451SERBSF10,627

451SERBSF10,627

Site Name (Subject):	SWISS BEAR INC/TEXACO INC.
Site ID (Document ID):	NCD075550517
Document Name (DocType):	Preliminary Assessment/Site Inspection (PA/SI)
Report Segment:	
Description:	Phase I Screening Site Inspection: References
Date of Document:	4/1/1991
Date Received:	
Box: *Enter SF and # with no spaces*	SF10,627
Access Level:	PUBLIC
Division:	WASTE MANAGEMENT
Section:	SUPERFUND
Program (Document Group):	SERB (SERB)
Document Category:	FACILITY

Print Report for Record | **Go to New Blank Record** | **Go to New Record - (default to last record values)** | **Delete Record**

STATE OF NORTH CAROLINA

Department of Environment, Health, and Natural Resources
Division of Solid Waste Management
Superfund Section

Swiss Bear, Inc.
NCD 075550517

References

April 1991

By:

Greenhorne & O'Mara, Inc.

LIST OF REFERENCES FOR SWISS BEAR, INC.
EPA ID NUMBER - NCD075550517

CERCLA

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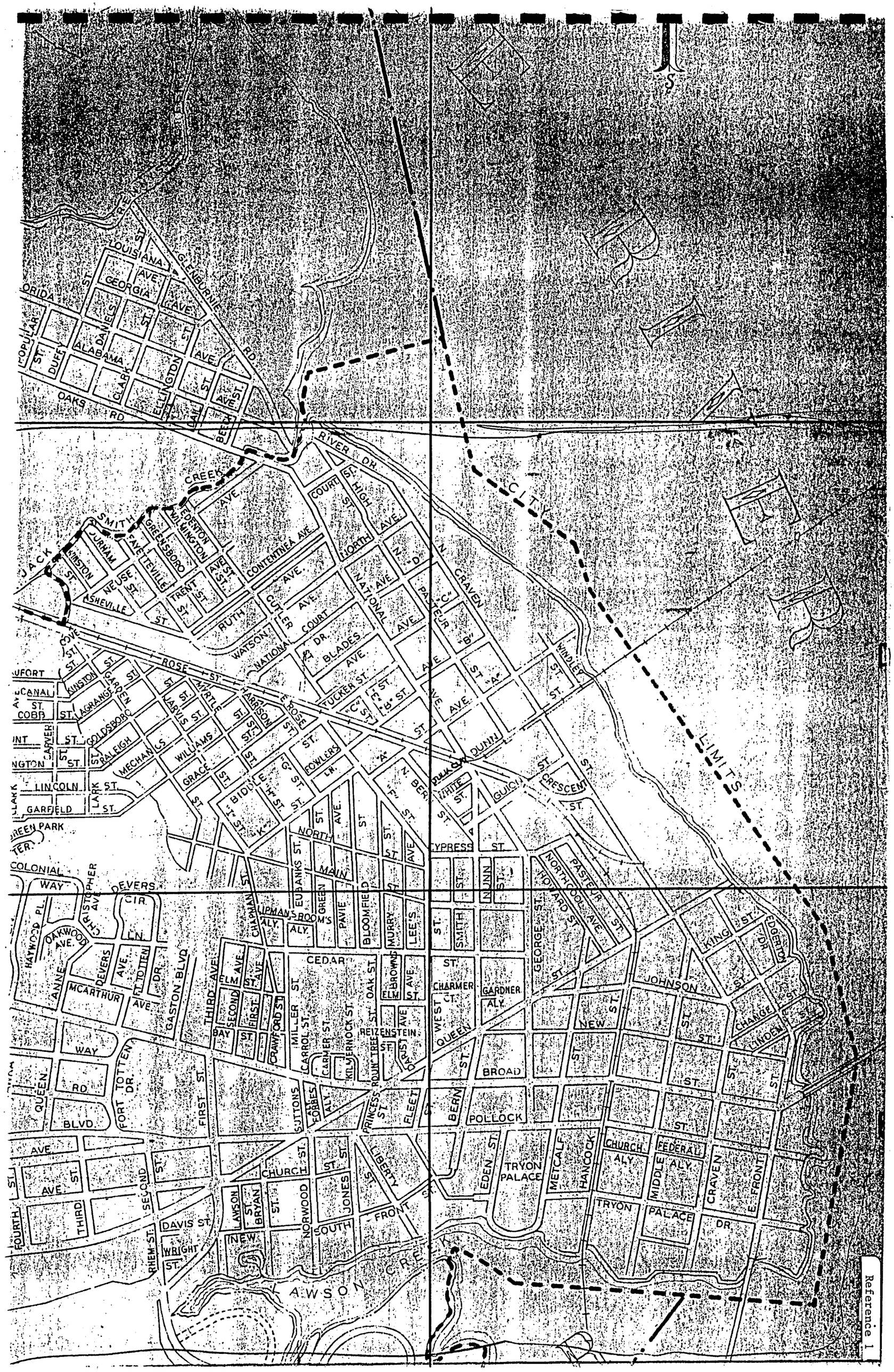
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RIVER DR.
CREEK
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EDENTON
WILMINGTON
GREENSBORO
FAYETTEVILLE
DURHAM
KINSTON
NEUSE
ASHEVILLE
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TUCKER
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MYRTLE
JARVIS
LAGRANGE
GOLDSBORO
RALEIGH
MECHANICS
WILLIAMS
GRACE
BIDDLE
POWELLS
LINCOLN
GARFIELD
GREEN PARK
COLONIAL
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DEVERS
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CHRISTOPHER AVE.
HAYWOOD PL.
OAKWOOD AVE.
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GASTON BLVD
FORT TOTTEN DR.
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WRIGHT ST.
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CHURCH
NORWOOD
SOUTH
JONES
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LIBERTY
SUTTONS
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PRINCESS
FLEET
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TRYON PALACE
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MIDDLE ALY.
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BAY
CRAWFORD ST.
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QUEEN
CHARMER
GARDNER ALY.
BROAD
NEW
JOHNSON
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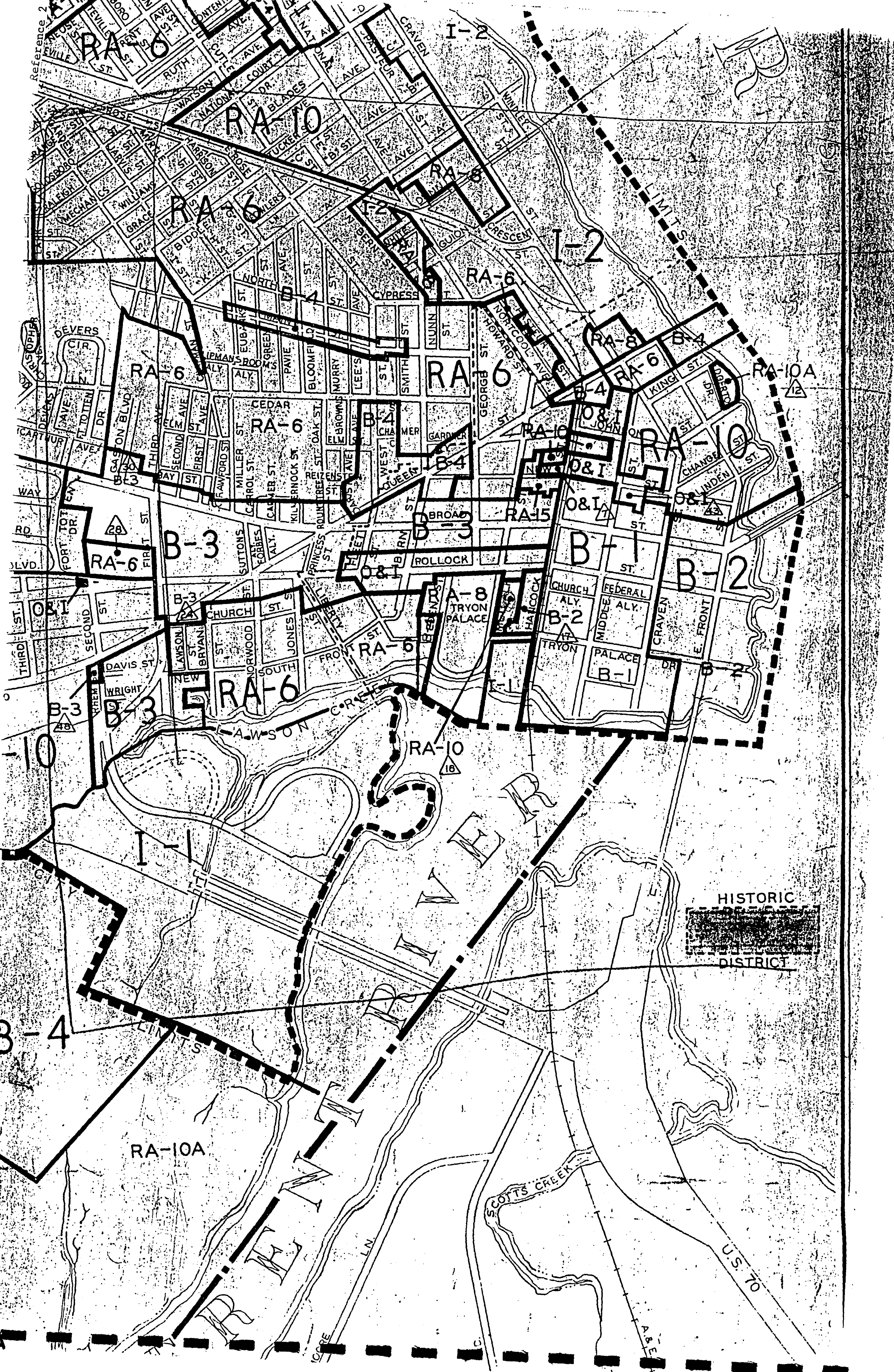
CYPRESS
WHITE
GUION
DUNN
N. BERN
LAWSON CREEK

Reference 1

REFERENCE 2



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RA-10
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HOWARD ST.
NORTCOOL AVE.
KING ST.
RA-10A
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FEDERAL
ALY.
MIDDLE
HANCOCK
CRAVEN
E. FRONT
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PALACE
DR.
TRYON PALACE
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FORT TOTTEN DR.
FIRST ST.
SUTTONS
FORBES ALY.
PRINCESS ST.
LIBERTY
SECOND ST.
THIRD ST.
DAVIS ST.
WRIGHT
LAWSON
BRYAN ST.
NORWOOD ST.
JONES
SOUTH
NEW
FRONT ST.
LAWSON CREEK
I-1
CITY LIMITS
RIVER
TRENT RIVER
HISTORIC DISTRICT
SCOTTS CREEK
U.S. 70
A&E
LN.

REFERENCE 3

Texaco, Inc. should be changed to Swiss Bear, Inc. (and City of New Bern) site.

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 1 - SITE INFORMATION AND ASSESSMENT

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
NC	D075550517

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site)	02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER				
Texaco, Inc.	200-208 East Front Street				
03 CITY	04 STATE	05 ZIP CODE	06 COUNTY	07 COUNTY CODE	08 CONG DIST
New Bern	NC	28506	Craven	25	01
09 COORDINATES LATITUDE	LONGITUDE				
35° 06' 18" N	077° 06' 08" W				

10 DIRECTIONS TO SITE (Starting from nearest public road)

Located at 200-208 East Front Street near Union Point along the Neuse River.

III. RESPONSIBLE PARTIES

01 ~~XXXXXXXX~~ (Present Owner)	02 STREET (Business, mailing, residential)		
Swiss Bear, Inc. (and City of New Bern)	P.O. Box 597 (320 Middle Street)		
03 CITY	04 STATE	05 ZIP CODE	06 TELEPHONE NUMBER
New Bern	NC	28560	(919) 638-5781
07 ~~OPERATOR (If known, leave blank)~~ (Past Owner)	08 STREET (Business, mailing, residential)		
Texaco, Inc.	P.O. Box 430		
09 CITY	10 STATE	11 ZIP CODE	12 TELEPHONE NUMBER
Bellaire	TX	77401	(713) 666-8000

13 TYPE OF OWNERSHIP (Check one)

☒ A. PRIVATE ☐ B. FEDERAL: _____ (Agency name) ☐ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL

☐ F. OTHER _____ (Specify) ☐ G. UNKNOWN

14 OWNER-OPERATOR NOTIFICATION ON FILE (Check all that apply)

☒ A. RCRA 3001 DATE RECEIVED 11/14/80 (MONTH DAY YEAR) ☐ B. UNCONTROLLED WASTE SITE (CERCLA 103 c) DATE RECEIVED ___/___/___ (MONTH DAY YEAR) ☐ C. NONE

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON-SITE INSPECTION

☐ YES DATE ___/___/___ (MONTH DAY YEAR)
☒ NO

BY (Check all that apply)

☐ A. EPA ☐ B. EPA CONTRACTOR ☐ C. STATE ☐ D. OTHER CONTRACTOR
☐ E. LOCAL HEALTH OFFICIAL ☐ F. OTHER _____ (Specify)

CONTRACTOR NAME(S) _____

02 SITE STATUS (Check one)	03 YEARS OF OPERATION	
☐ A. ACTIVE ☒ B. INACTIVE ☐ C. UNKNOWN	1952 (BEGINNING YEAR)	1979? (ENDING YEAR) ~~UNKNOWN~~ (~~Property sold 6-15-83 to Swiss Bear, Inc. and City of New Bern~~)

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN, OR ALLEGED

Leaded tank sludges potentially buried on-site, as this was commonly practiced by the petroleum industry prior to 1980.

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION

Potential burial of leaded sludges on facility site. Site is slated to become an extension of an adjacent park (Union Point Park). It is believed that any buried wastes could propose a health threat to park users.

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)

☐ A. HIGH (Inspection required promptly) ☒ B. MEDIUM (Inspection required) ☐ C. LOW (Inspection on time available basis) ☐ D. NONE (No further action needed; complete current disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT	02 OF (Agency/Organization)		03 TELEPHONE NUMBER
Marvin Davis	Swiss Bear, Inc.		(919) 638-5781
04 PERSON RESPONSIBLE FOR ASSESSMENT	05 AGENCY	06 ORGANIZATION	07 TELEPHONE NUMBER	08 DATE
Lee Crosby / D. Mark Durway	NC DEM	S&HW Mgmt.	(919) 733-2178	1/18/85 (MONTH DAY YEAR)

EPA FORM 2070-12 (7-81)

MD

Reference 3

EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 2 - WASTE INFORMATION

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
NC	D075550517

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

- [ ] A SOLID
- [ ] B POWDER, FINES
- [x] C SLUDGE
- [ ] D OTHER _____ (Specify)
- [ ] E SLURRY
- [x] F LIQUID
- [ ] G GAS

02 WASTE QUANTITY AT SITE (Measures of waste quantities must be independent)

TONS Unknown

CUBIC YARDS _____

NO OF DRUMS _____

03 WASTE CHARACTERISTICS (Check all that apply)

- [x] A TOXIC
- [ ] B CORROSIVE
- [ ] C RADIOACTIVE
- [x] D PERSISTENT
- [ ] E SOLUBLE
- [ ] F INFECTIOUS
- [ ] G FLAMMABLE
- [x] H IGNITABLE
- [ ] I HIGHLY VOLATILE
- [ ] J EXPLOSIVE
- [ ] K REACTIVE
- [ ] L INCOMPATIBLE
- [ ] M NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE	Unknown		
OLW	OILY WASTE	Unknown		
SOL	SOLVENTS			
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS			
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
MES	HEAVY METALS	Unknown		

IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
D001	EP Ignitable	--	accumulated in	Unknown	
D008	Lead	7439921	tanks, which were	"	
K049	Slop oil solids - ?	--	cleaned every 3-5	"	
K050	Heat exchanger sludge-?	--	years; potential	"	
K051	API separator sludge -?	--	on-site disposal	"	
K052	Leaded tank bottoms-?		prior to 1980	"	

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS	N/A		FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

VI. SOURCES OF INFORMATION (Cite specific references, e.g. state files, sample analysis, reports)

1. RCRA Part A, 11-14-80.
2. W.O. Hardin-@ Texaco, Inc., Bellaire, TX, telephone conversation, 1-17-85
3. Charles Shelton @ Texaco, Inc., " " " , 1-18-85
4. Martin Davis, executive director of Swiss Bear, Inc., telephone conversation 1-22-85

REFERENCE 4

GREENHORNE & O'MARA, INC.

Memorandum

TO: File

FROM: Rachel Spangenberg RMS

DATE: March 29, 1991

SUBJ: Telephone conversation with Nancy Bottorf, Director of the Department of Parks and Recreation, New Bern, North Carolina (919) 636-4060.

Ms. Bottorf informed me that the storage tanks used by Texaco on the site were removed and taken by barge up the Neuse River to North Craven Street where a fertilizer company, Royster Co., uses them to store fertilizer (possibly liquid nitrogen). She also said that Texaco is believed to have stopped operations at this site in the late 1960s or early 1970s. The Swiss Bear, Inc. site is presently called Duffy Park, its an extension of Union Point Park, but was dedicated as Duffy Park in memory of an active community member.

REFERENCE 5

GREENHORNE & O'MARA, INC.

Memorandum

TO: File

FROM: Rachel Spangenberg RMS

DATE: March 27, 1991

SUBJ: Telephone conversation with Nancy Bottorf, Director of the Department of Parks and Recreation, New Bern, North Carolina (919) 636-4060.

Ms. Bottorf informed me that the LWCF grant was given in 1985. The Texaco parcel was given to New Bern from Texaco (approximately one acre), this is where the tanks were located. The other two parcels, that make up Duffy Park, were owned by Swiss Bear, Inc. who sold the land to the city (basically at the cost of taxes only). Ms. Bottorf is unaware of any sludge being buried on the site. She assumes that when the tanks were cleaned that the sludge was taken to a dump area. The City knew at the time the tanks were removed that the site would be a park. The cement pads were "clean as a whistle." The park is now owned by New Bern and operated by the Parks and Recreation Dept. Grading of the site was done after grant was received in 1985. Not certain where the tanks were taken once they were removed (she will call me with that information). An environmental report was done for the park (she is sending me a copy of that report).

REFERENCE 6

(fill-in areas are spaced for elite type, i.e., 12 characters/inch).

Form Approved OMB No. 158-R0175

FORM 1 GENERAL

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY

GENERAL INFORMATION

Consolidated Permits Program

(Read the "General Instructions" before starting.)

I. EPA I.D. NUMBER

F NCD075550517

GENERAL INSTRUCTIONS

If a preprinted label has been provided, aff it in the designated space. Review the inform ation carefully; if any of it is incorrect, cro through it and enter the correct data in t appropriate fill-in area below. Also, if any the preprinted data is absent *(the area to t left of the label space lists the informati that should appear)*, please provide it in t proper fill-in area(s) below. If the label complete and correct, you need not comple Items I, III, V, and VI *(except VI-B whi must be completed regardless)*. Complete items if no label has been provided. Refer the instructions for detailed item descr tions and for the legal authorizations unc which this data is collected.

LABEL ITEMS

I. EPA I.D. NUMBER

III. FACILITY NAME

V. FACILITY MAILING ADDRESS

VI. FACILITY LOCATION

EPA I.D. #NCD075550517
TEXACO USA A DIVISION OF
TEXACO INC.
P. O. BOX 4582
ATLANTA, GEORGIA 30302
200 208 E. FRONT STREET
NEW BERN, N.C. 28560

II. POLLUTANT CHARACTERISTICS

INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of bold-faced terms.

SPECIFIC QUESTIONS	MARK 'X' YES	MARK 'X' NO	MARK 'X' FORM ATTACHED
A. Is this facility a publicly owned treatment works which results in a discharge to waters of the U.S.? (FORM 2A)		X	
B. Does or will this facility *(either existing or proposed)* include a concentrated animal feeding operation or aquatic animal production facility which results in a discharge to waters of the U.S.? (FORM 2B)		X	
C. Is this a facility which currently results in discharges to waters of the U.S. other than those described in A or B above? (FORM 2C)		X	
D. Is this a proposed facility *(other than those described in A or B above)* which will result in a discharge to waters of the U.S.? (FORM 2D)		X	
E. Does or will this facility treat, store, or dispose of hazardous wastes? (FORM 3)	X		X
F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)		X	
G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)		X	
H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)		X	
I. Is this facility a proposed stationary source which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X	
J. Is this facility a proposed stationary source which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X	

III. NAME OF FACILITY

1 SKIP TEXACO USA A DIVISION OF TEXACO INC

IV. FACILITY CONTACT

A. NAME & TITLE *(last, first, & title)*	B. PHONE *(area code & no.)*		
2 HARDIN W. O. ENV. PROT. COORD.	404	321	4411

V. FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX

3 P. O. BOX 4582

B. CITY OR TOWN	C. STATE	D. ZIP CODE
4 ATLANTA	GA	30302

VI. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER

5 200-208 E. FRONT STREET

B. COUNTY NAME

CRAVEN

704 / 554-1780

C. CITY OR TOWN	D. STATE	E. ZIP CODE	F. COUNTY CODE *(if known)*
6 NEW BERN	NC	28506	

Reference 6

...in the unshaded areas only ...spaced for elite type, i.e., 12 characters/inch). NEW BERN, N.C.

Form Approved OMB No. 158-S80004

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY

HAZARDOUS WASTE PERMIT APPLICATION

Consolidated Permits Program

(This information is required under Section 3005 of RCRA.)

I. EPA I.D. NUMBER

F NCD075550517

OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (yr., mo., & day)	COMMENTS

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below *(mark one box only)* to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA I.D. Number, or if this is a revised application, enter your facility's EPA I.D. Number in Item I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate date)*

[X] 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

[ ] 2. NEW FACILITY *(Complete item below)*

FOR EXISTING FACILITIES, PROVIDE THE DATE *(yr., mo., & day)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

C	YR.	MO.	DAY
8	52	04	01

FOR NEW FACILITIES, PROVIDE THE DATE *(yr., mo., & day)* OPERATION BEGAN OR EXPECTED TO BEGIN

YR.	MO.	DAY

B. REVISED APPLICATION *(place an "X" below and complete Item I above)*

[ ] 1. FACILITY HAS INTERIM STATUS

[ ] 2. FACILITY HAS A RCRA PERMIT

III. PROCESSES – CODES AND DESIGN CAPACITIES

A. PROCESS CODE – Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, describe the process *(including its design capacity)* in the space provided on the form *(Item III-C)*.

B. PROCESS DESIGN CAPACITY – For each code entered in column A enter the capacity of the process.

1. AMOUNT – Enter the amount.
2. UNIT OF MEASURE – For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER *(barrel, drum, etc.)*	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D79	GALLONS OR LITERS
LANDFILL	D80	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D81	ACRES OR HECTARES
OCEAN DISPOSAL	D82	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D83	GALLONS OR LITERS

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR OR GALLONS PER HOUR OR LITERS PER HOUR
OTHER *(Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Item III-C.)*	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE	UNIT OF MEASURE	UNIT OF MEASURE CODE	UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G	LITERS PER DAY	V	ACRE-FEET	
LITERS	L	TONS PER HOUR	D	HECTARE-METER	
CUBIC YARDS	Y	METRIC TONS PER HOUR	W	ACRES	
CUBIC METERS	C	GALLONS PER HOUR	E	HECTARES	
GALLONS PER DAY	U	LITERS PER HOUR	H		

EXAMPLE FOR COMPLETING ITEM III *(shown in line numbers X-1 and X-2 below)*: A facility has two storage tanks, one tank can hold 200 gallons and another can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

C DUP 1

LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	B. PROCESS DESIGN CAPACITY 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT	B. PROCESS DESIGN CAPACITY 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY
X-1	S02	600	G		5				
X-2	T03	20	E		6				
1	S01	2000	G		7				
2	S02	2000	G		8				
3					9				

CONTINUED FROM THE FRONT

VII. SIC CODES (4-digit, in order of priority)

A. FIRST	B. SECOND
7 5171 (specify) PETROLEUM TERMINAL	7 (specify)
C. THIRD	**D. FOURTH**
7 (specify)	7 (specify)

VIII. OPERATOR INFORMATION

A. NAME: 8 TEXACO USA

B. Is the name listed in Item VIII-A also the owner? [X] YES [ ]

C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box; if "Other", specify.)

F = FEDERAL
S = STATE
P = PRIVATE
M = PUBLIC (other than federal or state)
O = OTHER (specify)

P (specify) N/A

D. PHONE (area code & no.): A

E. STREET OR P.O. BOX: PO BOX 4582

F. CITY OR TOWN: 8 ATLANTA

G. STATE: GA

H. ZIP CODE: 30302

IX. INDIAN LAND

Is the facility located on Indian lands? [ ] YES [X] NO

X. EXISTING ENVIRONMENTAL PERMITS

A. NPDES (Discharges to Surface Water): 9 N	D. PSD (Air Emissions from Proposed Sources): 9 P
B. UIC (Underground Injection of Fluids): 9 U	E. OTHER (specify): 9 (specify)
C. RCRA (Hazardous Wastes): 9 R	E. OTHER (specify): 9 (specify)

XI. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property boundaries. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements.

XII. NATURE OF BUSINESS (provide a brief description)

PETROLEUM PRODUCTS AND TRANSPORTATION TERMINAL.

XIII. CERTIFICATION (see instructions)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE (type or print)	B. SIGNATURE	C. DATE SIGNED
C. A. REISDORF, VICE PRESIDENT	C. A. Reisdorf	NOV 14 1980

COMMENTS FOR OFFICIAL USE ONLY

tinued from the front.

I. PROCESSES *(continued)*

SPACE FOR ADDITIONAL PROCESS CODES OR DESCRIBING OTHER PROCESSES *(code "T0. . FOR EACH PROCESS ENTERED H*
INCLUDE DESIGN CAPACITY.

DESCRIPTION OF HAZARDOUS WASTES

PA HAZARDOUS WASTE NUMBER — Enter the four—digit number from 40 CFR, Subpart D for each listed hazardous waste you will handle. If you andle hazardous wastes which are not listed in 40 CFR, Subpart D, enter the four—digit number*(s)* from 40 CFR, Subpart C that describes the characteristics and/or the toxic contaminants of those hazardous wastes.

STIMATED ANNUAL QUANTITY — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual asis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non—listed waste*(s)* that will be handled which possess that characteristic or contaminant.

NIT OF MEASURE — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate odes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

ROCESSES

. PROCESS CODES:

For listed hazardous waste: For each listed hazardous waste entered in column A select the code*(s)* from the list of process codes contained in Item III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non—listed hazardous wastes: For each characteristic or toxic contaminant entered in column A, select the code*(s)* from the list of process codes contained in Item III to indicate all the processes that will be used to store, treat, and/or dispose of all the non—listed hazardous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code*(s)*.

. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

E: HAZARDOUS WASTES DESCRIBED BY MORE THAN ONE EPA HAZARDOUS WASTE NUMBER — Hazardous wastes that can be described by e than one EPA Hazardous Waste Number shall be described on the form as follows:

. Select one of the EPA Hazardous Waste Numbers and enter it in column A. On the same line complete columns B,C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
. In column A of the next line enter the other EPA Hazardous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other EPA Hazardous Waste Number that can be used to describe the hazardous waste.

MPLE FOR COMPLETING ITEM IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* — A facility will treat and dispose of an estimated 900 pounds ear of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non—listed wastes. Two wastes corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (If a code is not entered in D(1))
X	K054	900	P	T03 D80	
2	D002	400	P	T03 D80	
	D001	100	P	T03 D80	

m page 2.
copy this page before completing if you have more than 26 wastes to list.

Form Approved OMB No. 158-S80004

I.D. NUMBER (enter from page 1): CD075550517 | T/A: 3 | C: 1

FOR OFFICIAL U NLY: W DUP | T/A: | C: 2 | DUP

DESCRIPTION OF HAZARDOUS WASTES (continued)

UNIT NO.	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (If a code is not entered in D(1))
1	D001	0 to 40000	P	S01 S02	TANK BOTTOMS
2	D008	[illegible]	P	S01 S02	TANK BOTTOMS
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

Continued from the front.

. DESCRIPTION OF HAZARDOUS WASTES *(continued)*

. USE THIS SPACE TO LIST ADDITIONAL OCESS CODES FROM ITEM D(1) ON PA

EPA I.D. NO. *(enter from page 1)*	
NCD075550517	36

FACILITY DRAWING

existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail).*

I. PHOTOGRAPHS

ll existing facilities must include photographs *(aerial or ground—level)* that clearly delineate all existing structures; existing storage, eatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail).*

II. FACILITY GEOGRAPHIC LOCATION

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*
3506-18	77 06-08

III. FACILITY OWNER

X A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE
	G	I	

. OWNER CERTIFICATION

ertify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached ocuments, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the bmitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, cluding the possibility of fine and imprisonment.

A. NAME *(print or type)*	B. SIGNATURE	C. DATE SIGNED
C. A. REISDORF, VICE PRESIDENT	C. A. Reisdorf	NOV 14 1980

. OPERATOR CERTIFICATION

ertify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached cuments, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the bmitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, cluding the possibility of fine and imprisonment.

A. NAME *(print or type)*	B. SIGNATURE	C. DATE SIGNED
C. A. REISDORF, VICE	[illegible]	NOV 14 1980

~~SH~~
PART A
SUB

U 0 0 3 1 2

U 0 0 2 5 9

TEXACO

PETROLEUM PRODUCTS

RECEIVED
EPA/REGION IV

RECEIVED
EPA/REGION IV

MAR 25 12 30 PM '81

ENVIRONMENT
DIVISION

TEXACO INC.
P. O. BOX 4582
ATLANTA, GEORGIA 30302
404-321-4411

March 23, 1981

ENV-RCRA

EPA Region IV
RCRA Activities
Mr. R. M. Tallini
345 Courtland Street
Atlanta, Georgia 30365

Dear Mr. Tallini:

This is with reference to our phone conversation on Friday, March 20, 1981, on the following Hazardous Waste Permit Applications.

	EPA ID #	PAGE 3, LINE 1 COLUMN B
Greensboro, N.C.	NCD096165121	66000
Fayetteville, N.C.	NCT000623199	66000
New Bern, N.C.	NCD075550517	40000
Williamston, N.C.	NCT000623223	40000
Apex, N.C.	NCD086326741	50000
Paw Creek, N.C.	NCD046148318	66000

With reference to page 3 of 5 on all of the above, the amount shown in Column on line one (1) is listed as 0 to 66000, 0 to 50000, etc. The reason for this is that this is tank bottoms, and these tanks are cleaned about every three (3) to five (5) years, so some years we will have zero (0) waste and some years we will have the limit shown. Since you must have a figure for the computer, I have shown the figure to the right of those listed above which is the same figure shown on page 3, line 1, Column B.

All of the above should have the phrase "INCLUDED ABOVE" on page 3, line 2, Column D.2.

I think this corrects the items that we talked about.

This office is being closed as of March 31, 1981, and all the activities will be handled from our Bellaire, Texas office.

For future contacts on the above, please write or call the following: W. O. Hardin, Environmental Protection Coordinator, Texaco Inc., P.O. Box 430, Bellaire, Texas 77401. Phone 713-666-8000.

Yours very truly,

TEXACO INC.

RESPONDENT CONTACT RECORD (RCR)

FACILITY ID NUMBER	COMPANY NAME
UC1075550517	Texaco USA New Bern

COMPANY ADDRESS	CITY	STATE ABBREV.	ZIP CODE

CONTACT PERSON'S NAME/TITLE	TELEPHONE NUMBER (INCLUDE AREA CODE)
W. O. Hardin Env. Prot. Coord	

CONTACT RECORD

DATE	CONTRACTOR'S INITIALS	ITEMS DISCUSSED/RESOLUTION
3-20	rnd	3 IV
		the forms refer to storage tanks of leaded gasoline.
		the tanks are cleaned every 3-5 years and therefore
		the annual quantities are zero or very high. when informed
		of the data processing needs to have only one figure, Mr
		Hardin said to go with the upper figure. the D008
		waste is in each case included with the D001.
		as of 1 April the Atlanta office is moving to Houston
		Mr Hardin is to mail a letter confirming our conversation
		of the above issue and to provide a new facility mailing
		address and phone #.

REFERENCE 7

Ronald H. Levine, M.D., M.P.H.
STATE HEALTH DIRECTOR

DIVISION OF HEALTH SERVICES
P.O. Box 2091
Raleigh, N.C. 27602-2091

September 17, 1982

Mr. W. H. Hudspeth
Environmental Protection Coordinator
Texaco, U.S.A.
P.O. Box 430
Bellaire, Texas 77401

Dear Mr. Hudspeth:

In a conversation a few days ago with Mr. W. O. Hardin, I found that Texaco has closed its terminals in New Bern (NCD075550517) and Williamston, N.C. (NCD000623223). Unless there is some special reason for not doing so, we will remove these two locations from our list of hazardous waste generators.

We hope this procedure will be satisfactory to you. If not, please advise us promptly.

Sincerely,

Keith Lawson

Keith Lawson, Environmental Chemist
Solid & Hazardous Waste Management Branch
Environmental Health Section

KL:lc

cc: Mr. Emil Breckling

REFERENCE 8

Reference 8

Ronald H. Levine, M.D., M.P.H.
STATE HEALTH DIRECTOR

DIVISION OF HEALTH SERVICES
P.O. Box 2091
Raleigh, N.C. 27602-2091

March 13, 1984

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. W. H. Hudspeth
Texaco, Inc.
P.O. Box 430
Bellaire, Texas 77401

Re: NCD075550517

Dear Mr. Hudspeth:

On November 16, 1983, in response to a formal call for part B of a permit application, an officer of your company advised this Branch that a part B application would not be filed. Following this, on January 29, 1984 and February 1, 1984, the Solid and Hazardous Waste Management Waste Management Branch of the Department of Human Resources published a legal notice in the Raleigh papers, announcing its intention to deny a permit and terminate interim status for a number of plants, including yours.

You are now advised that this plant has been denied a permit as a hazardous waste treatment, storage, or disposal facility and its interim status has been formally terminated. As of March 30, 1984, the operators of it may not treat or dispose of hazardous waste, nor store it for more than 90 days from the of accumulation.

If you have any questions about this matter, please call or write to Mr. Keith Lawson at this office.

Very sincerely,

Co. W. Strickland, Head
Solid and Hazardous Waste Management Branch
Environmental Health Section

OWS/KL: tl

PERMITTING ACTION LOG ADDITIONS/DELETIONS/MODIFICATIONS

CODE	PRO	PERMITTING ACTION	DATE
C		Due 5/1/84	11/4/83
RW		Declined to file Part B	11/16/83
ID		Legal notice published	1/29/84
PD		Letter denying permit	3/13/84

(4) Report of a specific facility ID ☐

(5) Monthly report for EPA ☐

(6) Report of a specific process code ☐

(7) Report of a specific action code ☐

ENTERED
JUN 7 1984
DATA PROCESSING

FACILITY NAME Texaco, Inc.

EPA ID # NCD 075 550 517

PERSON REQUESTING ENTRY K. Lawson

DATE 6/5/84

PROCESS CODES

REFERENCE 9

SWISS BEAR
200-208 EAST FRONT STREET
NEW BERN, NC

Reference 9

Nancy Bottorf - Director of Parks & Recreation for City of New Bern (919-636-4060)

Danny Meadows - Director of Public Works

Think there was a gas station.

Two buildings. One was a warehouse.

LWCF Grant to turn property into park.
(land & water conservation fund).

Texaco parcel was given to the city. The other two parcel were owned by Swiss Bear (downtown redevelopment firm). City purchased the two parcels at a low cost.

Texaco parcel was possibly 1 acre.

Grant through Dept. of Interior but managed locally at the state level. Present recreation consultant is Jack Frauson. out of Wilmington.

Eventually would like to develop 75 feet in front of water line. Make ~~it~~ waterfront accessible to the public.

Cement pad very thick and would have taken months to remove it. City regraded property and planted grass on top of it.

EA done for development of park. Get a copy from Nancy.

Agricultural Extension Service: 70 West. Industrial Park (Clark St). At top of ramp turn right. Past Mack truck complex, turn right.

Texaco → 4 to 5 above ground tanks for bulk storage.

Company out of New York removed tanks. Pads underneath tanks were not removed. Tanks taken to Clark Agriculture.

When grading occurred, stained soils or sludges were not noticed.

Park now for passive recreation. Addition to Union Point Park. Referred to Duffy park.

Susan Moffit - Director of Swiss Bear. (919-638-5781). On Middle Street.

Hooked up to city water. City gets water from wells from Cove City.

To Danny's knowledge, there were no USTs.

Harvey will give us contact for Clean sites.

Water supply data.
Panamic picture for Monarch Furniture.

Water supply → Cove City
70 W (ByPass) toward Kinston. Get off at Cove City exit.
Randy Gould - Ex. City Eng.
Bill Rayburn 636-4004
Serves Trent Woods and town of Cove City and industrial park, as well as City of New Bern. Sells H_2O to Township 7.

Wells 13 miles in Cove City.

County will have their own wells put in the cove city area.

Swiss Bear 10/4/90
200-208 East Front St.

Leaded tank sludges potentially buried on-site.

Operational 1952 - 1979? by Texaco Inc

Property sold 6/15/83 to Swiss Bear Inc. & City of New Bern

leaded gasoline tanks - tanks are cleaned every 3-5 years

Interview Nancy Botorff - Director of Parks & Recreation
Danny Meadows

Front Part of property may have been a gas station
2 buildings onsite one may have been warehouse
WLCF grant - turned into a park 1985-1986 - got the

3 parcels -
Texaco given to City of New Bern
2 parcels to development Swiss Bear agency.

Texacco property ⇒ acre to two

Total Park - Union Point ⇒ 2 acres

Bulk Storage 4-5 above ground tanks -
gave property -
Contracted company to move bulk tanks.

City of New Bern

Tanks moved to and by Department of Agriculture to be reused.

Making park ~~be~~ put 3 foot of fill

Park extension of Union Park.

Susan Moffitt ⇒ w/ Swiss Bear
638-5781 - Middle street

City water system
City sewer system

City water from cook city - Castle Hayne
Grand water wells
Cove City pump from,

no underground tanks - found when developing the property.

2 buildings on the site
empty demolished.

Tanks were on cement pads.
grass in between -
grass growing.

Environmental Assessment performed
prior to development.

Go west 7 miles
Industrial Park complex (CLACKS)
turn Right at ramp
after Macks truck turn to
Right
get to rail road tracks turn to gun
Agriculture Extension Agency

Water supply for New Bern
70 West towards Kinston
Cave City Exit.

Treadtwoods
Cave City
New Bern
Industrial Park
} City water system.

sell water to
Township 7 - spring water.

Administration City.

wells in Cave City approx. 13 miles away.

Trent woods borders New Bern
1-Mile

County wells - Cave City Area.
2-3 outside of Cave City.

Randy Gould
Bill Rayband - 636-4004
City Engineer

REFERENCE 10

United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
United States Department of
Agriculture, Forest Service,
North Carolina Agricultural
Research Service,
North Carolina Agricultural
Extension Service,
North Carolina Department of
Natural Resources and
Community Development, and
Craven County Board of
Commissioners

Soil Survey of Craven County, North Carolina

Reference 10

Soil Survey of Craven County, North Carolina

By Roy A. Goodwin, Jr., Soil Conservation Service

Soils surveyed by Roy A. Goodwin, Jr., J. Michael Ortosky, Jr., John A. Gagnon, Jr., Peter T. Kleto, Van S. Jenkins, L.L. Mallard, and J.A. Meadows, Soil Conservation Service; and Gina Boccetti, North Carolina Department of Natural Resources and Community Development

United States Department of Agriculture, Soil Conservation Service
In cooperation with
United States Department of Agriculture, Forest Service,
North Carolina Agricultural Research Service,
North Carolina Agricultural Extension Service,
North Carolina Department of Natural Resources and Community Development,
and Craven County Board of Commissioners

CRAVEN COUNTY is in the Lower Coastal Plain of eastern North Carolina. In 1980, the U.S. Census reported a county population of 71,043. About two-thirds of the population live in and around New Bern, the county seat, and Havelock, which includes the Cherry Point U.S. Marine Corps Air Station. In 1980, the population in Township 8, the New Bern area, was 24,645; in Township 6, the Havelock-Cherry Point area, it was 21,963.

The county has a land area of 464,000 acres, or 725 square miles. According to data collected by the North Carolina Agricultural Extension Service in 1981, more than 72,000 acres was used as cropland. Most of the remaining acreage was in woodland. There is 60,933 acres of the Croatan National Forest in Craven County. The Cherry Point U.S. Marine Corps Air Station covers an 18 square mile area in the southern part of the county.

General Nature of the Survey Area

This section gives general information concerning the county. It discusses physiography and drainage, history and development, water supply, and climate.

Physiography and Drainage

Craven County is drained by the Neuse and Trent Rivers. The flow is sluggish in the rivers and their tributaries. The general slope of the county is to the southeast. According to the U.S. Geologic Survey topographic maps, elevation ranges from 63 feet above sea level at Dover to less than 5 feet in marshes and flood plains in the central and southeastern parts of the county. About 88 percent of the land is nearly level, 11 percent is gently sloping, and less than 1 percent is sloping to moderately steep.

The major physiographic areas in Craven County are the uplands of the Wicomico surface, the uplands of the Talbot surface, the flood plains along streams, and the stream terraces.

On the uplands of the Talbot and Wicomico surfaces, large areas of poorly drained and very poorly drained soils are on broad, nearly level interstream divides. Near the streams, nearly level and somewhat poorly drained soils grade into gently sloping, moderately well drained and well drained soils. Short, moderately steep side slopes are beside some larger drainageways (fig. 1).

Organic soils are in large pocosins in the southern part of the county and in other scattered areas. The surface appears flat, but an imperceptible slope extends from the

INSERT ILLUS. 7A

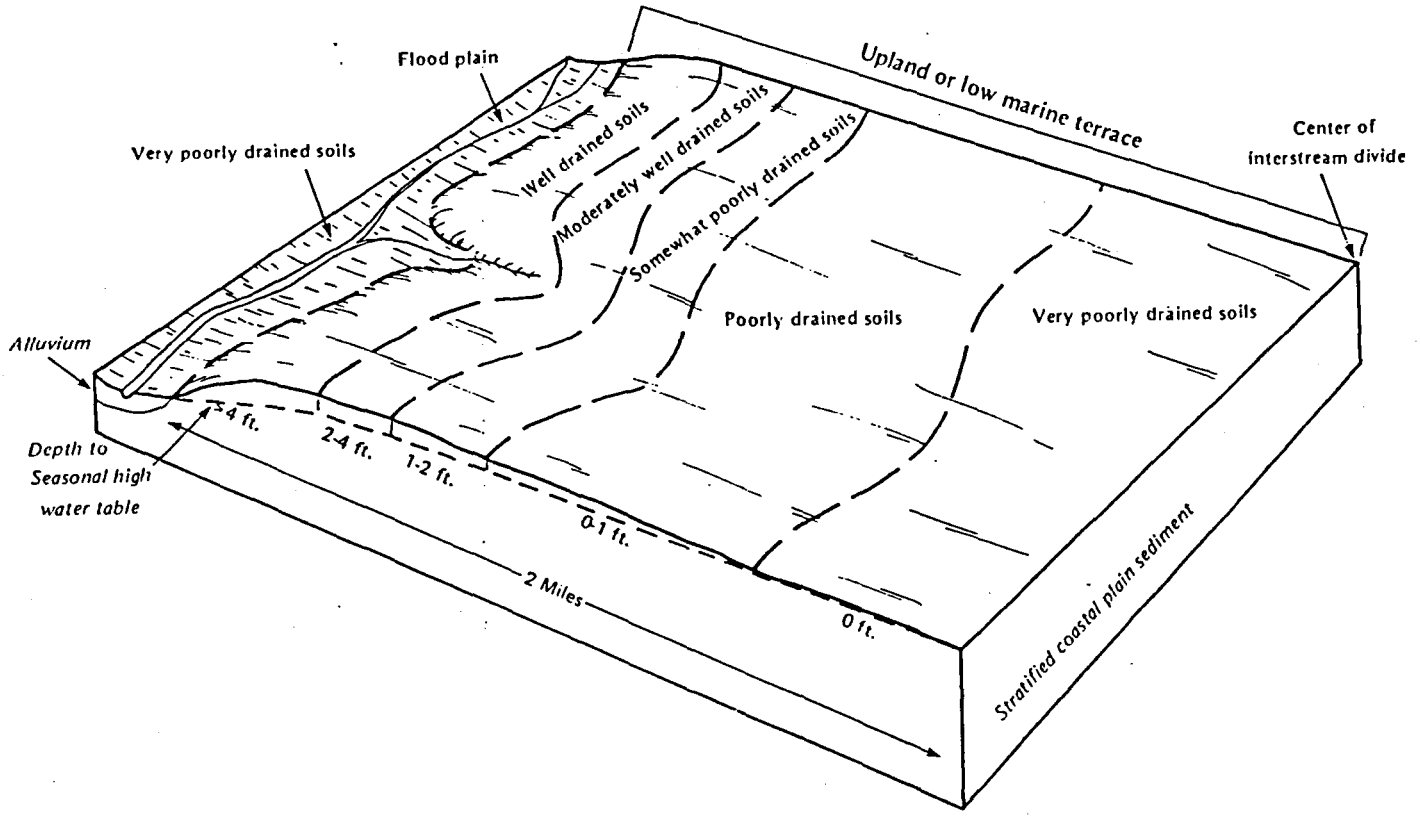


Figure 1.—Typical landscape position and drainage class relationships of soils from a drainageway to the center of a broad interstream divide. The seasonal high water table approaches the surface as distance from the drainageway increases.

center outward. In these places, surface runoff is very slow, the underlying material is slowly permeable, and rainfall exceeds evapotranspiration by about 19 inches a year *(7)*. These factors favor the accumulation of layers of organic material.

Nearly level, poorly drained and very poorly drained soils are on flood plains along the streams. Broad stream terraces are along the rivers and the larger creeks in the southeastern, central, and west-central parts of the county. On these terraces, excessively drained to very poorly drained soils are on nearly level to gently sloping ridges and nearly level flats and in depressions.

About 38 percent of the soils in Craven County is very poorly drained, 26 percent is poorly drained, 10 percent is somewhat poorly drained, 16 percent is moderately well drained, 7 percent is well drained, and 3 percent is excessively drained or somewhat excessively drained. The remaining 1 percent is urban land, pits, or small areas of water.

History and Development

Craven County was inhabited by the Tuscarora Indians when the first European settlers arrived in 1707. The first permanent settlements were made in 1710 by Germans and Swiss at New Bern and by Welsh Quakers near Hancock and Clubfoot Creeks *(14)*. After the Tuscarora War of 1711, Scotch and English settlers came from Virginia and other parts of North Carolina.

In 1712, Craven Precinct was established and named in honor of Lord William Craven, an English nobleman. The precinct became Craven County in 1722. New Bern, the county seat, was incorporated in 1723 and is the second oldest city in North Carolina. From 1737 to 1792, the city served as the colonial capital of North Carolina. Tryon Palace, completed in 1770, was used as the governor's residence and state house *(8)*. It has been restored and is a major tourist attraction.

Early agriculture in the county consisted of the production of corn, peas, wheat, oats, rice, and potatoes, and the raising of cattle, hogs, and sheep. By 1880, the leading crops were corn, cotton, sweet potatoes, rice,

oats, and wheat. In the early 1900's, the cotton acreage decreased because of the boll weevil, and tobacco and corn were the main crops. The soybean acreage also began to increase during this period.

Forest products have been a major part of the county's economy since the colonial period. Tar, pitch, and turpentine were produced in great quantity until about 1900, when most of the longleaf pine had been harvested. In 1979, the North Carolina Forest Service reported that 65 million board feet of logs for lumber, plywood, and veneer were harvested. Pulpwood production was 204,000 cords.

Early in the history of Craven County, New Bern was a thriving port and one of the largest towns in North Carolina. Large amounts of locally grown crops, naval stores, lumber, beef, pork, hides, furs, and other goods were exported. After the Civil War, New Bern became less important as a port. Other parts of the county became more populated as better roads and railroads replaced water as the principal means of transporting goods. As methods of farming and forestry became more efficient, many people moved away from the farms, and the county became more industrialized. The development of the Cherry Point U.S. Marine Corps Air Station made Havelock the fastest growing city in the state in the 1940's. National defense continues to be a major factor in the local economy *(14)*.

Water Supply

Ground water is plentiful throughout the survey area. It is near the surface in most places, particularly in winter and early in spring. On many farms, excavated ponds supply water for irrigation, livestock, and recreation. Most of the inactive borrow pits contain water, and several large lakes are in the southern part of the county.

Thousands of feet of sedimentary deposits underlie the soils of the survey area. The upper part of these deposits contains aquifers that supply the county's well water. The surficial aquifer ranges from the water table down to a maximum of about 60 feet. It is thicker in the southern part of the county. Earlier in the development of Craven County, this aquifer was the main source of small domestic water supplies. The use of shallow wells has decreased considerably because of small yield, frequent high content of dissolved iron, and the risk of contamination. The Castle Hayne Formation supplies most wells across the county. This aquifer is thin near the Lenoir and Pitt County lines but ranges up to 700 feet thick along the Carteret County line. In the upper part of this aquifer, the water is generally hard and often high in dissolved iron. In the lower part, the water is low in iron but is salty in some places, particularly in the southern part of the county. Because of the salty water in this aquifer, New Bern installed deep wells near Cove City. These wells draw large quantities of water with excellent chemical quality from the Black Creek Formation and the upper part of the Tuscaloosa Formation. However, this aquifer is not used east of Cove City because of its depth and probable content of salty water *(9)*.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Craven County is hot and humid in summer, but the coast is frequently cooled by sea breezes. Winter is cool and has occasional, brief cold spells. Rainfall occurs throughout the year and is fairly heavy at times. Annual precipitation is adequate for all crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at New Bern in the period 1951 to 1977. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 46 degrees F, and the average daily minimum temperature is 35 degrees. The lowest temperature on record, which occurred at New Bern on February 13, 1973, is 7 degrees. In summer the average temperature is 78 degrees, and the average daily maximum temperature is 89 degrees. The highest recorded temperature, which occurred at New Bern on June 27, 1954, is 106 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a 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.

The total annual precipitation is 54.5 inches. Of this, 33 inches, or 60 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 28 inches. The heaviest 1-day rainfall during the period of record was 12.23 inches at New Bern on September 19, 1955. Thunderstorms occur on about 50 days each year, and most occur in summer.

The average seasonal snowfall is 2 inches. The greatest snow depth at any one time during the period of record was 10 inches. Days with at least 1 inch of snow is on the ground are rare.

The average relative humidity in midafternoon is about 65 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 60 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 10 miles per hour, in spring.

Hurricanes occasionally cross the area. Records show that 12 have caused severe flooding and extensive damage in New Bern since 1902. In 5 of these, the flood

pepperbush, waxmyrtle, American holly, Virginia creeper, honeysuckle, sweetbay, bitter gallberry, blueberry, greenbrier, switchcane, poison-ivy, and Carolina jessamine. There are no major limitations for woodland use and management.

Seasonal wetness and rare flooding of low-lying areas limit the use of this soil as sites for buildings, sanitary facilities, and recreation. Wetness can be reduced by a drainage system that includes land grading for surface drainage and by the use of tile and open ditches. The hazard of flooding should be determined before planning the use and management of specific sites.

This Augusta soil is in capability subclass IIIw. The woodland ordination symbol is 9W.

Ap—Arapahoe fine sandy loam. This soil is nearly level and very poorly drained. It is on broad flats and in depressions on stream terraces along the Neuse River, Trent River, and the larger creeks in the southeastern, central, and northwestern parts of the county. The areas are irregular in shape and range from 5 to 500 acres.

Typically, the surface layer is black fine sandy loam 16 inches thick. The subsoil is dark grayish brown and grayish brown fine sandy loam to a depth of 41 inches. The substratum to a depth of 80 inches is gray fine sandy loam and loamy sand.

Permeability is moderately rapid. The surface layer, subsoil, and the upper part of the substratum range from extremely acid to strongly acid except where lime has been added. The lower part of the substratum ranges from medium acid to mildly alkaline. The seasonal high water table is at or near the surface. The soil in depressions is subject to frequent ponding for brief to long periods unless a drainage system has been installed. This soil is subject to rare flooding.

Included with this soil in mapping are small areas of the Deloss, Murville, Ponzer, Tomotley, and Leon soils. The Deloss and Murville soils are very poorly drained and occur at random within the map unit. The Ponzer soils are very poorly drained and are in depressions. The Tomotley and Leon soils are poorly drained and are in slightly higher areas than the Arapahoe soil. The included soils make up about 10 to 20 percent of this map unit.

Most of the acreage of this Arapahoe soil is native woodland. Small acreages are used as cropland.

The dominant trees on this soil are loblolly pine, sweetgum, blackgum, yellow-poplar, swamp chestnut oak, red maple, willow oak, water oak, pond pine, and baldcypress. The understory plants include redbay, sweetbay, American holly, bitter gallberry, large gallberry, fetterbush, sweet pepperbush, switchcane, waxmyrtle, blueberry, huckleberry, titi, honeysuckle, Virginia chainfern, grape, Virginia creeper, cinnamon fern, poison-ivy, and greenbrier. Trees grow well on this soil, however, wetness is a limitation to commercial woodland management. Areas managed for loblolly pine are ditched and bedded. Fertilizer is also used in some plantations.

This soil has been intensively drained in cultivated areas and is used for corn, soybeans, and wheat. Drainage systems include open ditches and tile. The sandy substratum causes ditchbank caving and makes ditch maintenance difficult. Suitable outlets are not available for drainage of some low-lying areas. Land grading improves surface drainage by eliminating depressions in which water ponds.

This soil generally is not used as sites for buildings, sanitary facilities, or recreation because of wetness, ponding, and rare flooding.

This Arapahoe soil is in capability subclass VIw (undrained) and IIIw (drained). The woodland ordinatior symbol is 10W.

AuB—Autryville loamy sand, 0 to 6 percent slope This soil is well drained. It is on gently undulating ridges on uplands near large drainageways mainly along the Trent and Neuse Rivers. The areas are irregular in shap and range from 5 to 500 acres.

Typically, the surface layer is grayish brown loamy sand 5 inches thick. The subsurface layer is light yellowish brown loamy sand to a depth of 29 inches. Tl subsoil to a depth of 37 inches is yellowish brown sanc loam. The next layer is very pale brown sand. Below that, the subsoil is brownish yellow sandy loam and loamy sand to a depth of 69 inches. The substratum to depth of 80 inches is yellow sand and brownish yellow loamy sand.

Permeability of the subsoil is moderately rapid, and tl available water capacity is low. The soil is very strongly acid or strongly acid except where lime has been adde It does not have a water table within a depth of 5 feet. Wind erosion is a hazard in areas not protected by plar cover.

Included with this soil in mapping are small areas of Norfolk and Goldsboro soils. The Norfolk soils are well drained and occur at random within the map unit. The Goldsboro soils are moderately well drained and are in slightly lower areas than the Autryville soil. Some areas of wet soils are in depressions. These areas are smalle than 4 acres and are shown on the map with a special symbol. The included soils make up about 10 to 15 percent of this map unit.

This Autryville soil is mainly used as woodland. In a few areas, it is used as pasture or cropland.

Loblolly pine, longleaf pine, southern red oak, Shumard oak, hickory, red maple, sweetgum, white oak and post oak are dominant on this soil. The understory plants include flowering dogwood, sourwood, turkey oa blueberry, Virginia creeper, bitter gallberry, waxmyrtle, sassafras, grape, sweetbay, redbay, American beautyberry, threeawn grass, and poison-ivy. The main limitation for woodland use and management is droughtiness.

This Roanoke soil is used mainly as woodland. In a few areas, it is used as pasture or cropland.

The dominant trees on this soil are loblolly pine, pond pine, blackgum, sweetgum, water oak, swamp chestnut oak, red maple, yellow-poplar, and willow oak. The common understory plants include redbay, sweetbay, American holly, switchcane, sweet pepperbush, greenbrier, waxmyrtle, bitter gallberry, large gallberry, fetterbush, honeysuckle, blueberry, huckleberry, poison-ivy, sweetleaf, grape, Virginia chainfern, cinnamon fern, Virginia creeper, and Carolina jessamine. Wetness is the main limitation for woodland use. Logging when this soil is wet causes deep ruts, compaction, poor surface drainage, and lower productivity. Areas managed for loblolly pine are generally ditched and bedded. Fertilizer is also used in many plantations.

Corn, soybeans, and wheat are the main crops on this soil. Wetness is a major limitation. Because the slowly permeable subsoil limits internal drainage, open ditches and land grading for surface drainage are used to reduce wetness. Tile is generally not used. Tillage needs to be avoided if the soil is wet because soil structure is destroyed and large clods form, resulting in ponding and a poor seedbed. Pasture forages include tall fescue and ladino clover.

