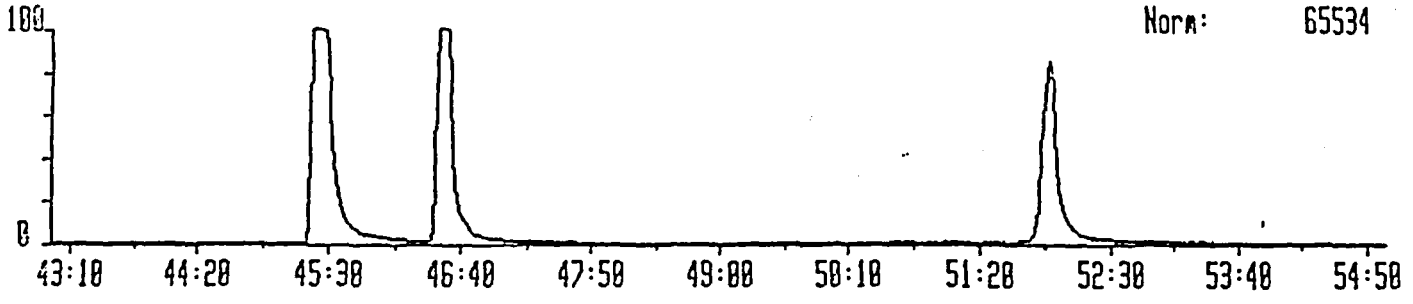
26

S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 423.7766
Text:LF2/9111 TLI#16661

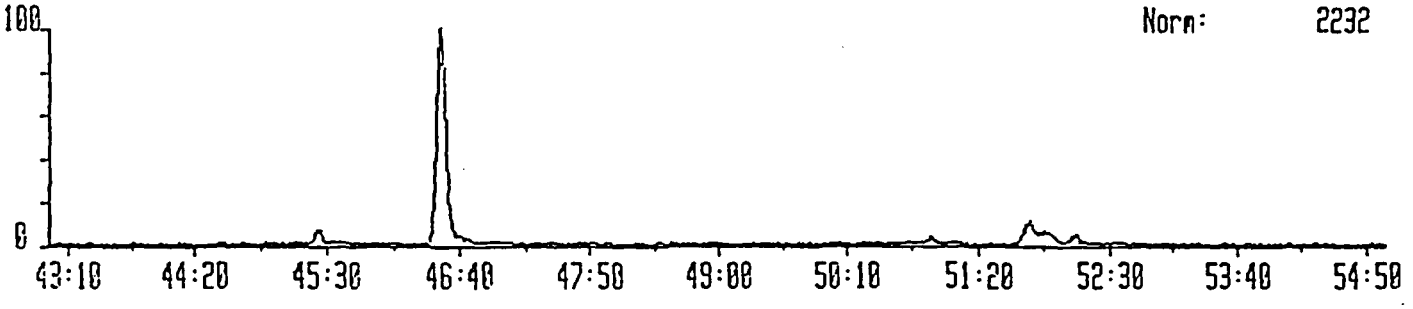
NOV 1 9 1990



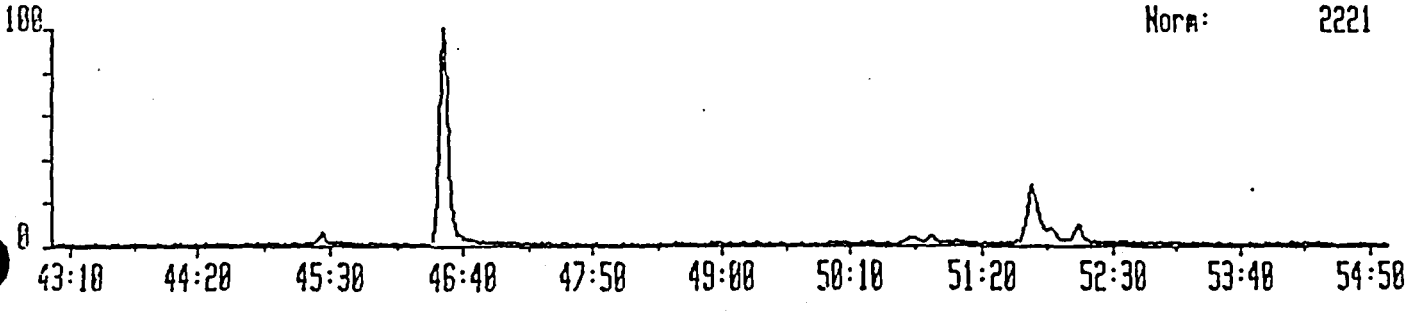
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 425.7737
Text:LF2/9111 TLI#16661



S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 435.8169
Text:LF2/9111 TLI#16661



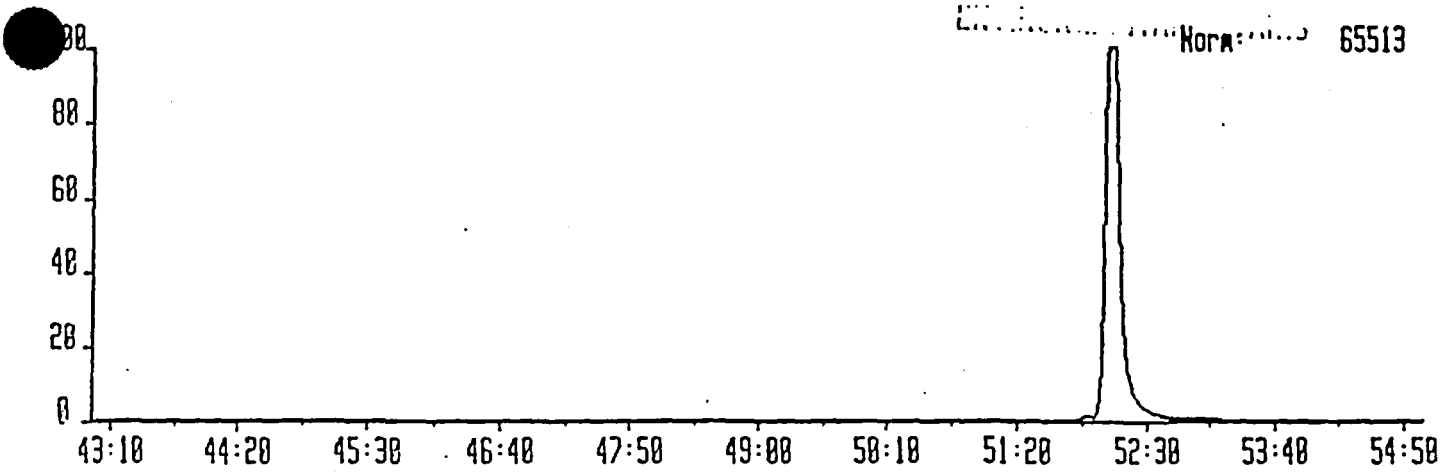
S903791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 437.8140
Text:LF2/9111 TLI#16661



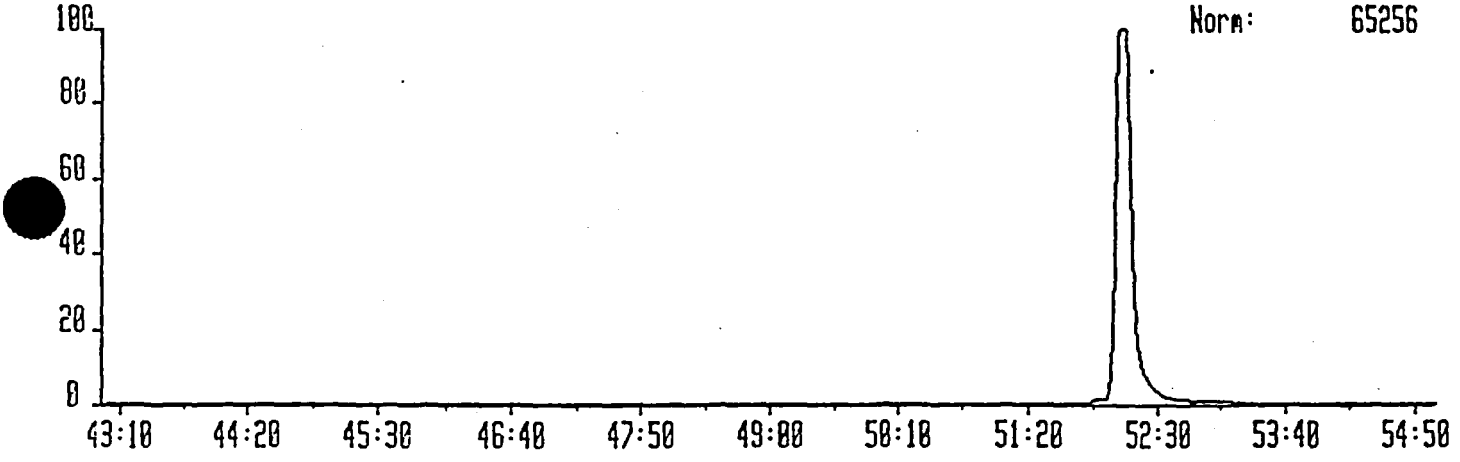
2

S983791 16-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 441.7428
Text:LF2/9111 TLI#16661

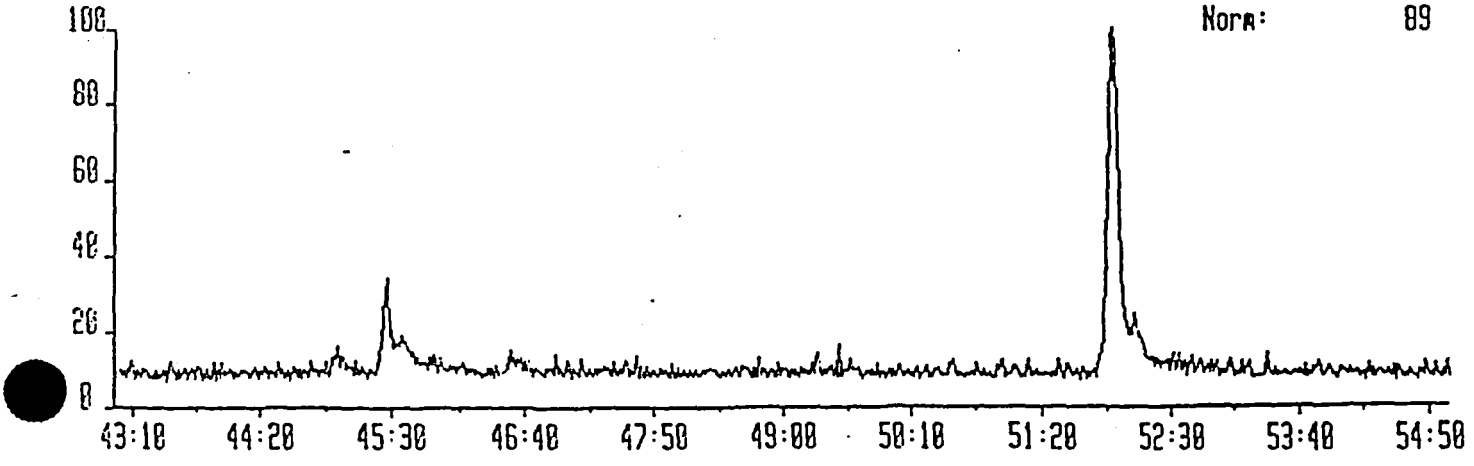
NOV 1 9 1990



S983791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 443.7399
Text:LF2/9111 TLI#16661



S983791 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 513.6775
Text:LF2/9111 TLI#16661



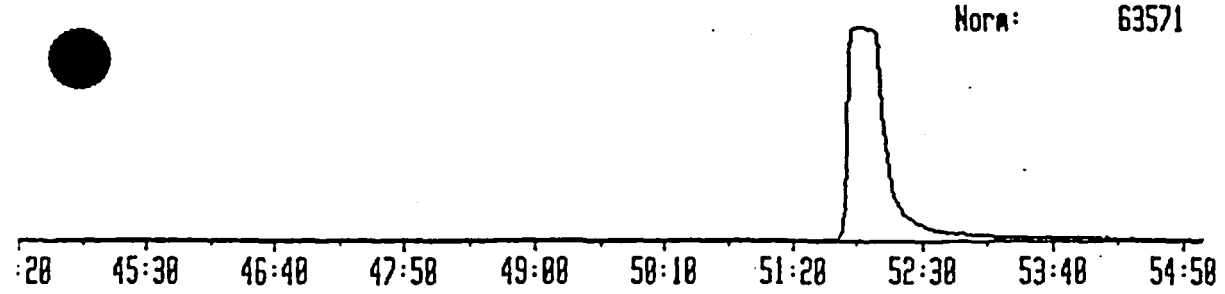
2

1P-OCT-90 Sir:Voltage 70S Sys: DB5US
Injection 1 Group 4 Mass 457.7377
11 TLI#16661

NOV 1 9 1990

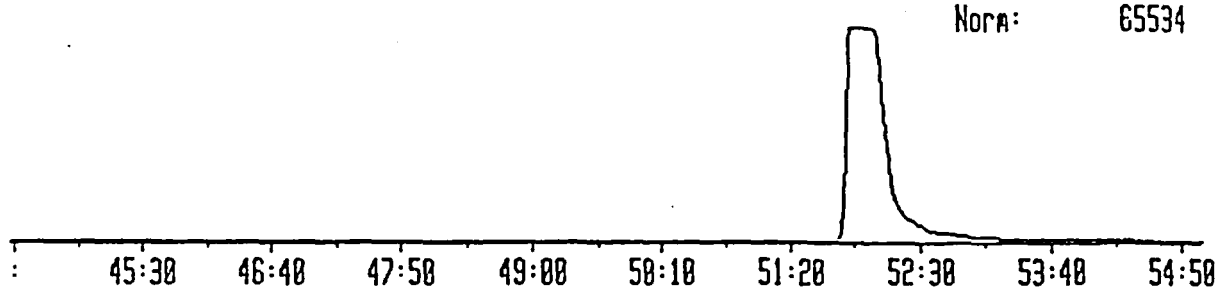
ENVIRONMENTAL ANALYSIS

Norm: 63571



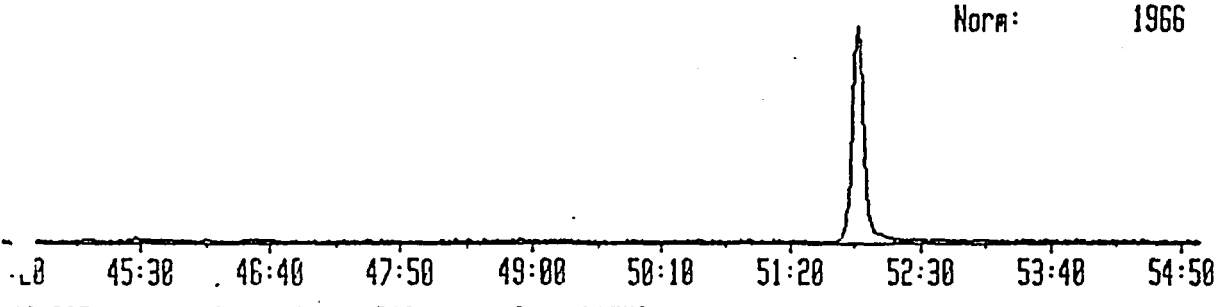
1 OCT-90 Sir:Voltage 70S Sys: DB5US
Injection 1 Group 4 Mass 459.7348
1' TLI#16661

Norm: 65534



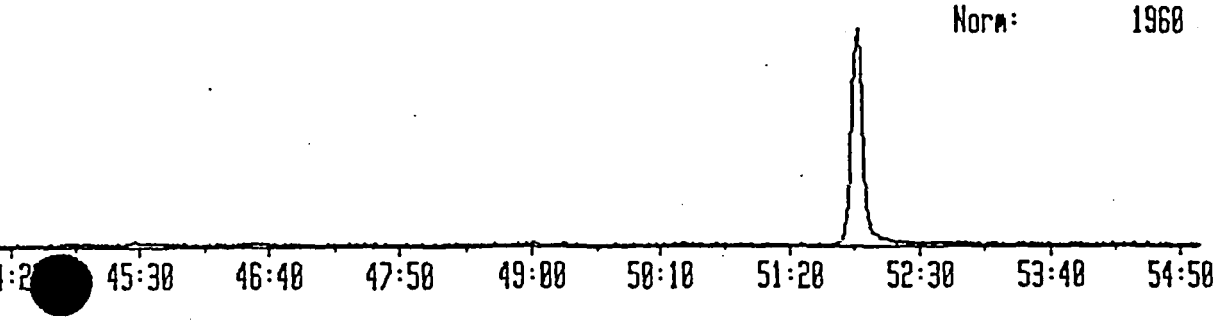
10-OCT-90 Sir:Voltage 70S Sys: DB5US
Injection 1 Group 4 Mass 469.7779
16661

Norm: 1966



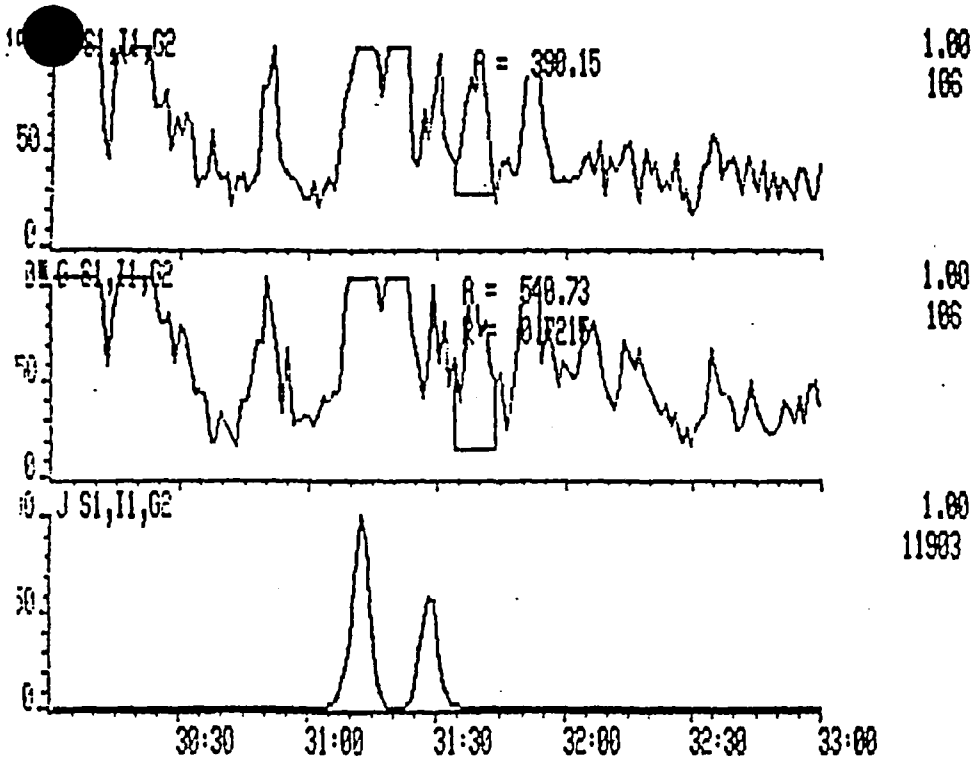
19-OCT-90 Sir:Voltage 70S Sys: DB5US
Injection 1 Group 4 Mass 471.7750
111 TLI#16661

Norm: 1960



2

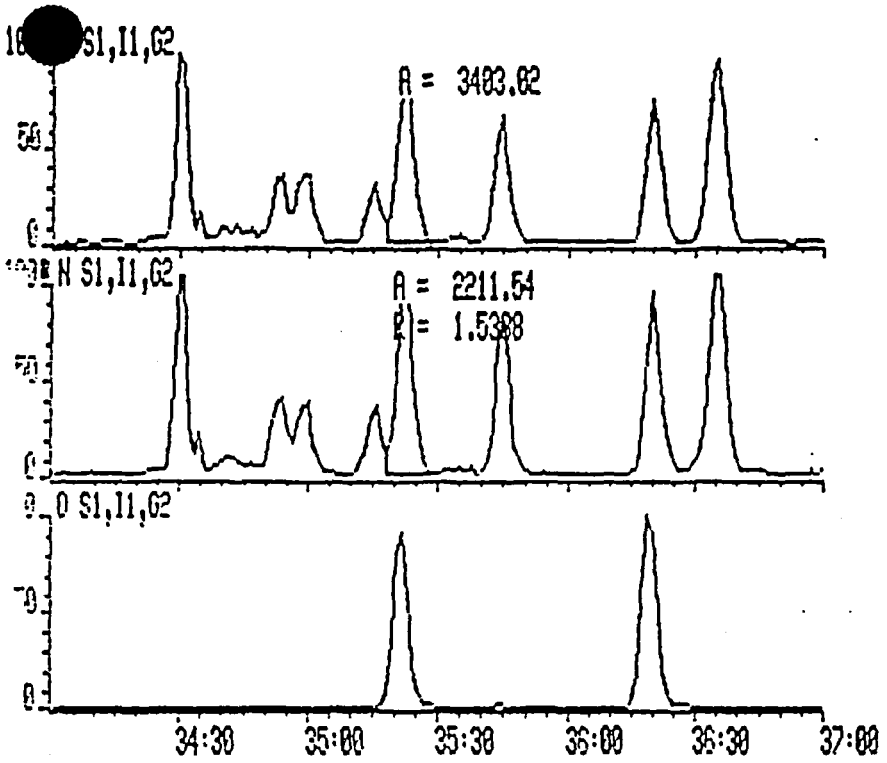
.:791 18-OCT-90 14:34 706 (EI+) Sus:D8505
2 F: 319.8955 G: 321.8336 H: 327.8847 I: 338.9732 J: 331.9368
:LF2/9111 TLI#16661



NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

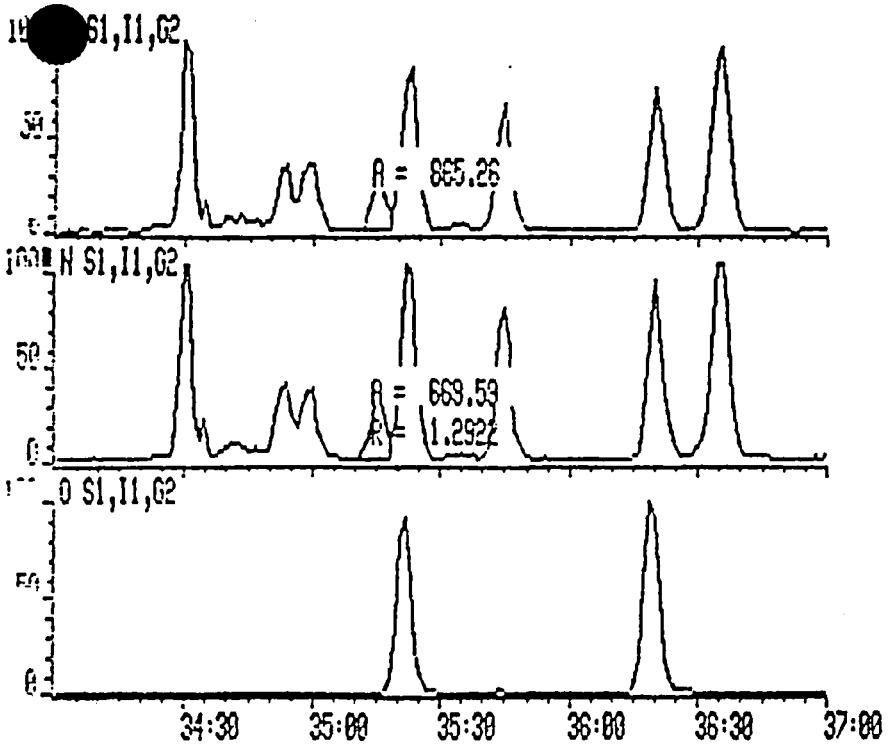
:291 18-OCT-90 14:34 70S (EI+) Sus:D55US
M: 339.8597 N: 341.8567 O: 351.9080 P: 353.8978 Q: 355.8546
:LF2/9111 TLI#16661

NOV 1 9 1990
ENVIRONMENTAL AFFAIRS



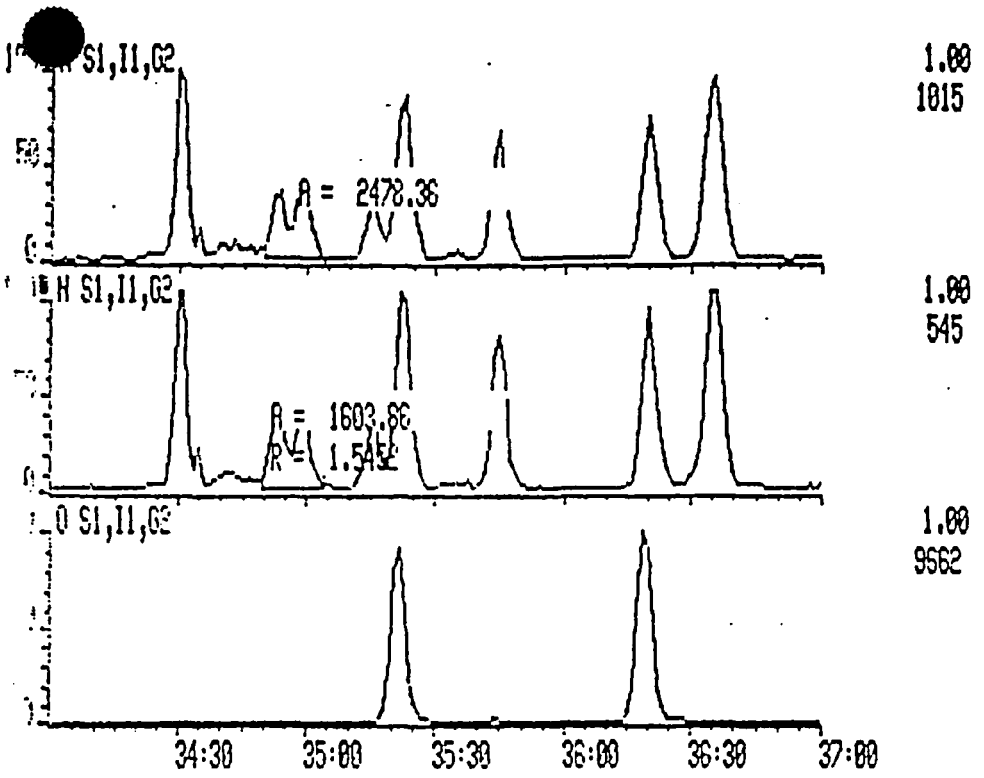
3.

[illegible]31 18-OCT-90 14:34 70S (EI+) Sus:D85U6
[illegible] M: 339.8597 N: 341.8567 O: 351.9000 P: 353.8970 Q: 355.8546
[illegible]:LF2/9111 TL1#16661



RECEIVED
NOV 19 1990
ENVIRONMENTAL AFFAIRS

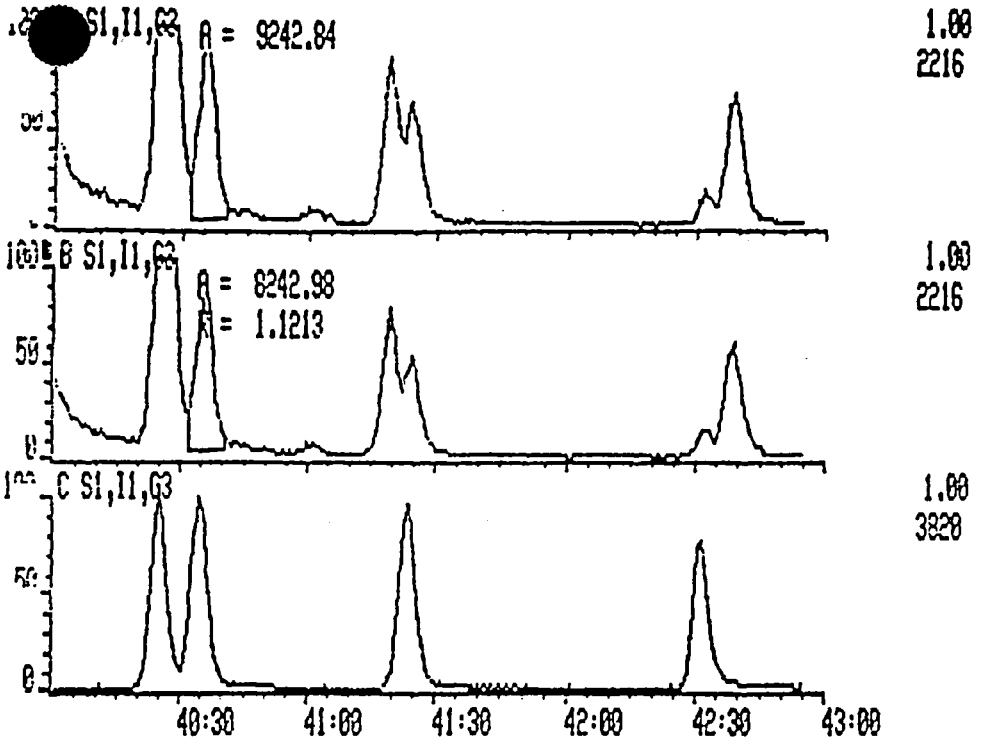
1
:91 16-OCT-90 14:34 785 (EI+) Sys:D65US
R: 335.5537 N: 341.8567 O: 351.9930 P: 353.8370 Q: 355.8546
:LF2/9111 TLI#16561



NOV 19 1993
ENVIRONMENTAL AFFAIRS

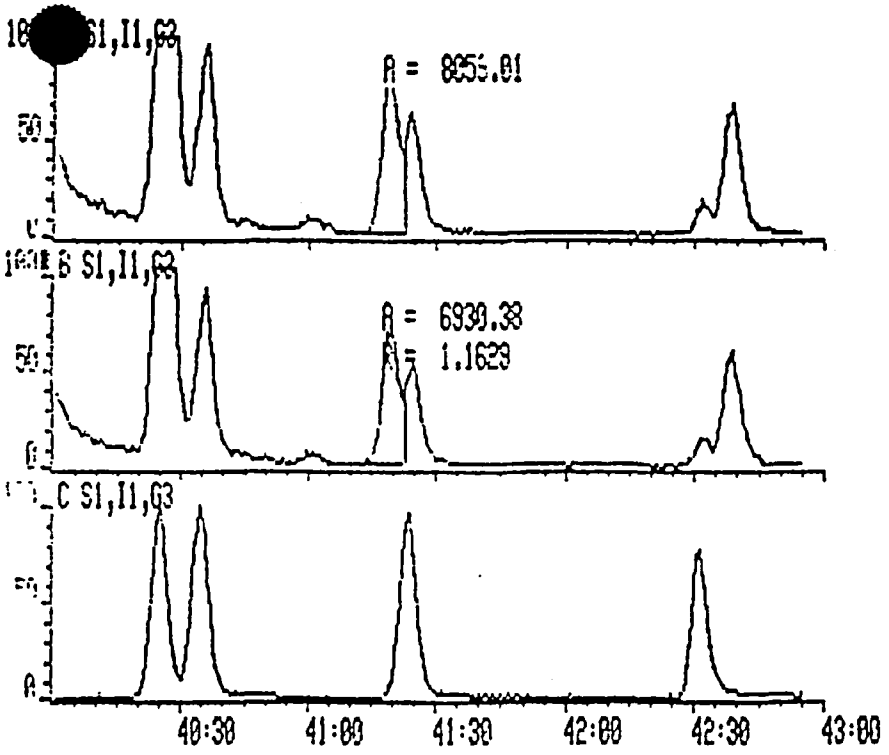
[0]31 18-OCT-90 14:34 786 (EI+) Sus:DESUS
A: 373.8288 B: 375.8178 C: 383.8639 D: 385.8610 E: 389.8156
ext:LF2/9111 TLI#16661

NOV 19 1990
ENVIRONMENTAL ANALS



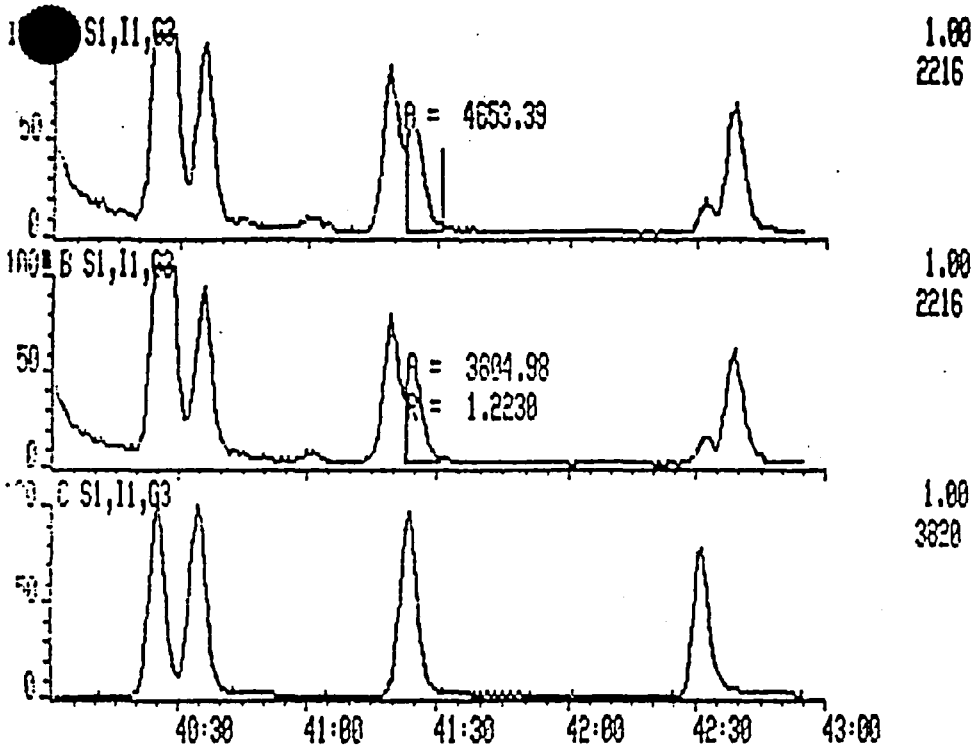
3c

791 10-OCT-90 14:34 783 (EI+) Sys:DB5US
A: 373.6288 B: 375.8178 C: 383.6639 D: 385.8510 E: 389.8156
:LF2/9111 TLI#16661



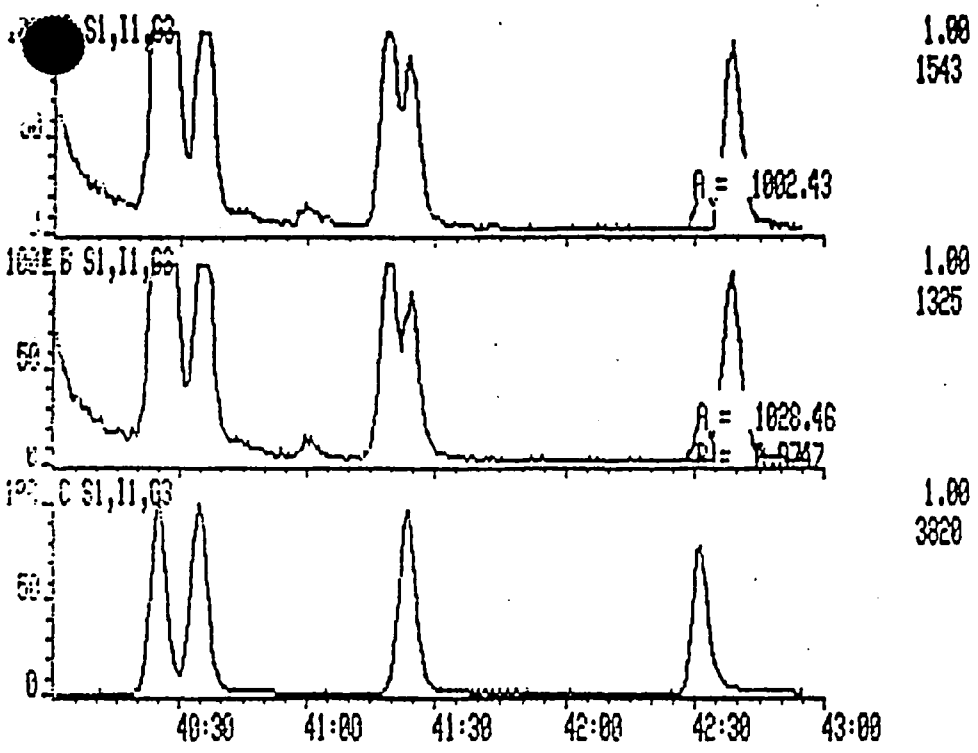
NOV 1 9 1990
ENVIRONMENTAL ANALYSIS

3291 18-OCT-90 14:34 785 (EI+) Sys:DESUS
3 A: 373.6286 B: 375.8178 C: 383.8539 D: 385.8610 E: 389.8156
Text:LF2/9111 TLI#16661



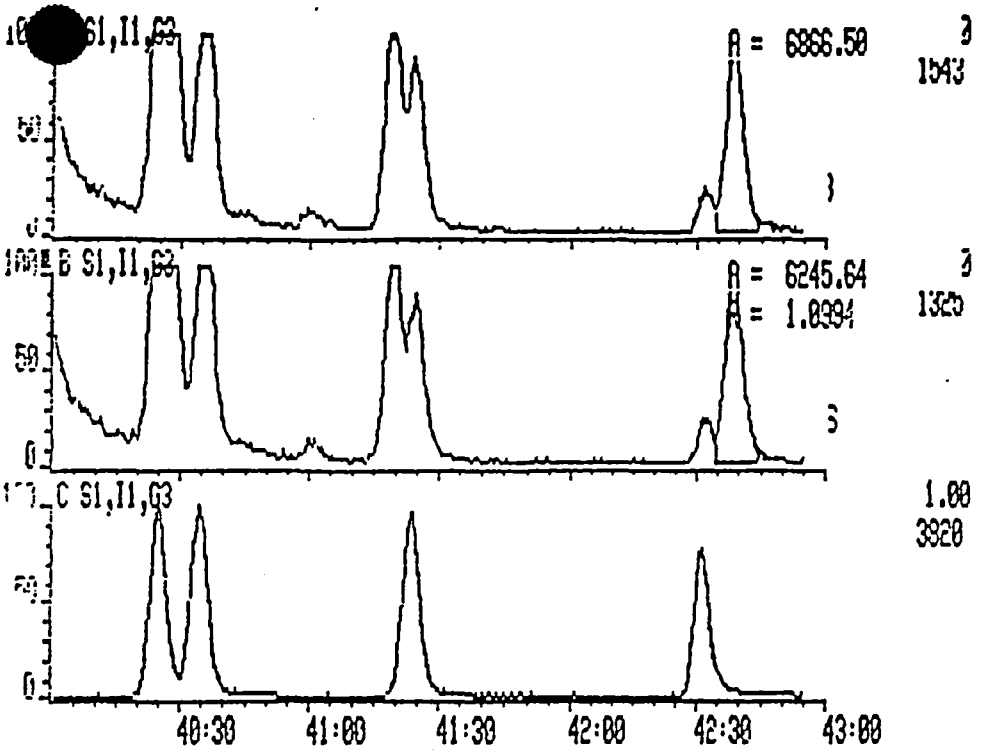
NOV 19 1990
ENVIRONMENTAL DIVISION

[illegible] 18-OCT-90 14:34 7[illegible] (EI+) Sys:D85US
A: 373.8266 B: 375.8176 C: 383.8839 D: 385.8616 E: 389.8156
Exc:LF2/5111 TL1#16661



NOV 1 9 1990
ENVIRONMENTAL ANALYS

-- 791 18-OCT-90 14:34 70S (EI+) Sus:D85US
3 A: 373.6206 B: 375.6176 C: 363.6339 D: 385.6610 E: 383.6156
Text :LF2/9111 TLI#16661



NOV 19 1990
ENVIRONMENTAL AFFAIRS

3

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b)

11/15/90

FILE NAME....: T904958 CLIENT ID....: SWP TLI NUMBER....: 37-26-2
CONCAL (VER).: T904955 SAMPLE ID....: LF2/9111 (DIL)
PROJECT NUMBER: 16661 ICAL DATE....: 10/16/90
ANALYST.....: SB ANALYSIS DATE: 11/13/90
SAMPLE SIZE..: 9.400 g SAMPLE MATRIX: SOIL SAMPLE ORIGIN: WILMINGTN
DATE RECEIVED.: 10/10/90 DATE COLLECTED: 10/09/90
SPIKE FILE...: SPX23710 SHIPMENT NO...: NC09001

NAME	CONC(ppb)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND		0.02				
12378-PeCDD	EMPC			0.06			
123478-HxCDD	0.30				1.29	41:27	
123678-HxCDD	1.9				1.22	41:35	
123789-HxCDD	1.3				1.28	42:04	
1234678-HpCDD	98.7				1.05	46:29	
OCDD	932				0.88	51:57	B
2378-TCDF	ND		0.01				
12378-PeCDF	0.07				1.58	35:11	
23478-PeCDF	ND		0.03				
123478-HxCDF	0.91				1.22	40:18	
123678-HxCDF	0.24				1.35	40:27	
234678-HxCDF	EMPC			0.45			B
123789-HxCDF	ND		0.04				
1234678-HpCDF	66.0				0.97	44:55	
1234789-HpCDF	1.1				1.12	47:10	
OCDF	83.3				0.94	52:12	
TOTAL TCDD	EMPC			0.04			
TOTAL PeCDD	0.67	3		1.2	1.57		
TOTAL HxCDD	14.3	6		14.4	1.26		
TOTAL HpCDD	573	2			1.04		
TOTAL TCDF	ND		0.01				
TOTAL PeCDF	1.2	4		1.3	1.62		
TOTAL HxCDF	34.4	6		34.8	1.20		
TOTAL HpCDF	164	3			1.02		

MSJS 11/15/90

X237_RPT rev:3.03

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b) QA/QC SUMMARY 11/15/90

FILE NAME....: T904958 CLIENT ID....: SWP TLI NUMBER....: 37-26-2
CONCAL (VER).: T904955 SAMPLE ID....: LF2/9111 (DIL)
PROJECT NUMBER: 16661 ICAL DATE....: 10/16/90
ANALYST.....: SB ANALYSIS DATE: 11/13/90
SAMPLE SIZE..: 9.400 g SAMPLE MATRIX: SOIL SAMPLE ORIGIN: WILMINGTN
DATE RECEIVED.: 10/10/90 DATE COLLECTED: 10/09/90
SPIKE FILE...: SPX23710 SHIPMENT NO...: NC09001

SURROGATE RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
37Cl-TCDD	0.77	72.7		31:11	___
13C12-PeCDF 234	0.71	67.1	1.49	36:07	___
13C12-HxCDF 478	0.59	55.4	0.51	40:16	___
13C12-HxCDD 478	0.67	62.9	1.21	41:26	___
13C12-HpCDF 789	0.36	33.5	0.40	47:09	___

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	0.62	58.2	0.52	42:24	___
13C12-HxCDF 234	0.59	55.0	0.51	41:15	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	0.81	76.4	0.85	30:21	___
13C12-2378-TCDD	0.83	78.2	0.77	31:10	___
13C12-PeCDF 123	0.64	60.2	1.50	35:09	___
13C12-PeCDD 123	0.59	55.0	1.47	36:37	___
13C12-HxCDF 678	0.51	48.3	0.51	40:26	___
13C12-HxCDD 678	0.48	44.9	1.40	41:35	___ Q RS2
13C12-HpCDF 678	0.42	39.3	0.46	44:54	___
13C12-HpCDD 678	0.39	36.7	1.15	46:28	___
13C12-OCDD	0.99	46.4	1.17	51:56	RD

MSS 11/15/90 X237_RPT rev:3.03

2

N = 13.4
(320)

	Initial	Date
B-File/Header Changes	MBS	11-15-90
Manual Integrations		
Transcription		
Dbase Corrections	MBS	11-15-90

Page No. 1 Listing of T904958B.dbf
11/14/90

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
304		0.71	27:09	48.64	T	F	0.895	
		2.35	27:44	21.14	F	F	0.914	
		0.29	27:56	35.06	F	F	0.920	
	D	0.38	28:20	48.53	F	F	0.934	S.N
		0.39	28:35	41.88	F	F	0.942	
		0.64	29:16	18.57	F	F	0.964	
		0.86	29:41	25.58	T	F	0.978	
		0.76	30:25	55.28	T	T	1.002	
304		*** Total ***		294.68	# of Peaks:		8	
316		0.85	30:21	2344.61	T	T	1.000	
316		*** Total ***		2344.61	# of Peaks:		1	
320		1.24	29:51	67.58	F	F	0.958	
		0.48	30:55	22.86	F	F	0.992	
	D	0.42	31:03	40.21	F	F	0.996	S.N
		0.38	32:20	28.05	F	F	1.037	
320		*** Total ***		158.70	# of Peaks:		4	
328		0.00	31:11	1434.90	T	T	1.001	
328		*** Total ***		1434.90	# of Peaks:		1	
332		0.85	30:57	1715.41	T	T	0.993	
		0.77	31:10	1464.78	T	T	1.000	
332		*** Total ***		3180.19	# of Peaks:		2	
340		1.59	32:41	728.06	T	F	0.930	
		1.69	34:08	549.73	T	F	0.971	
	ck	→ ~~2.22~~ 1.58	35:11	~~118.72~~ 88	~~T~~	T	1.001	
		1.63	35:34	94.65	T	F	1.012	
		3.01	36:23	137.10	F	F	1.035	
340		*** Total ***		1628.26	# of Peaks:		5	
352		1.50	35:09	880.83	T	T	1.000	
		1.49	36:07	1172.33	T	T	1.028	
352		*** Total ***		2053.16	# of Peaks:		2	
356	D	0.60	32:39	23.61	F	F	0.892	S.N
		1.53	34:13	432.71	T	F	0.934	
		2.73	34:49	106.87	F	F	0.951	
		1.55	35:09	65.63	T	F	0.960	
		1.63	35:20	66.18	T	F	0.965	
		0.80	35:34	79.52	F	F	0.971	
		1.05	35:55	123.91	F	F	0.981	
	D	0.92	36:12	18.72	F	F	0.989	S.N
		0.58	36:38	46.64	F	T	1.000	
	D	1.10	36:49	46.49	F	F	1.005	S.N
		[illegible]	[illegible]	[illegible]	F	F	1.019	

R.O. [illegible]

3

NOV 19 1993

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
356		*** Total ***		1057.09	# of Peaks:		11	
368		1.47	36:37	549.82	T	T	1.000	
368		*** Total ***		549.82	# of Peaks:		1	
374		1.09	38:46	2569.86	T	F	0.959	
		1.17	38:58	9195.60	T	F	0.964	
	D	2.16	39:27	42.80	F	F	0.976	S.N
	D	2.46	39:27	41.17	F	F	0.976	S.N
		1.17	39:41	28953.17	T	F	0.981	
		1.22	40:18	1254.38	T	T	0.997	
	ck →	~~1.51~~ 1.35	40:27	~~388.93~~ 361	T ~~F~~	T	1.000	
R.O ck →		1.02	41:11	486.21	F	T	1.019	
flat D →		1.41	42:26	47.33	T	T	1.049	S.N
		1.21	42:32	260.48	T	~~F~~	~~1.052~~ 1.053	
374		*** Total ***		43239.93	# of Peaks:		10	
384		0.51	40:16	992.13	T	T	0.996	
		0.51	40:26	1045.01	T	T	1.000	
		0.51	41:15	1034.41	T	T	1.020	
		0.52	42:24	978.50	T	T	1.049	
384		*** Total ***		4050.05	# of Peaks:		4	
390		1.27	39:34	8128.57	T	F	0.952	
	D	0.31	39:56	33.14	F	F	0.960	S.N
		1.25	40:16	769.60	T	F	0.968	
		1.27	40:37	5540.13	T	F	0.977	
		1.23	40:51	1718.12	T	F	0.982	
		1.29	41:27	213.82	T	T	0.997	
		1.22	41:35	1656.17	T	T	1.000	
		1.28	42:04	820.15	T	T	1.012	
	D	1.74	42:11	26.67	F	T	1.014	S.N
390		*** Total ***		18906.37	# of Peaks:		9	
402		1.21	41:26	666.76	T	T	0.996	
		1.40	41:35	751.00	T	T	1.000	
		1.25	42:03	1496.79	T	T	1.011	Q RS2
402		*** Total ***		2914.55	# of Peaks:		3	
408		0.97	44:55	80306.62	T	T	1.000	
		0.98	45:31	82164.18	T	F	1.014	
	D	1.44	46:28	282.36	F	F	1.035	N/+
		1.12	47:10	889.77	T	T	1.050	
408		*** Total ***		163642.93	# of Peaks:		4	
418		0.46	44:54	665.73	T	T	1.000	
		0.28	45:54	63.62	F	F	1.022	
		0.40	47:09	442.12	T	T	1.050	
		0.46	48:18	28.89	T	F	1.076	
418		*** Total ***		1200.36	# of Peaks:		4	
424		1.03	45:22	252355.41	T	F	0.976	
		1.05	46:29	52514.15	T	T	1.000	

NOV 19 1990

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat.	Match RT	REL_RT	Who/ Why
424		*** Total ***		304869.56	# of Peaks:		2	
436		1.15	46:28	463.06	T	T	1.000	
		0.84	46:44	26.77	F	F	1.006	
436		*** Total ***		489.83	# of Peaks:		2	
442		0.94	52:12	41400.75	T	T	1.005	
		0.67	53:48	57.82	F	F	1.036	
442		*** Total ***		41458.57	# of Peaks:		2	
458		0.88	51:57	438953.61	T	T	1.000	
458		*** Total ***		438953.61	# of Peaks:		1	
470 R.O.E. →		1.17	51:56	598.29	~~F~~T	T	1.000	
470		*** Total ***		598.29	# of Peaks:		1	

*** End of Report ***

Listing of T904958I.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
202	10:38	14.03	14:37	12.41	16:47	15.16	19:37	13.78
	10:59	20.21	14:44	22.06	17:08	33.60	19:49	21.48
	12:10	29.49	14:52	46.66	17:23	45.63	20:06	47.16
	12:31	19.71	15:38	14.81	17:40	29.54	20:54	9.60
	13:27	25.88	15:47	11.77	17:48	35.78	21:03	11.72
	13:45	9.61	16:05	23.19	17:57	17.51		
	14:00	24.86	16:21	30.38	18:30	18.77		
	14:22	11.01	16:35	20.82	18:54	11.76		
204	10:30	25.02	13:20	15.25	16:11	25.92	18:46	23.82
	10:46	16.96	13:52	36.93	16:20	19.24	19:11	23.42
	11:11	25.72	14:03	36.65	16:28	7.28	19:30	32.30
	11:41	10.17	14:20	57.08	16:42	32.36	19:38	20.34
	12:16	16.93	14:28	11.91	17:04	8.03	19:54	51.90
	12:28	12.96	14:37	10.18	17:14	8.96	20:05	8.31
	12:36	13.06	14:47	14.70	17:40	8.07	20:17	37.56
	13:01	19.68	14:55	8.56	18:30	39.28	20:40	14.30
	13:13	37.47	15:24	55.34	18:38	41.00	20:56	17.75
238	17:23	11.59	19:01	19.24	20:35	9.60	21:46	10.57
	17:29	14.57	19:18	23.31	21:15	10.69	22:09	10.68
	17:46	26.76	19:40	10.44	21:25	10.94		
240	17:38	22.79	18:16	8.08	19:38	8.01	20:49	19.38
	17:44	21.87	18:29	22.40	20:24	33.99	22:18	13.29
	18:00	32.27	19:22	18.33	20:36	7.89		
252	18:09	41.13	19:00	13.45	19:51	15.96	22:10	27.48
	18:17	13.89	19:16	34.58	20:46	26.19	22:23	43.75
	18:37	98.43	19:28	45.01	21:42	65.42	22:46	43.55
	18:50	20.95	19:42	79.56	21:51	94.96		
254	18:37	15.95	19:55	19.66	21:04	15.75	21:39	9.61
	19:00	8.20	20:31	9.01	21:11	17.18	21:55	29.90
	19:38	11.97	20:57	23.22	21:22	21.90	22:51	12.12
270	22:06	12.29	23:08	15.01	24:45	10.28		
	23:00	8.41	24:34	11.71				
272	24:06	21.13	24:26	9.29	24:41	19.93		
286	23:13	7.14	24:44	7.02	25:28	12.12	25:57	7.17
218	11:39	55.66	15:06	63.94	17:12	128.42	20:09	32.22
	12:16	34.40	15:33	67.85	17:27	48.24	20:34	112.99
	12:52	67.21	15:48	74.51	17:41	89.94	21:00	61.30
	13:35	44.67	15:58	62.92	18:40	125.86		
	14:22	123.28	16:36	90.68	19:20	169.47		
	14:47	52.63	16:53	27.62	19:56	40.79		
220	11:24	20.91	13:06	43.56	14:40	37.90	16:13	30.05
	11:40	19.53	13:17	11.76	14:57	33.75	16:26	45.07

Listing of T904958I.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
220	18:15	40.46	20:02	22.97	20:43	40.98	21:15	50.81
	18:38	9.27	20:31	31.99	21:02	15.44	21:39	53.00
304	27:09	20.19	28:35	11.66	31:17	10.12	33:21	10.98
	27:24	7.36	28:53	14.24	31:30	17.10	34:15	7.67
	27:44	14.83	29:16	7.28	32:15	12.54		
	27:56	7.90	29:41	11.84	32:43	8.96		
	28:20	13.27	30:25	23.93	33:02	10.08		
306	27:09	28.45	28:58	41.58	30:36	9.83	33:45	10.18
	27:16	9.75	29:17	11.29	32:02	12.52	33:57	6.80
	27:42	6.31	29:35	11.62	32:21	9.39	34:05	14.98
	27:55	27.16	29:41	13.74	32:39	14.89		
	28:22	35.26	29:52	9.58	32:55	8.80		
	28:35	30.22	30:24	31.35	33:16	7.63		
320	28:29	7.07	30:08	19.70	31:11	6.55	34:14	33.61
	29:06	8.08	30:55	7.44	31:58	7.28	34:21	7.01
	29:51	37.36	31:03	11.90	32:20	7.65	34:43	14.12
322	28:52	7.77	30:04	24.79	31:15	7.78	32:35	10.70
	29:10	10.17	30:57	15.42	32:01	6.64	32:45	7.27
	29:52	30.22	31:04	28.31	32:18	20.40	34:11	49.40
340	31:18	9.53	34:08	345.02	35:11	81.84	36:23	102.91
	32:41	447.42	34:31	8.08	35:24	9.04	36:38	18.50
	33:05	14.85	34:40	24.55	35:34	58.64	37:27	20.01
	33:58	13.38	34:48	28.00	36:09	44.25		
342	32:19	11.15	34:08	204.71	35:52	9.56	38:10	16.10
	32:41	280.64	34:45	45.76	36:06	27.29		
	33:12	6.95	35:11	36.88	36:23	34.19		
	33:22	6.62	35:34	36.01	37:18	9.11		
356	32:39	8.87	34:13	261.64	35:34	35.36	36:38	17.09
	32:56	11.60	34:49	78.19	35:47	28.90	36:49	24.37
	33:11	7.95	35:09	39.91	35:55	63.58	36:57	6.14
	33:33	9.61	35:20	41.04	36:12	8.98	37:19	20.26
358	32:39	14.74	34:49	28.68	36:11	9.74	37:41	10.36
	32:50	6.61	35:07	25.72	36:20	7.70	38:06	7.55
	33:06	7.80	35:20	25.14	36:37	29.55		
	34:11	171.07	35:35	44.16	36:47	22.12		
	34:33	17.48	35:57	60.33	37:18	26.55		
316	30:21	1076.68						
318	30:21	1267.93						
328	31:11	1434.90						
332	30:57	787.02	31:10	637.97				

NOV 19 1990

Listing of T9049581.dbf File
Raw Mass, Retention Time and Data Area

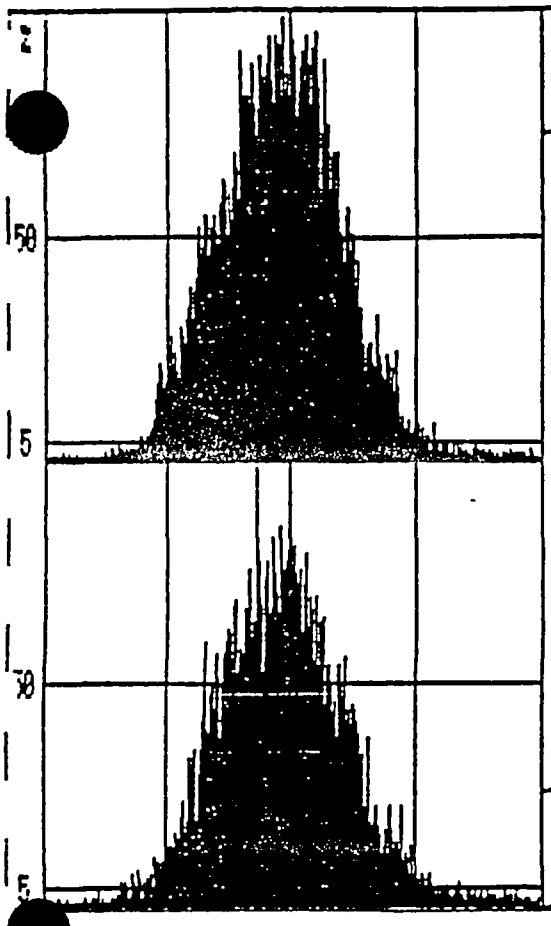
M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
334	30:57	928.39	31:10	826.81	31:53	25.10		
352	35:09	528.98	35:32	32.16	36:07	701.75		
354	35:09	351.85	36:07	470.58				
368	36:37	327.41						
370	36:37	222.41						
374	38:46	1339.91	39:41	15628.36	40:27	233.88	41:34	10.44
	38:58	4953.80	40:04	14.06	40:53	9.96	42:26	27.69
	39:27	29.27	40:18	688.55	41:11	245.81	42:32	142.87
376	38:46	1229.95	39:29	11.90	40:09	7.04	41:11	240.40
	38:58	4241.80	39:41	13324.81	40:17	565.83	42:24	19.64
	39:26	13.53	40:01	24.00	40:27	155.05	42:33	117.61
390	39:34	4555.03	40:37	3095.13	41:10	13.55	42:04	460.71
	39:56	7.79	40:51	947.54	41:27	120.29	42:11	16.95
	40:16	427.82	41:04	11.32	41:35	909.50	43:00	8.25
392	39:34	3573.54	40:36	2445.00	41:18	6.43	42:04	359.44
	39:45	19.89	40:51	770.58	41:28	93.53	42:11	9.72
	39:55	25.35	41:00	8.76	41:35	746.67	42:33	6.07
	40:16	341.78	41:07	10.81	41:50	12.84		
384	40:16	333.63	40:26	354.57	41:15	351.33	42:24	335.74
386	40:16	658.50	40:26	690.44	41:15	683.08	42:24	642.76
402	41:26	365.21	41:35	438.18	42:03	831.93		
404	41:27	301.55	41:34	312.82	42:03	664.86		
408	44:16	11.01	46:11	114.99	47:33	16.14		
	44:55	39513.21	46:28	166.63	47:51	19.98		
	45:31	40646.72	47:10	470.16	48:44	14.21		
410	44:55	40793.41	46:06	142.29	46:49	13.36	48:11	12.97
	45:31	41517.46	46:29	115.73	47:10	419.61		
418	43:45	10.44	45:10	16.16	45:54	13.97	48:18	9.12
	44:54	209.79	45:35	11.09	47:09	125.39		
420	44:21	9.14	45:23	18.29	47:09	316.73	48:18	19.77
	44:54	455.94	45:53	49.65	47:31	17.36		
424	45:22	128149.73	48:38	10.42	50:26	12.28		
	46:29	26872.76	49:18	23.15				
426	45:22	124205.68	47:07	143.14	47:55	31.35	49:21	10.72
	46:13	188.17	47:20	61.67	48:13	9.49		
	46:29	25641.39	47:34	22.03	48:23	15.58		

NOV 19 1990
ENVIRONMENTAL AFFAIRS

Listing of T904958I.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
436	46:28	247.36	46:44	12.21	47:02	13.78		
438	46:28	215.70	46:44	14.56				
442	48:12	10.70	51:30	14.03	53:33	51.41		
	48:23	10.63	52:12	20022.12	53:48	23.29		
	49:14	15.86	53:03	74.05	54:11	10.71		
444	49:53	10.84	52:11	21378.63	53:18	53.73	53:37	15.41
	50:33	9.43	53:00	82.01	53:27	26.41	53:50	34.53
458	51:57	205505.03	53:27	213.17	54:15	17.77		
	53:01	247.39	53:36	241.84				
460	51:57	233448.58	53:23	558.43				
470	51:14	9.67	52:11	11.73	52:53	16.40		
	51:56	323.01	52:28	15.98				
472	49:57	17.10	51:56	275.28				

*** End of Report ***



Ref. mass 292.9825 Peak top
Height 3.70 volts Span 200 ppm

System file name	D85US
Data file name	A:T904958
Resolution	10000
Group number	2
Ionization mode	EI+
Switching	VOLTAGE
Ref. masses	292.9825, 416.9760

A	293	J	332	S	368
B	304	K	334	T	370
C	306	L	338	U	376
D	316	M	340	Y	410
E	318	N	342		
F	320	O	352		
G	322	P	354		
H	328	Q	356		
I	331	R	358		

Channel I 330.9792 Peak top
Height 2.22 volts Span 200 ppm

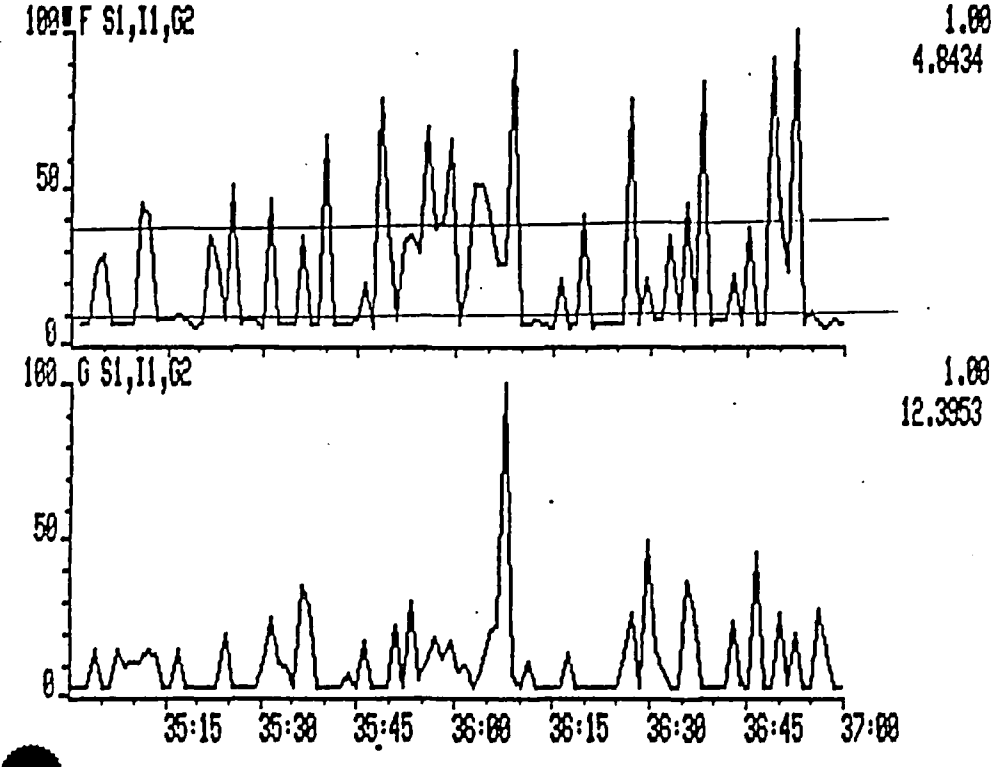
NOV 1 9 1990
ENVIRONMENTAL ASSAYS

NOV 1 0 1990

T904958 13-NOV-90 22:44 70-2506 (EI+) Sys:D85US
GR 2 F: 319.8965 G: 321.8936 H: 327.8847 I: 330.9792 J: 331.9368
Inst:LFI/9111 TLI#16661

Verified by (GC/MS) : CD 11-14

Verified by (Int. QC) : DB 11/14



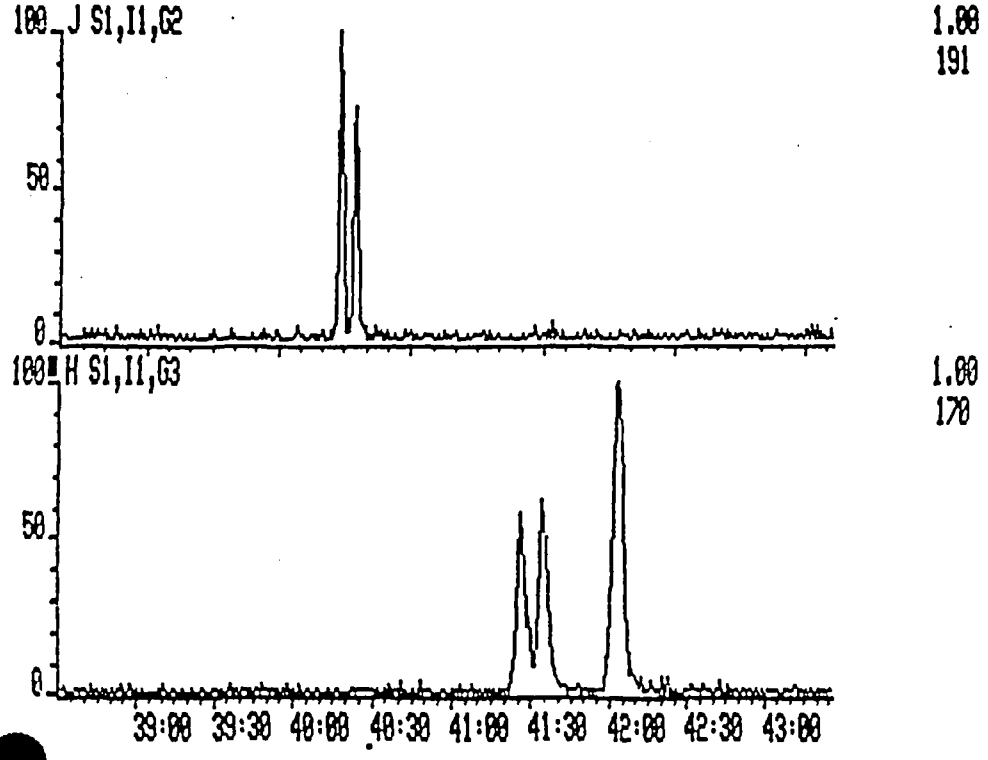
HpCDF OK
DB 11/14/90

N= ~28 22x 5 x 4.8 = 13.4

MJS
11-15-90

11

T994958 13-NOV-90 22:44 70-2505 (EI+) Sus:D85US
GR 3 F: 391.8127 G: 392.9760 H: 401.8558 I: 403.8529 J: 430.9729
:LFI/9111 TLI#16661

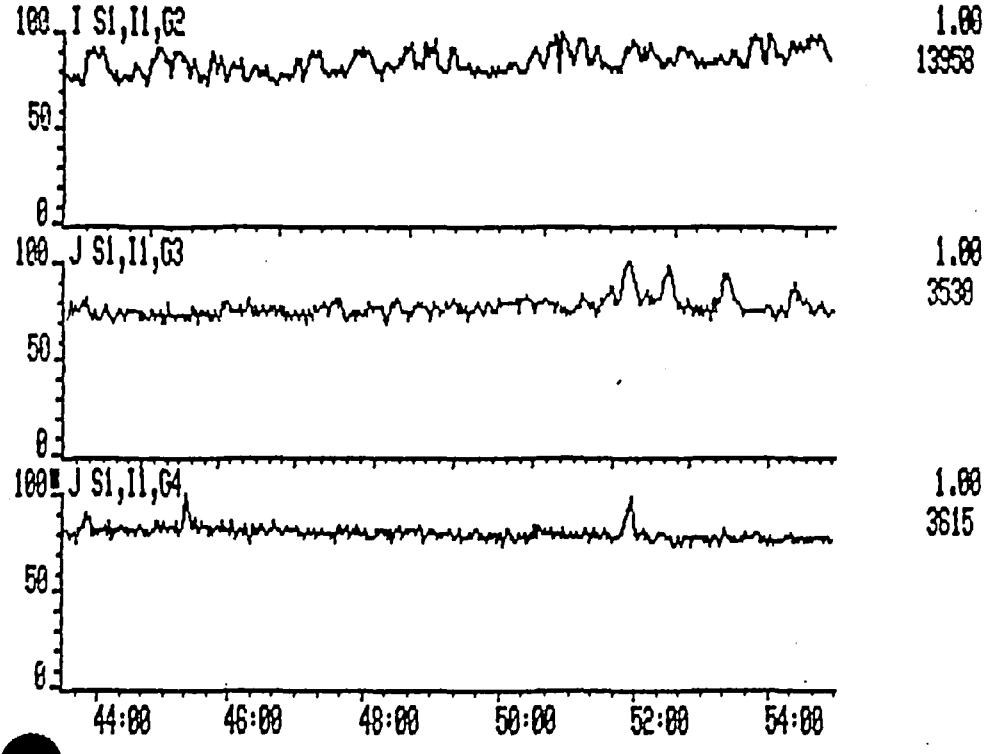


NOV 19 1990
ENVIRONMENTAL AFFAIRS

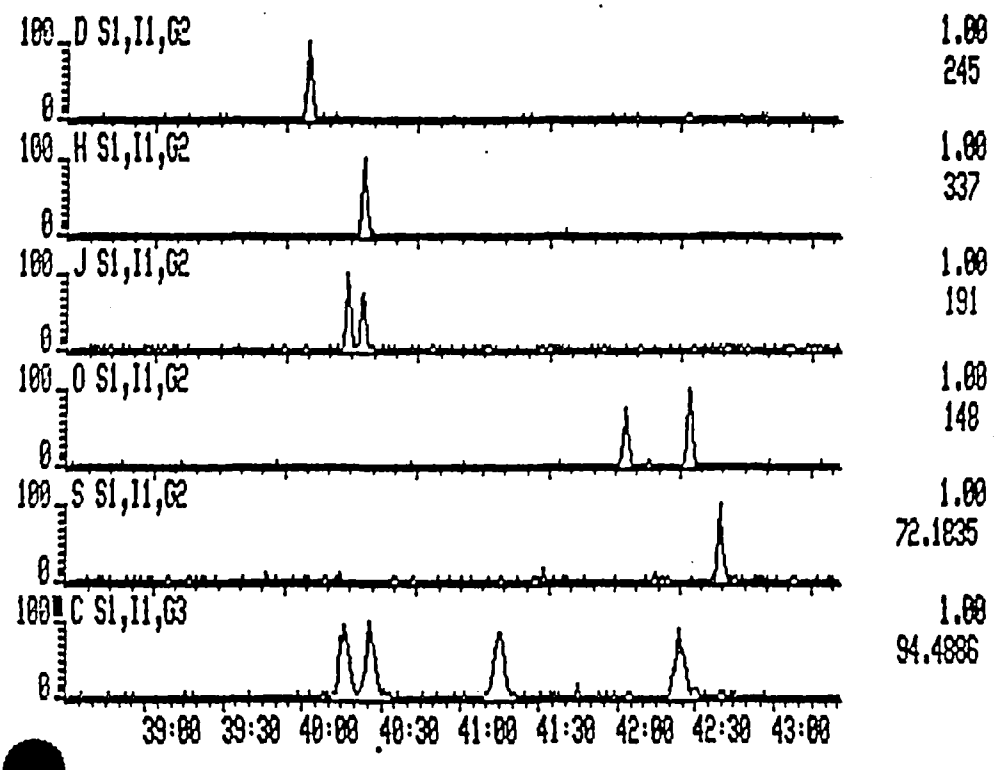
10

T904558 13-NOV-90 22:44 70-250S (EI+) Sus:D85US
R 4 D: 419.8228 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
LFI/9111 TLI#16661

NOV 19 1990
...TAL AFFAIRS

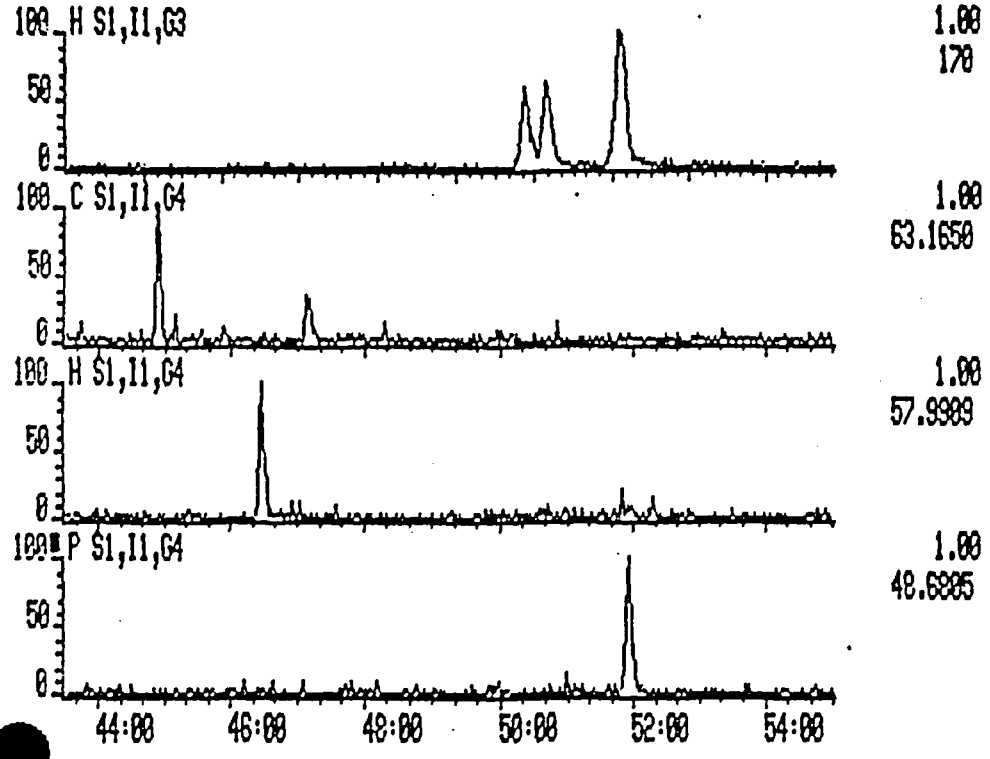


T994958 13-NOV-90 22:44 70-258S (EI+) Sus:D85US
#: 3 D: 385.8610 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558
Lab:LFI/9111 TLI#16661



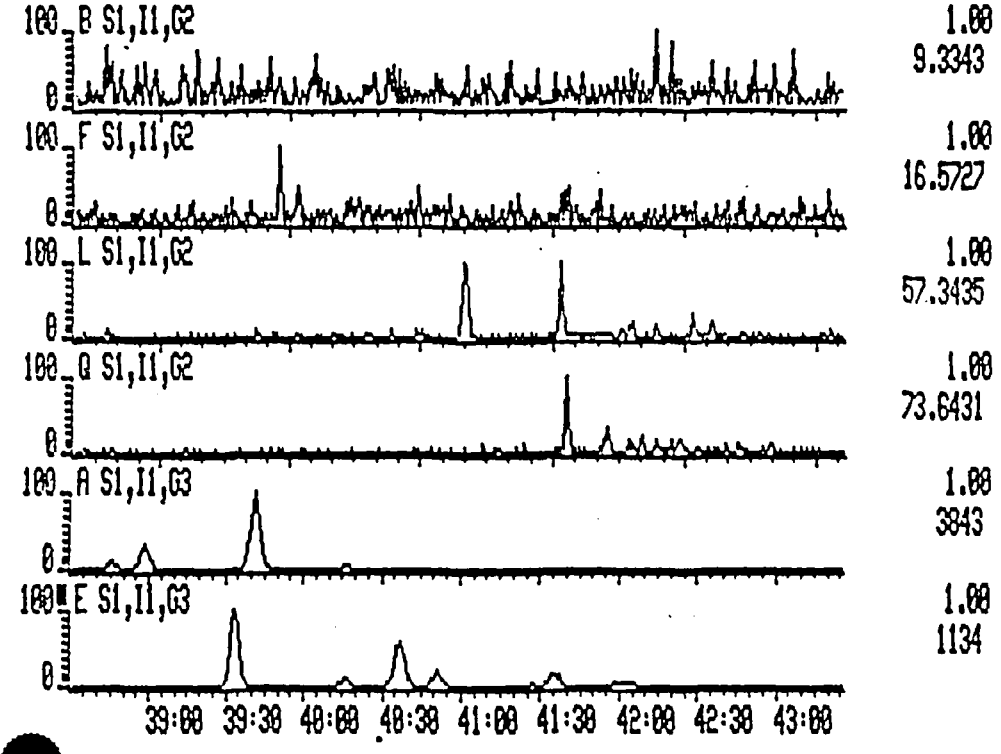
NOV 19 1990
ENVIRONMENTAL LABS

T904958 13-NOV-90 22:44 70-250S (EI+) Sys:D85US
GR 4 D: 419.8220 E: 423.7760 F: 425.7737 G: 430.9729 H: 435.8169
:LFI/3111 TLI#16661



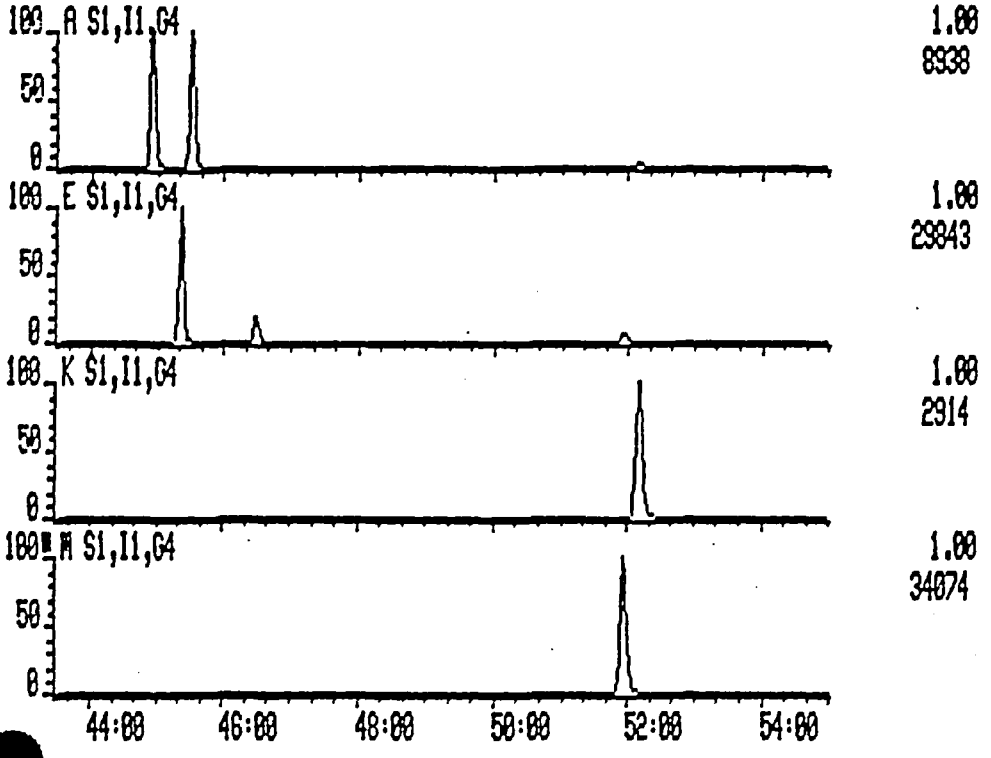
NOV 19 1990
ENVIRONMENTAL AFFAIRS

T904958 13-NOV-90 22:44 70-250S (EI+) Sys:D85US
GR 3 D: 385.8610 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558
Inst:LFI/9111 TLI#16661



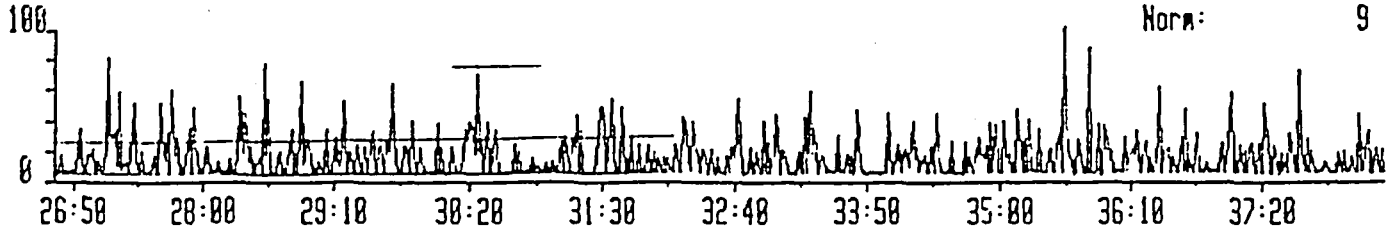
NOV 19
ENVIRONMENTAL

T984358 13-NOV-98 22:44 70-250S (EI+) Sus:D85US
3R 4 D: 419.8228 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
:LFI/9111 TLI#16661

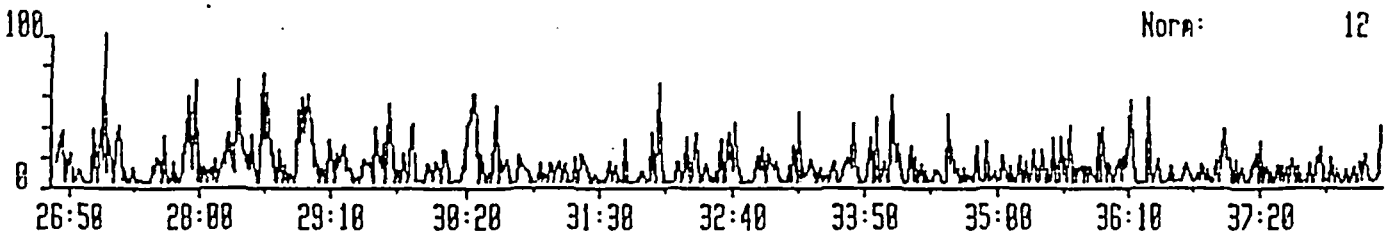


NOV 19 1998
ENVIRONMENTAL AFFAIRS

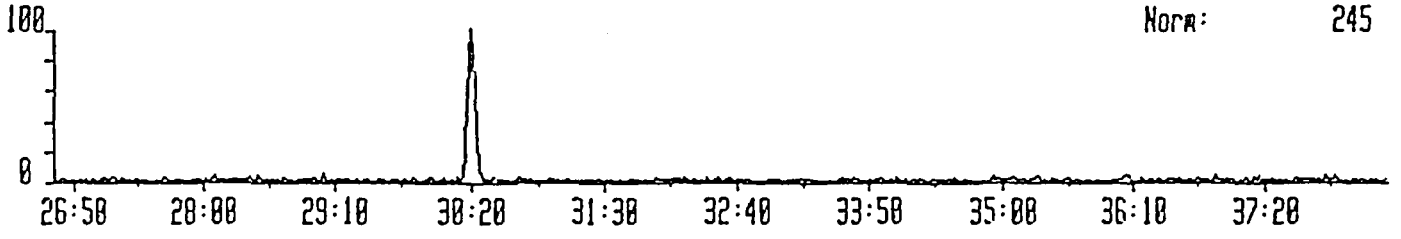
T984958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 303.9816
Text:LFI/9111 TLI#16661



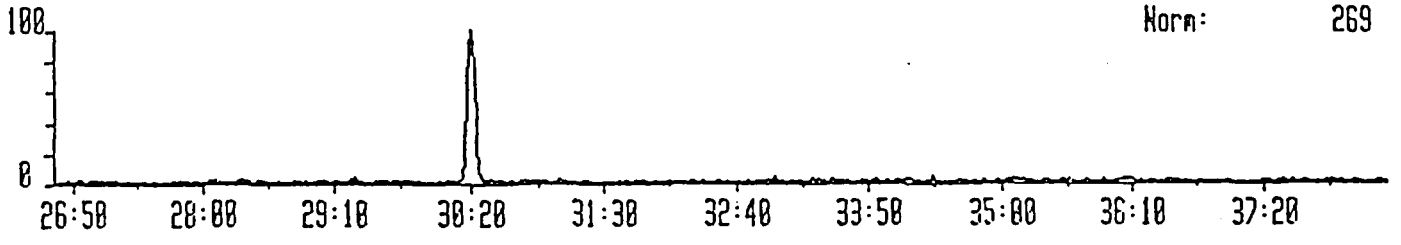
T984958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 305.8987
Text:LFI/9111 TLI#16661



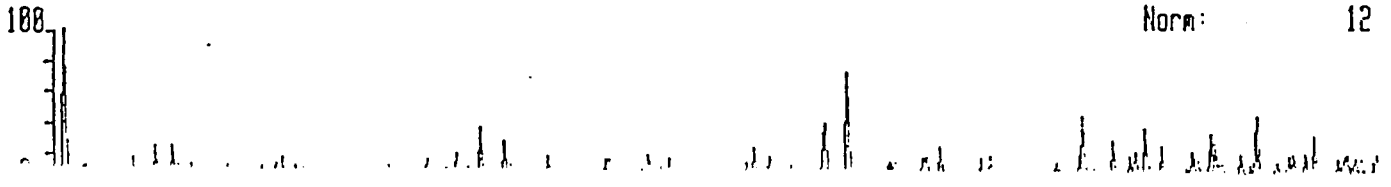
T984958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 315.9419
Text:LFI/9111 TLI#16661



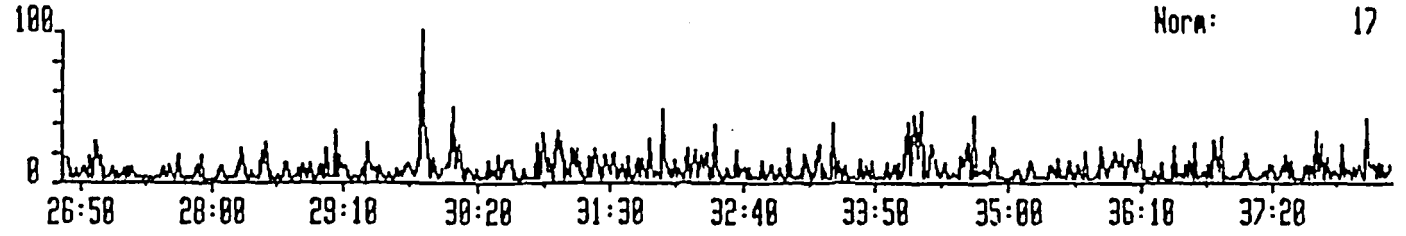
T984958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 317.9389
Text:LFI/9111 TLI#16661



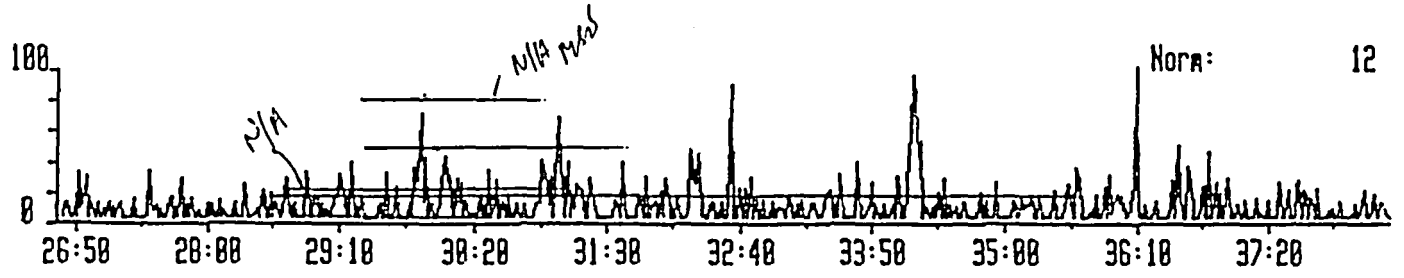
T984958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 375.8364
Text:LFI/9111 TLI#16661



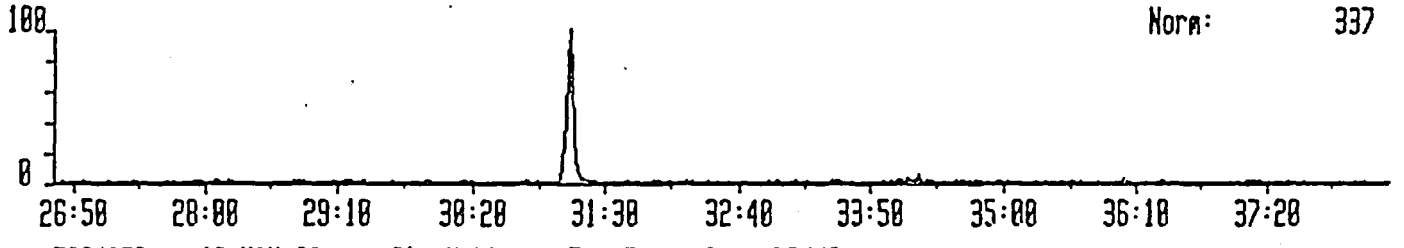
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 319.8965
Text:LFI/9111 TLI#16661



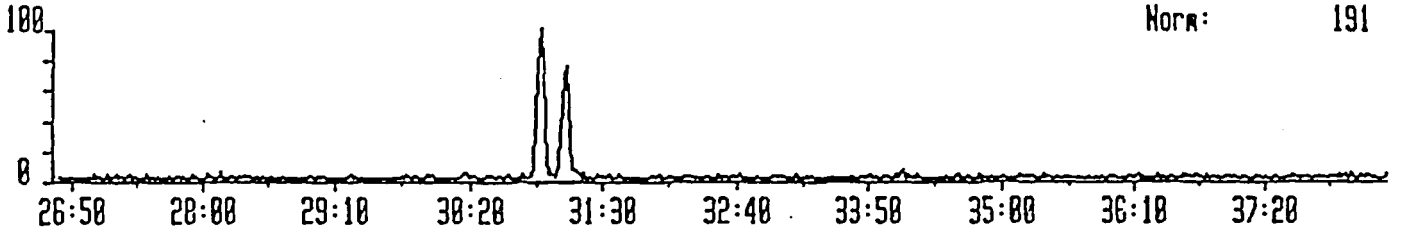
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 321.8936
Text:LFI/9111 TLI#16661



T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 327.8847
Text:LFI/9111 TLI#16661

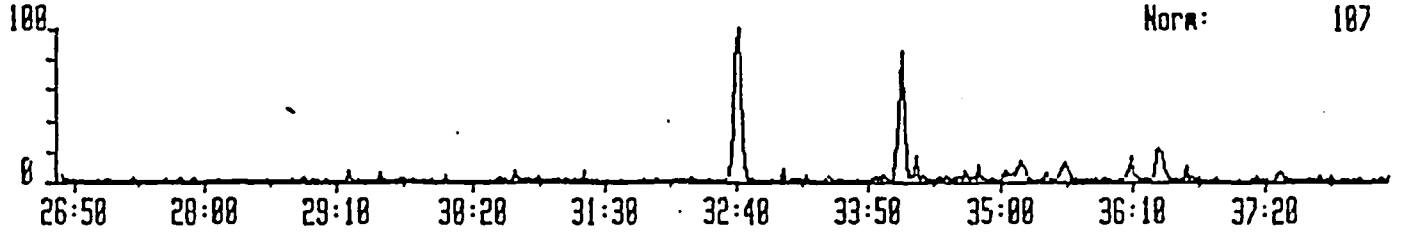


T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 331.9368
Text:LFI/9111 TLI#16661

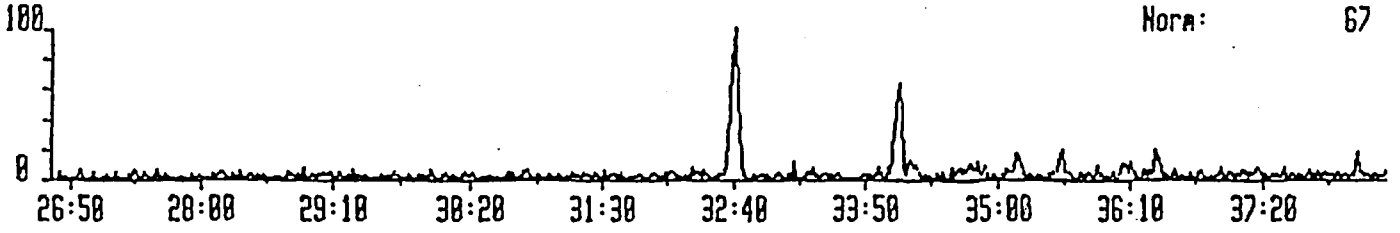


T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 333.9338
Text:LFI/9111 TLI#16661

T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 339.8597
Text:LFI/9111 TLI#16661



T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 341.8567
Text:LFI/9111 TLI#16661



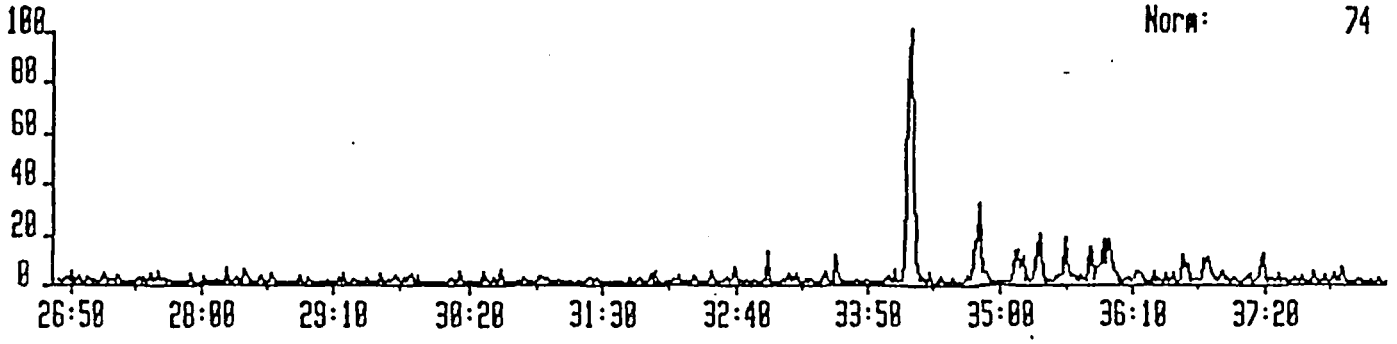
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 351.9000
Text:LFI/9111 TLI#16661

T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 353.8970
Text:LFI/9111 TLI#16661

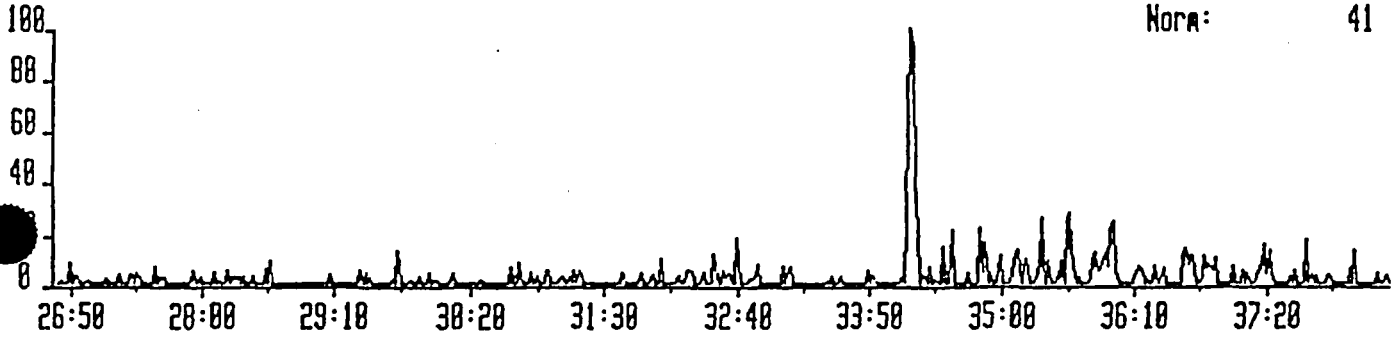
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 409.7974
Text:LFI/9111 TLI#16661

2

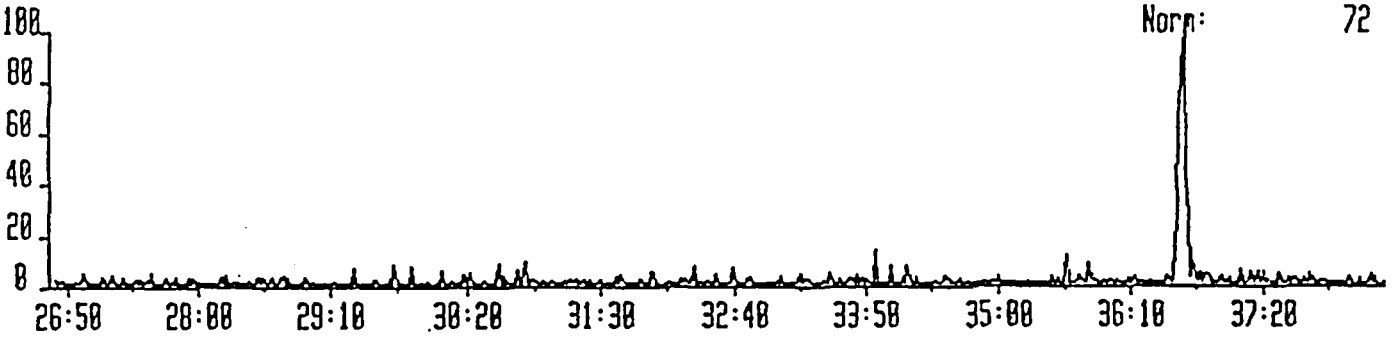
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 355.0546
Text:LFI/9111 TLI#16661



T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 357.0516
Text:LFI/9111 TLI#16661

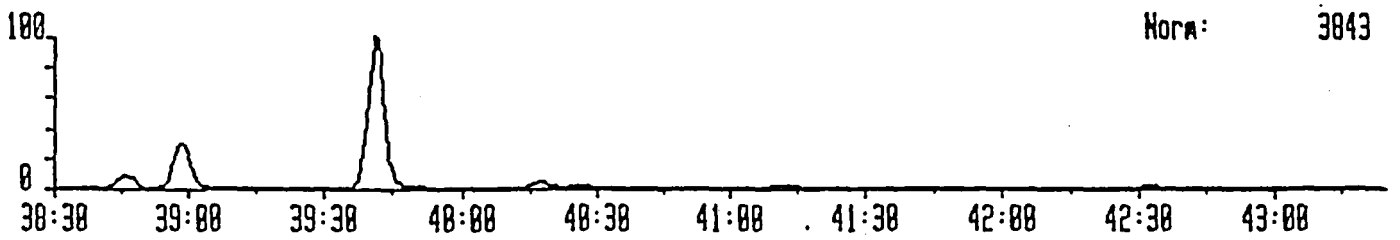


T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 367.0949
Text:LFI/9111 TLI#16661

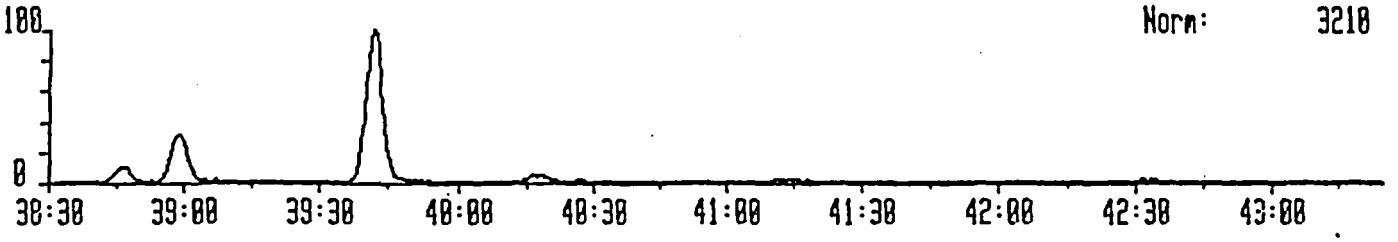


T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 369.0919
Text:LFI/9111 TLI#16661

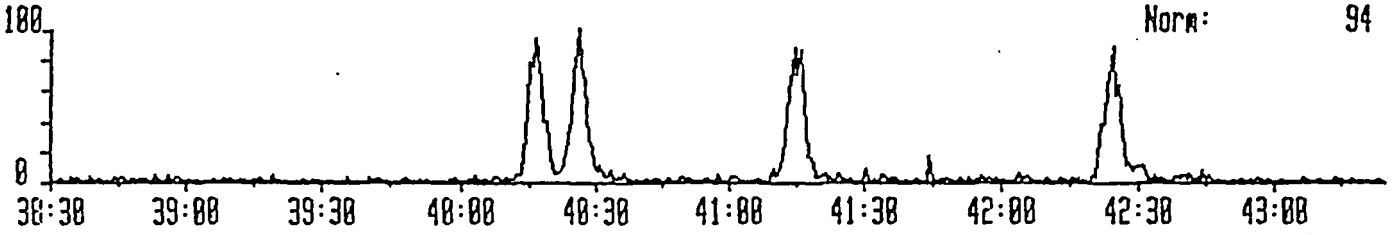
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 373.0200
Text:LFI/9111 TLI#16661



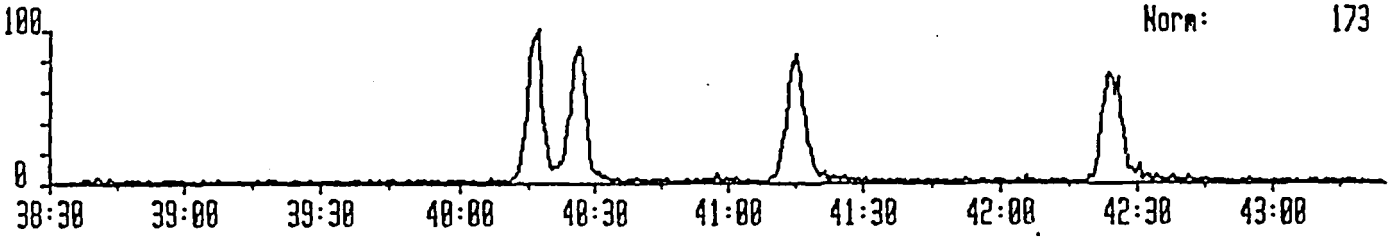
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 375.8170
Text:LFI/9111 TLI#16661



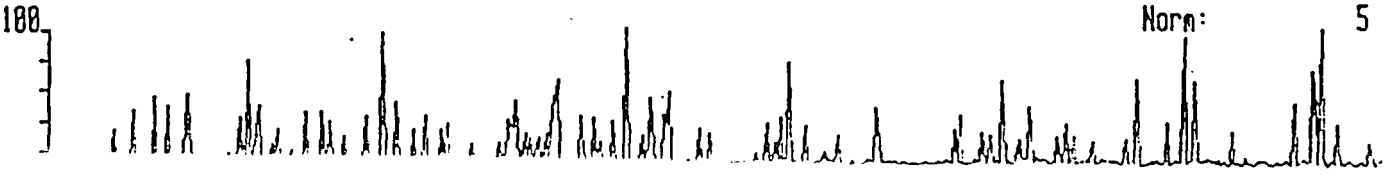
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 383.8639
Text:LFI/9111 TLI#16661



T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 385.8610
Text:LFI/9111 TLI#16661

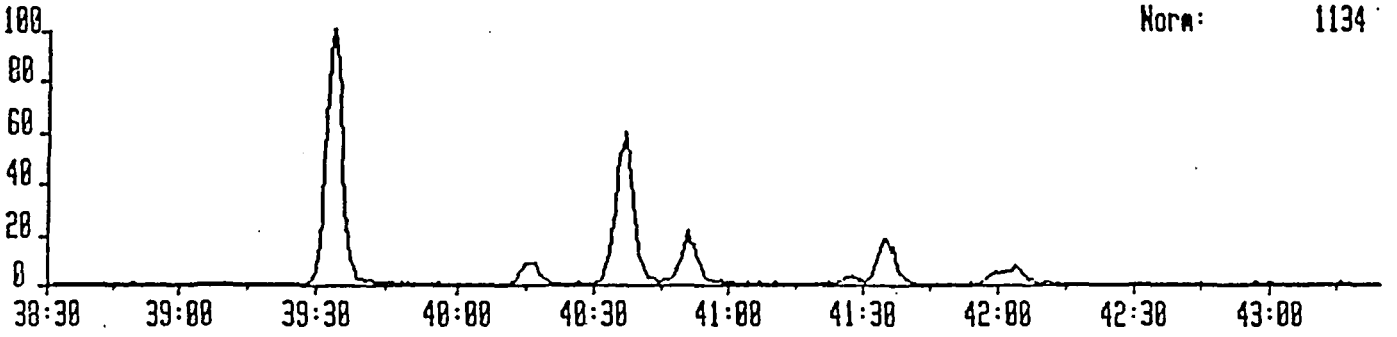


T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 445.7555
Text:LFI/9111 TLI#16661



2

T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 389.8156
Text:LFI/9111 TLI#16661



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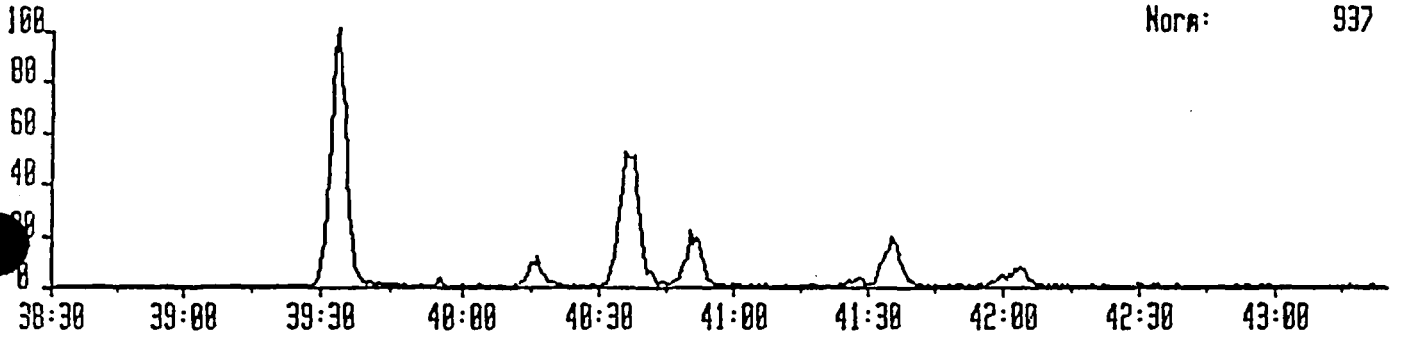
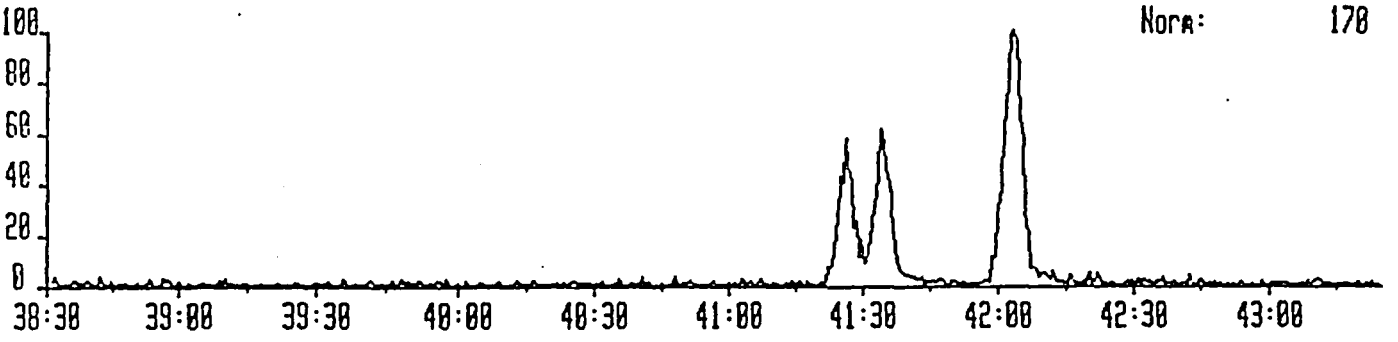
Sample 1 Injection 1 Group 3 Mass 391.8127
Text:LFI/9111 TLI#16661



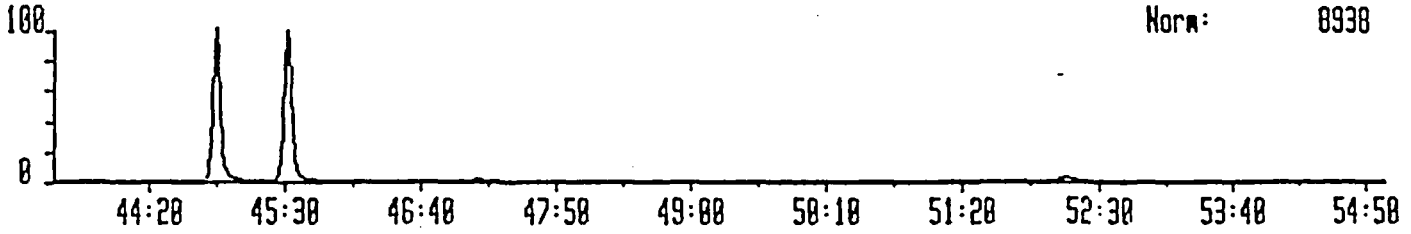
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 401.8558
Text:LFI/9111 TLI#16661



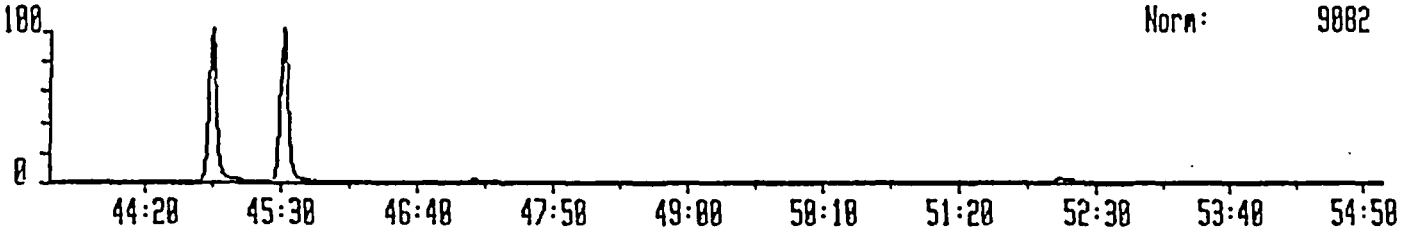
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 403.8529
Text:LFI/9111 TLI#16661

NOV 1 0 1993

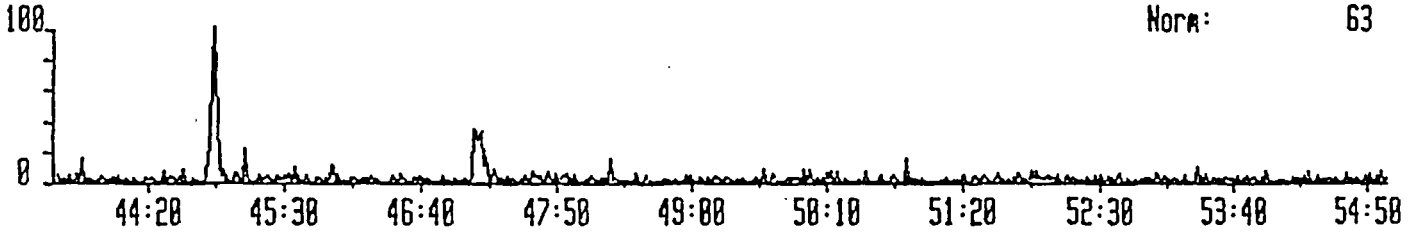
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 487.7818
Text:LFI/9111 TLI#16661



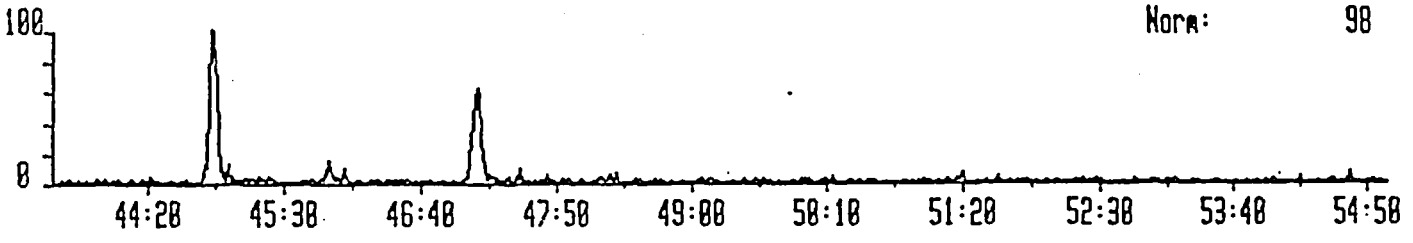
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 489.7789
Text:LFI/9111 TLI#16661



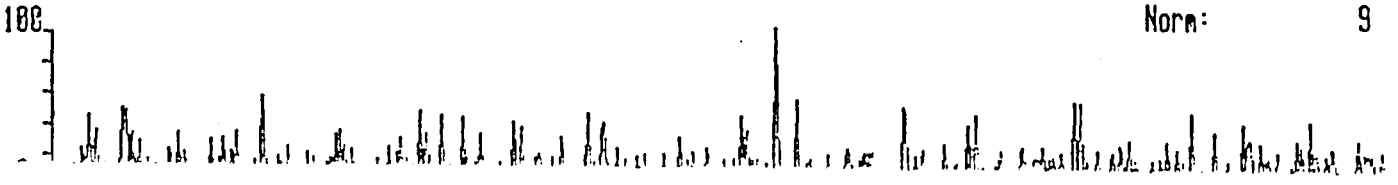
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 417.8253
Text:LFI/9111 TLI#16661



T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 419.8220
Text:LFI/9111 TLI#16661

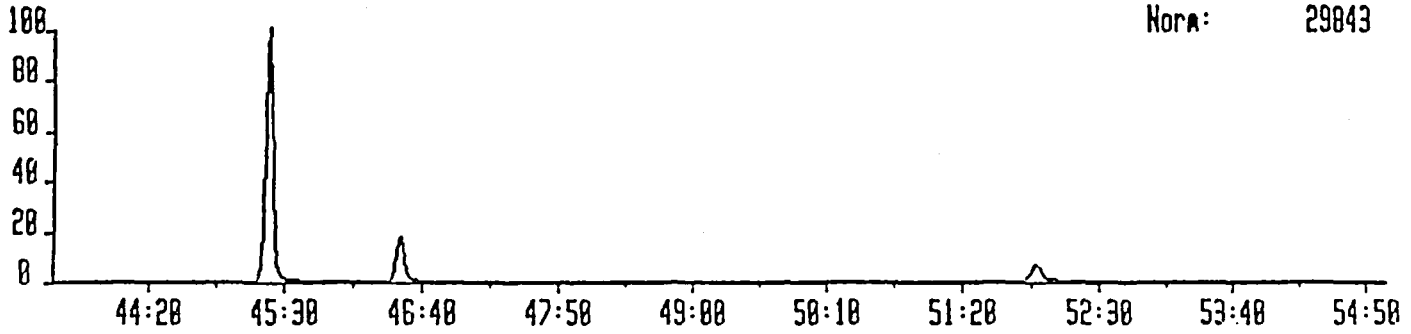


T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 479.7165
Text:LFI/9111 TLI#16661

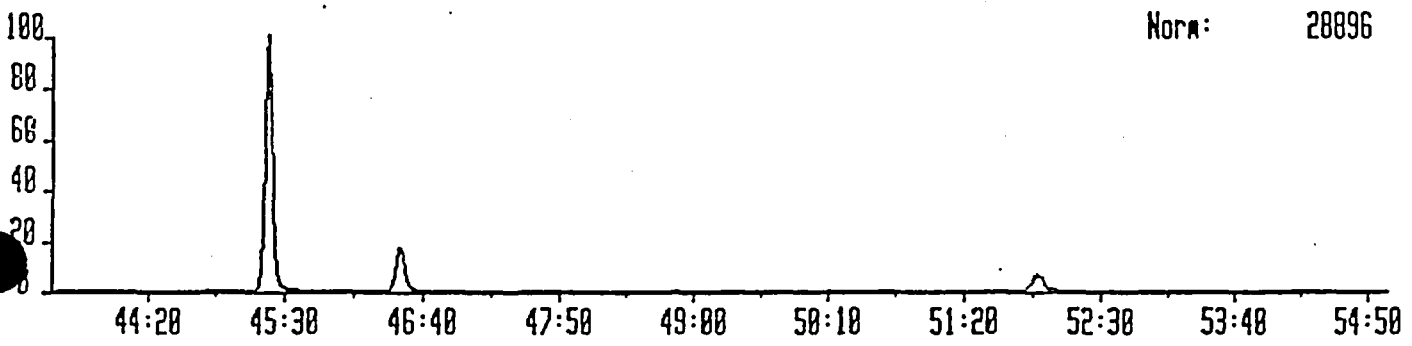


2

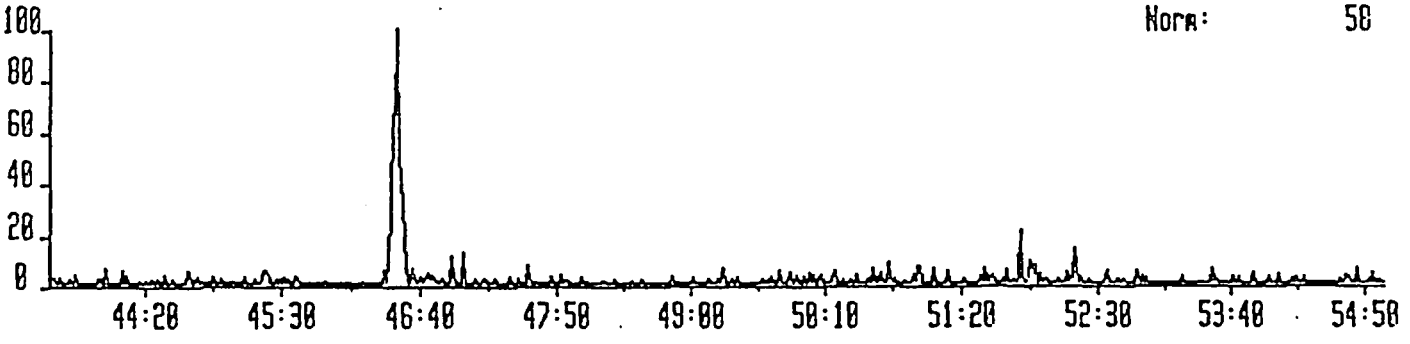
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 423.7766
Text:LFI/9111 TLI#16661



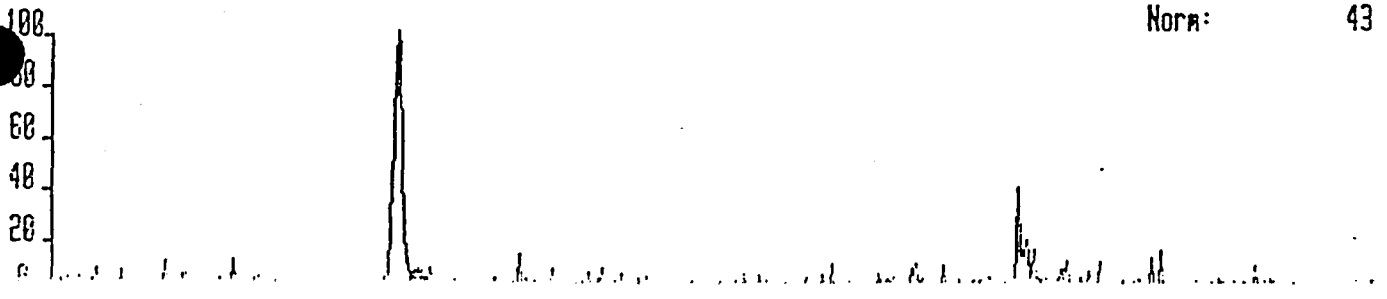
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 425.7737
Text:LFI/9111 TLI#16661



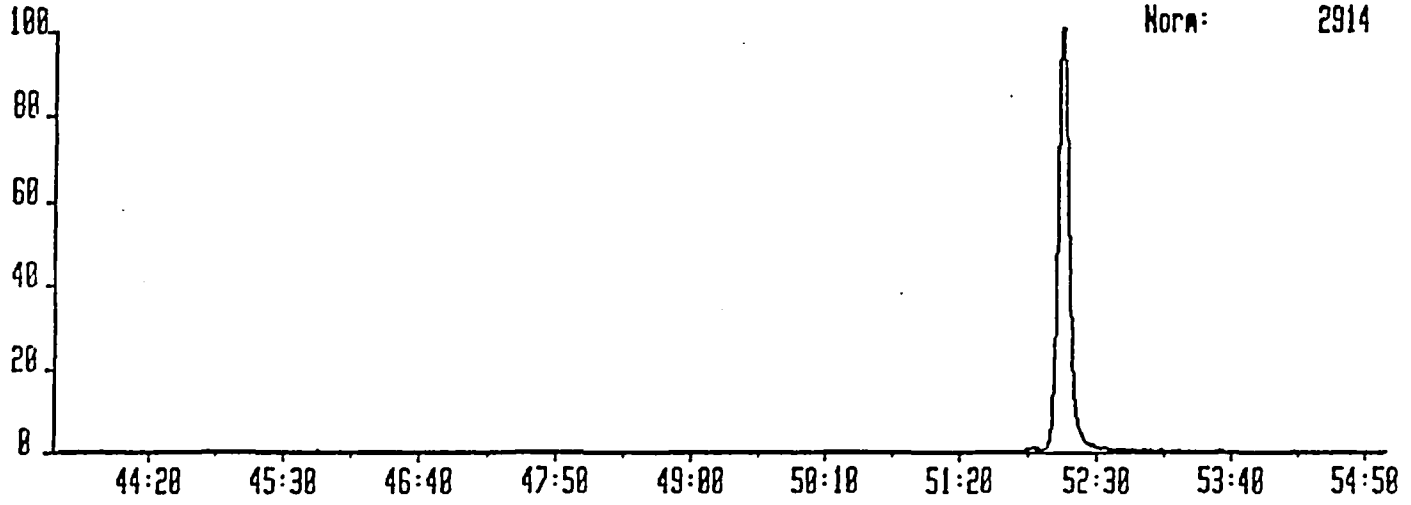
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 435.8169
Text:LFI/9111 TLI#16661



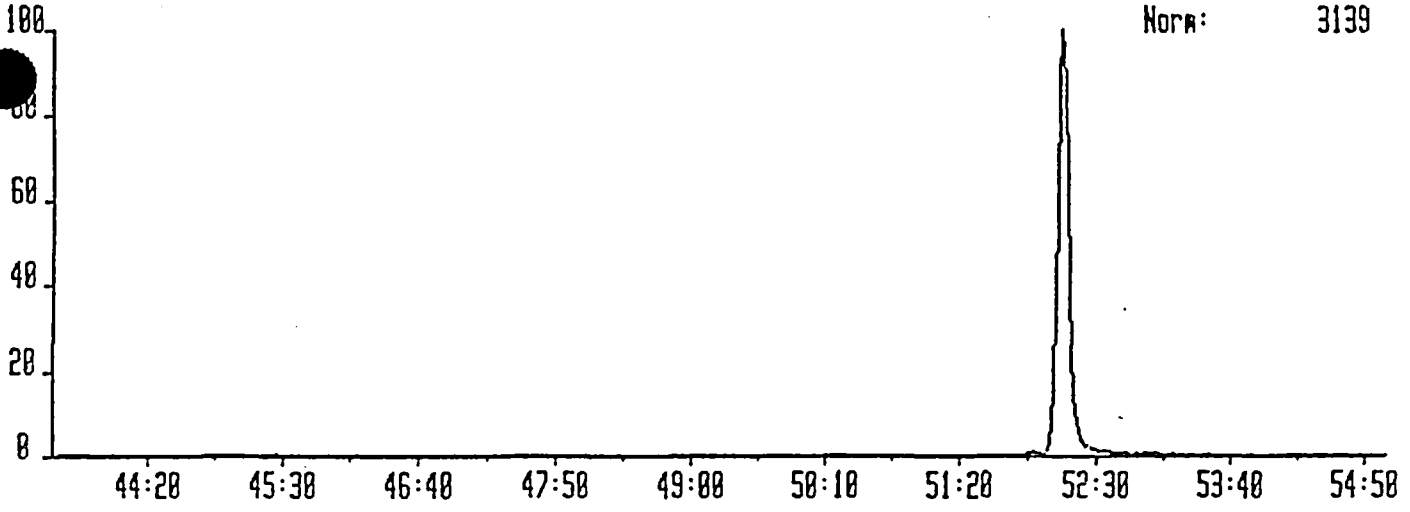
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 437.8140
Text:LFI/9111 TLI#16661



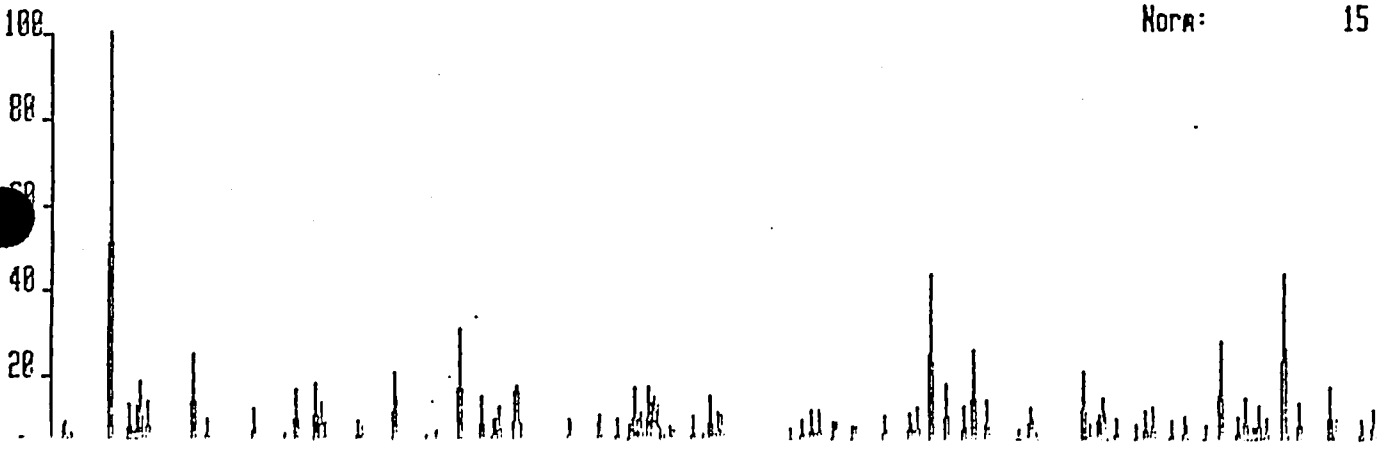
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 441.7428
Text:LFI/9111 TLI#16661



T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 443.7399
Text:LFI/9111 TLI#16661



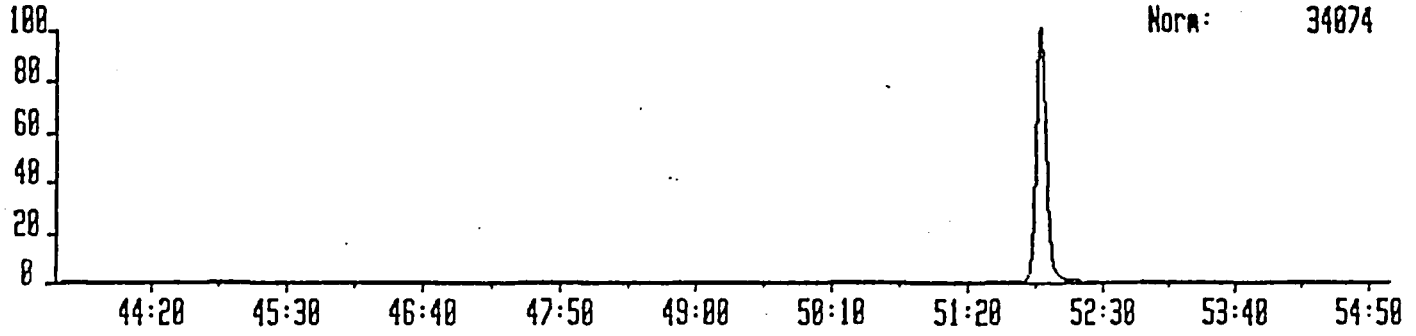
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 513.6775
Text:LFI/9111 TLI#16661



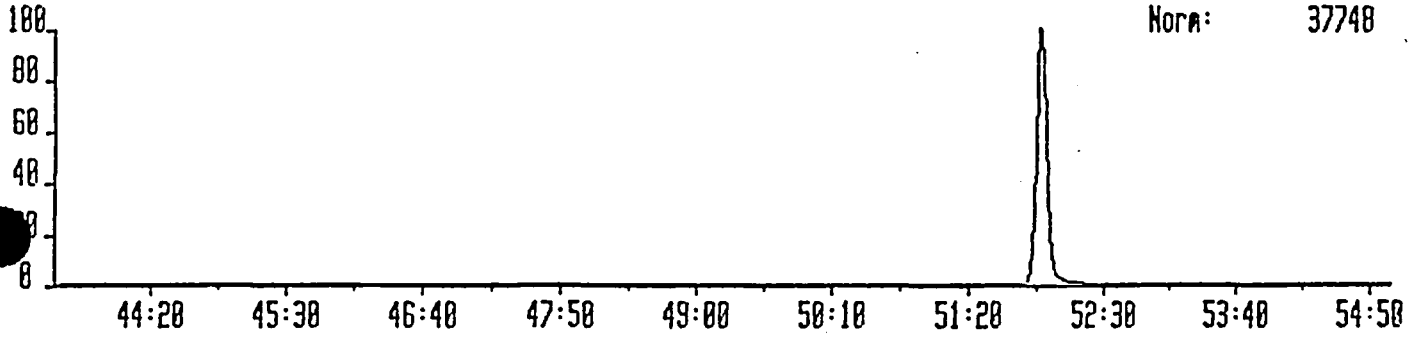
2

NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

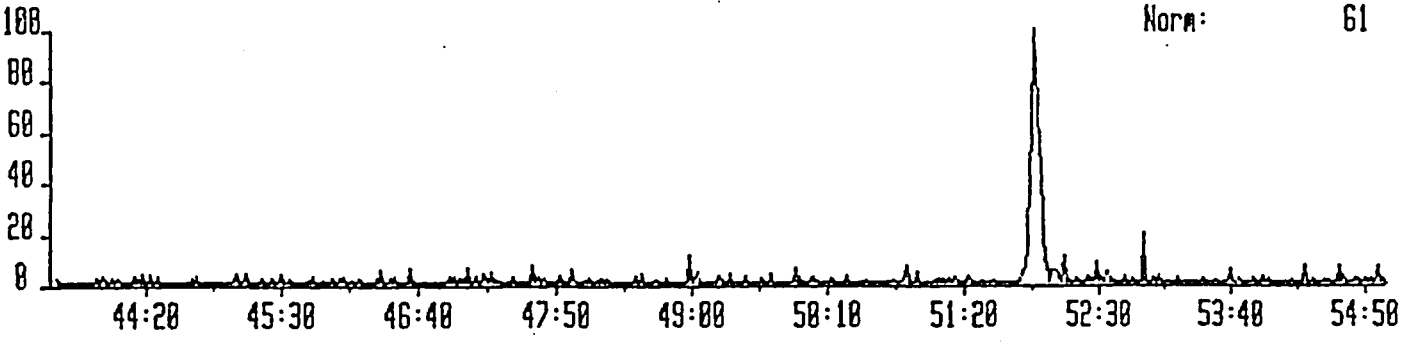
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 457.7377
Text:LFI/9111 TLI#16661



T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 459.7348
Text:LFI/9111 TLI#16661



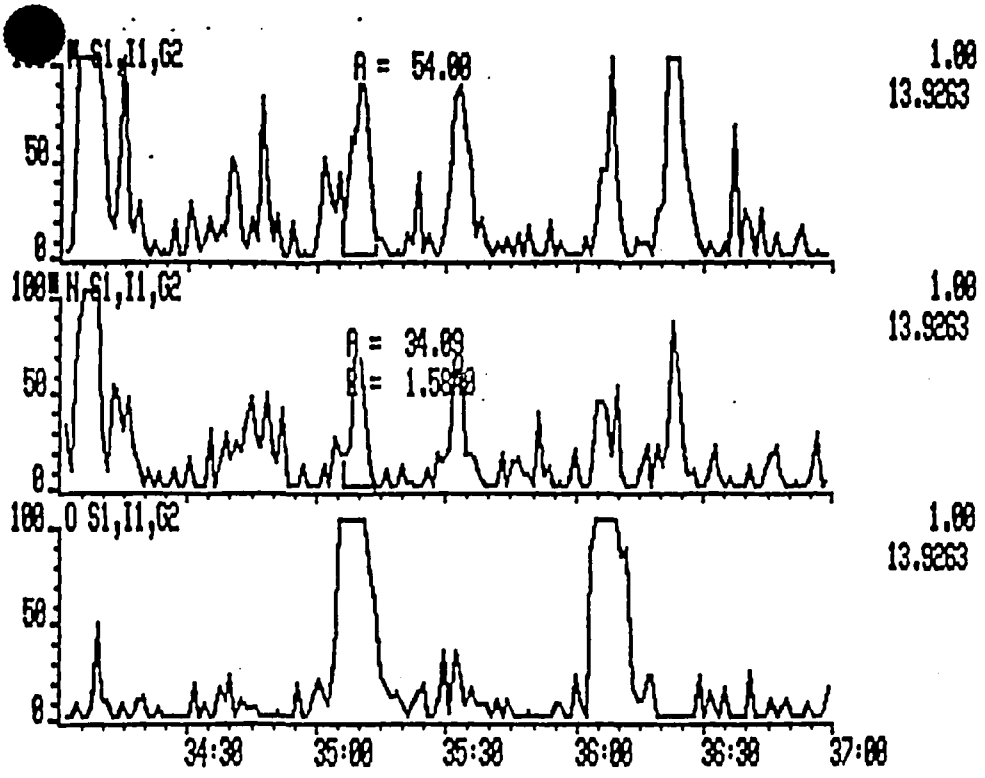
T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 469.7779
Text:LFI/9111 TLI#16661



T904958 13-NOV-90 Sir:Voltage 70-250S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 471.7750
Text:LFI/9111 TLI#16661

2

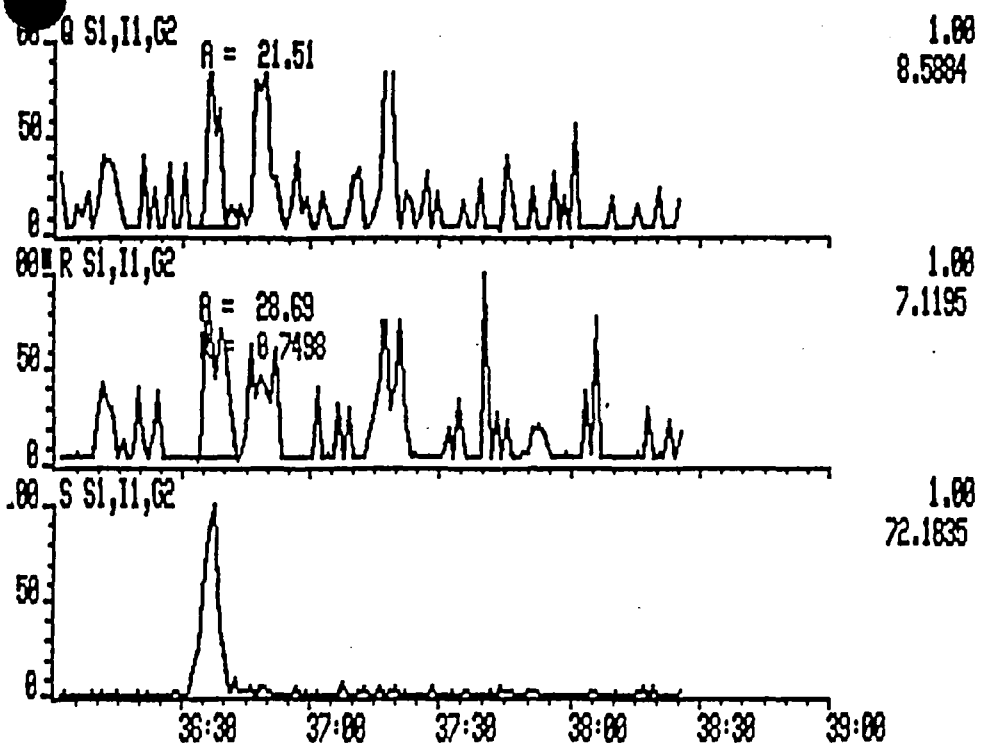
.994958 13-NOV-90 22:44 70-2505 (EI+) Sys:D85US
GR 2 M: 339.8597 N: 341.8567 O: 351.9000 P: 353.8970 Q: 355.8546
ext:LFI/9111 TLI#16661



NOV 1 9
ENVIRONM

2

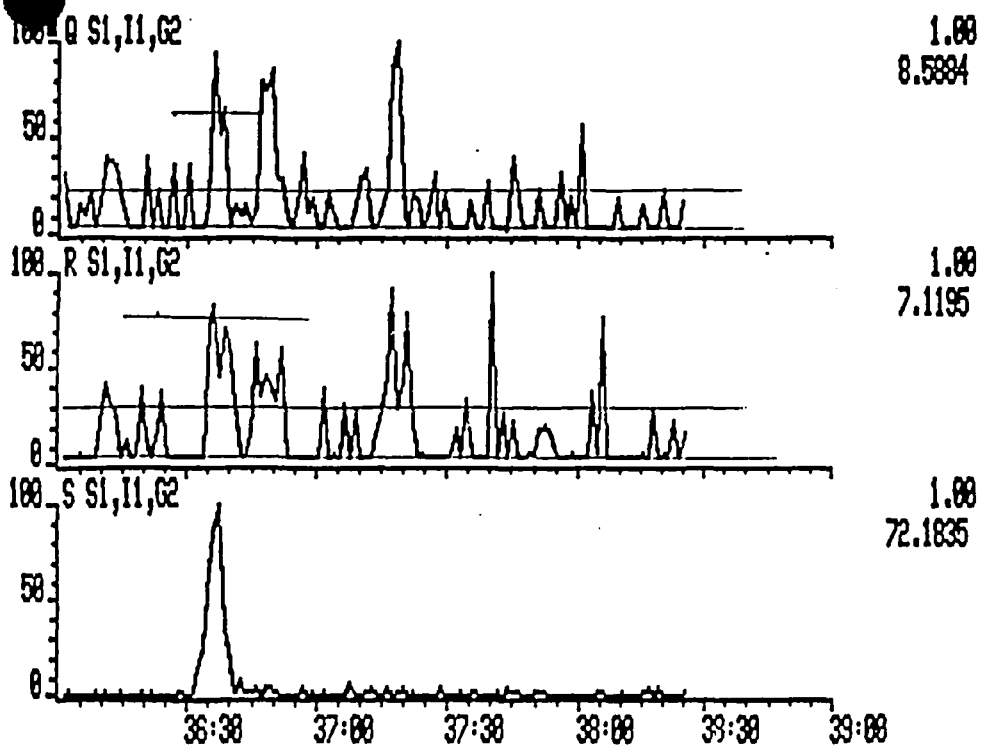
1984958 13-NOV-90 22:44 70-258S (EI+) Sys:D85US
P. 2 Q: 355.8546 R: 357.8516 S: 367.8949 T: 369.8919 U: 375.8364
ct:LFI/9111 TLI#16661



NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

MKS
11-15-90

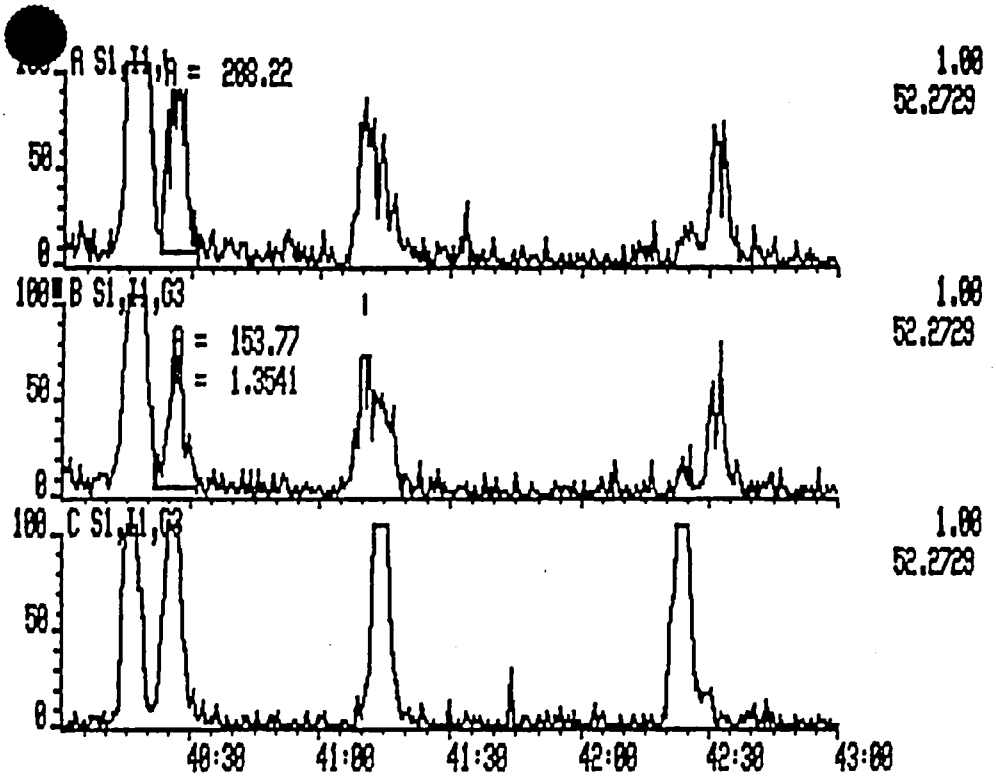
T984958 13-NOV-90 22:44 70-250S (EI+) Sus:D85US
CR 2 Q: 355.8546 R: 357.8516 S: 367.8949 T: 369.8919 U: 375.8364
ext:LFI/9111 TLI#16661



NOV 1 8 1990
ENVIRONMENTAL

MBS
11-15-90

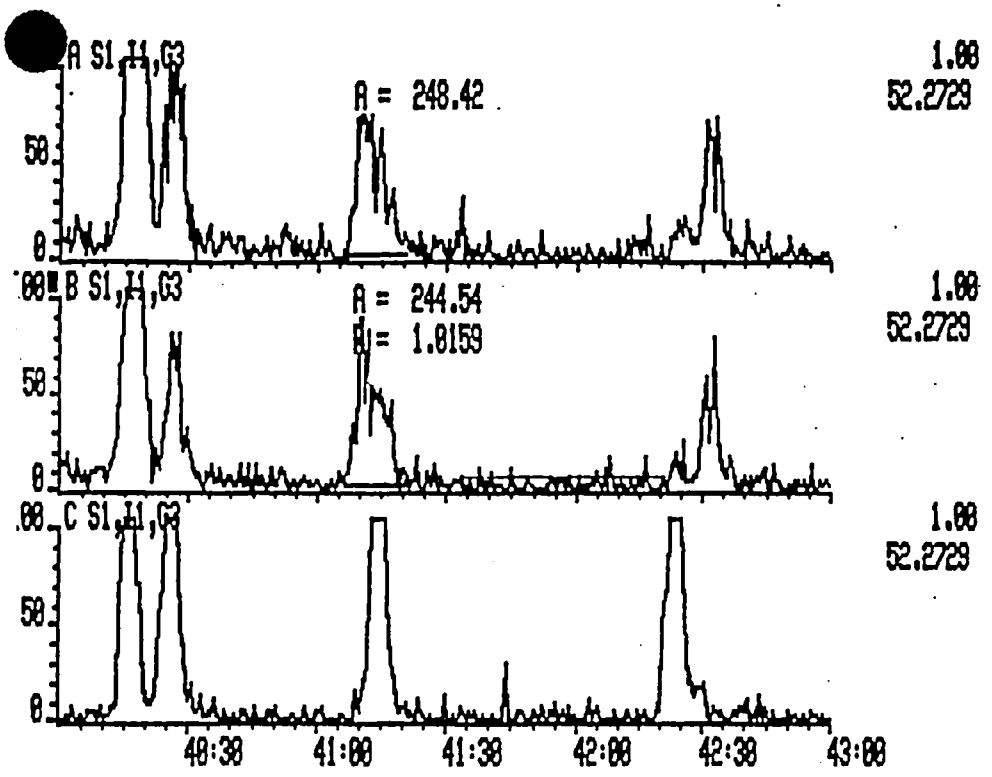
.984958 13-NOV-90 22:44 70-2505 (EI+) Sys:DB5US
GR 3 A: 373.8288 B: 375.8178 C: 383.8539 D: 385.8610 E: 389.8156
ext:LFI/9111 TLI#16661



NOV 3 0 1990
ENVIRONMENTAL

MAS
11-15-90

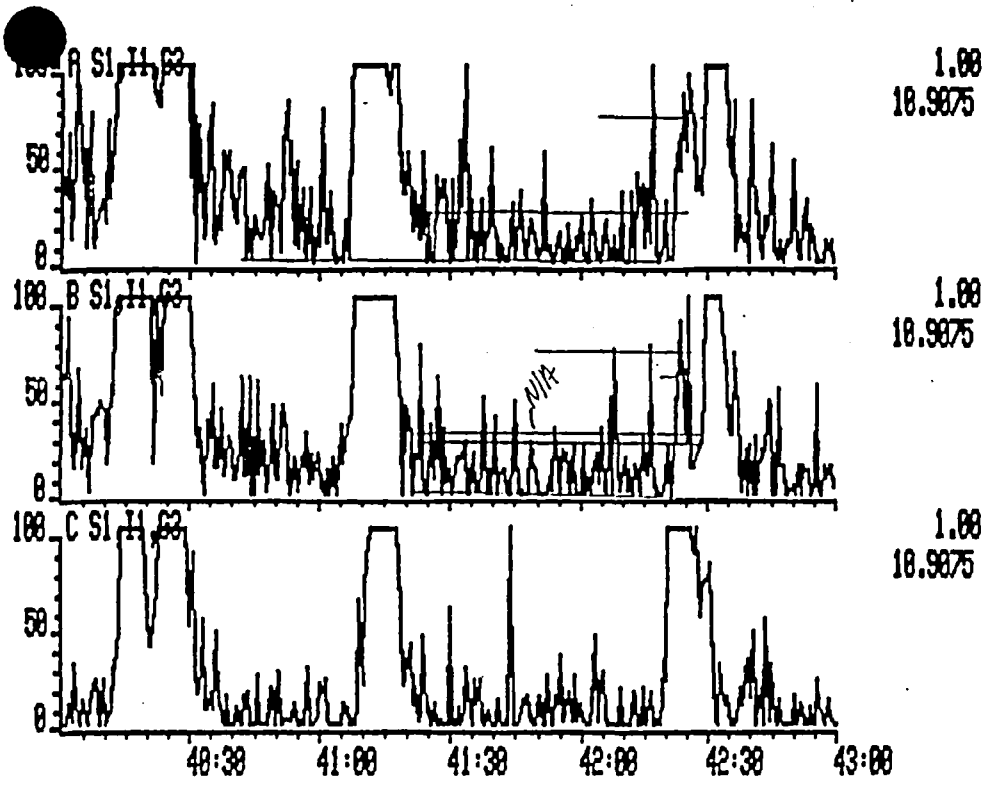
304958 13-NOV-90 22:44 70-250S (EI+) Sys:D85US
GR 3 A: 373.8288 B: 375.8178 C: 383.8639 D: 385.8610 E: 389.8156
ext:LFI/3111 TLI#16661



