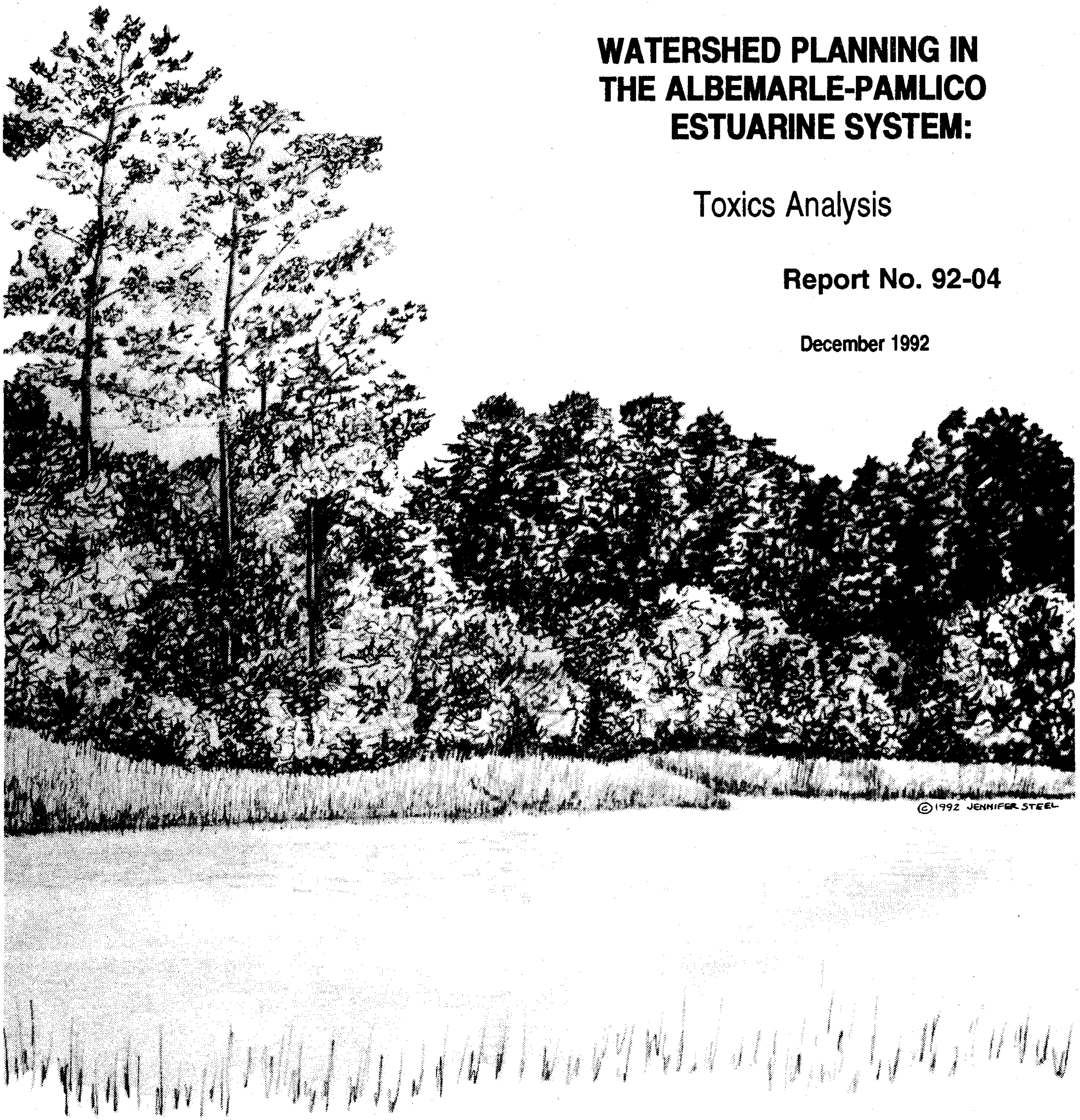
WATERSHED PLANNING IN THE ALBEMARLE-PAMLICO ESTUARINE SYSTEM:

Toxics Analysis

Report No. 92-04

December 1992



ALBEMARLE-PAMLICO ESTUARINE STUDY

NC Department of
Environment, Health,
and Natural Resources

Environmental
Protection Agency
National Estuary Program

Watershed Planning in the Albemarle-Pamlico Estuarine System

Report 3 - Toxics Analysis

by

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Randall E. Williams
Robert L. Chessin
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Center for Environmental Analysis

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PREFACE

This report is the third in a series of nine reports by Research Triangle Institute (RTI) to support watershed planning and the Comprehensive Conservation and Management Plan for the Albemarle-Pamlico (A/P) Estuary Study Area. This work is being done under Cooperative Agreement No. C-14010 between RTI and the U.S. Environmental Protection Agency, with funding also provided by the State of North Carolina.

Current plans call for the report series to include the following, when completed later in 1992:

- Annual Nutrient Budgets
- Groundwater Discharge and Groundwater Quality
- Toxics Analysis
- A Subbasin PC Database
- Fishing Practices Mapping
- Subbasin Profiles and Critical Areas
- Geographic Targeting for Nonpoint Source Programs
- Future Nutrient Loading Scenarios and Target Nutrient Reductions
- Nutrient Mass Balances.