This soil is generally not used as sites for buildings, sanitary facilities, or recreation because of seasonal wetness, slow permeability, moderate shrink-swell potential, and the clayey subsoil.

This Roanoke soil is in capability subclass IVw (undrained) and IIIw (drained). The woodland ordination symbol is 9W.

Sc—Seabrook-Urban land complex. This complex consists of Seabrook soil and Urban land. A typical mapped area is about 50 percent Seabrook soil and 30 to 40 percent Urban land. The Seabrook soil is nearly level and moderately well drained. It is in slightly convex areas on stream terraces of the Neuse and Trent Rivers. The Urban land is in the city of New Born. The areas are irregular in shape and range from 10 to 250 acres.

Typically, Seabrook soil has a dark brown loamy sand surface layer 6 inches thick. The underlying material to a depth of 80 inches is light yellowish brown loamy sand in the upper part. The middle part is very pale brown sand that has light gray mottles, and the lower part is light gray sand.

Permeability is rapid, and the available water capacity is low. The soil ranges from very strongly acid to slightly acid except where lime has been added. The seasonal high water table is 2 to 4 feet below the surface except in drained areas. Low-lying areas of this soil are subject to rare flooding. Surface runoff from rooftops and paved areas increases the hazard of flooding in low-lying areas.

Urban land consists of areas covered with buildings, streets, driveways, and parking lots.

Included with this complex in mapping are small areas of Tarboro, Altavista, and Augusta soils. The Tarboro soils are somewhat excessively drained and are slightly higher on the landscape than Seabrook soil. The Altavista soils are moderately well drained, and the Augusta soils are somewhat poorly drained. These soils occur at random within the mapped areas. Also included are small cut and fill areas where the natural soil has been altered or covered. These areas are commonly adjacent to the Urban land. The included soils make up about 10 to 20 percent of this map unit.

Seasonal wetness, seepage, and the hazard of rare flooding in low-lying areas are major limitations to the use of the Seabrook soil for building site development and sanitary facilities. Drainage systems have generally been installed where needed but low-lying areas can flood during severe storms. Summer droughtiness is a limitation in establishing and maintaining lawns and shrubs. Onsite investigation is needed before planning use and management of specific sites.

This complex has not been assigned to a capability subclass. There is no woodland ordination for the soil in this map unit.

Se—Seabrook loamy sand. This soil is nearly level and moderately well drained. It is in slightly convex areas on stream terraces mainly in the central and northwestern parts of the county along the Neuse River, Trent River, and the larger creeks. The areas are irregular in shape and range from 5 to 200 acres.

Typically, the surface layer is dark brown loamy sand 6 inches thick. The underlying material to a depth of 80 inches is light yellowish brown loamy sand in the upper part. The middle part is very pale brown sand that has light gray mottles, and the lower part is light gray sand.

Permeability is rapid, and the available water capacity is low. The soil ranges from very strongly acid to slightly acid except where lime has been added. The seasonal high water table is 2 to 4 feet below the surface. Low-lying areas of this soil are subject to rare flooding. Wind erosion is a hazard in areas that are not protected by plant cover.

Included with this soil in mapping are small areas of Altavista, Augusta, Conetoe, Leon, and Tarboro soils. The Altavista soils are moderately well drained, the Augusta soils are somewhat poorly drained, and the Leon soils are poorly drained. These soils occur at random within the mapped areas. The Conetoe soils are well drained, and the Tarboro soils are somewhat excessively drained. These soils are on low ridges. Some areas of wet soils in depressions smaller than 4 acres are shown on the map with a special symbol. The included soils make up about 10 to 15 percent of this map unit.

This Seabrook soil is used mainly as woodland. In a few areas, it is used as pasture or cropland.

the landscape than the Tomotley soil. The Roanoke soils are poorly drained, and they occur at random within the mapped areas. The Deloss soils are very poorly drained and are in depressions. The included soils make up about 10 to 20 percent of this map unit.

This Tomotley soil is used mainly as woodland. In a few areas, it is used as pasture or cropland.

The dominant trees on this soil are loblolly pine, pond pine, red maple, sweetgum, yellow-poplar, blackgum, water oak, swamp chestnut oak, and willow oak. The common understory plants include bitter gallberry, large gallberry, fetterbush, switchcane, sweet pepperbush, greenbrier, sweetleaf, American holly, blueberry, huckleberry, sweetbay, redbay, waxmyrtle, Virginia creeper, honeysuckle, poison-ivy, Carolina jessamine, Virginia chainfern, and cinnamon fern. Wetness is the main limitation for woodland use and management. Areas managed for loblolly pine benefit from ditching and bedding.

The principal crops on this soil are corn, soybeans, and wheat. Small acreages are used for cabbage and potatoes. Because of wetness, a drainage system that includes open ditches, tile, and land grading for surface drainage is needed. Pasture forages include tall fescue and ladino clover.

Seasonal wetness and rare flooding of low-lying areas limit the use of this soil as sites for buildings, sanitary facilities, and recreation. However, some areas that have intensive drainage systems including tile, open ditches, and land grading for surface drainage have been developed. The hazard of flooding should be determined before planning use and management of specific sites.

This soil is in capability subclass IVw (undrained) and IIIw (drained). The woodland ordination symbol is 10W.

To—Torhunta fine sandy loam. This soil is nearly level and very poorly drained. It is on broad flats and in depressions on uplands. Some of the larger areas of this soil are in the vicinity of Dover and Havelock. The areas are irregular in shape and range from 5 to 2,000 acres.

Typically, the surface layer is black fine sandy loam 12 inches thick. The subsoil is dark grayish brown sandy loam to a depth of 37 inches. The substratum to a depth of 80 inches is grayish brown loamy sand.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the substratum. The soil ranges from extremely acid to strongly acid except where lime has been added. The seasonal high water table is at or near the surface. Water ponds in depressions for brief to long periods except where drainage systems have been installed.

Included with this soil in mapping are small areas of Pantego, Murville, Leon, and Rains soils. The Pantego and Murville soils are very poorly drained. Occurring at random within the mapped areas are these soils and some areas of wet soils that have a black surface layer more than 24 inches thick or that have clayey substratum. The Leon and Rains soils are poorly drained and are slightly higher on the landscape than the Torhunta soil. The included soils make up about 10 to 20 percent of this map unit.

This Torhunta soil is used mainly as woodland. In a few areas, it is used as pasture or cropland.

The dominant trees on this soil are loblolly pine, pond pine, water oak, yellow-poplar, sweetgum, blackgum, swamp chestnut oak, red maple, willow oak, and baldcypress. Hardwoods are dominant in depressions that are ponded for long periods. The common understory plants include redbay, loblolly bay, fetterbush, sweet pepperbush, switchcane, waxmyrtle, bayberry, greenbrier, bitter gallberry, large gallberry, sweetleaf, blueberry, huckleberry, Virginia creeper, honeysuckle, poison-ivy, American holly, Virginia chainfern, titi, cinnamon fern, and honey cup. Wetness is the main limitation for commercial woodland use and management. Areas managed for loblolly pine need ditching and bedding. Fertilizer is also used in many plantations.

Corn, soybeans, and wheat are the major crops on this soil. Wetness is the main limitation; however, this limitation can be reduced by a drainage system that includes land grading to eliminate depressions in which water ponds and by the use of tile and open ditches. The sandy substratum causes ditchbank caving, and ditches are difficult to maintain. Also, suitable outlets may not exist for drainage of depressions. Pasture forages include tall fescue and ladino clover.

Seasonal wetness and ponding in depressions limit the use of this soil as sites for buildings and sanitary facilities. A few areas that have intensive drainage systems, including land grading for surface drainage, open ditches, and tile, have been developed. The sandy substratum causes ditchbank caving, and ditches are difficult to maintain. This soil generally is not used for recreational activities because of wetness.

This Torhunta soil is in capability subclass VIw (undrained) and IIIw (drained). The woodland ordination symbol is 9W.

TuB—Tarboro-Urban land complex, 0 to 6 percent slopes. This complex consists of Tarboro soil and Urban land. A typical mapped area consists of about 50 percent Tarboro soil and 30 to 40 percent Urban land. Tarboro soil is somewhat excessively drained. It is on gently undulating, low ridges on stream terraces of the Neuse and Trent Rivers. The Urban land is in the city of New Bern. The areas are irregular in shape and range from 20 to 200 acres.

Typically, Tarboro soil has a dark grayish brown sand surface layer 5 inches thick. The underlying material to a depth of 80 inches is brownish yellow and yellow sand.

Permeability is rapid or very rapid, and the available water capacity is low. The soil ranges from strongly acid to slightly acid except where lime has been added. It

does not have a water table within a depth of 6 feet. Low-lying areas of this soil are subject to rare flooding. Surface runoff from rooftops and paved areas increases the hazard of flooding in low-lying areas.

Urban land consists of areas covered with buildings, streets, driveways, and parking lots.

Included with this complex in mapping are small areas of Seabrook, State, and Conetoe soils. The Seabrook soils are moderately well drained, and the Conetoe and State soils are well drained. These soils are slightly lower on the landscape than the Tarboro soil. Also included are small cut and fill areas where the natural soil has been altered or covered and the slope has been modified. These areas are commonly adjacent to the Urban land. The included soils make up about 10 to 20 percent of this map unit.

The areas of this Tarboro soil above 12 feet in elevation are limited as sites for buildings only because of caving of cutbanks. Seepage is a major limitation for sanitary facilities, and the sandy surface layer is a major limitation for recreational uses. Droughtiness in the summer can be a problem in establishing and maintaining shrubs. In low-lying areas of this soil, flooding can cause damage. Onsite investigation is needed before planning use and management of specific sites.

This complex has not been assigned to a capability subclass. There is no woodland ordination symbol for the soil in this map unit.

Ud—Udorthents, loamy. This map unit consists of nearly level to gently sloping borrow areas and landfills. The nature of each area is labeled on the soil map. Some areas are currently active and are unvegetated. Other areas are inactive and have been revegetated. The covering layer is generally shaped for surface drainage in landfill areas. The areas are generally rectangular in shape and range from 10 to 100 acres.

In landfills, the covering layer of soil is typically about 3 feet thick, variable in color, and has a sandy or loamy texture. In borrow areas, the soil is typically loamy or sandy sediment of variable color.

The soil material has little or no organic matter. Permeability is moderate, and the available water capacity is low. Infiltration is moderate, and surface runoff is slow. The soil generally ranges from extremely acid to strongly acid except where lime has been added. Depth to the seasonal high water table is variable.

Most areas are revegetating with native plants, such as loblolly pine, broomsedge, and dogfennel. Closed landfills are planted to grass.

The soil in this map unit generally is not used as sites for buildings or recreational activities. Onsite investigation is needed to properly evaluate and plan the development of specific areas.

This map unit has not been assigned to a capability subclass. There is no woodland ordination symbol for the soil in this map unit.

Ur—Urban land. This map unit consists of areas where more than 75 percent of the land is covered by buildings, runways, military facilities, streets, driveways, and parking lots. These areas are in the cities of New Bern and Havelock and at Cherry Point Marine Corps Air Station. The areas range from 5 to 850 acres. Slope ranges from 0 to 2 percent.

The natural soil has been greatly altered by cutting, filling, grading, and shaping. The original landscape, topography, and commonly the drainage pattern have been changed. The soil between facilities is used for lawns, playgrounds, cemeteries, parks, or drainageways.

The major problem on Urban land is excessive surface water runoff from roofs, streets, runways, and parking lots. The runoff increases the hazard of flooding in low-lying areas. Onsite investigation is needed before planning the use and management of specific sites.

Urban land is not assigned a capability subclass. There is no woodland ordination symbol for the soil in this map unit.

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data recorded in the period 1951-77 at New Bern, North Carolina]

Month	Temperature						Precipitation				
	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*	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	Units	In	In	In		In
January----	56.7	33.7	45.2	78	12	87	3.89	2.30	5.31	8	0.7
February---	59.2	34.9	47.1	80	13	68	4.07	2.81	5.22	7	1.2
March------	66.0	40.8	53.4	86	22	189	3.72	2.44	4.87	8	0.5
April------	76.1	49.1	62.6	93	30	378	2.98	1.61	4.09	6	0.0
May--------	82.4	57.6	70.1	96	38	623	4.19	2.76	5.48	8	0.0
June-------	87.5	64.9	76.2	99	48	786	5.00	2.62	6.93	8	0.0
July-------	89.9	68.8	79.4	99	55	911	7.69	4.14	10.58	11	0.0
August-----	88.9	68.6	78.8	97	55	893	7.07	3.99	9.57	10	0.0
September--	84.3	62.9	73.6	95	45	708	6.02	3.39	8.15	7	0.0
October----	75.4	52.4	63.9	89	29	431	3.12	1.07	4.75	5	0.0
November---	66.6	41.8	54.2	82	22	147	3.10	1.37	4.50	5	0.0
December---	58.5	35.2	46.8	78	14	104	3.66	1.68	5.27	6	0.0
Yearly:											
Average--	74.3	50.9	62.6	---	---	---	---	---	---	---	---
Extreme--	---	---	---	101	11	---	---	---	---	---	---
Total----	---	---	---	---	---	5,325	54.51	47.84	61.17	89	2.4

* A growing degree day is a unit 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 °F).

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

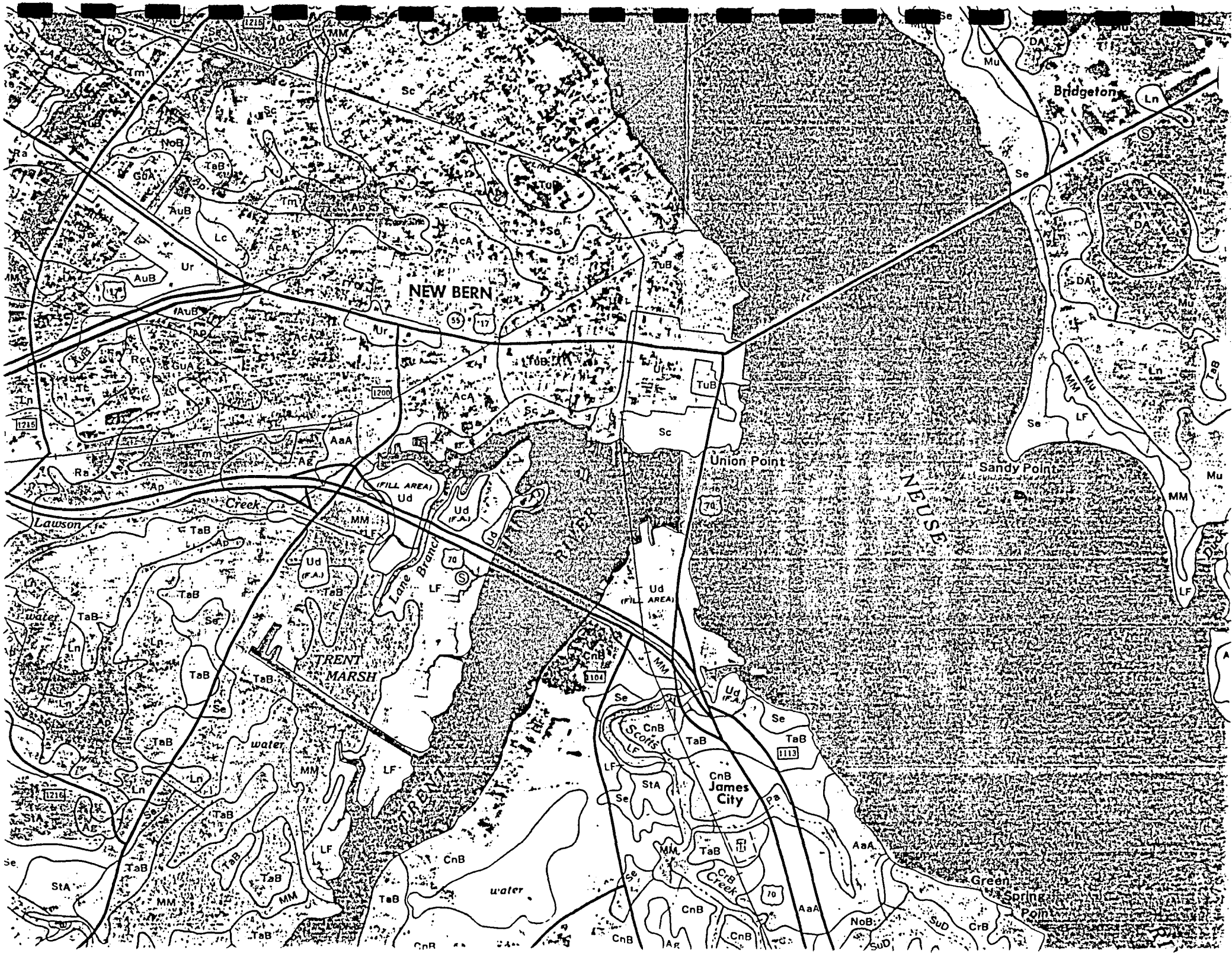
Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
AaA---------- Altavista	0-13	10-24	1.30-1.50	2.0-6.0	0.12-0.20	4.5-6.0	Low----------	0.24	5	.5-3
	13-46	18-35	1.30-1.50	0.6-2.0	0.12-0.20	4.5-6.0	Low----------	0.24		
	46-80	---	---	---	---	---	----------	----		
AcA:										
Altavista-------	0-13	10-24	1.30-1.50	2.0-6.0	0.12-0.20	4.5-6.0	Low----------	0.24	5	.5-3
	13-46	18-35	1.30-1.50	0.6-2.0	0.12-0.20	4.5-6.0	Low----------	0.24		
	46-80	---	---	---	---	---	----------	----		
Urban land.										
Ag---------- Augusta	0-17	5-20	1.30-1.50	2.0-6.0	0.10-0.15	4.5-6.0	Low----------	0.20	4	.5-2
	17-36	20-35	1.30-1.50	0.6-2.0	0.12-0.18	4.5-6.0	Low----------	0.24		
	36-45	3-18	1.35-1.55	2.0-6.0	0.06-0.12	4.5-6.0	Low----------	0.24		
	45-80	---	---	---	---	---	----------	----		
Ap---------- Arapahoe	0-16	8-18	1.45-1.60	2.0-6.0	0.11-0.15	3.6-5.5	Low----------	0.15	5	5-10
	16-56	8-18	1.45-1.60	2.0-6.0	0.10-0.14	3.6-7.8	Low----------	0.15		
	56-80	3-18	1.40-1.65	2.0-20	0.05-0.14	5.6-7.8	Low----------	0.10		
AuB---------- Autryville	0-29	2-10	1.60-1.70	>6.0	0.04-0.09	4.5-5.5	Low----------	0.10	5	.5-1
	29-37	10-25	1.40-1.60	2.0-6.0	0.08-0.13	4.5-5.5	Low----------	0.10		
	37-42	2-8	1.60-1.70	>6.0	0.03-0.08	4.5-5.5	Low----------	0.10		
	42-61	10-35	1.40-1.60	0.6-2.0	0.10-0.15	4.5-5.5	Low----------	0.17		
Ba---------- Bayboro	0-17	8-20	1.00-1.40	0.6-2.0	0.20-0.26	3.6-5.5	Low----------	0.10	---	10-20
	17-62	35-65	1.20-1.40	0.06-0.2	0.14-0.18	4.5-5.5	Moderate-----	0.32		
	62-72	---	---	---	---	---	----------	----		
BrB---------- Bragg	0-8	5-25	1.50-1.70	2.0-6.0	0.06-0.12	3.6-7.3	Low----------	0.20	5	0-2
	8-56	15-45	1.30-1.60	0.2-0.6	0.10-0.15	3.6-7.3	Low----------	0.28		
	56-66	---	---	---	---	---	----------	----		
CnB---------- Conetoe	0-24	2-10	1.60-1.75	6.0-20	0.05-0.10	4.5-6.0	Low----------	0.15	5	.5-2
	24-35	10-22	1.40-1.60	2.0-6.0	0.10-0.15	4.5-6.0	Low----------	0.15		
	35-80	2-10	1.60-1.75	6.0-20	0.05-0.10	4.5-6.0	Low----------	0.10		
CrB---------- Craven	0-9	6-20	1.30-1.55	0.6-2.0	0.12-0.18	3.6-5.5	Low----------	0.37	5	.5-2
	9-54	35-60	1.30-1.45	0.06-0.2	0.12-0.15	3.6-5.5	Moderate-----	0.32		
	54-80	---	---	---	---	---	----------	----		
CT---------- Croatan	0-28	---	0.40-0.65	0.06-6.0	0.35-0.45	<4.5	Low----------	----	---	25-60
	28-42	8-20	1.40-1.60	0.2-6.0	0.10-0.15	3.6-6.5	Low----------	----		
	42-56	10-35	1.40-1.60	0.2-2.0	0.12-0.20	3.6-6.5	Low----------	----		
	56-80	---	---	---	---	---	----------	----		
DA---------- Dare	0-60	---	0.40-0.65	0.06-0.2	0.20-0.26	3.6-4.4	Low----------	----	---	20-95
	60-80	2-12	1.60-1.70	6.0-20	0.04-0.09	3.6-6.0	Low----------	0.15		
De---------- Deloss	0-19	5-20	1.30-1.50	2.0-6.0	0.10-0.16	3.6-5.5	Low----------	0.24	5	2-9
	19-58	18-35	1.30-1.60	0.6-2.0	0.12-0.18	3.6-6.5	Low----------	0.24		
	58-80	---	---	---	---	---	----------	----		
DO---------- Dorovan	0-15	---	0.25-0.40	0.6-2.0	0.25-0.50	3.6-5.5	Low----------	----	---	20-80
	15-80	---	0.35-0.55	0.6-2.0	0.25-0.50	3.6-5.5	Low----------	----		20-80

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
Mu---------- Murville	0-10	2-8	1.20-1.40	6.0-20	0.15-0.20	3.6-5.5	Low----------	0.10	5	9-20
	10-36	2-8	1.60-1.75	2.0-6.0	0.05-0.09	3.6-5.5	Low----------	0.10		
	36-80	2-8	1.60-1.75	6.0-20	0.04-0.17	3.6-5.5	Low----------	0.10		
NoA, NoB--------- Norfolk	0-14	2-8	1.55-1.75	6.0-20	0.06-0.11	4.5-5.5	Low----------	0.20	5	.5-2
	14-80	18-35	1.30-1.45	0.6-2.0	0.10-0.20	4.5-5.5	Low----------	0.24		
NuB:										
Norfolk---------	0-14	2-8	1.55-1.75	6.0-20	0.06-0.11	4.5-5.5	Low----------	0.20	5	.5-2
	14-80	18-35	1.30-1.45	0.6-2.0	0.10-0.20	4.5-5.5	Low----------	0.24		
Urban land.										
On---------- Onslow	0-13	2-8	1.60-1.75	>6.0	0.07-0.11	3.6-5.5	Low----------	0.17	4	.5-2
	13-65	15-35	1.30-1.50	0.6-2.0	0.12-0.17	3.6-5.5	Low----------	0.24		
	65-80	---	---	---	---	---	----------	----		
Pa---------- Pantego	0-15	5-15	1.40-1.60	2.0-6.0	0.10-0.20	3.6-5.5	Low----------	0.15	5	4-10
	15-48	18-35	1.30-1.40	0.6-2.0	0.12-0.20	3.6-5.5	Low----------	0.28		
	48-62	18-40	1.25-1.40	0.6-2.0	0.15-0.20	3.6-5.5	Low----------	0.28		
	62-80	---	---	---	---	---	----------	----		
PO---------- Ponzer	0-40	---	0.40-0.65	0.06-6.0	0.35-0.45	3.6-4.4	Low----------	----	---	20-80
	40-54	5-25	1.30-1.60	0.2-6.0	0.10-0.24	3.6-7.8	Low----------	0.24		
	54-80	---	---	---	---	---	Low----------	----		
Pt. Pits										
Ra---------- Rains	0-16	5-20	1.30-1.60	2.0-6.0	0.10-0.14	3.6-5.5	Low----------	0.20	5	1-6
	16-41	18-35	1.30-1.50	0.6-2.0	0.11-0.15	3.6-5.5	Low----------	0.24		
	41-66	15-45	1.30-1.60	0.6-2.0	0.10-0.15	3.6-5.5	Low----------	0.28		
	66-80	---	---	---	---	---	----------	----		
Rc:										
Rains----------	0-16	5-20	1.30-1.60	2.0-6.0	0.10-0.14	3.6-5.5	Low----------	0.20	5	1-6
	16-41	18-35	1.30-1.50	0.6-2.0	0.11-0.15	3.6-5.5	Low----------	0.24		
	41-66	15-45	1.30-1.60	0.6-2.0	0.10-0.15	3.6-5.5	Low----------	0.28		
	66-80	---	---	---	---	---	----------	----		
Urban land.										
Ro---------- Roanoke	0-11	10-18	1.20-1.50	2.0-6.0	0.12-0.18	3.6-5.5	Low----------	0.28	4	1-3
	11-15	20-35	1.20-1.50	0.2-0.6	0.16-0.19	3.6-5.5	Moderate-----	0.24		
	15-41	35-60	1.35-1.65	0.06-0.2	0.10-0.19	3.6-5.5	Moderate-----	0.24		
	41-80	---	---	---	---	---	----------	----		
Sc:										
Seabrook--------	0-6	2-8	1.30-1.60	6.0-20	0.05-0.11	4.5-6.5	Low----------	0.10	5	.5-2
	6-80	2-10	1.30-1.60	6.0-20	0.02-0.09	4.5-6.5	Low----------	0.10		
Urban land.										
Se---------- Seabrook	0-6	2-8	1.30-1.60	6.0-20	0.05-0.11	4.5-6.5	Low----------	0.10	5	.5-2
	6-80	2-10	1.30-1.60	6.0-20	0.02-0.09	4.5-6.5	Low----------	0.10		
StA---------- State	0-13	2-8	1.35-1.45	2.0-6.0	0.06-0.09	4.5-5.5	Low----------	0.28	5	<1
	13-38	18-35	1.35-1.50	0.6-2.0	0.14-0.19	4.5-5.5	Low----------	0.28		
	38-70	2-15	1.35-1.50	>2.0	0.02-0.10	4.5-6.0	Low----------	0.17		
SuD---------- Suffolk	0-14	4-10	1.40-1.50	2.0-20	0.05-0.10	4.5-5.5	Low----------	0.24	4	.5-1
	14-38	10-33	1.40-1.50	0.6-2.0	0.10-0.15	4.5-5.5	Low----------	0.24		
	38-80	4-10	1.40-1.50	2.0-20	0.04-0.10	4.5-6.0	Low----------	0.17		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
TaB---------- Tarboro	0-30	3-8	1.60-1.75	6.0-20	0.05-0.09	5.1-6.5	Low----------	0.10	5	.5-1
	30-80	2-7	1.60-1.75	>20	0.02-0.06	5.1-6.5	Low----------	0.10		
Tc:										
Torhunta--------	0-12	5-18	1.35-1.65	2.0-6.0	0.10-0.15	3.6-5.5	Low----------	0.15	5	3-10
	12-37	5-18	1.35-1.60	2.0-6.0	0.10-0.15	3.6-5.5	Low----------	0.15		
	37-80	2-18	1.45-1.65	6.0-20	<0.05	3.6-5.5	Low----------	0.10		
Urban land.										
Tm---------- Tomotley	0-11	5-20	1.30-1.60	2.0-6.0	0.10-0.15	3.6-5.5	Low----------	0.20	5	1-6
	11-41	18-35	1.30-1.50	0.6-2.0	0.12-0.18	3.6-5.5	Low----------	0.20		
	41-80	---	---	---	---	---	----------	----		
To---------- Torhunta	0-12	5-18	1.35-1.65	2.0-6.0	0.10-0.15	3.6-5.5	Low----------	0.15	5	3-10
	12-37	5-18	1.35-1.60	2.0-6.0	0.10-0.15	3.6-5.5	Low----------	0.15		
	37-80	2-18	1.45-1.65	6.0-20	<0.05	3.6-5.5	Low----------	0.10		
TuB:										
Tarboro---------	0-30	3-8	1.60-1.75	6.0-20	0.05-0.09	5.1-6.5	Low----------	0.10	5	.5-1
	30-80	2-7	1.60-1.75	>20	0.02-0.06	5.1-6.5	Low----------	0.10		
Urban land.										
Ud. Udorthents										
Ur. Urban land										


NEW BERN
Bridgeton
Union Point
Sandy Point
NEUSE
RIVER
TRENT
TRENT MARSH
Lane Branch
Lawson Creek
Scotts Creek
James City
Green Spring Point
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(FILL AREA)
(F.A.)
55
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70
1200
1215
1216
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1113

REFERENCE 11

GREENHORNE & O'MARA. INC.

Memorandum

TO: File

FROM: Rachel Spangenberg RMS

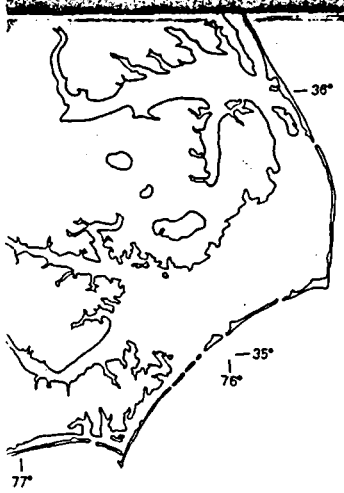
DATE: April 9, 1991

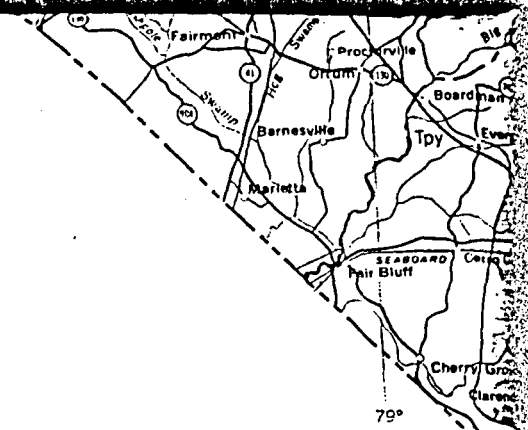
SUBJ: Telephone conversation with Aldridge Renn, employee of the N.C. Department of Environmental Health, and Natural Resources, Division of Environmental Management (919)733-5083.

Mr. Aldridge informed me that the Neuse River, at the point where it intersects with the Trent River in New Bern, North Carolina, is classified as SC NSW. SC denotes that it is a salt water suitable for all Class C uses which include fish and wildlife propagation, secondary recreation, and agriculture. The NSW designation denotes nutrient sensitive waters which require limitations on nutrient inputs.

The Trent River, at its confluence with the Neuse River, is classified as SB swamp NSW. The SB denotes that this is a salt water body suitable for primary recreation uses. The NSW designation denotes nutrient sensitive waters which require limitations on nutrient inputs.

REFERENCE 12



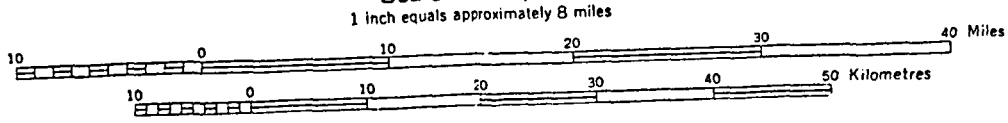


EOLOGIC MAP OF NORTH CAROLINA

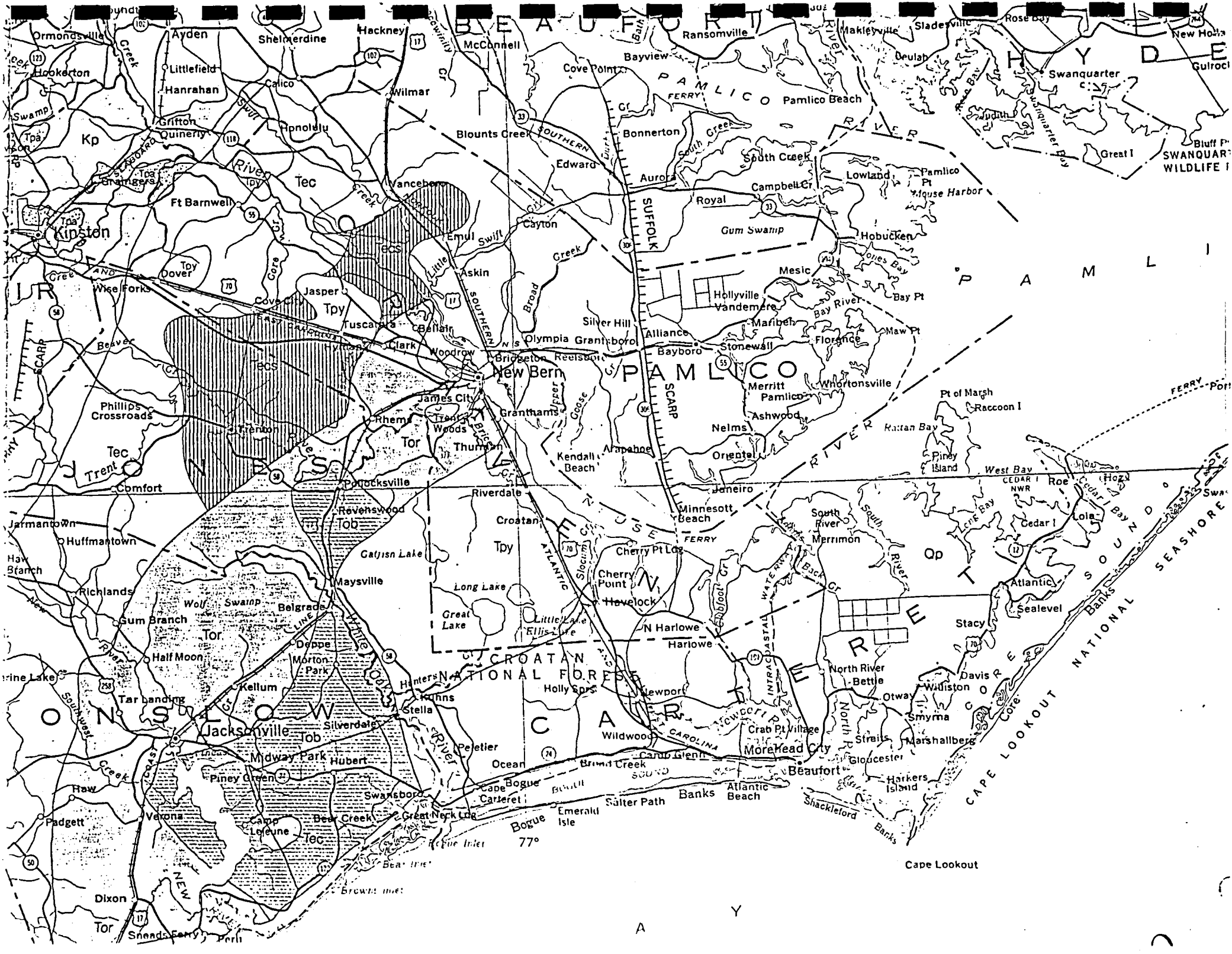
1985

Scale 1:500,000

1 inch equals approximately 8 miles



Reference 12


BEAUFORT
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PAMLICO RIVER
PAMLICO SOUND
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CAPE LOOKOUT NATIONAL SEASHORE
Ormondsville
Ayden
Shelmerdine
Hackney
McConnell
Ransomville
Makleyville
Sladeville
Rose Bay
New Holland
Hookerton
Littlefield
Hanrahan
Calico
Wilmar
Cove Point
Bayview
Deulah
Swanquarter
Gulrock
Grifton
Quinerly
Honolulu
Blounts Creek
Bonnerton
Pamlico Beach
Kp
Tpa
Kinston
Ft Barnwell
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Edward
Aurora
South Creek
Lowland
Pamlico Pt
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SWANQUARTER WILDLIFE
Campbell Cr
Royal
Gum Swamp
Hobucken
Cayton
Emul
Askin
Dover
Wise Forks
Jasper
Tuscarora
Bellair
Clark
Woodrow
Olympia
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Reelsboro
Bridgeton
New Bern
Silver Hill
Alliance
Bayboro
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Raccoon I
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Phillips Crossroads
Trenton
James City
Rhems
Trent Woods
Grantham
Thurman
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Pollocksville
Riverdale
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Arapahoe
Jarmantown
Huffmantown
Revenswood
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Croatan
Tpy
Catfish Lake
Maysville
Long Lake
Great Lake
Little Lake
Ellis Lake
Cherry Pt Ldg
Cherry Point
Havelock
Minnesott Beach
Janeiro
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Merrimon
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Wolf Swamp
Belgrade
Gum Branch
Half Moon
Deppe
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Tar Landing
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Holly Springs
Newport
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North River
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Davis
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Crab Pt Village
Straits
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Gloucester
Harkers Island
Jacksonville
Silverdale
Midway Park
Hubert
Piney Green
Swansboro
Peletier
Wildwood
Ocean
Bogue
Cape Carteret
Bogue Beach
Emerald Isle
Salter Path
Atlantic Beach
Shackleford Banks
Cape Lookout
Haw
Padgett
Verona
Camp Lejeune
Bear Creek
Great Neck Ldg
Dixon
Sneads Ferry
Perl
77°

DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
S. Thomas Rhodes, Secretary

Division of Land Resources
Stephen G. Conrad, Director and State Geologist

Compiled by

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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: Oyster-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

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15. Glover, Lynn, III, and S brian to early Cam and North Carolina

PRELIMINARY EXPLANATORY TEXT FOR THE 1985 GEOLOGIC MAP OF NORTH CAROLINA

Contractual Report 88-1

by

The North Carolina Geological Survey

November 4,1988

COASTAL PLAIN PROVINCE

Overview

The Coastal Plain of North Carolina is comprised of flat lying to very gently dipping sedimentary strata which overlay a "basement" of crystalline rocks. In aggregate, these deposits form a wedge-shaped mass that gradually thickens from a feather edge at its western border, where Coastal Plain sediments "lap onto" crystalline rocks of the Piedmont province, to a section nearly 10,000 feet thick at Cape Hatteras. Coastal Plain sediments are predominantly sand and sandstone, but a wide range of lithologies and degrees of induration occur within the section. These primarily include clay and silt shale, glauconitic and phosphatic sands, highly fossiliferous sand and clay, many varieties of carbonate, and peat.

The oldest sediments are Jurassic(?) in age (Brown and others, 1972; Owens and Gohn, 1985). These have been identified in the basal 708 feet of the sedimentary section in the Standard Oil of New Jersey Hatteras Light #1 oil test well (API # 32-055-00001) drilled to a total depth of 10,044 feet at Cape Hatteras in 1946. The Hatteras Light well and several other deep oil tests drilled to crystalline basement in the coastal counties provide information on the deepest portion of the Coastal Plain section, most of which does not extend to the surface.

The structure of the metamorphosed sedimentary and igneous rocks which comprise the crystalline basement is shown in figure 6. A broad, southeast plunging anticlinal structure known as the Cape Fear arch is delineated on the figure. The Cape Fear arch is one of a series of such structures found along the Atlantic Continental Margin (figure 7). The Norfolk arch (Fort Monroe high) of southeastern Virginia has also played a role in the geologic history of the North Carolina Coastal Plain. The intervening, relatively low area and its basinward extension beneath the prograded North Carolina coastline is the Albemarle embayment.

The sedimentary record indicates that these structural elements underwent periodic relative movement. For example, the Cape Fear arch area is underlain by a much thicker and relatively more complete Upper Cretaceous section than the area of the Norfolk arch. Conversely, Pliocene deposits are relatively thick in the northeastern part of North Carolina, indicating that area was relatively "low" during their deposition, while they are thin and patchy to the south. Regional reviews of the Atlantic Continental margin and its depositional history are contained in Poag (1985), and in Sheridan and Grow (1988).

The Coastal Plain province is characterized by flat to gently undulating topography. Relief generally increases with increasing elevation. The lower (or outer) Coastal Plain along the coast and through the expansive area between the Pamlico and Albemarle Sounds known as the Pamlimarle Peninsula, is relatively flat and low-lying. Surface elevations through this area are less than 25 feet above mean sea level. Through the middle and upper (or inner) Coastal Plain elevations gradually rise to several hundred feet above mean sea level. Dissection of the Coastal Plain surface becomes more marked in these areas, especially adjacent to the major rivers. Bluffs up to 50 or more feet are routinely developed on the southwest or right banks of these rivers.

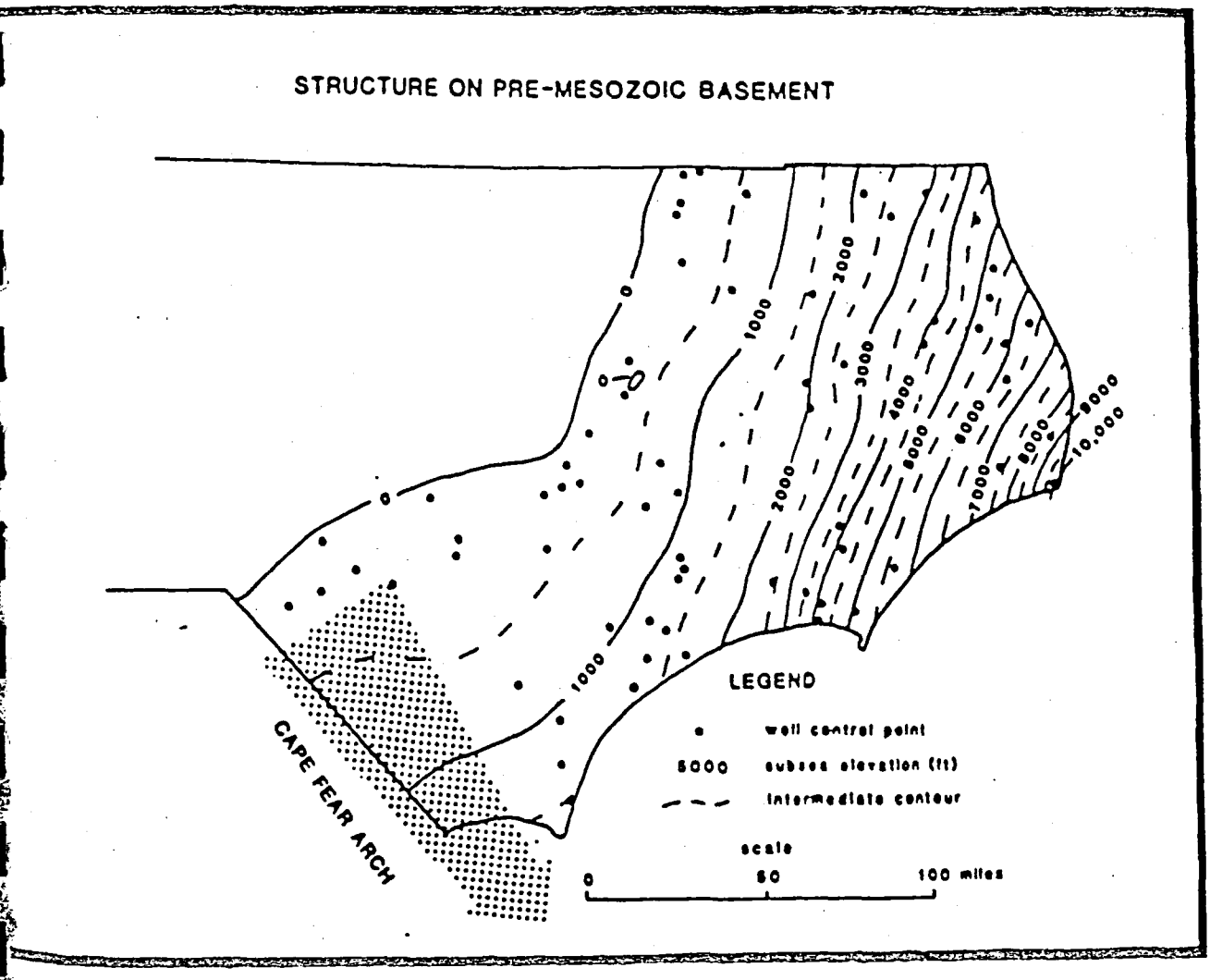

Figure 6. Structure map of pre-Mesozoic basement rocks beneath the Coastal Plain (modified from Brown and others, 1972).

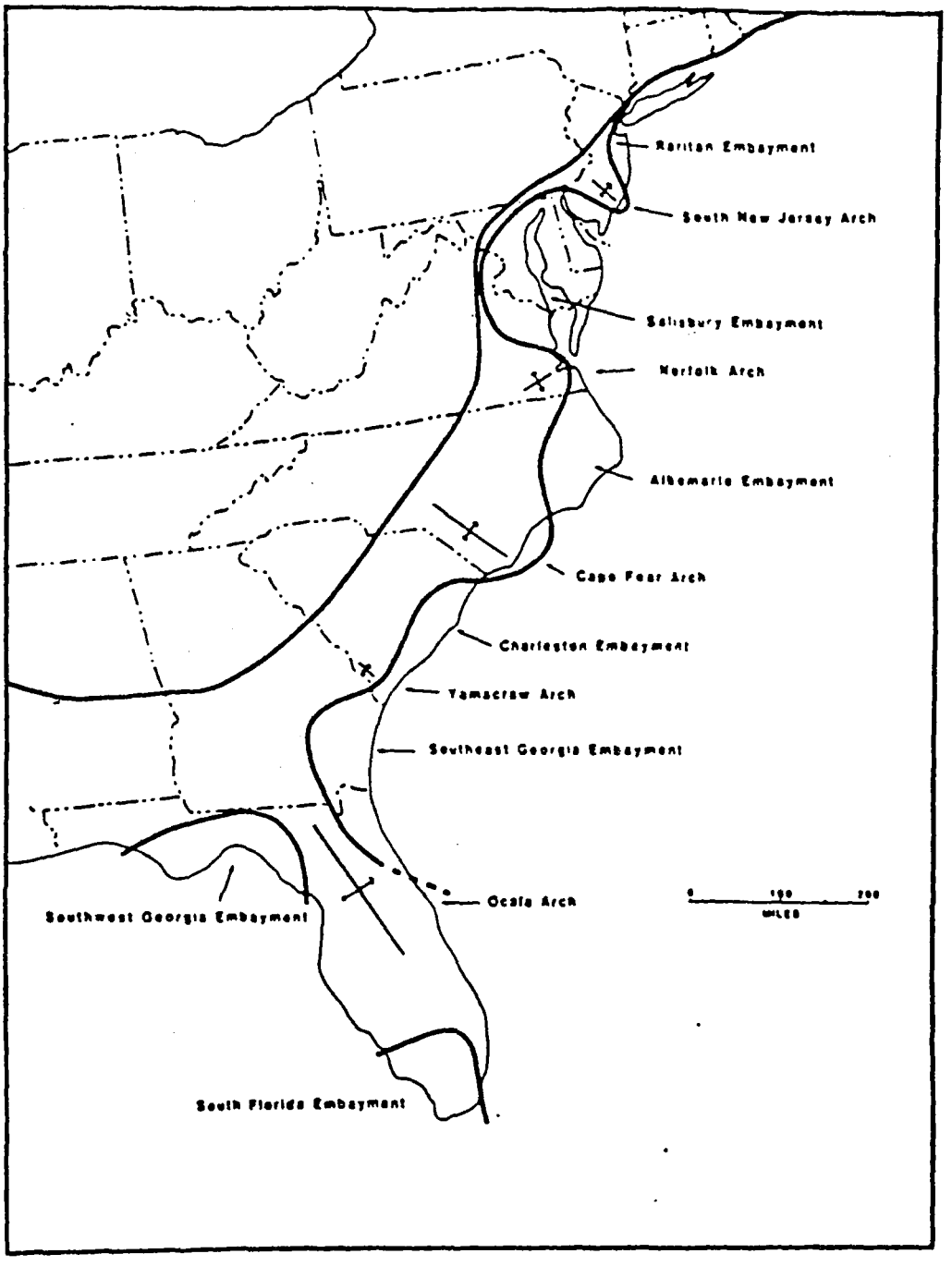

Figure 7. Map of principal structural features of the Atlantic Coastal Plain (from Ward and Strickland, 1985).

Thickness of the Comfort Member varies from a feather edge, adjacent to where it has been removed by erosion, to an estimated one hundred meters in the subsurface of the Cape Lookout area (Ward, 1977). Ward (1977) inferred an initially shallow, relatively high energy, normal marine depositional setting for the Comfort Member. Gradually, as deposition continued, deeper and quieter conditions developed. However, several episodes or cycles of deposition were postulated based on recurring thin glauconite and phosphate enriched horizons overlain by locally crossbedded bryozoan-echinoid calcirudite which grades upward to calcarenite. Ward (1977) made no attempt to trace these horizons laterally or to correlate them from one locality to another. Zullo and Harris (1987), however, interpret at least some of these horizons as being associated with eustatic sea level fluctuations and base depositional sequence boundaries, in part, on these features.

Dolomite cemented zones described by Textoris (1967) for the Castle Hayne were interpreted by Baum (1977) to have formed during relatively brief depositional hiatuses during which subaerial exposure created a "freshwater/saltwater lens" within the carbonate sediments.

Outliers of Castle Hayne Formation -- Numerous "outliers" of Castle Hayne Formation have been reported and mapped. Some of these, for example those that occur in Duplin County in the vicinity of Magnolia and another in Wayne County northwest of Seven Springs, are readily recognized as the Comfort Member. Others, particularly those found in Harnett, Hoke, Moore, and Wake Counties are of markedly different lithologic makeup and do not fall within the definition of any of the formally defined members. Molluscan molds or a rare bryozoan fragment are present in most of these outcrops and serve to identify them as correlative with the main body of the Castle Hayne Formation. Otte (1981) reviewed the historical literature and attempted to locate and sample all reported Castle Hayne Limestone (sensu Baum and others, 1978) localities. Due to vague original descriptions and/or natural or man-made alteration of the localities, most of the reported outliers were not found. The relatively few outliers shown on the 1985 State Geologic Map reflect the lack of exposure of previously reported outliers. One of the mapping prerequisites for these bodies was that outliers not strictly related lithologically to typical Castle Hayne Formation but that could be demonstrated to be of Eocene age were mapped as Castle Hayne, undivided. Ironstone capped hills in the inner Coastal Plain which are historically reported to be Eocene (for example. Richards, 1950) but which contained no faunal or other evidence to relate them to the Castle Hayne Formation were not mapped as Castle Hayne Formation. Also, reported outliers that were not or could not be adequately documented as to location and aerial extent are not shown on the 1985 State Geologic Map.

Tecs SPRING GARDEN MEMBER

This upper member of the Castle Hayne Formation consists of "tan to gray, arenaceous, molluscan-mold biocalcirudite rocks along the Neuse River from Rock Landing to New Bern. This gray and normally siliceous rock is well cemented by sparry calcite. Molluscan bivalve molds are partly or completely filled with silica, which forms siliceous pseudomorphs after the dominant mollusk, Macrocallista neusensis (Harris)" (Ward and others, 1978). Aragonitic molluscan bivalves, which were estimated to account for about 75 percent of the original rock, have been dissolved and the carbonate has been reprecipitated as calcite cement in the interstitial zones. Fine-grained phosphate, present in amounts up to ten percent, and quartz sand comprise

the remainder of the molluscan biocalcirudite facies. Bryozoans are rare. The unit grades downward to a basal calcareous quartz arenite. Baum (1977) and Baum and others (1978) recognized the rocks of the Spring Garden Member as The New Bern Formation.

The Spring Garden Member outcrop area is limited mainly to parts of Jones and Craven Counties. Exposed sections in the Martin Marietta New Bern quarry were up to six meters thick with approximately eight meters occurring below the pit floor (Ward, 1977). The type section, Spring Garden Landing on the Neuse River, Craven County, contains approximately three meters of Spring Garden Member.

In the subsurface, the Spring Garden Member extends east and northeast from the outcrop area. Estimated thickness of the unit in the Cape Lookout area is about 90 to 100 meters. The Spring Garden Member underlies the Pungo River Formation (Miocene) through much of Beaufort and Pamlico Counties.

The contact between the Spring Garden Member and the Comfort Member is not well exposed nor has it been recognized and described in the subsurface. Ward (1977) noted that the units are conformable at one locality where both units crop out, Rock Landing on the Neuse River, Craven County. Baum and others (1978) sited three localities where their New Bern Formation (Spring Garden Member) overlies limestone of the Castle Hayne limestone. They noted "phosphatized crusts, rounded phosphatized clasts of the underlying unit and a concentration of oysters" in interpreting the contact as a disconformity. Brown and others (1972), in their discussion of Rocks of Claiborne age, stated that molluscan limestone grades laterally into bryozoan limestone and downward into calcareous sand. Harris and Zullo (1987, Figure 13, p. 212) portrayed a lateral equivalency between the New Bern Formation (Spring Garden Member) and rocks which are part of the Comfort Member. These rocks are within their depositional sequence 4.

Ward (1977) interpreted the Spring Garden Member to represent shelf deposits of a shallowing, regressive sea that was receiving clastic input. Baum (1977) interpreted the basal calcareous quartz arenite facies to represent "intertidal deposition." The overlying molluscan-mold limestone facies were interpreted to represent surf zone to deeper water (to depths of 40 meters) deposits of a mollusk-dominated sandy shelf. Jones (1983) interpreted his lithofacies 4 (equal to Spring Garden Member) as an organic buildup (bioherm or reef) in an inner shelf setting.

Tor RIVER BEND FORMATION

The River Bend Formation (equal to Trent Formation of Baum, 1978) includes "limey, sandy shell and barnacle hashes and sandy, molluscan-mold biocalcirudites" (Ward, 1977) which previously have been included in the Trent Marl by Miller (1910, 1912) and later in the Castle Hayne Limestone by Brown (1955), LeGrand and Brown (1955), and by compilers of the 1958 State Geologic Map (Stuckey and Conrad, 1958). Ward and others (1978) proposed abandoning the name "Trent" because of confusion as to the specific identity of the Trent Marl. Brown (1955) had previously proposed abandoning the name because he thought rocks considered to be part of the Trent Marl were properly assigned to either the Castle Hayne Limestone or the Yorktown Formation. Baum and others (1978) proposed retaining the term "Trent" as the Trent Formation (restricted) and designated a "modified type section" as

being along the Trent River from New Bern to within 0.7 kilometers of Pollocksville. These workers recognized three distinct facies within their Trent Formation: a sandy, echinoid biosparite; an overlying sandy, pelecypod-mold biomicrudite; and a barnacle, pelecypod-mold biosparrudite. The Trent (restricted) equals only a part of the River Bend formation.

The name River Bend comes from River Bend Estates, a development about six miles south of New Bern on the Trent River in Craven County. A 3-meter-thick exposure on the left bank of the Trent River 0.3 kilometers above Rhems Landing was designated the type locality of the River Bend Formation (Ward and others, 1978). Quarries at New Bern and at Belgrade provide greater exposure of the unit. Additionally, outcrops occur along the New River from Jacksonville to the vicinity of Richlands, Onslow County. In the subsurface, correlative limestones and overlying scattered deposits of "recrystallized marl, shell hash, or sandy molluscan limestone" were mapped by Brown and others (1972) through eastern Pender County, most of Onslow, Jones, and Carteret Counties, and northeastward into the deeper part of the Albemarle embayment beneath parts of Pamlico, Hyde, and Dare Counties including the Pamlico Sound. Maximum thickness of this subsurface unit is about 500 feet in the Cape Lookout area.

The River Bend Formation unconformably overlies the Spring Garden Member of the Castle Hayne Formation. This contact is exposed at several places including outcrops on the New and Trent Rivers and in the Martin Marietta Quarry at New Bern. The unconformity surface is marked by a phosphatic crust. At Prettyman Landing on the Trent River, Ward (1977) reported a coarse conglomerate at the base of the River Bend. Otherwise, Ward (1977) describes the basal River Bend Formation as consisting chiefly of barnacle plates and molluscan molds in a calcarenite matrix with little or no clastic material. This facies grades vertically into a very sandy, slightly phosphatic, pelecypod biocalcirudite that is lithologically similar to the Spring Garden Member.

Baum (1977) described the basal part of his proposed Trent Formation (equal in part to River Bend Formation) as a friable to moderately consolidated, poorly washed, sandy, echinoid biosparite. By point count analysis, the facies consists of approximately 15 percent quartz sand, 20 percent micrite matrix, 30 percent allochems, 25 percent interparticulate porosity, and 10 percent cement. This facies interfingers with an overlying, massive, dense, well lithified, sandy, pelecypod-mold biomicrudite facies. Composition of this facies is approximately 25 percent quartz sand, 35 percent micrite and microspar matrix, 35 percent allochems (including over 25 percent moldic porosity), and 5 percent vuggy porosity. This facies interfingers with the uppermost facies, a barnacle, pelecypod-mold biosparrudite comprised of approximately 5 percent quartz sand, 15 percent microspar and micrite matrix, 55 percent allochems (including about 18 percent moldic porosity), 15 percent (mostly interparticulate) porosity, and 15 percent interparticulate cement.