RECEIVED
NOV 1 8 1990
ENVIRONMENTAL AFFAIRS

MJS
11-15-90

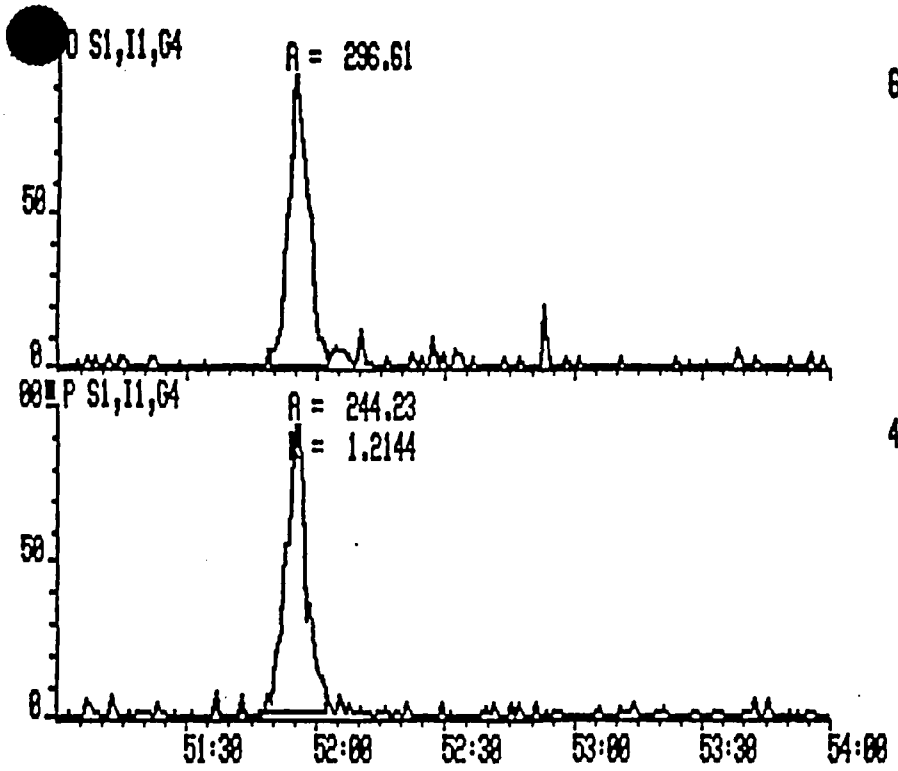
.984958 13-NOV-90 22:44 70-2508 (EI+) Sys:D85US
GR 3 A: 373.8288 B: 375.8178 C: 383.8639 D: 385.8610 E: 389.8156
ext:LFI/9111 TLI#16661



NOV 19 1990
ENVIRONMENTAL AFFAIRS

MBS
11-15-90

304958 - 13-NOV-90 22:44 70-250S (EI+) Sys:D85US
GR 4 O: 469.7779 P: 471.7750 Q: 479.7165 R: 513.6775
ext:LFI/9111 TLI#16661



NOV 19 1990
ENVIRONMENTAL AFFAIRS

MBS
11-15-90

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b)

11/15/90

FILE NAME....: S904212 CLIENT ID....: SWP TLI NUMBER....: 37-26-1
CONCAL (VER).: S904209 SAMPLE ID....: LF1/9110 (DIL)
PROJECT NUMBER: 16661 ICAL DATE....: 10/15/90
ANALYST.....: TM ANALYSIS DATE: 11/08/90
SAMPLE SIZE..: 9.460 g SAMPLE MATRIX: SOIL SAMPLE ORIGIN: WILMINGTN
DATE RECEIVED.: 11/10/90 DATE COLLECTED: 10/09/90
SPIKE FILE...: SPX23710 SHIPMENT NO...: NC09001

NAME	CONC(ppb)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND		0.03				
12378-PeCDD	ND		0.04				
123478-HxCDD	EMPC			0.11			
123678-HxCDD	1.3				1.30	41:53	
123789-HxCDD	0.61				1.32	42:20	PC
1234678-HpCDD	65.5				1.07	46:46	
OCDD	621				0.86	52:16	B
2378-TCDF	ND		0.02				
12378-PeCDF	EMPC			0.07			
23478-PeCDF	EMPC			0.08			
123478-HxCDF	0.77				1.15	40:35	
123678-HxCDF	0.24				1.25	40:45	
234678-HxCDF	0.41				1.27	41:28	B
123789-HxCDF	ND		0.04				
1234678-HpCDF	59.5				0.95	45:12	
1234789-HpCDF	EMPC			1.0			
OCDF	63.2				0.90	52:32	
TOTAL TCDD	EMPC			0.04			
TOTAL PeCDD	0.72	4		0.91	1.63		
TOTAL HxCDD	16.4	6		16.5	1.29		
TOTAL HpCDD	461	2			1.05		
TOTAL TCDF	ND		0.02				
TOTAL PeCDF	0.98	3		1.3	1.74		
TOTAL HxCDF	31.4	8		31.5	1.19		
TOTAL HpCDF	147	2		148	0.95		

MSS 11/15/90

X237_RPT rev:3.03

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b) QA/QC SUMMARY

11/15/90

FILE NAME....: S904212 CLIENT ID....: SWP TLI NUMBER....: 37-26-1
CONCAL (VER).: S904209 SAMPLE ID....: LF1/9110 (DIL)
PROJECT NUMBER: 16661 ICAL DATE....: 10/15/90
ANALYST.....: TM ANALYSIS DATE: 11/08/90
SAMPLE SIZE..: 9.460 g SAMPLE MATRIX: SOIL SAMPLE ORIGIN: WILMINGTN
DATE RECEIVED.: 11/10/90 DATE COLLECTED: 10/09/90
SPIKE FILE...: SPX23710 SHIPMENT NO...: NC09001

SURROGATE RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
37Cl-TCDD	0.91	86.4		31:32	___
13C12-PeCDF 234	1.1	108	1.53	36:27	___
13C12-HxCDF 478	0.63	59.6	0.52	40:34	___
13C12-HxCDD 478	0.73	69.4	1.07	41:43	___
13C12-HpCDF 789	0.55	52.4	0.43	47:26	___

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	0.74	70.0	0.54	42:42	___
13C12-HxCDF 234	0.65	61.7	0.51	41:33	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	0.84	79.0	0.83	30:42	___
13C12-2378-TCDD	0.98	92.3	0.84	31:30	___
13C12-PeCDF 123	0.95	89.7	1.43	35:29	___
13C12-PeCDD 123	1.1	105	1.55	36:56	___
13C12-HxCDF 678	0.56	53.2	0.49	40:44	___
13C12-HxCDD 678	0.72	68.3	1.30	41:52	___
13C12-HpCDF 678	0.55	52.4	0.41	45:11	___ Q,RS2
13C12-HpCDD 678	0.53	50.1	1.05	46:45	___
13C12-OCDD	1.5	72.7	0.99	52:16	___

MK 11/15/90

X237_RPT rev:3.03

2

N=28.8
(320)

	Initial	Date
B-File/Header Changes	MKS	11-15-90
Manual Integrations		
Transcription	KSD	11-15-90
Dbase Corrections		

Page No. 1 Listing of S904212B.dbf
11/10/90

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
304		1.60	28:58	58.44	F	F	0.944	
	D	0.83	30:44	54.69	T	T	1.001	S.N
		0.75	32:19	21.59	T	F	1.053	
		0.97	32:59	61.85	F	F	1.074	
	D	-0.41	34:25	73.90	F	F	1.121	R.W
304		*** Total ***		270.47	# of Peaks:		5	
316		0.83	30:42	3806.87	T	T	1.000	
316		*** Total ***		3806.87	# of Peaks:		1	
320	P	-1.95	29:11	50.73	F	F	0.926	S.N
		1.42	30:13	103.97	F	F	0.959	
		0.81	30:26	50.93	T	F	0.966	
		1.30	30:42	21.47	F	F	0.975	
		1.43	31:16	21.07	F	F	0.993	S.N
	D	0.44	31:24	50.57	F	F	0.997	
		1.77	32:38	18.80	F	F	1.036	
		0.60	34:25	16.63	F	F	1.093	
		1.28	34:33	37.82	F	F	1.097	R.W
	D	0.47	35:27	54.66	F	F	1.125	
320		*** Total ***		426.65	# of Peaks:		10	
328		0.00	31:32	2530.44	T	T	1.001	
		0.00	31:53	33.84	T	F	1.012	
328		*** Total ***		2564.28	# of Peaks:		2	
332		0.79	31:17	2682.43	T	T	0.993	
		0.84	31:30	2567.22	T	T	1.000	
332		*** Total ***		5249.65	# of Peaks:		2	
340		1.76	32:59	1395.38	T	F	0.930	
		1.68	34:25	977.18	T	F	0.970	
		1.77	35:08	110.65	T	F	0.990	
	Str R.O.	0.86	35:30	177.08	F	T	1.000	
		1.00	35:54	201.53	F	F	1.012	
	D	-0.37	36:06	25.67	F	F	1.017	S.N
	Str R.O.	1.10	36:28	193.52	F	T	1.028	
		2.00	36:44	724.26	F	F	1.035	
		0.86	37:31	27.08	F	F	1.057	
	D	0.61	37:49	29.91	F	F	1.066	S.N
340		*** Total ***		3362.26	# of Peaks:		10	
352		1.43	35:29	1746.13	T	T	1.000	
		1.39	35:50	81.17	T	F	1.010	
		1.53	36:27	2451.18	T	T	1.027	
		1.66	37:50	77.02	T	F	1.066	
[illegible]		*** Total ***		[illegible]	# of Peaks:		4	

3

NOV 19 1990
ENVIRONMENTAL ANALYS

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
356		1.77	34:31	868.65	T	F	0.935	
		1.67	35:08	156.16	T	F	0.951	
		2.10	35:29	126.60	F	F	0.961	
		2.45	35:40	155.09	F	F	0.966	
		1.50	35:53	125.40	T	F	0.972	
	D	-1.67	36:07	50.15	T	F	0.978	- S.N
		1.57	36:16	153.73	T	F	0.982	
	D	- 0.78	36:57	47.48	F	T	1.000	— S.N
		0.49	37:09	75.31	F	T	1.006	
	D	-1.24	37:38	50.87	F	F	1.019	- S.N
356		*** Total ***		1809.44	# of Peaks:		10	
368		1.55	36:56	1070.13	T	T	1.000	
368		*** Total ***		1070.13	# of Peaks:		1	
374		1.21	39:05	5165.86	T	F	0.959	
		1.17	39:17	17693.23	T	F	0.964	
		1.09	39:44	198.18	T	F	0.975	
		1.17	40:00	51352.02	T	F	0.982	
		0.54	40:27	88.67	F	F	0.993	
		1.15	40:35	2277.01	T	T	0.996	
		1.25	40:45	746.28	T	T	1.000	
	D	-0.94	40:53	93.92	F	F	1.004	—S.N
	flat D	-1.07	41:00	42.77	T	F	1.007	-S.N
	D	-3.15	41:07	48.51	F	F	1.009	-S.N
	D	-1.31	41:13	73.91	T	F	1.012	-S.N
		1.27	41:28	916.01	T	T	1.018	
	D	- 1.32	41:50	25.06	T	F	1.027	-S.N
~~ck flat~~	D →	0.49	42:42	75.11	F	T	1.048	-S.N
		1.20	42:50	574.75	T	~~T~~ F	~~1.052~~ 1.053	
	D	-0.78	43:00	21.02	F	F	1.056	-S.N
374		*** Total ***		79392.31	# of Peaks:		16	
384		0.52	40:34	2049.61	T	T	0.996	
		0.49	40:44	2078.08	T	T	1.000	
		0.51	41:33	2113.35	T	T	1.020	
		0.54	42:42	2023.50	T	T	1.048	
384		*** Total ***		8264.54	# of Peaks:		4	
390		1.28	39:52	13284.29	T	F	0.952	
	D	-1.21	40:13	38.92	T	F	0.961	-S.N
		1.27	40:34	1175.85	T	F	0.969	
		1.24	40:54	9230.06	T	F	0.977	
		1.30	41:09	3359.70	T	F	0.983	
	D	-0.49	41:35	61.13	F	F	0.993	-S.N
RD ~~ck~~	→	0.88	41:45	205.77	F	T	0.997	
		1.30	41:53	2492.00	T	T	1.000	
	D	-0.41	42:10	28.90	F	F	1.007	-S.N
ck	→	~~5.09~~/-32	42:20	~~956.52~~ 1051	T ~~F~~	T	1.011	
	D	-3.51	42:20	830.13	F	T	1.011	-S.N
	D	-2.46	42:32	47.39	F	F	1.016	-S.N
390		*** Total ***		31710.66	# of Peaks:		12	

4

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
402		1.07	41:43	1311.46	T	T	0.996	
		1.30	41:52	1666.53	T	T	1.000	
		1.27	42:20	2488.08	T	T	1.011	
402		*** Total ***		5466.07	# of Peaks:		3	
408		0.95	45:12	167169.15	T	T	1.000	
		0.94	45:49	163906.52	T	F	1.014	
	D	-0.86	46:47	773.95	F	F	1.035	-NH
	R.O.	-0.82	47:28	1721.49	F	T	1.051	
408		*** Total ***		333521.11	# of Peaks:		4	
418		0.41	45:11	1511.03	T	T	1.000	
		0.72	46:10	70.70	F	F	1.022	
		0.43	47:26	1151.35	T	T	1.050	
418		*** Total ***		2733.08	# of Peaks:		3	
424		1.02	45:39	462723.89	T	F	0.976	
		1.07	46:46	76585.72	T	T	1.000	
	D	-2.56	47:39	426.20	F	F	1.019	-NH
424		*** Total ***		539735.81	# of Peaks:		3	
436		1.05	46:45	1041.86	T	T	1.000	
436		*** Total ***		1041.86	# of Peaks:		1	
442		0.90	52:32	85101.39	T	T	1.005	
442		*** Total ***		85101.39	# of Peaks:		1	
458		0.86	52:16	708389.03	T	T	1.000	
458		*** Total ***		708389.03	# of Peaks:		1	
470		0.99	52:16	1435.01	T	T	1.000	
470		*** Total ***		1435.01	# of Peaks:		1	

*** End of Report ***

NOV 19 1990

Listing of S9042121.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
202	10:46	16.96	17:40	29.19	19:25	11.67		
	13:03	21.60	18:10	14.30	20:32	90.58		
	14:45	13.22	19:13	17.86	21:36	45.18		
204	10:50	13.92	14:02	24.65	17:12	14.95	19:28	10.94
	11:24	14.74	14:27	23.05	17:25	7.14	20:09	22.23
	11:56	15.04	14:45	22.98	17:33	34.33	20:22	16.64
	12:05	11.65	15:14	17.34	17:43	30.93	20:33	110.11
	12:13	16.71	15:29	9.32	17:56	14.13	20:55	9.11
	12:23	16.17	15:47	12.28	18:13	58.20	21:09	7.61
	12:42	11.34	16:08	16.49	18:31	7.08	21:35	63.47
	12:51	7.14	16:16	9.63	18:50	9.83		
	12:58	11.92	16:26	19.83	19:03	19.60		
	13:22	32.99	16:45	19.55	19:11	33.16		
238	17:49	10.49	19:01	11.27	19:43	21.48	22:16	20.12
	18:32	16.06	19:23	10.24	21:28	20.76	22:35	17.67
	18:53	12.36	19:31	12.95	21:36	15.65		
240	18:07	44.47	18:57	37.81	19:34	26.44	21:53	17.40
	18:30	15.14	19:05	33.08	20:41	51.65	22:02	12.78
	18:40	16.19	19:16	46.19	21:30	55.63		
252	18:43	34.60	19:23	45.84	21:36	79.93	23:07	31.79
	18:56	26.77	19:37	25.98	21:53	13.53		
	19:13	56.77	20:22	9.96	22:24	26.03		
254	18:33	16.46	19:38	21.94	22:03	11.54	23:21	22.53
	18:53	24.41	20:09	8.57	22:24	9.68		
	19:17	27.01	21:34	24.76	22:55	12.16		
270	22:08	7.91	22:28	17.93	23:20	25.29	25:43	7.83
	22:15	12.85	22:40	9.88	23:26	10.12	26:23	9.73
272	25:12	13.91						
286	24:31	17.86	25:08	7.90	26:51	9.75		
218	11:35	30.56	13:41	17.46	16:11	23.82	18:09	26.14
	11:46	16.23	13:54	17.92	16:23	21.00	18:36	18.32
	12:07	36.06	14:12	16.83	16:46	63.88	18:58	17.26
	12:53	97.94	14:27	11.78	17:15	86.18	19:26	9.08
	13:18	53.24	14:47	33.55	17:44	49.78	22:01	35.39
	13:34	7.86	15:46	11.17	17:54	31.63		
220	12:02	34.81	14:56	40.13	17:06	10.30	19:24	19.52
	13:04	23.07	15:38	25.57	17:22	11.07	20:09	25.61
	13:13	30.42	16:00	20.15	17:57	9.91	20:25	23.04
	13:26	41.63	16:13	34.33	18:14	29.64	20:47	26.77
	14:36	11.71	16:26	31.93	18:52	56.68		
	14:45	23.59	16:50	13.49	19:14	21.16		

Listing of S9042121.dbt File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
304	32:19	9.26	32:59	30.45	33:54	7.31		
	32:34	13.06	33:45	10.64	34:25	21.59		
306	28:01	9.74	28:58	22.49	30:46	29.82	33:40	31.46
	28:15	18.48	29:14	15.79	31:41	11.97	34:08	6.96
	28:36	30.87	29:35	23.19	32:19	12.33	34:26	52.31
	28:45	16.40	30:03	7.92	32:45	8.00	34:40	16.19
320	28:52	10.32	30:42	12.12	32:17	7.68	35:21	6.19
	29:11	33.56	31:16	12.39	32:38	12.01	35:27	17.48
	29:32	6.99	31:24	15.48	33:51	13.34		
	30:13	60.96	31:51	19.93	34:25	6.24		
	30:26	22.77	32:03	7.18	34:33	21.25		
322	29:11	17.17	30:52	12.00	32:24	9.01	35:09	10.29
	29:28	16.70	30:58	12.17	32:39	6.79	35:29	37.18
	30:12	43.01	31:16	8.68	34:26	10.39		
	30:26	28.16	31:23	35.09	34:32	16.57		
	30:44	9.35	31:57	16.63	34:43	7.78		
340	32:59	889.25	34:25	611.89	35:30	81.65	36:28	101.47
	33:13	6.87	34:49	18.57	35:42	14.85	36:44	149.58
	34:02	6.68	35:08	70.72	35:54	100.86	37:31	12.52
	34:12	12.62	35:23	33.87	36:06	6.94	37:49	11.37
342	32:15	7.97	35:01	29.68	35:53	100.67	36:53	17.78
	32:40	9.01	35:07	39.93	36:06	18.73	37:18	12.82
	32:59	506.13	35:30	95.43	36:28	92.05	37:32	14.56
	34:25	365.29	35:38	24.14	36:44	74.68	37:51	18.54
356	33:48	13.12	35:29	85.76	36:16	93.98	37:38	28.16
	34:31	555.26	35:40	110.14	36:32	34.45		
	34:45	7.72	35:53	75.19	36:57	20.84		
	35:08	97.61	36:07	31.40	37:09	24.67		
358	32:57	9.61	35:29	40.84	36:16	59.75	37:36	27.71
	34:31	313.39	35:40	44.95	36:24	19.67	38:05	6.32
	34:51	6.45	35:53	50.21	36:57	26.64		
	35:08	58.55	36:07	18.75	37:09	50.64		
316	30:42	1726.00						
318	30:42	2080.87						
328	31:32	2530.44	31:53	33.84				
332	31:17	1186.34	31:30	1168.38				
334	29:39	26.35	31:17	1496.09	31:30	1398.84		
352	35:29	1096.55	35:50	47.27	36:27	1484.11	37:30	48.02
354	32:24	25.63	35:49	33.90	37:50	29.00		
	35:29	719.58	36:27	967.07				

7

Listing of S9042121.dbt File
Raw Mass, Retention Time and Data Area

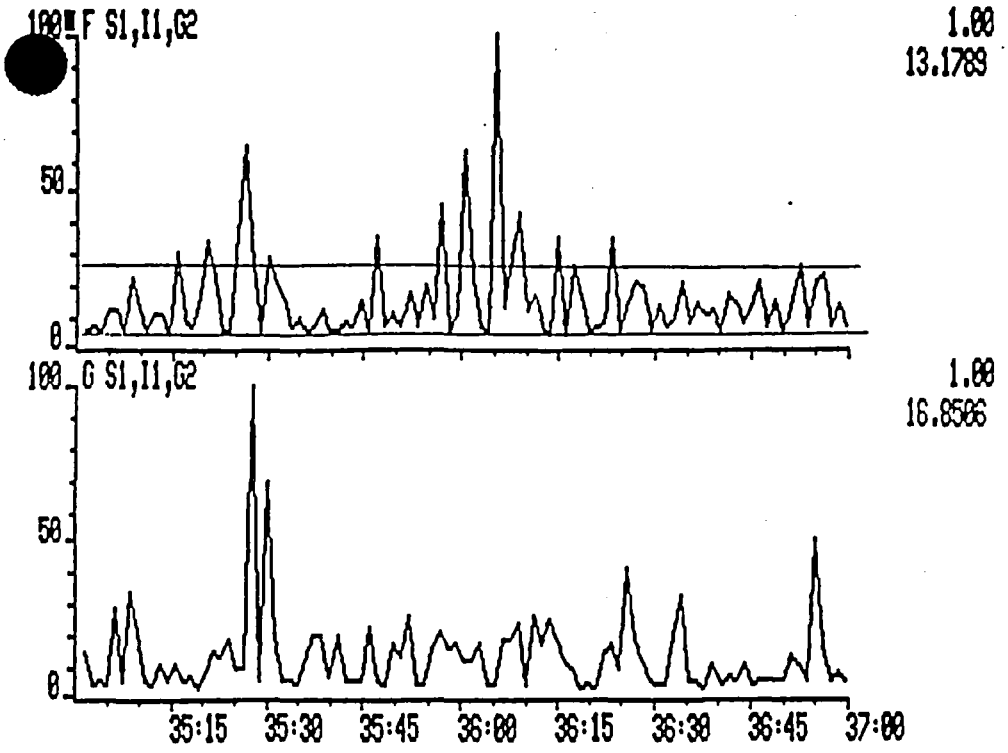
M_7	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
368	35:30	31.32	36:56	650.50	37:36	36.56		
370	36:56	419.63						
374	39:05	2826.59	40:35	1216.26	41:17	6.76	42:50	313.83
	39:17	9544.23	40:45	414.20	41:28	512.20	42:57	17.14
	39:30	191.73	40:53	45.51	41:41	8.80	43:00	9.20
	39:44	103.48	40:57	25.93	41:50	14.28	43:22	10.57
	40:00	27666.45	41:00	27.07	42:22	7.08		
	40:19	151.07	41:07	36.81	42:37	6.46		
	40:27	31.05	41:13	41.93	42:42	24.83		
376	39:05	2339.27	40:36	1060.75	41:20	10.03	42:50	760.92
	39:17	8149.00	40:45	332.08	41:29	403.81	43:00	11.82
	39:36	33.67	40:54	48.41	41:44	18.21	43:14	6.01
	39:45	94.70	41:00	20.70	41:49	10.78		
	40:00	23685.57	41:07	11.70	42:25	11.21		
	40:26	57.62	41:11	31.98	42:43	50.28		
390	39:52	7457.78	40:54	5112.75	41:45	96.21	42:32	33.70
	40:10	21.39	41:09	1898.47	41:53	1407.65	42:37	10.04
	40:13	21.30	41:26	26.13	42:10	8.35		
	40:34	656.94	41:35	20.09	42:20	646.21		
392	39:52	5826.51	40:54	4117.31	41:45	109.56	42:18	183.92
	40:13	17.62	41:09	1461.23	41:53	1084.35	42:22	310.31
	40:33	518.91	41:23	35.52	42:01	44.80	42:32	13.69
	40:42	14.12	41:34	41.04	42:08	20.55		
384	40:34	700.53	41:33	712.59	42:42	708.99		
	40:44	685.77	41:47	25.35				
386	40:34	1349.08	40:57	32.57	41:33	1400.76		
	40:44	1392.31	41:13	40.13	42:42	1314.51		
402	41:43	679.38	41:52	940.49	42:20	1392.24		
404	41:43	632.08	41:51	726.04	42:20	1095.84		
408	44:10	12.65	45:49	79537.45	47:28	773.31		
	45:12	81311.31	46:47	334.55				
410	45:12	85857.84	46:48	389.40	47:28	948.18		
	45:49	84369.07	47:02	204.39	48:11	13.10		
418	45:11	436.89	45:44	20.68	47:02	9.79	47:44	22.96
	45:35	10.29	46:10	29.66	47:26	346.59	48:58	9.31
420	45:11	1074.14	45:53	12.79	47:27	804.76		
	45:39	37.05	46:09	41.04	48:01	18.50		
424	45:39	233886.92	46:46	39541.36	47:57	127.56	49:35	15.64
	46:29	331.06	47:39	306.37	48:17	19.19	49:45	18.09

Listing of S9042121.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
426	45:39	228836.97	47:38	119.83	48:13	36.50		
	46:46	37044.36	47:53	141.20	50:05	20.05		
436	46:45	534.51	47:09	13.54	47:34	9.38		
438	46:45	507.35						
442	49:08	13.84	49:46	14.81	50:42	13.42	52:32	40236.93
444	49:20	13.27	49:38	20.18	50:23	12.63	52:32	44864.46
458	49:15	13.13	51:09	14.30	52:16	327642.47	53:49	51.92
460	52:16	380746.56						
470	52:16	713.14	52:37	46.65				
472	52:15	721.87						

*** End of Report ***

6384212 8-NOV-90 17:21 /GS (LI*) SUB:00005
GR 2 F: 319.8965 G: 321.8936 H: 327.8847 I: 330.9792 J: 331.9368
Text:LF1/9110 TLI# 16661



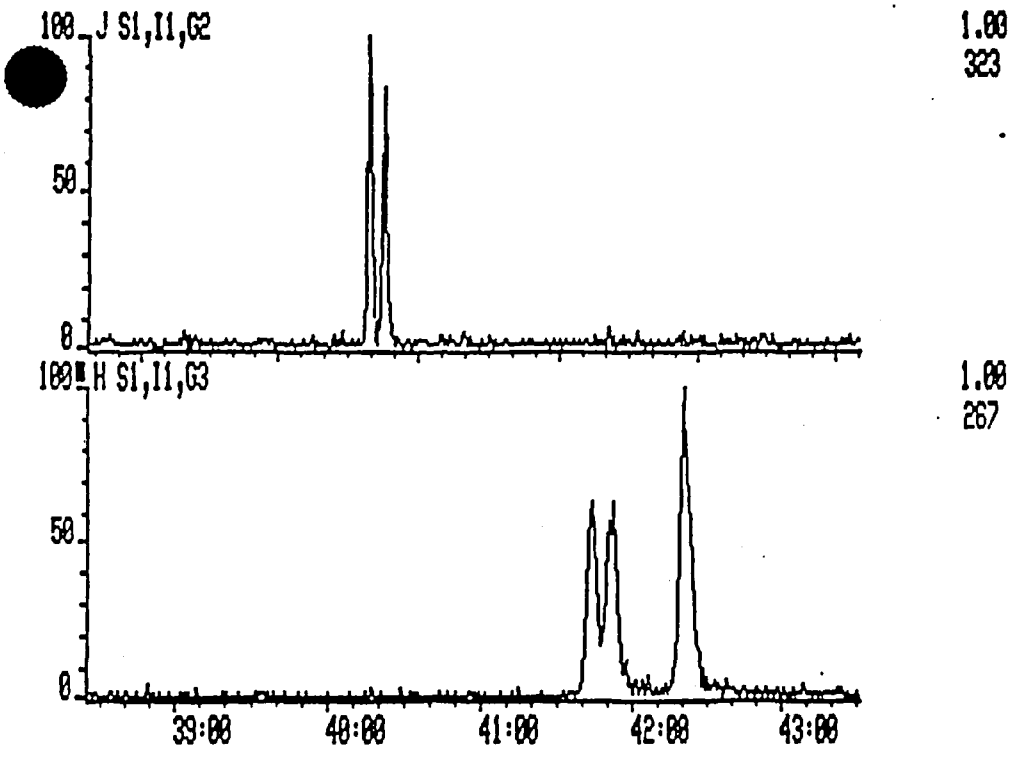
Verified by (GC/MS) : 11/8/90

Verified by (Int. QC) : 11/9/90

N = 0.22 x 2 x 5 x 13.1
= 28.8

MJS
11-15-90

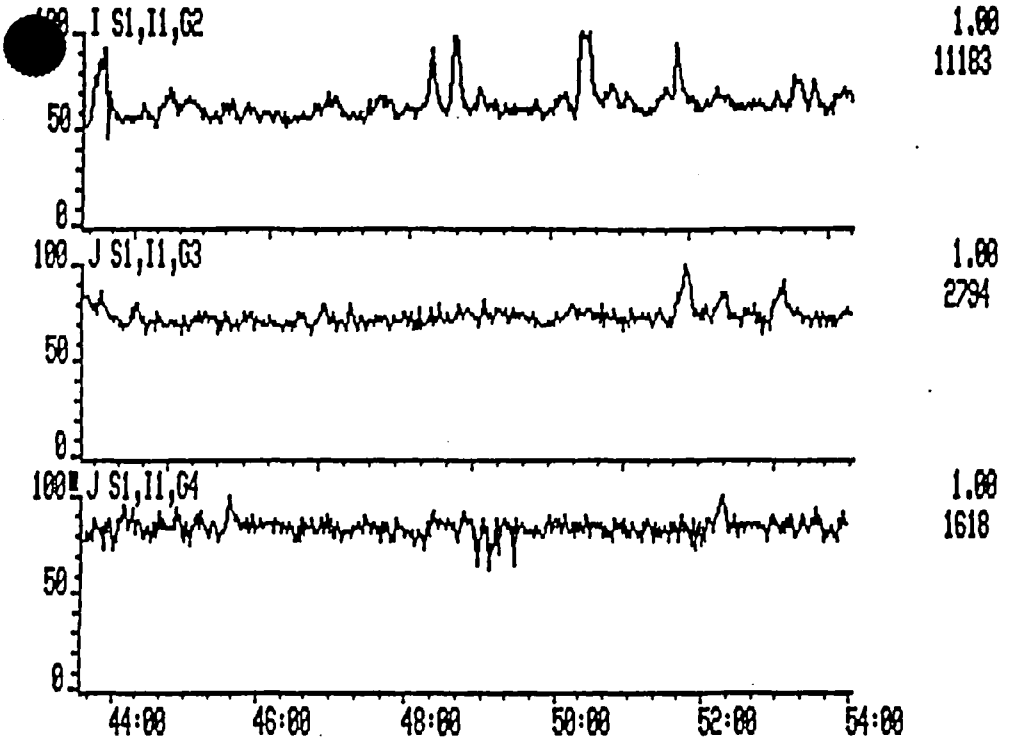
GR 3 F: 391.8127 G: 392.9760 H: 401.8558 I: 403.8529 J: 430.9729
Text:LF1/9110 TLI# 16661



NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

11

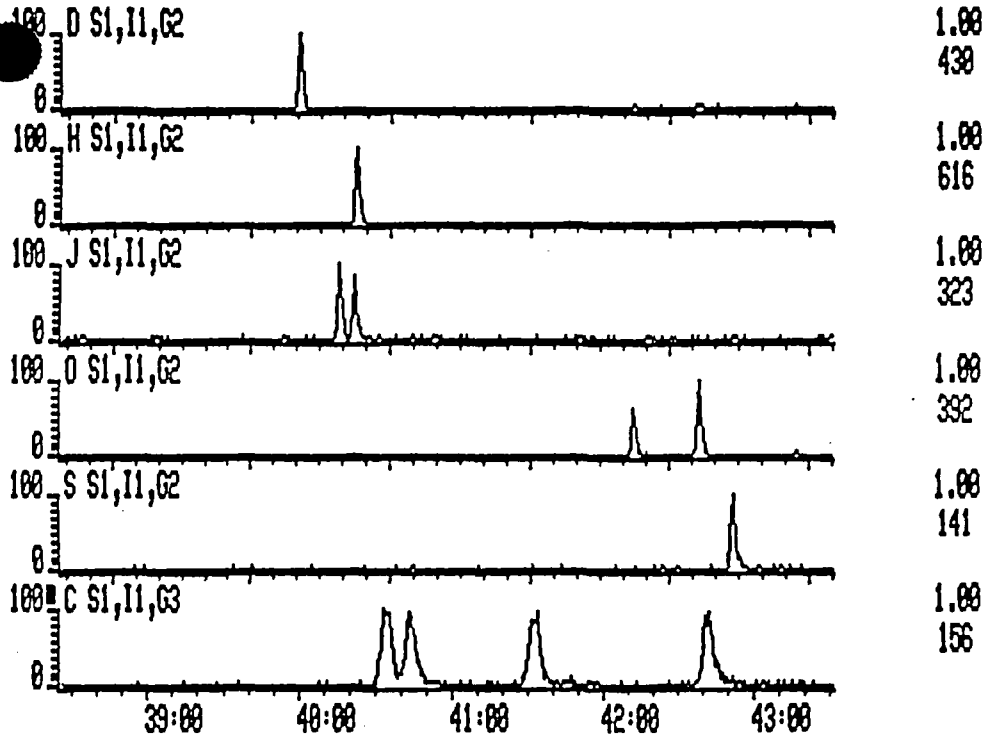
S904212 8-NOV-90 17:21 70S (EI+) Sys:U65US
GR 4 D: 419.8220 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text:LF1/9110 TLI# 16661



NOV 1 8 1990
ENVIRONMENTAL ANALYS

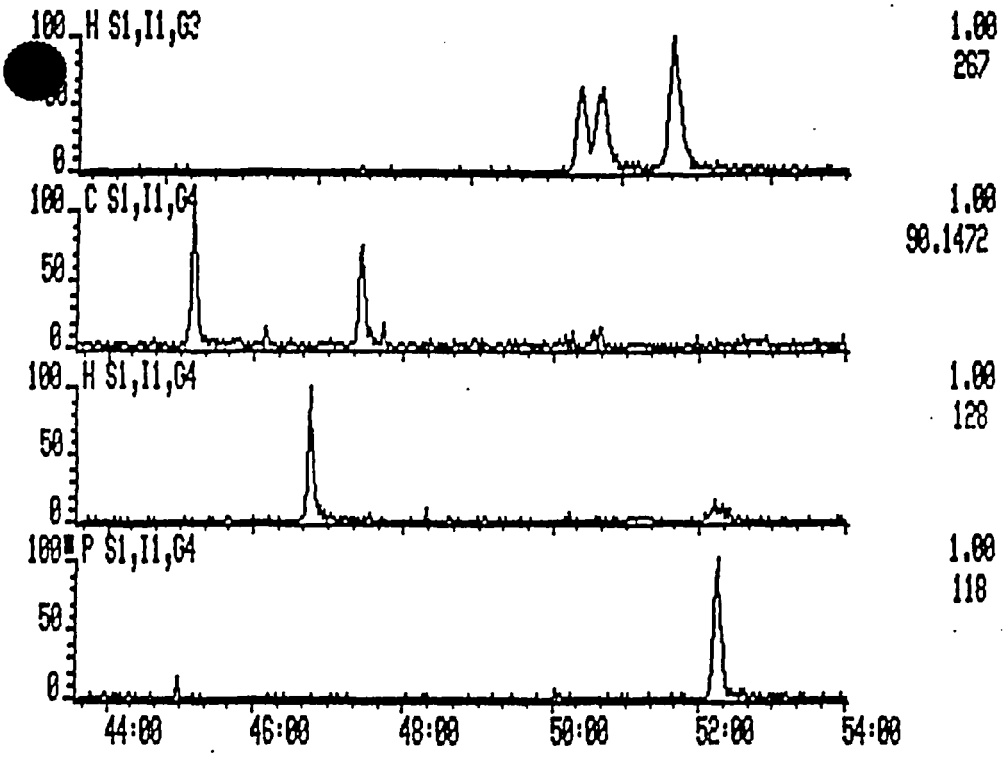
16

GR 3 D: 385.8610 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558
Text:LF1/9110 TLI# 16661



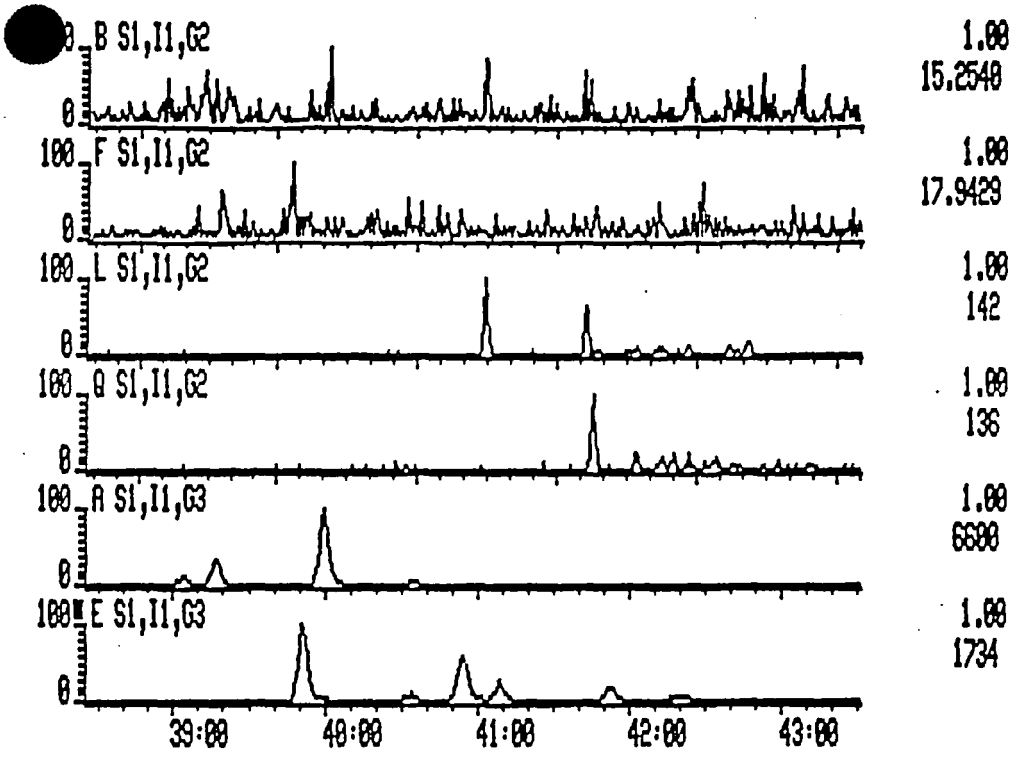
NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

GR 4 D: 419.8220 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text:LF1/9110 TLI# 16661



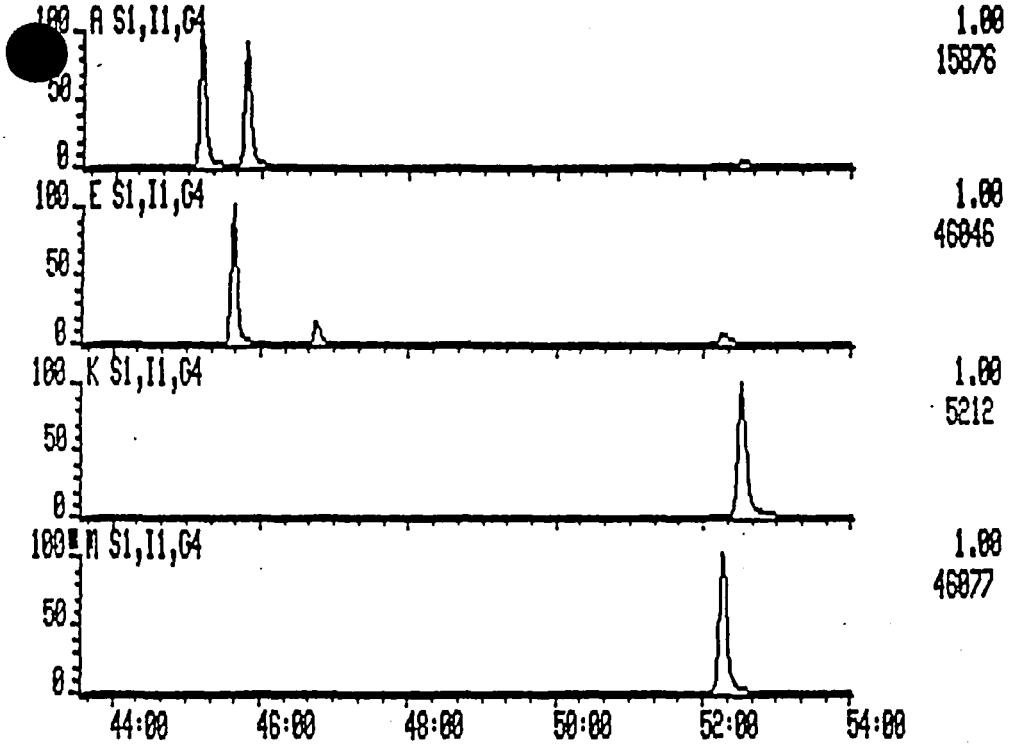
NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

S384212 8-NOV-90 17:21 70S (EI+) Sys:DB5US
GR 3 D: 385.8610 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558
Text:LF1/9110 TLI# 16661



NOV 1 9 1990
ENVIRONMENTAL ANALYS

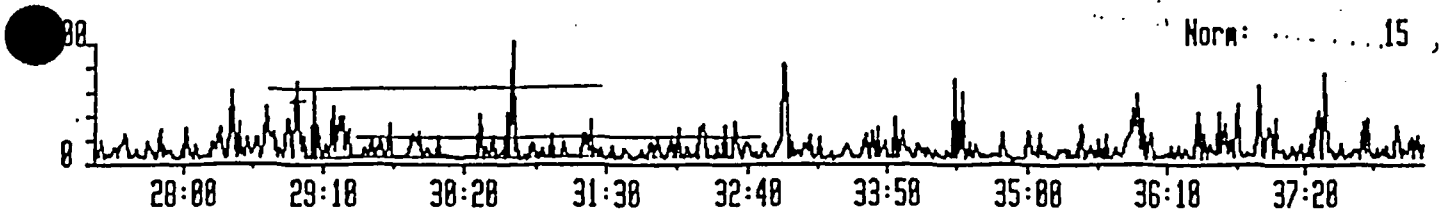
5504212 8-NOV-90 17:21 765 [illegible]
GR 4 D: 419.8228 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text:LF1/9118 TLI# 16661



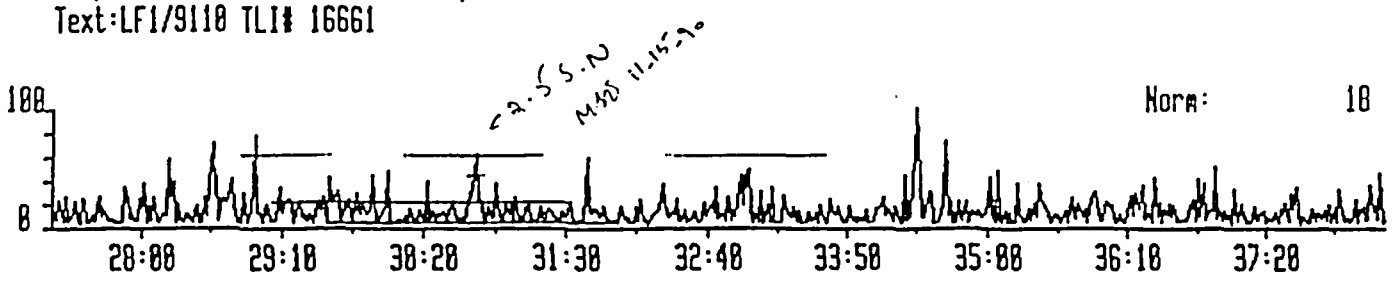
NOV 1 9 1990
ENVIRONMENTAL ANALYS

15

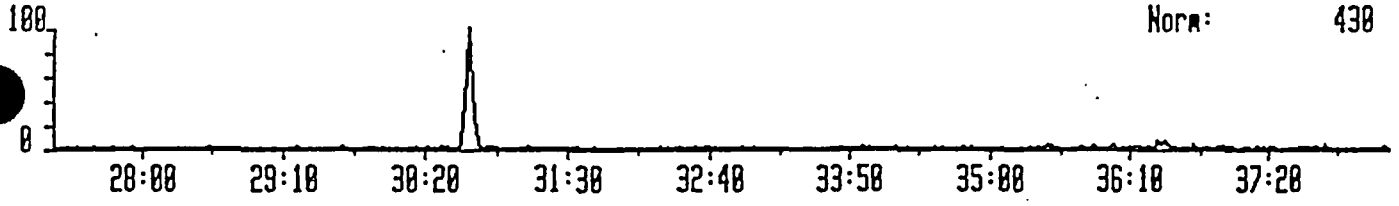
S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 303.9016
Text:LF1/9110 TLI# 16661



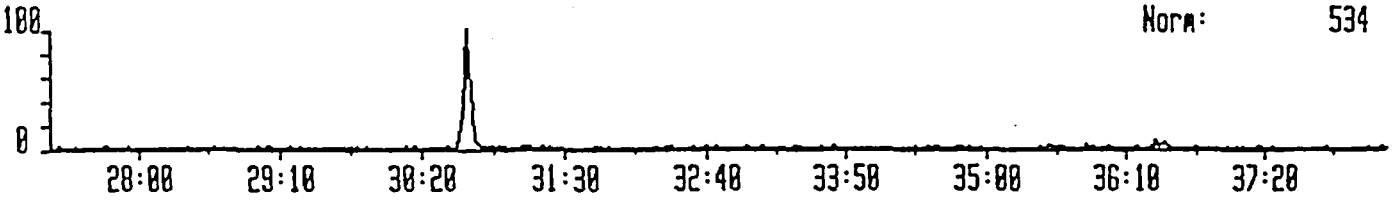
S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 305.8987
Text:LF1/9110 TLI# 16661



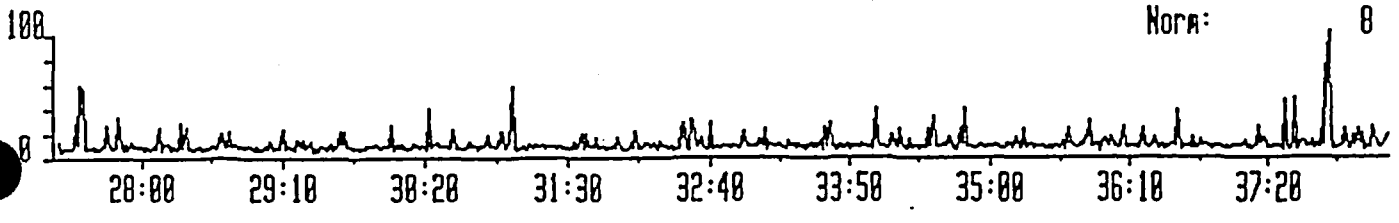
S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 315.9419
Text:LF1/9110 TLI# 16661



S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 317.9389
Text:LF1/9110 TLI# 16661

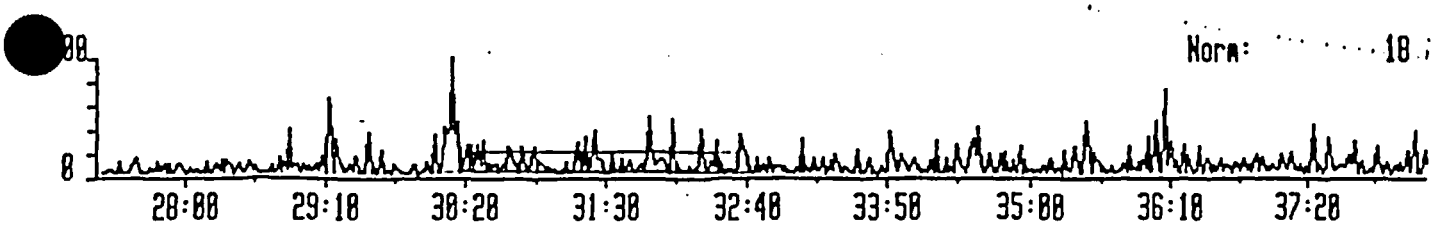


S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 375.8364
Text:LF1/9110 TLI# 16661

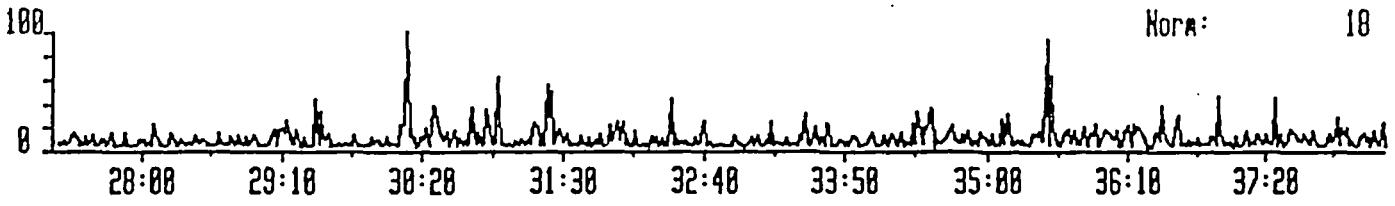


17

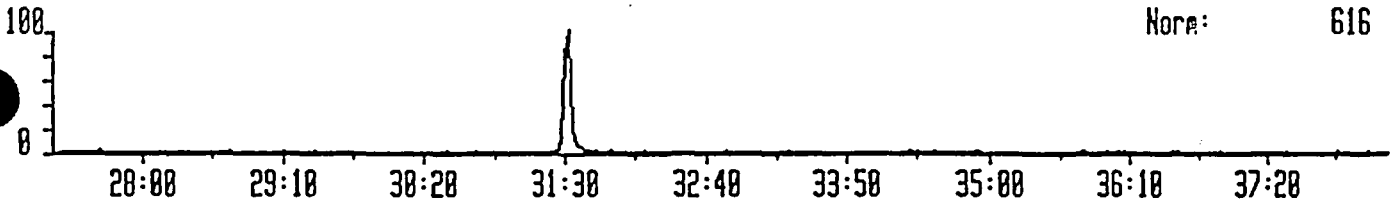
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 319.8965
Text:LF1/9110 TLI# 16661



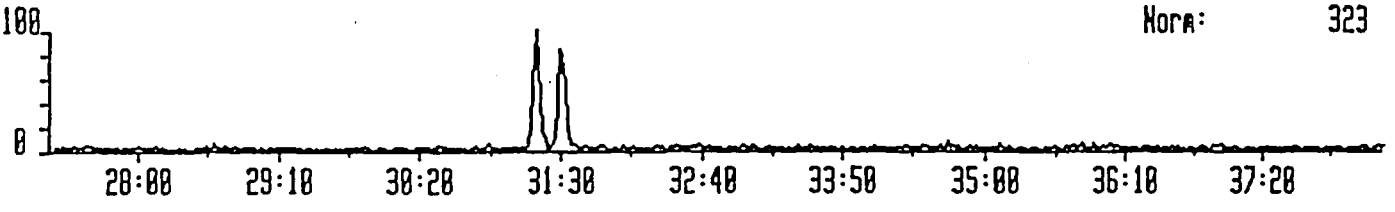
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 321.8936
Text:LF1/9110 TLI# 16661



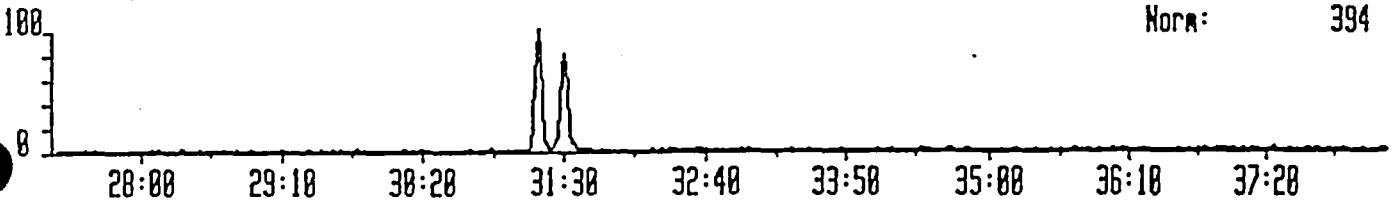
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 327.8847
Text:LF1/9110 TLI# 16661



S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 331.9368
Text:LF1/9110 TLI# 16661

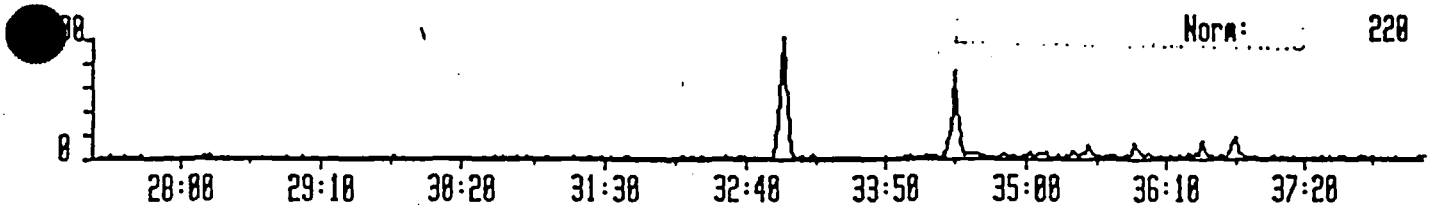


S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 333.9338
Text:LF1/9110 TLI# 16661

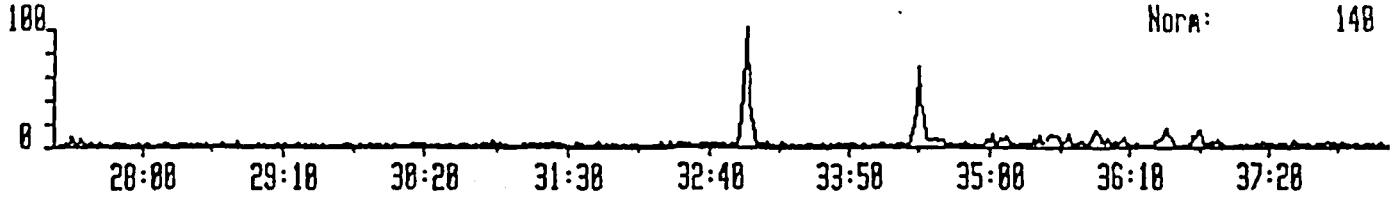


12

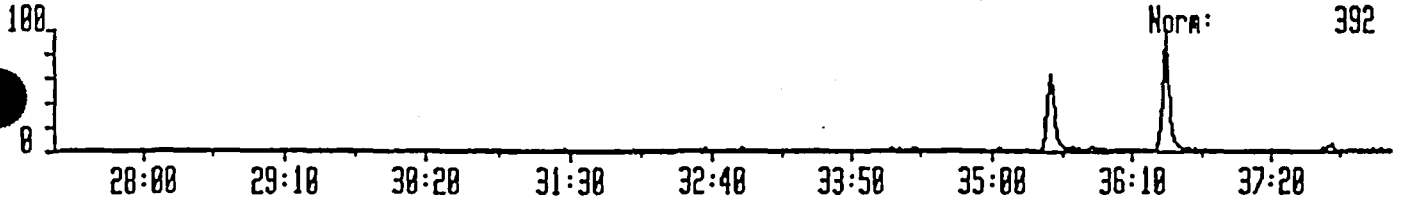
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 339.8597
Text:LF1/9110 TLI# 16661



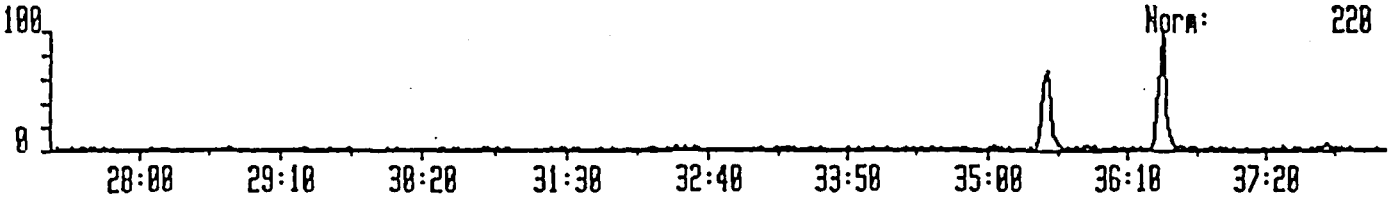
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 341.8567
Text:LF1/9110 TLI# 16661



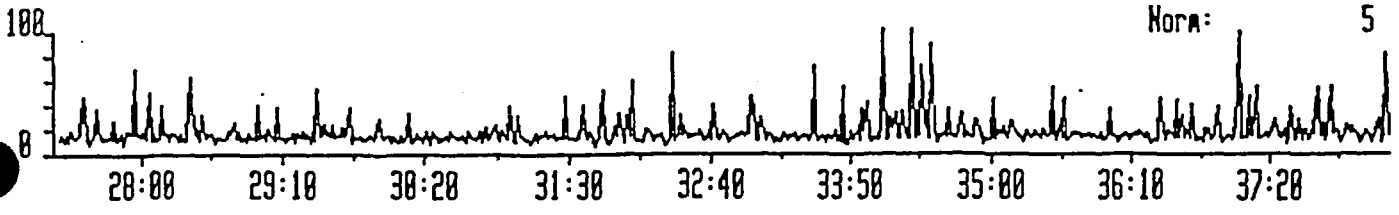
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 351.9000
Text:LF1/9110 TLI# 16661



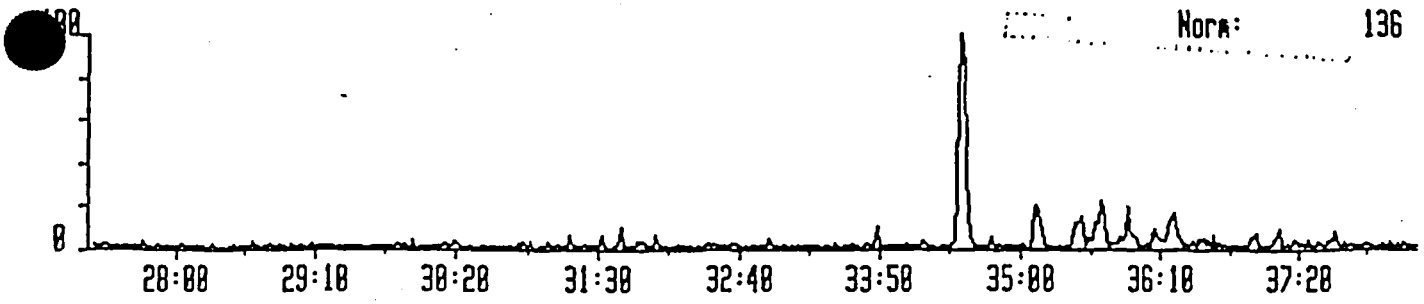
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 353.8970
Text:LF1/9110 TLI# 16661



S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 409.7974
Text:LF1/9110 TLI# 16661



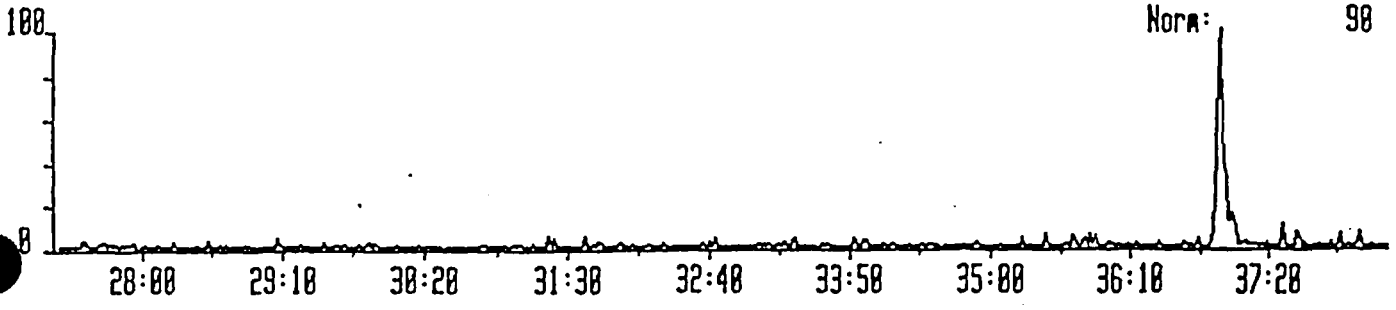
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 355.8546
Text:LF1/9110 TLI# 16661



S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 357.8516
Text:LF1/9110 TLI# 16661

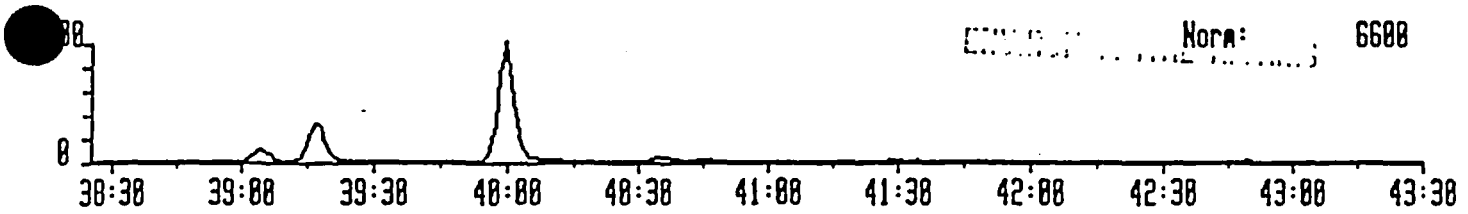
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 367.8949
Text:LF1/9110 TLI# 16661

S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 369.8919
Text:LF1/9110 TLI# 16661

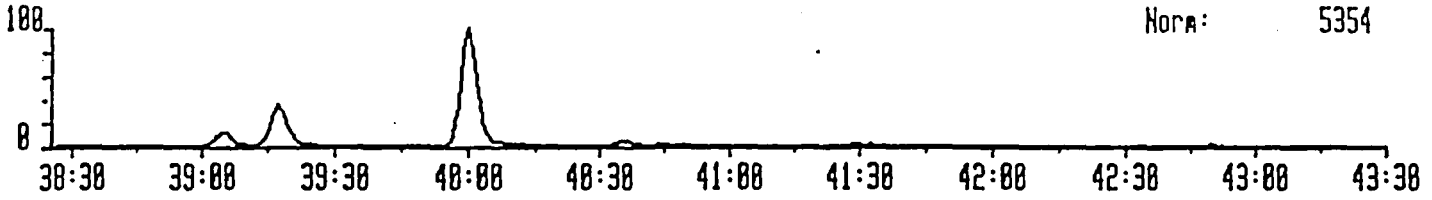


2C

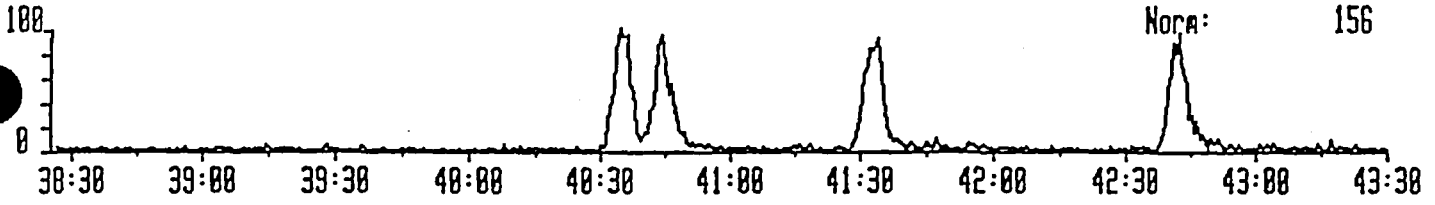
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 373.8208
Text:LF1/9110 TLI# 16661



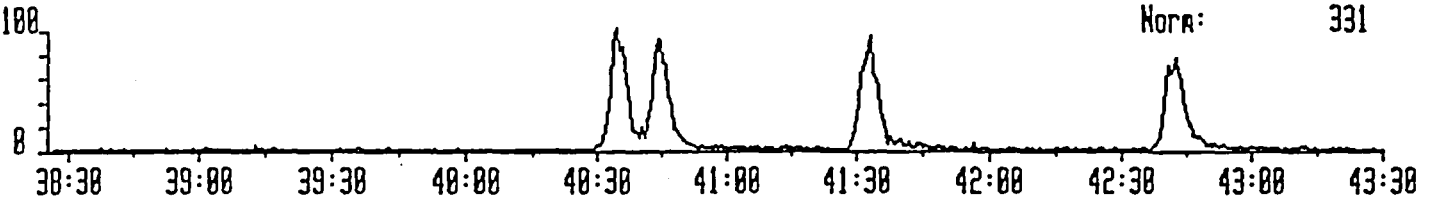
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 375.8178
Text:LF1/9110 TLI# 16661



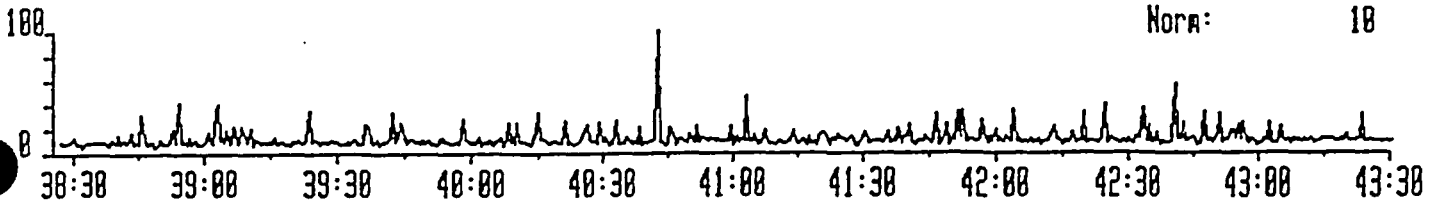
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 383.8639
Text:LF1/9110 TLI# 16661



S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 385.8610
Text:LF1/9110 TLI# 16661

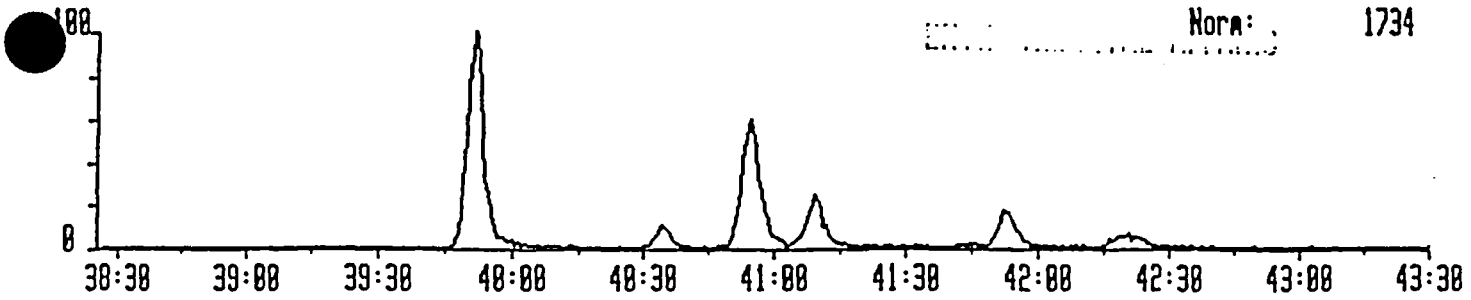


S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 445.7555
Text:LF1/9110 TLI# 16661

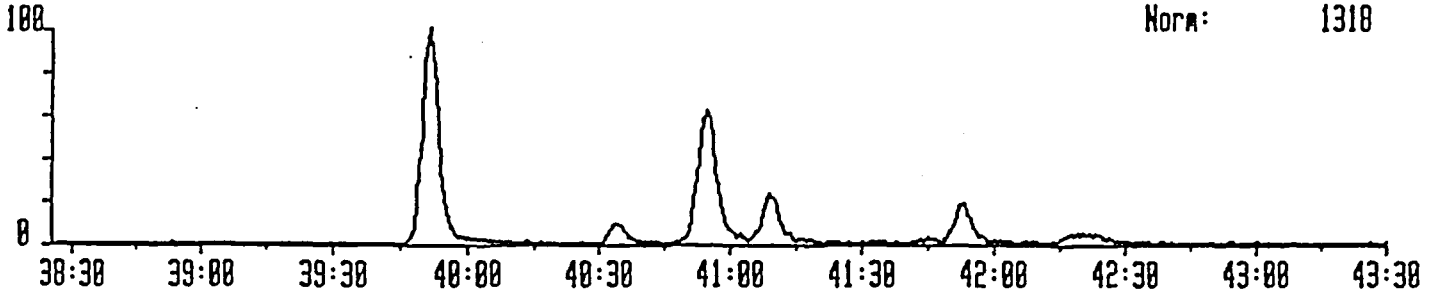


21

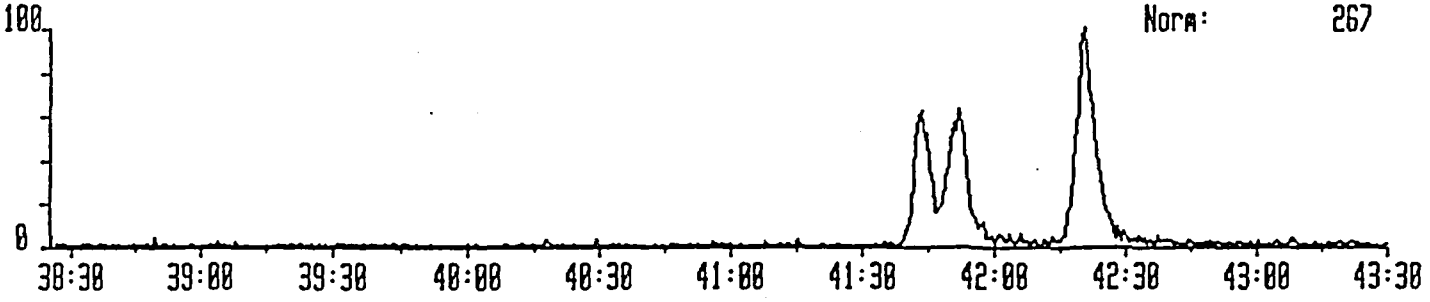
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 389.8156
Text:LF1/9110 TLI# 16661



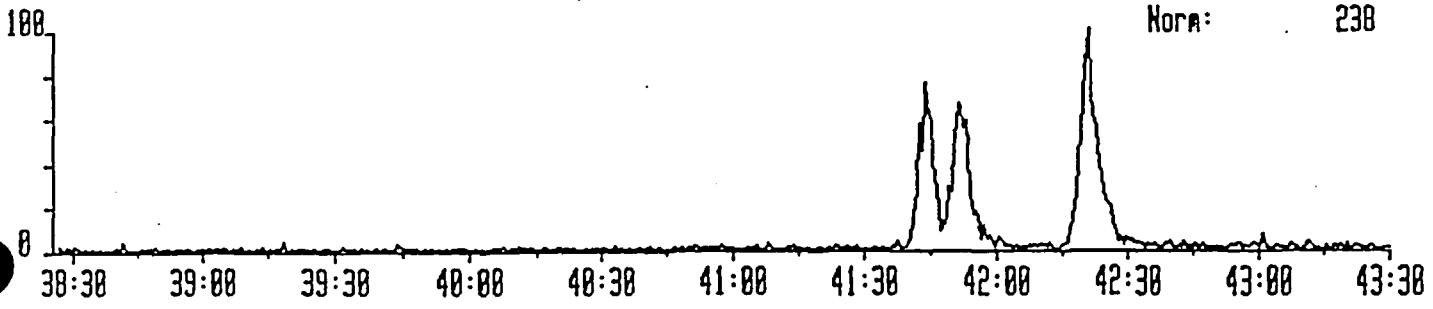
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 391.8127
Text:LF1/9110 TLI# 16661



S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 401.8558
Text:LF1/9110 TLI# 16661

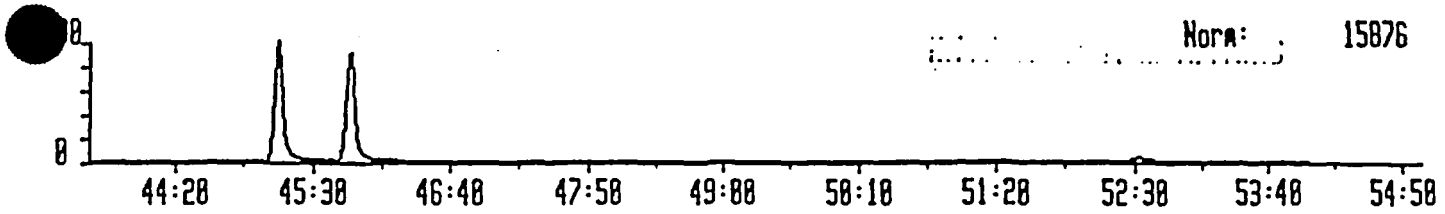


S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 403.8529
Text:LF1/9110 TLI# 16661

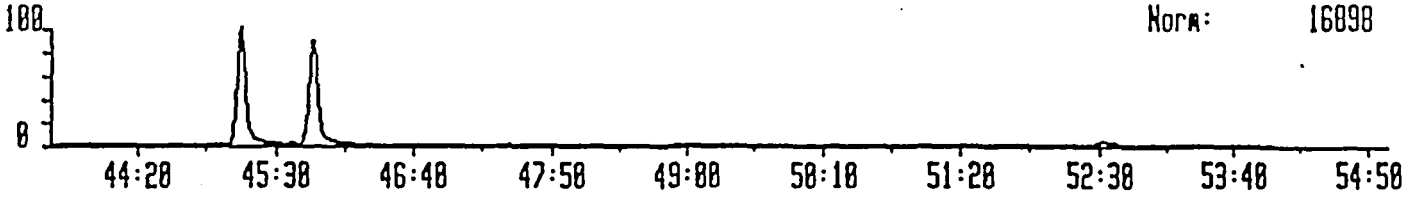


2.

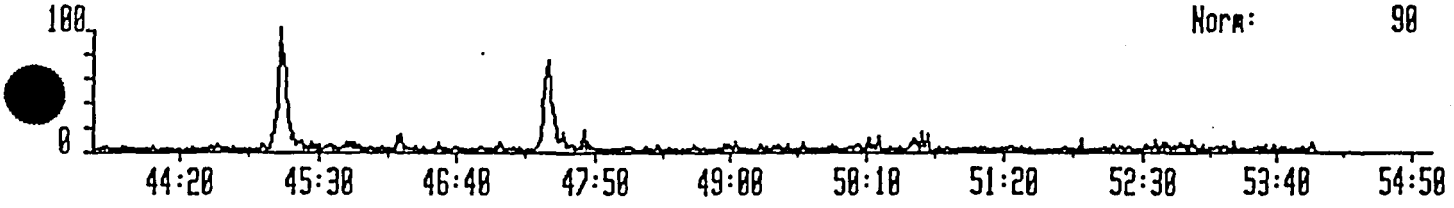
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 407.7818
Text:LF1/9110 TLI# 16661



S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 409.7789
Text:LF1/9110 TLI# 16661

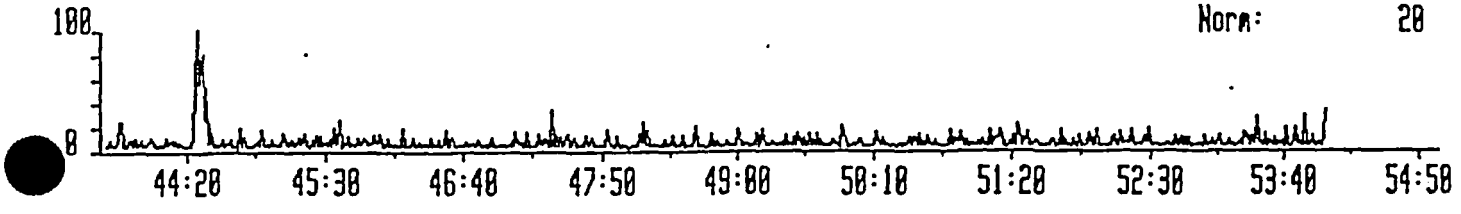


S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 417.8253
Text:LF1/9110 TLI# 16661



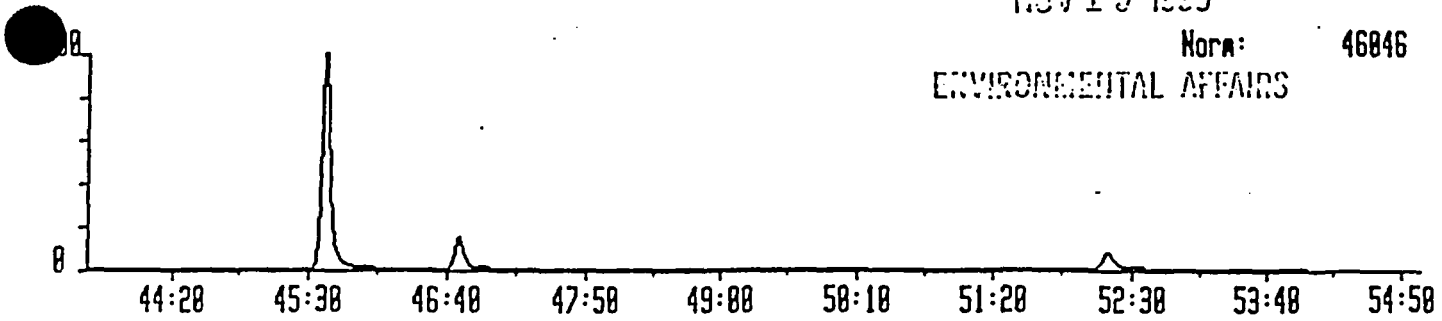
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 419.8220
Text:LF1/9110 TLI# 16661

S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 479.7165
Text:LF1/9110 TLI# 16661

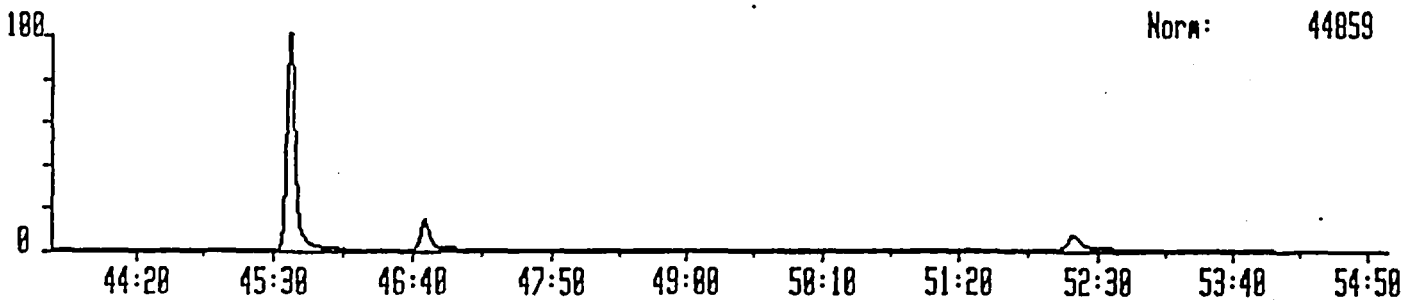


S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 423.7766
Text:LF1/9110 TLI# 16661

NOV 1 0 1990
ENVIRONMENTAL AFFAIRS



S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 425.7737
Text:LF1/9110 TLI# 16661

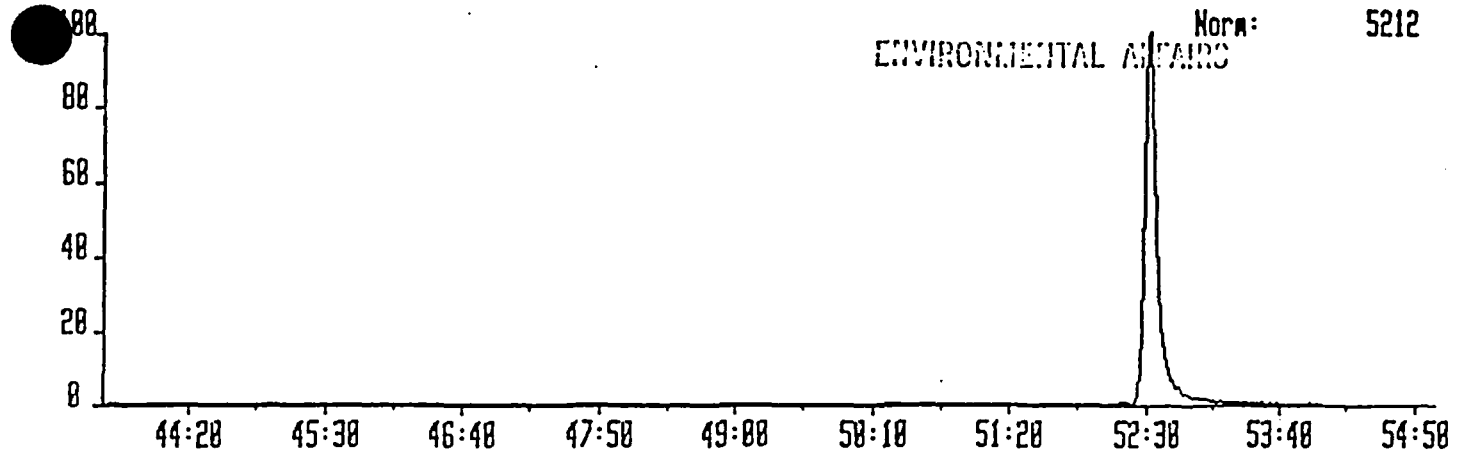


S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 435.8169
Text:LF1/9110 TLI# 16661

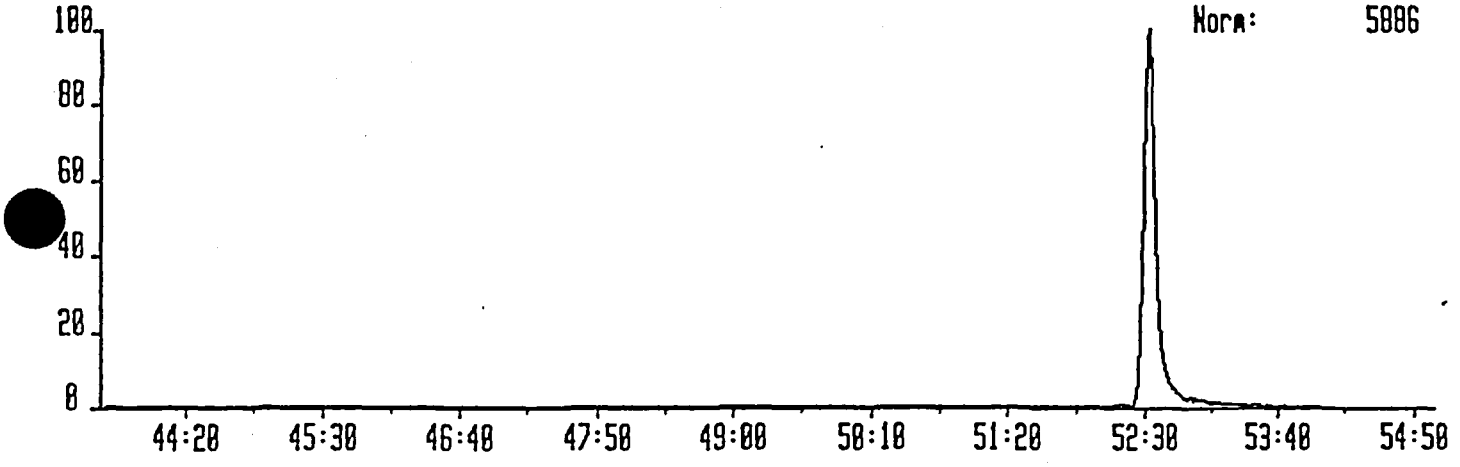
S984212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 437.8140
Text:LF1/9110 TLI# 16661

S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 441.7428
Text:LF1/9110 TLI# 16661

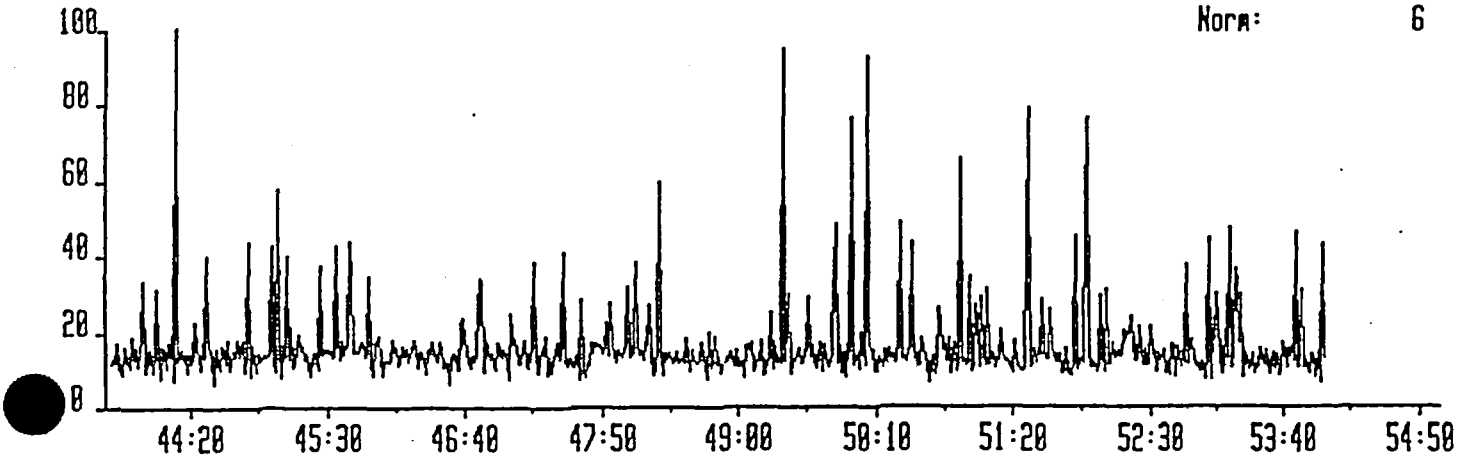
NOV 1 0 1990
ENVIRONMENTAL AFFAIRS



S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 443.7399
Text:LF1/9110 TLI# 16661



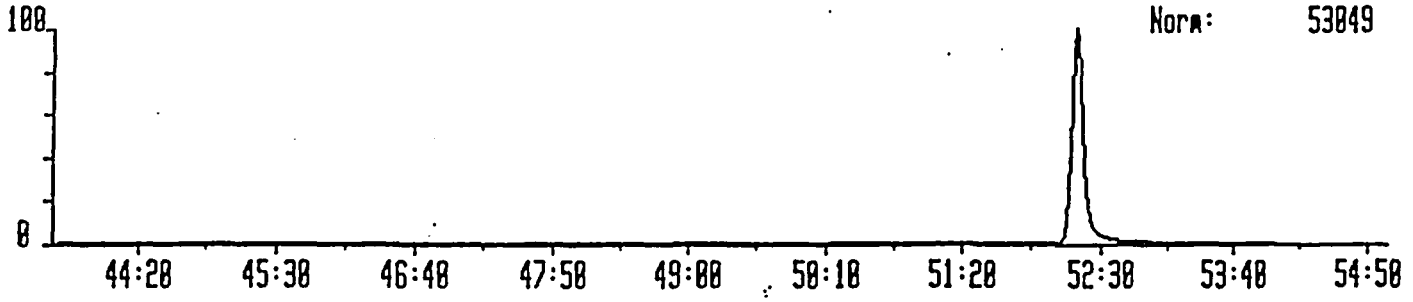
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 513.6775
Text:LF1/9110 TLI# 16661



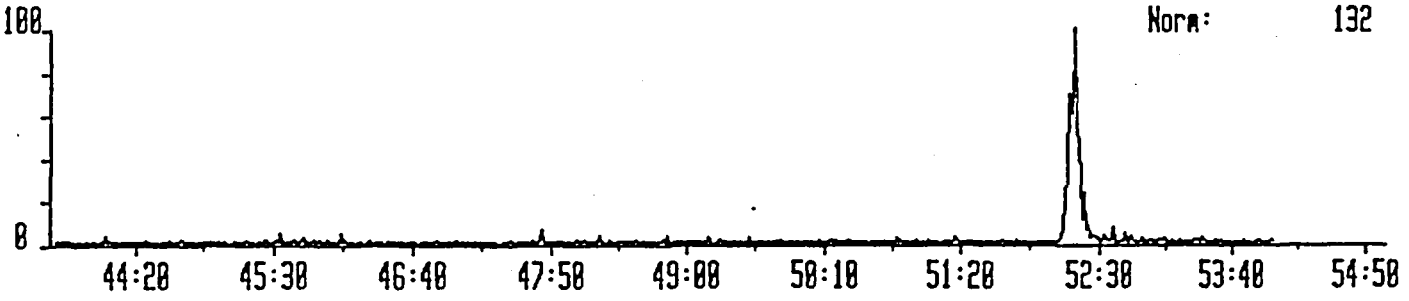
25

S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 457.7377
Text:LF1/9110 TLI# 16661

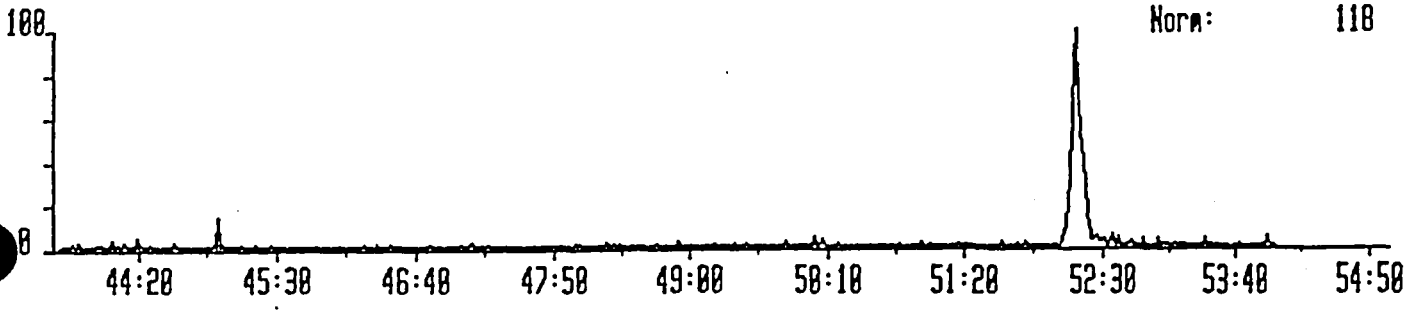
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 459.7348
Text:LF1/9110 TLI# 16661



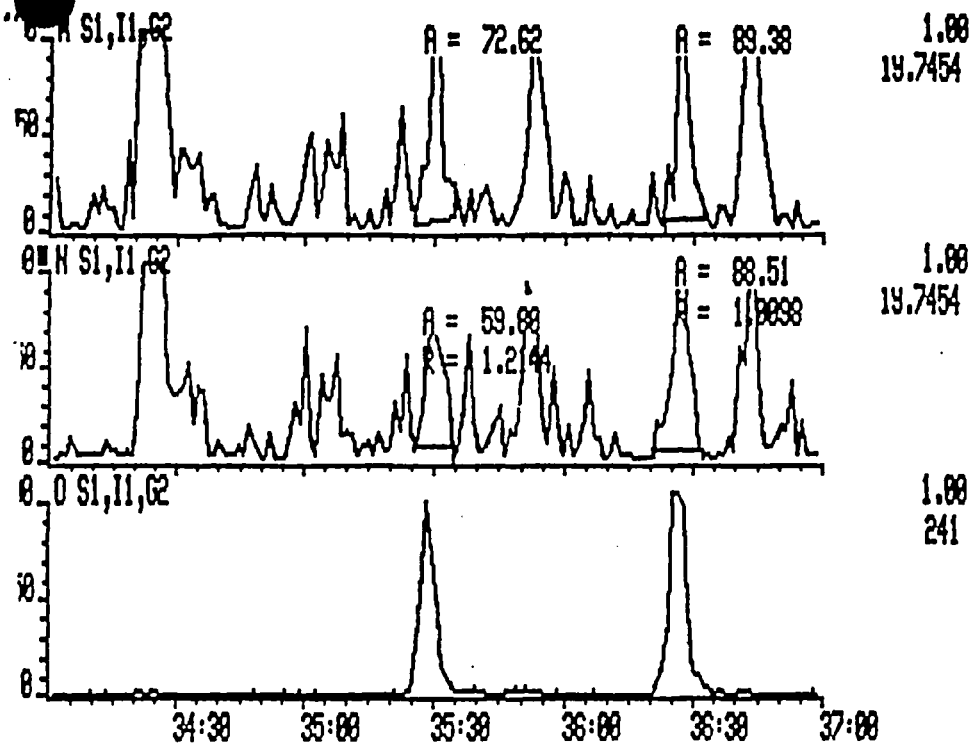
S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 469.7779
Text:LF1/9110 TLI# 16661



S904212 8-NOV-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 471.7750
Text:LF1/9110 TLI# 16661



4212 8-NOV-90 17:21 78S (EI+) Sys:D85US
GR 2 M: 339.8597 N: 341.8567 O: 351.9888 P: 353.8978 Q: 355.8546
t:LF1/9110 TLI# 16661

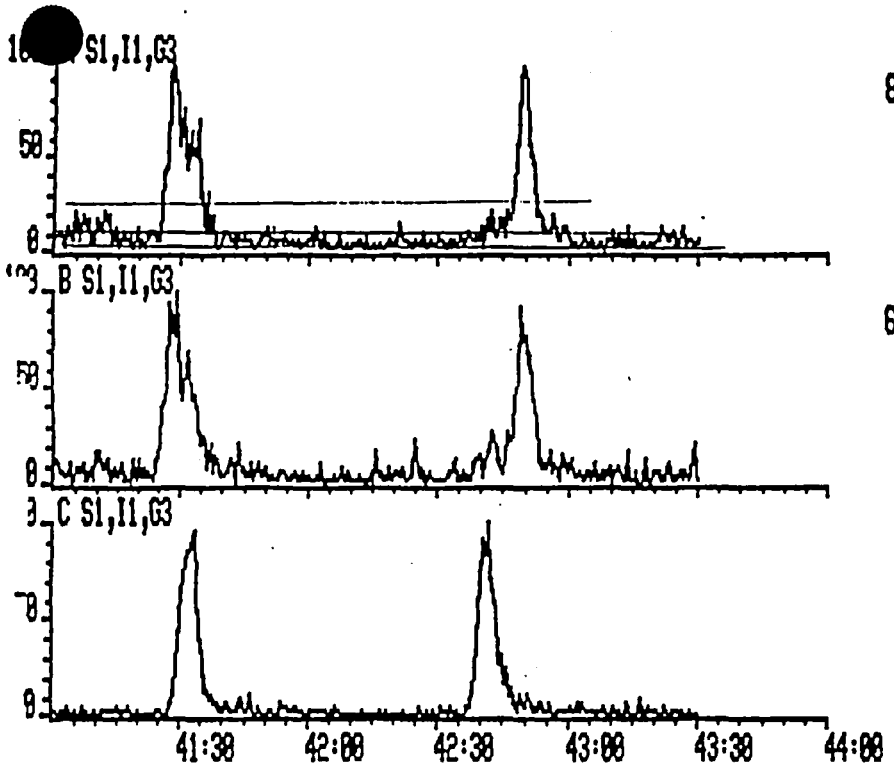


NOV 20 1990

MAS
11-15-90

2

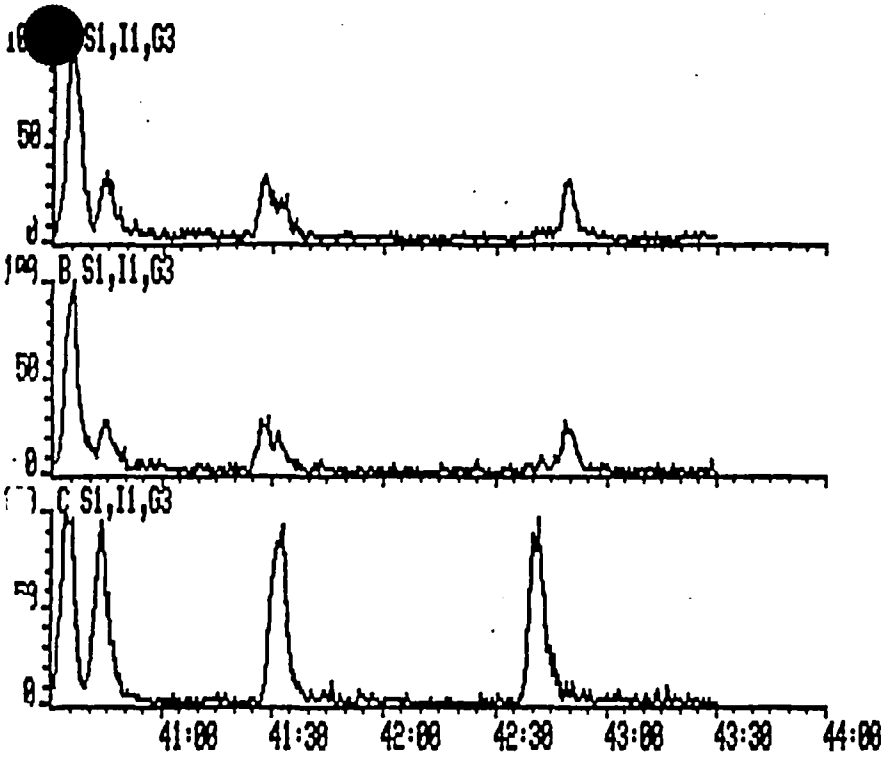
4212 8-NOV-90 17:21 78S (EI+) Sys:D85US
3 A: 373.8208 B: 375.8178 C: 383.8639 D: 385.8610 E: 389.8156
T-t:LF1/9110 TLI# 16661



NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

MSD
11-15-90

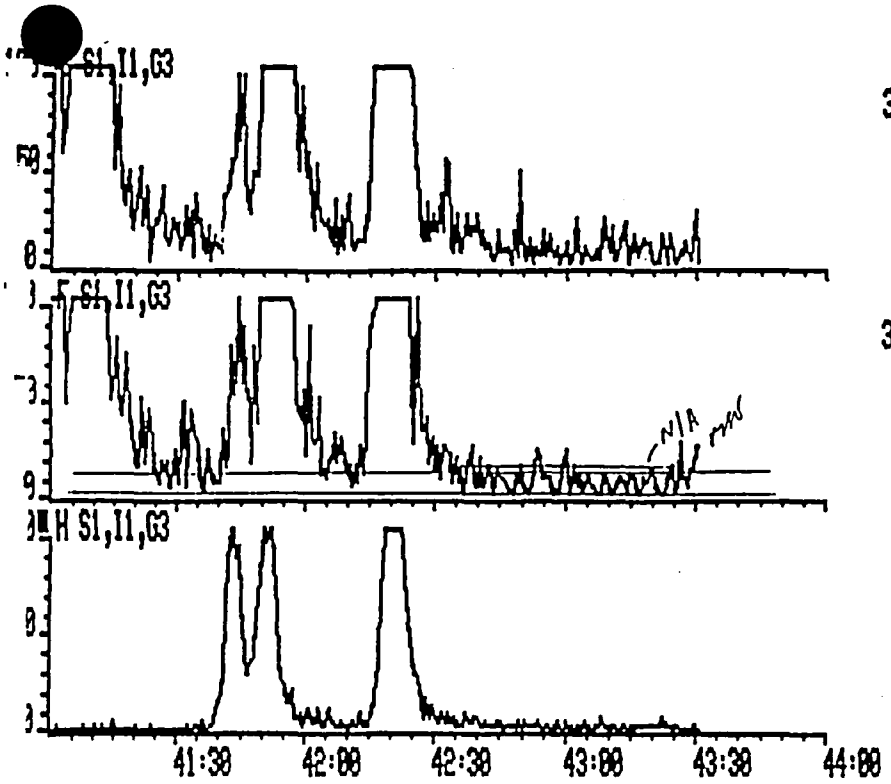
~ 1212 8-NOV-90 17:21 70S (EI+) Sys:D85US
:3 A: 373.8288 B: 375.8178 C: 383.8639 D: 385.8610 E: 389.8156
Text:LF1/9110 TLI# 16661



NOV 19 1990
ENVIRONMENTAL ANALYS

MJS
11-15-90

J4212 8-NOV-90 17:21 70S (EI+) Sus:D85US
GR-3 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558 I: 403.8529
T :LF1/9110 TLI# 16661

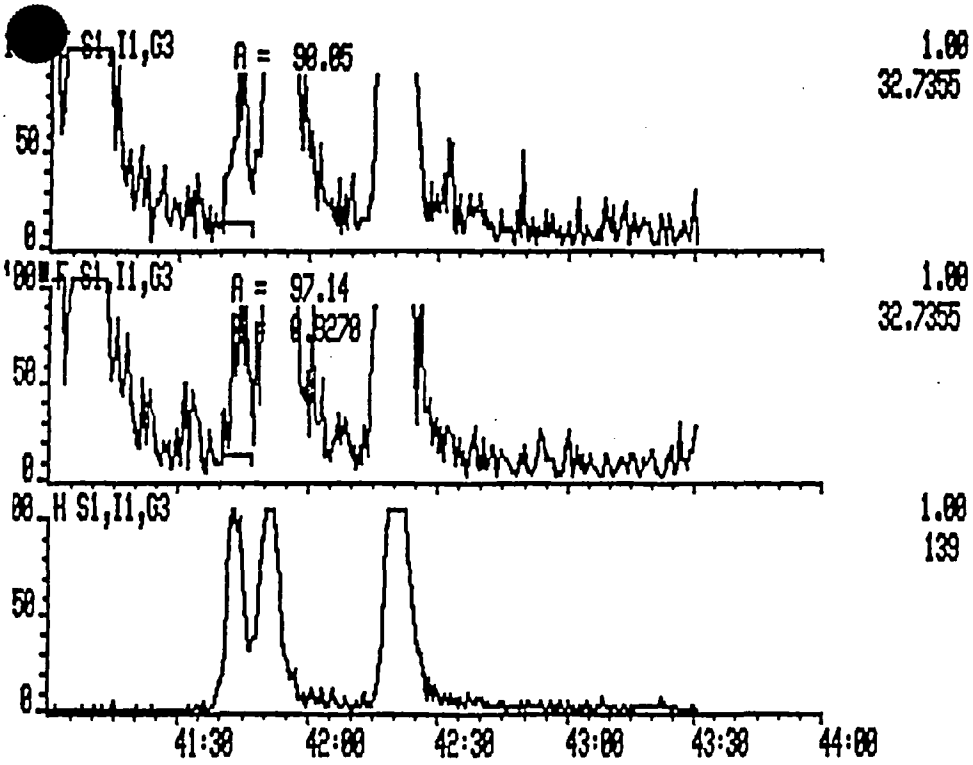


NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

MS25
11-15-90

3

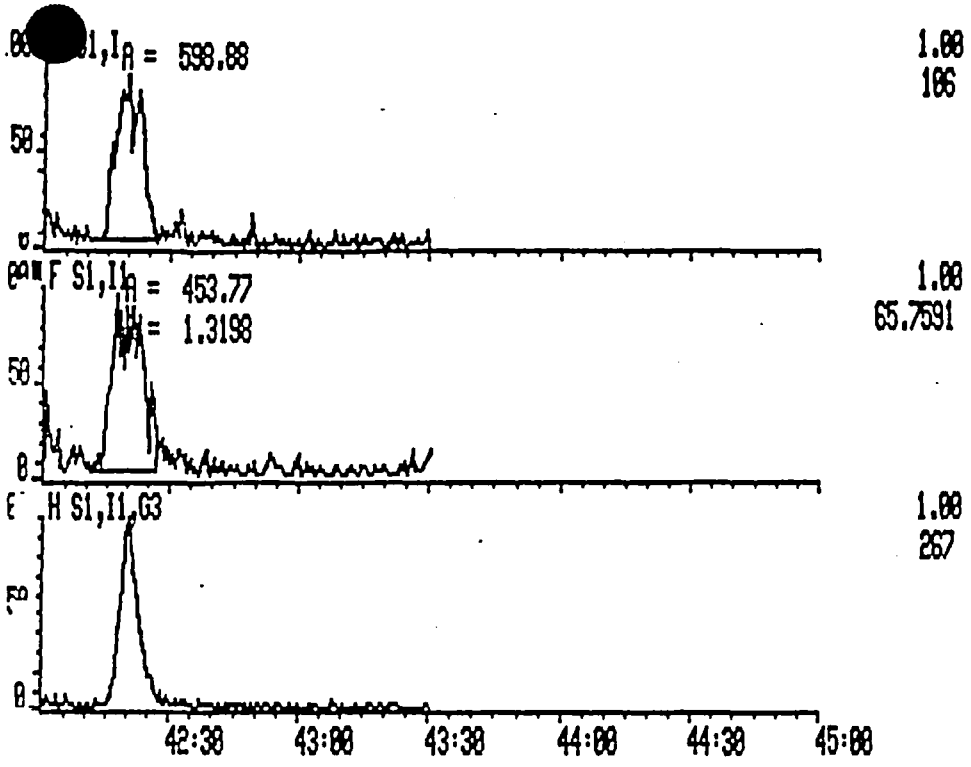
84212 8-NOV-90 17:21 70S (EI+) Sys:D85US
JR 3 E: 389.8156 F: 391.8127 G: 392.9769 H: 401.8558 I: 403.8529
T-xt:LF1/9110 TLI# 16661



NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

MSB
11-13-90

12 8-NOV-90 17:21 786 (EI+) Sus:D85US
E: 389.8156 F: 391.8127 G: 392.9768 H: 401.8558 I: 403.8529
:LF1/9110 TLI# 16661



NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

MSS
11-15-90

3.c

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b)

11/15/90

FILE NAME....: S903790
CONCAL (VER).: S903783
PROJECT NUMBER: 16661
ANALYST.....: CP
SAMPLE SIZE..: 9.460 g
DATE RECEIVED.: 10/10/90
SPIKE FILE...: SPX23710

CLIENT ID....: SWP
SAMPLE ID....: LF1/9110
ICAL DATE....: 10/13/90
ANALYSIS DATE: 10/18/90
SAMPLE MATRIX: SOIL
DATE COLLECTED: 10/09/90

TLI NUMBER....: 37-26-1
SAMPLE ORIGIN: WILMINGTO
SHIPMENT NO...: NC09001

NAME	CONC(ppb)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	EMPC			0.004			—
12378-PeCDD	0.03				1.56	36:55	—
123478-HxCDD	0.10				1.24	41:41	—
123678-HxCDD	1.3				1.22	41:49	—
123789-HxCDD	0.22				1.23	42:15	—
1234678-HpCDD	19.6				1.00	46:34	S
OCDD	56.3				0.92	52:00	S,B
2378-TCDF	0.02				0.74	30:47	—
12378-PeCDF	0.06				1.67	35:29	—
23478-PeCDF	0.06				1.59	36:26	Q
123478-HxCDF	0.71				1.15	40:32	—
123678-HxCDF	0.24				1.16	40:41	—
234678-HxCDF	0.16				1.18	41:31	B
123789-HxCDF	0.04				1.15	42:37	—
1234678-HpCDF	9.7				0.92	45:05	S
1234789-HpCDF	0.77				0.88	47:14	—
OCDF	28.4				0.96	52:13	S
TOTAL TCDD	0.14	7		0.17	0.75		—
TOTAL PeCDD	0.48	11			1.51		Q
TOTAL HxCDD	15.2	8		15.2	1.20		S
TOTAL HpCDD	49.1	2			1.00		S
TOTAL TCDF	0.09	8		0.11	0.76		Q
TOTAL PeCDF	0.92	10		0.92	1.54		Q
TOTAL HxCDF	3.9	9		13.8	1.16		S
TOTAL HpCDF	25.4	3		25.6	0.91		S

MBB 11/15/90

X237_RPT rev:3.03

TRIANGLE LABORATORIES, INC.
PCDD/PCDF 2378X ANALYSIS (b) QA/QC SUMMARY 11/15/90

NOV 19 1990

FILE NAME....: S903790	CLIENT ID....: SWP	TLI NUMBER....: 37-26-1
CONCAL (VER).: S903783	SAMPLE ID....: LF1/9110	
PROJECT NUMBER: 16661	ICAL DATE....: 10/13/90	
ANALYST.....: CP	ANALYSIS DATE: 10/18/90	
SAMPLE SIZE..: 9.460 g	SAMPLE MATRIX: SOIL	SAMPLE ORIGIN: WILMINGTO
DATE RECEIVED.: 10/10/90	DATE COLLECTED: 10/09/90	
SPIKE FILE...: SPX23710		SHIPMENT NO...: NC09001

SURROGATE RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
37Cl-TCDD	0.84	79.7		31:40	___
13C12-PeCDF 234	0.92	87.3	1.53	36:26	___
13C12-HxCDF 478	0.95	89.8	0.52	40:31	___
13C12-HxCDD 478	1.1	101	1.19	41:40	___
13C12-HpCDF 789	0.66	62.6	0.44	47:13	___

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	0.86	81.0	0.50	42:36	___
13C12-HxCDF 234	0.92	87.1	0.51	41:30	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	0.66	62.1	0.78	30:47	___
13C12-2378-TCDD	0.85	80.4	0.81	31:38	___
13C12-PeCDF 123	0.84	79.3	1.53	35:29	Q
13C12-PeCDD 123	1.1	109	1.58	36:55	___
13C12-HxCDF 678	0.85	80.3	0.52	40:40	___
13C12-HxCDD 678	0.98	93.1	1.18	41:47	___
13C12-HpCDF 678	0.69	64.8	0.46	45:02	___ Q, RS2
13C12-HpCDD 678	0.76	72.3	1.03	46:33	___
13C12-OCDD	1.5	69.6	0.98	52:01	___

17565	11/15/90	X237_RPT rev:3.03

2

	Initial	Date
B-File/Header Changes	KV	10/31/90
Manual Integrations	KV	10/31/90
Transcription	KV	10/31/90
Dbase Corrections	KV	10/31/90

NOV 19 1990
ENVIRONMENTAL ANALYSIS

Page No. 1 Listing of S903790B.dbf
10/26/90

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
304		0.56	28:00	1692.34	F	F	0.910	-
		0.68	28:17	2873.19	T	F	0.919	-
		0.77	28:34	3874.59	T	F	0.928	-
		0.79	28:53	4718.60	T	F	0.938	-
		0.68	29:13	4475.07	T	F	0.949	-
		0.85	29:39	2559.68	T	F	0.963	-
		0.63	29:54	3826.49	F	F	0.971	-
		0.75	30:15	2103.48	T	F	0.983	-
		0.92	30:32	509.74	F	F	0.992	-
		0.74	30:47	4362.84	T	T	1.000	
		0.78	31:20	513.24	T	F	1.018	-
		0.91	31:31	437.64	F	F	1.024	-
		0.28	31:49	139.53	F	F	1.034	SV
		0.71	33:16	5448.09	T	F	1.081	-
		0.27	33:32	189.74	F	F	1.089	- RV
		0.05	33:43	243.23	F	F	1.095	
304		*** Total ***		37967.49	# of Peaks:		16	
316		0.78	30:14	2302.09	T	F	0.982	
		0.78	30:47	291917.80	T	T	1.000	-
		0.74	31:18	2473.14	T	F	1.017	
316		*** Total ***		296693.03	# of Peaks:		3	
320		.67	31:10	787.6	T	F	1.006	
320		0.71	29:13	1072.05	T	F	0.924	
		0.62	29:30	1231.30	F	F	0.933	
		0.78	30:14.	9664.73	T	F	0.956	-
		0.91	30:26	4312.32	F	F	0.962	-
		0.72	31:00	1469.45	T	F	0.980	-
		~~0.22~~ .45	31:20	~~1967.16~~ 5064.6	~~F~~ T	F	0.991	-
		0.69	31:30	2955.45	T	F	0.996	
		ROC1= ~~0.91~~ .59	31:41	~~1116.60~~ 1660.3	~~F~~ F	T	1.002	
		0.85	32:01	1319.34	T	F	1.012	
		0.59	32:46	313.01	F	F	1.036	
		0.34	33:42	58.44	F	F	1.065	
		0.49	34:12	608.93	F	F	1.081	
		0.85	34:42	360.45	T	F	1.097	RV
		0.87	35:09	628.00	T	F	1.111	
320		*** Total ***		27097.23 KV 10/31/90	# of Peaks:		14	
320		.87	29:43	~~5064.6~~ 1353.5	T	F	.190	
328		0.00	31:23	433.95	T	F	0.992	
		0.00	31:40	227727.67	T	T	1.001	
328		*** Total ***		228161.62	# of Peaks:		2	
				261637				
332		~~0.61~~ .90	31:20	~~275871~~.77	T	~~F~~ T	0.991	
		0.81	31:38	218048.20	T	T	1.000	
332		*** Total ***		493919.97	# of Peaks:		2	
340		2.34	31:19	40.80	F	F	0.883	SV

h olse = 155.
(30

3

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
340		5.43	31:32	47.79	F	F	0.889	Sw
		b 1.54	31:38	21.31	T	F	0.891	
		2.26	32:51	219.17	F	F	0.926	
		1.56	33:16	113417.32	T	F	0.938	-Q
		D 6.99	33:57	76.87	F	F	0.957	Sw
		1.57	34:40	12262.45	T	F	0.977	
		1.33	34:49	1144.90	T	F	0.981	
		1.58	35:00	10244.35	T	F	0.986	
		1.51	35:22	5078.26	T	F	0.997	
		1.67	35:29	12930.20	T	T	1.000	
		1.24	35:42	670.89	F	F	1.006	
		1.55	35:51	9537.08	T	F	1.010	
		b 2.94	36:11	26.23	F	F	1.020	Sw
		1.59	36:26	12245.51	T	T	1.027	-Q
		1.57	36:41	21266.48	T	F	1.034	-Q
		3.06	37:04	248.89	F	F	1.045	
		1.51	37:46	1261.75	T	F	1.064	
340		*** Total ***		200740.25	# of Peaks:		18	
352		1.45	35:00	996.54	T	F	0.986	
		1.53	35:29	150619.29	T	T	1.000	-Q
		1.63	35:50	2491.58	T	F	1.010	
		1.53	36:26	193853.65	T	T	1.027	
		1.54	37:45	3534.99	T	F	1.064	
352		*** Total ***		351496.05	# of Peaks:		5	
356		D 0.48	32:47	295.96	F	F	0.888	RW
		1.57	34:40	7397.86	T	F	0.939	-Q
		1.54	35:08	13059.96	T	F	0.952	-Q
		1.35	35:27	9954.70	T	F	0.960	
		1.55	35:38	7433.02	T	F	0.965	
		1.54	35:52	6630.43	T	F	0.972	
		1.54	36:13	22786.14	T	F	0.981	-Q
		1.56	36:29	2347.26	T	F	0.988	
		1.43	36:40	877.45	T	F	0.993	
		1.56	36:55	6291.59	T	T	1.000	
		1.60	37:07	7157.32	T	F	1.005	
		1.35	37:34	3612.61	T	F	1.018	
356		*** Total ***		87844.30	# of Peaks:		12	
368		0.38	35:27	551.26	F	F	0.960	
		1.58	36:55	108306.59	T	T	1.000	
		1.56	37:34	918.87	T	F	1.018	
368		*** Total ***		109776.72	# of Peaks:		3	
374		1.14	39:01	425148.26	T	F	0.959	
		1.00	39:13	869382.69	F	F	0.964	-S
		1.12	39:40	11563.58	T	F	0.975	
		0.98	39:56	1157617.75	F	F	0.982	-S
		1.15	40:32	172380.56	T	T	0.997	
		1.16	40:41	61516.91	T	T	1.000	
		1.28	41:06	5889.81	T	F	1.011	
		1.13	41:25	39004.88	T	~~T~~ F	1.01~~8~~7	

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
374		1.18	41:31	29211.93	T	T	1.021	
		0.92	41:51	508.87	F	F	1.029	
		0.88	42:02	69.32	F	F	1.034	SN
		1.15	42:37	5875.95	T	T	1.048	
		1.16	42:44	42431.17	T	F	1.05	
374		*** Total ***		2820601.68	# of Peaks:		13	
384		0.99	38:59	242.62	F	F	0.959	
		1.16	39:13	524.81	F	F	0.964	
		0.52	40:31	166989.98	T	T	0.996	
		0.52	40:40	169774.90	T	T	1.000	
		0.51	41:30	161637.20	T	T	1.020	
		0.50	42:36	126704.03	T	T	1.048	
384		*** Total ***		625873.54	# of Peaks:		6	
390		1.26	42:12	30456.9	T	F	1.03	
390		0.13	38:05	588.74	F	F	0.911	
		1.07	39:48	789321.41	T	F	0.953	S
		1.22	40:29	96515.63	T	F	0.969	
		1.13	40:50	707897.62	T	F	0.977	
		1.22	41:05	245985.41	T	F	0.983	
		1.24	41:41	14374.73	T	T	0.997	
		1.22	41:49	180860.36	T	T	1.001	
		0.94	42:30	394.19	F	F	1.017	
		0.44	42:43	40.83	F	F	1.022	
390		*** Total ***		2035978.92	# of Peaks:		9	
390		1.23	42:15	28387.2	T	T	1.011	
402		1.19	41:40	103458.99	T	T	0.997	
		1.18	41:47	122975.65	T	T	1.000	
		1.20	42:15	134606.41	T	T	1.011	
402		*** Total ***		361041.05	# of Peaks:		3	
408		0.92	45:05	1828749.44	T	T	1.001	S
		0.93	45:38	1897536.75	T	F	1.013	S
		0.66	46:34	30904.72	F	F	1.034	
		0.88	47:14	86732.31	T	T	1.049	
408		*** Total ***		3843923.22	# of Peaks:		4	
418		0.46	45:02	100995.79	T	T	1.000	
		1.30	45:38	5094.47	F	F	1.013	
		0.50	45:57	6704.31	T	F	1.020	
		0.65	46:35	284.82	F	F	1.034	
		0.44	47:13	74411.68	T	T	1.048	
		0.97	48:10	837.17	F	F	1.070	
418		*** Total ***		188328.24	# of Peaks:		6	
424		1.00	45:29	2689020.38	T	F	0.977	S
		1.00	46:34	1789214.87	T	T	1.000	S
		1.38	50:08	1050.78	F	F	1.077	
424		*** Total ***		4479286.03	# of Peaks:		3	
436		1.44	45:29	3235.84	F	F	0.977	
		0.83	45:55	105.51	F	F	0.986	
		1.03	46:33	81233.24	T	T	1.000	

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
436		*** Total ***		84574.59	# of Peaks:		3	
442		0.96	52:13	1982768.00	T	T	1.004	- S
		1.12	54:03	2816.04	F	F	1.039	
442		*** Total ***		1985584.04	# of Peaks:		2	
470		1.70	50:13	24.94	F	F	0.965	
		0.57	51:02	26.26	F	F	0.981	
		0.98	52:01	74412.50	T	T	1.000	- S
470		*** Total ***		74463.70	# of Peaks:		3	

*** End of Report *** 0.92 52.00 3328608 T T 1.000 - S

458

6

NOV 1 9 1990

Listing of S9037901.dbf File
Raw Mass, Retention Time and Data.Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
202	10:25	60.07	14:55	85.02	18:29	83.21	20:04	575.05
	10:33	15.50	15:33	23.31	18:37	232.25	20:23	193866.37
	10:55	27.15	15:59	59.40	19:05	210.62	20:55	10844.85
	11:03	50.02	16:20	120.00	19:15	10115.42		
	11:26	46.61	17:01	31.17	19:29	915.05		
	13:31	67.90	17:13	1902.94	19:50	716.49		
204	10:25	21.46	13:04	28.30	16:48	26.13	19:15	249.50
	10:39	38.40	13:28	42.30	16:57	23.34	19:28	106.54
	11:14	12.92	13:45	37.77	17:06	62.37	19:43	21.67
	11:29	42.24	14:58	37.83	17:14	85.54	20:02	92.52
	11:59	18.13	15:33	26.81	17:30	96.69	20:10	222.67
	12:20	14.67	15:41	15.31	17:40	42.54	20:23	6364.32
	12:30	42.11	16:05	8.66	18:04	32.35	20:35	51.84
	12:38	21.36	16:13	34.08	18:15	24.53	20:55	394.12
	12:49	21.95	16:38	35.18	19:00	32.88		
238	17:35	176.81	18:18	63.36	19:27	162.69	21:19	55.14
	17:52	98.75	18:31	164.62	20:01	166.23	21:27	34.26
	18:01	113.05	18:40	486.32	20:22	21.97	21:52	484.53
	18:09	87.45	19:00	60.78	21:06	337.91	22:21	34.09
240	17:27	292.62	18:03	1052.84	19:00	128.39	20:03	577.23
	17:36	323.45	18:28	151.08	19:28	625.03	20:22	66.40
	17:50	374.42	18:41	300.52	19:42	255.87		
252	18:41	401.32	19:40	513.26	20:18	162.38	21:16	14.55
	18:59	44.11	19:57	16.72	20:51	38.33		
	19:32	508.25	20:06	181.02	21:07	41.91		
254	18:40	27.09	19:38	85.11	20:05	27.79	20:29	7.85
	19:23	26.64	19:56	48.42	20:16	37.85	20:53	38.45
270	21:41	26.91	23:39	5106.84	24:41	390.41	26:16	15.78
	22:16	14.68	24:03	294.10	24:56	166.96	26:22	16.16
	22:51	66.47	24:26	361.57	25:08	550.18		
272	22:52	80.49	24:26	433.15	25:22	54.66	26:16	56.70
	23:31	2458.44	24:40	463.88	25:31	35.07		
	23:40	2351.81	24:56	194.17	25:48	21.21		
	24:03	344.46	25:08	574.98	26:05	8.14		
286	23:37	3592.50	24:12	16.13	25:09	84.26	25:56	7.65
	23:51	146.26	24:29	301.19	25:21	41.49	26:06	194.24
	24:03	111.88	24:54	270.54	25:38	229.94	26:19	14.92
288	23:37	3343.27	24:53	245.46	25:37	272.60		
	24:03	80.71	25:09	123.85	26:06	237.89		
	24:29	353.51	25:22	57.12	26:32	43.96		
218	14:18	34.92	16:27	36.36	17:46	69.23	21:35	119.89
	15:33	118.93	16:39	98.23	19:31	128.14		
	16:13	55.80	16:54	68.08	20:10	109.89		

Listing of S9037901.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
220	11:16	28.64	15:03	76.19	16:08	7.91	20:33	102.56
	11:34	41.07	15:18	37.28	16:58	113.58	21:00	148.92
	11:53	19.83	15:31	112.02	17:15	25.51	21:34	118.46
	13:11	55.68	15:42	115.77	17:43	56.94	21:52	67.07
	14:34	25.02	15:53	69.12	19:30	169.47		
304	28:00	605.90	29:54	1477.06	31:42	30.82	33:32	40.84
	28:17	1165.16	30:15	898.62	31:49	30.82	33:43	10.69
	28:34	1689.98	30:32	244.55	32:19	9.14	33:53	25.21
	28:53	2076.80	30:47	1853.39	32:42	95.84		
	29:13	1811.15	31:20	224.49	32:56	44.89		
	29:39	1175.29	31:31	208.92	33:16	2255.05		
306	27:08	25.31	29:13	2663.92	31:01	62.09	32:48	9.75
	27:46	130.60	29:39	1384.39	31:09	139.61	33:07	59.33
	28:00	1086.44	29:54	2349.43	31:18	288.75	33:16	3193.04
	28:16	1708.03	30:16	1204.86	31:32	228.72	33:31	148.90
	28:36	2184.61	30:32	265.19	31:47	108.71	33:44	232.54
	28:53	2641.80	30:49	2509.45	32:02	74.29	33:59	43.64
320	27:51	69.27	29:53	27.25	31:41	531.59	34:12	199.81
	28:11	6.90	30:14	4229.59	32:01	604.40	34:42	165.39
	28:49	515.70	30:26	2053.39	32:25	18.94	35:09	291.42
	29:13	445.22	31:00	613.67	32:46	115.76		
	29:30	473.57	31:20	953.31	33:42	14.87		
	29:45	32.97	31:30	1206.10	33:59	36.68		
322	27:56	137.62	29:40	71.26	31:48	349.78	33:43	43.57
	28:07	105.76	30:14	5435.14	32:01	714.94	33:54	157.75
	28:34	14.33	30:26	2258.93	32:44	197.25	34:12	409.12
	28:46	643.37	30:58	855.78	32:58	18.07	34:41	195.06
	28:59	86.38	31:20	1033.85	33:04	59.57	34:58	87.55
	29:13	626.83	31:30	1749.35	33:15	57.47	35:09	336.58
	29:28	757.73	31:41	585.01	33:22	134.10		
340	31:19	28.59	33:16	69064.41	35:00	6266.78	36:11	19.58
	31:32	40.36	33:42	65.96	35:22	3054.10	36:26	7522.27
	31:38	12.91	33:57	67.25	35:29	8090.95	36:41	12978.15
	32:18	6.52	34:40	7488.54	35:42	371.05	37:04	187.58
	32:51	151.91	34:49	653.70	35:51	5795.49	37:46	759.48
342	31:18	12.21	33:16	44352.91	35:00	3977.57	36:26	4723.24
	31:31	7.43	33:45	34.84	35:22	2024.16	36:41	8288.33
	31:38	8.40	33:57	9.62	35:29	4839.25	37:04	61.31
	31:47	14.44	34:05	13.32	35:40	299.84	37:46	502.27
	31:55	18.04	34:40	4773.91	35:51	3741.59		
	32:51	67.26	34:49	491.20	36:09	6.65		
356	32:47	95.77	35:08	7908.56	36:13	13821.11	37:07	4406.94
	33:56	8.80	35:27	5712.18	36:29	1429.87	37:34	2073.22
	34:40	4513.74	35:38	4522.05	36:40	516.21		
	34:51	36.26	35:52	4016.13	36:55	3838.50		

Listing of S903790I.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
358	32:48	200.19	35:27	4242.52	36:13	8965.03	36:55	2453.09
	34:40	2884.12	35:38	2910.97	36:29	917.39	37:07	2750.38
	35:08	5151.40	35:52	2614.30	36:40	361.24	37:34	1539.39
316	29:52	214.80	30:14	1011.70	30:47	128225.55	31:18	1055.40
318	30:14	1290.39	30:47	163692.25	31:18	1417.74		
328	31:23	433.95	31:40	227727.67				
332	31:20	123464.13	31:38	97250.98				
334	31:20	152407.64	31:38	120797.22				
352	35:00	590.13	35:50	1543.13	37:45	2141.75		
	35:29	91092.96	36:26	117368.03				
354	35:00	406.41	35:50	948.45	37:45	1393.24		
	35:28	59526.33	36:25	76485.62				
368	35:27	152.06	36:55	66298.05	37:34	559.97		
370	35:27	399.20	36:54	42008.54	37:33	358.90	37:45	29.02
374	39:01	226401.06	40:41	33069.75	41:47	195.59	42:18	23.97
	39:13	435555.72	41:06	3305.09	41:51	244.10	42:21	13.44
	39:40	6115.86	41:15	475.83	41:58	25.61	42:37	3142.07
	39:56	572359.69	41:25	20728.52	42:02	32.35	42:44	22811.38
	40:32	92352.74	41:31	15807.68	42:07	23.33		
376	39:01	198747.20	40:32	80027.82	41:31	13404.25	42:37	2733.88
	39:14	433826.97	40:41	28447.16	41:50	264.77	42:44	19619.79
	39:40	5447.72	41:06	2584.72	41:55	188.20		
	39:55	585258.06	41:25	18276.36	42:04	36.97		
390	38:05	66.57	40:50	375531.50	41:49	99311.80	42:43	12.51
	39:48	408279.25	41:05	135098.17	42:13	36098.40		
	40:22	602.81	41:29	827.61	42:30	190.71		
	40:29	52957.75	41:41	7957.45	42:35	203.14		
392	38:07	522.17	40:50	332366.12	41:41	6417.28	42:32	203.48
	39:48	381042.16	41:05	110887.24	41:49	81548.56	42:44	28.32
	40:29	43557.88	41:32	342.65	42:16	29305.22	42:48	6.40
384	38:59	120.49	39:56	433.97	40:31	56927.87	41:30	54590.52
	39:13	282.29	40:13	60.42	40:40	57729.91	42:36	42427.23
386	39:00	122.13	40:31	110062.11	41:29	107046.68		
	39:13	242.52	40:40	112044.99	42:36	84276.80		
402	41:40	56112.88	41:47	66628.79	42:15	73374.01		
404	41:40	47346.11	41:47	56346.86	42:15	61232.40		

NOV 1 9 1990

Listing of S903790I.dbf File
Raw Mass, Retention Time and Data Area

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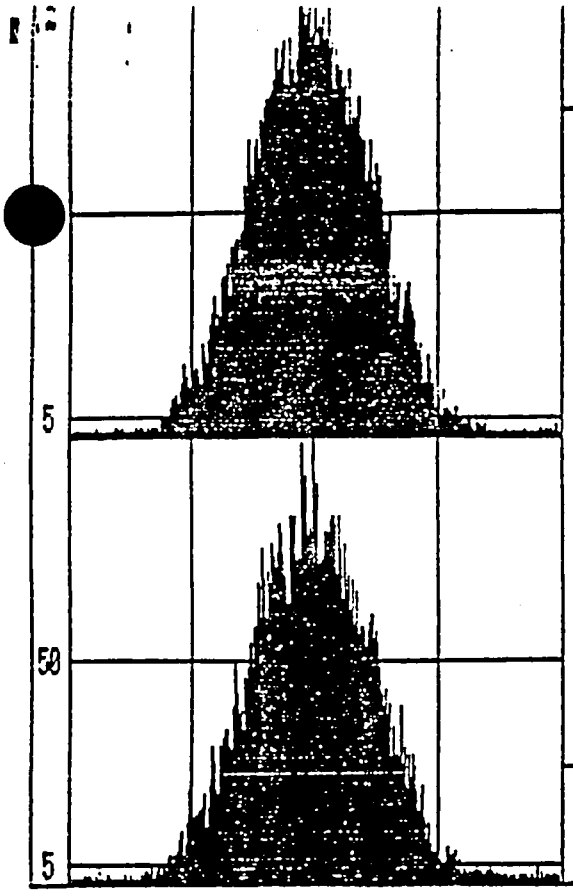
M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
408	43:25	162.23	45:38	913277.81	47:14	40539.87		
	45:05	876836.81	46:34	12313.11				
410	45:04	951912.63	45:39	984258.94	46:34	18591.61	47:14	46192.44
418	43:12	12.42	45:38	2875.60	46:35	111.75		
	44:12	13.42	45:57	2249.36	47:13	22576.09		
	45:02	31921.17	46:17	46.78	48:10	411.61		
420	43:30	12.83	45:38	2218.87	47:13	51835.59		
	44:00	20.48	45:57	4454.95	48:11	425.56		
	45:02	69074.62	46:33	173.07	48:46	19.59		
424	45:29	1343708.75	46:34	895721.25	50:08	608.78		
426	45:28	1345311.63	46:34	893493.62	50:10	442.00		
436	45:29	1911.16	45:55	47.70	46:33	41253.74		
438	45:30	1324.68	45:55	57.81	46:33	39979.50	47:20	176.40
442	52:13	973396.69	53:40	2840.78	54:03	1490.42	54:30	305.79
444	52:13	1009371.31	54:03	1325.62	54:34	99.89		
458	48:25	72.11	49:08	33.71	52:02	1942984.25		
460	51:57	2097182.25						
470	49:51	13.16	51:02	9.55	52:59	83.03		
	50:13	15.70	52:01	36840.71	53:18	65.30		
	50:22	22.08	52:45	126.22	53:43	43.97		
472	50:15	9.24	52:01	37571.79	52:53	62.39	53:22	48.56
	51:04	16.71	52:39	196.98	53:04	82.82		

*** End of Report ***



Ref. mass 292.9825 Peak top
Height 6.43 volts Span 200 ppm

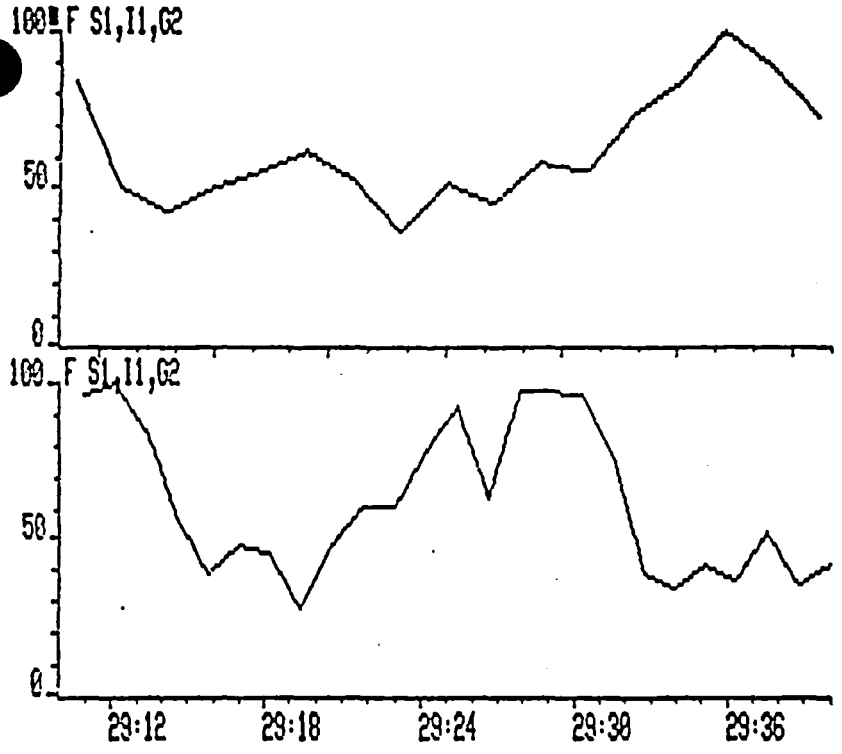
System file name	D85US
Data file name	D:S903790
Resolution	10000
Group number	2
Ionization mode	EI+
Switching	VOLTAGE
Ref. masses	292.9825, 416.9760

A	293	J	332	S	368
B	304	K	334	T	370
C	306	L	338	U	376
D	316	M	340	V	410
E	318	N	342		
F	320	O	352		
G	322	P	354		
H	328	Q	356		
I	331	R	358		

Channel I 330.9792 Peak top
Height 4.38 volts Span 200 ppm

NOV 1 0 1993
ENVIRONMENTAL AFFAIRS

GF: 2 F: 319.8965 G: 321.8336 H: 327.8347 I: 330.9792 J: 331.9368
Text:LF1/9110 TLI#16661



NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

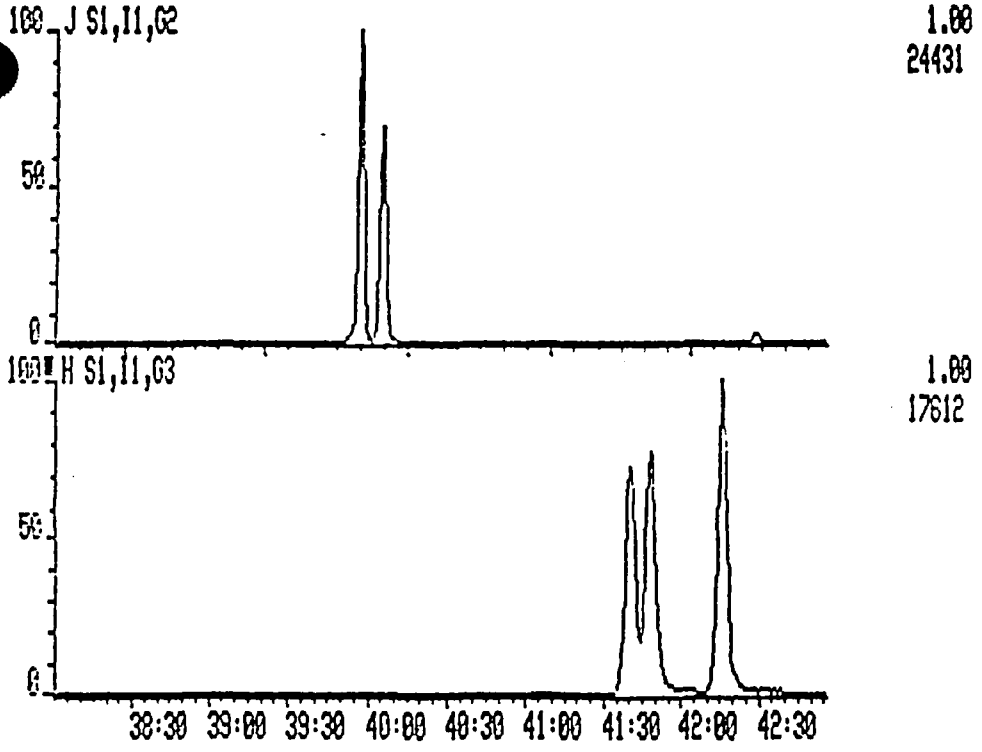
Verified by (GC/MS) Saturated MTB 10·18

Verified by (Int. QC) : TR 10/20/

Group 3+4 saturation
TR 10/20/90

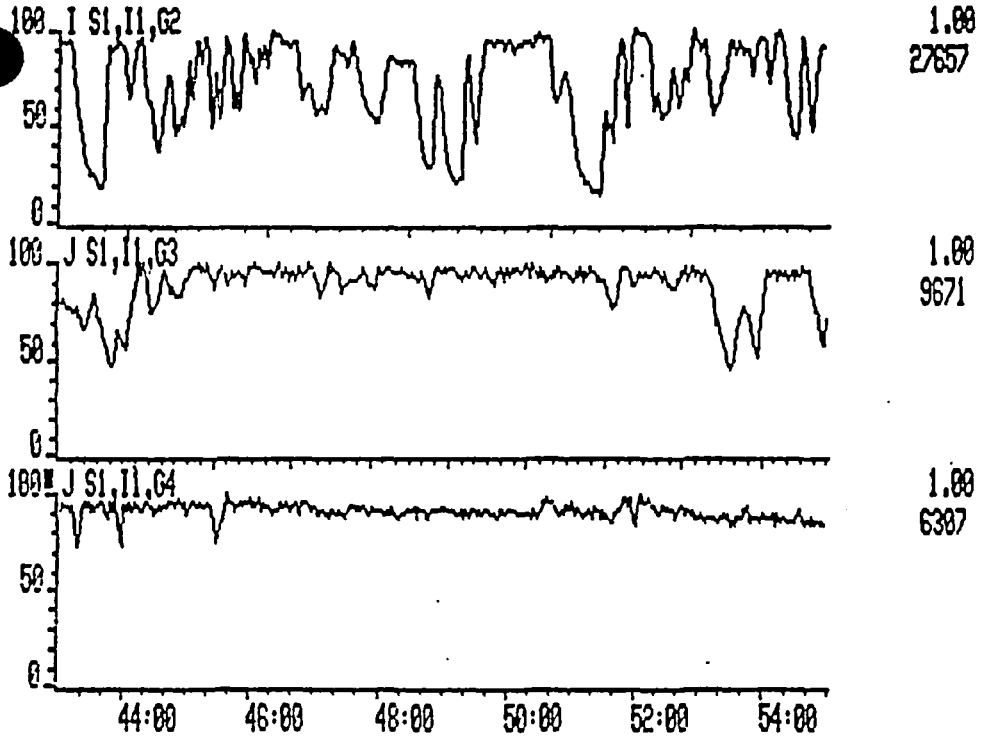
Process, dilute
reshoot. TR 10/23/

GR 3 F: 391.8127 G: 392.9762 H: 401.8558 I: 403.8529 J: 430.9729
Text:LF1/9116 TLI#16661



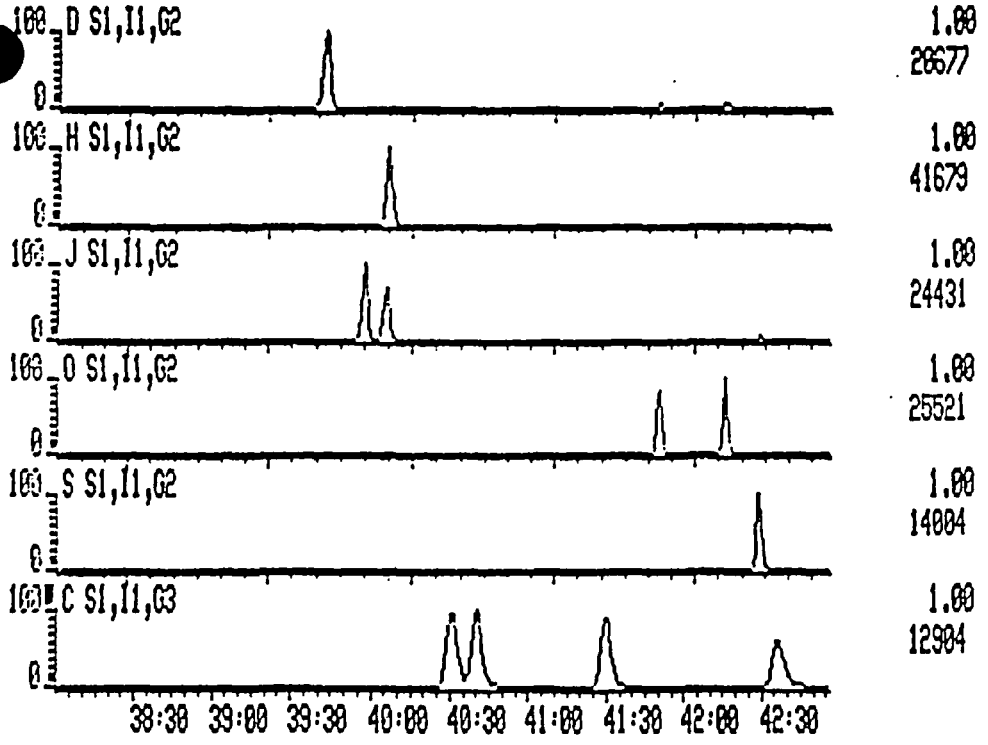
NOV 1 9 1999
ENVIRONMENTAL AFFAIRS

GR 4 D: 419.8220 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text:LF1/9110 TLI#16661



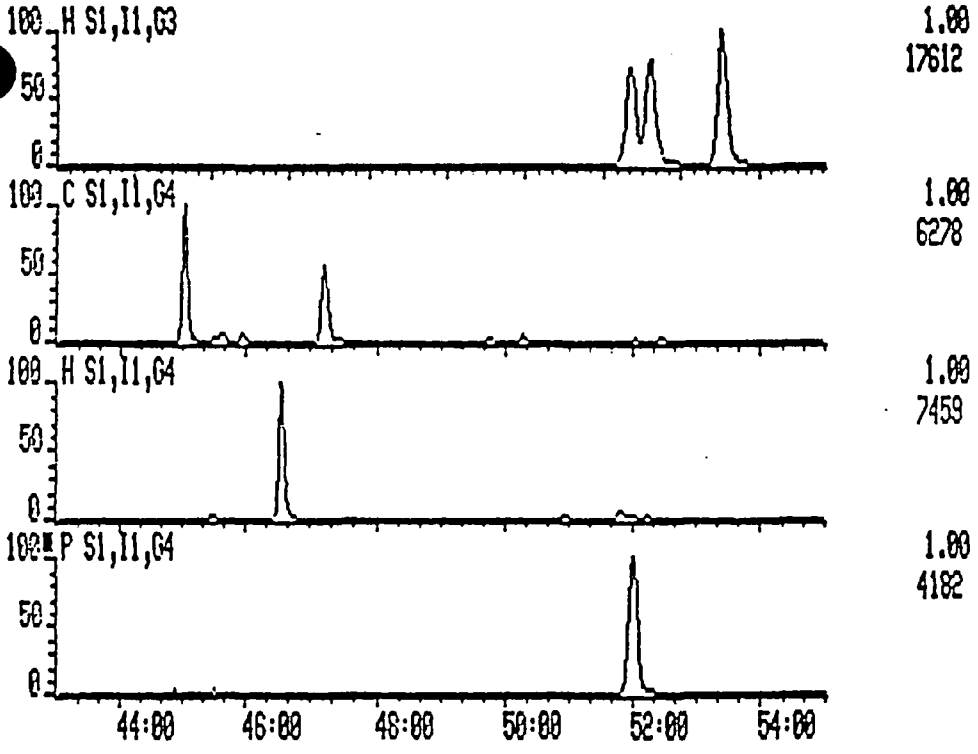
NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

S9037#0 16-OCT-90 13:28 /05 (E:-) SUB:06005
GR 3 D: 385.8610 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558
Text:LF1/9110 TLI#16661



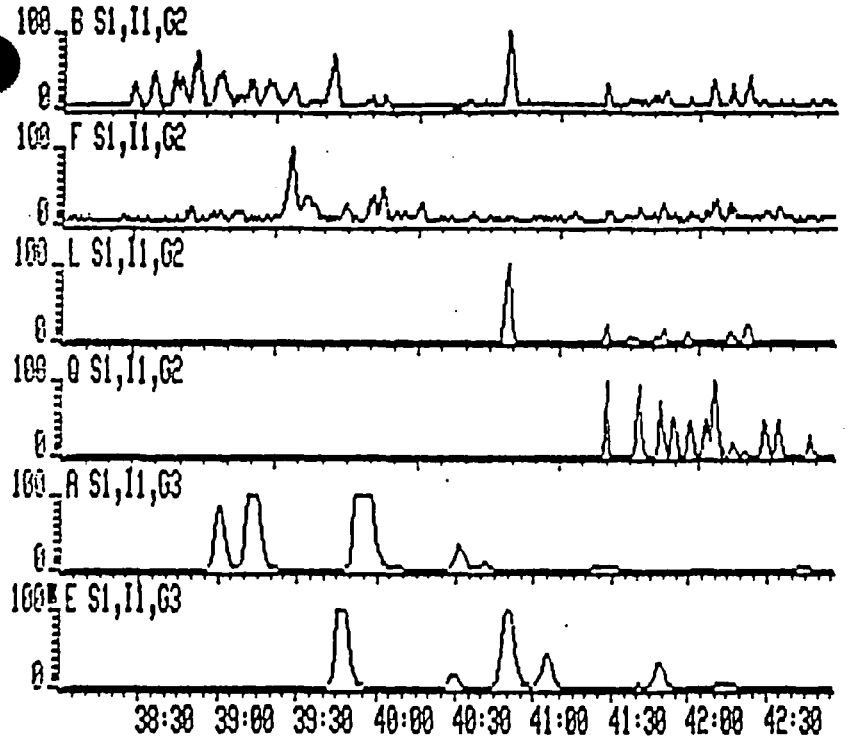
NOV 1 9 1990
ENVIRONMENTAL ANALYSIS

GR 4 D: 419.8220 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text:LF1/9110 TLI#16661



NOV 1 0 1999
ENVIRONMENTAL LABS

GF 3 D: 385.8610 E: 389.8156 F: 391.8127 G: 392.9760 H: 401.8558
Text:LF1/9110 TLI#16661



1.00
446

1.00
592

1.00
7873

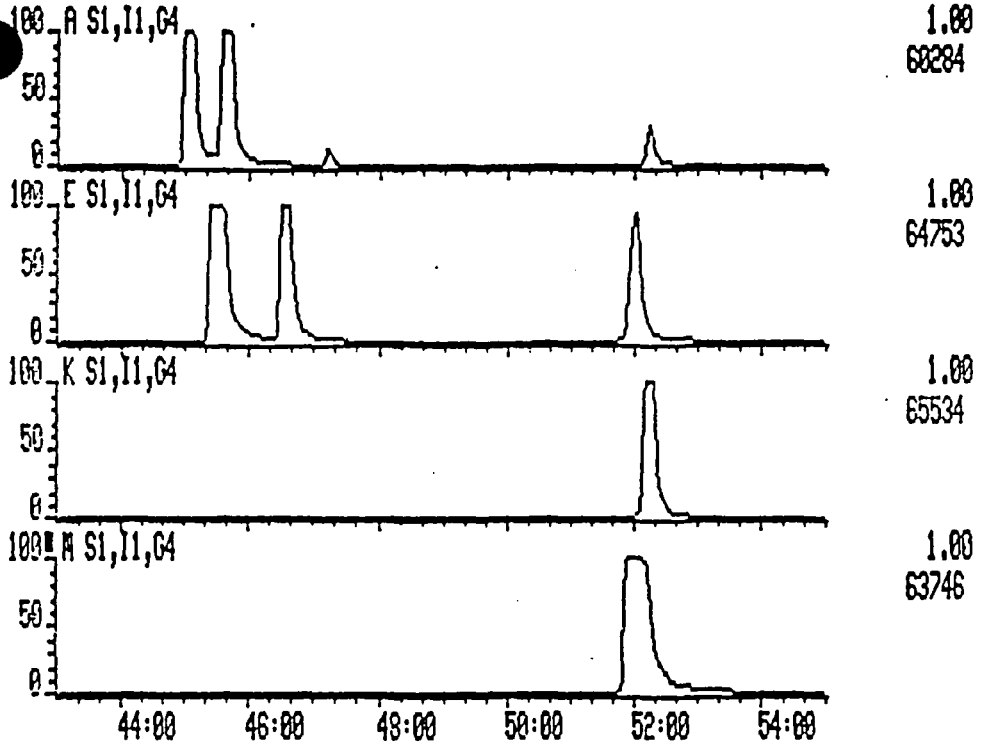
1.00
2004

1.00
60307

1.00
63985

NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

S333730 18-OCT-90 13:28 705 (Ei+) Sus:D85US
G: 4 D: 419.8228 E: 423.7766 F: 425.7737 G: 430.9729 H: 435.8169
Text:LF1/9110 TLI#16661