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ACKNOWLEDGMENTS

The authors wish to thank the following individuals for their assistance in obtaining data files and in recommending sources of standards and criteria used in this assessment analysis of toxics data from the A/P Study area:

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EXECUTIVE SUMMARY

The Albemarle-Pamlico (A/P) estuarine system is one of 17 estuaries identified nationwide under EPA's National Estuary Program. Major waterbodies of the A/P Study Area of North Carolina are shown in Figure ES-1. This report presents the results of a project to analyze multimedia toxics data from the system, one of several efforts by Research Triangle Institute (RTI) to support watershed planning in the A/P Study Area. The work was performed under contract to the North Carolina Department of Environment, Health and Natural Resources and the U.S. Environmental Protection Agency (EPA), Region 4.

The main purposes of this project were to

- Analyze toxics information from diverse agencies and databases in a consistent manner.
- Estimate annual toxics loadings from point sources in the A/P basins and predict the potential for exceedances of water quality standards due to these sources.
- Compare ambient water column, sediment, and fish tissue data to the most appropriate standards or criteria available to identify areas of concern where these standards or criteria are exceeded.
- Use Geographic Information System (GIS) technology to display the above results in graphical (map) form for further analysis and action by State agencies.

RTI reviewed major sources of information on toxics in point source discharges in the A/P estuarine system and in ambient water, sediment, and fish tissue samples collected from the A/P Study Area and screened these data against State standards. Sources of toxic inputs from nonpoint sources (e.g., atmospheric deposition, leaking from landfills, hazardous waste sites or treatment and disposal facilities (TSDFs) were not considered within the scope of this project. For those toxicants for which the State has not defined standards, EPA criteria, action levels, or other levels of concern were used as screening values. In concurrence with the State's recommendations, the screening studies were directed primarily at the evaluation of metal contamination issues. However, organic contaminants were evaluated in fish and shellfish tissue.

The reader should note that this report evaluated toxics data from watersheds in the North Carolina portion of the A/P Study Area. Data for some environmental matrices provided by the North Carolina Division of Environmental Management (NCDEM) were available for several watersheds in southern Virginia; however, a systematic evaluation of Virginia's toxics monitoring data was not within the scope of this study.