The River Bend Formation ranges in age from middle to late Oligocene. Ward (1977), primarily on the basis of mollusks, correlated this unit with upper Vicksburgian to Chickasawhayan rocks of the Gulf Coast area. Ward (1977) interpreted a warm-temperate to subtropical inner shelf depositional setting for the River Bend Formation. Shoal areas are indicated by the accumulation of barnacle and shell hashes. Quieter conditions are marked by fine-grained calcarenite. Shallowing conditions during later stages of

deposition resulted in increased clastic input and a flourishing mollusk population dominated by Mercenaria.

The Trent Formation of Baum and others (1978) equates with only the lower part of the River Bend Formation. Zullo and Harris (1987) assigned these rocks to their sequence 5, which they consider to be lowermost Oligocene (early to middle Rupelian). The outcrop area mapped for this unit (Baum, 1977) includes limestones exposed on the Trent River below Pollocksville, those which overlie the Castle Hayne Formation in the New Bern area, and the limestone exposed in the vicinity of Jacksonville.

The upper part of the River Bend, for example the limestone exposed in the Martin Marietta Belgrade quarry, was named the Belgrade Formation by Baum and others (1978) and was considered to be lowermost Miocene in age. Two facies, a basal unconsolidated quartz arenite with abundant Anomia and barnacles and an upper sandy, pelecypod-mold biomicrudite were recognized. Baum and others (1978), based on core hole information at the Belgrade quarry, reported that their Belgrade Formation disconformably overlies the barnacle, pelecypod-mold biosparrudite facies of their Trent Formation. Zullo and Harris (1987) placed the Belgrade Formation (of Baum and others, 1978) in their sequences 6 through 9 which span from late Oligocene (Chattian) to lower Miocene (Aquitanian).

Tob BELGRADE FORMATION, UNDIVIDED

Ward and others (1978) proposed the name Belgrade Formation for "unconsolidated, very arenaceous shell beds of two lithologies - a tan, somewhat leached, very arenaceous oyster (Crassostrea) member and a moderately phosphatic (as much as 15 percent), slightly calcareous, silty, arenaceous shell member containing occasional, thinly laminated olive clays." The first member is called the Pollocksville Member for exposures along the Trent River and surrounding area in the vicinity of that Jones County town. The latter unit is named the Haywood Landing Member for an outcrop at Haywood Landing on the White Oak River in Croatan National Forest, also in Jones County. The Pollocksville and Haywood Landing Members are lateral equivalents.

Rocks assigned the the Belgrade Formation of Ward and others (1978) were assigned by Baum and others (1978) to the Silverdale Formation (equal to Haywood Landing Member) and to the Crassostrea gigantissima facies (equal to Pollocksville Member), both of which were considered to be lower Miocene. Zullo and Harris (1987) placed the Silverdale Formation within the upper Oligocene (Chattian) section of their undivided sequences 6-8. the Crassostrea channel deposits were placed within their sequence 9, which straddles the Oligocene/Miocene boundary (Chattian/Aquitanian).

The Belgrade Formation unconformably overlies the River Bend Formation. The upper River Bend surface is highly irregular. It is marked by channels and solution cavities which are filled with strata of the Belgrade Formation. The type section of the Belgrade Formation is contained in the upper portion of the section exposed at the Martin Marietta Belgrade quarry. Here, 2.1 meters of Belgrade Formation overlies limestone of the River Bend Formation and is, in turn, overlain by deposits of the Duplin Formation (Pliocene).

Baum and others (1978) identified a type section for the Silverdale

REFERENCE 13

Reference 13

WELL RECORDS AND OTHER BASIC GROUND-WATER DATA CRAVEN COUNTY, NORTH CAROLINA

By

E. O. Floyd *Hydraulic Engineer*

and

A. T. Long *Geologist*

U. S. Geological Survey

GROUND WATER CIRCULAR 14

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
Craven County Board of Commissioners
and the
North Carolina Department of Water
and Air Resources

MARCH 1970

Collection of
G. C. Nicholson

WELL RECORDS AND OTHER BASIC GROUND-WATER DATA CRAVEN COUNTY, NORTH CAROLINA

DIVISION OF GROUND WATER

GROUND WATER CIRCULAR NO. 14

NORTH CAROLINA
DEPARTMENT OF WATER AND AIR RESOURCES

RALEIGH
MARCH
1970

SUMMARY OF AQUIFER CHARACTERISTICS

Aquifer No	Geology and lithology	Hydrology	Quality
1	Also referred to as the water-table aquifer. It is composed of beds of sand, silt, and shell with lenses of clay, all of which are generally of Miocene age and younger. It has a maximum thickness of about 60 feet in the southern part of the county. Its upper surface is the water table which fluctuates with changes in ground-water storage but generally ranges from land surface in the swamps to a depth of more than 15 feet along the sandy ridges bordering the Neuse River. The base, in most places, is a blue clay layer. In the western part of the county where the layer is discontinuous, aquifer 1 is hydraulically connected with aquifer 2.	Supplies water to dug wells in all parts of the county. Yields of these wells generally are less than 10 gpm, and specific capacities range from [illegible] to 0.[illegible] gpm per foot of drawdown after one day of continuous pumping.	[illegible] water that generally has high concentrations of dissolved iron and is slightly corrosive. [illegible] is subject to contamination from [illegible], septic tanks, chemical fertilizers, [illegible] water flooding in low areas.
2	Includes most of the Castle Hayne Limestone and overlying hydraulically interconnected beds of limestone, shell and interlayered sand of Eocene and Oligocene ages that contain water under artesian conditions. Aquifer 2 is separated from the water-table aquifer 1 in the southern part of the county by an "aquiclude" composed of layers of silt and clay that are sufficiently impermeable to confine the water under pressure. In the northern part of the county the confining bed between aquifers 1 and 2 is discontinuous. Occurs throughout the county and thickens from a featheredge near the Lenoir and Pitt County lines to about 200 feet along the extreme southern border of the county. Generally can be divided into two zones of limestone that are separated by a zone of sand with thin streaks of limestone. The uppermost zone of limestone is tapped by most of the wells in the county. It is composed of highly permeable gray to cream-colored shell limestone having different degrees of hardness. The sandy zone is composed of fine to medium-grained, gray to white, calcareous sand and contains thin streaks of limestone. The lower zone of limestone occurs near the bottom of the Castle Hayne Limestone of Eocene age and ranges in thickness from a featheredge in the extreme western part of the county to about 20 feet near the Carteret County line. This zone is composed of very hard, massive gray-green sandy limestone with grains of glauconite and phosphate. It yields water locally where it has been channeled by solution, but throughout most of the county this zone acts as a confining layer for aquifer 3.	Driven wells, open-hole wells, and a few gravel-packed wells are used to recover water from this aquifer. Specific capacities of 30" gravel-packed wells penetrating the upper limestone zone are known to be as high as 78 gpm per ft. after one day's pumping.	Throughout the county, water in the upper part of this aquifer is low in chloride content, quite hard, and high in dissolved iron. In the southern quarter of the county, the water in the lower part of the aquifer contains more than 250 mg/l of chloride, and throughout the southern half of the county, dissolved iron concentrations are less than 0.3 mg/l.
3	Includes the Beaufort Formation of Paleocene age and, in most places, the extreme lower part of the Castle Hayne Limestone. Composed of medium to coarse-grained, green to black, glauconitic sand with thin streaks of limestone and gray clay. Varies in thickness from about 10 feet near Dover to about 180 feet in the extreme eastern part of the county. Throughout most of the county it is separated from aquifer 2 by a zone of clay and sand and by the hard limestone zone at the bottom of aquifer 2.	Few wells derive water exclusively from this aquifer. In some places it is hydraulically connected with aquifer 2. Specific capacities of 2" and 30" wells penetrating this aquifer are estimated to be about 0.7 and 1.0 gpm per ft. respectively after one day's pumping.	Chemical quality of water in aquifer 3 is similar to that in aquifer 2. Generally the concentrations of dissolved iron are less than in water from aquifer 2, and chloride concentrations are more than 250 mg/l throughout most of the southeastern part of the county.
4	Occurs within the Peedee Formation of late Cretaceous age. Composed of fine to coarse-grained gray sand with thin streaks of limestone and gray clay. It has a fairly uniform thickness ranging from about 65 feet near the Lenoir County line to about 15 feet near the Carteret County line. Average thickness is about 30 feet.	Very few wells tap aquifer 4 in Craven County. Specific capacities of 2" and 36" wells, after one day of pumping, are estimated to be about 1.7 and 2.6 gpm per ft. respectively.	Contains water that generally is hard and has dissolved iron concentrations in excess of 0.3 mg/l. In some places, in the northwestern part of the county, concentrations of fluoride exceed 1.5 mg/l. Chloride content of water in aquifer 4 is more than 250 mg/l throughout the southeastern half of the county.
5	Occurs in the Snow Hill Member of the Black Creek Formation of Late Cretaceous age. Composed of fine to coarse-grained gray sand with thin streaks of limestone or cemented sand. Thickness ranges from about 20 feet to about 65 feet but averages about 30 feet throughout most of of the county.	Only three wells are known to derive water from this aquifer in the county. Specific capacities of 2" and 36" wells, after one day's pumping, are estimated to be about 1.3 and 1.8 gpm per ft. respectively.	Contains water of very good chemical quality in most of the northern half of the county. Throughout the southern half of the county, water in aquifer 5 contains dissolved iron in excess of 0.3 mg/l and concentrations of chloride greater than 250 mg/l.
6	Occurs in the lower part of the Snow Hill Member of the Black Creek Formation. Composed of two sandy zones separated by a zone of gray clay and thin streaks of sand. Upper zone contains fine to medium-grained gray sand with some glauconite. Lower zone contains fine to medium-grained gray sand with thin streaks of clay. Thickness ranges from about 40 feet in the western and southern parts of the county to about 100 feet in the south-central part. Average thickness is about 60 feet.	Wells are not known to tap this aquifer in Craven County. Test drilling data indicate specific capacities for 2" and 36" wells should be about 1.9 and 3.6 gpm per ft. after one day of pumping.	Contains water of good chemical quality in the west-central part of the county. In other parts the chloride content is greater than 250 mg/l and concentrations of dissolved iron and fluoride exceed 0.3 and 1.5 mg/l respectively.
7	Occurs in the upper part of the lower member (unnamed) of the Black Creek Formation. Composed of beds of fine to coarse-grained gray sand interspersed with beds of gray clay. Thickness ranges from about 80 feet in the extreme northern and southern parts of the county to about 110 feet in the Cove City area. Average thickness is about 90 feet.	Supplies water to municipal and industrial wells in Lenoir and Pitt Counties and is one of two aquifers being tapped by the new wells of the City of New Bern near Cove City. Specific capacities of 2" and 36" wells penetrating this aquifer are estimated to be about 17 and 47 gpm per ft. after one day of pumping.	[illegible] area, aquifer 7 contains water of excellent chemical quality. In other parts of the county, concentrations of chloride, iron, and fluoride exceed the recommended limits for public supplies as set by U. S. Public Health Service.
8	The deepest aquifer penetrated by test drilling during the investigation. Includes the lower part of the Black Creek Formation and the upper part of the Tuscaloosa Formation of Late Cretaceous age and is composed of two zones of medium to coarse-grained gray sand separated by a zone consisting of beds of clay and fine to medium-grained sand. Thickness ranges from about 60 feet in the western and southern parts of the county to more than 160 feet in the northernmost part. Average thickness is about 125 feet.	Supplies water to municipal and industrial wells in Lenoir and Pitt Counties and is one of two aquifers being tapped by the new wells of the City of New Bern near Cove City. In the vicinity of Cove City and Dover, specific capacities of wells tapping aquifer 8 are estimated to be about 17 and 24.5 gpm per ft. after one day of pumping.	In the area west of Cove City and Fort Barnwell, aquifer 8 contains water of excellent chemical quality. Data are insufficient to determine the quality of water in this aquifer for other parts of the county, but the water is assured to be salty in most of the central and southern parts.

4.-Summary of Aquifer Characteristics

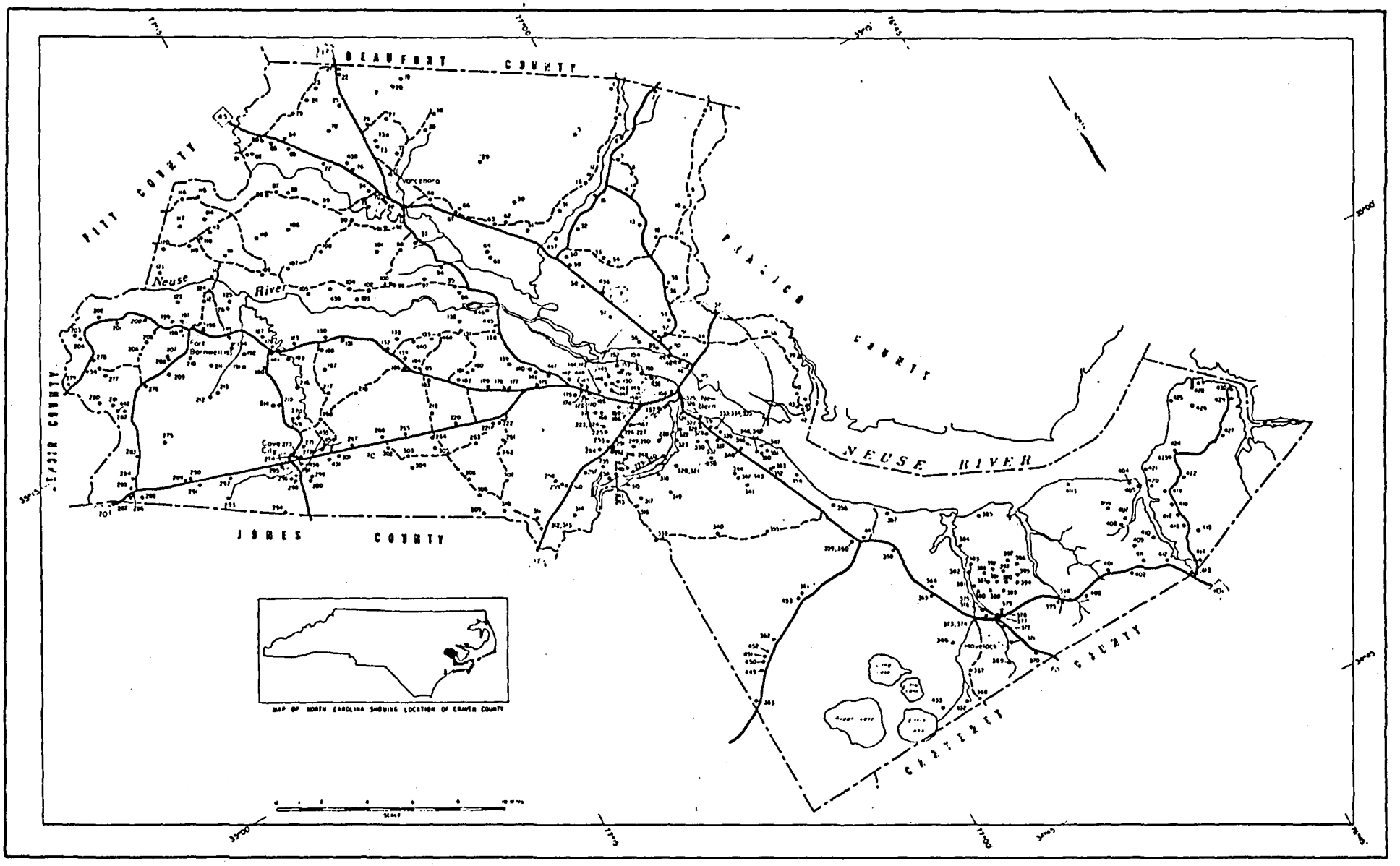

Figure 1. - Map of Craven County showing location of inventoried wells.

REFERENCE 14

U. S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

Technical Guide
Section II-A-2
March 1990

HYDRIC SOILS
Craven County, North Carolina

Hydric codes (HC): 1 = hydric soils, only because of saturation for a significant period during the growing season;

2 = hydric soils that are frequently flooded for long or very long periods during the growing season; and

3 = hydric soils that are ponded for long or very long periods during the growing season.

Vegetation codes (VC): 1 = hydric soils that support woody vegetation under natural conditions; and

2 = hydric soils that do not support woody vegetation under natural conditions.

Hydric soils in this county cannot be farmed under natural conditions without removing woody vegetation or hydrology manipulation.

A. Map units that are all hydric soils or have hydric soils as a major component.

Map Unit Symbol	HC	VC	Map Unit Name
Ap (87)	1,3	1	Arapahoe fine sandy loam
Ba (860)	1,3	1	Bayboro mucky loam
CT (CN)	1,3	1	Croatan muck
DA	1,3	1	Dare muck
De (816)(8) (82)	1,3	1	Deloss fine sandy loam
DO (JP)	1,2,3	1	Dorovan muck, frequently flooded
Gr (877)	1	1	Grantham silt loam
La (818)(30)	1	1	Leaf silt loam
LF (HB, CA) (CR)	1,2,3	2	Lafitte muck, frequently flooded
Ln (582)	1	1	Leon sand
Me (826)	1	1	Meggett sandy loam

A. Map units that are all hydric soils or have hydric soils as a major component.

Map Unit Symbol	HC	VC	Map Unit Name
MM (JB)	1,2,3	1	Masontown mucky fine sandy loam and Muckalee sandy loam, frequently flooded
Mu (891)	1,3	1	Murville mucky loamy sand
Pa (836)	1	1	Pantego fine sandy loam
PO (Po, Pa)	1	1	Ponzer muck
Ra (830)	1	1	Rains fine sandy loam
Rc (831)	1	1	Rains-Urban land complex (Rains part)
Ro (89, 552)	1	1	Roanoke fine sandy loam
Tc (28)	1	1	Torhunta-Urban land complex (Torhunta part)
Tm (876)	1	1	Tomotley fine sandy loam
To (870)	1	1	Torhunta fine sandy loam

B. Map units with inclusions of hydric soils or have wet spots.

Map Unit Symbol	Map Unit Name	Hydric Inclusion	HC	VC	Normal location of Inclusion
Ag (46)	Augusta fine sandy loam	Tomotley	1	1	depressions
KuB (704B)	Kureb sand	Leon	1	1	depressions
Le (56)	Lenoir silt loam	Leaf	1	1	depressions
Ly (417)	Lynchburg fine sandy loam	Rains	1	1	depressions
Se (452)	Seabrook loamy sand	Leon	1	1	intermingled areas of depressions
LC (41)	Lynchburg-Urban land complex	Rains	1	1	depressions

REFERENCE 15

State of North Carolina
Department of Natural Resources and Community Development
Division of Soil and Water Conservation
512 North Salisbury Street • Raleigh, North Carolina 27611

James G. Martin, Governor
S. Thomas Rhodes, Secretary

David W. Sides
Director

June 21, 1988

Ms. Pat DeRosa
Superfund Branch
Bath Building

Dear Ms. DeRosa:

Enclosed is the list of hydric soils of North Carolina. The soils are listed by soil order. The information is presented in the following order: county distribution, acreage, drainage class, capability class, and associated wetland communities. The soils with a red asterisk are floodplain soils and may be of more importance to you. The soil surveys of each county will be a valuable resource for approximate wetland boundaries by using the hydric soil list and the delineated soil maps. If I can be of further assistance to you on hydric soils or wetlands, please call.

Sincerely,

Kevin Moorhead

Kevin Moorhead
Wetlands Program

P.O. Box 27687 Raleigh, North Carolina 27611-7687 Telephone 919-733-2302

An Equal Opportunity/Affirmative Action Employer

THE HYDRIC SOILS OF NORTH CAROLINA

Over 100 hydric soils have been used in soil survey work in North Carolina. Seven of the 10 soil orders are represented and each soil order is discussed separately.

ALFISOLS

Argent - Washington, Tyrrell and Pamlico Counties, 27,200 acres. Poorly drained, 6w. Isolated swamps and pine/hardwood forests, pocosin fringes.

Brookman - Pamlico and Columbus Counties, 9,690 acres. Very poorly drained, 6w.

Grifton - Bladen, Columbus, Brunswick, Pender, Onslow, Duplin, Lenoir, Jones Counties, 64,958 acres. Poorly drained, 6w. Savannahs, bottomland forests, pine/hardwood forests.

Leaksville - Rockingham County, 1,901 acres. Somewhat poorly drained, 3w.

* Meggett - Nash, Edgecombe, Lenoir, Craven, Jones, Pender, Bladen, Robeson, Columbus Counties, 49,114 acres. Poorly drained, 4 to 6w (flooding). Bottomland forests.

Nakina - Columbus County, 18,721 acres. Very poorly drained, 6w.

Stockade - Pamlico and Jones Counties, 23,459 acres. Very poorly drained, 6w. Mixed hardwood/pine forests.

Tuckerman - Pitt County, 8,832 acres. Poorly drained, 3 to 5w (slope).

Yonges - Pamlico County, 27,286 acres. Poorly drained, 6w. Pocosin fringes.

ENTISOLS

* Bibb - Pasquotank, Hertford, Bertie, Halifax, Martin, Edgecombe, Nash, Pitt, Greene, Wilson, Nash, Wake, Johnston, Wayne, Lenoir, Duplin, Sampson, Harnett, Moore, Robeson, Scotland Counties, 287,668 acres. Poorly drained, 5w. Bottomland forests.

Bohicket - Onslow, Pender, Brunswick Counties, 23,522 acres. Very poorly drained, 8w. Tidal brackish marsh.

Capers - Hyde County? Very poorly drained, 6w.

Cartecay - Durham County, 1,831 acres. Somewhat poorly drained, 7w. The known acreage of Cartecay may not meet the criteria of hydric soil because this series is considered hydric only when ponded.

Carteret - Dare, Carteret, Onslow, Pender, Brunswick Counties, 24,729 acres. Very poorly drained, 8w. Tidal brackish marsh.

* Chastain - Rockingham, North Hampton, Martin, Johnston, Pender, Bladen, Columbus, Richmond Counties, 47,038 acres. Poorly drained, 4 to 6w. Bottomland forests.

* Chowan - Camden, Gates, Chowan, Perquimans, Tyrrell, Brunswick Counties, 27,596 acres. Very poorly drained, 7w. Cypress/gum swamps.

Duckston - Outer banks, 5,000 acres. Brackish marsh/shrub zone, swales between dunes.

Engelhard - New series in Hyde County. Poorly drained, 6w. Formerly mapped as a phase of Weeksville or Pasquotank series.

* Hatboro - Henderson County, 1,674 acres. Poorly drained, 3w. Bottomland forests.

Hobucken - Pamlico and Carteret Counties, 21,134 acres. Very poorly drained, 7w. Tidal brackish marsh.

Kinston - Lenoir, Greene and Wayne Counties, 11,009 acres. Poorly drained, 6w. Bottomland forests.

Muckalee - Washington, Beaufort, Craven, Jones, Onslow, Duplin, Pender, Columbus, Brunswick Counties, 187,878 acres. Poorly drained, 5w. Cypress/gum swamps, bottomland forests.

Nawney - Gates County. Very poorly drained, 7w.

Osier - Pitt, Robeson, Dare and Currituck Counties, 8,827 acres. Poorly drained, 5w. Marsh/shrub transition in the outer banks, ?

Wehadkee - Cherokee, Graham, Avery, Watagua, Caldwell, Wilke, Alexander, Catawba, Iredell, Cabarras, Yadkin, Forsyth, Rockingham, Guilford, Anson, Moore, Lee, Chatam, Alamance, Person, Granville, Vance, Warren, North Hampton, Hertford, Bertie, Halifax, Edgecombe, Nash, Wilson, Johnston, Harnett, Wake, Durham, Franklin Counties, 218,030 acres. Poorly drained, 6w. Bottomland forests.

Wysocking - Hyde County. Poorly drained, 6w.

HISTOSOLS

Belhaven - Camden, Gates, Dare, Tyrrell, Washington, Beaufort, Hyde, Pamlico, Carteret Counties, 160,346 acres. Very poorly drained, 7w. Pocosins.

Croatan - Martin, Beaufort, Pamlico, Craven, Carteret, Jones, Duplin, Onslow, Pender, Duplin, Cumberland, Bladen, Columbus, Brunswick Counties, 294,822 acres. 7w. Pocosins, Carolina Bays.

Currituck - Currituck, Dare and Beaufort Counties, 44,642 acres. Very poorly drained, 8w. Tidal brackish and freshwater marsh.

Dare - Currituck, Hyde, Beaufort, Craven, Pamlico, Carteret Counties, 83,881 acres. 7w. Pocosins.

Dorovan - Currituck, Camden, Perquimans, Chowan, Gates, Hertford, Bertie, Martin, Washington, Tyrrell, Hyde, Beaufort, Craven, Carteret, Onslow, Pender, Bladen, New Hanover, Brunswick, Columbus Counties, 255,712 acres. Very poorly drained, 7w. Cypress/gum swamps.

Hobanny - Jones, Dare and Camden Counties, 13,029 acres. Very poorly drained, 7w. Tidal freshwater marsh.

Lafitte - Craven, Pamlico, Onslow, Brunswick, Carteret Counties, 43,821 acres. Very poorly drained, 8w. Tidal brackish marsh.

Mattamuskeet- New series in Hyde County. Very poorly drained, 7w.

Pamlico - Wayne, Lenoir, Sampson, Bladen, New Hanover Counties, 42,834 acres. Very poorly drained, 7w. Pocosins.

Ponzer - Currituck, Dare, Hyde, Tyrrell, Beaufort, Washington, Craven, Carteret, Robeson Counties, 123,258 acres. 7w. Pocosins, isolated deciduous hardwood forests.

Pungo - Gates, Camden, Washington, Tyrrell, Dare, Hyde Counties, 250,811 acres. Very poorly drained, 7w. Pocosins.

Scuppernong - Chowan, Perquimans and Washington Counties, 9,810 acres. 7w. Pocosins.

INCEPTISOLS

Arapahoe - Chowan, Perquimans, Washington, Tyrrell, Beaufort, Craven, Pamlico, Carteret Counties, 88,436 acres. Very poorly drained, 6w. Mixed hardwood/pine forests, pocosin fringes.

Ballahack - Gates, Edgecombe and Pamlico Counties, 11,817 acres. Very poorly drained, 6w. Pocosin fringes, bottomland forests.

Chenneby - Columbus County (in association with Chastain). Somewhat poorly drained, 4w. Only the ponded phase of this series is considered hydric so the known acreage of Chenneby may not be considered a hydric soil.

Conaby - Currituck, Washington and Dare Counties, 7,337 acres. Very poorly drained, 6w. Mixed hardwood/pine forests, brackish marsh/shrub zone, bottomland forests.

Fortescue - Washington County, 720 acres. Very poorly drained, 6w.

* Johnston - Bertie, Edgecombe, Greene, Wayne, Lenoir, Duplin, Sampson, Hoke, Cumberland, Bladen, Robeson, Columbus, Scotland, New Hanover Counties, 245,727 acres. Very poorly drained, 7w. Bottomland forests, cypress-gum swamps.

Liddell - Wayne and Pender Counties, 29,658 acres. Poorly drained, 6w.

* Masontown - Pamlico, Craven, Carteret and Onslow Counties, 21,182 acres. Very poorly drained, 7w. Cypress-gum swamps.

* Nikwasi - Proposed mountain floodplain series in Haywood, Jackson, Clay and Macon Counties. Poorly and very poorly drained, 6w.

Pasquotank - Currituck and Pasquotank Counties, 17,669 acres. Poorly drained, 6w.

Pettigrew - New series in Hyde County. Very poorly drained, 6w.

Polawana - Harnett County, 791 acres. Very poorly drained, 6w.

Roper - Camden, Washington, Tyrrell and Dare Counties, 38,442 acres. Very poorly drained, 6w. Mixed pine/hardwood forests, pocosin fringes.

Rutledge - Scotland, Robeson and Pamlico Counties, 9,306 acres. Very poorly drained, 6w.

Sylva - New series in Jackson and Macon Counties. Poorly drained, 3w.

Torhunta - Beaufort, Craven, Carteret, Jones, Lenoir, Wayne, Onslow, Duplin, Sampson, Cumberland, Pender, Bladen, Hoke, Robeson, Columbus, Brunswick, New Hanover Counties, 276,924 acres. Very poorly drained, 6w. Carolina Bays, Pocosin fringes, mixed pine/hardwood forests.

* Toxaway - Graham, Clay, Transylvania, Henderson, Buncombe, Yancey, Ashe, Watagua, Avery, Mitchell Counties, 19,453 acres. Very poorly drained, 4w. Bottomland forests.

Wasda - Currituck, Camden, Tyrrell, Washington, Beaufort, Hyde, Pamlico, Carteret, Bladen Counties, 66,658 acres. Very poorly drained, 6w. Pocosin fringes.

Weeksville - Pasquotank, Hyde and Tyrrell Counties, 44,706 acres. Very poorly drained, 6w.

Wilbanks - Hertford, Halifax, Wilson and Bladen Counties, 11,447 acres. Very poorly drained, 6w.

MOLLISOLS

Armenia - Davie, Davidson and Cabarrus Counties, 2,445 acres. Poorly drained, 3 to 6w.

Picture - Granville County. Poorly drained.
Stono - Pasquotank County, 923 acres. Very poorly drained, 6w.

SPODOSOLS

Leon - Beaufort, Pamlico, Carteret, Jones, Craven, Lenoir, Wayne, Duplin, Onslow, Sampson, Pender, Cumberland, Hoke, Robeson, Bladen, Columbus, Brunswick, New Hanover, Gates, Dare Counties, 261,332 acres. Poorly drained, 4w. Pine flatwoods, savannahs.
Lynn Haven - Cumberland, Hoke, Sampson, Bladen, New Hanover, Chowan, Perquimans Counties, 62,670 acres. Poorly drained, 4w. Pine flatwoods, savannahs.
Murville - Pitt, Craven, Lenoir, Jones, Carteret, Onslow, Duplin, Pender, New Hanover, Brunswick, Columbus Counties, 178,870 acres. Very poorly drained, 5w. Pine flatwoods, savannahs, Carolina Bays.
Olustee - Pitt County, 1,265 acres. Poorly drained, 3w. Has recently been correlated to Murville soil.

ULTISOLS

Bayboro - Pasquotank, Hyde, Beaufort, Craven, Jones, New Hanover Counties, 80,781 acres. Very poorly drained, 6w.
Bethera - North Hampton, Halifax, Martin and Columbus Counties, 59,682 acres. Poorly drained, 6w. Bottomland forests.
Bladen - Gates, Hyde, Pitt and Pasquotank Counties, 64,610 acres. Poorly drained, 6w. Mixed hardwood/pine forests.
Byars - Hoke, Cumberland, Robeson, Bladen and Pitt Counties, 15,826 acres. Very poorly drained, 6w. Mixed pine/hardwood forests, Carolina bays, pocosin fringes.
Cape Fear - Cumberland, Bladen, Pitt, Edgecombe, Beaufort, Washington, Tyrrell, Dare, Currituck, Camden, Perquimans, Chowan, Gates Counties, 90,915 acres. Very poorly drained, 6w. Pocosin fringes, bottomland forests.
Chatuge - Jackson and Clay Counties. Poorly drained, 4w.
Coxville - Edgecombe, Franklin, Pitt, Wilson, Lenoir, Wayne, Harnett, Sampson, Bladen, Cumberland, Hoke, Robeson, Scotland, Columbus Counties, 99,771 acres. Poorly drained, 4w. Mixed hardwood/pine forests, pocosin fringes.
Deloss - Cumberland, Craven and Carteret Counties, 54,574 acres. Very poorly drained, 6w. Mixed pine/hardwood forests, pocosin fringes.
Elkton - Pasquotank County, 32,626 acres. Poorly drained, 5w. Has recently been correlated to Roanoke soil.
Fallsington - Pasquotank County, 1,712 acres. Poorly drained, 4w. Has recently been correlated to Tomotley soil.
Grantham - Bertie, Halifax, Edgecombe, Wilson, Greene, Craven, Jones, Johnston, Harnett, Sampson, Cumberland, Pender, Bladen, Columbus Counties, 81,959 acres. Poorly drained, 6w. Mixed pine/hardwood forests.
Hemphill - Haywood, Jackson, Macon Counties. Very poorly drained, 4w.
Hyde - Dare, Hyde, Tyrrell, Washington, Beaufort, Camden Counties, 81,813 acres. Very poorly drained, 6w. Pocosin fringes.

Icaria - Gates, Chowan, Perquimans and Dare Counties, 9,731 acres. Poorly drained, 6w.

Kenansville - Although on the hydric soil list, none of the known acreage in North Carolina meets the frequency of flooding criteria. Therefore; the mapped units do not meet the criteria of a hydric soil.

Kinkora - Henderson, Buncombe, Madison, Haywood Counties. 1221 acres. Poorly drained, 3w.

Leaf - Hertford, Bertie, Beaufort, Pitt, Craven, Pamlico, Jones, Lenoir, Wayne, Johnston Counties, 259,758 acres. Poorly drained, 4w. Pine/hardwood forests.

Lenoir - See the note for Kenansville soil above.

Lumbee - Edgecombe, Greene, Wayne, Lenoir, Duplin, Sampson, Pender, Brunswick, Columbus, Robeson, Scotland Counties, 76,087 acres. Poorly drained, 6w. Bottomland forest.

McColl - Hoke, Cumberland, Robeson and Scotland Counties, 19,183 acres. Poorly drained, 6w. Carolina Bays.

Myatt - Wayne, Hyde Counties, 20,637 acres. Poorly drained, 3 to 5w (flooding).

Nimmo - Currituck, Camden, Perquimans, Chowan Counties, 6,567 acres. Poorly drained, 4w.

Othello - Pasquotank County, 18,721 acres. Poorly drained, 3 to 5w (slope).

Pantego - Gates, Bertie, Beaufort, Martin, Pitt, Craven, Carteret, Jones, Lenoir, Wayne, Johnston, Onslow, Duplin, Sampson, Cumberland, Hoke, Robeson, Bladen, Pender, New Hanover, Columbus, and Brunswick Counties, 206,110 acres. Poorly drained, 6w. Pocosin fringes, pine/hardwood forests, Carolina bays.

Paxville - Greene, Pamlico, Sampson and Bladen Counties, 20,932 acres. Very poorly drained, 6w.

Perquimans - Camden, Chowan, Perquimans, Tyrrell and Beaufort Counties, 41,467 acres. Poorly drained, 6w.

Plummer - Wake, Robeson, Scotland and Anson Counties, 7,027 acres. Poorly drained, 5w.

Pocomoke - Pasquotank County, 5,312 acres. Very poorly drained, 3w.

Portsmouth - Currituck, Camden, Chowan, Perquimans, Pasquotank, Dare, Tyrrell, Washington, Beaufort, Pitt, Edgecombe, Lenoir, Harnett, Bladen, Robeson, Scotland Counties, 145,023 acres. Very poorly drained, 6w. Pocosin fringes, pine/hardwood forests.

Rains - Gates, Hertford, North Hampton, Halifax, Bertie, Martin, Beaufort, Pitt, Edgecombe, Nash, Wake, Johnston, Wayne, Wilson, Greene, Craven, Pamlico, Carteret, Jones, Lenoir, Onslow, Duplin, Sampson, Harnett, Cumberland, Hoke, Scotland, Richmond, Robeson, Bladen, Pender, New Hanover, Brunswick, Columbus Counties, 836,029 acres. Poorly drained, 3w. Pine/hardwood forests, Pocosin fringes, Carolina bays, bottomland forests.

Roanoke - Currituck, Camden, Pasquotank, Perquimans, Chowan, Gates, Hertford, North Hampton, Halifax, Bertie, Washington, Tyrrell, Beaufort, Martin, Edgecombe, Pitt, Craven, Carteret, Wilson, Franklin, Wake, Johnston, Durham, Chatham, Lee, Harnett, Cumberland, Sampson, Bladen, Davie, Iredell, Caldwell Counties, 352,125 acres. Poorly drained, 4 to 6w. Bottomland forests, mixed pine/hardwood forests.

Toisnot - Wilson, Franklin, Johnston, Harnett, Sampson, Bladen, Robeson Counties, 15,689 acres. Poorly drained, 5w.

Tomotley - Currituck, Camden, Pasquotank, Perquimans, Chowan, Gates, Hertford, Bertie, North Hampton, Halifax, Nash, Wilson, Johnston, Craven, Carteret, Beaufort, Tyrrell, Washington Counties, 170,764 acres. Poorly drained, 4w. Pocosin fringes, mixed pine/hardwood forests.

Trebloc - Robeson County, 9,774 acres. Poorly drained, 3 to 5w (flooding).

Weston - Wayne County, 9,544 acres. Poorly drained, 3w.

Woodington - Martin, Lenoir, Jones, Onslow, Duplin, Sampson, Cumberland, Hoke, Bladen, Pender, Brunswick, New Hanover Counties, 190,108 acres. Poorly drained, 6w. Pocosin fringes, mixed pine/hardwood forests.

Worsham - Cherokee, Avery, Watagua, Yadkin, Catawba, Lincoln, Gaston, Alamance, Anson, Wake. Yancey, Warren, Franklin, Nash, Halifax Counties, 30,267 acres, Poorly drained, 5w. Drainage heads.

DIV. SOIL & WATER CONS.
DNRCD
P. O. BOX 27687
RALEIGH, N.C. 27611
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"Wetlands" Definition for the HRS (40 CFR 230)

230.3 Definition.

(t) The term "wetlands" means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

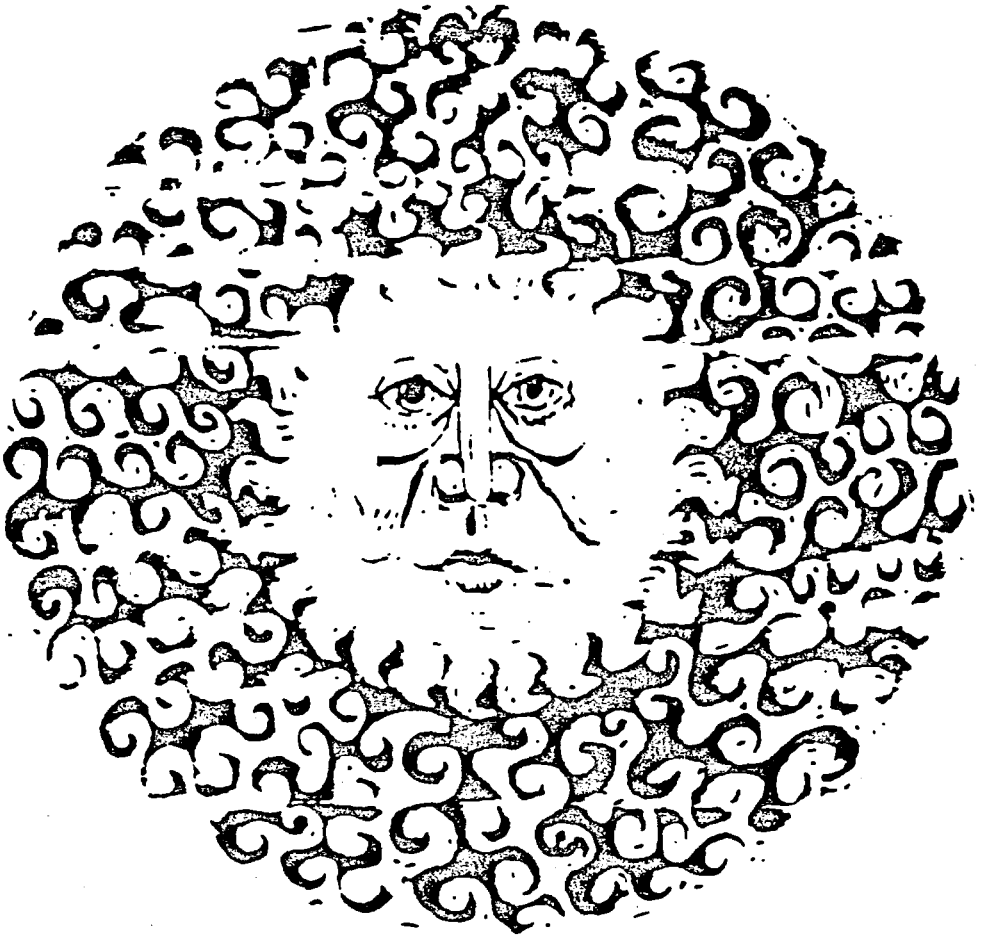
230.41 Wetlands.

(a)(1) Wetlands consist of areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions.

(2) Where wetlands are adjacent to open water, they generally constitute the transition to upland. The margin between wetland and open water can best be established by specialists familiar with the local environment, particularly where emergent vegetation merges with submerged vegetation over a broad area in such places as the lateral margins of open water, headwaters, rainwater catch basins, and groundwater seeps. The landward margin of wetlands also can best be identified by specialists familiar with the local environment when vegetation from the two regions merges over a broad area.

(3) Wetland vegetation consists of plants that require saturated soils to survive (obligate wetland plants) as well as plants, including certain trees, that gain a competitive advantage over others because they can tolerate prolonged wet soil conditions and their competitors cannot. In addition to plant populations and communities, wetlands are delimited by hydrological and physical characteristics of the environment. These characteristics should be considered when information about them is needed to supplement information available about vegetation, or where wetland vegetation has been removed or is dormant.

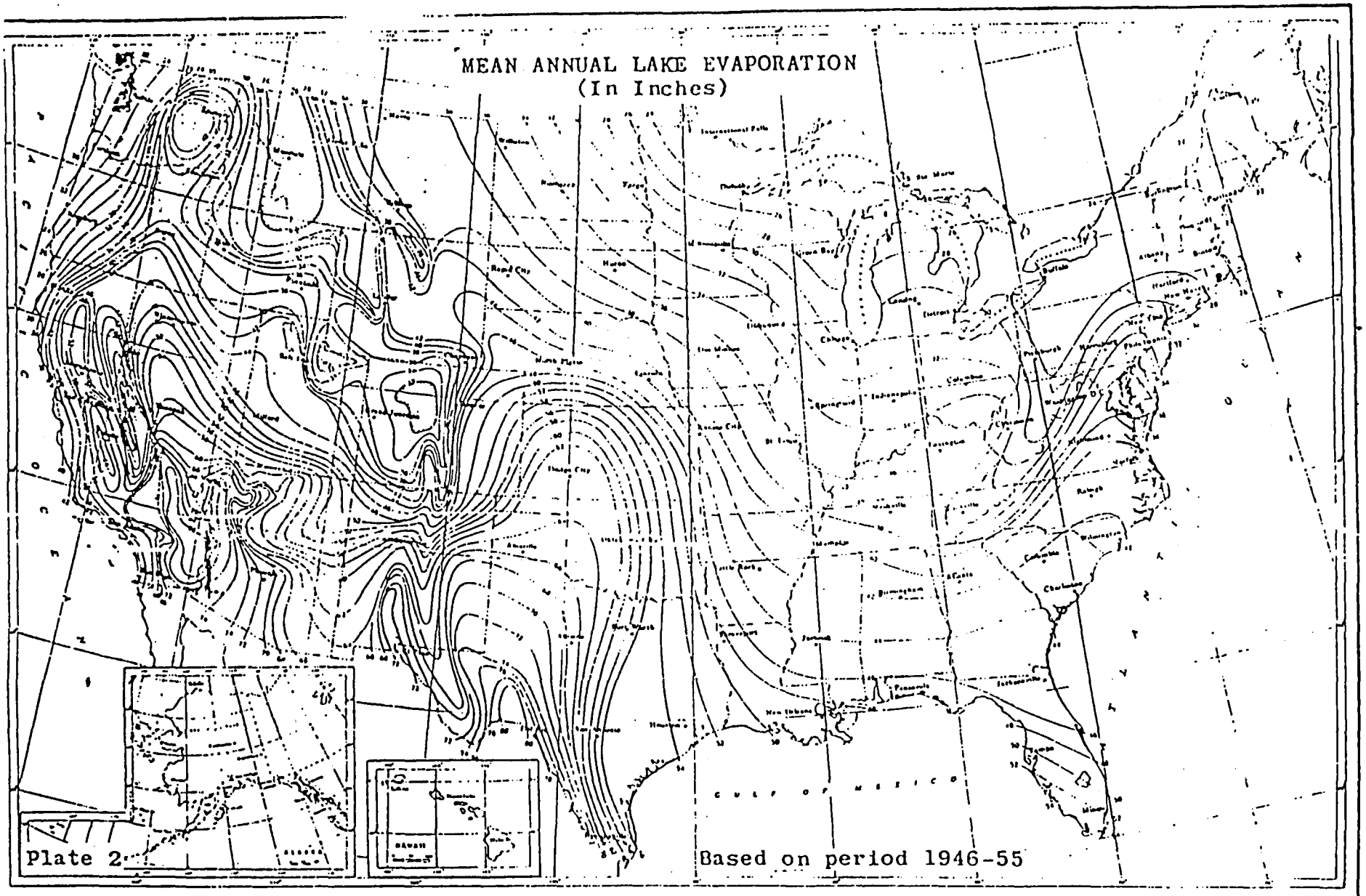
REFERENCE 16

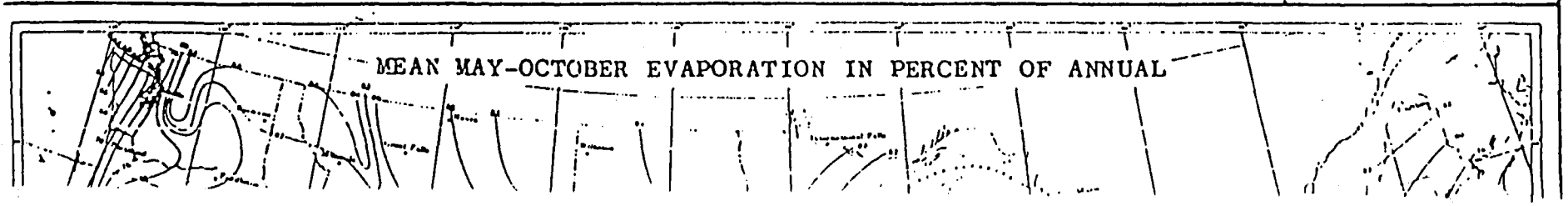


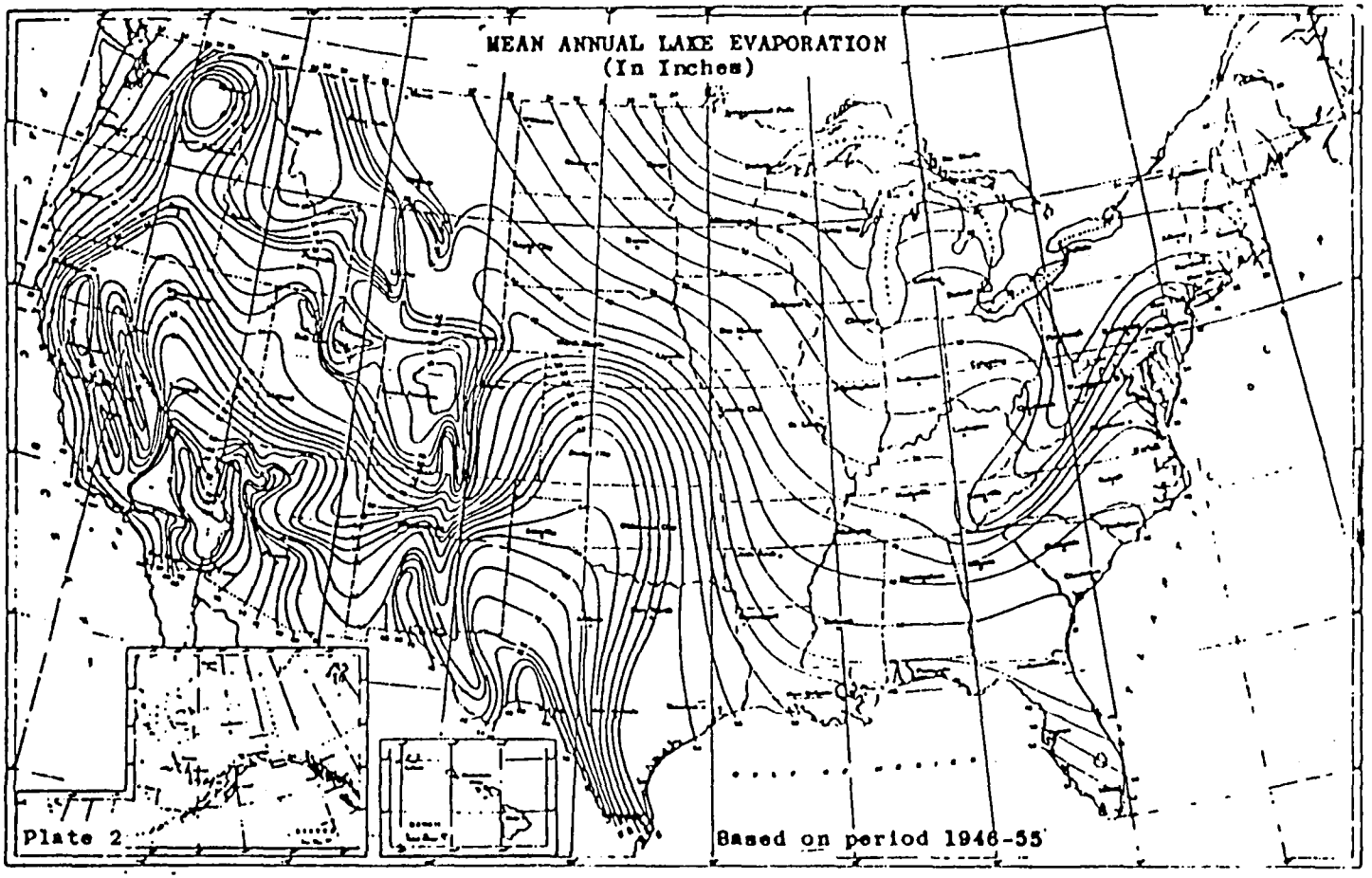
CLIMATIC ATLAS OF THE UNITED STATES

Climatic Atlas of the United States, US Department of Commerce, National Climatic Center, Asheville, NC, 1979.

AKE EVA JRATION

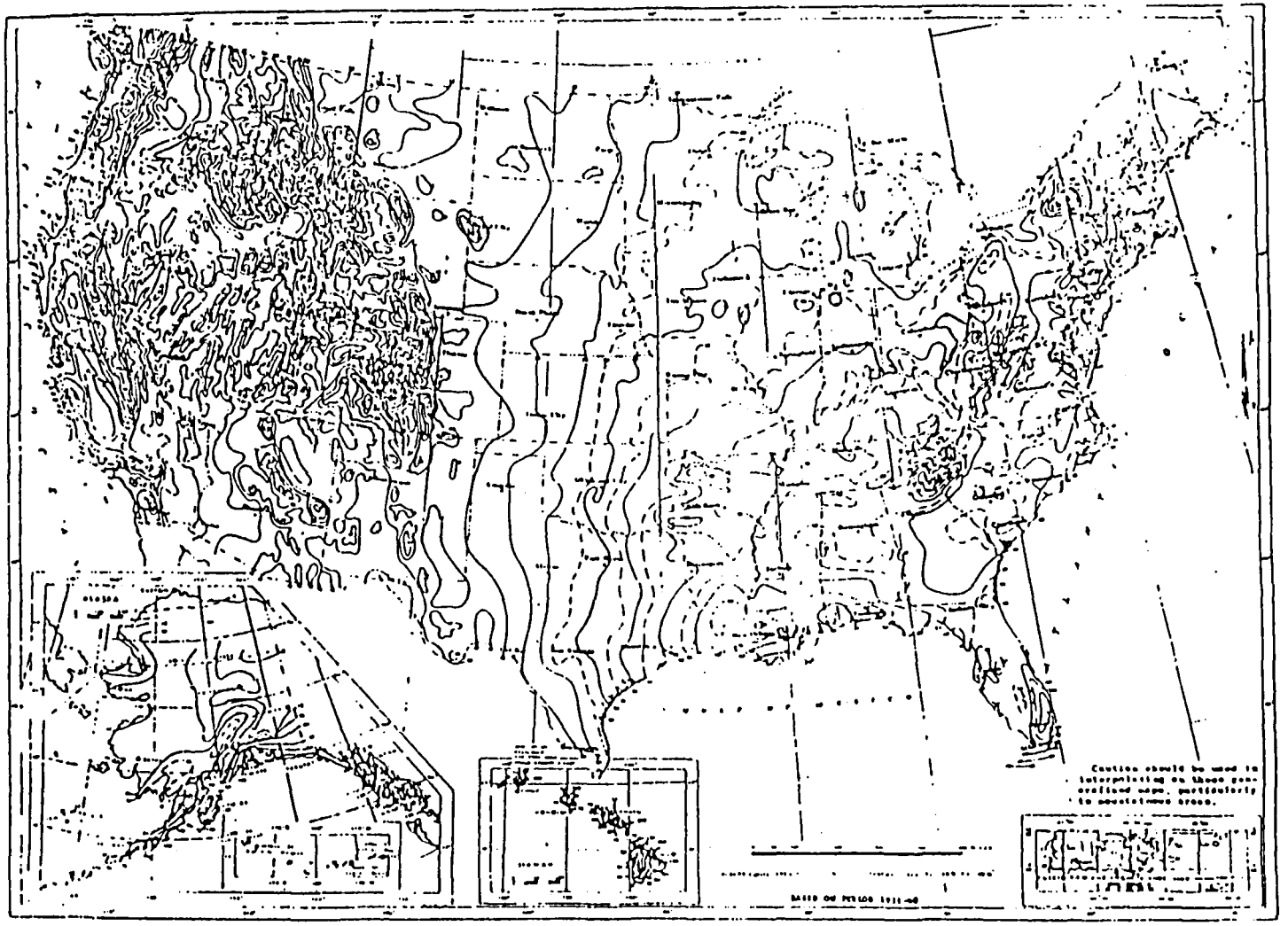






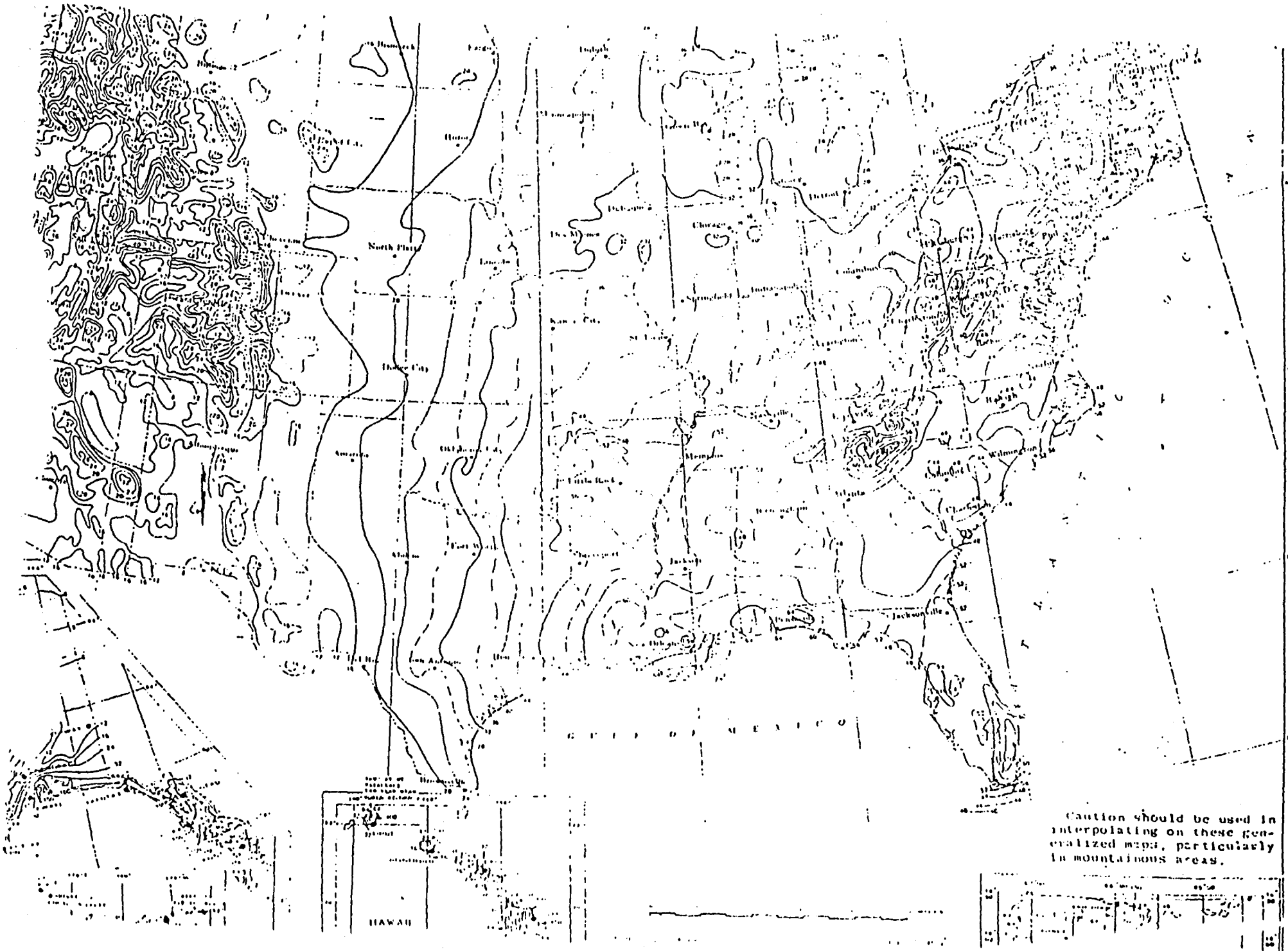
Source: Climatic Atlas of the United States, U.S. Department of Commerce, National Climatic Center, Ashville, N.C., 1979.