1.00
68284

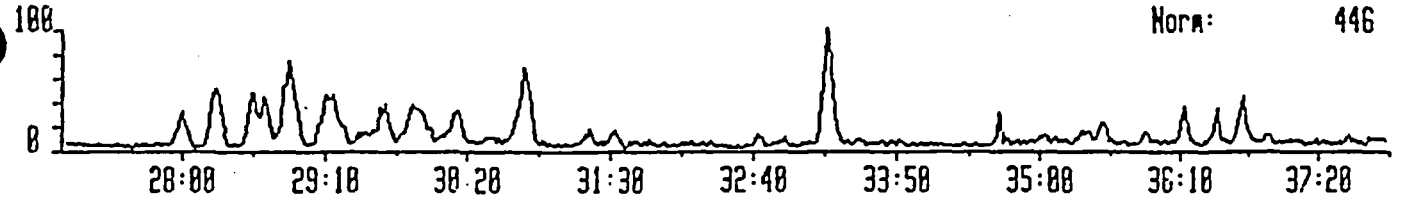
1.00
64753

1.00
65534

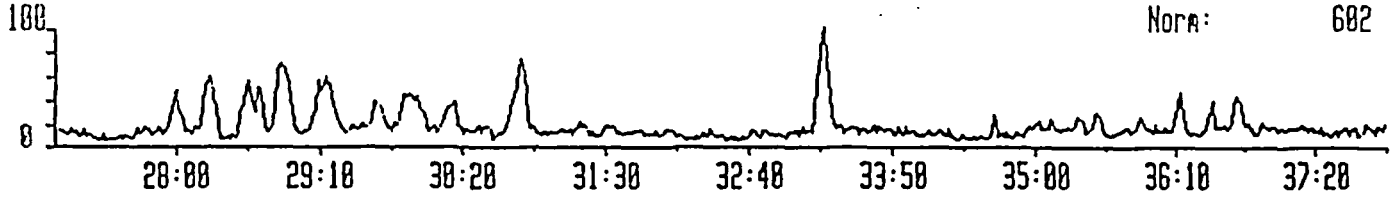
1.00
63746

NOV 1 9 1990
...TAL AFFAIRS

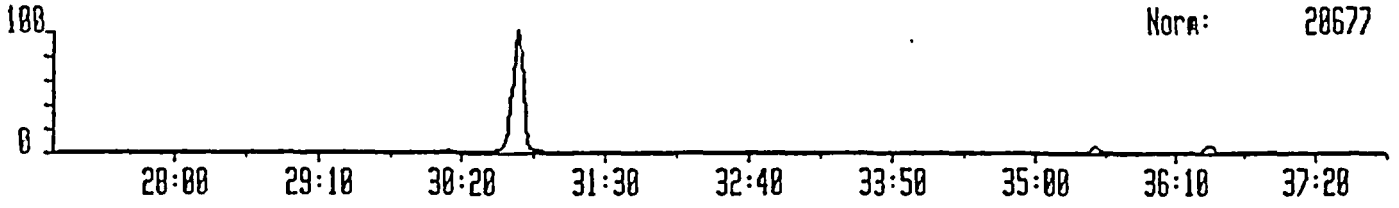
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 303.9016
Text:LF1/9110 TLI#16661



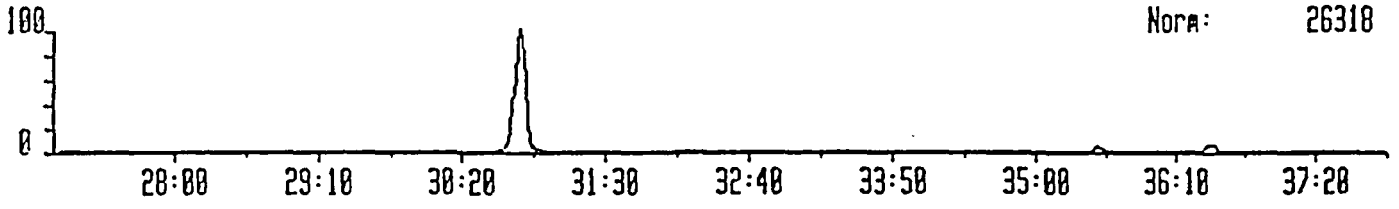
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 305.8987
Text:LF1/9110 TLI#16661



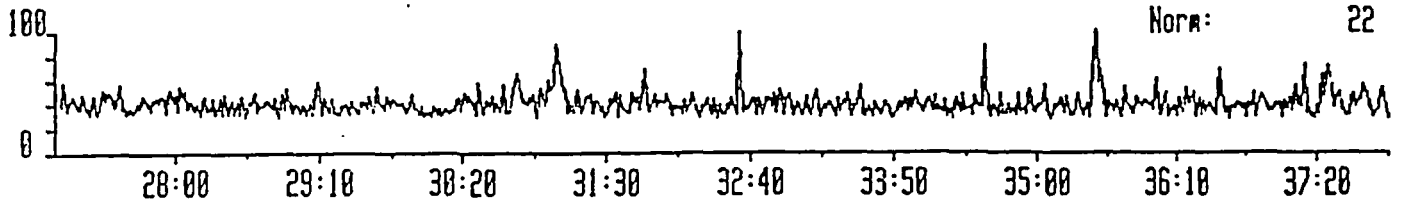
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 315.9419
Text:LF1/9110 TLI#16661



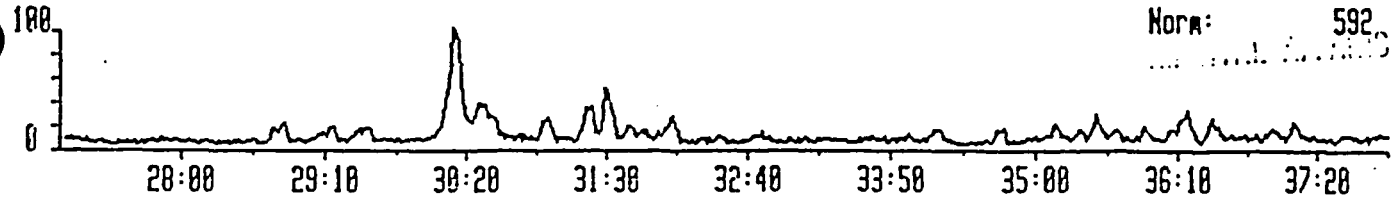
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 317.9389
Text:LF1/9110 TLI#16661



S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 375.8364
Text:LF1/9110 TLI#16661

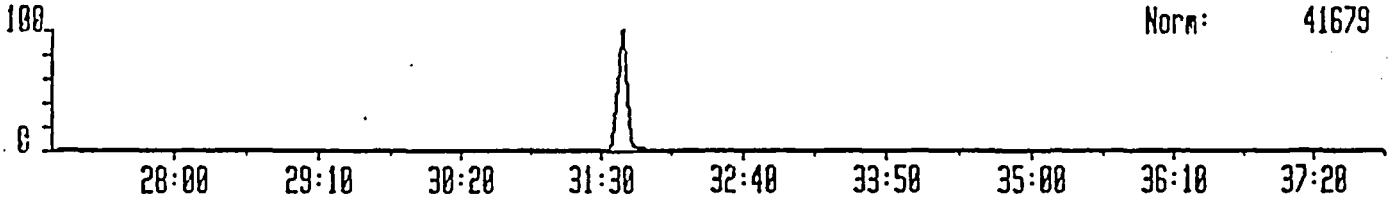


S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 319.8965
Text:LF1/9110 TLI#16661

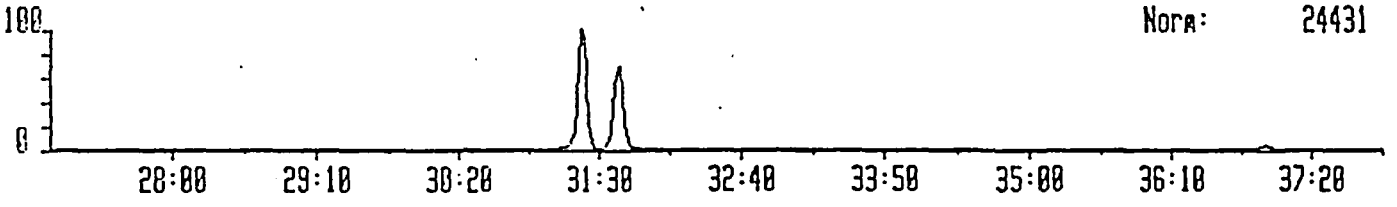


S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 321.8936
Text:LF1/9110 TLI#16661

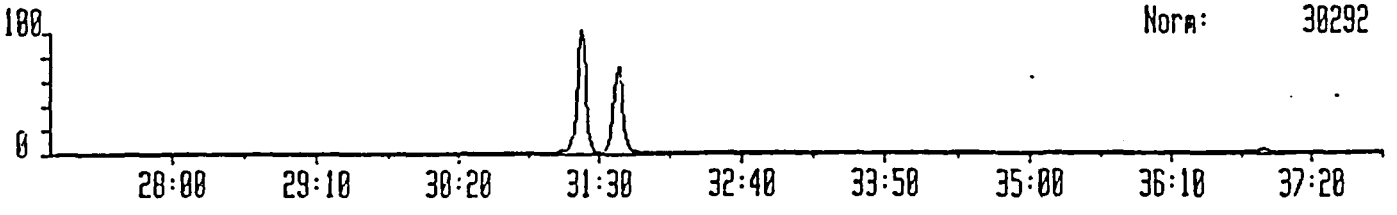
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 327.8847
Text:LF1/9110 TLI#16661



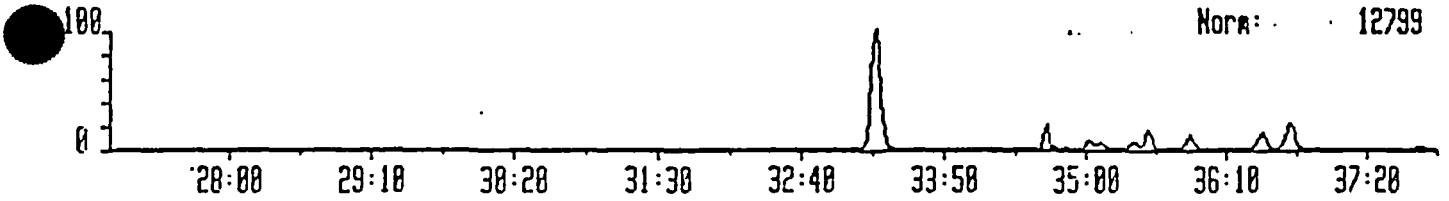
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 331.9368
Text:LF1/9110 TLI#16661



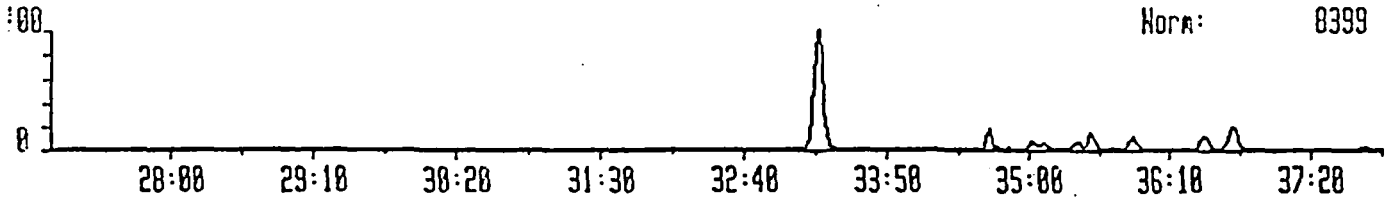
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 333.9338
Text:LF1/9110 TLI#16661



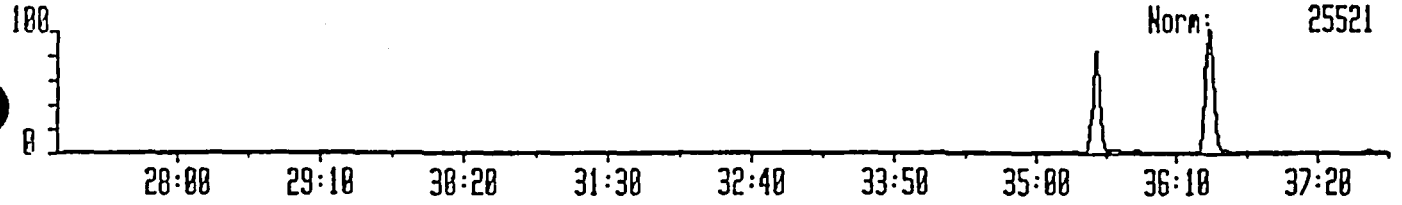
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 339.8597
Text:LF1/9110 TLI#16661



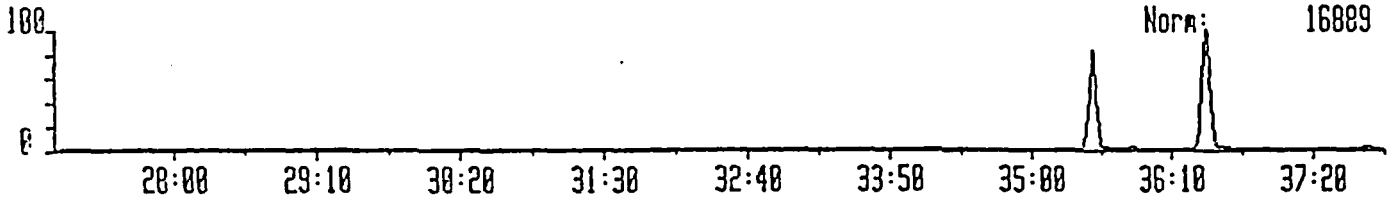
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 341.8567
Text:LF1/9110 TLI#16661



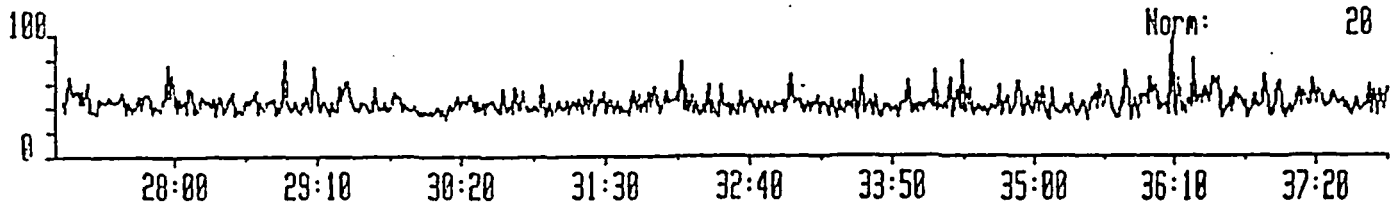
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 351.9000
Text:LF1/9110 TLI#16661



S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 353.8970
Text:LF1/9110 TLI#16661

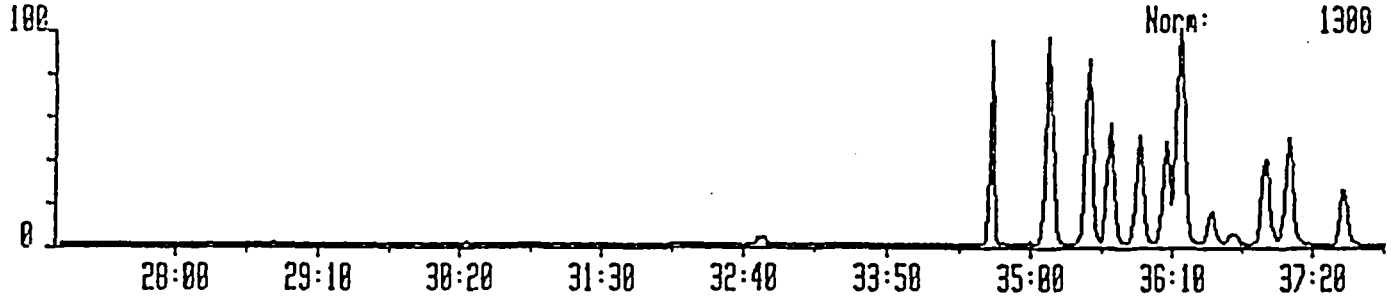


S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 409.7974
Text:LF1/9110 TLI#16661

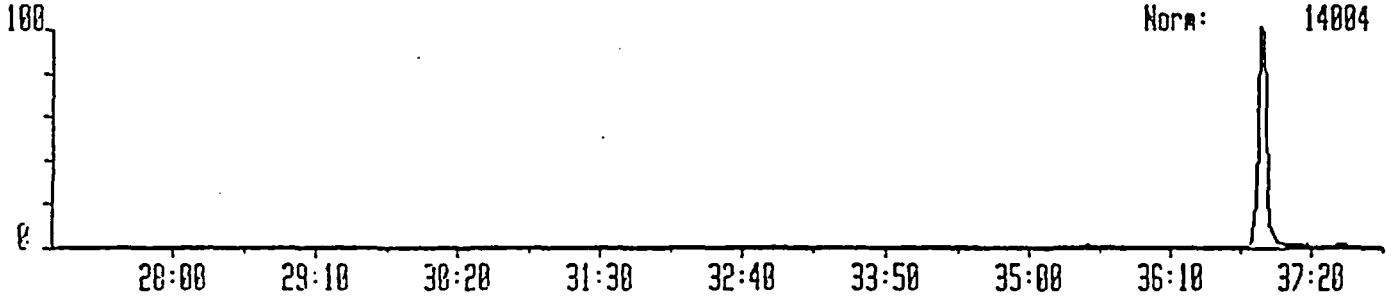


S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 355.8546
Text:LF1/9110 TLI#16661

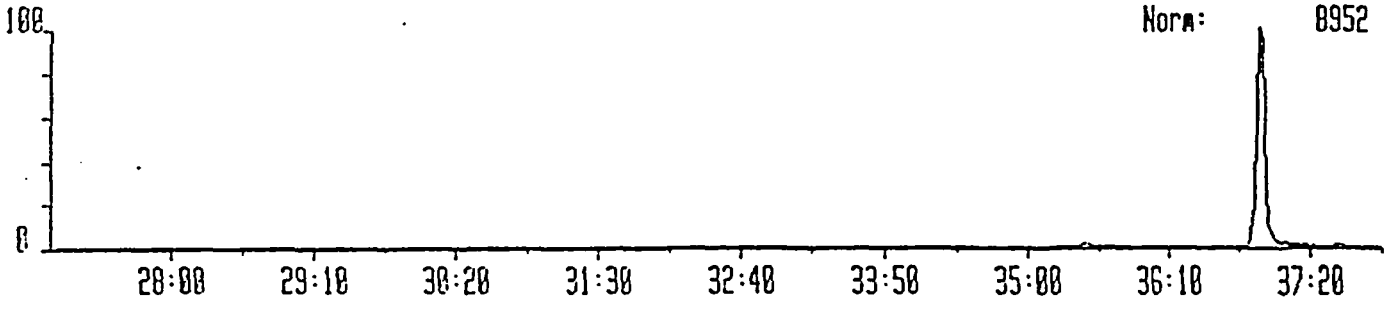
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 357.8516
Text:LF1/9110 TLI#16661



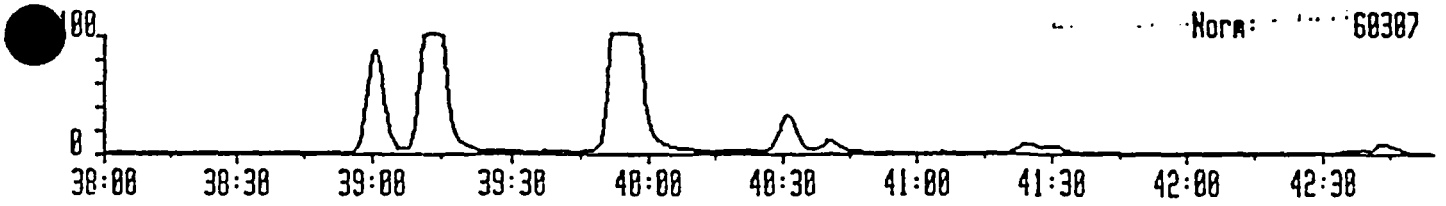
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 367.8949
Text:LF1/9110 TLI#16661



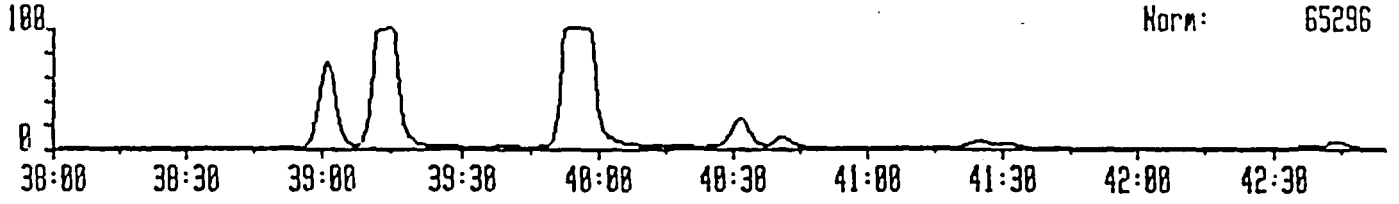
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 2 Mass 369.8919
Text:LF1/9110 TLI#16661



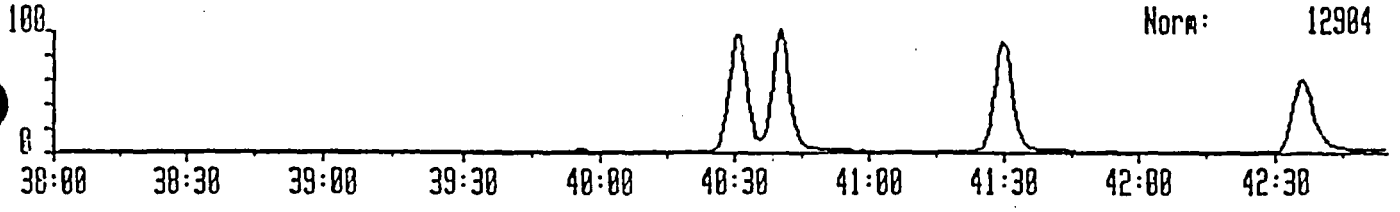
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 373.8208
Text:LF1/9110 TLI#16661



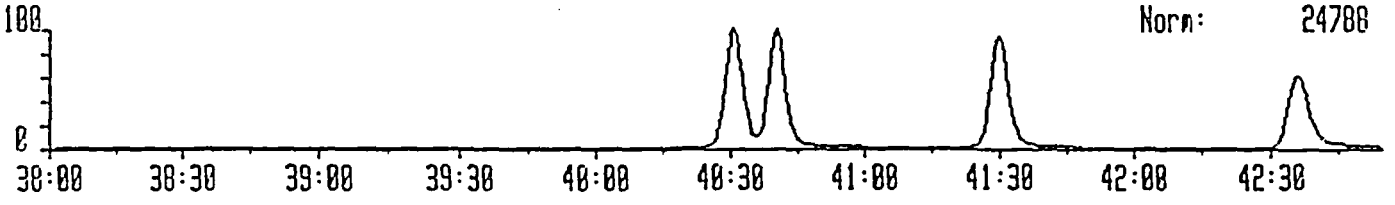
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 375.8178
Text:LF1/9110 TLI#16661



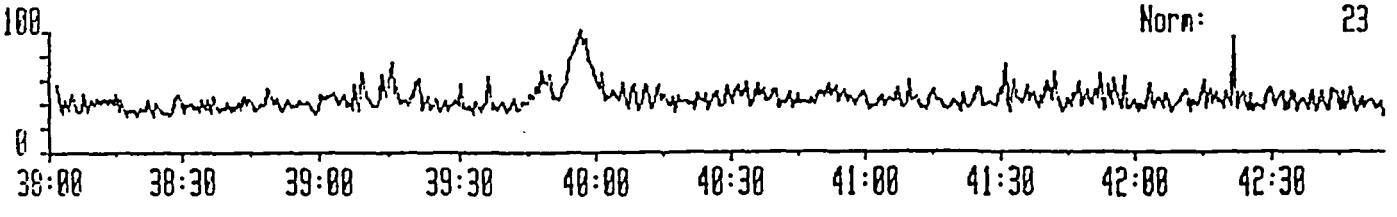
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 383.8639
Text:LF1/9110 TLI#16661



S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 385.8610
Text:LF1/9110 TLI#16661

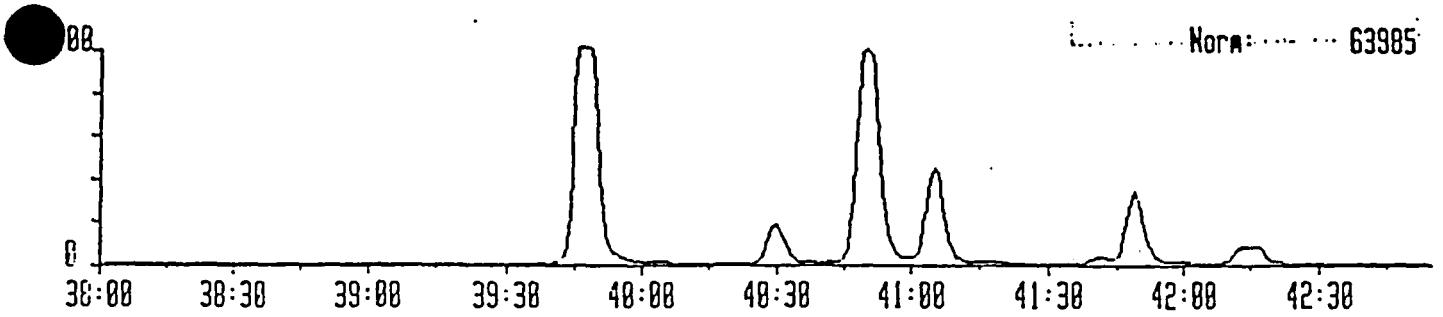


S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 445.7555
Text:LF1/9110 TLI#16661

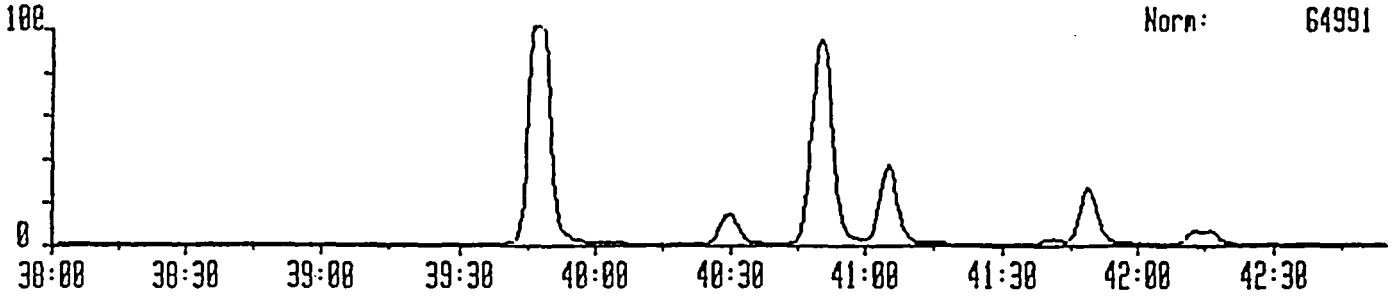


2

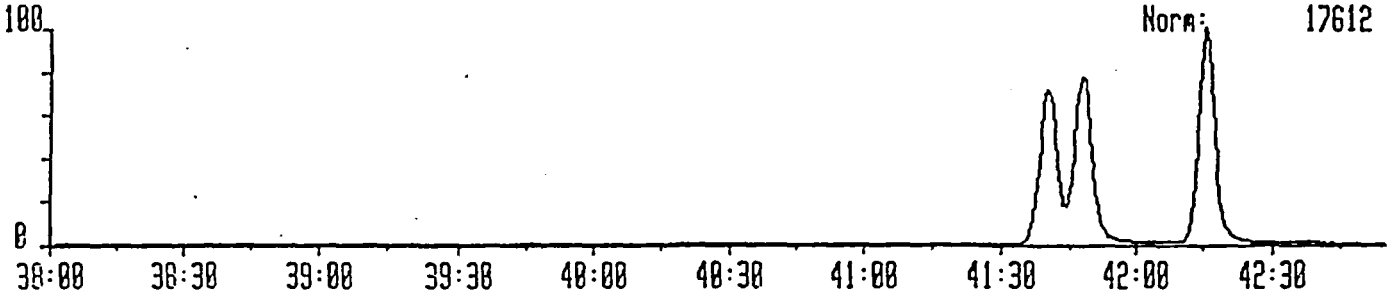
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 389.6156
Text:LF1/9110 TLI#16661



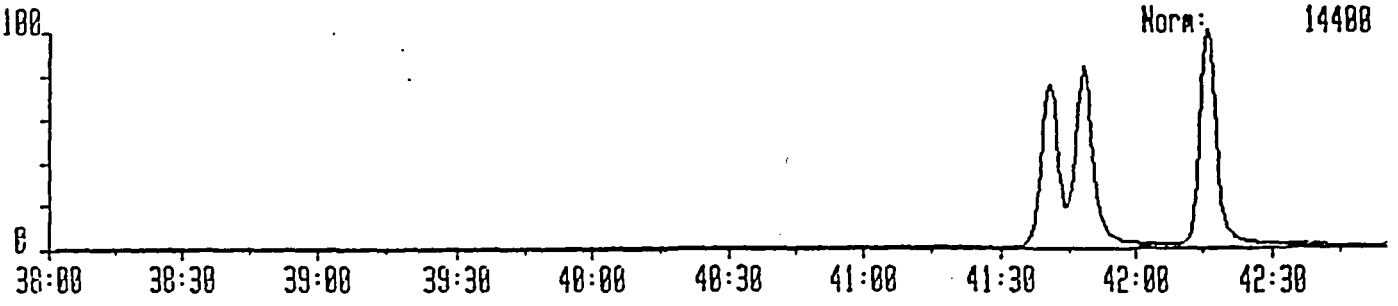
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 391.6127
Text:LF1/9110 TLI#16661



S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 401.6558
Text:LF1/9110 TLI#16661

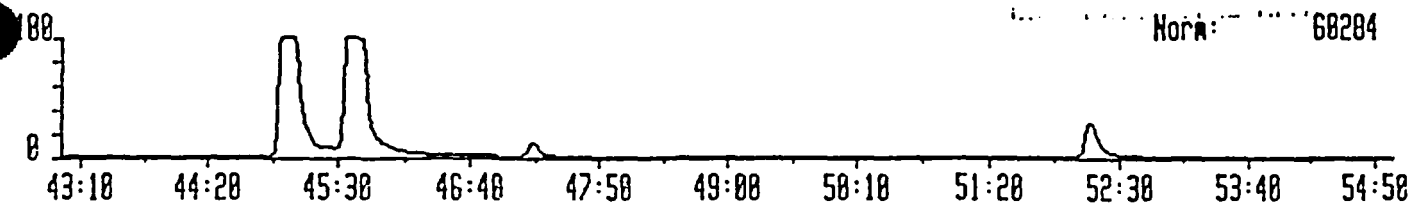


S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 3 Mass 403.6529
Text:LF1/9110 TLI#16661

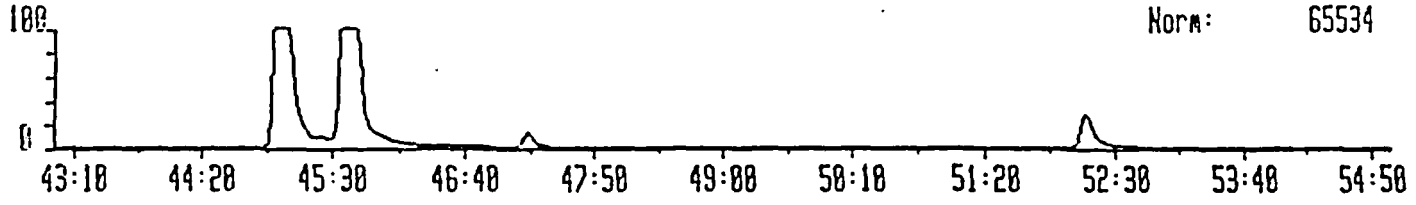


2

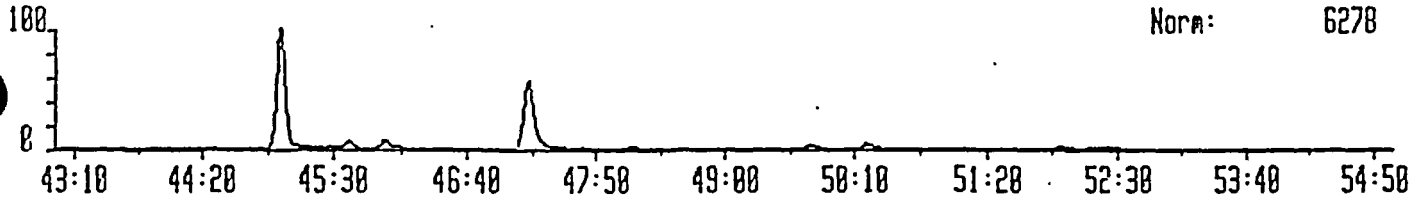
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 407.7818
Text:LF1/9110 TLI#16661



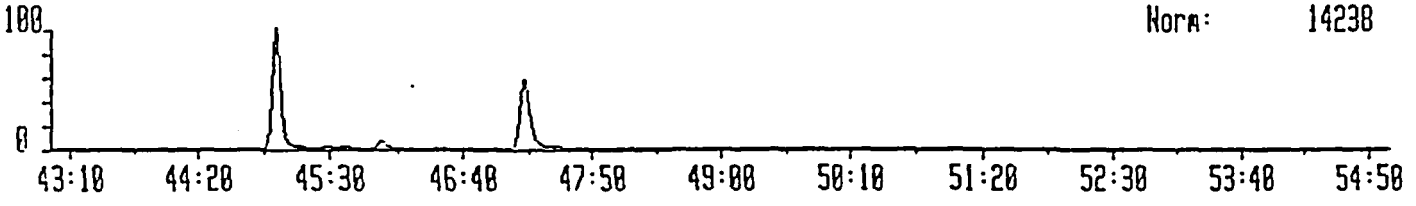
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 409.7789
Text:LF1/9110 TLI#16661



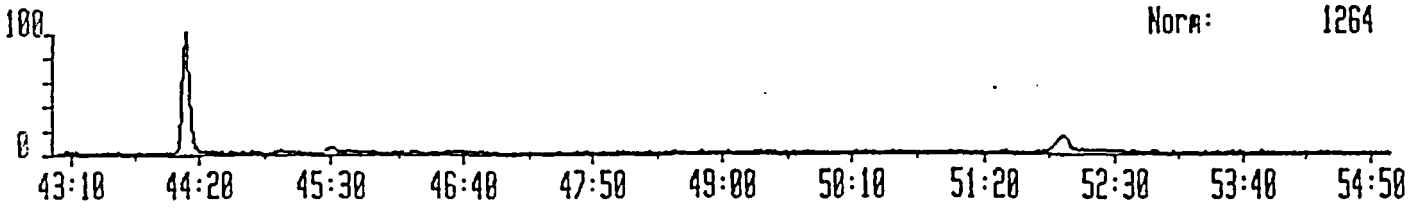
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 417.8253
Text:LF1/9110 TLI#16661



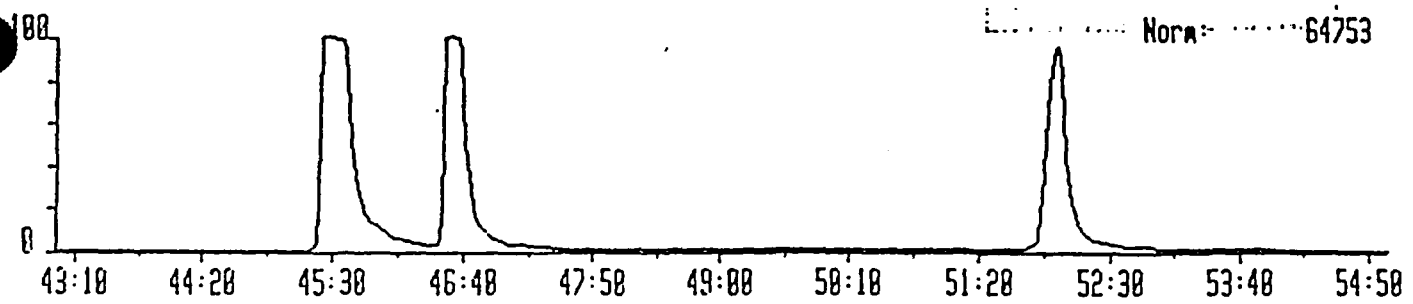
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 419.8220
Text:LF1/9110 TLI#16661



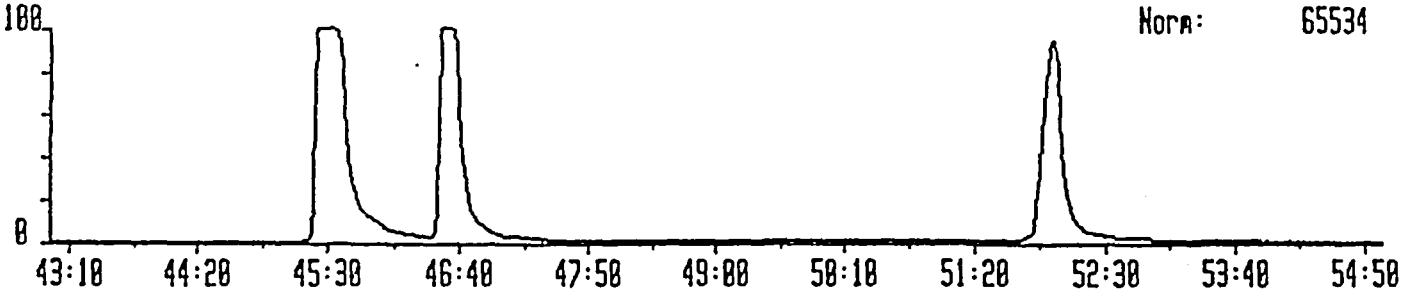
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 479.7165
Text:LF1/9110 TLI#16661



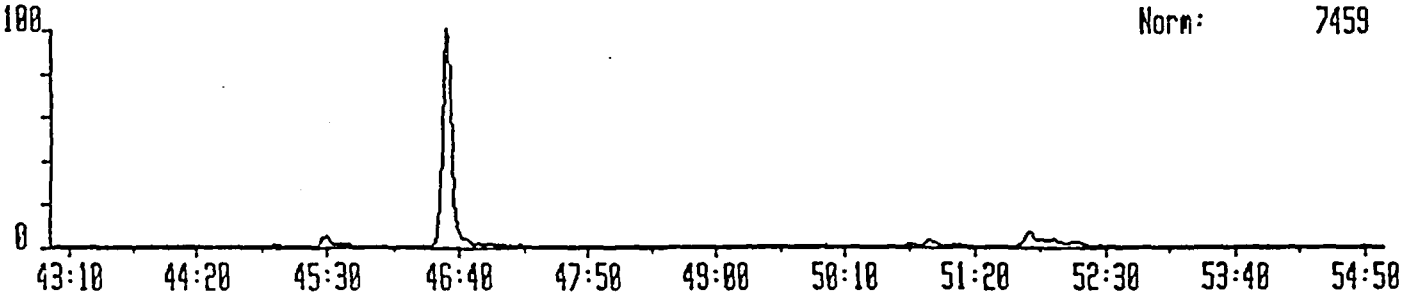
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 423.7766
Text:LF1/9110 TLI#16661



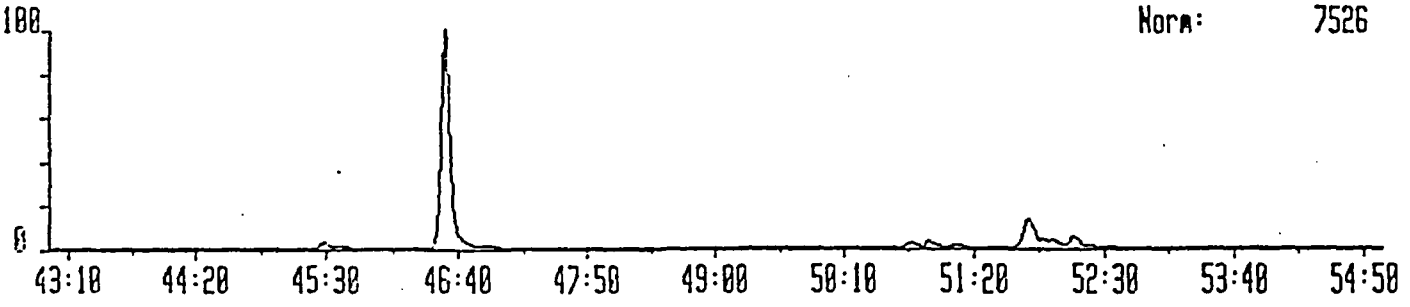
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 425.7737
Text:LF1/9110 TLI#16661



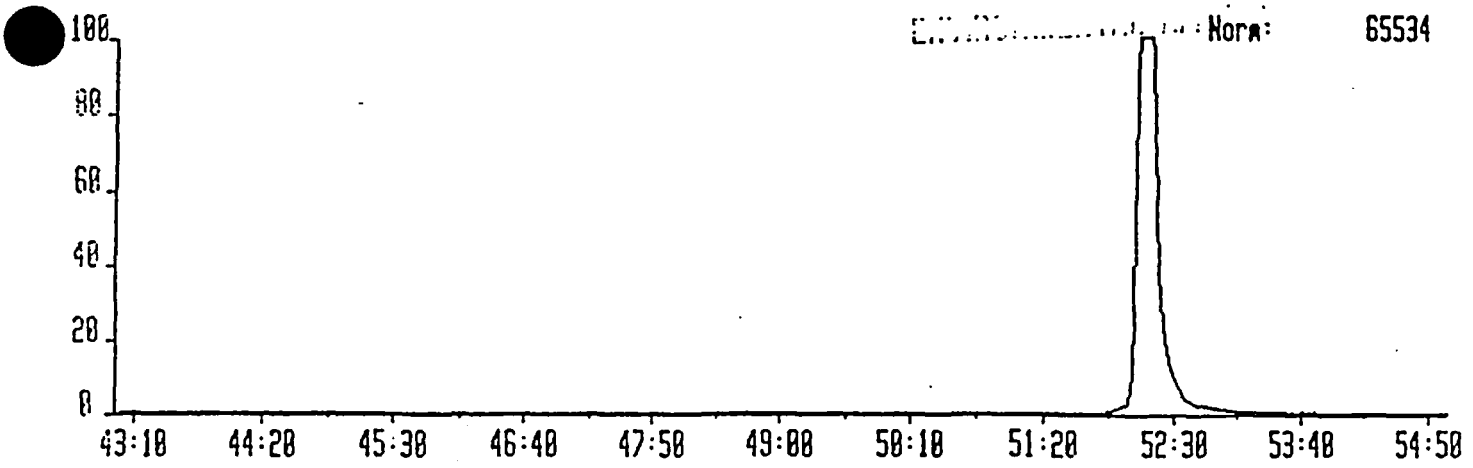
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 435.8169
Text:LF1/9110 TLI#16661



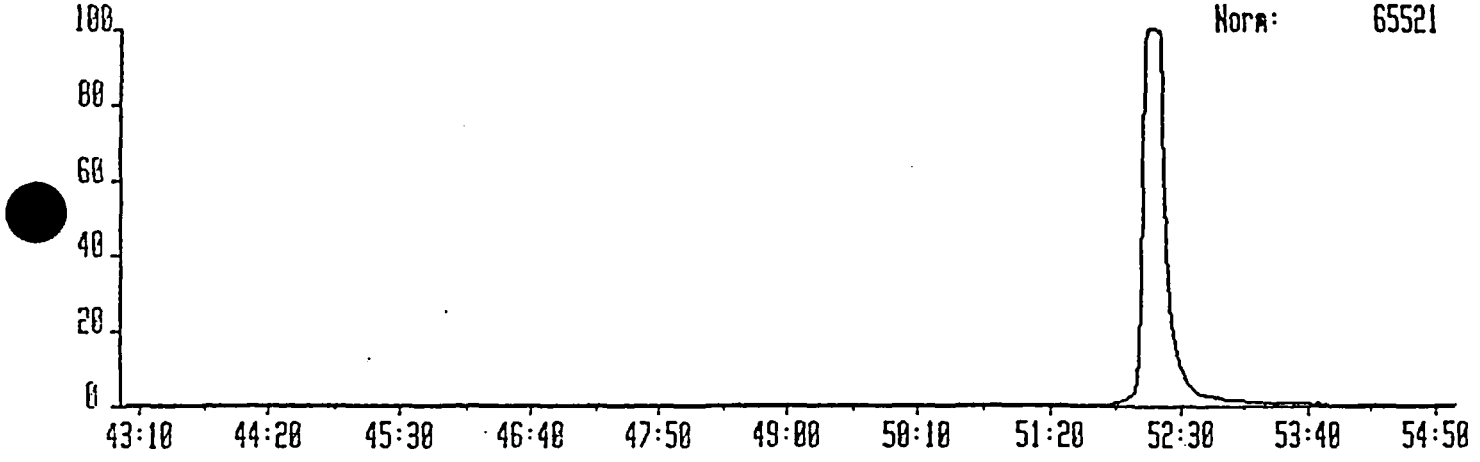
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 437.8140
Text:LF1/9110 TLI#16661



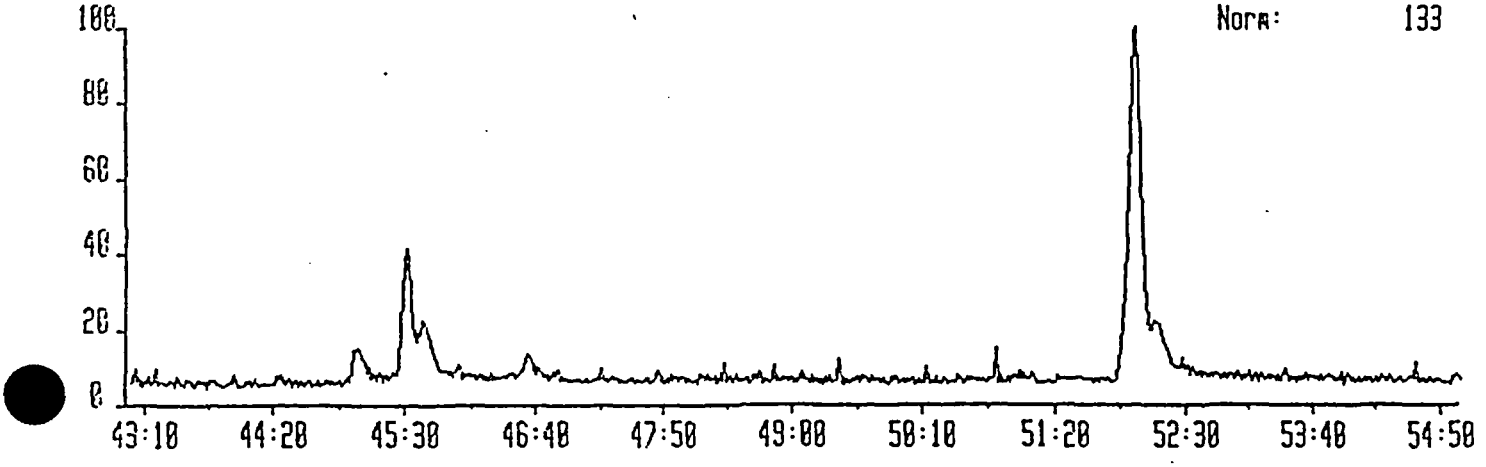
S903790 10-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 441.7420
Text:LF1/9110 TLI#16661



S903790 10-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 443.7399
Text:LF1/9110 TLI#16661

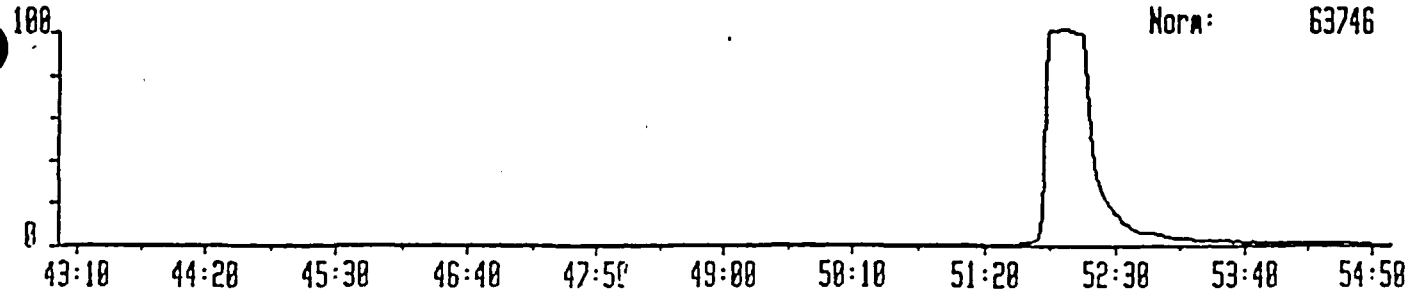


S903790 10-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 513.6775
Text:LF1/9110 TLI#16661

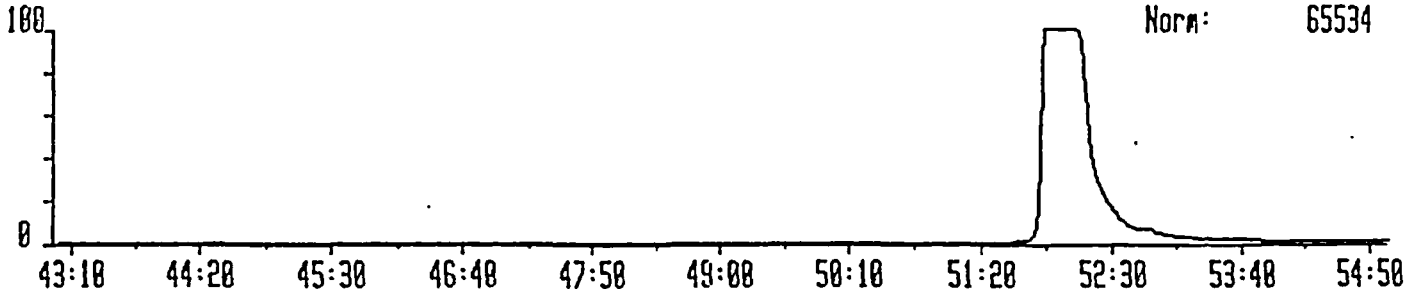


2

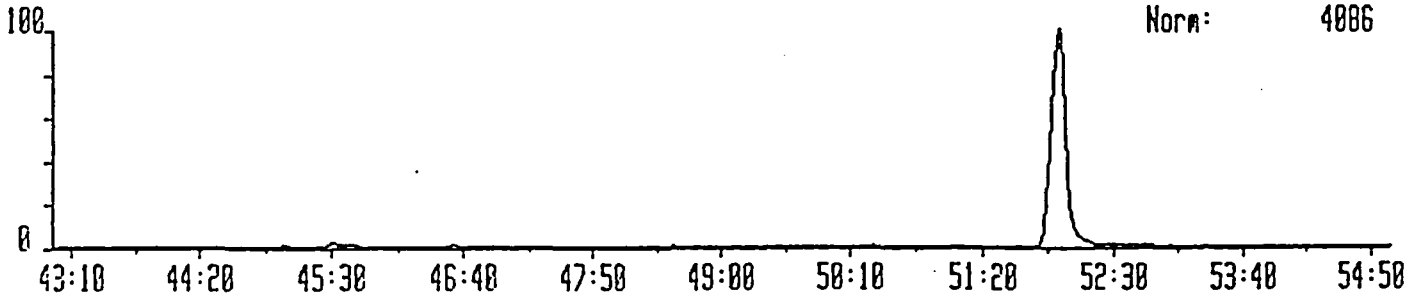
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 457.7377
Text:LF1/9110 TLI#16661



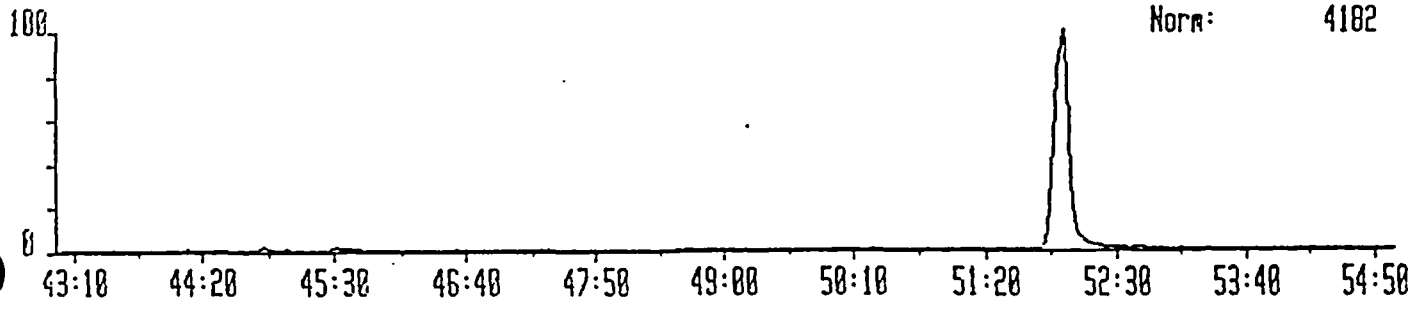
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 459.7348
Text:LF1/9110 TLI#16661



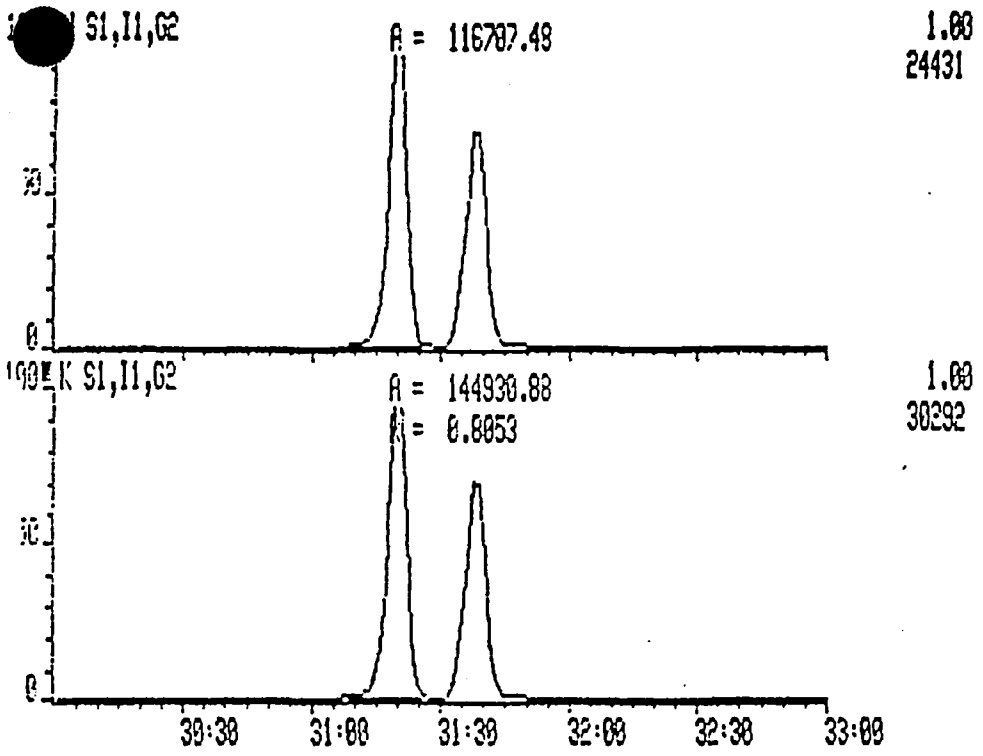
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 469.7779
Text:LF1/9110 TLI#16661



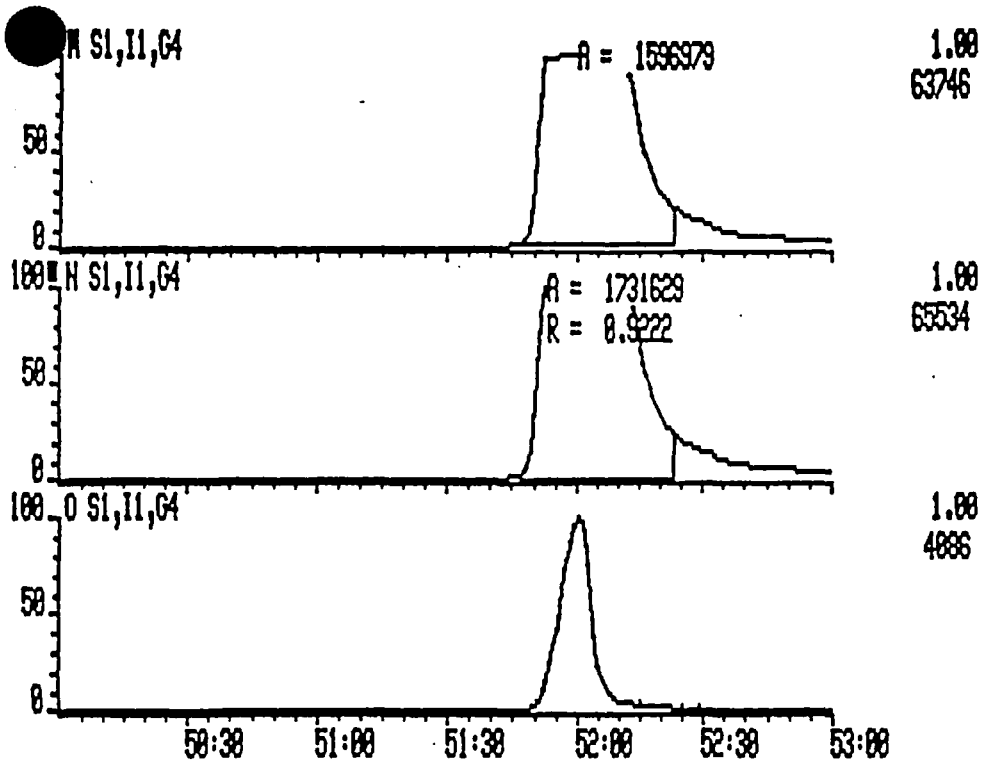
S903790 18-OCT-90 Sir:Voltage 70S Sys: DB5US
Sample 1 Injection 1 Group 4 Mass 471.7750
Text:LF1/9110 TLI#16661



[illegible]30 19-OCT-90 13:22 706 (EI+) Sus:D05US
[illegible] 2 J: 331.9368 K: 333.9338 L: 337.8626 M: 339.8597 N: 341.8567
Text:LF1/9110 TLI#16651



983790 18-OCT-90 13:28 70S (EI+) Sys:D85US
GR 4 M: 457.7377 N: 459.7348 O: 469.7779 P: 471.7750 Q: 479.7165
Text:LF1/9110 TLI#16661

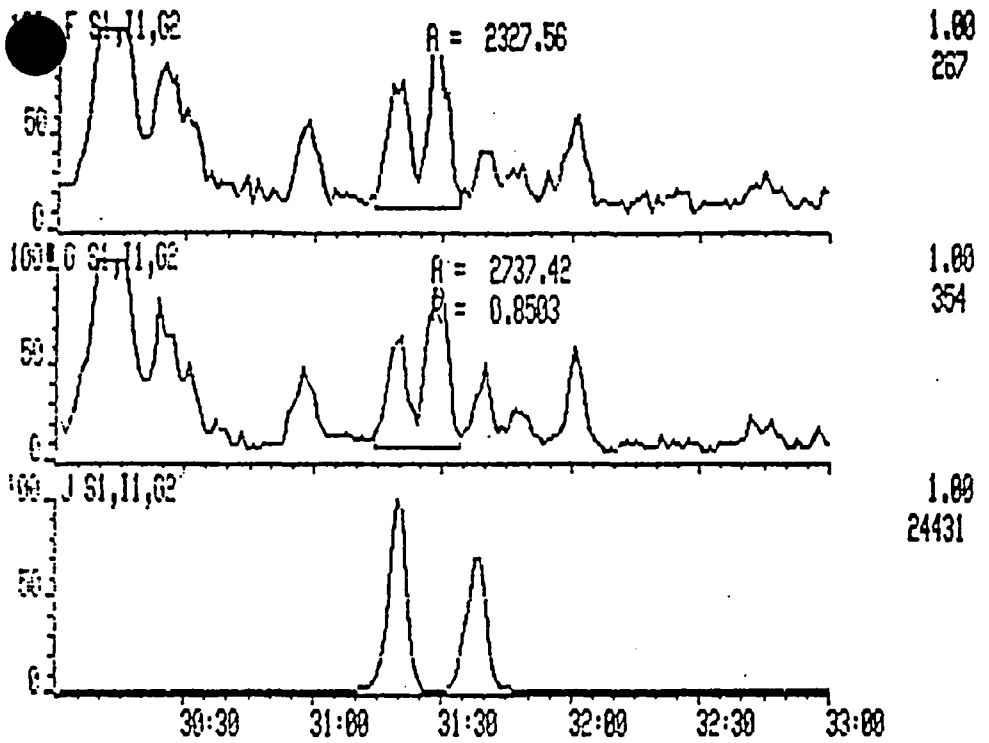


MSD
11-15-90

3

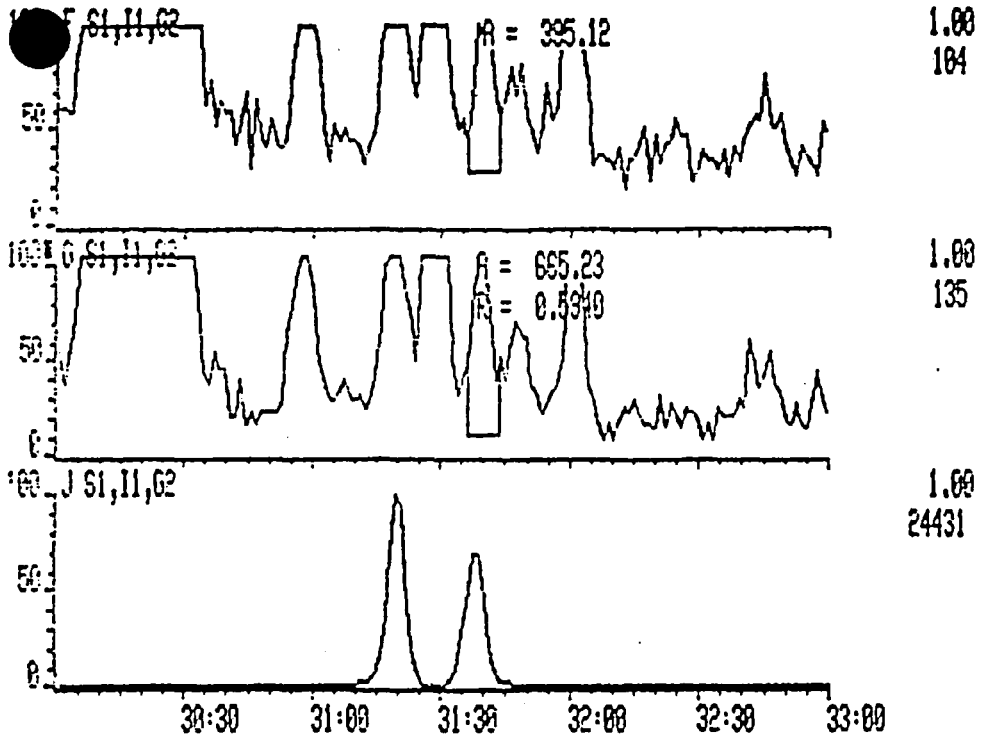
[illegible] 18-OCT-90 13:28 70S (EI+) Sys:DB5US
[illegible] 2 F: 319.8965 G: 321.8336 H: 327.8847 I: 330.9732 J: 331.9368
Text:LF1/9110 TLI#16661

NOV 1 9 1990
ENVIRONMENTAL AFFAIRS



3

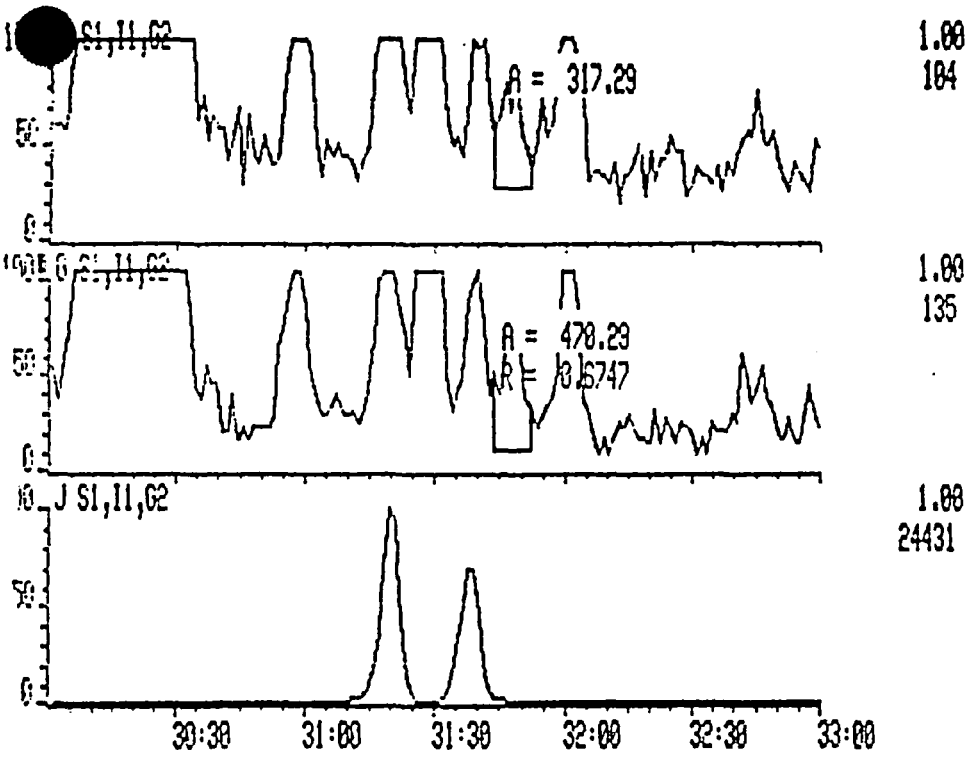
B30730 18-OCT-90 13:28 703 (EI+) Sus:D85U5
F: 319.8955 G: 321.8936 H: 327.8947 I: 330.9732 J: 331.9368
Text:LF1/S110 TLI#16661



NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

3

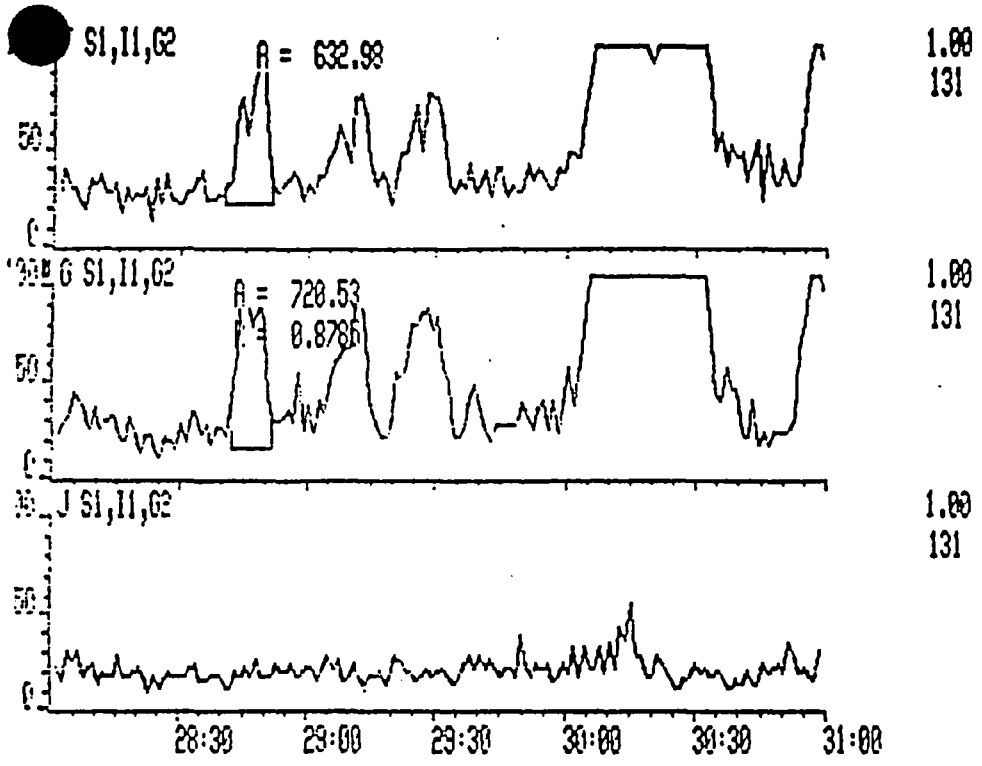
3730 18-OCT-90 13:28 78S (EI+) Sus:DB5US
F: 319.9965 G: 321.8636 H: 327.8847 I: 330.9792 J: 331.9368
Tmt:LF1/9110 TL1#18661



NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

3.

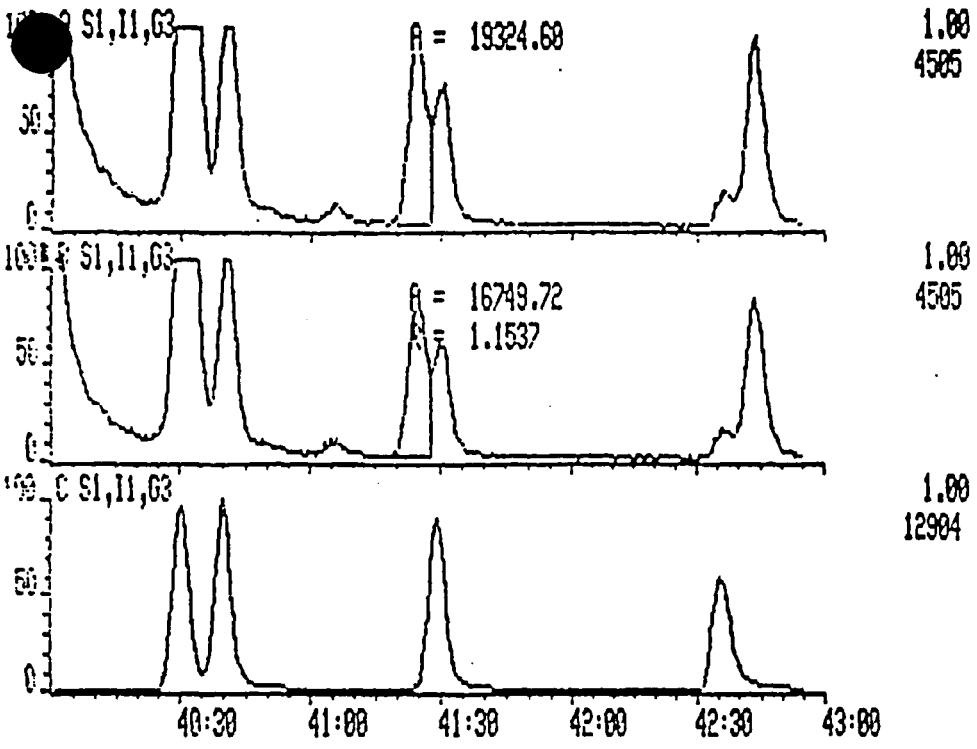
33790 18-OCT-95 13:26 785 (E1+) Sys:D85US
F: 319.8365 G: 321.8936 H: 327.8347 I: 330.5732 J: 331.9368
LF1/9110 TLI#16661



NOV 1 0 1995
ENVIRONMENTAL AFFAIRS

3

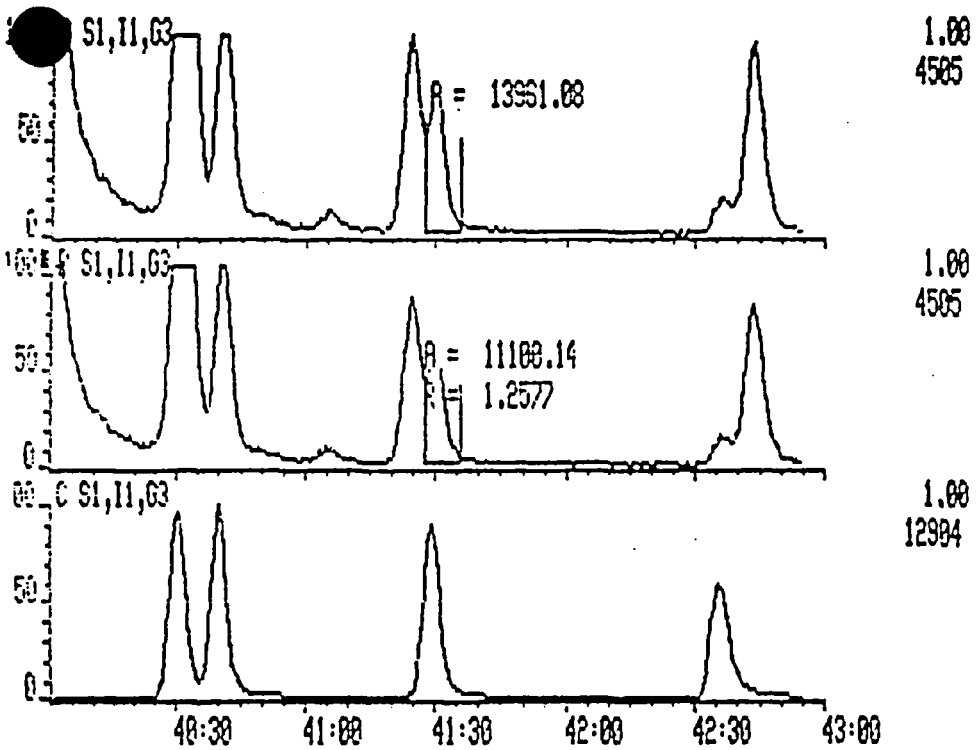
E9750 18-OCT-90 13:26 70S (EI+) Sus:DB5US
3 A: 373.6208 B: 375.6178 C: 383.8939 D: 385.8610 E: 389.8156
Text:LF1/9110 TLI#16661



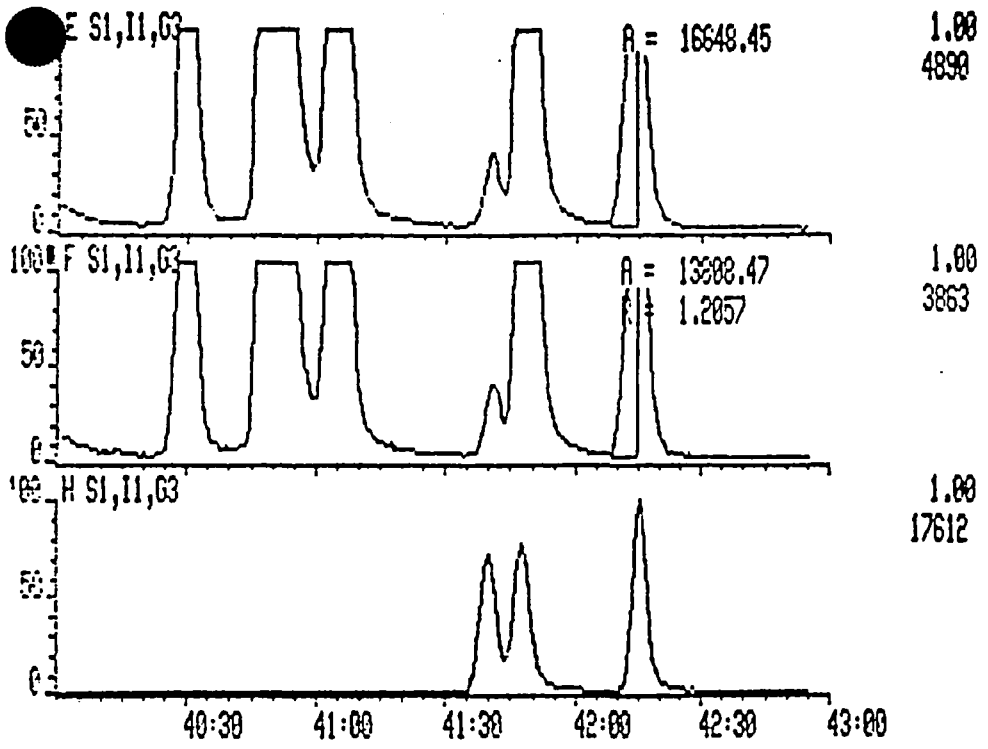
NOV 1 0 1990
ENVIRONMENTAL AFFAIRS

[illegible] 18-OCT-90 13:28 709 (EI+) Sus:D6506
[illegible] A: 373.8206 B: 375.8176 C: 383.6539 D: 385.6510 E: 389.8156
[illegible]:LF1/9118 TLI#16661

NOV 1 9 1990
ENVIRONMENTAL AFFAIRS

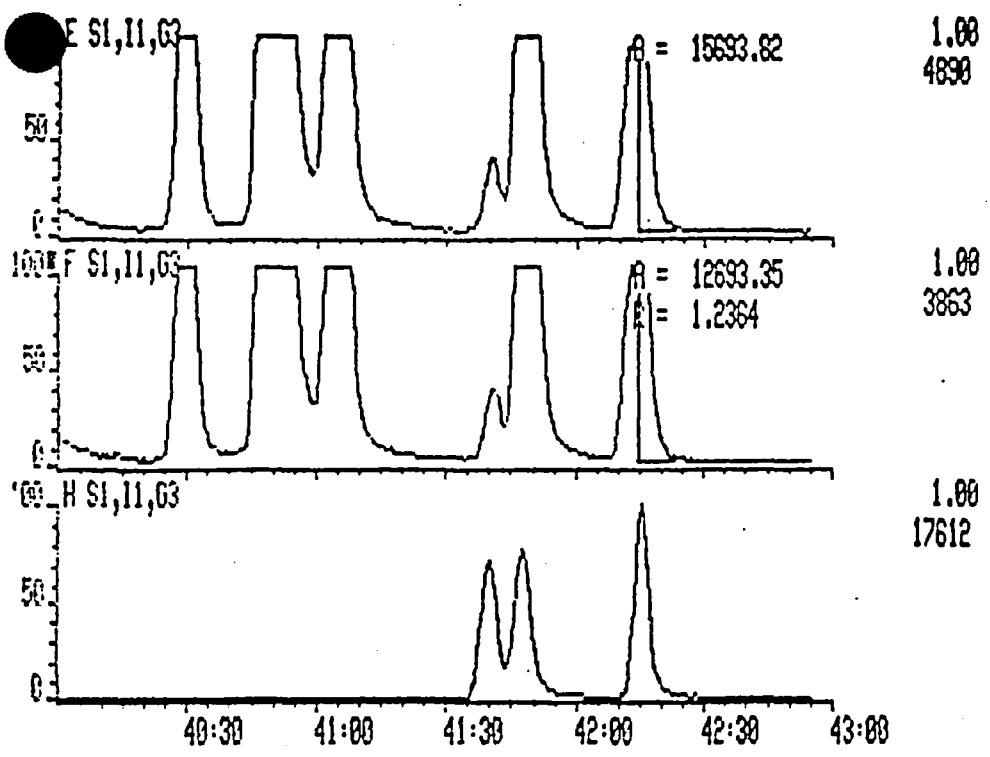


[illegible] 18-OCT-90 13:28 70S (EI+) Sys:DBSMS
[illegible] 3 E: 389.8156 F: 391.8127 G: 392.9768 H: 401.8558 I: 403.8529
Text: LF1/9110 TLI#16661



OCT 1 0 [illegible]
[illegible] IAL ANALYS

[illegible] 18-OCT-90 13:26 70G (EI+) Sus:D85US
[illegible] 3 E: 399.8156 F: 331.8127 G: 332.9760 H: 401.8558 I: 403.8529
Text:LF1/9118 TLI#16661



NOV 1 0 1990
ENVIRONMENTAL ANALYSIS

Confirmation Analyses

TRIANGLE LABORATORIES, INC.

NOV 10 1990

ENVIRONMENTAL AFFAIRS

SAMPLE DATA

NOV 19 1990

TRIANGLE LABORATORIES, INC. ENVIRONMENTAL AFFAIRS
CONFIRMATION ANALYSIS (DB-225)

11/15/90

FILE NAME....: U902306 CLIENT ID....: SWP TLI NUMBER....: 37-26-1
CONCAL (VER).: U902298 SAMPLE ID....: LF1/9110
PROJECT NUMBER: 16661 ICAL DATE....: 09/21/90
ANALYST.....: HA ANALYSIS DATE: 10/21/90
SAMPLE SIZE..: 9.460 g SAMPLE MATRIX: SOIL SAMPLE ORIGIN: WILMINGTO
DATE RECEIVED.: 10/10/90 DATE COLLECTED: 10/09/90
SPIKE FILE...: SPC2NF10 SHIPMENT NO...: NC09001

NAME	CONC(ppb)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	0.02				0.73	18:51	—
2378-TCDF	0.004				0.70	20:01	—
TOTAL TCDD	0.08	9		0.09	0.74		Q
TOTAL TCDF	0.02	6		0.04	0.74		Q

SURROGATE STD. RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
37Cl-TCDD	1.2	116		18:48	—

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	1.2	113	0.77	20:01	—
13C12-2378-TCDD	1.2	112	0.78	18:47	—

MKS 11/15/90 C2NF_RPT rev:3.01

N=3.4 (320)

RECEIVED NOV 09 1990 ENVIRONMENTAL AFFAIRS

	Initial	Date
B-File/Header Changes	MJB	11-6-90
Manual Integrations		
Transcription		
Dbase Corrections	MJB	11-15-90

Page No. 1 Listing of U902306B.dbf
10/29/90

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
304		0.66	16:40	79.67	T	F	0.833	-Q Total Q
		0.39	17:15	173.56	F	F	0.862	
		0.62	17:35	186.07	F	F	0.878	
		0.46	17:48	94.09	F	F	0.889	
		0.48	18:12	69.50	F	F	0.909	
		0.67	18:41	59.65	T	F	0.933	
		0.79	18:59	64.94	T	F	0.948	
		1.10	19:11	21.66	F	F	0.958	
		0.81	19:28	58.18	T	F	0.973	-Q
		~~0.44~~ 0.81	19:48	~~112.28~~ 142	T ~~F~~	F	0.989	
	ok →	~~0.45~~ 0.79	20:01	~~93.43~~ 121	T ~~F~~	T	1.000	
		0.58	20:12	27.43	F	F	1.009	
		0.41	21:56	21.25	F	F	1.096	
	D	-1.02	22:12	16.79	F	F	1.109	-R.W
304		*** Total ***		1078.50	# of Peaks:		14	
316		0.77	20:01	26834.43	T	T	1.000	
316		*** Total ***		26834.43	# of Peaks:		1	
320		0.75	16:31	26.67	T	F	0.879	-Q Total
		0.76	16:48	77.58	T	F	0.894	
		0.71	17:32	100.02	T	F	0.933	
		0.42	17:46	98.89	F	F	0.946	
		0.70	17:59	317.84	T	F	0.957	
		0.76	18:22	59.01	T	F	0.978	-Q
		0.95	18:35	28.79	F	F	0.989	
	ok →	~~0.98~~ 0.73	18:51	~~202.30~~ 234	T ~~F~~	T	1.004	-Q
		0.70	19:41	35.43	T	F	1.048	
		0.86	21:02	19.57	T	F	1.120	
	D	-0.49	22:11	24.56	F	F	1.181	-R.W
320		*** Total ***		990.66	# of Peaks:		11	
328		0.00	18:30	2857.34	T	F	0.985	
		0.00	18:48	16932.10	T	T	1.001	
328		*** Total ***		19789.44	# of Peaks:		2	
332		0.77	18:29	2297.58	T	F	0.984	
		0.78	18:47	16348.32	T	T	1.000	
		0.80	19:01	14047.60	T	T	1.012	
332		*** Total ***		32693.50	# of Peaks:		3	

*** End of Report ***

320	0.69	19:01	294	T	F	1.012	2
	0.64	19:18	34	F	F	1.035	

NOV 19 1990

ENVIRONMENTAL AFFAIRS

Listing of U9023061.dbf File
Raw Mass, Retention Time and Data Area

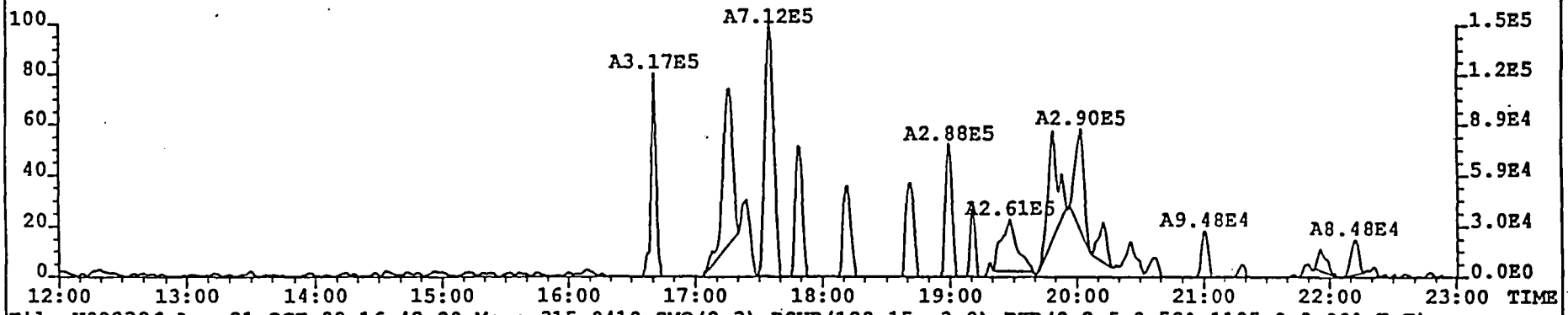
M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
304	16:40	31.67	18:12	22.64	19:28	26.11	21:01	9.48
	17:15	49.06	18:41	24.00	19:48	34.36	21:56	6.23
	17:35	71.24	18:59	28.76	20:01	29.01	22:12	8.48
	17:48	29.54	19:11	11.36	20:12	10.07		
306	16:40	48.00	18:12	46.86	19:48	77.92	21:55	15.02
	17:16	124.50	18:41	35.65	20:01	64.42	22:12	8.31
	17:24	46.92	19:00	36.18	20:10	17.36		
	17:35	114.83	19:11	10.30	20:22	9.89		
	17:49	64.55	19:28	32.07	20:38	5.18		
316	20:01	11655.46						
318	20:01	15178.97						
320	16:31	11.39	17:46	29.37	18:51	96.04	21:02	9.04
	16:48	33.55	17:59	130.71	18:57	113.48	22:11	8.13
	17:19	4.41	18:22	25.55	19:41	14.59		
	17:32	41.49	18:35	14.06	19:50	11.73		
322	16:31	15.28	17:45	69.52	18:35	14.73	19:41	20.84
	16:48	44.03	17:59	187.13	18:50	106.26	21:01	10.53
	17:32	58.53	18:22	33.46	19:04	34.29	22:11	16.43
328	18:30	2857.34	18:48	16932.10				
332	18:29	998.08	18:47	7189.04	19:01	6228.01		
334	18:29	1299.50	18:47	9159.28	19:01	7819.59		

*** End of Report ***

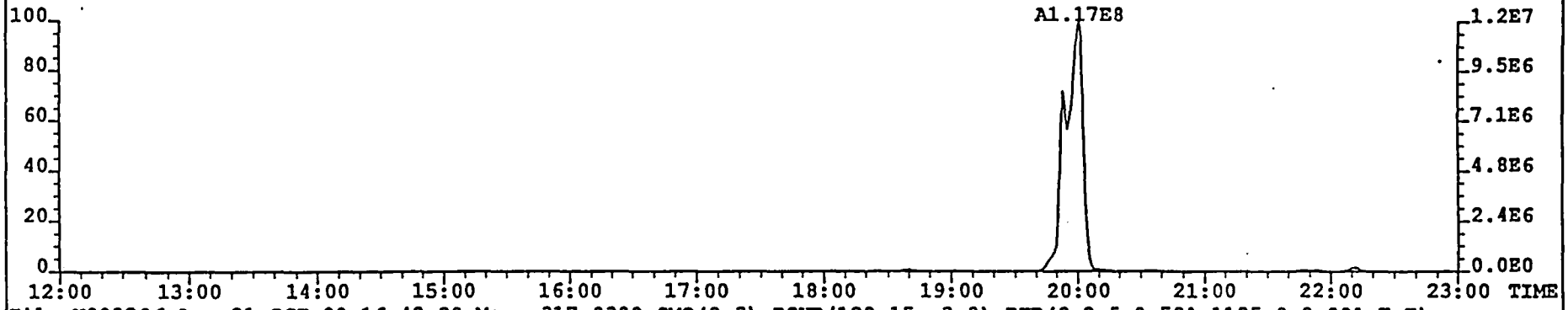
3

PKD 5
OCT. 25 1990
SBL

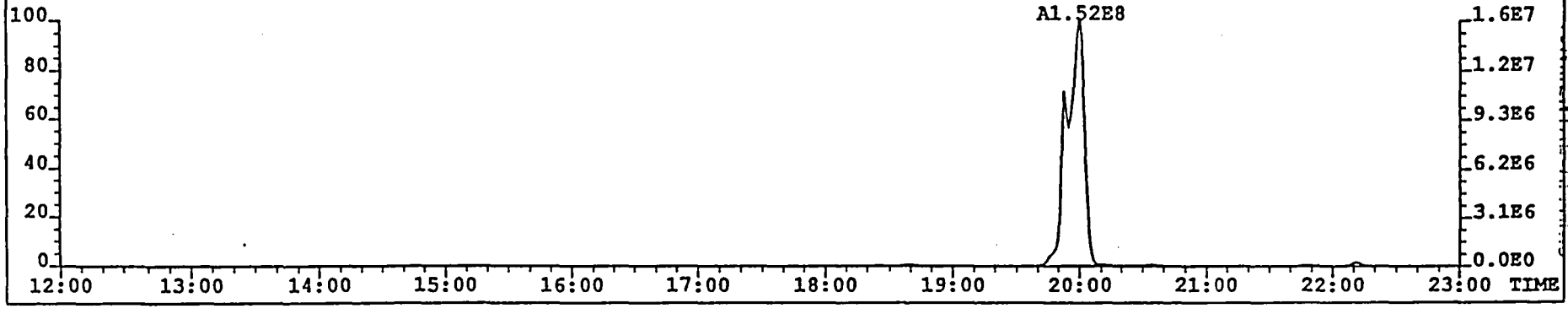
File:U902306 Acq:21-OCT-90 16:42:20 Mass 303.9016 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1560.0,0.00%,F,F)
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 315.9419 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1185.0,0.00%,F,F)
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 317.9389 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1125.0,0.00%,F,F)
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



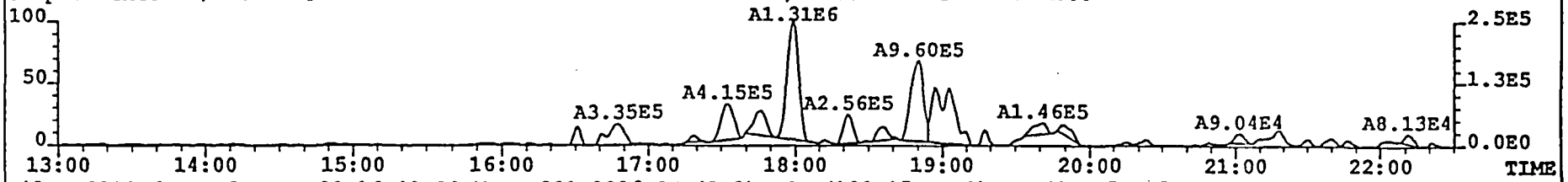
NOV 19 1990

f

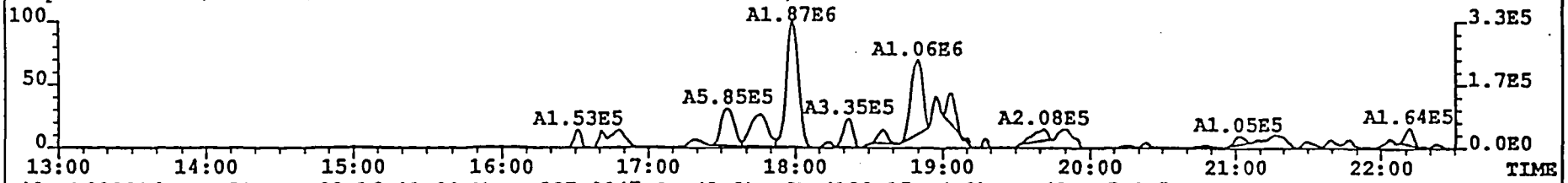
OCT. 25 1990

SBA

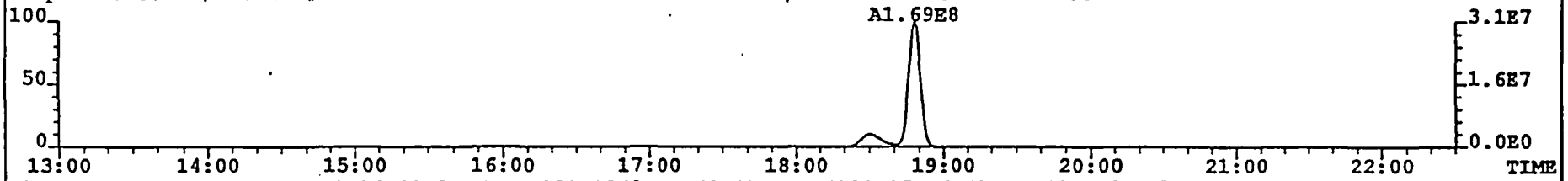
File:U902306 Acq:21-OCT-90 16:42:20 Mass 319.8965 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1782.0,0.00%,F,F)
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



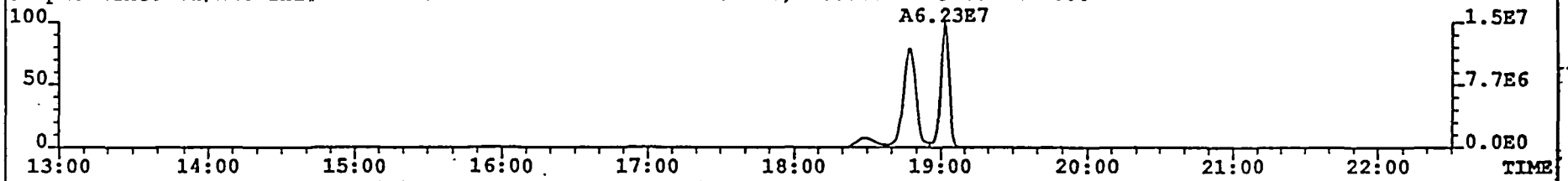
File:U902306 Acq:21-OCT-90 16:42:20 Mass 321.8936 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1278.0,0.00%,F,F)
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



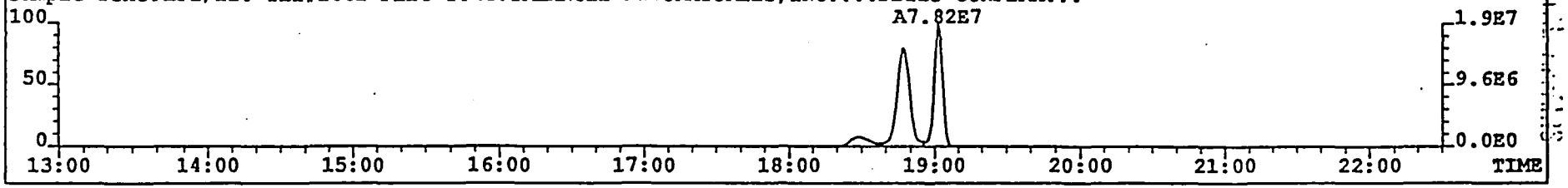
File:U902306 Acq:21-OCT-90 16:42:20 Mass 327.8847 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1017.0,0.00%,F,F)
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 331.9368 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,666.0,0.00%,F,F)
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 333.9338 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1695.0,0.00%,F,F)
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



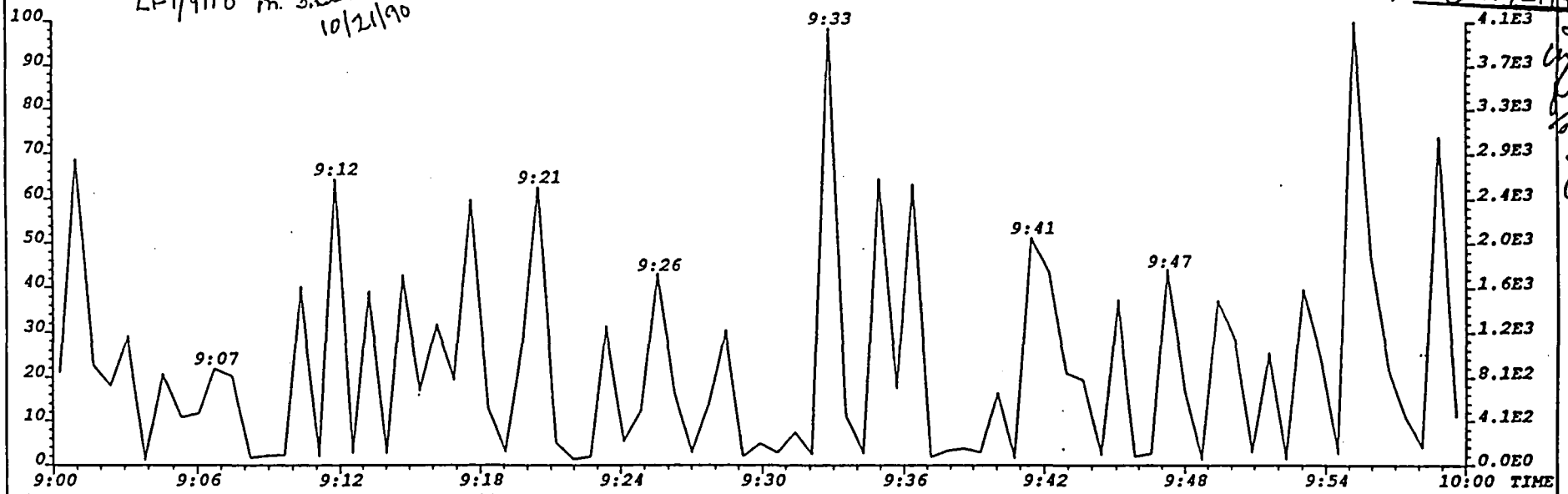
5

(GC/MS) : TA 10. 21. 90

(Int. QC) : TA 10/24/90

File:U902306 Acq:21-OCT-90 16:42:20 Mass 303.9016
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

LFI/9110 m. Smith 10/21/90

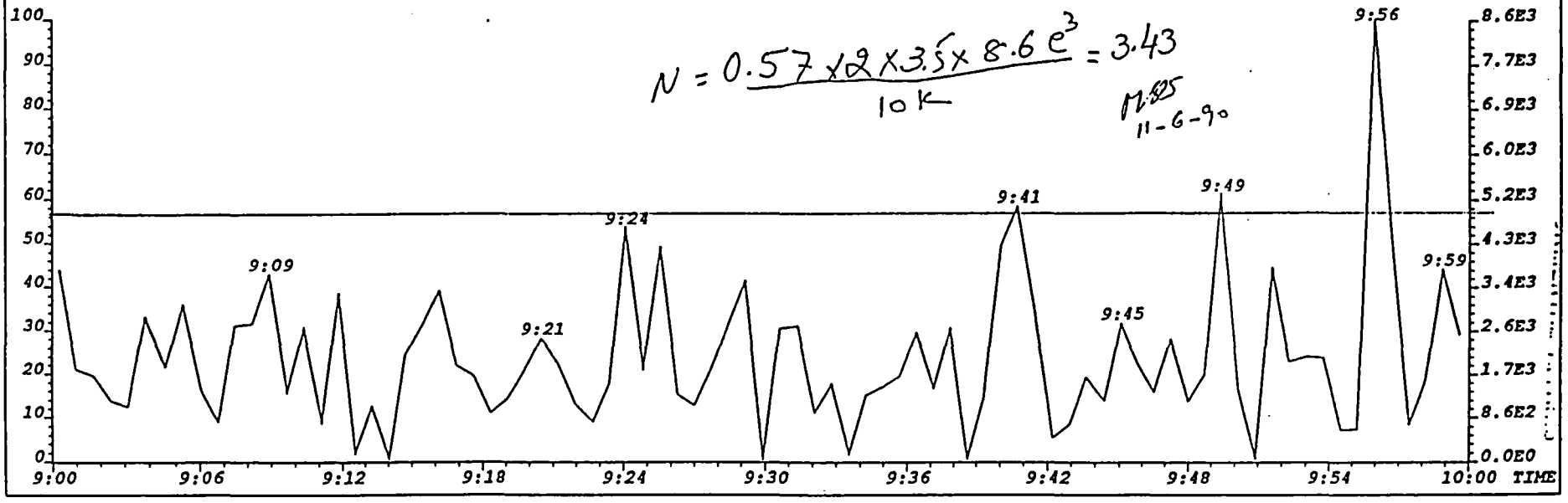


Interference from sample TA 10/24/90

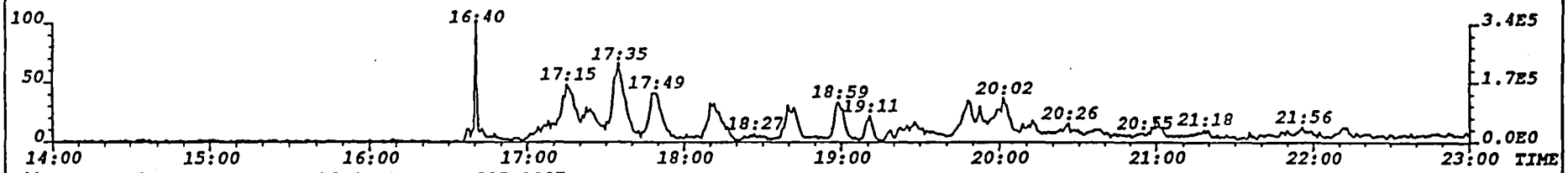
File:U902306 Acq:21-OCT-90 16:42:20 Mass 319.8965
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

$$N = \frac{0.57 \times 2 \times 3.5 \times 8.6\,e^3}{10\,K} = 3.43$$

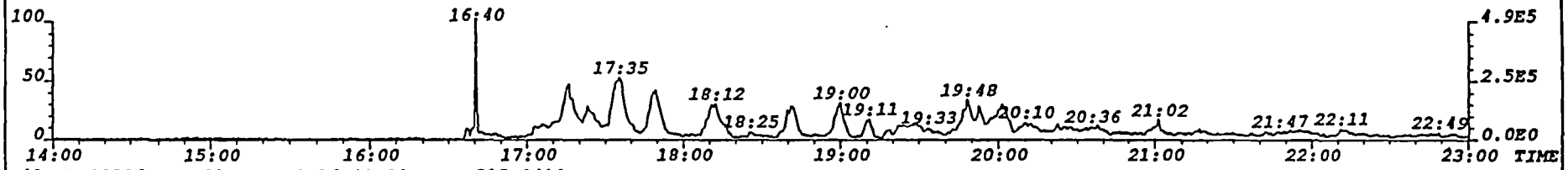
MJS 11-6-90



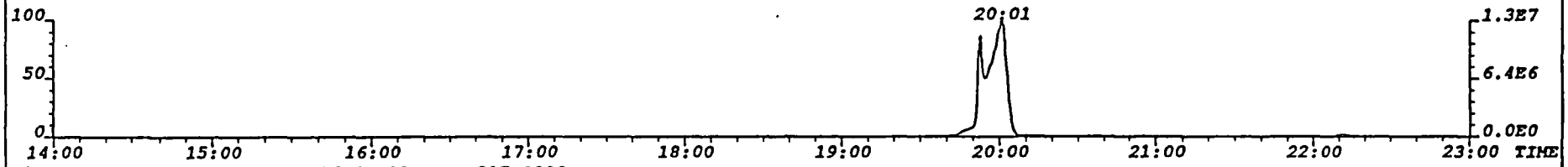
File:U902306 Acq:21-OCT-90 16:42:20 Mass 303.9016
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



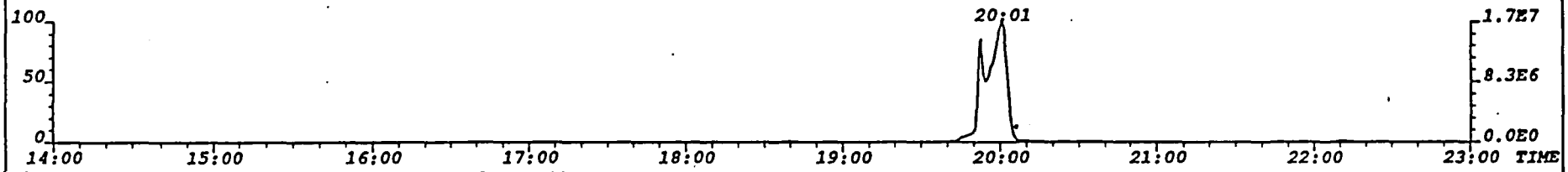
File:U902306 Acq:21-OCT-90 16:42:20 Mass 305.8987
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



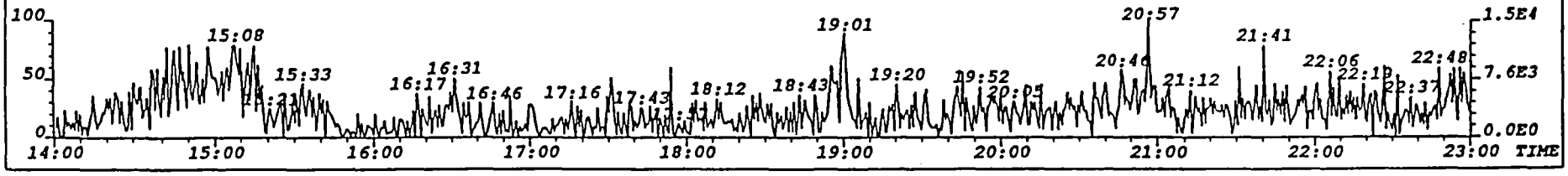
File:U902306 Acq:21-OCT-90 16:42:20 Mass 315.9419
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 317.9389
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

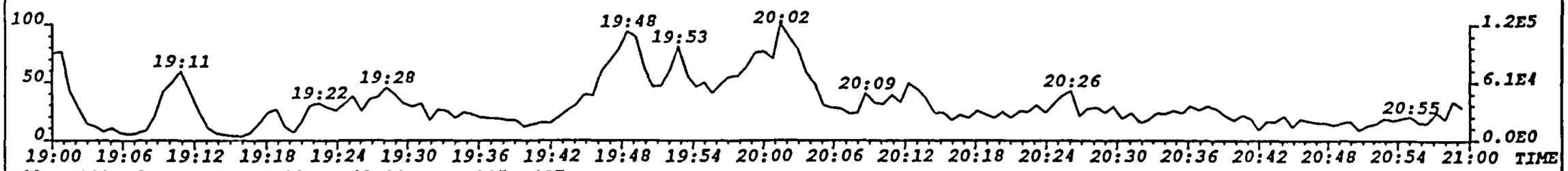


File:U902306 Acq:21-OCT-90 16:42:20 Mass 375.8364
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

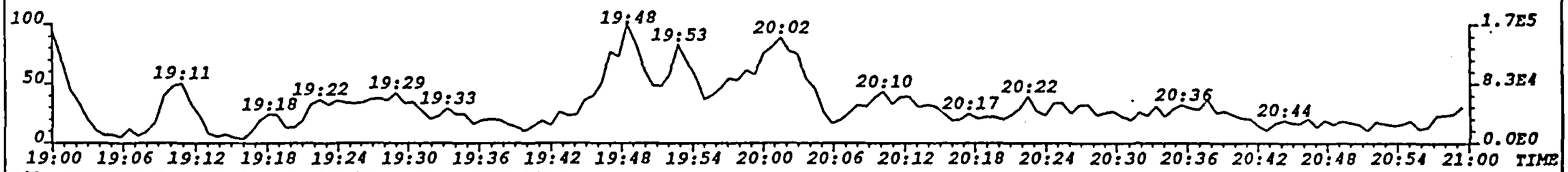


ENVIRONMENTAL AFFAIRS
NOV 19 1990

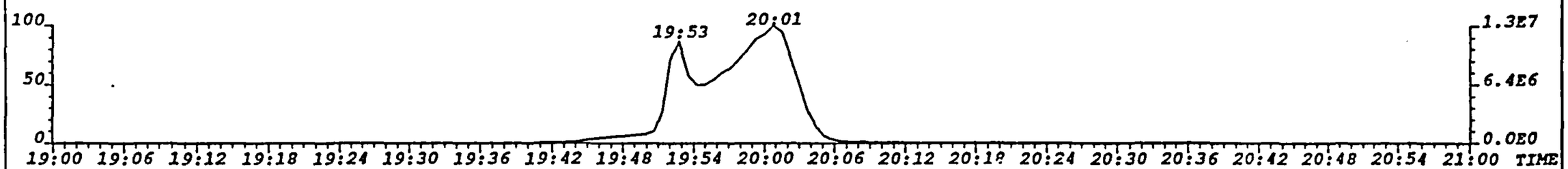
File:U902306 Acq:21-OCT-90 16:42:20 Mass 303.9016
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 305.8987
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 315.9419
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 317.9389
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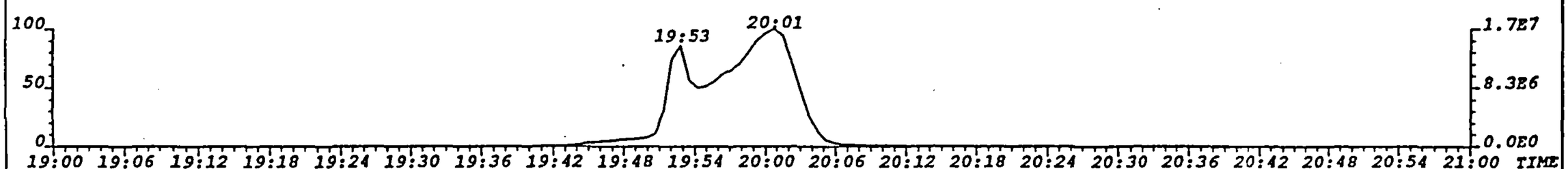

File:U902306 Acq:21-OCT-90 16:42:20 Mass 375.8364
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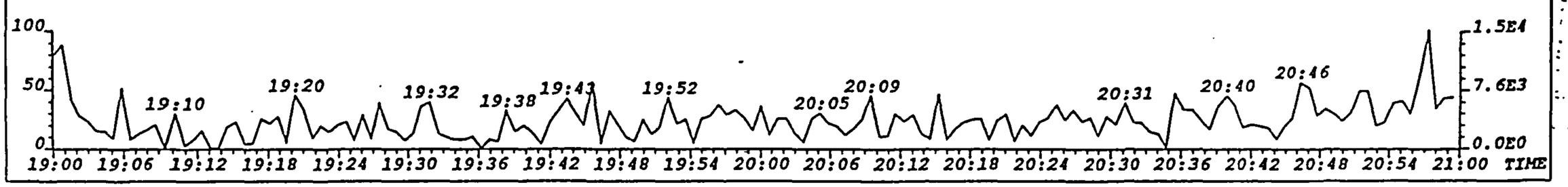
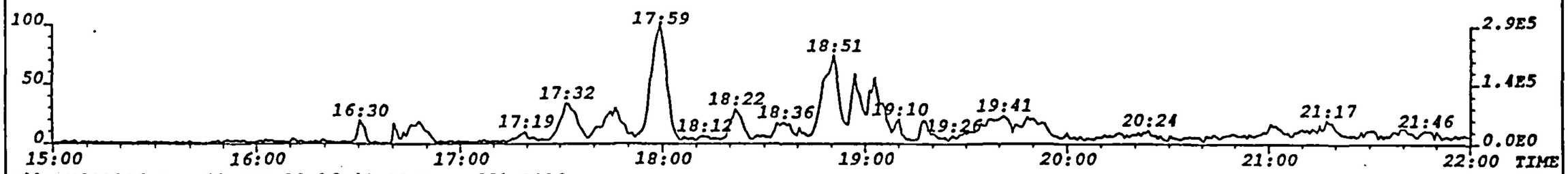


File:U902306 Acq:21-OCT-90 16:42:20 Mass 319.8965
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 321.8936
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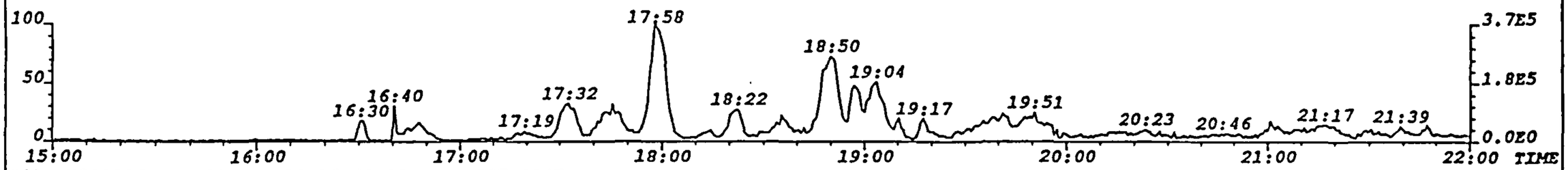
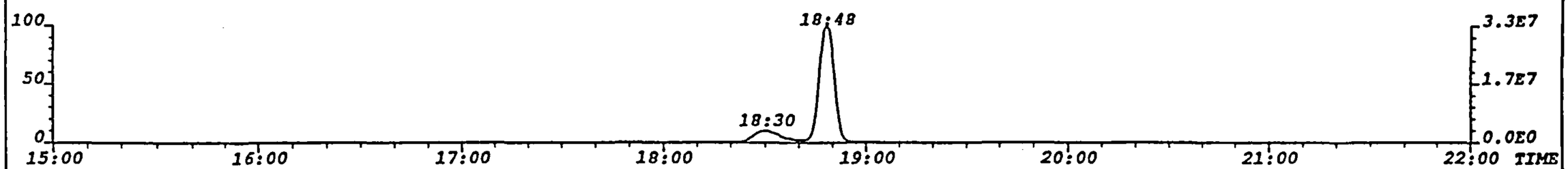
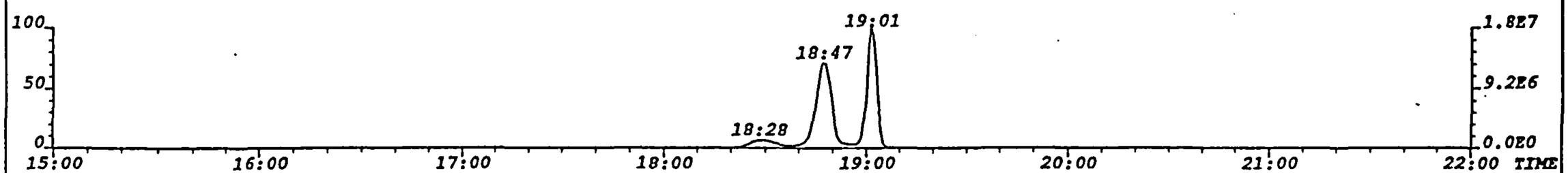


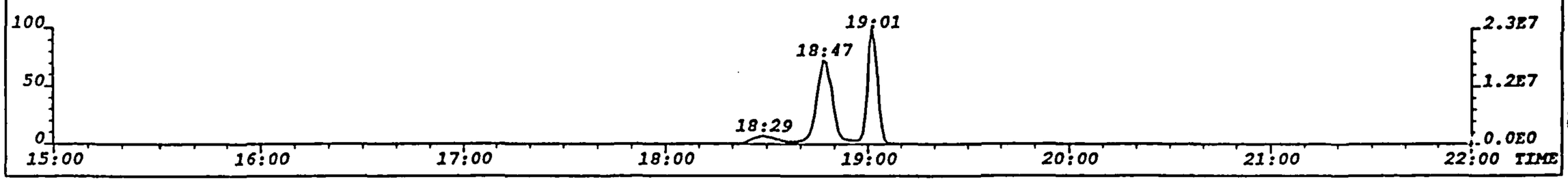
File:U902306 Acq:21-OCT-90 16:42:20 Mass 327.8847
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 331.9368
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



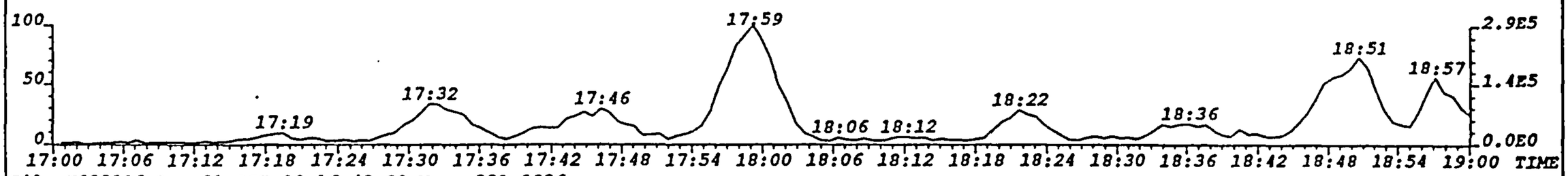
File:U902306 Acq:21-OCT-90 16:42:20 Mass 333.9338
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



NOV 19 1990

9

File:U902306 Acq:21-OCT-90 16:42:20 Mass 319.8965
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 321.8936
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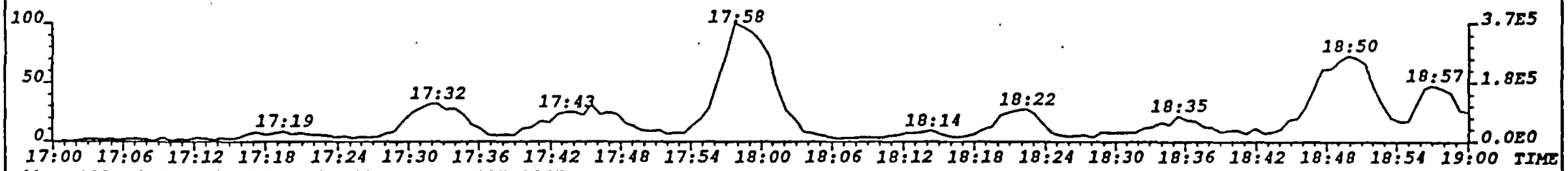
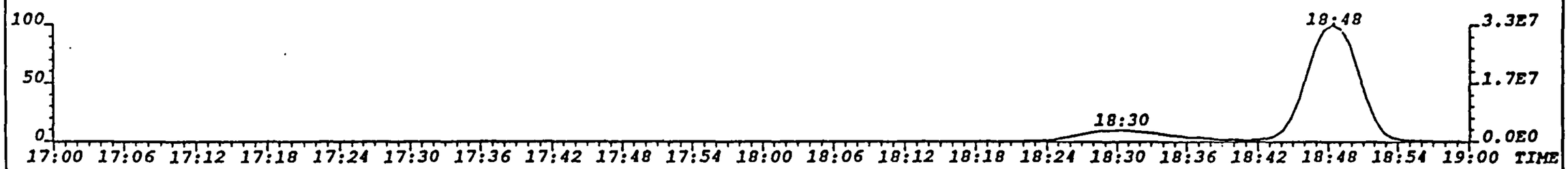


File:U902306 Acq:21-OCT-90 16:42:20 Mass 327.8847
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 331.9368
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

File:U902306 Acq:21-OCT-90 16:42:20 Mass 333.9338
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

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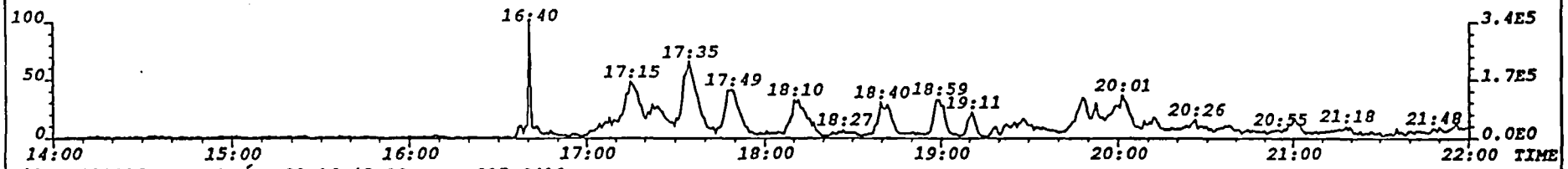
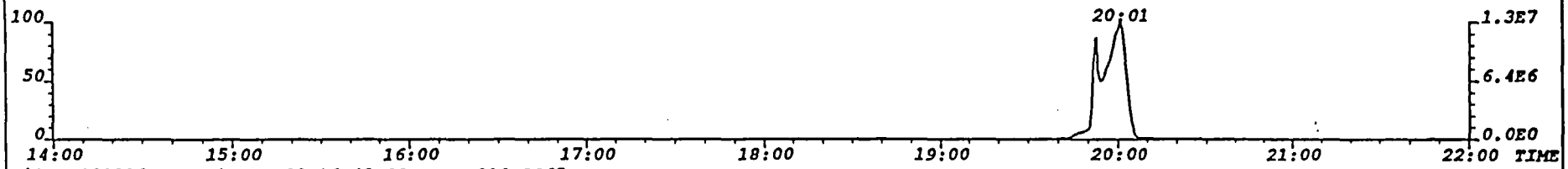
NOV 19 1990

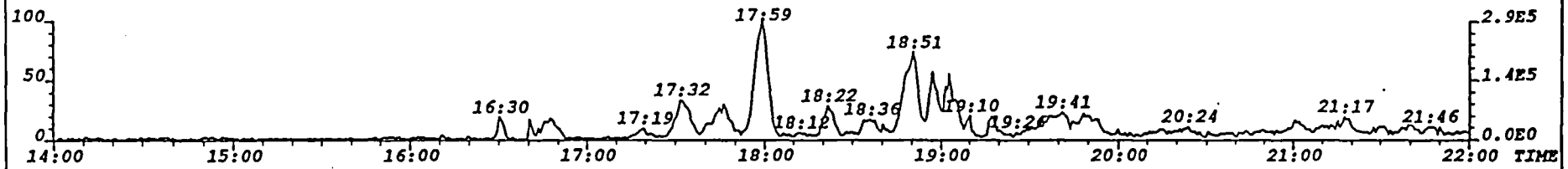
File:U902306 Acq:21-OCT-90 16:42:20 Mass 303.9016
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



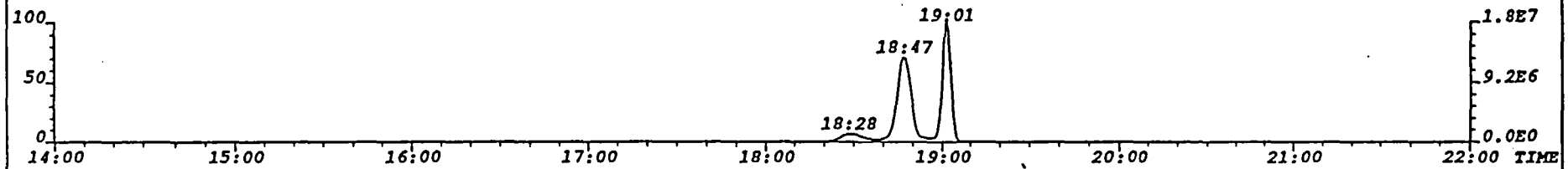
File:U902306 Acq:21-OCT-90 16:42:20 Mass 315.9419
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



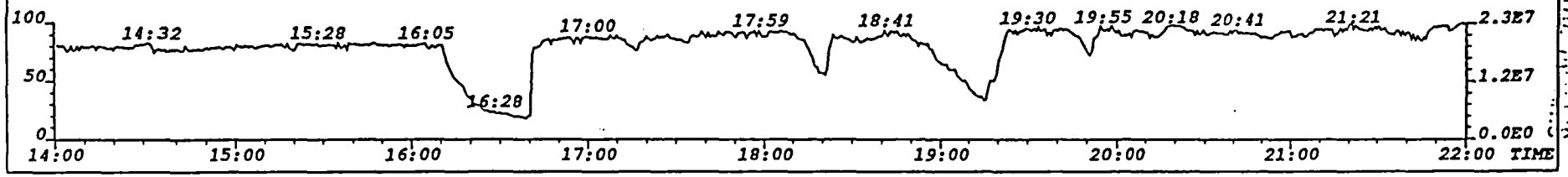
File:U902306 Acq:21-OCT-90 16:42:20 Mass 319.8965
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Acq:21-OCT-90 16:42:20 Mass 331.9368
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

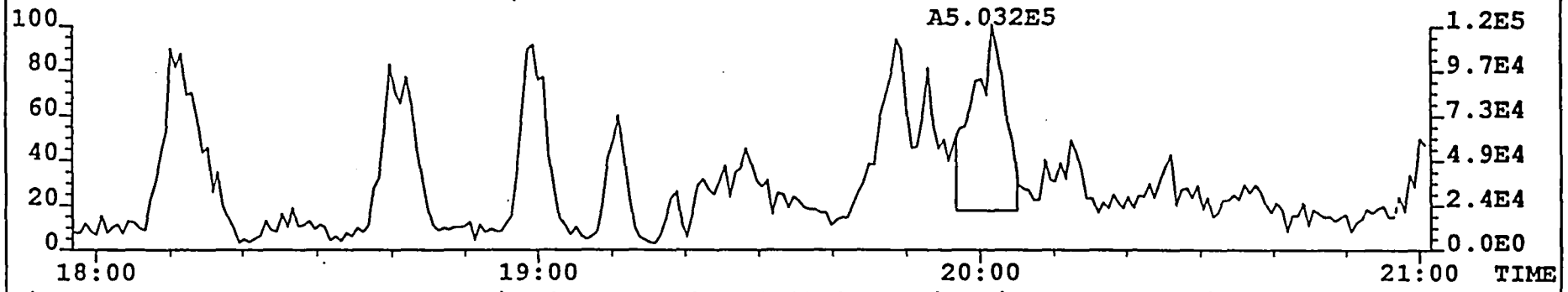


File:U902306 Acq:21-OCT-90 16:42:20 Mass 292.9825
Sample Text:LFI/110 TLI#1661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

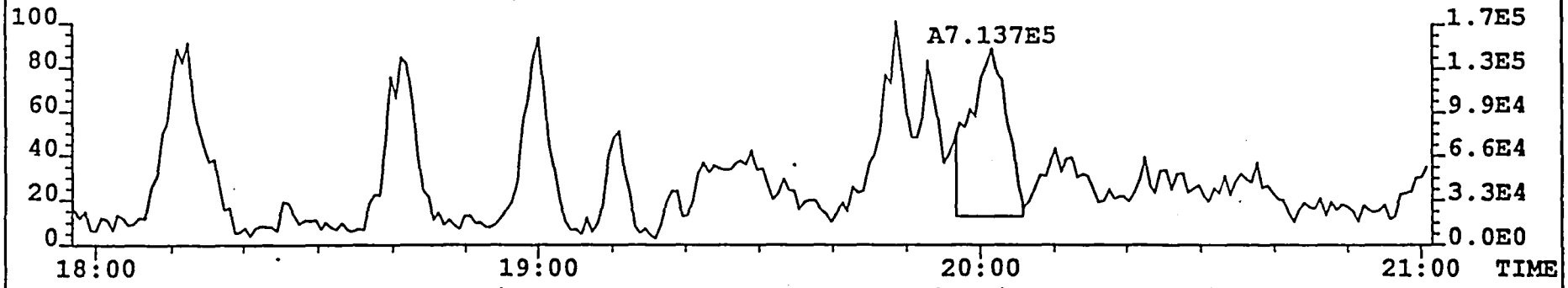


MBS 11-15-90

File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 303.9016 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 305.8987 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



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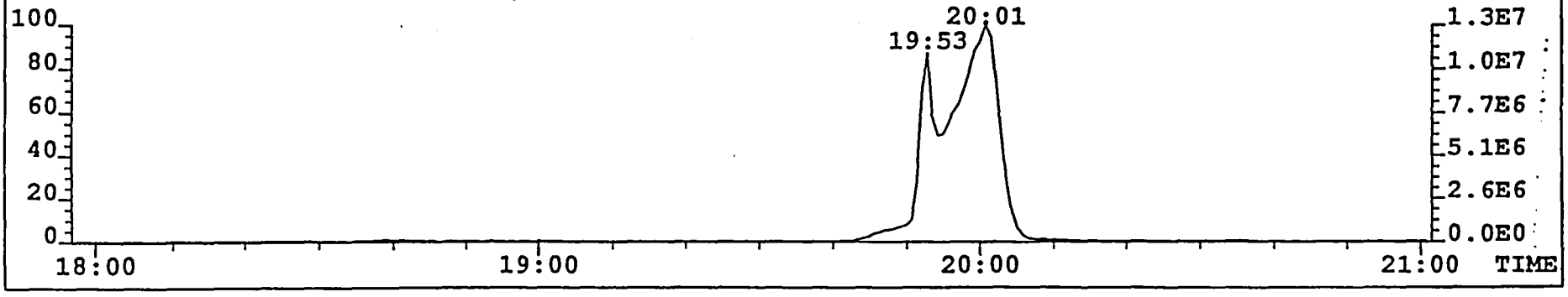
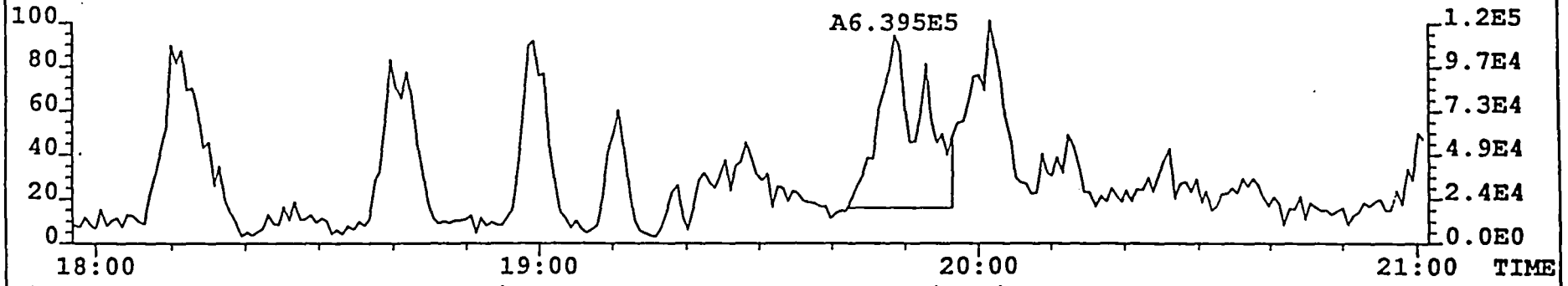
Mass 315.9419 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

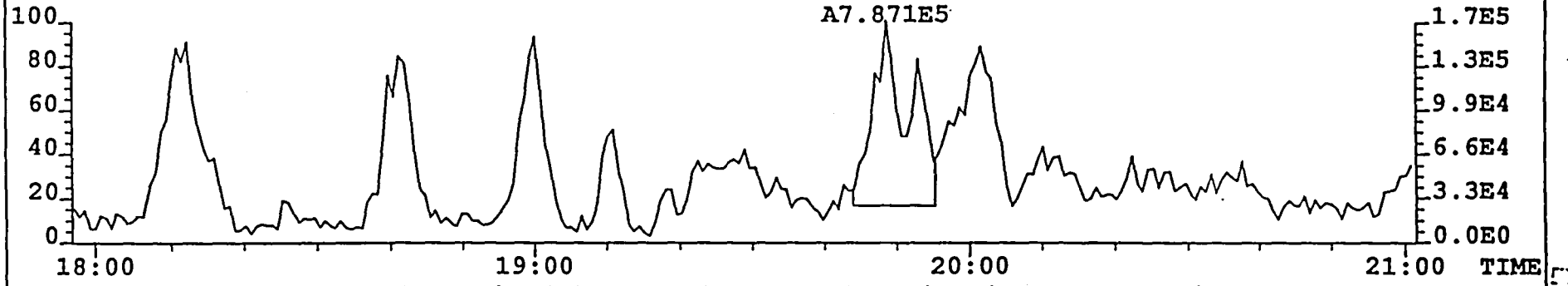


MBS 11-15-90

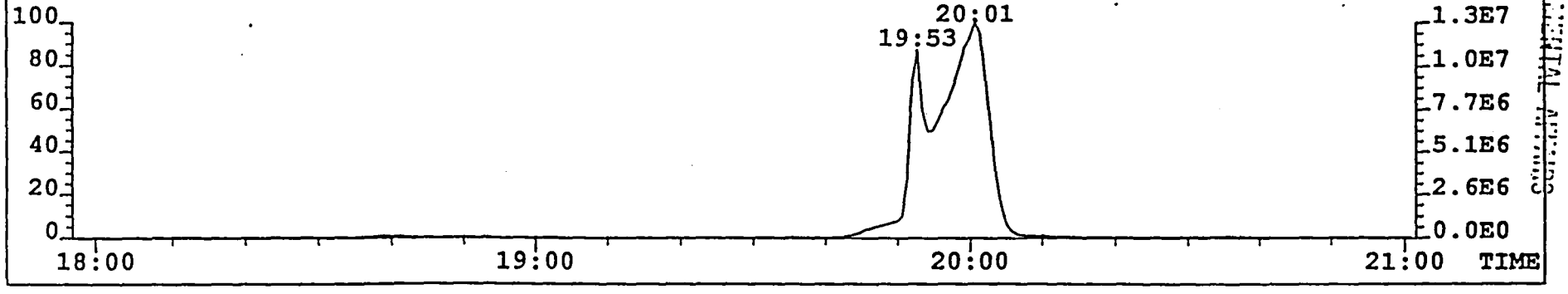
File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 303.9016 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 305.8987 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 315.9419 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



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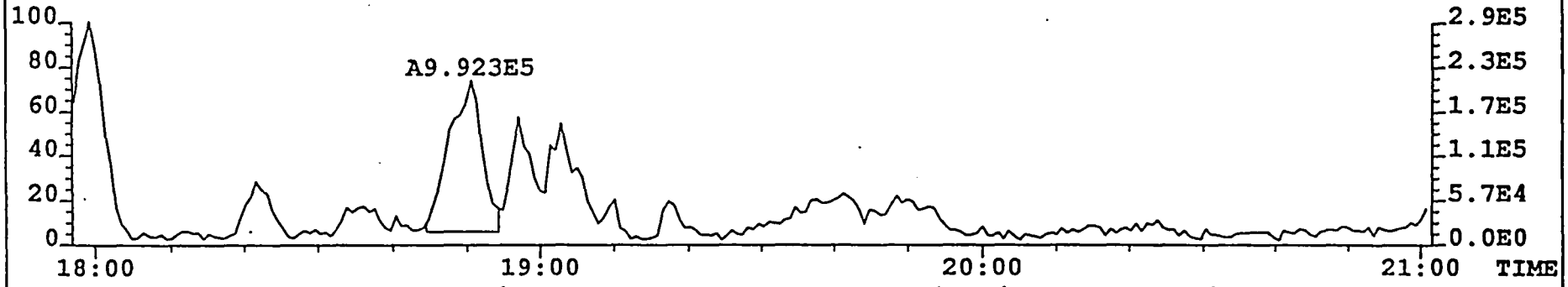
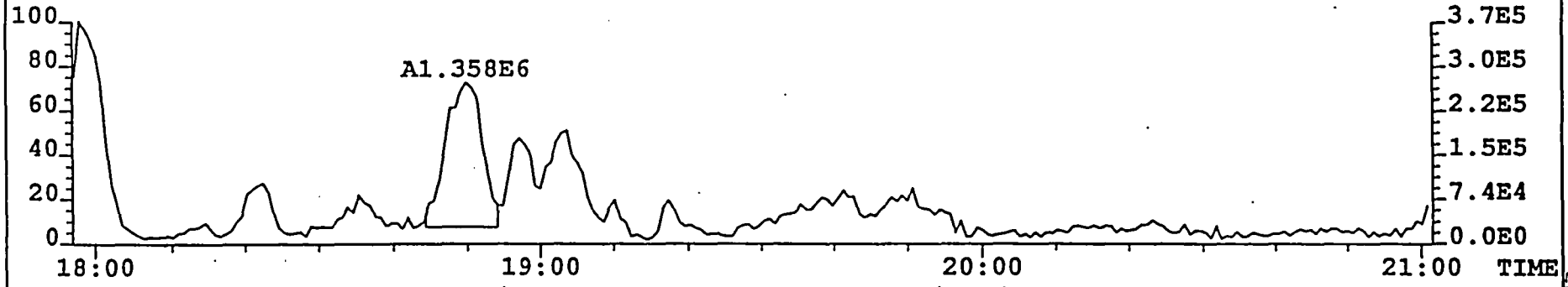
NOV 19 1990

MSB 11-15-90

File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 319.8965 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 321.8936 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



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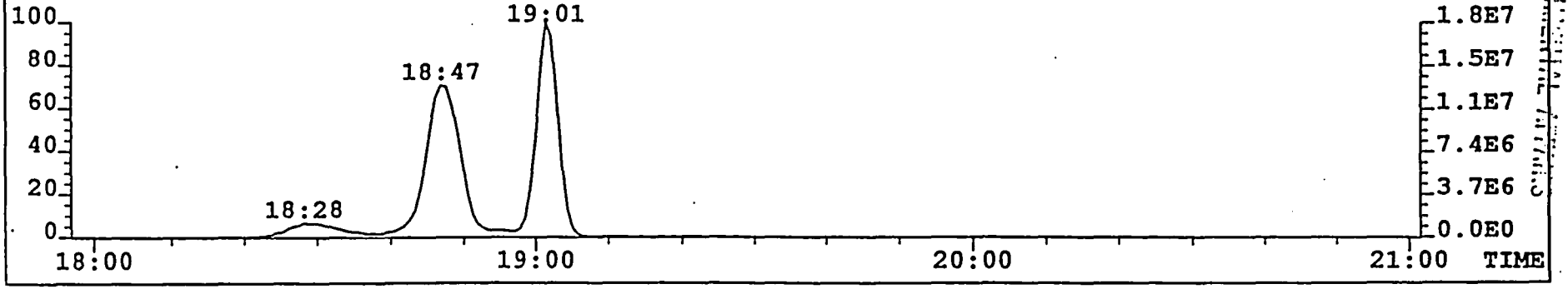
Mass 331.9368 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



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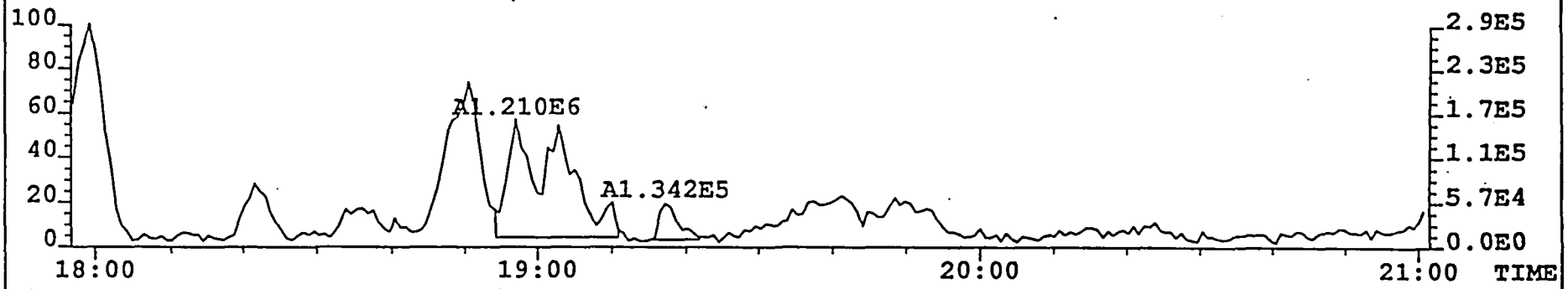
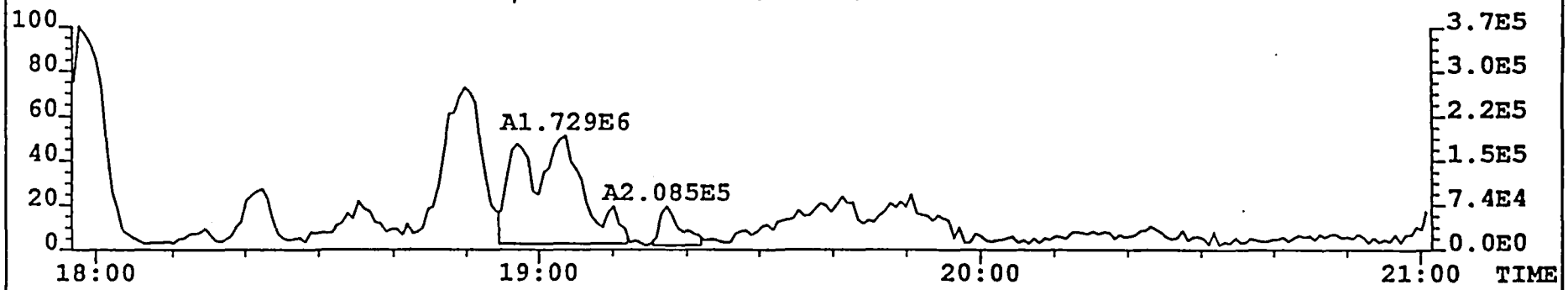
MBS 11-15-90

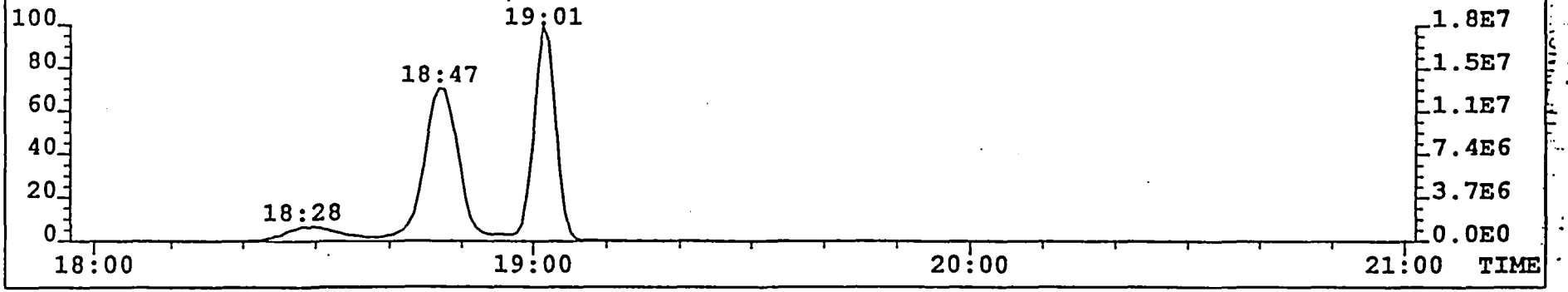
File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 319.8965 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 321.8936 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902306 Scans:1-1908 Acquired:21-OCT-90 16:42:20 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 331.9368 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



NOV 10 1990

TRIANGLE LABORATORIES, INC.
CONFIRMATION ANALYSIS (DB-225) 11/15/90

FILE NAME....: U902307 CLIENT ID....: SWP TLI NUMBER....: 37-26-2
CONCAL (VER).: U902298 SAMPLE ID....: LF2/9111
PROJECT NUMBER: 16661 ICAL DATE....: 09/21/90
ANALYST.....: JA ANALYSIS DATE: 10/21/90
SAMPLE SIZE..: 9.400 g SAMPLE MATRIX: SOIL SAMPLE ORIGIN: WILMINGTO
DATE RECEIVED.: 10/10/90 DATE COLLECTED: 10/09/90
SPIKE FILE...: SPC2NF10 SHIPMENT NO...: NC09001

NAME	CONC(ppb)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	0.03				0.75	18:51	___
2378-TCDF	0.005				0.86	20:00	___
TOTAL TCDD	0.14	6		0.16	0.80		Q
TOTAL TCDF	0.03	7		0.05	0.79		___

SURROGATE STD. RECOVERY SUMMARY (TYPE B)

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
37Cl-TCDD	1.1	101		18:48	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	CONC (ppb)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	1.0	96.1	0.77	19:59	___
13C12-2378-TCDD	0.97	91.1	0.74	18:48	___

MJS 11/15/90 C2NF_RPT rev:3.01

N-3 - (520)

	Initial	Date
B-File/Header Changes	MBS	11-6-90
Manual Integrations		
Transcription		
Dbase Corrections	MB	11-15-90

NOV 19 1990

ENVIRONMENTAL AFFAIRS

Page No. 1 Listing of U902307B.dbf
10/29/90

Matched GC Peaks / Ratio / Ret. Time

M_Z	Omit	Ratio	RT.	Area	Match Rat	Match RT	REL_RT	Who/ Why
304		0.79	16:43	52.16	T	F	0.837	-Q
		0.56	17:15	157.84	F	F	0.863	
		0.62	17:34	144.62	F	F	0.879	
		0.73	17:48	86.72	T	F	0.891	
		0.73	18:11	129.89	T	F	0.910	
		0.84	18:41	69.80	T	F	0.935	
		0.82	19:00	67.92	T	F	0.951	
		0.75	19:12	18.78	T	F	0.961	
		0.55	19:23	63.53	F	F	0.970	-Q
		0.39	19:48	98.23	F	F	0.991	
		0.86	20:00	94.80	T	T	1.001	
		0.39	20:12	19.33	F	F	1.011	
		1.17	21:54	13.82	F	F	1.096	JR.W
	D-F	0.65	22:11	13.47	T	F	1.110	
304		*** Total ***		1032.91	# of Peaks:		14	
316		0.77	19:59	16300.13	T	T	1.000	
316		*** Total ***		16300.13	# of Peaks:		1	
320		0.75	16:46	55.49	T	F	0.908	-Q
		0.97	17:32	87.28	F	F	~~0.949~~ 0.933	
		0.87	17:45	102.76	T	F	~~0.961~~ 0.946	
		0.81	17:58	358.52	T	F	~~0.973~~ 0.957	
		0.86	18:22	52.01	T	F	~~0.995~~ 0.978	
		0.54	18:36	32.08	F	F	~~1.007~~ 0.989	
	~~Et~~ →	~~0.80~~ 0.75	18:51	~~257.34~~ 256	T	~~F~~ T	~~1.021~~ 1.000	
		1.05	19:49	50.49	F	F	1.073	
320		*** Total ***		995.97	# of Peaks:		8	
328		0.00	18:30	1009.80	T	~~T~~ F	~~1.002~~ 0.984	
		0.00	18:48	10533.61	T	~~F~~ T	~~1.018~~ 1.000	
328		*** Total ***		11543.41	# of Peaks:		2	
332	~~Et~~ →	0.53	18:28	776.45	F	~~T~~ F	~~1.000~~ 0.984	
		0.74	18:48	9492.65	T	T	~~1.018~~ 1.000	
		0.77	19:03	10047.67	T	~~F~~ T	~~1.032~~ 1.012	
332		*** Total ***		20316.77	# of Peaks:		3	

*** End of Report ***

				321	T	F	1.012	-Q
320		0.74	19:03					
"		0.64	19:38	11.4	F	F	~~1.035~~ 1.044	2

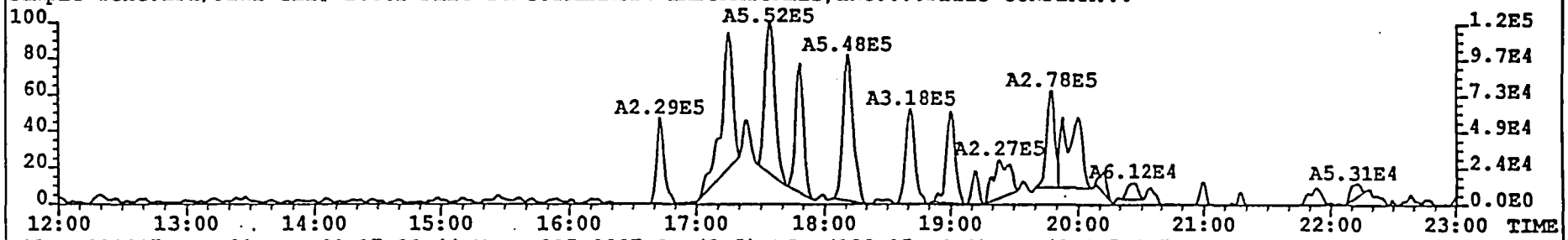
Listing of U902307I.dbf File
Raw Mass, Retention Time and Data Area