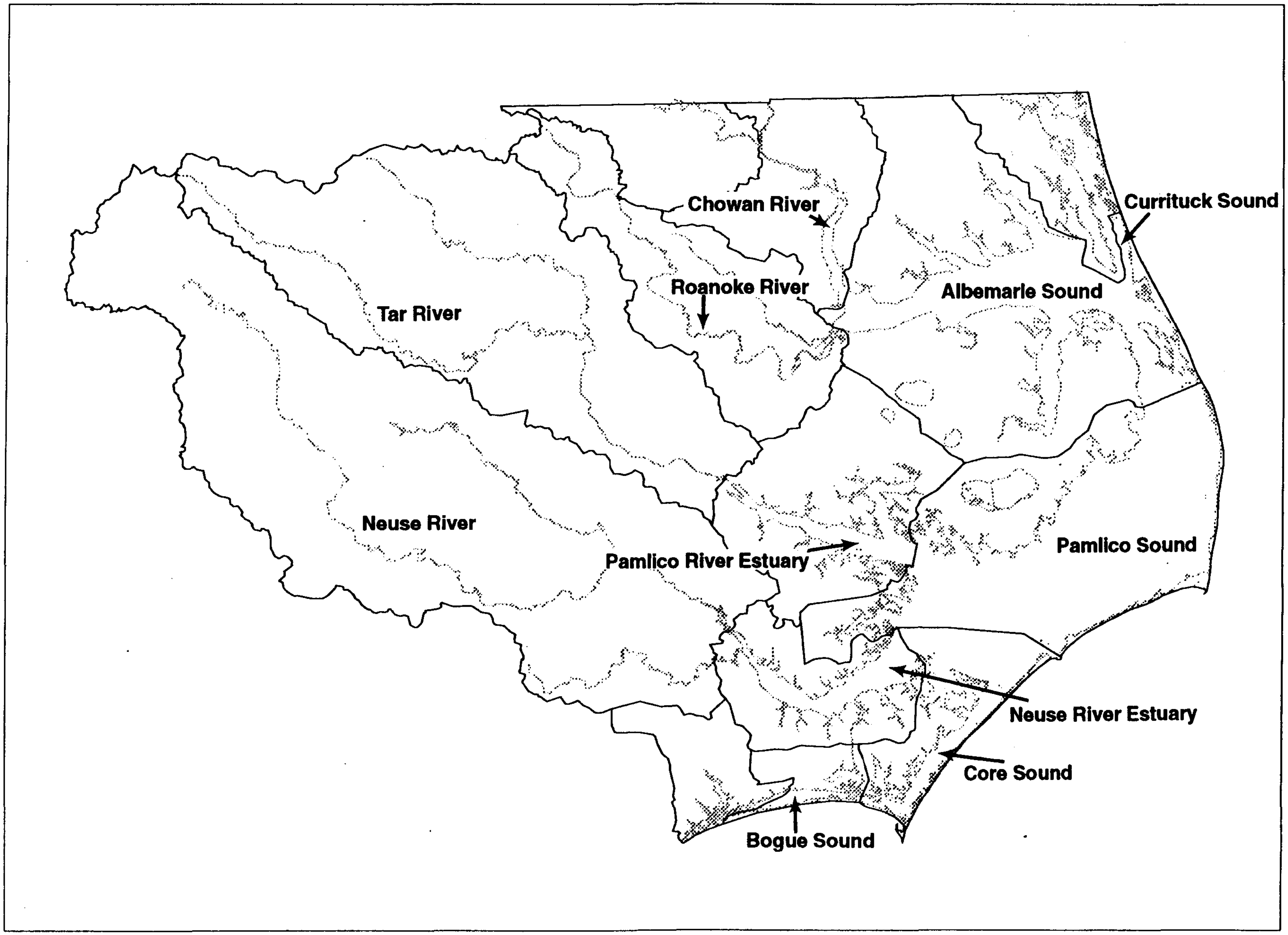


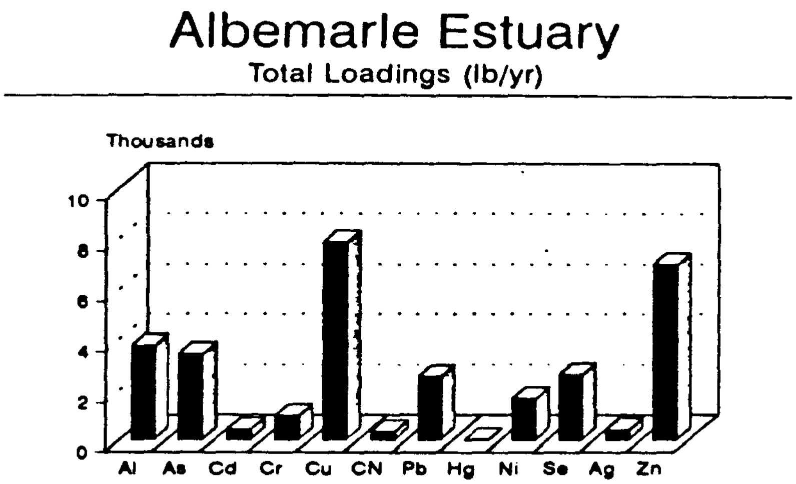
Figure ES-1. Major waterbodies of the Albemarle-Pamlico Study Area within North Carolina.

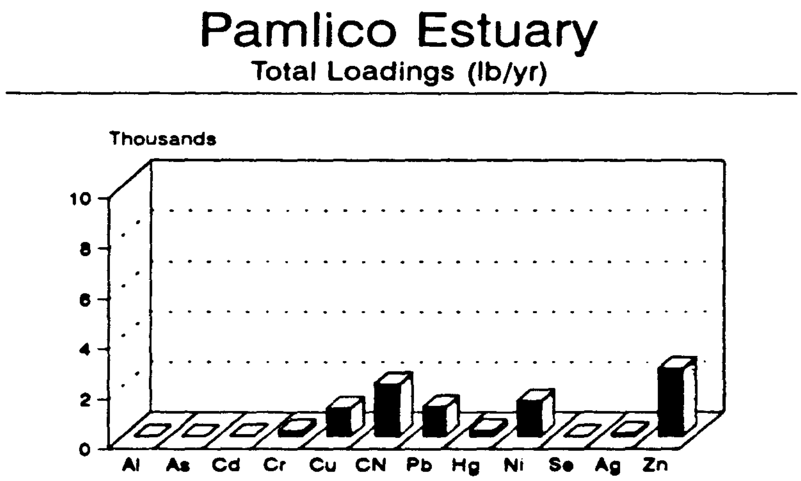
Toxics Loadings from Point Source Dischargers

Discharge Monitoring Report (DMR) data for 1989 and 1990, obtained from the North Carolina Compliance Monitoring System, were used to estimate annual toxics loadings from point source dischargers. Toxics loadings (pounds per year) for all three estuarine systems are compared in Figure ES-2. Metal loadings were higher overall for the Albemarle estuarine system than for either the Neuse or the Pamlico estuarine systems and were predominated by seven metals--copper, zinc, aluminum, arsenic, selenium, lead, and nickel. Loadings to the Albemarle estuarine system included one discharger to the Chowan River system, two dischargers to the Pasquotank River system, and 15 dischargers to the Roanoke River system. Annual toxics loadings from seven dischargers to the Pamlico estuarine system were the lowest of the three estuaries examined. Loadings were predominated by three heavy metals: zinc, cyanide, and nickel. Toxics loadings to the Neuse estuarine system included contributions from 21 dischargers and were predominated by four metals: zinc, copper, lead, and chromium. In general, three metals (zinc, copper, and lead) have the highest loadings to the A/P estuarine area; however, fluoride loading from an industrial facility (Texasgulf) on the Pamlico Estuary was the largest single source of a toxicant entering the system.

Potential for Exceedances of Water Quality Standards/Criteria

Data from the DMR database and the NC Annual Pollutant Analysis and Monitoring (APAM) reports were also used to assess potential discharger exceedances of water quality standards/criteria under two hypothetical flow regimes--7Q10 low flow and average flow. The 7Q10 is the minimum average flow for a period of 7 consecutive days that has an average recurrence of once in 10 years. Under low flow (7Q10), 21 dischargers were identified as having the potential to cause exceedances of water quality standards/criteria (Figure ES-3). The numbers shown in Figure ES-3 are tied to dischargers listed in Section 2.2 of this report. Under average flow conditions, 12 dischargers are predicted to have the potential to cause water quality exceedances. Under both flow conditions, water quality exceedances for the A/P estuarine system were predicted for more municipal than industrial facilities. Municipal facilities represented 64 percent of dischargers that could potentially cause water quality exceedances under 7Q10 flow conditions and 79 percent of dischargers that could potentially cause water quality exceedances under average flow conditions. Industrial wastes treated at some of these municipal facilities are likely sources for the toxicants discharged.