FIGURE 4
MEAN ANNUAL LAKE EVAPORATION
(IN INCHES)



Source: Climatic Atlas of the United States, U.S. Department of Commerce, National Climatic Center, Asheville, N.C., 1979.

FIGURE 5
NORMAL ANNUAL TOTAL PRECIPITATION (INCHES)



Caution should be used in interpolating on these generalized maps, particularly in mountainous areas.

REFERENCE 17

U.S. DEPARTMENT OF COMMERCE
Luther H. Hodges, Secretary

WEATHER BUREA
F. W. Reichelderfer, C

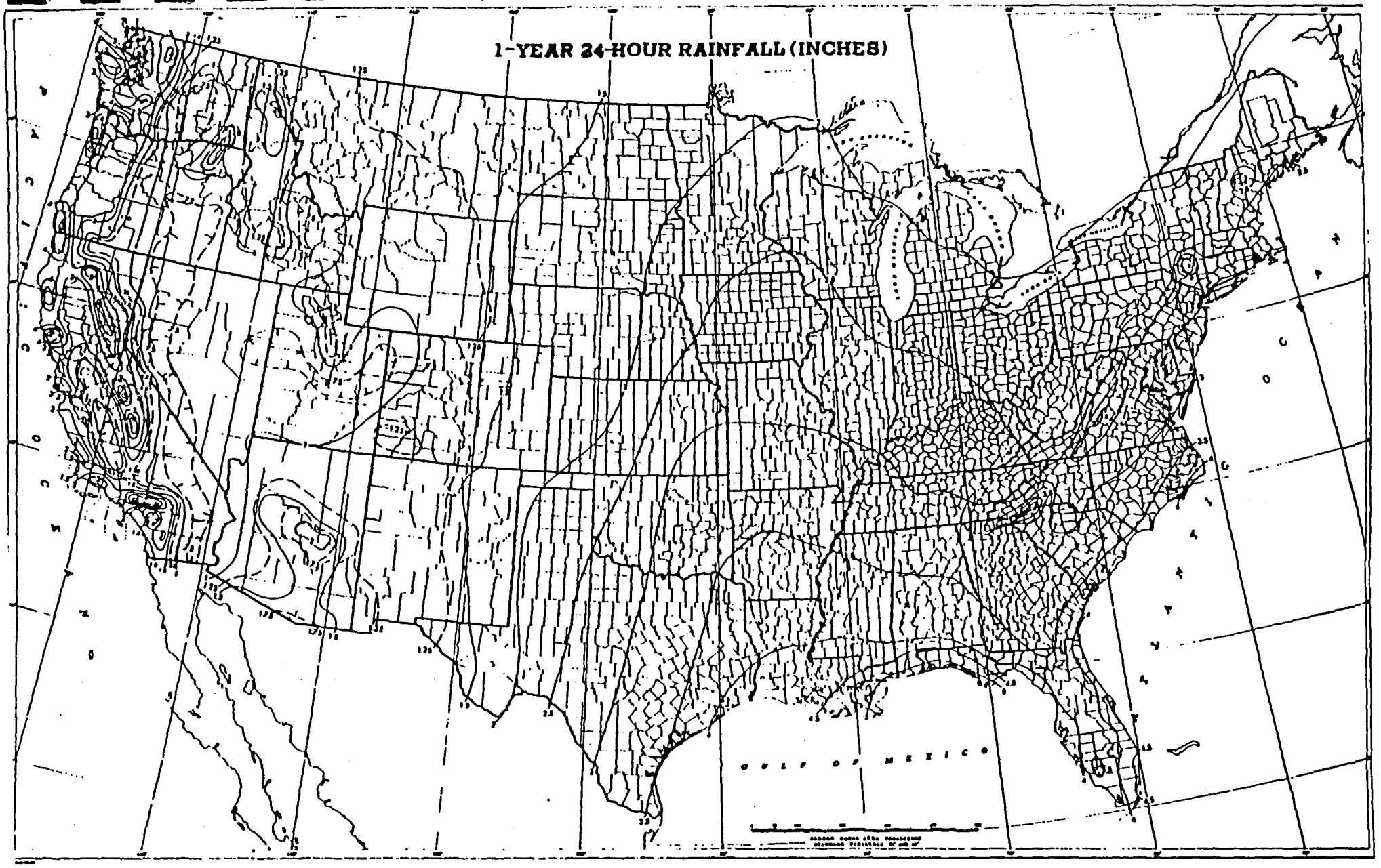
TECHNICAL PAPER NO. 40

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
DAVID M. HERSFIELD
Cooperative Studies Section, Hydrologic Services Division
for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

Reference 17


1-YEAR 24-HOUR RAINFALL (INCHES)
GULF OF MEXICO

2-YEAR 24-HOUR RAINFALL (INCHES)
GULF OF MEXICO

REFERENCE 18

Reference 18

LAND USE PLAN UPDATE

PREPARED FOR:

THE TOWN OF NEW BERN, N.C.

By:

SATILLA PLANNING

PLANNERS LANDSCAPE ARCHITECTS

ADOPTED MAY 26, 1987

CERTIFIED BY THE COASTAL RESOURCES COMMISSION

JUNE 4, 1987

LAND USE PLAN UPDATE

New Bern, North Carolina

Prepared by

SATILLA PLANNING

PLANNERS ▭ LANDSCAPE ARCHITECTS

P.O. BOX 1110, ST. MARYS, GEORGIA 31558

Adopted by the City of New Bern: May 26, 1987

CRC CERTIFICATION: JUNE 4, 1987

The preparation of this report was financed in part through a grant provided by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration.

November, 1985, the City had the following customer base:

Customer Categories	Number of Customers
Residential, in City	5,221
Commercial, in City	664
Industrial, in City	55
Residential, outside City	860
Commercial, outside City	33
Industrial, outside City	9

Additionally,the City sells water on a wholesale basis to Trent Woods and the Neuse River Sewer and Water District. According to the City's consulting engineers, Finkbeiner, Pettis and Strout, the average daily water demand in 1983 was 3.06 million gallons per day (gpd) with a maximum day demand of 5.14 million gpd. The system's existing capacity is 4.0 million g.p.d. Therefore, average daily demand is 76.5% of capacity. Peak demand is 128.5% of capacity.

The City is currently preparing a long range water system improvements plan. While this plan is not yet in final form, the following major improvements are under consideration:

- o addition of a 5th water supply well.
- o improvements to the in City water pumping plant to increase capacity and system pressure.
- o construction of a 500,000 gallon elevated water tank.

The fundamental objections of these improvements are to increase overall capacity to 5.0 million g.p.d. while providing sufficient water pressure throughout the water distribution system. A water system improvement plan is being prepared to identify the capacities necessary to serve future growth in and around New Bern.

Wastewater Collection and Treatment. The service area of the City's sewage system and its treatment plant, containing 5,632 customers as of November, 1985, are identified by Map Three. The City currently operates a 4 million gallon per day trickling filter type secondary wastewater treatment plant located at the northern end of Glenburnie Drive. The plant discharges into the Neuse River. The average daily wastewater flow is currently about 2.8 million gallons per day. Average daily flow is therefore 70% of capacity.

However, the City is currently under a moratorium on new connections and has applied for a special order by consent (soc) from the N.C. Division of Environmental Management. The moratorium is based on the City's inability to meet effluent BOD limitations.

The City prepared an interim action plan in April, 1987 to address these deficiencies which includes technical, governmental and engineering program elements. The Board of Aldermen has given a high

About half of New Bern's Planning area falls within the marginally suitable area including the areas currently receiving most of the new growth to the west. These lands can be satisfactorily converted to urban land uses provided that drainage improvements and sewer is provided. Additionally, organic material must be removed from the surface of some soils in the marginal category. It must be understood, however, that the cumulative effect of development in these areas can create water quality problems.

Areas of Environmental Concern. Areas of Environmental Concern (AEC's) are sensitive environmental and cultural areas protected by the Coastal Area Management Act (CAMA). General categories of these areas are identified through State guidelines according to the Administrative Procedures Act, as administered by the Division of Coastal Management. Special areas of local or regional environmental or cultural significance can be nominated as AEC's by individuals, groups or governing bodies. See also N.C.A.C. Section 15-7 for actual state regulations defining and governing allowable uses in these areas.

AEC's lying within New Bern's jurisdiction include Public Trust Waters, Coastal Wetlands, Estuarine Waters, and Estuarine Shorelines. Development or other land and water uses within AEC's generally requir CAMA permits. The State has established extensive guidelines regarding activites within AEC's, but generally does not preclude any land use by right. As part of an effort to share implementation of the Coastal Area Management Act with local governments, the State's land use planning guidelines require that local governments identify acceptable land use within AEC's in their planning jurisdiction. Descriptions of AEC's within New Bern's jurisdiction are provided below.

- Public Trust Waters

  These are legally defined areas of environmental concern where the public has a right to navigation and recreation. The primary concern is that uses such as bulkheads and marinas which must utilize public trust areas, do so without interfering with the public interest in these areas.

- Coastal Wetlands

  Coastal wetlands, or high tide marshlands, are found adjacent to the Neuse and Trent Rivers in two separate locations. The largest wetland area adjoins the Trent River and Lawson Creek, containing approximately 214 acres. Another wetland area is located on the western side of the Neuse River eastward from Woodrow subdivision. The primary plant species in both areas is cordgrass (spartina alterniflora).

  These marshes provide habitat for wildlife and waterfowl and act as a deterrent to shoreline erosion and sediment runoff

- Estuarine Waters

  Estuarine waters in New Bern's jurisdiction are those area

of the Neuse and Trent Rivers between the city limits and the mean high water mark, the high water mark being described as the clear line impressed on the land adjacent to the rivers. Generally the New Bern city limits extend about 300 feet from the high water mark into the Neuse and Trent Rivers. Estuarine waters are bordered by estuarine shoreline. These waters are among the most productive natural environments in North Carolina. Many fish and shellfish species spend all or part of their life cycle in estuarine waters. The water areas are used for commercial and recreational navigation, water sports, and provide aesthetic benefits.

o Estuarine Shorelines

Estuarine shorelines are defined as non-ocean shorelines which are especially vulnerable to erosion, flooding, or other adverse effects of wind and water and are intimately connected to the estuary. The estuarine shoreline encompasses the area landward along the estuaries, bays, sound and other brackish waters for a distance of 75 feet from the mean high water level. There are no specific restrictions within estuarine shoreline areas. The prime requirement is that all development substantially preserve natural barriers to erosion. In New Bern's planning jurisdiction, all shorelines of the Neuse and Trent Rivers fall within this classification.

Management guidelines and rules for uses for all Areas of Environmental Concern are described in the most recently amended version of Section 15-7H of the North Carolina Administrative Code. These rules are available through Division of Coastal Management offices in both Raleigh and Morehead City.

Community Facilities Capacity

Community Facility Capacities are identified and discussed by the Community Facilities Section (page 12) of Existing Conditions.

1. RESOURCE PROTECTION

a. The Estuarine System. The Areas of Environmental Concern (AEC's) within New Bern's planning jurisdiction are all components of the Estuarine System. These AEC's, as described by the Constraints to Development Chapter (page 23), are: 1) estuarine waters; and 2) estuarine shorelines of the Neuse and Trent Rivers, Jack Smith Creek, Lawson Creek and Renny's Creek to points inland where ocean tides no longer affect these water bodies; 3) coastal wetlands; and, 4) public trust areas. All shorelines below Wilson's Creek on the Trent River and Pitch Kettle Creek on the Neuse River are defined as Estuarine Shorelines and subject to applicable policies and regulations. The State Policy Statements for AEC's offer protection for New Bern's fragile and significant environmental resources through CAMA permitting procedures. In accordance with those policies set forth in subchapter 7H of the State CAMA regulations, New Bern adopts the following policies concerning AEC's in its jurisdiction.

(1) Estuarine Waters. In recognition of the importance of estuarine waters for the fisheries and related industries as well as aesthetics, recreation, and education, New Bern shall promote the conservation and quality of this resource. Activities in the estuarine water areas shall be restricted to those which do not permanently or significantly affect the function, cleanliness and circulation of estuarine waters. Appropriate uses are restricted to those such as marinas, piers, docks, boat ramps, bulkheads and aids to navigation that will prompt the public's interest in maintaining the critical Areas of Concern.

(2) Estuarine Shorelines. The City recognizes: the close association between estuarine shorelines and adjacent estuarine waters; the influence shoreline development has on the quality of estuarine life; and the damaging processes of shorefront erosion and flooding to which the estuarine shoreline is subject.

Suitable land uses are those compatible with both the dynamic nature of estuarine shorelines and the values of the estuarine system.

Residential, recreational, commercial and industrial land uses are all appropriate types of use along the estuarine shoreline provided that:

a. All CAMA permitting requirements are met;

b. All terms of the New Bern Zoning Ordinance are met;

c. The construction of impervious surfaces and areas

The preparation of this map was financed in part through a grant provided by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Ocean and Coastal Resource Management, N.O.A.A.

NEW BERN, N.C.

EXISTING LAND USE

Prepared By: SATILLA PLANNING
117 Osborne Street
St. Marys, Georgia

NORTH

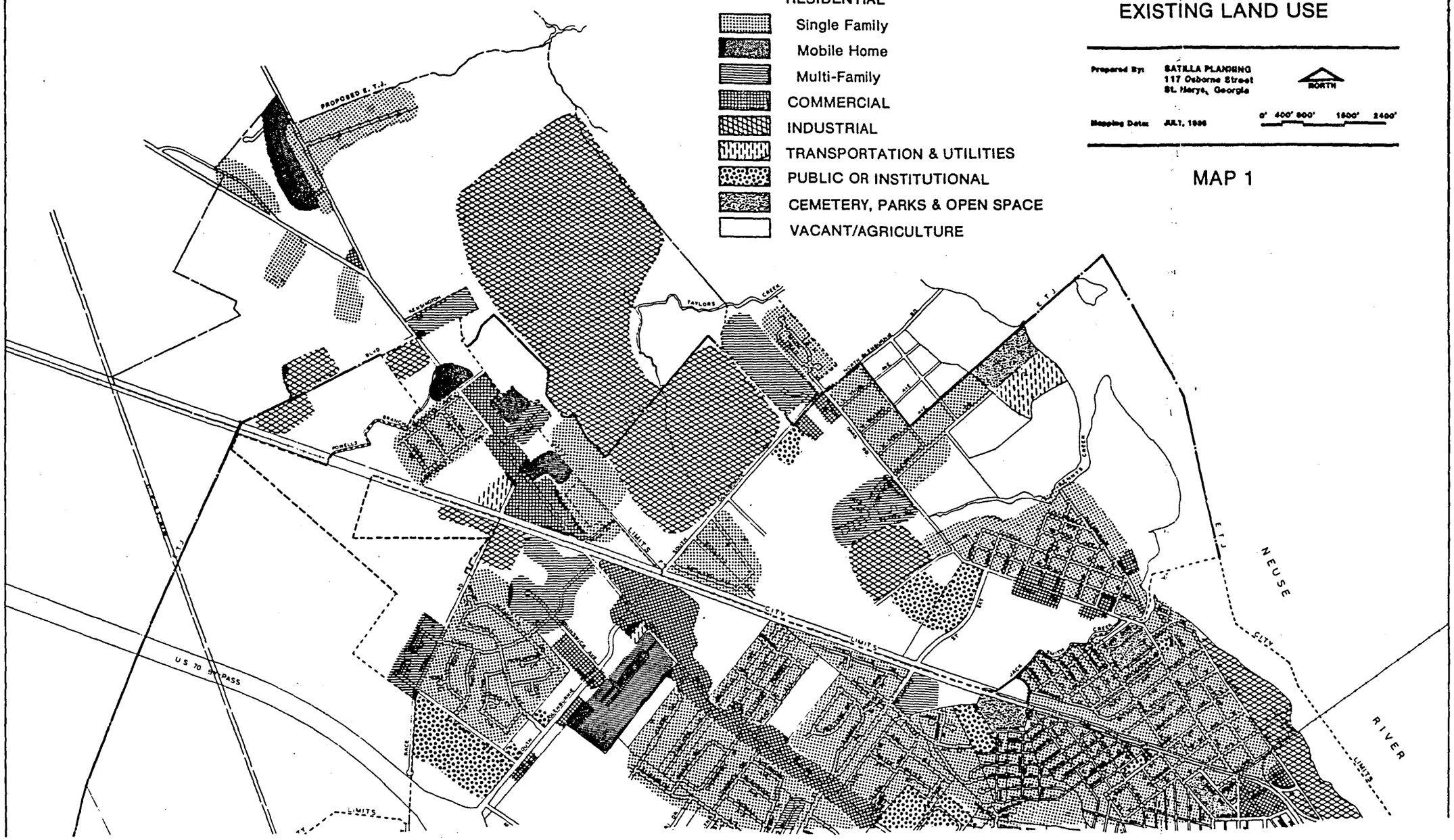
Mapping Date: JULY, 1996

0' 400' 800' 1600' 2400'

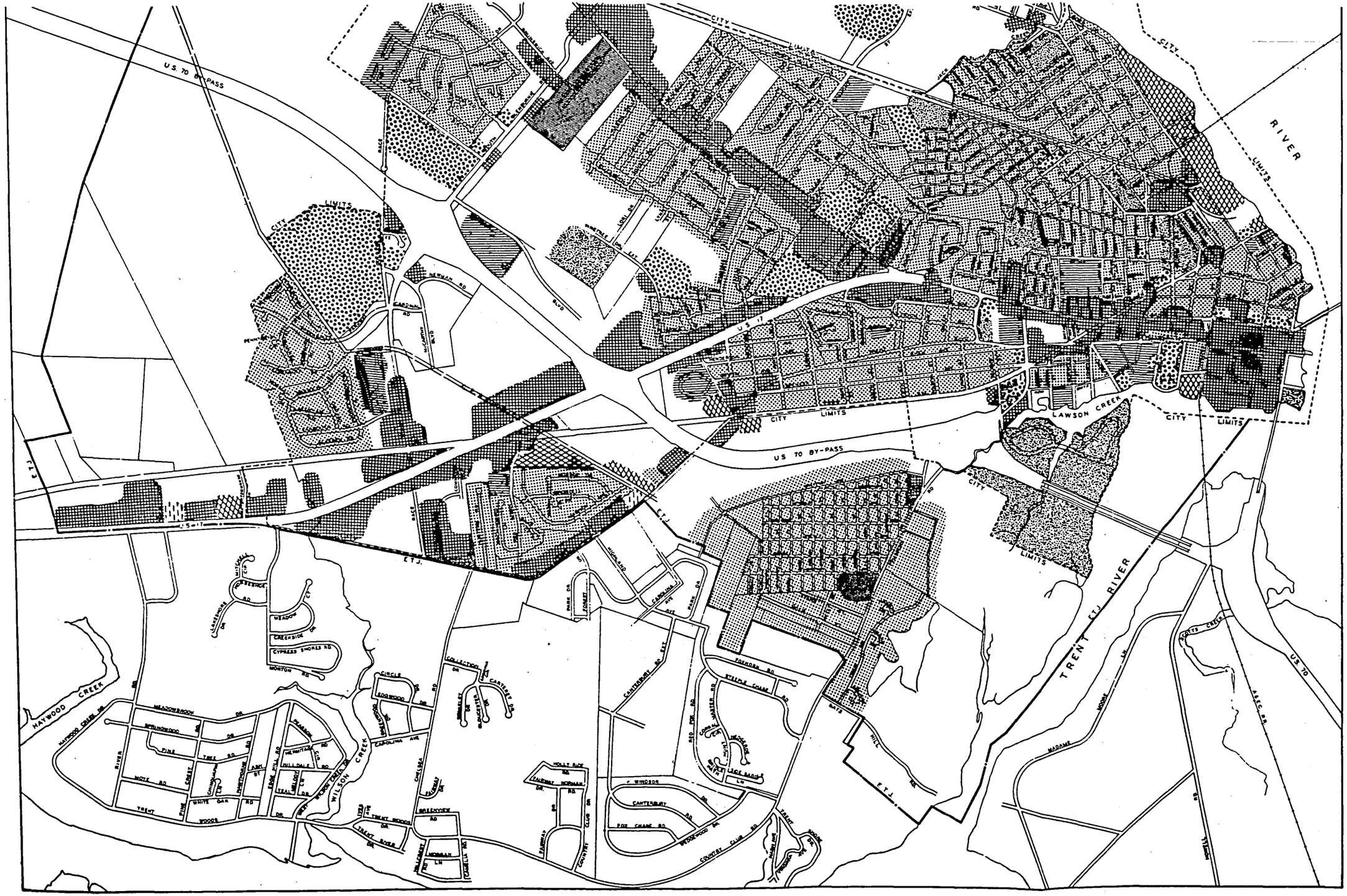
MAP 1

LEGEND:

- RESIDENTIAL
  - Single Family
  - Mobile Home
  - Multi-Family
- COMMERCIAL
- INDUSTRIAL
- TRANSPORTATION & UTILITIES
- PUBLIC OR INSTITUTIONAL
- CEMETERY, PARKS & OPEN SPACE
- VACANT/AGRICULTURE



Existing Land Use - North Portion



Existing Land Use - South Portion

Sewered & Water Distribution Areas - South Portion

The preparation of this map was financed in part through a grant provided by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Ocean and Coastal Resource Management, N.O.A.A.

NEW BERN, N.C.

SEWER & WATER DISTRIBUTION AREAS

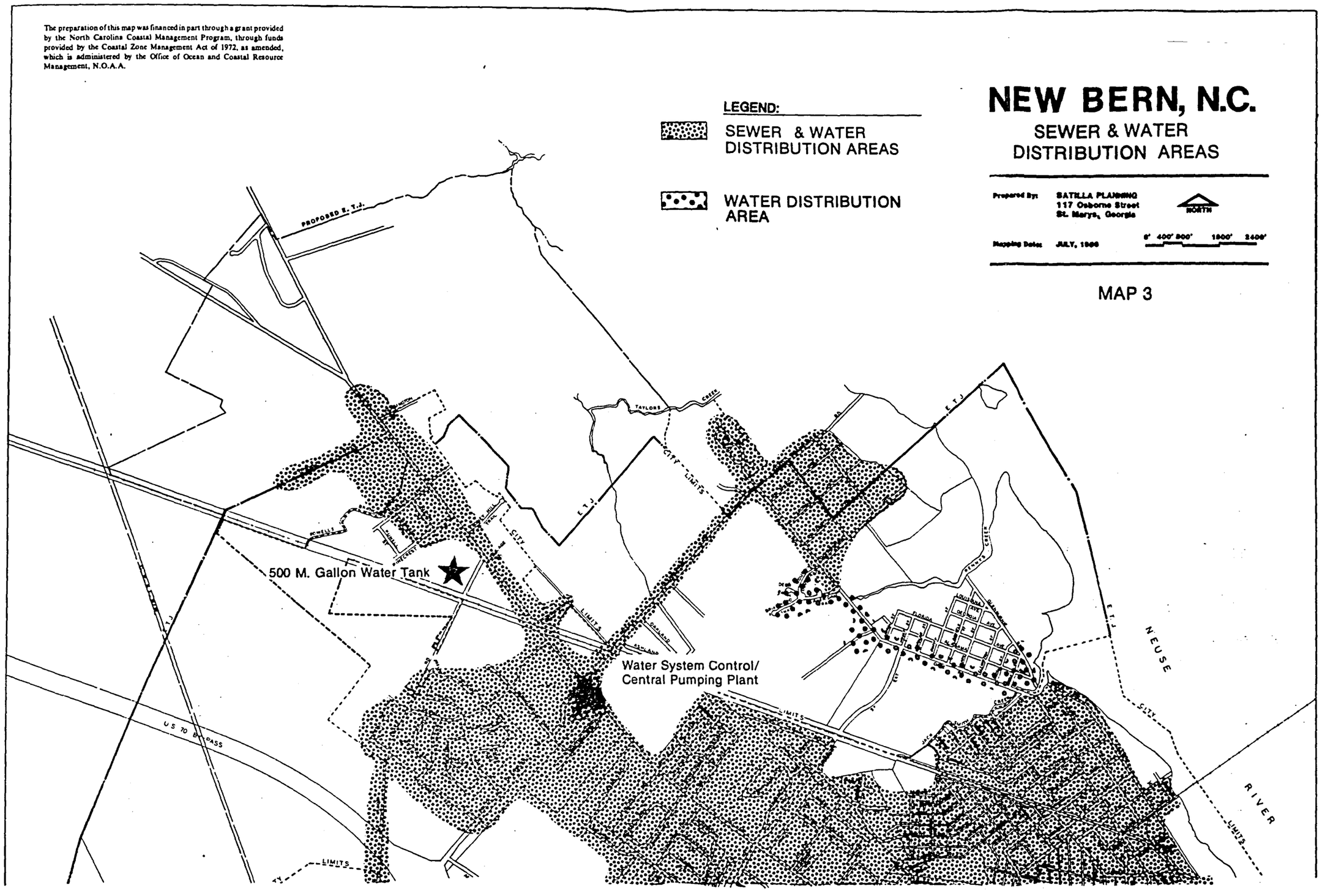
Prepared By: SATILLA PLANNING
117 Osborne Street
St. Marys, Georgia

NORTH

Mapping Date: JULY, 1986

0' 400' 800' 1600' 2400'

MAP 3



Sewered & Water Distribution Areas - North Portion

Community Facilities - South Portion

The preparation of this map was financed in part through a grant provided by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Ocean and Coastal Resource Management, N.O.A.A.

LEGEND:

1-PUBLIC LIBRARY
2-PARKING LOTS
3-FIREMANS MUSEUM
4-CENTRAL FIRE STA
5-FIRE PREVENTION OFFICE
6-CITY HALL
7-UNION POINT PARK
8-TRYON PALACE
9-POLICE STATION
10-KAFER PARK
11-CEDAR GROVE CEMETERY
12-BERN CEMETERY
13-RECREATIONAL BUILDING
14-GREENWOOD CEMETERY
15-FIRE STATION
16-NEIGHBORHOOD P
17-PEARCE FIELD
18-U.S. NATIONAL CEMETERY
19-HEBREW CEMETERY
20-DUFFYFIELD SCHOOL
21-STANLEY WHITE REC. CENTER & TENNIS COURTS
22-CITY WAREHOUSE
23-CITY GARAGE
24-LAWSON CREEK PARK & LANDFILL
25-NEW BERN SR. HIGH SCHOOL
26-TRENT PARK ELEM. SCHOOL
27-CRAVEN COUNTY HOSPITAL
28-CRAVEN COUNTY HEALTH DEPARTMENT
29-J.T. BARBER JR. HIGH SCHOOL
30-EVERGREEN CEMETERY
31-OAKS ROAD ELEM. SCHOOL
32-GLENBURNIE PARK
33-H.J. MCDONALD SCHOOL
34-CRAVEN COMMUNITY COLLEGE
35-SETH PARROTT PARK

NEW BERN, N.C.

COMMUNITY FACILITIES

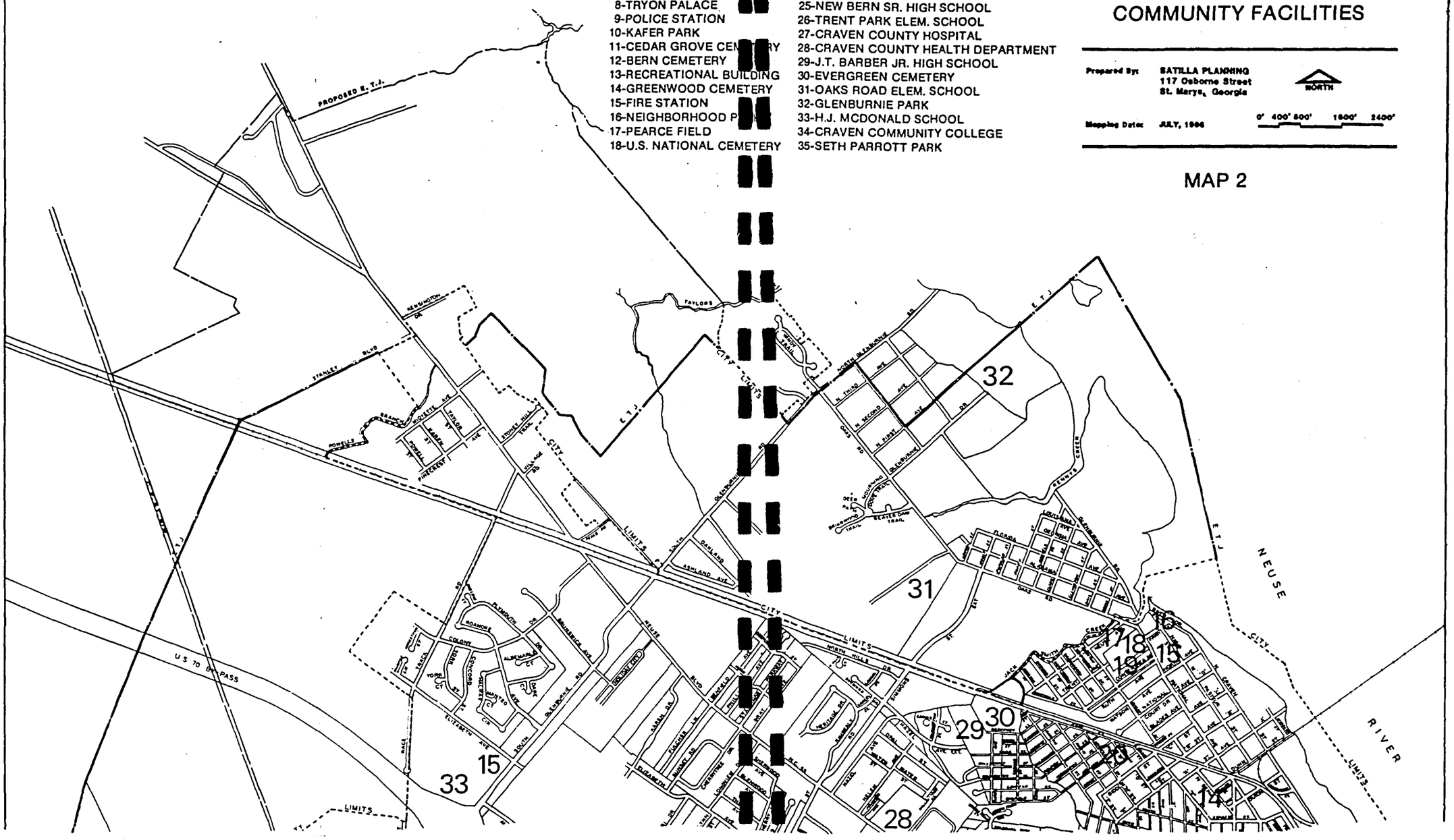
Prepared By: SATILLA PLANNING
117 Osborne Street
St. Marys, Georgia

NORTH

Mapping Date: JULY, 1986

0' 400' 800' 1600' 2400'

MAP 2



Community Facilities - North Portion

REFERENCE 19

RALEIGH, NORTH CAROLINA 27

Reference 19

Fifth Edition, 1984

North Carolina State Government

Statistical Abstract

North Carolina State Data Center

Research and Planning Services
Office of State Budget and Management

N.C. Stat. 1984

POPULATION [illegible] CAROLINA BY COUNTY
1960, 1970, 1980, 1982

County	Census April 1, 1960	Census April 1, 1970	Census April 1, 1980	Estimate July 1, 1982(a)
State Total(b)	4,556,155	5,084,411	5,881,766(b)	6,019,406
Alamance	85,674	96,502	99,319	100,818
Alexander	15,625	19,466	24,999	25,656
Alleghany	7,734	8,134	9,587	9,810
Anson	24,962	23,488	25,649	25,957
Ashe	19,768	19,571	22,325	22,764
Avery	12,009	12,655	14,409	14,645
Beaufort	36,014	35,980	40,355	41,638
Bertie	24,350	20,528	21,024	21,180
Bladen	28,881	26,477	30,491	30,642
Brunswick	20,278	24,223	35,777	39,027
Buncombe	130,074	145,056	160,934	163,631
Burke	52,701	60,364	72,504	74,055
Cabarrus	68,137	74,629	85,095	89,202
Caldwell	49,552	56,699	67,746	68,129
Camden	5,598	5,453	5,829	5,749
Carteret	27,430	31,603	41,092	43,700
Caswell	19,912	19,055	21,705	21,529
Catawba	73,191	90,873	105,208	107,779
Chatham	26,705	29,554	33,415	34,297
Cherokee	16,335	16,330	18,933	19,494
Chowan	11,729	10,764	12,558	12,593
Clay	5,526	5,180	6,619	6,845
Cleveland	66,048	72,556	83,435	83,755
Columbus	40,973	46,937	51,037	51,305
Craven	58,773	62,554	71,043	73,759
Cumberland	148,418	212,042	247,160	250,316
Currituck	6,601	6,976	11,089	11,671
Dare	5,935	6,995	13,377	14,693
Davidson	79,493	95,627	113,162	115,089
Davie	16,720	18,855	24,599	25,898
Duplin	40,270	30,015	40,952	41,005
Durham	111,993	132,601	152,705	155,885
Edgecombe	54,226	52,341	55,988	56,987
Forsyth	189,428	215,118	243,683	249,859
Franklin	20,755	26,820	30,055	30,744
Gaston	127,074	148,415	162,568	166,271
Gates	9,254	8,924	8,875	9,034
Graham	6,432	6,562	7,217	7,147
Granville	33,110	32,762	34,043	35,246
Greene	16,741	14,967	16,117	16,071
Guilford	345,529	288,645	317,154	320,872
Halifax	58,956	54,354	55,286	55,634
Harnett	40,236	49,667	59,570	60,993
Haywood	39,711	41,710	46,495	47,067
Henderson	35,163	42,804	50,300	61,943
Hertford	22,718	24,439	23,368	23,443
Hoke	16,356	16,436	20,383	21,553
Hyde	5,765	5,571	5,873	5,920
Iredell	62,526	72,197	82,538	84,393
Jackson	17,780	21,593	25,811	26,534
Johnston	67,936	61,737	70,599	72,386
Jones	11,005	9,779	9,705	9,729
Lee	26,561	30,467	36,718	37,735
Lenoir	55,276	55,204	59,819	60,098
Lincoln	28,814	32,682	42,372	43,273
McDowell	26,742	30,648	35,135	36,015
Macon	14,935	15,788	20,178	21,796
Madison	17,217	16,003	16,827	16,953
Martin	27,139	24,730	25,948	26,214
Mecklenburg	272,111	354,656	404,270	419,660
Mitchell	13,906	13,447	14,428	14,578
Montgomery	18,408	19,267	22,469	22,726
Moore	36,733	39,048	50,505	51,737
Nash	61,002	59,122	67,153	68,458
New Hanover	71,742	82,996	103,471	107,358
Northampton	26,811	23,099	22,584	22,542
Onslow	86,208	103,126	112,784	116,654
Orange	42,970	57,567	77,055	78,314
Pamlico	9,850	9,467	10,398	10,558
Pasquotank	25,630	26,824	28,462	28,704
Pender	10,500	18,149	22,215	22,923
Perquimans	9,178	8,351	9,486	9,567
Person	26,394	25,914	29,164	29,706
Pitt	69,942	73,900	90,146	92,982
Polk	11,395	11,735	12,984	14,137
Randolph	61,497	76,358	91,728	93,979
Richmond	39,202	39,089	45,481	44,963
Robeson	89,102	84,842	101,610	103,558
Rockingham	69,629	72,402	83,426	84,450
Rowan	82,817	90,035	99,186	100,828
Rutherford	45,091	47,337	53,787	55,740
Sampson	40,013	44,954	49,607	49,947
Scotland	25,103	26,929	32,273	33,058
Stanly	40,873	42,822	48,517	48,683
Stokes	22,314	23,782	33,086	34,192
Surry	48,205	51,415	59,449	59,672
Swain	8,387	8,835	10,283	10,535
Transylvania	16,372	19,713	23,417	24,220
Tyrrell	4,520	3,806	3,975	4,120
Union	44,670	54,714	70,300	73,633
Vance	32,002	32,691	36,740	37,290
Wake	169,002	229,006	301,327	314,799
Warren	19,652	15,340	16,232	16,076
Washington	13,408	14,038	14,001	14,370
Watauga	17,529	23,404	31,666	33,272
Wayne	82,059	85,408	97,054	97,711
Wilkes	45,269	49,524	58,657	59,432
Wilson	57,716	57,486	63,132	63,771
Yadkin	22,804	24,599	28,439	29,035
Yancey	14,008	12,629	14,934	15,205

(a) Provisional.

(b) Revised totals are 5,801,385 for the state, 22,262 for Pender county, and 91,300 for Randolph county.

SOURCE: U.S. Department of Commerce, Bureau of the Census.
Office of State Budget and Management, Research and Planning Services.

Table 8

URBAN AND RURAL DISTRIBUTION OF THE POPULATION OF NORTH CAROLINA COUNTIES
1950, 1960, 1970, 1980

County	1950 Percent Urban	1950 Percent Rural	1960 Percent Urban	1960 Percent Rural	1970[a] Percent Urban	1970[a] Percent Rural	1980 Percent Urban	1980 Percent Rural
State Total	33.7%	66.3%	39.5%	60.5%	45.5%	54.5%	48.0%	52.0%
Alamance	41.5	58.5	51.2	48.8	60.9	39.1	64.6	35.4
Alexander	-	100.0	-	100.0	-	100.0	3.4	96.6
Alleghany	-	100.0	-	100.0	-	100.0	-	100.0
Anson	12.7	87.3	15.0	85.0	16.9	83.1	16.4	83.6
Ashe	-	100.0	-	100.0	-	100.0	-	100.0
Avery	-	100.0	-	100.0	-	100.0	-	100.0
Beaufort	32.9	67.1	27.6	72.4	24.9	75.1	20.9	79.1
Bertie	-	100.0	-	100.0	-	100.0	-	100.0
Bladen	-	100.0	-	100.0	-	100.0	11.6	88.4
Brunswick	-	100.0	-	100.0	-	100.0	12.3	87.7
Buncombe	47.0	53.0	52.7	47.3	52.2	47.8	62.9	37.1
Burke	24.3	75.7	23.0	77.0	28.5	71.5	34.8	65.2
Cabarrus	66.0	34.0	67.7	32.3	64.0	36.0	62.6	37.4
Caldwell	18.2	81.8	26.0	74.0	30.9	69.1	28.4	71.6
Camden	-	100.0	-	100.0	-	100.0	-	100.0
Carteret	36.2	63.8	31.0	69.0	27.2	72.8	19.9	80.1
Caswell	-	100.0	-	100.0	-	100.0	-	100.0
Catawba	33.7	66.3	44.1	55.9	42.9	57.1	55.8	44.2
Chatham	9.8	90.2	16.6	83.4	15.9	84.1	13.3	86.7
Cherokee	-	100.0	-	100.0	-	100.0	-	100.0
Chowan	35.6	64.4	38.0	62.0	44.3	55.7	42.7	57.3
Clay	-	100.0	-	100.0	-	100.0	-	100.0
Cleveland	35.3	64.7	38.9	61.1	34.0	66.0	28.5	71.5
Columbus	8.4	91.6	9.6	90.4	8.9	91.1	16.2	83.8
Craven	32.4	67.6	26.7	73.3	55.2	44.8	49.6	50.4
Cumberland	39.7	60.3	47.3	52.7	76.1	23.9	86.6	13.4
Currituck	-	100.0	-	100.0	-	100.0	-	100.0
Dare	-	100.0	-	100.0	-	100.0	-	100.0
Davidson	39.7	60.3	39.4	60.6	37.1	62.9	33.4	66.6
Davie	-	100.0	-	100.0	13.4	86.6	10.7	89.3
Duplin	-	100.0	0.1	99.9	14.9	85.1	14.2	85.8
Durham	20.2	79.8	75.6	24.4	75.9	24.1	80.2	19.8
Edgecombe	40.7	59.3	42.9	57.1	47.1	52.9	45.9	54.1
Forsyth	65.8	34.2	69.2	30.8	68.8	31.2	75.2	24.8
Franklin	8.1	91.9	10.0	90.0	11.0	89.0	10.8	89.2
Gaston	55.2	44.8	61.8	38.2	71.0	29.0	69.1	30.9
Gates	-	100.0	-	100.0	-	100.0	-	100.0
Graham	-	100.0	-	100.0	-	100.0	-	100.0
Granville	21.0	79.0	21.1	78.9	32.7	67.3	34.8	65.2
Greene	-	100.0	-	100.0	-	100.0	-	100.0
Guilford	66.0	34.0	76.1	23.9	76.7	23.3	75.9	24.1
Halifax	24.1	75.9	32.7	67.3	36.5	63.5	37.1	62.9
Harnett	20.3	79.7	22.3	77.7	22.5	77.5	23.0	77.0
Haywood	27.1	72.9	28.3	71.7	27.9	72.1	24.5	75.5
Henderson	19.7	80.3	16.3	83.7	28.0	72.0	19.4	80.6
Hertford	16.7	83.3	31.8	68.2	36.6	63.4	33.8	66.2
Hoke	-	100.0	18.7	81.3	19.3	80.7	17.8	82.2
Hyde	-	100.0	-	100.0	-	100.0	-	100.0
Iredell	42.7	57.3	42.8	57.2	44.2	55.8	33.0	67.0
Jackson	-	100.0	-	100.0	-	100.0	-	100.0
Johnston	12.5	87.5	19.9	80.1	22.9	77.1	26.8	73.2
Jones	-	100.0	-	100.0	-	100.0	-	100.0
Lee	42.6	57.4	46.1	53.9	38.5	61.5	40.7	59.8
Lenoir	39.9	60.1	44.9	55.1	45.0	55.0	47.4	52.6
Lincoln	19.7	80.3	19.8	80.2	16.2	83.8	11.5	88.5
McDowell	21.9	78.1	12.5	87.5	30.6	69.4	10.5	89.5
Macon	-	100.0	-	100.0	-	100.0	13.1	86.9
Madison	-	100.0	-	100.0	-	100.0	-	100.0
Martin	17.8	82.2	25.5	74.5	26.6	73.4	23.7	76.3
Mecklenburg	71.5	28.5	78.0	22.0	79.6	20.4	87.6	12.4
Mitchell	-	100.0	18.0	82.0	-	100.0	-	100.0
Montgomery	-	100.0	-	100.0	-	100.0	12.0	88.0
Moore	12.9	87.1	14.2	85.8	15.2	84.8	23.8	76.2
Nash	24.7	75.3	28.4	71.6	32.2	67.8	40.0	60.0
New Hanover	71.2	28.8	69.0	31.0	69.5	30.5	86.7	13.3
Northampton	-	100.0	-	100.0	-	100.0	-	100.0
Onslow	18.2	81.8	20.5	79.5	57.5	42.5	64.6	35.4
Orange	26.7	73.3	29.3	70.7	50.3	49.7	57.5	42.5
Pamlico	-	100.0	-	100.0	-	100.0	-	100.0
Pasquotank	52.1	47.9	54.9	53.6	52.4	46.4	49.2	50.8
Pender	-	100.0	-	100.0	-	100.0	0.1	99.9
Perquimans	-	100.0	-	100.0	-	100.0	-	100.0
Person	17.7	82.3	19.5	80.5	20.7	79.3	25.8	74.2
Pitt	30.8	69.2	42.8	57.2	50.0	50.0	49.7	50.3
Polk	-	100.0	-	100.0	-	100.0	-	100.0
Randolph	15.2	84.8	25.3	74.7	30.2	69.8	30.3	69.7
Richmond	34.3	65.7	33.6	66.4	33.4	66.6	40.0	60.0
Robeson	10.5	89.5	20.3	79.7	27.3	72.7	29.3	70.7
Rockingham	38.5	61.5	41.1	58.9	44.7	55.3	40.3	59.7
Rowan	41.1	58.9	47.2	52.8	42.1	57.9	44.2	55.8
Rutherford	33.4	66.6	31.1	68.9	30.1	69.9	28.6	71.4
Sampson	8.9	91.1	15.5	84.5	15.9	84.1	15.2	84.8
Scotland	27.1	72.9	32.7	67.3	32.9	67.1	36.0	64.0
Stanly	31.8	68.2	30.0	70.0	26.0	74.0	31.1	68.9
Stokes	-	100.0	-	100.0	-	100.0	26.5	73.5
Surry	28.4	71.6	20.6	79.4	25.0	75.0	16.3	83.7
Swain	-	100.0	-	100.0	-	100.0	-	100.0
Transylvania	25.7	74.3	29.7	70.3	26.6	73.4	22.7	77.3
Tyrrell	-	100.0	-	100.0	-	100.0	-	100.0
Union	24.1	75.9	24.4	75.6	25.3	74.7	21.7	78.3
Vance	34.3	65.7	39.8	60.2	42.5	57.5	36.8	63.2
Wake	53.1	46.9	63.2	36.8	69.6	30.4	71.8	28.2
Warren	-	100.0	-	100.0	-	100.0	-	100.0
Washington	34.0	66.0	34.6	65.4	34.0	66.0	30.9	69.1
Watauga	16.2	83.8	21.0	79.0	37.4	62.6	32.2	67.8
Wayne	39.2	60.8	40.8	59.2	46.7	53.3	64.4	35.6
Wilkes	9.7	90.3	9.3	90.7	6.8	93.2	10.9	89.1
Wilson	42.2	57.8	49.8	50.2	51.1	48.9	54.5	45.5
Yadkin	-	100.0	-	100.0	-	100.0	-	100.0
Yancey	-	100.0	-	100.0	-	100.0	-	100.0

(a) Urban-rural percentages for 1970 were not corrected for all those counties which had population corrections after the 1970 urban-rural figures were published but were corrected in selected counties by the Bureau of the Census.

SOURCE: Office of State Budget and Management, Research and Planning Services, U.S. Department of Commerce, Bureau of the Census.

Table 3

PERCENT POPULATION CHANGE BY DECADE BY COUNTY
1920 THROUGH 1980

County	1920-1930	1930-1940	1940-1950	1950-1960	1960-1970	1970-1980
State Total	23.9%	12.7%	13.7%	12.2%	11.6%	15.7%
Alamance	28.8	36.3	24.0	20.3	12.6	2.9
Alexander	5.8	4.1	8.2	7.4	24.6	28.4
Alleghany	-2.9	16.1	-2.2	-5.7	5.2	17.9
Anson	3.6	-3.1	-5.8	-6.0	-5.9	9.7
Ashe	0.1	7.8	-3.5	-9.6	-1.0	14.1
Avery	14.2	14.9	-1.5	-10.1	5.4	13.9
Beaufort	12.9	4.0	1.9	-3.0	-0.1	12.2
Bertie	7.7	1.4	0.9	-7.9	-15.7	2.4
Bladen	13.3	21.3	9.4	-2.8	-8.3	15.2
Brunswick	6.3	8.3	12.3	5.4	19.5	47.7
Buncombe	52.7	11.0	14.4	4.6	11.5	10.9
Burke	26.2	31.3	17.9	15.0	14.5	20.1
Cabarrus	31.4	34.0	7.4	6.0	9.5	15.1
Caldwell	40.2	27.0	21.1	14.3	14.4	19.5
Camden	1.5	-0.4	-4.0	7.2	-2.6	6.9
Carteret	10.1	8.2	26.1	19.0	15.2	30.0
Caswell	15.6	10.0	4.2	-4.6	-4.3	8.7
Catawba	30.0	17.4	19.6	18.4	24.2	15.8
Chatham	1.5	2.3	2.7	5.5	10.3	13.1
Cherokee	6.0	16.5	-2.8	-10.7	-0.0	15.9
Chowan	5.9	2.6	8.4	-6.5	-8.2	16.7
Clay	17.0	17.9	-6.2	-8.0	-6.3	27.8
Cleveland	51.5	11.8	10.9	2.6	9.9	15.0
Columbus	25.2	21.1	10.9	-3.3	-4.2	8.7
Craven	5.6	2.1	56.0	20.4	6.4	13.6
Cumberland	29.0	31.2	61.8	54.6	42.9	16.6
Currituck	-7.7	-0.0	-7.6	6.5	5.7	59.0
Dare	1.7	16.1	-10.5	9.8	17.9	91.2
Davidson	36.0	11.5	16.6	27.7	20.3	18.3
Davie	6.0	3.6	3.4	8.5	12.7	30.5
Duplin	16.1	13.2	3.4	-2.0	-5.6	7.7
Durham	59.2	19.4	26.7	10.2	18.5	15.2
Edgecombe	26.1	2.6	5.0	5.0	-3.5	7.0
Forsyth	44.5	13.2	15.5	29.6	13.6	13.3
Franklin	10.5	3.1	3.2	-0.3	-6.7	12.1
Gaston	52.4	12.1	26.6	14.7	16.8	9.5
Gates	0.1	-4.7	-5.0	-3.2	-7.9	4.1
Graham	19.9	9.9	7.3	-6.6	2.0	10.0
Granville	7.0	2.2	0.3	4.1	-1.1	3.9
Greene	15.1	-0.6	-2.8	-7.[illegible]	-10.6	7.7
Guilford	67.8	15.7	24.1	29.0	17.1	9.9
Halifax	21.7	6.1	3.3	1.0	-0.6	2.6
Harnett	33.9	16.7	7.6	1.3	3.0	19.9
Haywood	20.3	23.1	8.1	5.5	5.0	11.5
Henderson	28.3	11.3	18.7	17.0	18.4	36.9
Hertford	7.7	10.3	10.9	5.9	7.6	-4.4
Hoke	21.5	4.9	5.5	3.0	0.5	24.0
Hyde	2.0	-8.1	-17.6	-11.0	-3.4	5.4
Iredell	23.0	8.0	11.7	11.1	15.5	14.3
Jackson	30.8	10.5	-0.5	-7.7	27.4	19.5
Johnston	17.6	10.7	3.3	-4.5	-1.9	14.4
Jones	5.2	4.8	0.7	0.0	-11.1	-0.8
Lee	26.8	10.3	25.5	12.9	14.7	20.5
Lenoir	20.8	15.4	11.5	20.3	-0.1	8.4
Lincoln	20.0	5.7	13.5	4.9	13.4	27.6
McDowell	21.3	13.1	11.8	4.0	14.6	14.6
Macon	6.1	16.1	1.9	-7.7	5.7	27.8
Madison	1.1	10.9	-0.9	-16.1	-7.1	5.1
Martin	12.3	11.6	7.0	-7.9	-8.9	4.9
Mecklenburg	58.6	18.6	29.8	38.1	30.3	14.0
Mitchell	23.8	14.5	-5.2	-8.2	-5.3	7.3
Montgomery	11.0	0.4	6.0	6.7	4.7	16.6
Moore	31.9	9.0	7.0	10.9	6.5	27.3
Nash	20.5	5.4	7.8	1.8	-3.1	13.6
New Hanover	5.9	11.5	32.0	13.4	15.7	24.7
Northampton	17.2	4.2	0.5	-5.7	-13.9	-2.2
Onslow	4.0	17.3	134.4	105.0	19.6	9.4
Orange	10.3	9.0	49.3	24.8	34.0	33.9
Pamlico	2.6	4.4	3.0	-1.4	-3.9	9.8
Pasquotank	8.3	7.4	18.4	5.3	4.7	6.1
Pender	6.1	12.9	4.0	0.5	-1.9	22.4
Perquimans	-4.2	-8.4	-1.7	-4.4	-9.0	13.6
Person	16.2	13.6	-2.7	8.3	-1.8	12.5
Pitt	19.5	12.4	4.2	9.6	5.7	22.0
Polk	15.7	16.2	-2.1	-2.0	3.0	10.6
Randolph	17.5	22.9	14.0	21.0	24.2	20.1
Richmond	33.0	8.2	7.6	-1.0	1.8	14.0
Robeson	21.7	15.6	14.7	1.5	-4.8	19.8
Rockingham	15.7	13.3	11.9	7.4	4.0	15.2
Rowan	20.6	22.1	9.0	9.8	8.7	10.7
Rutherford	20.7	12.7	1.7	-2.7	5.0	13.6
Sampson	11.3	18.4	4.9	-3.5	-6.4	10.5
Scotland	29.3	15.2	13.4	4.4	6.9	19.8
Stanly	10.7	0.7	13.1	10.1	4.8	13.3
Stokes	8.3	1.6	-5.0	3.7	6.6	37.1
Surry	22.4	5.1	9.1	5.7	6.7	15.6
Swain	-12.5	5.3	-18.5	-15.5	5.3	16.4
Transylvania	3.1	27.7	24.1	7.8	20.4	18.8
Tyrrell	6.5	7.6	-9.1	-10.5	-15.8	4.4
Union	13.7	-4.6	7.5	6.3	22.5	28.6
Vance	19.7	9.8	7.1	-0.3	2.2	12.4
Wake	26.1	15.6	24.6	23.9	35.4	31.6
Warren	8.2	-0.9	1.7	-16.5	-19.6	2.7
Washington	1.5	6.2	7.0	2.3	4.1	5.4
Watauga	12.5	19.4	1.3	-4.4	33.5	35.3
Wayne	21.5	10.0	10.2	27.7	4.1	13.6
Wilkes	10.0	18.9	5.2	0.1	9.4	18.4
Wilson	22.0	11.8	8.5	5.9	-0.4	9.8
Yadkin	9.9	14.7	7.1	3.0	7.9	15.6
Yancey	-4.0	18.7	-5.2	-14.1	-9.8	18.3

SOURCE: U.S. Department of Commerce, Bureau of the Census.

POPULATION DENSITY AND LAND AREA BY COUNTY
1960, 1970 AND 1980

County	Density[a] 1960	Density[a] 1970	Density[a] 1980	1980 Land Area (Sq. Mi.)
State Total	93	104	120	48,843
Alamance	197	226	229	433
Alexander	61	75	97	259
Alleghany	34	36	41	234
Anson	47	44	48	533
Ashe	46	46	52	426
Avery	49	52	58	247
Beaufort	43	44	49	826
Bertie	35	29	30	701
Bladen	33	30	35	879
Brunswick	23	28	42	861
Buncombe	202	221	244	659
Burke	104	118	144	505
Cabarrus	189	206	236	364
Caldwell	104	121	144	471
Camden	23	23	24	241
Carteret	52	59	78	525
Caswell	46	45	49	427
Catawba	150	231	266	396
Chatham	38	42	47	708
Cherokee	36	36	42	452
Chowan	65	62	69	181
Clay	25	25	31	214
Cleveland	142	155	178	468
Columbus	52	50	54	939
Craven	81	89	101	702
Cumberland	225	324	376	657
Currituck	24	28	43	256
Dare	15	18	34	391
Davidson	146	174	207	548
Davie	63	71	92	267
Duplin	49	47	50	819
Durham	375	450	513	298
Edgecombe	106	103	111	506
Forsyth	447	513	592	412
Franklin	58	55	61	494
Gaston	355	417	455	357
Gates	27	25	26	338
Graham	22	22	25	289
Granville	61	61	64	534
Greene	62	56	61	266
Guilford	379	441	487	651
Halifax	82	73	76	724
Harnett	80	82	99	601
Haywood	73	76	84	555
Henderson	95	113	156	375
Hertford	64	69	66	356
Hoke	50	42	52	391
Hyde	9	9	9	624
Iredell	106	126	144	574
Jackson	36	44	53	490
Johnston	79	77	89	795
Jones	24	21	21	470
Lee	104	119	142	259
Lenoir	141	138	149	402
Lincoln	94	110	142	298
McDowell	61	70	80	437
Macon	29	31	39	517
Madison	38	36	37	451
Martin	56	54	56	461
Mecklenburg	502	669	766	528
Mitchell	63	63	65	222
Montgomery	38	39	46	490
Moore	48	55	72	701
Nash	111	109	124	540
New Hanover	370	449	559	185
Northampton	50	43	42	538
Onslow	114	135	148	763
Orange	108	144	193	400
Pamlico	29	28	31	341
Pasquotank	112	118	125	228
Pender	22	21	25	875
Perquimans	35	34	39	246
Person	66	65	73	398
Pitt	107	113	137	656
Polk	49	49	55	238
Randolph	77	96	116	789
Richmond	82	84	95	477
Robeson	94	89	107	949
Rockingham	122	127	147	569
Rowan	160	172	191	519
Rutherford	80	84	95	568
Sampson	50	48	53	947
Scotland	79	84	101	319
Stanly	102	108	123	396
Stokes	49	52	73	452
Surry	90	96	110	539
Swain	16	17	20	526
Transylvania	43	52	62	378
Tyrrell	11	10	10	407
Union	70	86	110	639
Vance	129	131	148	249
Wake	196	267	353	854
Warren	44	37	38	427
Washington	40	41	45	332
Watauga	55	74	101	314
Wayne	148	153	175	554
Wilkes	59	65	78	752
Wilson	155	153	169	374
Yadkin	68	73	85	336
Yancey	45	40	48	314

[a] Population per square mile of land area. Land area calculations for 1960 and 1970 differ slightly from those for 1980.