M_Z	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....	mm:ss	Data.Area.....
304	16:43	22.94	18:11	54.81	19:23	22.66	20:26	6.12
	17:15	56.96	18:41	31.83	19:48	27.80	21:54	7.45
	17:34	55.22	19:00	30.53	20:00	43.92	22:11	5.31
	17:48	37.54	19:12	8.02	20:12	5.44		
306	16:43	29.22	18:11	75.08	19:47	70.43	21:53	6.37
	17:15	100.88	18:41	37.97	20:00	50.88	22:11	8.16
	17:24	40.27	19:00	37.39	20:10	13.89		
	17:35	89.40	19:12	10.76	20:22	7.20		
	17:48	51.18	19:22	40.87	20:37	4.05		
316	19:59	7106.94						
318	19:59	9193.19						
320	16:35	8.35	17:45	47.77	18:36	11.19	19:37	16.93
	16:46	23.82	17:58	160.15	18:51	114.28	19:49	25.81
	17:32	42.94	18:22	24.05	19:04	122.53		
322	16:46	31.67	17:59	198.37	18:50	143.06	19:49	24.68
	17:32	44.34	18:22	27.96	18:58	156.26	21:01	6.50
	17:45	54.99	18:35	20.89	19:40	27.85		
328	18:30	1009.80	18:48	10533.61				
332	18:28	267.36	18:48	4026.83	19:03	4358.68		
334	18:28	509.09	18:47	5465.82	19:02	5688.99		

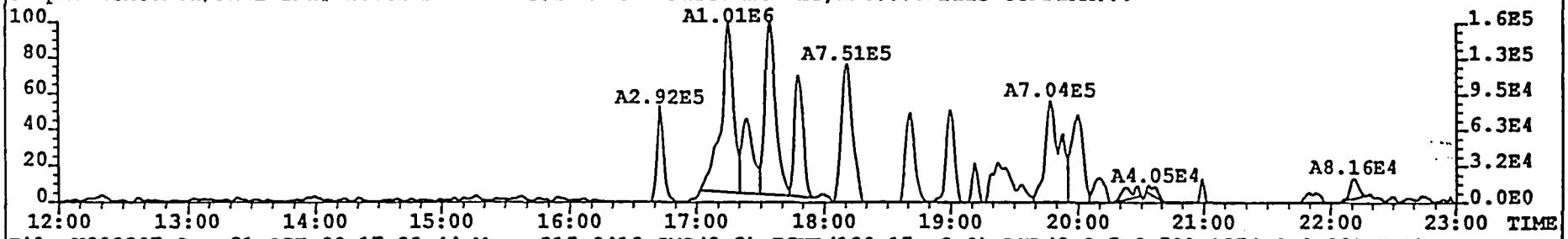
*** End of Report ***

OCT. 25 1990
SBR

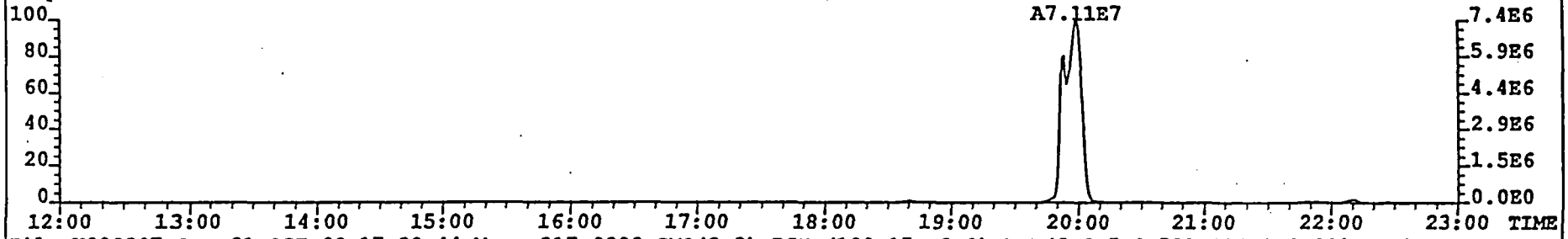
File:U902307 Acq:21-OCT-90 17:32:44 Mass 303.9016 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,576.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



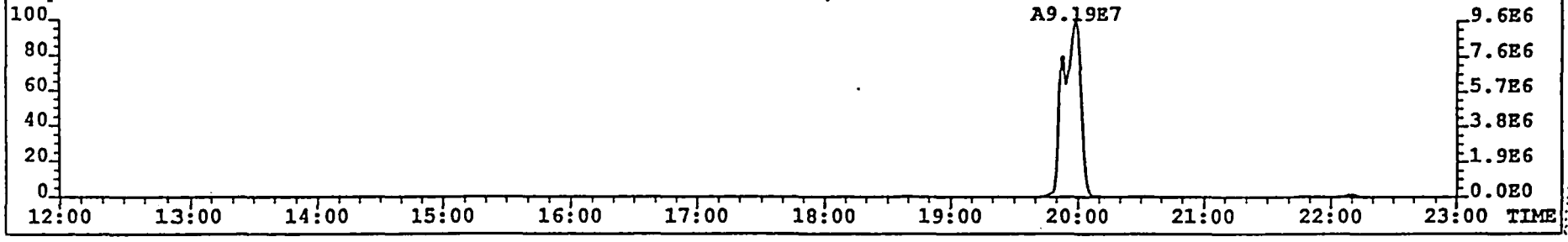
File:U902307 Acq:21-OCT-90 17:32:44 Mass 305.8987 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1362.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902307 Acq:21-OCT-90 17:32:44 Mass 315.9419 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1374.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



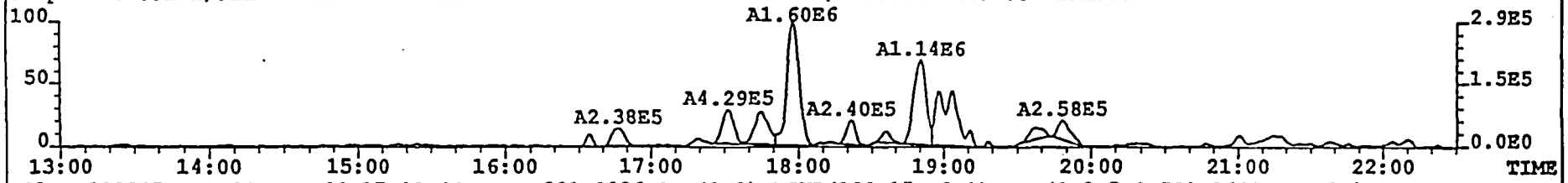
File:U902307 Acq:21-OCT-90 17:32:44 Mass 317.9389 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,924.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



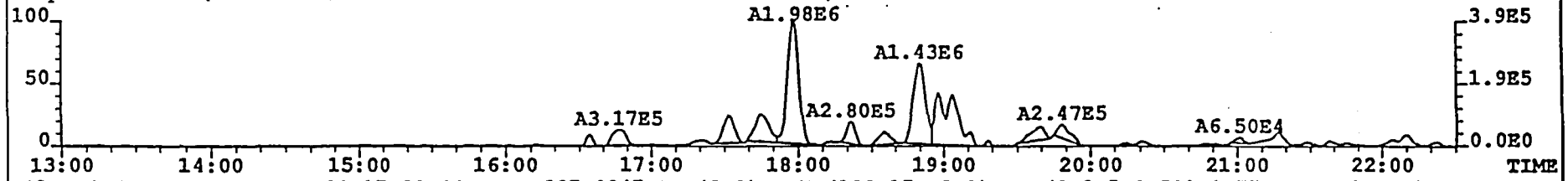
NOV 10 1990

OCT. 25 1990

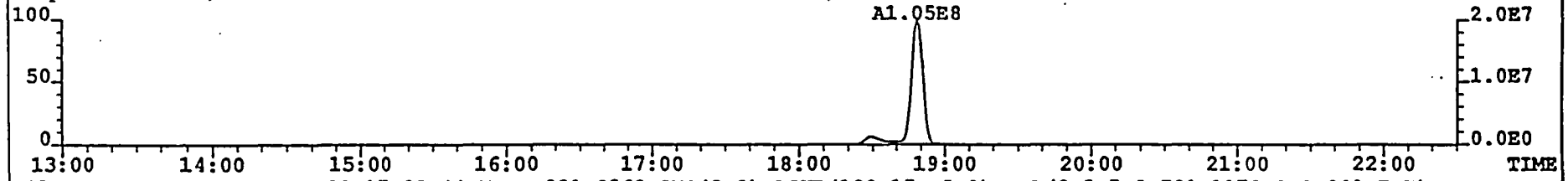
File:U902307 Acq:21-OCT-90 17:32:44 Mass 319.8965 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1698.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



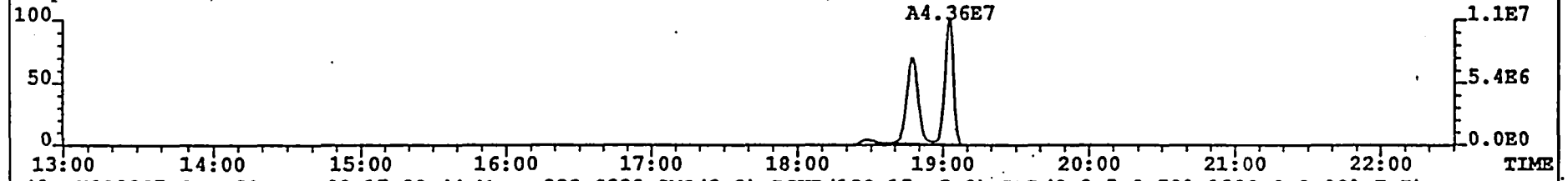
File:U902307 Acq:21-OCT-90 17:32:44 Mass 321.8936 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1641.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



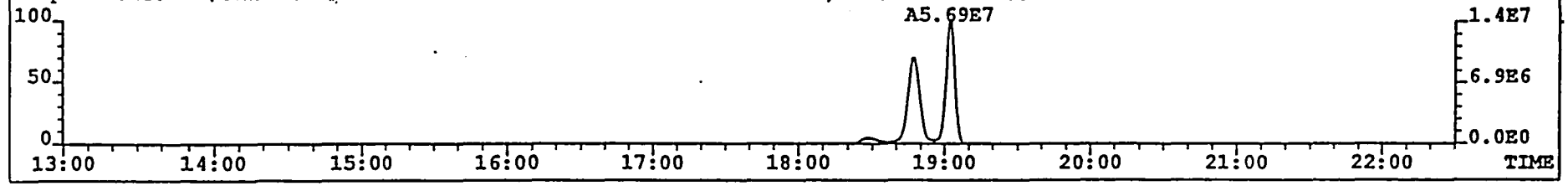
File:U902307 Acq:21-OCT-90 17:32:44 Mass 327.8847 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1077.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902307 Acq:21-OCT-90 17:32:44 Mass 331.9368 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1179.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



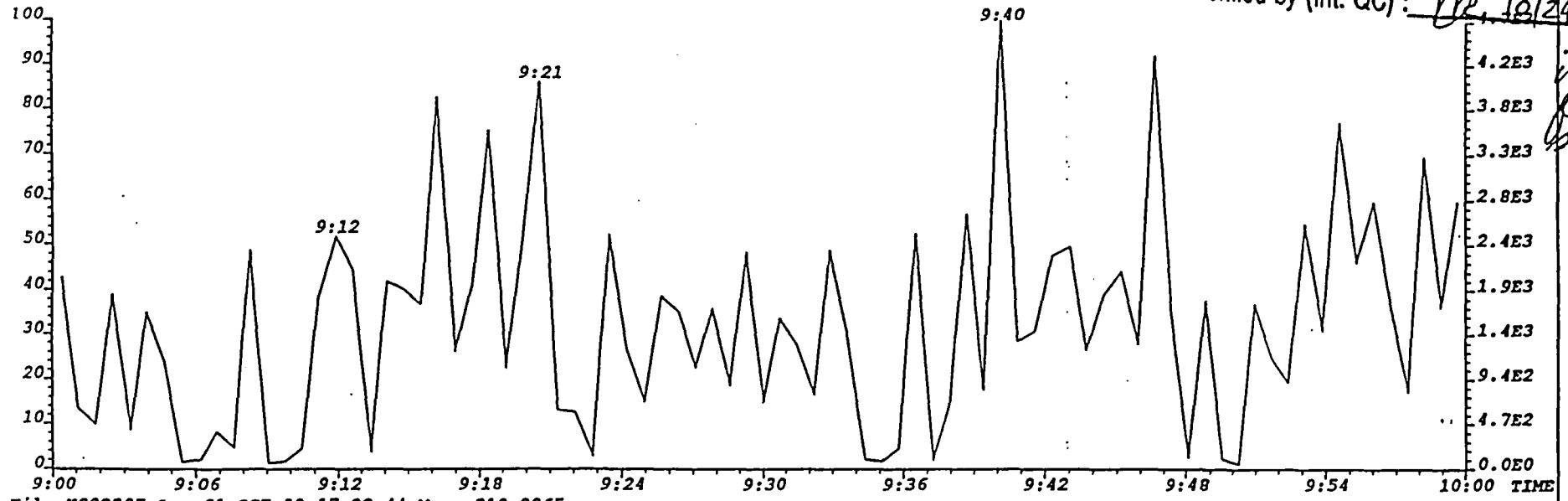
File:U902307 Acq:21-OCT-90 17:32:44 Mass 333.9338 SMO(2,3) BSUB(128,15,-3.0) PKD(9,2,5,0.50%,1380.0,0.00%,F,F)
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



Verified by (GC/MS) : JH 10-21-90

Verified by (Int. QC) : DR 10/24/90

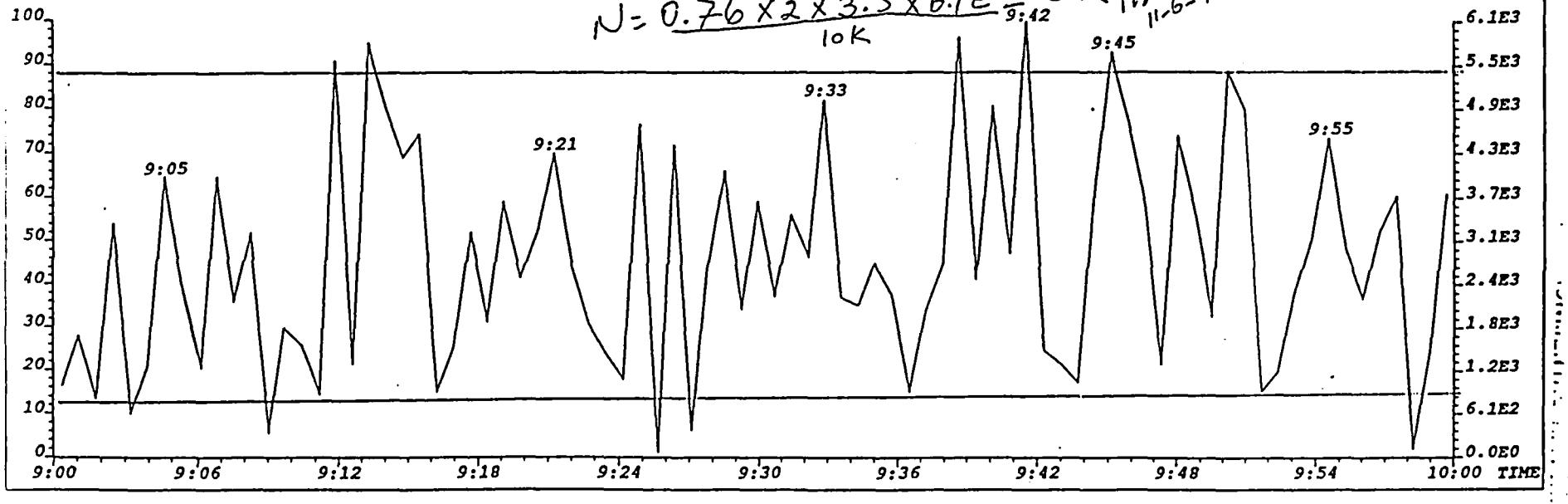
File:U902307 Acq:21-OCT-90 17:32:44 Mass 303.9016
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



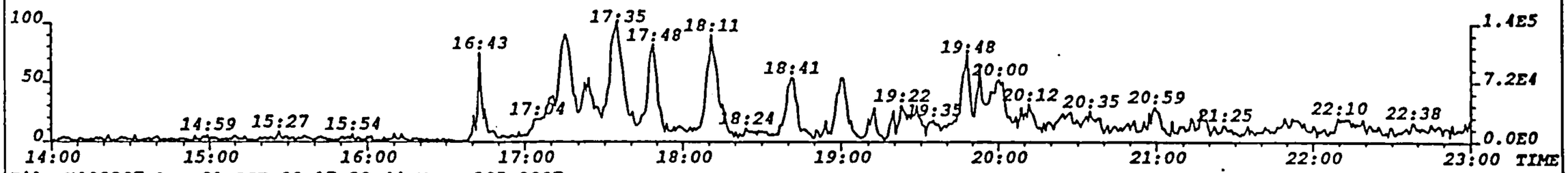
interference from sample DR 10/24/90

File:U902307 Acq:21-OCT-90 17:32:44 Mass 319.8965
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

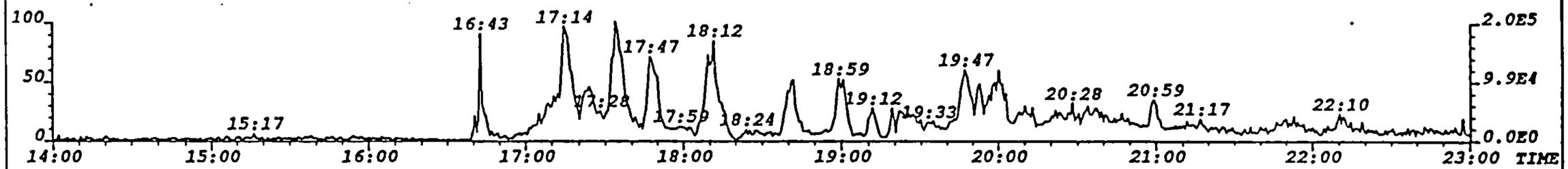
$N = \frac{0.76 \times 2 \times 3.5 \times 6.1e^3}{10K} = 3.2$ MJB 11-6-90



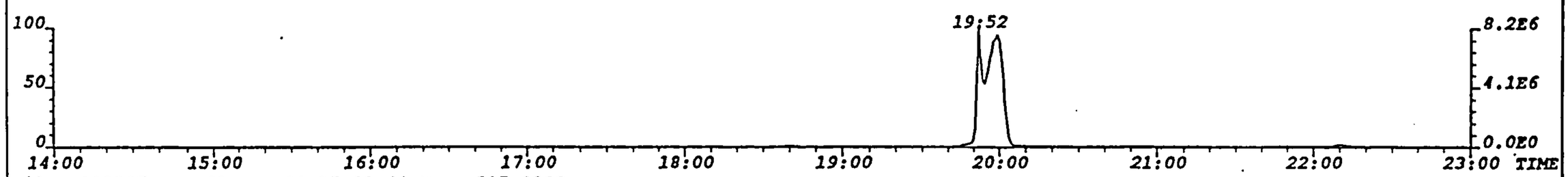
File:U902307 Acq:21-OCT-90 17:32:44 Mass 303.9016
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



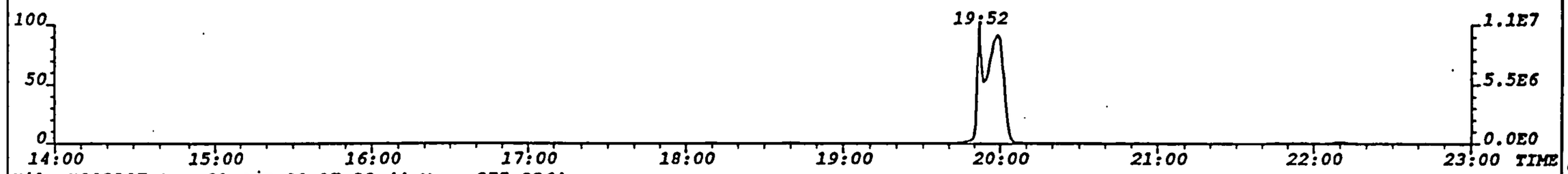
File:U902307 Acq:21-OCT-90 17:32:44 Mass 305.8987
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



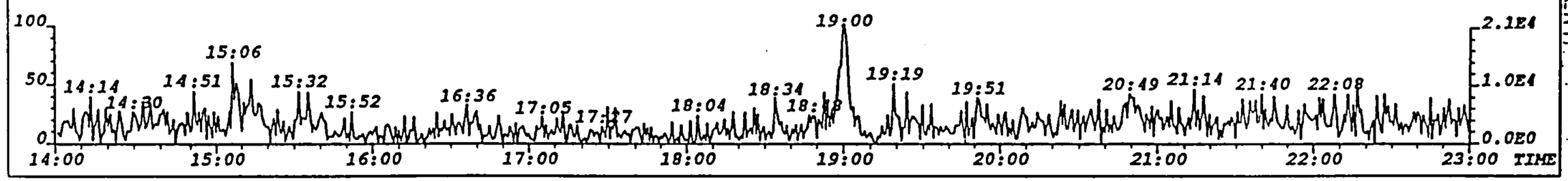
File:U902307 Acq:21-OCT-90 17:32:44 Mass 315.9419
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



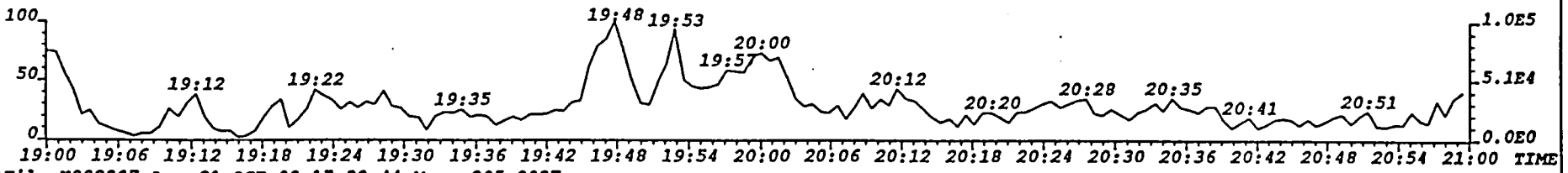
File:U902307 Acq:21-OCT-90 17:32:44 Mass 317.9389
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



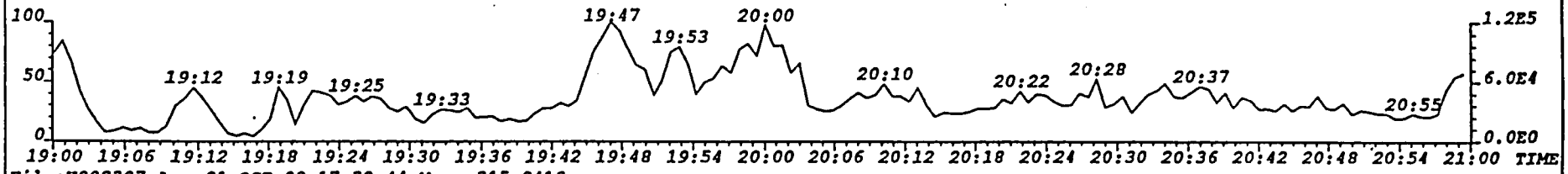
File:U902307 Acq:21-OCT-90 17:32:44 Mass 375.8364
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



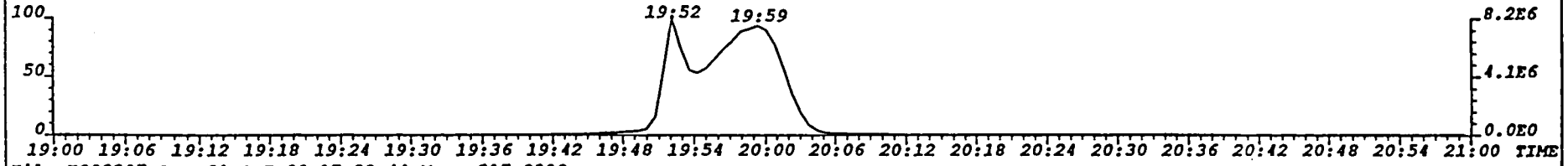
File:U902307 Acq:21-OCT-90 17:32:44 Mass 303.9016
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



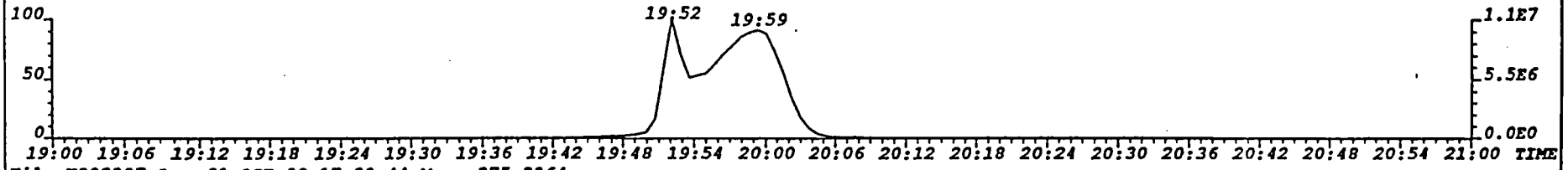
File:U902307 Acq:21-OCT-90 17:32:44 Mass 305.8987
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



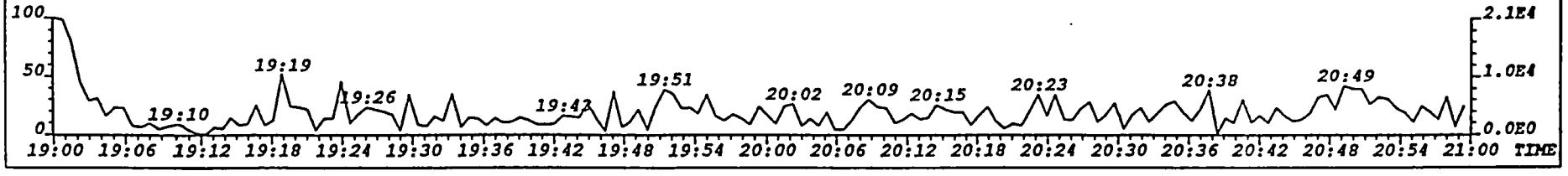
File:U902307 Acq:21-OCT-90 17:32:44 Mass 315.9419
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902307 Acq:21-OCT-90 17:32:44 Mass 317.9389
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

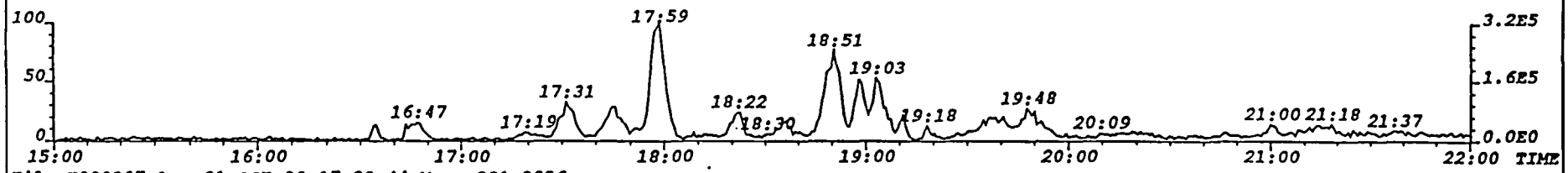


File:U902307 Acq:21-OCT-90 17:32:44 Mass 375.8364
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::

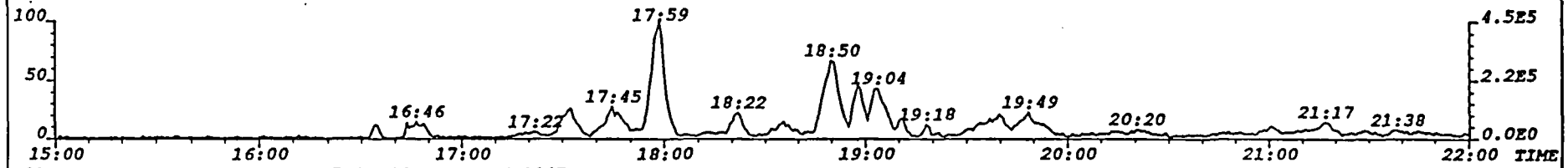


NOV 19 1990
ENVIRONMENTAL AFFAIRS

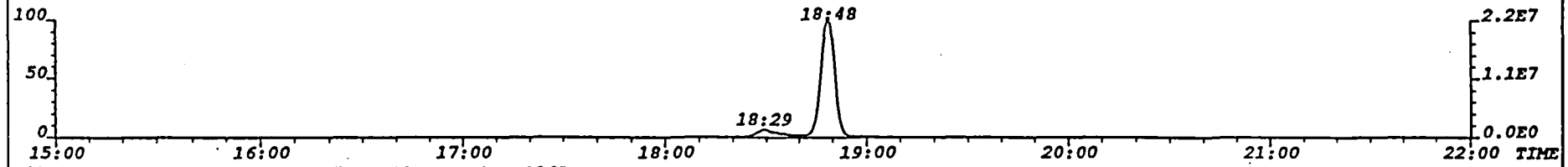
File:U902307 Acq:21-OCT-90 17:32:44 Mass 319.8965
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



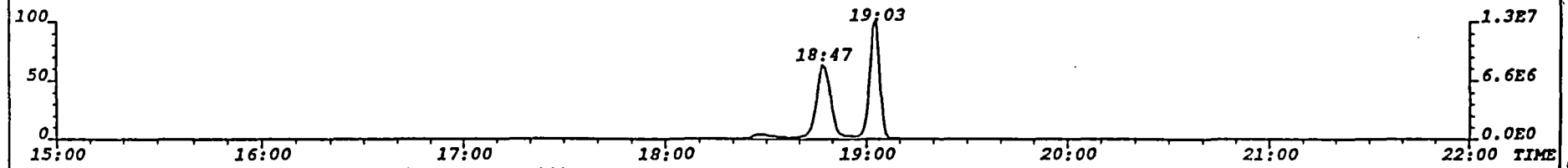
File:U902307 Acq:21-OCT-90 17:32:44 Mass 321.8936
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



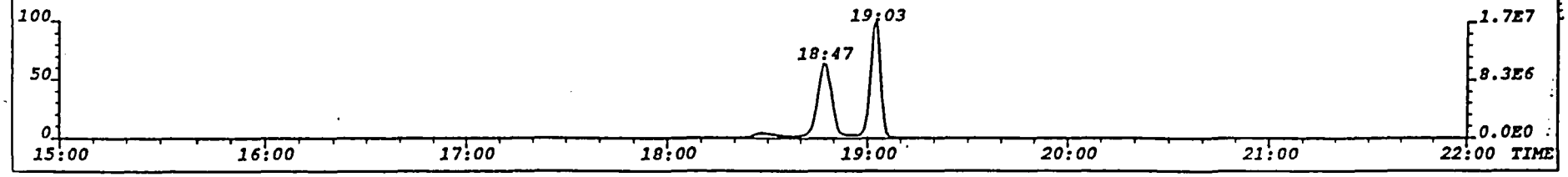
File:U902307 Acq:21-OCT-90 17:32:44 Mass 327.8847
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



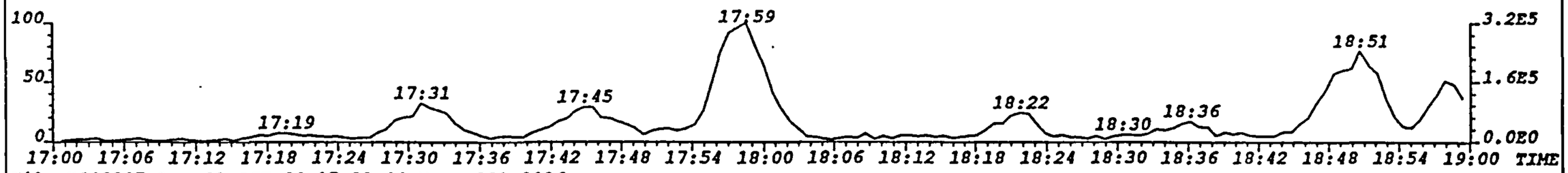
File:U902307 Acq:21-OCT-90 17:32:44 Mass 331.9368
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



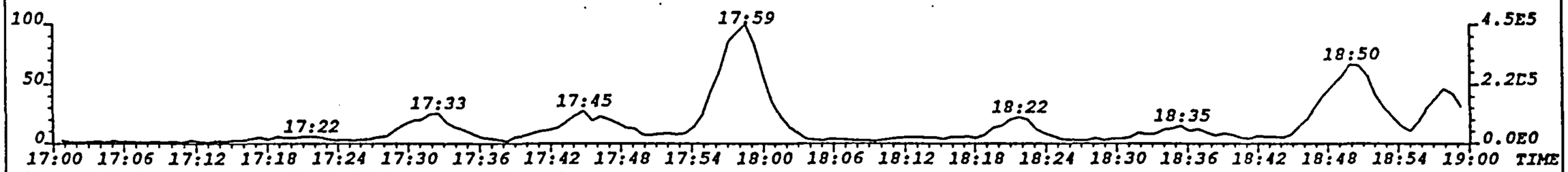
File:U902307 Acq:21-OCT-90 17:32:44 Mass 333.9338
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



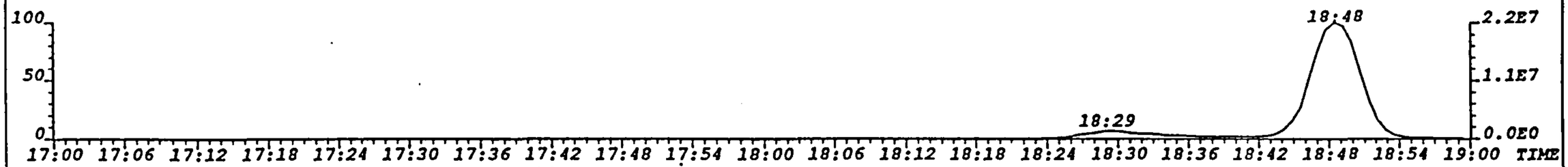
File:U902307 Acq:21-OCT-90 17:32:44 Mass 319.8965
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



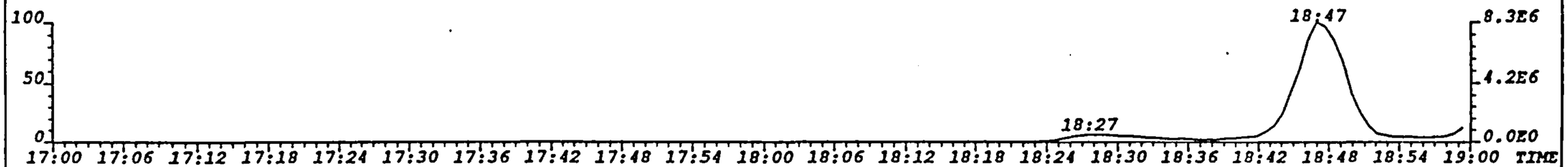
File:U902307 Acq:21-OCT-90 17:32:44 Mass 321.8936
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



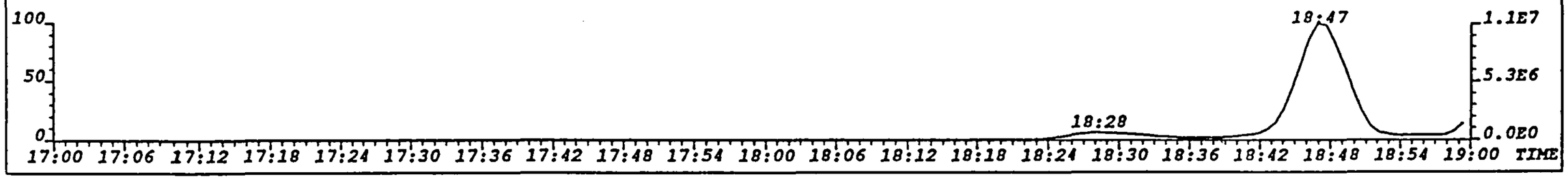
File:U902307 Acq:21-OCT-90 17:32:44 Mass 327.8847
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



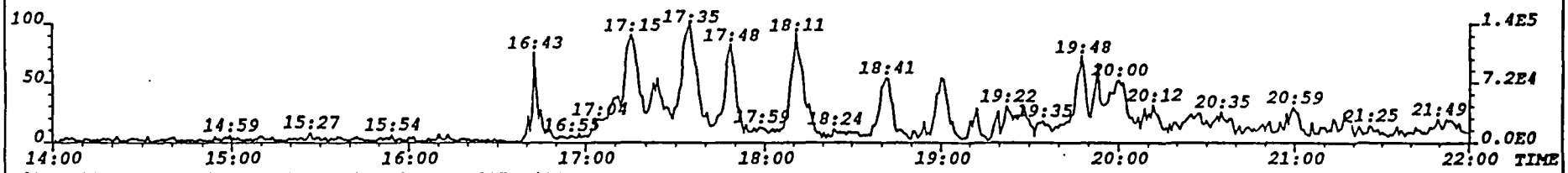
File:U902307 Acq:21-OCT-90 17:32:44 Mass 331.9368
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902307 Acq:21-OCT-90 17:32:44 Mass 333.9338
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



File:U902307 Acq:21-OCT-90 17:32:44 Mass 303.9016
Sample Text:LF1/9111 TLI# 16661 File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



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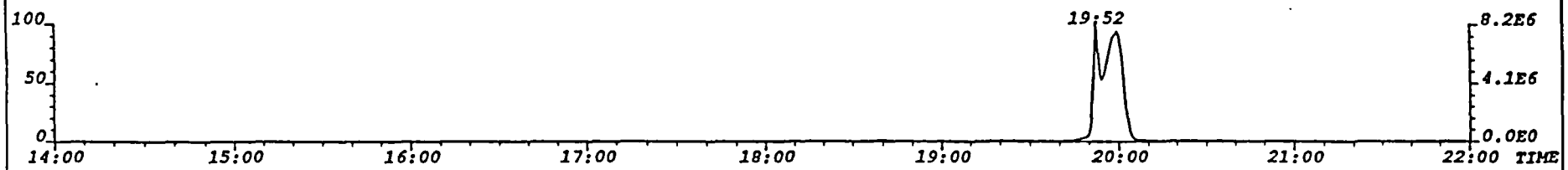

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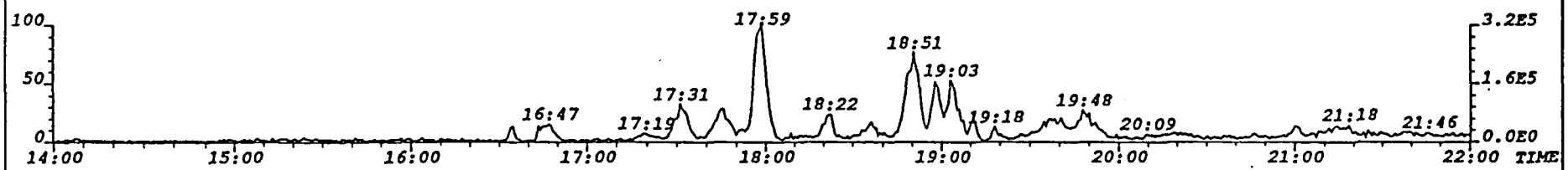

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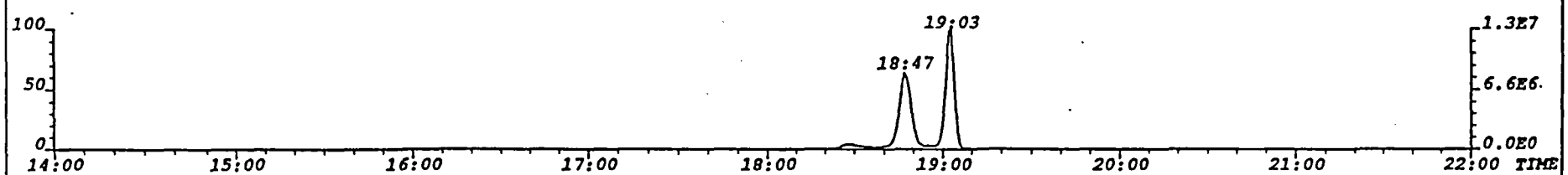

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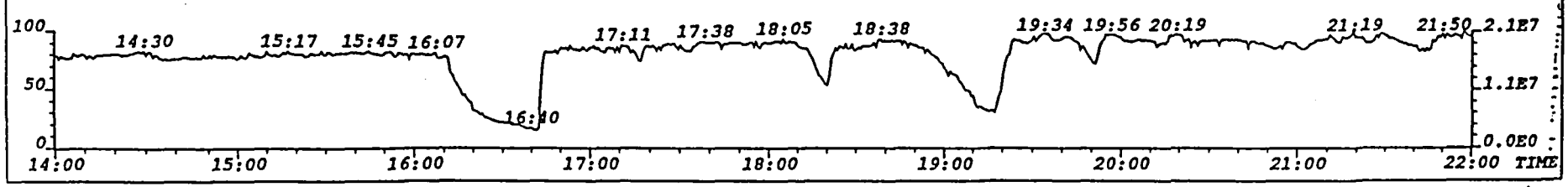

MDS 11-15-90

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Mass 319.8965 Experiment:DB225
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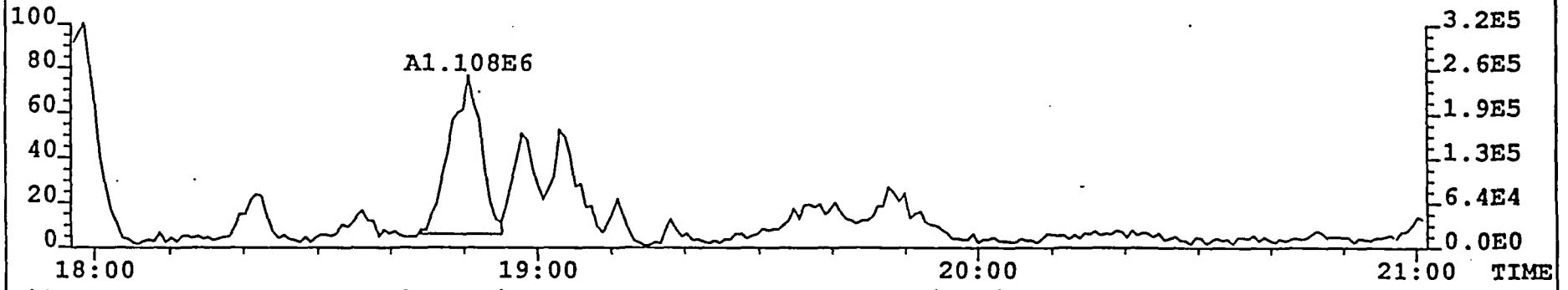

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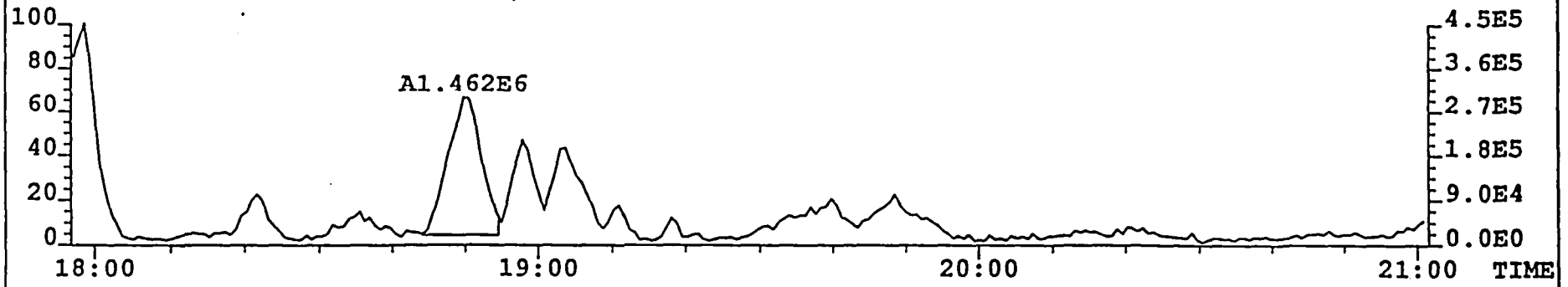

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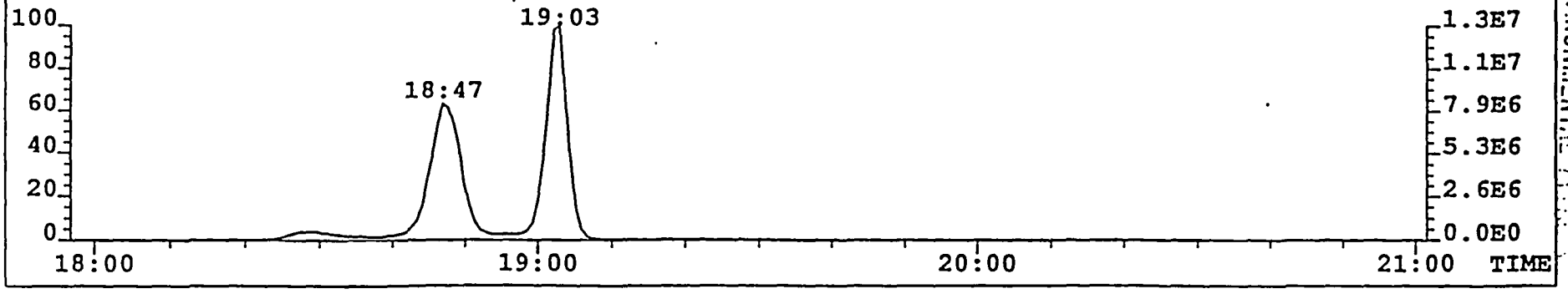

NOV 19 1990

MMB 11-15-90

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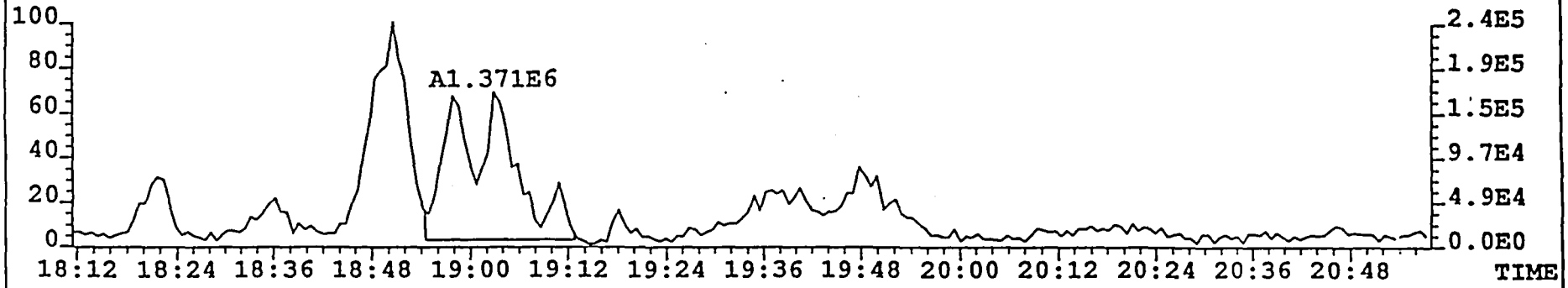

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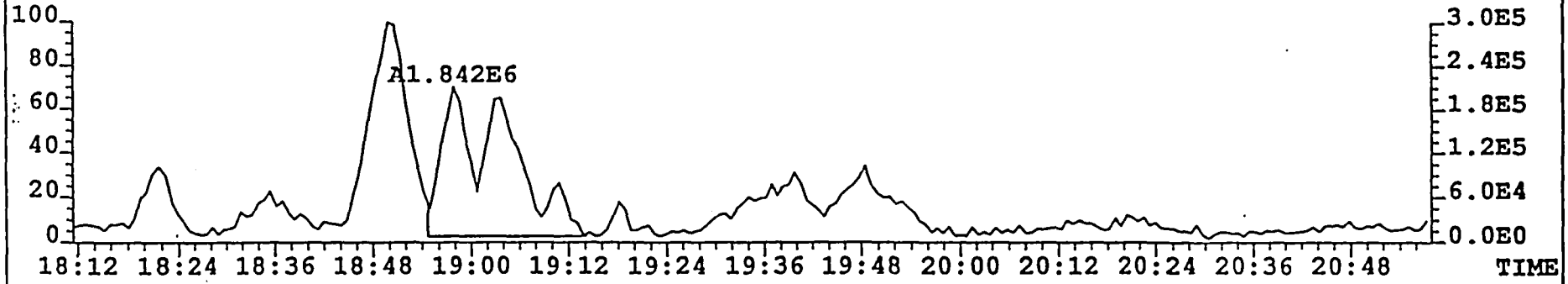

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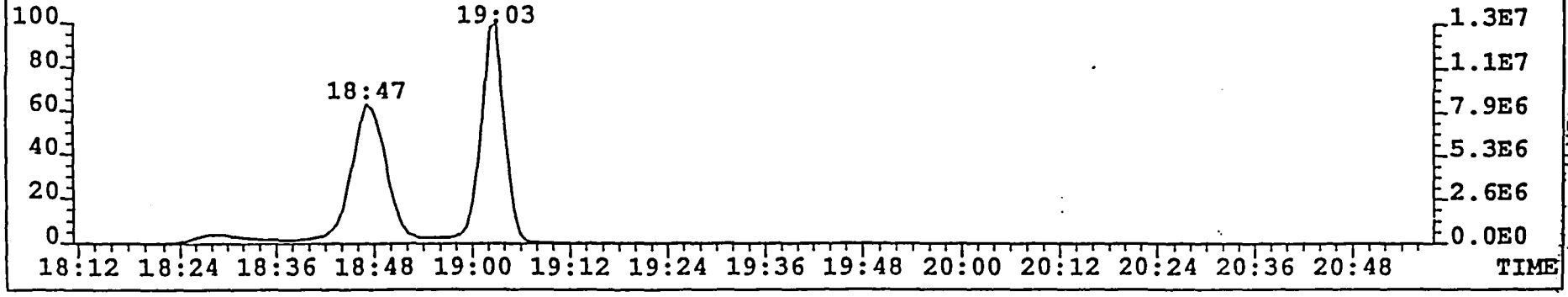
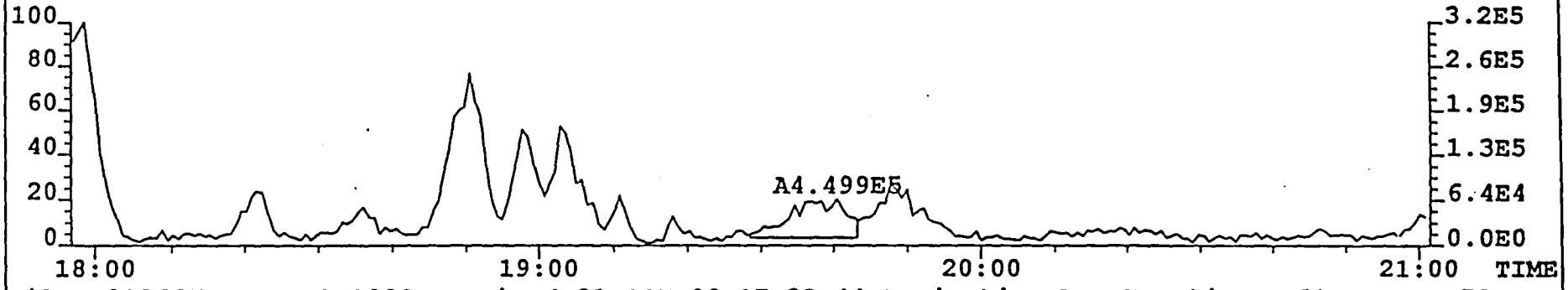


CONFIDENTIAL

NOV 19 1990

MAS 11-15-90

File:U902307 Scans:1-1908 Acquired:21-OCT-90 17:32:44 Ionization:EI+ Function:Voltage SIR 70SE »
Mass 319.8965 Experiment:DB225
File Text:TRIANGLE LABORATORIES,INC.:::DB225 CONFIRM:::



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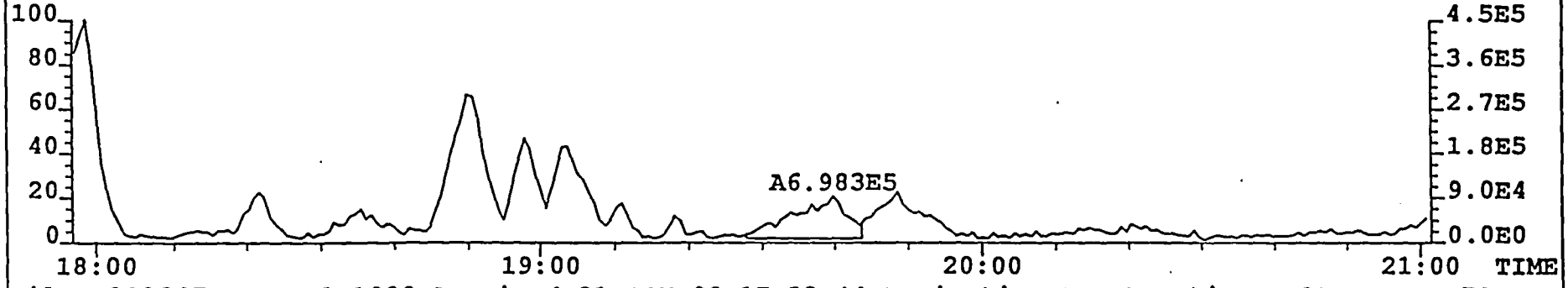

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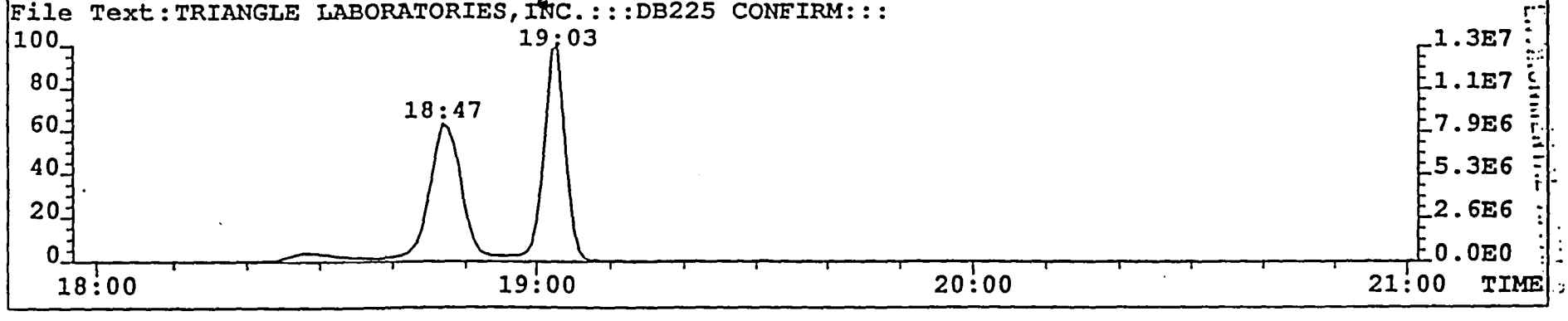


REFERENCE 17

P. O. Box 5447
Spartanburg, S. C. 29304

Phone 803/576-7660

Ref. 17

9

Southern Wood Piedmont Company

November 27, 1985

Mr. R. Douglas Holyfield
Division of Health Services
Solid & Hazardous Waste Management Branch
P. O. Box 4484
Wilmington, NC 28406

Dear Doug,

Enclosed you will find a copy of the grid system used to determine the areas for soil removal and encapsulation at Southern Wood Piedmont's (SWP) Wilmington site.

I trust this is sufficient, however, if there are any questions, please do not hesitate to call.

Sincerely,
Southern Wood Piedmont

Doug

Douglas E. Latham, P.E.
Assistant Environmental Manager

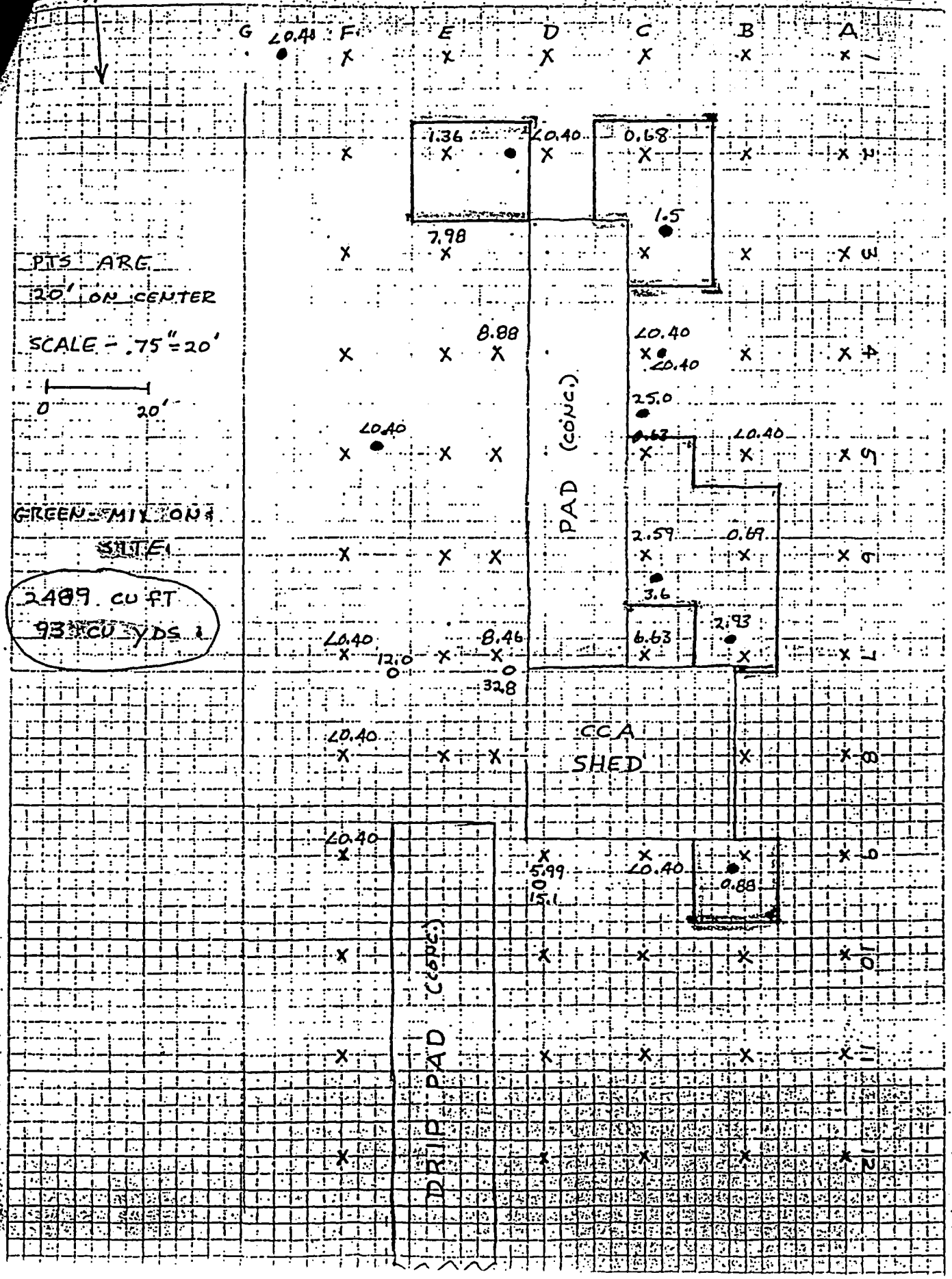
2173T/ms

cc: T. M. Davis - Baldwin
H. O. Phillips - Wilmington

SUBJECT WILMINGTON, N.C. BY DATE

0-3" ARSENIC CONCENTRATIONS SHEET NO. of

PROJECT NO. E.P. EXTRACTIONS



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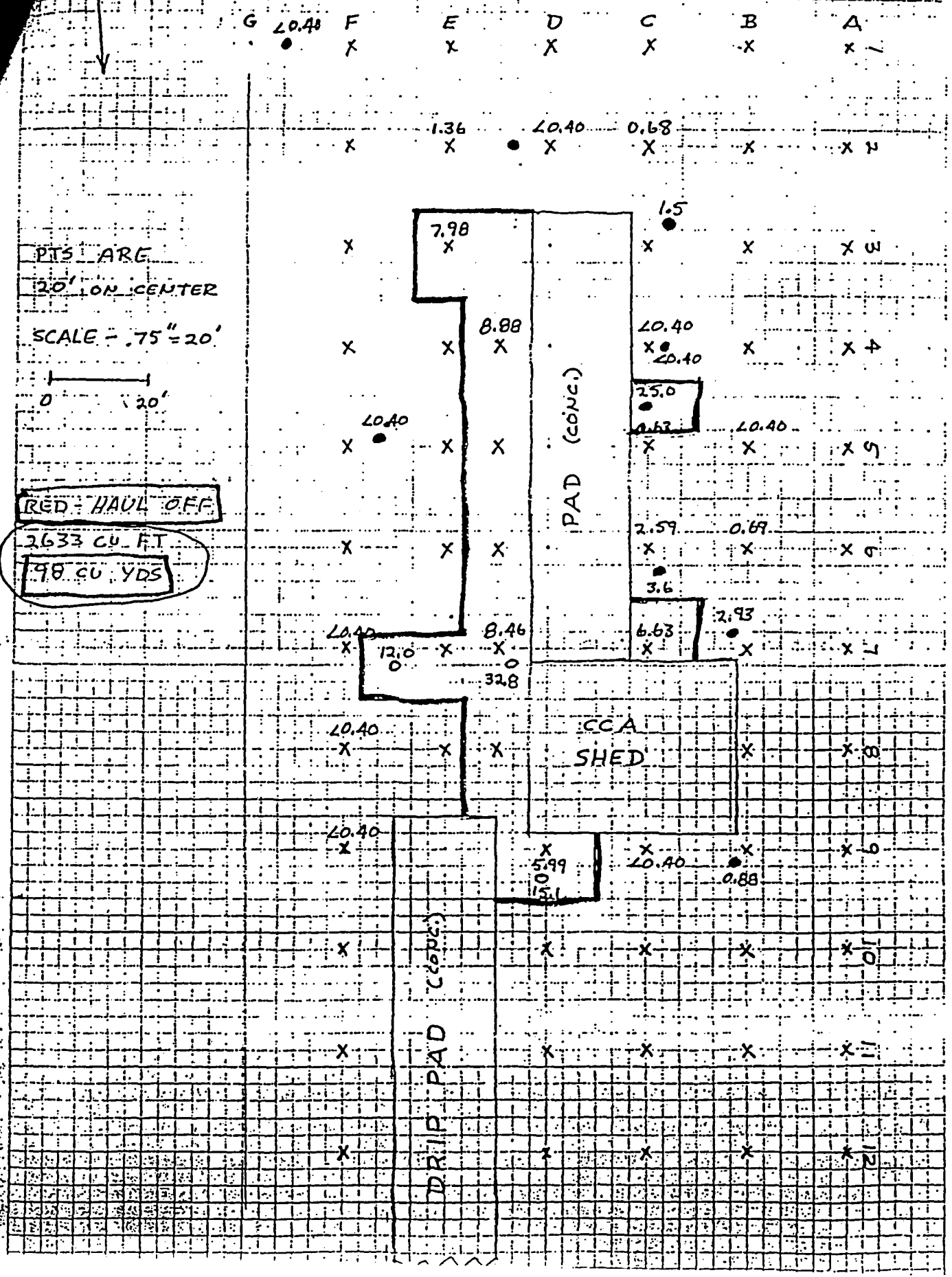
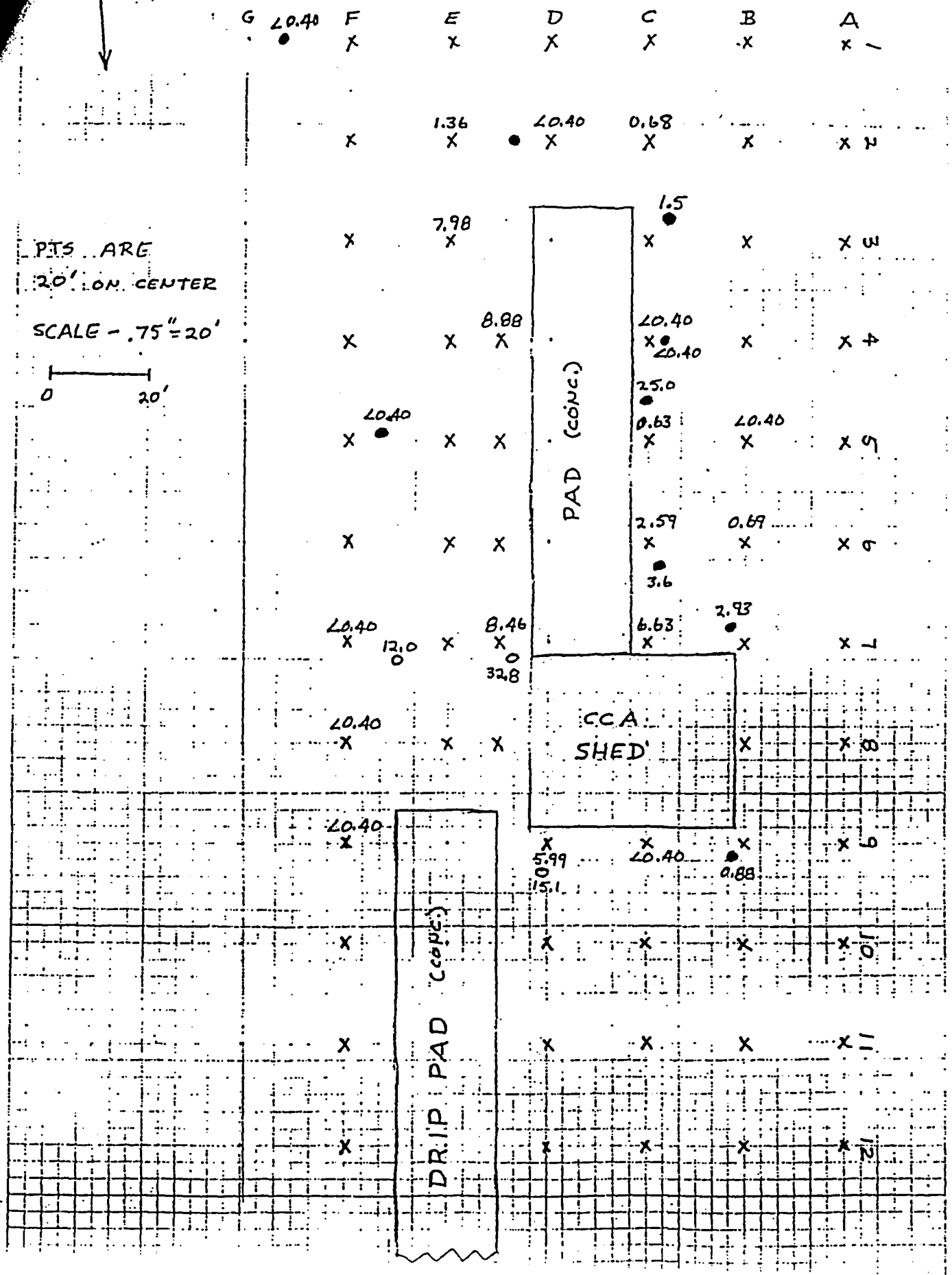


SUBJECT WILMINGTON, N.C.
0-3" ARSENIC CONCENTRATIONS
N

BY
DATE
SHEET NO. of
PROJECT NO. E.P. EXTRACTIONS

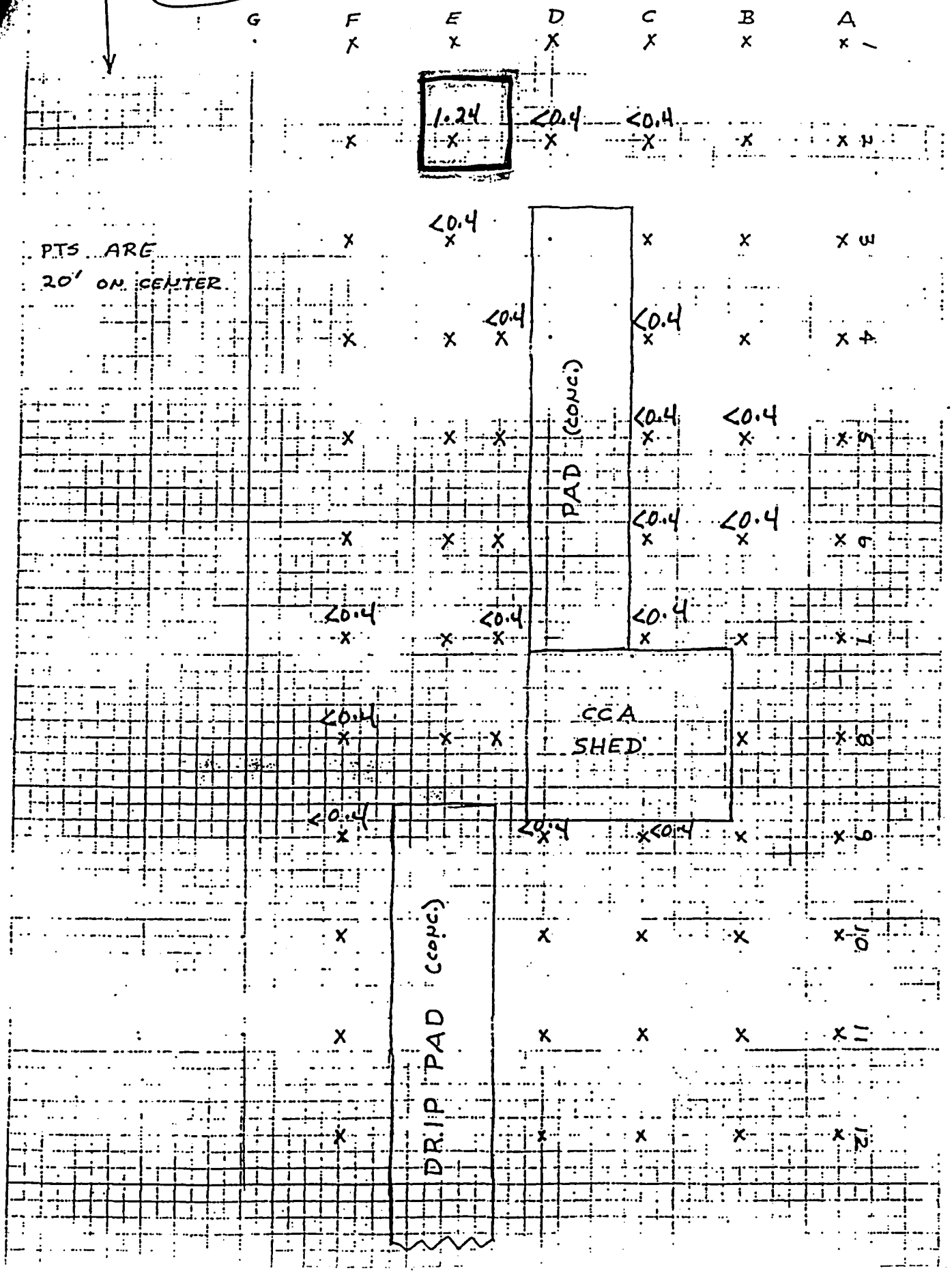


SUBJECT Wilmington 3rd Depth Arsenic Concentrations

DATE 9-02-85

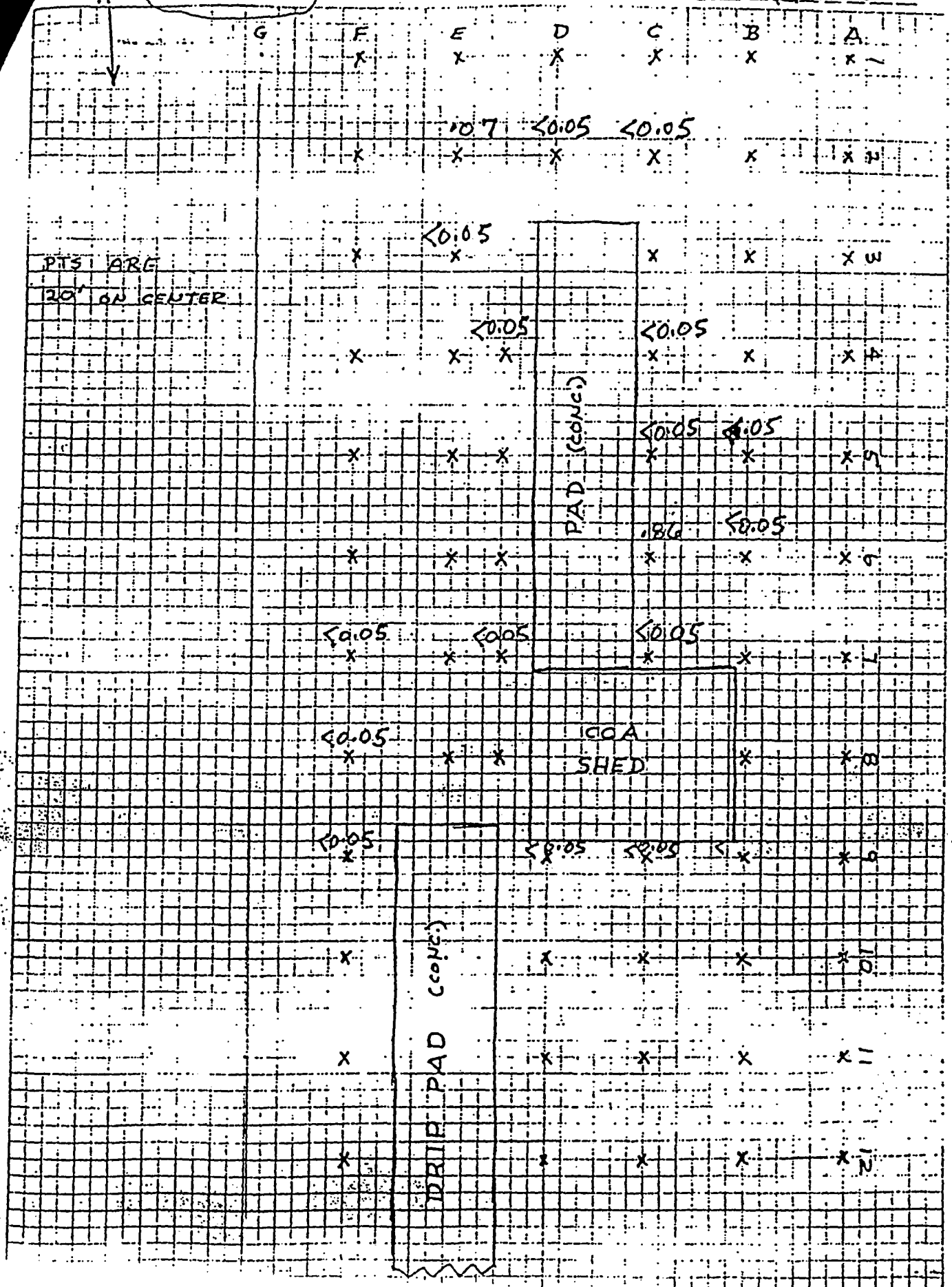
SHEET NO. 2 of

PROJECT NO. EP extractions



SUBJECT Wilmington
Chromium Concentrations

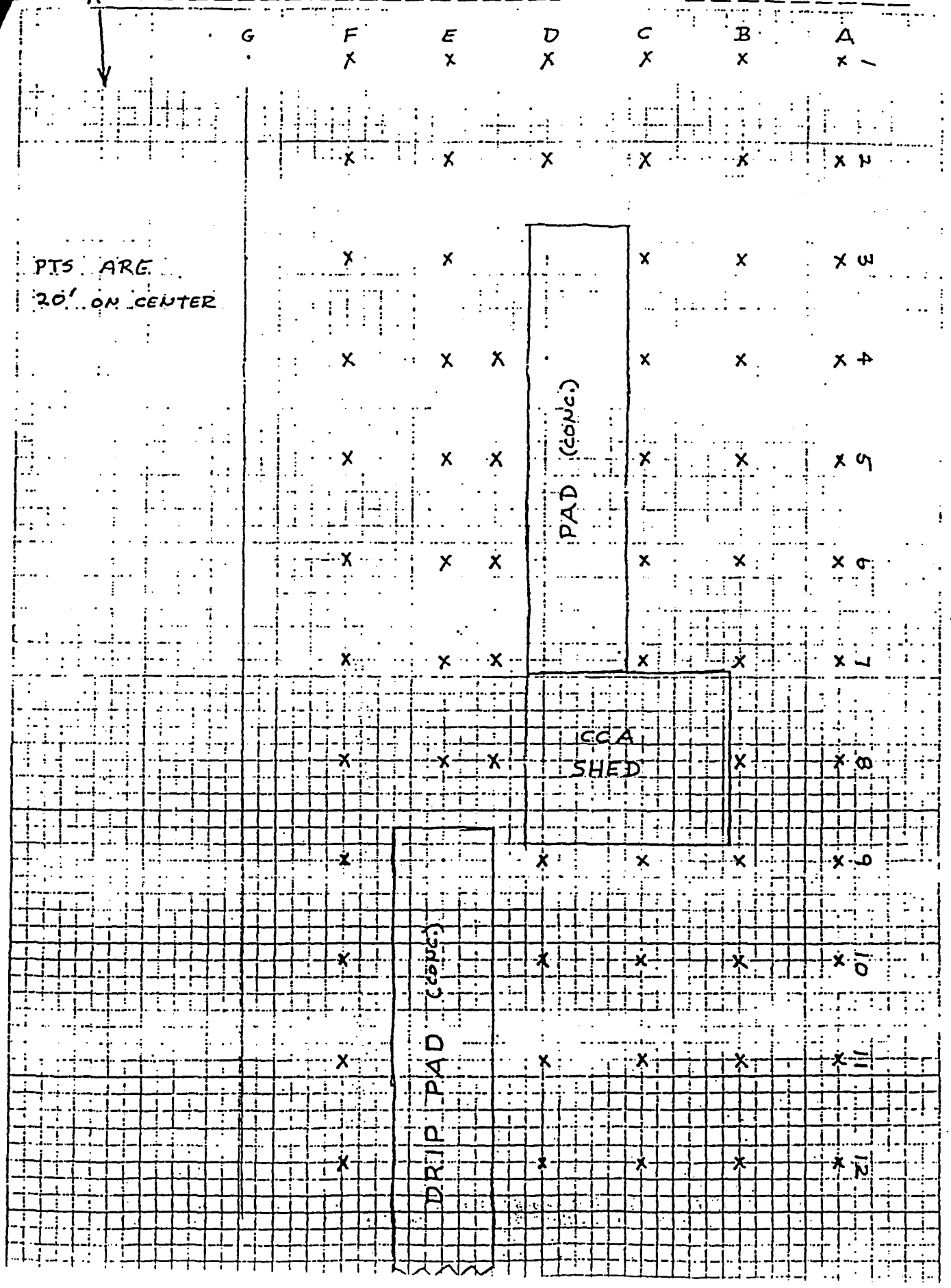
BY [illegible] DATE 7-17-85
SHEET NO. 60 of
PROJECT NO. EP Extracts



SUBJECT _____ BY _____ DATE _____

SHEET NO. ____ of _____

PROJECT NO. _____



REFERENCE 18

MEMORANDUM

To: File
From: Stuart F. Parker, Jr., Hydrogeologist
Date: December 20, 1994
Re: Southern Wood Piedmont Co, Wilmington
NCD 058 517 467
Source Area Dimensions

SFP utilized various methods and sources to estimate the volumes and/or surface areas of the various contaminant source areas designated during the SIP investigation. Methods are summarized below:

1) Track & Treating Areas: The Treating Area dimensions were estimated to be 250 x 200 ft. = 50,000 sq.ft., using Fig. 4 of ETE/Virogroup's Phase III Report (Ref. 7). The Track Area was assumed to be about 1 acre = 43,560 sq. ft. The depth of excavation in each area was reported by Chuck Davis to be about 4 ft (Ref. 57). Volume therefore = 93,560 sq. ft. x 4 ft.= 374,240 cu. ft. = 13,861 cu. yd.

2) Buried Creosote Ditch: The ditch was reported in the PA Letter Report (Ref. 10) to be 5 ft. x 25 ft. x 500 ft. = 125000 sq. ft.area = 62,500 cu. ft. volume (3215 cu. yd.).

3) Landfarm Areas: The landfarming areas were reported by Geraghty & Miller (Refs. 12-13) to be 5 acres in area.

4) Non-treated wood storage (NTA, NTB): Based on Geraghty & Miller's descriptions and illustrations (Ref. 14), the two areas measure approximately 750 ft. x 750 ft., and approximately 525 x 750 ft., or 956,250 sq. ft. (21.95 acres) total. The sampled depth interval is approximately 6 in. Therefore the combined volume of the areas is 478,125 cu. ft. or 17,208 cu. yd.

5) Treated wood storage(TWS): Based on Geraghty & Miller's descriptions and illustrations (Ref. 14), the area measures approximately 300 x 900 ft. and was sampled to a depth of 1.5 ft.
The area is therefore approximately 270,000 sq. ft. (6.2 acres), the volume is 270,000 ft. x 1.5 ft. = 405,000 cu. ft. = 15,000 cu yd.

6) Creosote Tank Storage Area: This area, based on the Geraghty & Miller report, measures approximately 120 ft. x 80 ft., and was contaminated to about 1 ft. deep (Refs. 7, 9). The volume is therefore 21,600 cu. ft. or 800 cu. yd.

7) Chromated Copper Arsenate (CCA)area: 93 cu.yd.of soils were treated at the area and another 98 cu. yd. were removed (Ref. 19).

REFERENCE 19

Ref. 19

SOIL SURVEY OF

New Hanover County, North Carolina

NEW HANOVER SWCD
NEW HANOVER ADMIN ANNEX
414 CHESTNUT ST, ROOM 305
WILMINGTON NC 28401

United States Department of Agriculture
Soil Conservation Service

In cooperation with
North Carolina Agricultural Experiment Station
and the
New Hanover County Board of Commissioners

SOIL SURVEY OF NEW HANOVER COUNTY, NORTH CAROLINA

BY ARLIN WEAVER, SOIL CONSERVATION SERVICE

Soils Surveyed by Arlin Weaver, Clarence Brandon, and W. Everette Lynn, Jr., Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in Cooperation with the North Carolina Agricultural Experiment Station and the New Hanover County Board of Commissioners

Introduction

New Hanover County is in the southeastern part of North Carolina (see opposite page). The county is 118,656 acres, or about 185 square miles, in size. According to the 1970 census, the population of the county was 82,996. Wilmington, the county seat, had a population of 46,169. It is one of the major ports along the Atlantic Coast.

New Hanover County is in the lower part of the Coastal Plain physiographic province. Elevation ranges from sea level to 60 feet. Most of the county is level to gently sloping, but short breaks separate the uplands from the flood plains and marshes.

New Hanover County is mainly industrial. There has been rapid, widespread urbanization over most of the county in recent years. Only a small percentage of the county is used for farms and pasture.

General Nature of the County

This section gives general facts about New Hanover County. It briefly discusses climate; water supply; settlement and development; transportation and industry; and community facilities.

Climate

New Hanover County is hot and humid in summer, but the coastal area of the county is frequently cooled by sea breezes. Winter is cool but has occasional brief cold spells. Rains occur throughout the year but are usually heaviest late in summer and early in fall. Annual precipitation is adequate for all crops.

Table 1 shows temperature and precipitation data for the county, as recorded at Wilmington for the period 1952 to 1974. Tables 2 and 3 show probable dates of the first and last freeze and the length of the growing season.

In winter the average temperature is about 47 degrees F, and the average daily minimum is 37 degrees. The lowest temperature on record, 10 degrees, occurred at Wilmington on December 13, 1962. In summer the average temperature is about 79 degrees F, and the average daily maximum is 88 degrees. The highest temperature on record, 104 degrees, was recorded on June 27, 1952.

Growing degree days, shown in table 1, are equivalent to "heat units." Starting in spring, growing degree days accumulate by the amount that the average temperature each day exceeds the base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 32.86 inches, or 61 percent, usually falls during the period April through September, which includes the growing season for most crops. Two years in 10, the April-September rainfall is less than 26.51 inches. The heaviest 1-day rainfall during the period of record was 7.49 inches at Wilmington on September 27, 1958. Thunderstorms number about 45 each year, 27 of which occur in summer.

Snowfall is rare. In 36 percent of the winters, there is no measureable snowfall, and in 59 percent the total snowfall is less than 2 inches. The heaviest snowfall ever observed in 1 day was more than 11 inches.

The average relative humidity in midafternoon in spring is less than 55 percent, and during the rest of the year it is about 58 percent. Humidity is higher at night in all seasons, and the average at dawn is about 83 percent. The percentage of possible sunshine is 65 percent in summer and 59 percent in winter. The prevailing direction of the wind is from the south-southwest. Average annual windspeed is 9.2 miles per hour. Average windspeed is highest, 10.9 miles per hour, in April.

Every few years a hurricane crosses the county.

Water Supply

Ground water is obtained from three geologic formations that are associated with three geologic ages. These are the Pee Dee Formation of upper Cretaceous Age, the Castle Hayne Limestone Formation of Eocene age, and the surficial sands of post-Miocene age.

main limitations in the use and management of this soil. If drained, this soil is suited to most locally grown crops. The main crops are corn, soybeans, tobacco, and peanuts. Minimum tillage and crop residue management aid in maintaining organic-matter content. This soil has good tilth and can be worked over a wide range of moisture content, but tillage is delayed during wet seasons. Drainage is needed for most uses. Capability subclass IIIe; woodland group 3w.

DO—Dorovan soils. These nearly level, very poorly drained soils are in bays and in long, broad areas of tidal and stream flood plains. All of the acreage is used for woodland and as wildlife habitat. The native vegetation is red maple, willow, tupelo, cypress, sweetgum, ash, American cyrilla, and greenbrier.

Typically the surface layer is black muck 4 inches thick. The underlying layer, to a depth of 64 inches, is black or very dark gray muck.

Included with these soils in mapping are small areas of Johnston soils and Tidal marsh. A few small areas of soils that have thin, continuous mineral layers are also included.

The organic-matter content in the surface layer is very high. Permeability is very slow, available water capacity is very high, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless the soils are limed. The seasonal high water table is at or near the surface. These soils are frequently flooded for very long periods.

Flooding and high organic-matter content are the main limitations in the use and management of these soils. If these soils are drained and tilled, the organic matter decomposes and the soil subsides. Capability subclass VIIIw; woodland group 4w.

JO—Johnston soils. These nearly level, very poorly drained soils are on flood plains of the major streams. Areas are commonly long and narrow. Most of the acreage is forested, and some small areas have been filled and used for industrial and residential sites. The native vegetation consists of pond pine, tupelo-gum, ash, water oak, cypress, red maple, sweetgum, American cyrilla, waxmyrtle, and gallberry.

Typically, the surface layer is 42 inches thick. It is black loam in the upper part and black sandy loam in the lower part. The underlying layer, to a depth of about 64 inches, is light gray sand.

Included with these soils in mapping are small areas of Pamlico, Dorovan, and Murville soils. A few small areas of soils that are less acid than these Johnston soils are also included.

The organic-matter content of the surface layer is high. Permeability is moderately rapid, available water capacity is high, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless these soils are limed. The seasonal high water table is at or near the surface. These soils are frequently flooded for long periods.

A seasonal high water table and flooding are the main limitations in the use and management of these soils. These soils subside if drained and tilled. Capability subclasses VIIw, where undrained, and IVw, where drained; woodland group 1w.

Ke—Kenansville fine sand, 0 to 3 percent slopes. This well drained soil is on broad smooth flats on the uplands. Areas are commonly large in size and irregular in shape. Most of the acreage is cultivated. The rest is forested or is used for residential or industrial sites. The native vegetation consists of longleaf and loblolly pines; white, red, black, turkey, water, and bluejack oaks; hickory; dogwood; holly; and sassafras.

Typically, the surface layer is grayish brown fine sand 3 inches thick. The subsurface layer is fine sand 30 inches thick. It is is pale brown in the upper part and mottled very pale brown in the lower part. The subsoil is fine sandy loam 17 inches thick. It is strong brown in the upper part and reddish yellow in the lower part. The underlying layer, to a depth of 80 inches, is yellow loamy fine sand.

Included with this soil in mapping are a few small areas of Norfolk and Lakeland soils. Some small areas of soils that are less acid throughout are also included.

The organic-matter content of the surface layer is very low. Permeability is moderately rapid, available water capacity is low, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless this soil is limed. The seasonal high water table is at a depth of more than 6 feet.

Leaching of plant nutrients, moderately rapid permeability, droughtiness, low available water capacity, and soil blowing are the main limitations in the use and management of this soil. This soil is well suited to most locally grown crops. The main crops are corn, soybeans, peanuts, tobacco, and truck crops, such as squash, lettuce, cucumbers, cabbage, snapbeans, and corn. Winter cover crops, minimum tillage, and crop residue management aid in maintaining organic-matter content and conserving moisture. Soil blowing is a concern in the management of this soil. The blowing sand often causes damage to young plants. This soil is droughty during periods of low rainfall. Some supplemental irrigation, soil conditioners, and fertilizers are needed for lawn grasses, shrubs, and trees. Capability subclass IIs; woodland group 3s.

Kr—Kureb sand, 1 to 8 percent slopes. This excessively drained soil is on long, broad ridges on the uplands. Areas are generally broad and long. Most of the acreage is forested. The rest is used for residential and industrial sites. The sparse native vegetation on the higher elevations is turkey oak, scattered longleaf pine, a few bluejack oaks, and scattered dwarf myrtle and huckleberry. Much of the area is barren of any vegetation, except for mosses and lichens. On the lower slopes, the vegetation increases in density and includes various oaks, scattered hickory, holly, and brackenfern.

Typically, the surface layer is dark gray sand 3 inches thick. The subsurface layer is light gray sand 23 inches

areas are flooded daily by tides. Further inland the seawater is diluted with freshwater. Some areas are protected from the seawater by long expanses of sand dunes that do not have inlets from the ocean. The water table is at or above the surface most of the time. Most of the acreage is used as natural habitat for shore and water birds, and some areas are used for shellfish gardens. Many areas are being dredged, filled, and converted to summer cottage sites and recreational areas. The dominant vegetation in areas that are flooded daily by saltwater is smooth cordgrass. Further inland, in areas that are flooded by seawater that has been diluted by freshwater, the vegetation is a mixture of smooth cordgrass and black rush.

Typically, the surface layer is black clay loam about 18 inches thick. The underlying layer is very dark gray and black silty clay loam to a depth of more than 60 inches.

Included with these soils in mapping are areas along the Intracoastal Waterway that are sandy because of the deep dredging.

The organic-matter content of the surface layer is high. Reaction is neutral to mildly alkaline. In the areas flooded by saltwater, sulfur content is 80 to 130 parts per million and salt content is 1 or 2 percent. Capability subclass VIIIw; woodland group not assigned.

To—Torhunta loamy fine sand. This nearly level, very poorly drained soil is on broad smooth flats and in slight depressions on the uplands. Areas are small to large in size and irregular in shape. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation consists of loblolly pine, pond pine, bay trees, red maple, water oak, gum, waxmyrtle, and gallberry.

Typically, the surface layer is 20 inches thick. It is black loamy fine sand in the upper part and very dark gray loamy fine sand in the lower part. The subsoil is mottled light gray fine sandy loam 26 inches thick. The underlying layer, to a depth of 64 inches, is mottled light gray fine sand.

Included with this soil in mapping are small areas of Stallings, Murville, and Pantego soils.

The organic-matter content of the surface layer is medium. Permeability is moderately rapid, available water capacity is medium, and shrink-swell potential is low. Reaction is extremely acid to strongly acid throughout where this soil has not been limed. The seasonal high water table is at or near the surface. This soil is frequently flooded for long periods.

A seasonal high water table and flooding are the main limitations in the use and management of this soil. Most lawn grasses, shrubs, and trees are generally easily established and maintained. Some shrubs and trees may be unsuited to this soil because of wetness. Capability subclasses Vw, where undrained, and IIIw, where drained; woodland group 2w.

Ur—Urban land. Urban land consists of areas where the original soil has been cut, filled, graded, or paved so that most soil properties have been altered to the extent that a soil series is not recognized. These areas are now used for shopping centers, factories, municipal buildings, apartment complexes, or parking lots, or for other purposes where buildings are closely spaced or soil is covered with pavement.

Included in mapping are a few small areas between buildings where the soil has not been altered. Also included are parks and other areas within the city of Wilmington. Some of the areas between buildings are used for small lawns, gardens, and shrubbery. Capability subclass and woodland group not assigned.

Wa—Wakulla sand, 1 to 8 percent slopes. This somewhat excessively drained soil is on broad smooth flats on the uplands. Areas are small to large in size and irregular in shape. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation on the higher elevations consists of longleaf pine, loblolly pine, post oak, bluejack oak, turkey oak, dwarf huckleberry, and myrtle. On the lower elevations, the vegetation increases in density and includes hickory, holly, water oak, blackjack oak, and a few dogwood trees.

Typically, the surface layer is grayish brown sand 2 inches thick. The subsurface layer is light yellowish brown sand 28 inches thick. The subsoil is strong brown loamy sand 18 inches thick. The underlying layer, to a depth of 64 inches, is strong brown sand.

Included with this soil in mapping are a few small areas of Kureb, Baymeade, Kenansville, Lakeland, and Rimini soils.

The organic-matter content of the surface layer is very low. Permeability is rapid, available water capacity is very low, and shrink-swell potential is low. Reaction is strongly acid or medium acid throughout where this soil has not been limed. The seasonal high water table is below a depth of 6 feet.

Droughtiness, slope, and rapid permeability are the main limitations in the use and management of this soil. Supplemental irrigation and fertilizers are generally needed to establish and maintain lawn grasses, shrubs, and trees. Capability subclass IIIs; woodland group 3s.

Wo—Woodington fine sandy loam. This nearly level, poorly drained soil is on broad smooth flats on the uplands. Areas are small in size and irregular in shape. Most of the acreage is forested or is used for residential and industrial sites. The native vegetation consists of loblolly pine, longleaf pine, pond pine, sweetgum, water oak, willow oak, poplar, waxmyrtle, eastern baccharis, American holly, gallberry, and sweet pepperbush.

Typically, the surface layer is very dark gray fine sandy loam 7 inches thick. The subsoil, to a depth of 65 inches, is mottled light brownish gray fine sandy loam in the upper part. The middle part is mottled gray fine sandy loam, and the lower part is mottled very pale brown fine sandy loam.

Included with this soil in mapping are small areas of Wrightsboro, Lynchburg, Seagate, and Stallings soils.

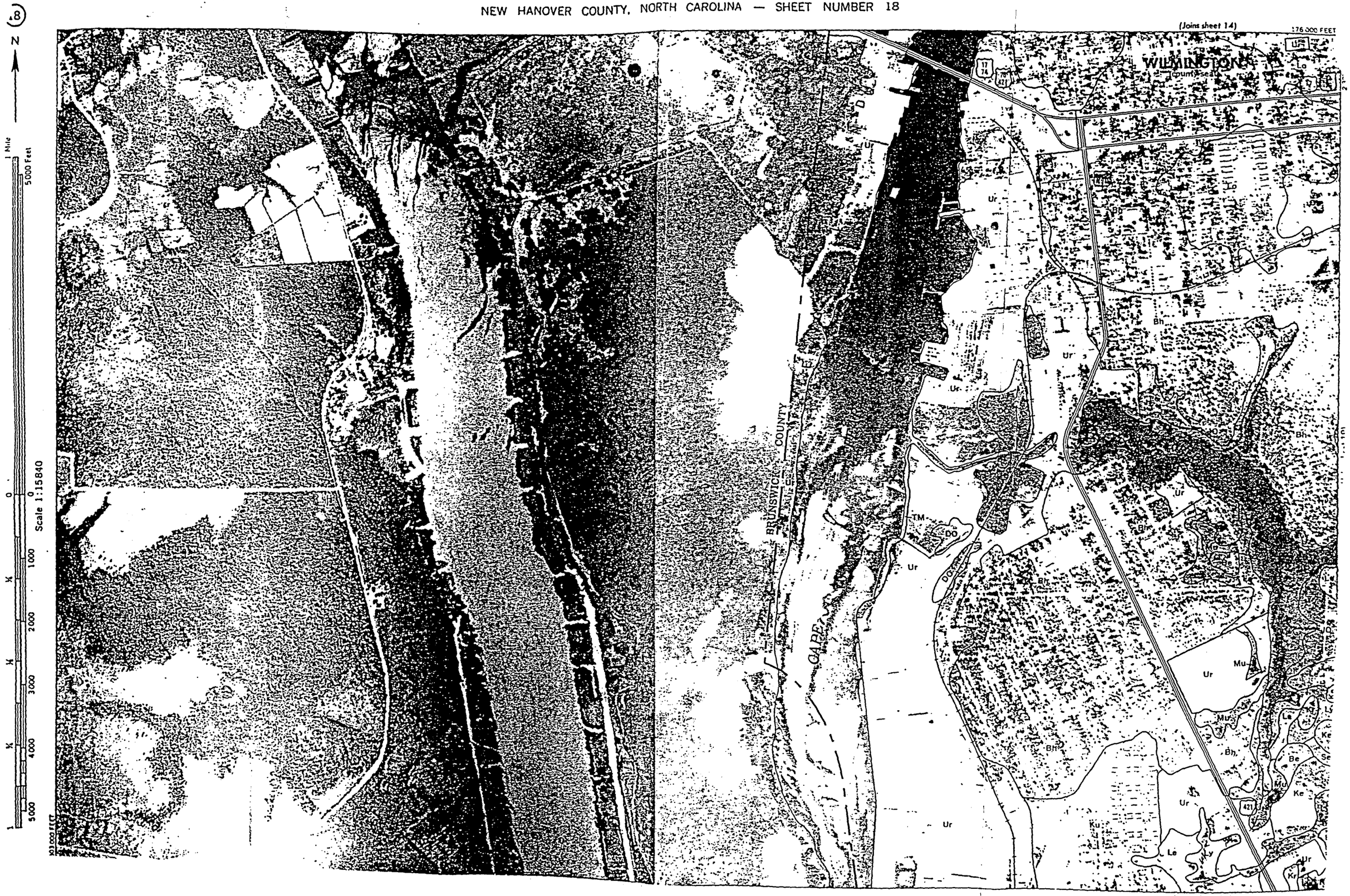
The organic-matter content of the surface layer is low. Permeability is moderately rapid, available water capacity

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

Month	Temperature[1]						Precipitation[1]				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[2]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	F	F	F	F	F		In	In	In		In
January----	55.9	35.3	45.6	77	17	57	3.41	1.94	4.61	7	.4
February---	58.3	37.1	47.7	79	19	69	3.66	2.40	4.80	7	1.0
March------	64.3	43.0	53.7	84	26	180	4.09	2.25	5.58	8	.3
April------	73.7	51.6	62.7	91	34	381	3.07	1.36	4.46	5	.0
May--------	80.8	60.1	70.5	95	43	636	4.09	2.27	5.57	6	.0
June-------	86.2	67.2	76.7	99	53	801	5.63	2.84	7.89	8	.0
July-------	89.0	71.2	80.1	98	61	933	7.72	4.47	10.36	10	.0
August-----	88.3	70.5	79.4	98	60	911	6.80	4.10	9.21	9	.0
September--	83.7	65.2	74.5	94	50	735	5.55	2.66	7.90	6	.0
October----	75.5	54.6	65.0	89	33	465	3.16	1.07	4.84	5	.0
November---	66.5	43.7	55.1	82	25	162	3.19	1.28	4.73	5	.0
December---	59.1	37.4	48.3	78	18	115	3.17	1.59	4.44	6	.4
Year-----	73.4	53.1	63.3	99	15	5,445	53.54	47.28	59.60	82	2.1

[1]Recorded in the period 1952-74 at Wilmington, N.C.

[2]A growing degree day is an index of the amount of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).


18
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176 000 FEET
WILMINGTON
(county seat)
BRUNSWICK COUNTY
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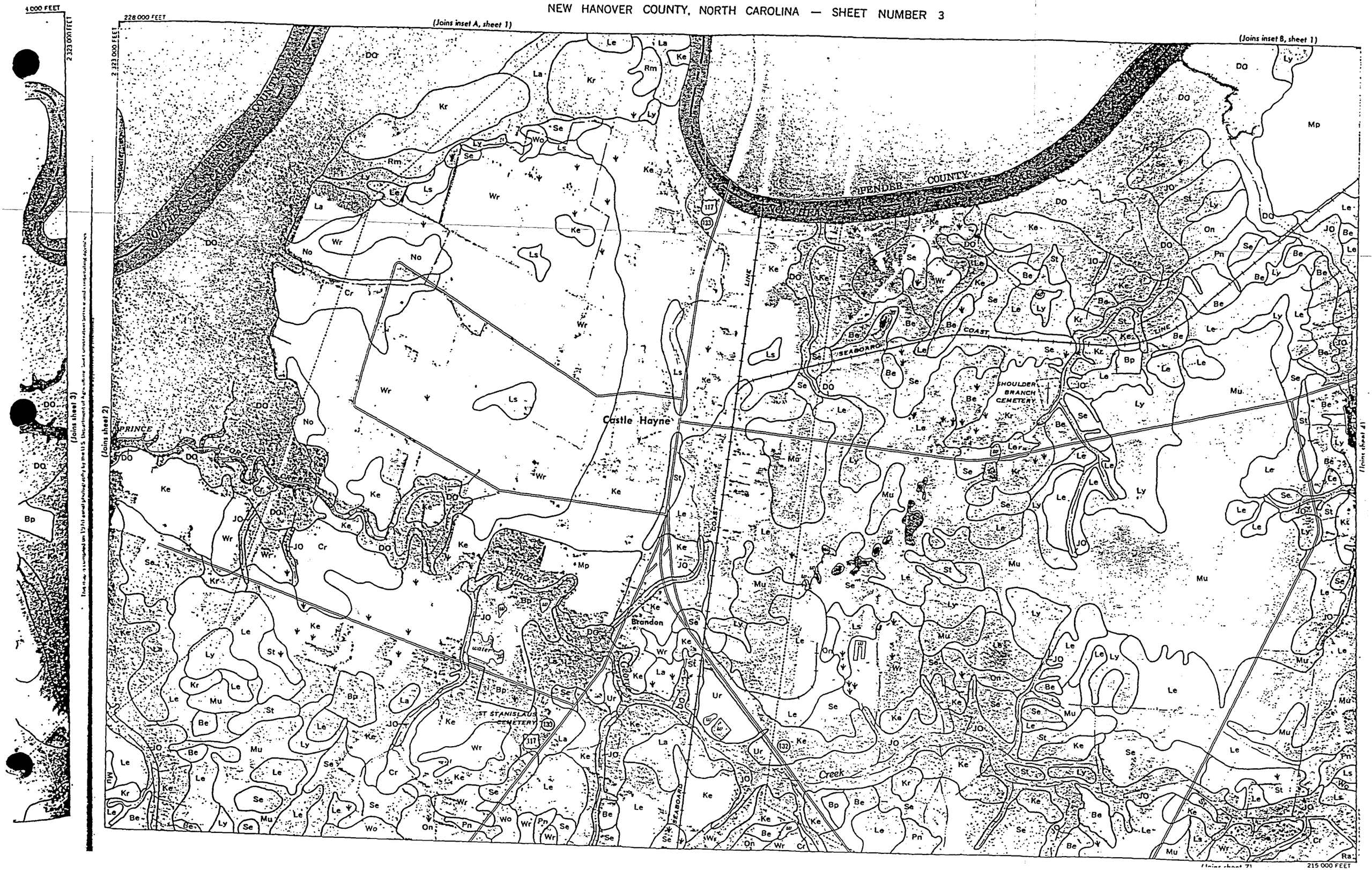
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(Joins sheet 7)
215 000 FEET
PENDER COUNTY
Castle Hayne
Brandon
SHOULDER BRANCH CEMETERY
ST STANISLAUS CEMETERY
SEABOARD COAST LINE
PRINCE GEORGE CREEK
Creek
117
133
132

1977 Aerials

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WILMINGTON NC 28401

SOIL SURVEY OF

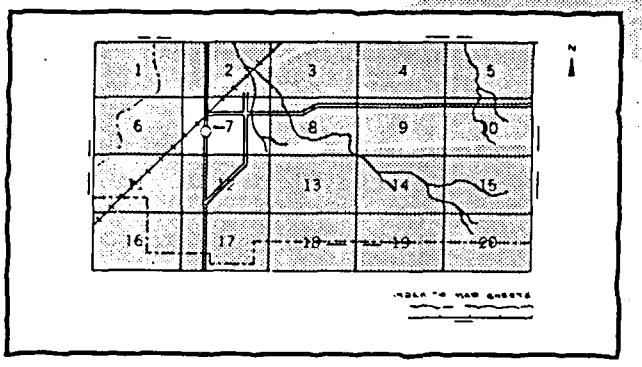
New Hanover County, North Carolina

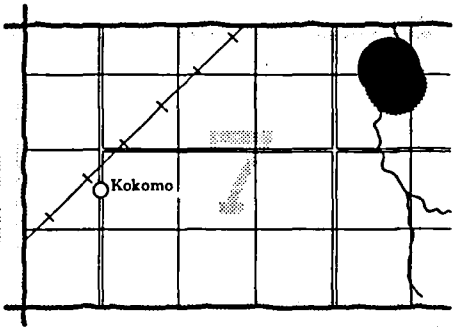
United States Department of Agriculture
Soil Conservation Service

In cooperation with
North Carolina Agricultural Experiment Station
and the
New Hanover County Board of Commissioners

HOW TO US

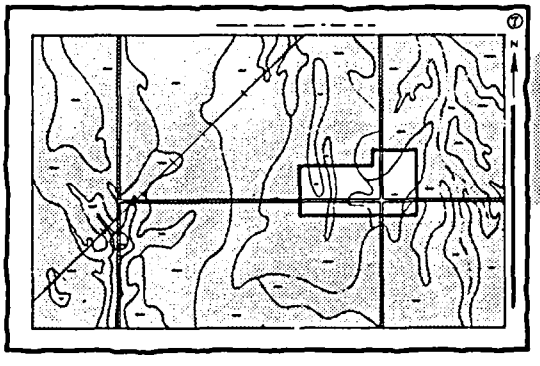
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

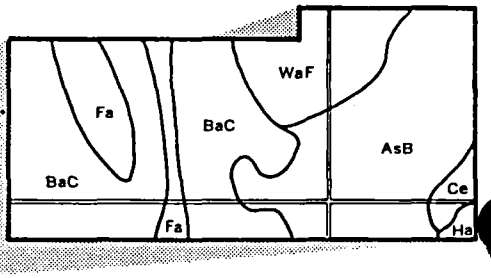




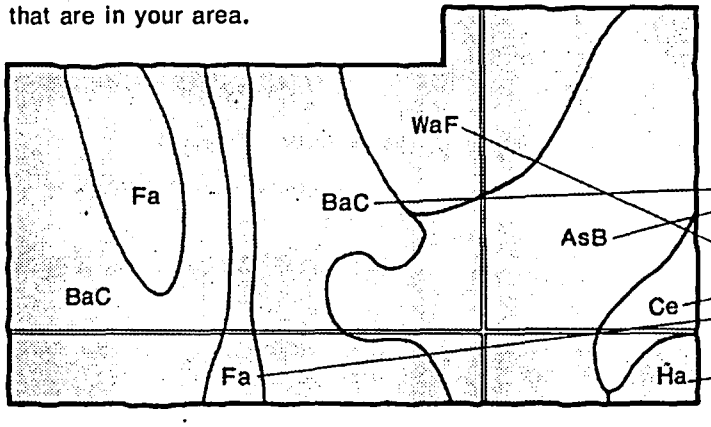
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the mapping unit symbols that are in your area.

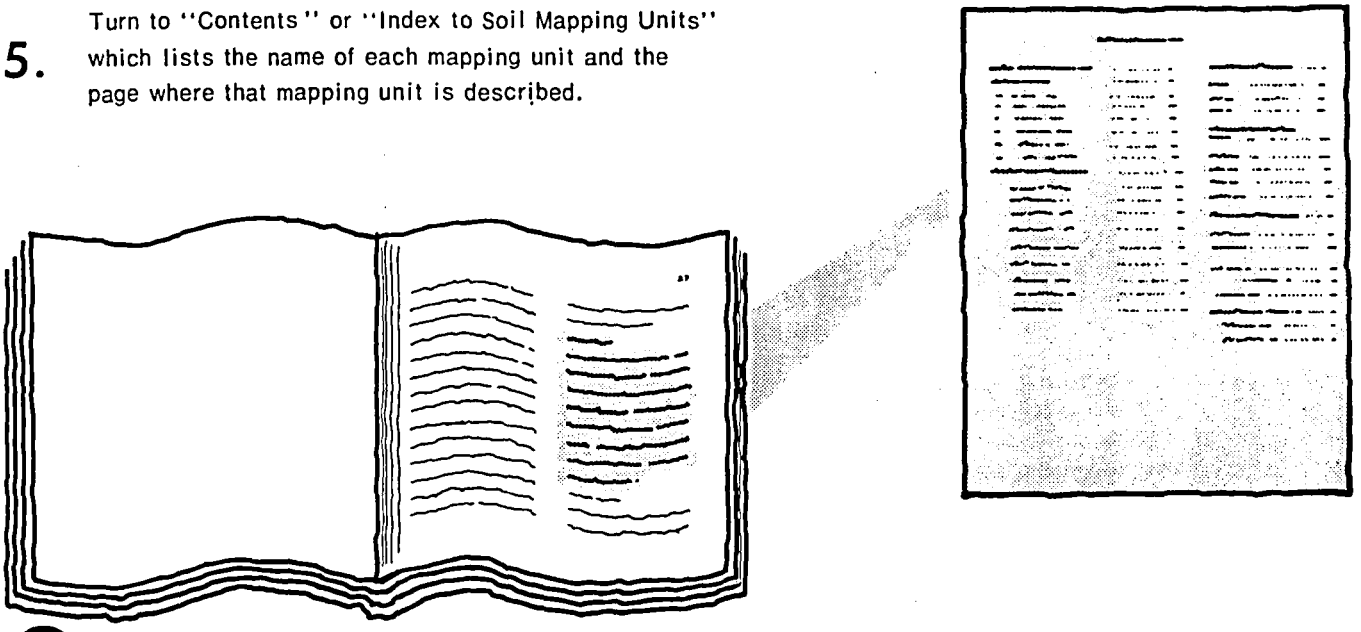


Symbols

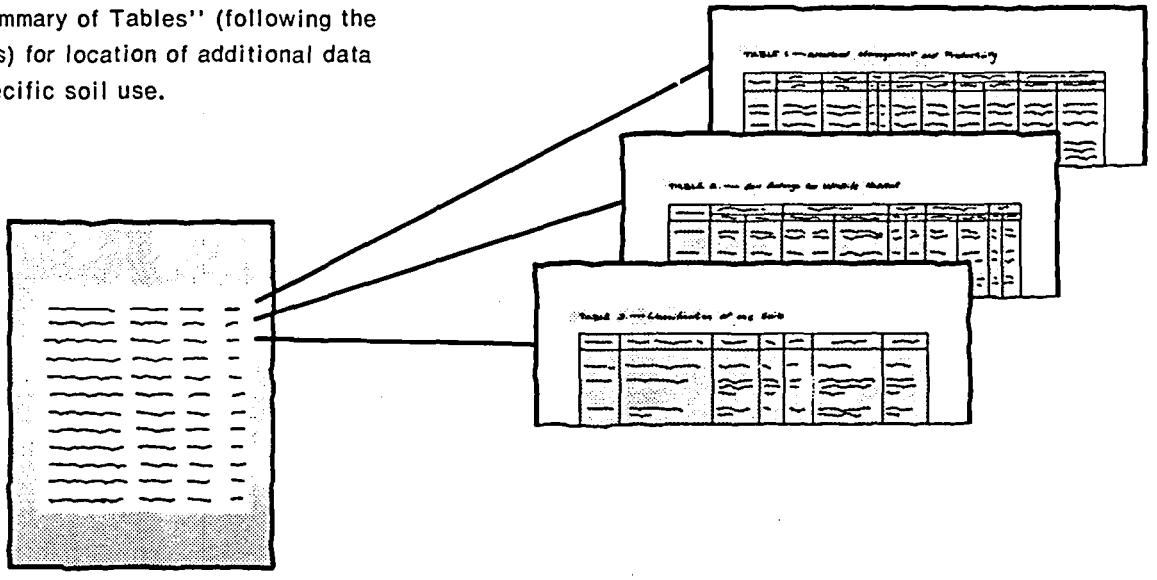
AsB
BaC
Ce
Fa
Ha
WaF

HS SOIL SURVEY

5. Turn to "Contents" or "Index to Soil Mapping Units" which lists the name of each mapping unit and the page where that mapping unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute to individual soil surveys. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1970-72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service, the North Carolina Agricultural Experiment Station, and the New Hanover County Board of Commissioners. It is part of the technical assistance furnished to the Lower Cape Fear Soil and Water Conservation District.

Soil maps in this survey may be copied without permission, but enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show the small areas of contrasting soils that could be shown on a larger mapping scale.

Contents

	Page
Index to soil mapping units	iv
Summary of tables	v
Introduction	1
General nature of the county	1
Climate	1
Water supply	1
Settlement and development	2
Transportation and industry	2
Community facilities	2
How this survey was made	2
General soil map	3
1. Dorovan-Johnston association	3
2. Kureb-Baymeade-Rimini association	3
3. Wrightsboro-Onslow-Kenansville association	4
4. Kenansville-Craven-Lakeland association	4
5. Tidal Marsh-Newhan association	4
6. Murville-Seagate-Leon association	5
Soil maps for detailed planning	5
Soil descriptions and potentials	5
Planning the use and management of the soils	14
Crops	14
Yields per acre	15
Capability classes and subclasses	15
Woodland management and productivity	16
Engineering	16
Building site development	17
Sanitary facilities	18
Construction materials	19
Water management	19
Recreation	20
Wildlife habitat	20
Soil properties	22
Engineering properties	22
Physical and chemical properties	23
Soil and water features	23
Engineering test data	24
Classification of the soils	24
Soil Series	24
Bayboro series	24
Baymeade series	24
Craven series	25
Dorovan series	25
Johnston series	25
Kenansville series	26
Kureb series	26
Lakeland series	26
Leon series	26
Lynchburg series	27
Lynn Haven series	27
Murville series	27
Newhan series	27
Norfolk series	28
Onslow series	28
Pamlico series	28
Pantego series	29
Rains series	29
Rimini series	29
Seagate series	29
Stalling series	30
Torhunta series	30
Wakulla series	30
Woodington series	31
Wrightsboro series	31
Classification	31
Formation of the soils	32
Plant and animal life	32
Climate	32
Parent material	32
Relief	33
Time	33
Literature cited	33
Glossary	33

Issued April 1977

Index to Soil Mapping Units

	Page
Ba—Bayboro loam	5
Be—Baymeade fine sand, 1 to 6 percent slopes	5
Bh—Baymeade-Urban land complex, 1 to 6 percent slopes	6
Bp—Borrow pits	6
Cr—Craven fine sandy loam, 1 to 4 percent slopes	6
DO—Dorovan soils	7
JO—Johnston soils	7
Ke—Kenansville fine sand, 0 to 3 percent slopes	7
Kr—Kureb sand, 1 to 8 percent slopes	7
Ku—Kureb-Urban land complex, 1 to 8 percent slopes	8
La—Lakeland sand, 1 to 8 percent slopes	8
Le—Leon sand	8
Lo—Leon-Urban land complex	8
Ls—Lynchburg fine sandy loam	9
Ly—Lynn Haven fine sand	9
Mp—Mine Pits	9
Mu—Murville fine sand	9
Nh—Newhan fine sand	10
No—Norfolk fine sandy loam, 0 to 4 percent slopes	10
On—Onslow loamy fine sand	10
Pm—Pamlico muck	11
Pn—Pantego loam	11
Ra—Rains fine sandy loam	11
Rm—Rimini sand, 1 to 6 percent slopes	11
Se—Seagate fine sand	12
Sh—Seagate-Urban land complex	12
St—Stallings fine sand	12
TM—Tidal Marsh	12
To—Torhunta loamy fine sand	13
Ur—Urban land	13
Wa—Wakulla sand, 1 to 8 percent slopes	13
Wo—Woodington fine sandy loam	13
Wr—Wrightsboro fine sandy loam, 0 to 2 percent slopes	14

Summary of Tables

Page

Acreage and Proportionate Extent of the Soils (Table 4) 40
Acres. Percent.

Building Site Development (Table 7) 46
Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets.

Classification of the Soils (Table 17) 69
Soil name. Family or higher taxonomic class.

Construction Materials (Table 9) 51
Road fill. Sand. Gravel. Topsoil.

Engineering Properties and Classifications (Table 13) 60
Depth. USDA texture. Classification—Unified, AASHTO. Fragments greater than 3 inches. Percentage passing sieve number—4, 10, 40, 200. Liquid limit. Plasticity index.

Engineering Test Data (Table 16) 67
Parent material. Depth. Horizon. Moisture density—Maximum dry density, Optimum moisture. Percentage passing sieve—10, 40, 200. Percentage smaller than—0.05, 0.02, 0.005, 0.002 mm. Liquid limit. Plasticity index. Classification—AASHTO, Unified.

Freeze Dates in Spring and Fall (Table 2) 39
Probability. Minimum temperature.

Growing Season Length (Table 3) 39
Probability. Daily minimum temperatures during growing season.

Physical and Chemical Properties of Soils (Table 14) 63
Depth. Permeability. Available water capacity. Soil reaction. Shrink-swell potential. Risk of corrosion—Uncoated steel, Concrete.

Recreational Development (Table 11) 56
Camp areas. Picnic areas. Playgrounds. Paths and trails.

Sanitary Facilities (Table 8) 48
Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.

Soil and Water Features (Table 15) 65
Flooding—Frequency, Duration, Months. High water table—Depth, Kind, Months.

Summary of Tables—Continued

	Page
Temperature and Precipitation Data (Table 1)	38
Month. Temperature. Precipitation.	
Water Management (Table 10)	53
Limitations, for—Pond reservoir areas; Embankments, dikes, and levees; Aquifer-fed ponds. Features affecting—Drainage, Irrigation, Terraces and diversions, Grassed waterways.	
Wildlife Habitat Potentials (Table 12)	58
Potential for habitat elements—Grain and seed crops, Grasses and legumes, Wild herbaceous plants, Hardwood trees, Coniferous plants, Wetland plants, Shallow water areas. Potential as habitat for—Open-land wildlife, Woodland wildlife, Wetland wildlife.	
Woodland Management and Productivity (Table 6)	43
Symbol. Management concerns—Erosion hazard, Equipment limitation, Seedling mortality, Windthrow hazard, Plant competition. Potential productivity—Important trees, Site index. Trees to plant.	
Yields Per Acre of Crops (Table 5)	41
Corn. Soybeans. Tobacco. Peanuts.	

Foreword

The soil survey of New Hanover County can help you and your community to plan and to use wisely one of our most precious natural resources—the soil.

This soil survey is intended for many different users. It can help a homebuyer or developer determine soil-related hazards or limitations that affect homesites. It can help land-use planners determine the suitability of areas for homes or onsite sewage disposal systems. This survey can help a farmer estimate the potential crop or forage production of his land. It can be used to determine the suitability and limitations of soils for pipelines, buildings, landfills, recreation areas, and many other uses.

Many people assume that soils are all more or less alike. They are unaware that great differences in soil properties can occur, even within short distances. Soils may be seasonally wet or subject to flooding. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

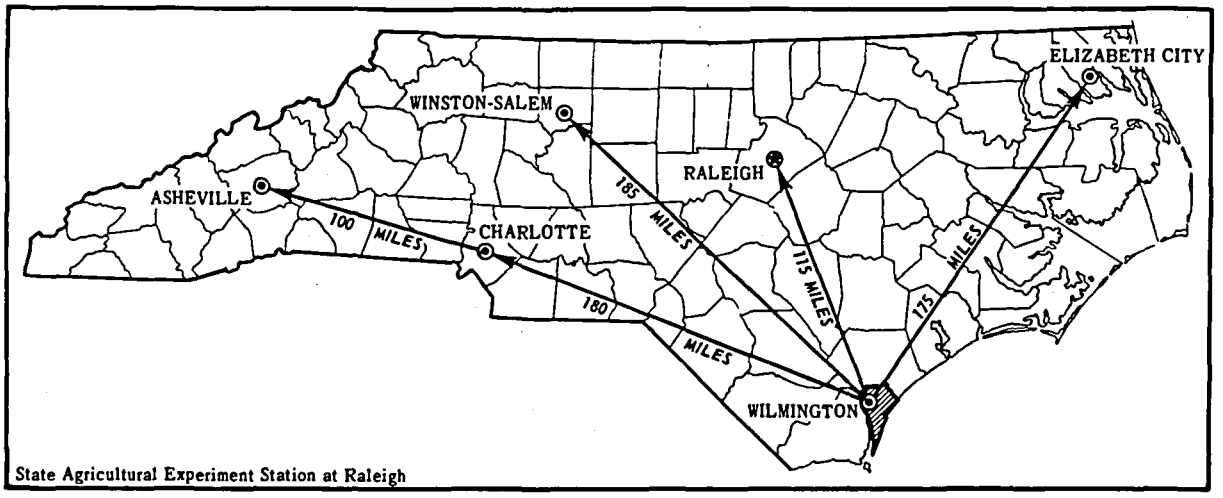
These and many other soil properties that affect land use are described in this soil survey. This publication also shows the location of broad areas of soils on the general soil map and the location of each kind of soil on detailed maps at the back. It provides descriptions of each kind of soil in the survey area, describes soil-related hazards and limitations, and gives much information on the suitability and potential of each soil for specific uses.

We cannot explain here all the ways this soil survey can help you. If you need additional information or assistance in using this survey, please call your local office of the Soil Conservation Service or the Cooperative Extension Service. The soil conservationist or soil scientist assigned to the Lower Cape Fear Soil and Water Conservation District or the county extension director can assist you.

We believe that this soil survey, along with other resource information, will enable you to have a better environment and a better life. The widespread use of this publication will greatly assist all of us in the conservation, development, and productive use of our soil, water, and related resources.

Jim L. Hicks

State Conservationist
Soil Conservation Service



Location of New Hanover County in North Carolina

SOIL SURVEY OF NEW HANOVER COUNTY, NORTH CAROLINA

BY ARLIN WEAVER, SOIL CONSERVATION SERVICE

Soils Surveyed by Arlin Weaver, Clarence Brandon, and W. Everette Lynn, Jr., Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in Cooperation with the North Carolina Agricultural Experiment Station and the New Hanover County Board of Commissioners

Introduction

New Hanover County is in the southeastern part of North Carolina (see opposite page). The county is 118,656 acres, or about 185 square miles, in size. According to the 1970 census, the population of the county was 82,996. Wilmington, the county seat, had a population of 46,169. It is one of the major ports along the Atlantic Coast.

New Hanover County is in the lower part of the Coastal Plain physiographic province. Elevation ranges from sea level to 60 feet. Most of the county is level to gently sloping, but short breaks separate the uplands from the flood plains and marshes.

New Hanover County is mainly industrial. There has been rapid, widespread urbanization over most of the county in recent years. Only a small percentage of the county is used for farms and pasture.

General Nature of the County

This section gives general facts about New Hanover County. It briefly discusses climate; water supply; settlement and development; transportation and industry; and community facilities.

Climate

New Hanover County is hot and humid in summer, but the coastal area of the county is frequently cooled by sea breezes. Winter is cool but has occasional brief cold spells. Rains occur throughout the year but are usually heaviest late in summer and early in fall. Annual precipitation is adequate for all crops.

Table 1 shows temperature and precipitation data for the county, as recorded at Wilmington for the period 1952 to 1974. Tables 2 and 3 show probable dates of the first and last freeze and the length of the growing season.

In winter the average temperature is about 47 degrees F, and the average daily minimum is 37 degrees. The lowest temperature on record, 10 degrees, occurred at Wilmington on December 13, 1962. In summer the average temperature is about 79 degrees F, and the average daily maximum is 88 degrees. The highest temperature on record, 104 degrees, was recorded on June 27, 1952.

Growing degree days, shown in table 1, are equivalent to "heat units." Starting in spring, growing degree days accumulate by the amount that the average temperature each day exceeds the base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 32.86 inches, or 61 percent, usually falls during the period April through September, which includes the growing season for most crops. Two years in 10, the April-September rainfall is less than 26.51 inches. The heaviest 1-day rainfall during the period of record was 7.49 inches at Wilmington on September 27, 1958. Thunderstorms number about 45 each year, 27 of which occur in summer.

Snowfall is rare. In 36 percent of the winters, there is no measureable snowfall, and in 59 percent the total snowfall is less than 2 inches. The heaviest snowfall ever observed in 1 day was more than 11 inches.

The average relative humidity in midafternoon in spring is less than 55 percent, and during the rest of the year it is about 58 percent. Humidity is higher at night in all seasons, and the average at dawn is about 83 percent. The percentage of possible sunshine is 65 percent in summer and 59 percent in winter. The prevailing direction of the wind is from the south-southwest. Average annual windspeed is 9.2 miles per hour. Average windspeed is highest, 10.9 miles per hour, in April.

Every few years a hurricane crosses the county.

Water Supply

Ground water is obtained from three geologic formations that are associated with three geologic ages. These are the Pee Dee Formation of upper Cretaceous Age, the Castle Hayne Limestone Formation of Eocene age, and the surficial sands of post-Miocene age.

Settlement and Development

New Hanover County was established on November 27, 1729. The original area included what is now Onslow, Bladen, Duplin, Pender, and Brunswick Counties. New Hanover County has had its present boundaries since 1875 (*3*).

Early economic activitites in the county were based on two main natural resources, the soil and the forest. The most important sources of income were naval stores of tar, pitch, and turpentine, which were derived from the abundant supply of longleaf pine in the area. Lumber, shingles, barrel staves, and other products came from the large expanse of various trees in the county.

Transportation and Industry

Overland access to the county is provided by four major highways—U.S. 421 and U.S. 117 from the north, U.S. 17 from the east and west, and U.S. 74-76 from the west—and by the Seaboard Coast Line Railroad from the west, north, and east.

The manufacturing plants in the county provide a wide variety of products and services, such as clothing, electronic equipment, chemicals, pile fabrics, concrete, fertilizer, boilers and related equipment, automotive parts, shipbuilding, and ship repair.

Wilmington is North Carolina's major deepwater port and is open to navigation 24 hours a day. Cruise ships that travel to the West Indies and South America frequently leave and return to Wilmington. Large quantities of paper products, tobacco, cotton goods, fertilizer materials, lumber, foodstuffs, and other commodities are handled regularly for export. Petroleum products are regularly shipped in large quantities into Wilmington for distribution. Bulk storage for approximately 8,000,000 barrels of petroleum is available. Imports handled are mostly nitrates, molasses, sugar, hardwood, softwood, and burlap. The port is capable of handling ten ships at a time.

There are about 15 shopping centers in the county and more than 60 hotels and motels.

Community Facilities

Many public elementary and high schools, along with eight private schools, are located throughout New Hanover County. Cape Fear Technical Institute offers a large number of 2-year courses and specializes in the field of marine technology. The University of North Carolina at Wilmington is a fully accredited, tax-supported institution. A private business college is also located in the county and provides training in business administration, accounting, and secretarial science. The county also has 145 churches and 3 hospitals.

Tourist attractions include the famed Greenfield and Airlie Gardens, Fort Fisher, Battleship Memorial U.S.S. North Carolina, and Blockade Runner Museum. Several golf courses are located in the county.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are located, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes, the size of streams and the general pattern of drainage, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has been changed very little by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Soil series commonly are named for towns or other geographic features near the place where they were first observed and mapped. Baymeade and Kureb, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in characteristics.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a named soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series, and some have little or no soil.

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. Existing ratings of suitabilities and

limitations (interpretations) of the soils are field tested and modified as necessary during the course of the survey, and new interpretations are added to meet local needs. This is done mainly through field observations of behavior of different kinds of soil for different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and other information available from State and local specialists. For example, data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so to be readily useful to different groups of users, among them farmers, managers of woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation. Presenting the detailed information in an organized, understandable manner is the purpose of this publication.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning of a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey area are described on the pages that follow.

1. Dorovan-Johnston association

Very poorly drained soils that have a muck, loam, or sandy loam surface layer and a muck or sand underlying layer; in areas that are flooded by streams or tides

This association consists of long, broad and narrow areas on the flood plains of the Cape Fear and Northeast Cape Fear Rivers. Some of the areas are subject to daily and seasonal tidal flooding.

This association makes up 6 percent of the county. It is 60 percent Dorovan soils and 30 percent Johnston soils. Soils of minor extent make up 10 percent of the association and are chiefly Pamlico, Murville, Lynn Haven, Torhunta, and Woodington soils.

The nearly level Dorovan soils are very poorly drained. The surface layer is black muck. The underlying layer is black or very dark gray muck.

The nearly level Johnston soils are very poorly drained. The surface layer is black loam in the upper part and black sandy loam in the lower part. The underlying layer is light gray sand.

The major soils in this association are used for forest, and some small areas have been filled and used for industrial and residential sites.

A seasonal high water table, flooding, and high organic-matter content are the main limitations in the use and management of the major soils in this association.

2. Kureb-Baymeade-Rimini association

Excessively drained and well drained soils that have a sand and fine sand surface layer and a sand, fine sandy loam, and loamy fine sand subsoil or underlying layer; on uplands

This association consists of nearly level to sloping soils on the uplands. These soils are in the broad areas between the major streams. This association is dissected by many small streams and depressions.

This association occupies 25 percent of the county. It is 25 percent Kureb soils, 20 percent Baymeade soils, and 8 percent Rimini soils. Soils of minor extent make up 47 percent of this association and are chiefly Lakeland, Leon, Lynn Haven, Murville, and Wakulla soils.

The nearly level to sloping Kureb soils are excessively drained. The surface layer is dark gray sand. The subsurface layer is light gray sand. The underlying layer is brownish yellow sand in the upper part and pale brown sand in the lower part.

The nearly level to gently sloping Baymeade soils are well drained. The surface layer is dark gray fine sand. The subsurface layer is light gray fine sand in the upper part and very pale brown fine sand in the lower part. The subsoil is strong brown fine sandy loam in the upper part and strong brown loamy fine sand in the lower part. The underlying layer is mottled white and very pale brown fine sand in the upper part and very pale brown fine sand and loamy fine sand in the lower part.

The nearly level to gently sloping Rimini soils are excessively drained. The surface layer is dark gray sand. The subsurface layer is light gray sand. The subsoil is dark reddish bown sand in the upper part and dark brown sand in the lower part.

The major soils in this association are used for forest and for residential and industrial sites.

Very low available water capacity, moderately rapid and rapid permeability, leaching of plant nutrients, droughtiness, and soil blowing are the main limitations in

the use and management of the major soils in this associaion.

3. Wrightsboro-Onslow-Kenansville association

Somewhat poorly drained to well drained soils that have a fine sandy loam, loamy fine sand, and fine sand surface layer and a sandy clay loam, clay, fine sandy loam, sandy loam, and clay loam subsoil; on uplands

This association consists of nearly level to gently sloping soils on broad, smooth flats on the uplands.

This association occupies 7 percent of the county. It is 22 percent Wrightsboro soils, 20 percent Onslow soils, and 15 percent Kenansville soils. Soils of minor extent make up 43 percent of this association and are chiefly Seagate, Stallings, Norfolk, Pantego, and Torhunta soils.

The nearly level Wrightsboro soils are moderately well drained. The surface layer is grayish brown fine sandy loam. The subsurface layer is very pale brown fine sandy loam. The subsoil is mottled brownish yellow sandy clay loam in the upper part and mottled light gray clay in the lower part.

The nearly level Onslow soils are moderately well drained and somewhat poorly drained. The surface layer is gray loamy fine sand. The subsurface layer is mottled dark brown and yellowish brown loamy sand in the upper part and mottled light yellowish brown loamy fine sand in the lower part. The subsoil is mottled light yellowish brown sandy clay loam in the upper part, mottled pale brown sandy loam in the middle part, and light gray clay loam in the lower part.

The nearly level to gently sloping Kenansville soils are well drained. The surface layer is grayish brown fine sand. The subsurface layer is fine sand that is pale brown in the upper part and mottled very pale brown in the lower part. The subsoil is strong brown fine sandy loam in the upper part and reddish yellow fine sandy loam in the lower part. The underlying material is yellow loamy fine sand.

The major soils in this association are used for cultivation, pasture and forest and for residential and industrial sites.

A seasonal high water table, moderate and moderately rapid permeability, leaching of plant nutrients, droughtiness, low available water capacity, and soil blowing are the main limitations in the use and management of the major soils in this association.

4. Kenansville-Craven-Lakeland association

Moderately well drained to excessively drained soils that have a sand, fine sand, or fine sandy loam surface layer and a fine sandy loam, clay loam, clay, and sand subsoil or underlying layer; on uplands

This association consists of nearly level to sloping soils on broad smooth flats on the uplands and on broad long ridges. The areas are dissected by many small drainageways.

This association occupies 3 percent of the county. It is 45 percent Kenansville soils, 20 percent Craven soils, and 15 percent Lakeland soils. Soils of minor extent make up 20 percent of this association and are chiefly Leon, Norfolk, Onslow, and Wrightsboro soils.

The nearly level to gently sloping Kenansville soils are well drained. The surface layer is grayish brown fine sand. The subsurface layer is fine sand that is pale brown in the upper part and mottled very pale brown in the lower part. The subsoil is strong brown fine sandy loam in the upper part and reddish-yellow fine sandy loam in the lower part. The underlying layer is yellow loamy fine sand.

The nearly level to gently sloping Craven soils are moderately well drained. The surface layer is dark gray fine sandy loam. The subsoil is mottled yellowish brown clay loam in the upper part, mottled light brownish gray clay loam in the middle part, and mottled light gray clay in the lower part. The underlying layer is mottled light gray sandy clay loam.

The nearly level to sloping Lakeland soils are excessively drained. The surface layer is grayish brown sand. The underlying layer is sand that is yellowish brown in the upper part and brownish yellow in the lower part.

The major soils in this association are used for cultivation, for forest, and for residential and industrial sites.

Low available water capacity, leaching of plant nutrients, permeability, soil blowing, erosion, seasonal wetness, and droughtiness are the main limitations in the use and management of the major soils in this association.

5. Tidal Marsh-Newhan association

Tidal Marsh and excessively drained soils that are sandy throughout; on flats and dunes along the seashore

This association consists of nearly level to gently sloping soils on dunes, commonly near beaches and waterways along the coast, and on flats between the coastal dunes and the interior uplands and along the Cape Fear River.

This association makes up 13 percent of the county. It is 53 percent Tidal Marsh and 25 percent Newhan soils. Soils of minor extent make up 22 percent of this association and are chiefly Urban land.

The Tidal Marsh is nearly level. The surface layer is black clay loam. The underlying layer is very dark gray and black silty clay loam.

The gently sloping Newhan soils are excessively drained. The surface layer is grayish brown fine sand. The underlying layer is light gray fine sand and sand.

Tidal Marsh is used as natural habitat for shore and water birds. Some areas are used for shellfish gardens. Many areas are dredged, filled, and converted to summer cottage sites and recreational areas. The Newhan soils are used as sites for year-round homes and summer beach cottages and as industrial and recreation sites.

Wetness and tidal flooding on the Tidal Marsh and permeability and droughtiness on the Newhan soils are the main limitations in the use and management of these soils.

6. Murville-Seagate-Leon association

Very poorly drained to somewhat poorly drained soils that have a fine sand and sand surface layer and a fine sand, sand, sandy loam, and clay loam subsoil; on uplands and stream terraces

This association consists of nearly level soils in flat or slightly depressional areas on rims of depressions and on broad smooth flats.

This association occupies 46 percent of the county. It is 26 percent Murville soils, 13 percent Seagate soils, and 13 percent Leon soils. Soils of minor extent make up 48 percent of this association and are chiefly Kureb, Lynn Haven, Onslow, Pamlico, Rimini, and Wakulla soils. Also, in areas adjacent to the towns, Urban land has been mapped with Baymeade, Kureb, Leon, and Seagate soils.

The nearly level Murville soils are very poorly drained. The surface layer and subsoil are black fine sand. The underlying layer is pale brown. It is fine sand in the upper part, sandy clay loam and sandy loam in the middle part, and fine sand in the lower part.

The nearly level Seagate soils are somewhat poorly drained. The surface layer is dark gray fine sand. The subsurface layer is light gray fine sand. The underlying layer is fine sand that is dark brown in the upper part, brown in the middle part, and light gray in the lower part. The subsoil is mottled brownish yellow sandy loam in the upper part and light gray clay loam in the lower part.

The nearly level Leon soils are poorly drained. The surface layer is very dark gray sand. The subsurface layer is light gray sand. The subsoil is dark reddish brown sand. The underlying material is light gray sand.

The major soils in this association are forested or are used as residential and industrial sites.

A seasonal high water table and leaching of plant nutrients are the main limitations in the use and management of the major soils in this association.

Soil Maps for Detailed Planning

The kinds of soil (mapping units) shown on the detailed soil maps at the back of this publication are described in this section. These descriptions together with the soil maps can be useful in determining the potential of soil and in managing it for food and fiber production, in planning land use and developing soil resources, and in enhancing, protecting, and preserving the environment. More detailed information for each soil is given in the section "Planning the Use and Management of the Soils."

Preceding the name of each mapping unit is the symbol that identifies the unit on the detailed soil map. Each mapping unit description includes general facts about the soil and a brief description of the soil profile. The potential of the soil for various major land uses is estimated. The principal hazards and limitations are indicated, and the management concerns and practices for the major uses are discussed.

A mapping unit represents an area on the landscape and consists of a dominant soil or soils for which the unit is named. Most mapping units have one dominant soil, but some have two or more dominant soils. A mapping unit commonly includes small, scattered areas of other soils. The properties of some included soils can differ substantially from those of the dominant soil or soils and thus greatly influence the use of the dominant soil. How the included soils may affect the use and management of the mapping unit is discussed.

In most areas surveyed there is land that has little or no identifiable soil and supports no vegetation. This land, called miscellaneous areas, is delineated on the map and given a descriptive name. Urban land is an example. Areas too small to be delineated are identified by special symbols on the soil maps.

The acreage and proportionate extent of each mapping unit are given in table 4, and additional information on each unit is given in interpretive tables in other sections (see "Summary of Tables"). Many of the terms used in describing soils are defined in the Glossary.

Soil Descriptions and Potentials

Ba—Bayboro loam. This nearly level, very poorly drained soil is on broad, smooth flats and in slight depressions on the uplands. The areas are small in size and irregular in shape. Most of the acreage is forested, and only a small acreage is used as residential areas. The dominant vegetation in the wooded areas consists of loblolly pine, pond pine, sweetgum, tupelo-gum, sweetbay, water oak, wax-myrtle, gallberry, greenbrier, and switchcane.

Typically, the surface layer is black loam 16 inches thick. The subsoil is about 56 inches thick. The upper part is very dark gray sandy clay loam, and the lower part is mottled gray clay loam.

Included with this soil in mapping are soils that are underlain by clay at a depth of 4 to 6 feet.

The organic-matter content of the surface layer is medium. Permeability is slow, available water capacity is high, and shrink-swell potential is moderate. Reaction is strongly acid or very strongly acid throughout, unless the soil is limed. The seasonal high water table is at or near the surface. Many areas are commonly flooded for brief periods.

A seasonal high water table, flooding, moderate shrink-swell potential, and slow permeability are the main limitations in the use and management of this soil. If this soil is drained, most lawn grasses and some varieties of shrubs are easily established. Some shrubs and trees, such as camellias and dogwood, may be difficult to establish because of wetness. Capability subclasses VIw, where undrained, and IIIw, where drained; woodland group 2w.

Be—Baymeade fine sand, 1 to 6 percent slopes. This well drained soil is on flats and low ridges that are on the uplands and in small areas that are along drainageways but are not subject to flooding. The areas are irregular in shape. Most of the acreage is used as residential and in-

dustrial sites, and the rest is forested. The dominant vegetation is longleaf pine, turkey oak, bluejack oak, post oak, dwarf waxmyrtle, dwarf huckleberry, and pineland three-awn. This vegetation increases in density on the lower slopes along with additional species, such as hickory, American holly, red oak, black oak, and bracken.

Typically, the surface layer is dark gray fine sand 3 inches thick. The subsurface layer is fine sand 33 inches thick. It is light gray in the upper part and very pale brown in the lower part. The subsoil is 22 inches thick. It is strong brown fine sandy loam in the upper part and strong brown loamy fine sand in the lower part. The underlying layer, to a depth of 78 inches, is mottled white and very pale brown fine sand in the upper part and very pale brown fine sand and loamy fine sand in the lower part.

Included with this soil in mapping are a few small areas of Norfolk, Kenansville, Seagate, and Wakulla soils.

The organic-matter content of the surface layer is very low. Permeability is moderately rapid, available water capacity is very low, and shrink-swell potential is low. Reaction is strongly acid to slightly acid throughout, unless the soil is limed. The seasonal high water table is at a depth of more than 4 feet.

Very low available water capacity, moderately rapid permeability, leaching of plant nutrients, droughtiness, and soil blowing are the main limitations in the use and management of this soil. If supplemental irrigation is not used, available moisture capacity in this soil is generally inadequate for the establishment and maintenance of most lawn grasses, shrubs, and trees. Soil conditioners may also be needed. Capability subclass IIIs; woodland group 3s.

Bh—Baymeade-Urban land complex, 1 to 6 percent slopes. This mapping unit is on the flats and low ridges of the upland and in small areas that are along the drainageways but are not subject to flooding. It consists of Baymeade soils and Urban land that are in areas so small and so intermingled that is was not practical to map them separately. About 35 to 45 percent of this mapping unit is Baymeade soils, and 30 to 50 percent is Urban land. The percentage of Urban land in the mapped areas is greater near the towns.

Typically, the surface layer of a Baymeade soil is dark gray fine sand 3 inches thick. The subsurface layer is fine sand 33 inches thick. It is light gray in the upper part and very pale brown in the lower part. The subsoil is 22 inches thick. It is strong brown fine sandy loam in the upper part and strong brown loamy fine sand in the lower part. The underlying layer, to a depth of 78 inches, is mottled white and very pale brown fine sand in the upper part and very pale brown fine sand and loamy fine sand in the lower part.

The Urban land part of this unit consists of areas where the original soils have been cut, filled, graded, or paved so that most soil properties have been altered to the extent that the soils cannot be identified. These areas are used for shopping centers, factories, municipal buildings, apartment complexes, or parking lots, or for other purposes where buildings are closely spaced or the soil is covered with pavement. Slope is generally modified to fit the site needs, and it generally ranges from 0 to 6 percent. The extent of site modification varies greatly. Many areas are relatively undisturbed, but other areas have been cut and filled.

Included with these soils in mapping are small areas of Kureb, Leon, Seagate, Rimini, Lakeland, Murville, Lynn Haven, and Torhunta soils.

The runoff of the Urban land is greater than that of the Baymeade soils because of the impervious cover of buildings, streets, and parking lots.

Very low available water capacity, moderately rapid permeability, leaching of plant nutrients, droughtiness, and soil blowing are the main limitations in the use and management of these soils. If supplemental irrigation is not used, available water capacity in this soil is generally inadequate for the establishment and maintenance of most lawn grasses, shrubs, and trees. Soil conditioners may be needed. Capability subclass not assigned; Baymeade part in woodland group 3s, Urban land part not placed in a woodland group.

Bp—Borrow pits. Borrow pits consists of small areas where the soil has been removed and is used as a fill material around bridges, industrial sites, and other structures. Areas range in size from about 2 to 15 acres, but most areas are less than 5 acres. Most areas have not been reclaimed, and areas that are revegetated were done so by volunteer stands of grasses and trees. Capability subclass and woodland group not assigned.

Cr—Craven fine sandy loam, 1 to 4 percent slopes. This moderately well drained soil is on broad, smooth flats on the uplands and on short side slopes along drainageways. Areas are small in size and irregular in shape. Most of the acreage is used for residential or industrial sites. The rest is used for pasture or is forested. The native vegetation is American holly, various oaks, hickory, loblolly pine, sweetgum, sweetleaf, sweet pepperbush, waxmyrtle, and gallberry.

Typically, the surface layer is dark gray fine sandy loam 8 inches thick. The subsoil is 48 inches thick. The upper part is mottled yellowish brown clay loam, the middle part is mottled light brownish gray clay loam, and the lower part is mottled light gray clay. The underlying layer, to a depth of 64 inches, is mottled light gray sandy clay loam.

Included with this soil in mapping are a few areas of soils that have a sandy loam and loamy fine sand surface layer. Also included are small areas of soils that have a sandy surface layer, and a few small areas of Norfolk, Onslow, and Wrightsboro soils.

The organic-matter content of the surface layer is low. Permeability is slow, available water capacity is medium, and shrink-swell potential is moderate. The seasonal high water table is at a depth of 2 to 3 feet.

The clayey texture of the lower part of the subsoil, erosion, seasonal wetness, and slow permeability are the

main limitations in the use and management of this soil. If drained, this soil is suited to most locally grown crops. The main crops are corn, soybeans, tobacco, and peanuts. Minimum tillage and crop residue management aid in maintaining organic-matter content. This soil has good tilth and can be worked over a wide range of moisture content, but tillage is delayed during wet seasons. Drainage is needed for most uses. Capability subclass IIIe; woodland group 3w.

DO—Dorovan soils. These nearly level, very poorly drained soils are in bays and in long, broad areas of tidal and stream flood plains. All of the acreage is used for woodland and as wildlife habitat. The native vegetation is red maple, willow, tupelo, cypress, sweetgum, ash, American cyrilla, and greenbrier.

Typically the surface layer is black muck 4 inches thick. The underlying layer, to a depth of 64 inches, is black or very dark gray muck.

Included with these soils in mapping are small areas of Johnston soils and Tidal marsh. A few small areas of soils that have thin, continuous mineral layers are also included.

The organic-matter content in the surface layer is very high. Permeability is very slow, available water capacity is very high, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless the soils are limed. The seasonal high water table is at or near the surface. These soils are frequently flooded for very long periods.

Flooding and high organic-matter content are the main limitations in the use and management of these soils. If these soils are drained and tilled, the organic matter decomposes and the soil subsides. Capability subclass VIIIw; woodland group 4w.

JO—Johnston soils. These nearly level, very poorly drained soils are on flood plains of the major streams. Areas are commonly long and narrow. Most of the acreage is forested, and some small areas have been filled and used for industrial and residential sites. The native vegetation consists of pond pine, tupelo-gum, ash, water oak, cypress, red maple, sweetgum, American cyrilla, waxmyrtle, and gallberry.

Typically, the surface layer is 42 inches thick. It is black loam in the upper part and black sandy loam in the lower part. The underlying layer, to a depth of about 64 inches, is light gray sand.

Included with these soils in mapping are small areas of Pamlico, Dorovan, and Murville soils. A few small areas of soils that are less acid than these Johnston soils are also included.

The organic-matter content of the surface layer is high. Permeability is moderately rapid, available water capacity is high, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless these soils are limed. The seasonal high water table is at or near the surface. These soils are frequently flooded for long periods.

A seasonal high water table and flooding are the main limitations in the use and management of these soils. These soils subside if drained and tilled. Capability subclasses VIIw, where undrained, and IVw, where drained; woodland group 1w.

Ke—Kenansville fine sand, 0 to 3 percent slopes. This well drained soil is on broad smooth flats on the uplands. Areas are commonly large in size and irregular in shape. Most of the acreage is cultivated. The rest is forested or is used for residential or industrial sites. The native vegetation consists of longleaf and loblolly pines; white, red, black, turkey, water, and bluejack oaks; hickory; dogwood; holly; and sassafras.

Typically, the surface layer is grayish brown fine sand 3 inches thick. The subsurface layer is fine sand 30 inches thick. It is is pale brown in the upper part and mottled very pale brown in the lower part. The subsoil is fine sandy loam 17 inches thick. It is strong brown in the upper part and reddish yellow in the lower part. The underlying layer, to a depth of 80 inches, is yellow loamy fine sand.

Included with this soil in mapping are a few small areas of Norfolk and Lakeland soils. Some small areas of soils that are less acid throughout are also included.

The organic-matter content of the surface layer is very low. Permeability is moderately rapid, available water capacity is low, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout, unless this soil is limed. The seasonal high water table is at a depth of more than 6 feet.

Leaching of plant nutrients, moderately rapid permeability, droughtiness, low available water capacity, and soil blowing are the main limitations in the use and management of this soil. This soil is well suited to most locally grown crops. The main crops are corn, soybeans, peanuts, tobacco, and truck crops, such as squash, lettuce, cucumbers, cabbage, snapbeans, and corn. Winter cover crops, minimum tillage, and crop residue management aid in maintaining organic-matter content and conserving moisture. Soil blowing is a concern in the management of this soil. The blowing sand often causes damage to young plants. This soil is droughty during periods of low rainfall. Some supplemental irrigation, soil conditioners, and fertilizers are needed for lawn grasses, shrubs, and trees. Capability subclass IIs; woodland group 3s.