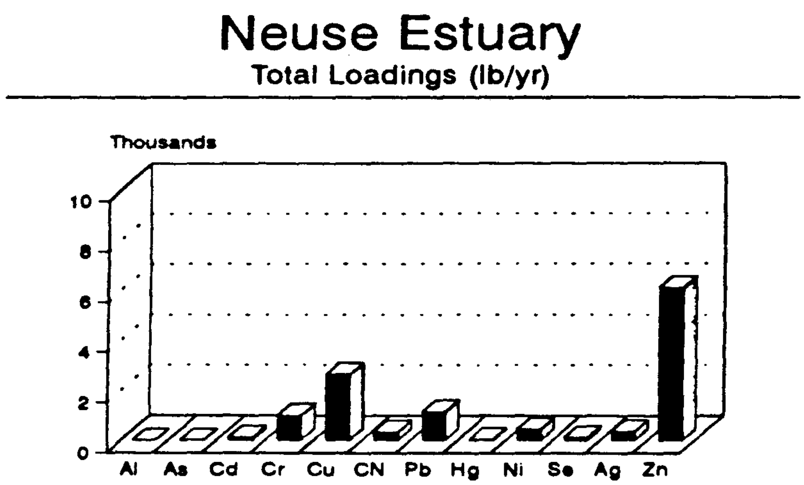


Figure ES-2. Comparison of annual loadings to the three estuarine systems.

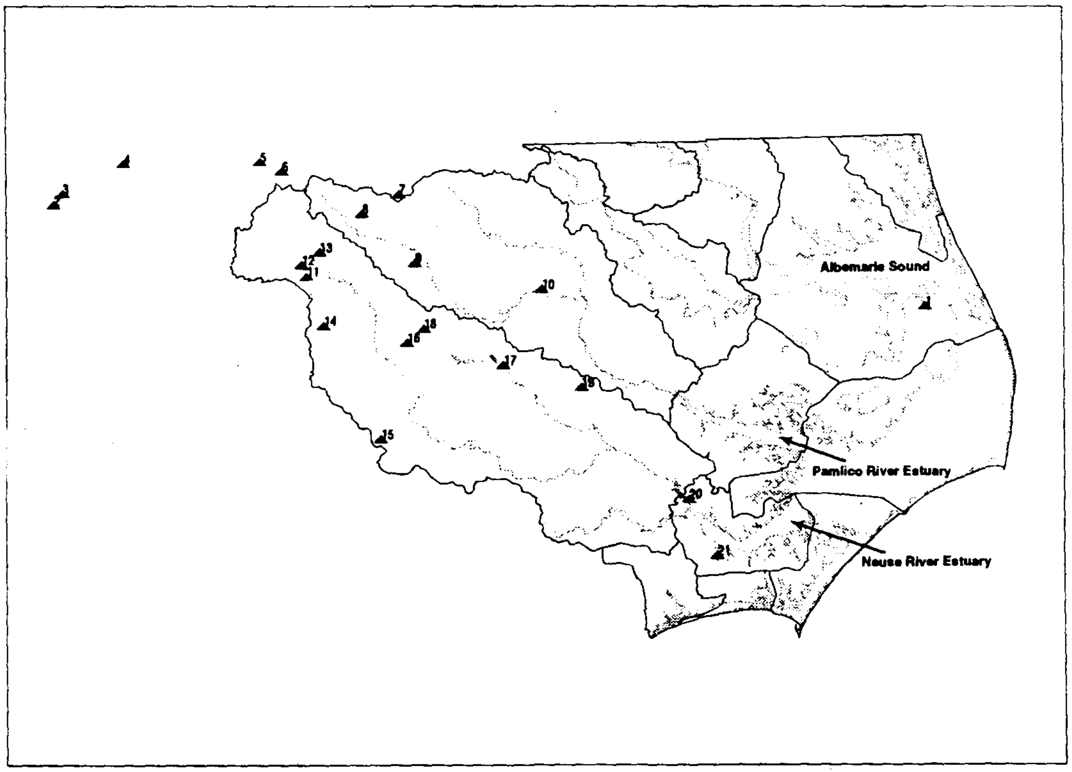


Figure ES-3. Locations of dischargers with the potential to cause exceedances of water quality standards under low flow conditions.