SOURCE: U.S. Department of Commerce, Bureau of the Census.
Office of State Budget and Management, Research and Planning Services.

Table 17

NORTH CAROLINA POPULATION OF INCORPORATED PLACES AND THEIR PERCENTAGE GROWTH
1970 TO 1980

City	County Location	1970 Census	1980 Census	Percentage Change
Aberdeen	Moore	1,592	1,945	22.2%
Ahoskie	Hertford	5,105	4,807	-4.3
Alamance	Alamance	NA	320	NA
Albemarle	Stanly	11,126	15,110	35.8
Alexander Mills	Rutherford	900	643	-34.9
Alliance	Pamlico	577	616	6.8
Andrews	Cherokee	1,304	1,621	17.1
Angier	Harnett	1,431	1,709	19.4
Ansonville	Anson	694	794	14.4
Apex	Wake	2,234	2,847	27.4
Arapahoe	Pamlico	212	467	120.3
Archdale	Guilford, Randolph	4,874	5,745	17.9
Arlington	Yadkin	711	872	22.6
Asheboro	Randolph	10,797	15,252	41.3
Asheville	Buncombe	57,929	53,583	-7.5
Askewville	Bertie	247	227	-8.1
Atkinson	Pender	325	298	-8.3
Atlantic	Carteret	NA	NA	NA
Atlantic Beach	Carteret	300	941	213.7
Aulander	Bertie	947	1,214	28.2
Aurora	Beaufort	620	698	12.6
Autryville	Sampson	213	220	35.2
Ayden	Pitt	3,450	4,361	26.4
Bailey	Nash	724	685	-5.4
Bakersville	Mitchell	409	373	-8.8
Banner Elk	Avery	754	1,087	44.2
Bath	Beaufort	231	207	-10.4
Battleboro	Edgecombe, Nash	562	632	12.5
Bayboro	Pamlico	665	759	14.1
Bear Grass	Martin	99	82	-17.2
Beaufort	Carteret	3,368	3,826	13.6
Belhaven	Beaufort	2,259	2,430	7.6
Belmont	Gaston	5,054	4,607	-8.8
Belville	Brunswick	59	102	72.9
Belwood	Cleveland	736	613	-16.7
Benson	Johnston	2,267	2,792	23.2
Bessemer City	Gaston	4,991	4,787	-4.1
Bethel	Pitt	1,514	1,825	20.5
Biscoe	Montgomery	1,244	1,334	7.2
Black Creek	Wilson	449	523	16.5
Black Mountain	Buncombe	3,204	4,083	27.4
Bladenboro	Bladen	703	1,428	82.4
Blowing Rock	Caldwell, Watauga	801	1,337	66.9
Boiling Spring Lakes	Brunswick	245	998	307.8
Boiling Springs	Cleveland	2,204	2,381	4.2
Bolivia	Brunswick	185	252	36.2
Bolton	Columbus	534	563	5.4
Boone	Watauga	8,754	10,191	16.4
Boonville	Yadkin	687	1,020	49.6
Bostic	Rutherford	289	476	64.7
Brevard	Transylvania	5,243	5,323	1.5
Bridgeton	Craven	520	461	-11.3
Broadway	Lee	694	908	30.8
Brookford	Catawba	590	467	-20.8
Brunswick	Columbus	206	223	8.3
Bryson City	Swain	1,290	1,556	20.6
Bunn	Franklin	284	505	77.8
Burgaw	Pender	1,744	1,586	-9.1
Edenton	Chowan	4,956	5,357	8.1
Elizabeth City	Camden, Pasquotank	14,381	14,004	-2.6
Elizabethtown	Bladen	1,418	3,551	150.4
Elk Park	Avery	503	535	6.4
Elkin	Surry, Wilkes	2,099	2,050	-1.4
Ellenboro	Rutherford	465	560	20.4
Ellerbe	Richmond	913	1,415	55.0
Elm City	Wilson	1,201	1,561	30.0
Elon College	Alamance	2,150	2,873	33.6
Emerald Isle	Carteret	122	865	607.0
Enfield	Halifax	3,272	2,995	-8.5
Erwin	Harnett	2,852	2,828	-0.8
Eureka	Wayne	263	303	15.2
Everetts	Martin	198	213	7.6
Fair Bluff	Columbus	1,033	1,095	5.4
Fairmont	Robeson	2,027	2,658	-6.0
Falcon	Duplin	598	636	6.4
Faith	Rowan	506	552	9.1
Falcon	Cumberland, Sampson	351	339	-3.4
Fairland	Pitt	130	118	-9.2
Fallston	Cleveland	301	614	104.0
Farmville	Pitt	4,424	4,707	6.4
Fayetteville	Cumberland	53,510	59,507	11.2
Forest City	Rutherford	7,119	7,608	7.1
Fountain	Pitt	434	424	-2.3
Four Oaks	Johnston	1,057	1,049	-0.8
Foxfire	Moore	9	153	1,600.0
Franklin	Macon	2,336	2,640	13.0
Franklinton	Franklin	1,459	1,394	-4.5
Franklinville	Randolph	794	607	-23.6
Fremont	Wayne	1,596	1,736	8.8
Fuquay-Varina	Wake	3,576	3,110	-13.0
Garland	Sampson	656	805	34.9
Garner	Wake	4,923	10,073	104.6
Garysburg	Northampton	231	1,434	520.8
Gaston	Northampton	1,105	883	-20.1
Gastonia	Gaston	47,322	47,333	0.0
Gatesville	Gates	338	363	7.4
Germanton	Stokes	NA	NA	NA
Gibson	Scotland	502	533	6.2
Gibsonville	Alamance, Guilford	2,019	2,865	41.9
Glen Alpine	Burke	727	645	-12.1
Godwin	Cumberland	129	233	80.6
Gold Point	Martin	108	NA	NA
Goldsboro	Wayne	26,960	31,871	18.2
Goldston	Chatham	364	353	-3.0
Graham	Alamance	8,172	8,674	6.1
Grainger	Lenoir	NA	NA	NA
Granite Falls	Caldwell	2,380	2,580	8.0
Granite Quarry	Rowan	1,344	1,294	-3.7
Grannavers	Duplin	424	477	12.5
Greensboro	Guilford	144,076	155,642	8.0
Greenville	Pitt	29,063	35,740	23.0
Grifton	Lenoir, Pitt	1,860	2,179	17.2
Grimesland	Pitt	394	453	15.0
Grover	Cleveland	555	597	7.6
Halifax	Halifax	335	253	-24.5
Hamilton	Martin	579	638	10.2
Hamlet	Richmond	6,627	6,720	2.0
Harmony	Iredell	377	470	24.7

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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	Duplin	472	609	[illegible]
[redacted]	Moore	204	223	
[redacted]	Montgomery	561	860	
Canton	Haywood	3,150	4,631	-10.2
Cape Carteret	Carteret	616	944	53.2
Carolina Beach	New Hanover	1,663	2,000	20.3
Carrboro	Orange	5,050	7,336	45.0
Carthage	Moore	1,034	925	-10.5
Cary	Wake	7,606	21,763	183.2
Casar	Cleveland	339	346	2.1
Cashiers	Jackson	230	553	140.4
Castalia	Nash	265	358	35.1
Caswell Beach	Brunswick	70	110	297.9
Catawba	Catawba	565	509	-9.9
Centerville	Franklin	123	135	9.8
Cerro Gordo	Columbus	322	295	-8.4
Chadbourn	Columbus	2,213	1,975	-10.8
Chadwick Acres	Onslow	12	15	25.0
Chapel Hill	Durham, Orange	26,199	32,421	23.7
Charlotte	Mecklenburg	241,420	314,447	30.2
Cherryville	Gaston	5,258	4,844	-7.9
China Grove	Rowan	1,708	2,001	16.4
Chocowinity	Beaufort	566	644	13.8
Claremont	Catawba	788	880	11.7
Clarkton	Bladen	662	664	0.3
Clayton	Johnston	3,103	4,091	31.8
Cleveland	Rowan	614	595	-3.1
Clinton	Sampson	7,157	7,552	5.5
Clyde	Haywood	814	1,008	23.8
Coakley	Edgecombe	NA	NA	NA
Coats	Harnett	1,051	1,305	31.0
Colfield	Hertford	318	465	46.2
Colerain	Bertie	373	284	-23.9
Columbia	Tyrrell	902	758	-16.0
Columbus	Polk	731	727	-0.5
Como	Hertford	211	89	-57.8
Concord	Cabarrus	18,464	16,942	-8.2
Conetoe	Edgecombe	160	215	34.4
Conover	Catawba	3,355	4,245	26.5
Conway	Northampton	694	678	-2.3
Cornelius	Mecklenburg	1,296	1,460	12.7
Cove City	Craven	485	500	3.1
Cramerton	Gaston	2,142	1,869	-12.7
Creedmoor	Granville	1,405	1,641	16.8
Creswell	Washington	633	426	-32.7
Crossnore	Avery	264	297	12.5
Dallas	Gaston	4,059	3,340	-17.7
Danbury	Stokes	152	140	-7.9
Davidson	Iredell, Mecklenburg	2,931	3,241	10.6
Delview	Gaston	11	7	-36.4
Denton	Davidson	1,017	949	-6.7
Dillsboro	Jackson	215	179	-16.7
Dobson	Surry	933	1,222	31.0
Dorches	Nash	606	805	29.0
Dover	Craven	585	600	2.6
Drexel	Burke	1,431	1,392	-2.7
Dublin	Bladen	283	477	60.6
Dudley	Wayne	199	NA	NA
Dundarrach	Nike	53	NA	NA
Dunn	Harnett	8,302	8,962	7.9%
Durham	Durham	95,430	100,831	5.7
Earl	Cleveland	193	206	5.6
East Arcadia	Bladen	556	461	-17.1
East Bend	Yadkin	485	602	24.1
East Laurinburg	Scotland	487	536	10.1
East Spencer	Rowan	2,217	2,150	-3.0
Eden	Rockingham	15,871	15,672	-1.3

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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Hassell	Martin	160	[illegible]	[illegible]
Havelock	Craven	3,017	[illegible]	488.7
Haw River	Alamance	1,944	[illegible]	-4.4
Hayesville	Clay	420	[illegible]	-12.1
Haywood	Chatham	NA	190	NA
Hazelwood	Haywood	2,057	1,811	-12.0
Henderson	Vance	13,896	13,522	-2.7
Hendersonville	Henderson	6,443	6,062	6.5
Herford	Pergulmans	2,073	1,941	-4.1
Hickory	Burke, Catawba	20,599	20,757	0.9
High Point	(a)	63,229	63,389	0.2
High Shoals	Gaston, Lincoln	563	586	4.1
Highlands	Macon	583	653	12.0
Hildebran	Burke	521	628	20.5
Hillsborough	Orange	1,444	3,019	109.1
Hobgood	Halifax	530	483	-8.9
Hoffman	Richmond	434	389	-10.4
Holden Beach	Brunswick	136	232	70.6
Holly Springs	Wake	697	608	-1.3
Holly Ridge	Onslow	415	465	12.0
Hollyville	Pamlico	NA	100	NA
Hookerton	Greene	441	460	4.3
Hope Mills	Cumberland	1,066	5,417	190.0
Hot Springs	Madison	653	678	3.8
Hudson	Caldwell	2,820	2,888	2.4
Huntersville	Mecklenburg	1,530	1,294	-15.9
Indian Beach	Carteret	245	54	-78.0
Indian Trail	Union	405	811	100.2
Jackson	Northampton	762	720	-5.5
Jackson Springs	Moore	NA	NA	NA
Jacksonville	Onslow	16,289	17,056	4.7
Jamestown	Guilford	1,297	2,148	65.6
Jamesville	Martin	533	604	13.3
Jason	Greene	NA	NA	NA
Jefferson	Ashe	943	1,086	15.2
Jonesville	Yadkin	1,659	1,752	5.6
Jupiter	Buncombe	200	NA	NA
Kelford	Bertie	275	254	-13.9
Kenansville	Duplin	762	931	22.2
Kenly	Johnston, Wilson	1,370	1,433	4.6
Kernersville	Forsyth	4,815	6,802	41.3
Kill Devil Hills	Dare	357	1,796	403.1
Kings Mountain	Cleveland, Gaston	8,465	9,000	7.3
Kinston	Lenoir	23,020	25,234	9.6
Kittrell	Vance	427	225	-47.3
Knightdale	Wake	815	985	20.9
Kure Beach	New Hanover	394	611	55.1
LaGrange	Lenoir	2,679	3,147	17.5%
Lake Lure	Rutherford	456	488	7.0
Lake Waccamaw	Columbus	924	1,133	22.6
Landis	Rowan	2,297	2,092	-8.9
Lansing	Ashe	283	194	-31.4
Lasker	Northampton	114	96	-15.8
Lattimore	Cleveland	257	237	-7.8
Laurel Park	Henderson	581	764	31.5
Laurinburg	Scotland	8,859	11,480	29.6
Lawndale	Cleveland	544	469	-13.8
Lawrence	Edgecombe	NA	NA	NA
Leggett	Edgecombe	120	97	-17.5
Lenoir	Caldwell	14,705	13,748	-6.5
Leviston	Bertie	327	459	40.4
Lexington	Davidson	17,205	15,711	-8.7
Liberty	Randolph	2,167	1,997	-7.8
Lilesville	Anson	641	508	-0.3
Lillington	Harnett	1,155	1,948	68.7
Lincolnton	Lincoln	5,293	4,879	-7.8
Linden	Cumberland	205	365	78.0

City	County Location	1970 Census	1980 Census	Percentage Change
Linville	Avery	NA	244	NA
Littleton	Halifax	903	820	-9.2
Locust	Stanly	1,484	1,590	7.1
Long Beach	Brunswick	493	1,844	274.0
Long View	Burke, Catawba	3,360	3,587	6.8
Louisburg	Franklin	2,941	3,230	10.1
Love Valley	Iredell	40	55	37.5
Lowell	Gaston	3,307	2,917	-11.8
Lucama	Wilson	610	1,070	75.4
Lumber Bridge	Robeson	117	171	46.2
Lumberton	Robeson	16,961	18,241	7.5
McAdenville	Gaston	950	947	-0.3
McDonald	Robeson	80	117	46.3
McFarlan	Anson	140	133	-5.0
Macclesfield	Edgecombe	536	504	-6.0
Macon	Warren	179	153	-14.5
Madison	Rockingham	2,018	2,806	39.0
Maggie Valley	Haywood	159	202	27.0
Magnolia	Duplin	614	592	-3.6
Maiden	Catawba, Lincoln	2,416	2,574	6.5
Manteo	Dare	547	902	64.9
Marietta	Robeson	70	NA	NA
Marion	McDowell	3,335	3,684	10.5
Mars Hill	Madison	1,623	2,126	31.0
Marshall	Madison	982	809	-17.6
Marshville	Union	1,405	2,011	43.1
Matthews	Mecklenburg	783	1,648	110.5
Maury	Greene	421	NA	NA
Maxton	Robeson, Scotland	1,885	2,711	43.8
Mayodan	Rockingham	2,875	2,627	-8.6
Maysville	Jones	912	877	-3.8
Mebane	Alamance, Orange	2,573	2,782	8.1
Mesic	Pamlico	369	390	5.7
Micro	Johnston	300	438	46.0
Middleburg	Vance	149	185	24.2
Middlesex	Nash	729	837	14.8
Mildred	Edgecombe	NA	NA	NA
Milton	Caswell	235	235	0.0
Minnesott Beach	Pamlico	41	171	317.1
Mint Hill	Mecklenburg	2,262	7,915	249.9
Mocksville	Davie	2,529	2,637	4.3
Monroe	Union	11,282	12,639	12.0
Montreat	Buncombe	581	741	27.5
Mooresboro	Cleveland	453	405	-8.6
Mooresville	Iredell	8,808	8,575	-2.6
Morehead City	Carteret	5,233	4,359	-16.7
Morganton	Burke	13,629	13,763	1.0
Morrisville	Wake	209	251	20.1
Morven	Anson	562	765	36.1
Mount Airy	Surry	7,325	6,862	-6.3
Mount Gilead	Montgomery	1,206	1,423	18.0
Mount Holly	Gaston	5,107	4,530	-11.3
Mount Olive	Duplin, Wayne	4,914	4,876	-0.8
Mount Pleasant	Cabarrus	1,1[illegible]	1,210	3.1
Murfreesboro	Hertford	4,418	3,007	-31.9
Murphy	Cherokee	2,082	2,070	-0.6
Nags Head	Dare	414	1,020	146.4
Nashville	Nash	1,670	2,678	60.4
Navasse	Brunswick	487	439	-9.9
New Bern	Craven	14,660	14,557	-0.7

City	County Location	1970 Census	1980 Census	Percentage Change
Newland	Avery	929	1,339	34.0
Nashville	Edgecombe, Nash	34,204	41,283	20.4
Nebo	Wake	533	381	-28.5
Newdale	Wilkes	465	457	-1.7
Newport	Washington	649	795	22.5
Nine Mile	Duplin	1,448	1,508	4.1
Nobeboro	Sampson	1,235	1,227	-0.6
Norman	Transylvania	407	512	25.8
Norland	Robeson	1,358	1,041	35.6
Norboro	Person	5,370	7,532	-88.6
Norwood	Bertie	347	278	-19.9
Nurel Hall	Forsyth	1,287	1,336	3.6
Nuth	Rutherford	360	381	5.8
Nutherford College	Burke	821	1,108	35.0
Nutherfordton	Rutherford	3,245	3,434	5.8
Salemburg	Sampson	669	742	10.9
Salisbury	Rowan	22,515	22,677	0.7
Salude	Polk	546	607	11.2
Sanford	Lee	11,716	14,773	26.1
Saratoga	Wilson	391	381	-2.6
Scotland Neck	Halifax	2,867	2,814	-1.7
Seaboard	Northampton	611	687	12.4
Seagrove	Randolph	354	294	-16.9
Selma	Johnston	4,356	4,762	9.3
Seven Devils	Avery, Watauga	0	54	0
Seven Springs	Wayne	188	166	-11.7
Severn	Northampton	356	309	-13.2
Shady Forest	Brunswick	17	43	152.9
Shallotte	Brunswick	597	680	13.9
Sharpsburg	(b)	789	997	26.4
Shelby	Cleveland	16,320	15,310	-6.2
Siler City	Chatham	4,689	4,446	-5.2
Simpson	Pitt	383	407	6.3
Sims	Wilson	205	192	-6.3
Smithfield	Johnston	6,677	7,288	9.2
Snow Hill	Greene	1,359	1,374	1.1
Southern Pines	Moore	5,937	8,670	45.7
Southern Shores	Dare	75	395	NA
Southport	Brunswick	2,220	2,824	27.2
Sparta	Alleghany	1,304	1,687	29.4
Spivey	Edgecombe	142	95	-33.1
Spencer	Rowan	3,075	2,938	-4.5
Spencer Mountain	Gaston	300	169	-43.7
Spindale	Rutherford	3,048	4,246	10.3
Spring Hope	Nash	1,334	1,254	-6.0
Spring Lake	Cumberland	3,968	6,273	58.1
Spruce Pine	Mitchell	2,333	2,282	-2.2
St. Pauls	Robeson	2,011	1,639	-18.5
Stacey	Randolph	239	204	-14.6
Stallings	Union	726	1,826	151.5
Stanfield	Stanly	450	463	1.1
Stanley	Gaston	2,336	2,341	0.2
Stantonsburg	Wilson	869	920	5.9
Star	Montgomery	852	816	-8.5
Statesville	Iredell	20,007	18,672	-6.9
Stedman	Cumberland	505	723	43.2
Stem	Granville	247	722	-8.3
Stoneville	Rockingham	1,030	1,054	2.3
Stonewall	Pamlico	335	360	7.5
Stovall	Granville	405	417	3.0

[illegible]	Stanly	205	454	[illegible]
[illegible]	Avery	524	722	[illegible]
Newport	Carteret	1,735	1,683	8.5
Newton	Catawba	7,053	7,624	-3.0
Newton Grove	Sampson	546	564	3.3
Norlina	Warren	969	901	-7.0
Norman	Richmond	157	252	60.5
North Wilkesboro	Wilkes	3,337	3,260	-2.9
Norwood	Stanly	1,096	1,810	-4.1
Oak City	Martin	559	475	-15.0
Oakboro	Stanly	568	587	3.3
Ocean Isle Beach	Brunswick	70	143	83.3
Old Fort	McDowell	676	752	11.2
Old Sparta	Edgecombe	NA	NA	NA
Oriental	Pamlico	445	536	20.4
Orrum	Robeson	162	167	3.1
Oxford	Granville	7,178	7,603	5.9
Pantego	Beaufort	218	185	-15.1
Parkton	Robeson	550	564	2.5
Parmele	Martin	373	484	29.8
Patterson Springs	Cleveland	470	731	52.9
Peachland	Anson	556	506	-9.0
Pembroke	Robeson	1,902	2,590	36.1
Pikeville	Wayne	580	662	14.1
Pilot Mountain	Surry	1,309	1,090	-16.7
Pine Knoll Shores	Carteret	62	646	941.9
Pine Level	Johnston	983	953	-3.1
Pinebluff	Moore	570	935	64.0
Pinehurst	Moore	1,056	NA	NA
Pinetops	Edgecombe	1,379	1,465	6.2
Pineville	Mecklenburg	1,948	1,525	-21.7
Pink Hill	Lenoir	522	644	23.4
Pittsboro	Chatham	1,447	1,332	-7.9
Plymouth	Washington	4,774	4,571	-4.3
Polkton	Anson	845	762	-9.8
Polkville	Cleveland	494	528	6.9
Pollocksville	Jones	456	318	-30.3
Powellsville	Bertie	247	320	29.6
Princeton	Johnston	1,044	1,034	-1.0
Princeville	Edgecombe	654	1,508	130.6
Proctorville	Robeson	157	205	30.6
Raeford	Hoke	3,180	3,630	14.2
Raleigh	Wake	122,030	150,255	22.3
Ramseur	Randolph	1,320	1,162	-12.5
Randleman	Randolph	2,312	2,156	-6.7
Ranlo	Gaston	2,092	1,774	-15.2
Raynham	Robeson	75	83	10.7
Red Oak	Nash	359	314	-12.5
Red Springs	Robeson	3,383	3,607	6.6
Reidsville	Rockingham	13,636	12,492	-0.4
Rennert	Robeson	175	178	1.7
Rhodhiss	Burke, Caldwell	784	727	-7.3
Rich Square	Northampton	1,254	1,057	-15.7
Richfield	Stanly	306	373	21.9
Richlands	Onslow	935	825	-11.8
Roanoke Rapids	Halifax	13,500	14,702	8.8
Robbins	Moore	1,059	1,236	16.6
Robbinsville	Graham	777	1,370	76.3
Robersonville	Martin	1,910	1,981	3.7
Rockingham	Richmond	5,832	8,300	41.8
Sunset Beach	Brunswick	[illegible]	[illegible]	181.5
Surf City	Pender	166	71	135.5
Swansboro	Onslow	1,207	976	-19.1
Sylva	Jackson	1,561	1,699	8.8
Tabor City	Columbus	2,400	2,710	12.9
Tar Heel	Bladen	87	118	35.6
Tarboro	Edgecombe	9,475	8,634	-8.9
Taylorville	Alexander	1,231	1,103	-10.4
Teachey	Duplin	219	373	70.3
Thomasville	Davidson	15,230	14,144	-7.1
Topsail Beach	Pender	108	264	144.4
Trent Woods	Craven	719	1,177	63.7
Trenton	Jones	539	407	-24.5
Troutman	Iredell	797	1,360	70.6
Troy	Montgomery	2,429	2,702	11.2
Tryon	Polk	1,931	1,796	-7.0
Turkey	Sampson	329	417	26.7
Unionville	Union	NA	NA	NA
Valdese	Burke	3,187	3,364	5.7
Vanceboro	Craven	750	833	9.9
Vanderbilt	Pamlico	379	335	-11.6
Vass	Moore	885	828	-6.4
Waco	Cleveland	745	322	31.4
Wade	Cumberland	315	574	90.5
Wadesboro	Anson	3,977	4,206	5.8
Wagram	Scotland	718	616	-14.1
Wake Forest	Wake	3,148	3,780	20.1
Wallace	Duplin, Pender	2,905	2,903	-0.1
Walnut Cove	Stokes	1,213	1,147	-5.4
Walnut Creek	Wayne	81	343	323.5
Walstonburg	Greene	176	181	2.8
Warrenton	Warren	1,035	938	-12.3
Warsaw	Duplin	2,701	2,910	7.7
Washington	Beaufort	8,961	8,418	-6.1
Washington Park	Beaufort	517	514	-0.6
Watha	Pender	181	196	8.3
Weldon	Halifax	1,241	1,208	-3.7
Waynesville	Haywood	6,488	6,763	4.3
Weaverville	Buncombe	1,280	1,495	16.8
Webster	Jackson	181	200	10.5
Weldon	Halifax	2,304	1,844	-20.0
Wendell	Wake	1,929	2,222	15.2
West Jefferson	Ashe	849	822	-7.3
Whispering Pines	Moore	562	1,160	220.4
Whitakers	Edgecombe, Nash	926	924	-0.2
White Lake	Bladen	212	968	317.2
Whiteville	Columbus	4,175	5,565	32.7
Wilkesboro	Wilkes	2,030	2,335	14.6
Williamsboro	Vance	NA	59	NA
Williamston	Martin	6,530	6,159	-6.3
Wilmington	New Hanover	46,169	44,000	-4.7
Wilson	Wilson	29,347	34,424	17.3
Windsor	Bertie	2,199	2,126	-3.3
Winfall	Perquimans	501	634	9.15
Wingate	Union	2,569	2,615	1.8
Winston-Salem	Forsyth	133,683	131,005	-1.3
Winterville	Pitt	1,437	2,052	42.8
Winton	Hertford	917	825	-10.0
Woodfin	Buncombe	2,831	3,260	15.2
Woodland	Northampton	744	861	15.7
Woodville	Bertie	253	212	-16.2
Wrightsville Beach	New Hanover	1,701	2,910	71.1
Yadkinville	Yadkin	2,232	2,216	-0.7
Yaupon Beach	Brunswick	334	569	70.4
Youngsville	Franklin	555	486	-12.4
Zebulon	Wake	1,839	2,055	11.7
North Carolina Municipal Population		2,210,008	2,476,041	15.6

(a) Davidson, Guilford, and Randolph counties.
(b) Edgecombe, Nash, and Wilson counties.
NA - Not Available

SOURCES: U.S. Department of Commerce, Bureau of the Census.
Office of State Budget and Management, Research and Planning Services

Table 18

POPULATION DENSITY[a] PLACES WITH 2,500 OR MORE INHABITANTS
YEARS 1960, 1970 AND 1980

Place	1960	1970	1980
Ahoskie	3,274	2,607	1,800
Albemarle	2,151	1,910	1,035
Apex	1,052	NA	1,139
Archdale	1,382	1,130	942
Asheboro	2,197	2,076	1,387
Asheville	2,774	2,507	1,067
Aydon	2,072	2,029	1,017
Beaufort	5,844	3,062	1,594
Belmont	2,635	2,292	1,772
Bunson	2,355	NA	2,140
Bessemer City	1,217	1,581	1,496
Black Mountain	1,313	1,001	972
Bonnie Doone (CDP)	953	NA	1,700
Boone	2,304	2,245	2,602
Brevard	2,057	2,497	2,047
Brogdon (CDP)	NA	NA	1,358
Burlington	2,677	2,364	2,231
Butner (CDP)	NA	1,220	1,514
Camp Lejeune Central (CDP)	NA	2,107	1,636
Canton	973	2,715	2,437
Carrboro	2,853	1,265[b]	2,934
Cary	1,243	1,161	2,176
Chapel Hill	3,592	3,274	2,594
Charlotte	3,199	3,173	2,251
Cherryville	2,576	1,013	1,794
Clayton	1,660	1,939	1,023
Clemmons (CDP)	NA	NA	705
Clinton	2,487	2,105	1,678
Concord	3,632	2,676	2,017
Conover	2,851	2,237	1,249
Dallas	1,721	2,136	2,306
Davidson	2,573	1,466	1,350
Dunn	3,153	2,025	1,067
Durham	3,676	2,608	2,484
East Flat Rock (CDP)	822	938	990
East Rockingham (CDP)	2,676	2,382	1,442
Eden	NA	1,356	1,339
Edenton	2,026	1,362	1,488
Elizabeth City	3,430	2,014	2,900
Elizabethtown	2,321	NA	986
Elkin	896	906	752
Elon College	2,140	NA	2,394
Elroy (CDP)	NA	NA	590
Enfield	2,482	2,727	2,496
Enka (CDP)	NA	NA	843
Enochville (CDP)	NA	NA	696
Erwin	2,449	2,194	1,760
Fairmont	1,203	1,767	1,477
Fairplains (CDP)	NA	NA	634
Farmville	3,075	2,450	2,241
Fayetteville	3,209	2,207	1,803
Forest City	1,601	825	1,220
Fort Bragg (CDP)	NA	2,701	2,213
Franklin	701	NA	852
Fuquay-Varina	1,093	1,192	972
Garner	1,726	2,140	2,143
Gastonia	3,504	2,369	2,181
Glasgonville	1,704	NA	1,791
Glen Raven (CDP)	1,051	1,499	672
Goldsboro	4,067	2,979	2,213
Gorman (CDP)	NA	NA	256
Lumberton	2,834	3,141	1,614
Madison	2,731	NA	510
Maiden	NA	NA	1,287
Marion	2,573	2,387	2,047
Mar-Mac (CDP)	NA	NA	732
Mebanville (CDP)	NA	NA	616
Maxton	1,950	NA	1,595
Mayodan	3,300	2,875	1,751
Mebane	1,609	NA	1,855
Mint Hill	NA	NA	574
Mocksville	743	790	733
Monroe	1,727	1,736	1,620
Mooresville	2,096	1,957	1,824
Morehead City	3,722	3,489	2,180
Morganton	2,355	1,841	1,012
Mount Airy	2,822	1,592	1,430
Mount Holly	2,125	1,459	1,562
Mount Olive	3,115	2,730	2,438
Murfreesboro	1,888	2,339	1,769
Myrtle Grove (CDP)	NA	NA	381
Nashville	2,372	NA	1,275
New Bern (CDP)	6,287	3,858	2,510
New Hope (CDP) (Wake County)	NA	NA	602
New Hope (CDP) (Wayne County)	NA	NA	942
New River Station (CDP)	NA	1,192	711
Newton	2,018	2,910	1,588
North Belmont (CDP)	1,020	1,098	1,170
North Wilkesboro	976	746	724
Ogden (CDP)	NA	NA	574
Oxford	2,251	1,795	2,001
Parkwood (CDP)	NA	NA	1,710
Pembroke	1,524	NA	3,373
Pinehurst (CDP)	934	NA	135
Pine Valley (CDP)	NA	NA	929
Piney Green-White Oak (CDP)	NA	NA	556
Plymouth	1,728	1,540	1,203
Poplar Tent (CDP)	NA	NA	461
Pumpkin Center (CDP)	NA	NA	852
Raeford	1,176	1,178	1,344
Raleigh	2,787	2,708	2,793
Red Springs	2,516	1,990	1,202
Reidsville	1,877	1,794	1,666
Roanoke Rapids	2,562	2,209	2,014
Rockingham	1,969	1,773	1,627
Rocky Mount	3,457	2,765	2,281
Rosewood (CDP)	NA	NA	564
Roxboro	2,145	2,238	2,036
Rutherfordton	1,305	1,248	1,374
St. Stephens (CDP)	NA	NA	900
Salem (CDP) (Burke County)	NA	NA	601
Salisbury	3,435	2,649	1,718
Sanford	2,705	2,663	1,252
Scotland Neck	2,704	2,391	1,009
Seagate (CDP)	NA	NA	815
Selma	2,585	2,904	2,381
Shelby	2,493	2,206	1,988
Siler City	1,142	1,172	1,112
Silver Lake (CDP)	NA	NA	541
Smithfield	2,781	2,087	1,157
Southern Pines	1,181	1,142	1,119
South Gastonia (CDP)	1,344	NA	1,362
South Goldsboro (CDP)	NA	NA	791

Greensboro	[illegible]	2,640	[illegible]
Greenville	3,629	2,549	[illegible]
Half Moon (CDP)	NA	NA	[illegible]
Hamlet	2,470	2,012	[illegible]
Havelock	1,217	1,506(b)	979
Henderson	3,267	3,563	2,940
Hendersonville	2,815	2,478	2,214
Hickory	2,196	2,070	1,715
Hickory North (CDP)	467	NA	636
High Point	2,035	2,052	2,012
Hillsborough	2,690	NA	1,372
Hope Mills	652	NA	1,546
Hudson	960	1,175	1,155
Jacksonville	4,352	3,815	2,159
Jacksonville East (CDP)	NA	NA	3,003
James City (CDP)	921	1,432	1,055
Kannapolis (CDP)	1,403	1,214	1,434
Kernersville	1,634	1,605	1,620
King (CDP)	NA	NA	431
Kings Grant (CDP)	NA	NA	1,238
Kings Mountain	2,503	1,881	1,816
Kinston	5,065	3,718	2,004
La Grange	2,370	NA	1,574
Laurinburg	2,010	1,926	1,573
Lenoir	2,385	1,400	1,109
Lewisville (CDP)	NA	NA	433
Lexington	2,775	1,670	2,123
Lincolnton	2,850	2,647	1,877
Long View	2,141	2,100	2,110
Louisburg	2,044	2,101	1,542
Lowell	1,326	1,575	1,167

[illegible]	[illegible]	[illegible]	[illegible]
Spindale	1,856	1,749	923
Spring Lake	3,736	3,607	2,163
Stanleyville (CDP)	711	NA	646
Statesville	2,181	2,127	1,663
Swannanoa (CDP)	1,288	NA	266
Tabor City	2,126	NA	1,084
Tarboro	4,427	2,547	2,272
Thomasville	2,713	2,343	2,000
Trinity (CDP)	NA	NA	604
Troy	1,564	NA	1,509
Valdese	1,279	1,326	1,005
Wadesboro	1,703	1,591	1,602
Wake Forest	1,776	2,099	1,800
Wallace	1,904	2,421	1,075
Warsaw	1,709	1,422	1,213
Washington	5,231	2,358	1,913
Waynesville	2,124	2,093	1,990
Welcome (CDP)	NA	NA	345
West Concord (CDP)	2,204	2,228	792
Whiteville	2,036	1,670	1,357
Williamston	2,473	2,666	2,053
Wilmington	5,791	2,638	2,047
Wilson	4,228	3,623	2,608
Windsor (CDP)	NA	NA	1,055
Wingate	1,449	NA	2,012
Winston-Salem	3,399	2,352	2,173
Winter Park (CDP)	NA	NA	1,732
Woodfin	NA	NA	959
Wrightsboro (CDP)	NA	NA	486
Wrightsville Beach	NA	NA	2,079

(a) Population per square mile of land area.
(b) Revised.
CDP Census Designated Place.
NA Not Available

NOTE: Figures are shown as they appear in the Census Bureau's published documents and do not reflect any corrections that were made to the population counts since revisions to the land area are not available.

SOURCE: U.S. Department of Commerce, Bureau of the Census.

Table 22

NUMBER OF HOUSEHOLDS AND PERSONS PER HOUSEHOLD BY RACE, BY COUNTY
1960, 1970, 1980

County	Total Population						White Population						Nonwhite Population					
	Number of Households			Persons Per Household			Number of Households			Persons Per Household			Number of Households			Persons Per Household		
	1960	1970	1980	1960	1970	1980	1960	1970	1980	1960	1970	1980	1960	1970	1980	1960	1970	1980
State Total	1,204,715	1,509,564	2,043,291	3.66	3.24	2.78	954,266	1,220,681	1,623,193	3.44	3.08	2.66	250,449	288,883	420,098	4.50	3.93	3.25
Alamance	23,920	29,851	35,962	3.54	3.18	2.71	20,609	25,553	29,987	3.30	3.05	2.60	3,231	4,298	5,975	4.53	3.98	3.21
Alexander	4,172	5,796	8,520	3.71	3.33	2.91	3,960	5,472	8,058	3.64	3.26	2.87	212	324	470	5.03	4.46	3.54
Alleghany	2,198	2,677	3,596	3.48	3.01	2.64	2,141	2,618	3,521	3.46	2.99	2.63	57	59	75	4.09	4.03	2.89
Anson	6,212	6,787	8,386	3.99	3.42	3.03	3,806	4,202	5,138	3.40	2.89	2.61	2,406	2,585	3,248	4.93	4.33	3.67
Ashe	5,242	6,039	8,028	3.75	3.24	2.77	5,195	5,988	7,950	3.74	3.23	2.76	47	51	78	4.23	4.41	2.89
Avery	2,968	3,667	4,826	3.86	3.26	2.80	2,944	3,645	4,791	3.87	3.26	2.79	24	22	35	3.29	3.50	2.77
Beaufort	9,642	11,030	14,253	3.70	3.24	2.82	6,710	7,998	10,413	3.36	2.99	2.62	2,932	3,032	3,840	4.49	3.92	3.33
Bertie	5,774	5,664	6,897	4.20	3.61	3.04	2,973	3,030	3,347	3.32	2.93	2.54	2,801	2,634	3,550	5.14	4.39	3.51
Bladen	6,722	7,363	10,113	4.27	3.56	2.98	4,386	4,994	6,650	3.78	3.18	2.72	2,336	2,369	3,463	5.18	4.35	3.47
Brunswick	5,014	6,958	12,411	4.01	3.47	2.87	3,620	5,297	9,947	3.59	3.15	2.72	1,386	1,661	2,464	5.11	4.46	3.43
Buncombe	38,413	47,248	60,274	3.29	2.99	2.61	34,312	43,342	55,070	3.27	2.97	2.59	3,901	3,906	5,204	3.47	3.22	2.78
Burke	13,460	17,645	25,338	3.57	3.19	2.73	12,628	16,642	23,787	3.52	3.15	2.70	832	1,003	1,551	4.38	3.84	3.13
Cabarrus	19,447	23,400	30,610	3.44	3.12	2.77	16,861	20,475	26,949	3.33	3.02	2.69	2,586	3,013	3,661	4.10	3.78	3.29
Caldwell	12,913	16,833	23,331	3.80	3.35	2.80	12,209	15,936	22,131	3.75	3.32	2.86	771	897	1,200	4.54	3.99	3.20
Camden	1,450	1,596	1,931	3.84	3.40	3.02	974	1,137	1,437	3.32	3.01	2.73	476	459	494	4.97	4.36	3.84
Carteret	7,634	9,997	15,128	3.58	3.13	2.66	6,871	9,125	13,921	3.46	3.04	2.59	763	872	1,207	4.61	4.08	3.35
Caswell	4,531	5,119	6,516	4.34	3.67	3.12	2,707	3,118	4,023	3.69	3.13	2.84	1,744	2,001	2,493	5.39	4.51	3.56
Catawba	20,396	27,974	37,300	3.55	3.20	2.77	18,886	26,079	34,309	3.48	3.13	2.72	1,510	1,895	2,999	4.48	4.19	3.34
Chatham	7,013	8,943	12,063	3.79	3.28	2.74	5,352	6,777	9,282	3.42	3.01	2.59	1,661	2,166	2,781	5.00	4.14	3.25
Cherokee	4,355	5,195	6,847	3.72	3.14	2.74	4,266	5,083	6,630	3.71	3.12	2.73	89	112	217	4.24	3.98	2.99
Chowan	2,970	3,171	4,350	3.92	3.30	2.85	1,864	2,108	2,700	3.35	2.95	2.59	1,114	1,063	1,570	4.88	4.25	3.31
Clay	1,494	1,688	2,490	3.69	3.07	2.66	1,476	1,676	2,475	3.70	3.06	2.65	18	12	15	2.78	4.00	3.33
Cleveland	17,427	21,422	28,458	3.76	3.33	2.80	14,442	18,042	23,529	3.52	3.14	2.74	2,985	3,380	4,929	4.92	4.39	3.32
Columbus	12,046	13,487	17,266	4.04	3.45	2.92	8,567	9,922	12,412	3.71	3.20	2.74	3,479	3,565	4,854	4.87	4.15	3.37
Craven	14,985	17,543	23,499	3.71	3.30	2.84	11,118	13,346	17,351	3.50	3.15	2.72	3,867	4,197	6,148	4.29	3.77	3.16
Cumberland	33,856	52,000	74,934	3.82	3.46	2.98	25,972	39,867	50,985	3.59	3.29	2.84	7,884	12,133	23,949	4.57	3.99	3.27
Currituck	1,061	2,164	3,897	3.51	3.17	2.80	1,385	1,742	3,381	3.22	2.93	2.71	476	422	516	4.35	4.17	3.32
Dare	1,826	2,465	5,359	3.17	2.80	2.48	1,709	2,311	5,026	3.15	2.77	2.46	117	154	333	3.43	3.22	2.69
Davidson	22,068	29,478	40,010	3.56	3.21	2.80	20,053	26,992	36,404	3.50	3.15	2.76	2,015	2,486	3,606	4.20	3.82	3.20
Davie	4,638	5,870	8,540	3.56	3.19	2.85	4,159	5,281	7,771	3.48	3.12	2.80	479	589	769	4.32	3.80	3.30
Duplin	10,205	11,199	13,993	3.93	3.38	2.90	6,961	7,973	9,815	3.60	3.12	2.71	3,244	3,226	4,178	4.62	4.03	3.35
Durham	31,228	40,921	55,614	3.37	3.05	2.61	22,123	28,987	36,840	3.20	2.89	2.46	9,105	11,934	18,774	3.77	3.41	2.89
Edgecombe	13,114	14,709	18,397	4.09	3.53	3.01	7,442	8,886	10,233	3.47	3.07	2.65	5,672	5,823	8,164	4.91	4.23	3.46
Forsyth	54,151	67,502	90,146	3.40	3.09	2.62	41,044	53,175	69,730	3.34	3.04	2.54	12,307	14,327	20,416	3.62	3.28	2.89
Franklin	7,174	7,622	9,983	3.97	3.41	2.91	4,574	5,073	6,552	3.39	2.94	2.58	2,550	2,549	3,431	5.00	4.34	3.53
Gaston	34,753	44,757	56,362	3.62	3.27	2.86	30,707	40,009	49,962	3.56	3.21	2.81	4,046	4,748	6,400	4.08	3.78	3.20
Gates	2,279	2,396	2,809	4.05	3.52	3.03	1,275	1,365	1,609	3.31	2.89	2.58	1,004	1,031	1,200	5.00	4.36	3.54
Graham	1,633	1,956	2,481	3.93	3.35	2.91	1,586	1,875	2,388	3.88	3.32	2.85	47	81	93	5.45	3.95	4.20
Granville	7,516	8,294	10,445	3.97	3.49	2.99	4,501	5,140	6,434	3.41	3.04	2.65	3,005	3,146	4,011	4.67	4.23	3.51
Greene	3,694	3,915	5,059	4.50	3.78	3.14	2,258	2,510	3,259	2.60	3.17	2.65	1,436	1,397	1,800	5.79	4.96	4.01
Guilford	69,128	87,027	114,084	3.45	3.16	2.67	56,731	71,107	88,379	3.34	3.05	2.57	12,377	16,720	25,755	3.93	3.65	3.02
Halifax	14,044	15,036	18,286	4.12	3.51	2.96	7,959	9,040	10,622	3.30	2.93	2.54	6,089	5,900	7,664	5.20	4.34	3.51
Harnett	12,374	14,692	20,140	3.82	3.25	2.83	9,618	11,835	16,061	3.53	3.01	2.68	2,756	2,857	4,087	4.82	4.29	3.43
[illegible]	[illegible]	[illegible]	16,997	3.50	3.12	2.70	11,061	12,996	16,694	3.49	3.11	2.69	202	232	303	4.09	3.49	3.03
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.96	2.57	512	540	761	3.61	3.62	2.92

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3.36
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3,113	3.65	3.20	2.74	1,620	1,776	2,911	[redacted]			3.85
[redacted]	3,466	3,960	6,024	4.53	3.97	3.20	1,066	[redacted]	1	1,430	3.13	2.97	2.63	469	495	599				3.49
[redacted]	1,532	1,604	2,029	3.76	3.42	2.89	1,063	1												
[redacted]	17,531	22,411	29,120	3.53	3.19	2.81	15,025	.25		24,941	3.39	3.07	2.69	2,506	3,118	4,187		3.95		3.45
[redacted]	4,476	6,036	8,502	3.75	3.16	2.67	4,117	5,531		7,666	3.65	3.05	2.60	359	525	836	4.87	4.25		3.31
Johnston	16,659	19,190	25,157	3.76	3.20	2.78	13,661	15,969		20,972	3.55	3.03	2.67	2,990	3,221	4,185	4.69	4.03		3.34
Jones	2,533	2,679	3,203	4.33	3.64	3.03	1,528	1,691		2,003	3.02	3.17	2.72	1,005	900	1,200	5.12	4.45		3.53
Lee	7,146	9,118	12,914	3.69	3.30	2.81	5,002	7,351		10,385	3.53	3.15	2.71	1,344	1,767	2,529	4.36	3.93		3.21
Lenoir	13,873	15,941	20,674	3.81	3.30	2.80	9,009	10,695		13,450	3.48	3.09	2.64	4,064	5,246	7,224	4.43	3.75		3.09
Lincoln	7,708	9,960	14,674	3.72	3.27	2.87	7,032	9,200		13,601	3.57	3.18	2.80	676	760	1,073	5.20	4.37		3.65
McDowell	7,319	9,412	12,224	3.63	3.23	2.83	6,920	9,002		11,722	3.61	3.20	2.80	349	410	502	3.97	3.82		3.26
Macon	4,172	5,197	7,701	3.56	3.01	2.59	4,089	5,108		7,607	3.56	3.00	2.58	83	89	94	3.55	3.29		2.91
Madison	4,462	4,960	5,844	3.65	3.17	2.72	4,470	4,926		5,799	3.65	3.17	2.72	34	34	45	3.53	3.50		2.82
Martin	6,476	7,019	8,615	4.17	3.50	2.98	3,811	4,364		5,327	3.56	3.11	2.66	2,665	2,655	3,288	5.05	4.15		3.48
Mecklenburg	76,877	109,532	146,967	3.47	3.17	2.69	60,403	86,400		111,196	3.33	3.06	2.56	16,474	23,132	35,771	3.99	3.62		3.09
Mitchell	3,734	4,248	5,263	3.72	3.16	2.74	3,723	4,237		5,235	3.72	3.16	2.74	11	11	28	3.91	3.73		2.75
Montgomery	4,884	5,708	7,760	3.74	3.33	2.85	3,964	4,627		6,241	3.46	3.09	2.66	920	1,081	1,519	4.96	4.37		3.62
Moore	9,866	11,830	18,502	3.65	3.22	2.67	7,609	9,431		15,132	3.47	3.04	2.56	2,257	2,407	3,450	4.25	3.97		3.13
Nash	15,345	17,331	23,470	3.94	3.35	2.83	10,535	12,454		16,968	3.46	2.99	2.61	4,810	4,877	6,502	5.01	4.29		3.41
New Hanover	20,932	26,623	37,691	3.37	3.08	2.69	15,650	21,050		30,042	3.24	3.00	2.61	5,274	5,573	7,649	3.75	3.37		2.97
Northampton	6,095	6,214	7,097	4.34	3.65	3.03	2,943	3,030		3,244	3.27	2.80	2.51	3,152	3,184	3,853	5.34	4.38		3.46
Onslow	17,185	22,761	30,307	3.82	3.40	2.96	15,217	19,730		24,616	3.69	3.30	2.87	1,968	3,031	5,691	4.76	4.07		3.34
Orange	10,763	16,544	27,044	3.51	3.00	2.50	8,604	13,994		22,605	3.72	2.82	2.39	2,159	2,550	4,359	4.68	3.97		3.03
Pamlico	2,519	2,806	3,678	3.91	3.20	2.82	1,837	2,172		2,720	3.39	2.97	2.60	682	764	958	5.27	4.12		3.44
Pasquotank	6,081	7,952	9,723	3.61	3.23	2.78	4,631	5,468		6,629	3.28	2.97	2.62	2,250	2,484	3,094	4.27	3.79		3.12
Pender	4,613	5,237	7,511	3.99	3.42	2.91	2,775	3,318		4,908	3.46	3.03	2.71	1,838	1,919	2,603	4.72	4.09		3.29
Perquimans	2,380	2,500	3,783	3.77	3.30	2.85	1,400	1,637		2,209	3.72	2.93	2.61	900	863	1,074	4.65	4.01		3.33
Person	6,567	7,536	9,858	3.99	3.42	2.93	4,717	5,603		7,266	3.58	3.08	2.70	1,850	1,933	2,592	5.06	4.38		3.57
Pitt	17,031	20,914	30,198	3.96	3.32	2.76	10,649	14,643		21,046	3.47	3.00	2.52	6,382	6,269	9,152	4.77	4.07		3.31
Polk	3,390	3,955	5,023	3.33	2.95	2.55	3,078	3,576		4,644	3.23	2.86	2.49	312	379	379	4.30	3.80		3.21
Randolph	17,453	24,108	32,917	3.50	3.15	2.77	16,263	22,668		30,973	3.45	3.11	2.74	1,190	1,440	1,944	4.19	3.05		3.15
Richmond	10,392	12,051	15,009	3.71	3.25	2.83	7,736	9,101		11,905	3.57	3.06	2.70	2,656	2,950	3,024	4.76	3.84		3.24
Robeson	19,999	22,162	31,372	4.40	3.78	3.19	10,010	11,249		14,429	3.58	3.16	2.69	9,909	10,913	16,943	5.22	4.42		3.60
Rockingham	19,443	22,406	29,616	3.56	3.20	2.80	16,053	18,699		24,481	3.40	3.06	2.67	3,390	3,787	5,135	4.31	3.91		3.35
Rowan	23,820	28,714	35,949	3.39	3.03	2.68	20,575	24,928		31,061	3.28	2.95	2.61	3,245	3,786	4,888	4.07	3.59		3.09
Rutherford	12,634	14,993	19,221	3.52	3.12	2.76	11,420	13,751		17,214	3.43	3.04	2.70	1,214	1,242	2,007	4.41	4.08		3.28
Sampson	11,872	13,032	16,646	4.02	3.42	2.95	8,111	9,104		11,553	3.66	3.12	2.73	3,761	3,928	5,093	4.81	4.12		3.45
Scotland	6,026	7,307	10,343	4.13	3.53	3.03	3,829	4,944		6,463	3.65	3.24	2.80	2,197	2,443	3,870	4.98	4.11		3.39
Stanly	11,606	13,632	17,378	3.44	3.08	2.73	10,617	12,439		15,699	3.36	3.00	2.66	1,069	1,193	1,679	4.20	3.80		3.34
Stokes	5,905	7,221	11,252	3.75	3.27	2.92	5,470	6,749		10,576	3.64	3.19	2.87	435	472	676	5.21	4.52		3.61
Surry	13,509	16,332	21,301	3.55	3.13	2.76	12,910	15,671		20,316	3.51	3.10	2.74	599	661	985	4.48	3.89		3.13
Swain	2,219	2,394	3,565	3.77	3.20	2.82	1,888	2,143		2,016	3.55	3.06	2.65	331	251	749	5.04	4.37		3.44
Transylvania	4,304	5,906	8,200	3.63	3.22	2.75	4,202	5,685		7,871	3.58	3.19	2.71	182	221	329	4.68	4.22		3.42
Tyrrell	1,161	1,128	1,301	3.89	3.36	2.88	709	763		943	3.22	2.82	2.56	372	365	430	5.30	4.50		3.55
Union	11,687	15,904	22,921	3.76	3.34	3.00	9,722	13,558		19,716	3.55	3.16	2.88	1,965	2,346	3,205	4.80	4.38		3.74
Vance	8,244	9,406	12,239	3.84	3.42	2.95	5,244	6,156		7,710	3.39	3.03	2.64	3,000	3,250	4,529	4.62	4.16		3.48
Wake	45,476	67,533	106,525	3.45	3.16	2.67	35,634	55,061		85,348	3.24	3.01	2.58	9,842	12,472	21,177	4.22	3.81		3.03
Warren	4,529	4,339	5,257	4.31	3.62	3.05	2,129	2,093		2,321	3.29	2.82	2.48	2,400	2,246	2,936	5.25	4.38		3.49
Washington	3,254	3,810	4,729	4.10	3.64	3.10	2,107	2,585		3,049	3.51	3.16	2.71	1,147	1,225	1,600	5.19	4.66		3.78
Watauga	4,536	6,525	10,746	3.55	3.03	2.56	4,482	6,462		10,598	3.54	3.03	2.55	54	63	148	4.30	3.41		2.72
Wayne	20,142	23,829	32,300	3.79	3.36	2.88	14,164	16,033		22,649	3.54	3.17	2.73	5,978	6,996	9,651	4.39	3.80		3.23
Wilkes	11,805	14,960	20,522	3.81	3.29	2.84	11,205	14,204		19,543	3.79	3.26	2.82	600	676	979	4.33	3.76		2.99
Wilson	14,737	16,709	21,549	3.83	3.35	2.85	9,767	11,581		14,726	3.45	3.03	2.61	4,970	5,128	6,823	4.57	4.06		3.34
Yadkin	6,346	7,881	10,211	3.57	3.09	2.75	6,006	7,562		9,797	3.54	3.06	2.72	260	319	414	4.33	3.77		3.31
Yancey	3,662	3,876	5,277	3.81	3.22	2.79	3,620	3,841		5,225	3.81	3.22	2.78	34	35	52	3.97	3.97		3.36

SOURCE: U.S. Department of Commerce, Bureau of the Census.
Office of State Budget and Management, Research and Planning Services.