Kr—Kureb sand, 1 to 8 percent slopes. This excessively drained soil is on long, broad ridges on the uplands. Areas are generally broad and long. Most of the acreage is forested. The rest is used for residential and industrial sites. The sparse native vegetation on the higher elevations is turkey oak, scattered longleaf pine, a few bluejack oaks, and scattered dwarf myrtle and huckleberry. Much of the area is barren of any vegetation, except for mosses and lichens. On the lower slopes, the vegetation increases in density and includes various oaks, scattered hickory, holly, and brackenfern.

Typically, the surface layer is dark gray sand 3 inches thick. The subsurface layer is light gray sand 23 inches

thick. The underlying layer, to a depth of 89 inches, is brownish yellow sand in the upper part and pale brown sand in the lower part.

Included with this soil in mapping are small areas of Lakeland, Baymeade, Rimini, and Leon soils. Some small areas of soils that are generally at an elevation of less than 25 feet are also included. These soils have mixed mineralogy.

The organic-matter content of the surface layer is very low. Permeability is rapid, available water capacity is very low, and shrink-swell potential is low. Reaction is neutral to very strongly acid throughout, unless this soil is limed. The seasonal high water table is at a depth of more than 6 feet.

Very low available water capacity and rapid permeability are the main limitations in the use and management of this soil. This soil is very droughty. Irrigation, soil conditioners, and fertilizer are needed if lawn grasses, shrubs, and trees are to be established. Capability subclass VIIs; woodland group 5s.

Ku—Kureb-Urban land complex, 1 to 8 percent slopes. This mapping unit consists of areas of Kureb soils and Urban land that are too small and too intermingled to be mapped separately. About 30 to 40 percent of the acreage is Kureb soils, and about 30 to 35 percent is Urban land. The percentage of Urban land in the mapped areas is greatest near towns and around shopping centers.

Typically, the surface layer of a Kureb soil is dark gray sand 3 inches thick. The subsurface layer is light gray sand 23 inches thick. The underlying layer, to a depth of 89 inches, is brownish yellow sand in the upper part and pale brown sand in the lower part.

The urban land consists of areas where the original soil has been cut, filled, graded, or paved so that most soil properties have been altered to the extent that a soil series is not recognized. These areas are now used for shopping centers, factories, municipal buildings, apartment complexes, or parking lots, or for other purposes where buildings are closely spaced or soil is covered with pavement. Slope is generally modified to fit the site needs and commonly ranges from 0 to 5 percent. The extent of site modification varies greatly. Many areas are relatively undisturbed, but in the process of smoothing, high areas have been cut down and low areas have been filled.

Included in mapping are small areas of Lakeland, Baymeade, Leon, and Rimini soils. A few small areas of soils that have slopes greater than 8 percent are also included.

Runoff from Urban land is greater than that from Kureb soils, because of the impervious cover of buildings, streets, and parking lots.

Very low available water capacity and rapid permeability are the main limitations in the use and management of this unit. It is very droughty. Irrigation, soil conditioners, and fertilizer are needed if lawn grasses, shrubs, and trees are established. Capability subclass not assigned; Kureb part in woodland group 5s, Urban land part not placed in a woodland group.

La—Lakeland sand, 1 to 8 percent slopes. This excessively drained soil is on broad, long ridges on uplands. Areas generally are large in size and irregular in shape. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation on the higher elevations is dominantly turkey oak, bluejack oak, and sand post oak. Some scattered longleaf pine, dwarf myrtle, and huckleberry trees are also in these areas.

Typically the surface layer is grayish brown sand 2 inches thick. The underlying layer, to a depth of 80 inches, is sand that is yellowish brown in the upper part and brownish yellow in the lower part.

Included with this soil in mapping are small areas of Kureb, Baymeade, and Wakulla soils.

The organic-matter content of the surface layer is very low. Permeability is very rapid, available water capacity is low, and shrink-swell potential is very low. Reaction is medium acid to very strongly acid throughout where this soil is not limed. The seasonal high water table is at a depth of more than 6 feet.

Low available water capacity, leaching of plant nutrients, and soil blowing are the main limitations in the use and management of this soil. The soil is very droughty. Irrigation, soil conditioners, and fertilizers are needed if grasses, shrubbery, and trees are established. Capability subclass IVs; woodland group 3s.

Le—Leon sand. This nearly level, poorly drained soil is on rims of depressions, on smooth flats, and in indefinite patterns on the uplands and stream terraces. Areas are irregular in shape and are 5 to 250 acres in size. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation consists of longleaf pine, pond pine, sweetbay, water oak, winterberry, gallberry, bracken, and, in the more nearly open areas, a dense cover of pineland three-awn and creeping blueberry.

Typically the surface layer is very dark gray sand 3 inches thick. The subsurface layer is light gray sand 13 inches thick. The subsoil is dark reddish brown sand 24 inches thick. The underlying layer, to a depth of 64 inches, is light gray sand.

The organic-matter content of the surface layer is very low. Permeability is rapid in the surface layer, moderate to moderately rapid in the subsoil, and very rapid in the underlying layer. Available water capacity is low, and shrink-swell potential is very low. Reaction is strongly acid throughout, where this soil has not been limed. The seasonal high water table is at or near the surface.

A seasonal high water table and leaching of plant nutrients are the main limitations in the use and management of this soil. Most lawn grasses, shrubs, and trees are easily established and maintained. Some soil conditioners and liberal amounts of fertilizer may be needed in most areas. Capability subclass IVw; woodland group 4w.

Lo—Leon-Urban land complex. This mapping unit is on rims of depressions, on smooth flats, and in indefinite patterns on the uplands and stream terraces. It consists of areas of Leon soils and Urban land that are

too small and too intermingled to be mapped separately. About 35 to 45 percent of the mapping unit is Leon soils, and about 30 to 50 percent is Urban land. The percentage of Urban land is greater near towns.

Typically, the surface layer of a Leon soil is very dark gray sand 3 inches thick. The subsurface layer is light gray sand 13 inches thick. The subsoil is dark reddish brown sand 24 inches thick. The underlying layer, to a depth of 64 inches, is light gray sand.

Urban land consists of areas where the original soil has been cut, filled, graded, or paved so that most soil properties have been altered to the extent that a soil series is not recognized. These areas are used for shopping centers, factories, municipal buildings, apartment complexes, or parking lots, or for other purposes where buildings are closely spaced or soil is covered with pavement. Slope is generally modified to fit the site needs. The extent of site modification varies greatly. Many areas are relatively undisturbed, while other areas have been cut or filled.

Included in mapping are small areas of Seagate, Onslow, Rimini, Murville, Lynn Haven, Kureb, Lakeland, and Baymeade soils.

The runoff of the Urban Land part of this mapping unit is greater than that of the Leon soils because of the impervious cover of buildings, streets, and parking lots.

A seasonal high water table and leaching of plant nutrients are the main limitations in the use and management of this complex. Most lawn grasses, shrubs, and trees are easily established and maintained. Some soil conditioners and liberal amounts of fertilizer may be needed in most areas. Capability subclass not assigned; Leon part in woodland group 4w, Urban land part not placed in a woodland group.

Ls—Lynchburg fine sandy loam. This nearly level, somewhat poorly drained soil is on broad, smooth flats on the uplands. Areas are small in size and irregular in shape. Most of the acreage is used for residential or industrial sites. The rest is mainly forested. The dominant native vegetation consists of longleaf pine, loblolly pine, water oak, willow oak, red maple, waxmyrtle, short gallberry, tall gallberry, and sweet pepperbush.

Typically, the surface layer is grayish brown fine sandy loam 6 inches thick. The subsoil, to a depth of 64 inches, is very pale brown sandy clay loam in the upper part. The middle part is mottled, brownish yellow, light gray, and yellowish red sandy clay loam, and the lower part is mottled, light gray, brownish yellow, reddish yellow, and yellow clay loam.

Included with this soil in mapping are small areas of Rains, Stallings, Onslow, Woodington, and Wrightsboro soils.

The organic-matter content of the surface layer is low. Permeability is moderate, available water capacity is medium, and shrink-swell potential is low. Reaction is strongly acid or very strongly acid throughout if this soil has not been limed. The seasonal high water table is 1.5 feet from the surface.

Wetness is the main limitation in the use and management of this soil. Most lawn grasses, shrubs, and trees are easily established and maintained. Capability subclass IIw; woodland group 2w.

Ly—Lynn Haven fine sand. This nearly level, poorly drained soil is in broad, almost level to flat or depressional areas on uplands. Areas are irregular in shape and small to large in size. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation consists of longleaf pine, pond pine, red maple, water oak, American cyrilla, greenbrier, fetterbush, and pineland three-awn.

Typically, the surface layer is black fine sand 18 inches thick. The subsurface layer is gray fine sand 6 inches thick. The subsoil is 34 inches thick. It is sand that is black in the upper part, black and dark brown in the middle part, and dark brown and brown in the lower part. The underlying layer, to a depth of 75 inches, is pale brown sand in the upper part and light brownish gray sandy loam and dark greenish gray sandy clay in the lower part.

Included with this soil in mapping are small areas of Murville, Leon, and Torhunta soils.

The organic-matter content of the surface layer is low. Permeability is rapid in the surface layer and moderate and moderately rapid in the subsoil. Available water capacity is low, and shrink-swell potential is very low. Reaction is strongly acid to extremely acid throughout where this soil has not been limed. Unless this soil is artificially drained, the seasonal high water table is at or near the surface during periods of heavy rainfall. This soil is frequently flooded for brief periods.

A seasonal high water table is the main limitation in the use and management of this soil. Most lawn grasses, shrubs, and trees are fairly easily established and maintained. Some shrubs and trees, such as camellias and dogwood, may be unsuited because of wetness. Capability subclasses VIIw, where ponded, and IVw, where drained; woodland group 3w.

Mp—Mine Pits. Mine Pits consists of strip mines in the northern part of the county where soil material has been removed to a depth of 10 to 30 feet and the underlying marl has been removed to a depth of 20 to 70 feet. Active mining is still underway.

Some areas are covered with water, and other areas are continually pumped to keep the water level low enough for mining operations. Some areas are partially filled with water and covered with native vegetation, such as typha, sedges, and other annual weeds and grasses.

Reclamation of these areas is planned so that they may be used for recreation and as wildlife habitat. A few of these areas have been reclaimed and put to practical use. Capability subclass and woodland group not assigned.

Mu—Murville fine sand. This nearly level, very poorly drained soil is in flat or slightly depressional areas. Areas are irregular in shape and range from small to very large. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation is lon-

gleaf pine, pond pine, red maple, water oak, redbay, sweetbay, American cyrilla, greenbrier, and pineland three-awn.

Typically, the surface layer is black fine sand 8 inches thick. The subsoil is black fine sand 37 inches thick. The underlying material, to a depth of 70 inches, is pale brown fine sand in the upper part, sandy clay loam and sandy loam in the middle part, and fine sand in the lower part.

Included with this soil in mapping are small areas of Lynn Haven, Leon, and Pamlico soils. Also included are small areas of soils that have a much thicker subsoil than the Murville soils.

The organic-matter content of the surface layer is low. Permeability is rapid in the surface layer and moderately rapid in the subsoil. Available water capacity is low, and shrink-swell potential is low. The seasonal high water table is at or near the surface. This soil is frequently flooded for brief periods.

A seasonal high water table and rapid and moderately rapid permeability are the main limitations in the use and management of this soil. Most lawn grasses, shrubs, and trees are fairly easily established and maintained. Some shrubs and trees, such as camellias and dogwoods, may be unsuited because of wetness. Capability subclasses Vw, where drained, and VIIw, where ponded; woodland group 2w.

Nh—Newhan fine sand. This excessively drained soil is on dunes, commonly near beaches and waterways along the coast. Slopes are 2 to 6 percent. Most of the acreage is used for year-round homes and summer beach cottages and as industrial and recreation sites. The native vegetation consists of scattered waxmyrtle, eastern baccharis, yaupon, live oak, seaoats, cordgrass, marsh elder, beach pea, and hydrocotyle.

Typically, the surface layer is grayish brown fine sand 2 inches thick. The underlying layer, to a depth of 72 inches, is light gray fine sand and sand.

Included with this soil in mapping are small areas of Tidal Marsh and all of the coastal beach (figure 1, at end of section).

The organic-matter content of the surface layer is very low. Permeability is very rapid, available water capacity is very low, and shrink-swell potential is low. Reaction is neutral to mildly alkaline throughout. The seasonal high water table is at a depth of more than 6 feet.

Very low available water capacity and very rapid permeability are the main limitations in the use and management of this soil. Many species of shrubs are suited to this soil. Establishing and maintaining shrubs require soil conditioning and supplemental irrigation. Capability subclass VIIIs; not placed in a woodland group.

No—Norfolk fine sandy loam, 0 to 4 percent slopes. This well drained soil is on broad, smooth flats on the uplands. Areas are irregular in shape and are 5 to 50 acres in size. Most of the acreage is forested or is used as residential and industrial sites. The rest is cultivated. The native vegetation is water oak, red oak, black oak, post oak, hickory, dogwood, and holly.

Typically, the surface layer is grayish brown fine sandy loam 7 inches thick. The subsurface layer is pale brown loamy fine sand 5 inches thick. The subsoil is 58 inches thick. It is yellowish brown sandy clay loam in the upper part, mottled brownish yellow sandy loam in the middle part, and mottled yellowish brown sandy clay loam in the lower part. The underlying layer, to a depth of 120 inches, is mottled light gray clay in the upper part; mottled red, light gray, and yellow sandy loam in the middle part; and very pale brown stratified sand and loamy sand in the lower part.

Included with this soil in mapping are some small areas of Kenansville, Wrightsboro, Craven, and Stallings soils. Also included are soils that are less acid throughout than this Norfolk soil.

The soil is low in natural fertility and low in organic-matter content. Permeability is moderate, available water capacity is medium, and shrink-swell potential is low. The seasonal high water table is more than 6 feet below the surface.

Slope, surface runoff, and a hazard of erosion are the main limitations in the use and management of this soil. This soil is well suited to all locally grown crops. The main crops are corn, soybeans, tobacco, and peanuts (figure 2, at end of section). Winter cover crops, minimum tillage, and crop residue management aid in controlling runoff and erosion and maintaining tilth and organic-matter content. Conservation practices, such as maintaining drainageways in sod, establishing terraces and diversions, and rotating crops, also aid in conserving soil and water. Most lawn grasses, trees, and shrubs are easy to establish and maintain. Capability subclass IIe; woodland group 2o.

On—Onslow loamy fine sand. This nearly level, moderately well drained and somewhat poorly drained soil is on broad smooth flats on the uplands. Areas are irregular in shape and small in size. Most of the acreage is used as residential and industrial sites. The rest is forested (figure 3, at end of section). The dominant native vegetation is longleaf pine, loblolly pine, oaks, holly, hickory, dogwood, blackgum, waxmyrtle, sweet pepperbush, gallberry, and huckleberry.

Typically, the surface layer is gray loamy fine sand 7 inches thick. The subsurface layer is 10 inches thick. It is mottled dark brown and yellowish brown loamy sand in the upper part and mottled light yellowish brown loamy fine sand in the lower part. The subsoil is 47 inches thick. It is mottled light yellowish brown sandy clay loam in the upper part, mottled pale brown sandy loam in the middle part, and light gray clay loam in the lower part.

Included with this soil in mapping are small areas of Norfolk, Lynchburg, and Seagate soils.

The organic-matter content of the surface layer is low. Permeability is moderate, available water capacity is medium, and shrink-swell potential is low. Reaction is very strongly acid or strongly acid throughout where this soil is not limed. The seasonal high water table is at a depth of about 2 feet.

A seasonal high water table and moderate permeability are the main limitations in the use and management of this soil. This soil is well suited to all locally grown crops. The main crops are corn, soybeans, peanuts, and tobacco. Winter cover crops, minimum tillage, and crop residue management aid in maintaining organic-matter content. This soil has good tilth and can be worked over a fairly wide range of moisture content, but tillage is delayed during wet seasons. Some crops, such as tobacco, require drainage. Most lawn grasses, shrubs, and trees are fairly easily established and maintained. Capability subclass IIw; woodland group 2w.

Pm—Pamlico muck. This level or nearly level, very poorly drained soil is in broad, flat bay areas on uplands and along flood plains. Most of the acreage is forested. The rest is used for residential and recreation sites. The native vegetation consists of pond pine, bay trees, cypress, gum, red maple, American cyrilla, greenbrier, and gallberry.

Typically, the surface layer is very dark brown muck 3 inches thick. The underlying layer, to a depth of 60 inches, is very dark brown and black muck in the upper part and very dark grayish brown and gray sand in the lower part.

Included with this soil in mapping are small areas of Dorovan, Johnston, Murville, and Torhunta soils.

The organic-matter content of the surface layer is very high. Permeability is moderate, available water capacity is very high, and shrink-swell potential is low. The seasonal high water table is at or near the surface. This soil is frequently flooded for very long periods.

Wetness is the main limitation in the use and management of this soil. If the soil is drained, and if it is excessively dry, the burning of organic material and subsidence are limitations in the use and management of this soil. Unless this soil is drained, it is unsuited to use as residential and recreational sites. If this soil is drained and tilled, the organic matter decomposes and the soil subsides. Capability subclasses VIIw, where undrained, and IVw, where drained; woodland group 4w.

Pn—Pantego loam. This nearly level, very poorly drained soil is on broad, smooth flats and in slight depressions on the uplands. Areas are irregular in shape and small to large in size. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation is loblolly pine, pond pine, sweetgum, tupelo-gum, sweetbay, water oak, ash, red maple, waxmyrtle, greenbrier, switchcane, and bracken.

Typically, the surface layer is black loam 16 inches thick. The subsoil, to a depth of 100 inches, is gray sandy clay loam in the upper part and mottled gray clay loam in the lower part.

Included with this soil in mapping are small areas of Bayboro, Rains, and Woodington soils. Also included are some small areas of soils that have a combined surface layer and subsoil less than 60 inches thick.

The organic-matter content of the surface layer is medium. Permeability is moderate, available water capacity is medium, and shrink-swell potential is low. Reaction is strongly acid or very strongly acid throughout where this soil has not been limed. The seasonal high water table is at or near the surface.

A seasonal high water table and moderate permeability are the main limitations in the use and management of this soil. Most lawn grasses and some varieties of shrubs and trees are easily established and maintained. Some shrubs and trees, such as aucuba, camellia, and dogwood, may not be suited to these soils because of wetness. Capability subclasses VIw, where undrained, and IIIw, where drained; woodland group 1w.

Ra—Rains fine sandy loam. This nearly level, poorly drained soil is on broad smooth flats and in slight depressions on the uplands. Areas are irregular in shape and small in size. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation consists of loblolly pine, American holly, sweetgum, poplar, blackgum, water oak, willow oak, waxmyrtle, sweet pepperbush, and gallberry.

Typically, the surface layer is black fine sandy loam 5 inches thick. The subsoil is 59 inches thick. It is gray fine sandy clay loam in the upper part, mottled gray clay loam in the middle part, and mottled light gray clay in the lower part. The underlying layer, to a depth of 68 inches, is mottled light gray fine sandy loam.

Included with this soil in mapping are small areas of Torhunta, Pantego, Woodington, Lynchburg, and Wrightsboro soils.

The organic-matter content of the surface layer is low. Permeability is moderate, available water capacity is medium, and shrink-swell potential is low. The reaction is very strongly acid or strongly acid throughout where this soil has not been limed. The seasonal high water table is at or near the surface. This soil is frequently flooded for brief periods.

A seasonal high water table and flooding are the main limitations in the use and management of this soil. In areas that are drained, most lawn grasses, shrubs, and trees are easy to establish and maintain. Some shrubs and trees, such as camellias and dogwood, may be unsuited to this soil because of wetness. Capability subclasses Vw, where undrained, and IIIw, where drained; woodland group 2w.

Rm—Rimini sand, 1 to 6 percent slopes. This excessively drained soil is around the rims of bays and on broad smooth flats on the uplands. Areas are irregular in shape and small in size. Most of the acreage is forested. The rest is used for residential or industrial sites. The native vegetation consists of scattered longleaf pine, turkey oak, sand post oak, scattered dwarf myrtle, and huckleberry.

Typically, the surface layer is dark gray sand 3 inches thick. The subsurface layer is light gray sand 53 inches thick. The subsoil, to a depth of 80 inches, is dark reddish brown sand in the upper part and dark brown sand in the lower part.

Included with this soil in mapping are small areas of Lakeland, Kureb, and Leon soils. Also included are small areas of soils that have slopes of more than 6 percent.

The organic-matter content of the surface layer is very low. Permeability is moderate, available water capacity is very low, and shrink-swell potential is low. Reaction is strongly acid or very strongly acid throughout where this soil has been limed. The seasonal high water table is below a depth of 6 feet.

Droughtiness and leaching of plant nutrients are the main limitations in the use and management of this soil. Irrigation, soil conditioners, and fertilizer are needed to establish lawn grasses, shrubs, and trees. Capability subclass VIs; woodland group 5s.

Se—Seagate fine sand. This nearly level, somewhat poorly drained soil is on broad, smooth flats on uplands. Areas are irregular in shape and are small to large in size. Most of the acreage is used for residential and industrial sites. The rest is wooded. The native vegetation consists of turkey oak, post oak, red oak, water oak, longleaf pine, loblolly pine, waxmyrtle, gallberry, and pineland three-awn.

Typically, the surface layer is dark gray fine sand 8 inches thick. The subsurface layer is light gray fine sand 4 inches thick. Below this to a depth of 36 inches is fine sand that is dark brown in the upper part, brown in the middle part, and light gray in the lower part. The subsoil, to a depth of 66 inches, is mottled brownish yellow sandy loam in the upper part and light gray clay loam in the lower part.

Included with this soil in mapping are small areas of Onslow and Leon soils and a few small areas of soils that are poorly drained.

The organic-matter content of the surface layer is low. Permeability is rapid to a depth of 36 inches and moderately slow below. Available water capacity is low, and the shrink-swell potential is low. Reaction is medium acid to very strongly acid throughout where this soil has not been limed. The seasonal high water table is about 1.5 to 2.5 feet below the surface.

A seasonal high water table is the main limitation in the use and management of this soil. Supplemental irrigation and soil conditioners may be needed to establish lawns, shrubs, and trees. Capability subclass IIIw; woodland group 3w.

Sh—Seagate-Urban land complex. This mapping unit is on broad, smooth flats on uplands. It consists of areas of Seagate soils and Urban land that are too small and too intermingled to be mapped separately. About 35 to 45 percent of the mapping unit is Seagate soils, and about 30 to 50 percent is Urban land. The percentage of Urban land is greater near towns.

Typically, the surface layer of a Seagate soil is dark gray fine sand 8 inches thick. The subsurface layer is light gray fine sand 4 inches thick. Below this, to a depth of 36 inches, is fine sand that is dark brown in the upper part, brown in the middle part, and light gray in the lower part. The subsoil, to a depth of 66 inches, is mottled brownish yellow sandy loam in the upper part and light gray clay loam in the lower part.

Urban land consists of areas where the original soils have been cut, filled, graded, or paved so that most soil properties have been altered to the extent that a soil series is not recognized. These areas are now used for shopping centers, factories, municipal buildings, apartment complexes, or parking lots, or for other purposes where buildings are closely spaced or soil is covered with pavement. Slope is generally modified to fit the site needs. The extent of site modification varies greatly. Many areas are relatively undisturbed, other areas have been cut down, and still other areas have been filled.

Included in mapping are small areas of Leon, Onslow, Rimini, Torhunta, Murville, Lynn Haven, Kureb, Baymeade, and Lakeland soils.

Runoff is greater on Urban land than on the Seagate soils because of the impervious cover of buildings, streets, and parking lots.

A seasonal high water table is the main limitation in the use and management of this complex. Supplemental irrigation and soil conditioners may be needed to establish lawns, shrubs, and trees. Capability subclass not assigned; Seagate part in woodland group 3w, Urban land part not placed in a woodland group.

St—Stallings fine sand. This nearly level to gently sloping, somewhat poorly drained soil is on broad smooth flats and on low ridges on the uplands. Areas are small in size and irregular in shape. Most of the acreage is forested or is used for residential and industrial sites. The native vegetation consists of longleaf pine, water oak, willow oak, sweetgum, blackgum, red maple, waxmyrtle, and gallberry.

Typically, the surface layer is dark gray fine sand 8 inches thick. The subsurface layer is light yellowish brown fine sand 6 inches thick. The subsoil, to a depth of 68 inches, is mottled light yellowish brown fine sandy loam in the upper part. The middle part is mottled light gray and light brownish gray fine sandy loam, and the lower part is mottled pale yellow loamy fine sand and fine sandy loam.

Included with this soil in mapping are small areas of Leon, Lynn Haven, Seagate, and Rimini soils.

The organic-matter content of the surface layer is low. Permeability is moderately rapid, available water capacity is medium, and shrink-swell potential is low. Reaction is strongly acid or very strongly acid throughout where this soil is not limed. The seasonal high water table is 1.5 to 2.5 feet below the surface.

A seasonal high water table is the main limitation in the use and management of this soil. Most lawn grasses, shrubs, and trees are fairly easily established and maintained if supplementary irrigation is occasionally used during long dry spells. Capability subclass IIw; woodland group 2w.

TM—Tidal Marsh. This land type is on the nearly level flats between the coastal dunes and the interior uplands and along the Cape Fear River near Wilmington. Many

areas are flooded daily by tides. Further inland the seawater is diluted with freshwater. Some areas are protected from the seawater by long expanses of sand dunes that do not have inlets from the ocean. The water table is at or above the surface most of the time. Most of the acreage is used as natural habitat for shore and water birds, and some areas are used for shellfish gardens. Many areas are being dredged, filled, and converted to summer cottage sites and recreational areas. The dominant vegetation in areas that are flooded daily by saltwater is smooth cordgrass. Further inland, in areas that are flooded by seawater that has been diluted by freshwater, the vegetation is a mixture of smooth cordgrass and black rush.

Typically, the surface layer is black clay loam about 18 inches thick. The underlying layer is very dark gray and black silty clay loam to a depth of more than 60 inches.

Included with these soils in mapping are areas along the Intracoastal Waterway that are sandy because of the deep dredging.

The organic-matter content of the surface layer is high. Reaction is neutral to mildly alkaline. In the areas flooded by saltwater, sulfur content is 80 to 130 parts per million and salt content is 1 or 2 percent. Capability subclass VIIIw; woodland group not assigned.

To—Torhunta loamy fine sand. This nearly level, very poorly drained soil is on broad smooth flats and in slight depressions on the uplands. Areas are small to large in size and irregular in shape. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation consists of loblolly pine, pond pine, bay trees, red maple, water oak, gum, waxmyrtle, and gallberry.

Typically, the surface layer is 20 inches thick. It is black loamy fine sand in the upper part and very dark gray loamy fine sand in the lower part. The subsoil is mottled light gray fine sandy loam 26 inches thick. The underlying layer, to a depth of 64 inches, is mottled light gray fine sand.

Included with this soil in mapping are small areas of Stallings, Murville, and Pantego soils.

The organic-matter content of the surface layer is medium. Permeability is moderately rapid, available water capacity is medium, and shrink-swell potential is low. Reaction is extremely acid to strongly acid throughout where this soil has not been limed. The seasonal high water table is at or near the surface. This soil is frequently flooded for long periods.

A seasonal high water table and flooding are the main limitations in the use and management of this soil. Most lawn grasses, shrubs, and trees are generally easily established and maintained. Some shrubs and trees may be unsuited to this soil because of wetness. Capability subclasses Vw, where undrained, and IIIw, where drained; woodland group 2w.

Ur—Urban land. Urban land consists of areas where the original soil has been cut, filled, graded, or paved so that most soil properties have been altered to the extent that a soil series is not recognized. These areas are now used for shopping centers, factories, municipal buildings, apartment complexes, or parking lots, or for other purposes where buildings are closely spaced or soil is covered with pavement.

Included in mapping are a few small areas between buildings where the soil has not been altered. Also included are parks and other areas within the city of Wilmington. Some of the areas between buildings are used for small lawns, gardens, and shrubbery. Capability subclass and woodland group not assigned.

Wa—Wakulla sand, 1 to 8 percent slopes. This somewhat excessively drained soil is on broad smooth flats on the uplands. Areas are small to large in size and irregular in shape. Most of the acreage is forested. The rest is used for residential and industrial sites. The native vegetation on the higher elevations consists of longleaf pine, loblolly pine, post oak, bluejack oak, turkey oak, dwarf huckleberry, and myrtle. On the lower elevations, the vegetation increases in density and includes hickory, holly, water oak, blackjack oak, and a few dogwood trees.

Typically, the surface layer is grayish brown sand 2 inches thick. The subsurface layer is light yellowish brown sand 28 inches thick. The subsoil is strong brown loamy sand 18 inches thick. The underlying layer, to a depth of 64 inches, is strong brown sand.

Included with this soil in mapping are a few small areas of Kureb, Baymeade, Kenansville, Lakeland, and Rimini soils.

The organic-matter content of the surface layer is very low. Permeability is rapid, available water capacity is very low, and shrink-swell potential is low. Reaction is strongly acid or medium acid throughout where this soil has not been limed. The seasonal high water table is below a depth of 6 feet.

Droughtiness, slope, and rapid permeability are the main limitations in the use and management of this soil. Supplemental irrigation and fertilizers are generally needed to establish and maintain lawn grasses, shrubs, and trees. Capability subclass IIIs; woodland group 3s.

Wo—Woodington fine sandy loam. This nearly level, poorly drained soil is on broad smooth flats on the uplands. Areas are small in size and irregular in shape. Most of the acreage is forested or is used for residential and industrial sites. The native vegetation consists of loblolly pine, longleaf pine, pond pine, sweetgum, water oak, willow oak, poplar, waxmyrtle, eastern baccharis, American holly, gallberry, and sweet pepperbush.

Typically, the surface layer is very dark gray fine sandy loam 7 inches thick. The subsoil, to a depth of 65 inches, is mottled light brownish gray fine sandy loam in the upper part. The middle part is mottled gray fine sandy loam, and the lower part is mottled very pale brown fine sandy loam.

Included with this soil in mapping are small areas of Wrightsboro, Lynchburg, Seagate, and Stallings soils.

The organic-matter content of the surface layer is low. Permeability is moderately rapid, available water capacity

is medium, and shrink-swell potential is low. The reaction is strongly acid or very strongly acid where this soil has not been limed. The seasonal high water table is at or near the surface.

A seasonal high water table and moderately rapid permeability are the main limitations in the use and management of this soil. Most lawn grasses, shrubs, and trees are easily established and maintained. Some trees, such as dogwood, may not be suited to this soil because of wetness. Capability subclasses VIw, where undrained, and IIIw, where drained; woodland group 2w.

Wr—Wrightsboro fine sandy loam, 0 to 2 percent slopes. This moderately well drained soil is on broad, smooth flats on the uplands. Areas are small to large in size and are irregular in shape. About half of the acreage is cultivated or is used for pasture. The rest is used as residential and industrial sites or is forested (figure 4, at end of section). The native vegetation is loblolly pine, longleaf pine, water oak, willow oak, sweetgum, waxmyrtle, gallberry, sweet pepperbush, dogwood, and holly.

Typically, the surface layer is grayish brown fine sandy loam 6 inches thick. The subsurface layer is very pale brown fine sandy loam 3 inches thick. The subsoil, to a depth of 65 inches, is mottled brownish yellow sandy clay loam in the upper part and mottled light gray clay in the lower part.

Included with this soil in mapping are small areas of Norfolk and Lynchburg soils and a few small areas of soils that have a higher clay content than this Wrightsboro soil.

The organic-matter content of the surface layer is low. Permeability is moderate, available water capacity is medium, and shrink-swell potential is low. Reaction is very strongly acid to medium acid throughout where this soil is not limed. The seasonal high water table is about 2 to 3 feet below the surface.

A seasonal high water table and moderate permeability are the main limitations in the use and management of this soil. This soil is well suited to most locally grown crops. The main crops are corn, soybeans, peanuts, tobacco, and truck crops, such as squash, lettuce, cucumbers, cabbage, greens, snap beans, and corn. Winter cover crops, minimum tillage, and crop residue management aid in maintaining tilth and organic-matter content. This soil has good tilth and can be worked throughout a fairly wide range of moisture content, but tillage is delayed during wet seasons. Some crops, such as tobacco, require drainage. Most lawn grasses, shrubs, and trees are generally easily established and maintained. Capability subclass IIw; woodland group 2w.

Planning the Use and Management of the Soils

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area—the soil. It may be used to fit the use of the land, including urbanization, to the limitations and potentials of the natural resources and the environment and to help avoid soil-related failures in uses of the land.

During a soil survey soil scientists, conservationists, engineers, and others keep extensive notes, not only about the nature of the soils but also about unique aspects of behavior of these soils in the field and at construction sites. These notes include observations of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating the kinds of soil and their productivity, potentials, and limitations under various uses and management. In this way field experience incorporated with measured data on soil properties and performance is used as a basis for predicting soil behavior.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for crops and pasture, range, woodland, and many nonfarm uses, including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses may be determined, soil limitations to these land uses may be identified, and costly failures in homes and other structures, because of unfavorable soil properties, may be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area, and on the environment. Both of these factors are closely related to the nature of the soil. Plans can be made to maintain or create a land use pattern in harmony with the natural soil.

Contractors can find information useful in locating sources of sand and gravel, road fill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, trees and shrubs, and most other uses of land are influenced by the nature of the soil.

Crops

The major management concerns when using the soils for crops are described in this section. In addition, the crops best adapted to the soil are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the predicted yields of the main crops are presented for each soil.

This section provides information about the overall agricultural potential and needed practices in the survey area for those in the agribusiness sector—equipment

Figure 3.—Longleaf pine trees on Onslow loamy fine sand.

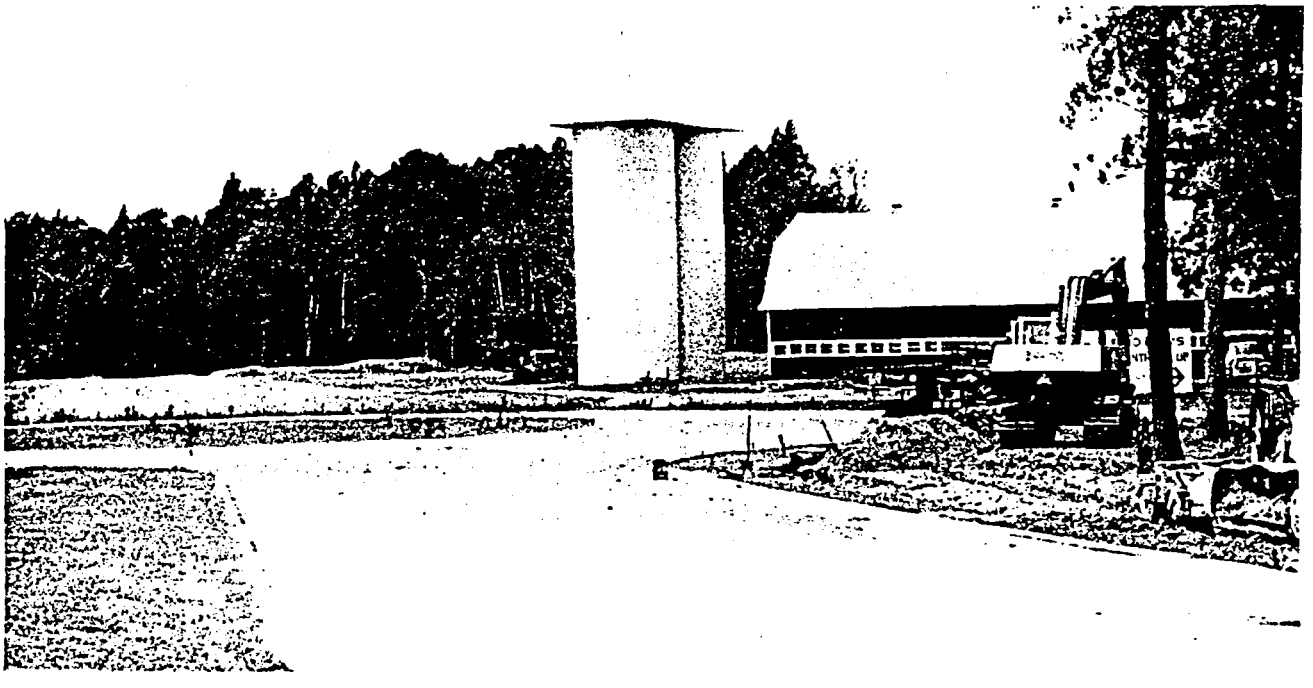


Figure 4.—Foreground shows streets being cut for a residential development in an area that had been used for farming.

Figure 1.—Fishing pier at Carolina Beach.

Figure 2.—Corn and soybeans on Norfolk fine sandy loam, 0 to 4 percent slopes.

dealers, drainage contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil Maps for Detailed Planning." Plans for management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

Yields Per Acre

The per acre average yields that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in table 5 because of seasonal variations in rainfall and other climatic factors. Absence of a yield estimate indicates that the crop is not suited to or not commonly grown on the soil or that irrigation of a given crop is not commonly practiced on the soil.

The predicted yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The latest soil and crop management practices used by many farmers in the county are assumed in predicting the yields. A few farmers may be using more advanced practices and obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends upon the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; for effective use of crop residue, barnyard manure, and green-manure crops; for harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The predicted yields reflect the relative productive capacity of the soils for each of the principal crops. Yields are likely to increase in the future as new production technology is developed. The relative productivity of a given soil compared to other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but because their acreage is small, predicted yields for these crops are not included. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the productivity and management concerns of the soils for these crops.

Capability Classes and Subclasses

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. This classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineerng purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. Only the capability class and subclass are used in this survey. These levels are defined in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial plants.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty or stony; and *c*, used in only some parts of the United States, but not in New Hanover County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c*, because the soils in class V are subject to little or no erosion, though they

have other limitations that restrict their use to pasture, range, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each soil mapping unit in the section "Soil Maps for Detailed Planning."

Woodland Management and Productivity

Table 6 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Mapping unit symbols for those soils suitable for wood crops are listed alphabetically by soil name, and the woodland group for each soil is given. All soils in the same group require the same general kinds of woodland management and have about the same potential productivity.

The first part of the woodland group symbol, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates no significant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the order in which the letters are listed above—x, w, t, d, c, s, f, and r.

In table 6 the soils are also rated for a number of factors to be considered in management. The ratings of slight, moderate, and severe are used to indicate the degree of major soil limitations.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well-managed woodland. The risk is *slight* if the expected soil loss is small; *moderate* if some measures are needed to control erosion during logging and road construction; and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings when plant competition is not a limiting factor. The ratings are for seedlings from good planting stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competiion is expected to hinder the development of a fully stocked stand of desirable trees; and *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable trees on a soil is expressed as a site index. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners, community decision makers and planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in tables in this section are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by the soil survey and used in determining the ratings in this section are grain-size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within 5 or 6 feet of the surface, soil wetness characteristics, depth to a seasonal water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

Based on the information assembled about soil properties, ranges of values may be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values may be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to—(1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations and testing.

The information is presented mainly in tables. Table 7 shows, for each kind of soil, ratings of the degree and kind of limitations for building site development; table 8, for sanitary facilities; and table 10, for water management. Table 9 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have different meanings in soil science and in engineering; the Glossary defines many of these terms.

Building Site Development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 7. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by the soil wetness of a high seasonal water table, the texture and consistence of soils, the tendency of soils to cave in or slough, and the presence of very firm, dense soil layers. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 7 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation do not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Slope is also an important consideration in the choice of sites for these structures and was considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 7 have an all-weather surface that can carry light to medium traffic all year. They consist of subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The AASHTO and Unified classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, and depth to very compact layers, all of which affect stability and ease of excavation, were also considered.

Sanitary Facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that deal with the ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 8 shows the degree and kind of limitations of each soil for these uses and for use of the soil as daily cover for landfills.

If the degree of soil limitation is indicated by the rating *slight*, soils are favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance are required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, and susceptibility to flooding. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel at a depth of less than 4 feet below the tilelines. In these soils the absoption field does not adequately filter the effluent, and as a result ground water supplies in the area may be contaminated. Soils having a hazard of inadequate filtration are indicated by footnotes in table 8.

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity.

In many of the soils that have moderate or severe limitations for septic tank absorption fields, it may be possible to install special systems that lower the seasonal water table or to increase the size of the absorption field so that satisfactory performance is achieved.

Sewage lagoons are shallow ponds constructed to hold sewage while bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. They generally are designed so that depth of the sewage is 2 to 5 feet. Impervious soil at least 4 feet thick for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in organic matter are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste, either in excavated trenches or on the surface of the soil. The waste is spread, compacted in layers, and covered with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this purpose. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bedrock and a seasonal water table, are free of large stones and boulders, and are not subject to flooding. In areas where the seasonal water table is high, water seeps into the trenches and causes problems in excavating and filling the trenches. Also, seepage into the refuse increases the risk of pollution of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 8 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill during both wet and dry weather. Soils that are loamy or silty are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for final cover of landfills should be suitable for growing plants. In comparison with other horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Construction Materials

The suitability of each soil as a source of road fill, sand, gravel, and topsoil is indicated in table 9 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed and described as the survey is made, generally about 6 feet.

Road fill is soil material used in embankments for roads. The ratings reflect the ease of excavating and working the material and the expected performance of the material after it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within the profile. The estimated engineering properties in table 13 provide more specific information about the nature of each horizon that can help determine its suitability for road fill.

According to the Unified soil classification system, soils rated *good* have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as high shrink-swell potential, high potential frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*, regardless of the quality of the suitable material.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 9 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 13.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are low in content of gravel and other coarse fragments and have gentle slopes. They are low in soluble salts, which can limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel or soluble salt.

Soils rated *poor* are very sandy soils, very firm clayey soils, soils with suitable layers less than 8 inches thick, soils having large amounts of gravel or soluble salt, steep soils, and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is much preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water Management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 10 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Soil and site limitations are expressed as slight, moderate, and severe. *Slight* means that the soil properties and site features are generally favorable for the specified use and that any limitation is minor and easily overcome. *Moderate* means that some soil properties or site features are unfavorable for the rated use but can be overcome or modified by special planning and design. *Severe* means that the soil properties and site features are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance are required.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have low seepage

potential, which is determined by the permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and is of favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Aquifer-fed excavated ponds are bodies of water created by excavating a pit or dugout into a ground-water aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 10 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability, texture, structure, depth to claypan or other layers that influence rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and allow the water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity of slope and steepness, depth to bedrock or other unfavorable material, permeability, ease of establishing vegetation, and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff at nonerosive velocities to outlets. Features that affect the use of soils for waterways are slope, permeability, erodibility, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 11 according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreational use by the duration of flooding and the season when it occurs. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreational facilities.

In table 11 the limitations of soils are rated as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 11 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 8, and interpretations for dwellings without basements and for local roads and streets, given in table 7.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stablizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface absorbs rainfall readily but remains firm and is not dusty when dry. Strong slopes can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and not wet nor subject to flooding during the season of use. The surface is firm after rains and is not dusty when dry.

The design and layout of *paths and trails* for walking, horseback riding, and bicycling should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the period of use. They should have moderate slopes.

Wildlife Habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populates an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife will either be scarce or will not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

In table 12 the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in—

1. Planning the use of parks, wildlife refuges, nature study areas, and other developments for wildlife.
2. Selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat.
3. Determining the intensity of management needed for each element of the habitat.
4. Determining areas that are suitable for acquisition to manage for wildlife.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, sorghum, wheat, oats, millet, soybeans, and sunflowers. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, lovegrass, ryegrass, panicgrass, clover, trefoil, and annual lespedeza. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are tickclover, ragweed, wild strawberry, and pokeweed. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, and flood hazard. Soil temperature and soil moisture are also considerations.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Examples of native plants are oak, poplar, sweetgum, dogwood, persimmon, sassafras, sumac, hickory, blackberry, grape, viburnum, and greenbriers. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated good are autumn-olive and crabapple. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are cone-bearing trees, shrubs, or ground cover that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Examples are pine, yew, cedar, and juniper. Major soil properties that affect the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, wild millet, rushes, sedges, reeds, saltgrass, cordgrass, and cattail. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, and slope.

Shallow water areas are bodies of surface water that have an average depth of less than 5 feet and are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, and other wildlife ponds. Major soil properties affecting shallow water areas are wetness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Open-land habitat consists of croplands, pastures, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, meadowlark, field sparrow, cottontail rabbit, red fox, and woodchuck.

Woodland habitat consists of hardwoods or conifers or a mixture of both, with associated grasses, legumes, and wild herbaceous plants. Examples of wildlife attracted to this habitat are marsh rabbit, woodpeckers, tree squirrels, raccoon, and deer.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are ducks, geese, herons, shore birds, rails, muskrat, and mink.

Soil Properties

Extensive data about soil properties collected during the soil survey are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of samples selected from representative soil profiles in the field.

When he makes soil borings during field mapping, the soil scientist can identify several important soil properties. He notes the seasonal soil moisture condition, or the presence of free water and its depth in the profile. For each horizon, he notes the thickness of the soil and its color; the texture, or the amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or natural pattern of cracks and pores in the undisturbed soil; and the consistence of soil in-place under the existing soil moisture conditions. He records the root depth of existing plants; determines soil pH, or reaction; and identifies any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to characterize key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many of the soil series are available from nearby areas.

Based on summaries of available field and laboratory data, and listed in tables in this section, are estimated ranges in engineering properties and classifications and in physical and chemical properties for each major horizon of each soil in the survey area. Also, pertinent soil and water features, engineering test data, and data obtained from laboratory analyses, both physical and chemical, are presented.

Engineering Properties

Table 13 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. Depth to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and in properties of each horizon is given for each soil series in "Soil Series Descriptions and Morphology."

Texture is described in table 13 in standard terms used by the United States Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms used by USDA are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified soil classification system (Unified) (*2*) and the American Association of State Highway and Transportation Officials soil classification system (AASHTO) (*1*). In table 13 soils in the survey area are classified according to both systems.

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified as one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. The AASHTO classification for soils tested in the survey area is given in table 16. The estimated classification, without group index numbers, is given in table 13.

Also in table 13 the percentage, by weight, of cobbles, the rock *fragments more than 3 inches* in diameter, are estimated for each major horizon. These estimates are determined largely by observing volume percentage in the field and then converting it, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four standard sieves is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistency of soil. These indexes are used in both the Unified and the AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior.

Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

Physical and Chemical Properties

Table 14 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the representative profile of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships between the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for water movement in a vertical direction when the soil is saturated. Not considered in the estimates are lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and design of drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops and ornamental or other plants to be grown, in evaluating soil amendments for fertility and stabilization, and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others it was estimated on the basis of the kind of clay and on measurements of similar soils. Size of imposed loadings and the magnitude of changes in soil moisture content are also important factors that influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A *high* shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion, as used in table 14, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rating of soils for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely within one kind of soil or within one soil horizon.

Soil and Water Features

Features that relate to runoff or infiltration of water, to flooding, to grading and excavation, and to subsidence and frost action of each soil are indicated in table 15. This information is helpful in planning land uses and engineering projects that are likely to be affected by the amount of runoff from watersheds, by flooding and a seasonal high water table.

Flooding is rated in general terms that describe the frequency and duration of flooding and the period of the year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about floodwater heights and the extent of flooding; and local knowledge that relates the unique landscape position of each soil to historic floods.

The generalized description of flood hazards is of value in land use planning and provides a valid basis for land use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick in soils for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed during the course of the soil survey. Indicated are the depth to the seasonal high water table; the kind of water table, whether perched, artesian, or the upper part of the ground water table; and the months of the year that the high water commonly is present. Only those saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Engineering Test Data

Samples of 5 soils were tested by the North Carolina State Highway Commission so that the soils could be evaluated for engineering purposes. For the soil series not tested, classification was estimated from descriptions of soil profiles written by the soil scientists. The test data are given in table 16. The test data indicate the characteristics of the soil at the specified location. The physical characteristics of similar soils at other locations may vary from those of the soil sampled. All samples were obtained at a depth of less than 7 feet.

The engineering classifications in table 16 are based on data obtained by mechanical analyses and by tests made to determine liquid limits and plastic limits. Mechanical analyses were made by combined sieve and hydrometer methods.

Moisture-density data are obtained by compacting soil material at a successively higher moisture content. Assuming that the compactive effort remains constant, the density of the compacted material increases until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The highest density obtained in the compaction test is termed "maximum dry density." Optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The tests to determine plastic limit and liquid limit measure the effect of water on the consistency of the soil material. As the moisture content of a clayey soil increases from a dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. The plasticity index indicates the range of moisture content within which soil material is in a plastic condition.

Classification of the Soils

This section describes the soil series of the survey area, defines the current system of classifying soils, and classifies the soils of the area according to that system.

Soil Series

On the following pages each soil series in the survey area is described in detail. The series descriptions are presented in alphabetic order by series name.

For each series, some facts about the soil are presented first. Then a pedon, a small three dimensional area of soil typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*4*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series mapped in this survey area. Phases, or mapping units, of each soil series are described in the section "Soil Maps for Detailed Planning."

Bayboro series

The Bayboro series consists of very poorly drained, slowly permeable, nearly level soils that formed in marine and fluvial sediments. These soils are on flats and in slight depressions. Slopes are 0 to 2 percent.

Typical pedon of Bayboro loam 6.5 miles north of Wilmington on U.S. Highway 117, 0.5 mile east of U.S. Highway 117, on North Carolina Horticultural Crops Research Farm:

A1—0 to 16 inches, black (10YR 2/1) loam; moderate medium and coarse granular structure; friable; strongly acid; clear wavy boundary.

B1g—16 to 19 inches, very dark gray (10YR 3/1) sandy clay loam; few fine distinct brownish yellow mottles; weak medium subangular blocky structure; friable; few faint clay films on peds; very strongly acid; gradual wavy boundary.

B2tg—19 to 56 inches, gray (10YR 5/1) clay loam; many fine and medium distinct strong brown (7.5YR 5/8) mottles; moderate medium prismatic structure that parts to moderate medium angular blocky structure; firm, very sticky, very plastic; common amounts of A1 material in root channels and between primary structural aggregates; faces of primary structural aggregates are dark gray (10YR 4/1); prominent clay films on faces of peds; common fine roots mainly between faces of primary structural aggregates; very strongly acid; gradual wavy boundary.

B3g—56 to 72 inches, gray (10YR 6/1) clay loam; common medium distinct strong brown (7.5YR 5/8) mottles; massive; friable; few fine roots; very strongly acid.

The Ap or A1 horizon is black or very dark gray loam or fine sandy loam. The B1 horizon is very dark gray or dark gray sandy clay loam or clay loam. The B2 horizon is gray or dark gray clay loam, clay, or sandy clay. The B3 horizon is gray or light gray clay loam or sandy clay loam. The C horizon, if present, is dominantly gray and ranges from sand to clay.

Baymeade series

The Baymeade series consists of well drained, moderately rapidly permeable, nearly level and gently sloping soils that formed on flats and low ridges. Slopes are 1 to 6 percent.

Typical pedon of Baymeade fine sand, 1 to 6 percent slopes, in Wilmington, 0.5 mile south of Dawson and Sixteenth Street intersection, on west side of Sixteenth Street road cut:

A1—0 to 3 inches, dark gray (10YR 4/1) fine sand; weak granular structure; loose; many fine and medium roots; many uncoated sand grains; medium acid; abrupt smooth boundary.

A2—3 to 12 inches, light gray (10YR 7/2) fine sand; single grained; loose; many fine and medium roots; slightly acid; gradual wavy boundary.

A2&Bh—12 to 36 inches, very pale brown (10YR 7/4) fine sand; single grained; loose common irregular bodies of friable organic coated sand that are dark brown (7.5YR 3/2) and brown (7.5YR 4/4) make up about 12 percent of this horizon; many fine and medium roots; medium acid; abrupt smooth boundary.

B2t—36 to 49 inches, strong brown (7.5YR 5/6) fine sandy loam; weak coarse subangular blocky structure; very friable; many fine and medium roots; medium acid; gradual wavy boundary.

B3—49 to 58 inches, strong brown (7.5YR 5/6) loamy fine sand; weak fine granular structure; very friable; few fine roots; medium acid; gradual wavy boundary.

C1—58 to 75 inches, mottled white (10YR 8/1) and very pale brown (10YR 7/4) fine sand; single grained; loose; medium acid; gradual wavy boundary.

C2—75 to 78 inches, very pale brown (10YR 8/3) fine sand and loamy fine sand; single grained; loose; medium acid.

The A1 horizon is dark gray or gray and has some clean white sand grains. The A2 horizon is light gray or white. The Bh part of the A2&Bh horizon is very pale brown, brown, dark brown, very dark brown, or black and has organic coatings. The B2t horizon is strong brown, brown, reddish yellow, or light olive brown fine sandy loam or sandy clay loam. In some pedons this horizon occurs as lamellae of fine sand and fine sandy loam with a composite thickness of more than 6 inches. The B3 horizon is strong brown, reddish yellow, brownish yellow, or olive yellow. The C horizon is white, very pale brown, yellow, light gray, or brownish yellow fine sand or loamy fine sand. Some pedons have thin discontinuous Bh bodies in the C horizon.

Craven series

The Craven series consists of moderately well drained, slowly and very slowly permeable, nearly level and gently sloping soils that formed on flats and side slopes on uplands. Slopes are 1 to 4 percent.

Typical pedon of Craven fine sandy loam, 1 to 4 percent slopes, 0.6 mile northwest from Masonboro on State Road 1515, and about 600 feet north of State Road 1515 on farm road, 100 feet east of farm road:

Ap—0 to 8 inches, dark gray (10YR 4/1) fine sandy loam; weak medium granular structure; very friable; common medium and large roots; strongly acid; abrupt smooth boundary.

B21t—8 to 20 inches, yellowish brown (10YR 5/6) clay loam; few medium distinct reddish yellow (7.5YR 6/8) mottles; moderate coarse angular blocky structure; very firm, very sticky, very plastic; continuous silt and clay coating on faces of peds; common medium and large roots; strongly acid; gradual wavy boundary.

B22t—20 to 28 inches, yellowish brown (10YR 5/6) clay loam; many medium distinct yellowish red (5YR 5/8) and strong brown (7.5YR 5/8) mottles, and common medium faint light brownish gray (10YR 6/2) mottles; moderate coarse angular blocky structure; very firm, very sticky, very plastic; continuous clay films on faces of peds; few medium and large roots; very strongly acid; gradual wavy boundary.

B23tg—28 to 44 inches, light brownish gray (10YR 6/2) clay loam; common medium prominent red (2.5YR 5/8) and common medium distinct strong brown (7.5YR 5/8) mottles; moderate fine and medium angular blocky structure; very firm, very sticky, very plastic; prominent clay films on faces of peds; very strongly acid; abrupt smooth boundary.

IIB24tg—44 to 56 inches, light gray (10YR 7/1) clay; common medium prominent red (2.5YR 4/8) and common medium distinct strong brown (7.5YR 5/8) mottles; massive and weak medium angular blocky structure; very firm, very sticky, very plastic; few fine roots; very strongly acid; gradual wavy boundary.

IICg—56 to 64 inches, light gray (10YR 7/1) sandy clay loam with pockets of sandy loam; few medium distinct yellowish red (5YR 5/8) and strong brown (7.5YR 5/8) mottles; massive; friable; very strongly acid.

The A1 or Ap horizon is gray, dark gray, or dark grayish brown fine sandy loam or loam. If present, the A2 horizon is pale brown or very pale brown loamy fine sand or fine sandy loam. The B21t and B22t horizons are brownish yellow, yellowish brown, or light yellowish brown clay loam, clay, and silty clay. The B23tg horizon is brownish yellow, strong brown, yellowish red, light brownish gray, or light gray clay loam and clay. The B24tg horizon is light gray or very pale brown clay, clay loam, or sandy clay loam. The C horizon is light gray or gray sandy clay loam, sandy loam, or sand.

Craven soils in New Hanover County have slightly less clay in the upper part of the B2t horizon than is defined as within the range for the series. This difference, however, does not significantly alter their usefulness or behavior.

Dorovan series

The Dorovan series consists of very poorly drained, very slowly permeable, nearly level soils that formed on tidal and stream flood plains and in bays. Slopes are less than 1 percent.

Typical pedon of Dorovan muck in an area of Dorovan soils west of Wilmington from north bridge along U.S. Highway 421 north to railroad crossing, about 100 feet west of U.S. Highway 421 and 50 feet north of railroad:

Oe—0 to 4 inches, black (10YR 2/1) hemic material (muck); massive; about 50 percent fiber after rubbing; very strongly acid; clear smooth boundary.

Oa1—4 to 36 inches, black (10YR 2/1) sapric material; about 25 percent fiber, about 10 percent after rubbing; massive; nonsticky; few to common roots, partially decomposed limbs and logs; very strongly acid; diffuse smooth boundary.

Oa2—36 to 55 inches, very dark gray (10 YR 3/1) saphic material; about 25 percent fiber, about 10 percent after rubbing; massive; few roots; partially decomposed limbs and twigs and occasional logs; very strongly acid; diffuse smooth boundary.

Oe—55 to 64 inches, black (10YR 2/1) hemic material; about 50 percent fiber, about 20 percent after rubbing; massive; decomposed limbs and twigs and occasional logs; very strongly acid.

The Oe horizon is black or very dark grayish brown. Fiber content is 50 to 90 percent unrubbed and 20 to 50 percent rubbed. The Oa horizon is black or very dark gray. Fiber content is 15 to 35 percent unrubbed and 5 to 20 percent rubbed. Many logs, limbs, and other woody fragments are in the middle and lower parts of the organic layer.

Johnston series

The Johnston series consists of very poorly drained, moderately rapidly permeable soils that formed on the flood plains of the major streams. Slopes are less than 2 percent.

Typical pedon of Johnston loam, in an area of Johnston soils about 4 miles south of Wilmington, 300 yards west of U.S. Highway 421, 0.2 mile southwest of entrance to dairy farm, in wooded area along stream:

A11—0 to 20 inches, black (10YR 2/1) loam; weak medium granular structure; very friable; many medium and fine roots; strongly acid; gradual wavy boundary.

A12—20 to 36 inches, black (10YR 2/1) loam; weak medium granular structure; friable; few medium and large roots; strongly acid; gradual wavy boundary.

A13—36 to 42 inches, black (10YR 2/1) sandy loam; weak medium granular structure; very friable; strongly acid; gradual wavy boundary.

C1—42 to 64 inches, light gray (10YR 7/1) sand; single grained; loose, compact in places; strongly acid.

The A horizon is black or very dark gray loam, sandy loam, or fine sandy loam. The AC horizon, if present, is dark gray or dark grayish brown loamy fine sand or loamy sand. The C horizon is light gray, light brownish gray, or dark gray sand, fine sandy loam, sandy loam, or loamy sand.

Kenansville series

The Kenansville series consists of well drained, moderately rapidly permeable, nearly level soils that formed on flats in the uplands. Slopes are less than 3 percent.

Typical pedon of Kenansville fine sand, 0 to 3 percent slopes, 0.7 mile northeast of Ogden along U.S. Highway 17 to Bayshore Estate Road (State Road 1363), then 0.8 mile southeast along State Road 1363 to State Road 1364, then 0.5 mile northeast on State Road 1364 to cultivated field on the north side of road, then 100 yards northeast on east side of farm road in woods.

O1—2 to 0 inches, partially decomposed pine needles.

A1—0 to 3 inches, grayish brown (10YR 5/2) fine sand; weak granular structure; loose; many fine and medium roots; medium acid; gradual smooth boundary.

A21—3 to 16 inches, pale brown (10YR 6/3) fine sand; single grained; loose; few fine and medium roots; medium acid; gradual wavy boundary.

A22—16 to 33 inches, very pale brown (10YR 8/4) fine sand; few fine faint brownish yellow mottles; single grained; loose; few fine and medium roots; medium acid; abrupt smooth boundary.

B21t—33 to 38 inches, strong brown (7.5YR 5/6) fine sandy loam; weak medium subangular blocky structure; friable; few fine and medium roots; strongly acid; clear smooth boundary.

B22t—38 to 44 inches, strong brown (7.5YR 5/8) fine sandy loam; weak medium subangular blocky structure; friable; common coarse sand grains; strongly acid; clear smooth boundary.

B23t—44 to 50 inches, reddish yellow (7.5YR 6/8) fine sandy loam; weak coarse subangular blocky structure; friable; strongly acid; clear smooth boundary.

C—50 to 80 inches, yellow (10YR 7/8) loamy fine sand; single grained; loose; grades to very pale brown with depth; strongly acid.

The Ap or A1 horizon commonly is grayish brown, gray, or dark grayish brown sand or fine sand, but in places it is loamy sand or loamy fine sand. The A2 horizon is pale brown, very pale brown, and light yellowish brown fine sand, sand, or loamy sand. The Bt horizon is strong brown, yellowish brown, light yellowish brown, brownish yellow, or reddish yellow. The Bt horizon commonly is fine sandy loam or sandy loam, but in places it has thin layers of sandy clay loam. The C horizon commonly is yellow, pale yellow, light yellowish brown, or brownish yellow sand, loamy sand, fine sand, or loamy fine sand.

Kureb series

The Kureb series consists of excessively drained, rapidly permeable, nearly level to sloping soils that formed on ridges. Slopes are 1 to 8 percent.

Typical pedon of Kureb sand, 1 to 8 percent slopes, 1.75 miles south of junction of U.S. Highway 421 and North Carolina Highway 132 to Battle Park development, east about 1/4 mile, then south 200 feet on east side of road:

A1—0 to 3 inches, dark gray (10YR 4/1) sand; single grained; loose; organic matter and quartz grains have salt and pepper appearance; many fine and large roots; neutral; clear wavy boundary.

A2—3 to 26 inches, light gray (10YR 7/1) sand; single grained; loose; few large roots; neutral; clear irregular boundary.

C&Bh—26 to 51 inches, brownish yellow (10YR 6/6) sand; single grained; loose; few tongues of light gray extend from above horizon; dark brown (7.5YR 4/4) bands and few lumps of dark reddish brown (5YR 3/2) are intermittent at horizon contact and run vertically along walls of tongues; many clean grains and coated sand grains are observable; neutral; gradual wavy boundary.

C—51 to 89 inches, pale brown (10YR 6/3) sand; single grained; loose; slightly acid.

Texture of the profile is sand or coarse sand, and content of clay plus silt is less than 5 percent. The A1 horizon is dark gray or gray and has many clean grains of white or light gray quartz. The A2 horizon is light gray or white. Tongues of the A2 horizon fill old root channels extending into the C&Bh horizon. The C&Bh horizon is brownish yellow, yellowish brown, light yellowish brown, or pale brown. It has vertical streaks and bands of brownish yellow, dark brown, and dark reddish brown scattered throughout. The C horizon is light yellowish brown, very pale brown, pale brown, or light gray.

Lakeland series

The Lakeland series consists of excessively drained, very rapidly permeable, nearly level to sloping soils that formed on ridges. Slopes are 1 to 8 percent.

Typical pedon of Lakeland sand, 1 to 8 percent slopes, 0.6 mile northeast of the junction of U.S. Highway 421 and State Road 1148 along State Road 1148, 600 feet east on dirt road and on north bank of road:

A1—0 to 2 inches, grayish brown (10YR 5/2) sand; weak fine granular structure; very friable; few fine roots; medium acid; clear smooth boundary.

C1—2 to 48 inches, yellowish brown (10YR 5/8) sand; single grained; loose; common coated dark minerals; medium acid; gradual wavy boundary.

C2—48 to 80 inches, brownish yellow (10YR 6/8) sand; single grained; loose; common dark minerals and clean sand grains; strongly acid.

The A horizon is gray, dark gray, grayish brown, or dark grayish brown. The C horizon is yellow, yellowish brown, very pale brown, and brownish yellow sand and fine sand.

Leon series

The Leon series consists of poorly drained, nearly level, rapidly permeable soils on the rims of depressions and on flats. Slopes are 0 to 2 percent.

Typical pedon of Leon sand 0.7 mile east of cemetery on Shipyard Boulevard to stoplight, then north on paved road 0.4 mile, on east side of road:

A1—0 to 3 inches, very dark gray (10YR 3/1) sand that has salt and pepper appearance; weak granular and single grained structure; very friable and loose; many medium and fine roots; strongly acid; gradual wavy boundary.

A2—3 to 16 inches, light gray (10YR 7/1) sand; single grained; loose; few medium roots; strongly acid; abrupt wavy boundary.

B21h—16 to 24 inches, dark reddish brown (5YR 2/2) sand; massive; firm and weakly cemented; streaked and tongued with very pale brown; strongly acid; gradual wavy boundary.

B22h—24 to 40 inches, dark reddish brown (5YR 2/2) sand; massive; strongly cemented; strongly acid; abrupt wavy boundary.

C—40 to 64 inches, light gray (10YR 7/1) sand; single grained; loose; strongly acid.

The profile is sand or fine sand to a depth of 72 inches. The A1 or Ap horizon is dark gray, very dark gray, or black. The organic material and clean sand grains in this horizon give it a salt and pepper appearance. The A2 horizon is light gray to white. The Bh horizon is black, dark reddish brown, and reddish brown, with the darkest colors in the upper part of the horizon. It is sand, loamy sand, or fine sand. This horizon in places is a series of intermittent layers that are weakly cemented or loose and have lighter colored loose sand layers in between; less commonly the Bh horizon is continuous and extends to a depth of more than 64 inches. The C horizon is light gray or gray.

Lynchburg series

The Lynchburg series consists of somewhat poorly drained, moderately permeable, nearly level soils on smooth flats of uplands. Slopes are 0 to 2 percent

Typical pedon of Lynchburg fine sandy loam 1 mile south of Wrightsboro along State Road 1318, on west bank of road opposite State Road 1386 junction:

Ap—0 to 6 inches, grayish brown (10YR 5/2) fine sandy loam; weak medium granular structure; very friable; few fine roots; medium acid; abrupt smooth boundary.

B21t—6 to 12 inches, very pale brown (10YR 7/4) sandy clay loam; weak fine subangular blocky structure; very friable; medium acid; gradual wavy boundary.

B22tg—12 to 20 inches, brownish yellow (10YR 6/6) sandy clay loam; many medium faint light gray (10YR 7/1) and reddish yellow (7.5YR 7/8) mottles; weak medium subangular blocky structure; thin patchy clay films on faces of peds; strongly acid; gradual wavy boundary.

B23tg—20 to 30 inches, brownish yellow (10YR 6/8), light gray (10YR 7/2), and yellowish red (5YR 5/8) sandy clay loam; moderate medium subangular blocky structure; friable; patchy clay films on faces of peds; strongly acid; gradual wavy boundary.

B24tg—30 to 40 inches, gray (N 5/6), brownish yellow (10YR 6/8), and reddish yellow (7.5YR 7/8) clay loam; moderate medium subangular blocky structure; friable, sticky when wet; continuous clay films on faces of peds; root channels filled with dark gray silt, clay, and very fine sand; strongly acid; gradual wavy boundary.

IIB3—40 to 64 inches, light gray (N 7/0) and yellow (10YR 7/8) clay loam; weak thin platy structure; very fine sand coatings between platy layers; plastic when wet, hard and brittle when dry; very strongly acid.

The Ap or A1 horizon is dark gray, dark grayish brown, or grayish brown sandy loam, fine sandy loam, or loamy fine sand. The B21t and B22tg horizons are very pale brown, light yellowish brown, and brownish yellow, and the B23tg and B24tg horizons are light gray, gray, grayish brown, brownish yellow, reddish yellow, or yellowish red. The B2t horizon is chiefly sandy clay loam or clay loam. The C horizon, if present, is gray or light gray fine sandy loam, loamy sand, clay, or silty clay stratified with sandy material.

The upper part of the B horizon has high chroma colors to a slightly greater depth than is defined as within the range for the series. This difference, however, does not significantly alter usefulness or behavior.

Lynn Haven series

The Lynn Haven series consists of poorly drained, moderately permeable and moderately rapidly permeable, nearly level soils in flat or depressional areas of uplands. Slopes are less than 2 percent.

Typical pedon of Lynn Haven fine sand on west side of North Carolina Highway 132, 1.06 miles north of junction with U.S. Highway 421, at northeast corner of church property:

A1—0 to 18 inches, black (10YR 2/1) fine sand; weak medium granular structure; very friable; many fine roots; organic material gives loamy sand appearance; extremely acid; gradual wavy boundary.

A2—18 to 24 inches, gray (10YR 6/1) fine sand; single grained; loose; few fine roots; extremely acid; gradual wavy boundary.

B21h—24 to 31 inches, black (5YR 2/1) sand; massive; friable, weakly cemented; some streaks and pockets of A2 material, apparently in old root channels; very strongly acid; gradual wavy boundary.

B22h—31 to 50 inches, black (5YR 2/1) and dark brown (10YR 4/3) sand; massive; friable, loose to weakly cemented; very strongly acid; gradual wavy boundary.

B23h—50 to 58 inches, dark brown (10YR 4/3) and brown (10YR 5/3) sand; single grained; loose; very strongly acid; gradual wavy boundary.

C1—58 to 64 inches, pale brown (10YR 6/3) sand; single grained; loose; very strongly acid; gradual wavy boundary.

C2—64 to 75 inches, interbedded light brownish gray (10YR 6/2) sandy loam and dark greenish gray (5GY 4/1) sandy clay; strongly acid.

The A1 horizon is very dark gray or black sand, loamy fine sand, or fine sand. The A2 horizon is gray, light gray, or white sand or fine sand. The Bh horizon is black, dark reddish brown, dark brown, or brown sand or fine sand. The C horizon is pale brown, light brownish gray, dark greenish gray, gray, or light gray sand, fine sand, sandy loam, or sandy clay.

Murville series

The Murville series consists of very poorly drained, moderately rapidly permeable, nearly level soils on flats or in slight depressions on uplands. Slopes are 0 to 2 percent.

Typical pedon of Murville fine sand about 0.5 mile north of junction of U.S. Highway 421 and North Carolina Highway 132 along North Carolina Highway 132 and east 1,600 feet in wooded area along canal:

O1—0 to 2 inches, partially decayed leaves, moss, and twigs.

A1—0 to 8 inches, black (N 2/0) fine sand; weak fine granular structure; soft, very friable; many roots; many clean quartz grains; loamy feel and appearance results from organic matter content; very strongly acid; clear wavy boundary.

B2h—8 to 45 inches, black (10YR 2/1) fine sand; massive; soft, very friable; few roots in upper part, sand grains mostly have dark films or coatings; few clean quartz grains; loamy feel and appearance results from organic matter content; very strongly acid; gradual wavy boundary.

C1—45 to 56 inches, pale brown (10YR 6/3) fine sand; single grained; loose; streaks of light gray (10YR 7/1); few old root channels; very strongly acid; clear wavy boundary.

IIC2—56 to 60 inches, pale brown (10YR 6/3) sandy clay loam and sandy loam; streaks and splotches of light gray (10YR 7/1); massive; friable; strongly acid; clear wavy boundary.

IIIC3—60 to 70 inches, pale brown (10YR 6/3) fine sand; single grained; loose; strongly acid.

The O1 horizon is absent in some areas or blends into the mass of roots in the upper few inches of the A1 horizon. The A1 horizon has a loamy feel because of the organic matter content. It is sand or fine sand. The A1 horizon is black and has few to many clean quartz grains. It rests on a Bh horizon or has an intermittent A2 horizon a few centimeters thick in places. Transitional horizons (B3h) are in pedons that have a thinner B2h horizon. The Bh horizon is black or very dark gray. The sand grains are mostly coated with an organic film, but in some pedons this horizon has very thin discontinuous lamellae of clean quartz grains. The C horizon is light gray, gray, light brownish gray, grayish brown, pale brown, and very pale brown. The C horizon is dominantly fine sand, but lenses and layers of loamy textured material occur in places below a depth of 50 inches.

Newhan series

The Newhan series consists of excessively drained, very rapidly permeable, gently sloping soils on dunes, on beaches, and along waterways near the Atlantic Ocean. Slopes are 2 to 6 percent.

Typical pedon of Newhan fine sand at north end of Carolina Beach about 0.4 mile north of fishing pier and 0.2 mile west of surf in area of beach dunes:

A1—0 to 2 inches, grayish brown (10YR 5/2) fine sand; single grained; few fine roots; mildly alkaline; clear wavy boundary.

C1—2 to 50 inches, light gray (10YR 7/2) fine sand; single grained; loose; few fine roots in upper part of horizon; common small fragments of colored marine shells; uncoated; about 5 percent of grains are black and dark brown; mildly alkaline; gradual wavy boundary.

C2—50 to 72 inches, light gray (10YR 7/2) sand; single grained; loose; uncoated; about 5 percent of grains are black and dark brown; common small, medium, and large fragments of marine shells; few whole shells; mildly alkaline.

Shells and shell fragments mostly of sand grain size make up 5 to 10 percent of the soil mass, along with 2 to 5 percent phosphate pebbles. Shell fragments are calcareous and will effervesce with weak acid. Content of silt plus clay is less than 5 percent. The A horizon is grayish brown or light gray. The C horizon is light gray to white fine sand or sand.

Norfolk series

The Norfolk series consists of well drained, moderately permeable soils that formed in unconsolidated, stratified marine sediment. These soils are on uplands. Slopes range from 0 to 4 percent.

Typical pedon of Norfolk fine sandy loam, 0 to 4 percent slopes, 0.28 mile south of the junction of State Road 1322 and State Road 1318 along State Road 1318 and 412 feet east of road on the edge of a borrow pit:

Ap—0 to 7 inches, grayish brown (10YR 5/2) fine sandy loam; weak medium granular structure; very friable; medium acid; abrupt smooth boundary.

A2—7 to 12 inches, pale brown (10YR 6/3) loamy fine sand; weak medium granular structure; very friable; strongly acid; gradual wavy boundary.

B2t—12 to 40 inches, yellowish brown (10YR 5/8) sandy clay loam; weak medium subangular blocky structure; friable; strongly acid; gradual wavy boundary.

B31—40 to 60 inches, brownish yellow (10YR 6/6) sandy loam; common medium distinct yellowish red (5YR 5/8) mottles; weak medium subangular blocky structure; very friable; strongly acid; gradual wavy boundary.

B32t—60 to 70 inches, yellowish brown (10YR 5/8) sandy clay loam; common coarse distinct red (2.5YR 5/8) and common medium distinct light gray (10YR 7/2) mottles; massive; friable; very strongly acid; gradual wavy boundary.

IIC1—70 to 85 inches, light gray (10YR 7/1) clay; common coarse distinct red (2.5YR 5/8) and common medium distinct yellowish brown (10YR 5/8) mottles; massive; very firm; very strongly acid; gradual wavy boundary.

IIC2—85 to 105 inches, mottled red (2.5YR 5/8), light gray (10YR 7/2), and yellow (10YR 7/6) sandy loam; massive; very friable; very strongly acid; gradual wavy boundary.

IIC3—105 to 120 inches, very pale brown (10YR 7/4) stratified sand and loamy sand; single grained; loose; very strongly acid.

The Ap or A1 horizon is mainly gray and grayish brown fine sandy loam, but in places it is loamy fine sand. The A2 horizon is very pale brown and pale brown loamy sand and loamy fine sand. The B2t horizon is yellowish brown and brownish yellow to strong brown sandy clay loam, fine sandy loam, or clay loam. The B3 horizon is brownish yellow, yellowish brown, strong brown, and yellowish red sandy loam, sandy clay loam, or clay loam. The IIC horizon is quite variable, and it ranges from gray to yellow. It includes sandy to clayey materials.

Onslow series

The Onslow series consists of moderately well drained and somewhat poorly drained, moderately permeable soils that formed in stratified marine sediment. These soils are on broad smooth uplands. Slopes are less than 3 percent.

Typical pedon of Onslow loamy fine sand 4 miles north of Wilmington to first paved road north of nursery, east side of U.S. Highway 117, then along paved road east 2,000 feet, then north 340 feet in cultivated field:

Ap—0 to 7 inches, gray (10YR 5/1) loamy fine sand; weak medium granular structure; very friable; few medium fibrous roots; few small brown concretions on surface; strongly acid; abrupt smooth boundary.

A2&Bh—7 to 10 inches, mottled dark brown (7.5YR 3/2) and yellowish brown (10YR 5/4) loamy sand; massive friable, weakly cemented; few medium roots; strongly acid; clear irregular boundary.

A'2—10 to 17 inches, light yellowish brown (10YR 6/4) loamy fine sand; few fine reddish yellow (7.5YR 6/8) mottles; weak medium granular structure; very friable; few fine roots; common medium pores; few pockets of sandy loam; few medium strong brown, yellowish brown, and yellowish red nodules; very strongly acid; gradual wavy boundary.

B'21t—17 to 29 inches, light yellowish brown (10YR 6/4) sandy clay loam; common medium distinct strong brown (7.5YR 5/6) and light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; friable; few medium roots; few patchy clay films on faces of peds; few clean sand grains; very strongly acid; gradual wavy boundary.

B'22t—29 to 40 inches, pale brown (10YR 6/3) sandy loam; many coarse distinct strong brown (7.5YR 5/6) and light brownish gray (10YR 6/2) mottles and few coarse prominent red (2.5YR 5/6) mottles; weak medium subangular blocky structure; friable, sticky when wet; few patchy clay films on faces of peds; few clean sand grains; very strongly acid; gradual wavy boundary.

IIB'3g—40 to 64 inches, light gray (10YR 7/1) clay loam pocketed with yellowish brown and yellowish red sandy clay loam and sandy loam; weak medium subangular blocky; firm, sticky and plastic; very strongly acid.

Some pedons contain few to common mica flakes and a few other weatherable minerals that make up less than 10 percent of the pedon.

The A horizon is loamy sand, loamy fine sand, fine sand, or fine sandy loam. The A1 or Ap horizon is gray, dark gray, or dark grayish brown. The A2 and A'2 horizon is gray, light gray, light brownish gray, light yellowish brown, or yellowish brown. The Bh part of the A2&Bh horizon makes up about 15 to 35 percent of the horizon and is dark yellowish brown, dark brown, or dark reddish brown, weakly to strongly cemented concretions 1/4 to 1 inch in size. In undisturbed areas, the Bh horizon is commonly 8 to 15 inches below the surface. In some cultivated areas the A2&Bh horizon has been obliterated through tillage and the brown concretions remain as evidence in the Ap layer. The B1 horizon, where present, is pale brown, light yellowish brown, brownish yellow, or light olive brown fine sandy loam or sandy loam. The B'2t horizon is pale brown, light yellowish brown to yellowish brown, or light olive brown sandy loam, sandy clay loam, or clay loam. Few to common mottles of gray are within 18 to 30 inches of the surface. The B'3 horizon is generally gray or prominently mottled sandy clay loam, clay loam, or sandy loam.

Pamlico series

The Pamlico series consists of very poorly drained, moderately permeable soils that formed in decomposed organic matter over mineral sediment. The Pamlico soils are on the flood plains of major streams, in level areas, and in depressional areas.

Typical pedon of Pamlico muck 10 miles south of Wilmington, 0.7 mile north of the junction of U.S. Highway 421 and State Road 1148, and 660 feet east of U.S. Highway 421 in bay area:

Oi—0 to 3 inches, very dark brown (10YR 2/2) fibric material; 75 percent fiber content after rubbing; friable; fiber consists of roots, twigs, and leaves; extremely acid; gradual wavy boundary.

Oa1—3 to 14 inches, very dark brown (10YR 2/2) sapric material; 30 percent fiber content; less than 16 percent rubbed; 15 percent mineral content; friable, slightly sticky; noncolloidal; common stumps, logs, and large roots; extremely acid; clear smooth boundary.

Oa2—14 to 36 inches, black (N 2/0) sapric material; 30 percent fiber content; 5 to 10 percent rubbed; about 35 percent mineral content; slightly sticky; common logs, stumps, and large roots; extremely acid; gradual wavy boundary.

IIClg—36 to 48 inches, very dark grayish brown (10YR 3/2) sand; single grained; loose; very strongly acid; clear smooth boundary.

IIC2g—48 to 60 inches, gray (10YR 5/1) sand; single grained; loose; very strongly acid.

The Oi horizon is black or very dark brown. Fiber content ranges from 60 to 70 percent when rubbed. The Oa horizon is black, very dark brown, or very dark grayish brown. Fiber content is less than 33 percent when unrubbed and less than 16 percent when rubbed. The IICg horizon is gray, brown, or very dark grayish brown.

Pantego series

The Pantego series consists of very poorly drained, moderately permeable soils that formed in marine sediment. The Pantego soils are in nearly level areas and in slightly depressional areas. Slopes are less than 2 percent.

Typical pedon of Pantego loam 2 5/8 miles northeast of Wrightsboro on State Road 1318, northwest 7/16 mile on paved road and farm road, and 50 feet west of road in a cultivated field:

Ap—0 to 6 inches, black (10YR 2.5/1) loam; weak medium granular structure; very friable; few fine roots; strongly acid; abrupt smooth boundary.

A1—6 to 16 inches, black (10YR 2.5/1) loam; weak medium granular structure; very friable; few medium roots; strongly acid; abrupt wavy boundary.

B21tg—16 to 30 inches, gray (10YR 5/1) sandy clay loam; weak medium subangular blocky structure; friable; few fine root channels with yellowish brown (10YR 5/6) lining channels; very strongly acid; clear wavy boundary.

B22tg—30 to 50 inches, gray (10YR 5/1) sandy clay loam; weak medium subangular blocky structure; friable; few fine root channels with yellowish brown (10YR 5/6) lining channels and few fine sand lenses of light gray (10YR 7/1); very strongly acid; clear wavy boundary.

IIB23tg—50 to 100 inches, gray (10YR 6/1) clay loam; few fine distinct yellowish brown and brownish yellow mottles; weak medium subangular blocky structure; firm; very strongly acid.

The Ap or A1 horizon commonly is black or very dark gray loam but ranges to fine sandy loam or sandy loam. The Bt horizon is chiefly gray or light gray sandy clay loam but ranges to clay loam or sandy loam. The C horizon is commonly light gray or light brownish gray sand but ranges to loam.

Rains series

The Rains series consists of poorly drained, moderately permeable soils that formed in fluvial and marine sediment. These nearly level soils are on flats, in slight depressions, and around the heads of intermittent drainageways. Slopes are less than 2 percent.

Typical pedon of Rains fine sandy loam 0.7 mile northwest from Masonboro on State Road 1515 and about 650 feet north of State Road 1515, 250 feet west of farm road in woods:

O1—1 inch to 0, partially decomposed pine straw and roots.

A1—0 to 5 inches, black (10YR 2/1) fine sandy loam; weak medium granular structure; very friable, slightly sticky; many medium and large roots; very strongly acid; abrupt wavy boundary.

B1g—5 to 8 inches, gray (10YR 6/1) fine sandy clay loam; weak medium subangular blocky structure; friable; common bodies of A1 material; common medium and large roots; very strongly acid; clear wavy boundary.

B21tg—8 to 22 inches, gray (10YR 5/1) clay loam with pockets of sandy clay loam; few medium faint brownish yellow (10YR 6/6) mottles; weak medium subangular blocky structure; firm, sticky, plastic; few thin discontinuous clay films on faces of peds; common medium and large roots; very strongly acid; gradual wavy boundary.

B22tg—22 to 40 inches, gray (10YR 6/1) clay loam, common medium and coarse prominent red (2.5YR 5/8) mottles and common medium and coarse distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; firm, sticky, very plastic; few medium and large roots; very strongly acid; abrupt smooth boundary.

B23tg—40 to 64 inches, light gray (10YR 7/1) clay; common coarse prominent red (2.5YR 5/8) mottles and few fine faint strong brown mottles; massive and weak coarse angular blocky structure; very firm, very sticky, very plastic; very strongly acid; gradual wavy boundary.

Cg—64 to 68 inches, light gray (10YR 7/1) fine sandy loam with pockets of sandy clay loam; common medium distinct brownish yellow mottles; massive; friable; very strongly acid.

The A1 or Ap horizon is black or dark gray fine sandy loam or loam. Where present, the A2 horizon is light gray fine sandy loam or loamy fine sand. The B horizon is gray, light gray, or dark gray fine sandy clay loam, clay loam, sandy clay, or clay. The C horizon is fine sandy loam, sandy loam, sandy clay loam, or sand.

Rains soils have an A horizon that is slightly thinner and are slightly more clayey in the lower part of the Bt horizon than is defined as within the range for the series. These differences, however, do not significantly alter the usefulness or behavior of these soils.

Rimini series

The Rimini series consists of excessively drained, moderately permeable soils that formed in marine sediment. The Rimini soils are on rims around "Carolina Bays" and on broad smooth divides. Slopes range from 1 to 6 percent.

Typical pedon of Rimini sand, 1 to 6 percent slopes, south of Wilmington, on west side of North Carolina Highway 132, about 10 feet to south edge of Pine Valley development:

A1—0 to 3 inches, dark gray (10YR 4/1) sand; many clean white grains; weak granular structure; very friable; common fine and medium roots; strongly acid; abrupt smooth boundary.

A2—3 to 56 inches, light gray (10YR 7/1) sand; single grained; loose; few medium roots; strongly acid; clear irregular boundary.

B21h—56 to 64 inches, dark reddish brown (5YR 3/2) sand with streaks and pockets of light gray (10YR 7/1) sand; massive; weakly cemented; strongly acid.

B22h—64 to 80 inches, dark brown (7.5YR 4/2) sand with pockets of light gray (10YR 7/1) sand; massive; very friable; strongly acid.

The A1 horizon is dark gray or gray. The A2 horizon is light gray or white. The Bh horizon is black, dark reddish brown, dark brown, or very dark gray. The C horizon, where present, is very pale brown, light gray, or white sandy or loamy material.

Seagate series

The Seagate series consists of somewhat poorly drained, moderately permeable soils that formed in

marine sediment. Seagate soils are in nearly level flatwood areas. Slopes generally are less than 2 percent but are as much as 3 percent.

Typical pedon of Seagate fine sand 0.4 mile north of junction of North Carolina Highway 132 and U.S. Highway 421, 300 yards west of U.S. 421, 20 feet north of field road:

Ap—0 to 8 inches, dark gray (10YR 4/1) fine sand; single grained; very friable; many fine roots; many clean sand grains; slightly acid; abrupt smooth boundary.

A2—8 to 12 inches, light gray (10YR 7/1) fine sand; single grained; loose; few medium roots; medium acid; clear wavy boundary.

B21h—12 to 23 inches, dark brown (7.5YR 3/2) fine sand; massive; friable, weakly cemented; many sand grains coated with organic matter; few clean sand grains; strongly acid; abrupt irregular boundary.

B22h—23 to 28 inches, brown (10YR 5/3) fine sand; single grained; loose; few fine weakly cemented concretions; many sand grains coated with organic matter; strongly acid; clear wavy boundary.

A'2—28 to 36 inches, light gray (10YR 7/2) fine sand; single grained; loose; few fine and medium brown (10YR 5/3) concretions; medium acid; clear smooth boundary.

B'1t—36 to 40 inches, brownish yellow (10YR 6/6) sandy loam; many medium distinct light gray (10YR 7/2) mottles; weak medium subangular blocky structure; friable; sand grains are coated and bridged with clay; few patchy clay films on faces of peds; strongly acid; clear wavy boundary.

B'2tg—40 to 66 inches, light gray (10YR 7/1) clay loam; weak medium subangular blocky structure; firm, plastic, sticky; very strongly acid.

The Ap or A1 horizon is very dark gray, dark gray, or gray loamy fine sand, fine sand, or sand. The Bh horizon is black, dark brown, very dark reddish brown, dark yellowish brown, or brown sand, fine sand, or loamy sand. The B'2t horizon is brownish yellow, yellowish brown, light brownish gray, light gray, or very pale brown sandy clay loam, sandy loam, or clay loam. The C horizon is gray or light gray clayey to sandy material.

Stallings series

The Stallings series consists of somewhat poorly drained, moderately rapidly permeable soils that formed in marine sediment. The Stallings soils are on nearly level interstream divides. Slopes are less than 3 percent.

Typical pedon of Stallings fine sand north of Wilmington on Horticulture Crops Research Station, along farm road 1650 feet east of station office, and 50 feet north of road in blueberry field:

A1—0 to 8 inches, dark gray (10YR 4/1) fine sand; weak medium granular structure; very friable; medium acid; clear wavy boundary.

A2—8 to 14 inches, light yellowish brown (2.5Y 6/4) fine sand; few fine distinct pale brown mottles; weak medium granular structure; very friable; very strongly acid; gradual wavy boundary.

B21t—14 to 24 inches, light yellowish brown (2.5Y 6/4) fine sandy loam; common medium distinct light gray (10YR 7/2) and yellowish brown (10YR 5/6) mottles; weak medium granular structure; very friable; very strongly acid; gradual wavy boundary.

B22tg—24 to 30 inches, light gray (10YR 7/1) fine sandy loam; common medium distinct very pale brown (10YR 7/3) and yellowish brown (10YR 5/6) mottles; weak medium and fine granular structure; very friable; very strongly acid; gradual wavy boundary.

B23tg—30 to 54 inches, light brownish gray (10YR 6/2) fine sandy loam; common coarse distinct light gray (10YR 7/1) mottles; weak medium and fine granular structure; very friable; very strongly acid; gradual wavy boundary.

B3—54 to 68 inches, pale yellow (2.5Y 7/4) loamy fine sand and fine sandy loam; common coarse distinct light brownish gray (2.5Y 6/2) mottles; weak medium and fine granular structure; single grained; loose; very strongly acid.

The A1 or Ap horizon is very dark gray, dark gray, or dark grayish brown loamy fine sand, fine sand, or fine sandy loam. The A2 horizon is very pale brown, light yellowish brown, and light brownish gray loamy sand, loamy fine sand, or fine sand. The B2t horizon is light yellowish brown, yellow, or pale yellow. The B2tg horizon is light brownish gray, grayish brown, or light gray. The B2t and B2tg horizons are sandy loam or fine sandy loam. The B3 horizon is loamy sand, loamy fine sand, or fine sandy loam.

Torhunta series

The Torhunta series consists of very poorly drained, moderately rapidly permeable soils that formed in stratified marine and fluvial sediment. These nearly level soils are in slightly depressional areas. Slopes are less than 2 percent.

Typical pedon of Torhunta loamy fine sand north of Wilmington and east of Wrightsboro along State Road 1322, 1.68 miles from the intersection of U.S. Highway 117 and State Road 1322, north 0.5 mile along path, and 60 feet east of path in sparsely wooded area:

A11—0 to 8 inches, black (10YR 2.5/1) loamy fine sand; weak medium granular structure; very friable; many fine roots; extremely acid; gradual wavy boundary.

A12—8 to 20 inches, very dark gray (10YR 3/1) loamy fine sand; weak fine granular structure; very friable; few fine roots; very strongly acid; gradual wavy boundary.

B—20 to 47 inches, light gray (10YR 7/2) fine sandy loam; weak fine granular structure; common fine yellowish brown mottles; very friable; very strongly acid; gradual wavy boundary.

C1g—47 to 64 inches, light gray (10YR 7/1) fine sand; common medium faint brownish yellow (10YR 6/6) and pale brown (10YR 6/3) mottles; single grained; loose; very strongly acid.

The A horizon is black, very dark gray, or very dark grayish brown fine sandy loam, loam, or loamy fine sand. The B horizon is gray, light gray, dark gray, grayish brown, or light brownish gray sandy loam or fine sandy loam. The C horizon is fine sandy loam, loamy fine sand, or fine sand. Its color is about the same as that of the B horizon.

Wakulla series

The Wakulla series consists of somewhat excessively drained, rapidly permeable soils that formed in marine, fluvial, or eolian sediment. These soils are nearly level to gently sloping and occur on broad stream terraces and on uplands. Slopes range from 0 to 6 percent.

Typical pedon of Wakulla sand, 1 to 8 percent slopes, 0.56 mile north of the junction of State Road 1544 and State Road 1148, 330 feet east and 660 feet north, on west side of road in urban area:

A1—0 to 2 inches, grayish brown (10YR 5/2) sand; weak fine granular structure; very friable; strongly acid; clear smooth boundary.

A2—2 to 30 inches, light yellowish brown (10YR 6/4) sand; weak fine granular structure; loose; strongly acid; clear wavy boundary.

B2t—30 to 48 inches, strong brown (7.5YR 5/6) loamy sand; weak medium granular structure; very friable; sand grains coated and bridged with clay; medium acid; clear wavy boundary.

C—48 to 64 inches, strong brown (7.5YR 5/6) sand; single grained; loose; medium acid.

The Ap or A1 horizon is dark grayish brown or grayish brown sand or loamy sand. The A2 horizon is brownish yellow or light yellowish brown. The Bt horizon is strong brown, yellowish red, and yellowish brown. The C horizon is reddish yellow, yellow, very pale brown, strong brown, or light gray.

Woodington series

The Woodington series consists of poorly drained, moderately rapidly permeable soils that formed in marine sediment. These soils are nearly level and occur on smooth interstream divides. Slopes are less than 2 percent.

Typical pedon of Woodington fine sandy loam 0.6 mile west of North Carolina Highway 132 and State Road 1322 intersection, on edge of wooded area on north side of road:

A1—0 to 7 inches, very dark gray (10YR 3/1) fine sandy loam; weak medium granular structure; very friable; few fine and medium roots; medium acid; clear wavy boundary.

B21tg—7 to 34 inches, light brownish gray (10YR 6/2) fine sandy loam; common medium faint white (10YR 8/1) mottles; weak fine subangular blocky structure; friable; few fine and medium roots; few thin patchy clay films on faces of peds; strongly acid; gradual wavy boundary.

B22tg—34 to 48 inches, gray (10YR 6/1) fine sandy loam; common medium faint very pale brown (10YR 7/3) and white (10YR 8/2) mottles; weak medium and fine subangular blocky structure; friable; thin patchy clay films on faces of peds; strongly acid; gradual wavy boundary.

B3g—48 to 65 inches, very pale brown (10YR 7/3) fine sandy loam; many medium faint light gray (10YR 7/2) and white (10YR 8/1) mottles; weak fine granular structure; very friable; strongly acid.

The Ap or A1 horizon is dark gray or very dark gray sandy loam or fine sandy loam. The A2 horizon, where present, is light gray or light brownish gray fine sandy loam or loamy fine sand. The B21t horizon is light brownish gray, light gray, or gray, and the B22t horizon is gray or light gray. The C horizon, where present, is gray to very pale brown loamy fine sand, sand, or fine sand.

Wrightsboro series

The Wrightsboro series consists of moderately well drained, moderately permeable soils that formed in stratified marine sediment. These soils are nearly level and occur on interstream divides. Slopes range from 0 to 2 percent.

Typical pedon of Wrightsboro fine sandy loam, 0 to 2 percent slopes, 3.5 miles north of Wilmington on U.S. Highway 117, 100 feet west of U.S. Highway 117 and 50 feet north of State Road 1329:

Ap—0 to 6 inches, grayish brown (10YR 5/2) fine sandy loam; weak medium granular structure; very friable; few fine roots; medium acid; clear smooth boundary.

A2—6 to 9 inches, very pale brown (10YR 7/4) fine sandy loam; weak medium granular structure; very friable; few fine roots; strongly acid; clear wavy boundary.

B21t—9 to 24 inches, brownish yellow (10YR 6/6) sandy clay loam; few fine distinct light gray mottles below depth of 19 inches; weak medium subangular blocky structure; friable; few patchy clay films on faces of peds and pore walls; strongly acid; gradual wavy boundary.

B22t—24 to 36 inches, brownish yellow (10YR 6/6) sandy clay loam; common medium distinct light gray (10YR 7/2) and very pale brown (10YR 7/3) mottles; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; few patchy clay films on faces of peds and on walls of root channels; very strongly acid; gradual wavy boundary.

B23t—36 to 48 inches, brownish yellow (10YR 6/6) sandy clay loam; many medium distinct light gray (10YR 7/1) mottles and common medium distinct yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; firm, slightly sticky, slightly plastic; prominent clay films on faces of peds; few pockets of sandy loam; very strongly acid; clear smooth boundary.

IIB3g—48 to 65 inches, light gray (10YR 7/2) clay; many coarse distinct yellow (10YR 7/8) mottles and common prominent reddish yellow (5YR 6/6) mottles; weak fine angular blocky structure and massive; very firm, very sticky, very plastic; few fine flakes of mica; reddish yellow mottles commonly surround fine root channels; some very fine sand and silt coatings between layers; strongly acid.

The A1 or Ap horizon is gray, grayish brown, olive gray, dark grayish brown, very dark gray, or brown. The A2 horizon is light gray, very pale brown, pale yellow, yellow, light brownish gray, pale brown, or light yellowish brown. The A horizon is fine sandy loam, sandy loam, loamy fine sand, or loamy sand. The Bt horizon is yellowish brown, brownish yellow, yellow, olive yellow, light yellowish brown, or pale brown. In some pedons, the B23t horizon is light brownish gray, gray, grayish brown, or light gray. Mottles of high contrast are common in the lower part of the Bt horizon. The B21t and B22t horizons are sandy clay loam or clay loam. The B23t horizon is sandy clay loam or sandy loam. Clay content averages 24 to 35 percent and silt content is less than 30 percent in the upper 20 inches of the Bt horizon. Transitional B1 and B3 horizons of sandy loam are present in some pedons. A clayey IIB horizon is present between depths of 40 and 80 inches. It is gray or light gray and has mottles of high contrast. Lenses or bodies of fine sand or silt are common.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (*5*). Readers interested in further details about the system should refer to the latest literature available (*6*).

The system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the bases for classification are the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 17 the soils of the survey area are classified according to the system. Classes of the system are briefly discussed in the following paragraphs.

ORDER: Ten soil orders are recognized. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Ultisol.

SUBORDER: Each order is divided into suborders based primarily on properties that influence soil genesis and that are important to plant growth or that were selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquult (*Aqu*, meaning water, plus *ult*, from Ultisol).

GREAT GROUP: Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. The name of a great group ends with the name of a suborder. A prefix added to the name suggests something about the properties of the soil. An example is Paleaguults (*Pale*, meaning horizons that have more than normal development, plus *aquults*, the suborder of Ultisols that have an aquic moisture regime).

SUBGROUP: Each great group is divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades that have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. The names of subgroups are derived by placing one or more adjectives before the name of the great group. The adjective *Typic* is used for the subgroup that is thought to typify the great group. An example is Typic Paleaquults.

FAMILY: Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, siliceous, thermic Typic Paleaquults.

SERIES: The series consists of a group of soils that are formed from a particular kind of parent material and have horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Formation of the Soils

This section discusses the factors of soil formation, relates them to the formation of soils in the survey area, and explains the processes of soil formation.

Plant and Animal Life

Before the county was settled, the native vegetation consisted of many kinds of hardwoods and several kinds of conifers. This vegetation had a major influence on the development of the soils. In addition, the activities of micro-organisms, earthworms, larvae, and other forms of animal life were important in the cycle of decay and regeneration of plants.

The activity of fungi and micro-organisms and the soil mixing carried on by earthworms and other small invertebrates are mainly confined to the upper few inches of the soil.

Trees and other plants take up minerals from the soil and store them in their roots, stems, and leaves. When these plants or parts of them decay, the minerals re-enter the soil and are used again by other plants. Unless disturbed, this cycle continues indefinitely.

Soil development is also affected by plant roots, which penetrate soil material to various depths and generally increase its porosity. Organic acids produced by plants and the decay of these organic acids react on basic minerals in the parent material. Minerals taken into solution or suspension may be leached from a soil or translocated within it.

Plants and animals for the most part determine the kinds of organic matter added to the soil and the way in which it is incorporated with the soil. They transfer nutrient elements from one horizon to another and in many places transport soil material from one horizon to another. Plants and animals also affect the gains and losses in organic matter, nitrogen, and other plant nutrients. Soil structure and porosity are also altered by plant and animal life.

Climate

Climate affects the physical, chemical, and biological relationship in the soil, mainly through the influence of precipitation and temperature. Water dissolves minerals, is necessary for biological activity, and transports minerals and organic residue through the soil profile. The amount of water that actually percolates through the soil is dependent mainly on the amount and duration of rainfall, relative humidity, evapotranspiration, length of the frost-free period, and soil characteristics. Temperature influences the kind and growth of organisms and the speed of physical and chemical reaction in the soils.

The climate of New Hanover County is warm and humid. Precipitation is well distributed. The relatively mild temperatures and the abundant moisture cause rapid decomposition of organic matter and speed up chemical reactions in the soil. The high rainfall leaches out large amounts of soluble bases, and less soluble, fine materials are moved deeper in the soil.

Variations of climate in the county are small and probably are not the cause of local differences in the soils.

Parent Material

Parent material is the unconsolidated rock from which a soil is formed. It is the soil forming factor that is mainly responsible for the chemical and mineralogical composition of the soil. It is the most important factor that has caused differences among the soils of New Hanover County. Some of the differences, such as texture, color, or depth, are easily determined in the field.

Minor differences in mineralogical composition are determined by laboratory analysis.

The parent materials of the soils of New Hanover County are of two basic kinds. The first is unconsolidated rock material, sand, silt, and clay that make up the marine and fluvial sediments of the Coastal Plain province. The second basic kind is the aeolian sand deposits.

Many of the differences among the soils of the county reflect the varying geologic materials are:

1. Soils that formed in sediment that has a high percentage of sand are Kureb, Lakeland, Newhan, Kenansville, Leon, Lynn Haven, Murville, Stallings, Rimini, Torhunta, Wakulla, and Baymeade soils.
2. Soils that formed in loamy sediment are Wrightsboro, Norfolk, Lynchburg, Onslow, and Pantego soils.
3. Soils that formed in clayey sediment are Bayboro and Craven soils.
4. Soils that formed in sediment of mixed textures are Johnston soils and Tidal Marsh.
5. Soils that formed on continuously wet flood plains and have high organic-matter content are Dorovan and Pamlico soils.

Relief

Relief has been an important factor in soil formation in this county. It strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind. Relief largely governs natural drainage. Soils of New Hanover County range from level to gently sloping. The upland soils in higher areas, such as Norfolk, Kensansville, Lakeland, Baymeade, Kureb, and Wakulla soils, are well drained or excessively drained and are relatively low in content of organic matter. Soils in depressions where water stands for a significant length of time, such as Bayboro, Pantego, Johnston, and Torhunta soils, are very poorly drained and have a dark-colored or black surface horizon. In marshy areas, which are almost constantly covered by water, soils that have a large accumulation of organic matter, such as Dorovan and Pamlico soils, may develop.

Time

The length of the time required for a soil to develop depends on the other factors of soil formation. Less time is required in a warm, humid region where vegetation is dense than in a cold, dry region where vegetation is sparse. In the same environment, less time is required for a soil to develop from coarse-textured material.

The age of soils varies considerably. Old soils generally have better defined horizons than young soils. In New Hanover County, older soils on the smoother uplands have well defined horizons. In contrast, the young alluvial soils and those in dune areas have not been in place long enough to develop well defined horizons.

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Glossary

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single *mapping unit.*

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficuty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake. The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probaable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Low strength. Inadequate strength for supporting loads.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Piping. Formation by moving water of subsurface tunnels or pipelike cavities.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.005 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt*, *silt loam*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands

in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

APPENDIX

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

Month	Temperature[1]						Precipitation[1]				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[2]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	F	F	F	F	F		In	In	In		In
January----	55.9	35.3	45.6	77	17	57	3.41	1.94	4.61	7	.4
February---	58.3	37.1	47.7	79	19	69	3.66	2.40	4.80	7	1.0
March------	64.3	43.0	53.7	84	26	180	4.09	2.25	5.58	8	.3
April------	73.7	51.6	62.7	91	34	381	3.07	1.36	4.46	5	.0
May--------	80.8	60.1	70.5	95	43	636	4.09	2.27	5.57	6	.0
June-------	86.2	67.2	76.7	99	53	801	5.63	2.84	7.89	8	.0
July-------	89.0	71.2	80.1	98	61	933	7.72	4.47	10.36	10	.0
August-----	88.3	70.5	79.4	98	60	911	6.80	4.10	9.21	9	.0
September--	83.7	65.2	74.5	94	50	735	5.55	2.66	7.90	6	.0
October----	75.5	54.6	65.0	89	33	465	3.16	1.07	4.84	5	.0
November---	66.5	43.7	55.1	82	25	162	3.19	1.28	4.73	5	.0
December---	59.1	37.4	48.3	78	18	115	3.17	1.59	4.44	6	.4
Year-----	73.4	53.1	63.3	99	15	5,445	53.54	47.28	59.60	82	2.1

[1]Recorded in the period 1952-74 at Wilmington, N.C.

[2]A growing degree day is an index of the amount of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature[1]		
	24 F or lower	28 F or lower	32 F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Mar. 11	Mar. 26	Apr. 2
2 years in 10 later than--	Mar. 1	Mar. 17	Mar. 28
5 years in 10 later than--	Feb. 10	Feb. 27	Mar. 19
First freezing temperature in fall:			
1 year in 10 earlier than--	Nov. 20	Nov. 9	Oct. 31
2 years in 10 earlier than--	Nov. 29	Nov. 15	Nov. 4
5 years in 10 earlier than--	Dec. 16	Nov. 26	Nov. 13

[1]Recorded in the period 1952-74 at Wilmington, N.C.

TABLE 3.--GROWING SEASON LENGTH

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24 F	Higher than 28 F	Higher than 32 F
	Days	Days	Days
9 years in 10	271	237	220
8 years in 10	283	249	226
5 years in 10	307	271	238
2 years in 10	332	292	250
1 year in 10	349	304	256

[1]Recorded in the period 1952-74 at Wilmington, N.C.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ba	Bayboro loam	330	0.3
Be	Baymeade fine sand, 1 to 6 percent slopes	6,405	5.4
Bh	Baymeade-Urban land complex, 1 to 6 percent slopes	2,176	1.8
Bp	Borrow pits	110	.1
Cr	Craven fine sandy loam, 1 to 4 percent slopes	8,804	7.4
DO	Dorovan soils	8,766	7.4
JO	Johnston soils	4,426	3.7
Ke	Kenansville fine sand, 0 to 3 percent slopes	3,875	3.3
Kr	Kureb sand, 1 to 8 percent slopes	8,337	7.1
Ku	Kureb-Urban land complex, 1 to 8 percent slopes	889	.8
La	Lakeland sand, 1 to 8 percent slopes	2,595	2.2
Le	Leon sand	7,953	6.7
Lo	Leon-Urban land complex	1,084	.9
Ls	Lynchburg fine sandy loam	810	.7
Ly	Lynn Haven fine sand	4,767	4.0
Mp	Mine Pits	1,323	1.1
Mu	Murville fine sand	14,351	12.1
Nh	Newhan fine sand	3,961	3.3
No	Norfolk fine sandy loam, 0 to 4 percent slopes	841	.7
On	Onslow loamy fine sand	2,171	1.8
Pm	Pamlico muck	958	.8
Pn	Pantego loam	2,182	1.8
Ra	Rains fine sandy loam	682	.6
Rm	Rimini sand, 1 to 6 percent slopes	1,936	1.6
Se	Seagate fine sand	7,172	6.0
Sh	Seagate-Urban land complex	495	.4
St	Stallings fine sand	1,896	1.6
TM	Tidal Marsh	8,304	7.1
To	Torhunta loamy fine sand	2,460	2.1
Ur	Urban land	3,936	3.3
Wa	Wakulla sand, 1 to 8 percent slopes	2,029	1.7
Wo	Woodington fine sandy loam	682	.6
Wr	Wrightsboro fine sandy loam, 0 to 2 percent slopes	1,950	1.6
	Total	118,656	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS

[All yields were estimated for a high level of management in 1974. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Corn	Soybeans	Tobacco	Peanuts
	Bu	Bu	Lb	Lb
Bayboro:				
Ba	---	---	---	---
Baymeade:				
Be, [1]Bh	60	---	---	2,100
Borrow pits:				
Bp.				
Craven:				
Cr	105	40	2,500	2,800
Dorovan:				
[1]DO	---	---	---	---
Johnston:				
[1]JO	---	---	---	---
Kenansville:				
Ke	70	---	2,000	2,400
Kureb:				
Kr	---	---	---	---
[1]Ku	---	---	---	---
Lakeland:				
La	55	20	1,700	2,000
Leon:				
Le, [1]Lo.				
Lynchburg:				
Ls	115	45	2,800	--
Lynn Haven:				
Ly	70	---	---	---
Mine pits:				
Mp.				
Murville:				
Mu	---	---	---	---
Newhan:				
Nh	---	---	---	---
Norfolk:				
No	100	35	2,900	3,700
Onslow:				
On	115	40	2,700	3,000
Pamlico:				
Pm	---	---	---	---
Pantego:				
Pn	---	---	---	---
Rains:				
Ra	---	---	---	---
Rimini:				
Rm	---	---	---	---

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Corn	Soybeans	Tobacco	Peanuts
	Bu	Bu	Lb	Lb
Seagate:				
Se	75	30	1,800	2,400
[1]Sh	---	---	---	---
Stallings:				
St	100	35	2,500	---
Tidal marsh:				
TM.				
Torhunta:				
To	---	---	---	---
Urban land:				
Ur.				
Wakulla:				
Wa	45	20	1,700	---
Woodington:				
Wo	---	---	---	---
Wrightsboro:				
Wr	125	45	---	3,000

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Potential productivity: Important trees	Site index	Trees to plant
Bayboro:									
Ba	2w	Slight	Severe	Severe	--------	--------	Loblolly pine	95	Slash pine, loblolly pine, sweetgum, water tupelo.
							Sweetgum	94	
							Slash pine	95	
							Yellow-poplar	---	
							Southern red oak	---	
							White oak	---	
Baymeade:									
Be, [1]Bh	3s	Slight	Moderate	Moderate	--------	--------	Loblolly pine	80	Loblolly pine, slash pine, longleaf pine.
							Slash pine	80	
							Longleaf pine	65	
Craven:									
Cr	3w	Slight	Moderate	Slight	--------	--------	Loblolly pine	81	Loblolly pine, slash pine.
							Longleaf pine	67	
							Water oak	80	
Dorovan:									
[1]DO	4w	Slight	Severe	Severe	--------	--------	Blackgum	70	(2)
							Sweetbay	---	
Johnston:									
[1]JO	1w	Slight	Severe	Severe	--------	--------	Loblolly pine	97	(2)
							Sweetgum	111	
							Water oak	103	
Kenansville:									
Ke	3s	Slight	Moderate	Moderate	--------	--------	Loblolly pine	80	Loblolly pine, slash pine.
							Longleaf pine	65	
Kureb:									
Kr	5s	Slight	Severe	Severe	--------	--------	Longleaf pine	50	Longleaf pine, slash pine.
							Slash pine	60	
							Sand pine	---	
[1]Ku:									
Kureb part	5s	Slight	Severe	Severe	--------	--------	Longleaf pine	50	Longleaf pine, slash pine.
							Slash pine	60	
							Sand pine	---	
Urban land part.									
Lakeland:									
La	3s	Slight	Moderate	Moderate	Slight	Slight	Slash pine	80	Slash pine, loblolly pine.
							Loblolly pine	80	
							Longleaf pine	70	
Leon:									
Le	4w	Slight	Moderate	Moderate	--------	--------	Loblolly pine	75	Loblolly pine slash pine.
							Slash pine	75	
							Longleaf pine	70	

See footnotes at end of table.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--continued

Soil name and map symbol	Symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Potential productivity: Important trees	Site index	Trees to plant
Leon:									
[1]Lo:									
Leon part	4w	Slight	Moderate	Moderate	--------	--------	Loblolly pine	75	Loblolly pine, slash pine.
							Slash pne	75	
							Longleaf pine	70	
Urban land part.									
Lynchburg:									
Ls	2w	Slight	Moderate	Slight	--------	--------	Slash pine	91	Slash pine, loblolly pine, American sycamore, sweetgum.
							Loblolly pine	86	
							Longleaf pine	74	
							Yellow-poplar	92	
							Sweetgum	90	
							Southern red oak	---	
							White oak	---	
							Blackgum	---	
Lynn Haven:									
Ly	3w	Slight	Moderate	Moderate	Slight	Moderate	Slash pine	80	Slash pine, loblolly pine.
							Loblolly pine	80	
							Longleaf pine	70	
							Pond pine	70	
Murville:									
Mu	2w	Slight	Severe	Severe	--------	--------	Loblolly pine	90	Loblolly pine, slash pine.
							Slash pine	90	
Norfolk:									
No	2o	Slight	Slight	Slight	--------	--------	Loblolly pine	86	Slash pine, loblolly pine.
							Longleaf pine	68	
							Slash pine	86	
Onslow:									
On	2w	Slight	Slight	Slight	--------	--------	Loblolly pine	76	Slash pine, loblolly pine.
							Slash pine	80	
							Longleaf pine	67	
Pamlico:									
Pm	4w	Slight	Severe	Severe	--------	--------	Slash pine	70	Slash pine, loblolly pine, water tupelo.
							Pond pine	55	
							Baldcypress	---	
							Water tupelo	---	
Pantego:									
Pn	1w	Slight	Severe	Severe	--------	--------	Loblolly pine	98	Loblolly pine, slash pine, sweetgum, American sycamore, water tupelo.
							Slash pine	95	
							Pond pine	73	
							Baldcypress	---	
							Water tupelo	---	
							Water oak	---	
Rains:									
Ra	2w	Slight	Severe	Severe	--------	--------	Loblolly pine	94	Loblolly pine, slash pine, sweetgum, American sycamore.
							Slash pine	91	
							Sweengum	90	

See footnotes at end of table.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Potential productivity: Important trees	Site index	Trees to plant
Rimini:									
Rm	5s	Slight	Severe	Severe	--------	--------	Loblolly pine	65	Slash pine, longleaf pine.
							Slash pine	65	
							Longleaf pine	55	
Seagate:									
Se	3w	Slight	Moderate	Moderate	--------	--------	Slash pine	80	Slash pine, loblolly pine.
							Loblolly pine	80	
							Longleaf pine	70	
[1]Sh:									
Seagate part	3w	Slight	Moderate	Moderate	--------	--------	Slash pine	80	Slash pine, loblolly pine.
							Loblolly pine	80	
							Longleaf pine	70	
Urban land part.									
Stallings:									
St	2w	Slight	Moderate	Slight	--------	--------	Loblolly pine	90	Loblolly pine, slash pine, yellow-poplar, American sycamore, sweetgum.
							Slash pine	90	
							Longleaf pine	75	
							Sweetgum	90	
							Yellow-poplar	100	
							Water oak	90	
Torhunta:									
To	2w	Slight	Severe	Severe	--------	--------	Loblolly pine	90	Loblolly pine, sweetgum, slash pine, American sycamore.
							Slash pine	86	
							Sweetgum	90	
							Water tupelo	---	
Wakulla:									
Wa	3s	Slight	Moderate	Moderate	--------	--------	Loblolly pine	80	Loblolly pine, slash pine, longleaf pine.
							Slash pine	80	
							Longleaf pine	65	
Woodington:									
Wo	2w	Slight	Severe	Severe	--------	--------	Slash pine	93	Slash pine, loblolly pine, American sycamore, water tupelo, water oak, sweetgum.
							Loblolly pine	90	
							Sweetgum	90	
							White oak	90	
							Southern red oak	71	
							Water tupelo	---	
Wrightsboro:									
Wr	2w	Slight	Moderate	Slight	Slight	Severe	Loblolly pine	90	Loblolly pine, slash pine, American sycamore, yellow-poplar, sweetgum.
							Slash pine	90	
							Longleaf pine	75	
							Sweetgum	90	

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

[2]Commercial management is not favorable on these soils unless they are drained. Because of their position in the landscape and difficulty in producing drainage, it is not practical to manage these soils for commercial timber production.

TABLE 7.--BUILDING SITE DEVELOPMENT

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Bayboro:					
Ba	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Baymeade:					
Be, [1]Bh	Moderate: cutbanks cave.	Slight	Moderate: wetness.	Moderate: wetness.	Moderate: low strength.
Borrow pits:					
Bp.					
Craven:					
Cr	Severe: too clayey.	Moderate: wetness.	Severe: wetness.	Severe: wetness.	Moderate: shrink-swell.
Dorovan:					
[1]DO	Severe: wetness, floods, excess humus.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
Johnston:					
[1]JO	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Kenansville:					
Ke	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Kureb:					
Kr	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
[1]Ku:					
Kureb part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Urban land part.					
Lakeland:					
La	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Leon:					
Le, [1]Lo	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Lynchburg:					
Ls	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, corrosive.	Moderate: wetness.
Lynn Haven:					
Ly	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: corrosive, wetness.	Severe: wetness.
Mine pits:					
Mp.					

See footnotes at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Murville: Mu	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Newhan: Nh	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Norfolk: No	Slight	Slight	Slight	Slight	Slight.
Onslow: On	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Slight.
Pamlico: Pm	Severe: floods, wetness.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
Pantego: Pn	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Rains: Ra	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, corrosive.	Severe: wetness, floods.
Rimini: Rm	Moderate: cutbanks cave.	Slight	Slight	Slight	Slight.
Seagate: Se	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.
[1]Sh: Seagate part	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.
Stallings: St	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.
Tidal Marsh: TM.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Torhunta: To	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Wakulla: Wa	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Woodington: Wo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Wrightsboro: Wr	Severe: wetness.	Slight	Moderate: wetness.	Moderate: wetness.	Severe: low strength.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 8.--SANITARY FACILITIES

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Bayboro:					
Ba	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, floods.
Baymeade:					
Be, [1]Bh	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
Borrow pits:					
Bp.					
Craven:					
Cr	Severe: percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: too clayey.
Dorovan:					
[1]DO	Severe: wetness, floods.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods.	Poor: wetness, floods, excess humus.
Johnston:					
[1]JO	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Kenansville:					
Ke	Slight[2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
Kureb:					
Kr	Slight[2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: too sandy.
[1]Ku:					
Kureb part	Slight[2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: too sandy.
Urban land part.					
Lakeland:					
La	Slight[2]	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
Leon:					
Le, [1]Lo	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage.	Poor: seepage, too sandy, wetness.
Lynchburg:					
Ls	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
Lynn Haven:					
Ly	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
Mine pits:					
Mp.					

See footnotes at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Murville:					
Mu	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Newhan:					
Nh	Slight[2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: too sandy.
Norfolk:					
No	Slight	Moderate: seepage.	Slight	Slight	Good.
Onslow:					
On	Severe: wetness.	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Good.
Pamlico:					
Pm	Severe: wetness, floods.	Severe: wetness, floods, excess humus.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, excess humus, hard to pack.
Pantego:					
Pn	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Rains:					
Ra	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, floods.
Rimini:					
Rm	Slight[2]	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Seagate:					
Se	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: thin layer, seepage.
[1]Sh:					
Seagate part	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: thin layer, seepage.
Urban land part.					
Stallings:					
St	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.
Tidal marsh: TM.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, floods.
Torhunta:					
To	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Urban land: Ur.					
Wakulla:					
Wa	Slight[2]	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: too sandy.

See footnotes at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Woodington:					
Wo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Wrightsboro:					
Wr	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Good.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

[2]Contamination of nearby water supplies is a hazard if the soils are used for sewage disposal.

TABLE 9.--CONSTRUCTION MATERIALS

["Excess fines" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited." Absence of an entry means soil was not rated]

Soil name and map symbol	Road fill	Sand	Gravel	Topsoil
Bayboro:				
Ba	Poor: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Baymeade:				
Be, [1]Bh	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Borrow pits:				
Bp.				
Craven:				
Cr	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Dorovan:				
[1]DO	Poor: wetness, excess humus.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, excess humus.
Johnston:				
[1]JO	Poor: wetness, excess humus.	Poor: excess fines.	Poor: excess fines.	Poor: wetness.
Kenansville:				
Ke	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Kureb:				
Kr	Good	Good	Unsuited: excess fines.	Poor: too sandy.
[1]Ku:				
Kureb part	Good	Good	Unsuited: excess fines.	Poor: too sandy.
Urban land part.				
Lakeland:				
La	Good	Good	Unsuited: excess fines.	Poor: too sandy.
Leon:				
Le, [1]Lo	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Lynchburg:				
Ls	Fair: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Lynn Haven:				
Ly	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy, wetness.
Mine pits:				
Mp.				
Murville:				
Mu	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.

See footnotes at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Road fill	Sand	Gravel	Topsoil
Newhan:				
Nh	Good	Good	Unsuited: excess fines.	Poor: too sandy.
Norfolk:				
No	Good	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Onslow:				
On	Good	Poor: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Pamlico:				
Pm	Poor: wetness, excess humus.	Poor: excess humus.	Unsuited: excess humus.	Poor: wetness.
Pantego:				
Pn	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.
Rains:				
Ra	Poor: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Rimini:				
Rm	Good	Good	Unsuited: excess fines.	Poor: too sandy.
Seagate:				
Se	Fair: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too sandy.
[1]Sh:				
Seagate part	Fair: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Urban land part.				
Stallings:				
St	Fair: wetness.	Poor: excess fines.	Unsuited: excess fines.	Good.
Tidal marsh:				
TM.	Poor: wetmess.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Torhunta:				
To	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.
Urban land:				
Ur.				
Wakulla:				
Wa	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Woodington:				
Wo	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.
Wrightsboro:				
Wr	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 10.--WATER MANAGEMENT

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not evaluated]

Soil name and map symbol	Limitations for--			Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Bayboro:							
Ba	Slight	Moderate: shrink-swell.	Slight	Percs slowly, floods.	Wetness, floods.	Not needed	Not needed.
Baymeade:							
Be, [1]Bh	Severe: seepage.	Moderate: piping.	Severe: deep to water.	Not needed	Fast intake, droughty.	Too sandy	Droughty.
Borrow pits:							
Bp.							
Craven:							
Cr	Slight	Moderate: piping.	Severe: deep to water, slow refill.	Percs slowly	Erodes easily, percs slowly.	Percs slowly	Percs slowly.
Dorovan:							
[1]DO	Severe: seepage.	Severe: unstable fill, excess humus.	Severe: excess humus.	Floods	Floods	Not needed	Not needed.
Johnston:							
[1]JO	Severe: seepage.	Severe: piping.	Slight	Poor outlets, floods.	Wetness, floods.	Not needed	Not needed.
Kenansville:							
Ke	Severe: seepage.	Moderate: seepage.	Severe: deep to water.	Not needed	Fast intake, droughty.	Too sandy	Droughty.
Kureb:							
Kr	Severe: seepage.	Severe: seepage.	Severe: no water.	Not needed	Fast intake, seepage.	Too sandy	Droughty.
[1]Ku:							
Kureb part	Severe: seepage.	Severe: seepage.	Severe: no water.	Not needed	Fast intake, seepage.	Too sandy	Droughty.
Urban land part.							
Lakeland:							
La	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Not needed	Droughty, seepage, fast intake.	Not needed	Not needed.
Leon:							
Le, [1]Lo	Severe: seepage.	Severe: seepage, piping, erodes easily.	Moderate: deep to water.	Cutbanks cave, wetness.	Wetness	Not needed	Not needed.

See footnotes at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Lynchburg: Ls	Moderate: seepage.	Moderate: piping.	Moderate: deep to water.	Favorable	Wetness	Not needed	Not needed.
Lynn Haven: Ly	Severe: seepage.	Severe: seepage, piping, erodes easily.	Slight	Cutbanks cave, wetness.	Wetness	Not needed	Not needed.
Mine pits: Mp.							
Murville: Mu	Severe: seepage.	Severe: seepage.	Slight	Poor outlets, floods.	Wetness, floods.	Not needed	Not needed.
Newhan: Nh	Severe: seepage.	Severe: seepage.	Severe: deep to water.	Not needed	Fast intake, droughty.	Not needed	Not needed.
Norfolk: No	Moderate: seepage.	Slight	Severe: deep to water.	Not needed	Favorable	Favorable	Favorable.
Onslow: On	Moderate: seepage.	Moderate: piping.	Severe: deep to water.	Favorable	Wetness	Not needed	Not needed.
Pamlico: Pm	Severe: seepage.	Severe: piping.	Slight	Floods, poor outlets.	Wetness, floods.	Not needed	Not needed.
Pantego: Pn	Moderate: seepage.	Slight	Slight	Poor outlets	Wetness	Not needed	Not needed.
Rains: Ra	Moderate: seepage.	Slight	Moderate: deep to water.	Wetness, floods.	Wetness, floods.	Not needed	Not needed.
Rimini: Rm	Severe: seepage.	Severe: seepage, unstable fill.	Severe: no water.	Not needed	Droughty, seepage.	Too sandy	Droughty.
Seagate: Se	Severe: seepage.	Moderate: piping.	Slight	Wetness	Favorable	Not needed	Not needed.
[1]Sh:							
Seagate part	Severe: seepage.	Moderate: piping.	Slight	Wetness	Favorable	Not needed	Not needed.
Urban land part.							

See footnotes at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Stallings: St	Severe: seepage.	Moderate: piping.	Moderate: deep to water.	Cutbanks cave	Wetness	Not needed	Not needed.
Tidal marsh: TM.							
Torhunta: To	Severe: seepage.	Moderate: piping.	Slight	Poor outlets, cutbanks cave.	Wetness	Not needed	Not needed.
Urban land: Ur.							
Wakulla: Wa	Severe: seepage.	Severe: seepage.	Severe: no water.	Not needed	Fast intake, seepage.	Too sandy	Not needed.
Woodington: Wo	Severe: seepage.	Moderate: piping.	Moderate: deep to water.	Cutbanks cave	Wetness	Not needed	Not needed.
Wrightsboro: Wr	Slight	Moderate: low strength.	Moderate: deep to water.	Wetness	Wetness	Wetness	Wetness.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 11.--RECREATIONAL DEVELOPMENT

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Bayboro:				
Ba	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Baymeade:				
Be, [1]Bh	Moderate: too sandy.	Moderate: too sandy.	Severe: too sandy.	Severe: too sandy.
Borrow pits:				
Bp.				
Craven:				
Cr	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Dorovan:				
[1]DO	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.
Johnston:				
[1]JO	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Kenansville:				
Ke	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
Kureb:				
Kr	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
[1]Ku:				
Kureb part	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Urban land part.				
Lakeland:				
La	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Leon:				
Le, [1]Lo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Lynchburg:				
Ls	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Lynn Haven:				
Ly	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Mine pits:				
Mp.				
Murville:				
Mu	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.

See footnotes at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Newhan:				
Nh	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Norfolk:				
No	Slight	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Onslow:				
On	Moderate: too sandy, wetness.	Moderate: too sandy, wetness.	Moderate: too sandy, wetness.	Moderate: too sandy.
Pamlico:				
Pm	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Pantego:				
Pn	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Rains:				
Ra	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Rimini:				
Rm	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Seagate:				
Se	Moderate: too sandy, wetness.	Moderate: too sandy, wetness.	Severe: too sandy.	Severe: too sandy.
[1]Sh:				
Seagate part	Moderate: too sandy, wetness.	Moderate: too sandy, wetness.	Severe: too sandy.	Severe: too sandy.
Urban land part.				
Stallings:				
St	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
Tidal marsh:				
TM.				
Torhunta:				
To	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Wakulla:				
Wa	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Woodington:				
Wo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Wrightsboro:				
Wr	Slight	Slight	Slight	Slight.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 12.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Bayboro:										
Ba	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Baymeade:										
Be, [1]Bh	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Borrow pits:										
Bp.										
Craven:										
Cr	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Dorovan:										
[1]DO	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
Johnston:										
[1]JO	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Kenansville:										
Ke	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Kureb:										
Kr	Very poor.	Poor	Poor	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.
[1]Ku:										
Kureb part	Very poor.	Poor	Poor	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Urban land part.										
Lakeland:										
La	Poor	Fair	Fair	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Leon:										
Le, [1]Lo.										
Lynchburg:										
Ls	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Lynn Haven:										
Ly	Poor	Fair	Fair	Poor	Fair	Fair	Fair	Poor	Fair	Fair.
Mine pits:										
Mp.										
Murville:										
Mu	Very poor.	Poor	Poor	Poor	Poor	Good	Fair	Poor	Poor	Fair.
Newhan:										
Nh	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Norfolk:										
No	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

See footnotes at end of table.

TABLE 12.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Onslow:										
On	Poor	Fair	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
Pamlico:										
Pm	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Pantego:										
Pn	Very poor.	Poor	Poor	Poor	Poor	Good	Fair	Poor	Poor	Fair.
Rains:										
Ra	Very poor.	Very poor.	Very poor.	Fair	Fair	Good	Good	Very poor.	Poor	Good.
Rimini:										
Rm	Very poor.	Very poor.	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
Seagate:										
Se	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
[1]Sh:										
Seagate part	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
Urban land part.										
Stallings:										
St.										
Tidal marsh:										
TM.										
Torhunta:										
To	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Urban land:										
Ur.										
Wakulla:										
Wa	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Woodington:										
Wo	Poor	Fair	Fair	Fair	Fair	Good	Poor	Fair	Fair	Fair.
Wrightsboro:										
Wr	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Bayboro:											
Ba	0-16	Loam	CL, ML	A-6, A-7	0	100	100	85-100	60-80	30-42	11-22
	16-72	Clay loam, sandy clay loam.	CL, CH	A-7	0	100	100	85-100	55-90	41-70	20-40
Baymeade:											
Be, [1]Bh	0-36	Fine sand	SM, SP-SM	A-2, A-3	0	100	100	51-70	5-15	---	[2]NP
	36-49	Fine sandy loam	CL, CL-ML, SC, SM-SC	A-2, A-4	0	100	100	60-90	30-55	10-20	5-9
	49-78	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	51-75	5-30	---	NP
Borrow pits:											
Bp.											
Craven:											
Cr	0-8	Fine sandy loam	ML, CL-ML	A-4	0	100	100	75-100	51-70	<25	NP-7
	8-64	Clay loam, clay, sandy clay loam.	CH, MH	A-7	0	100	100	90-100	70-95	51-60	18-35
Dorovan:											
[1]DO	0-64	Muck	Pt	---	0	---	---	---	---	---	---
Johnston:											
[1]JO	0-42	Loam, sandy loam	ML, CL, SM, SC	A-2, A-4	0	100	100	60-95	30-75	<35	NP-10
	42-64	Sand	SM, SP-SM	A-2, A-4	0	100	100	50-85	5-12	---	NP
Kenansville:											
Ke	0-33	Fine sand	SM	A-1, A-2	0	100	95-100	45-60	10-25	<25	NP-3
	33-50	Fine sandy loam	SM, SC, SM-SC	A-2	0	100	95-100	50-65	20-35	<30	NP-10
	50-80	Loamy fine sand	SP-SM, SM	A-1, A-2, A-3	0	100	95-100	40-60	5-30	---	NP
Kureb:											
Kr	0-89	Sand	SP	A-3	0	100	100	60-95	0-5	---	NP
[1]Ku:											
Kureb part	0-89	Sand	SP	A-3	0	100	100	60-95	0-5	---	NP
Urban land part.											
Lakeland:											
La	0-48	Sand	SP-SM	A-3, A-2-4	0	90-100	90-100	60-100	5-12	---	NP
	48-80	Sand	SP, SP-SM	A-3, A-2-4	0	90-100	90-100	50-100	1-12	---	NP
Leon:											
Le, [1]Lo	0-6	Sand	SP, SP-SM	A-3, A-2-4	0	100	100	80-100	2-12	---	NP
	6-64	Sand	SM, SP-SM	A-3, A-2-4	0	100	100	80-100	5-20	---	NP

See footnotes at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Lynchburg:											
Ls	0-6	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	100	75-100	25-50	<30	NP-7
	6-64	Sandy clay loam, clay loam.	SM-SC, SC, CL, CL-ML	A-2, A-4, A-6	0	100	100	70-100	25-60	15-40	4-18
Lynn Haven:											
Ly	0-24	Fine sand	SP, SP-SM	A-3, A-2-4	0	100	100	80-100	2-12	---	NP
	24-64	Sand	SM, SP-SM	A-3, A-2-4	0	100	100	80-100	5-20	---	NP
	64-75	Sandy clay, sandy loam.	SP, SP-SM, SM, SM-SC	A-3, A-2-4	0	100	100	80-100	2-30	<30	NP-7
Mine pits:											
Mp.											
Murville:											
Mu	0-8	Fine sand	SP-SM, SM	A-2, A-3	0	100	100	95-100	5-20	---	NP
	8-56	Fine sand	SM, SP-SM	A-2	0	100	100	95-100	12-20	---	NP
	56-60	Sandy clay loam, sandy loam.	SC, SM-SC, CL, CL-ML	A-2, A-4, A-6	0	100	95-100	70-95	30-55	20-40	4-2
	60-70	Fine sand	SP-SM	A-2, A-3	0	100	100	95-100	5-12	---	NP
Newhan:											
Nh	0-72	Fine sand, sand	SP	A-3	0	95-100	95-100	60-75	0-5	---	NP
Norfolk:											
No	0-12	Fine sandy loam, loamy fine sand.	SM, SM-SC, SC	A-2	0	95-100	95-100	50-91	15-33	<25	NP-14
	12-85	Sandy loam, sandy clay loam, clay.	SC, SM-SC, CL, CL-ML	A-2, A-4, A-6	0	95-100	91-100	70-96	30-55	20-40	4-20
Onslow:											
On	0-17	Loamy fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	100	95-100	60-85	5-30	---	NP
	17-64	Sandy clay loam, sandy loam, clay loam.	SM, CL, SM-SC, SC	A-2, A-4, A-6	0	100	95-100	60-90	30-55	<30	NP-12
Pamlico:											
Pm	0-36	Muck	Pt	---	0	---	---	---	---	---	---
	36-60	Sand	SM, SP-SM	A-2, A-3	0	100	100	70-95	5-20	---	NP
Pantego:											
Pn	0-16	Loam	SM, SM-SC, CL, CL-ML	A-2, A-4, A-6	0	100	100	60-95	30-75	<30	NP-12
	16-99	Sandy clay loam, clay loam.	SC, CL	A-4, A-6	0	100	95-100	80-100	36-80	25-40	8-16
Rains:											
Ra	0-8	Fine sandy loam, fine sandy clay loam.	SM, SM-SC	A-2, A-4	0	100	95-100	50-85	25-50	<35	NP-10
	8-64	Clay loam, clay	SC, SM-SC, CL, CL-ML	A-2, A-4, A-6	0	100	98-100	65-98	30-70	18-40	4-18
	64-68	Fine sandy loam	SM, SC, ML, CL CL-ML, SM-SC	A-2, A-4, A-6	0	100	95-100	60-95	30-60	<35	NP-7

See footnotes at end of table.

TABLE 13.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Rimini:											
Rm	0-56	Sand	SP, SP-SM	A-3	0	100	98-100	60-98	2-5	---	NP
	56-80	Sand	SP, SP-SM	A-3	0	100	98-100	75-100	3-10	---	NP
Seagate:											
Se	0-12	Fine sand	SM, SP-SM	A-2, A-3	0	100	100	90-100	5-20	---	NP
	12-28	Fine sand	SM, SP-SM	A-2	0	100	100	90-100	10-25	---	NP
	28-36	Fine sand	SM, SP-SM	A-2	0	100	100	90-100	5-20	---	NP
	36-40	Sandy loam	SM, SM-SC	A-2, A-4	0	100	100	85-100	20-45	<30	NP-7
	40-66	Clay loam	CL	A-6, A-7	0	100	100	80-100	55-95	35-50	16-27
[1]Sh:											
Seagate part	0-12	Fine sand	SM, SP-SM	A-2, A-3	0	100	100	90-100	5-20	---	NP
	12-28	Fine sand	SM, SP-SM	A-2	0	100	100	90-100	10-25	---	NP
	28-36	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	100	90-100	5-20	---	NP
	36-40	Sandy loam	SM, SM-SC	A-2, A-4	0	100	100	85-100	20-45	<30	NP-7
	40-66	Clay loam	CL	A-6, A-7	0	100	100	80-100	55-95	35-50	16-27
Urban land part.											
Stallings:											
St	0-14	Fine sand	SM	A-2	0	100	95-100	51-85	15-30	---	NP
	14-54	Fine sandy loam	SM	A-2, A-4	0	100	95-100	51-95	20-50	<25	NP-3
	54-68	Fine sandy loam, loamy fine sand	SM, SP-SM	A-2, A-4	0	100	95-100	51-95	10-50	<25	NP-3
Tidal marsh: TM.											
Torhunta:											
To	0-20	Loamy fine sand	SM	A-2, A-4	0	100	95-100	70-85	20-49	---	NP
	20-47	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-85	20-40	---	NP
	47-64	Fine sand	SM, SP-SM	A-2, A-3	0	100	95-100	65-85	5-25	---	NP
Urban land: Ur.											
Wakulla:											
Wa	0-30	Sand	SM, SP-SM	A-2, A-3	0	100	100	75-90	5-15	---	NP
	30-48	Loamy sand	SM, SP-SM	A-2	0	100	100	80-95	10-25	---	NP
	48-64	Sand	SM, SP-SM	A-2, A-3	0	100	100	75-80	5-15	---	NP
Woodington:											
Wo	0-7	Fine sandy loam	SM	A-2, A-4	0	100	95-100	50-95	20-50	<25	NP-3
	7-65	Fine sandy loam	SM	A-2, A-4	0	100	95-100	50-95	20-50	<25	NP-3
Wrightsboro:											
Wr	0-9	Fine sandy loam	SM	A-2, A-4	0	98-100	95-100	51-95	20-50	<25	NP-3
	9-48	Sandy clay loam	SC, CL	A-6, A-7	0	98-100	95-100	60-95	40-70	30-50	11-25
	48-65	Clay	CH	A-7	0	98-100	95-100	85-98	75-95	50-75	25-45

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.
[2]Nonplastic.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[Dashes indicate data were not available. The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
	In	In per hour	In per in of soil	pH			
Bayboro:							
Ba	0-16	0.6-2.0	0.15-0.20	4.5-5.5	Low	High	High.
	16-72	0.06-0.2	0.14-0.18	4.5-5.5	Moderate	High	High.
Baymeade:							
Be, [1]Bh	0-36	6.0-20	0.02-0.06	5.1-6.5	Low	Low	Moderate.
	36-49	2.0-6.0	0.10-0.14	5.1-6.5	Low	Low	Moderate.
	49-78	6.0-20	0.02-0.10	5.1-6.5	Low	Low	Moderate.
Borrow pits:							
Bp.							
Craven:							
Cr	0-8	0.6-2.0	0.12-0.18	4.5-6.0	Low	High	High.
	8-64	<0.2	0.12-0.15	4.5-5.5	Moderate	High	High.
Dorovan:							
[1]DO	0-4	<0.06	0.25-0.50	4.5-5.5	----------	High	High.
	4-64	<0.06	0.25-0.50	4.5-5.5	----------	High	High.
Johnston:							
[1]JO	0-42	2.0-6.0	0.10-0.20	4.5-5.5	Low	High	High.
	42-64	6.0-20	0.06-0.12	4.5-5.5	Low	High	High.
Kenansville:							
Ke	0-33	6.0-20	0.04-0.10	4.5-6.0	Low	Low	High.
	33-50	2.0-6.0	0.10-0.14	4.5-6.0	Low	Low	High.
	50-80	6.0-20	<0.05	4.5-6.0	Low	Low	High.
Kureb:							
Kr	0-89	6.0-20	<0.05	4.5-7.3	Low	Low	Low.
[1]Ku:							
Kureb part	0-89	6.0-20	<0.05	4.5-7.3	Low	Low	Low.
Urban land part.							
Lakeland:							
La	0-48	>20	0.05-0.08	4.5-6.0	Very low	Low	Moderate.
	48-80	>20	0.03-0.08	4.5-6.0	Very low	Low	Moderate.
Leon:							
Le, [1]Lo	0-6	6.0-20	0.02-0.05	3.6-5.5	Very low	High	High.
	6-30	0.6-6.0	0.05-0.10	3.6-5.5	Very low	High	High.
	30-80	>20	0.02-0.05	3.6-5.5	Very low	High	High.
Lynchburg:							
Ls	0-6	2.0-6.0	0.09-0.13	3.6-5.5	Low	High	High.
	6-64	0.6-2.0	0.12-0.16	3.6-5.5	Low	High	High.
Lynn Haven:							
Ly	0-24	6.0-20	0.02-0.05	3.6-5.5	Very low	High	High.
	24-64	0.6-6.0	0.05-0.10	3.6-5.5	Very low	High	High.
	64-75	>20	0.01-0.05	3.6-5.5	Very low	High	High.
Mine pits:							
Mp.							
Murville:							
Mu	0-8	6.0-20	0.05-0.09	3.6-5.5	Low	High	Moderate.
	8-60	2.0-6.0	0.05-0.09	3.6-5.5	Low	High	Moderate.
	60-70	6.0-20	0.04-0.07	3.6-5.5	Low	High	Moderate.

See footnotes at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
	In	In per hour	In per in of soil	pH			
Newhan:							
Nh	0-72	>20	<0.05	6.6-7.8	Low	High	Low.
Norfolk:							
No	0-12	2.0-6.0	0.06-0.10	4.5-6.0	Low	Moderate	High.
	12-85	0.6-2.0	0.10-0.15	4.5-5.5	Low	Moderate	High.
Onslow:							
On	0-17	>6.0	0.07-0.11	3.6-5.5	Low	High	High.
	17-64	0.6-2.0	0.12-0.17	3.6-5.5	Low	High	High.
Pamlico:							
Pm	0-36	0.6-2.0	0.24-0.26	3.6-4.4	----------	High	High.
	36-60	6.0-20	0.03-0.06	3.6-5.5	Low	High	High.
Pantego:							
Pn	0-16	2.0-6.0	0.10-0.20	4.5-5.5	Low	Moderate	High.
	16-99	0.6-2.0	0.12-0.20	4.5-5.5	Low	High	High.
Rains:							
Ra	0-8	2.0-6.0	0.08-0.12	4.5-6.5	Low	High	High.
	8-64	0.6-2.0	0.10-0.15	4.5-5.5	Low	High	High.
	64-68	0.6-2.0	0.10-0.15	4.5-5.5	Low	High	High.
Rimini:							
Rm	0-56	>20	0.02-0.05	3.6-5.5	Low	Low	Low.
	56-80	0.6-2.0	0.03-0.07	3.6-5.5	Low	Low	Low.
Seagate:							
Se	0-12	6.0-20.0	0.03-0.06	3.6-6.0	Low	High	High.
	12-28	6.0-20.0	0.05-0.12	3.6-6.0	Low	High	High.
	28-36	6.0-20.0	0.03-0.06	3.6-6.0	Low	High	High.
	36-40	0.6-2.0	0.12-0.20	3.6-6.0	Low	High	High.
	40-66	0.6-2.0	0.15-0.20	3.6-6.0	Low	High	High.
[1]Sh:							
Seagate part	0-12	6.0-20.0	0.03-0.06	3.6-6.0	Low	High	High
	12-28	6.0-20.0	0.05-0.12	3.6-6.0	Low	High	High.
	28-36	6.0-20.0	0.03-0.06	3.6-6.0	Low	High	High.
	36-40	0.6-2.0	0.12-0.20	3.6-6.0	Low	High	High.
	40-66	0.6-2.0	0.15-0.20	3.6-6.0	Low	High	High.
Stallings:							
St	0-14	6.0-20	0.06-0.11	3.6-5.5	Low	High	High.
	14-54	2.0-6.0	0.10-0.15	3.6-5.5	Low	High	High.
	54-68	2.0-20	0.06-0.15	3.6-5.5	Low	High	High.
Tidal marsh:							
TM.							
Torhunta:							
To	0-20	2.0-6.0	0.10-0.15	3.6-5.5	Low	High	High.
	20-47	2.0-6.0	0.10-0.15	3.6-5.5	Low	High	High.
	47-64	6.0-20	<0.05	3.6-5.5	Low	High	High.
Wakulla:							
Wa	0-30	6.0-20	<0.05	4.5-6.0	Low	Low	High.
	30-48	6.0-20	0.05-0.10	4.5-6.0	Low	Low	High.
	48-64	6.0-20	<0.05	4.5-6.0	Low	Low	High.
Woodington:							
Wo	0-7	2.0-6.0	0.10-0.15	3.6-5.5	Low	High	High.
	7-65	2.0-6.0	0.10-0.15	3.6-5.5	Low	High	High.
Wrightsboro:							
Wr	0-9	2.0-6.0	0.10-0.15	4.5-6.0	Low	Moderate	High.
	9-48	0.6-2.0	0.12-0.20	4.5-6.0	Low	Moderate	High.
	48-65	.06-0.2	0.18-0.20	4.5-6.0	Moderate	Moderate	High.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 15.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. See Glossary for definition of flooding and the terms used to describe frequency and duration of flooding. The symbol < means less than; > means greater than]

Soil name and map symbol	Flooding			High water table		
	Frequency	Duration	Months	Depth	Kind	Months
				Ft		
Bayboro:						
Ba	Common	Brief	Dec-Mar	0-0.5	Apparent	Dec-Apr
Baymeade:						
Be, [1]Bh	None	---	---	4.0-5.0	Apparent	Dec-Apr
Borrow pits:						
Bp.						
Craven:						
Cr	None	---	---	2.0-3.0	Apparent	Dec-Mar
Dorovan:						
[1]DO	Frequent	Very long	Jan-Dec	<0.5	Apparent	Jan-Dec
Johnston:						
[1]JO	Frequent	Long	Nov-Jul	([2])-1.5	Apparent	Nov-Jun
Kenansville:						
Ke	None	---	---	>6.0	---	---
Kureb:						
Kr	None	---	---	>6.0	---	---
[1]Ku:						
Kureb part	None	---	---	>6.0	---	---
Urban land part.						
Lakeland:						
La	None	---	---	>6.0	---	---
Leon:						
Le, [1]Lo	None	---	---	0-1.0	Apparent	Jun-Feb
Lynchburg:						
Ls	None	---	---	0.5-1.5	Apparent	Nov-Apr
Lynn Haven:						
Ly	Frequent	Brief	Jan-Mar	0-1.0	Apparent	Jun-Feb
Mine pits:						
Mp.						
Murville:						
Mu	Frequent	Brief	Nov-Jun	0-1.0	Apparent	Nov-Apr
Newhan:						
Nh	None to rare	---	---	>6.0	---	---
Norfolk:						
No	None	---	---	>6.0	---	---
Onslow:						
On	None	---	---	1.5-3.0	Apparent	Nov-Apr
Pamlico:						
Pm	Frequent	Very long	Nov-Jun	([2])-1.0	Apparent	Nov-Jul
Pantego:						
Pn	None to rare	Very brief	Nov-Feb	0-1.5	Apparent	Nov-Apr

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Flooding			High water table		
	Frequency	Duration	Months	Depth	Kind	Months
				Ft		
Rains:						
Ra	Rare to common.	Brief	Dec-Mar	0-1.0	Apparent	Nov-Apr
Rimini:						
Rm	None	---	---	>6.0	---	---
Seagate:						
Se	None	---	---	1.5-2.5	Apparent	Nov-Apr
[1]Sh:						
Seagate part	None	---	---	1.5-2.5	Apparent	Nov-Apr
Urban land part.						
Stallings:						
St	None	---	---	1.5-2.5	Apparent	Dec-Mar
Tidal marsh:						
TM.						
Torhunta:						
To	Frequent	Long	Jan-Apr	([3])-1.5	Apparent	Nov-Apr
Urban land:						
Ur.						
Wakulla:						
Wa	None	---	---	>6.0	---	---
Woodington:						
Wo	None	---	---	0.5-1.0	Apparent	Dec-Mar
Wrightsboro:						
Wr	None	---	---	2.0-3.0	Apparent	Dec-Feb

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

[2]Water table is 1.0 foot above the surface of the soil.

[3]Water table is .5 foot above the surface of the soil.

TABLE 16.--ENGINEERING TEST DATA

Soil name and location	Parent material	Report No.	Depth	Horizon	Moisture density: Maximum dry density	Moisture density: Optimum moisture	Percentage passing sieve--: No. 10	No. 40	No. 200	Percentage smaller than--: 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification: AASHTO[4]	Classification: Unified[5]
			In		Pct	Pct								Pct			
Wrightsboro fine sandy loam (modal): 3.5 miles north of Wilmington to junction of U.S. Highway 117 and State Route 1329, 100 feet west of U.S. Highway 117 and 50 feet north of State Route 1329, in cultivated field.	Coastal Plain sediment.	6-1	0-6	Ap	119	9	100	86	42	30	13	4	2	--	[6]NP	A-4	SM
		6-4	24-36	B22t	111	16	100	88	61	54	43	32	28	44	24	A-7	CL
		6-6	48-65	IIC	105	17	100	97	86	74	59	46	42	55	34	A-7	CH
Kureb sand (modal): 1.75 miles south of junction of U.S. Highway 421 and South Carolina Highway 132 to Battle Park development, east to first paved street and then south to junction of next street, on east side of New Road.	Coastal Plain sediment.	5-2	3-26	A2	98	17	100	79	2	1	1	1	1	--	NP	A-3	NP
		5-3	26-51	C&Bh	102	15	100	77	2	1	1	1	1	--	NP	A-3	SP
Lynchburg fine sandy loam (modal): 100 feet southeast of northwest corner of New Hanover County Airport and 3 feet east of Airport property line at edge of cultivated field.	Coastal Plain sediment.	4-1	0-6	Ap	109	13	100	98	38	24	14	8	6	--	NP	A-4	SM
		4-4	33-46	B22tg	115	14	100	99	47	38	29	23	21	28	9	A-4	SC
		4-6	66-72	Cg	115	13	100	99	40	31	24	20	18	26	6	A-4	SC-SM

See footnotes at end of table.