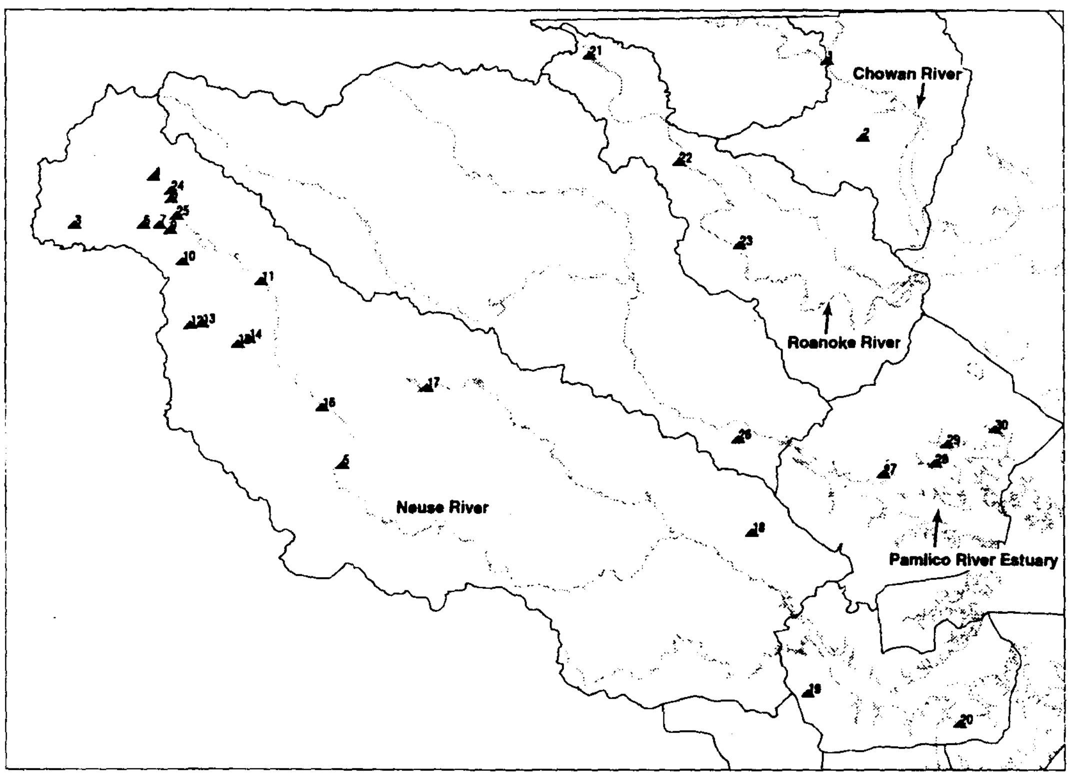


Figure ES-4. Sites where ambient water quality standards and/or criteria were exceeded.

Ambient Water Quality

Ambient water quality for fresh water and salt water was assessed using the EPA Storage and Retrieval (STORET) system. All ambient water quality data were screened against current North Carolina State Standards for Fresh Waters and Tidal Salt Waters. If no State standard was available, EPA chronic freshwater or saltwater criteria were used. If no EPA water quality criterion was available, the North Carolina human health standard or the EPA human health criterion was used. A total of 24 freshwater stations and 6 estuarine stations were identified as having ambient water column pollutant concentrations that exceeded State standards and/or EPA criteria (Figure ES-4). The numbers shown in Figure ES-4 are linked to ambient water quality monitoring stations identified in Section 3 of this report. Ambient freshwater quality exceedances were mainly found in headwater river reaches of major tributaries to the Albemarle-Pamlico estuarine system. This is particularly striking in the upper Neuse River basin where 75 percent of all fresh water quality standard exceedances in the A/P area were detected. Only six estuarine/marine stations were identified as having water column pollutant concentrations that exceeded State standards and/or EPA criteria. These areas of water quality exceedances were generally located in estuaries lateral to the major estuarine systems.

Sediment Quality

The EPA STORET system was the primary source of sediment data used to evaluate freshwater sediment quality within the A/P Study Area. Currently there are no State standards or EPA criteria for freshwater sediment; therefore, all sediment data were screened against threshold concentrations developed by EPA and calculated using the sediment-water equilibrium partitioning approach. Results for nine metals showed that the threshold concentrations were not exceeded at any station in the A/P Study Area, although sampling was conducted only at three freshwater sediment sites during the 3-year period of record accessed (1989-1991).

The primary sources of sediment data used to evaluate estuarine/marine sediment quality within the A/P Study Area were from Riggs et al. (1989, 1991, and 1992). Currently there are no State standards or EPA criteria for estuarine/marine sediment; therefore, all sediment data were screened against low effects range (ER-L) values and median effects range (ER-M) values derived by the National Oceanic and Atmospheric Administration (NOAA) for evaluating estuarine/marine sediments as part of their National Status and Trends Program. The ER-L value for each pollutant represents the concentration above which adverse effects may begin or are predicted among sensitive life stages and/or species. The ER-M value for each pollutant represents the concentration above which toxic effects are frequently or always observed among most species. Sites where ER-M exceedances were detected represent areas where sediment contamination is most likely to produce toxic effects. A total of 22 sites in the Albemarle Estuary were found to exceed ER-M values for four metals (chromium, lead, mercury, and zinc). Lead and mercury accounted for the majority of exceedances of ER-M values (Figure ES-5). Four sites in the Albemarle contained sediment concentrations in exceedance of ER-M values for more than one metal--two sites on the Pasquotank River and two sites on the lower Roanoke River near Welch Creek. Overall, the largest number of sites (15) exceeding ER-M values were detected in the Pasquotank River basin near Elizabeth City, NC.

A total of 13 sites in the Pamlico Estuary were found to exceed ER-M values. Lead and zinc were the only two metals found to exceed ER-M values. Lead accounted for 12 of the 13 exceedances of ER-M values. No sites in the Pamlico Estuary had sediment concentrations in exceedance of ER-M values for more than one metal. All of the sites found to exceed ER-M values were localized in the lower Tar River in the vicinity of Kennedy Creek near Washington, NC.