EMISSIONS INTENDED SUBMITTED FOR PROJECT
FROM PO[illegible] SOURCES, BY COUNTY
'79

County	Particulates		Sulfur Dioxide		Nitrogen Oxides		Volatile Organic Compounds and Hydrocarbons		Carbon Monoxide	
	Area Sources	Point Sources	Area Sources	Point Sources	Area Sources	Point Sources	Area Sources	Point Sources	Area Sources	Point Sources
State Total	553,662	222,263	43,247	731,157	334,096	290,035	560,734	114,695	2,416,603	130,670
Alamance	7,718	068	810	1,420	5,090	266	11,740	3	45,600	21
Alexander	2,150	633	173	120	1,150	32	1,634	535	6,800	2
Alleghany	2,168	-	63	-	611	-	924	-	3,931	-
Anson	2,537	291	183	2	1,618	16	2,700	92	10,909	4
Ashe	5,022	422	127	9	1,127	74	1,713	231	7,535	12
Avery	1,705	70	09	03	799	50	797	8	4,116	7
Beaufort	5,334	1,079	307	21,236	2,731	1,145	4,277	23	19,654	51
Bertie	2,927	1,608	144	316	1,598	312	2,107	63	11,434	101
Bladen	3,565	135	191	551	1,935	99	2,731	104	12,777	8
Brunswick	3,293	913	204	16,616	2,018	3,418	3,205	29,359	16,967	10,845
Buncombe	15,826	4,523	1,036	101,654	0,073	34,100	17,219	536	66,409	2,245
Burke	5,906	560	485	1,520	4,066	671	6,335	1,406	27,445	109
Cabarrus	6,136	765	581	2,630	4,775	1,126	8,704	998	45,995	94
Caldwell	6,070	3,050	581	303	3,400	435	4,897	5,600	19,740	69
Camden	707	3	47	-	517	-	025	-	4,021	-
Carteret	1,949	0	270	01	2,269	16	5,000	-	20,445	2
Caswell	2,430	099	124	-	1,160	-	1,516	-	0,430	-
Catawba	7,537	19,814	1,345	75,330	7,029	33,000	13,934	3,016	40,662	1,932
Chatham	4,994	9,679	349	12,200	2,464	5,352	3,999	756	15,675	009
Cherokee	3,332	50	104	1	1,050	6	1,750	1	7,010	1
Chowan	747	54	93	326	795	54	1,405	227	6,347	4
Clay	2,096	-	71	-	1,200	-	2,076	-	17,274	-
Cleveland	6,160	365	945	406	4,030	929	6,461	-	15,717	46
Columbus	5,040	1,406	391	1,735	3,216	2,002	4,170	412	20,162	12,427
Craven	6,501	3,350	399	6,706	3,677	2,614	6,602	1,040	32,514	7,005
Cumberland	17,810	506	1,120	2,927	9,493	601	17,624	034	90,631	74
Currituck	1,100	159	700	-	1,200	2	1,400	-	4,900	-
Dare	605	5	104	240	932	71	3,926	2	14,039	12
Davidson	10,207	355	756	998	6,301	629	10,320	2,470	44,355	144
Davie	2,233	420	149	66	1,259	31	5,206	181	8,991	5
Duplin	4,709	105	273	763	2,949	154	3,668	41	10,942	13
Durham	10,624	036	770	000	6,398	194	12,903	703	58,610	15
Edgecombe	3,302	3,041	491	407	4,010	81	4,720	1,367	21,017	17
Forsyth	17,830	528	2,173	5,037	16,754	2,152	24,192	21,408	95,712	186
Franklin	2,050	-	101	-	1,771	-	3,165	03	13,206	-
Gaston	10,171	7,566	1,145	62,730	0,842	29,610	15,598	607	61,159	1,789
Gates	1,298	-	69	-	729	-	740	-	4,277	-
Graham	042	44	35	60	364	19	479	3	2,231	4
Granville	5,457	70	206	720	2,277	1,020	4,013	515	19,515	188
Greene	1,329	11	87	-	998	-	1,330	-	7,063	-
Guilford	33,493	2,702	2,769	3,330	20,142	909	31,063	14,057	139,190	495
Halifax	5,044	1,306	315	9,556	2,903	2,405	5,316	329	29,552	10,410
Harnett	5,575	143	306	765	3,268	169	4,409	5	24,530	14
Haywood	4,414	602	205	9,760	2,520	4,703	5,531	49	17,166	43,964
Henderson	6,042	300	370	2	3,040	20	5,703	3	21,240	7
Hertford	2,005	005	152	276	1,410	2,615	2,270	54	11,197	111
Hoke	097	31	122	193	979	54	1,034	-	6,977	3
Hyde	020	140	95	-	014	-	3,074	-	11,064	-
Iredell	10,157	2,169	729	916	4,950	665	9,541	1,029	31,946	114
Jackson	4,694	99	153	5	2,007	30	3,203	6	10,941	6

Johnston	7,755	1,671	429	[illegible]	[illegible]	31	[illegible]	110	[illegible]	
Jones	995	-	70		-	-	[illegible]	-	[illegible]	
Lee	1,936	81	[illegible]	-	[illegible]	[illegible]	[illegible]	214	[illegible]	
Lenoir	32,597	451	968	2,979	2,020	1,094	[illegible]	19	[illegible]	[illegible]
Lincoln	2,892	116	275	714	2,126	173	3,292	167	11,732	13
McDowell	2,645	185	179	1,042	1,060	992	2,698	290	12,728	44
Macon	3,202	16	263	-	2,016	-	3,091	-	15,900	-
Madison	3,444	1	160	14	1,165	7	1,442	2	7,027	2
Martin	3,523	3,750	93	18,647	863	7,719	1,037	1,093	5,520	12,789
Mecklenburg	20,607	3,356	3,503	3,631	24,715	813	26,601	5,707	156,667	1,750
Mitchell	1,591	[illegible]	[illegible]	[illegible]	[illegible]	13	[illegible]	[illegible]	[illegible]	1
Montgomery	1,949	[illegible]	190	36	[illegible]	31	3,359	13	[illegible]	23
Moore	4,410	92	265	71	2,464	46	4,295	60	10,219	9
Nash	5,322	559	594	1,203	4,573	323	8,567	309	35,373	30
New Hanover	4,042	4,675	1,080	36,403	5,411	13,157	10,379	8,344	45,872	655
Northampton	2,193	[illegible]	144	627	1,607	200	[illegible]	150	10,632	43
Onslow	6,007	27	415	30	4,326	10	7,442	-	35,560	-
Orange	6,169	90	336	1,174	2,929	615	4,836	57	20,433	31
Pamlico	995	-	91	-	773	-	1,635	-	6,356	-
Pasquotank	1,508	432	166	140	1,220	211	2,436	20	11,002	49
Pender	2,248	-	130	-	1,620	-	2,232	-	12,432	-
Perquimans	1,004	21	76	-	755	-	1,065	-	5,240	-
Person	4,221	15,859	195	73,710	1,533	34,504	2,968	593	11,436	1,923
Pitt	8,053	390	423	1,500	3,970	312	6,656	30	37,356	26
Polk	1,917	37	82	34	703	56	970	-	4,441	1
Randolph	11,786	83	627	64	3,543	31	9,203	377	27,791	-
Richmond	2,903	21	405	30	2,663	8	4,786	-	17,374	80
Robeson	9,120	452	621	6,434	5,365	2,634	8,985	631	41,534	154
Rockingham	10,052	34,193	586	7,270	4,726	3,390	8,993	251	36,541	199
Rowan	7,590	3,541	698	10,791	5,126	4,909	9,062	139	31,959	272
Rutherford	6,778	2,994	331	37,072	2,930	14,013	4,912	282	21,256	707
Sampson	5,900	101	345	705	3,321	126	4,853	95	23,036	11
Scotland	1,780	272	171	505	1,663	191	3,[illegible]	2,450	12,[illegible]	22
Stanly	3,915	1,280	321	2,307	2,745	305	3,764	130	17,[illegible]	11,436
Stokes	4,900	30,172	106	146,460	1,627	65,072	2,150	1,052	10,276	3,594
Surry	8,047	1,265	521	1,413	3,990	445	6,535	154	23,[illegible]	66
Swain	900	102	53	-	532	-	850	-	3,293	-
Transylvania	2,181	31	116	807	939	291	1,968	3	6,691	12
Tyrrell	674	5	70	-	627	-	1,130	-	4,752	-
Union	6,003	896	534	107	4,126	72	6,294	704	23,997	7
Vance	2,452	267	200	66	2,193	33	3,913	50	16,660	1
Wake	25,540	214	1,039	265	16,875	119	26,054	891	144,690	499
Warren	2,761	-	108	-	1,183	-	1,584	-	8,294	-
Washington	1,494	930	622	36	1,307	173	2,501	36	7,466	35
Watauga	4,143	47	176	585	1,509	140	2,260	33	11,054	9
Wayne	6,682	29,090	564	21,769	5,475	6,828	9,922	144	37,706	1,619
Wilkes	9,765	1,001	415	1,074	3,599	327	3,732	189	17,403	41
Wilson	4,374	202	539	86	4,449	18	8,416	16	30,285	1
Yadkin	3,292	10	189	18	1,710	4	2,171	-	11,295	1
Yancey	1,831	13	95	102	771	19	1,023	-	5,[illegible]	2

SOURCE: North Carolina Department of Natural Resources and Community Development, Division of Environmental Management.

A 35.1ACT

COUNTY POPULATION ESTIMATES AS OF JULY 1, 1987

Alamance	104,935
Alexander	27,100
Alleghany	9,730
Anson	26,211
Ashe	23,351
Avery	15,154
Beaufort	42,754
Bertie	21,132
Bladen	30,783
Brunswick	49,631
Buncombe	171,489
Burke	76,226
Cabarrus	93,715
Caldwell	70,571
Camden	5,984
Carteret	50,485
Caswell	22,453
Catawba	115,810
Chatham	36,330
Cherokee	20,888
Chowan	13,535
Clay	7,195
Cleveland	86,290
Columbus	52,854
Craven	80,272
Cumberland	257,802
Currituck	13,689
Dare	19,992
Davidson	123,385
Davie	27,405
Duplin	41,644
Durham	169,227
Edgecombe	59,127
Forsyth	264,786
Franklin	35,205
Gaston	172,670
Gates	9,686
Graham	7,124
Granville	38,217
Greene	16,467
Guilford	333,677
Halifax	56,586
Harnett	64,967
Haywood	48,021
Henderson	67,966
Hertford	23,862
Hoke	23,954
Hyde	5,796
Iredell	89,880
Jackson	26,836
Johnston	79,234
Jones	10,090
Lee	41,395
Lenoir	60,341
Lincoln	47,435
McDowell	36,350
Macon	23,153
Madison	17,379
Martin	26,615
Mecklenburg	466,335
Mitchell	14,577
Montgomery	24,248
Moore	57,532
Nash	72,344
New Hanover	116,337
Northampton	22,247
Onslow	125,642
Orange	86,236
Pamlico	10,830
Pasquotank	30,466
Pender	26,277
Perquimans	10,725
Person	30,987
Pitt	99,601
Polk	14,518
Randolph	100,489
Richmond	45,934
Robeson	107,209
Rockingham	85,891
Rowan	104,744
Rutherford	57,130
Sampson	50,659
Scotland	34,357
Stanly	50,507
Stokes	36,130
Surry	62,075
Swain	10,662
Transylvania	25,944
Tyrrell	4,144
Union	81,842
Vance	39,127
Wake	374,582
Warren	16,560
Washington	14,658
Watauga	34,594
Wayne	98,152
Wilkes	61,226
Wilson	65,304
Yadkin	29,953
Yancey	15,934
North Carolina	6,411,810

Office of State Budget and Management, Management and Information Services

REFERENCE 20

GREENHORNE & O'MARA, INC.

Memorandum

TO: File

FROM: Rachel Spangenberg RMS

DATE: April 1, 1991

SUBJ: Telephone conversation with Ms. D. LaCasse, Supervisor of the Craven County, Water and Sewer Division (919) 636-6615.

Ms. LaCasse informed me that the City of New Bern's water supply is from wells located in Cove City. James City purchases water from New Bern (water is from the same Cove City wells). There are many private wells in the area, a lot of people have municipal water inside the house and wells for outdoor use.

GREENHORNE & O'MARA, INC.

Memorandum

TO: File

FROM: Rachel Spangenberg RMS

DATE: April 10, 1991

SUBJ: Telephone conversation with Ms. D. LaCasse, Supervisor of the Craven County, Water and Sewer Division (919) 636-6615.

I asked Ms. LaCasse for clarification on what areas were served by the wells located in Cove City and which areas in the vicinity had their own municipal system or have private wells. Ms. LaCasse informed me that Granthams, James City, Trent Woods, and New Bern are all served by wells located in Cove City.

REFERENCE 21

GREENHORNE & O'MARA, INC.

Memorandum

TO: File

FROM: Rachel Spangenberg RMS

DATE: April 10, 1991

SUBJ: Phone conversation with Bridgeton Water and Sewer Agency (919) 633-6500.

The representative for the Bridgeton Water and Sewer Agency informed me that the Town of Bridgeton has their own wells which serve the Town of Bridgeton only. The remaining areas, i.e. Dickerson, are assumed to be served by private wells.

REFERENCE 22

May 18, 1989

TO: Superfund Branch Staff

FROM: Pat DeRosa PD

RE: Critical Habitats of Federally Listed Endangered Species in North Carolina

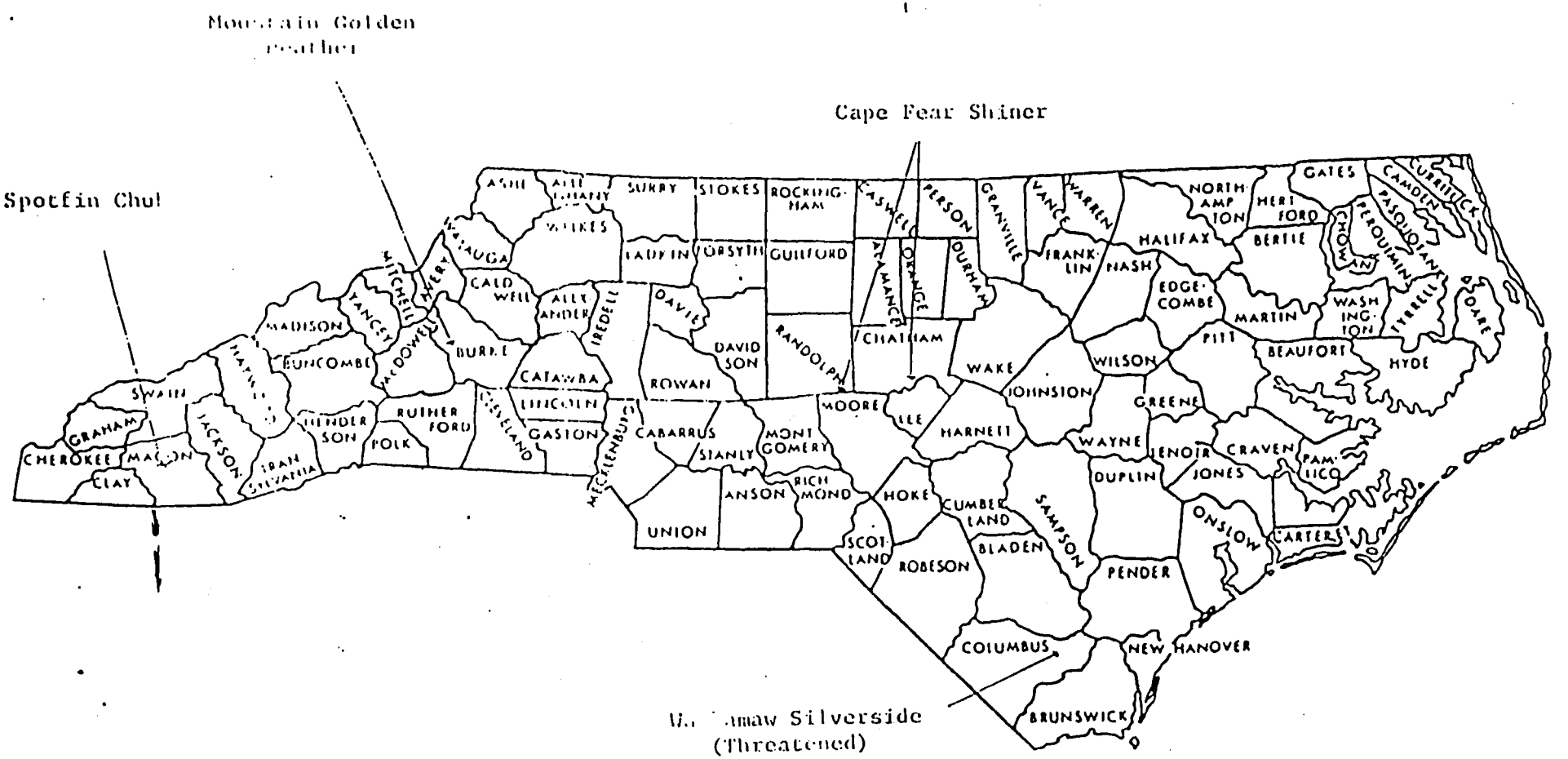
On May 18, 1989, I spoke by telephone with John Fridell, US Fish and Wildlife Service, Asheville, NC (704) 259-0321 to request an update on critical habitats in North Carolina. Mr. Fridell said the Fish and Wildlife Service has been reorganized into a western and eastern office in North Carolina. His office now handles only western North Carolina. He said there have been no changes in the designated critical habitats identified in western North Carolina.

I then spoke by telephone with Debby Mignogno, US Fish and Wildlife Service, Raleigh, NC (919) 856-4520 regarding critical habitats in eastern North Carolina. Ms. Mignogno sent the attached maps of the 2 critical habitats designated in eastern North Carolina. Please note that the Waccamaw Silverside is listed as threatened, not endangered.

PD/pb/critical.hab

CRITICAL HABITATS OF FEDERALLY LISTED

ENDANGERED SPECIES IN NC



1 inch = approx. 53 miles

RECEIVED
MAY 19 1989
6/88
SUPERFUND BRANCH

~~CAPE~~ FEAR SHINER

Notropis mekistocholas

Order: Cypriniformes

Family: Cyprinidae

Status: Endangered (Federal Register 9/25/87)

Range: The Cape Fear shiner is known from four small populations in the Cape Fear River drainage in Randolph, Moore, Lee, Harnett, and Chatham Counties, North Carolina.

The strongest population is located around the junction of the Rocky River and Deep River in Chatham and Lee Counties where the fish inhabits the Deep River from the upstream limits of the backwaters of Locksville Dam upstream to the Rocky River; then upstream from the Rocky River to Bear Creek, and upstream from Bear Creek to the Chatham County Road 2156 Bridge. A few individuals have been collected just downstream of the Locksville Dam, but because of the limited extent of Cape Fear shiner habitat at this site, it is not believed this is a separate population. Instead, it is thought these fish represent a small number of individuals that periodically drop down from the population above Locksville Dam pool.

The second population is located above the Rocky River Hydroelectric Dam. This population was historically the best, but the area yielded only one specimen after extensive surveys by Pottern and Huish (1985). The third population is found in the Deep River system in Randolph and Moore Counties. This population is believed to be small (Pottern and Huish 1985, 1986). In a 1985 survey, three individuals were found above the Highfalls Hydroelectric Reservoir; one in Fork Creek, Randolph County, and two in the Deep River, Moore County. The species was also found downstream of the Highfalls Dam. However, the extent of suitable habitat in this stream reach is limited, and it is thought that these individuals likely result from downstream movement from above the reservoir where Cape Fear shiner habitat is more extensive. The fourth population is found in Neal Creek, which flows into the Cape Fear River near Lillington in Harnett County.

Three historic populations have apparently been extirpated: one in Robeson Creek, Chatham County, believed lost when Jordan Lake flooded part of the creek; and one each in Parkers Creek and Kenneth Creek in Harnett County, which disappeared for unknown reasons. Other undiscovered populations or population segments have likely been lost due to reservoir construction in the Deep, Haw, and Cape Fear Rivers.

CAPE FEAR SHINER - N. mekistocholas 6/88

Description: The Cape Fear shiner is small, rarely exceeding 2 inches in length. The fish's body is flushed with a pale silvery yellow, and a black band runs along its sides (Snelson 1971). The fins are yellowish and somewhat pointed. The upper lip is black, and the lower lip bears a thin black bar along its margin. The Cape Fear shiner, unlike most other members of the large genus Notropis, feeds extensively on plant material, and its digestive tract is modified for this diet by having an elongated, convoluted intestine.

Reasons for Current Status: The Cape Fear shiner may always have existed in low numbers. However, its recent reduction in range and its small population size (Pottern and Huish 1985, 1986) increases the species' vulnerability to a catastrophic event, such as a toxic chemical spill. Dam construction in the Cape Fear system has probably had the most serious impact on the species by inundating the species' rocky riverine habitat; and changes in flow regulation at existing hydroelectric facilities could further threaten the species.

The deterioration of water quality has likely been another factor in the species' decline. The North Carolina Department of Natural Resources and Community Development (1983) classified water quality in the Deep River, Rocky River, and Bear Creek as good to fair, and referred to the Rocky River below Siler City as an area where their sampling indicates degradation. That report also stated: "Within the Cape Fear Basin, estimated average annual soil losses from cropland ranged from 3 tons per acre in the lower basin to 12 tons in the headwaters." The North Carolina State Division of Soil and Water Conservation considers 5 tons of soil loss per acre as the maximum allowable.

Potential threats to the species and its habitat could come from such activities as road construction, stream channel modification, changes in stream flows for hydroelectric power, impoundments, land use changes, wastewater discharges, and other projects in the watershed if such activities are not planned and implemented with the survival of the species and the protection of its habitat in mind.

Habitat: The species is generally associated with gravel, cobble, and boulder substates and has been observed to inhabit slow pools, riffles, and slow runs (Snelson 1971, Pottern and Huish 1985). In these habitats, the species is typically associated with schools of other related species, but it is never the numerically dominant species. Juveniles are often found in slackwater, among large rock outcrops in midstream, and in flooded side channels and pools (Pottern and Huish 1985).

Critical Habitat: (1) North Carolina, Chatham County. Approximately 4.1 miles of the Rocky River from North Carolina State Highway 902 Bridge downstream to Chatham County Road 1010 Bridge; (2) North Carolina,

Chatham and Lee Counties. Approximately 0.5 river mile of Bear Creek, from Chatham County Road 2156 Bridge downstream to the Rocky River, then downstream in the Rocky River (approximately 4.2 river miles) to the Deep River, then downstream in the Deep River (approximately 2.6 river miles) to a point 0.3 river mile below the Moncure, North Carolina, U.S. Geological Survey Gaging Station; and (3) North Carolina. Randolph and Moore Counties. Approximately 1.5 miles of Fork Creek, from a point 0.1 river mile upstream of Randolph County Road 2873 Bridge downstream to the Deep River then downstream approximately 4.1 river miles of the Deep River in Randolph and Moore Counties, North Carolina, to a point 2.5 river miles below Moore County Road 1456 Bridge.

Constituent elements include clean streams with gravel, cobble, and boulder substrates with pools, riffles, shallow runs and slackwater areas with large rock outcrops and side channels and pools with water of good quality with relatively low silt loads.

Feeding Habits: Plant material forms the primary part of the diet.

Reproduction and Development: No information is presently available on breeding behavior, fecundity, or longevity.

Population Level: Total numbers are unknown, but all populations appear be small. Surveys conducted in 1984 and 1985 yielded 101 individuals from the population located around the junction of the Rocky River and Deep River in Chatham and Lee Counties, 1 specimen from the Rocky River near State Highway Bridge 902 in Chatham County, and 6 specimens from the Deep River system in Randolph and Moore Counties.

Management and Protection: Assuring survival of the Cape Fear shiner will require, at a minimum, maintaining good water quality and the natural conditions of the remaining habitat. Providing for a higher level of security will necessitate determining limiting factors and reestablishing additional populations into suitable waters within the historic range.

References:

North Carolina Department of Natural Resources and Community Development. 1983. Status of Water Resources in the Cape Fear River Basin. 135 pp.

Pottern, G.B., and M.T. Huish. 1985. Status survey of the Cape Fear shiner (Notropis mekistocholas). U.S. Fish and Wildlife Service Contract No. 14-16-0009-1522. 44 pp.

Pottern, G.B., and M.T. Huish. 1986. Supplement to the status survey of the Cape Fear shiner (Notropis mekistocholas). U.S. Fish and Wildlife Service Contract No. 14-16-0009-1522. 11 pp.

Snelson, F.F. 1971. *Notropis mekistocholas*, a new cyprinid fish endemic to the Cape Fear River basin. North Carolina. Copeia 1971:449-462.

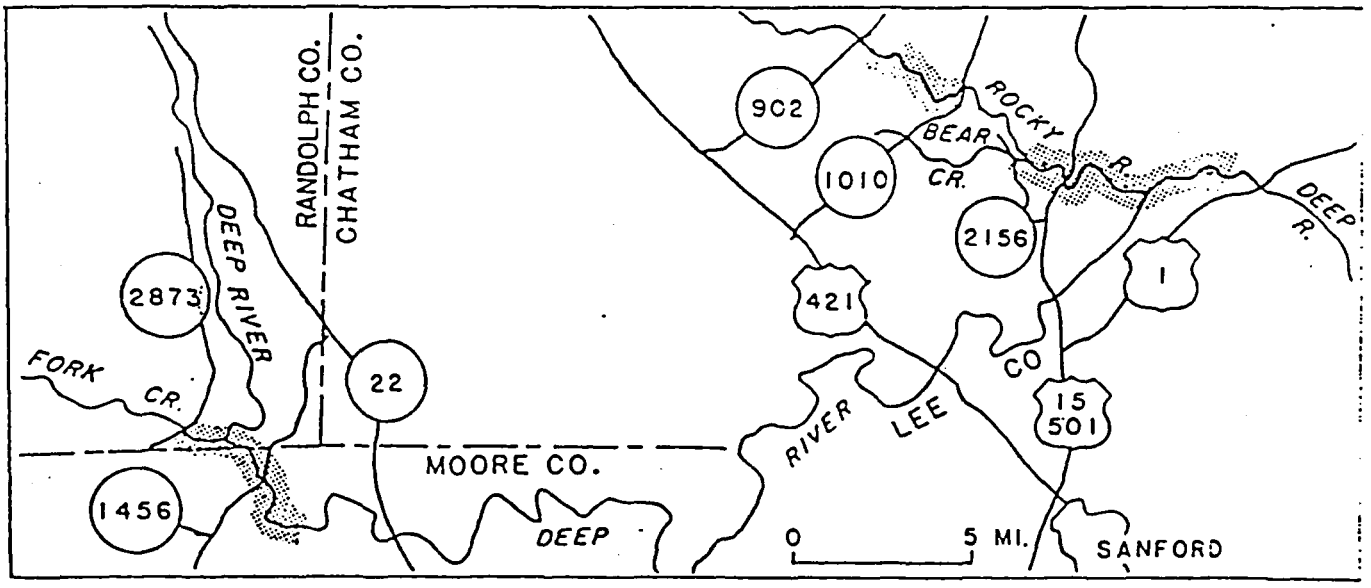
U.S. Fish and Wildlife Service. 1987. Endangered and threatened wildlife and plants; determination of endangered species status and designation of critical habitat for the Cape Fear shiner. Federal Register 52(186):36034-36039.

NORTH CAROLINA - Critical Habitat

Notropis mekistocholas, "Cape Fear shiner"

(1) Chatham County. Approximately 4.1 miles of the Rocky River from North Carolina State Highway 902 Bridge downstream to Chatham County Road 1010 Bridge;
(2) Chatham and Lee Counties. Approximately 0.5 river mile of Bear Creek, from Chatham County Road 2156 Bridge downstream to the Rocky River, then downstream in the Rocky River (approximately 4.2 river miles) to the Deep River, then downstream in the Deep River (approximately 2.6 river miles) to a point 0.3 river mile below the Moncure, North Carolina, U.S. Geological Survey Gaging Station; and
(3) Randolph and Moore Counties. Approximately 1.5 miles of Fork Creek, from a point 0.1 river mile upstream of Randolph County Road 2873 Bridge downstream to the Deep River then downstream approximately 4.1 river miles of the Deep River in Randolph and Moore Counties, North Carolina, to a point 2.5 river miles below Moore County Road 1456 Bridge.

Constituent elements include clean streams with gravel, cobble, and boulder substrates with pools, riffles, shallow runs and slackwater areas with large rock outcrops and side channels and pools with water of good quality with relatively low silt loads.



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7/87

WACCAMAW SILVERSIDE

Menidia extensa

Order: Mugiliformes

Family: Atherinidae

Status: Threatened (Federal Register 4/8/87)

Range: Known only from Lake Waccamaw and the upper Waccamaw River in Columbus County, North Carolina. The silverside is found in the upper Waccamaw River only during periods of high water and is not a permanent resident. Lake Waccamaw (not to be confused with the town of Lake Waccamaw) is the property of the State of North Carolina and is administered by the North Carolina Department of Natural Resources and Community Development's Division of Parks and Recreation.

Description: The Waccamaw silverside, also known as "skipjack" or "glass minnow," is a small (growing to about 2.5 inches), slim, almost transparent fish with a silvery stripe along each side. Its body is laterally compressed, the eyes are large, and the jaw is sharply angled upward.

Reasons for Current Status: The primary threat is the deterioration of water quality in Lake Waccamaw resulting from nutrient buildup. Although specific sources are currently unidentified, runoff and leachate from surrounding development may be contributing to the buildup. Nutrients in the lake increased since 1973, and it now appears that any further increase could tip the scales toward water quality conditions that would threaten the species. The existing data, as interpreted by Casterlin et al. (1986), indicate that phosphate concentrations and loading rates in the lake more than tripled in the years between 1973 and 1981. They further state that "continued high rates of phosphorus input (organic pollution) will likely bring the lake to a hyper-eutrophic state . . . by the end of the century." Water quality could also be affected by habitat alteration from development and other changes in land use, both around the lake and in its watershed (especially Big Creek), if these activities are not planned and implemented with the protection of the Lake Waccamaw ecosystem in mind.

A permit to propagate hybrid bass at several sites in the Lake Waccamaw watershed has been granted by the North Carolina Wildlife Resources Commission. Although the permit stipulates certain precautionary measures, escape of non-native predators from such a project into the system could upset the existing predator-prey relationships in the lake to the detriment of the Waccamaw silverside and other fishes now present in the lake.

A final factor that could threaten the Waccamaw silverside relates to its very short life cycle. The fish spawn when one-year-old and most die shortly thereafter. Failure to spawn in any one year could jeopardize the species. Water quality problems related to nutrient loading, even on a short-term basis, could cause the extinction of this fish.

WACCAMAW SILVERSIDE - *M. extensa*

Habitat: Lake Waccamaw is a natural lake with an approximate surface area of 8,934 acres and an average depth of 7.5 feet. Although it is fed by acidic swamp streams, the lake has a virtually neutral pH. This neutral condition, unusual among North Carolina's coastal plain lakes, is believed to be caused by the buffering effect of the calcareous Waccamaw Limestone formation, which underlies the lake and is exposed on the north shore. The Waccamaw silverside inhabits open water throughout the lake, where schools are commonly found near the surface over shallow, dark-bottomed areas.

Critical habitat: North Carolina, Columbus County. Lake Waccamaw in its entirety to mean high water level, and Big Creek from its mouth at Lake Waccamaw upstream approximately 0.6 kilometers (0.4 miles) to where the creek is crossed by County Road 1947.

Constituent elements include high quality clear open water, with a neutral pH and clean sand substrate.

Reproduction and Development: Spawning occurs from April through June, but reaches to peak when water temperatures are between 68 and 72F. Fully developed larvae form small isolated schools by early May. No parental care of the young has been noted. The silversides reach sexual maturity by the following spring, spawn, and then shortly thereafter most of the adults die off. A few may survive a second winter.

Population level: Estimated to be in the millions.

Management (Activities, Recommendations, Implications): The taking of silversides for fish bait or for scientific purposes is not considered a threat to the species. These activities may continue in accordance with State regulations. Activities which could affect water and substrate quality by increasing siltation and/or nutrient loading, or by altering temperature or pH, will require monitoring and control as necessary and feasible. Some of the activities that could prove detrimental include indiscriminate logging, land use changes, stream alteration such as channelization or impoundment, bridge and road construction, improper pesticide/herbicide application, and point and nonpoint pollution discharge.

References:

Casterlin, M.E., W.W. Reynolds, D.G. Lindquist, and C.G. Yarbrough. 1986. Algal and Physicochemical Indicators of Eutrophication in a Lake Harboring Endemic Species: Lake Waccamaw, North Carolina. Journal of the Elisha Mitchell Scientific Society 100(3):83-103.

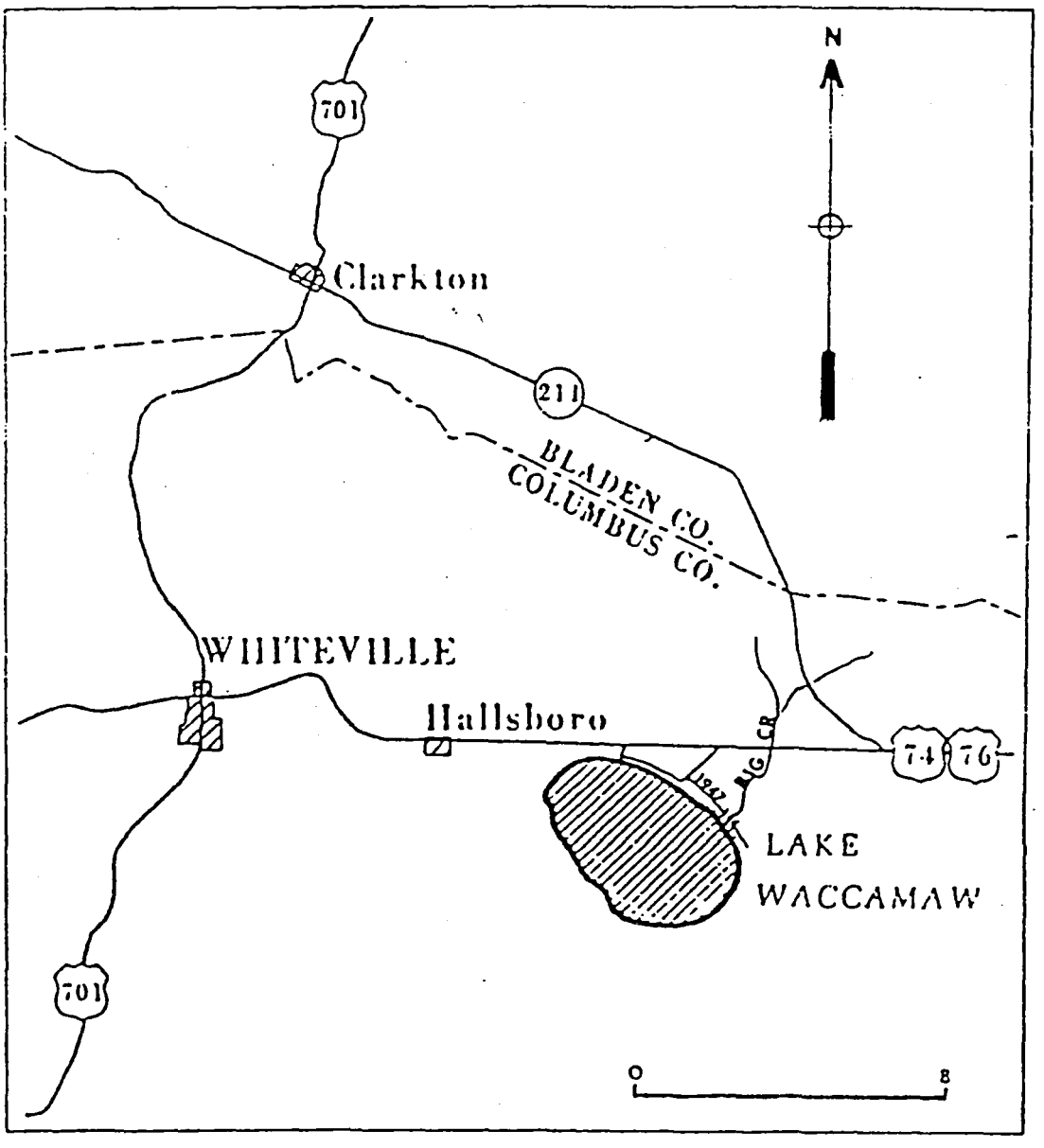
Davis, J.R. and D.E. Louder. 1969. Life History of *Menidia extensa*. Transactions of the American Fisheries Society 98(3):466-472.

NORTH CAROLINA - Critical Habitat

Menidia extensa, "Waccamaw silverside"

Columbus County. Lake Waccamaw in its entirety to mean high water level, and Big Creek from its mouth at Lake Waccamaw upstream approximately 0.6 kilometer (0.4 mile) to where the creek is crossed by County Road 19-7.

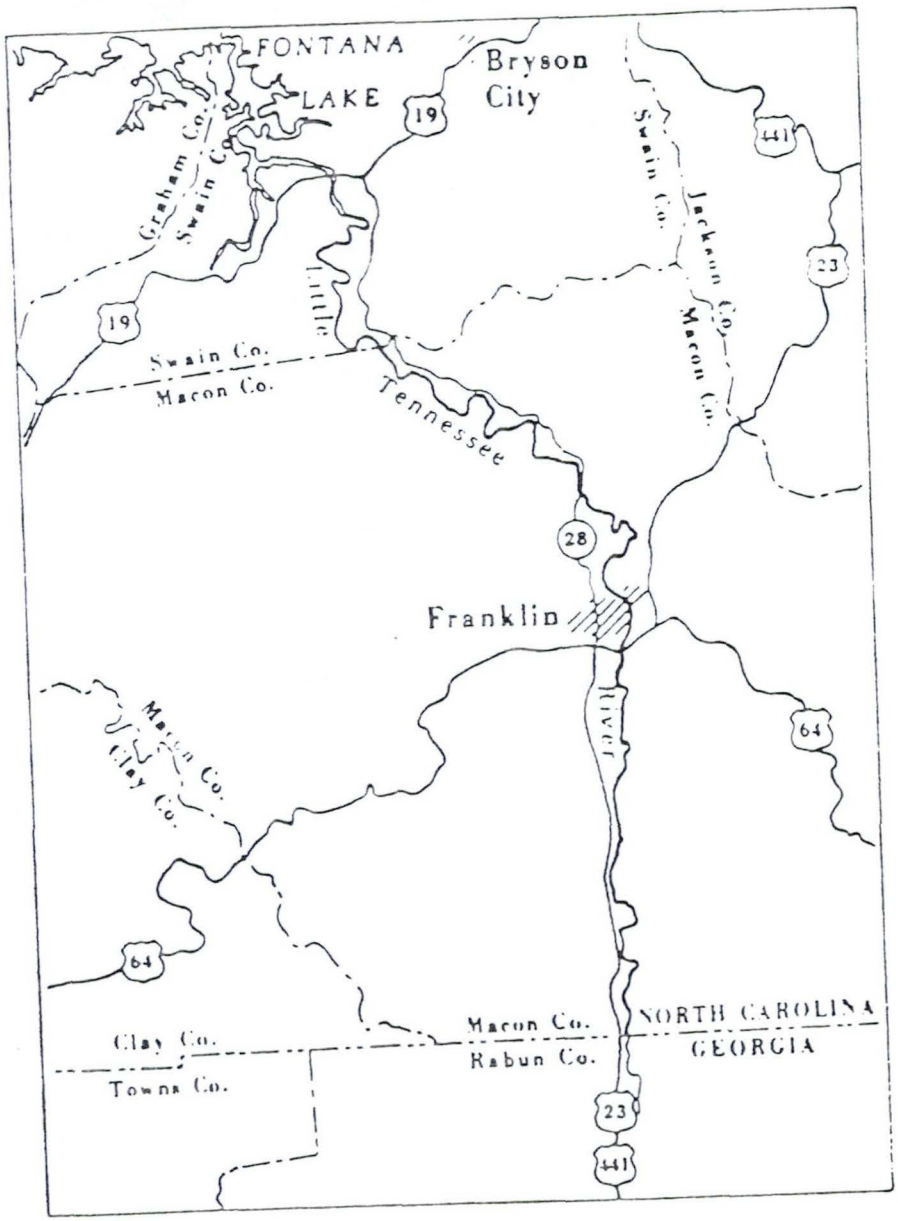
Constituent elements include high quality clear open water, with a neutral pH and clean sand substrate.



NORTH CAROLINA - Critical Habitat

Hybopsis monacha, "spotfin chub"

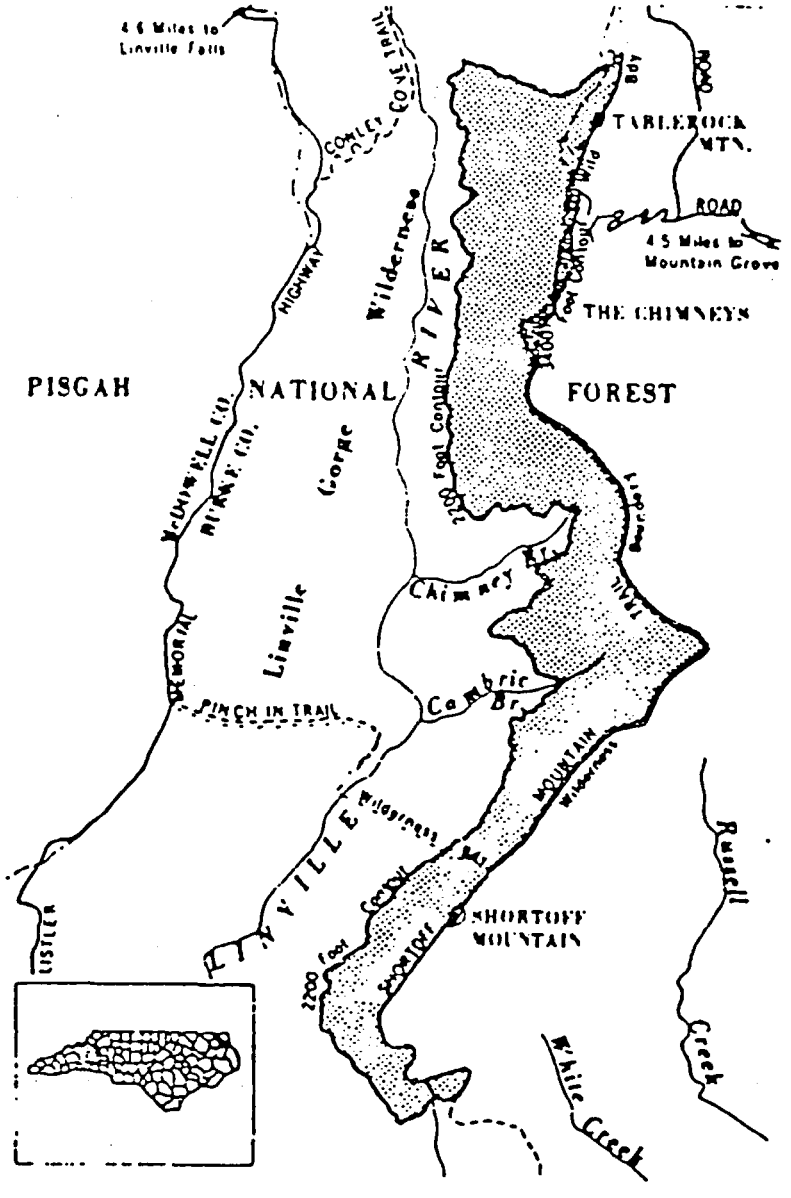
Macon and Swain Counties. Little Tennessee River, main channel from the backwaters of Fontana Lake upstream to the North Carolina-Georgia state line.



NORTH CAROLINA - Critical Habitat

Hudsonia montana, "mountain golden heather"

Burke County. The area bounded by the following: on the west by the 2200' contour; on the east by the Linville Gorge Wilderness Boundary north from the intersection of the 2200' contour and the Shortoff Mountain Trail to where it intersects the 3400' contour at "The Chimneys"--then follow the 3400' contour north until it reintersects the Wilderness Boundary--then follow the Wilderness Boundary again northward until it intersects the 3200' contour extending west from its intersection with the Wilderness Boundary until it begins to turn south--at this point the Boundary extends due east until it intersects the 2200' contour.



REFERENCE 23

NWI MAPS ARE NOT FOR REGULATORY USE

THE NATIONAL WETLANDS INVENTORY (NWI) IS A PROJECT OF THE U.S. FISH AND WILDLIFE SERVICE. THE NWI MAPS DO NOT DEFINE WETLANDS FOR REGULATORY PURPOSES. WETLAND BOUNDARIES MAY NOT BE EXACT.

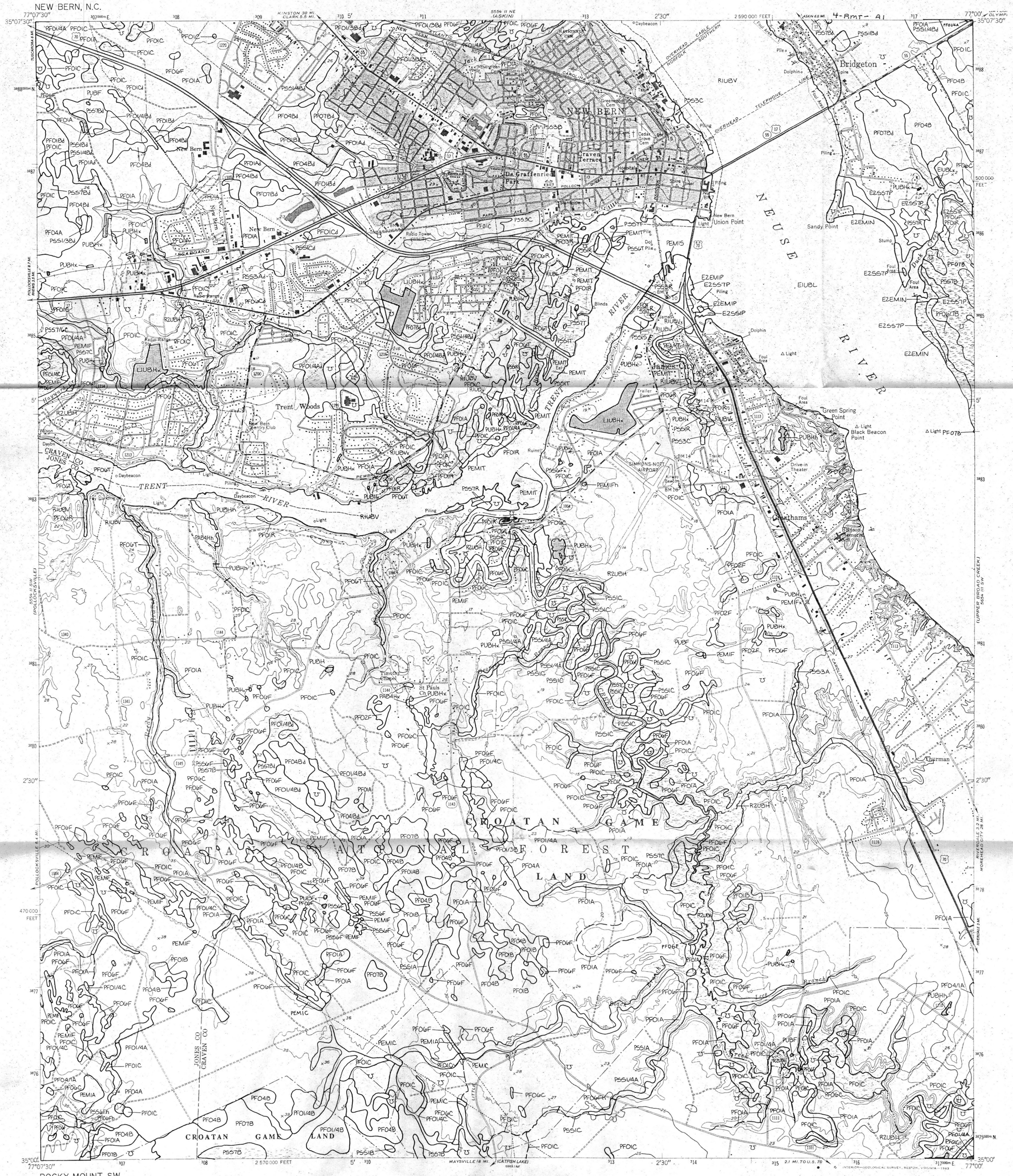
IF YOU ARE CONSIDERING LAND USE CHANGES AND YOU ARE NOT SURE WHETHER THE LAND CONTAINS REGULATED WETLANDS, YOU CAN OBTAIN A SITE-SPECIFIC WETLANDS DETERMINATION FROM A PRIVATE CONSULTING FIRM OR THE APPROPRIATE GOVERNMENT AGENCY, SUCH AS:

U.S. ARMY CORPS OF ENGINEERS
U.S. ENVIRONMENTAL PROTECTION AGENCY
U.S. SOIL CONSERVATION SERVICE

NATIONAL WETLANDS INVENTORY

UNITED STATES DEPARTMENT OF THE INTERIOR

NEW BERN, N.C.



ROCKY MOUNT SW
KINSTON

NEW BERN, N.C.

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

1 acre — 10 acres — 20 acres

ACREAGE GUIDE

DRAFT

SPECIAL NOTE

This document was prepared primarily by stereoscopic analysis of high altitude aerial photographs. Wetlands were identified on the photographs based on vegetation, visible hydrology, and geography in accordance with **Classification of Wetlands and Deepwater Habitats of the United States** (FWS/OBS - 79/31 December 1979). The aerial photographs typically reflect conditions during the specific year and season when they were taken. In addition, there is a margin of error inherent in the use of the aerial photographs. Thus, a detailed on the ground and historical analysis of a single site may result in a revision of the wetland boundaries established through photographic interpretation. In addition, some small wetlands and those obscured by dense forest cover may not be included on this document.

Federal, State and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, State or local government or to establish the geographical scope of the regulatory programs of government agencies. **Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, State or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.**

SYMBOLOGY EXAMPLE

SYSTEM
SUBSYSTEM
CLASS
L2EM2F
SUBCLASS, WATER REGIME
UPLAND (NON-WETLAND)
R2OWH
(LINEAR DEEPWATER HABITAT)

6 — Primarily represents **upland** areas, but may include unclassified wetlands such as man-modified areas, non photo-identifiable areas and/or unintentional omissions.

NOTES TO THE USER

- Wetlands which have been field examined are indicated on the map by an asterisk (*).
- Additions or corrections to the wetlands information displayed on this map are solicited. Please forward such information to the address indicated.
- Subsystems, Classes, Subclasses, and Water Regimes in *Italics* were developed specifically for NATIONAL WETLANDS INVENTORY mapping.
- Some areas designated as R4SB, R4SBW, OR R4SBJ (INTERMITTENT STREAMS) may not meet the definition of wetland.
- This map uses the class Unconsolidated Shore (US). On earlier NWI maps that class was designated Beach/Bar (BB), or Flat (FL). Subclasses remain the same in both versions.

Other information including a narrative report concerning the wetland resources depicted on this document may be available. For information, contact:

1:100,000 NAME: ROCKY MOUNT SW KINSTON
TOPO NAME: NEW BERN, N.C.

TECHNICAL RESPONSIBILITY		
TASK	NAME	DATE
ZTS Transfer / Lettering	M. Meredith	10-12-89
ZTS QC	G. REEVES	10-12-89
MAP PI QC	D. Fowler	11-17-89
ZTS CORRECTION	M. Meredith	11/29/89
CORRECTION CHECK	G. REEVES	11/30/89
F.W.S. ACCEPT	JIM TERRY	12-8-89

AERIAL PHOTOGRAPHY

DATE: 3 / /81	DATE: / /
SCALE: 1:58 000	SCALE:
TYPE: CIR	TYPE:

U.S. DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Prepared by National Wetlands Inventory

SYSTEM: M — MARINE

SUBSYSTEM	1 — SUBTIDAL					2 — INTERTIDAL			
CLASS	RB — ROCK BOTTOM	UB — UNCONSOLIDATED BOTTOM	AB — AQUATIC BED	RF — REEF	OW — OPEN WATER/ Unknown Bottom	AB — AQUATIC BED	RF — REEF	RS — ROCKY SHORE	US — UNCONSOLIDATED SHORE
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vascular 5 Unknown Submergent	1 Coral 3 Worm		1 Algal 3 Rooted Vascular 5 Unknown Submergent	1 Coral 3 Worm	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic

SYSTEM: E — ESTUARINE

SUBSYSTEM	1 — SUBTIDAL					2 — INTERTIDAL						
CLASS	RB — ROCK BOTTOM	UB — UNCONSOLIDATED BOTTOM	AB — AQUATIC BED	RF — REEF	OW — OPEN WATER/ Unknown Bottom	AB — AQUATIC BED	RF — REEF	SB — STREAMBED	RS — ROCKY SHORE	US — UNCONSOLIDATED SHORE	EM — EMERGENT	SS — SCRUB-SHRUB	FO — FORESTED
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 3 Rooted Vascular 4 Floating Vascular 5 Unknown Submergent 6 Unknown Surface	2 Mollusc 3 Worm		1 Algal 3 Rooted Vascular 4 Floating Vascular 5 Unknown Submergent 6 Unknown Surface	2 Mollusc 3 Worm	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Persistent 2 Nonpersistent	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

SYSTEM: R — RIVERINE

SUBSYSTEM	1 — TIDAL		2 — LOWER PERENNIAL		3 — UPPER PERENNIAL		4 — INTERMITTENT	5 — UNKNOWN PERENNIAL
CLASS	RB — ROCK	UB — UNCONSOLIDATED BOTTOM	*SB — STREAMBED	AB — AQUATIC BED	RS — ROCKY SHORE	US — UNCONSOLIDATED SHORE	**EM — EMERGENT	OW — OPEN WATER/ Unknown Bottom
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Bedrock 2 Rubble 3 Cobble-Gravel 4 Sand 5 Mud 6 Organic 7 Vegetated	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 Unknown Submergent 6 Unknown Surface	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent	

*STREAMBED is limited to TIDAL and INTERMITTENT SUBSYSTEMS, and comprises the only CLASS in the INTERMITTENT SUBSYSTEM.

**EMERGENT is limited to TIDAL and LOWER PERENNIAL SUBSYSTEMS. The remaining CLASSES are found in all SUBSYSTEMS.

SYSTEM: L — LACUSTRINE

SUBSYSTEM	1 — LIMNETIC				2 — LITTORAL						
CLASS	RB — ROCK BOTTOM	UB — UNCONSOLIDATED BOTTOM	AB — AQUATIC BED	OW — OPEN WATER/ Unknown Bottom	RB — ROCK BOTTOM	UB — UNCONSOLIDATED BOTTOM	AB — AQUATIC BED	RS — ROCKY SHORE	US — UNCONSOLIDATED SHORE	EM — EMERGENT	OW — OPEN WATER/ Unknown Bottom
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 Unknown Submergent 6 Unknown Surface		1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 Unknown Submergent 6 Unknown Surface	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	2 Nonpersistent	

SYSTEM: P — PALUSTRINE

CLASS	RB — ROCK BOTTOM	UB — UNCONSOLIDATED BOTTOM	AB — AQUATIC BED	US — UNCONSOLIDATED SHORE	ML — MOSS-LICHEN	EM — EMERGENT	SS — SCRUB-SHRUB	FO — FORESTED	OW — OPEN WATER/ Unknown Bottom
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular 5 Unknown Submergent 6 Unknown Surface	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	

MODIFIERS

In order to more adequately describe wetland and deepwater habitats one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

WATER REGIME

Non-Tidal:
- A Temporarily Flooded
- B Saturated
- C Seasonally Flooded
- D *Seasonally Flooded/ Well Drained*
- E *Seasonally Flooded/ Saturated*
- F Semipermanently Flooded
- G Intermittently Exposed
- H Permanently Flooded
- J Intermittently Flooded
- K Artificially Flooded
- W Intermittently Flooded/Temporary
- Y Saturated/Semipermanent/ Seasonal
- Z Intermittently Exposed/Permanent
- U *Unknown*

Tidal:
- K *Artificially Flooded*
- L Subtidal
- M Irregularly Exposed
- N Regularly Flooded
- P Irregularly Flooded
- *S Temporary-Tidal
- *R Seasonal-Tidal
- *T Semipermanent-Tidal
- *V Permanent-Tidal
- U *Unknown*

*These water regimes are only used in tidally influenced, freshwater systems.

WATER CHEMISTRY

Coastal Halinity:
- 1 Hyperhaline
- 2 Euhaline
- 3 Mixohaline *(Brackish)*
- 4 Polyhaline
- 5 Mesohaline
- 6 Oligohaline
- 0 Fresh

Inland Salinity:
- 7 Hypersaline
- 8 Eusaline
- 9 Mixosaline
- 0 Fresh

pH Modifiers for all Fresh Water:
- a Acid
- t Circumneutral
- i Alkaline

SOIL
- g Organic
- n Mineral

SPECIAL MODIFIERS
- b *Beaver*
- d *Partially Drained/Ditched*
- f Farmed
- h *Diked/Impounded*
- r Artificial Substrate
- s *Spoil*
- x Excavated

REFERENCE 24

THE MERCK INDEX

AN ENCYCLOPEDIA OF
CHEMICALS, DRUGS, AND BIOLOGICALS

ELEVENTH EDITION

Susan Budavari, *Editor*
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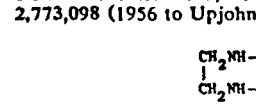
RAHWAY, N.J., U.S.A.