TABLE 16.--ENGINEERING TEST DATA--Continued

Soil name and location	Parent material	Report No.	Depth	Horizon	Moisture density: Maximum dry density	Moisture density: Optimum moisture	Percentage passing sieve--: No. 10	No. 40	No. 200	Percentage smaller than--: 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification: AASHTO[4]	Unified[5]
			In		Pct	Pct								Pct			
Seagate sand (modal): 0.4 mile north of intersection of North Carolina 132 and U.S. highway 421, along north edge of field road, in cultivated field.	Coastal Plain sediment.	2-1	0-8	A1	100	15	100	99	5	4	3	1	1	--	NP	A-1	SP-SM
		2-3	12-23	B21h	107	13	100	100	15	11	8	5	4	--	NP	A-2	SM
		2-6	36-40	B'2t	116	13	100	100	25	23	20	16	15	22	1	A-2	SM
		2-7	40-64	IIC	107	17	100	100	89	73	52	37	33	47	27	A-7	CL
Murville loamy fine sand (modal): 0.5 mile north of junction of U.S. Highway 421 and North Carolina Highway 132 along North Carolina Highway 132, 1,600 feet east along canal, in wooded area.	Coastal Plain sediment.	1-1	0-8	A1	109	14	100	96	16	14	11	6	3	--	NP	A-2	SM
		1-2	8-45	B2h	114	11	100	96	14	13	11	7	5	--	NP	A-2	SM
		1-3	45-56	C1	102	16	100	100	4	4	3	2	1	--	NP	A-3	SP
		1-4	56-64	IIC2	112	14	100	100	78	53	26	12	8	23	4	A-4	CL-ML

[1]Tests performed by the North Carolina State Highway Commission in accordance with standard procedures of the American Association of State Highway and Transportation Officials (AASHTO).

[2]Based on AASHTO Designation T 99, Method A. (1).

[3]Mechanical analyses according to the AASHTO Designation T 88 (1). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diamter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[4]Based on AASHTO Designation M 145-49 (1).

[5]Based on the Unified soil classification system (2).

[6]Nonplastic.

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

Soil name	Family or higher taxonomic class
Bayboro	Clayey, mixed, thermic Umbric Paleaquults
Baymeade	Loamy, siliceous, thermic Arenic Hapludults
*Craven	Clayey, mixed, thermic Aquic Hapludults
Dorovan	Dysic, thermic Typic Medisaprists
Johnston	Coarse-loamy, siliceous, acid, thermic Cumulic Humaquepts
Kenansville	Loamy, siliceous, thermic Arenic Hapludults
Kureb	Thermic, uncoated Spodic Quartzipsamments
Lakeland	Thermic, coated Typic Quartzipsamments
Leon	Sandy, siliceous, thermic Aeric Haplaquods
*Lynchburg	Fine-loamy, siliceous, thermic Aeric Paleaquults
Lynn Haven	Sandy, siliceous, thermic Typic Haplaquods
Murville	Sandy, siliceous, thermic Typic Haplaquods
Newhan	Mixed, thermic Typic Udipsamments
Norfolk	Fine-loamy, siliceous, thermic Typic Paleudults
Onslow	Fine-loamy, siliceous, thermic Spodic Paleudults
Pamlico	Sandy or sandy-skeletal, siliceous, dysic, thermic Terric Medisaprists
Pantego	Fine-loamy, siliceous, thermic Umbric Paleaquults
*Rains	Fine-loamy, siliceous, thermic Typic Paleaquults
Rimini	Sandy, siliceous, thermic Grossarenic Entic Haplohumods
Seagate	Sandy over loamy, siliceous, thermic Typic Haplohumods
Stallings	Coarse-loamy, siliceous, thermic Aeric Paleaquults
Torhunta	Coarse-loamy, siliceous, acid, thermic Typic Humaquepts
Wakulla	Sandy, siliceous, thermic Psammentic Hapludults
Woodington	Coarse-loamy, siliceous, thermic Typic Paleaquults
Wrightsboro	Fine-loamy, siliceous, thermic Aquic Paleudults

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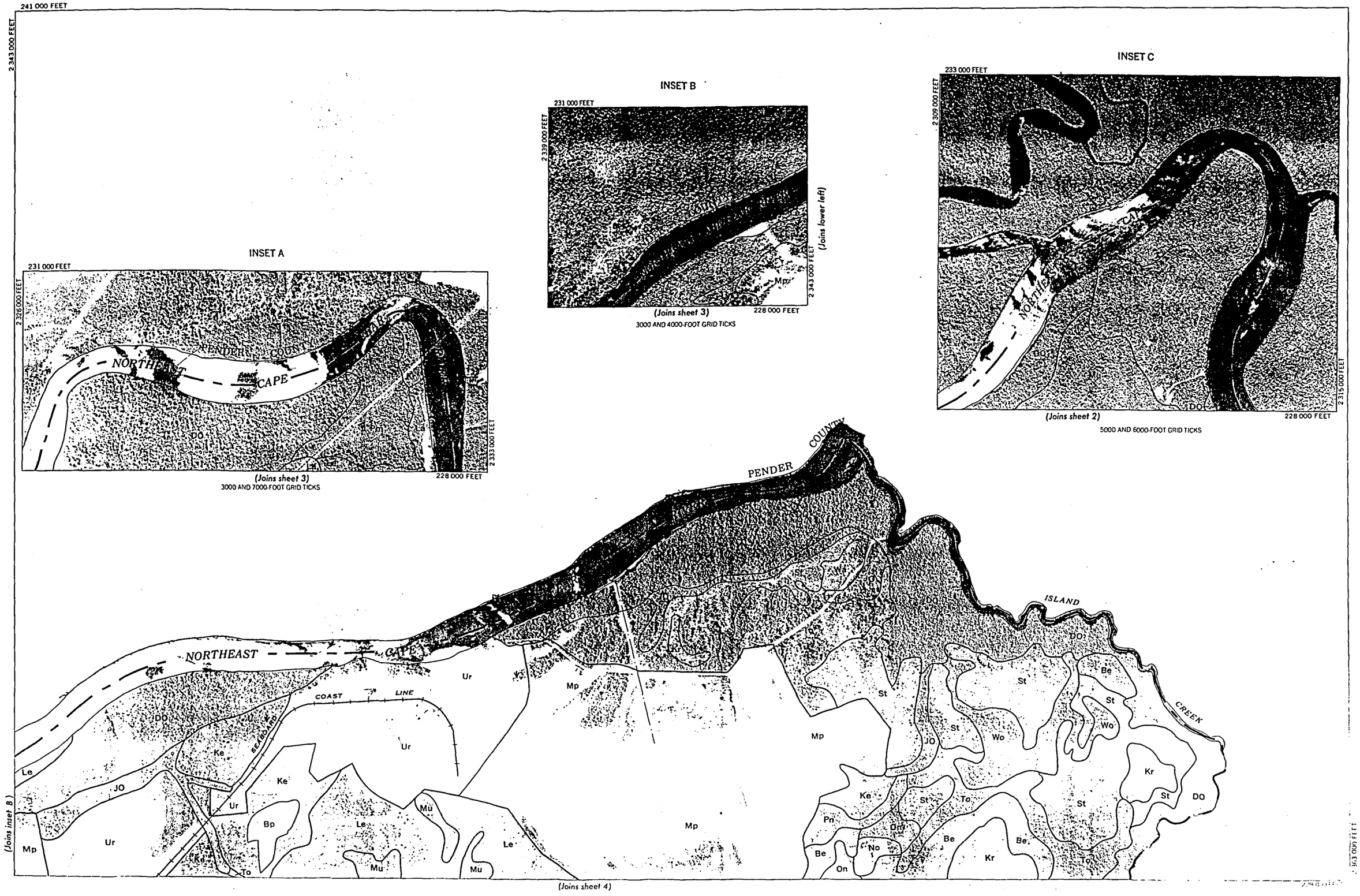

NEW HANOVER COUNTY, NORTH CAROLINA — SHEET NUMBER 2

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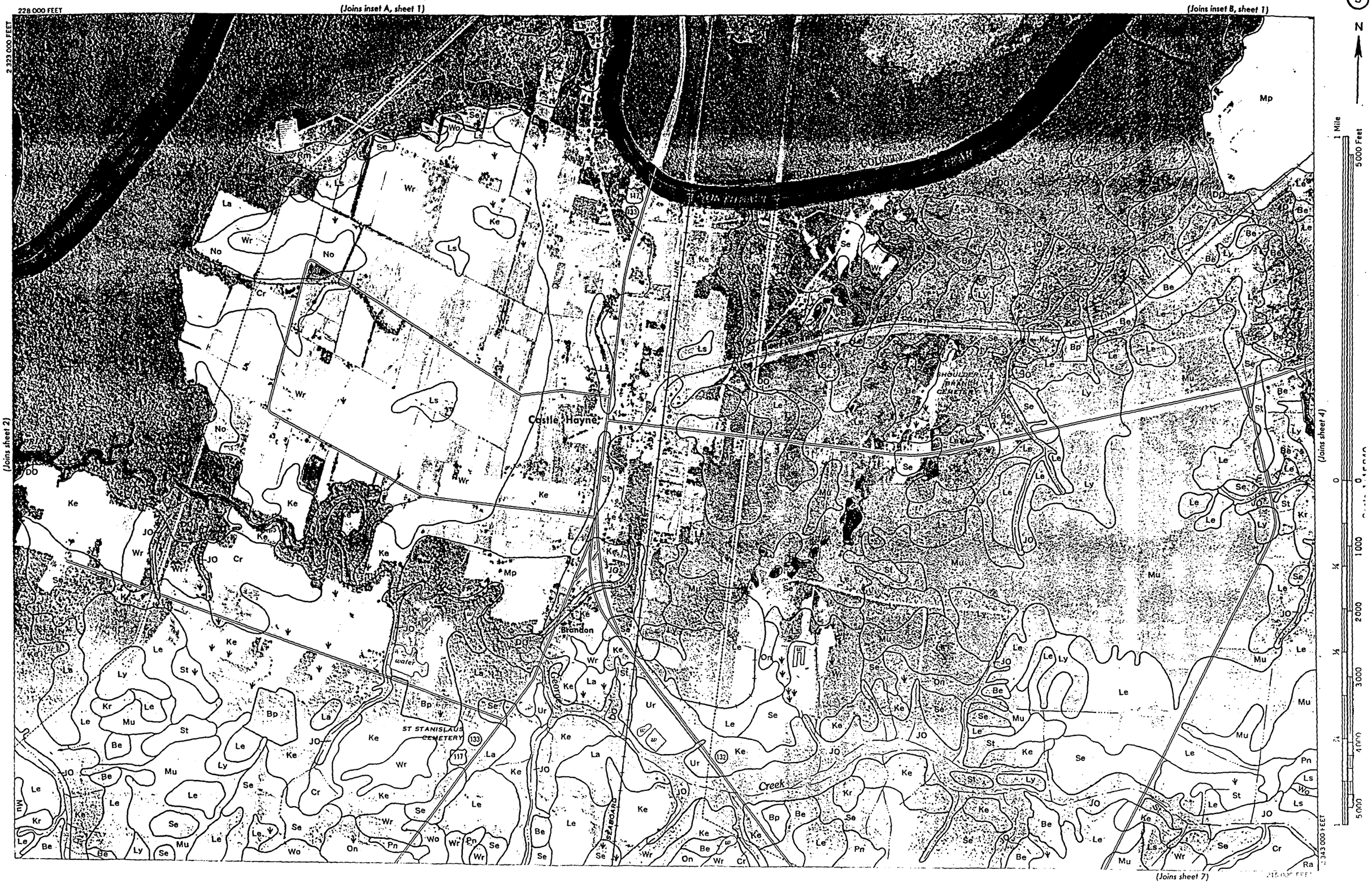

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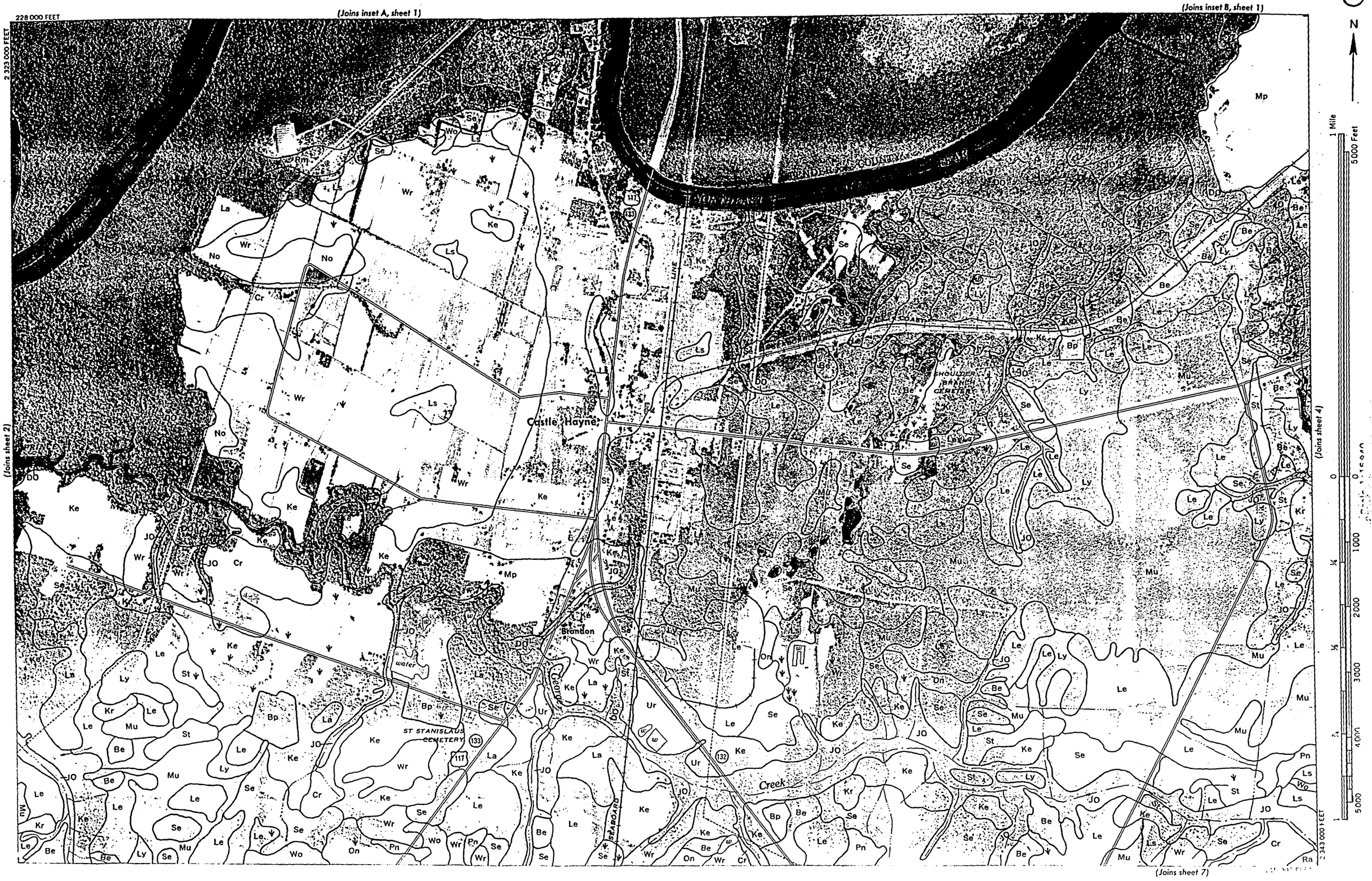

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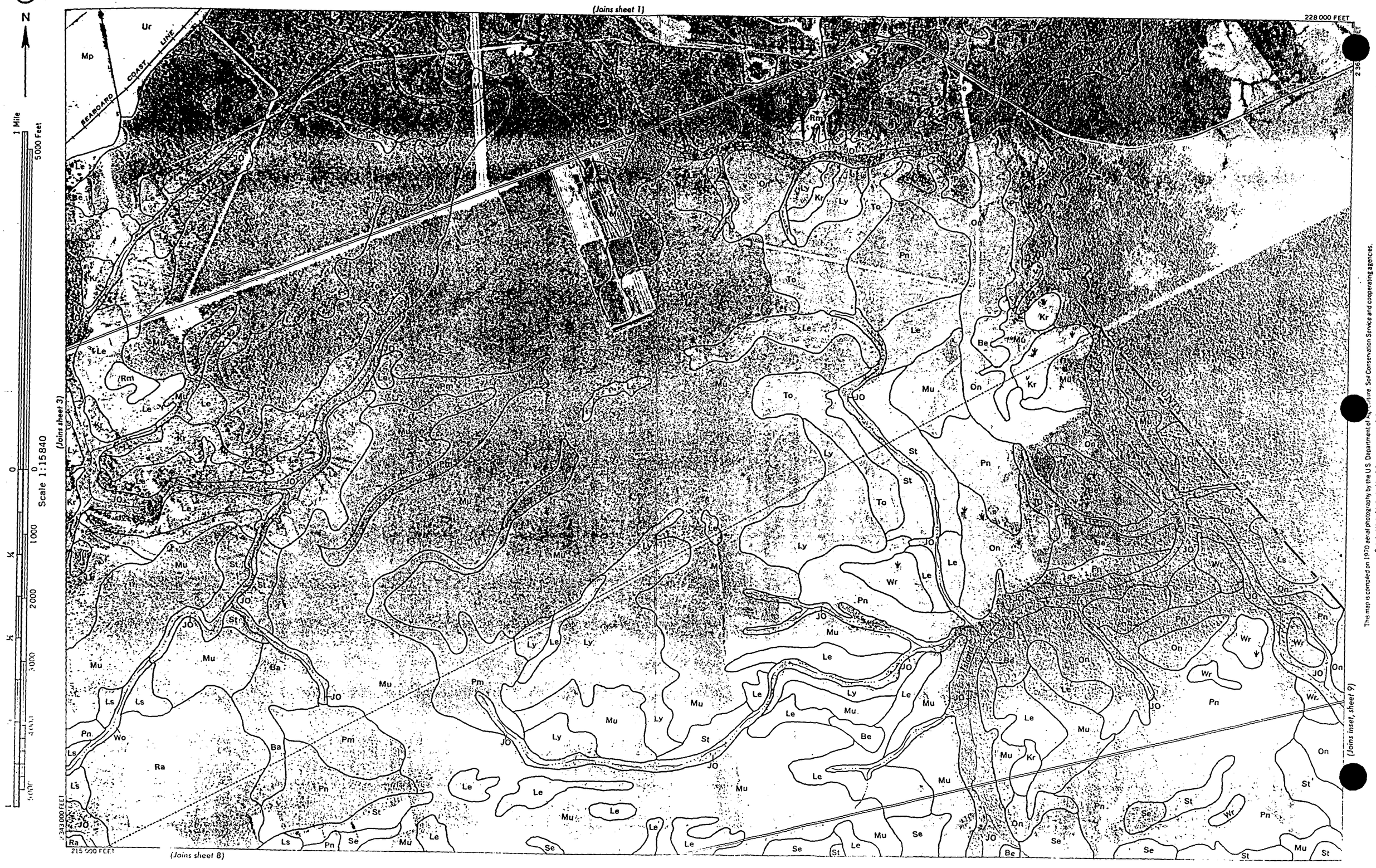

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

215 000 FEET

2 283 000 FEET

202 000 FEET

(Joins lower right)

2 296 000 FEET

(Joins sheet 10)

2 303 000 FEET

191 000 FEET

(Joins sheet 6)

2 303 000 FEET

(Joins inset)

202 000 FEET

N

1 Mile

5000 Feet

Scale 1:15840

1 ¾ ½ ¼ 0

0 1000 2000 3000 4000 5000

6

N

1 Mile

5000 Feet

Scale 1:15840

(Joins sheet 2)

215 000 FEET

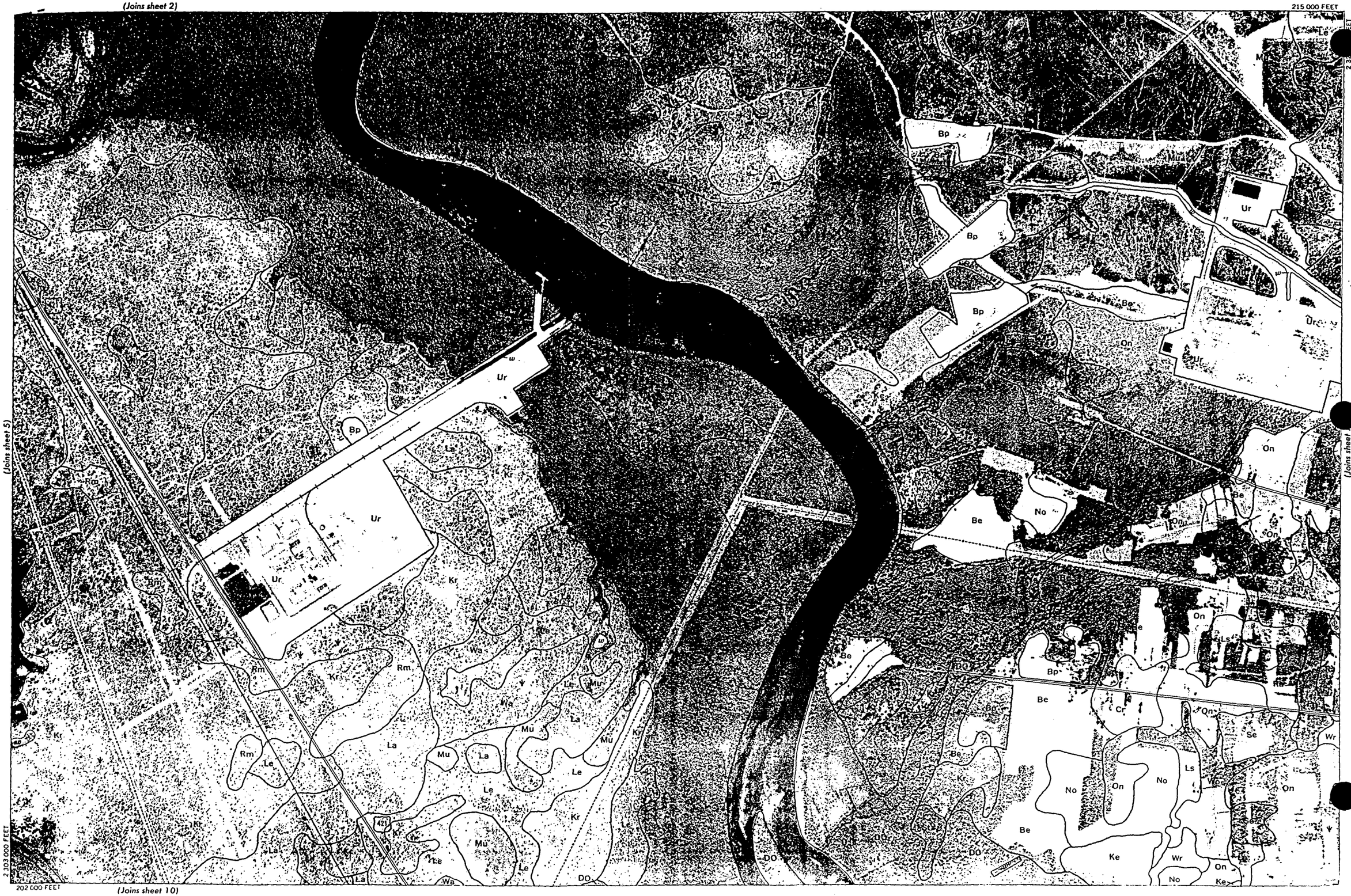
(Joins sheet 5)

(Joins sheet 7)

2 303 000 FEET

202 000 FEET

(Joins sheet 10)



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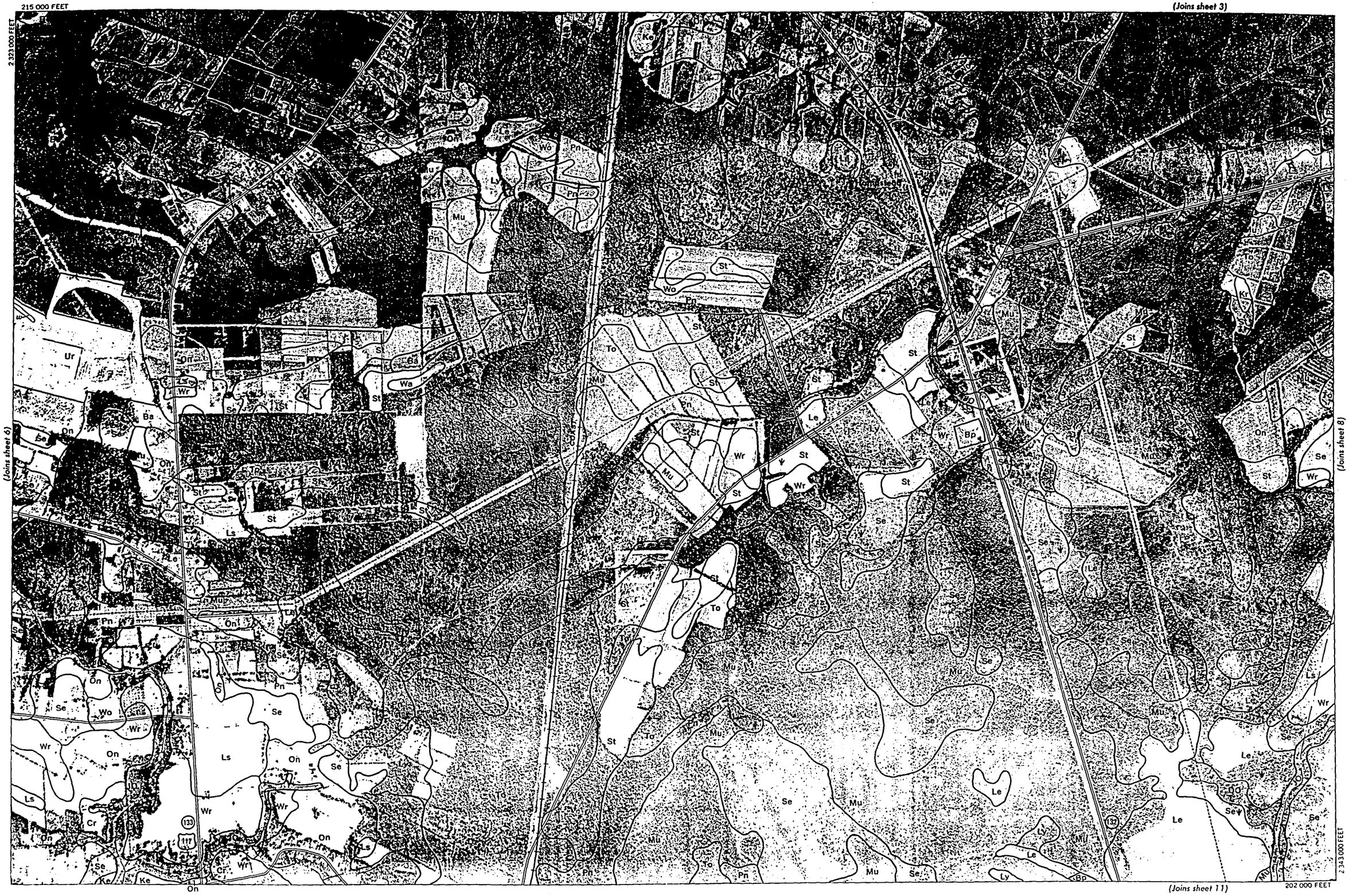

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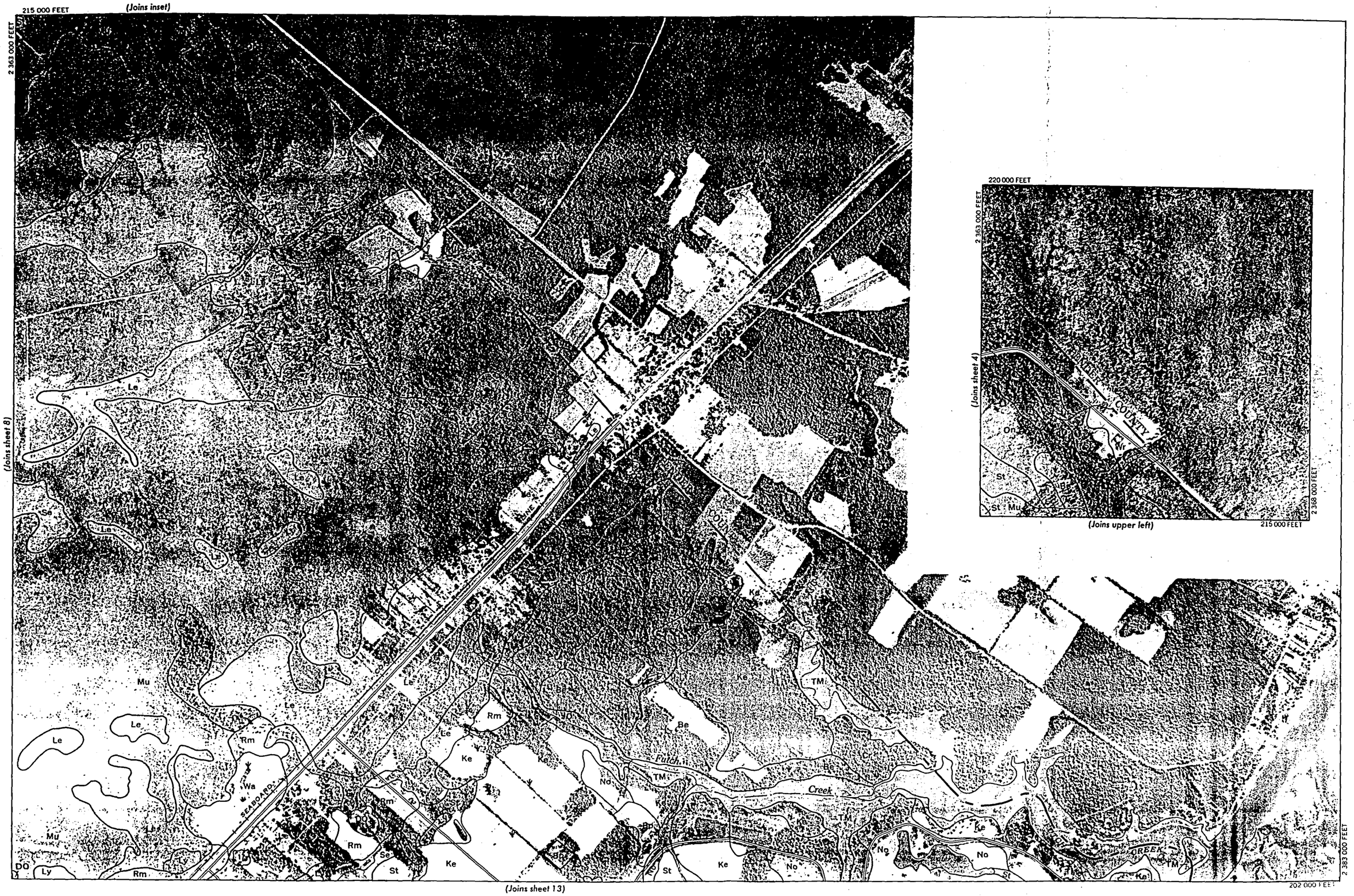

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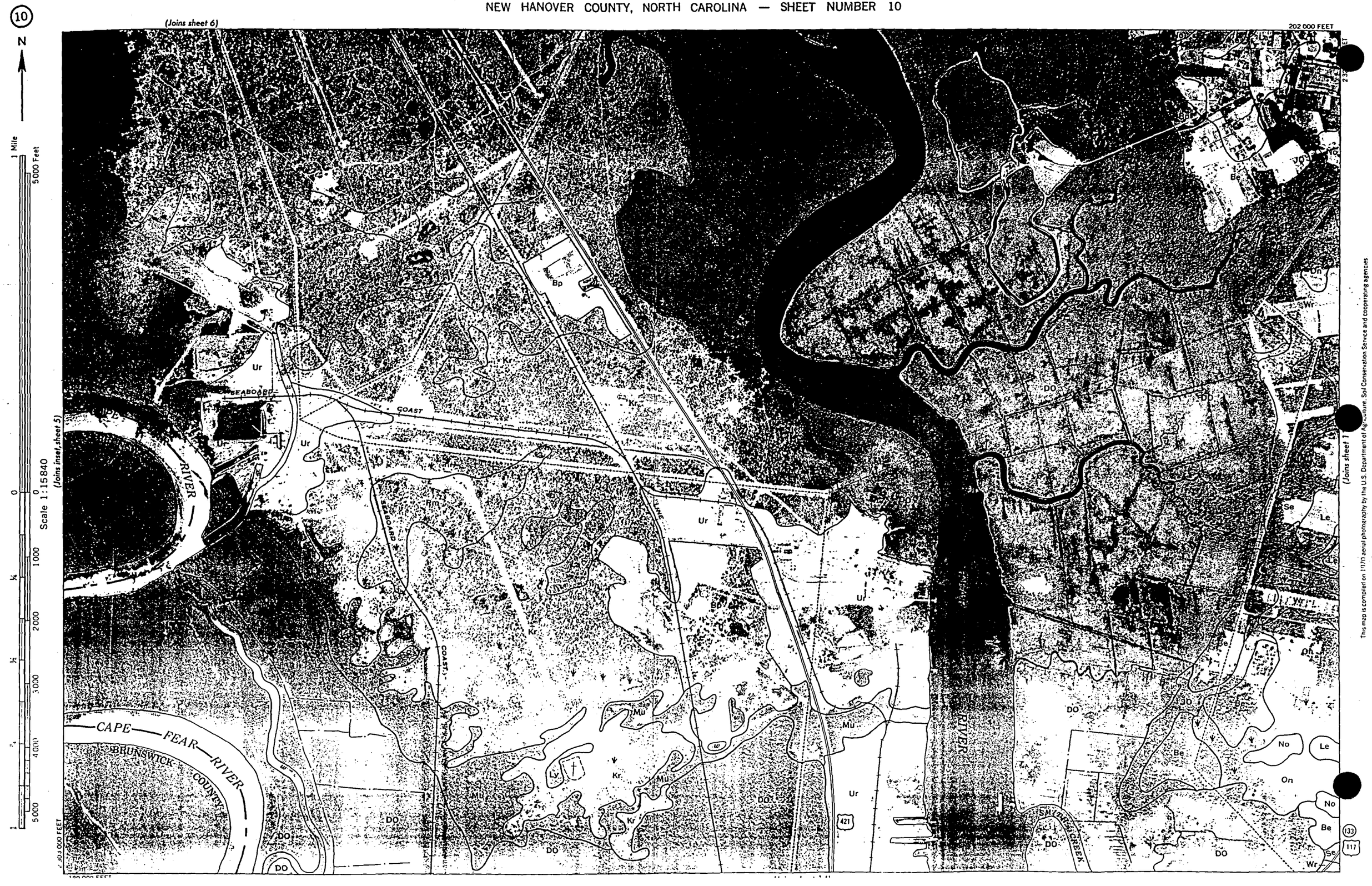

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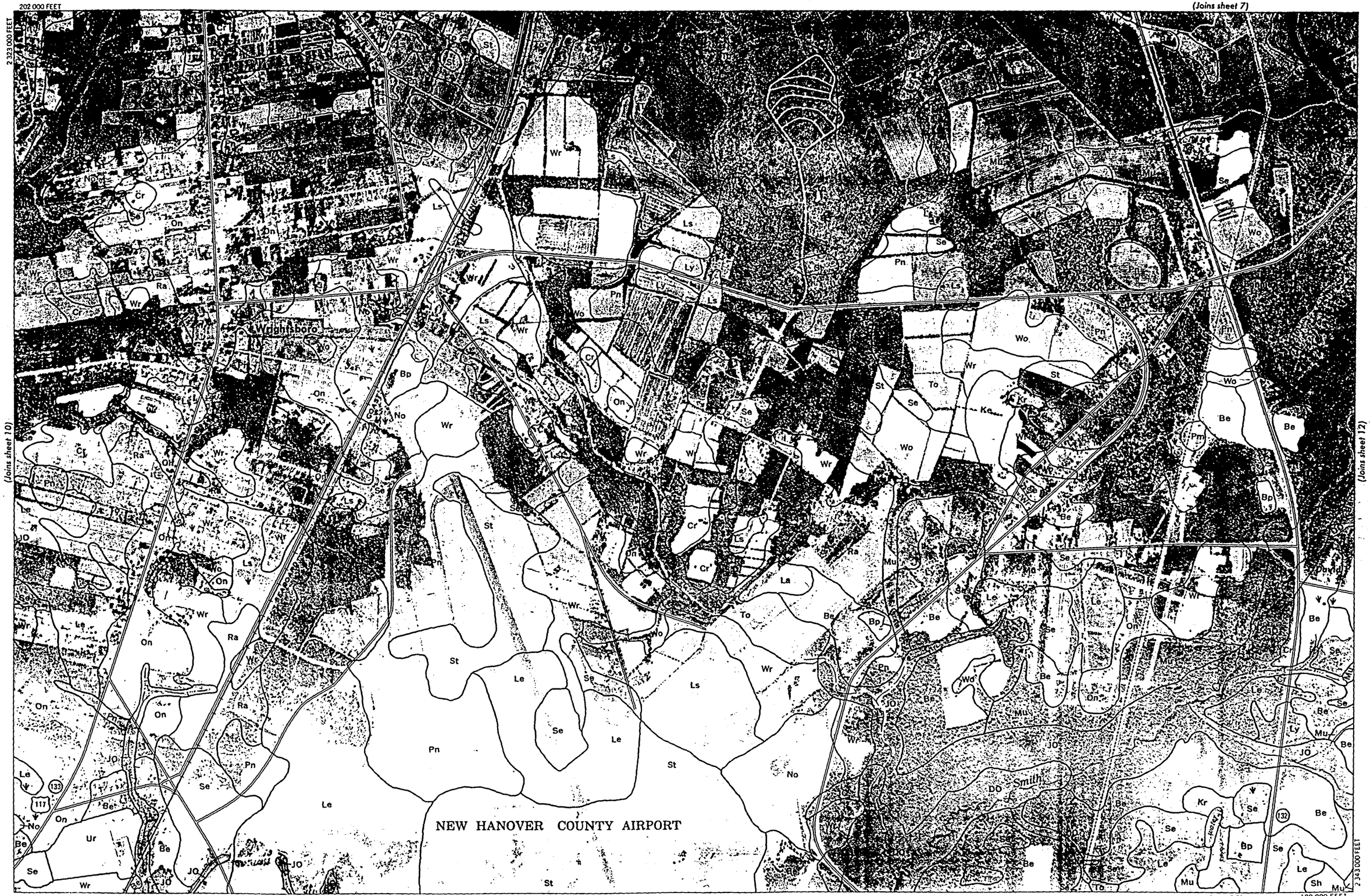

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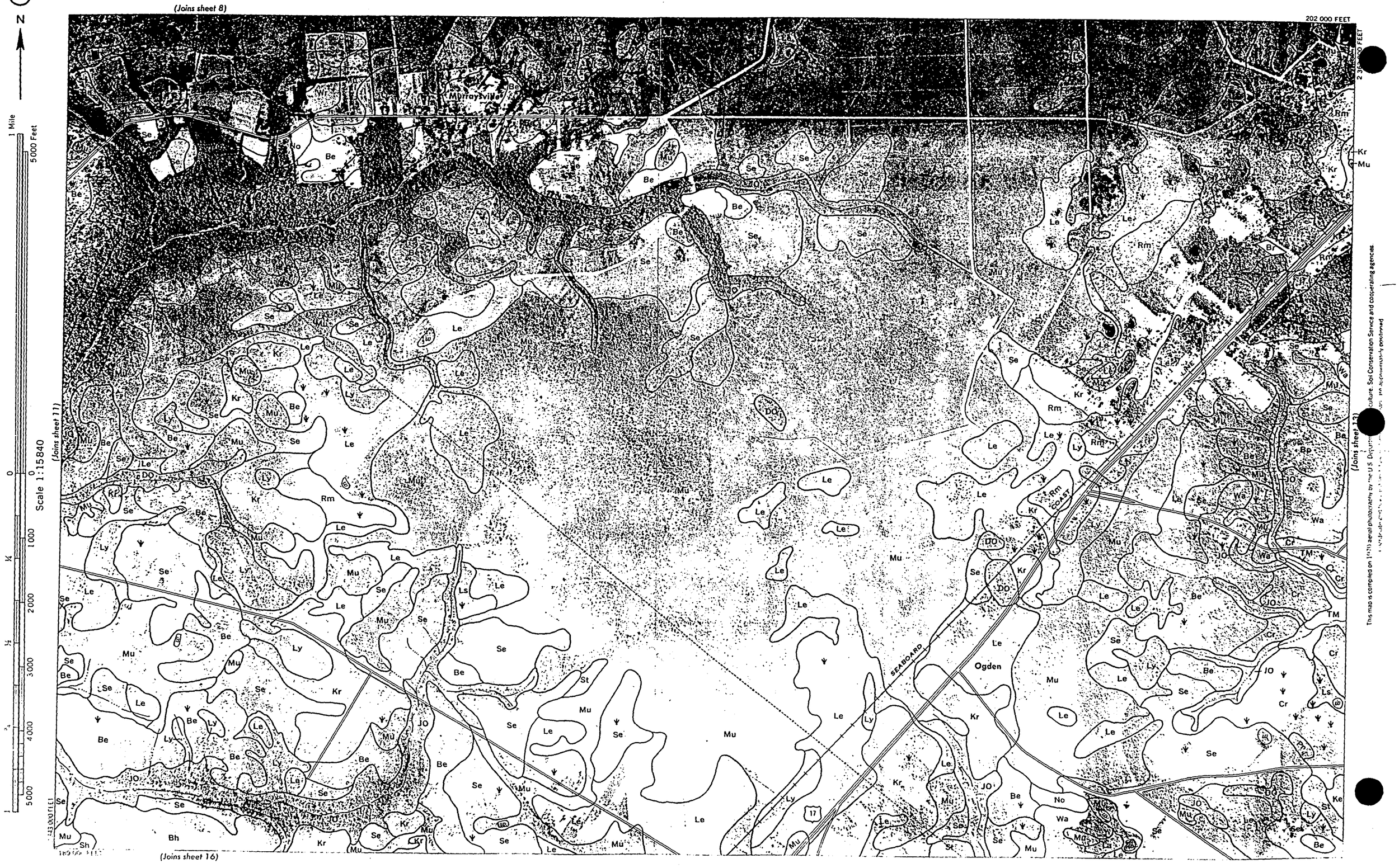

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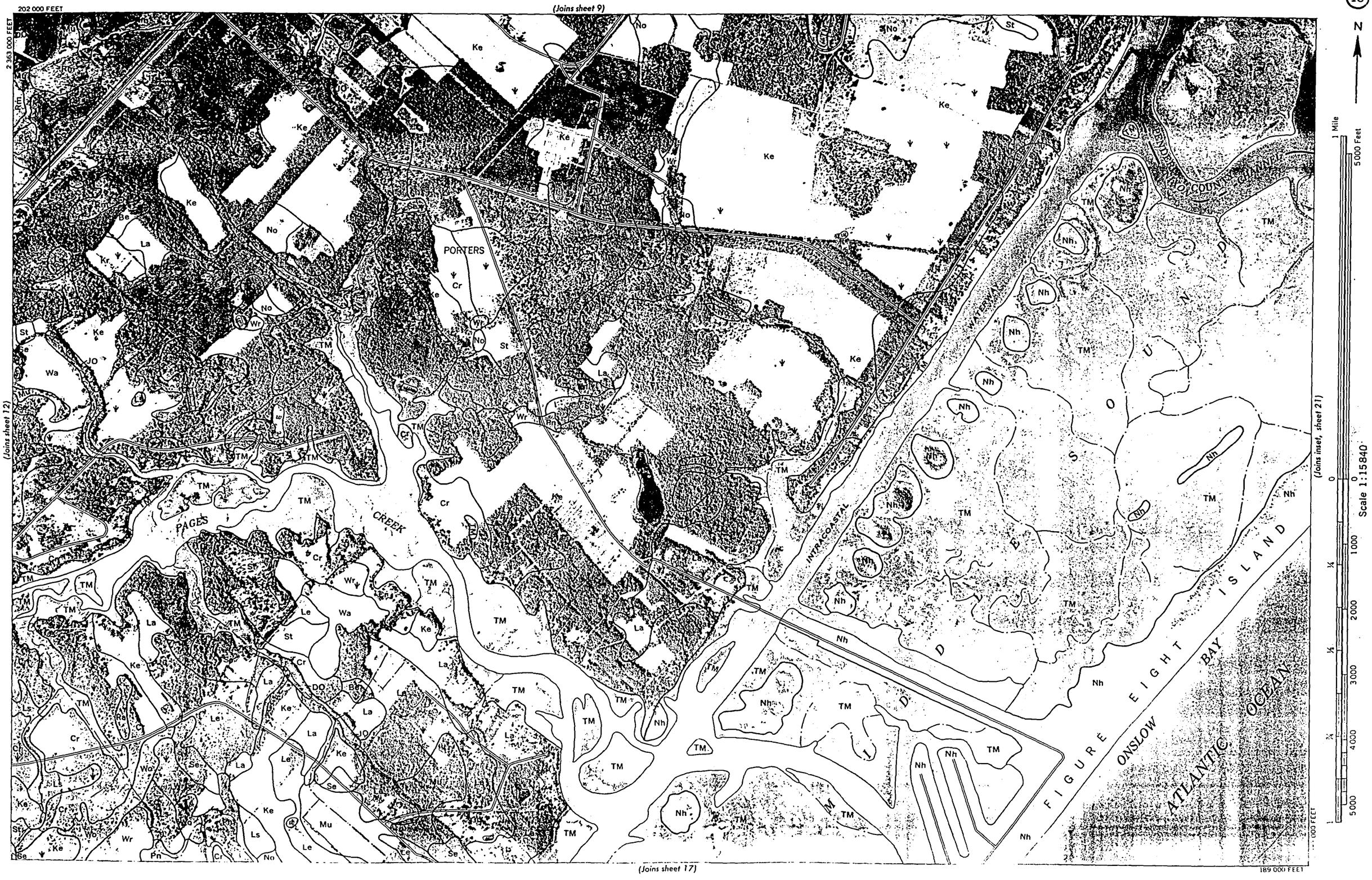
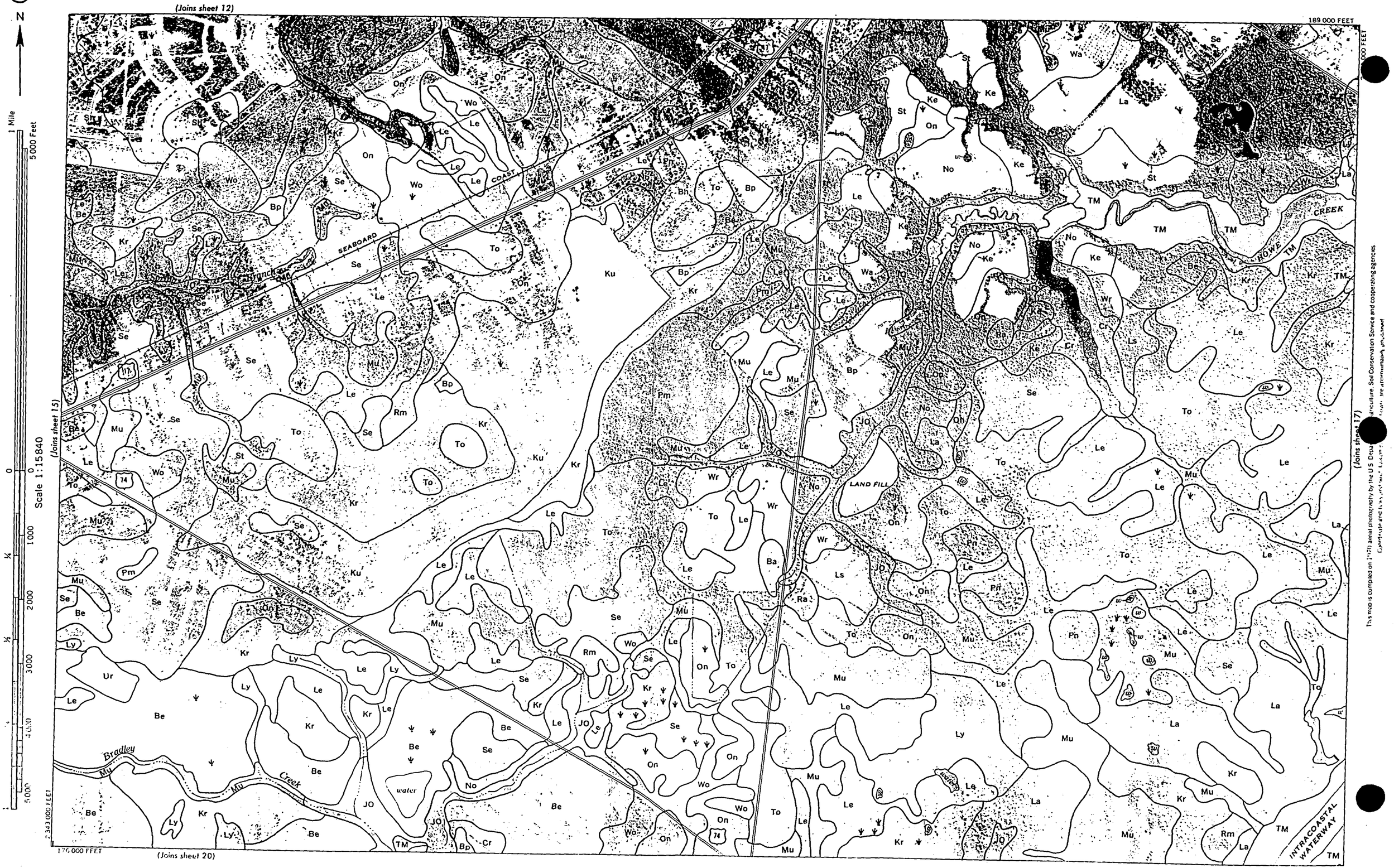


This map is compiled on 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(Joins sheet 10)
189 000 FEET
2 304 000 FEET
N
1 Mile
5000 Feet
Scale 1:15840
0
1000
2000
3000
4000
5000
Hightsville
LAND FILL
CAPE
FEAR
RIVER
BRUNSWICK
COUNTY
NORTH
CAROLINA
COAST
LINE
SEABOARD
WILMINGTON
(county seat)
DO
Ur
Ku
Be
Bh
Lo
Rm
Kr
Ke
Ws
421
133
117
176 000 FEET
(Joins sheet 18)
(Joins sheet 15)
This map is compiled on 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.



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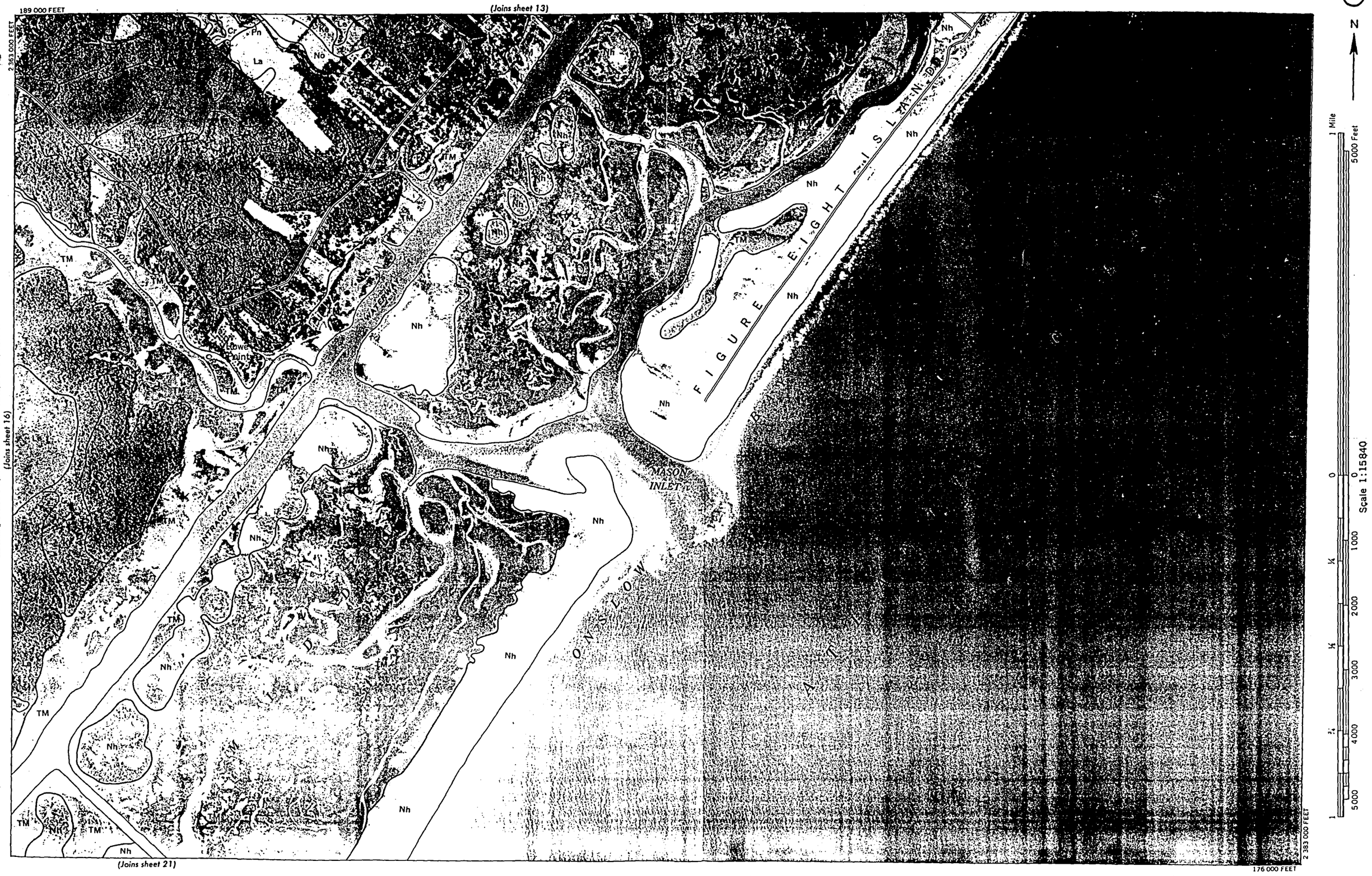

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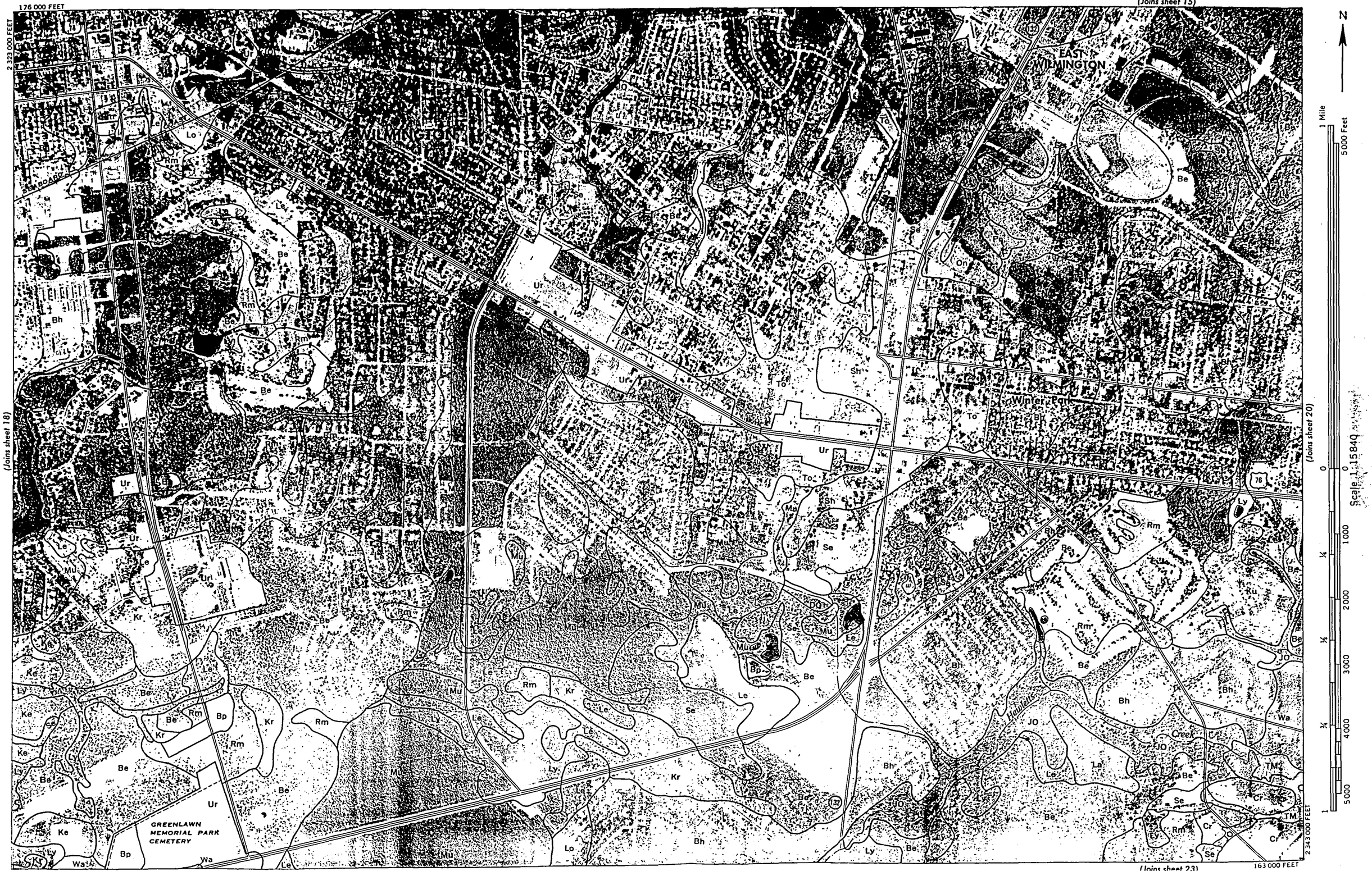

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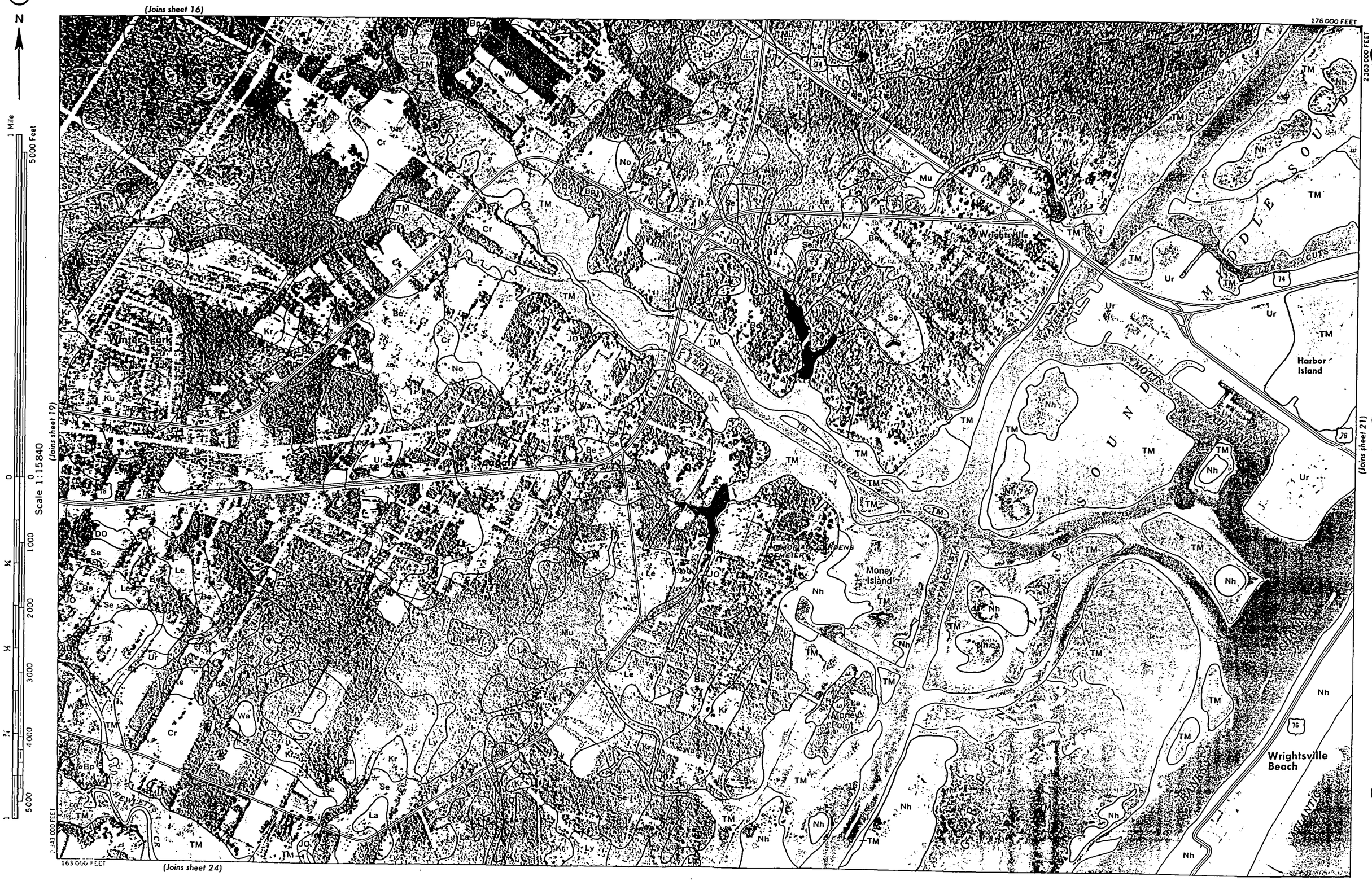

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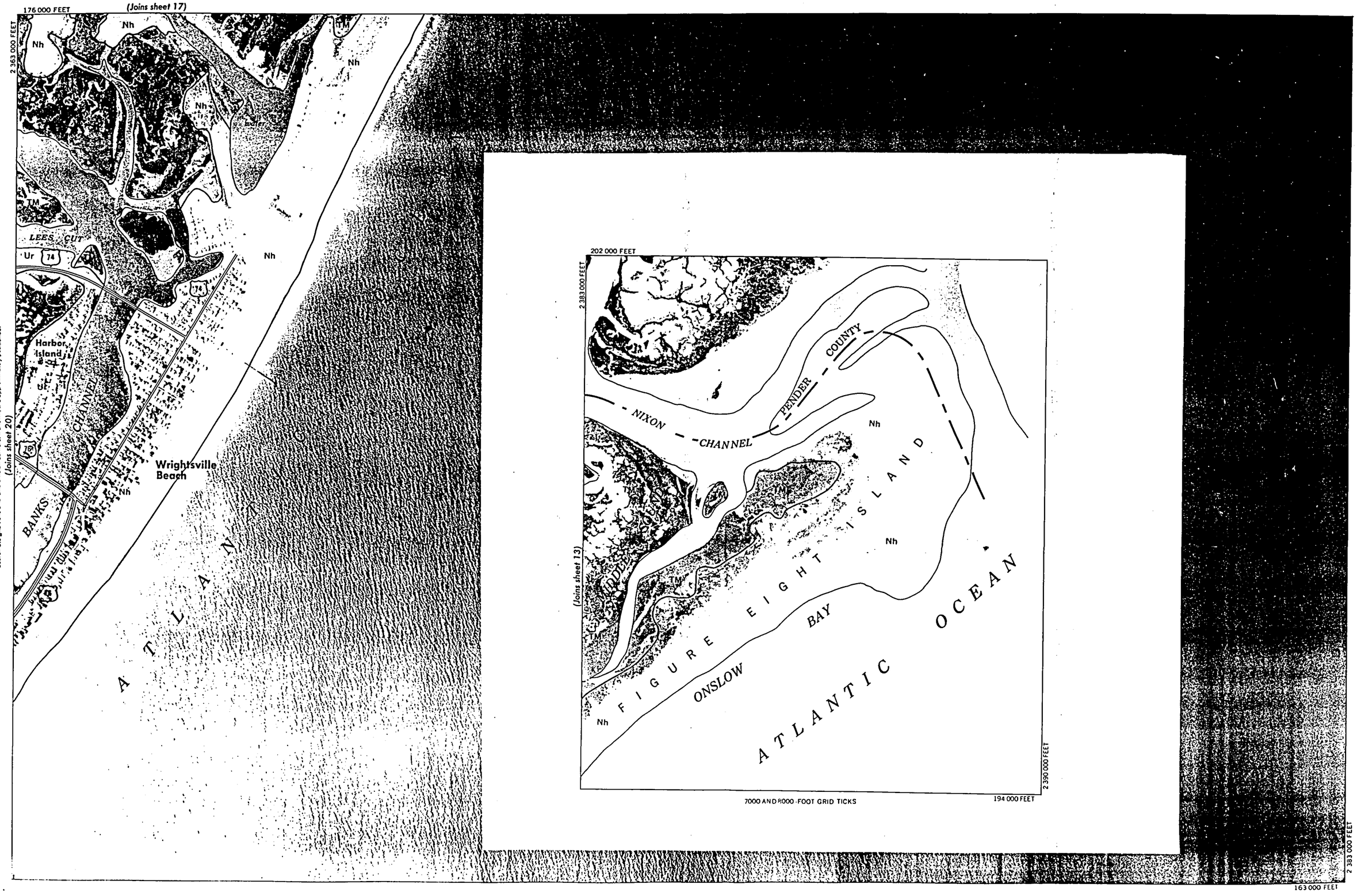

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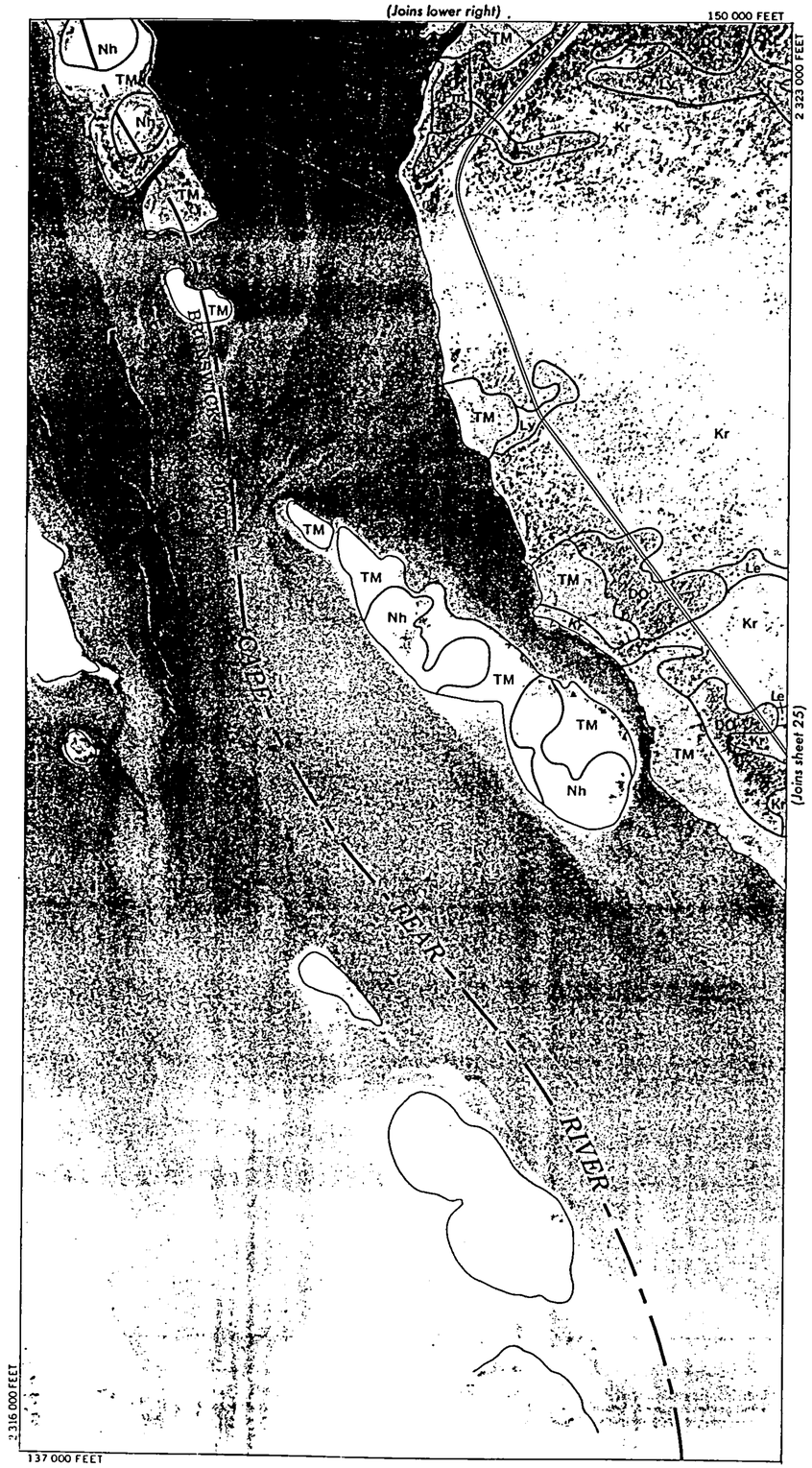
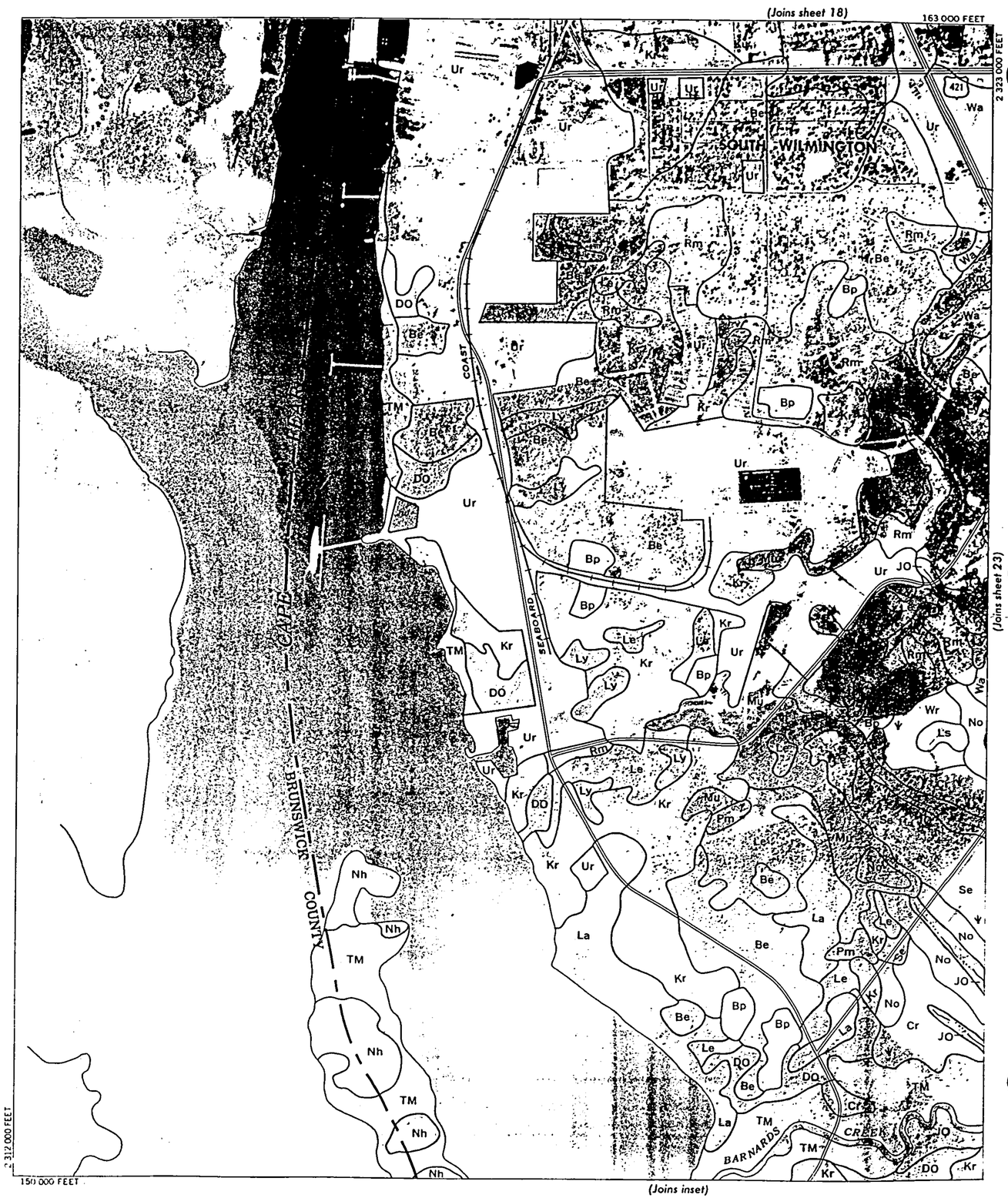
N

1 Mile

5000 Feet

Scale 1:15840





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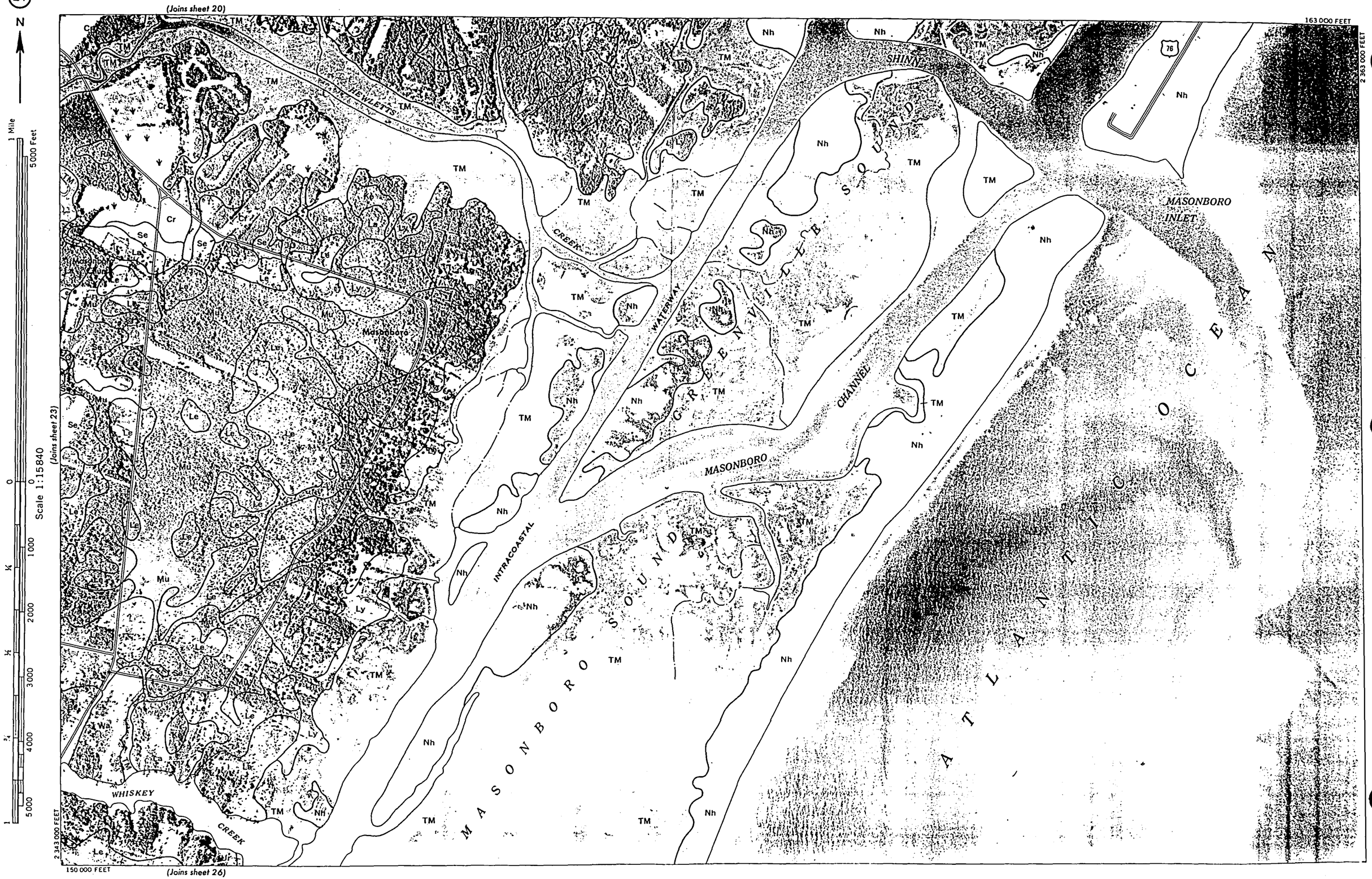

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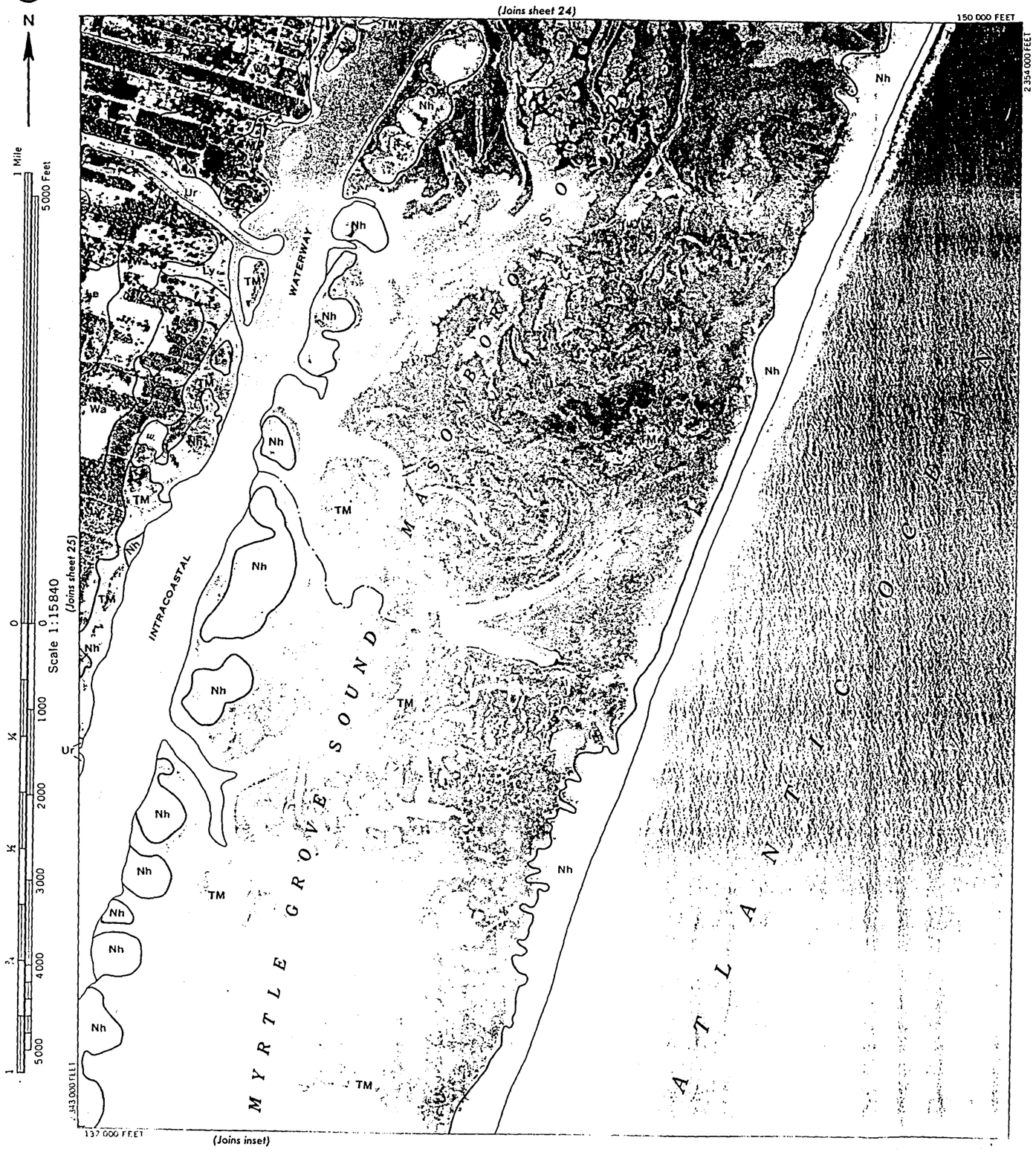

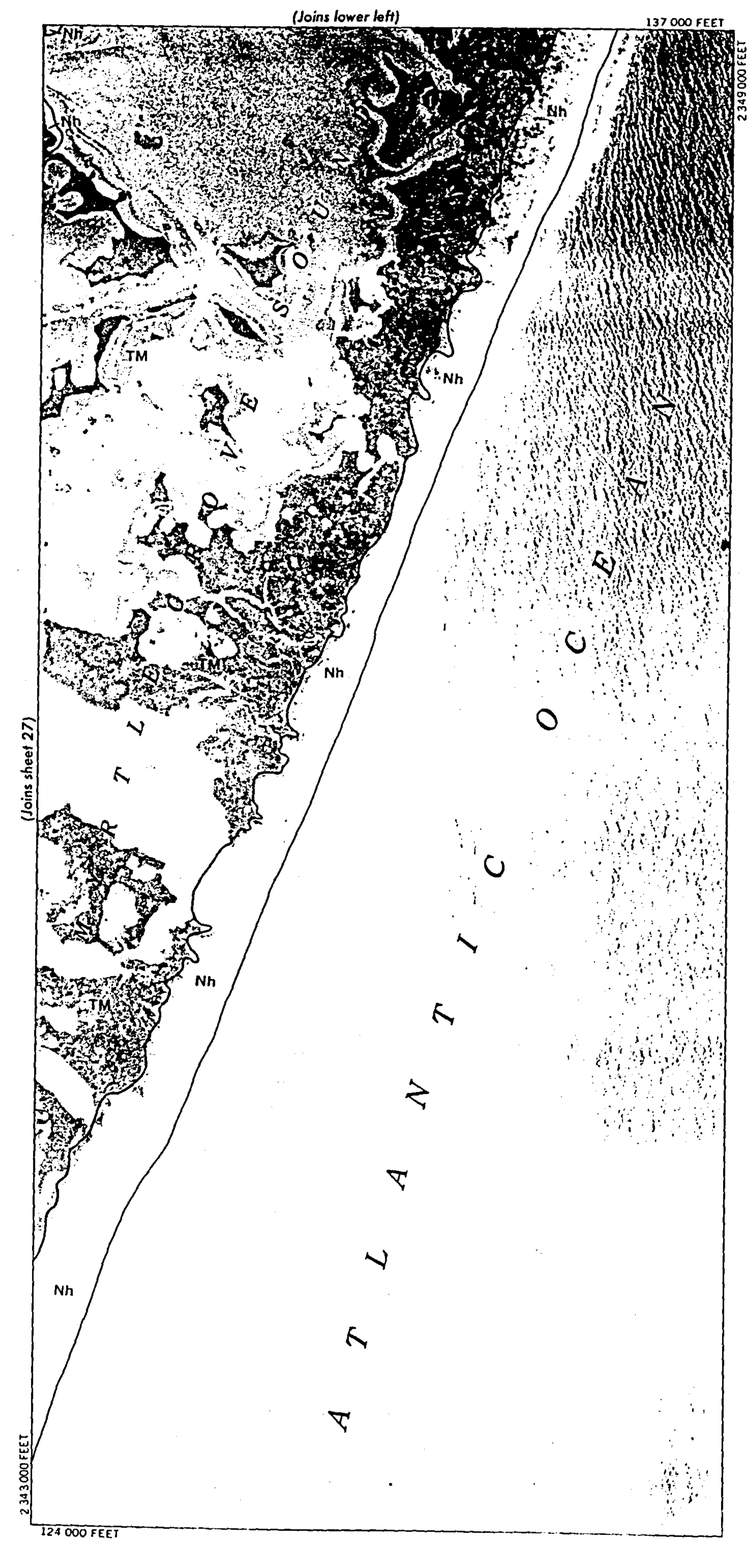

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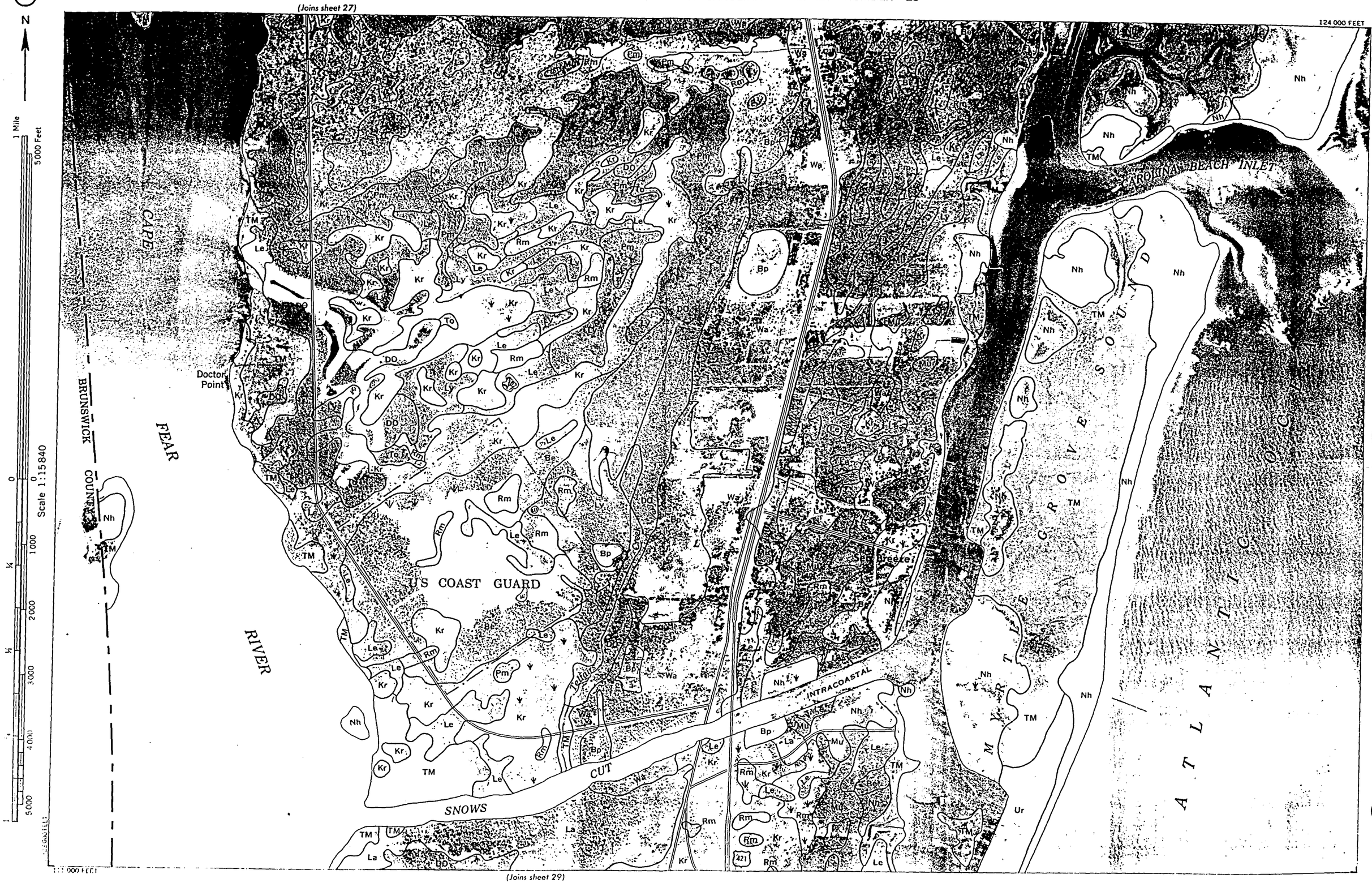
137 000 FEET
(Joins sheet 25)
2 323 000 FEET
N
1 Mile
5000 Feet
Scale 1:15 840
(Joins inset, sheet 26)
(Joins sheet 28)
124 000 FEET
CAPE FEAR RIVER
BALD HEAD ISLAND
MYRTLE GROVE SOUND
INTRACOASTAL
Everett Creek
Keyes
Lords Creek
421



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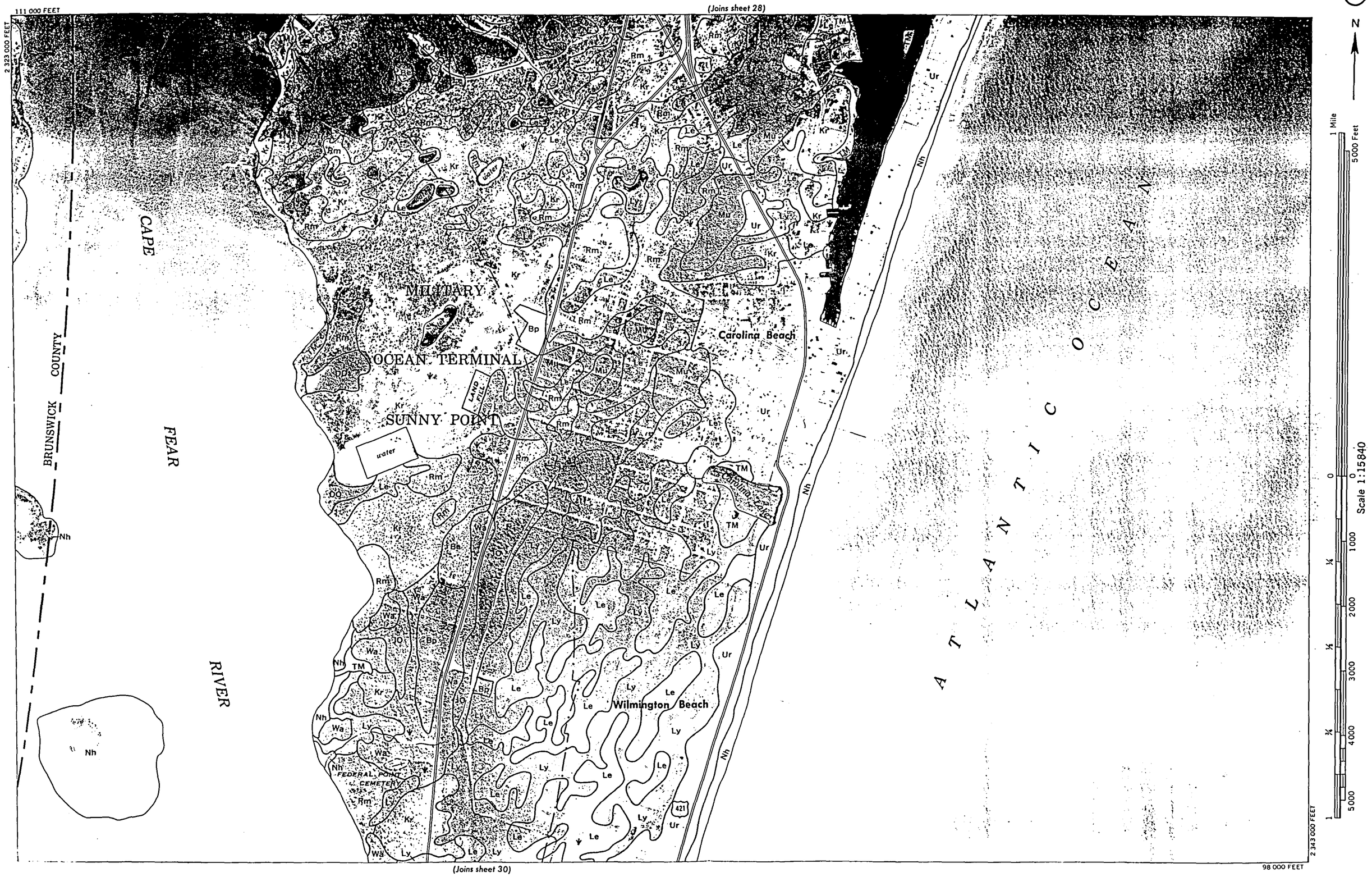

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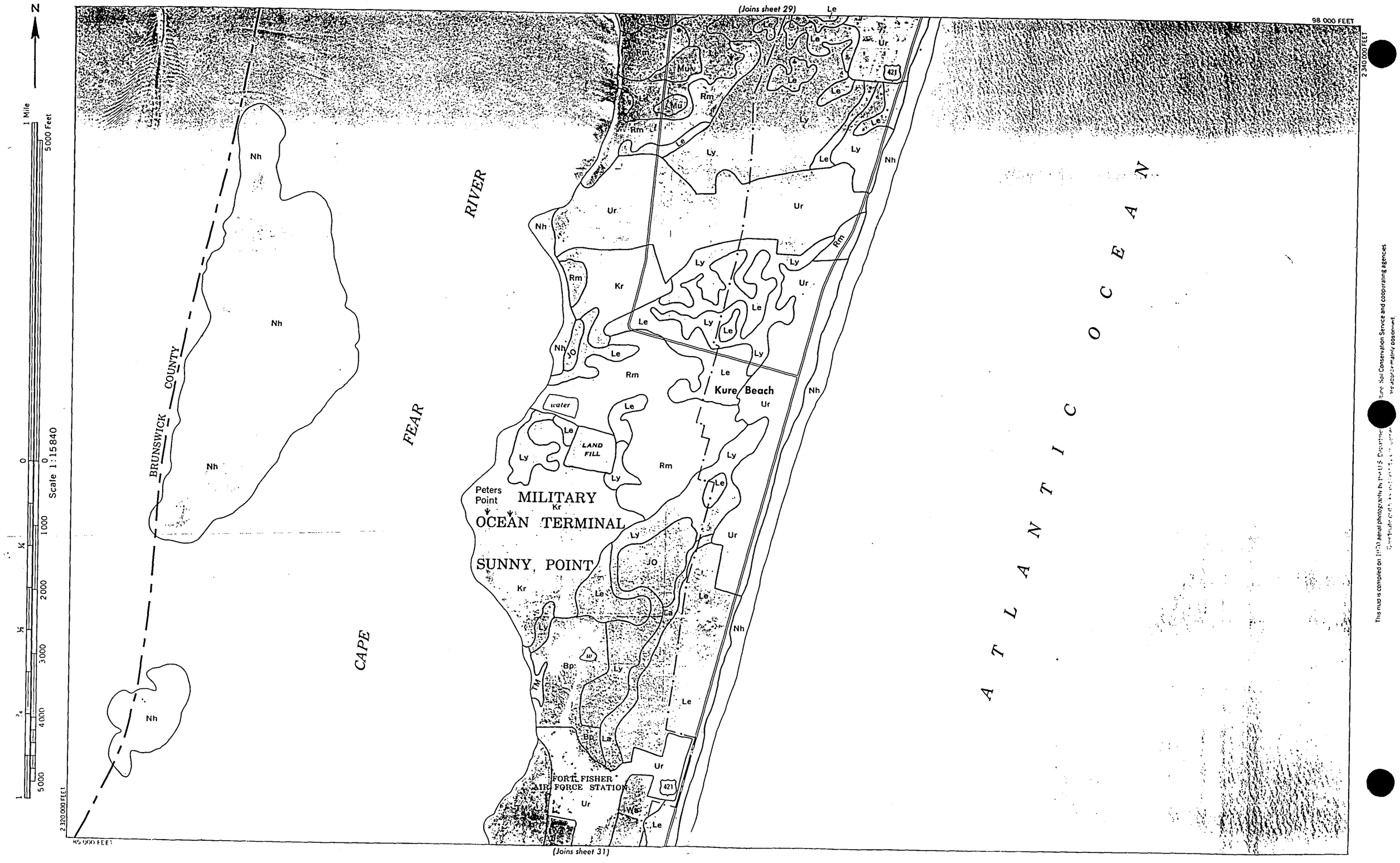

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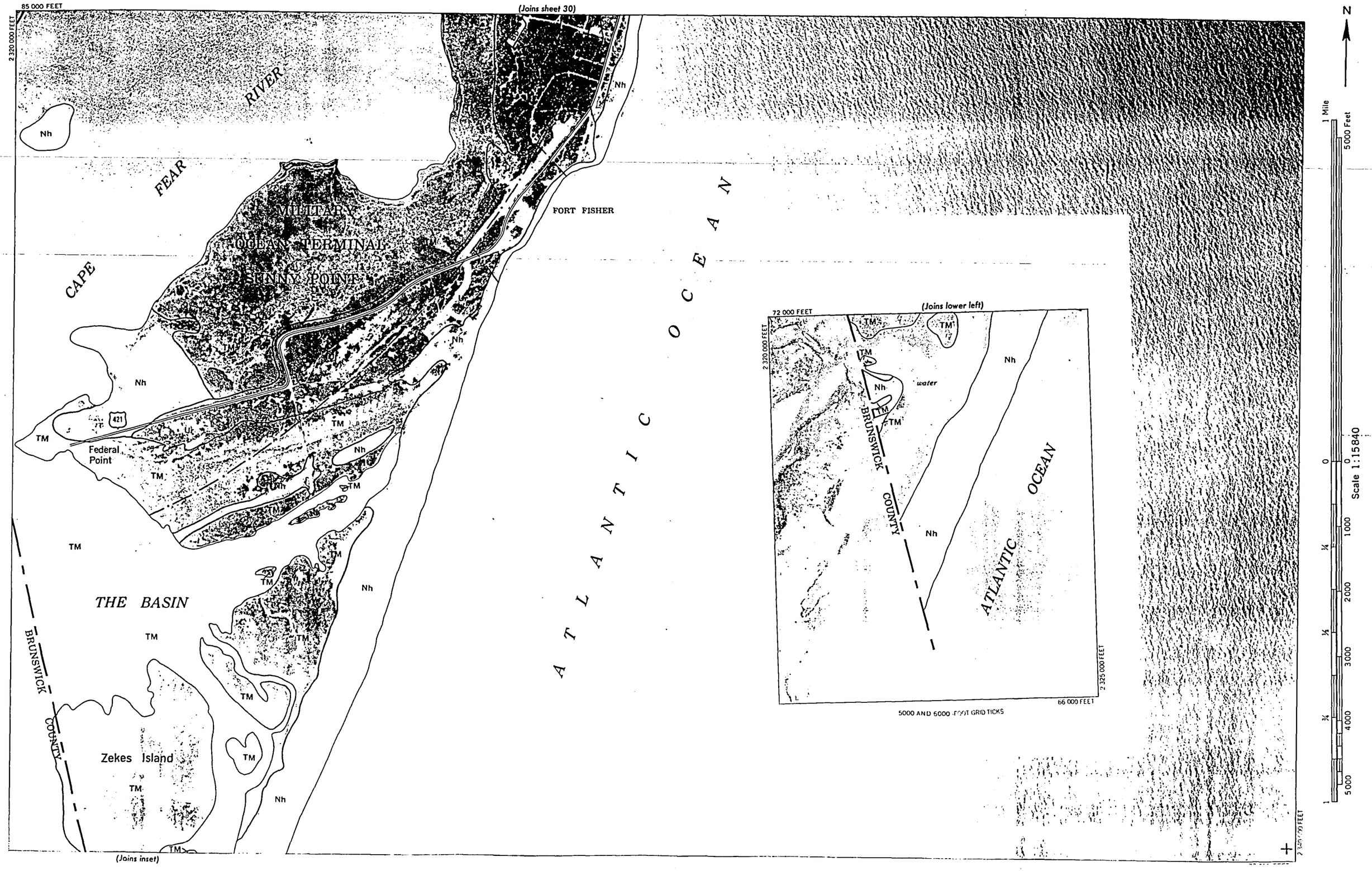


This map is compiled on 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canal or ditch, single line unclassified

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

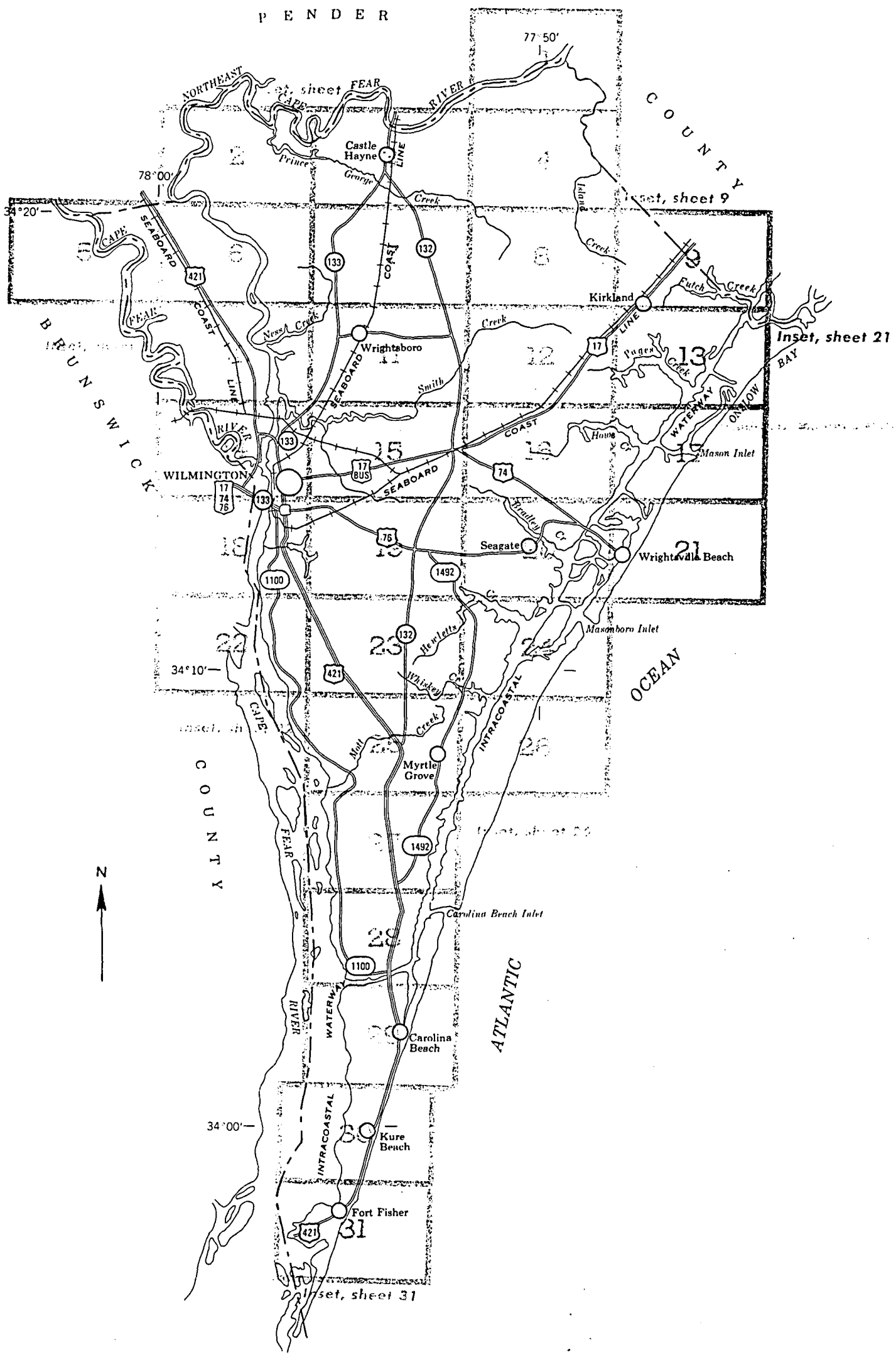
- Soil boundary and symbol (Dx)
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully

SOIL LEGEND

The first letter, always a capital, is the initial letter of the soil name. The second letter is a capital if the mapping unit is broadly defined 1/; otherwise, it is a small letter.

SYMBOL	NAME
Ba	Bayboro loam
Be	Baymeade fine sand, 1 to 6 percent slopes
Bh	Baymeade-Urban land complex, 1 to 6 percent slopes
Bp	Borrow pits
Cr	Craven fine sandy loam, 1 to 4 percent slopes
DO	Dorovan soils
JO	Johnston soils
Ke	Kenansville fine sand, 0 to 3 percent slopes
Kr	Kureb sand, 1 to 8 percent slopes
Ku	Kureb-Urban land complex, 1 to 8 percent slopes
La	Lakeland sand, 1 to 8 percent slopes
Le	Leon sand
Lo	Leon-Urban land complex
Ls	Lynchburg fine sandy loam
Ly	Lynn Haven fine sand
Mp	Mine Pits
Mu	Murville fine sand
Nh	Newhan fine sand
No	Norfolk fine sandy loam, 0 to 4 percent slopes
On	Onslow loamy fine sand
Pm	Pamlico muck
Pn	Pantego loam
Ra	Rains fine sandy loam
Rm	Rimini sand, 1 to 6 percent slopes
Se	Seagate fine sand
Sh	Seagate-Urban land complex
St	Stallings fine sand
TM	Tidal Marsh
To	Torhunta loamy fine sand
Ur	Urban land
Wa	Wakulla sand, 1 to 8 percent slopes
Wo	Woodington fine sandy loam
Wr	Wrightsboro fine sandy loam, 0 to 2 percent slopes

1/ The composition of these units is more variable than that of others in the survey area, but has been controlled well enough to be interpreted for the expected use of the soils.

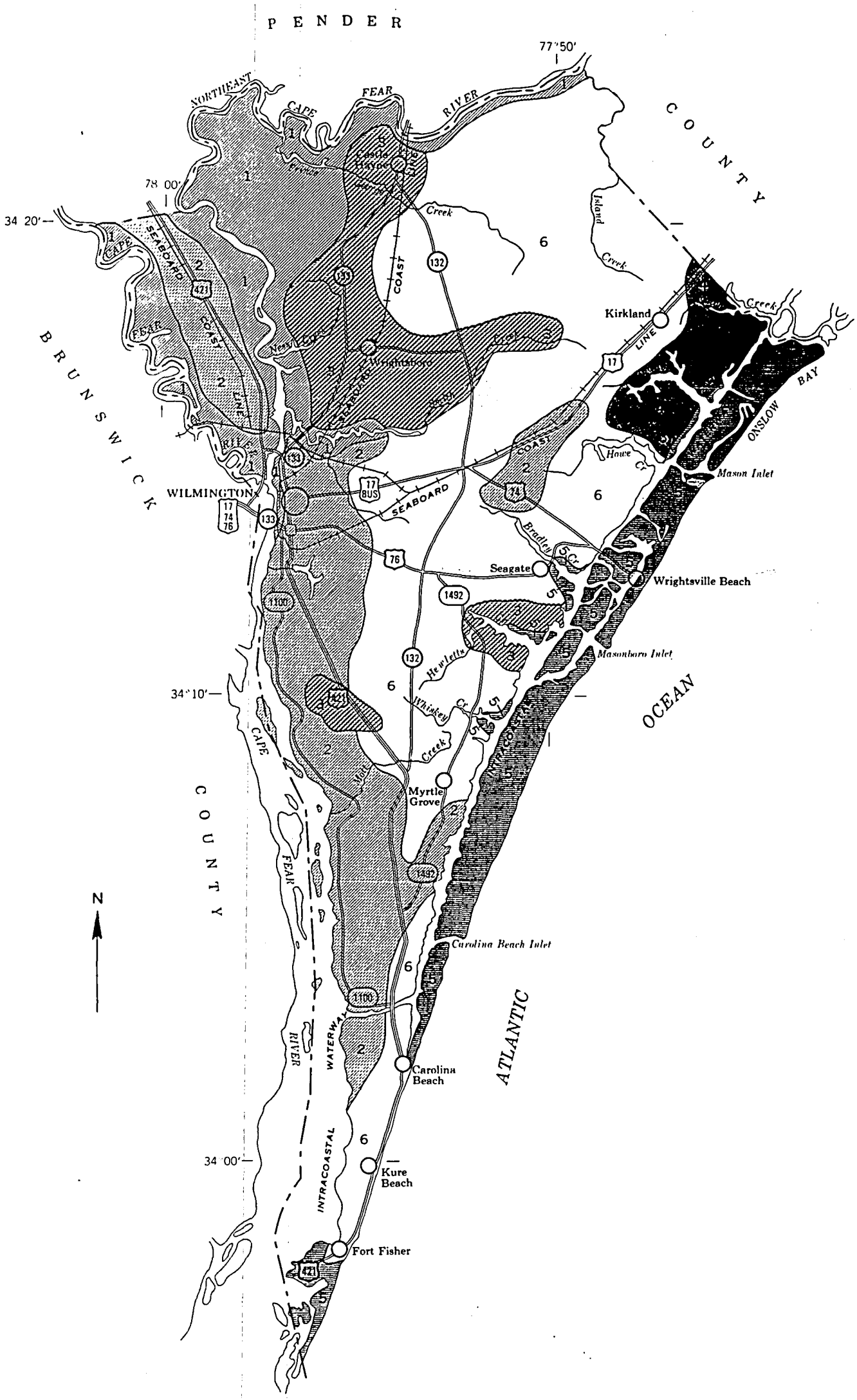


INDEX TO MAP SHEETS

NEW HANOVER COUNTY
NORTH CAROLINA

Scale 1:253,440

1 0 1 2 3 4 Miles



SOIL ASSOCIATIONS

1 — Dorovan-Johnston association: Very poorly drained soils that have a muck, loam, or sandy loam surface layer and a muck or sand underlying layer; in areas that are flooded by streams or tides.

2 — Kureb-Baymeade-Rimini association: Excessively drained and well drained soils that have a sand and fine sand surface layer and a sand, fine sandy loam, and loamy fine sand subsoil or underlying layer; on uplands.

3 — Wrightsboro-Onslow-Kenansville association: Somewhat poorly drained to well drained soils that have a fine sandy loam, loamy fine sand, and fine sand surface layer and a sandy clay loam, clay, fine sandy loam, sandy loam, and clay loam subsoil; on uplands.

4 — Kenansville-Craven-Lakeland association: Moderately well drained to excessively drained soils that have a sand, fine sand, or fine sandy loam surface layer and a fine sandy loam, clay loam, clay, and sand subsoil or underlying layer; on uplands.

5 — Tidal Marsh-Newhan association: Tidal Marsh and excessively drained soils that are sandy throughout; on flats and dunes along the seashore.

6 — Murville-Seagate-Leon association: Very poorly drained to somewhat poorly drained soils that have a fine sand and sand surface layer and a fine sand, sand, sandy loam, and clay loam subsoil; on uplands and stream terraces.

Compiled 1976

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NEW HANOVER COUNTY BOARD OF COMMISSIONERS
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

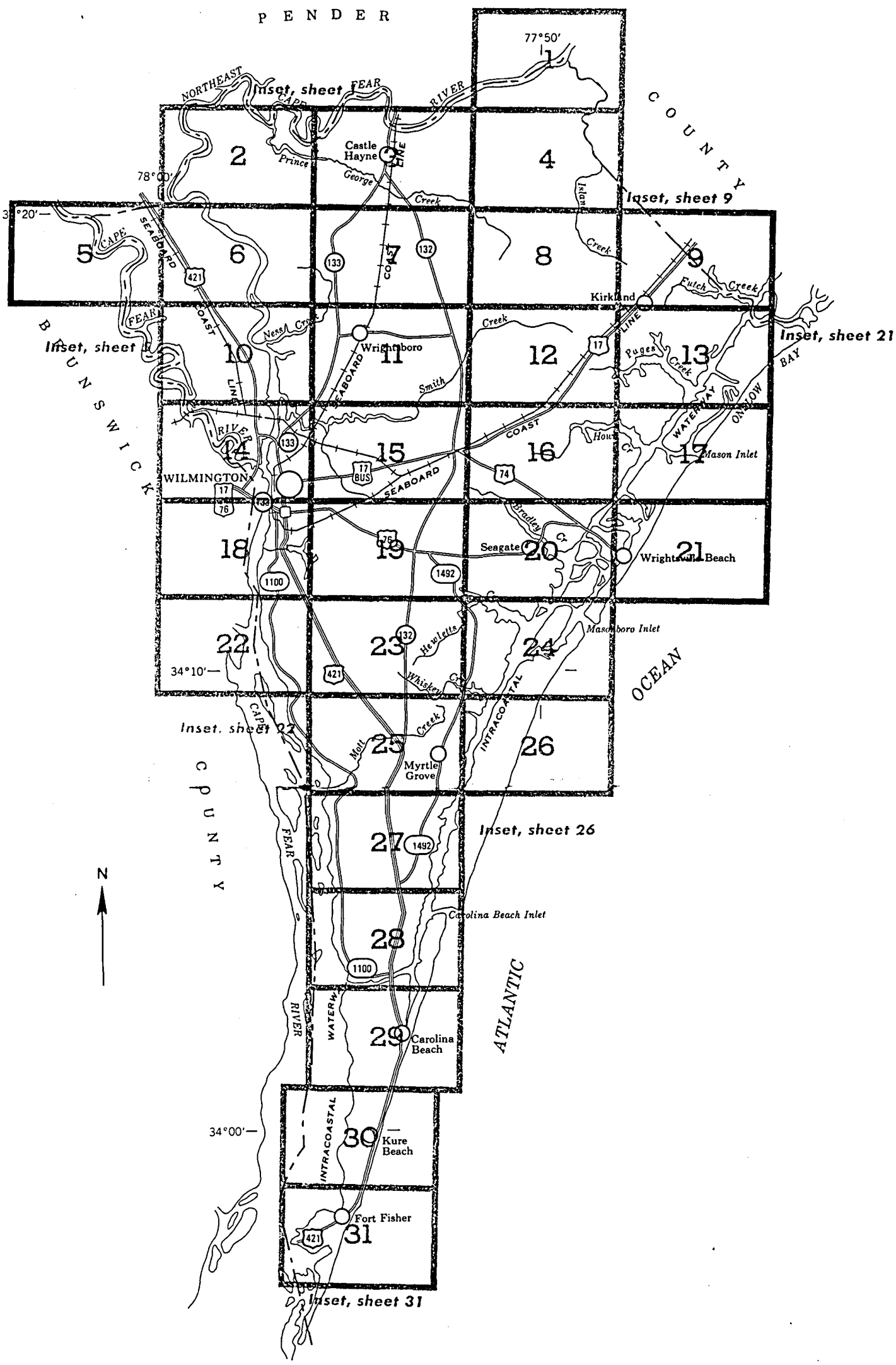
GENERAL SOIL MAP

NEW HANOVER COUNTY
NORTH CAROLINA

Scale 1:253,440

1 0 1 2 3 4 Miles

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



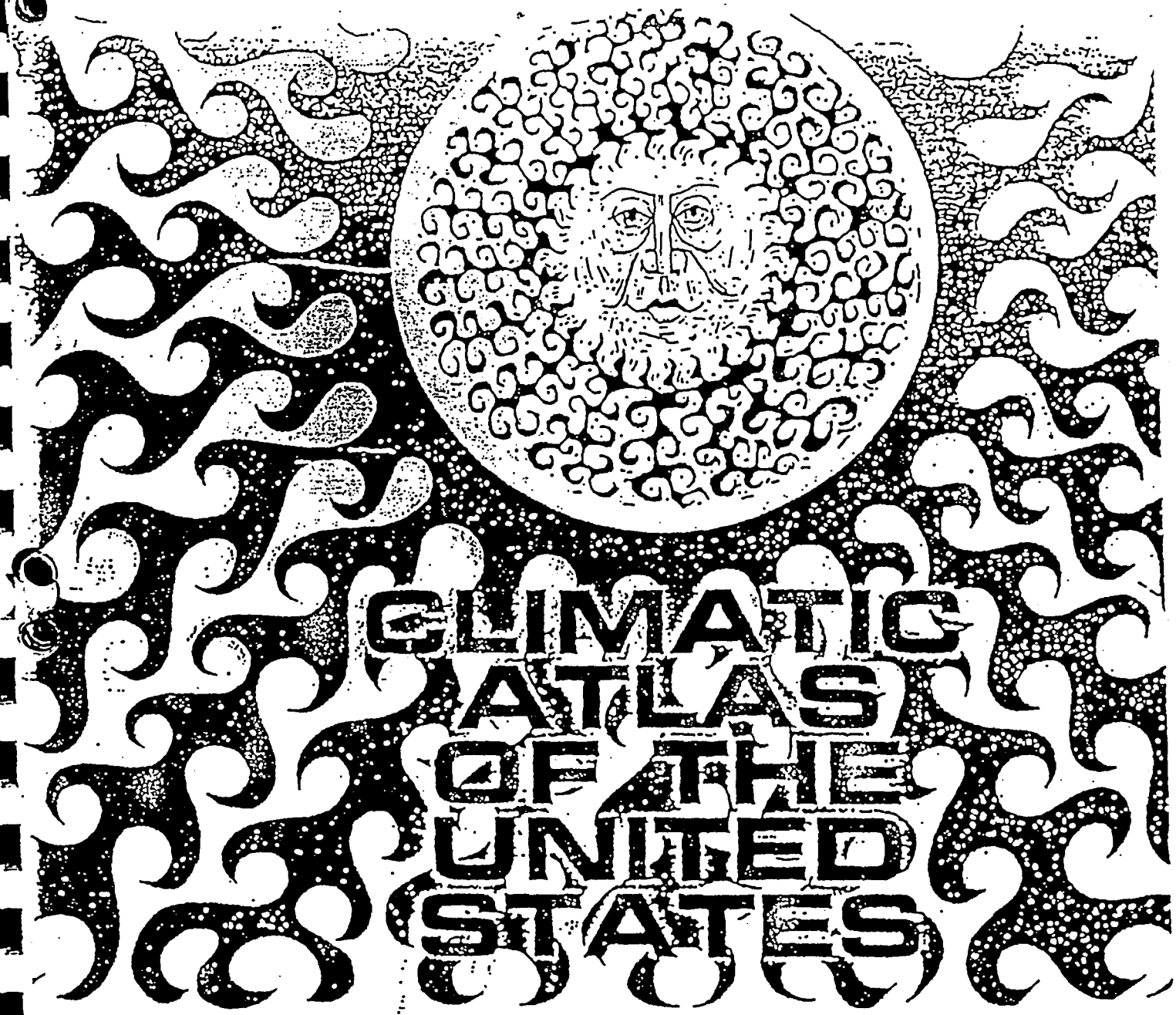
INDEX TO MAP SHEETS

NEW HANOVER COUNTY
NORTH CAROLINA

Scale 1:253,440

1 0 1 2 3 4 Miles

REFERENCE 20



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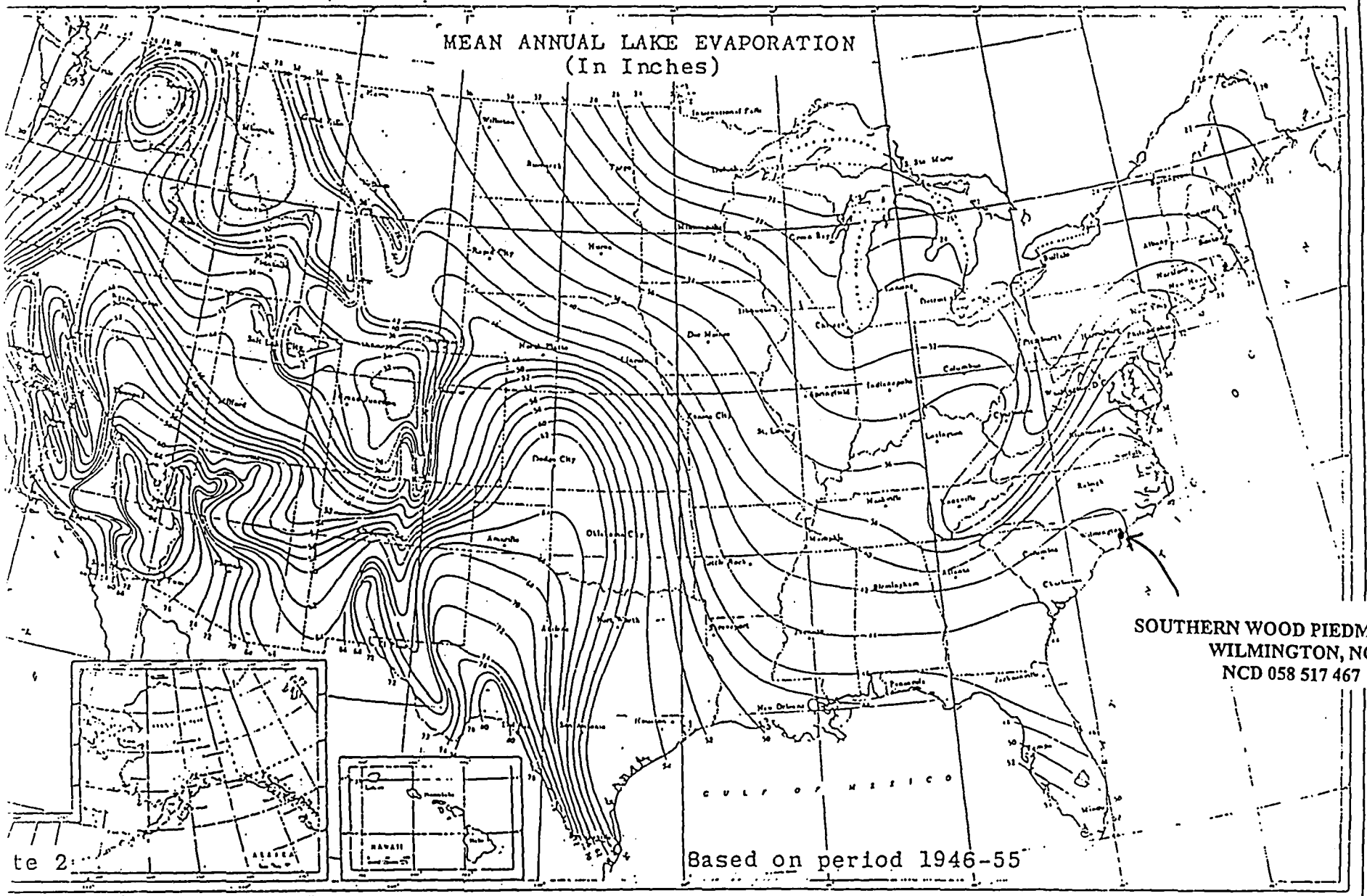
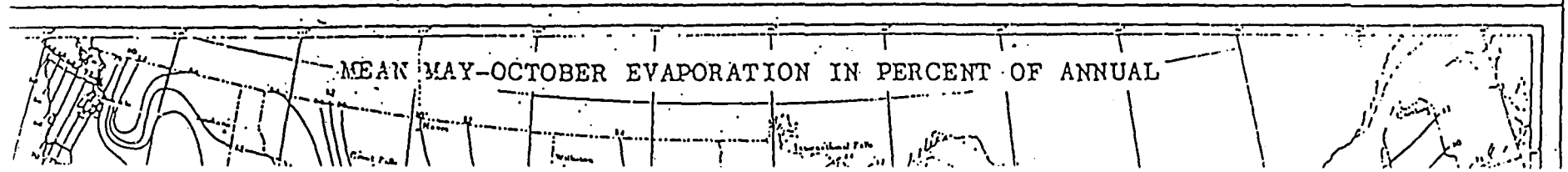
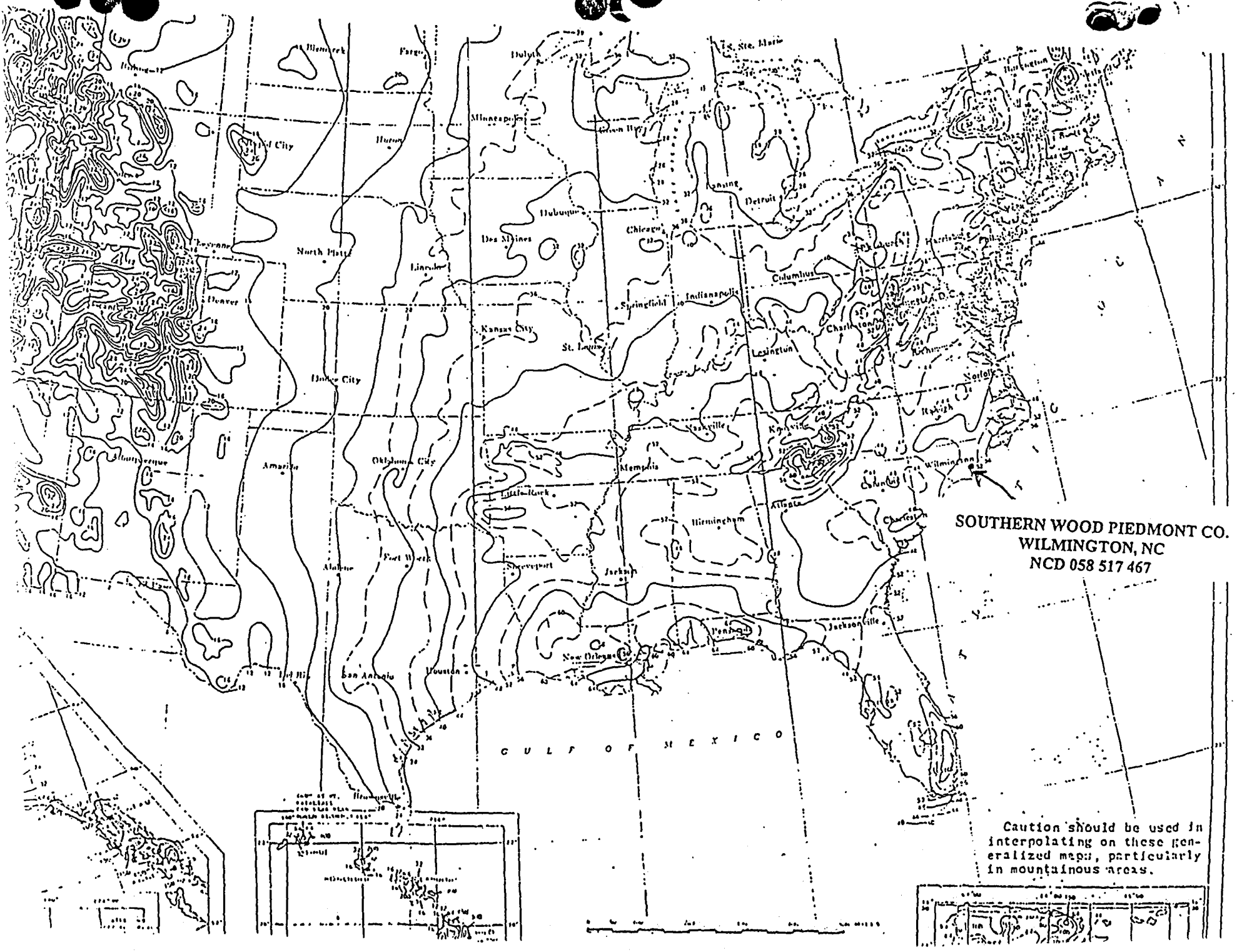


SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC
NCD 058 517 467





SOUTHERN WOOD PIEDMONT CO.
WILMINGTON, NC
NCD 058 517 467

Caution should be used in interpolating on these generalized maps, particularly in mountainous areas.

REFERENCE 21

NORTH CAROLINA ATLAS

PORTRAIT OF A CHANGING SOUTHERN STATE

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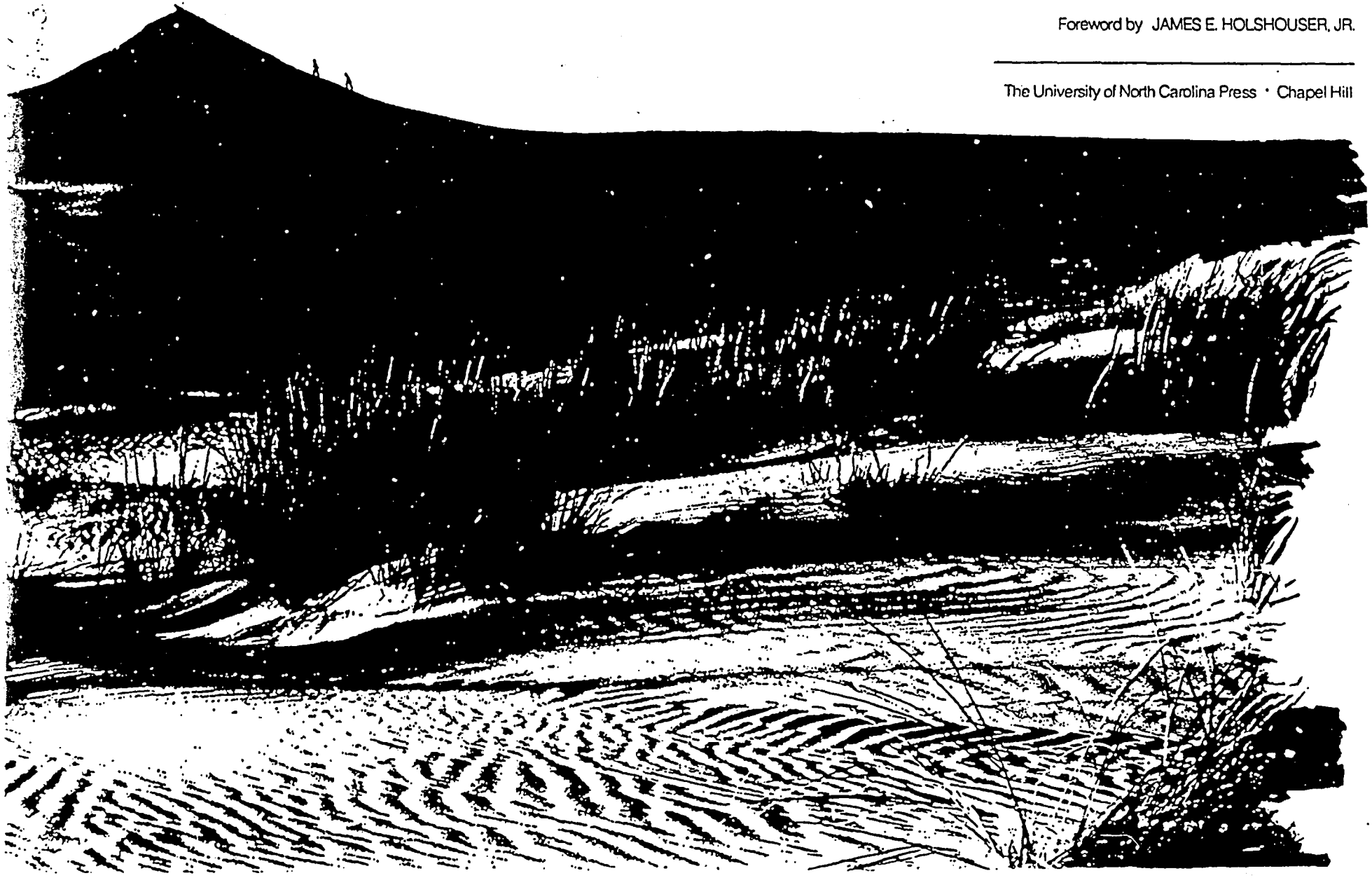
P. O. BOX 2091
RALEIGH, NORTH CAROLINA 27602

Edited by JAMES W. CLAY
DOUGLAS M. ORR, JR.
ALFRED W. STUART

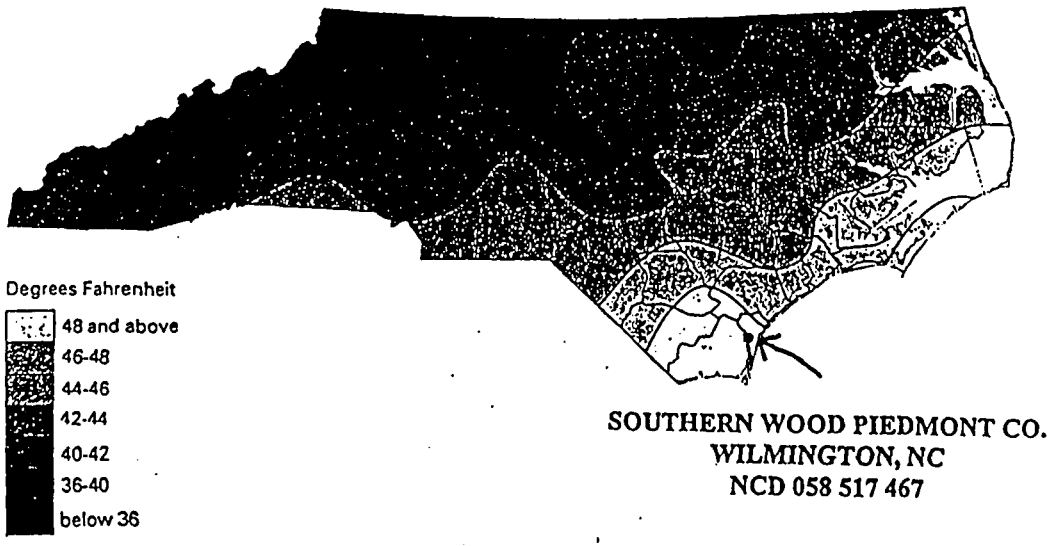
Foreword by JAMES E. HOLSHOUSER, JR.

The University of North Carolina Press · Chapel Hill



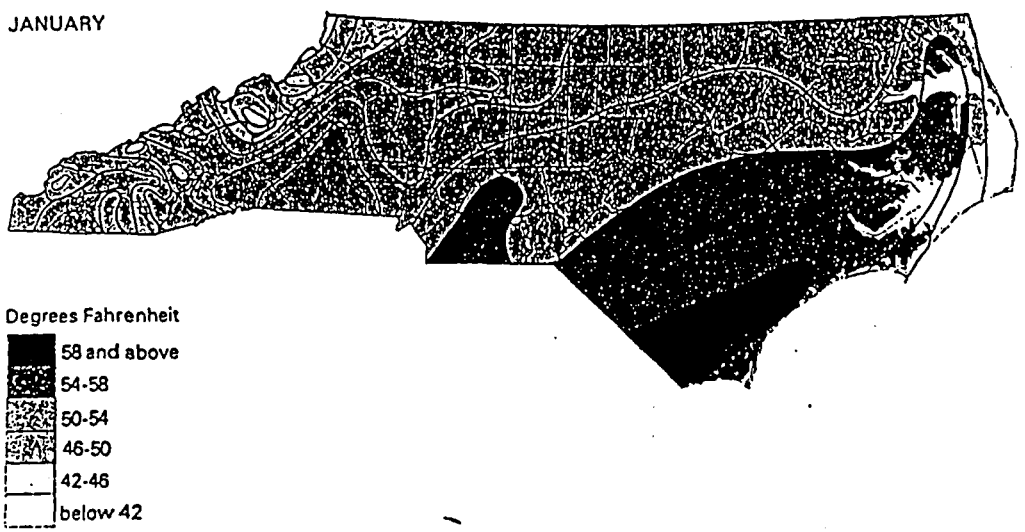
Ref. 21

Figure 5.2 Average January Temperatures in N.C.



Source: U.S. Department of Commerce, *Weather and Climate in North Carolina*, 1972.

Figure 5.3. Mean Maximum Temperature in N.C.



Source: U.S. Department of Commerce, *Weather and Climate in North Carolina*, 1972.

Seasonal Changes In Climate

Winter The alternate passage of low- and high-pressure systems over the state during winter months results in changing weather conditions. Moisture and warmer temperatures are characteristically associated with frequently passing low-pressure cells. Lows are followed by polar highs, which bring lower temperatures and clear skies. However, even when under the influence of these polar highs, temperatures seldom fall below 10° F., and midday temperatures reach into the forties, making the winter season very tolerable by northern standards.

January average temperatures shown in Figure 5.2 illustrate the mildness of winters. Only at the highest elevations do temperatures average below freezing. The mean temperature for January at Mount Mitchell is 28.7° F., the lowest in the state. Yet, at Asheville, located on the lee side of the mountains, temperatures for January average 39.4° F.

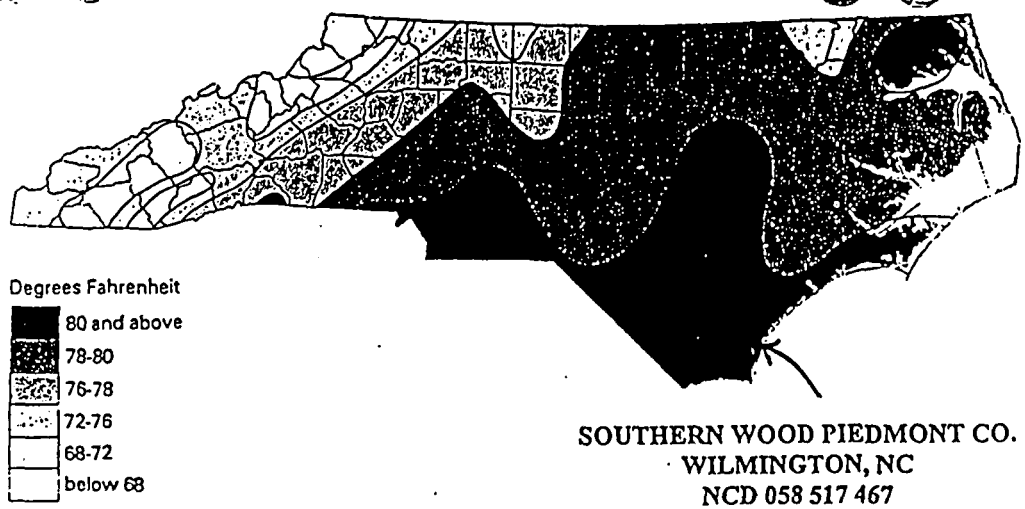
Nowhere else in North Carolina is the local contrast in temperatures as great as in the western counties. Temperature contrasts are least where the climate is mildest. Hatteras, on the Outer Banks, has a January mean of 48.0° F., and only thirteen days each year when temperatures of 32° F. and below are recorded.

The tendency for January isotherms to parallel the coast shows the influence of the Atlantic Ocean. Wilmington, in southeastern North Carolina, the most subtropical area in the state, exemplifies the maritime effect. This coastal city has a January mean temperature of 47.8° F., and an average of only eight days during January when temperatures dip to 32° F. or less, as compared with eighteen days at Raleigh and nineteen at Asheville.

In the Piedmont, latitude is the primary control on temperature, and the isotherms maintain a zonal pattern. As might be expected, temperature averages lie between those exhibited by the surrounding regions. Charlotte has a mean January temperature of 42.3° F., Greensboro, 39.0° F., and Raleigh, 42.7° F.

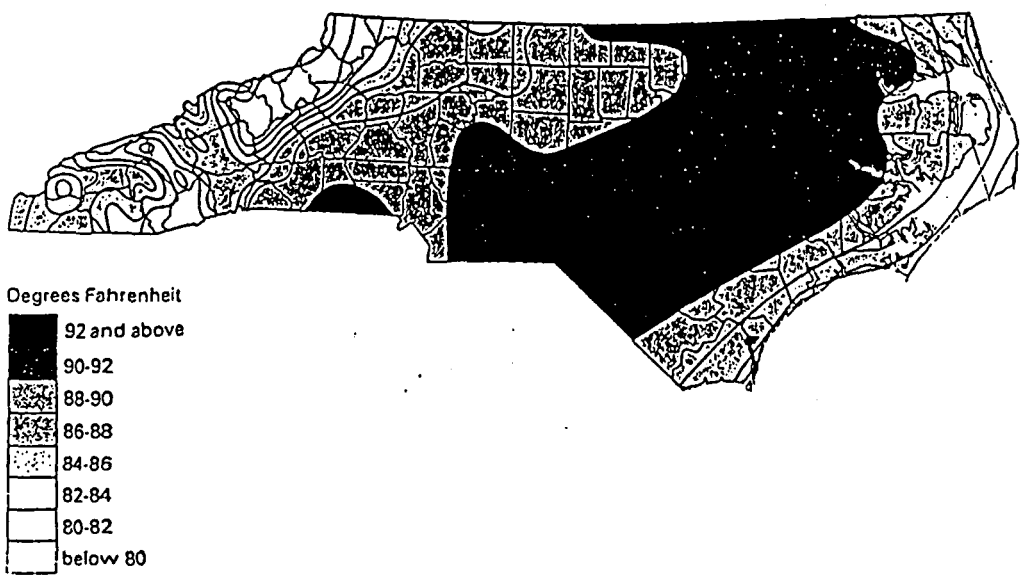
However, whereas Asheville averages eighty-three days each year when temperatures drop below freezing, Winston-Salem has freezing temperatures eighty-eight days annually, and Greensboro has eighty-four days with freezing temperatures.

Figure 5.9. Average July Temperature in N.C.



Source: U.S. Department of Commerce, *Weather and Climate in North Carolina*, 1972.

Figure 5.10. Mean Maximum July Temperature in N.C.



Source: U.S. Department of Commerce, *Weather and Climate in North Carolina*, 1972.

These strip-like regions have longer frost-free seasons and thereby show earlier dates for the end of the freeze period than their surroundings. They support frost-susceptible vegetation long after the greenery has disappeared in nearby areas. Often in early winter or even in midwinter a contrasting belt of green flanked above and below by brown may be seen. These green belts are characteristically located along slopes that face the winter sun, are protected from cold northern winds, and have cold air drainage to lower valleys. The blossoming of dogwood and redbud moves across the state in a pattern similar to that of the end of the freeze season to blanket North Carolina with color and beauty.

Summer Summer is characterized by its high temperatures, high humidities, high amounts of rainfall, and high physiological stress. Except for the amelioration of these climatic elements in the Mountains, and the relief afforded by sea breezes along the coast, elsewhere in the state summer is a season of extremes. Mean monthly minimum temperatures for July and August are in the upper seventies and eighties and mean maximum temperatures reach into the nineties.

However, to quote a popular adage, "it's not the heat but the humidity," and North Carolina's temperatures in combination with the high water vapor amounts prevalent during the summer months are definitely uncomfortable. In addition, high sunshine percentages and a predominance of southerly winds tend to aggravate an already unpleasant climatic condition. Only the periodic passage of cool, dry air masses from the north and sea breezes in the coastal areas alleviate the discomfort of summer weather for North Carolina's low-lying counties.

July Average Temperatures The pattern of mean temperatures in July is similar to the pattern in January (Figure 5.9). However, in the Piedmont and Coastal Plain, isotherms are fewer in number and farther apart. In the Mountains, the reverse is true. The widespread isotherms east of the Mountains indicate that temperature averages across central and eastern North Carolina exhibit little contrast. From the western Piedmont to the coast, the difference in mean temperatures is only 4° F. Although the influence of the ocean is not evident in the arrangement of isotherms, the high temperatures of the Coastal Plain are made less severe by the cooling power of the sea breeze. Hatteras, on the Outer Banks, records a temperature of 90° F. on the average of only one day each year, while Wilmington, a short distance from the coast, has an occurrence of 90° F. temperatures about twenty-four days annually. In contrast with these locations, Raleigh and Winston-Salem mean temperatures for July are slightly lower, but the average number of days on which a temperature of 90° F. or above is experienced increases to more than forty.

REFERENCE 22

DEPARTMENT OF COMMERCE
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TECHNICAL PAPER NO. 40

RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years

Prepared by
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Comparative Studies Section, Hydrologic Services Division
for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

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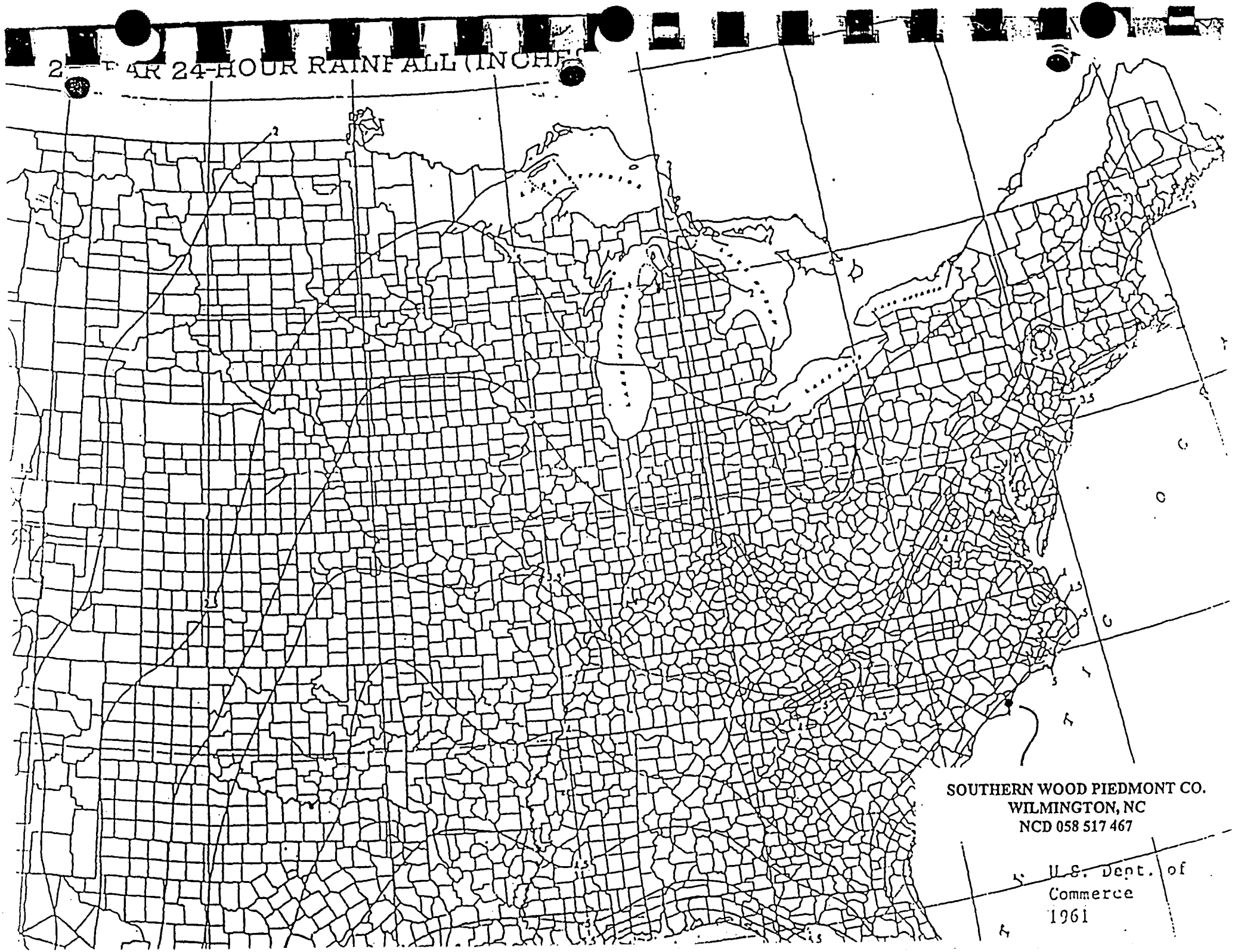
2-YEAR 24-HOUR RAINFALL (INCHES)
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GEOLOGY AND GROUND-WATER RESOURCES OF NEW HANOVER COUNTY, NORTH CAROLINA

DIVISION OF GROUND WATER

GROUND WATER BULLETIN NUMBER 17

North Carolina
Department of Water & Air Resources

Raleigh
April
1970

GEOLOGY AND GROUND-WATER RESOURCES OF NEW HANOVER COUNTY, NORTH CAROLINA

By
George L. Bain
Geologist, U. S. Geological Survey

GROUND WATER BULLETIN NO. 17

North Carolina
Department of Water and Air Resources
George E. Pickett, *Director*

DIVISION OF GROUND WATER
Harry M. Peek, *Chief*

Prepared by the
United States Geological Survey
in cooperation with the
New Hanover County Board of Commissioners
and the
North Carolina Department of Water and Air Resources

APRIL 1970

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North Carolina Department of Water Resources

Raleigh, North Carolina

1970

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February 12, 1970

The Honorable Robert W. Scott
Governor of North Carolina
Raleigh, North Carolina

Dear Governor Scott:

I am pleased to submit Ground-Water Bulletin Number 17, "Geology and Ground-Water Resources of New Hanover County, North Carolina" by George L. Bain, Geologist, U. S. Geological Survey.

This report contains the results of a detailed study of the ground-water resources made by the U. S. Geological Survey in cooperation with the New Hanover County Board of Commissioners and the North Carolina Department of Water and Air Resources. It should prove to be of much value toward the economic and industrial development of the County.