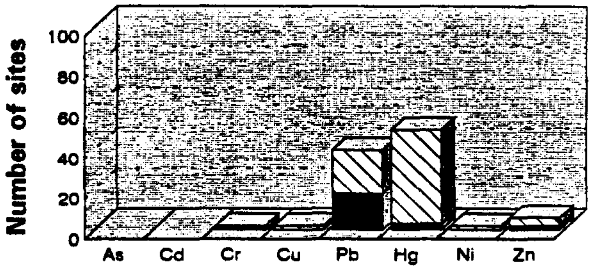
A total of 16 sites in the Neuse Estuary were found to exceed ER-M values. Lead and zinc accounted for the majority of these ER-M exceedances. Eleven sites in the Neuse Estuary had exceedances of ER-M values for more than a single metal. Contamination in the Neuse Estuary generally occurred in the lower reaches of the Neuse River prior to where it empties into the estuary (New Bern/Bridgeton area) and in three lateral estuaries--Trent River/Lawson Creek, Slocum Creek, and Oriental Harbor.

Of the three estuarine systems examined, the Neuse Estuary contained a larger number of sites contaminated with multiple metals at concentrations exceeding ER-M values than either the Albemarle or Pamlico Estuaries. In all three systems, contaminated sites were most frequently found in the lower reaches of the major tributary rivers and in estuaries lateral to the primary estuaries.

Fish Contamination--Hazard to Wildlife

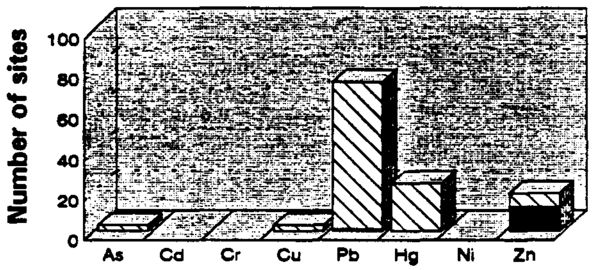
The N.C. Division of Environmental Management (DEM) Fish Contaminant Monitoring database was the primary source of whole fish contaminant data used to assess the hazard to piscivorous (fish-eating) wildlife of consumption of chemically contaminated fish. Currently there are no State standards or EPA criteria for protection of wildlife, therefore appropriate screening values were selected from the scientific literature. All metal contaminant data were screened against the 85th percentile values reported for the most recent U.S. Fish and Wildlife Service (FWS) National Contaminant Biomonitoring Program (NCBP). These values were recommended by the U.S. FWS staff for screening metals contaminant data.

Albemarle Estuary
Contaminated Sediment Sites



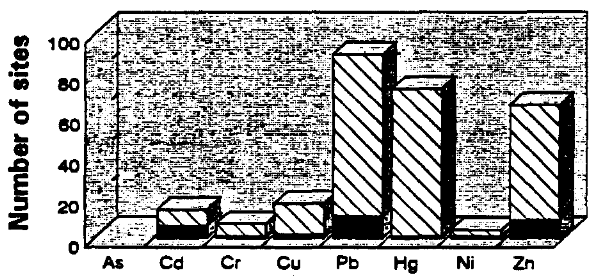
	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Total Sites	0	0	2	2	40	50	2	6
ER-L Sites ▨	0	0	0	2	22	47	2	4
ER-M Sites ■	0	0	2	0	18	3	0	2

Pamlico Estuary
Contaminated Sediment Sites



	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Total Sites	3	0	0	3	74	24	0	19
ER-L Sites ▨	3	0	0	3	73	24	0	7
ER-M Sites ■	0	0	0	0	1	0	0	12

Neuse Estuary
Contaminated Sediment Sites



	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Total Sites	0	14	7	17	90	73	4	65
ER-L Sites ▨	0	8	6	15	79	72	3	56
ER-M Sites ■	0	6	1	2	11	1	1	9

Figure ES-5. Comparison of contaminated sediment sites.

Unfortunately, the 85th percentile values were not available for organic contaminants, so appropriate screening values were gleaned from the scientific literature. The National Academy of Science values for protection of aquatic organisms and animals that consume them were used as screening values for aldrin, total DDT, endosulfan, and lindane. U.S. FWS values derived from contaminant hazard reviews for the protection of fish, wildlife, and invertebrates were used as screening values for chlordane and dioxin. Fish flesh criteria for piscivorous wildlife used by the New York Department of Environmental Conservation in the Niagara River Biota Contamination Project were used as screening values for p,p'-DDE, dieldrin, endrin, and total PCBs.

Sites where fish contaminant concentrations of metals and organochlorine pesticides exceeded levels of concern for wildlife are shown in Figure ES-6. The numbers shown in Figure ES-6 are tied to sampling locations identified in Section 5.1 and the open circles denote areas where multiple sites were found to be contaminated. Whole fish samples collected at 22 sites in the Albemarle estuarine system were found to exceed levels of concern, primarily for copper, mercury, and lead. Samples of whole fish from seven stations