1989

Reference 24

amino)ethane; DBED. $C_{16}H_{20}N_2$; mol wt 240.34. C 79.95%, H 8.39%, N 11.66%. Prepd from *N,N'*-dibenzenesulfonyl-*N,N'*-dibenzylethylenediamine by heating with concd HCl in bomb tube at 170-180°: Bleier, *Ber.* 32, 1829 (1899); from ethylene chloride and benzylamine: Frost *et al.*, *J. Am. Chem. Soc.* 71, 3842 (1949); by reduction of *N,N'*-dibenzylidenecthylenediamine: Ger. pat. 98,031 (1898 to Schering); *Chem. Zentr.* 1898, II, 743; Van Alphen, *Rec. Trav. Chim.* 54, 93 (1935); Lob, *ibid.* 55, 859 (1936); Szabo *et al.*, *Antibiot. & Chemother.* 1, 499 (1951); Rebenstorf, U.S. pat. 2,773,098 (1956 to Upjohn).



Oily liquid, mp 26°. d_4^{20} 1.024. bp_{12} 212-213°; bp_4 195°. n_D^{20} 1.5624. Insol in water. Freely sol in the usual organic solvents except CS_2, with which it gives a solid addition product.

Diacetate, $C_{16}H_{20}N_2 \cdot 2CH_3COOH$, needles, mp 111°. Soly in water: 253 mg/ml.

Dihydrobromide, $C_{16}H_{20}N_2 \cdot 2HBr$, shiny leaflets, dec 300°. Soly in water: 30 mg/ml.

Dihydrochloride, $C_{16}H_{20}N_2 \cdot 2HCl$, shiny leaflets, dec 298°. Soly in water: 23.9 mg/ml.

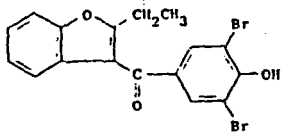
Sulfate, $C_{16}H_{20}N_2 \cdot H_2SO_4$, crystals, dec 247-250°. Soly in water: 15.8 mg/ml.

Disalicylate, $C_{16}H_{20}N_2 \cdot 2C_6H_5(OH)COOH$, crystals, mp 85°. Soly in water: 2.43 mg/ml.

Penicillin salt, benzathine penicillin, *see* separate entries.

USE: Manuf of a repository form of penicillin.

1073. Benzbromarone. *(3,5-Dibromo-4-hydroxyphenyl)-(2-ethyl-3-benzofuranyl)methanone; 3,5-dibromo-4-hydroxyphenyl 2-ethyl-3-benzofuranyl ketone;* 3-(3,5-dibromo-4-hydroxybenzoyl)-2-ethylbenzofuran; 2-ethyl-3-benzofuranyl 4-hydroxy-3,5-dibromophenyl ketone; 2-ethyl-3-(3,5-dibromo-4-hydroxybenzoyl)benzofuran; 2-ethyl-3-(3,5-dibromo-4-hydroxybenzoyl)oxaindene; 2-ethyl-3-benzofuryl 3,5-dibromo-4-hydroxyphenyl ketone; L 2214; MJ 10061; Azubromaron; Besuric; Desuric; Max-Uric; Minuric; Narcaricin; Normurat; Uricovac; Urinorm. $C_{17}H_{12}Br_2O_3$; mol wt 424.11. C 48.15%, H 2.85%, Br 37.68%, O 11.32%. Prepn: Belg. pat. 553,621 (1957 to Labaz); Buu-Hoi *et al.*, *J. Chem. Soc.* 1957, 625; Buu-Hoi, Beaudet, U.S. pat. 3,012,042 (1961 to Soc. Belge l'Azote Prod. Chim. Marly). Structure-activity study: Delbarre *et al.*, *Chim. Ther.* 3, 470 (1968). Pharmacology of hypouricemic effect: D. S. Sinclair, I. H. Fox, *J. Rheumatol.* 2, 437 (1975). Pharmacokinetic and clinical studies: T. F. Yu, *ibid.* 3, 305 (1976). Pharmacokinetics and biotransformation in man: H. Ferber *et al.*, *Eur. J. Clin. Pharmacol.* 19, 431 (1981). HPLC determn in serum: H. Vergin *et al.*, *J. Chromatog.* 183, 383 (1980).



Yellowish prisms, mp 151°.

THERAP CAT: Uricosuric.

1074. Benzene. Benzol; cyclohexatriene. C_6H_6; mol wt 78.11. C 92.25%, H 7.75%. Discovered by Faraday in compressed oil gas in 1825. Obtained in the coking of coal and in the production of illuminating gas from coal. Purification by washing with water: Brit. pat. 863,711 (1961 to Schloven-Chemie and H. Koppers GmbH), *C.A.* 55, 16971f (1961). Lab prepn from aniline: Gattermann-Wieland, *Praxis des organischen Chemikers* (de Gruyter, Berlin, 40th ed., 1961) p 247. Production of pure benzene: French, *Ind. Chemist* 39, 9-12 (1963). Manuf: Faith, Keyes & Clark's *Industrial Chemicals*, F. A. Lowenheim, M. K. Moran, Eds. (Wiley-Interscience, New York, 4th ed., 1975) pp 126-137. Physical properties: Thorne *et al.*, *Ind. Eng. Chem. Anal. Ed.* 17, 481 (1945). Solubility studies: F. P. Schwarz, *Anal. Chem.* 52, 10 (1980). Toxicity data: Kimura *et al.*, *Toxicol. Appl. Pharmacol.* 19, 699 (1971). Review of toxicology: E. Browning, *Toxicity and Metabolism of Industrial Solvents* (Elsevier, New York, 1965) pp 3-65; R. Snyder *et al.*, *Rev. Biochem. Toxicol.* 3, 123-154 (1981). *Review:* W. P. Purcell in Kirk-Othmer *Encyclopedia of Chemical Technology* vol. 3 (Wiley-Interscience, New York, 3rd ed., 1978) pp 744-771.

Clear, colorless, highly flammable liquid; characteristic odor. d_4^{15} 0.8787. bp 80.1°. mp +5.5°. n_D^{20} 1.50108. Flash pt, closed cup: 12°F (−11°C). Soly in water at 23.5°C (w/w): 0.188%. Miscible with alcohol, chloroform, ether, carbon disulfide, carbon tetrachloride, glacial acetic acid, acetone, oils. *Keep in well-closed containers in a cool place and away from fire.* LD_{50} orally in young adult rats: 3.8 ml/kg (Kimura).

Sodium deriv, C_6H_5Na; *phenyl sodium.* Prepn: Schlosser, *Angew. Chem.* 76, 267 (1964). Solid mass, dec by water, acids, alkalies. Sol in liquid ammonia, tetrahydrofuran.

Human Toxicity: Acute (from ingestion or inhalation): Irritation of mucous membranes, restlessness, convulsions, excitement, depression. Death may follow from respiratory failure. *Chronic:* Bone marrow depression and aplasia; rarely, leukemia. Harmful amts may be absorbed through skin. Benzene has been listed as a known carcinogen: *Fourth Annual Report on Carcinogens* (NTP 85-002, 1985) p 34.

USE: Manuf of medicinal chemicals, dyes and many other organic compounds, artificial leather, linoleum, oil cloth, airplane dopes, varnishes, lacquers; as solvent for waxes, resins, oils, etc.

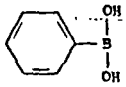
THERAP CAT (VET): Destroys screwworm larvae in wounds.

1075. Benzenearsonic Acid. Phenylarsonic acid. $C_6H_7AsO_3$; mol wt 202.03. C 35.67%, H 3.49%, As 37.08%, O 23.76%. $C_6H_5AsO(OH)_2$.

Cryst powder. mp 158-162° with dec. Sol in 40 parts water, 50 parts alcohol; insol in chloroform.

USE: Reagent for tin.

1076. Benzeneboronic Acid. *Phenylboronic acid;* phenylboric acid; phenylboron dihydroxide. $C_6H_7BO_2$; mol wt 121.94. C 59.10%, H 5.79%, B 8.87%, O 26.24%. Prepd by the reaction of phenylmagnesium bromide with methyl borate: Washburn *et al.*, *Advances in Chemistry Series* 23, 102-128 (1959). Crystal and molecular structure: S. J. Rettig, J. Trotter, *Can. J. Chem.* 55, 3071 (1977).



Crystals from water. Spontaneous conversion to C_6H_5BO, *benzene boronic anhydride* or *phenylboroxide* on standing in dry air, although the best method is by azeotropic dehydration with toluene. mp 215-216° (anhydride). Ka 13.7. Dipole moment 1.72 (dioxane). Soly in water at 25°: 2.5%, benzene: 1.75%, xylene: 1.2%, ether: 30.2%, methanol: 178%.

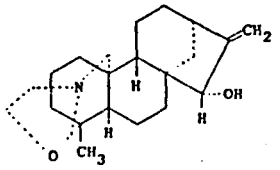
1077. Benzenestibonic Acid. *Dihydroxyphenylstibine oxide;* phenylstibonic acid; phenylstibinic acid. $C_6H_7O_3Sb$; mol wt 248.87. C 28.95%, H 2.84%, O 19.29%, Sb 48.92%. $C_6H_5SbO(OH)_2$. Arylstibonic acids exist in the solid state as polymers of high mol wt, associated by H-bonds. The ions exist probably in the form $\{ArSb(OH)_5\}^-$. Benzenestibonic acid is prepd from benzenediazonium chloride and antimony trioxide in the presence of alkali: Schmidt, *Ann.* 421, 176-188 (1920); Ger. pat. 254,421; *Chem. Zentr.* 1913, I, 343; *Frdl.* 11, 1084. From the double compd of benzenediazonium chloride and antimony trichloride by the action of alkali: May, *J. Chem. Soc.* 101, 1033 (1912); U.S. pat. 1,260,701.

Minute crystals from acetic acid, larger diamond-shaped glistening crystals from alcohol-chloroform mixture on the addition of water. Not melted at 250°, dec at higher temps. Insol in water; slightly sol in alc; more sol in acetone, a

U.S. *Constit.* Alliin, allicin, volatile and fatty oils, mucilage, albumin. Effect of garlic oil in hypercholesterolemic rabbits: R. C. Jain, D. B. Konar, *Atherosclerosis* 29, 125 (1978); in humans: A. Bordia, H. C. Bansal, *Lancet* 2, 1491 (1973).

USE: As a spice and seasoning in foods.

4269. Garryine. $C_{22}H_{33}NO_2$; mol wt 343.49. C 76.92%, H 9.68%, N 4.08%, O 9.32%. From bark of *Garrya veatchii* Kellog, *Garryaceae*, where it occurs together with veatchine and other alkaloids: Oneto, *J. Am. Pharm. Assoc.* 35, 204 (1946); Wiesner *et al., Can. J. Chem.* 30, 608 (1952). Structure: Wiesner *et al.: J. Am. Chem. Soc.* 76, 6068 (1954); Djerassi *et al., ibid.* 77, 4801 (1955). Stereochemistry: Solo, Pelletier, *Chem. & Ind. (London)* 1960, 1108. Racemic syntheses and resolution: Masamune, *J. Am. Chem. Soc.* 86, 290 (1964); Nagata *et al., ibid.* 929, 89, 1499 (1967); Guthrie *et al., Coll. Czech. Chem. Commun.* 31, 602 (1966).



Monohydrate, crystals from dil acetone. Bitter taste, mp 74-82°. pK 8.70. $[\alpha]_D^{27.5}$ −84.23° (c = 1.44 in ethanol). Sol in water, alcohol.

Hydrochloride, $C_{22}H_{33}NO_2.HCl$, crystals from abs ethanol + ether, dec 263-268°. Soluble in water.

4270. Gasoline. Petrol (British); Benzin (German). A mixture of C_4 to C_{12} hydrocarbons. Natural gasoline, obtained by fractional distillation of petroleum contains mostly saturated hydrocarbons; but the ordinary commercial grades of motor gasoline contain paraffins, olefins, naphthenes, and aromatics, all in substantial concns. Motor gasolines are made chiefly by cracking processes, in which heavier petr fractions are converted into more volatile fractions by thermal or catalytic decompn. (Where petr is scarce, as in Germany, gasoline also has been made commercially by catalytic high-pressure hydrogenation of soft coal and by catalytic synthesis of hydrocarbons from carbon monoxide and hydrogen.) Some gasolines sold in the U.S.A. contain a minor proportion of tetraethyllead, which is added in concns not exceeding 3 ml per gallon of motor gasoline to prevent "knock" in engines in which the gasoline is used as fuel. Knock is the audible manifestation of an excessive rate of pressure rise when the gasoline vapor is ignited under compression in an engine. (The relative knocking tendencies of gasolines are measured in terms of "Octane Number," which is defined as the percentage of iso-octane, having "100 Octane No.," to be blended with *n*-heptane, having "0 Octane No." by definition, in order to obtain the same degree of knock as is obtained with the gasoline being rated, under standard conditions in a standardized test engine.)

Commercial grades of tetraethyllead or Ethyl fluid typically contain about 63% tetraethyllead and about 35% ethylene dichloride or dibromide, which aids in evacuating the products of combusion of the lead compd from engines. In addition, the fluid contains a red or a blue dye. All leaded gasolines are dyed for recognition and should be used only as motor fuel. Other materials occasionally blended in gasoline to decrease knock, particularly in Europe, are benzene and ethanol. Comprehensive review: J. C. Lane, "Gasoline and Other Motor Fuels" in Kirk-Othmer *Encyclopedia of Chemical Technology* vol. 11 (Wiley-Interscience, New York, 3rd ed., 1980) pp 652-695.

Gasoline is a highly flammable, mobile liq with characteristic odor. Evaporates quickly: Flash pt ~−50°F (−4-5°C). Explosive limits, vol % in air: lower 1.3, upper 6.0; sp gr 60/60°F: 0.72 to 0.76. Initial bp 39°C; after 10% distilled bp 60°; after 50% bp 110°; after 90% bp 170°; final bp 204°. Insol in water; freely sol in abs alcohol, ether, chloroform, benzene. Dissolves fats, oils, natural resins.

USE: As fuel in internal combusion engines of the spark-ignited, reciprocating type. *Caution:* Ingestion causes inebriation, vomiting, vertigo, fever, drowsiness, confusion, cyanosis; aspiration causes bronchitis or pneumonia. Inhalation causes intense burning in throat and lungs; possibly bronchopneumonia.

4271. Gastrins. Gastrointestinal hormones isolated from the mucosal lining of the gastric antrum of various mammalian species. Highly potent gastric secretion stimulants, first discovered by J. S. Edkins: *Proc. Roy. Soc. London* 76B, 376 (1905). Several gastrins have been identified; they are referred to as "little gastrin", "big gastrin" and "minigastrin". "Little gastrin" or G-17 exists in two forms. 18-34-gastrin I or G-17-I and 18-34-gastrin II or G-17-II, which are heptadecapeptides that are identical in amino acid sequence, with the latter having sulfated tyrosine residues. There are relatively small species differences in amino acid sequences of G-17, although there are differences in the ratio of the non-sulfated to the sulfated forms. This ratio is about 3:4 in hog compared to about 2:1 in man. "Big gastrin" or 1-34-gastrin, also found in two forms, consists of the heptadecapeptides of "little gastrins" extended from their *N*-termini by additional heptadecapeptides with amino acid compositions different from G-17. For each species, the G-17-I and G-17-II portions of the G-34 gastrin are identical. Pairs of shorter gastrins, or "minigastrins" (22-34-gastrin) are C-terminal tetradecapeptides.

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5-oxo-Pro-Gly-Pro-Trp-Leu-Glu-Glu-Glu-Glu-Glu-

Ala-Tyr-Gly-Trp-Met-Asp-Phe-NH2

18-34-gastrin I (human)
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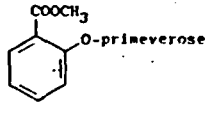
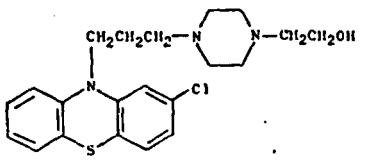
Structure of porcine "little gastrins": Gregory *et al., Nature* 204, 391 (1964); human: Bentley *et al., ibid.* 209, 583 (1966). Synthesis of porcine "little gastrins": Anderson *et al., ibid.* 204, 933 (1964); human: Beecham *et al., ibid.* 209, 585 (1966); human and canine: Agarwal, Kenner, *J. Chem. Soc. (C)* 1969, 2213; ovine: Agarwal *et al., ibid.* 954; feline: *eidem, Experientia* 25, 346 (1969). General synthetic method: E. Brown *et al., Chem. Commun.* 1980, 1093. Isoln of "big gastrins" from Zollinger-Ellison tumor tissue: R. A. Gregory, H. J. Tracy, *Lancet* 2, 797 (1972). Isoln of "minigastrins" from Zollinger-Ellison tumor tissue: *eidem, Gut* 15, 683 (1974). Amino acid sequences of porcine and human "big gastrins": *eidem*, in *Gastrointestinal Hormones*, J. C. Thompson, Ed. (Univ. Texas Press, Austin, 1975) pp 13-14. Revised sequence of porcine: G. J. Dockray *et al., Bioorg. Chem.* 8, 465 (1979); of human: A. M. Choudhury *et al., Z. Physiol. Chem.* 361, 1719 (1980). Synthesis of human: G. Wendlberger *et al., Monatsh.* 112, 1297 (1981). Structure and synthesis of "minigastrins": R. A. Gregory *et al., Z. Physiol. Chem.* 360, 73 (1979). Review of chemical studies: Kenner, Sheppard, *Proc. Roy. Soc. London* 170B, 89 (1968). Review of physiological advances: Gregory, *ibid.* 81. General reviews: Sanders, Schimmel, *Am. J. Med.* 49, 380 (1970); McGuigan, *Vitam. Horm.* 32, 47-88 (1974); V. Mutt, *ibid.* 39, 231-426 (1982).

4272. Gaultherin. *2-[(6-O-β-D-Xylopyranosyl-β-D-glucopyranosyl)oxy]benzoic acid methyl ester;* methyl salicylate-2-glucoxyloside; methyl salicylate-2-primeveroside; monotropitin; monotropitoside. $C_{19}H_{26}O_{12}$; mol wt 446.40. C 51.12%, H 5.87%, O 43.01%. In the wintergreen plant, *Gaultheria procumbens* L., in *Monotropa hypopitys* L., *Ericaceae* in *Betula lenta* L., *Betulaceae*, in *Spiraea ulmaria* L. and *S. filipendula* L., *Rosaceae:* Bridel, *Compt. Rend.* 177, 642 (1923); 179, 991 (1924); 180, 1421, 1864 (1925); Bridel, Grillon, *ibid.* 187, 609 (1928). Synthesis: Robertson, Waters, *J. Chem. Soc.* 1931, 1881. On hydrolysis with 3% H_2SO_4 gaultherin forms 1 mol methyl salicylate, 1 mol D-glucose and 1 mol D-xylose. Enzymatic hydrolysis gives methyl salicylate and primeverose (glucoxylose).



plants as well as animals, fungi, and bacteria. The richest plant sources are the sap of the fig tree and the root of horseradish. Review and bibliography: Paul, "Peroxidases", in *The Enzymes*, vol. 8, P. D. Boyer *et al.*, Eds. (Academic Press, New York, 1963) pp 227-274; B. C. Saunders *et al.*, *Peroxidase* (Butterworths, Washington, D.C., 1964) 271 pp.

7135. Perphenazine. *4-[3-(2-Chloro-10H-phenothiazin-10-yl)propyl]-1-piperazineethanol;* 2-chloro-10-[3-[1-(2-hydroxyethyl)-4-piperazinyl]propyl]phenothiazine; 1-(2-hydroxyethyl)-4-[3-(2-chloro-10-phenothiazinyl)propyl]-piperazine; chlorpiprazine; chlorpiprozine; PZC; Sch 3940; Trilafon; Trilifan; Decentan; Fentazin; Perphenan. $C_{21}H_{26}ClN_3OS$; mol wt 403.97. C 62.43%, H 6.49%, Cl 8.78%, N 10.40%, O 3.96%, S 7.94%. Prepn: Cusic, U.S. pat. 2,766,235 (1956); Sherlock, Sperber, U.S. pat. 2,860,138 (1958 to Schering). Metabolism: U. Breyer, H. J. Gaertner, *Adv. Biochem. Psychopharmacol.* 9, 167 (1974); H. J. Gaertner *et al.*, *Drug Metab. Dispos.* 3, 437 (1975). Crystal structure: J. J. H. McDowell, *Acta Crystallogr.* B34, 686 (1978).



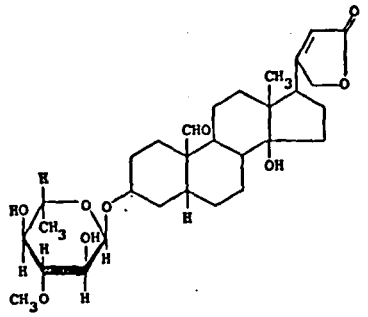
Crystals. Sensitive to light. mp 94-100°. $bp_{0.15}$ 214-218°; bp_1 278-281°. Practically insol in water. Soly (mg/ml): ethanol 153; acetone 82. Practically insol in sesame oil.

Dihydrochloride, $C_{21}H_{28}Cl_3N_3OS$, crystals from alcohol, mp 225-226°.

THERAP CAT: Antipsychotic.

THERAP CAT (VET): Tranquilizer, pre-anesthetic agent.

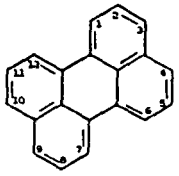
7136. Peruvoside. *(3β,5β)-3-[(6-Deoxy-3-O-methyl-α-L-glucopyranosyl)oxy]-14-hydroxy-19-oxocard-20(22)-enolide;* cannogenin α-L-thevetoside; Encordin. $C_{30}H_{44}O_9$; mol wt 548.65. C 65.67%, H 8.08%, O 26.25%. Cardenolide (cardiac glycoside) found in seeds of the tropical garden plant *Thevetia peruviana* (Pers.) K. Schum. (*Th. neriifolia* Juss.), *Apocynaceae* (named trumpet flower in Florida). Isoln: Rangaswami, Venkata Rao, *J. Sci. Ind. Res.* 17B, 331 (1958). Structure: Bloch *et al.*, *Helv. Chim. Acta* 43, 652 (1960). Pharmacological studies: *Arzneimittel-Forsch.* 18, 1582-1608 (1968).



Spears from methanol + ether, mp 161-164°. $[\alpha]_D^{22}$ −71.7° (c = 1.54 in methanol). One gram dissolves in about 2500 ml water. Freely soluble in chloroform and acetone, sparingly soluble in methanol and ethanol.

THERAP CAT: In cardiac insufficiency.

7137. Perylene. Dibenz[*de,kl*]anthracene; *peri*-dinaphthalene. $C_{20}H_{12}$; mol wt 252.30. C 95.20%, H 4.79%. Occurs in coal tar. Isoln from pitch distillate: Cook *et al.*, *J. Chem. Soc.* 1933, 395. From 2,2'-dihydroxy-1,1'-dinaphthyl: Zinke *et al.*, *Monatsh.* 64, 415 (1934). From the reaction of phenanthrene with acrolein in anhydr HF: Weinmayr, U.S. pat. 2,145,905 (1939); *cf. J. Am. Chem. Soc.* 61, 949 (1939).



Yellow to colorless crystals from toluene. mp 273-274°. Sublimes 350-400°. d 1.35. Absorption spectrum: Clar, *Ber.* 65, 848 (1932). Freely sol in CS_2, chloroform; moderately sol in benzene; slightly in ether, alcohol, acetone; very sparingly sol in petr ether. Insol in water.

Monopicrate, $C_{26}H_{15}N_3O_7$, dark violet-blue needles, mp 223-225°.

7138. Petrolatum. Petroleum jelly; paraffin jelly; vaseline; Filtrolatum; Filtrosoft; Kremoline; Pureline; Sherolatum; Stanolind; Vaseline; Saxoline; Cosmoline. Purified mixture of semisolid hydrocarbons, chiefly of the methane series of the general formula C_nH_{2n+2}. Actually, petrolatum is a colloidal system of nonstraight-chain solid hydrocarbons and high-boiling liq hydrocarbons, in which most of the liq hydrocarbons are held inside the micelles. Detailed historical account including chemistry and modern mfg methods: Schindler, *Drug Cosmet. Ind.* 89, 36-37, 76, 78-80, 82 (1961).

Yellowish to light amber or white, semisolid, unctuous mass; practically odorless and tasteless. d_{15}^{60} 0.820-0.865. mp 38-54°. n_D^{60} 1.460-1.474. White petrolatum is transparent in thin layers even at 0°. Practically insol in water, glycerol, alcohol. Sol in benzene, chloroform, ether, petr ether, carbon disulfide, oils.

Premium white petrolatum, *Stanolene.*

USE: As ointment base in pharmaceuticals and cosmetics. Lubricating firearms and machinery, leather grease, shoe polish, rust preventives, modeling clays.

7139. Petrolatum, Liquid. Liquid paraffin; mineral oil; white mineral oil; paraffin oil; Clearteck; Drakeol; Hevyteck; Filtrawhite; Frigol; Kremol; Kaydol; Alboline; Nujol; Paroleine; Saxol; Adepsine oil; Glymol. A mixture of liquid hydrocarbons from petroleum.

Colorless, oily liquid; practically tasteless and odorless even when warmed. The density of the "light" oil is usually 0.83-0.860; the "heavy" 0.875-0.905. Surface tension at 25° slightly below 35 dynes/cm. Insol in water, alc. Sol in benzene, chloroform, ether, carbon disulfide, petr ether, oils.

THERAP CAT: Cathartic.

THERAP CAT (VET): Laxative, externally as a protectant, lubricant.

7140. Petroleum. Crude oil; mineral oil; rock oil; coal oil; seneca oil. Consists of a mixture of hydrocarbons from C_2H_6 and up—chiefly of the paraffins, cycloparaffins, or of cyclic aromatic hydrocarbons, with small amounts of benzene hydrocarbons, sulfur, and oxygenated compounds. *Occurrence:* U.S., Mexico, Iran, Russia, Roumania, Poland, Dutch East Indies, etc.

Dark yellow to brown or greenish-black, oily liquid. Insol in water and only a small portion of it may dissolve in alcohol; sol in benzene, chloroform, ether.

USE: Source of gasoline, petr ether, liq and solid petrolatum, fuel and lubricating oils, butane, isopropyl alcohol, etc.

7141. Petroleum Benzin. *Naphtha;* benzin; petroleum naphtha. Term that has been applied to low boiling fractions of petroleum, consisting chiefly of hydrocarbons of the methane series—principally pentanes and hexanes.

Clear, colorless, nonfluorescent, *highly flammable,* volatile liq; characteristic odor; does not solidify in the cold. The vapors mixed with air explode if ignited. d 0.625-0.660; bp between 35-80°. Flash pt about −40°. Insol in water. Miscible with abs alc, benzene, chloroform, ether, carbon disulfide, carbon tetrachloride, and oils except castor oil. *Caution: Keep tightly closed in a cool place and away from fire.*

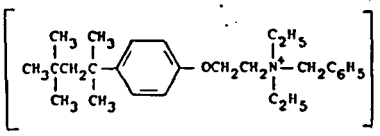
Human Toxicity: See Kerosene.

USE: Pharmaceutic aid (solvent).

THERAP CAT: Counterirritant.

THERAP CAT: Antipyretic, analgesic.

7205. Phenoctide. *N,N-Diethyl-N-[2-[4-(1,1,3,3-tetramethylbutyl)phenoxy]ethyl]benzenemethanaminium chloride; benzyldiethyl-2-[(p-1,1,3,3-tetramethylbutyl)phenoxy]ethylammonium chloride; β-p-tert-*octylphenoxyethyldiethylbenzylammonium chloride; Octaphen. $C_{27}H_{42}ClNO$; mol wt 432.11. C 75.05%, H 9.80%, Cl 8.21%, N 3.24%, O 3.70%. Prepn: Goldberg, Besly, Brit. pat. 703,477 (1954 to Ward Blenkinsop); Erekaev, *C.A.* 54, 12483i (1960).

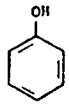


Crystals from ethyl acetate. mp 112-114° (Goldberg, Besly); mp 95° (Erekaev).

USE: Orthophosphate as lubricant: Semmens, Summers-Smith, Brit. pat. 790,056 (1958 to I.C.I.).

THERAP CAT: Topical anti-infective.

7206. Phenol. Carbolic acid; phenic acid; phenylic acid; phenyl hydroxide; hydroxybenzene; oxybenzene. C_6H_6O; mol wt 94.11. C 76.57%, H 6.43%, O 17.00%. Obtained from coal tar, or made by fusing sodium benzenesulfonate with NaOH, or by heating monochlorobenzene with aq NaOH under high pressure. The crystalline article of commerce contains at least 98% phenol. Review of mfg processes: A. Dierichs, R. Kubicka, *Phenole und Basen, Vorkommen und Gewinnung* (Akademie-Verlag, Berlin, 1958) 472 pp; Faith, Keyes & Clark's *Industrial Chemicals*, F. A. Lowenheim, M. K. Moran, Eds. (Wiley-Interscience, New York, 4th ed., 1975) pp 612-623. Use in treatment of spasticity: D. E. Garland *et al., Clin. Orthop.* 165, 217 (1982); *eidem, Arch. Phys. Med. Rehab.* 65, 243 (1984). Review of use in pain relief: K. M. Wood, *Pain* 5, 205-229 (1978). Review of toxicology: H. Babich, D. L. Davis, *Regul. Toxicol. Pharmacol.* 1, 90-109 (1981). Toxicity: W. B. Deichmann, S. Witherup, *J. Pharmacol. Exp. Ther.* 80, 233 (1944). *Review:* C. Thurman in Kirk-Othmer *Encyclopedia of Chemical Technology* vol. 17 (Wiley-Interscience, New York, 3rd ed., 1982) pp 373-384.



Colorless, acicular crystals or white, crystalline mass; characteristic odor. *Poisonous and caustic!* Prone to redden on exposure to air and light, hastened by presence of alkalinity. d 1.071. When free from water and cresols it congeals at 41° and melts at 43°. Ultrapure material mp 40.85°. The commercial product contains an impurity which raises the mp. bp 182°. Flash pt, closed cup: 175°F (79°C). n_D^{41} 1.5425. pKa at 25° = 10.0. pH of aq solns about 6.0. It is liquefied by mixing with about 8% water. One gram dissolves in about 15 ml water, 12 ml benzene; very sol in alcohol, chloroform, ether, glycerol, carbon disulfide, petrolatum, volatile and fixed oils, aq alkali hydroxides. Almost insol in petr ether. LD_{50} orally in rats: 530 mg/kg (Deichmann, Witherup). *Keep well closed and protected from light. Do not handle with bare hands.*

Incompat. Phenol coagulates collodion; liquefies or becomes semiliquid when triturated with acetanilide, butylchloral hydrate, camphor, monobromated camphor, chloral hydrate, diuretin, lead acetate, menthol, naphthalene, naphthol, acetophenetidin, pyrogallol, resorcinol, salol, sodium phosphate, thymol, urethane, chloralamide, terpin hydrate.

Ammonium salt, C_6H_5NO, *ammonium phenate, ammonium carbolate.* White to pink cryst masses. Sol in water.

Sodium salt, C_6H_5NaO, *phenolate sodium.*

Aqueous solution with phenolate sodium, *Chloraseptic.*

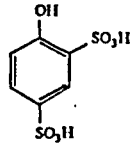
Human Toxicity: Ingestion of even small amounts may cause nausea, vomiting, circulatory collapse, tachypnea, paralysis, convulsions, coma, greenish or smoky-colored urine, necrosis of mouth and G.I. tract, icterus, death from respiratory failure, sometimes from cardiac arrest. Average fatal dose is 15 g but death from as little as one gram has been reported. Fatal poisoning may also occur by skin absorption following application to large areas. Chronic poisoning with renal and hepatic damage may occur from industrial contact. *See* C. J. Polson, R. N. Tattersall, *Clinical Toxicology* (Lippincott, Philadelphia, 1969) pp 51-62; Deichmann, Keplinger in Patty's *Industrial Hygiene and Toxicology* vol. 2A, G. D. Clayton, F. E. Clayton, Eds. (Wiley-Interscience, New York, 3rd ed., 1981) pp 2567-2584.

USE: As a general disinfectant, either in soln or mixed with slaked lime, etc., for toilets, stables, cesspools, floors, drains, etc.; for the manuf of colorless or light-colored artificial resins, many medical and industrial organic compds and dyes; as a reagent in chemical analysis. Pharmaceutic aid (preservative).

THERAP CAT: Aqueous soln as topical anesthetic; topical antiseptic; topical antipruritic.

THERAP CAT (VET): Antiseptic caustic. Topical anesthetic in pruritic skin conditions. Has been used internally and externally as an antiseptic.

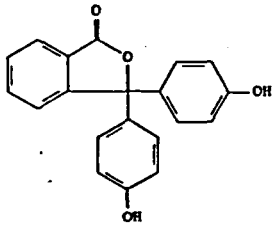
7207. Phenoldisulfonic Acid. *4-Hydroxy-1,3-benzenedisulfonic acid; 4-hydroxy-m-benzenedisulfonic acid;* 1-phenol-2,4-disulfonic acid. $C_6H_6O_7S_2$; mol wt 254.23. C 28.34%, H 2.38%, O 44.05%, S 25.22%. Conveniently prepd by hydrolysis of the dichloride which is obtained by the action of chlorosulfonic acid on phenol at room temp: Pollak *et al., Monatsh.* 46, 395 (1925). Monograph: E. E. Gilbert, *Sulfonation and Related Reactions* (Interscience, New York, 1965) 529 pp.



Deliquescent needles, vague melting range from 89° to 100°. Decomp above 100°. Freely sol in water, methanol. Practically insol in ether, petr ether.

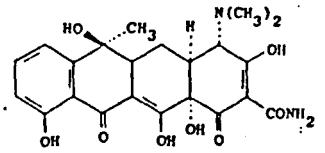
USE: In the manuf of aminophenoldisulfonic acids which are intermediates in the dye industry.

7208. Phenolphthalein. *3,3-Bis(4-hydroxyphenyl)-1-(3H)-isobenzofuranone;* 3,3-bis(*p*-hydroxyphenyl)phthalide; α-(*p*-hydroxyphenyl)-α-(4-oxo-2,5-cyclohexadien-1-ylidene)-*o*-toluic acid; Chocolax; Darmol; Laxin. $C_{20}H_{14}O_4$; mol wt 318.31. C 75.46%, H 4.43%, O 20.10%. Prepd by condensing phenol with phthalic anhydride: Baeyer, *Ann.* 202, 69 (1880); Herzog, *Chem. Ztg.* 51, 84 (1927); Hubacher, U.S. pat. 2,192,485 (1940 to Ex Lax); Gamrath, U.S. pat. 2,522,939 (1950 to Monsanto).



Minute, triclinic crystals, often twinned, mp 258-262°. d 1.299. Color: White or yellowish-white, *see also* Yellow Phenolphthalein. Almost insoluble in water. One gram dissolves in 12 ml alcohol, in about 100 ml ether. Very slightly sol in chloroform.

USE: A 1% alcoholic soln as an indicator in titrations of mineral and organic acids and most alkalies. Not suitable for ammonia. Very sensitive to CO_2, and in estimating carbonates the liq must be boiled. Borax can be titrated with



Trihydrate, crystals. Swells at 165°. Dec 170-175°. Becomes anhydr by drying *in vacuo* at 60° for 8 hrs. $[\alpha]_D^{25}$ −257.9° (0.1*N* HCl); $[\alpha]_D^{25}$ −239° (methanol). uv max (0.1*N* HCl): 220, 268, 355 nm (ε 13000, 18040, 13320). pKa (50% aq DMF): 8.3, 10.2. Stable in neutral and in alkaline soln. Soly at about 28°: 1.7 mg/ml water; > 20 mg/ml methanol. LD_{50} in rats, mice (mg/kg): 807, 808 orally (Goldenthal).

Hydrochloride. $C_{22}H_{25}ClN_2O_7$. *Achro, Achromycin V, Ala Tet, Ambracyn, Artomycin, Cefracycline tablets, Cyclopar, Diacycline, Dumocyclin, Helvecyclin, Imex, Mephacyclin, Partrex, Quadracycline, Quatrex, Remicyclin, Ricycline, Ro-cycline, Stilciclina, Subamycin, Supramycin, Sustamycin, Tefilin, Teline, Telotrex, Tetrabakat, Tetrabid, Tetrablet, Tetrachel, Tetracompren, Tetra-D, Tetrakap, Tetralution, Tetramavan, Tetramycin, Tetrosol, Tetra-Wedel, Topicycline, Totomycin, Triphacyclin, Unicin, Unimycin, Vetquamycin-324.* Crystals from butanol +HCl, dec 214°. $[\alpha]_D^{25}$ −257.9° (c = 0.5 in 0.1*N* HCl). Freely sol in water, sol in methanol, ethanol. Insol in ether, hydrocarbons. pH (2% aq soln): 2.1-2.3. LD_{50} orally in rats: 6443 mg/kg (Goldenthal).

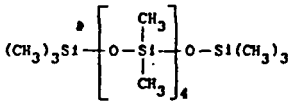
Phosphate complex, *Panmycin Phosphate, Sumycin, Tetradecin Novum, Tetrex, Upcyclin.* (Elemental analysis shows about 45% C; 6-8% P; 4.8% N; 3.9% H; 0.7-1.4% NA). Yellow, odorless powder. Sparingly sol in water; slightly sol in ethanol.

Lauryl sulfate, *Lauracycline.*

THERAP CAT: Anti-amebic; antibacterial; antirickettsial.

THERAP CAT (VET): Antibacterial.

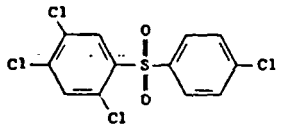
9131. Tetradecamethylhexasiloxane. $C_{14}H_{42}O_5Si_6$; mol wt 459.03. C 36.63%, H 9.22%, O 17.43%, Si 36.72%. Prepd by hydrolysis of dimethyldichlorosilane and trimethylchlorosilane: Patnode, Wilcock, *J. Am. Chem. Soc.* 68, 358 (1946); by reaction of hexamethyldisiloxane with octamethylcyclotetrasiloxane and sulfuric acid: *eidem, ibid.* 362; Patnode, U.S. pat. 2,469,888 (1949 to General Electric); by cohydrolysis of ethoxytrimethylsilane and diethoxydimethylsilane: Hunter *et al., J. Am. Chem. Soc.* 68, 2284 (1946); Hyde, U.S. pat. 2,457,677 (1948 to Corning Glass).



Liquid; bp_{20} 142°; d_4^{20} 0.8910; n_D^{20} 1.3948. Flash pt 118.33°. Freezes below −100°. Stable. Inert to most chemical reagents and rubber. Maintains about the same viscosity over a wide temp range. Sol in benzene and the lighter hydrocarbons; slightly sol in alcohol and the heavy hydrocarbons.

USE: As a basis for silicone oils or fluids designed to withstand extremes of temp; as a foam suppressant in petroleum lubricating oil.

9132. Tetradifon. *1,2,4-Trichloro-5-[(4-chlorophenyl)-sulfonyl]benzene; p-chlorophenyl 2,4,5-trichlorophenyl sulfone;* 2,4,5,4'-tetrachlorodiphenyl sulfone; Duphar; Tedion; Tedion-V_{18}. $C_{12}H_6Cl_4O_2S$; mol wt 356.06. C 40.48%, H 1.70%, Cl 39.83%, O 8.99%, S 9.01%. Prepd by modified Friedel-Crafts reaction between 2,4,5-trichlorobenzene sulfonyl chloride and monochlorobenzene; also by Sandmeyer diazotization of 2,4,5-trichloro-4'-aminodiphenyl sulfone in the presence of CuCl: Meltzer, Huisman, U.S. pat. 2,812,-281 (1957 to Phillips); Huisman *et al., Rec. Trav. Chim.* 77, 103 (1958).



Crystals from benzene; mp 146.5-147.5°. Stable to concd and dil alkalies, mineral acids, high temp, and u.v. light. Soly data: Huisman *et al., loc. cit.* LD_{50} in rats: 556 mg/kg orally, Ben-dyke *et al., World Rev. Pest Contr.* 9, 119 (1970).

USE: Acaricide. Ovicide on deciduous fruits, citrus, cotton and other crops.

9133. Tetraethylammonium Bromide. *N,N,N-Triethylethanaminium bromide;* TEAB; TMD-10; Etylon; Etambro; Sympatektoman; Tetranium. $C_8H_{20}BrN$; mol wt 210.16. C 45.72%, H 9.59%, Br 38.03%, N 6.67%. $(C_2H_5)_4NBr$. Ganglion blocking agent. Prepd from triethylamine and ethyl bromide: Hofmann, *Ann.* 78, 263 (1851). Review of the pharmacology of the tetraethylammonium ion: Moe, Freyburger, *Pharmacol. Rev.* 2, 61-95 (1950).

Deliquesc crystals. Freely sol in water, alc, chloroform, acetone. Slightly sol in benzene. pH of a 10% aq soln 6.5. The pH is not changed by heating for 28 hrs at 95°.

9134. Tetraethylammonium Chloride. Etamon chloride; T.E.A. chloride. $C_8H_{20}ClN$; mol wt 165.71. C 57.98%, H 12.17%, Cl 21.40%, N 8.45%. $(C_2H_5)_4NCl$. Ganglion blocking agent. *See* Tetraethylammonium Bromide.

Deliquescent crystals. d_4^{21} 1.0801. Freely sol in water, alcohol, chloroform, acetone; slightly sol in benzene. pH of 10% aq soln 6.48. The pH is not changed by heating for 28 hrs at 95°.

Tetrahydrate, monoclinic prismatic crystals. mp 37.5°. d 1.084.

9135. Tetraethylammonium Hydroxide. $C_8H_{21}NO$; mol wt 147.26. C 65.25%, H 14.37%, N 9.51%, O 10.86%. $(C_2H_5)_4NOH$. Made from the corresp halide by treating with silver oxide or with a soln of potassium hydroxide in methanol.

Marketed as an aq soln. A 10% soln has a d_4^{25} of about 1.01. The free base is known only in soln or as hydrates; tetrahydrate, mp 49-50°; hexahydrate, mp 55°. Dec on boiling. It is a very strong base readily absorbing CO_2 from the air. The aq soln is colorless, odorless, bitter, caustic, strongly alkaline, and imparts a soapy feel to the skin. *Keep well closed.*

9136. Tetraethyllead. *Tetraethylplumbane;* lead tetraethyl; TEL. $C_8H_{20}Pb$; mol wt 323.45. C 29.70%, H 6.23%, Pb 64.06%. $Pb(C_2H_5)_4$. Prepd by the action of $PbCl_2$ on zinc ethyl or on a Grignard reagent; by heating C_2H_5Cl and sodium-lead alloy in an autoclave. The production from lead, ethylene, and hydrogen using triethylaluminum as intermediate was first described by K. Ziegler at the 14th International Congress of Pure and Applied Chemistry (July 1955): *Chem. & Eng. News* 33, 3486 (1955). Alternate synthesis using nonhalide compds: Pearson *et al., Advances in Chemistry Series* 23, 299-305 (1959).

Colorless liq; burns with an orange-colored flame with green margin. *Extremely poisonous!* d^{20} 1.653. bp about 200° also stated as 227.7° with decompn. n_D^{20} 1.5198. Practically insoluble in water; soluble in benzene, petr ether, gasoline, slightly in alcohol. LD_{50} orally in rats: 12.3 mg/kg, Schroeder *et al., Experientia* 28, 923 (1972).

USE: As a gasoline additive to prevent "knocking" in motors. *See also* Milde, Beatty, "Chemical Reactions of Tetraethyllead" in *Advances in Chemistry Series* 23, 306-318 (1959). *Caution:* Acute or chronic poisoning may occur if inhaled or absorbed through skin. *See* E. Browning, *Toxicity of Industrial Metals* (Appleton-Century-Crofts, London, 2nd ed., 1969) pp 192-199.

9137. *N,N,N',N'*-Tetraethylphthalamide. *N,N,N',N'-Tetraethyl-1,2-benzenedicarboxamide;* orthophthalic acid didiethylamide; *o*-phthalic acid bis[diethylamide]; tetraethylbis(phthalamide); Analetil; Neo-Cardiamine; Neospiran; Unispiran. $C_{16}H_{24}N_2O_2$; mol wt 276.37. C 69.53%, H 8.75%, N 10.14%, O 11.58%. Prepd by treating phthalyl chloride with diethylamine: Fr. pat. 785,428; Brit. pat.

443,396; U.S.
Grünau); by he
phosphate: Fr.

Crystals, mp
saline.
THERAP CAT:

9138. Tetrac
raethyl ester; pyr
ethylphosphoric
40; Vapotone; T
290.20. C 33.1
commercially b
phoric acid chlo
to Monsanto);
Chemical histo
Schrader, *Die E*
Ester (Verlag C

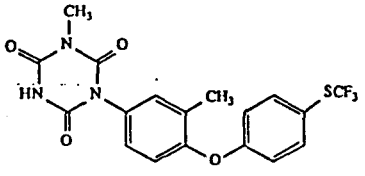
Mobile liquid
Thermal decon
ethylene. $bp_{0.0}$
30° = 4.7 × 1
but quickly hy
50 v/v mixt.).
benzene, chloro
glycol, propyle
ether, kerosene,
mg/kg, T. B.
(1969).
USE: Insectic

9139. 2,2,3,
hol. $C_3H_4F_4$
57.55%, O 12.
Rehn, Ger. pa
Liquid. d_4^{20}
Surface tension
p-Nitrobenz
USE: To in
molecule. Pro
agents, lubrica

9140. Tetr
Aqua. $C_{16}H_{42}$
I 59.58%, N
.2½I_2. Prepn
(1952); Morris
Flat needles
light, dec 162-
USE: Decon
Used in amou
A tablet contg
will decontam
days' storage
dine. Less sta

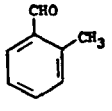
9141. Tetr
raethylene gl
glycol. $C_{18}H$
35.99%. CH_3
col methyl eth
U.S. pat. 2,11
Purification:
Liquid. d_4^{20}
bp_2 118°. n_D^{20}
solvents. LD_5
J. Ind. Hyg. 7

321-340 (1985). Field trial in sheep: B. Gjerde, O. Helle, *Acta Vet. Scand.* 27, 124 (1986); in chickens: H. D. Chapman, *J. Comp. Path.* 97, 21 (1987).



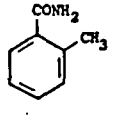
mp 194°.
THERAP CAT (VET): Coccidiostat.

9453. *o*-Tolualdehyde. *2-Methylbenzaldehyde; o-toluylaldehyde.* C_8H_8O; mol wt 120.14. C 79.97%, H 6.71%, O 13.32%. Prepd by reacting nitropropane with *o*-xylyl bromide in the presence of sodium ethanoate: Hass, Bender, *Org. Syn.* 30, 99 (1950).



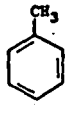
Liquid. d_4^{19} 1.0386. bp_{760} 200-202°; bp_{15} 94-96°; bp_6 68-72°. n_D^{25} 1.5430; n_D^{19} 1.549; n_α^{19} 1.5423; n_β^{19} 1.5650; n_γ^{19} 1.5798.

9454. *o*-Toluamide. *2-Methylbenzamide.* C_8H_9NO; mol wt 135.16. C 71.09%, H 6.71%, N 10.36%, O 11.84%. Prepd by reacting *o*-tolunitrile, hydrogen peroxide, 95% alcohol, and sodium hydroxide at 40-50°: Noller, *Org. Syn.* coll. vol. II, 586 (1943). Also prepared by reacting the nitrile with boron fluoride in dil acetic acid: Hauser, Hoffenberg, *J. Org. Chem.* 20, 1448 (1955).



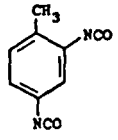
Crystals from water, mp 144-145°. Very sol in alcohol, hot water, concd HCl, less sol in ether. Sparingly sol in benzene. Practically insol in cold water.
Caution: Explosive. Keep away from open flame.

9455. Toluene. *Methylbenzene;* toluol; phenylmethane; Methacide. C_7H_8; mol wt 92.13. C 91.25%, H 8.75%. Obtained mainly from tar oil. Review of mfg processes: Faith, Keyes & Clark's *Industrial Chemicals.* F. A. Lowenheim, M. K. Moran, Eds. (Wiley-Interscience, New York, 4th ed., 1975) pp 822-830. Solubility: F. P. Schwarz, *Anal. Chem.* 52, 10 (1980). Myelotoxic potential: L. Greenburg *et al., J. Am. Med. Assoc.* 118, 573 (1942). Comparison with benzene of effects on hematopoiesis and bone marrow metabolism: H. W. Gerard, *AMA Arch. Ind. Health* 13, 468 (1956). Acute toxicity: H. F. Smyth *et al., Am. Ind. Hyg. Assoc. J.* 30, 470 (1969). Evaluation of chronic occupational exposure: H. Tahti *et al., Int. Arch. Occup. Environ. Health* 48, 61 (1981). *Review:* M. C. Hoff in Kirk-Othmer *Encyclopedia of Chemical Technology* vol. 23 (Wiley-Interscience, New York, 3rd ed., 1983) pp 246-273.



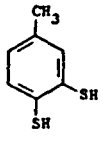
Flammable, refractive liq; benzene-like odor. d_4^{20} 0.866. mp −95°. bp 110.6°. n_D^{20} 1.4967. Flash pt, closed cup: 40°F (4.4°C). Soly in water at 23.5°C (w/w): 0.067%. Very slightly sol in water; misc with alc, chloroform, ether, acetone, glacial acetic acid, carbon disulfide. LD_{50} orally in rats: 7.53 g/kg (Smyth).
Caution: Narcotic in high concns: E. Browning, *Toxicity and Metabolism of Industrial Solvents* (Elsevier, New York, 1965) pp 66-76; Patty's *Industrial Hygiene and Toxicology* vol. 2B, G. D. Clayton, F. E. Clayton, Eds. (Wiley-Interscience, New York, 3rd ed., 1981) pp 3283-3291.
USE: In manuf benzoic acid, benzaldehyde, explosives, dyes, and many other organic compds; as a solvent for paints, lacquers, gums, resins, in the extraction of various principles from plants; as gasoline additive.

9456. Toluene 2,4-Diisocyanate. 2,4-Diisocyanatotoluene; 2,4-tolylene diisocyanate; TDI; Nacconate 100. $C_9H_6N_2O_2$; mol wt 174.15. C 62.07%, H 3.47%, N 16.09%, O 18.37%. Usually prepd from toluene-2,4-diamine and phosgene. *Review:* Astle, *Industrial Organic Nitrogen Compounds* (New York, 1961) pp 284-313; Faith, Keyes & Clark's *Industrial Chemicals.* F. A. Lowenheim, M. K. Moran, Eds. (Wiley-Interscience, New York, 4th ed., 1975) pp 831-835.



Liquid at room temperature. Sharp, pungent odor. mp 19.5-21.5°. d_4^{20} liq 1.2244. bp_{760} 251°; bp_{11} 126°. Darkens on exposure to sunlight. Reacts with water with evolution of carbon dioxide. Flash pt, open cup: 132° (270°F). Misc with alcohol (decompn), diglycol monomethyl ether, ether, acetone, carbon tetrachloride, benzene, chlorobenzene, kerosene, olive oil. Concd alkaline compds such as NaOH or *tert*-amines may cause run-away polymerization.
Caution: Vapor is irritating to eyes, skin and respiratory tract: *Clinical Toxicology of Commercial Products.* R. E. Gosselin *et al.*, Eds. (Williams & Wilkins, Baltimore, 5th ed., 1984) Section II, p 414. This substance may reasonably be anticipated to be a carcinogen: *Fourth Annual Report on Carcinogens* (NTP 85-002, 1985) p 190.
USE: In the manuf of polyurethane foams and other elastomers.

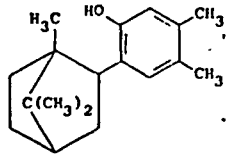
9457. Toluene-3,4-dithiol. 1,2-Dimercapto-4-methylbenzene; "dithiol". $C_7H_8S_2$; mol wt 156.27. C 53.80%, H 5.16%, S 41.04%. Prepd from toluene-3,4-disulfonyl chloride with tin and hydrochloric acid: Mills, Clark, *J. Chem. Soc.* 1936, 178.



Crystals, mp 31°. bp_{84} 185-187°. Sol in benzene, in aq alkali hydroxide solns.
USE: For the detection of bismuth, molybdenum, rhenium, tin, tungsten, *see* Bickford *et al., J. Am. Pharm. Assoc., Sci. Ed.* 37, 255 (1948).

9458. *p*-Toluenesulfinic Acid. $C_7H_8O_2S$; mol wt 156.20. C 53.82%, H 5.16%, O 20.49%, S 20.53%. $CH_3C_6H_4SO_2H$. Prepd by reduction of *p*-toluenesulfonyl chloride with zinc dust: Whitmore, Hamilton, *Org. Syn.* 2, 89 (1922). Because the sulfinic acid is difficult to dry without partial conversion to the sulfonic acid, the sodium salt, $CH_3C_6H_4SO_2Na.2H_2O$, is usually prepd. The free sulfinic acid is then obtained as needed by dissolving the sodium salt in cold water and carefully acidifying the soln with the exact amt of HCl needed.
Long, rhombic plates or needles from water. mp 85°. Freely sol in alc, ether; sparingly sol in water, hot benzene.

9459. *p*-Toluenesulfonic Acid. *4-Methylbenzenesulfonic acid;* tosic acid. $C_7H_8O_3S$; mol wt 172.20. C 48.82%, H 4.68%, O 27.87%, S 18.62%. $CH_3C_6H_4SO_3H$. Prepd by sulfonation of toluene with 96-100% H_2SO_4; when carried out at 75° the compn of the reaction product is 75% *para*-, 19% *ortho*- and 6% *meta*-toluenesulfonic acid. Convenient lab prepn: L. F. Fieser, *Experiments in Organic Chemistry,*

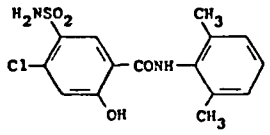


Crystals from petr ether, mp 94-96°, bp_3 165-168°. Also reported as very viscous, pale yellow liquid; bp_9 185-189°. d_4^{20} 1.0240. n_D^{20} 1.5382 (Starkov, Glushkova).

USE: Rubber antioxidant.

THERAP CAT: Antibacterial.

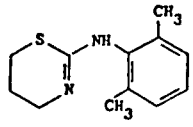
9986. **Xipamide.** *4-Chloro-5-sulfamoyl-2',6'-salicyloxylidide;* 4-chloro-2',6'-dimethyl-5-sulfamoylsalicylanilide; 4-chloro-5-sulfamylsalicyloyl-2',6'-dimethylanilide; Bei 1293; Aquaphor; Diurexan; Lumitens. $C_{15}H_{15}ClN_2O_4S$; mol wt 354.81. C 50.78%, H 4.26%, Cl 9.99%, N 7.89%, O 18.04%, S 9.04%. Salicylic acid derivative. Prepn: Neth. pat. Appl. 6,607,680 corresp to Liebenow, U.S. pat. 3,567,-777 (1966 and 1970 to P. Beiersdorf). Clinical studies: O. Hammer, U. Dembowski, *Med. Klin.* 64, 1862 (1969); R. Fischer, A. Lenhartz, *Med. Welt* 1970, 270. Review of pharmacology and therapeutic efficacy: B. N. C. Prichard, R. N. Brogden, *Drugs* 30, 313-332 (1985).



Crystals from methanol-water, mp 256°.

THERAP CAT: Diuretic. Antihypertensive.

9987. **Xylazine.** *N-(2,6-Dimethylphenyl)-5,6-dihydro-4H-1,3-thiazin-2-amine; 5,6-dihydro-2-(2,6-xylidino)-4H-1,3-thiazine;* 2-(2,6-dimethylphenylamino)-4*H*-5,6-dihydro-1,3-thiazine; BAY 1470; BAY VA 1470; Wh7286; Rompun (also the hydrochloride). $C_{12}H_{16}N_2S$; mol wt 220.33. C 65.42%, H 7.32%, N 12.71%, S 14.55%. Prepn: Behner *et al.*, Ger. pat. 1,173,475 (1964), *C.A.* 61, 13323c (1964); *eidem*, Belg. pat. 634,552 (1964) corresp to U.S. pat. 3,235,550 (1966) (all to Bayer). Pharmacology: G. Sagner *et al.*, *Deut. Tieraerztl. Wochenschr.* 75, 565 (1968); Kroneberg, Schlossman, *Arch. Pharmakol. Exp. Pathol.* 268, 348 (1971). Metabolic studies: Duhm *et al.*, *Berlin. München. Tieraerztl. Wochenschr.* 82, 104 (1969). Veterinary clinical studies: Clarke, Hall, *Vet. Rec.* 85, 512 (1969); Burns, McMullan, *Vet. Med.* 67, 77 (1972).