Respectfully submitted,

George E. Pickett

GEP:hbd

CONTENTS

	Page
Abstract	1
Introduction	3
Previous investigations	4
Acknowledgments	4
Geography	5
Location, area, and population	5
Climate	5
Physical features	7
Geology	8
Outline of geology	8
Basement rock	8
Cretaceous System	9
Black Creek Formation	9
Peedee Formation	9
Tertiary System	13
Castle Hayne Limestone	13
Undifferentiated deposits of late Tertiary age	15
Quaternary System	18
Undifferentiated surface deposits	18
Hydrology	21
General statement	21
Aquifer characteristics	22
Aquifers containing fresh water	24
Peedee Formation	24
Castle Hayne Limestone	26
Undifferentiated deposits of late Tertiary age	30
Undifferentiated surface deposits	30
Hydraulic characteristics of aquifers	34
Water-level fluctuations	41
Low-flow discharge measurements	41
Quality of water	44
Dissolved mineral constituents	44
Specific conductance	44
Hydrogen-ion concentration (pH)	44
Temperature	47
Silica (SiO_2)	47
Calcium (Ca) and magnesium (Mg)	47
Sodium (Na) and potassium (K)	48
Bicarbonate (HCO_3) and carbonate (CO_3)	48
Sulfate (SO_4)	48
Chloride (Cl)	48
Fluoride (F)	49
Nitrate (NO_3)	49
Phosphate (PO_4)	50
Aluminum (Al)	50
Iron (Fe) and manganese (Mn)	50

CONTENTS (Continued)

Page

Quality of water--continued
Dissolved mineral constituents--continued
Dissolved solids..... 51
Hardness..... 51
Occurrence of salty water and its possible encroachment..... 51
Wells and well construction..... 55
Conclusions..... 58
References..... 60

ILLUSTRATIONS

Page

Figure 1. Index map of North Carolina showing the location of New Hanover County..... 5
2. Graphs showing average monthly temperature and precipitation for the 30-year period of record 1931-60 at Wilmington, North Carolina..... 6
3. Map showing the locations of selected wells.....facing page 8
4. Sections showing correlation of formations by gamma-ray logs..... ...facing page 8
5. Generalized diagram showing the relation of geologic conditions to the occurrence of fresh ground water..... 10
6. Map showing the altitude of the top of the uppermost saline aquifer..... 11
7. Map showing the altitude of the top of the sandstone aquifer in the Peedee Formation..... 12
8. Map showing the thickness of the clay aquiclude in the Peedee Formation..... 14
9. Map showing thickness of the Castle Hayne Limestone..... 16
10. Map showing altitude of the top of the Castle Hayne Limestone 17
11. Map showing the geographic distribution of Miocene clay and sand and Pleistocene(?) coarse sand..... 19
12. Diagrammatic sections showing the effect of pumping on the water table and the piezometric surface..... 23
13. Map showing the piezometric surface of the sandstone aquifer in the Peedee Formation..... 25
14. Map showing the hardness of water in the sandstone aquifer in the Peedee Formation..... 27
15. Map showing the concentration of chloride in water of the sandstone aquifer in the Peedee Formation..... 28
16. Map showing the concentration of iron in water of the sandstone aquifer in the Peedee Formation..... 29
17. Map showing the altitude of the water level in wells penetrating the Castle Hayne Limestone..... 31
18. Map showing the concentration of iron and chloride in water of the Castle Hayne Limestone aquifer..... 32
19. Map showing measured specific capacities of wells with depths less than 180 feet below mean sea level..... 39
20. Composite graph of precipitation at the New Hanover County Airport, discharge from Smiths Creek, and fluctuations of the water level in well 141..... 42
21. Diagram showing the circulation of salt water and fresh water in a coastal aquifer..... 53
22. Diagram showing types of wells constructed in New Hanover County..... 56

TABLES

Page

Table 1. Aquifer test data on selected wells..... 35
2. Chemical analyses of water..... 45
3. Summary of deep test well data..... 52
4. The composition of sea water..... 54
5. Records of wells in New Hanover County, N. C..... 62

GEOLOGY AND GROUND-WATER RESOURCES OF NEW HANOVER COUNTY, NORTH CAROLINA

By

George L. Bain

Geologist, U. S. Geological Survey

ABSTRACT

This report describes the ground-water resources of New Hanover County in southeastern North Carolina. The county is a part of the Atlantic Coastal Plain Province and occupies a peninsula between the Atlantic Ocean and the Cape Fear and Northeast Cape Fear Rivers. New Hanover County is a relatively flat sandy plain, few points in the county being more than 50 feet above sea level. The climate is humid; the average annual precipitation is about 50 inches.

Ground water occurs in a system of slightly inclined formations underlying the Coastal Plain. Although individual formations dip and thicken in various directions, they in aggregate, thicken in wedge-like fashion toward the coast, reaching a maximum thickness in New Hanover County of slightly more than 1,500 feet. Most of the formations are composed of unconsolidated sands and clays containing a few beds of limestone and calcareous sandstone. A veneer of sand and sandy clay of probable Pleistocene age tends to conceal the underlying sequence of rock materials of Tertiary and Cretaceous age.

The volume of water stored in the Coastal Plain formations in New Hanover County is large; however, water in all but the shallow formations is too salty for most uses.

Three major aquifers, or water-bearing beds, furnish water to wells, at least two of them being available for use in most parts of the county. They include a sandstone bed in the Peedee Formation of Late Cretaceous age, the Castle Hayne Limestone of Eocene age, and the shallow surface sands.

The sandstone aquifer in the Peedee Formation averages about 35 feet in thickness, sloping from sea level in the northwestern part of the county to about 190 feet below sea level at Wrightsville Beach. Where data are available, the aquifer is known to contain fresh water and is separated from underlying beds containing salty water by 100 to 150 feet of relatively impermeable clay. Except along the Cape Fear River and the Atlantic coast, ground water in the Peedee sandstone is under sufficient pressure to rise above sea level, and it rises to more than 30 feet above sea level in the center of the county. Some wells tapping this aquifer yield more than 400 gallons per minute, and the specific capacity in part of the county is more than 30 gallons per minute per foot of drawdown.

The Castle Hayne Limestone is irregular in thickness and areal distribution, being thicker and more extensive under the northeastern and southern parts of the county. It lies within about 30 feet of the land surface except along the coastal margin where it is somewhat deeper. The Castle Hayne has easy access for replenishment, and much water enters the limestone in the center of the county. Some wells tapping this aquifer yield more than 400 gallons per minute, and the specific capacity ranges from 3 to 80 gallons per minute per foot of drawdown.

Sand, clay, and marl of Pleistocene and Miocene age cover the land surface in all of the county. The sands comprise the uppermost aquifer in the county--that is, the water-table aquifer, except in a few places where the Castle Hayne Limestone and Peedee Formation are near the land surface. The water table commonly lies within 10 feet of the land surface and is easily reached by the common type of drive-point well.

Water of acceptable chemical quality for most purposes is available throughout the county, but a wide range in quality of water within the aquifers is common. Water in the Peedee sandstone is hard in most places, and the iron content exceeds 1 milligram per liter in the central and north-central parts. Water in the Castle Hayne Limestone is a calcium bicarbonate type ranging from moderately hard to very hard. The iron content ranges from 0.01 to more than 12 milligrams per liter. Water in the surficial sands is soft but almost everywhere is corrosive.

The current withdrawal of ground water is only a small part of the available supply, but the availability of water varies considerably from one part of the county to another. The aquifers are susceptible to salt-water encroachment because of aquifers containing salty water underlying the Peedee sandstone aquifer and because of the bordering Atlantic Ocean and brackish Cape Fear River. The present position of the interface between salty and fresh water in the ground is maintained by the volume and hydrostatic head of the fresh water. Thus, a substantial reduction in rainfall or changes in ground-water conditions created by man's activities, such as withdrawal of water through pumping, swamp drainage, or dredging which reduces the fresh-water hydrostatic head, may cause a corresponding encroachment of salt water. Salt-water encroachment may be controlled at least partially by well-field design and management. Proper practices include pumping more wells at lower rates and the use of multiple well points and infiltration galleries in shallow aquifers.

INTRODUCTION

This report describes the ground-water resources of New Hanover County. The purpose of this study was to determine the thickness, lithology, and areal extent of the water-bearing formations (aquifers), the source of replinishment or recharge to the aquifers, the direction of water movement within the aquifers, and the quantity and chemical quality of the ground water.

Fieldwork, done for this report during the period from January 1963 to June 1966, included the following:

1. Fifty auger holes were drilled to determine the lithology, thickness, age, and areal extent of the geologic formations. Where feasible, the auger holes were cased to permit water sampling, gamma-ray logging, observation of water-level fluctuations, and pumping tests.

2. Two deep test holes were drilled to determine the depth to the deeper lying Black Creek Formation, the chemical quality of water in the deeper aquifers, and the position of the fresh water-salt water interface.

3. Data on 412 wells including drillers' records, well cuttings, and water samples were collected from well drillers and owners, as well as from published sources.

4. Gamma-ray well logs were made in cased auger holes, deep test holes, and some existing wells. Electric logs of the deep test holes also were made.

5. Water-level data were collected at 5 wells equipped with continuous recorders at 20 wells which were measured monthly, and at more than 100 wells which were measured semiannually.

6. More than 250 water samples were collected and analyzed to determine the quality of the ground water.

7. Thirty-seven pumping tests were made, and data from a few drillers pumping tests were collected to determine hydraulic characteristics of the aquifers.

8. The base-flow discharge of four small streams was measured to evaluate ground-water discharge.

9. A network of more than 150 altitude control points (accurate to ± 5 feet), necessary for geologic and hydrologic control, was established by barometric leveling.

PREVIOUS INVESTIGATIONS

No previous detailed geologic or ground-water investigations have been made in New Hanover County. David G. Thompson, U. S. Geological Survey, made a preliminary study of the ground-water resources of Wilmington (1941). A drought during the fall of 1940 had so reduced the fresh-water flow in the Cape Fear River that salt water contaminated the public water supply through the Toomers Creek intake. Thompson recommended that the surficial sand deposits of several areas on the outskirts of Wilmington be used as sources of emergency public supplies while the water intake was being extended to Lock 1 on the Cape Fear River. The sand hills area along U. S. 421 northwest of Wilmington was among those areas recommended.

The formations penetrated and the chloride concentrations of several wells in New Hanover County and vicinity were described by Clark and others (1912). Data collected by Thompson in 1941, M. J. Mundorff between 1941 and 1948, and H. E. LeGrand between 1952 and 1958 were combined in a reconnaissance report entitled, "Geology and Ground-Water Resources of Wilmington-New Bern Area, North Carolina" (LeGrand, 1960). LeGrand briefly describes the physiography and geology of the county, points out the potential of the Castle Hayne Limestone as an aquifer, and gives additional hydrologic data on the sand hills area northwest of Wilmington.

ACKNOWLEDGMENTS

The assistance of well owners, municipal and industrial officials, and well drillers is gratefully acknowledged. Particular acknowledgment is due Bill Dobo, Robert Meadows, Maurice Johnson, and H. H. Harward for furnishing well records, water-level data, and well cuttings. Auger and test-hole cuttings were processed and paleontological determinations were made by P. M. Brown, U. S. Geological Survey, Raleigh, North Carolina. Except where otherwise noted, water samples were analyzed by the Laboratory Unit, Water Resources Division, U. S. Geological Survey, Raleigh, North Carolina.

The study was initiated in January of 1963 by the U. S. Geological Survey in cooperation with the New Hanover Board of County Commissioners and the North Carolina Department of Water and Air Resources (formerly the North Carolina Department of Water Resources). The investigation was conducted under the general supervision of O. Milton Hackett, Chief, Ground Water Branch, U. S. Geological Survey. Immediate supervision was by P. M. Brown and G. G. Wyrick, former District Geologists, Raleigh, North Carolina.

GEOGRAPHY

LOCATION, AREA, AND POPULATION

New Hanover County is in the southeastern part of the Coastal Plain of North Carolina and occupies a peninsula between the Atlantic Ocean and the Northeast Cape Fear and Cape Fear Rivers. Figure 1 shows the location of the county.

The county has an area of 194 square miles. The Bureau of the Census reported the population in 1960 to be 71,742--about 370 people per square mile. Wilmington, the county seat, had a population of 44,013. Smaller towns in the county are Carolina Beach, Castle Hayne, Kure Beach, and Wrightsville Beach. Forests and farmland comprise 58 and 14 percent of the total land area, respectively. Sixty-nine percent of the residences are classed as urban.

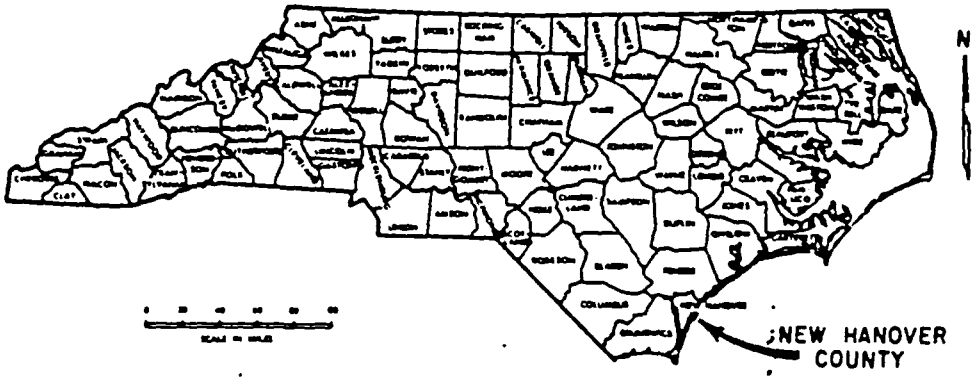

Figure 1.--Index map of North Carolina showing the location of New Hanover County.

CLIMATE

New Hanover County has a mild, humid climate. The U. S. Weather Bureau statistics for the Wilmington station show an average annual temperature of 63.8°F and an average annual precipitation of 51.29 inches for the 30-year period 1931-60. The average monthly variations in temperature and precipitation at this station are shown in figure 2. It may be observed that precipitation during July, August, and September tends to be considerably higher than in the other months. At Southport, near the southern tip of the county, the average annual temperature and precipitation for the same period of record are 64.3°F and 49.49 inches, respectively.

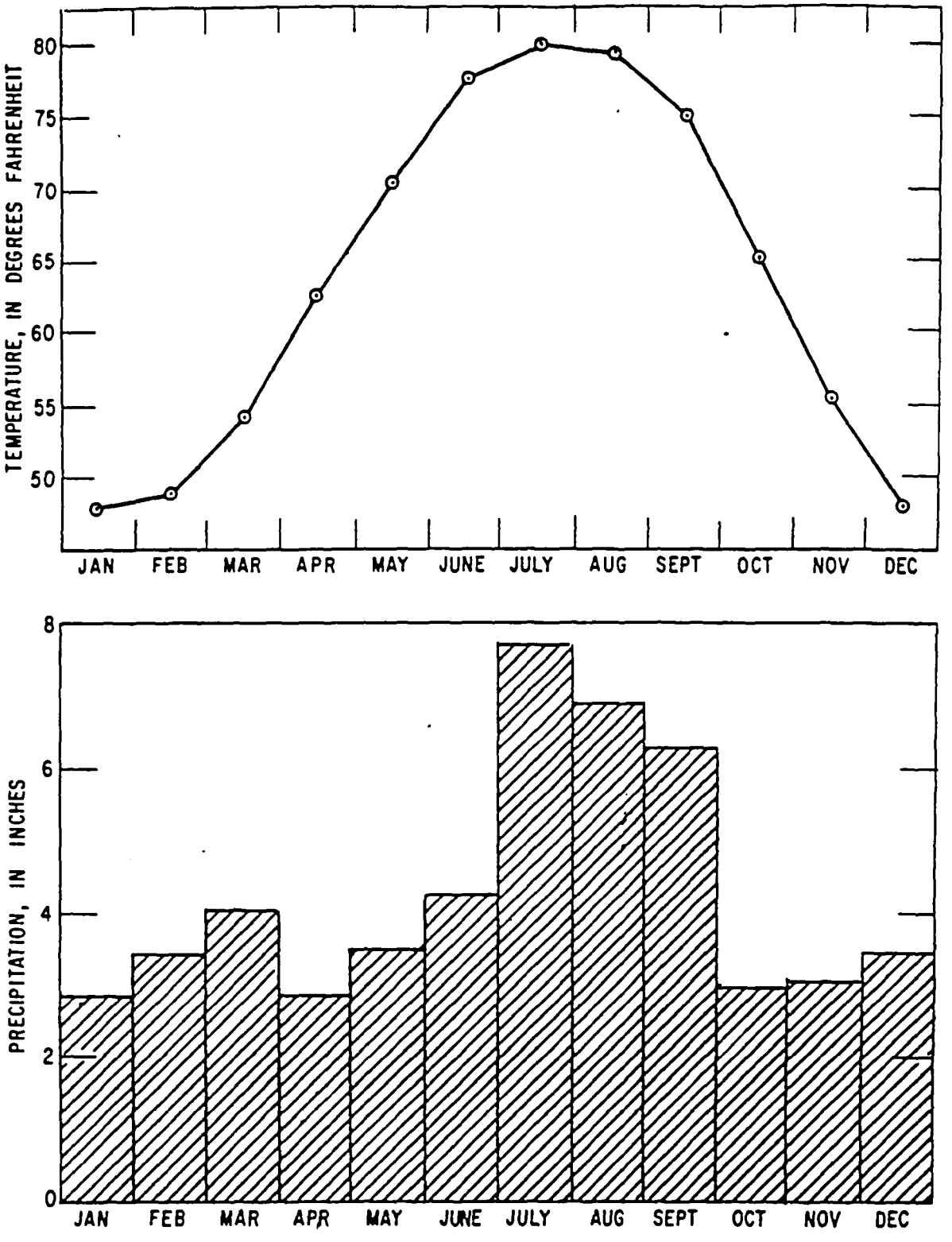

Figure 2.--Graphs showing average monthly temperature and precipitation for the 30-year period of record 1931-60 at Wilmington, North Carolina.

PHYSICAL FEATURES

The land surface of New Hanover County is a plain with a slight overall slope toward the Atlantic coast and the Cape Fear River. This plain is relatively flat in the broad interstream areas but is broken by low escarpments along the Northeast Cape Fear and Cape Fear Rivers and breached by short tributary creeks. The plain represents the part of a Pleistocene sea floor that has been exposed by withdrawal of the sea in the relatively recent geologic past. Parts of the land surface are covered with rolling sand hills. These sand hills constitute accumulations of beach sand which were shifted by the wind to form dunes. Salt marshes, tidal flats, and shallow sounds between the present-day barrier beaches and the mainland are connected to the ocean by narrow inlets.

Several topographic features are important to the ground-water hydrology in the county. The fossil dunes or sand hills extend northeastward from Fort Fisher along U. S. Highway 421 through Wilmington to and beyond the Pender-New Hanover County line. They are best developed in an area between the Cape Fear River and the Northeast Cape Fear River, northwest of Wilmington, southeast of Greenfield Lake, and south of Barnard Creek. The highest altitude in the county of 80 feet above sea level occurs on one such fossil dune system east-southeast of Greenfield Lake. Most of these thick sand deposits have no surficial drainage. Another sandy area extends northeast along U. S. Highway 17 parallel to the coast in the northeastern part of the county. This sandy area was a long bar at a time when the sea stood some 35 or 40 feet higher than it does today. To the west of this bar was a broad shallow lagoon, which is now drained by the northeast Cape Fear River. Today the area is flat and marshy. Small shallow sinks are common in the vicinity of the town of Castle Hayne and from Wilmington southward. The sinks, usually filled with water, result from the solution of near-surface limestone and coquina beds.

The altitude of much of the county is from 30 to 40 feet above mean sea level. The Talbot Terrace described by Cooke (1931) occurs at this level. Cooke also described a terrace at 25 feet above mean sea level which may be distinctive from the village of Porters Neck southward and slightly west of the sounds.

GEOLOGY

OUTLINE OF GEOLOGY

The present-day quality, occurrence, and availability of ground water in New Hanover County depend upon the physical and chemical character of the sediments beneath the county. Such characteristics as: kind of sediment, lithology, thickness, and attitude have been predetermined by the county's geologic history. When any area is inundated through a general rise in sea level or localized subsidence of the earth's crust, accumulation of marine sediment begins and erosion ceases. The kind and character of the sediment being deposited at any one place, whether limestone, sandstone, clay, shale, or sand, whether coarse or fine, or whether cemented or unconsolidated depends on many complex variables. Some variables include the kind of source material and degree of weathering, distance of sediment transport, and rate of accumulation of the shells of marine organisms.

Crustal movements along the axis of the geologic structure known as the Cape Fear Arch had a profound effect upon the type, thickness, and inclination (dip) of the sedimentary formations beneath New Hanover County and thus, ultimately have influenced the ground water. The Cape Fear Arch is now a broad gentle uplift roughly paralleling the Cape Fear River and trending southeastward through New Hanover County. Crustal movements along this axis are responsible for the lack of deposition of Lower Cretaceous sediments in part of the county, the deposition of a thick sequence of Upper Cretaceous sediments, and thin to nondeposition of the more recent Tertiary formations.

Sediment accumulation on the crystalline basement floor ranges in thickness from about 1,100 feet at Wilmington to 1,500 feet at Fort Fisher. Nearly 90 percent of the sediments accumulated during Cretaceous time when the county was on the flank of a depositional basin. These deposits, ranging in age from Cretaceous through Tertiary, are divided from oldest to youngest into the Black Creek, Peedee, Castle Hayne, and undifferentiated deposits of Oligocene(?) and Miocene age. They are overlain at the surface by sands, clays, and marls deposited during the comparatively recent geologic past.

BASEMENT ROCK

The submerged erosional surface upon which the Upper Cretaceous sediments were deposited consists of schist, gneiss, granite, and metamorphosed volcanic rocks typical of rocks which are exposed in the Piedmont Province of North Carolina. Granite occurs at a depth of 1,109 feet in well 202, which was drilled as a municipal water well for Wilmington in 1899. A well drilled during 1905-07 at Fort Caswell, across the Cape Fear River from the southern tip of the county, penetrated basement rock at 1,540 feet (Clark and others, 1912, p. 194-196). The ages of the basement rocks are unknown but may range from Precambrian(?) to Mississippian(?).

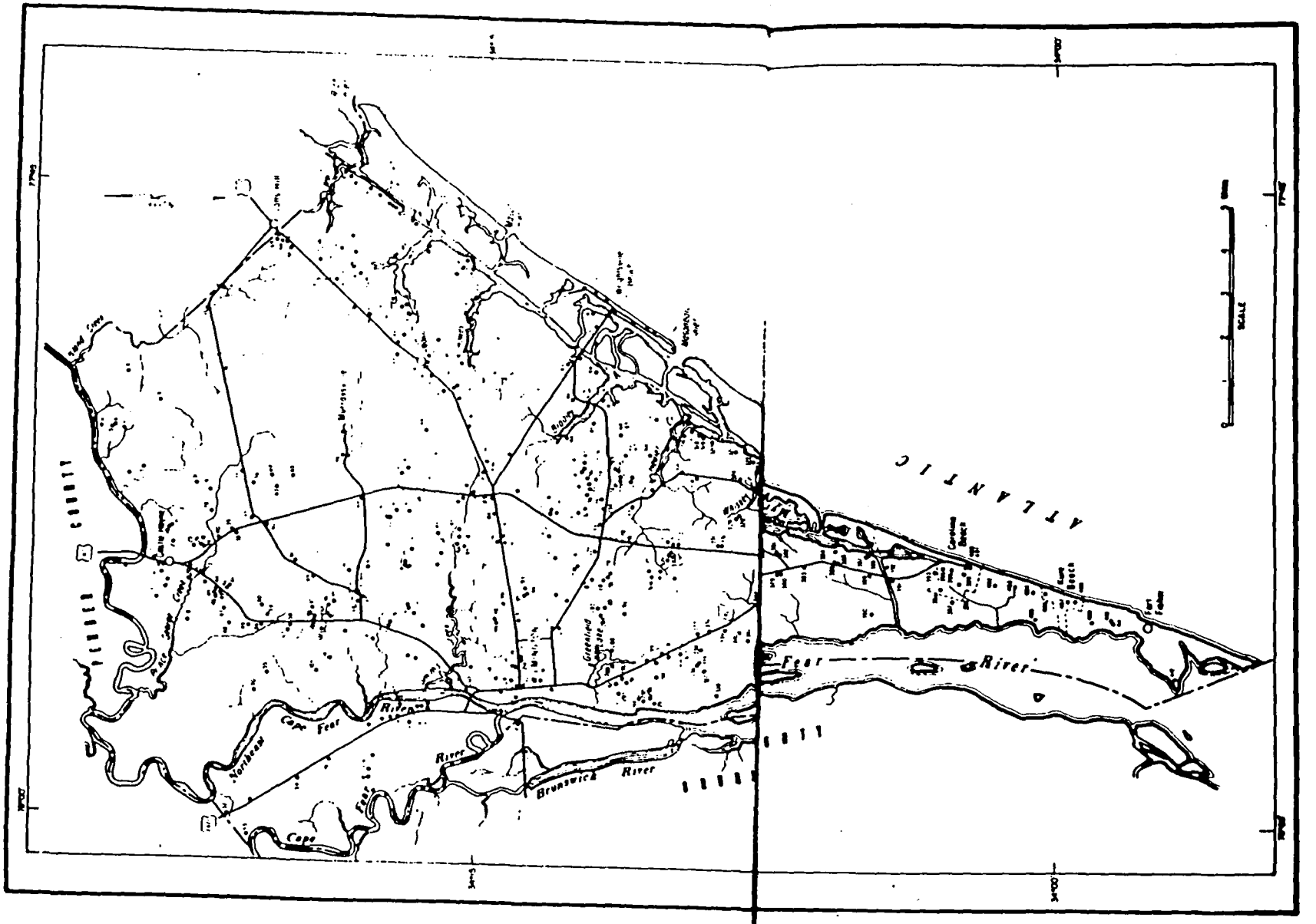

Figure 3.--Map showing the located wells.

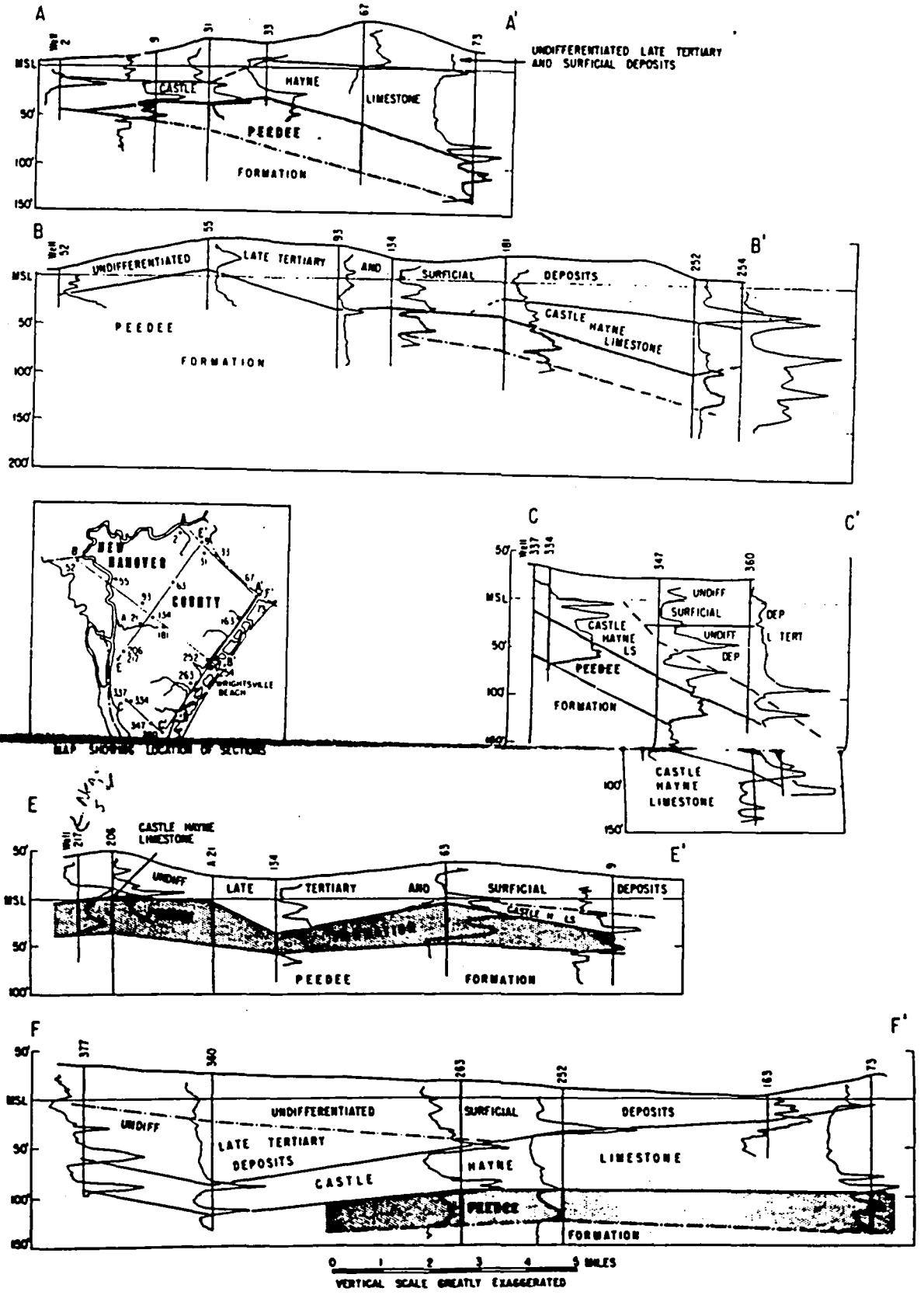

Figure 4.--Sections showing correlations by gamma-ray logs.

CRETACEOUS SYSTEM

BLACK CREEK FORMATION

The Black Creek Formation of Late Cretaceous age rests unconformably upon the basement rocks at Wilmington. Lower Cretaceous sediments and the Tuscaloosa Formation, prominent in other parts of the Coastal Plain, are not known to be present beneath New Hanover County (Brown, 1959a).

The Black Creek Formation is approximately 380 feet thick in New Hanover County. The upper and lower contacts were placed at 711 and 1,100 feet below sea level, respectively, in the Hilton Park well (well 202, see fig. 3), by T. W. Stanton (Clark and others, 1912). The top of the Black Creek was penetrated at 673 feet below mean sea level in the Murraysville test well (well 87) but was not reached in the Edwards test hole (well 347), which was drilled to a depth of 610 feet below sea level.

The Black Creek Formation is assumed to contain saline water everywhere beneath New Hanover County. Highly saline water was found in the Hilton Park well in all zones below 370 feet and in a well at Fort Caswell, Brunswick County, below 354 feet (Clark and others, 1912).

PEEDEE FORMATION

The Peedee Formation conformably overlies the Black Creek Formation in New Hanover County. It typically consists of unconsolidated greenish-gray to dark-gray silt, olive-green to gray sand, and massive black clay interbedded with consolidated calcareous sandstone and impure limestone. Glauconite gives the Peedee Formation its characteristic salt and pepper appearance. There appears to be an increase in sand and lime and a decrease in clay toward the top of the formation in New Hanover County.

The Peedee Formation in New Hanover County is 710 feet thick at well 202 and 645 feet thick at well 87, and contains four water-bearing beds of sand. The uppermost sand contains fresh water and the lower three contain brackish to saline water throughout the county. The general relationship of the Peedee Formation to the other formations in the county is illustrated in figures 4, 5, and 6. Figure 6 is a structure contour map of the top of the uppermost salt-water bearing sand. The top of the sand strikes N. 25° E. and dips toward the southeast at the rate of 10 feet per mile.

Figure 7 is a structure contour map of the top of a calcareous sandstone, the topmost sandstone in the Peedee Formation and the principal fresh-water aquifer in New Hanover County. It is discussed in a later section as the sandstone aquifer.

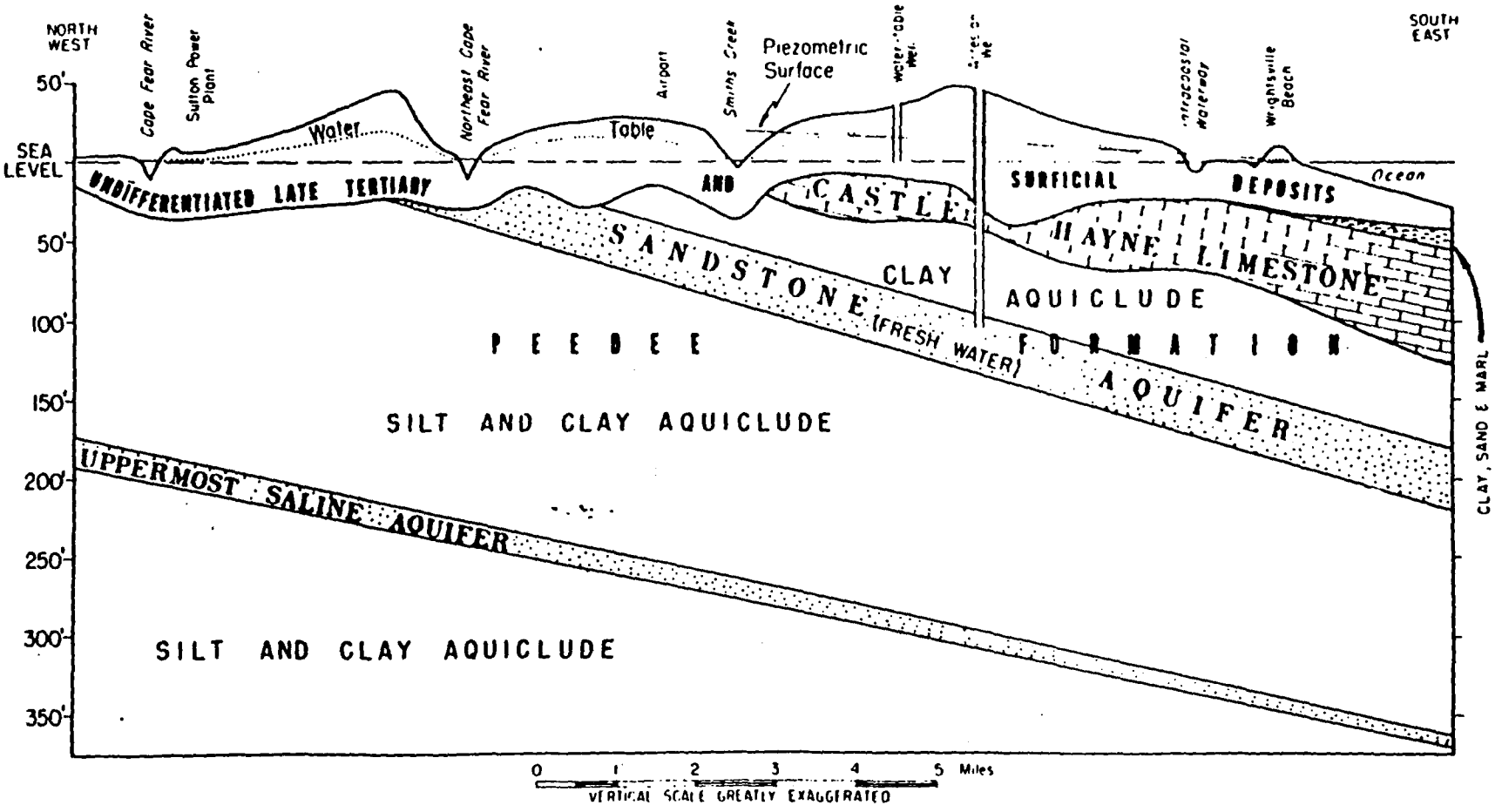

Figure 5.--Generalized diagram showing the relation of geologic conditions to the occurrence of fresh ground water.

occur of fresh ground water.

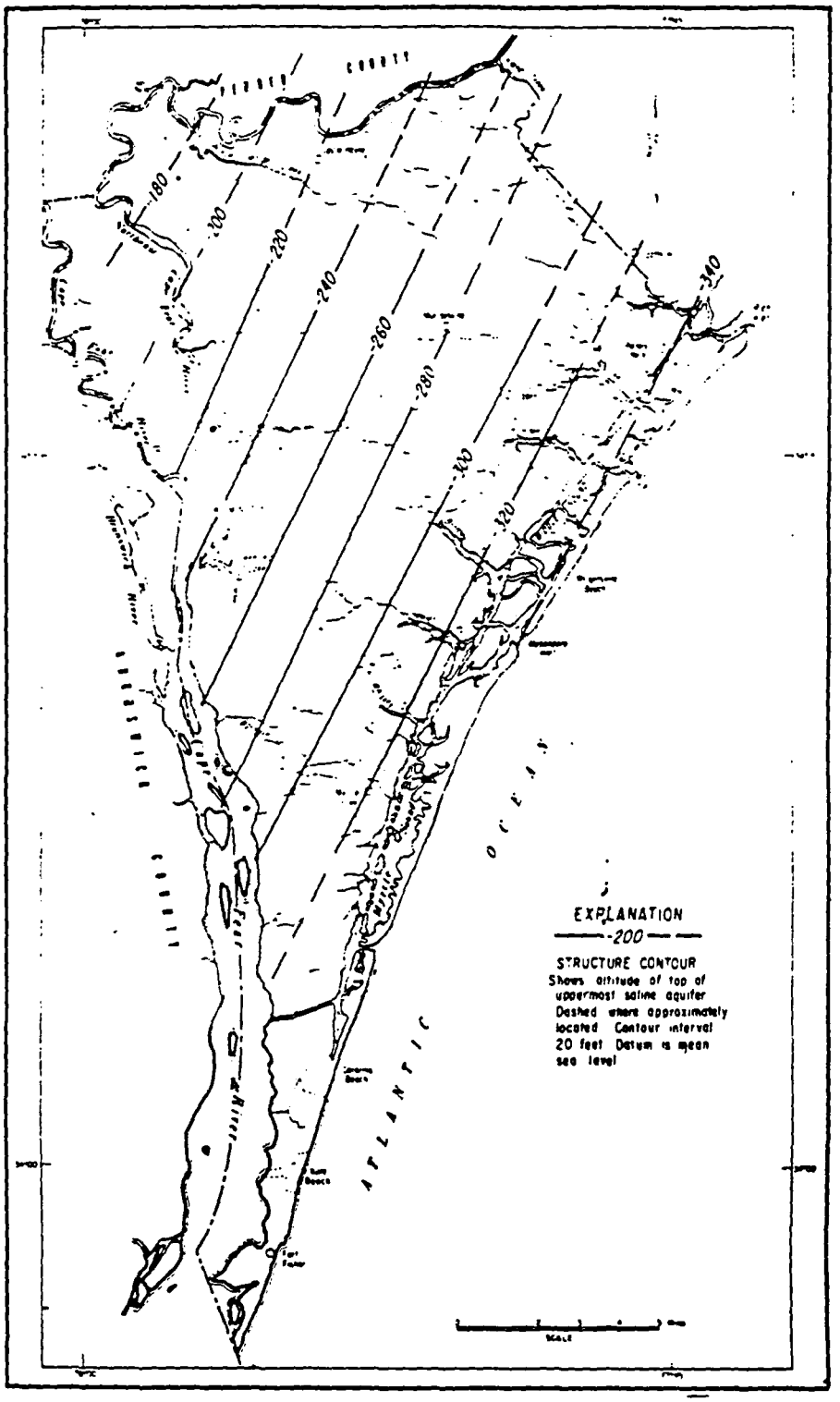

Figure 6.--Map showing the altitude of the top of the uppermost saline aquifer.

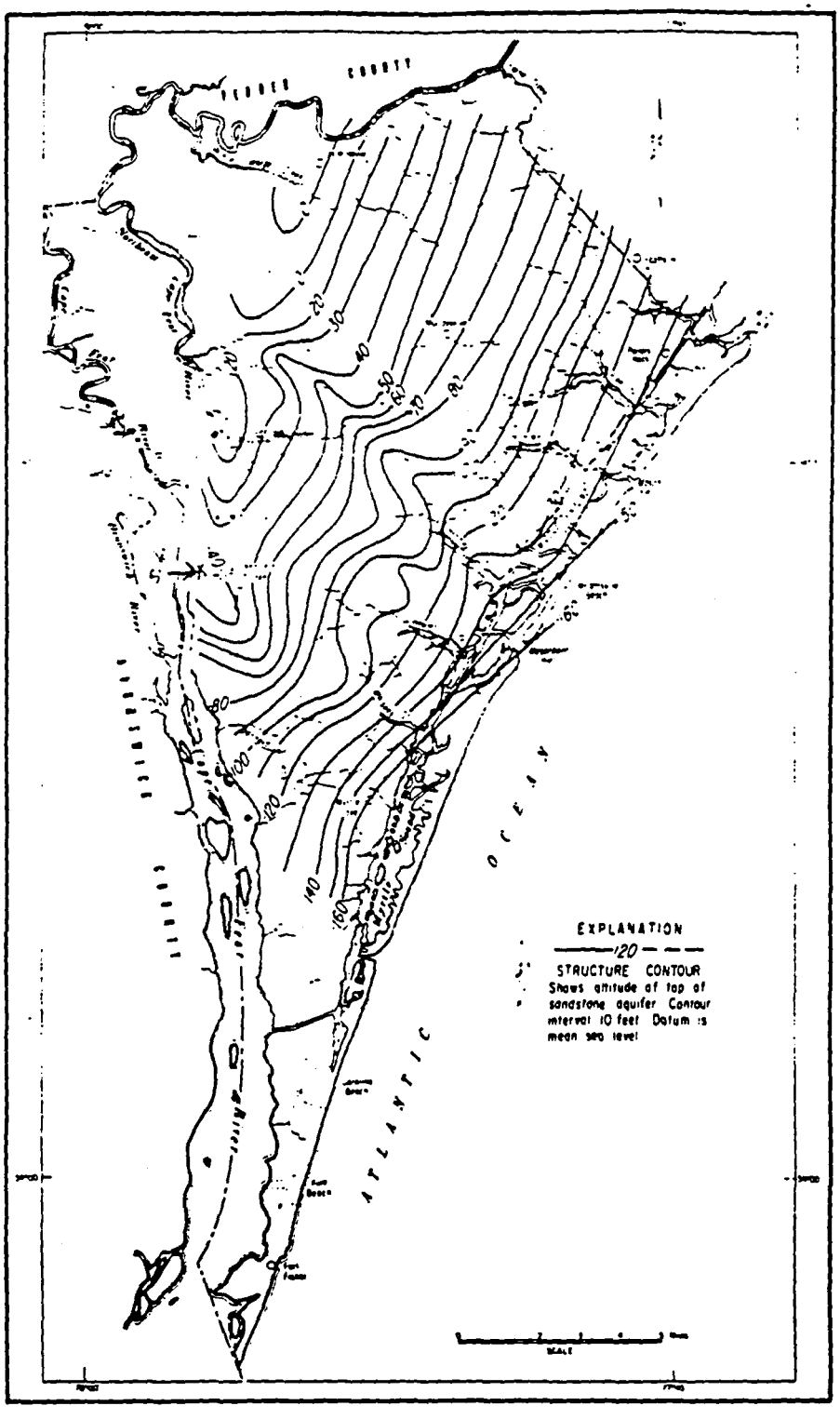

Figure 7.--Map showing the altitude of the top of the sandstone aquifer in the Peedee Formation.

All water below the altitudes shown on figure 6 is saline. All water in and above the sandstone shown in figure 7 is known to be fresh except that south of Myrtle Grove, where there are no data. Fresh water of unknown but probably limited extent and quantity was detected in well 87 in fine unconsolidated sand below the sandstone aquifer.

Figure 8 is an isopach map showing the distribution and thickness of the massive clay aquiclude lying between the calcareous sandstone and the top of the Peedee Formation. In effect, this figure shows the thickness of the impermeable beds lying between the sandstone aquifer and the Castle Hayne Limestone, the next higher aquifer.

TERTIARY SYSTEM

CASTLE HAYNE LIMESTONE

The Castle Hayne Limestone of middle and late Eocene age (LeGrand and Brown, 1955) was first described by Miller (Clark and others, 1912) at a quarry near the intersection of Prince George Creek and U. S. Highway 421 at the town of Castle Hayne. Rocks of Paleocene age were not deposited in the county because of erosion or nondeposition upon the elevated Cape Fear Arch. Thus, the Castle Hayne Limestone unconformably overlies the channeled and eroded upper surface of the Peedee Formation.

The Castle Hayne Limestone is quite variable lithologically, consisting of shell, marl, sand, and limestone. A complete geologic section in New Hanover County includes:

A. A basal sandy shell conglomerate containing much reworked material from the Peedee Formation. It is discontinuous in occurrence because it was deposited in channels on the top of the Peedee Formation. It is approximately 30 feet thick in the Superior Stone quarry near the town of Castle Hayne.

B. Above the basal shell-conglomerate is a glauconitic shell limestone. It is light-gray toward the top and yellow and dolomitic toward the bottom. In places it contains interbedded sand. Where the lower unit is missing the shell limestone facies rests unconformably upon the Peedee Formation. The glauconitic shell limestone thickens from a featheredge along its up-dip extremities to about 40 feet at the town of Wrightsville Beach and to more than 80 feet at the town of Carolina Beach.

C. The shell facies is overlain by a dense, chalk-white siliceous limestone that contains phosphate at its base. This limestone, called "cap rock," by local well drillers averages about 3 feet in thickness throughout the county.

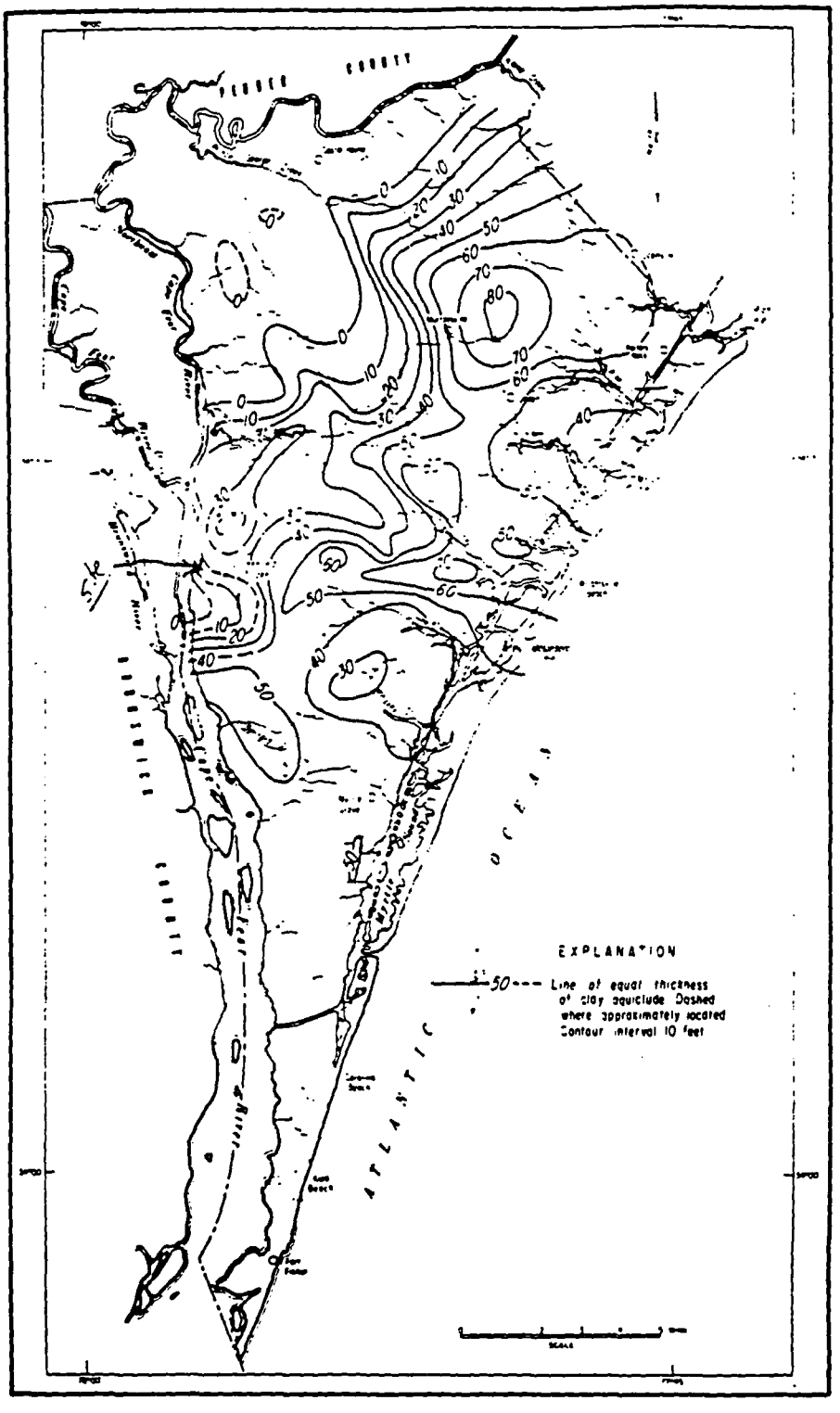

Figure 8.--Map showing thickness of the clay aquiclude in the Peedee Formation.

D. Overlying the "cap rock" is a cream to light-green, glauconitic, bryozoan-bearing "shell hash" (a coarse, braided mixture of shell fragments). This unit is generally confined to the northeastern section of the county north of a line connecting the city of Wilmington and Wrightsville Beach. South of this line the unit, if deposited, has apparently been removed by erosion. At the Ideal Cement Company quarry in the northern part of the county, where this unit is approximately 10 feet thick, it is mined for the manufacturing of cement. At Porters Neck crossroad it ranges from 55 to 80 feet thick.

The irregular distribution and thickness of the Castle Hayne Limestone (figs. 9 and 10) results from its deposition on an eroded surface of the Peedee Formation and from subsequent erosion and solution of the upper surface of the Castle Hayne. Areas in which the Castle Hayne Limestone is missing or spotty are also shown in figure 9.

The sandy, shell part of the Castle Hayne Limestone is generally a productive aquifer. Yields of individual wells in the county depend largely upon the degree to which the porosity and permeability have been increased by solution.

UNDIFFERENTIATED DEPOSITS OF LATE TERTIARY AGE

Overlying the Castle Hayne Limestone in the southern part of the county are sediments that probably range in age from late Oligocene through late Miocene. Most of the sediments in this late Tertiary sequence are phosphatic sands, silts and clays, and phosphatic limestones similar to materials in the Pungo River Formation described by Kimrey (1964) in Beaufort County, North Carolina. The upper part of the Pungo River Formation is equivalent in age to the Calvert Formation of Maryland (Brown, 1958b, p. 89) (Gibson, 1967, p. 636), which the U. S. Geological Survey currently recognizes as middle Miocene. The possibility that the lower part of the Pungo River is of early Miocene or late Oligocene has not been discounted (Brown, 1958b, p. 90) (Gibson, 1967, p. 637). According to Gibson (written communication, July 1, 1968), the sediments in southern New Hanover County "are in part facies equivalents of the phosphatic sands, limes, and diatomites of the Pungo River, but whether they belong lithologically and genetically is another question." Thus, the name Pungo River should not be applied to the deposits in New Hanover County although they are probably facies equivalents.

In the Carolina Beach area the above deposits consist chiefly of marl interbedded with light-green to dark-gray silty clay containing thin shell beds. The silty phase is replaced to the northwest by light-gray sand and sandy coquina overlain by olive-green sand. The sandy coquina, present in wells 368 and 381, is possibly of late Miocene age. Phosphate is present but is not known to be in sufficient quantities to warrant economic

ion.

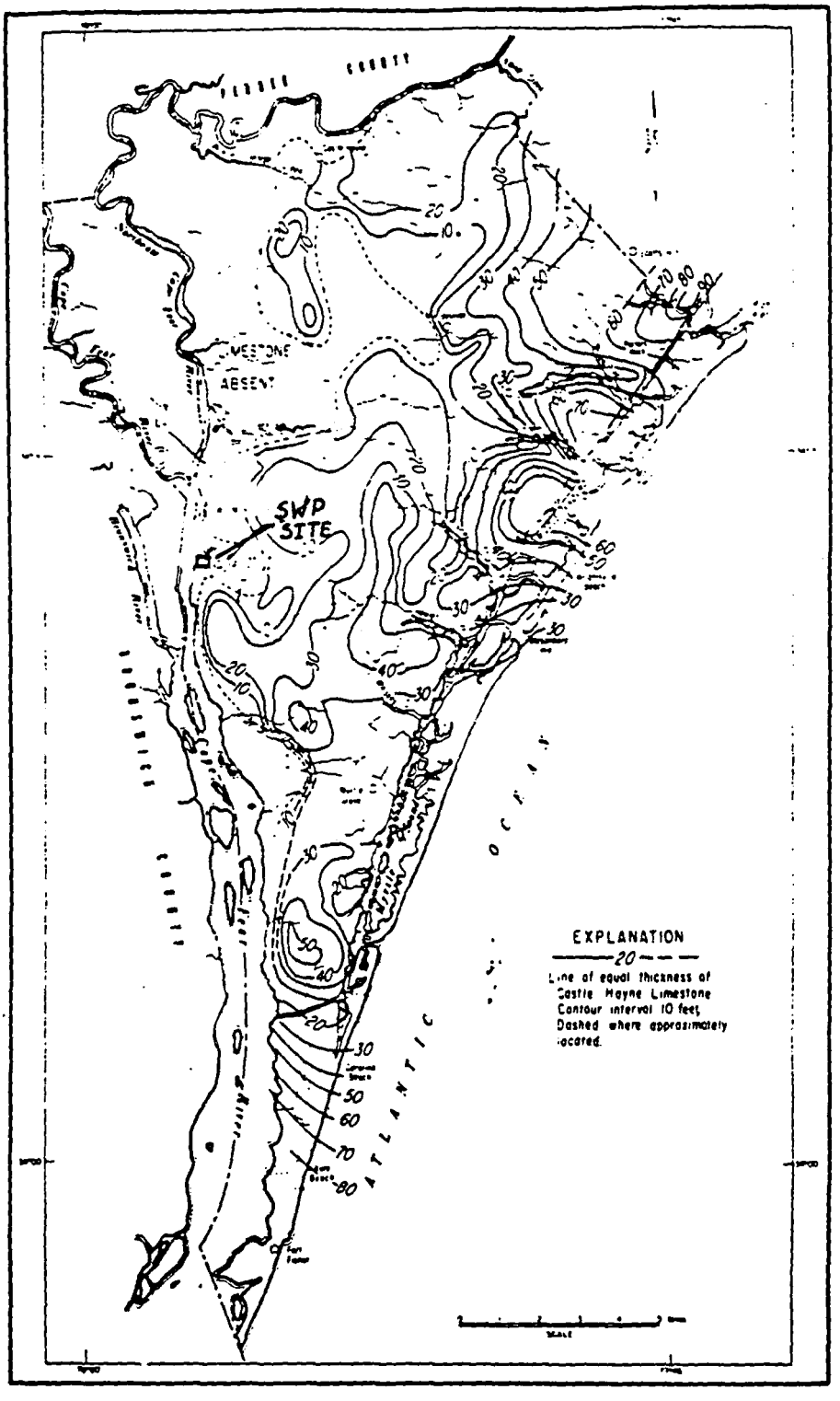

Figure 9.--Map showing thickness of the Castle Hayne Limestone.

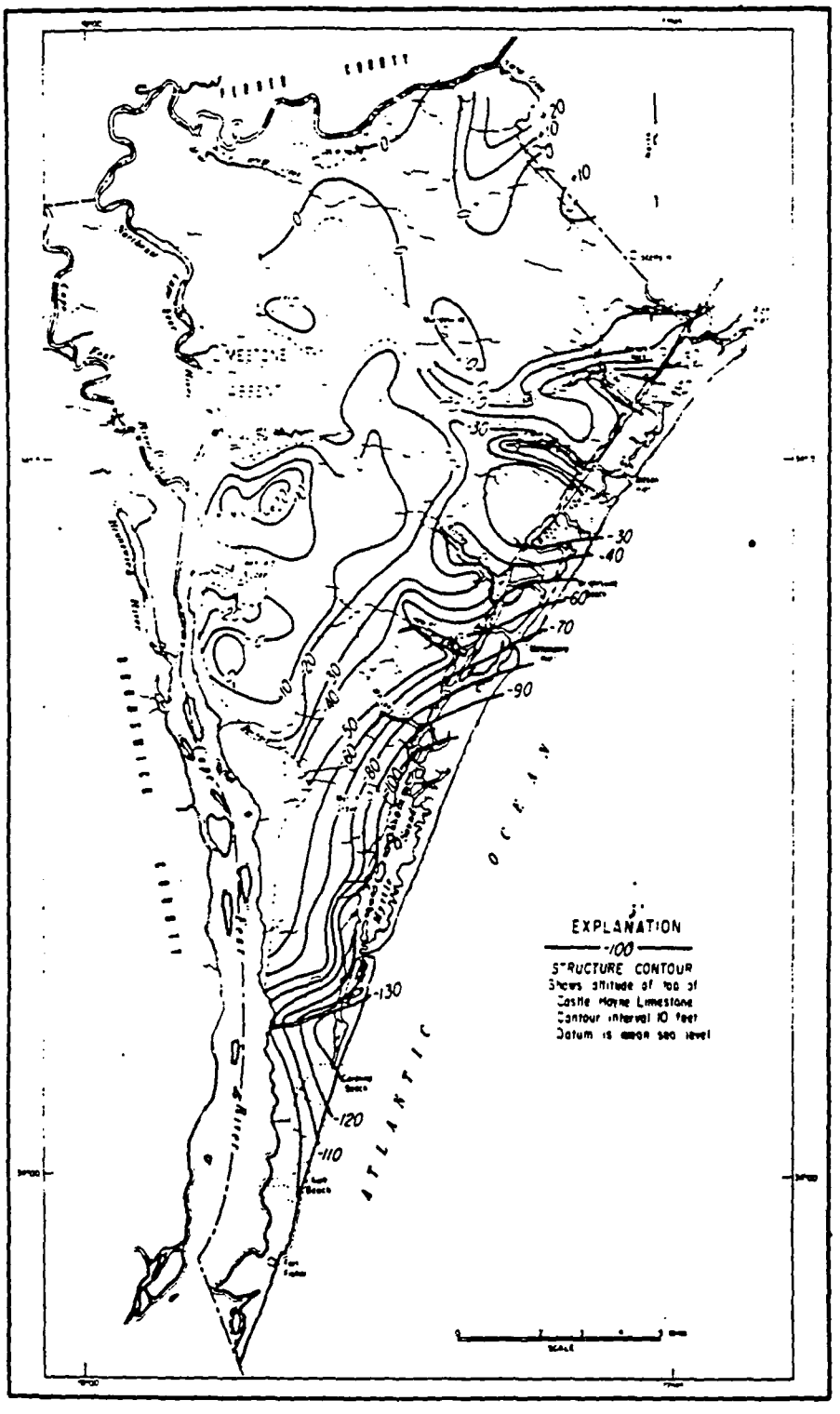

Figure 10.--Map showing altitude of the top of the Castle Hayne Limestone.

development. The lower silty part of the unit thickens southward from about 10 feet at Wrightsville Beach to 75 feet at well 394 at Carolina Beach and dips to the south-southeast and southeast at 10 to 25 feet per mile. It is overlain in the southeastern part of the county by 20 to 30 feet of fine- to medium-grained sand containing dark-gray to chocolate-brown clay beds that change southward to light-gray to olive-green clay and shell beds. This late Miocene unit is as much as 10 feet above sea level. In the north-central and northeastern sections of the county--10 to 20 feet of fine- to medium-grained sand containing a dark-gray to blue-gray clay is overlain by 5 to 20 feet of blue or gray dense clay of late Miocene age. The late Miocene clay occurs in a zone as much as 25 feet above sea level.

The silty part of the unit functions as a hydraulic barrier (aquiclude) between the overlying water-table aquifer and the underlying Castle Hayne aquifer near the seacoast.

Small to moderate water supplies are available from the sandy coquina, but only small supplies are available from the shallow sands and from the thin shell beds of this formation.

QUATERNARY SYSTEM

UNDIFFERENTIATED SURFACE DEPOSITS

Overlying the channeled surfaces of the formations previously described are deposits of clay, sand, and marl. Their age, thickness, and origin vary from one place to another. As used in this report the deposits include all of the sediments between land surface and the undifferentiated deposits of late Tertiary age. Thus, they include terraced and barrier-beach deposits, sandy coquinas (DuBar and Johnson, 1964), fossil sand dunes, stream channel deposits, and possibly thin and scattered remnants of the underlying formation. These sediments are absent in the towns of Castle Hayne and Wilmington, where the underlying limestone is exposed, but are as much as 70 feet deep near the Cape Fear River west of Myrtle Grove.

Eastward from a line connecting Fort Fisher, Myrtle Grove, and Wrightsville Beach, the base of these surficial sediments rests upon silt, clay, and shell beds of the underlying deposits of late Tertiary age. In the northwest one-third of the county they rest upon the Peedee Formation where the Castle Hayne Limestone is missing as shown in figure 10. Between the above areas they rest upon the Castle Hayne Limestone.

The surficial sediments may be divided into the following oversimplified or generalized categories:

1. In the central and western parts of the county, 0 to 35 feet of coarse, clean, nonfossiliferous quartz sand generally from 0 to 30 feet below sea level. Reference to figures 10 and 11 shows that the coarse sand occurs where the Castle Hayne is missing, or more specifically, in

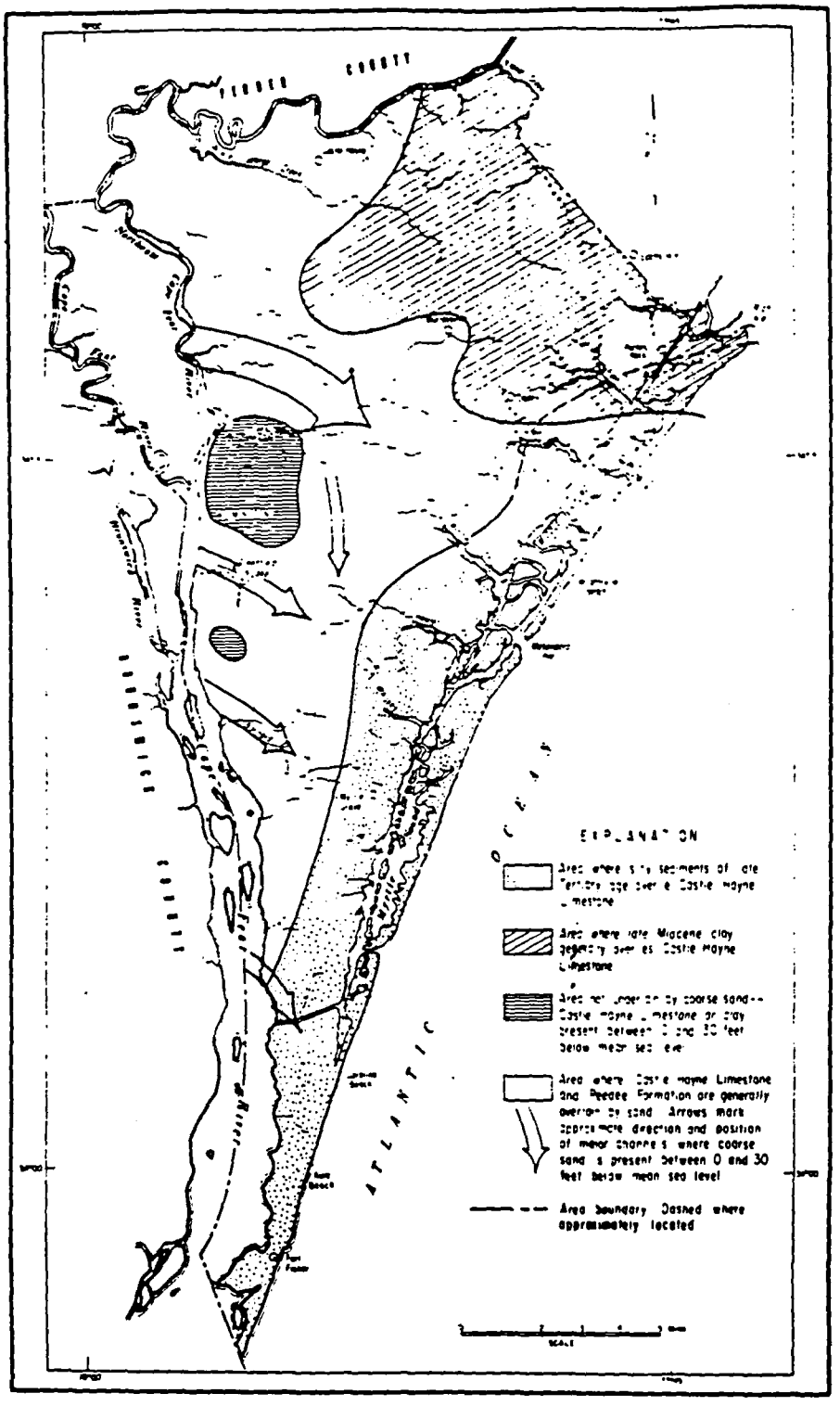

Figure 11.--Map showing the geographic distribution of Miocene clay and sand and Pleistocene(?) coarse sand.

channels cut into the surfaces of the Peedee and Castle Hayne Formations. Although there is no direct evidence, the sand is probably of Pleistocene age.

2. Throughout the county 0 to 60 feet of fine- to medium-grained Pleistocene sand tend to cover underlying clays and sands. The sandy veneer includes the commonplace surface sand and the fossil dunes and beach bars. Where swampy the sand is dark brown or black with humic material, and where well drained it is tan to gray white. Sandy coquina and marl beds occur at shallow depths in the sand along the present-day coast and mark the sites of Pleistocene beaches and inlets. As much as 20 feet of red clay and sandy clay overlie the Castle Hayne Limestone along Middle and Topsail Sounds. At a few isolated spots the surface material is a weathered product of the Castle Hayne Limestone or Peedee Formation.

The occurrence and distribution of the above sands and clays affect the water yield potential of various parts of the county. Moderate to large yields are available from these deposits northwest of Wilmington and south and southeast of Greenfield Lake where coarse sand is overlain by thick and extensive fossil dune deposits. Although the water in such deposits is acidic, iron and hydrogen sulfide are negligible. Small yields are available for domestic and small irrigation supplies from the finer grained and shallower surface sands throughout the county.

HYDROLOGY

GENERAL STATEMENT

The earth's vast but fixed supply of water is kept in endless circulation by energy supplied from the sun. Water evaporates from the oceans, lakes, streams, and land surfaces and is carried in the atmosphere as water vapor until it condenses and falls as precipitation. Part of the precipitation flows overland as surface runoff, a part is returned directly to the atmosphere by evaporation, a part is transpired by plants, and the remaining part enters the ground from which it eventually discharges to streams or to the coast.

Ground water occurs in the spaces between the rock particles in the zone of saturation. Where the spaces are interconnected and large enough to permit flow through them the rocks will yield water to wells. Rock units that yield water to wells are called aquifers. In New Hanover County two types of spaces that transmit and store water are: (1) the openings between the sand grains; and (2) the larger interconnected openings, created by solution of some of the calcareous cement and shell material from the limestone and shell beds. Interbedded clay sediments contain numerous pore spaces, but the pores are extremely small and the yield to wells is so small that they are not considered to be aquifers.

Ground water not evaporated to the atmosphere or transpired by vegetation is eventually discharged to the streams or to the ocean. The discharge of ground water is facilitated where streams have incised their channels into, or below, the water table. The discharge of water as springs or seeps in such topographically low places creates a significant difference in hydrostatic pressure between the water level in the interstream and stream areas. New Hanover County is essentially a peninsula; thus the Northeast, Cape Fear and the Cape Fear Rivers serve as diffuse discharge lines along the west boundary and the Atlantic serves the same purpose along the east boundary. The upward movement through the confining beds occurs over large areas, and through the geologic ages it has been sufficient to cause partial flushing of the original connate water from the aquifers.

The uppermost water-bearing unit includes the surface sand that covers most of the county to depths of 50 feet or more in places. The lower part of the surface material is saturated with water; in the upper part the water is moving downward in response to gravity. The upper surface of the saturated zone is called the water table.

All of the sediments below the water table are saturated, not only in the surface sand, but also in the underlying limestone, clay, and sand. Where beds of clay and silt (aquicludes) are impermeable enough to retard the movement of water, the water in the underlying beds of limestone and sand is confined under hydraulic pressure and is called artesian water. The height to which artesian water will rise in wells forms an imaginary surface called the piezometric surface.

Artesian water moves to discharge areas in many places along the major streams and the coast. The rate of water movement from areas of recharge to areas of discharge ranges from a few feet to as much as a few hundred feet per year.

The aquifers in New Hanover County are recharged by local rainfall. Areas of significant recharge are identified on the maps showing the piezometric surfaces as the areas having higher water levels, and on the water quality maps as the areas of lower chloride and of higher iron and hardness values. These are in the interstream areas where the topography is relatively high. Conditions for recharge are excellent in New Hanover County because most of the areas are underlain by sand.

AQUIFER CHARACTERISTICS

The quantity of water that an aquifer can hold in storage is governed by its porosity. Porosity is the ratio of volume of pore space or interstices to the total volume of the rock material and is usually expressed as a percentage. Clean, well-sorted sand may have an initial porosity as high as 40 percent, but during its transformation into a sandstone the porosity may be reduced by compaction and cementation to less than 10 percent. Clay may have a porosity of 50 percent, but because of the minute size of its pores, a large percentage of the water stored in clay is retained by molecular attraction. Consequently, clays and clayey sediments act as aquicludes and tend to retard water movement.

The permeability of an aquifer is a measure of its ability to transmit water in response to gravity or to differences in hydrostatic pressure. It is governed by the size and shape of pore spaces and the degree to which these spaces are interconnected. A rock unit that is nonporous is also impermeable However, water may be yielded freely from rocks of low porosity if the pores are interconnected and are large enough to freely transmit water. In New Hanover County, the removal of cementing material from the calcareous sandstones and limestones by solution has increased the effective porosity and permeability of these rocks, thus increasing their water-bearing potential.

The water level in an unpumped well is referred to as the "static" water level. Withdrawal of water from a well creates a difference in head between the water in the well and that in the surrounding aquifer with the result that water flows toward the well. The surface of the water around the well assumes the shape of an inverted cone (cone of depression) whose apex is at the well. (See fig. 12.) The vertical distance between the static water level and the pumping level is called the drawdown. The area in which water levels are lowered by the pumping of a well is termed the area of influence.

The coefficient of transmissibility is the quantity of water, in gallons per day, that will move through a vertical section of an aquifer 1-foot wide and extending to its full saturated thickness under a hydraulic gradient of 1 foot per foot at the prevailing water temperature. The coefficient of storage is a measure of the volume of water that an aquifer releases from or takes into storage under a unit surface area by a unit change in head.

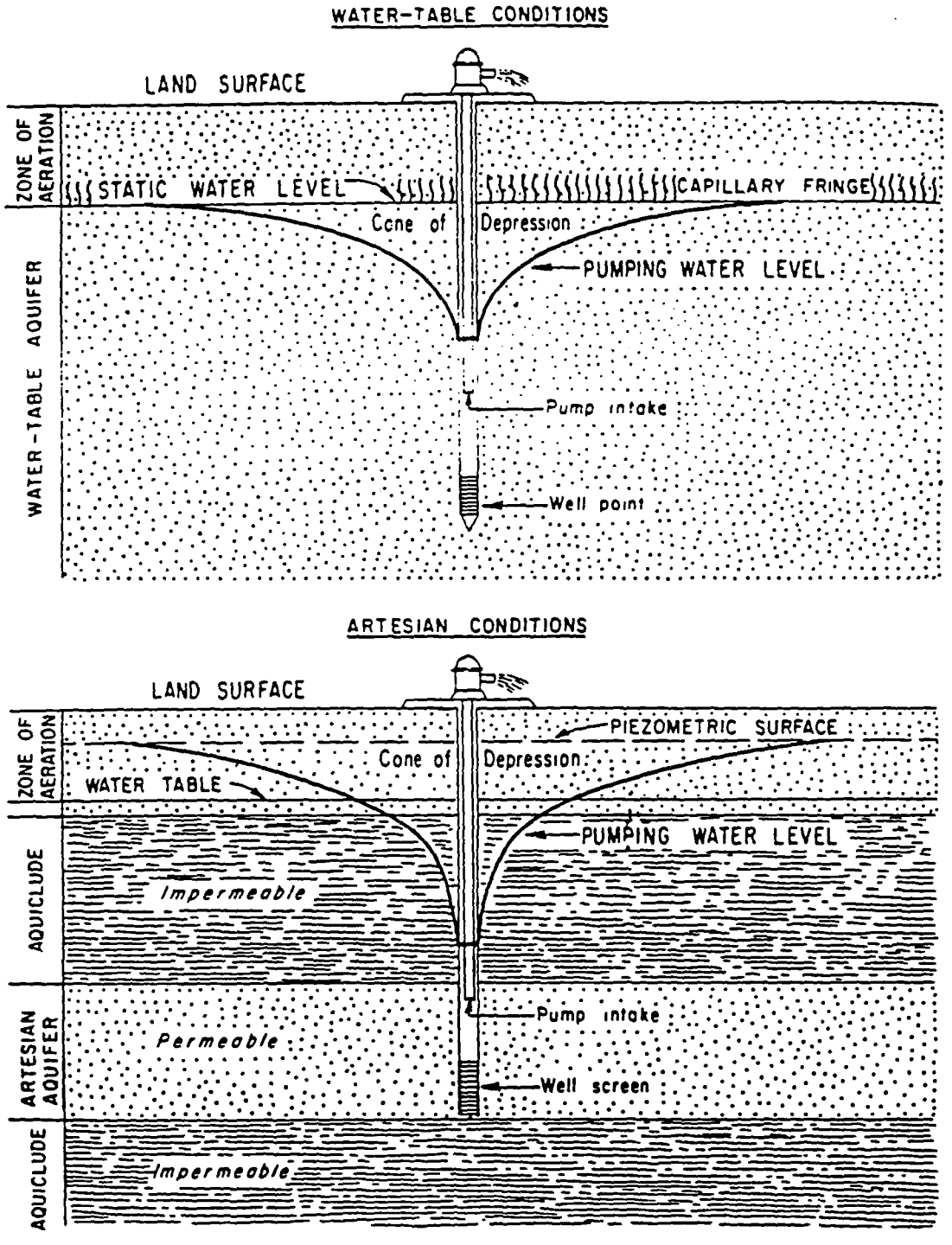

Figure 12.--Diagrammatic sections showing the effect of pumping on the water table and the piezometric surface.

The shape, size, and rate of growth of the cone of depression (and thus the yield of the well) are controlled by the transmissibility and storage coefficients of the aquifer and the rate and duration of pumping.

The specific capacity of a well is the quantity of water in gallons per minute (gpm) that a well yields for each foot of drawdown in water level after a given period of continuous pumping. The theoretical specific capacity can be calculated from the transmissibility and storage coefficients of the aquifer. The actual specific capacity is found by dividing the yield in gallons per minute by the number of feet of drawdown. Comparison of the theoretical and actual specific capacities is useful in determining the efficiency of a well.

AQUIFERS CONTAINING FRESH WATER

The deposits underlying New Hanover County may be grouped according to their ability to transmit water. The productive zones are termed aquifers, and the relatively nonproductive zones are termed aquicludes. One objective of the study was to identify and map the productive zones.

The chief fresh-water-bearing zones or aquifers in New Hanover County are: an indurated calcareous sand in the upper part of the Peedee Formation, a sandy limestone in the Castle Hayne Limestone, and beds of sand and some coquina in deposits younger than the Castle Hayne at the land surface.

Peedee Formation

The lowermost productive zone is a bed of sand in the upper part of the Peedee Formation (see fig. 7). This zone is about 35 feet thick in most of the county except where it has been partly or entirely removed by erosion; it dips to the southeast at about 14 feet per mile. It consists of quartz sand which is usually indurated with calcareous cement and is underlain by an aquiclude about 150 feet thick consisting of very fine sand and clay. Water in this zone is under artesian pressure throughout most of the county. The permeability of this sand has been increased by solution of its calcareous cement in an area that lies generally northwest of U. S. Route 17. The specific capacities of wells in this area range from 20 to 75 gpm per foot of drawdown, whereas they range from 1 to 7 gpm per foot in the eastern part of the county.

Many of the wells that tap this productive zone in the Peedee Formation are of the open-hole type, the casing being set in sandstone or on the overlying limestone. These wells are developed by using compressed air to remove loose sand, silt, and clay.

The zone is generally 10 to 25 feet below land surface in the northwestern part of the county but is more than 150 feet below land surface along the Atlantic coast. It is overlain by a clay bed that ranges in thickness from only a few feet to more than 50 feet in places. The clay bed retards the movement of water both into and out of the sand. The piezometric surface (fig. 13) is highest in the interstream areas in the central part of the county. These are the areas in which the sandstone aquifer is recharged.

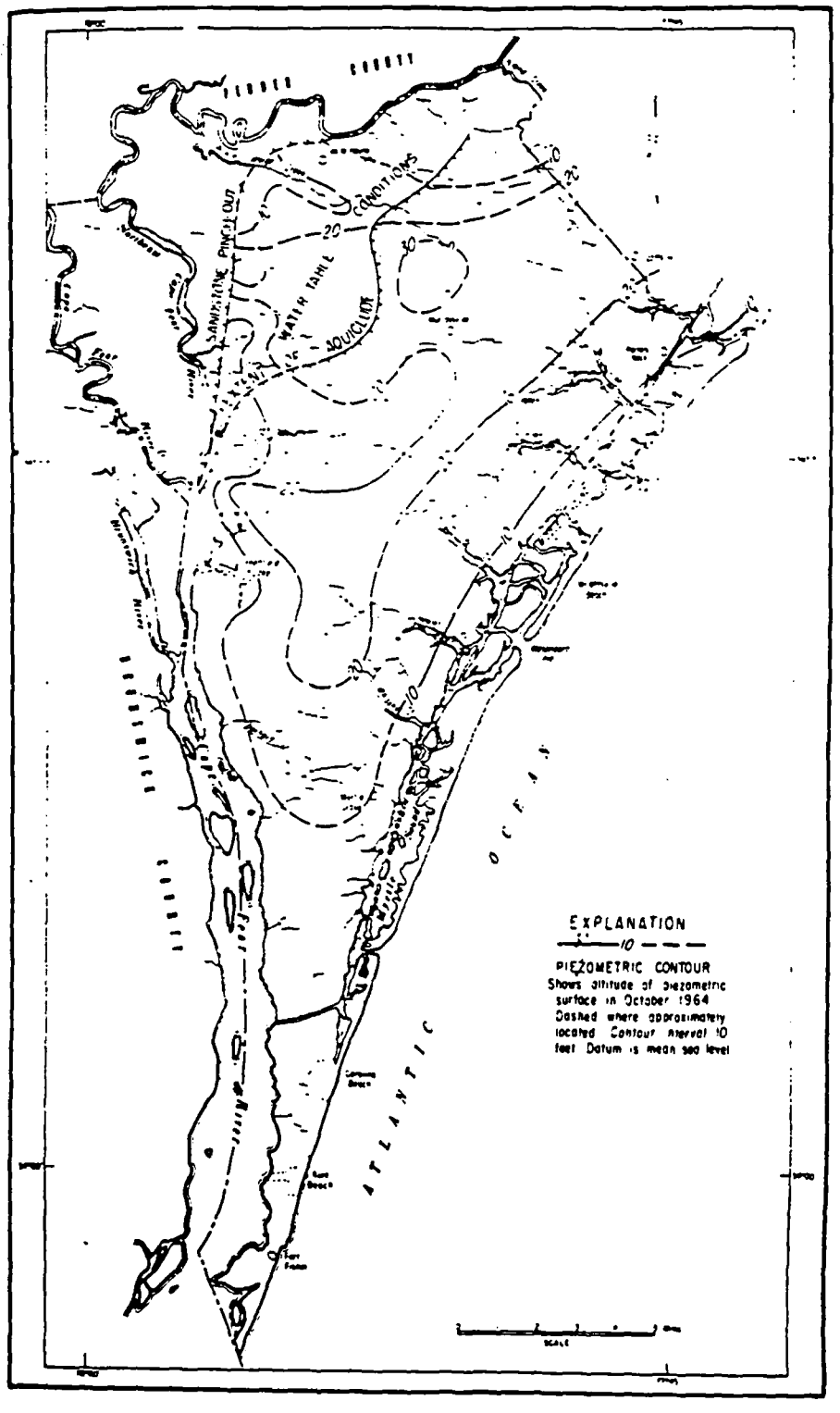

Figure 13.--Map showing the piezometric surface of the sandstone aquifer in the Peedee Formation.

This recharge occurs as water moves downward from the overlying beds. The natural discharge from the sandstone aquifer is in the major stream valleys and upward through the overlying beds along the coast.

The quality of the water from the sand in the Peedee Formation is acceptable for most uses. The hardness ranges from less than 60 mg/l (milligrams per liter) to more than 200 mg/l (fig. 14), the higher values being in the northern half of the county where the sandstone aquifer shows the greatest degree of calcium carbonate concentration. Figure 15 shows that the chloride content generally ranges from 5 to about 200 mg/l. Note that the chloride map roughly outlines the areas of recharge and discharge. The area surrounded by the 20 mg/l chloride contour approximates the area in which the Peedee sandstone aquifer is receiving recharge, and the area outside of this contour is approximately the area of discharge. The iron content in samples analyzed ranges from 0.01 mg/l to 3.0 mg/l in areas of effective recharge (fig. 16).

Castle Hayne Limestone

The Castle Hayne Limestone overlies the Peedee Formation and is a productive aquifer in much of the county. The limestone is absent in an area west and northwest of Wilmington but in other parts of the county it thickens toward the southeast. It is predominantly a sandy shell limestone, but in some places it is a hard limestone. The Castle Hayne is readily identified from well-cuttings, as it is an indurated light-colored fossiliferous limestone. Although it contains some relatively impermeable beds of marl or dense limestone, much of it is highly permeable; the permeability resulting from solution of the rock by circulating ground water (LeGrand, 1960, p. 17-18) (Mundorff, 1945, p. 50).

In the southern part of the county beds of sandy coquina and clay, probably of Miocene age, overlie the Castle Hayne Limestone. The sandy coquina yields some water to wells and probably forms a single hydrologic unit with the Castle Hayne.

Where the Castle Hayne Limestone is present in the northern part of the county, it lies near the land surface, but is more than 100 feet deep in the southern part. The thickness of the Castle Hayne varies greatly from one place to another, being generally less than 50 feet in much of the county and more than 100 feet in the southern part (fig. 9).

The water-bearing characteristics of the Castle Hayne are variable from place to place, depending on the thickness and permeability. The specific capacities of wells tested range from 4 to more than 50 gpm per foot of drawdown. The highest yields obtained from the Castle Hayne Limestone are in the area between U. S. Highway 17 and Wrightsville Beach. The water in the Castle Hayne occurs under water-table conditions in the northern part of the county. Elsewhere, however, the water may be confined beneath clay beds. Wells generally tap only the Castle Hayne in the southern part of the county where the limestone is thickest, but in the northern part, where it is thinner, the wells also generally tap both the Castle Hayne and the sand in the Peedee Formation.

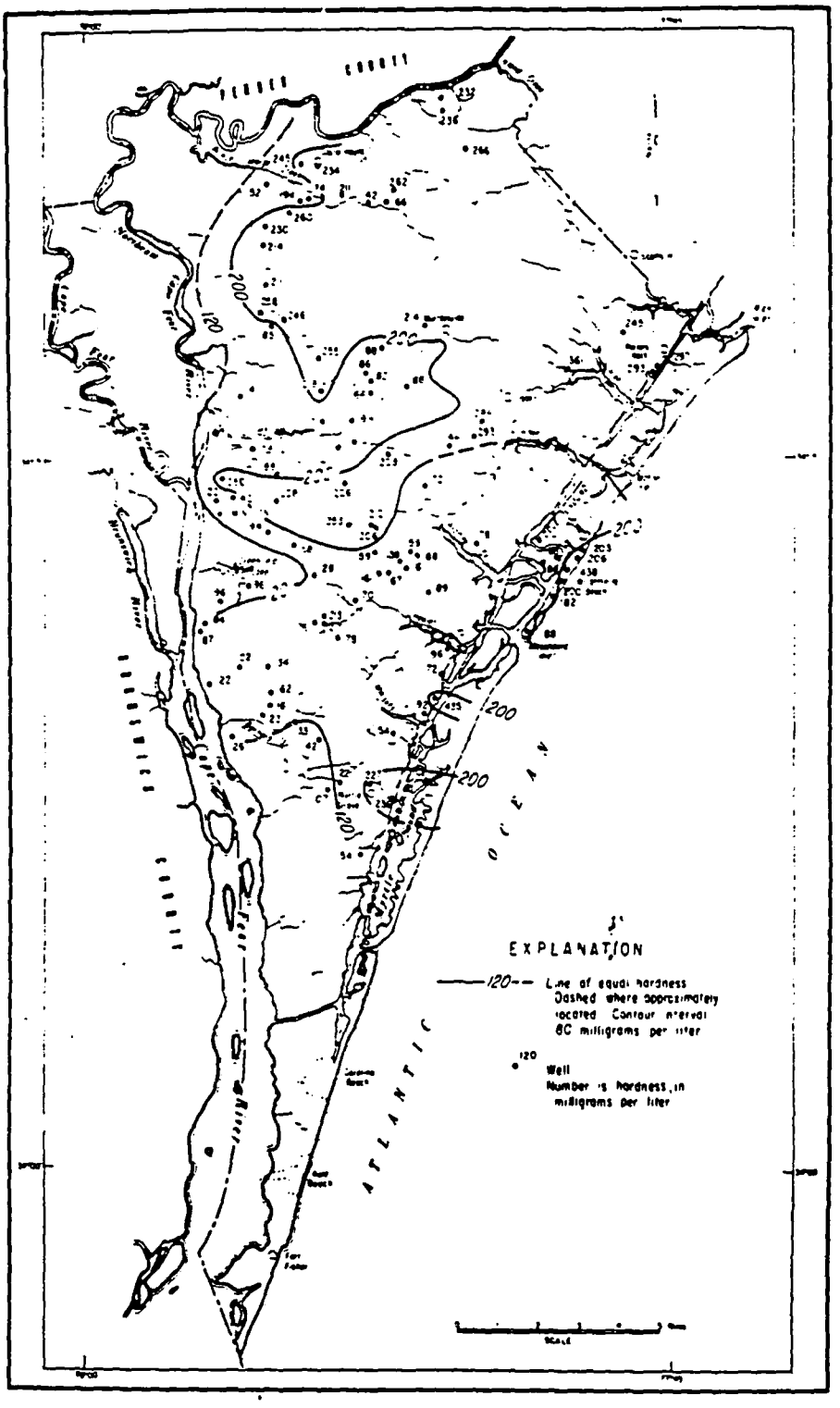

Figure 14.--Map showing the hardness of water in the sandstone aquifer in the Peedee Formation.

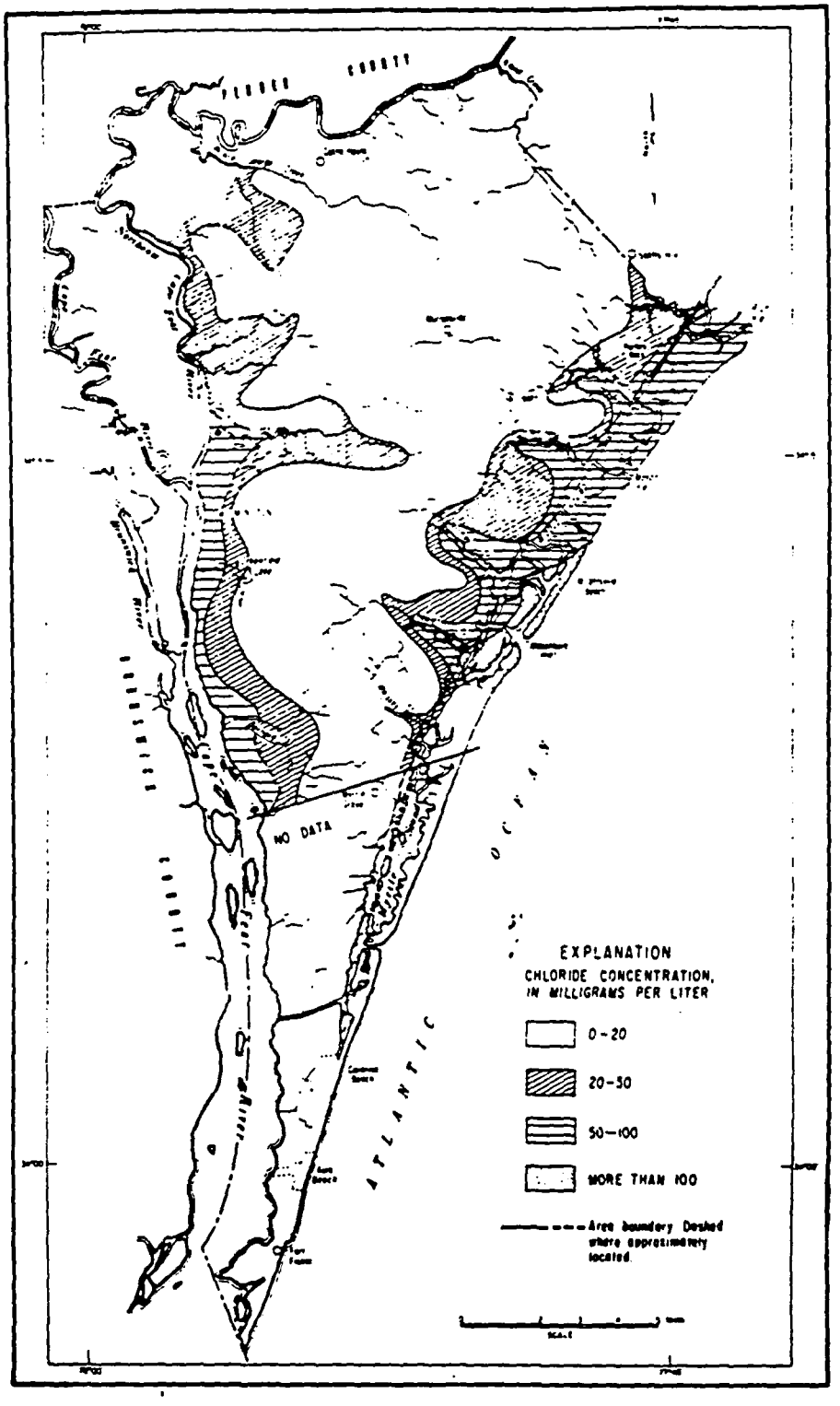

Figure 15.--Map showing the concentration of chloride in water of the sandstone aquifer in the Peedee Formation.

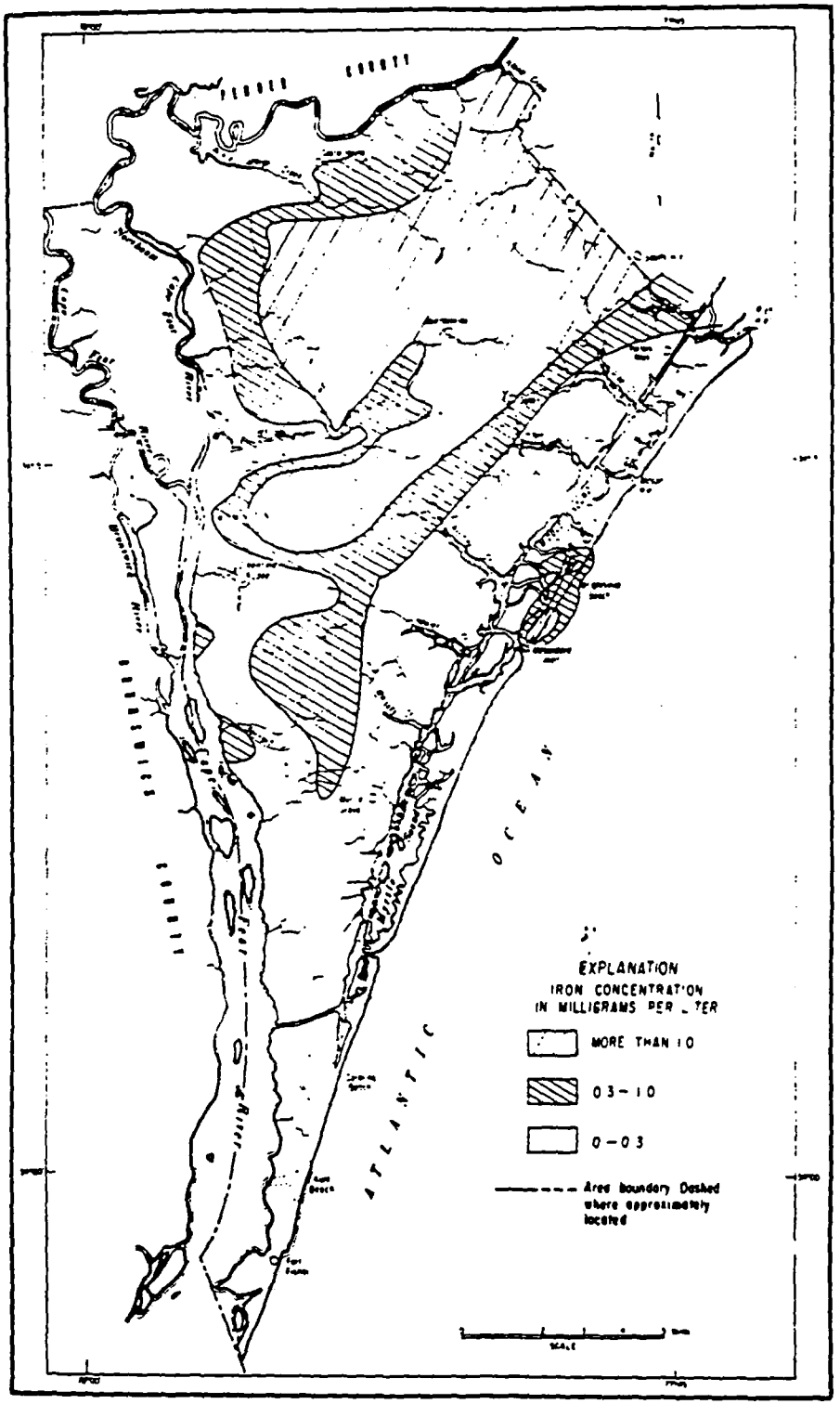

Figure 16.--Map showing the concentration of iron in water of the sandstone aquifer in the Peedee Formation.

Many wells penetrating the Castle Hayne are of the open-end type, the casing being set near the top of the formation in hard limestone. A few unscreened wells have been noted to yield water containing coarse quartz sand and fine gravel from the upper part of the formation, probably from sand-filled solution channels or cavities in the weathered surface.

The water levels in the limestone (fig. 17) are highest in the interstream areas, indicating that the formation is recharged locally; water levels are lowest in the major stream valleys and along the Atlantic coast where natural discharge takes place. Recharge of the limestone is facilitated in the northeastern part of the county where the limestone is shallow and where it is overlain by flat-lying sandy material into which precipitation readily infiltrates.

The quality of the water in the Castle Hayne Limestone is acceptable for most uses. The iron concentration of water samples analyzed ranges from 0.1 to 12 mg/l (fig. 18) and in general decreased from areas of recharge toward areas of discharge. The chloride content of the water generally is low except along the Atlantic coast where there may be leakage of sea water into the limestone. Figure 18 also shows that the chloride concentrations increase in the areas of discharge--creeks, sounds, and inlets--and are greatest along the coast from Wrightsville Beach northward. The water is moderately hard (61 - 120 mg/l) to very hard (more than 200 mg/l).

Undifferentiated deposits of late Tertiary age

Southwest of Wrightsville Beach the Castle Hayne is overlain by an aquiclude of calcareous clays, sands, and silts containing thin shell beds. This marly sequence thickens southward from Wrightsville Beach and Barnard Creek toward Carolina Beach where it is about 75 feet thick. Only very small supplies are available from the thin shell beds and cleaner shallow sands of this unit. Locally sandy coquina of irregular distribution forms a minor aquifer at or near the top of the above sequence. Specific capacities of two wells in sandy coquina (table 1) were 2.6 gpm per foot of drawdown for well 368 and 6 gpm per foot of drawdown for well 381. In four wells for which quality of water data are available, the iron concentration ranged from 0.3 to 3.1 mg/l, the chloride concentration ranged from 5 to 22 mg/l, and the total hardness ranged from 84 to 278 mg/l.

Undifferentiated surface deposits

The slightly inclined rock units previously described are overlain at the surface by beds of sand, clay, and marl. Such surficial deposits include terraced materials and related beach sands, the present day beaches, sandy coquina beds marking Pleistocene beaches and inlets, high fossil sand dunes along U. S. Highway 421 from the Pender County line to Carolina Beach, Pleistocene stream channels filled with coarse sand, and silty interstream deposits. The surface material throughout almost all the area contains the uppermost ground-water body.

The water in the surface material is under water-table conditions throughout the county. The configuration of the water table approximates the topography of the land surface.

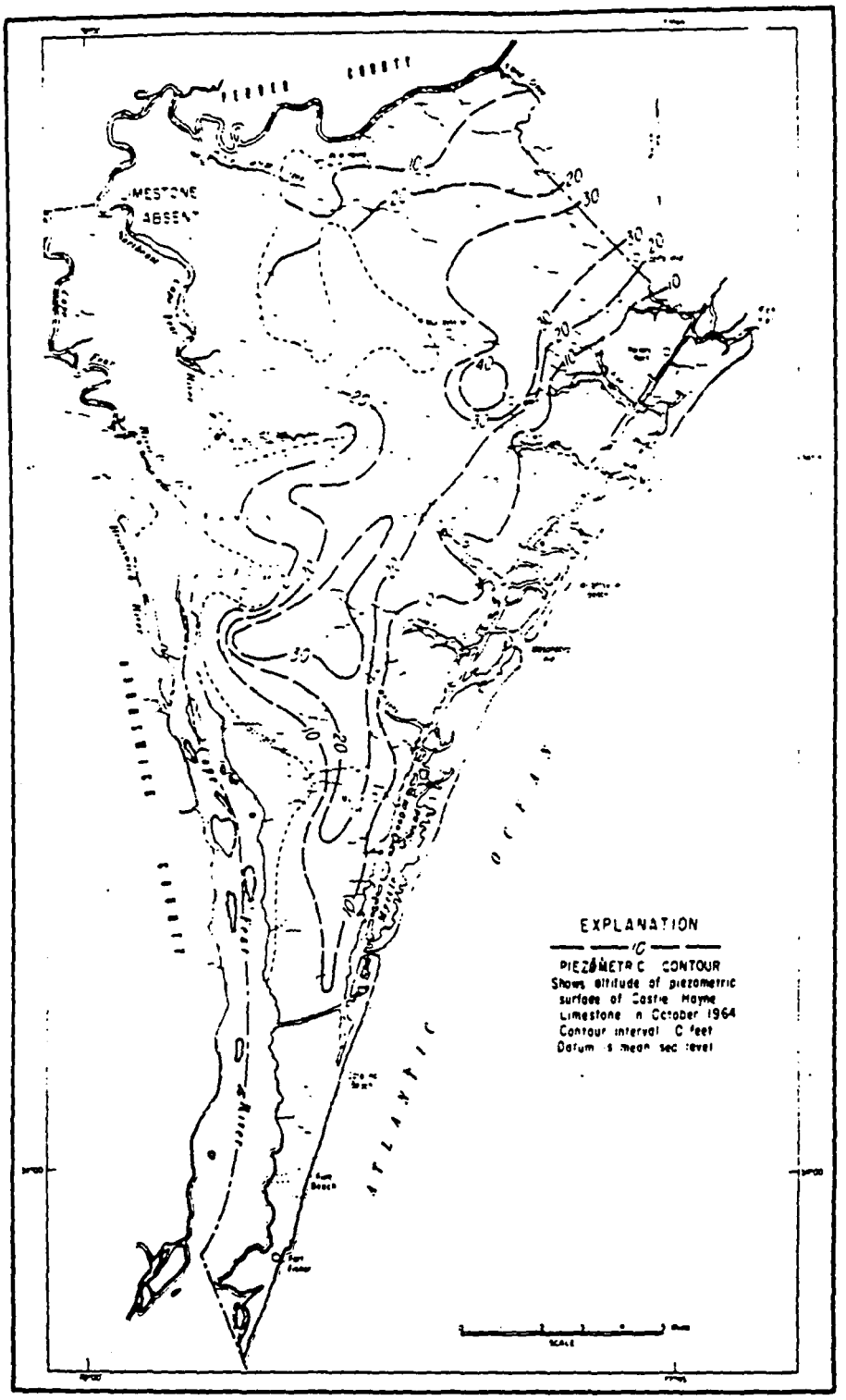

Figure 17.--Map showing the altitude of the water level in wells penetrating the Castle Hayne Limestone.

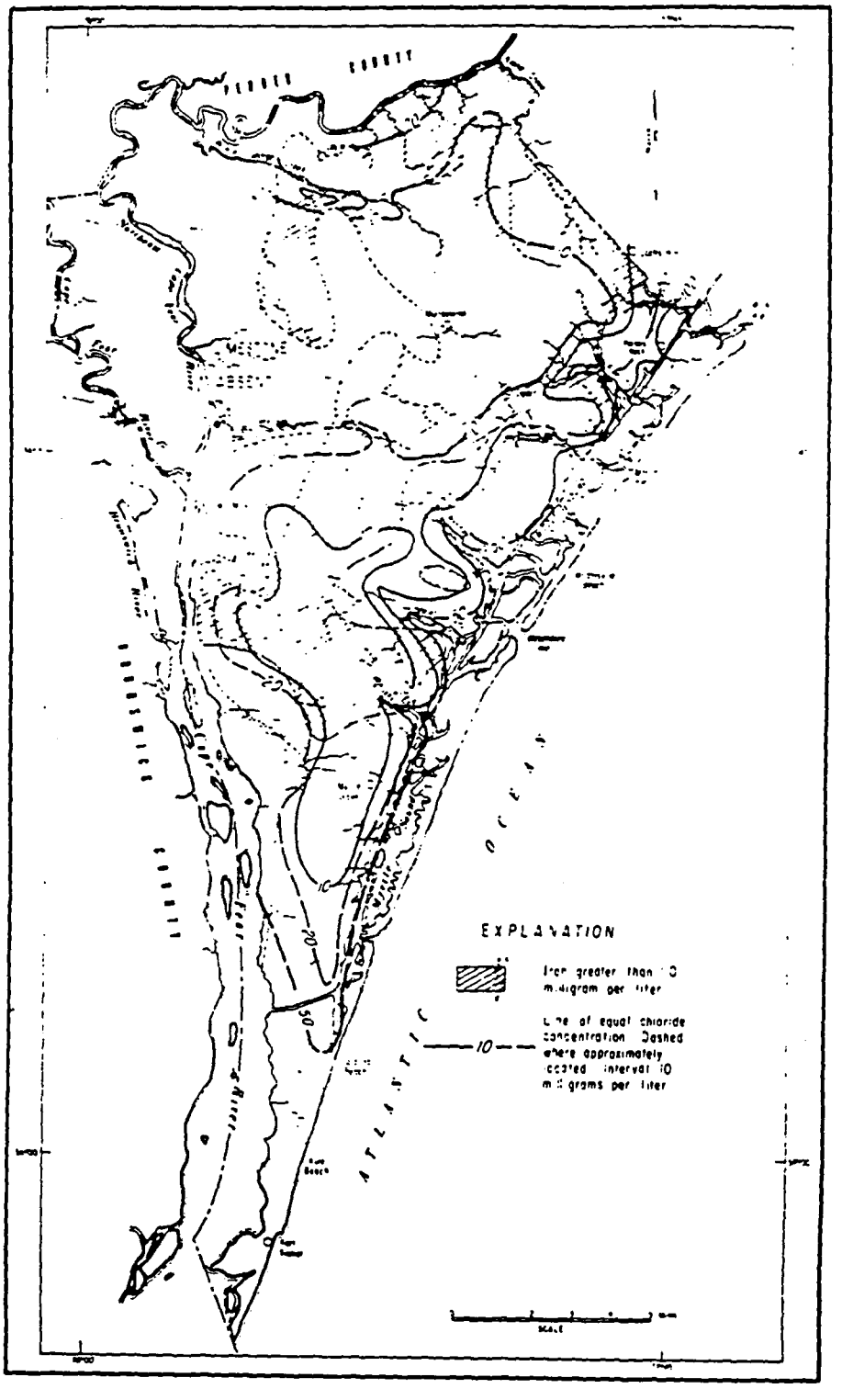

Figure 18.--Map showing the concentration of iron and chloride in water of the Castle Hayne Limestone aquifer.

The high altitude of the water table beneath topographic highs in New Hanover County indicate that the recharge areas are the broad areas between the streams. The uplands are favorable recharge areas, as they generally are flat and very sandy. Runoff is low to nonexistent. The streams have incised their channels into the surface material, and the ground water discharges as springs and seeps along the stream channels.

The thickness and water-bearing capacity of the surface material vary considerably from one site to another. The thickness determined from auger holes, ranges from less than 20 feet to about 60 feet. The water-bearing capacity depends not only on the thickness but also on the character of the material.

During this investigation the geology and hydrology were further explored through installation of 8 test sites and observation wells. The results of these tests are reported and interpreted in the following section of Hydraulic Characteristics of Aquifers.

The sand dune areas south of Wilmington are similarly underlain by coarse sand in many places, and the hydrology is thus similar. However, infiltration from the tidal creeks and the river must be prevented because the Cape Fear River estuary is quite brackish downstream from Wilmington. Brackish water extends farther up the Northeast Cape Fear than up the Cape Fear River. Therefore, all infiltration wells to be screened in the dune sand and stream deposits adjacent to the Northeast Cape Fear River between Wilmington and Castle Hayne should be managed carefully to avoid lateral salt-water encroachment.

Elsewhere, small yields are available for small irrigation and domestic supplies from the finer grained and shallower surface sands throughout the county.

The iron content in water from the surface material generally is high everywhere except adjacent to creeks, sounds, and estuaries, ranging from 0.01 to 12 mg/l. However, in the sand hills area the iron content of the water is less than 0.3 mg/l except near the rivers where some infiltration probably occurs.

The chloride concentration is less than 20 mg/l throughout the county in the surface sands. Where the sands are adjacent to parts of the Cape Fear River that contain brackish water, the risk of drawing brackish water into the sands is increased by pumping of wells.

The hardness of the water in the surface sediments ranges from soft (less than 60 mg/l) to moderately hard (61-120 mg/l) throughout most of the county.

Large yields of water have been obtained from wells in the sand hills area between the Cape Fear River and Northeast Cape Fear River north of Wilmington. A yield of 1,100 gpm was obtained from a multiple well-point installation for several weeks during construction of the Sutton Power Plant in 1952 (LeGrand, 1960). One large pond near well 105 on the east bank of the Cape Fear River is reported to have a similar high yield. Well 108 which taps the dune sand has been tested at 480 gpm at 7.0 feet of drawdown--or a specific capacity of 69 gpm per foot of drawdown. However, specific capacities of wells at the nearby Nitrex Plant range from 2 to 15 gpm per foot. Screens for naturally developed wells in these sands range from 35 to 60 slot size.

Previous investigators (LeGrand, 1960, and Thompson, 1941) have noted the permeable character, the lack of surface runoff from, and the infiltration potential of the above sand hill deposits. LeGrand (1960) suggested that about 90 percent of the prcipitation in the sand hills area soaks into the ground, and estimated that about 730 million gallons a year per square mile becomes ground water. He also indicated that because of the great permeability of the sand, the ground water discharges readily into the swamps bordering the rivers, and the water table is nowhere more than a few feet above river level. He further suggested that water from the rivers could be induced as additional recharge to the sand where water levels are lowered below river level by pumping wells and cautioned that where recharge from the river occurs the chemical quality of the water pumped from the sand may be objectionable where the river water is brackish.

HYDRAULIC CHARACTERISTICS OF AQUIFERS

A phase of the ground-water study was designed to determine such characteristics as the coefficients of transmissibility and storage of the aquifers, and the specific capacity of wells drawing from the several aquifers. Aquifer characteristics were determined by making pumping tests on test wells, selected irrigation wells, and domestic wells; assisting well drillers in making pumping tests on wells following construction; evaluating drillers' records of previous pumping tests; comparing tidal fluctuations in wells with the corresponding ocean tides, and making pressure recovery tests on flowing wells. The test data are presented in table 1. The well numbers correspond to the numbers shown on the well location map (fig. 3).

For those tests which were of less than 24-hours duration, the specific capacities are shown as measured at the end of the tests. The adjusted 24-hour specific capacities are then tabulated in the following column, and plotted on figure 19. The coefficients of transmissibility are calculated from pumping-test data or estimated from specific-capacity data. The saturated thickness of an aquifer is given where that information is available. The approximate field permeability may be calculated at some well sites by dividing the transmissibility by the saturated thickness.

Specific-capacity data derived from the tests of 1-1/2- and 1-1/4-inch wells are affected by incomplete development, partial penetration of aquifers, pipe friction, and screen losses. Adjusted specific capacities of small diameter wells in the sand hills northwest of Wilmington differed from the observed specific capacity of the 10-inch gravel-packed wells at the Sutton Plant by a factor of about 1 to 20. Calculated coefficients of transmissibilities differed by as much as 1 to 4.

Comparison of the tested coefficients of transmissibility of wells 51 and 107 with those of established production wells in the area indicates that the coefficients of transmissibility of the coarse sand most reasonably range from 50,000 gpd (gallons per day) per foot in the north near the Pender County line to 100,000 gpd per foot in the vicinity of the Sutton Plant. The sand is also known to thicken in this direction. From the above transmissibilities and the observed ground-water levels the sand hills area is calculated to be discharging 0.88 to 2.0 mgd (million gallons per day) per square mile to the surrounding river and underlying formations. Of the 50 inches of annual precipitation 18.5 to 41 inches is contributed to ground-water recharge.

Table 1.--Aquifer test data on selected wells

Well No.	Pumping rate (gpm)	Draw-down (ft)	Length of test (hours)	Specific capacity gpm/ft of drawdown: End of test	Specific capacity gpm/ft of drawdown: End of 24-hours	Transmissibility (gpd/ft)	Storage coefficient	Aquifer[a]	Saturated thickness (ft)	Remarks
1	25.5	7.6	3	3.4	3.2	13,000 - 29,000[b]		Kpd	45	3' of 1½" screen, #30 slot
2	30	5.3	2.5	5.7	5	7,000 - 14,000[b]	0.1-0.25	Tch	50	
4	322	45	24	7.2	7.2	10,000[b]		Tch-Kpd		
5	325	20	24	16	16	20,000[b]		Tch-Kpd		
7	325	47	24	7	7	10,000[b]		Tch-Kpd		
16	63	3.6	.67	17.5	14	25,000[b]		Tch-Kpd	40	
24	400	75	96	5.3	5.3+	8,000[c]		Tch-Kpd		
25	300	28	24	10.7	10.7	15,500[c]		Tch-Kpd		
27	200	12	24	16.7	16.7	24,000[c]		Tch-Kpd		
36	32	2.6	.3	12.7	9.0	20,000[b]	.005-.05	Kpd		
47	35	4.1	.6	9	6.5	10,900[b]		Kpd		
48	55	4.6	.9	12	8.3	11,200[b]		Kpd		
50	2.6	8.7	.3	.3	.3[c]	4,550[b]		Kpd	20	2' of 2" screen, #10 slot
51	10	4.4	.7	2.3	2.3[c]	20,000 - 30,000[b]		TQ	38	2' of 1½" screen, #10 slot
52	12.3	5.2	2	2.4	2.4[c]	26,000 - 50,000[d]	.2	TQ	22	Transmissibility calculated from tidal effects
53	2	24	.5	.1	.1[c]	3,000[b]		TQ	27	3' of 1½" screen, #10 slot
54	12	3.7	2	3.2	3.2[c]	22,600 - 63,500[b]		TQ	41	3' of 1½" screen, #10 slot
63	36.5	2.6	.3	14	7.7	11,000[b]		Kpd	40+	
73	24	?	.5	1.8 ?	1.3	4,000[b]		Kpd		Only 7' penetrate

Table 1.--Aquifer test data on selected wells--Continued

Well No.	Pumping rate (gpm)	Draw-down (ft)	Length of test (hours)	Specific capacity gpm/ft of drawdown: End of test	Specific capacity gpm/ft of drawdown: End of 24-hours	Transmissibility (gpd/ft)	Storage coefficient	Aquifer[a]	Saturated thickness (ft)	Remarks
82	52.5	0.65	0.3	81	60	140,000[b]		Tch	50+	
88	36	1	4	36	30	40,000[c]		Kpd		
90	53	1.3	.3	40	28	40,000[b]		Kpd	20+	
91	62	1.4	.5	44	23	25,000[b]		Kpd	30+	
106	46	12.7	2	3.6	3.6[e]	28,000 - 30,000[b]	0.15	TQ	33	10' of 2" screen, #10 slot
107	12	3.5	2	3.4	3.4[e]	60,000 - 130,000[d]		TQ	25	3' of 1½" screen, #10 slot
108	480	7	?	69		100,000[c]		Kpd-TQ	46 - 67	Gravel packed fro 33 to 53'
110	16.5	4.2	2.2	3.9	3.9[e]	70,000[b]	.3	TQ	36	
111	3.9	9.3	1	.42	.42[e]	4,000[b]		Kpd-TQ	20+	3' of 1½" screen, #30 slot
113	200	18	19	11	11	15,000[c]		Kpd	28	
114	200	13	72	15	15+	20,000[c]		Kpd	37	
115	80	20.4	24	3.9	3.9	5,000[c]		Kpd	24+	
127	7.8	.16	1	49	34	80,000[b]		Kpd	40+	
128	210	8.7	18	24.4	24	30,000[c]		Kpd	40+	
129	300	7.5	?	40		60,000[c]		Kpd	40	
131	343	9	10	38		50,000[b]		Kpd		
132	465	8	?	58		70,000[c]		Kpd		
134	64	2.6	.3	24	15	30,000[b]		Kpd		
141	73	.73	.25	100	75	100,000[b]		Tch-Kpd	38+	
175	165	<.54	?	3.1+		6,000[c]		Tch-Kpd		
181	250	60	24	4.2	4.2	6,000[c]		Kpd		Gravel pack
196	100	14	?	7.1		10,000[c]		[illegible]		

Table 1.--Aquifer test data on selected wells--Continued

Well No.	Pumping rate (gpm)	Draw-down (ft)	Length of test (hours)	Specific capacity gpm/ft of drawdown: End of test	Specific capacity gpm/ft of drawdown: End of 24-hours	Transmissibility (gpd/ft)	Storage coefficient	Aquifer[a]	Saturated thickness (ft)	Remarks
208	97	14.4	24	6.8	6.8	13,000[b]		Kpd	40+	
215	165	44.5	?	3.7		5,000[c]		Kpd		
218	220	20	?	11		20,000[c]		Tch-Kpd		
228	340	80	24	4.25	4.25	6,000[c]		Tch-Kpd		Gravel pack
230	360	55	24	6.6	6.6	10,000[c]		Tch-Kpd		Gravel pack
244	16.4	5.9	3	2.8	2.5	8,000[b]		Tch-Kpd		
254	60	16	.3	3.7	2.6	6,000[c]	0.001	Kpd		
260	150	20	48 ?	7.5	7.5	11,000[c]		Kpd		
262	150	90	48 ?	1.7	1.7	4,000[c]		Kpd		
290	100	15		6.7		10,000[c]		Kpd		
294	275	58	24	4.8	4.8	9,000[c]		Kpd		Gravel pack
299	144	36.7	24	4.0	4.0	7,000[c]		Tch-Kpd		
302	110	17	24	6.5	6.5	14,000[c]		Tch-Kpd		
323	50	7.6	?	6.6		14,000[c]		Tch-Kpd		
329	25	7.8	1	3.2[c]		9,000[b]		Tch-Kpd		
335	192	36	24	5.3	5.3	7,000[b]		Kpd		
341	4.7	2.4	5.4	1.95	1.8	4,000[b]		Kpd		
342	600	19.6	8	30.6	21.3	40,000[b]		TQ-Kpd		Gravel pack
343	60	15	24	4	4	6,000[b]		Kpd		
361	50	7	.17	7	4	6,000[b]		Tch-Kpd		
368	5	1.8	5.1	2.8	2.6	4,000[b]	.5	TQ	54	2' of 1¼" screen, #10 slot
397	150	33	24	4.55	4.55	7,000+ [c]		Tch		
398	153	51	24	3.0	3.0	5,000+[c]		Tch		

Table 1.--Aquifer test data on selected wells--Continued

Well No.	Pumping rate (gpm)	Draw-down (ft)	Length of test (hours)	Specific capacity gpm/ft of drawdown: End of test	Specific capacity gpm/ft of drawdown: End of 24-hours	Transmissibility (gpd/ft)	Storage coeffi-cient	Aquifer[a/]	Saturated thickness (ft)	Remarks
406	28	1.7	0.3	16.5	12	30,000[b/]	0.0001	Tch		
407	170	30	5	5.7	5.4	20,000[b/]		Tch		
410	235	23	9	10	9	20,000[c/]		Tch		
412	30	8	3	3.8	2.8	5,000+		Tch		

a/ Kpd - Peedee.
Tch - Castle Hayne.
TQ - Undifferentiated late Tertiary and Quaternary sands.

b/ Calculated from time-drawdown graph.

c/ Estimated from specific capacity and storage data.

d/ Calculated from tidal effects.

e/ Still undergoing development at end of test.

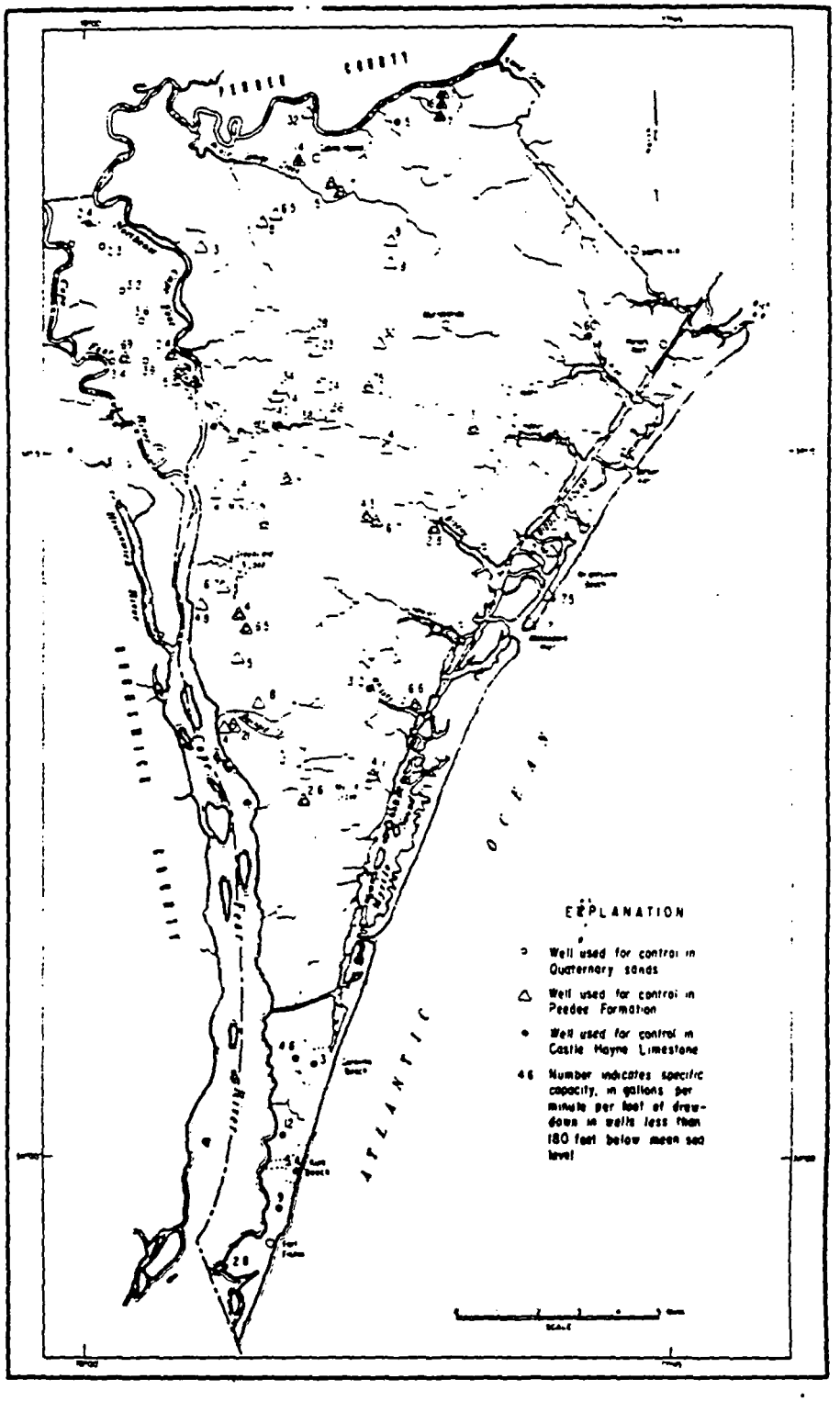

Figure 19.--Map showing measured specific capacities of wells with depths less than 180 feet below mean sea level.

The amount of ground-water discharge that can be salvaged as potable water depends upon future well-field design and development, the degree to which the area is left unpaved, and the manner of disposal of industrial wastes. The moderate coefficient of transmissibility and high coefficient of storage indicate that the coarse sand deposits can be developed using infiltration galleries, open ponds, multiple well points or large-diameter gravel-packed wells.

The data from the sand hills area northwest of Wilmington indicate that yields from wells 8-inches in diameter, gravel packed to a nominal 16-inch diameter with 20 feet of screen, and spaced at least 500 feet apart will be at least 250 gpm. Similar yields should be expected from such well-field designs in the sand-dune area south of Wilmington where underlain by coarse sand. Larger yields may be obtainable as a result of induced infiltration in areas where the sands are hydraulically connected with the rivers, such as at the Carolina Power and Light Company's Sutton Plant and along the Northeast Cape Fear River below Castle Hayne. Care must be exercised, however to prevent infiltration from the rivers where they contain brackish water. Brackish water extends upstream in the Cape Fear River as much as 10 miles above Wilmington during periods of low flow. This fluctuation in quality of water from time to time requires careful planning of ground-water development near the river.

Elsewhere the specific capacity of a properly designed and developed well generally is found to be at least 3 gpm per foot of drawdown throughout the county (fig. 19). Minimum yields of 150 to 250 gpm of potable water may be developed almost anywhere in the county.

The specific capacity of wells in the watershed of Smiths Creek north of Wilmington is greater than 20 gpm per foot of drawdown. Here, the sandstone aquifer, containing some calcareous material, has undergone solution and channels (fig. 19) in its upper surface contain up to 30 feet of coarse sand. Solution in the aquifer may account in part for the abnormally high specific capacity of well 112. Wells having exceptionally high specific capacities also are found in the limestone aquifer at Porters Neck (well 82) and near Wrightsville Beach (well 251). However, high specific capacities of wells in the limestone is much more sporadic than in the other aquifers.

The prohibitive cost of drilling test wells and the limited time available made it necessary to collect most of the data from existing privately owned wells. Thus, the available hydrologic data from remote and unpopulated areas are less than desired. Specifically, the position of the salt-water interface and information on the water-bearing characteristics of the sandstone aquifer are unavailable in the southern tip of the county. In areas where the geology is known but the hydrologic data are deficient, the aquifer characteristics are estimated by projecting known data from similar geologic situations.

The information presented in this section does not preclude the necessity of drilling exploratory wells when the desired quality of water is critical or when the needed quantity of water approaches the limits indicated in this report.

WATER-LEVEL FLUCTUATIONS

Observation wells were established in the different aquifers during the initial phase of the study to measure changes in ground-water storage.

Despite heavy rains ground-water storage is least during June, July, and August when evapotranspiration demands are greatest, and again during December after the fall "drought." The water level is highest in late February and early March during the period when winter rains are heavy and vegetation is dormant. There is frequently a secondary peak in ground-water levels in September resulting from heavy rains.

LOW-FLOW DISCHARGE MEASUREMENTS

The low-flow discharge of streams, sometimes called the "base flow," is that streamflow which occurs during long periods of fair weather. This flow is derived entirely from ground-water discharge. In order to evaluate the amount of ground water discharging in New Hanover County, measurements were made of the low flow of Smiths, Prince George, and Todds Creeks, as well as the flow from Greenfield Lake. These creeks and the lake are important areas of ground-water discharge in New Hanover County and may represent significant sources of water supplies.

In October 1965 a low-flow recession recorder was placed in operation on Smiths Creek about 500 feet southwest of N. C. Highway 132. Data from this recorder were used to determine what part of the streamflow is supplied by ground water. The streamflow in Smiths Creek, water levels in well 141, and the precipitation at the New Hanover County Airport are shown for the period from October 1965 to March 1966 in figure 20.

Smiths Creek has a drainage area of 8.9 square miles upstream from the low-flow recession recorder. It is a rural, sparsely populated area of which two-thirds is forest-covered and one-third is agricultural. Large ground-water withdrawals are not known in the area.

Figure 20 illustrates the relationship between precipitation, ground-water levels, and streamflow variations. During the period from late October through December the total precipitation at the nearby New Hanover County Airport totaled only 2 inches. Although plant transpiration and evaporation were low, they utilized nearly all the precipitation, and very little ground water was added to storage. Thus, the water level in well 141 declined at the nearly uniform rate of 0.03 feet per day. The ground water discharge into Smiths Creek, as indicated by the nearly horizontal segments of streamflow graph during this period, was approximately 2 cfs (cubic feet per second).

During the period from early January through the middle of March, when evapotranspiration losses were still at a minimum, the increased precipitation resulted in a rise in the water level in well 141 at rates of about 0.06 to 0.03 feet per day. As the aquifers became saturated a decreasing amount of the available precipitation went into storage and the contribution to streamflow was correspondingly increased.

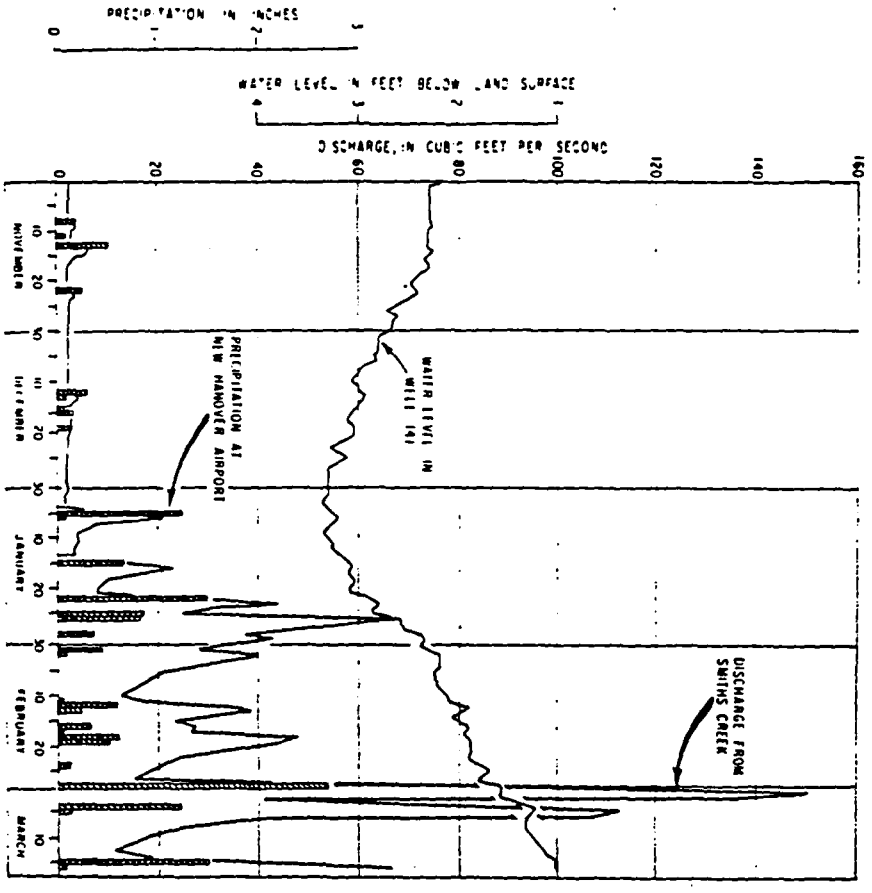

Figure 20.--Composite graph of precipitation at the New Hanover County Airport, discharge from Smiths Creek, and fluctuations of the water level in well 141.

On March 16 the water level in well 141 declined sharply possibly due to reduction of backwater effects in Smiths Creek combined with increased evapotranspiration. If it can be assumed that the evaporation losses and the precipitation from late October to January were similar to those from March 15 to April 25, then the 0.01 foot per day increase in the water-level decline in well 141 during that period can be attributed to plant transpiration.

The January 4, 1966, low-flow discharge of 1.8 cfs at the station on Smiths Creek represents about 1.2 mgd of ground-water effluent. The April 25, 1966, low flow of 1.6 cfs (1.07 mgd) is about 89 percent of its January rate.

Greenfield Lake is on the southern edge of the city of Wilmington. It has a drainage area of 4.1 square miles and was discharging 3.1 cfs (1.9 mgd) of water at the spillway on December 8, 1965. The streams draining into the lake are quite short, and their gradients range from 30 to 50 feet per mile. Thus the lake is in effect a very large spring. Although storm sewers drain into the lake, sanitary sewage lines do not.

Prince George Creek has a drainage area of 2.4 square miles above its intersection with the Blue Clay Road (rural road no. 1318). Most of the area is forest land. The December 9, 1965, discharge of 0.22 cfs represents 0.14 mgd of ground-water discharge.

Todds Creek has a forest drainage area of 0.03 square miles above its intersection with N. C. Highway 132. The December 9, 1965, discharge was 0.11 cfs (0.07 mgd).

QUALITY OF WATER

The quality of ground water in New Hanover County is influenced by the chemical and physical character of the water as it enters the ground and by the composition of the rocks through which it moves. Rainwater usually contains dissolved gases, chiefly oxygen and carbon dioxide, that make it slightly acidic and thus capable of dissolving mineral matter from the rocks comprising the aquifers. The chemical quality of water varies considerably between areas of recharge and areas of discharge. Shallow ground water in the county has a low hardness where the Pleistocene and Miocene sediments are not composed of soluble carbonates. Because of the water's acidity and the high solubility of iron in acid water, iron is leached from minerals in the aquifer. As water moves through the aquifer toward the [illegible] it tends to increase in mineral content, chiefly because of the [illegible] calcareous cement.

DISSOLVED MINERAL CONSTITUENTS

Chemical compounds of calcium, iron, potassium, sodium, magnesium, and most other common metals make up most of the dissolved mineral matter in ground water. Chemical analyses of water sampled from various aquifers in New Hanover County are given in table 2; partial analyses are reported in table 5. Complete analyses were made to give adequate areal and chemical representation of the individual aquifers. The sampling sites were chosen on the basis of data obtained from partial analyses.

The chemical analyses in this report are expressed in milligrams per liter (mg/l). As of October 1, 1967, the U. S. Geological Survey reports results of chemical analyses in milligrams per liter (mg/l) instead of in parts per million (ppm). In the fresh through moderately saline water range, mg/l are virtually equal to ppm. The following discussion gives pertinent information concerning the geologic source of dissolved mineral constituents, the recommended limits of the U. S. Public Health Service, methods of treatment, and their significance in relation to use.

SPECIFIC CONDUCTANCE

Specific conductance is a measure of the capacity of water to conduct an electric current. The conductance is primarily dependent upon the amount of dissolved constituents and their degree of ionization. Therefore, specific conductance values may be used to estimate the total amount of solids in solution. They are expressed in reciprocal ohms times 10^6 (micromhos) at a standard temperature of 25°C.

HYDROGEN-ION CONCENTRATION (pH)

The hydrogen-ion concentration, expressed in pH units, is the degree of acidity or alkalinity of the water. The pH of a solution is the negative logarithm of the concentration of the hydrogen ion in moles per liter. Numerically, the pH scale extends from 0 to 14. A water having a pH value of 7 is said to be neutral, and the concentration of hydrogen ions is equal to the

Table 2.--Chemical analyses of water

(Results in milligrams per liter except as indicated)

Well Number	Date of collection	Sample Depth	Specific conductance (micromhos at 25°C)	pH	Temperature (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Aluminum (Al)	Iron (Fe)	Manganese (Mn)	Dissolved solids (calculated)	Hardness Calcium, magnesium	Hardness Noncarbonate	Color
22	09/22/65		360	6.9 a/	65	12	64	3.3	7.0	1.1	190	10	9.4	0.3	1.9	0.0	0.1	0.32	0.02	202	174	18	0
23	05/20/52		737	7.1	--	41	84	8.5	58 b/		305	2.4	84	.1	.7	.--	--	.92	.07	446	245	--	2
29	10/21/65		427	6.8 a/	65	24	83	2.1	8.0	1.4	264	.4	11	.2	.2	.16	.1	2.9	.08	261	217	0	10
34	09/27/65		400	6.8 a/	64	29	72	1.1	12	1.4	230	.4	16	.1	.3	.1	.1	2.7	.09	246	186	0	5
38	09/23/65		456	7.1 a/	66	26	87	3.8	7.8	2.3	282	.4	12	.2	.1	.0	.2	1.6	.10	279	233	2	5
50	09/27/65		242	7.5	65	12	45	1.3	4.2	.8	129	8.4	7.0	.2	.2	.3	.1	.64	.03	143	117	10	5
51	06/11/65		33	6.5	66	5.9	3.4	.2	1.8	.6	11	2.4	1.6	.0	.4	.00	.1	.03	.01	21	10	1	0
53	06/11/65		195	7.2	68	5.9	17	.7	18	2.2	52	8.6	27	.0	.1	.01	.1	.57	.03	106	45	20	5
68	09/24/65		511	6.8 a/	66	12	101	2.9	8.6	1.0	310	.8	16	.2	.6	.1	.2	2.0	.05	297	264	10	70
70	09/24/65		540	6.7 a/	68	28	103	4.4	11	1.3	327	2.6	19	.2	.4	.0	.1	4.9	.08	331	276	8	10
86	09/23/65		447	7.1 a/	66	15	77	5.3	13	1.8	267	.6	16	.2	.3	.0	.1	1.0	.00	260	214	0	5
87	08/02/65	599	26100	7.7	68	8.8	195	233	5350	200	406	546	8780	.5	2	.0	.5	6.0	.10	15600	1450	110	7
87	08/12/65	320	10480	7.9	68	9.8	67	84	2330	90	408	58	3350	.1	1.1	.0	.3	.61	.04	6700	512	177	4
87	08/06/65	220	331	7.5	--	--	19	1.6	40	--	75	--	47	--	--	--	--	--	.00	--	54	0	--
96	09/23/65		582	7.2 a/	68	--	89	5.8	--	--	322	--	36	--	--	--	--	2.8	.09	--	246	0	5
108	09/27/65		29	5.1 a/	67	4.5	1.8	.5	2.1	.5	6	3.2	4.4	.1	5	.0	.0	.02	.02	21	6	2	0
111	06/10/65		31	6.9	68	4.1	3.0	.4	1.8	1.9	10	2.2	3.0	.0	3	.00	.0	.08	.03	22	9	1	0
115	08/04/65		174	6.5	66	6.9	18	1.5	7.8	1.9	14	9.4	14	.1	40	.0	.0	.89	.07	107	52	40	4
131	05/18/65		325	8.2		17	35	9.1	19	2.4	164	3.8	27	.1	1	.0	.0	.19	.03	195	126	0	2
134	09/23/65		452	7.5	64	18	81	3.6	12	1.6	265	.4	18	.2	.1	.1	.1	2.2	.08	265	218	0	5
147	09/27/65		465	6.8 a/	68	--	90	2.9	--	--	284	--	13	--		--	--	2.7	.13	--	236	4	8
154	10/21/65		603	7.2 a/	68	22	86	12	32	3.8	333	1.4	39	.1	.3	.03	.2	.02	.00	361	264	0	12
155	09/24/65		450	7.0 a/	66	10	70	4.3	15	1.2	184	10	38	.2	13	.2	.1	.02	.01	252	193	42	5
160	09/27/65		774	7.0	66	30	100	10	50	5.1	359	1.4	78	.4	.5	.0	.2	.03	.01	452	293	0	15
167	12/06/65		677	7.6	--	23	80	14	44	6.3	322	8.8	61	.4	.2	.07	.2	.02	.00	396	256	0	7
177	09/24/65		361	7.1 a/	68	20	49	12	8.8	5.0	210	.4	15	.4	.1	.0	.1	.02	.02	214	170	0	5
178	09/24/65		369	6.7 a/	65	10	71	1.4	6.6	.8	220	.6	12	.1	.1	.0	.1	.71	.04	211	184	3	5
209	06/10/64		502	7.8	--	16	52	4.6	44	4.8	178	15	58	.2	.2	.0	--	.42	--	283	150	4	--
230	09/12/61		390 c/	7.4	--	12	200	12	--	--	--	70	20	--	.0	.0	.8	1.8	--	312	212	--	10
249	10/14/65		337	7.1 a/	--	6.7	60	2.8	8.7	.6	190	1.2	15	1	.3	.36	.2	.67	.03	191	161	4	8
253	04/20/65		590	7.9	66	18	54	12	58	8.4	228	8.2	87	.3	.2	.0	.0	.65	.01	357	184	0	5
255	04/20/65		730	7.9	64	18	60	13	63	8.6	234	9.2	107	.3	.3	.0	.1	.85	.00	393	203	11	9
256	04/20/65		840	8.0	64	18	20	38	85	8.8	236	14	136	.3	.2	.0	.1	.32	.01	438	206	13	12
257	04/20/65		3050	8.0	64	18	69	64	392	22	228	88	800	.2	.1	.1	.2	.93	.00	1560	438	251	7
258	04/20/65		920	7.9	64	17	54	16	95	9.8	207	17	170	.4	.1	.1	.1	.43	.01	482	200	30	7
259	04/19/65		830	8.1	60	17	32	25	86	9.6	204	16	147	.4	.0	.0	.1	.09	.00	433	182	15	5

a/ Field pH meter value. b/ Calculated Na plus K, reported as Na. c/ Fulbright Laboratories, Inc.

Table 2.--Chemical analyses of water--Continued

(Results in milligrams per liter except as indicated

Well Number	Date of collection	Sampled Depth	Specific conductance (micromhos at 25°C)	pH	Temperature (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Aluminum (Al)	Iron (Fe)	Manganese (Mn)	Dissolved solids (calculated)	Hardness Calcium, magnesium	Hardness Noncarbonate	Col
260	04/20/65		980	7.8	56	17	60	19	100	9.3	223	16	187	0.4	0.1	0.0	0.0	2.5	0.02	519	226	44	7
262	04/21/65		671	7.6	--	17	56	12	67	8.9	222	9.6	109	.4	.2	.2	.1	1.9	.02	389	188	6	5
264	10/04/65		355	7.2 a/	--	--	61	4.2	--	--	204	--	16	--	--	--	--	2.0	.07	--	168	2	--
275	10/15/65		281	7.4 a/	--	--	48	2.3	--	--	152	--	11	--	--	--	--	.25	.02	--	128	4	--
281	10/20/65		260	7.3 a/	65	11	47	2.6	4.3	.8	154	1.4	7.0	.2	.1	.05	.2	.20	.01	151	128	2	10
287	09/30/65		195	7.4 a/	67	5.6	37	1.3	3.5	.5	110	7.2	7.0	.1	.1	.22	.2	.25	.15	117	98	8	8
288	09/29/65		218	7.7 a/	67	--	28	7.1	--	--	131	--	9.6	--	--	--	--	.06	.01	--	98	0	--
316	10/14/65		658	7.5 a/	--	18	50	17	64	6.8	260	2.6	90	.1	.2	.05	.2	.28	.01	377	196	0	14
317	10/14/65		598	7.5	--	30	55	22	32	2.4	237	1.0	72	.1	.1	.02	.1	1.3	.04	332	228	34	10
331	10/21/65		374	7.1 a/	66	3.1	72	2.3	5.9	.4	218	8.0	11	.2	.3	.24	.1	.05	.04	211	188	10	10
335	09/30/65		207	7.6 a/	67	--	31	6.1	--	--	126	--	62	--	--	--	--	.11	.02	--	102	0	--
340	09/30/65		426	6.8 a/	67	--	33	7.9	--	--	172	--	52	--	--	--	--	.14	.01	--	116	0	--
343	10/19/65		952	7.9 a/	67	12	31	12	142	12	147	12	219	.1	.1	.09	.1	1.4	.01	513	126	6	7
345	09/30/65		--	6.4 a/	65	--	48	1.6	--	--	151	--	16	--	--	--	--	4.0	.08	--	128	2	--
346	09/30/65		--	7.0 a/	68	--	72	6.0	--	--	245	--	13	--	--	--	--	6.3	.08	--	205	4	--
347	09/02/65	332	10300	6.8 a/	69	9.0	81	69	2000	70	365	545	2860	1.5	1.8	.01	.2	2.7	.05	5830	486	187	5
347	08/30/65	622	25300	7.3 a/	70	7.4	232	153	5110	5	346	405	8110	1.1	1.9	.00	.4	15	.14	14600	1210	927	5
349	09/30/65		384	7.5 a/	66	18	35	13	25	4.8	178	2.0	18	.1	.2	.17	.2	.10	.02	225	142	0	12
362	10/18/65		552	7.3 a/	--	27	46	33	17	19	344	1.6	21	.5	.1	.10	.2	.81	.02	335	248	0	15
368	10/21/65		181	7.8 a/	69	--	33	.7	--	--	104	--	5.0	--	--	--	--	.26	.01	--	84	0	--
371	10/14/65		192	7.8 a/	--	9.1	35	1.8	3.7	.5	111	.8	6.9	.1	.2	.16	.2	.10	.01	114	94	3	10
372	09/30/65		324	7.3 a/	66	8.6	57	4.1	7.3	.7	190	1.4	12	.1	.2	.18	.2	.09	.03	185	158	3	15
381	10/20/65		271	7.9 a/	67	13	46	1.9	8.0	.6	152	1.6	12	.1	.2	.09	.0	1.3	.10	159	124	0	7
383	10/14/65		274	7.8 a/	--	12	35	7.8	10	1.4	144	2.4	15	.0	.2	.01	.1	.01	.01	155	118	0	1
388	10/14/65		374	7.4 a/	67	38	40	16	8.7	9.2	208	.6	22	.1	.1	.06	.1	.03	.01	237	168	0	11
390	10/21/65		129	6.8 a/	67	5.2	17	1.8	5.7	.9	50	5.2	10	.1	2.1	.05	.0	.14	.02	71	48	8	6
396	11/09/64		445	7.9	--	22	40	16	17	16	204	.6	37	.1	.1	.0	.1	.48	.00	249	166	0	10
397	11/10/64		522	8.0	--	27	39	24	22	18	243	.4	17	.1	.4	.0	.1	.96	.00	297	196	0	18
398	11/10/64		422	7.8	--	21	42	12	14	17	190	1.4	35	.1	.0	.0	.1	.25	.00	236	155	0	18
399	11/10/64		530	7.7	--	29	45	21	24	19	244	1.0	19	.1	.1	.0	.2	.22	.00	308	200	0	17
400	11/09/64		535	8.0	--	29	38	25	24	20	247	.2	50	.1	.0	.0	.2	.57	.00	308	200	0	7
405	10/22/64		675	7.8	67	43	87	13	28	17	354	.8	64	.2	1.1	.0	.3	.42	.00	428	274	0	25
406	10/19/65		490	7.5 a/	68	--	82	8.0	--	--	272	--	27	--	--	--	--	.60	.01	--	229	8	--
407	10/22/64		419	7.6	67	45	33	21	14	16	221	.4	34	.2	.1	.0	.1	.16	.00	273	170	0	10
409	02/07/63		397	7.7	--	40	30	22	6.6	17	207	.8	20	.2	.0	.0	.2	.13	.00	239	167	0	5
410	02/08/63		938	7.7	68	34	46	24	86	20	223	7.6	163	.2	1.1	.0	.2	.35	.00	493	215	32	5
411	02/08/63		419	7.6	66	32	65	3.6	15	1.8	205	4.0	26	.1	.0	.0	.1	.25	.03	249	178	10	5
412	10/11/65		1440	7.3 a/	68	22	60	16	197	18	195	1.6	360	.2	.3	.05	.2	.52	.02	771	217	57	10

a/ Field pH meter value.

concentration of hydroxyl ions. A water having a pH value greater than 7 is referred to as basic; that is, the concentration of hydroxyl ions exceeds the concentration of hydrogen ions. Conversely, if the pH is less than 7 the hydrogen ions exceed the concentration of hydroxyl ions and the water is said to be acidic. Inasmuch as the pH values are the numerical change to the logarithmic base, a water with a pH of 3 is ten times as acid as water with a pH of 4, and conversely a water with a pH of 9 is ten times as basic as a water with a pH of 8. The pH values are important indicators of the corrosive potential of ground water. Acid waters generally are more corrosive than alkaline waters.

The pH of ground water was determined by the author using a pH meter calibrated by standard buffer solution before each measurement. The water was pumped until its temperature stabilized, and then it was conducted by closed system to the pH cell. Most artesian water in the county had a field pH slightly greater than 7.0. The pH of waters that remained in sample bottles for several days ranged up to 8.2.

TEMPERATURE

The temperature of most water samples from New Hanover County ranged from 64 to 66°F. The average annual air temperature at the Wilmington weather station is 63.8°F for a 30-year period of record. Higher temperatures noted in table 2 were caused by warming of the water by the sampling pump or while in above-ground storage tanks. The higher temperatures of water from wells 87 and 347 are related to the relatively great depths to the aquifers at these wells.

SILICA (SiO_2)

Silica in ground water is derived from the weathering of silicate minerals that are common in the Coastal Plain materials. Except when present in high-pressure boiler feed or steam-turbine water, high concentrations of silica in ground water are not objectionable for most industrial processes. The concentrations of silica range from 4.1 to 45 mg/l and are highest in water from the limestone aquifer in New Hanover County.

CALCIUM (Ca) AND MAGNESIUM (Mg)

Compounds of calcium and magnesium are abundant in the limestones, marls, calcareous sands, and sandstones in the county and impart most of the hardness to the water. The ions of calcium and magnesium are similar in chemical reaction insofar as most water uses are concerned and are considered together in this report. Circulating acidic water dissolves calcium carbonate and carries it in solution as calcium bicarbonate. The quantity in solution is directly related to the carbon dioxide content of the water. The reaction is reversible so that where carbon dioxide is being released, such as at the screen and well head where there is a decrease in pressure, calcium carbonate is redeposited. In one well near Myrtle Grove, carbon dioxide (identified by chemical test) is occasionally released in sufficient quantities to cause cavitation of a 1/2-horsepower centrifugal pump.

The calcium and magnesium concentrations of well water in New Hanover County are given in table 2.

SODIUM (Na) AND POTASSIUM (K)

Concentrations of sodium and potassium in New Hanover County are low in ground water, except in wells 300 feet or more in depth, and in shallow wells near the coast. Along the sounds and beaches brackish water contains relatively high concentrations of sodium as well as chloride.

Water containing as much as 50 mg/l of sodium and potassium may be used for most domestic purposes; however, greater concentrations may cause foaming in high-pressure boilers. Sodium and potassium do not impart a noticeable taste to water in concentrations of less than several hundred milligrams per liter.

BICARBONATE (HCO_3 AND CARBONATE (CO_3)

Ground water in New Hanover County is principally the bicarbonate type with calcium and magnesium as the dominant cations. Where the chief cations are calcium and magnesium the water is usually hard. As demonstrated by water from well 87, the sodium ion is sometimes exchanged for the calcium and magnesium ions to produce a soft sodium bicarbonate water. This ion exchange principle is used in the zeolite softeners for domestic and industrial water supplies.

Bicarbonate has little effect on the domestic use of water, but it may cause foaming and scale formation in some industrial uses.

SULFATE (SO_4)

Sulfur-bearing minerals such as pyrite and marcasite are present in the sediments beneath the county. These minerals, and the calcium and magnesium sulfates frequently associated with shell and limestone beds, are soluble in ground water. Sulfate is also contributed to rainwater from airborne salt spray and industrial pollutants. Except in the deep test holes (wells 87 and 347), sulfate in water tested in the county did not exceed the U. S. Public Health Service recommended limit of 250 mg/l. However, sulfate may be reduced by bacteria and decaying organic matter to produce hydrogen sulfide and sulfur. The gas, hydrogen sulfide, a common nuisance in coastal counties, has an offensive rotten-egg odor; and when dissolved in water, forms a weak acid and imparts a characteristically disagreeable taste. The odor of these reduced waters can usually be remedied by chlorination to prevent bacterial growth. The effectiveness of both aeration and chlorination in the removal of H_2S is dependent upon the pH of the raw water.

CHLORIDE (Cl)

Small amounts of chloride are available from the decomposition of igneous rocks. However, the original source of most oceanic chloride is probably from volcanic gas and hot spring emanations associated with volcanic activity. More than 90 percent of the dissolved solids in the oceans are chloride salts, and the chloride ion concentration ranges from 19,000 to 20,000 mg/l in sea water. Chloride salts are incorporated within the porous sediments when they

are deposited or submerged beneath the ocean. Airborne salt spray also contributes chloride to the aquifers in coastal areas (Wait and Callahan, 1965). The rate of flushing of these aquifers by fresh water depends on time, the hydraulic head, and the composition of the flushing water.