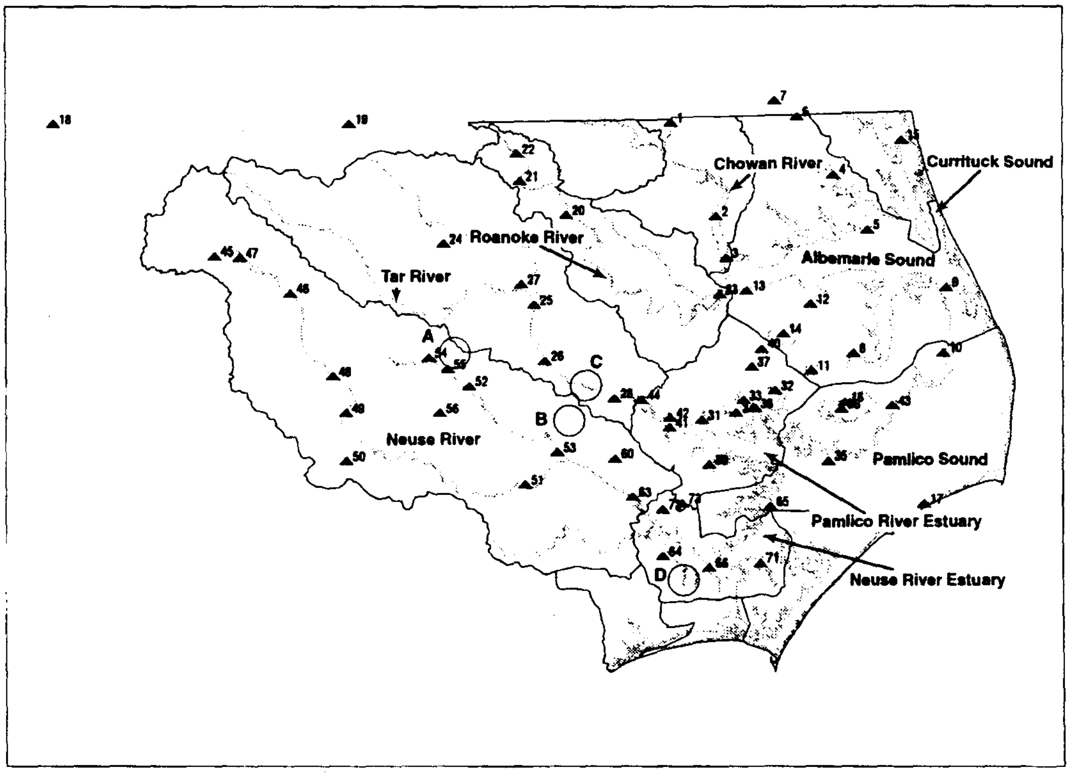


Figure ES-6. Sites where fish contaminant concentrations of metals and organochlorines exceeded levels of concern for wildlife.

exceeded the U.S. FWS maximum concentration for mercury measured in the National Contaminant Biomonitoring Program. Whole fish samples collected at 12 sites in the Albemarle Estuary were found to exceed the level of concern for 2,3,7,8-TCDD (dioxin). These 12 sites included seven sites in the Chowan basin (from the Meherrin River near the NC/SC border to the mouth of the Chowan River), four sites in the lower Roanoke basin in the vicinity of Welch Creek, and one site in western Albemarle Sound.

Whole fish samples collected at 22 sites in the Pamlico estuarine system were found to exceed levels of concern for piscivorous wildlife, primarily for copper, mercury, lead, and cadmium. Samples of whole fish from several stations exceeded the U.S. FWS maximum concentrations for cadmium and mercury. Whole fish samples did not exceed the level of concern for 2,3,7,8-TCDD (dioxin) at any site in the Pamlico.

Whole fish samples collected at 31 sites in the Neuse estuarine system were found to exceed levels of concern for piscivorous wildlife, primarily for mercury, copper, lead, and cadmium. Samples of whole fish from several stations exceeded the U.S. FWS maximum concentrations for mercury and cadmium. Whole fish samples at one site in the Neuse Estuary (near the Weyerhaeuser Facility in New Bern) exceeded the level of concern for 2,3,7,8-TCDD (dioxin).

Fish Contamination–Human Health Risk Assessment

The DEM Fish Contaminant Monitoring database was the primary source of fish fillet and shellfish data used to assess the risk to human health from consumption of chemically contaminated fish. Currently there are no State standards for contaminants in fish tissues, although the State has in the past used U.S. Food and Drug Administration (FDA) action levels for evaluating human health concerns. The U.S. EPA recently published a risk-based approach for calculating screening values (SVs) for assessing the health risk of consuming chemically contaminated fish (edible portions) and shellfish. All fish fillet and shellfish contaminant data were screened against the EPA risk-based screening value calculated for protection of the 50th percentile of recreational fishermen, which assumes a fish/shellfish consumption rate of 30 g/d for adults. One exception was the use of an SV of 1 part per trillion (ppt) for screening dioxin data. The computed EPA SV was 0.15 ppt for dioxin, but the detection limit for the chemical analysis procedure used for dioxin is 1 ppt; therefore, the detection limit of 1 ppt was used as the SV for dioxin.