Colorless, almost tasteless crystals from benzene + ligroin, mp 140-142°. Also reported as mp 136-139°. Soluble in dilute acids, benzene, acetone, chloroform; sparingly sol in petr ether. Practically insol in water, alkalies. LD_{50} in mice (mg/kg): 43 i.v.; 121 s.c.; 240 orally (Sagner).

Hydrochloride, $C_{12}H_{17}ClN_2S$, crystals from ethanol + ethyl ether, mp 236-239°.

THERAP CAT (VET): Sedative, analgesic, muscle relaxant.

9988. **Xylene.** *Dimethylbenzene;* xylol. C_8H_{10}; mol wt 106.16. C 90.50%, H 9.50%. $C_6H_4(CH_3)_2$. First isolated from a crude wood distillate: Cahours, *Compt. Rend.* 30, 319 (1850). Obtained from coal tar: Fittig, *Ann.* 153, 265 (1870). The xylene of commerce is a mixture of the three isomers *o*-, *m*- and *p*-xylene, the *m*-isomer predominating. Manuf from pseudocumene: Seubold, U.S. pat. 2,960,545 (1960 to Union Oil); by catalytic isomerization of a hydrocarbon fraction: Berger, U.S. pat. 3,078,318 (1963 to Universal Oil Prod.). Separation of isomers by clathration: Schaeffer, U.S. pat. 3,029,300 (1962 to Union Oil). Toxicology: E. Browning, *Toxicity and Metabolism of Industrial Solvents* (Elsevier, New York, 1965) pp 77-89. Use as clearing agent: K. Kubota, *J. Polym. Sci.* 5, 1179 (1967); J. B. Matthews, *J. Clin. Pathol.* 34, 103 (1981). Review of mfg processes: Faith, Keyes & Clark's *Industrial Chemicals*, F. A. Lowenheim, M. K. Moran, Eds. (Wiley-Interscience, New York, 4th ed., 1975) pp 874-881. Toxicity: H. F. Smyth *et al.*, *Am. Ind. Hyg. Assoc. J.* 23, 95 (1962).

Mobile, flammable liquid; d about 0.86; bp 137-140°. Flash pt 29°. Practically insol in water. Miscible with abs alcohol, ether, and many other organic liquids.

m-Xylene, colorless liquid; d_4^{15} 0.8684; mp −47.4°; bp 139.3°; n_D^{20} 1.4973. Flash pt, closed cup: 77°F (25°C). Insol in water. Miscible with alcohol, ether, and many other organic solvents. LD_{50} orally in rats: 7.71 ml/kg (Smyth).

o-Xylene, colorless liquid; d_4^{20} 0.8801; mp −25°; bp 144°; n_D^{20} 1.5058. Flash pt, closed cup: 63°F (17°C). Insol in water. Miscible with alc, ether.

p-Xylene, colorless plates or prisms at low temp; d_4^{20} 0.86104; mp 13-14°; bp 137-138°; n_D^{20} 1.49575: Thorne *et al.*, *Ind. Eng. Chem. Anal. Ed.* 17, 481 (1945). Flash pt, closed cup: 77°F (25°C). Insol in water. Sol in alcohol, ether, and many other organic solvents.

Caution: May be narcotic in high concns. Chronic toxicity not well defined, but is less toxic than benzene.

USE: As solvent; raw material for production of benzoic acid, phthalic anhydride, isophthalic and terephthalic acids as well as their dimethyl esters used in the manufacture of polyester fibers; manuf dyes and other organics; sterilizing catgut; with Canada balsam as oil-immersion in microscopy; clearing agent in microscope technique.

9989. **Xylenol.** *Dimethylphenol.* $C_8H_{10}O$; mol wt 122.16. C 78.65%, H 8.25%, O 13.10%. $(CH_3)_2C_6H_3OH$. Constituent of "cresylic acid." There are 6 isomers of xylenol. They are only slightly sol in water but freely sol in alcohol, chloroform, ether, benzene, etc.; also sol in NaOH soln. Prepn and physical properties: R. J. L. Andon *et al.*, *J. Chem. Soc.* 1960, 5246.

2,3-Dimethylphenol, *vic-o-xylenol.* Needles from water or dil alc, mp 75°, bp 218°: Thöl, *Ber.* 18, 2561 (1885); also reported as mp 72.57° ±0.02°. bp_{760} 216.87° ±0.001° (Andon).

2,4-Dimethylphenol, *as-m-xylenol.* Crystals, bp_{764} 211.5°; mp 25.4-26°: Jacobsen, *Ber.* 11, 17 (1887); 18, 3463 (1885); also reported as mp 24.54° ±0.01°. bp_{760} 210.931° ±0.001° (Andon).

2,5-Dimethylphenol, *p-xylenol.* Crystals from alcohol + ether, mp 74.5°, bp_{762} 211.5°: Jacobsen, *loc. cit.* bp 213.5°: Würtz, *Ann.* 147, 372 (1868); also reported as mp 74.85° ±0.02°. bp_{760} 211.132° ±0.002° (Andon).

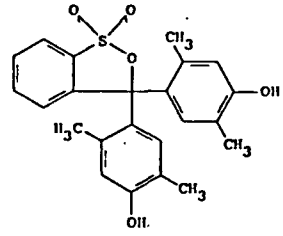
2,6-Dimethylphenol, *vic-m-xylenol.* Needles, mp 49°, bp 203°: Gattermann, *Ann.* 357, 313 (1907); also reported as mp 45.62° ±0.01°. bp_{760} 201.030° ±0.001° (Andon).

3,4-Dimethylphenol, *as-o-xylenol.* Needles from water, mp 62.5°, bp 225°: Jacobsen, *Ber.* 17, 159 (1884); also reported as mp 65.11° ±0.01°. bp_{760} 226.947° ±0.001° (Andon).

3,5-Dimethylphenol, *sym-m-xylenol.* Needles from water, mp 64°, bp 219.5°: Thöl, *Ber.* 18, 359 (1885); also reported as mp 63.27° ±0.02°. bp_{760} 221.962° ±0.003° (Andon).

USE: For the prepn of coal tar disinfectants; manuf of artificial resins.

9990. **Xylenol Blue.** *4,4'-(3H-2,1-Benzoxathiol-3-ylidene)bis[2,5-dimethylphenol] S,S-dioxide; p-*xylenolsulfonephthalein; 1,4-dimethyl-5-hydroxybenzenesulfonephthalein; α,4,4'-trihydroxy-2,5,2',5'-tetramethyltriphenylmethane-



REFERENCE 25

Hawley's Condensed Chemical Dictionary

ELEVENTH EDITION

Revised by

N. Irving Sax
and
Richard J. Lewis, Sr.

VNR VAN NOSTRAND REINHOLD COMPANY
New York

Reference 25

Derivation: From benzoic anhydride and aniline with sodium hydroxide.
Use: Intermediate in the synthesis of dyes, drugs and perfumes.

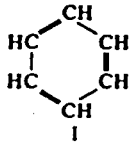
benzanthrone. $C_{17}H_{10}O$. A four-ring system.
Properties: Pale yellow needles; soluble in alcohol and other organic solvents. Mp 170C.
Derivation: (a) From anthranol and glycerol via condensation via sulfuric acid (anthranol is made from anthraquinone); (b) from anthracene in sulfuric acid solution by addition of glycerol and heating to 100–110C until the anthracene disappears. The reaction mass is then diluted with water, salted out and purified.
Method of purification: Crystallization from toluene.
Use: Dyes.

benzathine penicillin G. (N,N'-dibenzylethylenediamine dipenicillin G).
$2C_{16}H_{18}N_2O_4S \cdot C_{16}H_{20}N_2 \cdot 4H_2O$.
Properties: White, odorless, crystalline powder; slightly soluble in alcohol; almost insoluble in water; pH of a saturated solution is 4.5–7.5.
Grade: USP.
Use: Medicine (antibiotic).

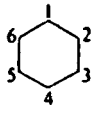
benzazimide. See 4-ketobenzotriazine.

"Benzedrine."[71] TM for amphetamine sulfate.

benzene. CAS: 71-43-2. C_6H_6. 16th highest-volume chemical produced in US (1985).


I

II


III

IV

Structure: I. Complete ring showing all elements. II. Standard ring showing double bonds only. III. Simple ring without double bonds, with numerals indicating position of carbon atoms to which substituent atoms or groups may be attached (2 = ortho, 3 = meta, 4 = para). IV. Generalized structure with enclosed circle suggesting the resonance of this compound. This structure is now in general use. These structures are also referred to as the benzene nucleus.
Properties: Colorless to light-yellow, mobile, nonpolar liquid of highly refractive nature; aromatic odor; vapors burn with smoky flame; bp 80.1C; fp 5.5C, d 0.8790 (20/4C); wt/gal 7.32 lb; refr index 1.50110 at 20C, flash p 12F (−11C) (CC), surface tension 29 dynes/cm. Autoign temperature 1044F (562C). Miscible with alcohol, ether, acetone, carbon tetrachloride, carbon disulfide, acetic acid; slightly soluble in water.
Derivation: (a) Hydrodealkylation of toluene or pyrolysis of gasoline; (b) transalkylation of toluene by disproportionation reaction; (c) catalytic reforming of petroleum; (d) fractional distillation of coal tar.
Grade: Crude, straw color; motor; industrial pure (2C); nitration (1C); thiophene-free; 99 mole %; 99.94 mole %; nanograde.
Hazard: A carcinogen. Highly toxic. Flammable; dangerous fire risk. Explosive limits in air 1.5 to 8% by volume. TLV: 10 ppm in air.
Use: Manufacturing of ethylbenzene (for styrene monomer); dodecylbenzene (for detergents); cyclohexane (for nylon); phenol; nitrobenzene (for aniline); maleic anhydride; chlorobenzene; diphenyl; benzene hexachloride; benzene-sulfonic acid; as a solvent.
See also aromatic.

benzene azimide. See 1,2,3-benzotriazole.

benzeneazoanilide. See diazoaminobenzene.

benzeneazobenzene. See azobenzene.

benzeneazo-p-benzeneazo-β-naphthol. ("Sudan" III; tetraazobenzene-β-naphthol).
$C_{22}H_{16}ON_4$. A red dye; CI 26100.444.
Properties: Brown powder; mp 195C, insoluble in water; soluble in alcohol, oils, chloroform, glacial acetic acid.
Use: Coloring oils red; biological stain.

benzeneazonaphthylethylenediamine. See azodine.

benzenecarboxylic acid. See benzoic acid.

benzenediazonium chloride. $C_6H_5N(N)Cl$.
Properties: Ionic salt. Very soluble in water; insoluble in most organic solvents.
Hazard: Highly toxic. Can explode on heating.
Use: Dye intermediate.

benzene dibromide. See dibromobenzene.

benzene-o-dicarboxylic acid. See phthalic acid.

benzene-p-dicarboxylic acid. See terephthalic acid.

benzene hexachloride. (BHC). A commercial mixture of isomers of 1,2,3,4,5,6-hexachlorocyclohexane. An insecticide.
Hazard: The gamma isomer is highly toxic. Use may be restricted.
See also lindane.

fuels were produced from coal on large scale in Germany by both hydrogasification and Fischer-Tropsch methods. More recently, large-scale coal conversion has been successfully achieved by the Lurgi and Sasol methods; the latter, in South Africa, is the only large-scale installation utilizing the Fischer-Tropsch technology. The Lurgi technique is in production at a number of locations.

Catalytic gasification of peat for production of methanol is now utilized on a commercial scale, use of lignite and wood for this purpose is under development.

See also Fischer-Tropsch process, synthesis gas.

gas, inert. See noble gas, inert.

gas laws. See Boyle's law, Charles' law, Gay-Lussac's law, ideal gas.

gas, liquefied petroleum. See liquefied petroleum gas.

gas liquid. See light hydrocarbon.

gas, natural. See natural gas.

gas, noble. See noble.

gas oil. A liquid petroleum distillate with viscosity and boiling range between kerosene and lubricating oil. Boiling range 232–426C, flash p 150F (65.5C), autoign temperature 640F (337C). Combustible.

Use: Absorption oil, manufacture of ethylene.

gasoline. CAS: 8006-61-9. A mixture of volatile hydrocarbons suitable for use in a spark-ignited internal combustion engine and having an octane number of at least 60. The major components are branched-chain paraffins, cycloparaffins, and aromatics. There are several methods of production: distillation or fractionation which yields straight-run product of relatively low octane number, used primarily for blending; thermal and catalytic cracking; reforming; polymerization; isomerization; and dehydrocyclodimerization. All but the first are various means of converting hydrocarbon gases into motor fuels by modifications of chemical structure, usually involving catalysis. The present source of gasoline is petroleum, but it may also be produced from shale oil and Athabasca tar sands as well as by hydrogenation or gasification of coal.

antinock gasoline A gasoline to which a low percentage of methyl-tert-butyl ether (MBTE) has been added to eliminate knocking and increase octane number. This compound has almost completely replaced tetraethyllead. Gasolines of octane number 100 or more are used chiefly as aviation fuel; those having a research octane number of approximately 90 are in general automotive use.

See also antiknock agent, octane number.

casinghead gasoline, see natural gasoline (below).

cracked gasoline Gasolines produced by the catalytic decomposition of high-boiling components of petroleum. In general, such gasolines have much higher octane ratings (80–100) than that produced by fractional distillation. The difference is due to the prevalence of unsaturated, aromatic and branched-chain hydrocarbons in the cracked gasoline. The actual properties vary widely with the nature of the starting material and the temperature, time, pressure, and catalyst used in cracking.

high-octane gasoline A gasoline with an octane number of 90–100.

See antiknock gasoline, octane number.

lead-free gasoline An automotive fuel containing no more than 0.05 g of lead per gallon, designed for use in engines equipped with catalytic converters.

natural gasoline A gasoline obtained by recovering the butane, pentane, and hexane hydrocarbons present in small proportion in certain natural gases. Used in blending to produce a finished gasoline with adjusted volatility but low octane number. Do not confuse with natural gas.

polymer gasoline A gasoline produced by polymerization of low molecular weight hydrocarbons such as ethylene, propene, and butenes. Used in small amounts for blending with other gasolines to improve their octane number.

pyrolysis gasoline Gasoline produced by thermal cracking as a byproduct of ethylene manufacture. It is used as a source of benzene by the hydrodealkylation process.

reformed gasoline A high octane gasoline obtained from low octane gasoline by heating the vapors to a high temperature or by passing the vapors through a suitable catalyst.

straight-run gasoline Gasoline produced from petroleum by distillation without use of cracking or other chemical conversion processes. Its octane number is low.

white gasoline An unleaded gasoline especially designed for use in motorboats; it is uncracked and strongly inhibited against oxidation to avoid gum formation and is usually not colored to distinguish it from other grades. It also serves as a fuel for camp lanterns and portable stoves.

Hazard: Highly flammable, dangerous fire and explosion risk. TLV 300 ppm.

gas, perfect. See ideal gas.

Gastaldi synthesis. Formation of dicyanopyrazines by cyclization of two molecules of an ami-

nocyanomethyl keton
of an isonitrosometh
pound with potassium
chloric acid, and oxi

gastric juice. A mixtu
pepsin secreted by gl
sponse to a condition
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See also digestion (1).

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at high pressure. A
allows the reaction
pressure.

gauge. An instrumen
ing such process vari
steam, air), liquid le
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chanical, ultrasonic.
pneumatic means. S
of automatic contr
the term "gauge"
thickness, especially
plastics fields. Ligh
from about 0.005–
to thicknesses from
See also mil, meter (

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mental work. He
knowledge of gases
the law of combini
dent discovery (180
relationship of tem
gases. He graduated
Polytechnique, beco
His work in chemi

hydrazobenzene. (1,2-diphenylhydrazine).
CAS: 12-2-66-7. $C_6H_5NHNHC_6H_5$.
Properties: Mw 184.24, mp 123–126C, d 1.158(16/4C).

hydrazoic acid. (hydrogen azide).
CAS: 7782-79-8. HN_3.
Properties: Colorless, volatile liquid. Soluble in water, obnoxious odor, fp −80C, bp 37C.
Derivation: Reaction of hydrazine and nitrous acid, or of nitrous oxide and sodium amide (with heat).
Hazard: Dangerous explosion risk when shocked or heated. Strong irritant to eyes and mucous membranes.

hydride. An inorganic compound of hydrogen with another element. Some are ionic and others are covalent. Hydrides may be either binary or complex; the latter are transition-metal complexes, e.g., carbonyl hydrides and cyclopentadienyl hydrides. Most common are hydrides of sodium, lithium, aluminum, boron, etc.
Hazard: Flammable, dangerous fire risk, react violently with water and oxidizing agents. Irritant:
See Lithium aluminum hydride, sodium borohydride.

"Hydroholac."[23] TM for plasticized nitrocellulose lacquer emulsions, including clear finishes, binders and colors. Produce flexible, lacquer-type, cleanable leather finishes from aqueous systems.
Use: Finishes on glove, garment, handbag and shoe leather.

"Hydricin."[202] TM for a castor-derived base oil for industrial functional fluids and SAE hydraulic brake fluids.

"Hydrin."[119] TM for a series of synthetic rubbers based on epichlorohydrin.
Use: Industrial and automotive molded goods.

hydriodic acid. CAS: 10034-85-2.
Properties: Colorless or pale yellow liquid (an aqueous solution of hydrogen iodide, which is a gas at room temperature), a constant-boiling solution is formed (bp 127, d 1.7) containing 57% hydrogen iodide; strong acid and an active reducing agent.
Derivation: (a) By passing hydrogen with iodine vapor over warm platinum sponge and absorption in water. (b) By the action of iodine on a solution of hydrogen sulfide.
Grade: Technical, 47%; NF, diluted, 10%.
Hazard: Strong irritant to eyes and skin.
Use: Preparation of iodine salts, organic preparations, analytical reagent, disinfectant, pharmaceuticals.
See also hydrogen iodide.

hydroabietyl alcohol. See dihydroabietyl alcohol.

hydrobiotite. A natural ore of magnesium, iron, and aluminum silicate occurring in Montana. Source of verxite.

hydroboration. The reaction of diboranes either with alkenes (olefins) to form trialkylboron compounds or with acetylene to yield alkenylboranes. Much research has been devoted to developing these reactions, the products of which are called organoboranes. They are useful in many complex organic syntheses, including prostaglandins and insect pheronomes.
See also borane, organoborane, carborane.

hydrobromic acid. CAS: 10035-10-6.
Hydrogen bromide in aqueous solution.
Properties: Colorless or faintly yellow liquid consisting of an aqueous solution of hydrogen bromide, which is a gas at room temperature. Soluble in water and alcohol, a constant-boiling solution is formed of d 1.49, containing 48% hydrogen bromide; bp at 700 mm (122C), saturated solution contains 68.8% hydrogen bromide at 0C. Hydrobromic acid is a strong acid and sensitive to light. Noncombustible.
Derivation: By dissolving hydrogen bromide in water or by distilling from a mixture of sodium bromide and 50% sulfuric acid.
Grade: Technical 40%; medicinal 48%, 62%.
Hazard: Strong irritant to eyes and skin.
Use: Analytical chemistry, solvent for ore minerals, manufacture of inorganic and some alkyl bromides, alkylation catalyst.
See also hydrogen bromide.

hydrocarbon. An organic compound consisting exclusively of the elements carbon and hydrogen. Derived principally from petroleum, coal tar, and plant sources. Following is a resume of the principal types.

I. Aliphatic (straight-chain)
  (1) Paraffins (alkanes): generic formula C_nH_{2n+2}. Saturated, single bonds only.
  (2) Olefins: generic formula C_nH_{2n}.
    (a) alkenes: unsaturated (one double bond).
    (b) alkadienes: unsaturated (two double bonds) (butadiene).
  (3) Acetylenes: generic formula C_nH_{2n-2}. Unsaturated (triple bond).
  (4) Acyclic terpenes. Unsaturated (polymers of isoprene C_5H_8). *Note*: Some aliphatic compounds have branched chains in which the subchain also contains carbon atoms (isobutane); both chains are essentially straight.

II. Cyclic (closed ring)
(1) Alicyclic: three or more carbon atoms in a ring structure with properties similar to those of aliphatics.
(a) Cycloparaffins (naphthenes): saturated compounds often having a boat or chair structure, e.g., cyclohexane, cyclopentane.
(b) Cycloolefins: unsaturated, two or more double bonds, e.g., cyclopentadiene (2), cyclooctatetraene (4).
(c) Cycloacetylenes (cyclynes): unsaturated (triple bond).
(2) Aromatic: unsaturated, hexagonal ring structure (three double bonds), single rings and double or triple fused rings.
(a) benzene group (1 ring).
(b) naphthalene group (2 rings).
(c) anthracene group (3 rings).
(3) Cyclic terpenes: monocyclic (dipentene) dicyclic (pinene).

Note: Olefinic (isoprenoid) hydrocarbons are produced by a number of plants. Notably *Hevea braziliensis* (rubber), guayule, and various members of the Euphorbiaceae family. Current research on the latter group indicates that they could be used as a source of liquid fuels and chemical feedstocks by genetic modification of the plants and control of their molecular constitution. It is estimated that oil obtained by large-scale cultivation of such plants, which grow well in semi-arid environments, could become economically competitive with petroleum within a few years.

See also guayule, biomass, copaiba.

hydrocarbon, halogenated. A hydrocarbon in which one or more of the hydrogen atoms has been replaced by fluorine, chlorine, bromine, or iodine. Examples: carbon tetrachloride, chlorobenzene, chloroform, trifluoromethane. This greatly increases the anesthetic and narcotic action of aliphatic hydrocarbons. Many halogenated hydrocarbons are highly toxic; some may detonate on contact with barium. A number of the chlorinated types are used as insecticides.

See also fluorocarbon, chlorofluorocarbon.

hydrocellulose. See cellulose, hydrated.

hydrochloric acid. (HCl). CAS: 7647-01-0. 25th highest-volume chemical produced in US (1985). Hydrogen chloride in aqueous solution.

Properties: Colorless or slightly yellow, fuming, pungent liquid; flash p none; a constant-boiling acid containing 20% hydrochloric acid is formed. Hydrochloric acid is a strong, highly corrosive acid. The commercial "concentrated" or fuming acid contains 38% hydrochloric acid and has a d 1.19; soluble in water, alcohol, and benzene. Noncombustible.

Derivation: Dissolving hydrogen chloride in water at various concentrations.

Grade: USP (35–38%), NF dilution (10%), technical (usually 18, 20, 22, 23 degrees Bé, corresponding to 28, 31, 35, 37% hydrogen chloride), FCC.

Hazard: Toxic by ingestion and inhalation, strong irritant to eyes and skin.

Use: Acidizing (activation) of petroleum wells, boiler scale removal, chemical intermediate, ore reduction, food processing (corn syrup, sodium glutamate), pickling and metal cleaning, industrial acidizing, general cleaning, e.g., of membrane in desalination plants, alcohol denaturant, laboratory reagent.

See also hydrogen chloride.

hydrocinnamic acid. (3-phenylpropionic acid). CAS: 501-52-0. $C_6H_5CH_2CH_2COOH$.

Properties: Crystals with hyacinth-rose odor; mp 46C; bp 280C; soluble in hot water, alcohol, benzene, ether.

Derivaton: Reduction of cinnamic acid with sodium amalgam.

Use: Fixative for perfumes, flavoring.

hydrocinnamic alcohol. See phenylpropyl alcohol.

hydrocinnamic aldehyde. See phenylpropyl aldehyde.

hydrocinnamyl acetate. See phenylpropyl acetate.

hydrocolloid. A hydrophilic colloidal material used largely in food products as emulsifying, thickening, and gelling agents. They readily absorb water, thus increasing viscosity and imparting smoothness body texture to the product, even in concentrations of less than 1%. Natural types are plant exudates (gum arabic), seaweed extracts (agar), plant seed gums or mucilages (guar gum), cereal gums (starches), fermentation gums (dextran), and animal products (gelatin). Semisynthetic types are modified celluloses and modified starches. Completely synthetic types are also available, e.g., polyvinylpyrolidone. Most are carbohydrate polymers but a few such as gelatin and casein are proteins.

hydrocortisone. (17-hydroxycorticosterone; cortisol; hydrocortisone alcohol). CAS: 50-23-7. $C_{21}H_{30}O_5$. An adrenal cortical steroid hormone.

Properties: White, odorless, crystalline powder; sensitive to light; bitter taste. Mp 212–220C with some decomposition, soluble in sulfuric acid, partially soluble in alcohol and propylene glycol.

Derivaton: Isolation from extracts of adrenal glands, synthesis from other steroids.

Grade: USP.
Use: Medicine (anti-infl
used as the acetate and
See also cortisone.

hydrocracking. The crac
products in the preser
catalysts are used, for
solid base of mixed sil
chloride.
See also hydrogenation
forming.

hydrocyanic acid. (pru
nide; formonitrile).
Properties: Water-whit
low 26.5C; faint odo
commercial material
0.688 (20/4C), (gas)
−13.3C; flash p 0F (
The solution is weak
When not absolutely
cyanide polymerizes
sive violence. Miscib
ble in ether, autoign
Derivation: (a) By cat
and air with methan
covery from coke o
nous coal and amn
cyanide occurs natur
oleander).
Grade: Technical (96-
tions. All grades usu
ally 0.05% phospho
Hazard: Flammable,
limits in air 6–41%
tion, and skin abso
Use: Manufacture of
ponitrile, cyanide s
cides, pesticides.

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genation used in pe
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See also transalkyla

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coating (raw fruits and vegetables), and defoaming agent (beet sugar, yeast). The liquid form (white mineral oil) is used as a laxative, textile lubricant, and dispersing agent. There are three grades of both solid and liquid types with various specifications (USP, NF, and FCC).
See also ointment.

petrolatum wax. A microcrystalline wax containing hydrocarbons from $C_{33}H_{70}$ to $C_{43}H_{88}$. Solidifying range 71–83C.
See also wax, microcrystalline.

"Petrolene."[200] TM for a petroleum solvent prepared by straight-run distillation.
Properties: Water-white, initial bp 140–145F, 95% distills between 195–200F, d 0.701 (15.5C), flash p (TCC) −16F (−26.6C), mild, nonresidual odor.
Hazard: Highly flammable, dangerous fire risk.
Use: Rubber cements, sealers, fast-drying lacquers, lacquer dopes, roto inks used on high-speed presses.

petroleum. (crude oil). A highly complex mixture of paraffinic, cycloparaffinic (naphthenic), and aromatic hydrocarbons, containing a low percentage of sulfur and trace amounts of nitrogen and oxygen compounds. Said to have originated from both plant and animal sources 10–20 million years ago. The most important petroleum fractions, obtained by cracking or distillation, are various hydrocarbon gases (butane, ethane, propane), naphtha of several grades, gasoline, kerosene, fuel oils, gas oil, lubricating oils, paraffin wax, and asphalt. From the hydrocarbon gases, ethylene, butylene, and propylene are obtained; these are important industrial intermediates, being the source of alcohols, ethylene glycols and monomers for a wide range of plastics, elastomers, and pharmaceuticals. Benzene, phenol, toluene, and xylene can be made from petroleum, and hundreds of other products, including biosynthetically produced proteins, are petroleum-derived. About 5% of the petroleum consumed in the US is used as feedstocks by the chemical industries.
Occurrence: At present half of the world's proven resources are in the Middle East and North Africa, the other half being divided among the US (including Alaska), Canada, Venezuela, USSR, the North Sea area, Indonesia, Mexico, Rumania, and Australia.
Properties: Viscous, dark-brown liquid, unpleasant odor, d 0.78–0.97, flash p 20–90F.
Hazard: Flammable, moderate fire risk. Toxic by ingestion, local skin irritant.
For further information refer to American Petroleum Institute, 1271 Avenue of the Americas, NY, NY.
See also natural gas, petrochemical, See Appendix E.4 for history of the industry.

petroleum benzin. A special grade of ligroin.

petroleum coke. See coke.

petroleum ether. This term is used synonymously with petroleum naphtha. It is also sometimes used as a synonym for ligroin or petroleum spirits. It is technically a misnomer for it is not an ether in the chemical sense. For details about specified distillation ranges and other distinctive properties, consult ASTM and API specifications.
See naphtha (1).

petroleum gas, liquefied. See liquefied petroleum gas.

petroleum jelly. See petrolatum

petroleum naphtha. See naphtha (1).

petroleum spirits. In Great Britain the term "petroleum spirits" refers to a volatile hydrocarbon mixture having a flash p 32F (0C).
Hazard: Highly flammable, dangerous fire risk.
See naphtha (1a). See also spirits; petroleum ether.

petroleum, synthetic. See pyrolysis.

petroleum thinner. See naphtha (1a).

petroleum wax. A high molecular weight solid hydrocarbon derived from petroleum. There are three types: paraffin waxes, microcrystalline waxes, and petrolatum waxes. All are made mostly by solvent dewaxing, although pressing and sweating processes are still used.
See specific entry.

"Petronates."[45] TM for salts of petroleum sulfonic acids, varying in molecular weight and color.
Use: Emulsifying agents, dispersing agents, wetting agents, corrosion-preventive.

"Petrosul."[25] TM for a series of highly purified natural petroleum sulfonate products available in high, medium, and low molecular weight ranges. Useful in applications requiring the surface active functions of foaming, detergency, emulsibility, dispersion, solubilization, spreading, and rust protection.

"Petrotect."[25] TM for a series of rust-preventive and hydraulic fluids in general meeting military specifications. The rust preventives are classified as solvent cut backs, petrolatum barriers, general purpose preservatives, and engine perservative lubricants. Hydraulic fluids include both preservative and operational types.

p-nitrophenol with ethyl
esence of sodium hydrox-
ion with iron filings and

stion, inhalation, and skin

iate, pharmaceuticals, lab

yl ether).
$H_5OC_2H_5$.

$-OC_2H_5$

ily liquid. Bp 172C, fp
), insoluble in water, solu-
r. Combustible.

minophenyl salicylate.

α-ethyl-β-propylacrylani-

ural and synthetic rubber

,3-indanedione).
$H_{10}O_2$.
crystals; practically odor-
soluble in methanol, alco-
zene; solutions in alkalies
d sulfuric acid blue.
nticoagulant).

prophenpyridamine ma-
ridyl)-3-di-methylamino-
CAS: 132-20-7.

alline powder with faint
4–108C. Very soluble in
ghtly soluble in benzene
has pH between 4.5 and

mine).

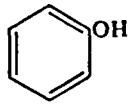
a 10% phenylmercuric
n.

rbital; phenylethylmalo-
lbarbituric acid).
$_{12}N_2O_3$.
ing, crystalline powder;
4–178C; soluble in alco-
alkali hydroxides, alkali
ringly soluble in water.

Derivation: Condensation of phenylethylmalonic acid derivatives and urea.
Grade: USP.
Hazard: May have damaging side effects. See barbituate.
Use: Medicine (sedative), laboratory reagent. Also available as the sodium salt which has good water-solubility.

phenocoll hydrochloride. (aminoacetophenetidide hydrochloride; glycocoll-p-phenetidine hydrochloride).
$C_2H_5OC_6H_4NHCOCH_2NH_2 \cdot HCl$.
Properties: Fine, white, crystalline powder; soluble in water and warm alcohol; slightly soluble in chloroform, ether, and benzene; mp 95C.
Derivation: By the action of aminoacetic acid upon phenetidine and acidifying.
Use: Medicine (analgesic).

phenol. (1) A class of aromatic organic compounds in which one or more hydroxy groups are attached directly to the benzene ring. Examples are phenol itself (benzophenol), the cresols, xylenols, resorcinol, naphthols. Though technically alcohols, their properties are quite different.
(2) phenol. (carbolic acid; phenylic acid; benzophenol; hydroxybenzene). CAS: 108-95-2.
C_6H_5OH.



34th highest-volume chemical produced in US (1985).
Properties: White, crystalline mass which turns pink or red if not perfectly pure or if under influence of light; absorbs water from the air and liquefies; distinctive odor; sharp burning taste. When in very weak solution it has a sweetish taste. D 1.07, mp 42.5–43C, bp 182C, flash p (CC) 172.4F (78C). Soluble in alcohol, water, ether, chloroform, glycerol, carbon disulfide, petrolatum, fixed or volatile oils, and alkalies. Autoign temperature 1319F (715C). Combustible.
Derivation: Most of the phenol in the US is made by the oxidation of cumene, yielding acetone as a byproduct. The first step in the reaction yields cumene hydroperoxide, which decomposes with dilute sulfuric acid to the primary products, plus acetophenone and phenyl dimethyl carbinol. Several other benzene-based processes have been used in the past; derivation from benzoic acid is also possible.
Method of purification: Rectification.
Grade: Fused, crystals, or liquid, all as technical

(82%, 90%, 95%, other components mostly cresols), CP, and USP.
Hazard: Toxic by ingestion, inhalation, and skin absorption; strong irritant to tissue. TLV: 5 ppm in air.
Use: Phenolic resins, epoxy resins (bisphenol-A) nylon-6 (caprolactam), 2,4-D, selective solvent for refining lubricating oils, adipic acid, salicylic acid, phenolphthalein, pentachlorophenol, acetophenetidine, picric acid, germicidal paints, pharmaceuticals, laboratory reagent, dyes and indicators, slimicide, biocide, general disinfectant.
Note: High-boiling phenols are mixtures containing predominantly m-substituted alkyl phenols. Their boiling points range from 238 to 288C, they set to a glass at −30C.
Use: In phenolic resins, as fuel-oil sludge inhibitors, as solvents and as rubber chemicals.

phenolate process. A process for removing hydrogen sulfide from gas by the use of sodium phenolate, which reacts with the hydrogen sulfide to give sodium hydrosulfide and phenol. This can be reversed by steam heat to regenerate the sodium phenolate.

phenol coefficient. In determining the effectiveness of a disinfectant using phenol as a standard of comparison, the phenol coefficient is a value obtained by dividing the highest dilution of the test disinfectant by the highest dilution of phenol that sterilizes a given culture of bacteria under standard conditions of time and temperature. See also disinfectant.

phenoldisulfonic acid. CAS: 96-77-5.
$C_6H_6O_7S_2$.
Properties: Deliquescent crystals, mp 90C, decomposes above 100C, soluble in water and alcohol.
Use: Manufacture of dye intermediates.

phenol-formaldehyde resin. The first synthetic thermosetting polymer, the reaction product of phenol with aqueous 37–50% formaldehyde at 50–100C, with basic catalyst, discovered by Baekeland in 1907 and trademarked "Bakelite" in 1911. Polymerization is of the condensation type, proceeding through three stages. With an acid catalyst "novolak" resins are produced, which are thermoplastic.
Properties: Gray to black, hard, infusible solid when cured, resistant to moisture, solvents, and heat up to 200C, dimensionally stable, good electrical resistance, noncombustible, sound- and noise-absorbent, decomposed by oxidizing acids, fair resistance to alkalies. Cannot be successfully colored.
Use: Molded and cast articles, bonding powders, ion exchange, laminating and impregnating, ply-

in water, slightly soluble in methanol, miscible with most organic solvents.
Use: Heat-transfer medium, hydraulic fluid, wide temperature-range lubricant.

tetraethyl dithiopyrophosphate. (TEDP). See sulfotepp.

tetraethylene glycol. (TEG).
$HO(C_2H_4O)_3C_2H_4OH$.
Properties: Colorless liquid; hygroscopic; soluble in water; insoluble in benzene, toluene, or gasoline. D 1.1248 at 20/20C, fp −4C, bp 327.3C, vap press above 0.001 mm (20C), refr index 1.4577 (20C), flash p 345F (174C), bulk d 9.4 lb/gal (20C). Combustible.
Use: Solvent for nitrocellulose, plasticizer, lacquers, coating compositions.

tetraethylene glycol dibutyl ether. See dibutoxytetraglycol.

tetraethylene glycol dimethacrylate.
Properties: Water-white to pale straw liquid, bp 200C (1 mm), d 1.075 (20/20C), refr index 1.4620 (20C), viscosity 12 cp. Insoluble in water; soluble in styrene, many esters and aromatics; limited solubility in aliphatic hydrocarbons. Combustible.
Hazard: Irritant to skin and eyes.
Use: Plasticizer.

tetraethylene glycol dimethyl ether. See dimethoxytetraglycol.

tetraethylene glycol distearate.
$(C_{17}H_{35}COOCH_2CH_2OCH_2CH_2)_2O$.
Properties: Liquid, mp 32–33C, insoluble in water. Combustible.
Use: Plasticizer.

tetraethylene glycol monostearate.
$C_{17}H_{35}COO(CH_2CH_2O)_4H$.
Properties: Liquid, d 0.971, mp 30–31C, insoluble in water. Combustible.
Use: Plasticizer.

tetraethylenepentamine. CAS: 112-57-2.
$NH_2(CH_2CH_2NH)_3CH_2CH_2NH_2$.
Properties: Viscous, hygroscopic liquid. D 0.9980 at 20/20C, fp −30C, bp 333C, vap press above 0.01 mm (20C), bulk d 8.3 lb/gal (20C), flash p 325F (162.7C), soluble in most organic solvents and water. Combustible.
Hazard: Strong irritant to eyes and skin.
Use: Solvent for sulfur, acid gases, various resins and dyes; saponifying agent for acidic materials; manufacture of synthetic rubber; dispersant in motor oils; intermediate for oil additives.

tetra-(2-ethylhexyl) silicate.
$[C_4H_9CH(C_2H_5)CH_2O]_4Si$.
Properties: Colorless liquid, d 0.8838, bp 350–370C, fp −90C, solubility in water below 0.01, 7.4 lbs/gallon, flash p 390F (198C). Combustible.
Use: Synthetic lubricants and functional fluids.

tetra-(2-ethylhexyl) titanate.
(tetrakis(2-ethylhexyl)titanate).
$[C_4H_9CH(C_2H_5)CH_2O]_4Ti$.
Properties: Light yellow, viscous liquid from the transesterification of isopropyl titanate with 2-ethylhexanol. Combustible.
Use: Crosslinking agent, condensation catalyst, adhesion promoter, water repellents.

tetraethyl lead. (TEL). CAS: 78-00-2.
$Pb(C_2H_5)_4$.
Properties: Colorless, oily liquid; pleasant odor. Soluble in all organic solvents, insoluble in water and dilute acids or alkalies, d 1.65, bp 198–202C, 75–85C (13–14 mm), fp −136C, decomposes slowly at room temperature, rapidly at 125–150C. Combustible.
Derivation: (a) Alkylation of lead-sodium alloy with ethyl chloride; (b) electrolysis of an ethyl Grignard reagent with an anode of lead pellets.
Grade: One grade only, about 98% pure.
Hazard: Toxic by ingestion, inhalation, and skin absorption. TLV (as Pb): 0.1 mg/m³ of air.
Use: Antiknock agent. Leaded gasoline contains 1.10 g of lead per gal. TEL has been largely replaced by MBTE.

tetraethyl orthosilicate. See ethyl silicate.

tetraethyl pyrophosphate. Legal label name for tepp.

tetraethylthiuram disulfide. (disulfiram; TTD; TETD; bis[diethylthiocarbamyl] disulfide).
CAS: 97-77-8. $[(C_2H_5)_2NCS]_2S_2$.
Properties: Light gray powder; d 1.27; melting range 65–70C; slight odor; soluble in carbon disulfide, benzene, and chloroform; insoluble in water.
Hazard: Toxic symptoms when ingested with alcohol; animal teratogen. TLV: 2 mg/m³ of air.
Use: Fungicide, ultra-accelerator for rubber.

tetraethylthiuram sulfide.
[bis-(diethylthiocarbamyl)sulfide]
$[(C_2H_5)_2NCS]_2S$.
Properties: Dark brown powder, slight odor, d 1.12 (20/20C), boiling range 225–240C (3 mm).
Hazard: Toxic by ingestion and inhalation.
Use: Pharmaceutical ointments, fungicide, insecticide.

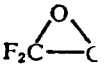
tetraethyltin. CAS: 5
Properties: Colorless
181C, fp −112C, in
alcohol and ether.
Hazard: Toxic materia
of air.

"Tetra-Flex."[511] TM
resins based on polyn
manent flexibility ma
trial and electrical la

tetrafluorodichloroethar
roethane.

tetrafluoroethylene. (p
CAS: 116-14-3. F
Properties: Colorless g
insoluble in water, m
Derivation: By passi
through a hot tube.
Hazard: Flammable, d
Use: Monomer for pol
mers.

tetrafluoroethylene epox



Derivation: Oxidation
120C with UV light;
radical mechanism.
Use: Monomer for proc
to polymers of dp 35;
See also "Freon E" and

tetrafluorohydrazine. C
F_2NNF_2.
Properties: Colorless, n
gas; bp (calc) −73C;
cal/mole; critical temp
Hazard: Explodes on co
and at high pressures.
Use: Organic synthesis,
ets, missiles, etc.

tetrafluoromethane. (flu
tetrafluoride). CAS
Properties: Colorless ga
slightly soluble in wat
at −184C, sp vol 4.4 cb
ble.
Grade: 95% min purity.
Hazard: Toxic by inhala
Use: Refrigerant, gaseou

tetrafluorosilane. See sil

"Tolpit."[79] TM for a tall oil pitch used in roofing cements, caulking compounds, shoemaker's wax, asphalt emulsions and anti-stripping agents, coal dust briquetting.

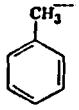
Topfer's reagent. Dimethylaminoazobenzene 0.5 g in 100 cc 95% ethanol.
Use: To test acidity of stomach contents.

tolualdehdye. See tolyl aldehydes.

toluazotoluidine. See o-aminoazotoluene.

tolu balsam. See balsam.

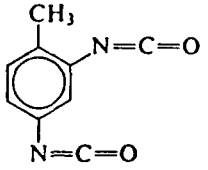
toluene. (methylbenzene; phenylmethane).
CAS: 108-88-3. $C_6H_5CH_3$ 27th highest-volume chemical produced in US (1985).



Properties: Colorless liquid, benzene-like odor, d 0.866 (20/4C), fp −94.5C, bp 110.7C, refr index 1.497 (20C), aniline equivalent 15, flash p (CC) 40F (4.4C), autoign temperature 997F (536C). Soluble in alcohol, benzene and ether; insoluble in water.
Derivation: (a) By catalytic reforming of petroleum. (b) By fractional distillation of coal-tar light oil.
Method of purification: Rectification.
Grade (usually defined in terms of boiling ranges): Pure, commercial, straw-colored, nitration, scintillation, industrial.
Hazard: Flammable, dangerous fire risk. Explosive limits in air 1.27–7%. Toxic by ingestion, inhalation, and skin absorption. TLV: 100 ppm in air.
Use: Aviation gasoline and high-octane blending stock; benzene, phenol, and caprolactam; solvent for paints and coatings, gums, resins, most oils, rubber, vinyl organosols; diluent and thinner in nitrocellulose lacquers; adhesive solvent in plastic toys and model airplanes; chemicals (benzoic acid, benzyl and benzoyl derivatives, saccharin, medicines, dyes, perfumes); source of toluenediisocyanates (polyurethane resins); explosives (TNT); toluene sulfonates (detergents); scintillation counters.

toluene-2,4-diamine. (m-tolylenediamine; MTD; m-toluylenediamine; diaminotoluene).
CAS: 95-80-7. $CH_3C_6H_3(NH_2)_2$.
Properties: Colorless crystals; soluble in water, alcohol, and ether; mp 99C; bp 280C.
Derivation: Reduction of m-dinitrotoluene with iron and hydrochloric acid.
Hazard: A carcinogen.
Use: Chain extender and crosslinker, intermediate in organic synthesis of dyes, polymers, especially polyurethanes.

toluene-2,4-diisocyanate. (2,4-tolylene diisocyanate; m-tolylene diisocyanate; TDI).
CAS: 584-84-9. $CH_3C_6H_3(NCO)_2$.



Properties: Water-white to pale yellow liquid, sharp pungent odor, bp 251C, 120C (10 mm), flash p 270F (132C), mp 19.4–21.5C (pure isomer), d 1.22 (25/15.5C), vap press 0.01 mm at 20C. Reacts with water producing carbon dioxide; reacts with compounds containing active hydrogen (may be violent); soluble in ether, acetone, and other organic solvents. Combustible.
Derivation: Reaction of 2,4-diaminotoluene with phosgene.
Method of purification: Distillation to remove hydrogen chloride.
Grade: 100% 2,4-isomer; 80% and 65% 2,4-isomer both mixed with 2,6-isomer.
Hazard: Toxic by ingestion and inhalation, strong irritant to skin and tissue, especially to eyes. TLV: 0.005 ppm in air.
Use: Polyurethane foams, elastomers and coatings, crosslinking agent for nylon 6.

toluene-2,6-diisocyanate. See toluene-2,4-diisocyanate.

p-toluenesulfamine. See p-toluenesulfonamide.

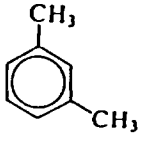
p-toluenesulfanilide. $CH_3C_6H_4SO_2C_6H_4NH_2$.
Properties: White to pink crystalline solid, mp 103C, soluble in most lacquer solvents. Combustible.
Derivation: p-Toluene sulfonchloride treated with aniline in presence of lime or carefully regulated amounts of alkalies.
Grade: Technical.
Use: Softener for acetylcellulose in proportions up to 50%, dyestuff intermediate.

o-toluenesulfonamide. CAS: 88-19-7.
$CH_3C_6H_4SO_2NH_2$.
Properties: Colorless crystals, mp 156.3C, soluble in alcohol, slightly soluble in water and ether. Combustible.
Use: Plasticizer.

graphic plates and fluorescent screens. (3) Ionization of the gases through which they pass. (4) Ability to damage or destroy diseased tissue; there is also a cumulative deleterious effect on healthy tissue.
Hazard: Overexposure can permanently damage cells and tissue structures; effect is cumulative.
Use: Spectrometry; structure determination of molecules, cancer therapy, diagnostic medicine, nondestructive testing of metals, identification of original paintings, preservation of foods.
See also radiation, ionizing, diffraction, Roentgen.

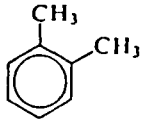
xylene. (dimethylbenzene). CAS: 1330-20-7. $C_6H_4(CH_3)_2$. A commercial mixture of the three isomers, o-, m-, and p-xylene. The last two predominate. 26th highest-volume chemical produced in US (1975) (all grades).
Properties: Clear liquid, soluble in alcohol and ether, insoluble in water, d about 0.86. See under Grade for boiling range; flash p (TOC) from 81–115F (27.2–46.1C).
Derivation: (a) Fractional distillation from petroleum (90%), coal tar or coal gas, (b) by catalytic reforming from petroleum, followed by separation of p-xylene by continuous crystallization, (c) from toluene by transalkylation.
Grade: Nitration (bp range 137.2–140.5C), 4 degrees (bp range 138–134C), 5 degrees (bp range 137–142C, high in m- isomer), 10 degrees (bp range 135–145C), industrial (bp 90% 40C, complete 160C). Also other grades depending upon use. In some cases one or another of the industrial isomers are partially removed for use in chemical production.
Hazard: Flammable, moderate fire risk. Toxic by ingestion and inhalation. TLV: 100 ppm in air.
Use: Aviation gasoline; protective coatings; solvent for alkyd resins, lacquers, enamels, rubber cements; synthesis of organic chemicals.
See also following entries.

m-xylene. (1,3-dimethylbenzene). CAS: 108-38-3. $1,3\text{-}C_6H_4(CH_3)_2$.



Properties: Clear, colorless liquid; soluble in alcohol and ether; insoluble in water. D 0.8684 (15C), fp −47.4C, bp 138.8C, refr index 1.4973 (20C), flash p 85F (29.4C), autoign temperature 982F (527.7C).
Derivation: Selective crystallization or solvent extraction of m-p- mixture.
Grade: 95% (technical), 99%, 99.9% (research).
Hazard: Flammable, moderate fire risk. TLV: 100 ppm in air.
Use: Solvent; intermediate for dyes and organic synthesis, especially isophthalic acid; insecticides; aviation fuel.

o-xylene. (1,2-dimethylbenzene). CAS: 95-47-6. $1,2\text{-}C_6H_4(CH_3)_2$.
Properties: Clear, colorless liquid; soluble in alcohol and ether; insoluble in water. D 0.880 (20/4C), fp −25C, bp 144C, refr index 1.505 (20C), flash p (TOC) 115F (46.1C), autoign temperature 867F (463.8C). Combustible.
Grade: 99%, free of hydrogen sulfide and sulfur dioxide, technical 95%, research 99.9%.
Hazard: Moderate fire risk. TLV: 100 ppm in air.
Use: Manufacture of phthalic anhydride, vitamin and pharmaceutical syntheses, dyes, insecticides, motor fuels.



p-xylene. (1,4-dimethylbenzene). CAS: 106-42-3. $1,4\text{-}C_6H_4(CH_3)_2$. 28th highest-volume chemical produced in US (1985).

Properties: Colorless liquid, crystallizes at low temperature, soluble in alcohol and ether, insoluble in water, d 0.8611 (20C), mp 13.2C, bp 138.5C, refr index 1.5004 (21C), flash p (TOC) 81F (27.2C).
Derivation: Selective crystallization or solvent extraction of m-, p- mixture; separation from mixed-xylene feedstocks by adsorption (parex process[416]).
Hazard: Flammable, dangerous fire risk. TLV: 100 ppm in air.
Use: Synthesis of terephthalic acid for polyester resins and fibers ("Dacron", "Mylar," "Terylene"), vitamin and pharmaceutical syntheses, insecticides.

p-xylene-α,α'-diol. $C_6H_4(CH_2OH)_2$.
Properties: White, crystalline solid; mp 118C; bp 138–144C (0.8–1.0 mm). Slightly soluble in water (25C). Purity: 98%.
Use: Polyester resins.

REFERENCE 26
(See Appendix A, Figure 2)

REFERENCE 27

Reference 27

Uncontrolled Hazardous Waste Site Ranking System

A Users Manual

(HW-10)

Originally Published in
the July 16, 1982, *Federal Register*

United States
Environmental Protection
Agency

1984

TABLE 2

PERMEABILITY OF GEOLOGIC MATERIALS*

Type of Material	Approximate Range of Hydraulic Conductivity	Assigned Value
Clay, compact till, shale; unfractured metamorphic and igneous rocks	$<10^{-7}$ cm/sec	0
Silt, loess, silty clays, silty loams, clay loams; less permeable limestone, dolomites, and sandstone; moderately permeable till	$10^{-5} - 10^{-7}$ cm/sec	1
Fine sand and silty sand; sandy loams; loamy sands; moderately permeable limestone, dolomites, and sandstone (no karst); moderately fractured igneous and metamorphic rocks, some coarse till	$10^{-3} - 10^{-5}$ cm/sec	2
Gravel, sand; highly fractured igneous and metamorphic rocks; permeable basalt and lavas; karst limestone and dolomite	$>10^{-3}$ cm/sec	3

*Derived from:

Davis, S. N., Porosity and Permeability of Natural Materials in Flow-Through Porous Media, R.J.M. DeWest ed., Academic Press, New York, 1969

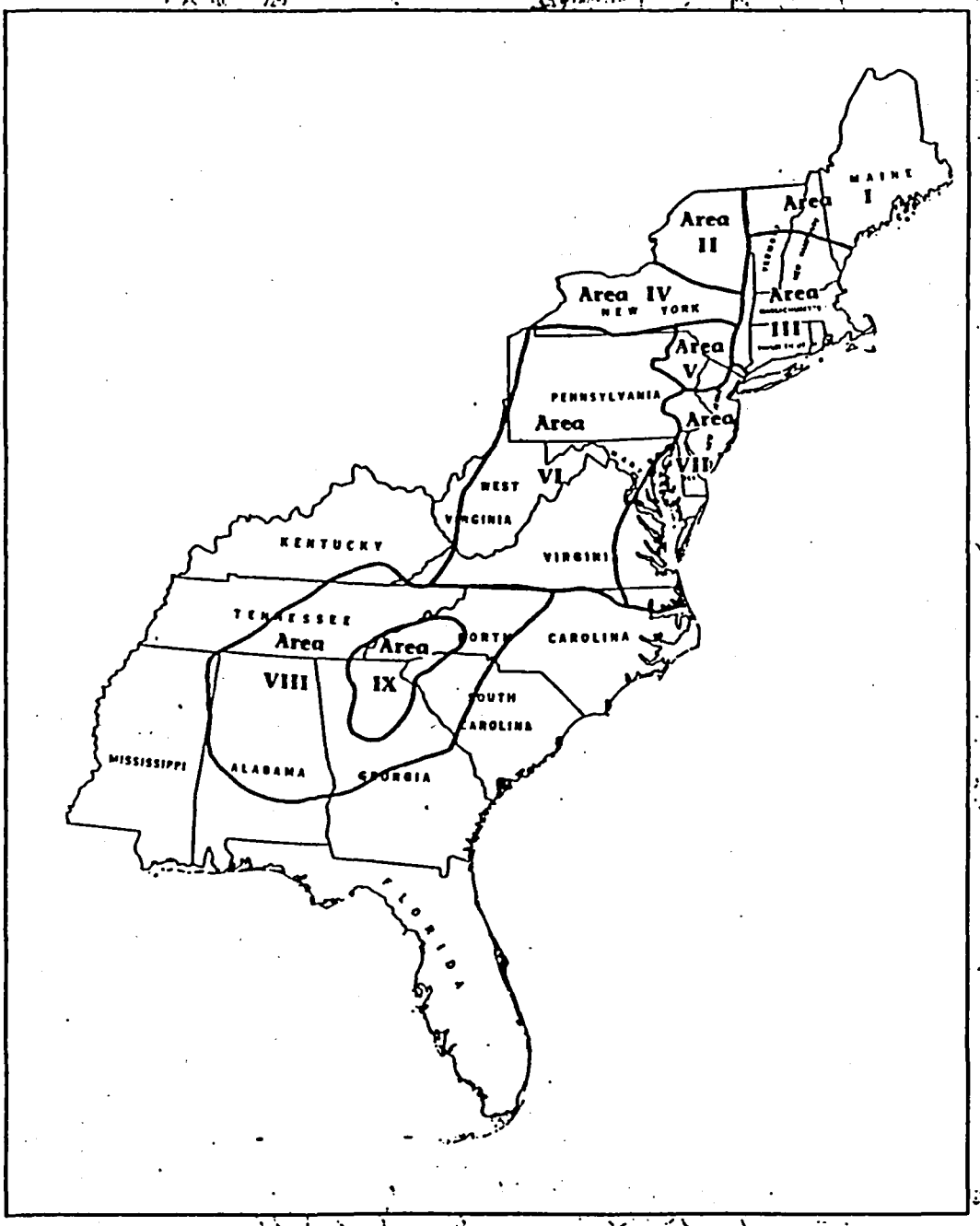
Freeze, R.A. and J.A. Cherry, Groundwater, Prentice-Hall, Inc., New York, 1979

REFERENCE 28

U.S. Geological Survey Water-Resources Investigations Report 88-4094

Ref. 28.

MAP OF MEAN ANNUAL RUNOFF FOR THE NORTHEASTERN, SOUTHEASTERN, AND MID-ATLANTIC UNITED STATES, WATER YEARS 1951-80



Prepared in cooperation with the
U.S. Environmental Protection Agency

REFERENCE 29

Ref. 29

U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT

DRAINAGE AREAS OF SELECTED STREAMS IN NORTH CAROLINA

Prepared in cooperation with the

North Carolina Department of Natural

Resources and Community Development

REFERENCE 30

Ref. 30

July 2, 1991

To: File

From: Harvey Allen Harvey H. Allen

RE: Swiss Bear Inc.
NCD 075 550 517

Calculations of average stream flow for the Neuse River.

Neuse River

Avg Drainage Area (DA) = >2500 sq mi.

Mean Annual Runoff (MAR) = 18 in/year

$$\frac{MAR * DA}{13.58} = >3314 \text{ cfs}$$

REFERENCE 31

Ref. 31

July 2, 1991

To: File

From: Harvey Allen Harvey H. Allen

RE: Swiss Bear Inc.
NCD 075 550 517

Calculations of Wetlands lining the Neuse River: These determinations were based on hydric soil classifications as identified from References 10 and 14. The total length of wetlands, within the study area along the Neuse River in Pamlico County, was assumed to be approximately 8.9 miles.

The following Hydric Soils and their respective lengths were approximated from References 10 and 14.

Se	-	3.4 miles
LF	-	5.9 miles
MM	-	2.0 miles
Le	-	0.4 miles
Ag	-	0.3 miles
		12.0

Total length of wetlands = 12.0 + 8.9 = 20.9 miles