Chloride concentrations are less than 40 mg/l in waters from the water-table aquifer. Chloride concentration is less than 20 mg/l in the limestone aquifer (fig. 18), except along the estuaries and sounds where it ranges from 50 to 400 mg/l due to lateral encroachment of brackish water. Encroachment of brackish water is a problem, especially where dredging of the Intracoastal Waterway along Middle Sound has breached the permeable Castle Hayne Limestone. Chloride concentration in the sandstone aquifer (fig. 15) is less than 50 mg/l everywhere within the interior of the county at depths of less than about 200 feet. Except in areas of heavy pumping, chloride concentrations in this aquifer along the sounds and at Wrightsville Beach range from 50 to 260 mg/l. No information is available from the southern end of the county where the sandstone aquifer lies below a depth of 200 feet. In test wells 87 and 347 the chloride content of the water is about 3,000 mg/l at a depth of 300 feet and more than 8,000 mg/l at a depth of 600 feet.

The U. S. Public Health Service recommends that the chloride content not exceed 250 mg/l in water used for domestic and public supplies. The chloride-contamination problem is further discussed in a following section.

FLUORIDE (F)

Fluoride in ground water is due to the solution of fluoride-bearing minerals such as apatite, fluorapatite, the phosphates, the micas, hornblende, and organic matter such as shells. The micas, phosphates, and shells are prevalent in the sediments of the county and probably contribute most of the fluoride in the ground water.

Fluoride in concentrations between 1.0 and 1.5 mg/l in drinking water aids in reducing tooth decay in children. In concentrations greater than 1.5 mg/l fluoride may cause permanent mottling of the teeth (dental fluorosis) when used by children (Maier, 1950, p. 1120-1132. Fluoride concentrations averaged 0.2 mg/l and ranged from 0 to 0.5 mg/l in all ground water tested in wells as much as 200 feet deep.

NITRATE (NO_3)

Nitrate in ground water is generally considered to be the final oxidation product of nitrogeneous (organic) waste. A nitrate concentration in excess of 3.0 mg/l generally would indicate a nearby source of pollution. Shallow dug wells and well points are most often subject to pollution from sewage, fertilizers, and polluted surface waters.

The so-called "blue-baby" condition is a possible hazard when water containing nitrate concentrations in excess of 45 mg/l is mixed in feeding formulas. Water from all but one of the wells tested in the county had nitrate concentrations less than the U. S. Public Health Service recommended maximum of 45 mg/l. Well 115, which draws water from beds of permeable sand, is probably contaminated by nitrogen fertilizers.

PHOSPHATE (PO_4)

Phosphate in ground water may result from the solution of apatite or phosphate fertilizers. Phosphate concentrations in ground water tested in New Hanover County were below 0.4 mg/l.

ALUMINUM (Al)

Aluminum is a very common element in the earth's crust. However, high concentrations of aluminum are not common in ground water because this metal is only slightly soluble in water under the conditions that prevail in New Hanover County. Aluminum concentrations in ground water tested were below 0.5 mg/l.

IRON (Fe) AND MANGANESE (Mn)

Iron in excess of 0.3 mg/l is objectionable for many uses. Excessive amounts of iron and manganese impart a reddish-brown color to utensils, plumbing fixtures, and laundry. It also interferes with dyeing and the manufacturing of some products, such as paper and photographic film.

Excessive iron concentrations are common in water in the shallow sediments in the county. The shallow ground water generally is more corrosive than deeper water. Oxygen and carbon dioxide are the principal constituents of ground water causing corrosion. As the shallow water moves downward through the soil and other sediments, the oxygen is used up in the oxidation of organic and inorganic matter; the carbon dioxide reacts with carbonates to form bicarbonates.

it is not always apparent whether the iron is in the water as it enters the well, or whether it is dissolved from the well casing and pipes. It is important to determine the source of the iron, whether dissolved from the rocks or the pipes, before methods for its removal are employed.

Iron concentrations in the water sampled are generally more than 1 mg/l from wells in the water-table aquifer, between 0.3 and 4.0 mg/l for water from the limestone aquifer, and less than 0.3 mg/l in the sandstone aquifer in areas along the Atlantic coast and the Cape Fear and the Northeast Cape Fear Rivers.

The chemical behavior of manganese in water resembles that of iron. However, since manganese is much less abundant in rocks, its concentrations in ground water are generally lower than iron concentrations. The U. S. Public Health Service recommends that manganese not exceed 0.05 mg/l in drinking and cooking water. Ninety-one percent of the water samples analyzed for manganese contained less than 0.05 mg/l. Manganese ranged from 0.0 to 1.5 mg/l in ground water in New Hanover County.

DISSOLVED SOLIDS

Total dissolved solids are the residue after a given volume of water has been evaporated and dried at a definite temperature (180°C by the U. S. Geological Survey methods). Computed dissolved solids are equal to approximately one-half the bicarbonate plus the sum of the other chemical constituents in milligrams per liter. Computed dissolved solids are used in the report, unless stated otherwise.

The U. S. Public Health Service recommends that dissolved solids in public water supplies not exceed 500 mg/l. Except in cases of chloride contamination, dissolved solids are less than 500 mg/l in ground water in New Hanover County.

HARDNESS

Hardness of water is usually recognized by the increased amount of soap necessary to form and maintain a lather. Hard water is objectionable not only because of its soap-consuming properties, but also because it forms scale in boilers and, to a lesser degree, encrustations in cooking utensils. The principal ions that produce hardness in ground water are calcium and magnesium, which have been discussed in a previous section. The following classification of water hardness is used by the U. S. Geological Survey.

Hardness as $CaCO_3$ (mg/l)	Classification
0 - 60	Soft water
61 - 120	Moderately hard water
121 - 200	Hard water
More than 200	Very hard water

Figure 14 shows the areal distribution of the hardness in the sandstone aquifer. Most of the water in the county with the exception of that from the water-table aquifer would be classed as hard to very hard water of the calcium-bicarbonate type.

Hardness in excess of that equivalent to the carbonate and bicarbonate present in the water is referred to as noncarbonate hardness.

OCCURRENCE OF SALTY WATER AND ITS POSSIBLE ENCROACHMENT

In New Hanover County it is important to know where the salty water occurs in the ground as well as in the major rivers so that fresh water can be developed without encroachment of salty water. The county is underlain by aquifers containing brackish to highly saline sea water. The overlying reservoir of fresh water exists in dynamic equilibrium with the underlying and surrounding salt water.

The contact between fresh water and the underlying salt water lies within the Peedee Formation everywhere in the county except in the limestone near the sound at Porters Neck. The upper part of the Peedee contains fresh water. The data from several deep wells indicate that saline water progressively increases in chloride concentration to basement. Figure 6 shows the general configuration of the top of a sand bed in the Peedee Formation that contains more than 3,000 mg/l chloride, and indicates that the top ranges from about 180 feet below mean sea level in the western part of the county to about 340 feet below sea level in the eastern part.

The chloride and other pertinent data from two deep test wells drilled during this investigation and the available data from all previously known exploratory wells are summarized below in table 3.

Table 3.--Summary of deep test well data

Name	Date Drilled	Well No.	Depth to saline water below msl (ft)	Formation	Elevation of land surface (ft)	Water level below mean sea level (ft)	Chloride (mg/l)	Temperature (°F)	pH	Remarks
Olsen, near Murrayville	1965	67	278 357	Peedee Peedee	22	18 [illegible]	[illegible] [illegible]	[illegible] 69		
Edwards, about 2 miles NW of Myrtle Grove	1965	347	300 595	Peedee Peedee	22	12 [illegible]	[illegible] [illegible]	[illegible] 72	[illegible] [illegible]	
Wrightsville Beach	1953	201	225 350	Peedee Peedee	5		680 1,000+			Brown, 1956a
Allied Kennecot		342	194	Peedee	17					Brackish water reported
Carolina Power & Light		Near 128	180	Peedee	6					Brackish water reported
Swart Dairy		47	333	Peedee	35	26	3,000 approx.			
Fort Caswell	1903		1,340	Tuscaloosa			8,000+	99		Salty from 365 to 1,340
Carolina Trucking Development Co.	1905	Near 115	250-318 318-350	Peedee Peedee	20 20	Nonflowing Flowing				Reported salty, Clark and others, 1912

Saline waters from these aquifers are possible sources of bromine and other rare salts. Too, the chloride-total hardness ratios in these waters are such that they possibly may be used to regenerate sodium cation water softeners. With suitable noncorrosive plumbing, their high temperatures could be employed for heating. There is a possibility that these aquifers could be used for disposal of industrial wastes.

Ocean water lies everywhere off the county's eastern shore and moves with the tides up and down the Cape Fear and Northeast Cape Fear Rivers and most of the larger creeks. The distance traveled depends upon the volume of downstream flow and the height of the tides. The denser sea water moves wedge-like along the stream bottom, and the fresh water flows out above it; however, turbulence causes some mixing along the salt-water interface. Where

infiltration occurs, the quality of water from wells located near the ocean and river estuaries is dependent on the salt content of the water that infiltrates and the proportion it represents of the water pumped.

The position of the salt-water interface beneath New Hanover County depends upon the height of the fresh water above sea level and the density of the sea water. Due to the difference in density between fresh water and salt water, fresh water floats upon salt water much as oil does upon water in accordance with Archimedes' principle. In a small land body composed of homogeneous sand and surrounded by water a reduction in the fresh water level of one foot will theoretically cause a corresponding rise in the underlying sea water of 40 feet. Although exact conformance with the above principle does not occur in New Hanover County or in most coastal aquifers due to diffusion or mixing along the salt-water interface (fig. 21) (Kohout, 1961, and Cooper and others, 1964) variation in vertical and horizontal aquifer permeabilities, and incomplete encirclement of the county by sea water, a small decrease in the height of the fresh water above sea level may result in a much larger upward movement of the salt-water interface. Thus, a reduction in rainfall or an increase in the withdrawal of water by pumping, swamp drainage, or dredging reduces the hydrostatic head and results in a corresponding encroachment of the salt water.

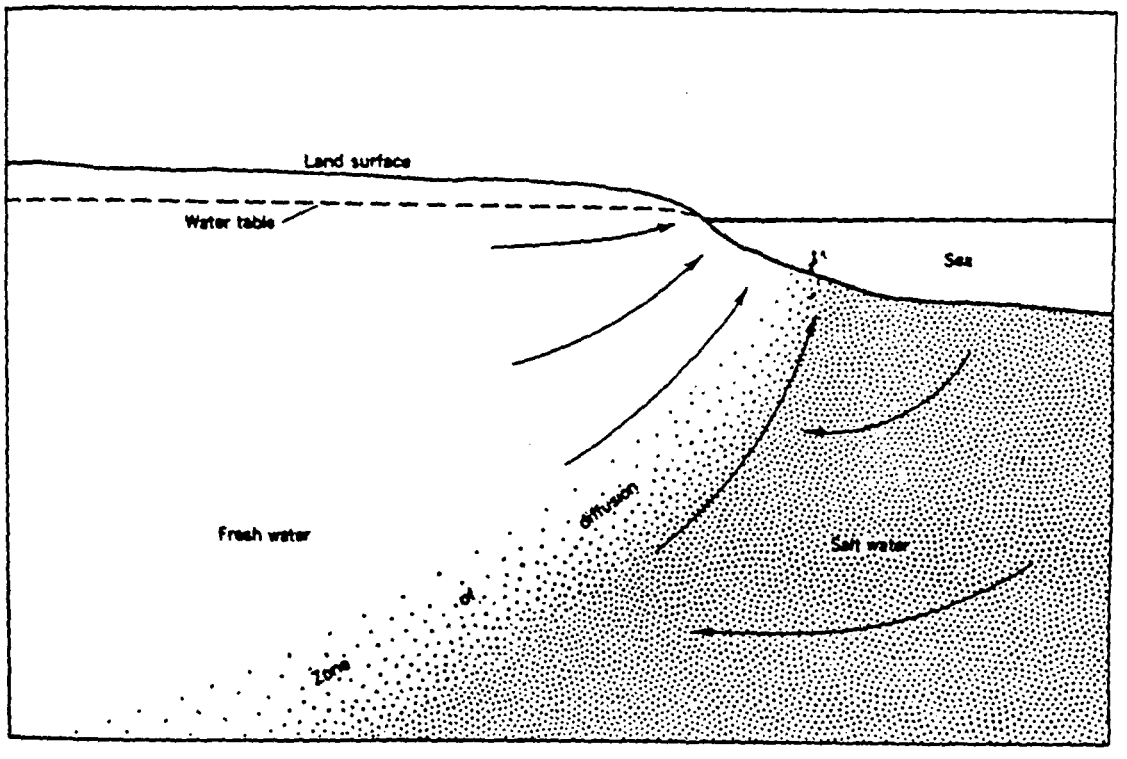

Figure 21.--Diagram showing the circulation of salt water and fresh water in a coastal aquifer. (Include credit in title).

Figures 15 and 18 show that the chloride concentrations are greater in the vicinity of creeks, sounds, and estuaries where the hydrostatic head approaches zero. This is shown also at Kure, Carolina, and Wrightsville Beaches where the hydrostatic head has been lowered by pumping. The result has been a slight upward movement of salt water or lateral movement of sea water from the ocean and estuary, or both. Where lateral encroachment of saline water occurs in the shallow aquifers, such as along the Cape Fear River and the sound at Porters Neck, entrance of salt water to the well may be prevented by extending the well casing through the contaminated zones and deriving water from the fresh zones below. Vertical encroachment can be controlled by well-field design and management practices that decrease the drawdown of the water level and spread the cones of depression over a wider area. Proper practices include pumping more wells at lower rates and using multiple well points and infiltration galleries for shallow installations.

Although chloride contamination is not a serious problem in New Hanover County, the fact that it can happen is borne out by the increased chloride content of the Wilmington wells pumped at high rates during the drought of 1940, and by the recent increase of chloride in wells 342 and 257.

Data are insufficient for making quantitative determinations of safe yields for wells in the several aquifers at any specific point in the county. In areas of heavy pumping it is advisable to monitor the chloride content of the water at the point of pumping and in surrounding observation wells. This method is being used by the Superior Stone Company for advanced warning of contamination.

The quality of ground water near the rivers may be influenced by the quality of the river water. Chloride concentrations and other chemical data collected by the U. S. Geological Survey on the Cape Fear and Northeast Cape Fear Rivers are given in Bulletin 1, volume 7, of the North Carolina Department of Water Resources (Woodard and Phibbs, 1965). A typical chemical analysis of sea water is given in table 4 for those constituents that occur in excess of 1 mg/l.

Table 4.--The composition of sea water

Constituent	Concentration (mg/l)
Chloride (Cl)	18,980
Sodium (Na)	10,560
Sulfate (SO_4)	2,560
Magnesium (Mg)	1,272
Calcium (Ca)	400
Potassium (K)	380
Bicarbonate (HCO_3)	142
Bromide (Br)	65
Strontium (Sr)	13
Boron (B)	4.6
Fluoride (F)	1.4

(Adapted from Rankama and Sahama as given in Hem, 1959.)

WELLS AND WELL CONSTRUCTION

Existing privately-owned wells and test wells drilled for or by the U. S. Geological Survey were the source of most of the data used in this report. Data for these wells are given in table 5 at the end of the report. The 412 wells inventoried are numbered horizontally across the map of the county and are shown in figure 3.

The well data indicate that problems encountered in obtaining adequate supplies of well water of good chemical quality may result from inadequate well construction. Wells frequently have a low specific capacity because of poor construction or development methods, and they may produce water of undesirable chemical quality because they tap the least desirable of several aquifers. The following section on well construction, adapted in part from Wyrick (1966) is included to help minimize some of the problems by improved well design.

Water-well construction is usually governed by the owner's water needs and the cost of the well. As the owner must determine what his requirements are, the following discussion describes the various methods of well construction and the advantages and disadvantages of each. The types of wells constructed in New Hanover County are shown in figure 22. These wells fall into three categories; bored wells, driven wells, and drilled wells. In figure 22 diagram A is a large dug well, the next one (B) is a driven well, and the others shown are drilled wells.

Where large quantities of water are needed for irrigation, ponds are frequently dug and used as wells. The chemical quality of the water is comparable to that from shallow driven wells. Infiltration galleries and multiple well-point installations also may be constructed where domestic needs preclude the use of open ponds or where caving is a problem.

Driven wells are constructed by driving a length of steel well casing with a pointed drive-screen into a sandy water-bearing zone. The well is developed to clear the finer sandy material from the screen area and then equipped with a pump. Driven wells in New Hanover County are usually 1-1/4- to 2-inches in diameter and less than 30 feet in depth.

Several types of drilled wells are constructed in New Hanover County. Among these types are: open-end wells, single- or multiple-screened natural-development wells, and the single- or multiple-screened gravel-pack wells. Multiple-screen wells may also be naturally developed, but none of this type were found in the county.

Well C in figure 22 illustrates the open-hole type of well. This type is constructed by drilling into consolidated rock, such as the Castle Hayne Limestone, and setting a steel casing in the top of the consolidated rock. Usually the well is then deepened to the sandstone aquifer of the Peedee Formation and cleaned by pumping. This type of construction is restricted to areas which are underlain by materials sufficiently consolidated to insure

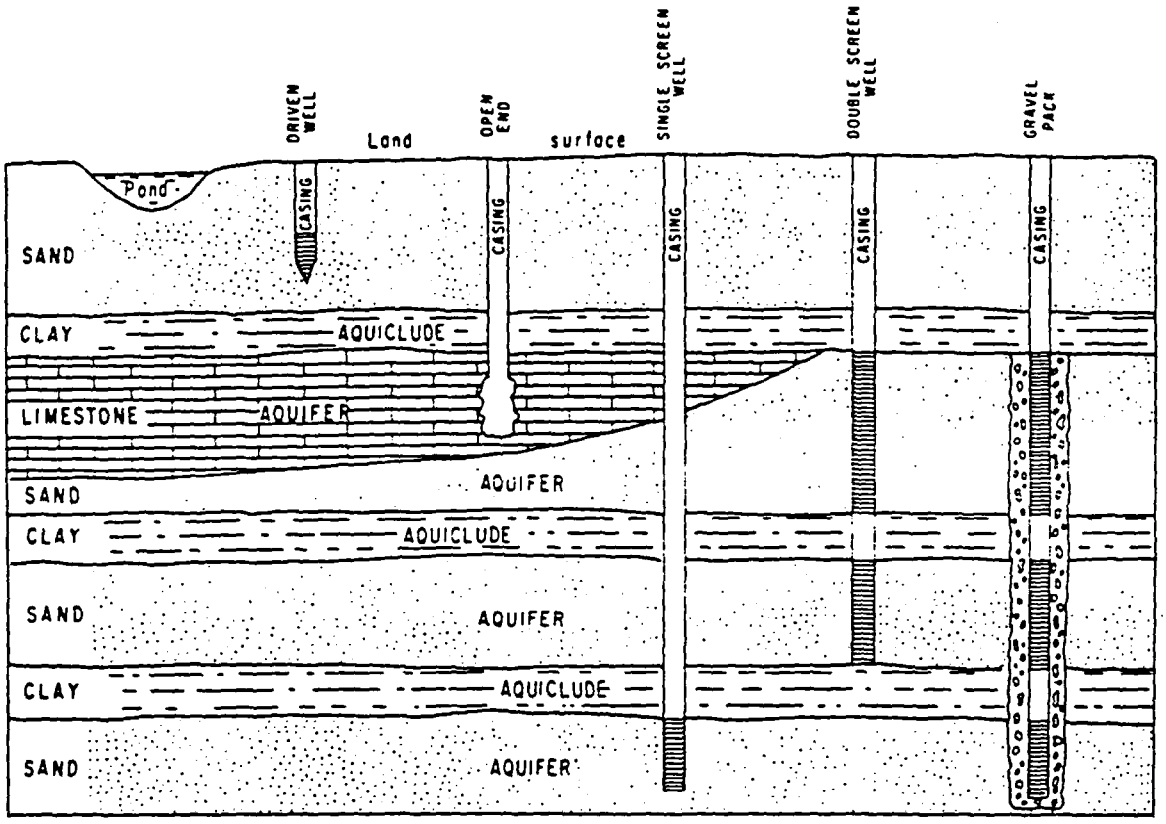

Figure 22.--Diagram showing types of wells constructed in New Hanover County.

that the hole will remain open below the bottom of the casing. This is the most common type of construction for domestic wells in the county.

The screened naturally developed well is illustrated by diagram D in figure 22. This type of well is constructed by drilling into a sandy aquifer and setting a steel casing with one or more screens on the lower end so that the screens are in the sandy aquifers. The well is developed by washing fine sand and clay particles from the aquifer around the screen. In this method of construction it is important that the screen openings be large enough to allow about 50 to 70 percent of the fine sand in the aquifer to wash into the well. In developing the well by pumping and surging, the fine material of the aquifer is washed out of the well and the nearby formation, leaving coarse, more permeable material packed around the screen. Common problems in this type of well construction usually include (1) poor well development due to improper screen size or insufficient surging and pumping, and (2) setting the screen so that part of the screen openings are blocked by clay layers.

Screened gravel-packed wells are illustrated by diagrams E and F in figure 22. This type of well is constructed by drilling a hole through one or several aquifers, reaming or washing a large diameter hole in each aquifer to be screened, setting a casing with screens spaced in the casing at each reamed

aquifer, pumping gravel into the large diameter holes outside of the screens, and developing the well to remove drilling clay and fine material from the gravel zones. The gravel packing effectively increases the radius of the well in each aquifer. This, in turn, increases the specific capacity of the well. Generally, only municipal or industrial wells are constructed in this manner because of the greater cost.

CONCLUSIONS

New Hanover County is underlain by sediments ranging in age from Cretaceous to Holocene. These sediments occur in layers most of which tend to slope at low angles toward the Atlantic coast. They are composed of sands, clays, and limestone, and lie on a floor of hard consolidated rocks at a depth greater than 1,000 feet. A very large volume of water is stored in the sediments of the Coastal Plain, but sediments below depths of approximately 300 feet contain water that is too salty for normal use.

The usable ground water in the county occurs in three major aquifers. The uppermost aquifer is that of the surface sands, of Miocene and Pleistocene age, that extend over the county. This aquifer is especially important along the western edge of the county where sand dunes overlie coarse sand of Pleistocene(?) age. This aquifer is replenished by precipitation directly, and the water table is near land surface in much of the county. Water from this aquifer discharges into streams and into low swampy areas and into the underlying aquifers. Many shallow well points obtain water easily from this aquifer. The water is low in mineral matter but tends to be corrosive.

Below the surface sand in the eastern, central, and northern parts of the county is the Castle Hayne Limestone of Eocene age. This limestone is in most places less than 40 feet thick. It yields as much as 600 gallons per minute to a few wells, 150 to most, and is considered a good aquifer. Specific capacities of existing wells range from 3 to 60 gpm per foot of drawdown. The water is of the calcium bicarbonate type, being moderately hard to very hard in quality.

Underlying the Castle Hayne Limestone and separated from it by some relatively impermeable clays is the sandstone aquifer in the Peedee Formation. It yields 200 gpm to many wells and in excess of 400 to some; in most places it is used in conjunction with the Castle Hayne Limestone aquifer. Specific capacities range from one to 75 gpm per foot of drawdown.

Although each of the aquifers is to a great degree a separate unit, the less permeable materials between the aquifers allow some interchange of water. Heavy withdrawals from either the Castle Hayne or the Peedee sandstone aquifers will tend to affect movement of water to or from the other.

The development of ground water on a large scale in New Hanover County should be considered with care because of the possibility of encroachment of salty water into the fresh-water beds. This encroachment may occur vertically upward from beds containing salty water. Near the coast and along the Cape Fear and Northeast Cape Fear Rivers lateral encroachment of brackish water or sea water into the fresh-water formations is possible when the water level is drawn down appreciably by pumping.

If heavy withdrawal is contemplated the following considerations may prove helpful:

1. A more detailed investigation of the local hydrologic conditions is needed to determine the positions and character of impermeable beds that could prevent or retard encroachment.

2. Periodic determinations of chloride in water from one or more observation wells that yield water from an area between the producing wells and the salt-water body, would be helpful in detecting increase in chloride content. This would give sufficient warning so that the rate of pumping could be decreased and an orderly evaluation of the water problem could be made.

3. Properly spaced producing wells would prevent excessive drawdown at the apex of the cone of depression.

4. The draining of swamps in recharge areas would lower the water table and have other effects upon the ground-water reservoir.

5. Capping flowing wells in the county would help to preserve the hydrostatic head necessary to prevent salt-water encroachment.

6. Introduction of contaminants into the aquifer would pollute the water supply.

7. Long-lived radioactive waste would make the water unsafe for generations. Plugging all abandoned salt-water wells with clay or concrete (from the bottom up) would prevent the contamination of fresh-water aquifers in the event that corrosion causes eventual rupture of the well casing.

So long as care is taken to prevent the encroachment of salty water into the fresh-water aquifers, a fuller use of the ground-water resources can be made. The county has not yet approached an optimum development of its ground-water resources.

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Table 5.--Records of wells in New Hanover County, N. C.

Ownership: C-County; F-Federal Government; M-Municipal; N-Corporation or Company; P-Private; S-State agency; Use: A-Air Conditioning; C-Commercial; H-Domestic; I-Irrigation; N-Industrial; P-Public supply; S-Stock supply; T-Institutional; U-Unused. Type of QW analysis available: P-Partial; C-Complete. Log data available: D-Driller's log; E-Electric log; G-Geological log; J-Gamma-ray log. Well finish: G-Gravel with screen; S-Screen; T-Sand point; X-Open hole. Quality of water: Iron, pH, Chloride, Hardness, and Specific conductance are coded according to range in concentration. Explanation of code given on last page of tables. Aquifer: Kpd-Peedee; Tch-Castle Hayne; TQ-Undifferentiated late Tertiary and Quaternary sands

Well No.	Well location		Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water					Water-bearing unit	Remarks
	Lat	Long															Iron	pH	Cl	Hardness	Sp.Cond.		
1	342216N	0775403	1	USGS	F	U	P	G	29	30	2	T	5				5	7	1	4	2	Kpd	Temp 65°F
2	342205N	0775154	1	SUPERIOR STONE	N	U		J	50		2	X	5	5					2			Tch	
3	342147N	0775145	1	LEWIS NIXON	P	H	P		60		1	X	25	23								Tch	
4	342239N	0775048	1	IDEAL CEMENT	N	N	C	D	160	23	24	G		15	322	30						Tch-Kpd	
5	342235N	0775049	1	IDEAL CEMENT	N	N	C	D	164		24	G	27	19	325	20						Tch-Kpd	
6	342232N	0775045	1	IDEAL CEMENT	N	U			75		7	X										Tch-Kpd	ob. well
7	342211N	0775051	1	IDEAL CEMENT	N	N	C	D	160		24	G		18	329	20						Tch-Kpd	
8	342209N	0774930	1	HARLEY SMITH	P	H			40		1	X	23	7			7		0	5	3	Tch	
9	342180N	0775008	1	J B WILCOX	P	I	P	J	117	54	6	X	26	29	125		8		0	6	3	Tch-Kpd	
10	342115N	0775309	1	E NIXON	P	H			50	21	2	X	24	12								Tch-Kpd	
11	342112N	0775306	1	W A PENDER SR	P	H			35		1	X	23	12								Tch-Kpd	
12	342111N	0775329	1	NEGRO BAPT CH	P	T			26		1	X	23	10								Tch	
13	342133N	0775353	1	QUEEN TIRE SER	P	C			50	30	2	X	19	9	90		2		1	6	3	Kpd	
14	342116N	0775402	1	RAINBOW END MOT	P	C			50	36	2	X	19	11			3		1	6	3	Kpd	
15	342123N	0775414	1	JOHN LOREK	P	I			30	12	5	X	13	8	80							Tch-Kpd	
16	342127N	0775427	1	JOHN LOREK	P	I	P		21		4	X	14	8	100		5		1	6	4	Tch-Kpd	
17	342120N	0775440	1	JOHN LOREK	P	H			18		1	X										Tch-Kpd	
18	342051N	0775520	1	W H JONES	P	H			37		2	X	15	7			2		0	5	2	Kpd	

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location		Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water					Water-bearing unit	Remarks
	Lat	Long															Iron	pH	Cl	Hardness	Sp.Cond.		
19	342045N	0775404	1	SMITH BARBER	P	H	P		40		1	X					6		0	6	3	Kpd	
20	342043N	0775402	1	MELLO ICE CREAM	N	C	P		10		30	X					0	7	0	5	3		Spring flow 10 gpm
21	342030N	0775427	1	ST STANISLAUS	P	T	P		180		2	X					4		0	5	3	Kpd	
22	342033N	0775413	1	WILM PACKING	N	C	C		68		4	X	18		80'		3	6'	1	5	3	Kpd	
23	342033N	0775409	1	WILM PACKING	N	A	C		21		6	X	*15	9			4		2	6	4	Tch	
24	342033N	0775326	1	REASOR CHEMICAL	N	N		DJ	150	30	10	G	22	9	400	75			2			Tch-Kpd	3 screens between 30'-120'
25	342045N	0775336	1	REASOR CHEMICAL	N	N		D	148	34	10	G		8	300	20						Tch-Kpd	Screened 33'-148'
26	342034N	0775323	1	REASOR CHEMICAL	N	U		D	212	14	6	X	22	11								Tch-Kpd	Stratigraphic test
27	342035N	0775324	1	REASOR CHEMICAL	N	N		D	150	33	6	G		4	200	12	5		2	6	4	Tch-Kpd	Screened [illegible]'-133'
28	342025N	0775245	1	HENRY BAND	P	I			69	26	2	X	16	1			6		2	4	3	Tch-Kpd	
29	342028N	0775216	1	R D TARDUGNO	P	H	C	G	60	20	2	X	29	11	*30		5	6'	1	6	3	Tch-Kpd	Temp 65°F
30	342043N	0775207	1	A H PARKER	P	H			60	20	2	X	29		*40		7		1	6	4	Tch-Kpd	
31	342012N	0774925	1	USGS	F	U		J	94	92	1	T	33	7								Kpd	Auger hole No 6
32	342012N	0774925	2	USGS	F	U		J	42	40	1	T	33	4								Tch	Auger hole No 6
33	342036N	0774755	1	USGS	F	U		J	75	73	1	T	22	0								Kpd	Auger hole No 45
34	342019N	0774727	1	JOSEPH WENEUT	P	H	C		42		2	X	40	9			5	6'	1	5	3	Tch	Temp 66°F
35	341948N	0775147	1	C LITTLEJOHN JR	P	H			50		2	X					5		0	5	3	Tch	Hole from reported
36	341933N	0775205	1	RAEFORD TRASK	P	I			87		6	X	39	12								Kpd	
37	341934N	0775253	1	ARTHUR KAUFMAN	P	U			29		1	X	28	4								Tch	
38	341954N	0775316	1	K E KORNEGAY	P	H	C		58	52	2	X					5	7'	1	6	3	Kpd	
39	341959N	0775312	1	MR HILL	P	H			52	24	2	X		9	*100							Tch-Kpd	
40	342015N	0775323	1	H A BRANCH JR	P	H	P		40		2	X					5		1	6	3		
41	342001N	0775431	1	S C STRICKLAND	P	U	P		24		1	X	21	7			7					Tch	
42	342003N	0775434	1	S C STRICKLAND	P	H			90	81	2	X	21	6	45							Kpd	

* Estimated. ' pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond	Water-bearing unit	Remarks
43	342010N	0775441	1	J W SAVAGE	P	H	P		44		2	X	* 21	5	*60		6		1	4	2	Tch-Kpd	
44	342017N	0775436	1	J S CAMERON	P	U			40		4	X		8								Kpd	
45	342018N	0775441	1	J S CAMERON	P	U			179		4	X		8			3	7	5			Kpd	
46	342018N	0775445	1	J S CAMERON	P	H			55		1	X					3	7	1	6		Kpd	
47	342007N	0775504	1	HUGH OOSTERWYK	P	I			71		3	X	21	6								Kpd	
48	342000N	0775524	1	HUGH OOSTERWYK	P	I	P		74		8	X	21				5		2	6	4	Kpd	
49	341936N	0775527	1	S J SZCZERBIAK	P	H			100		1	X	25	1			4		2	6	3	Kpd	
50	341926N	0775658	1	USGS	F	U	C	GJ	54	52	2	T	34				1	7[1]	0	4	2	Kpd	Obs [illegible]
51	341928N	0775939	1	USGS	F	U	C	GJ	48	46	1	T	18	15			0		0	0	0	TQ	Ob [illegible]
52	341957N	0775957	1	USGS	F	U		J	38	36	2	T	7									TQ	
53	341932N	0780127	1	USGS	F	U	C	G	20	18	2	T	3	1									Ao [illegible]
54	341832N	0775904	1	USGS	F	U		GJ	65	62	2	T	17									TQ	
55	341910N	0775634	1	USGS	F	U		GJ	75	73	2	T	39									Kpd	Ob [illegible] 25
56	341919N	0775526	1	JOHN G OWENS	P	H			40		1	X	25	7								Kpd-Tch	
57	341847N	0775531	1	MAGGIE L ALLEN	P	H			46		1	X		8								Kpd	
58	341844N	0775524	1	ST JAMES AME CH	P	T	P		54		2	X	36	10			5		1	6	3	Kpd	
59	341912N	0775510	1	US DEPT OF AGRI	F	I			45	35	3	X		5	100		6		0	5	3	Tch	
60	341920N	0775458	1	US DEPT OF AGRI	F	U		J	31		3	X	35	5								TQ	Ob [illegible] 11
61	341839N	0775352	1	RAEFORD TRASK	P	U			27		1	T	35	5								TQ	
62	341918N	0775303	1	PAULINE CORE	P	H			72		2	X	28	6								Kpd	
63	341904N	0775208	1	RAEFORD TRASK	P	I		J	119		4	X	38	11								Kpd	
64	341912N	0775153	1	RAEFORD TRASK	P	I			64		4	X	40	4	*100							Kpd	
65	341845N	0775153	1	RAEFORD TRASK	P	I		J	98	84	6	X	38	8	250							Kpd	
66	341856N	0774628	1	E C BRINKLEY	P	H	P		14		36	X	48	11			1	6	2	3		TQ	

* Estimated. [1]pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (GPM)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
67	341902N	0774617	1	USGS	F	U		GJ	74	72	1	T	48									Tch	Obs well, August 1967
68	341905N	0774618	1	J C WELLS	P	H	C		70	60	1	X	50	26			5	6'	1	6	4	Tch	Temp. 66°F.
69	341913N	0774615	1	J F SWAN SR	P	H			100		2	X	50	28			8		1	6	3	Tch	
70	341911N	0774611	1	J F SWAN JR	P	H	C		172	130	2	X	46				6	6'	1	6		Kpd	
71	341816N	0774458	1	RALPH MOORE	P	H			30	22	2	X	24	11	15							Tch	Temp. 66°F.
72	341819N	0774450	1	HARRY L SMITH	P	H			20	18	1	T	20	9			0		2	5	3	TQ	Cl 2289 at [illegible]'
73	341754N	0774440	1	MR ORNESBY	P	H		JD	165	159	2	X	18	9			3	7				Kpd	
74	341753N	0774441	1	R G JOHNSTON	P	H	P		60		2	X					1	7	4	7		Tch	
75	341747N	0774444	1	E E CASTEEN	P	H	P		47	27	2	X		17			1	7	5	7		Tch	
76	341743N	0774611	1	COR-DAVIS HOME	N	T	P		181	131	6	X	25	10	*450			7'	1			Kpd	
77	341738N	0774634	1	JOHN F MURRAY	P	H	P				1	X	23	12			1	7	1	4		Tch	
78	341755N	0774628	1	C E RIVENBARK	P	1	P		75		6	X		17	450		1		0	4	2	Tch	
79	341820N	0774646	1	C E RIVENBARK	P	J		J	60	38	2	X	40	12								Tch	
80	341800N	0774714	1	R D DREW JR	P	H			55		2	X	42	21			5		0	5	3	Tch	
81	341741N	0774655	1	W J WILSON	P	H	P		21	19	1	T	24	15			7		0	2	2	TQ	
82	341731N	0774704	1	W J WILSON	P	1			81	32	6	X	29	18	275	23	6		1	5	3	Tch	
83	341738N	0774752	1	A L SOUTHERLAND	P	H			56	52	1	X	36	12			5		1	6	3	Tch	
84	341722N	0774803	1	G P WILSON	P	U			41		1	X	37	20								Tch	
85	341746N	0775048	1	JOHN D MURRAY	P	H	P		123		2	X	42	16			5		0	7	3	Kpd	
86	341745N	0775123	1	JOHN D OLSEN	P	H	C		120	105	2	X	34	13			4	7'	1	6	3	Kpd	
87	341741N	0775123	1	USGS	F	U	C		740	120	4	X	32									Kpd	Test - 11
88	341722N	0775223	1	ALEXENDER WEIDE	P	H			109	78	2	X	42	17						5		Kpd	
89	341817N	0775414	1	USGS	F	U		GJ	55	53	1	T	38									Tch	[illegible]
90	341734N	0775406	1	RAEFORD TRASK	P	I		J	83		6	X	31									Kpd	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gal/min)	Drawdown (feet)	Quality of water: Iron	Quality of water: Sulfate	Quality of water: Chloride	Quality of water: Hardness	Quality of water: Sp. Cond.	Water-bearing unit	Remarks
91	341711N	0775401	1	RAEFORD TRASK	P	I		J	90		8	X	28		300		1	7'	2	6	3	Kpd	[illegible]
92	341724N	0775436	1	CORNELIUS MOORE	P	C			21	19	1	T	34	12								TQ	
93	341720N	0775443	1	USGS	F	U		GJ	130	128	1	T	34	11								Kpd	
94	341722N	0775448	1	J C LONG	P	H		G	55	51	2	S	35	13	*20		1		1	2	1	TQ	
95	341751N	0775451	1	J L. SMITH	P	H		J	62		2	X	34	13								Tcs, Kpd	
96	341758N	0775458	1	REED SMITH SR	P	H	P		55	42	2	X	30	9				7'				Kpd	
97	341818N	0775459	1	SWART SONS INC	N	U	P		367	309	8	X	35	1	*30			9	8			Kpd	[illegible]
98	341815N	0775512	1	A D COX	P	I			63		4	X	28	13	*50							Kpd	
99	341816N	0775516	1	A D COX	P	H			45		1	T	31	11								TQ	
100	341759N	0775507	1	G PLOTT	P	H			70	52	2	X	30	9								Kpd	
101	341754N	0775512	1	TINGA NURSERY	P	I			80	35	4	X	32		100'		[illegible]		1	5	3	Kpd	
102	341806N	0775530	1	E M STANLEY	P	H	P		67		2	X	*20	8	*100		[illegible]		1	[illegible]	1	Kpd	
103	341738N	0775532	1	C R WATTS	P	U			29	27	1	T	23	12								TQ	
104	341755N	0775612	1	ROY BROWN	P	H			26	24	1	T	26	20								TQ	[illegible]
105	341811N	0775630	1	E H TINGA	P	U			28	26	1	T	26	10								TQ	
106	341753N	0775836	1	USGS	F	U		GJ	57	47	2	S	14									TQ	
107	341700N	0775921	1	USGS	F	U		GJ	50	47	2	T	11									TQ	
108	341705N	0775902	1	CAROLINA POWER	N	N	C	D	53	33	10	G	8	9	480	7		5'				Kpd-TQ	[illegible]
109	341706N	0775849	1	CAROLINA POWER	N	N			55		10	G	12									Kpd-TQ	
110	341701N	0775831	1	USGS	F	U		GJ	57	54	2	T	18									TQ	
111	341706N	0775748	1	USGS	F	U	C	G	56	53	2	T	20				1	7	0	0	0	Kpd-TQ	
112	341651N	0775738	1	CAROLINA NITRO	N	N		D	84	56	8	G	41		200							Kpd-TQ	
113	341642N	0775734	1	CAROLINA NITRO	N	N	P	J	65	30	8	G	33	27	200	13						Kpd-TQ	
114	341634N	0775732	1	CAROLINA NITRO	N	N		D	60	40	8	G	24	23	200	13						Kpd-TQ	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
115	341631N	0775721	1	CAROLINA NITRO	N	N	C	D	72	47	8	G	24	23	80	20						Kpd	
116	341619N	0775741	1	JOHNNY MALPASS	P	H	P		25	23	1	T	12	5			5		0	1	1	TQ	
117	341619N	0775727	1	SWIFT AGRI CHEM	N	N			55	35	8	G		6	*100							Kpd	
118	341609N	0775719	1	ROBERTSON CHEM	N	H			21	18	2	T		4				5'	1			TQ	Reported high Fe
119	341605N	0775718	1	ROBERTSON CHEM	N	U			47		4	X	5	3			5		0	1	0	Kpd	
120	341558N	0775719	1	HORTON IRON MET	N	H			20	15	2	T	6									TQ	
121	341558N	0775713	1	HORTON IRON MET	N	N			40		4	X	5	2	*50		8		1	4	2	Kpd	
122	341613N	0775609	1	GROVER SCOTT	P	H			60	42	2	X		14								Kpd	
123	341629N	0775604	1	FRED TOWNSEND	P	H	C		60	42	2	X	24	17	*100		6	6'	1	4	3	Kpd	Temp. 66°F.
124	341706N	0775544	1	W F INGOLD	P	U			20	18	1	T	25	9								TQ	
125	341646N	0775524	1	EDGAR MCKOY	P	H		D	75	72	2	X			*50							Kpd	
126	341644N	0775517	1	M K MALPASS	P	H			78	70	2	X	28	12	*100							Kpd	
127	341624N	0775452	1	NEW HAN AIRPORT	M	U	P	DJ	89		8	X	29	15								Kpd	Specific cap. 34 gpm/ft
128	341623N	0775455	1	NEW HAN AIRPORT	M	P			105	65	8	X		15	211	9						Kpd	
129	341616N	0775505	1	NEW HAN AIRPORT	M	P			102	93	8	X		17	300	8						Kpd	
130	341605N	0775523	1	PILOT FRGT INC	N	C			75	51	2	X	25	12								Kpd ?	
131	341550N	0775355	1	ADC DIS COMPLEX	F	P	C				8	X		8	425	13						Kpd	12" in 5x6 orifice
132	341545N	0775339	1	ADC DIS COMPLEX	F	P			96	74	8	X		1	445	8	5		2	5	3	Kpd	13" in 5x6 orifice
133	341623N	0775357	1	S H FEENSTRA	P	H	P		20	17	1	T	21	5			6		1	0	1	TQ	H_2S
134	341628N	0775357	1	S H FEENSTRA	P	1	C		113		8	X	20	0			5	7'	1	6	3	Kpd	Temp. 64°F.
135	341629N	0775351	1	S H FEENSTRA	P	1		J			4	X		2								Kpd	H_2S
136	341622N	0775332	1	FRED A JORDAN	P	U			25	23	1	T	21	6			5		1	2	1	TQ	H_2S
137	341649N	0775329	1	DOROTHY PEOPLES	P	H	P		22	20	1	T	24	4			7		1	2	1	TQ	H_2S
138	341652N	0775248	1	J N CORBETT	P	U			36	34	1	T	40	9								TQ	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond	Water-bearing unit	Remarks
139	341649N	0775249	1	E E LEWIS	P	H	C		121	90	2	X	41	5	*130		3	7	0	5	3	Kpd	Temp. 66°F.
140	341641N	0775240	1	G W SHEARON	P	H	P		115	110	2	X					5		0	5	3	Kpd	
141	341626N	0775241	1	HARRELLS BLDG	N	I		J	87		6	X	29	3			6	7'	0	5		Tch-Kpd ?	Temp. 65°F.
142	341635N	0775147	1	HERBERT NEWTON	P	H					2	X	38	19			5	8	0	5	4	Kpd ?	
143	341629N	0775139	1	RAYMOND MCKOY	P	H	P		20	17	1	T	45	5								TQ	
144	341610N	0775045	1	E F PRIDGEN	P	P		D	146	92	2	X	41	21			5		0	5	3	Kpd	
145	341608N	0774923	1	NEGRO CHURCH	P	T		J	87		4	X	46	6								Tch	
146	341616N	0774907	1	J W COVIL	P	C	P		75		2	X		18	*60		6		1	6	3	Tch	Has Fe
147	341613N	0774857	1	CHRISTIAN CH	P	T	C		65	50	2	X	45	12				7'				Tch	Temp. 68°F
148	341646N	0774858	1	FRANK PARKER	P	H		J	155	60	2	X	47									Tch Kpd	
149	341646N	0774842	1	BAYSHORE EST	N	U		J	68		2	X	44	9								Tch	
150	341639N	0774830	1	E K CARTER JR	P	H	P				1		31				4		0	4	2		
151	341634N	0774758	1	M L HONEYCUTT	P	H		G	80	40	2	X	16	12								Tch	
152	341641N	0774750	1	M P HAINES	P	H		G	90		2	X	20	13	*30		5		1	5	3	Tch	
153	341637N	0774747	1	D P HERBERT	P	H			50	41	2	X		15	*20							Tch	
154	341654N	0774739	1	M MARSHBURN	P	H	C		150	110	2	X	23					7'				Kpd	Temp. 66°F., much H_2S
155	341648N	0774642	1	W J ROBINSON	P	H	C		60	55	1	X	10				2	7'	2	5	3	Tch	Temp. 66°F.
156	341723N	0774503	1	C M DAVIS	P	H	P		85			X					0		3	4	3	Tch	
157	341712N	0774510	1	M H BELL	P	H	P		120		2	X					0	8	2	5		Tch	
158	341659N	0774522	1	G A RYALS	P	H			180	126	2	X	20	15	*50		5		2	6	4	Kpd	
159	341654N	0774525	1	J N MCCARTNEY	P	H	P		42	40	1	X					0	8	5	7		Tch	
160	341652N	0774526	1	G D FARMER	P	H	C		170	127	2	X	20	15				7'				Kpd	Temp. 66°F.
161	341631N	0774548	1	CAMERON - TRASK	P	H	P		38		1	T					1		1	5	3	TQ	
162	341629N	0774552	1	CAROLINA POWER	N	H	P		70		2	X					0		1	4	2	Tch ?	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
163	341613N	0774628	1	J N CORBETT	P	U		J	65		2	X	5									Tch	Reported brackish
164	341613N	0774624	1	P R MASON	P	H	P		42		1	X	8	9	*20		2		4	7	5	Tch	H_2S odor
165	341539N	0774700	1	ROBERT JAMES	P	H			60		2	X	23	17	15		5	7	0	4	2	Tch	Temp. 67°F.
166	341530N	0774653	1	GEORGE HULBERT	P	H			48	42	2	X	27	27								Tch	
167	341525N	0774643	1	DR HK THOMPSON	P	H	C		165		3	X		30								Kpd	
168	341515N	0774653	1	L M MERRILL	P	A	P		186	124	4	X	6	8	250		2	7	2	6		Kpd	1.1 ppm H_2S
169	341512N	0774735	1	DR WC VONGLAHN	P	H		D	83	64	4	X	24	16	*40		5		1	6	3	Tch	
170	341557N	0774837	1	OGDEN SCHOOL	C	P		D	93	68	6	X	31	12	250		4		1	6	3	Tch	
171	341527N	0774910	1	W E COVIL	P	I			204		6	X	19	2	400		2		1	6	4	Tch-Kpd	H_2S odor
172	341535N	0774941	1	E B TOWLES	P	P			163	81	4	X	*39	19								Tch-Kpd	
173	341537N	0774944	1	E B TOWLES	P	P		J	157	64	2	X	44									Tch-Kpd	
174	341549N	0774949	1	J D HENEGAR SR	P	H			162	95	2	X	46				4		1	6	4	Kpd ?	
175	341531N	0774958	1	NC HWY PATROL	S	H	C	D	180	86	6	X		30	165		5	7	1	6	4	Tch-Kpd	
176	341515N	0775040	1	CHARLES WELLS	P	H		G	153	63	2	X	44	17	*70		5		0	5	3	Tch-Kpd	Temp. 67°F.
177	341426N	0775115	1	RICHARD NAPIER	P	H	C		160	130	4	X	47					7				Kpd	Temp. 68°F.
178	341454N	0775128	1	COLL VIEW TRLR	P	P	C		62		2	X		8	60		4	7	1	5	3	Tch	Temp. 65°F.
179	341457N	0775144	1	JOHN TAYLOR	P	H	P		130	60	2	X	38	7			5		1	2	1	Tch-Kpd	
180	341457N	0775144	2	JOHN TAYLOR	P	U	P		30	24	1	T	38	6			5		1	2	1	TQ	
181	341508N	0775213	1	CORNING GLASS	N	U		DJ	140		8	G	27	7	250	60	5	8	2	6	3	Kpd	Temp. 66°F., H_2S odor
182	341522N	0775218	1	HOME REALITY	N	C	P		25	21	2	T	31	8			3		0	2	1	TQ	
183	341446N	0775220	1	B W PARSONS	P	P			25	21	2	T		9								TQ	
184	341444N	0775241	1	W K RHODES	P	H		D	96	53		X		8	10	10						Tch-Kpd	
185	341526N	0775304	1	J D DILL	P	H	P		80		2	X					0	8	2	4	3	Kpd	Temp. 65°F.
186	341551N	0775311	1	M L BLAKE	P	H	P	D	87	79	4	X	17	6	*100		3		1	5	3	Kpd ?	

* Estimated. [1]pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
187	341525N	0775315	1	ALLENDALE DEV	P	U			29		1	T	21	11								TJ	
188	341526N	0775325	1	E C AKERS	P	H			70	43	2	X	15									Kpd	Flows
189	341519N	0775328	1	H C JOHNSTON	P	H			92		2	X	28	15								Kpd	
190	341438N	0775321	1	LEON SULLIVAN	P	P			129	42	3	X	38	16	100'							Tch-Kpd	
191	341432N	0775313	1	SANDRE - BASS	P	H			151	57	2	X	40	22								Tch-Kpd	
192	341431N	0775320	1	BECKERS BLDS	N	C	C		150	105	2	X	42		*40		5	7'	1	6	3	Kpd	Temp 67°F.
193	341405N	0775426	1	D L SNEEDEN	P	S			130	35	2	X	36	10								Tch-Kpd	
194	341402N	0775434	1	JOS FREEDLAND	P	A		D	89	72	4	X		12	*100							Tch-Kpd	
195	341405N	0775435	1	B W NEWKIRK	P	H		D	87	40		X		19	*60							Tch-Kpd	
196	341430N	0775448	1	BNAI ISR SYNAG	P	A		D	91	15		X	35	8	100	14						Tch-Kpd	
197	341411N	0775512	1	RUDOLPH KONIG	P	H		D	75	27	4	X					1		1	6	3	Tch-Kpd	
198	341441N	0775511	1	J FRED MURRAY	P	I		D	97	75	4	X	28	25	*100		5		1	5	3	Kpd	
199	341438N	0775515	1	R L DAVIS	P	I		G	90	34	2	X	28	24								Tch-Kpd	
200	341517N	0775544	1	SOUTHERN BOX	N	N	P		85		6	X	21	20	185				2	5		Kpd	
201	341507N	0775621	1	BOYLE ICE CO	N	C			65		8	X			650				2			Kpd	
202	341530N	0775651	1	HILTON PARK CO	M	U	P	G	1330		6	X	9		*50		5	8	8	5	8	Kpd ?	Temp 70°F., Br 31 ppm
203	341512N	0775653	1	HILTON PARK CO	N	U			80		10	X	10	6	400							Kpd	
204	341437N	0775636	1	INDEPENDENT ICE	N	U			120	75	12	X			325	6			2	6		Kpd	
205	341417N	0775616	1	COCA COLA BOTT	N	C	P		180		4	X	44	19	*80		2		1	5	3	Kpd	
206	341413N	0775618	1	WARDS FUNERAL	N	U		J	82		4	X	53									Tch-Kpd	
207	341407N	0775644	1	PEOPLES SAVINGS	N	A			86		6	X	38	31	100	12						Kpd	Fe bacteria rptd.
208	341407N	0775644	2	PEOPLES SAVINGS	N	A		D	122	108	8	G	38	44	96		2	8	2	4	3	Kpd	
209	341407N	0775644	3	PEOPLES SAVINGS	N	A	C	D	133	110	8	G	36	41	97	14						Kpd	
210	341430N	0775655	1	WILM COLD STOR	N	C		J	104		10	X	21	26								Kpd	

* Estimated. 'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
211	341412N	0775702	1	WACHOVIA BANK	N	U			80		6	X							3			Kpd	test well
212	341409N	0775738	1	USGS	F	U	P	G	93	91	1	T	4				5	7	3	6		Kpd	Auger hole #60
213	341403N	0775818	1	TERMINAL CITY	N	C			63		3	S	4	8	*6							Kpd	
214	341407N	0775609	1	ROSE ICE CO	N	C			96		6	X										Tch-Kpd	Cl rept 62 ppm in 1942
215	341407N	0775605	1	NEW HAN HIGH SC	C	P		D	122	50	6	X		18	165							Kpd	
216	341349N	0775637	1	5TH AVE BAPT CH	P	T		D	90	58	6	X	45	18	*35							Kpd	
217	341331N	0775646	1	BRIGADE BOYS CL.	P	T		J	115	40	4	X	47	42								Kpd	
218	341330N	0775522	1	PEPSI COLA BOTT	N	C		D	75	41	8	X	37	11	220	20	5		0	5	3	Tch-Kpd	
219	341324N	0775521	1	WHITEBROOK FARM	N	C					8	X	38		150							Tch-Kpd	rept. Cl 62 ppm, Hard. 210
220	341314N	0775442	1	ALBERT PERRY	P	I	P		163	58	3	X	35		*80		5		0	5	3	Tch-Kpd	
221	341327N	0775434	1	L B FINDERG	P	I			135		4	X			*100							Tch-Kpd	
222	341306N	0775356	1	R A YOPP	P	H		G	135	100	4	X	40	2								Kpd	
223	341329N	0775341	1	J D PRIDGEN	P	H			25	21	1	T	28	7	*10							TQ	
224	341302N	0775352	1	D E JOHNSON	P	H	P	G	140	50	2	X	38	9	*40		4		1	6	3	Tch-Kpd	
225	341243N	0775331	1	W S ARTHURS	P	H			98	58	2	X	42	10								Tch	
226	341337N	0775312	1	L J MINTZ	P	H		D	140	86	4	X	38	28	165		5		1	6	3	Kpd	
227	341416N	0775206	1	W D MCKEE	P	H		J	135	60	2	X	41									Tch-Kpd	
228	341337N	0775239	1	WILM COLLEGE	S	A	P	D	165	80	10	G		12	340	80	2	8	2	6	3	Tch-Kpd	temp 66°F
229	341330N	0775236	1	WILM COLLEGE	S	U		J	84		4	X	42									Tch	
230	341336N	0775232	1	WILM COLLEGE	S	A	P	D	180	80	10	G		7	360	50						Tch-Kpd	
231	341303N	0775236	1	M J PIERCE	P	H	P	D	170	80	2	X	42		*60		4		0	5	3	Tch-Kpd	
232	341255N	0775231	1	MRS EARL DIGGS	P	H			35	31	1	T	40	13			4		1	1	1	TQ	
233	341257N	0775252	1	ANDY MASON	P	H		G	159	76	2	X	*42									Tch-Kpd	
234	341233N	0775231	1	E R WILSON	P	H		D	163	82	4	X	41	30			3		1	5	3	Kpd	

* Estimated.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (GPM)	Drawdown (feet)	Quality of water Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
235	341236N	0775216	1	RUSSELL KEY	P	H		D	147	71	4	X	*35	15			3		0	5	3	Kpd	
236	341253N	0775211	1	EVA BERKLEY	P	H			160	78	2	X	39	16								Tch-Kpd	
237	341250N	0775203	1	LESTER ROBINSON	P	H			87	79	4	X		8	*35							Tch	
238	341251N	0775158	1	D W BENNETT	P	H		G	165	86	2	X	*32	16	*60		3		0	4	2	Kpd	
239	341244N	0775150	1	CAPE FEAR HOSP	P	T		J	154		6	X	34				2		2	5	3	Tch-Kpd	
240	341253N	0775148	1	B L FOWLER	P	H			146	70	2	X	34	14								Tch-Kpd	
241	341259N	0775139	1	L A BARNES	P	H			150	60	2	X	30	6	*30		1		0	5	3	Tch-Kpd	
242	341258N	0775134	1	R E HARRELL	P	H		G	159	64	2	X	30		75		3		1	5	3	Tch-Kpd	Obs. well
243	341257N	0775127	1	E C ORRELL	P	H		J	139	60	2	X	25									Tch-Kpd	
244	341321N	0775050	1	J P ELLINGTON	P	H	P	P	145	60	2	X	8	6			0	7'	2	5	4	Tch-Kpd	[illegible]
245	341246N	0775029	1	A B POWLASS	P	H			160	59	2	X	15	15								Tch-Kpd	
246	341314N	0774956	1	J J DENNING	P	H			170	120	2	X	24	16			2	6'	2	5	1	Kpd	
247	341240N	0774958	1	BRAD CK MARINA	N	C			178	65	8	X	21	17	500							Tch-Kpd	[illegible]
248	341246N	0774917	1	WSR BEANE	P	H			175	74	4	X		17								Tch-Kpd	
249	341318N	0774906	1	EARL MILLER	P	H	C		100	64	2	X	15	9				7'				Tch	
250	341316N	0774902	1	BABIES HOSPITAL	P	T		D	136	72	6	X		8	750							Tch	
251	341313N	0774859	1	BABIES HOSPITAL	P	T		D	107	62	6	X		8	650							Tch	
252	341308N	0774856	1	WATERWAY MOTEL	P	C		J	172		6	X	10									Tch-Kpd	
253	341248N	0774813	1	WRIGHTSVILLE BE	M	P	C		182	140	8		3	40	200							Kpd	
254	341253N	0774753	1	JOHN ANDERSON	P	U		GJ	169	128	2	X	5	15	60	15	3		2	5	4	Kpd	
255	341303N	0774717	1	WRIGHTSVILLE BE	M	P	C		179	163	10		8	40	150							Kpd	
256	341253N	0774730	1	WRIGHTSVILLE BE	M	P	C		176	146	10		10		150							Kpd	Has yielded [illegible]
257	341239N	0774736	1	WRIGHTSVILLE BE	M	P	C		193	156	8		10		140							Kpd	Tested at 450 gpm for 10 hrs.
258	341227N	0774749	1	WRIGHTSVILLE BE	M	P	C		180				6	35	175							Kpd	

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
259	341207N	0774804	1	WRIGHTSVILLE BE	M	P	C		180		8		6		175							Kpd	
260	341148N	0774813	1	WRIGHTSVILLE BE	M	P	C		178				10	30	175	23						Kpd	
261	341140N	0774820	1	WRIGHTSVILLE BE	M	U	P	GE	412			X	5									Kpd	Stratigraphic test
262	341118N	0774837	1	WRIGHTSVILLE BE	M	P	C		174	160	10		8	32	150	90						Kpd	
263	341135N	0775024	1	L M WALLACE	P	H		J	165		2	X	19	24								Tch-Kpd	
264	341216N	0775046	1	U R CARROLL	P	H	C	G	70	54	2	X	25	12			5	7'	1	5	3	Tch	
265	341216N	0775046	2	U R CARROLL	P	U	P		29	25	1	T	25	14			6		1	2	1	TQ	
266	341209N	0775114	1	M E ROGERS	P	H			150	80	2	X	18	12			4		1	5	3	Tch-Kpd	Temp. 66°F.
267	341209N	0775114	2	M E ROGERS	P	U			34	30	1	T	18	13								TQ	
268	341139N	0775114	1	DR W A PHILLIPS	P	S			110	45	2	X										Tch	
269	341222N	0775134	1	A H HARRELL	P	H			100	70	2	X		16								Tch	
270	341217N	0775136	1	J O PETTET	P	H			100	72	2	X	18	8								Tch	
271	341215N	0775144	1	W H RIVENBARK	P	H			100	70	2	X	23	10								Tch	
272	341201N	0775146	1	W S SLATER	P	H			140	70	2	X	14	2								Tch-Kpd	
273	341215N	0775149	1	A M FOSTER	P	H			100	73	2	X	21									Tch	
274	341221N	0775157	1	V K PAINTER	P	H		J	134		2	X	26									Tch-Kpd	
275	341202N	0775151	1	ROBERT MEADOWS	P	H			85	63	2	X	15	3				7'				Tch	
276	341135N	0775202	1	RAY HOLLAND	P	H	P		177	80	2	X	12	12			1	7'	2	5	4	Tch-Kpd	Flows 1-6 gpm
277	341200N	0775227	1	W GRANEY	P	H		J	149	130	2	X	27	8								Kpd	
278	341202N	0775309	1	JACK ROGERS	P	H	P	G	162	81	2	X	44				3		0	5	3	Tch-Kpd	
279	341223N	0775403	1	GILBERT PARRISH	P	H			150	110	2	X	45	21								Kpd	
280	341227N	0775408	1	W F ELMORE	P	H		G	150		2	X	48	11								Tch-Kpd	
281	341231N	0775412	1	R P BROWN	P	H	C		140	100?	2	X	41					7'				Tch-Kpd	Temp. 65°F
282	341245N	0775412	1	W F ANDERSON	P	H			140		2	X	41	21								Tch-Kpd	

[1]pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Pumping level	Quality of water: Iron	Fl	Cl	Hardness	Sp. Cond.	Water-bearing unit
283	341238N	0775452	1	DR S V ALLEN	P	I	P		19	16	1	T			*15		7		2	2	2	PQ
284	341234N	0775502	1	W D BEERY III	P	I			155		6	X	33									Kpd
285	341230N	0775450	1	MR STALLWORTH	P	H			158	66	3	X	45	29	*100							Kpd
286	341206N	0775457	1	C R DRINDELL	P	H			160	60	2	X	55	46	*20							Tch-Kpd
287	341238N	0775547	1	GEORGE LAMICA	P	H	C		30	24	2	X	22				2	7'	0	4	2	Tch
288	341220N	0775553	1	JOHN W DIXON JR	P	H	C		110	90	2	X	*7	1			1	8'	0	1	2	Kpd
289	341220N	0775613	1	LEE E MORROW	P	H			26	22	1	T	10	3								PQ
290	341207N	0775630	1	SUNSET PK METH	P	T		D	82		8	X	19	15								Kpd
291	341202N	0775638	1	SUNSET CO 3	N	U	P		140		6	G			132				2	3		Kpd
292	341214N	0775639	1	SUNSET CO 4	N	U			140		6	G			150	18						Kpd
293	341210N	0775654	1	BILL CANNON	P	U			20	16	1	T	23	11								PQ
294	341146N	0775703	1	WILM SHIPYARD	F	C		D	123	70	10	G		20	275	58						Kpd
295	341141N	0775703	1	WILM SHIPYARD	F	U	P							13								Kpd
296	341132N	0775702	1	WILM SHIPYARD	F	A	P		103	81	10	G		28	300	18	1	8	1	3	2	Kpd
297	341126N	0775708	1	SHELL OIL CO	N	C	P		76	36	8	X		6	*325	6	7	7	2	4		Kpd
298	341125N	0775630	1	WECT TV	N	A			133	55	4	X	52	26	100'							Tch-Kpd
299	341127N	0775609	1	MOFFIT VILLAGE	N	P		G	175		10		43	9	110	17						Tch-Kpd ?
300	341138N	0775608	1	L W CARROLL	P	H			57	44	4	X	*30	14			7		0	1	2	Tch
301	341120N	0775555	1	NATL YOUTH ASSN	P	U		D			6		56	24								Tch-Kpd
302	341112N	0775559	1	HANOVER MILLS	N	N			157	79	8	X	57	30	*100	17		8	1			Tch-Kpd
303	341058N	0775555	1	H B LUDLUM	P	H		G	140	76	2	X	56	17								Tch-Kpd
304	341134N	0775406	1	J R KUTRON	P	H	P		160	60	2	X	40		*40		5		0	5	3	Tch-Kpd
305	341139N	0775357	1	H M DANIELS	P	H	P		160		4	X	48		100'		6		0	6	3	Tch-Kpd
306	341124N	0775357	1	FRED CONNER	P	H	P		160	60	3	X	50	19			5		0	6	3	Tch-Kpd

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
307	341107N	0775406	1	G L KEIFER	P	H		J	146		2	X	39	14								Tch-Kpd	
308	341115N	0775340	1	S FOREST JR	P	H	C		150	79	2	X	50	21			3	7'	0	5	3	Tch-Kpd	H_2S odor
309	341114N	0775334	1	W H DANNERMAN	P	H	C		80	70	2	X	50	18	*17		3	7'	0	5	3	Tch	
310	341113N	0775331	1	MARGARET JONES	P	H	P		170	94	2	X	50	27	*60							Tch-Kpd	
311	341116N	0775316	1	J D MCFAYDEN	P	H			170	84	2	X	*51	18								Tch-Kpd	
312	341110N	0775318	1	D W NOBLES	P	H		J	154		2	X	50		*40							Tch-Kpd	
313	341103N	0775318	1	J M GAITHER	P	H		G	170	89	2	X	50	29								Tch-Kpd	
314	341045N	0775142	1	PARSLEY ESTATE	P	U			158		4	X	28	23								Tch-Kpd	
315	341103N	0775137	1	HERMAN WALTON	P	C	P		62		2	X	15	4	*80		5		1	5	4	Tch	
316	341101N	0775042	1	W R MALOTT	P	H	C		163	125	3	X	*12	9	*100		2	8'	2	5	4	Kpd	Partial [illegible]
317	341052N	0775036	1	H V REID	P	H	C	D	94	90	4	X	12	10	100		5	8	2	6	4	Tch	
318	341042N	0775043	1	A D HURST	P	H	P		44		1	T	12	11			3		1	6	3	TQ	
319	341040N	0775044	1	A D HURST	P	U			66		2	X	15	13								TQ	
320	341030N	0775054	1	JAMES FERGER	P	I	P		185		2	X	*21		*60		2		2	5	4	Tch-Kpd	H_2S odor
321	341000N	0775105	1	C H MCALLISTER	P	I	P		144	85	3	X		10			2		1	6	4	Tch-Kpd	
322	340938N	0775119	1	R E JULIAN	P	H	P		150	85	2	X		30			4		1	5	4	Tch-Kpd	
323	340935N	0775134	1	B F SUTHERLAND	P	H	P	D	124	86	6	X		18			2		1	5	4	Tch-Kpd	
324	340950N	0775146	1	R C FOWLER	P	H			80	72	2	X		22								Tch	
325	340939N	0775155	1	A B JENKINS	P	H			100	70	2	X		15								Tch	
326	340926N	0775152	1	H H HODGIN	P	H	P		140	105	2	X	*18	19			5		1	5	3	Tch	
327	340914N	0775212	1	M EMMART JR	P	H	P		140		2	X		20			0		1	5	3	Tch	
328	340954N	0775235	1	W J HODDER	P	U			175		2			6								Tch-Kpd	
329	340958N	0775239	1	W J HODDER	P	I		J	170		4	X	24	14								Tch-Kpd	Obs well
330	341018N	0775320	1	M R SOMERSETT	P	H			160	84	2	X	44	17								Tch-Kpd	

* Estimated. [1]pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water Iron	Fl	Ca	Hardness	Sp. Cond.	Water-bearing unit	Remarks
331	341012N	0775320	1	A L TODD	P	H	C		100		2	X						7'				Tch	Temp. 66°F
332	341025N	0775520	1	W J LANGLEY	P	P	P		117		2	X	30		60'		4		0	5	2	Tch-Kpd	
333	341037N	0775528	1	ONIETA DAVIS	P	H	P		120		2	X					4		0	4	2	Tch-Kpd	
334	341034N	0775539	1	E J BELLAMY	P	H		J	108		2	X	30	12								Tch-Kpd	
335	341036N	0775607	1	TENNY ENGINEERS	N	N	P	D	120	104	6	X		9	226		2	8'	2	4	2	Kpd	Temp. 67°F.
336	341037N	0775611	1	TENNY ENGINEERS	N	N		D	122		6	X		11								Kpd	
337	341030N	0775619	1	USGS	F	U		G	38	36	1	T	36									TQ	Obs. well, auger hole 619
338	341015N	0775654	1	STACKHOUSE INC	N	N	P		135		4	X					1		2	4	3	Kpd	H_2S odor
339	341006N	0775519	1	ECHO DAIRY	P	C	P		160	70	6	X			150		4		1	5	3	Kpd	
340	340940N	0775522	1	ECHO DAIRY	P	H	P		160	70	4	X		10	100'		2	7'	2	4	3	Kpd	Temp. 67°F.
341	340939N	0775533	1	ECHO DAIRY	P	I	P		48		10	X	3	15			0	8	2	4	3	Kpd	Flows
342	340909N	0772620	1	ALLIED KENNECOT	N	U	P	GJE	142		10	G	17	13	600				2			Kpd-TQ	
343	340909N	0775628	1	ALLIED KENNECOT	N	N	C	J	151		8	S	12	6	60	15		8'	3			Kpd	Obs. well, Temp. 67°F.
344	340907N	0775440	1	G H COOK	P	H	P		132	72	2	X	10	1			0		2	4	3	Kpd	
345	340905N	0775406	1	J A EDWARDS	P	H	P		30		1	T	22				6	6'	1	1		TQ	Temp. 65°F.
346	340905N	0775406	2	J A EDWARDS	P	I	P		62		1	T	22				7	7'	1	6		TQ	
347	340905N	0775406	3	USGS	F	U	C	GJE	630		6	X	22									Kpd	Test well
348	340905N	0775413	1	W I MILLER	P	U			35		1	T	23	8								TQ	
349	340902N	0775410	1	J A EDWARDS	P	H	C		165	130	4	X	23	14			1	8'	2	4	3	Kpd	
350	340842N	0775426	1	HUGH NOFTSINGER	P	H	P		37	33	2	T	*20	8	8		5		0	1	0	TQ	Much H_2S
351	340829N	0775344	1	MR PRESLEY	P	P		D	161	74	4	X	20	7	250							Tch-Kpd	
352	340802N	0775351	1	N W DIRKINS	P	H		G	130	112	2	X	36	21	*15		4		0	4	2	Kpd	
353	340802N	0775351	2	N W DIRKINS	P	U			18		1	T	36	11								TQ	
354	340811N	0775334	1	W E HARRIS	P	H	P		140	92	2	X	37	16	*50		4		0	4	2	Tch-Kpd	

* Estimated. [1]pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp.Cond.	Water-bearing unit	Remarks
355	340803N	0775337	1	GEO W JAMES	P	H			155	107	2	X	42	20								Teh-Kpd	
356	340807N	0775246	1	OTTIE SULLIVAN	P	H	P		200+		4	X	28	16			2		1	6	3	Teh-Kpd	
357	340815N	0775243	1	FERGER NURSERY	P	C	P		57		2	T	28	11			6		1	6	4	TQ	
358	340825N	0775236	1	H S EMMART	P	H			50		1	T	29	17								TQ	
359	340803N	0775234	1	W G SUTHERLAND	P	U			18	16	1	T	26	6								TQ	High Fe rept.
360	340800N	0775234	1	USGS	F	U		GJ	161	159	2	T	26	15								Kpd	Obs. well, auger hole 125
361	340756N	0775203	1	H K LOUGHLIN	P	C	P	D	185	119	4	X	5	6	50	7			3	6	5	Teh-Kpd	
362	340755N	0775209	1	JOHN HINEBUCKLE	P	H	C		135	115	2	X	10	4	5	19		7'				Teh	
363	340730N	0775210	1	T E RUSS	P	U			150	75	1	X	5	13								Teh	
364	340745N	0775238	1	C K JOHNSON	P	U			85		2	X	23	14								TQ	
365	340733N	0775212	1	JULIAN GRISSOM	P	H	P	D	125	120	4	X	5		50'		3		0	5	3	Teh	Flows
366	340727N	0775246	1	W T BRYAN	P	H	P		148	116	2	X		18								Teh	
367	340710N	0775243	1	ROBERT B LONG	P	H	P		137		1	X		15			2		0	3	2	Teh	
368	340732N	0775423	1	USGS	F	U	P		65	63	1	T	38	15			2	8'	0	3	2	TQ	
369	340720N	0775352	1	MR ROLLER	P	H			121	85	2	X	40	26								Teh	H_2S odor
370	340716N	0775354	1	A E ROLLER	P	H			140	123	2	X	34									Kpd	
371	340714N	0775356	1	R H DINGLER JR	P	H	C		119	104	2	X	40	15				8'				Teh	
372	340638N	0775258	1	HAMP BOWEN	P	H	C	G	147	126	2	X	28	18				7'				Teh-Kpd	Temp. 66°F.
373	340630N	0775308	1	PAUL GRIFFIN	P	H	P	D	135	122	4	X	28	18	100		5		0	5	2	Teh	
374	340622N	0775312	1	C L BOWDEN	P	H	P		112	100	2	X	22	9			1	8'	0	5	2	Teh	
375	340622N	0775312	2	C L BOWDEN	P	U	P		17		1	T	22	7			7	6	2	1	1	TQ	
376	340624N	0775357	1	J L ENGLISH	P	C	P		23	20	1	T	40	4	10		5		0	1	0	TQ	H_2S odor
377	340614N	0775403	1	K L KYE	P	U		J	173		2	X	35	14								Teh-Kpd	
378	340611N	0775403	1	W H BLACKLEDGE	P	C	P		25		1	T	31				1		0	0	0	TQ	

'pH measured in field.

Table 5.--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
379	340530N	0775346	1	LEE DAVIS	P	H	P		133	105	4	X	26	15	*200		0		1	4	2	Tch	
380	340528N	0775346	1	LEE DAVIS	P	U			17		1	T	24	6			2		2	3	3	TQ	
381	340530N	0775325	1	H H HARWARD	P	I	C	D	75	52	1	X	26	14	100							TQ	
382	340527N	0775327	1	C K STALLINGS	P	H		D	70	58	4	X	22									TQ	
383	340447N	0775347	1	ALFRED MITCHELL	P	H	C		132	91	2	X	22	12	*20		0	9'	1	4	2	Tch	
384	340420N	0775325	1	A H GOODSON	P	H			140	113	2	X	11	15								Tch	
385	340421N	0775340	1	W L BURNETT SR	P	H	P		90		2	X	15		30'		6		0	3	2	Tch	
386	340416N	0775342	1	G T FOWLER	P	U			29	26	1	T	15	6								TQ	High Fe reported
387	340342N	0775332	1	RICHARD DAILY	P	C			55		1		6	2								TQ	
388	340340N	0775330	1	RICHARD DAILY	P	C	C	G	150	119	2	X	6	2	*20		0	7'	1	5	3	Tch	
389	340340N	0775359	1	A FREEMAN	P	U		J	104		2	X	22	14								Tch	
390	340336N	0775454	1	USGS	P	U	C	G	49	47	1	T	16	6			2	7'	0	2	1	TQ	Obs. well, [illegible]
391	340310N	0775404	1	MCMEEKIN CONST	N	U			105	104	2	X	19	8	*30							TQ	
392	340317N	0775347	1	OCEAN REALTY	N	H		J	80		[illegible]	X	9	4								TQ	
393	340218N	0775355	1	V MARTIN	P	U		J	143		2	X	16	21								Tch	
394	340213N	0775419	1	R E WEEKS	P	H		J	167	159	2	X	26	38								Tch	
395	340210N	0775350	1	CAROLINA BEACH	N	P	C	[illegible]	201	96	8	X										Tch	
396	340159N	0775351	1	CAROLINA BEACH	N	P	C		195	125	8	X										Tch	
397	340158N	0775437	1	CAROLINA BEACH	N	P	C		161		8	X		27	150	30						Tch	
398	340151N	0775411	1	CAROLINA BEACH	N	P	C		189		10	X		23	150	50						Tch	
399	340147N	0775357	1	CAROLINA BEACH	N	P	C		195	125	8	X			300							Tch	
400	340143N	0775343	1	CAROLINA BEACH	N	P	C		180	125	8	X										Tch	
401	340136N	0775344	1	GRAHAM HARWARD	P	H		J	140		4	X	8	16								Tch	
402	340109N	0775412	1	WILMINGTON BCH	N	P	P		147	90	10	X			80'		2		2	7	4	Tch	

* Estimated. 'pH measured in field.

Table 5 .--Records of wells in New Hanover County, N. C.--Continued

Well No.	Well location Lat	Well location Long	Sequence No.	Owner	Ownership	Use of water	QW analysis	Log data	Depth (feet)	Depth cased (feet)	Diameter (in)	Finish	Altitude of LSD (feet)	Water level (feet below LSD)	Yield (gpm)	Drawdown (feet)	Quality of water: Iron	pH	Cl	Hardness	Sp. Cond.	Water-bearing unit	Remarks
403	340145N	0775414	1	WILMINGTON BCH	N	P	P		153	90	10	X			100[1]							Tch	
404	340123N	0775418	1	INTERNATL NICKE	N	U		J	126		1	X	18	23								Tch	Salty water rept
405	340110N	0775421	1	KURE BEACH	M	P	C		202	115	8	X	17	26	265		3		2	7	4	Tch	
406	340122N	0775501	1	ETHYL DOW	N	U	C	J	158		6	X	18		150			8				Tch	Obs well
407	335941N	0775435	1	KURE BEACH	M	P	C	GJ	180	120	8	X	17	21	170	30			2	6	3	Tch	Temp. 67°F.
408	335933N	0775433	1	JAMES TEETER	P	U			15		1	T	14	11								TQ	
409	335913N	0775506	1	701ST RADAR SQ	F	A	C	D	150	109	4	X			*35							Tch	
410	335850N	0775503	1	701ST RADAR SQ	F	A	C	D	201	112	10	X	21	21	250		3		3	6	4	Tch	
411	335849N	0775506	1	701ST RADAR SQ	F	P	C		172	150	10	X			250							Tch	
412	335735N	0775628	1	FT FISHER FERRY	S	P	C	D	170		6	X	10	12	30	10						Tch	

* Estimated. [1]pH measured in field.

Explanation of Quality of Water Code

Constituent	Range (mg/l)	Code Number
Iron	0.00-0.05	0
Do	0.06-0.1	1
Do	0.11-0.30	2
Do	0.31-0.50	3
Do	0.51-1.0	4
Do	1.1 -3.0	5
Do	3.1 -5.0	6
Do	5.1 -10	7
Do	11 -15	8
Do	More than 15	9
pH	4.0 -4.9	4
Do	5.0 -5.9	5
Do	6.0 -6.9	6
Do	7.0 -7.0	7
Do	8.0 -8.9	8
Chloride	0 -10	0
Do	11 -25	1

Constituent	Range (mg/l)	Code Number
Chloride	26-100	2
Do	101-250	3
Do	251-500	4
Do	501-1000	5
Do	1001-2000	6
Do	2001-5000	7
Do	5001-20,000	8
Hardness	0-10	0
Do	11-20	1
Do	21-50	2
Do	51-100	3
Do	101-150	4
Do	151-200	5
Do	201-300	6
Do	301-500	7

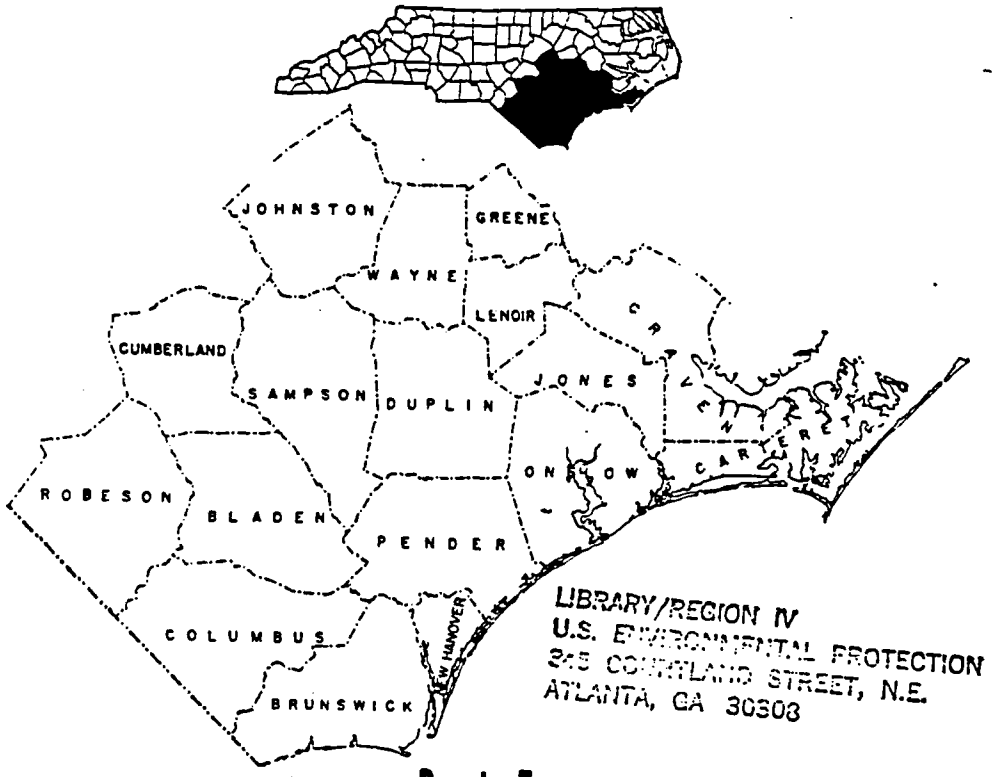
Characteristic	Range (Micromhos)	Code Number
Sp. Cond.	0-50	0
Do	51-150	1
Do	151-300	2
Do	301-500	3
Do	501-1000	4
Do	1001-2000	5
Do	2001-5000	6
Do	5001-10,000	7
Do	10,001-20,000	8

REFERENCE 24

NCA00255

STATE OF NORTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT

PUBLIC WATER SUPPLIES OF NORTH CAROLINA



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Part 5
SOUTHERN COASTAL PLAIN

By

T. M. Robison and L. T. Mann, Jr.

Prepared by
United States Department of the Interior
Geological Survey
In Cooperation with the
North Carolina Department of Natural Resources and Community Development

Raleigh, N.C
JULY 1977

NEW HANOVER COUNTY

WATER-RESOURCES APPRAISAL

New Hanover County is in the southeastern part of the North Carolina Coastal Plain. The topography is flat and low with many swampy areas. The western and northern parts of the county are drained by the Cape Fear River and its tributaries. This river also forms the western boundary of the county. The Cape Fear River and its major tributaries are estuarine and salty in the county. The eastern part of the county is drained by streams that flow to the Atlantic Ocean, which forms the eastern boundary of the county. The average discharge of streams in the county is 1.0 (Mgal/d)/mi^2. Minimum flow and 7-day, 2-year low flow data are not available for the county. However, streams with drainage areas up to 10 square miles have been observed to go dry. Four public water supplies in the county have 500 or more customers: Wilmington, Carolina Beach, Wrightsville Beach, and Kings Grant. All of these supplies, except that of Wilmington, are from ground water. In addition, smaller public and individual water supplies and large industrial water supplies are obtained from ground water in the county. The county population in 1970 was 82,996.

The county is underlain by sedimentary deposits that thicken in a southeasterly direction. The upper sandy aquifer averages only about 50 feet in thickness. Except for a small area in northwest New Hanover County, the upper sandy aquifer is underlain by the limestone aquifer. Where present the limestone aquifer is about 50 feet thick in the northern part of the county and reaches a thickness of over 150 feet in the southern part of the county. Even where this highly-permeable aquifer is thin, well yields of a few hundred gallons per minute are obtainable. Where it is thickest, well yields of over 1,000 gal/min can be obtained. The limestone aquifer is underlain by the lower sandy aquifer. The lower sandy aquifer is about 1,000 feet thick in the northwestern part of the county increasing to about 1,300 feet in thickness in the southeast. However, the fresh-water part of the aquifer is relatively thin. The occurrence of salt water in New Hanover County is erratic, especially in the coastal areas and off-shore strands. The lower sandy aquifer might be able to produce a few hundred gallons per minute to wells at some places in these areas, but lower yields would be more prudent in order to avoid salt-water encroachment. The same statement would apply to the limestone aquifer in the coastal areas. There is an isolated occurrence of salt water in the extreme northwest corner of the county where the depth to salt water can be less than 200 feet. In this area, the lower sandy aquifer might yield only 100 gal/min of fresh water to wells. The maximum ground-water yield in the county is estimated at 1.0 (Mgal/d)/mi^2. The ground water is usually hard and may contain excessive iron or hydrogen sulfide.

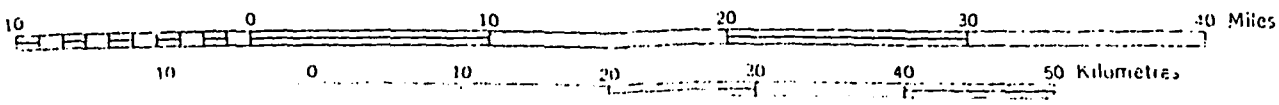
REFERENCE 25

GEOLOGIC MAP OF NORTH CAROLINA

1985

Scale 1:500,000

1 inch equals approximately 8 miles



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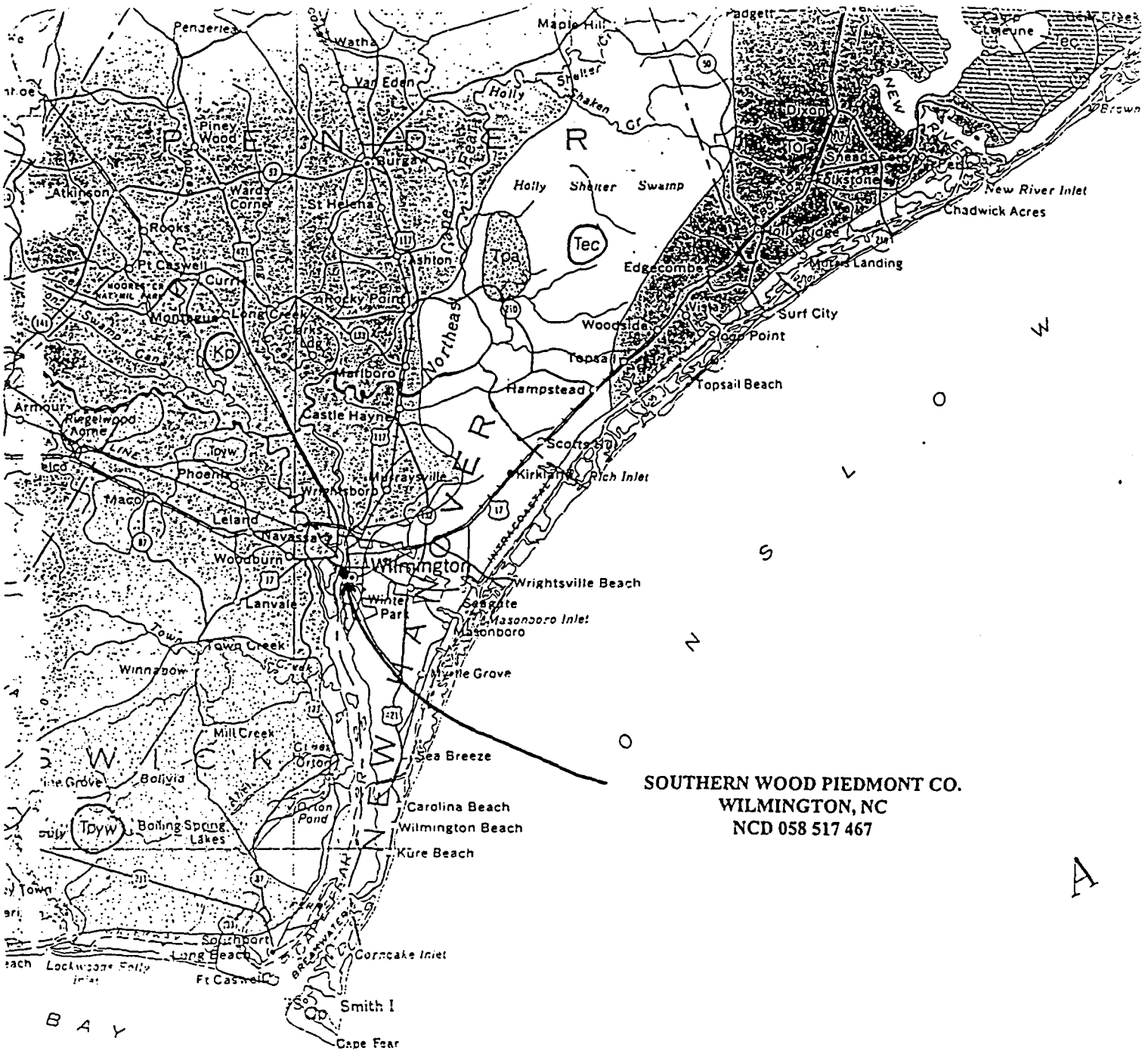
Penderlea
Watha
Maple Hill
Padgett
Camp Lejeune
Van Eden
Holly
Shelter
Shaken Cr
Piney Wood
Burgaw
Holly Shelter Swamp
Dixon
Atkinson
Wards Corner
St Helena
Rocks
Pt Caswell
Curry
Ashton
Tec
Tpa
Edgecombe
New River Inlet
Chadwick Acres
Holly Ridge
Morris Landing
Surf City
Rocky Point
Long Creek
Clarks Ldg
Montreuil
Kp
Woodside
Topsail
Hampstead
Topsail Beach
Marlboro
Northeast Cape Fear R
Armour
Ringgelwood
Acme
Castle Hayne
Scotts Hill
Toyw
Phoenix
Kirkland
Rich Inlet
Maco
Wrightsboro
Murraysville
Leland
Navassa
Woodburn
Wilmington
Wrightsville Beach
Lanvale
Winter Park
Seagate
Masonboro Inlet
Masonboro
Town Creek
Winnabow
Myrtle Grove
Mill Creek
Orton
Sea Breeze
Bolivia
Carolina Beach
Orton Pond
Wilmington Beach
Boiling Spring Lakes
Kure Beach
Southport
Long Beach
Corncake Inlet
Lockwoods Folly Inlet
Ft Caswell
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Cape Fear
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SOUTHERN WOOD PIEDMONT CO.
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NCD 058 517 467

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COASTAL PLAIN

QUATERNARY

Qp — SURFICIAL DEPOSITS, UNDIVIDED — Sand, clay, gravel, and peat deposited in marine, fluvial, eolian, and lacustrine environments. Quaternary deposits not shown at altitudes greater than approximately 25 feet above mean sea level (Suffolk Scarp, in part)

TERTIARY

Tp — PINEHURST FORMATION — Sand, medium- to coarse-grained, cross-bedding and rhythmic bands of clayey sand common, unconsolidated

Tt — TERRACE DEPOSITS AND UPLAND SEDIMENT — Gravel, clayey sand, and sand, minor iron-oxide cemented sandstone

Tpyw — WACCAMAW FORMATION — Fossiliferous sand with silt and clay, bluish-gray to tan, loosely consolidated. Straddles Pleistocene-Pliocene boundary

Tpy — YORKTOWN FORMATION AND DUPLIN FORMATION, UNDIVIDED

Yorktown Formation: Fossiliferous clay with varying amounts of fine-grained sand, bluish gray, shell material commonly concentrated in lenses; mainly in area north of Neuse River

Duplin Formation: Shelly, medium- to coarse-grained sand, sandy marl, and limestone, bluish gray; mainly in area south of Neuse River

Tob — BELGRADE FORMATION, UNDIVIDED

Pollocksville Member: Cyster-shell mounds in tan to orange sand matrix, indurated locally

Haywood Landing Member: Fossiliferous clayey sand, gray to brown. Members grade into each other laterally

Tor — RIVER BEND FORMATION — Limestone, calcarenite overlain by and intercalated with indurated, sandy, molluscan-mold limestone

CASTLE HAYNE FORMATION

Tecs — Spring Garden Member: Molluscan-mold limestone, indurated, very sandy. Grades downward into a calcareous sand and laterally into Comfort Member

Tec — Comfort Member and New Hanover Member, undivided

Comfort Member: Bryozoan-echinoid skeletal limestone, locally dolomitized, solution cavities common

New Hanover Member: Phosphate-pebble conglomerate, micritic, thin; restricted to basal part of Castle Hayne Formation in southeastern counties

Tpa — BEAUFORT FORMATION, UNDIVIDED

Unnamed upper member: Sand and silty clay, glauconitic, fossiliferous, and locally calcareous

Jericho Run Member: Siliceous mudstone with sandstone lenses, thin bedded; basal phosphatic pebble conglomerate

CRETACEOUS

Kp — PEEDEE FORMATION — Sand, clayey sand, and clay, greenish gray to olive black, massive, glauconitic, locally fossiliferous and calcareous. Patches of sandy molluscan-mold limestone in upper part

Kb — BLACK CREEK FORMATION — Clay, gray to black, lignitic; contains thin beds and laminae of fine-grained micaceous sand and thick lenses of cross-bedded sand. Glauconitic, fossiliferous clayey sand lenses in upper part

Km — MIDDENDORF FORMATION — Sand, sandstone, and mudstone, gray to pale gray with an orange cast, mottled, clay balls and iron-cemented concretions common, beds laterally discontinous, cross-bedding common

Kc — CAPE FEAR FORMATION — Sandstone and sandy mudstone, yellowish gray to bluish gray, mottled red to yellowish orange, indurated, graded and laterally continuous bedding, blocky clay, faint cross-bedding, feldspar and mica common

1. A
2. I
3. E
4. E
5. E
6. D
7. D
8. Fa
9. Fu
10. Fu
11. Fu
12. Fu
13. Fu
14. Fu
15. Gl

REFERENCE 26

Ref. 26

The Geology of the Carolinas

Carolina Geological Society Fiftieth Anniversary Volume

Edited by J. Wright Horton, Jr., and Victor A. Zullo

The University of Tennessee Press KNOXVILLE

REFERENCE 27

Ref. 27

LAW ENVIRONMENTAL, INC.

112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

November 27, 1985

Southern Wood Piedmont Company
P. O. Box 5447
Spartanburg, South Carolina 29301

Attention: Mr. Mike Pruett

Subject: Monitoring Well Installation and Hydrogeologic Report
Wilmington, North Carolina Plant
LES Project No. HA-5276

Dear Mr. Pruett:

Law Environmental, Inc. is pleased to submit the attached report of Monitoring Well Installation and Hydrogeologic Assessment at your Wilmington, North Carolina facility. The work for this report was outlined in the Law Environmental proposal No. LE5021.41 on June 17, which was revised on August 13, 1985.

This report includes the following:

- Introduction
- Well Installation
- Geologic Conditions
- Water Levels and Ground-Water Flow Directions
- Rate of Ground-Water Flow

We appreciate this opportunity to provide Southern Wood Piedmont with our services. Please do not hesitate to contact us if you have any questions.

Sincerely,

John T. Bradburne
Site Field Geologist

Stephen E. Blevins, P.E.
Project Manager

JTB/SEB/cl

cc: Mr. T. M. Davis

TABLE OF CONTENTS

1.0 INTRODUCTION

2.0 WELL INSTALLATION

3.0 GEOLOGIC CONDITIONS

3.1 Regional Geology
3.2 Site Geology

4.0 WATER LEVELS AND GROUND-WATER FLOW DIRECTIONS

5.0 RATE OF GROUND-WATER FLOW

5.1 Hydraulic Conductivity Test Results
5.2 Ground-Water Flow Velocities

6.0 REFERENCES

TABLES

Table 1 - Monitoring Well Construction Data

Table 2 - Ground-Water Level Data Summary

Table 3 - Hydraulic Conductivity Summary

FIGURES

Figure 1 - Site Location Map

Figure 2 - Monitoring Well and Cross Section Location Map

Figure 3 - Type III Well Construction Diagram

Figure 4 - Hydrogeologic Cross Sections A-A' and B-B'

Figure 5 - Ground-Water Elevations - September 19, 1985

APPENDIX

Test Boring Records

1.0 INTRODUCTION

Law Environmental Services (LES) has completed the installation of four ground-water monitoring wells at the Southern Wood Piedmont (SWP) Wilmington, North Carolina facility (Figure 1). These wells were installed between September 5 and 10, 1985 in accordance with the LES revised proposal of August 13, 1985, proposal No. LE5021.41. The wells were installed around the limits of the land farming area (Figure 2) and are designated MW-6 through MW-9. Hydraulic conductivity tests were performed in the four wells on September 10 and 11, 1985. Ground-water levels were recorded in all facility wells on September 19, 1985. Surveying of all site wells was completed on September 27, 1985 by Robert H. Goslee and Associates.

This report documents well installation, geologic conditions, hydrogeologic conditions (including ground-water flow rates and directions) and hydraulic conductivity test data results.

2.0 WELL INSTALLATION

The four wells were installed as Type III wells to avoid carrying potential surficial contamination down into the zone of interest while drilling (Figure 3). All four wells were drilled by a licensed North Carolina well driller employed by Law Engineering Testing Company. Specific information concerning soil conditions encountered during well installation and a graphic presentation of placement of well screens, sand pack, bentonite seals, grout, and casing are contained on the Test Boring Records in the Appendix. Table 1 presents a summary of construction data for the four monitoring wells.

Monitoring well MW-6 was installed at the northeast corner of the land farming area to address ground-water conditions within the uppermost aquifer upgradient of the area. Monitoring wells MW-7, MW-8 and MW-9 were installed at the west, southwest and southern boundaries of the land farming area (respectively) to monitor ground-water conditions downgradient of this area in the uppermost aquifer. Locations of all site wells are shown on Figure 2.

Installation and development of the Type III monitoring wells proceeded in accordance with the following steps:

1. All down-hole equipment was steam cleaned prior to drilling each hole.

2. A borehole of 10-inch diameter was advanced with wash drilling techniques using a mixture of potable water and bentonite as a drilling fluid. Split-spoon samples were obtained at 2.5-foot intervals to a depth of 10 feet where samples were obtained every five feet thereafter,

or more frequently as required to adequately describe subsurface lithology. The split spoon was washed between each sample with a phosphate-free soap and rinsed with potable water.

3. Threaded 6-inch diameter schedule 40 PVC casing was placed in the 10-inch borehole and grouted in place. Grout consisted of approximately 5 to 8 gallons of water and 1 to 3 pounds of bentonite for each 94-pound sack of Portland cement.

4. After the grout used to seal the outer casing had set, the borehole was extended beyond the bottom of the outer casing using a 5 7/8-inch tricone roller bit and wash drilling techniques. A bentonite and potable water mixture was used as drilling fluid.

5. The borehole was then flushed with a "new" bentonite and potable water mixture (low viscosity). A 10-foot section of 0.010-inch machine-slotted, schedule 40 PVC screen and schedule 40 PVC riser pipe was then installed. A bottom cap and vented top cap were installed. Centralizers were used around the well screen. Only threaded, 2-inch diameter PVC well pipe (no glue) was used.

6. Clean concrete sand backfill was placed around each well screen to a level approximately 2 feet above the top of the well screen. Concrete sand has proven to provide a satisfactory filter between sandy or silty soils and the 0.010-inch slot screen in numerous monitoring wells installed in the Coastal Plain of North Carolina.

7. A bentonite clay seal 2-feet thick was installed at the top of the sand pack by pouring bentonite pellets around the riser pipe and packing with a stainless steel rod.

8. The annulus between the riser pipe and outer casing was grouted. Grout was pumped through a hose extending to the top of the clay seal. The hose was removed as the grout level rose to the surface.

9. A 4-inch diameter steel outer protective casing having a cover and lock was firmly grouted in place at the ground surface.

10. Each well was developed by pumping water from the well until reasonably clear water was withdrawn and pH measurements stabilized. A 1 1/4-inch diameter threaded PVC pipe having a one-way valve on the bottom was inserted into the well and a gasoline powered surface pump with a suction hose inserted into the 1 1/4-inch PVC pipe were used to remove water from the well.

In addition to well installation, the four temporary cased post holes installed in July 1985 for ground water elevation measurements around the limits of the land farming area were grouted and the casings pulled. The grout mixture consisted of approximately 5 to 6 gallons of water and 1 to 3 pounds of bentonite for each 94-pound sack of Portland cement.

3.0 GEOLOGIC CONDITIONS

3.1 Regional Geology

The Southern Wood Piedmont Wilmington, North Carolina facility is located in the Coastal Plain physiographic province. The site is situated on undifferentiated Post-Miocene surficial sands directly overlying sediments of the Upper Cretaceous Peedee geologic formation (Berry 1949).

The surficial soils in the site area typically consist of 5 to 60-feet of fine sands. The sands are tan to white in the well-drained upland areas, while they are brown to black and may contain several feet of organics in low lying or poorly-drained areas. The soils have been eroded and redeposited many times, resulting in buried stream channels, swamps and marsh areas, often containing soft organic silts, clays and peat.

Sediments of the Peedee formation typically range from 650 to 700 feet in thickness. The Peedee soils generally consist of dense to very dense sand with zones of cemented sands and impure limestones. The sands have a characteristic salt and pepper appearance and the Peedee formation is considered a major aquifer in this area.

3.2 Site Geology

Subsurface soil conditions encountered at each of the four boring locations were very similar. Soil conditions are presented on the Test Boring Records in the Appendix and shown graphically on the hydrogeologic cross-sections of Figure 4. The cross-section locations are shown on Figure 2.

A fill material was encountered from 0.5 to 0.7 feet below the ground-surface. This material consisted of a dark brown and black silty fine to medium sand with cinders and occasional coarse sand. The fill material encountered at monitoring well location MW-6 was primarily cinders.

Below the fill, a dark to light brownish-gray/grayish-brown fine to medium sand with traces of silt occurs to depths of 10 to 12.5 feet. This fine sand unit is found to be overlying a dark brown peat and organic silt layer with varying amounts of wood and root fragments.

4.0 WATER LEVELS AND GROUND-WATER FLOW DIRECTIONS

Ground-water levels were recorded in the nine site wells on September 19, 1985 (with the exception of B-3; this well was reported to have collapsed). The top of the 2-inch PVC riser pipe, the protective casing and ground surface were surveyed on all new and existing wells by Robert E. Goslee and Associates on September 27, 1985. In addition, the surveyors recorded ground-water elevations in the wells and water level elevations for the Cape Fear River on September 27, 1985. Ground-water elevations are listed in Table 2.

Ground-water flow directions are shown on Figure 5. As shown by the arrows on the potentiometric map, ground-water flow around the immediate limits of the land farming area is to the west-northwest and southwest toward the Cape Fear River. Within the southeasternmost portion of the plant, a southern ground-water flow exists with ground water apparently discharging into a marshy area just south of the property line.

Ground-water elevations ranged from 2.82 feet, msl in well B-5 to a low of 1.42 feet, msl in well B-4.

5.0 RATE OF GROUND-WATER FLOW

5.1 Hydraulic Conductivity Test Results

Hydraulic conductivity (k) tests were performed on the four newly-installed ground-water monitoring wells (MW-6, MW-7, MW-8 and MW-9) on September 11, 1985. Hydraulic conductivity was derived using the bailing method which measures the change in water level in a well after a volume of water is removed or the well is bailed dry. The coefficient of permeability was calculated using the equations described by Bouwer and Rice (1976).

Values of hydraulic conductivity range from 3×10^{-5} cm/sec in monitoring well MS-6 to 1×10^{-6} cm/sec in well MW-8. This range of permeabilities is typical for silts for which the test interval is located (Johnson, A.I., 1964). Results of hydraulic conductivity are listed in Table 3.

5.2 Ground-Water Flow Velocities

The average ground-water flow velocity was estimated using the formula derived from Darcy's Law: v=Ki/Ne, where:

v = average velocity of flow (ft/yr)
K = hydraulic conductivity (6.8 ft/yr)
i = hydraulic gradient (2.8×10^{-3} ft/ft)
Ne = effective porosity (0.2)

The average ground-water flow velocity was calculated assuming the test interval for the wells to be that portion below the bottom of the bentonite seal down to the bottom of the screen section. A logarithmic average of the hydraulic conductivities determined at the four wells (MW-6, 7, 8 and 9) was used as a representative permeability value. The effective porosity value that was used to estimate ground-water flow velocity was assumed to be 0.2 (Davis and Dewiest, 1966).

The average ground-water velocity was estimated to be about 0.10 feet per year for the screened well interval.

6.0 REFERENCES

Berry, Willard E., 1949, Geologic Map Coastal Plain - North Carolina; North Carolina Department of Conservation and Development, Division of Mineral Resources.

Bouwer, H., and R. C. Rice, 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells; Water Resources Research, v. 12, no. 3.

Davis and Dewiest, 1966, Hydrogeology; John Wiley and Sons, New York, 463 pp.

Johnson, A.I., 1964, Conversion Factors and Miscellaneous Tables; U.S. Geological Survey Open-file Report.

TABLES

TABLE 1

MONITORING WELL CONSTRUCTION DATA
SOUTHERN WOOD PIEDMONT - WILMINGTON, NORTH CAROLINA FACILITY

WELL NO.	DATE INSTALLED	WELL TYPE	BOREHOLE DEPTH(FT)	DEPTH TO BOTTOM OF SEAL(FT)	DEPTHS OF THE SCREENED INTERVAL(FT)	GROUND ELEVATION (FT,MSL)*	ELEVATIONS OF THE SCREENED INTERVAL(FT,MSL)	TOP OF 2" PVC PIPE ELEVATION(FT,MSL)*
B-1	11-03-81	SME	44.8	NA	10.0 to 15.0	2.90	-7.1 to -12.1	5.52
B-2	11-04-81	SME	48.9	NA	7.0 to 12.0	4.70	-2.3 to - 7.3	7.61
B-3	11-03-81	SME	50.0	NA	2.5 to 7.5	4.20	1.7 to - 3.3	7.12
B-4	11-04-81	SME	49.0	NA	13.0 to 18.0	4.10	-8.9 to -13.9	6.75
B-5	11-04-81	SME	44.0	NA	10.0 to 15.0	4.20	-5.8 to -10.8	6.57
MW-6	09-05-85	III	20.0	8.0	10.09 to 19.78	3.46	-6.63 to -16.32	5.04
MW-7	09-06-85	III	19.8	8.0	9.83 to 19.52	4.16	-5.67 to -15.36	6.07
MW-8	09-09-85	III	19.2	8.0	9.28 to 19.02	4.26	-5.02 to -14.76	6.75
MW-9	09-10-85	III	19.4	8.0	9.52 to 19.22	4.46	-5.06 to -14.76	6.51

NA: Data Not Available
* Surveyed by Robert H. Goslee and Associates.

TABLE 2

GROUND-WATER LEVEL DATA SUMMARY
SOUTHERN WOOD PIEDMONT - WILMINGTON, NORTH CAROLINA FACILITY

WELL NO.	TOP OF 2" PVC PIPE ELEVATION(FT,MSL)	9-19-85 DEPTH TO GROUND WATER(FT)	9-19-85 GROUND-WATER ELEVATION(FT,MSL)	9-27-85 DEPTH TO GROUND WATER(FT)	9-27-85 GROUND-WATER ELEVATION(FT,MSL)	RIVER GAUGE WATER LEVEL(FT,MSL)
B-1	5.52	3.54	1.98	3.22	2.30	0.45
B-2	7.61	5.33	2.28	4.88	2.73	0.50
B-3	7.12	NA	NA	NA	NA	NA
B-4	6.75	5.33	1.42	NA#	NA#	0.60
B-5	6.57	3.75	2.82	3.72	2.85	0.40
MW-6	5.04	2.67	2.37	3.27	1.77	2.00
MW-7	6.07	3.83	2.24	4.14	1.93	1.90
MW-8	6.75	4.25	2.50	4.49	2.26	1.90
MW-9	6.51	4.08	2.43	4.24	2.27	1.70

NOTE: Monitoring well B-3 was reported to have collapsed; therefore, ground-water level data was not available.

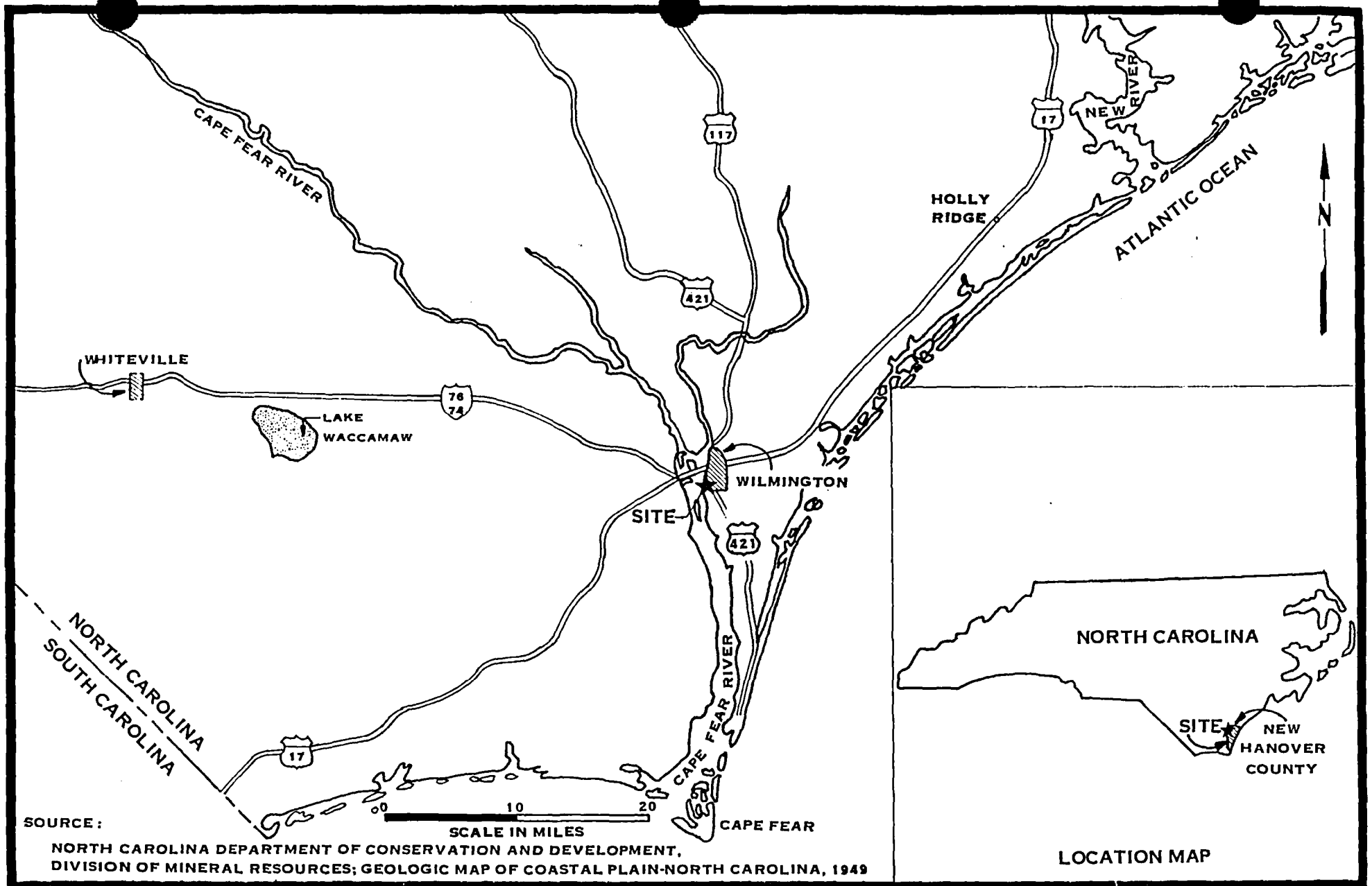
* Surveyed by Robert H. Goslee and Associates.
\# Ground-water level was too low to be recorded by surveyor (below 6 feet).

TABLE 3

HYDRAULIC CONDUCTIVITY SUMMARY

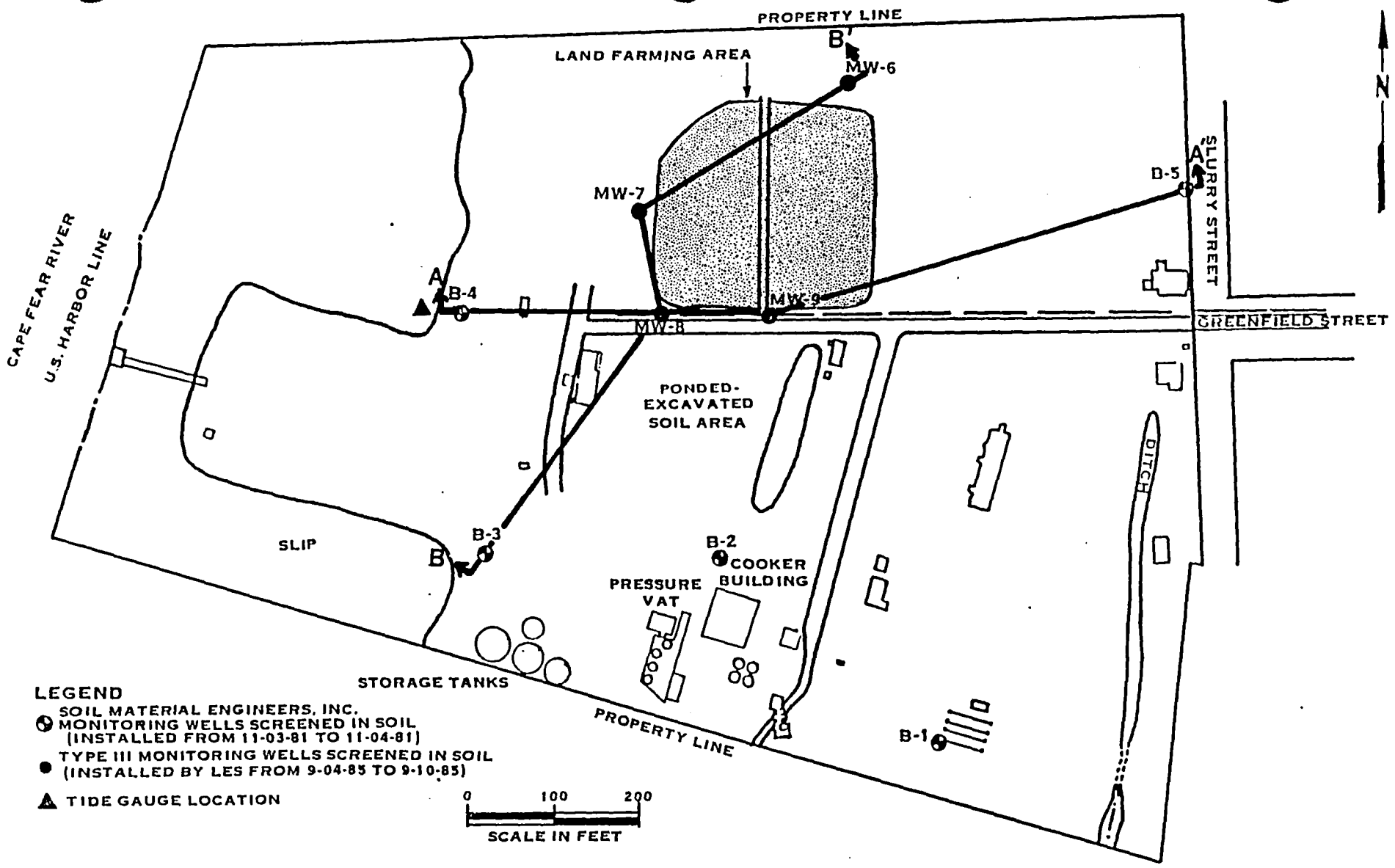
WELL NO.	TEST INTERVAL DEPTH(FT)	MATERIAL TESTED	HYDRAULIC CONDUCTIVITY(CM/SEC)
MW-6	8.0 - 19.78	Silt with Wood and Root Fragments	3×10^{-5}
MW-7	8.0 - 19.52	Silt with Wood and Root Fragments	6×10^{-6}
MW-8	8.0 - 19.02	Silt with Wood and Root Fragments	1×10^{-6}
MW-9	8.0 - 19.22	Silt with Wood and Root Fragments	1×10^{-5}

FIGURES

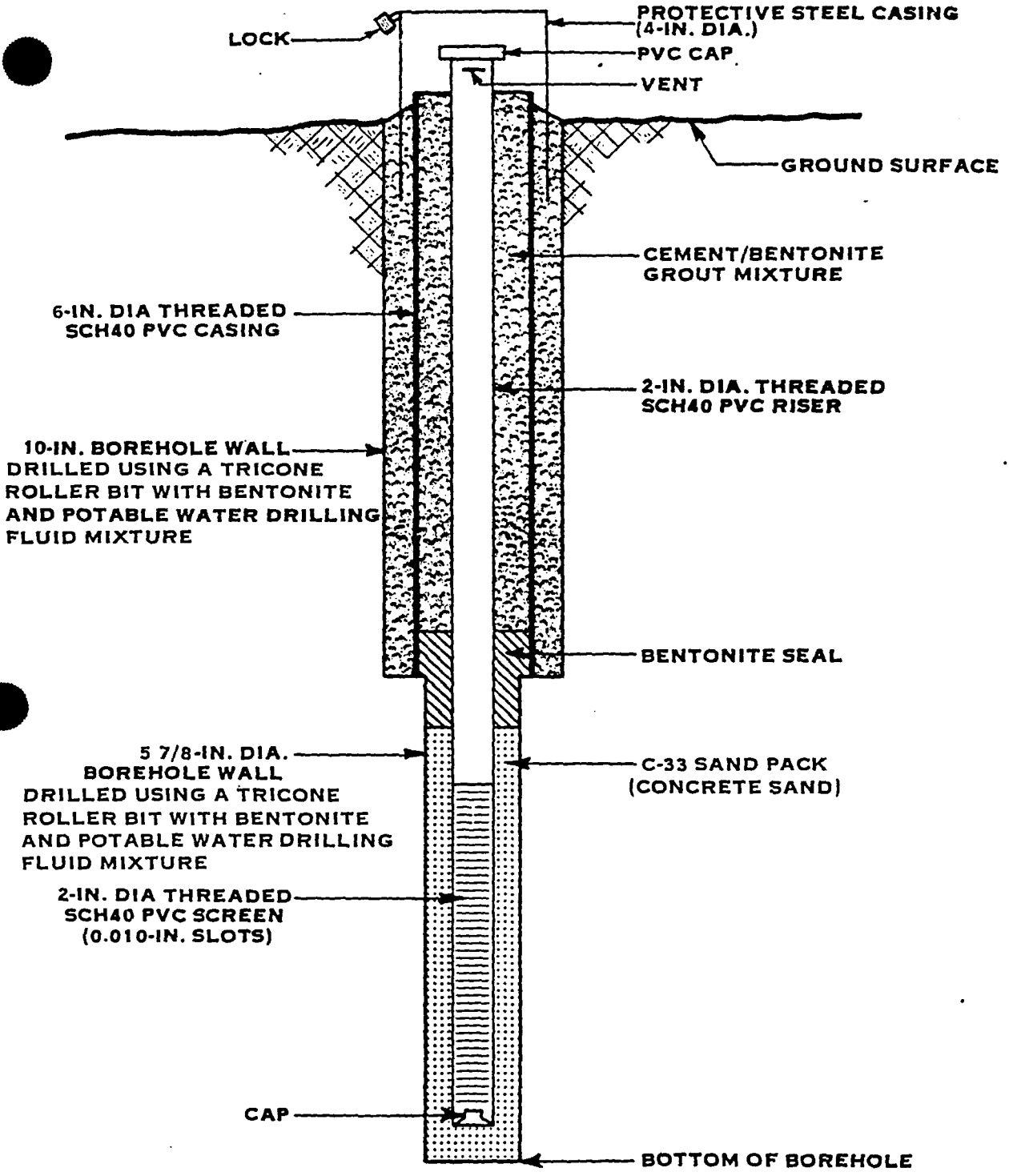


SOURCE:
NORTH CAROLINA DEPARTMENT OF CONSERVATION AND DEVELOPMENT, DIVISION OF MINERAL RESOURCES; GEOLOGIC MAP OF COASTAL PLAIN-NORTH CAROLINA, 1949

SOUTHERN WOOD PIEDMONT WILMINGTON, NORTH CAROLINA	LAW ENVIRONMENTAL SERVICES MARIETTA, GEORGIA	SITE LOCATION MAP JOB NO. HA5276 FIGURE 1

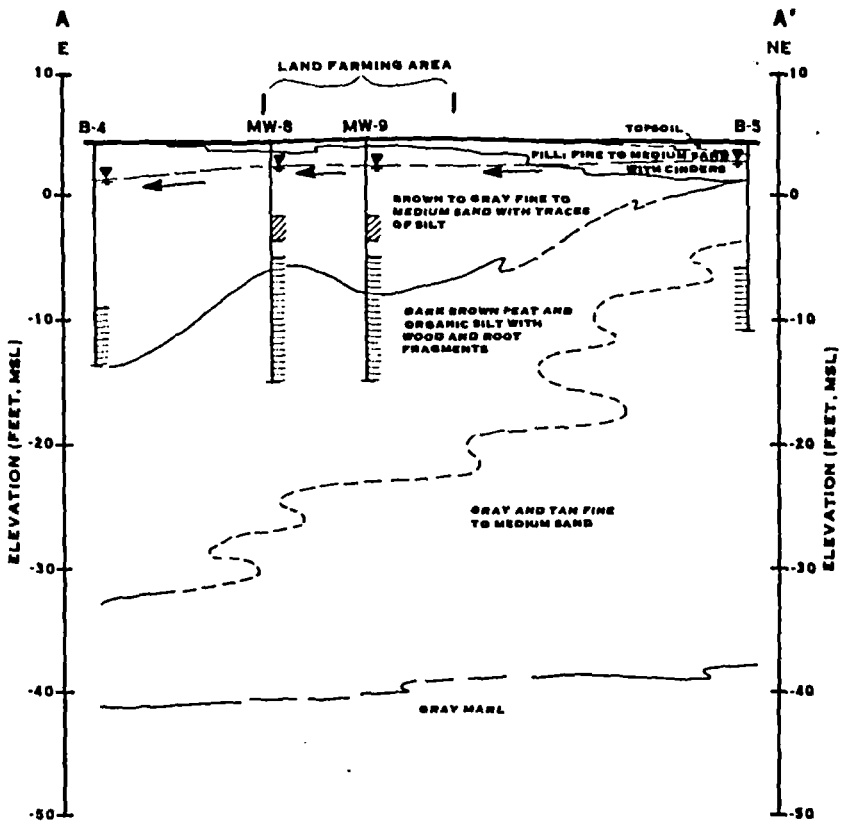


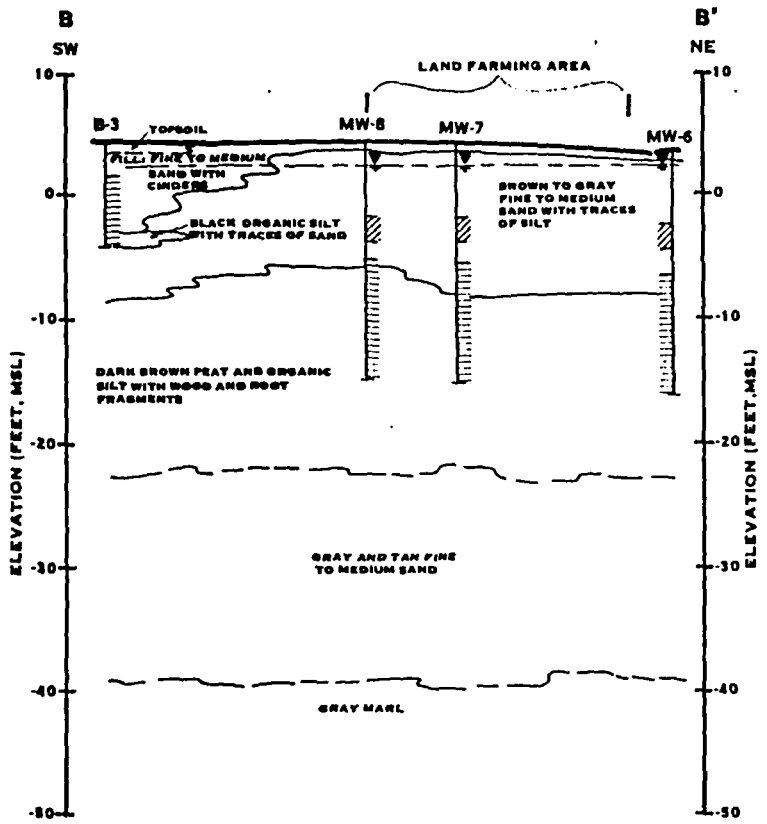
SOUTHERN WOOD PIEDMONT WILMINGTON, NORTH CAROLINA	LAW ENVIRONMENTAL SERVICES MARIETTA, GEORGIA	MONITORING WELL AND CROSS SECTION LOCATION MAP JOB NO. HA 5276 FIGURE 2



(NOT TO SCALE)

UTHERN WOOD PIEDMONT WILMINGTON, NORTH CAROLINA	LAW ENVIRONMENTAL SERVICES MARIETTA, GEORGIA	TYPE III WELL CONSTRUCTION DIAGRAM JOB NO. HA 5276 FIGURE 3





LEGEND

B-4 MONITORING WELL LOCATION

GROUND SURFACE

GROUND-WATER LEVEL MEASURED ON 5/19/85 FROM DATUM (ARROWS INDICATE DIRECTION OF FLOW

BENTONITE SEAL

MONITORING WELL SCREEN LOCATION

SCALE IN FEET

0 10 20

NOTE: THE TEST BORING RECORDS ARE CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATION. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

SOUTHERN WOOD PIEDMONT

WILMINGTON, NORTH CAROLINA

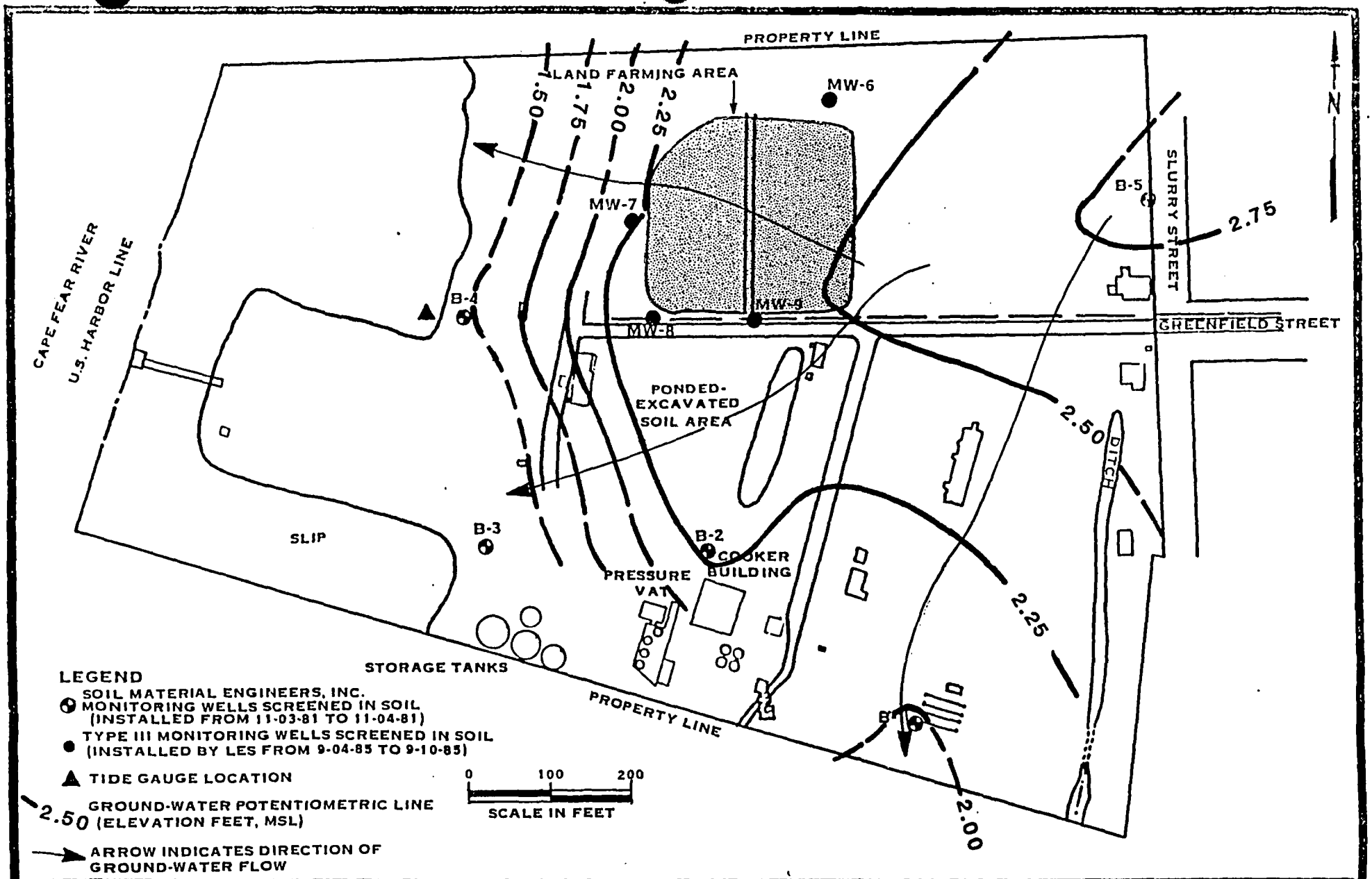
LAW ENVIRONMENTAL SERVICES

MARIETTA, GEORGIA

HYDROGEOLOGIC CROSS-SECTIONS A-A' AND B-B'

JOB NO. HA5278

FIGURE 4



SOUTHERN WOOD PIEDMONT

WILMINGTON, NORTH CAROLINA

LAW ENVIRONMENTAL SERVICES

MARIETTA, GEORGIA

GROUND-WATER ELEVATIONS
SEPTEMBER 19, 1985

JOB NO. HA 5276

FIGURE 5

APPENDIX

KEY TO CLASSIFICATIONS AND SYMBOLS

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	NO. OF BLOWS, N	RELATIVE DENSITY
SANDS	0-4	VERY LOOSE
	4-10	LOOSE
	10-30	FIRM
	30-50	DENSE
	OVER 50	VERY DENSE
		CONSISTENCY
SILTS AND CLAYS	0-2	VERY SOFT
	2-4	SOFT
	4-8	FIRM
	8-15	STIFF
	15-30	VERY STIFF
	30-50	HARD
	OVER 50	VERY HARD

SYMBOLS

▮	-UNDISTURBED SAMPLE (UD) RECOVERED
▯	-UNDISTURBED SAMPLE (UD) NOT RECOVERED
100 / 2''	-NUMBER OF BLOWS (100) TO DRIVE THE SPOON A NUMBER OF INCHES (2)
AX BX. NX	-CORE BARREL SIZES WHICH OBTAIN CORES 1-1/8, 1-5/8 AND 2-1/8 INCHES IN DIAMETER RESPECTIVELY
65 %	-PERCENTAGE (65) OF ROCK CORE RECOVERED
RQD	-ROCK QUALITY DESIGNATION-%OF CORE SEGMENTS 4 OR MORE INCHES LONG
▽	-WATER TABLE AT LEAST 24 HOURS AFTER DRILLING
▽	-WATER TABLE ONE HOUR OR LESS AFTER DRILLING
◀	-LOSS OF DRILLING WATER
A	-ATTERBERG LIMITS TEST PERFORMED
C	-CONSOLIDATION TEST PERFORMED
GS	-GRAIN SIZE TEST PERFORMED
T	-TRIAXIAL SHEAR TEST PERFORMED
P	-PROCTOR COMPACTION TEST PERFORMED
V	-FIELD VANE SHEAR TEST PERFORMED
18	-PERCENT OF NATURAL MOISTURE CONTENT (18)

DRILLING PROCEDURES

THE STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS OF A 140 POUND HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D., 1.4 INCH I.D. SPLIT SPOON SAMPLER ONE FOOT.

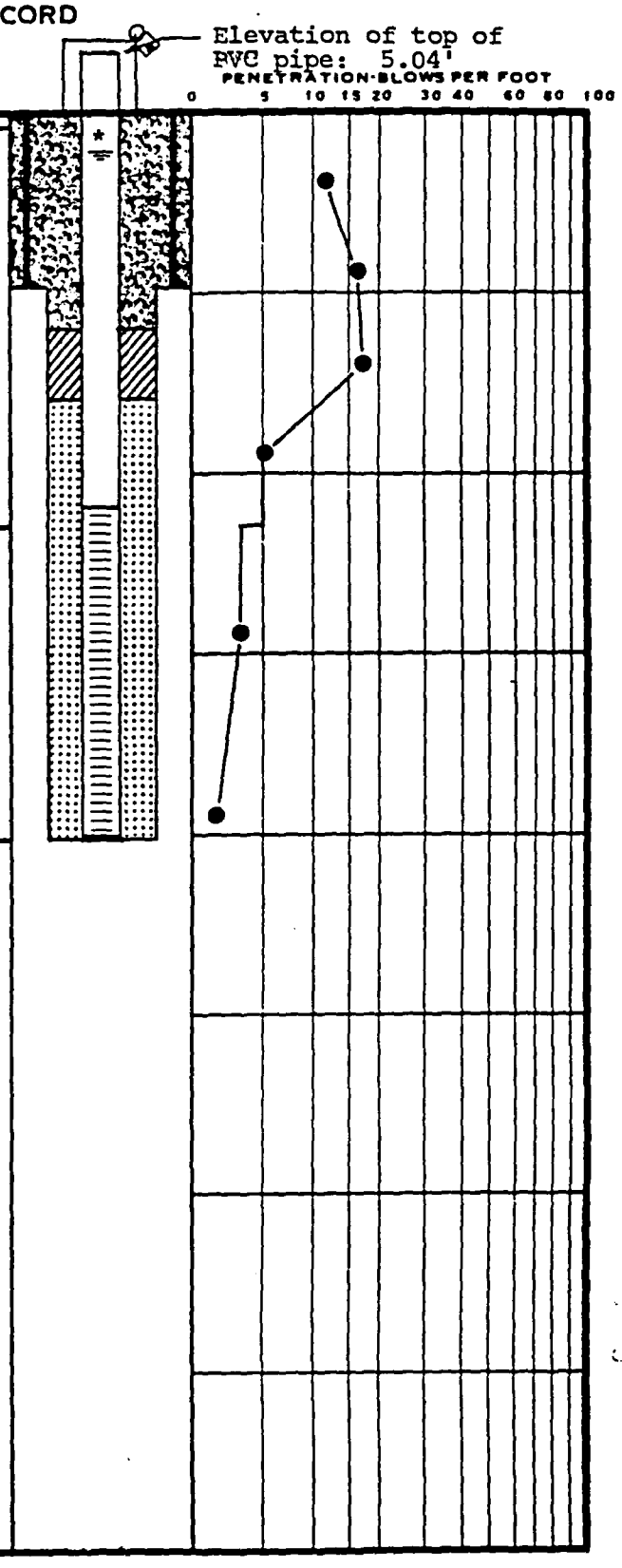
CORE DRILLING IN ACCORDANCE WITH ASTM DESIGNATION D 2113-62T.

THE UNDISTURBED SAMPLING PROCEDURE IS DESCRIBED BY ASTM SPECIFICATION D 1587-67.

TEST BORING RECORD

Elevation of top of PVC pipe: 5.04'

ELEV.	DEPTH FEET	DESCRIPTION
3.46	0.0	
	0.5	FILL: Dark brown and black CINDERS and silty fine to medium SAND
-1.54		Firm to loose dark to light brownish-gray/grayish-brown fine to medium SAND with traces of silt
-6.54		
	11.5	
-11.54		Soft to very soft dark brown PEAT and ORGANIC SILT with wood and root fragments
-16.54	20.0	BORING TERMINATED
-21.54		



REMARKS:

* Water level on 9-19-85

1) Wash drilled with 10-inch wing bit using a bentonite and potable water drilling fluid mixture to 4.8 feet; Wash drilled with 5 7/8-inch rotary bit using a bentonite and potable water drilling fluid mixture from 4.8 to 20.0 feet

2) Well developed on 9-10-85

DRILLED BY L.S.
LOGGED BY J.T.B.
CHECKED BY C.A.S.

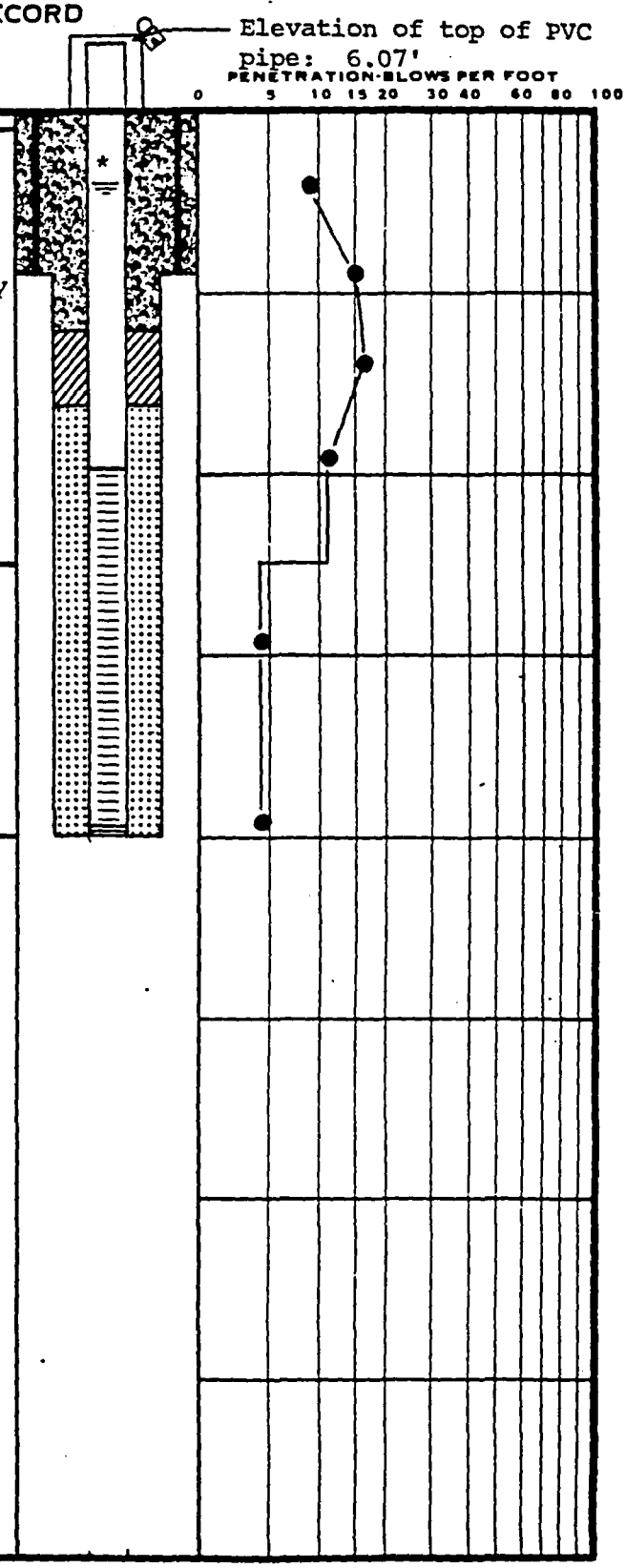
BORING NUMBER MW-6
DATE STARTED 9-4-85
DATE COMPLETED 9-5-85
JOB NUMBER HA-5276

SWP - Wilmington

TEST BORING RECORD

Elevation of top of PVC pipe: 6.07'

ELEV.	DEPTH FEET	DESCRIPTION
4.16	0.0	FILL: Brown slightly silty fine SAND with cinders
	8.5	
-0.84		Loose to firm brown slightly silty fine to medium SAND to fine to medium SAND with traces of silt
-5.84		
	12.5	
-10.84		Soft to firm dark brown PEAT and ORGANIC SILT with wood and root fragments becoming predominantly wood in last sample
-15.84	20.0	BORING TERMINATED
-20.84		



REMARKS:

* Water level on 9-19-85

1) Wash drilled with 10-inch wing bit using a bentonite and potable water drilling fluid mixture to 4.5 feet; wash drilled with 5 7/8-inch roller bit using a bentonite and potable water drilling fluid mixture from 4.5 to 20.0 feet

2) Well developed on 9-11-85

DRILLED BY L.S.
LOGGED BY J.T.B.
CHECKED BY C.A.S.

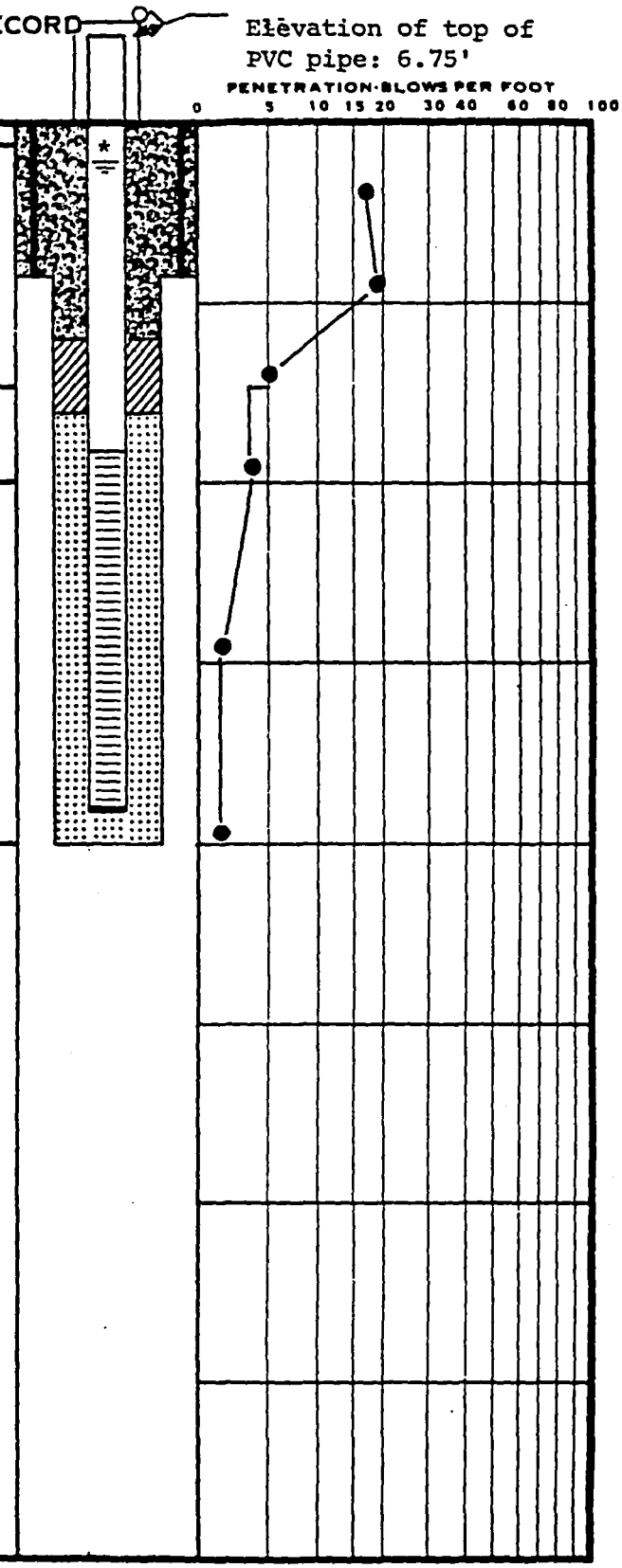
BORING NUMBER MW-7
DATE STARTED 9-4-85
DATE COMPLETED 9-6-85
JOB NUMBER HA-5276

SWP - Wilmington

TEST BORING RECORD

Elevation of top of PVC pipe: 6.75'

ELEV.	DEPTH FEET	DESCRIPTION
4.26	0.7	FILL: Dark brown silty fine SAND with occasional coarse sand
-0.74	7.4	Firm to loose dark brown to grayish-brown and brown slightly silty fine to medium SAND with traces of coarse sand
-5.74	10.0	Buried log from 7.4 to 10.0 feet
-10.74		Very soft to soft dark brown PEAT and ORGANIC SILT with wood and root fragments
-15.74	20.0	BORING TERMINATED
-20.74		



REMARKS:

* Water level on 9-19-85

1) Wash drilled with 10-inch wing bit using a bentonite and potable water drilling fluid mixture to 4.5 feet; wash drilled with 5 7/8-inch roller bit using a bentonite and potable water drilling fluid mixture from 4.5 to 20.0 feet

2) Well developed on 9-11-85

DRILLED BY L.S.
LOGGED BY J.T.B.
CHECKED BY C.A.S.

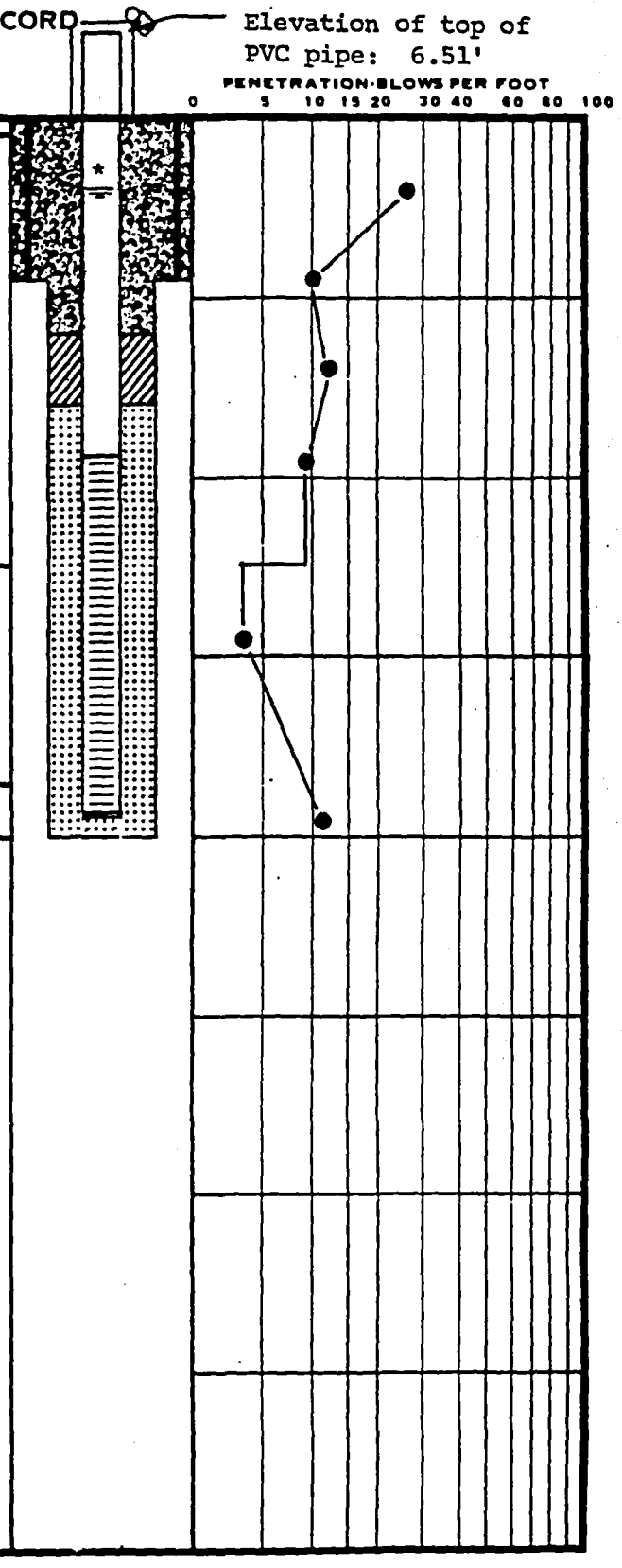
BORING NUMBER MW-8
DATE STARTED 9-4-84
DATE COMPLETED 9-9-85
JOB NUMBER HA-5276

SWP - Wilmington

TEST BORING RECORD

Elevation of top of PVC pipe: 6.51'

ELEV.	DEPTH FEET	DESCRIPTION
4.46	0.9	
	0.5	FILL: Dark brown silty fine SAND with occasional coarse sand
-0.54		Very firm to loose gray to grayish-brown fine to medium SAND with traces of silt
-5.54		
	12.5	
-10.54		Soft dark brown PEAT and ORGANIC SILT with root and wood fragments
	18.5	
-15.54	20.0	Buried log from 18.5 to 20.0 feet
		BORING TERMINATED
-20.54		



REMARKS:

* Water level on 9-19-85

1) Wash drilled with 10-inch wing bit using a bentonite and potable water drilling fluid mixture to 4.5 feet; wash drilled with 5 7/8-inch roller bit using a bentonite and potable water drilling fluid mixture from 4.5 to 20.0 feet

2) Well developed on 9-11-85

DRILLED BY L.S.
LOGGED BY J.T.B.
CHECKED BY C.A.S.

BORING NUMBER MW-9
DATE STARTED 9-5-85
DATE COMPLETED 9-10-85
JOB NUMBER HA-5276

SWP - Wilmington