Sites where fish contaminant concentrations exceeded human health SVs for metals and organochlorine pesticides are shown in Figure ES-7. The numbers shown in Figure ES-7 are tied to sampling locations identified in Section 5.2 of this report and the open circle denotes an areas where multiple sites were contaminated. In the Albemarle estuarine system,

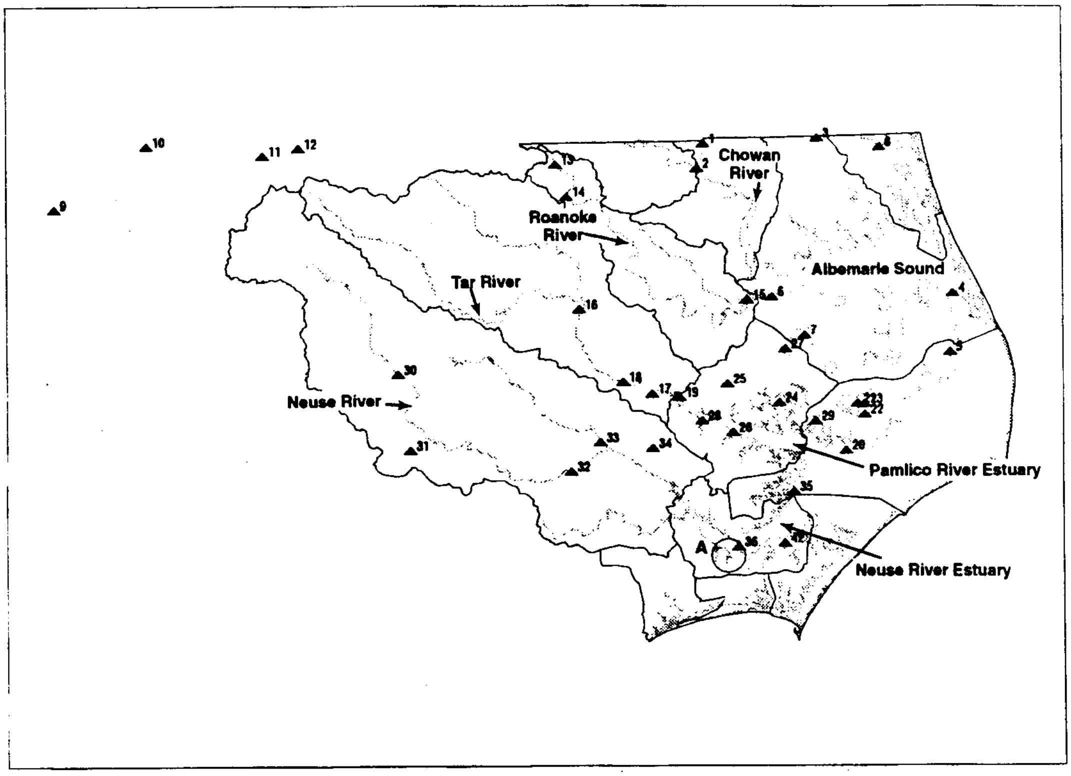


Figure ES-7. Sites where contaminant concentrations of metals and organochlorine pesticides in edible fish tissue exceeded human health screening values.

fish fillet samples collected at eight stations in the Chowan basin and seven stations in the Roanoke basin were found to exceed human health SVs for arsenic, lead, mercury, selenium, and DDT. Concentrations exceeded the mercury SV at nine stations and the SV for dioxin (1 ppt) at 33 sites, the largest number of dioxin exceedances found in any of the three estuarine systems. Shellfish samples collected at 10 sites in the Albemarle Estuary exceeded SVs for arsenic, lead, and zinc. Nine of the ten sites where exceedances were detected were in the Pasquotank basin; one was in the lower Roanoke basin.

In the Pamlico estuarine system, fish fillet samples collected at 14 sites were found to exceed human health SVs for arsenic, lead, mercury, and dieldrin. Fish fillet concentrations exceeded the mercury SV at eight stations. No fillet samples collected in the Pamlico Estuary exceeded the SV for dioxin. Shellfish samples collected at three sites in the Pamlico Estuary exceeded SVs for either arsenic, lead, or zinc, and one shellfish sample near South Creek exceeded the SV for dioxin.

In the Neuse estuarine system, fish fillet samples collected at 13 sites were found to exceed human health SVs for arsenic, copper, lead, and mercury. Fish fillet concentrations most frequently exceeded the mercury SV (six sites) and arsenic SV (six sites). Fish fillet samples collected at six sites in the lower Neuse River were found to exceed the SV for dioxin. Shellfish samples collected at five sites in the Neuse exceeded SVs for arsenic or lead.

Overall, dioxin and mercury were the two toxic pollutants most frequently detected in fish tissues at concentrations exceeding the selected human health SVs. The primary sources of dioxin in the A/P Study Area are presumed to be from several large pulp and paper mills that have historically employed bleach kraft processing. The sources of mercury contamination are less well defined. Mercury loadings released by several North Carolina municipal and industrial dischargers to the A/P area and additional loadings from facilities in Virginia (which were not assessed in this study) and nonpoint sources such as urban runoff or leachate from landfills or resource extraction activities may also have contributed to mercury contamination. Recently published evidence suggests that atmospheric deposition of contaminants also may be an important environmental source of mercury.

Recommendation

In addition to analyzing toxics data from the A/P Study Area, this report recommends a method for prioritizing sites for further study based on the number of exceedances observed and makes recommendations for future monitoring and data quality management strategies (see Section 6). Information gained by this analysis of toxics within the A/P area can be used by the State to

- Identify dischargers that have the potential to cause water quality exceedances under specific flow conditions, and, through permit reviews, revise permit limits for toxicants of concern
- Focus on potential toxics problem areas and prioritize them with respect to the severity of the contamination
- Assess the adequacy of existing data for various environmental matrixes
- Develop future monitoring and assessment strategies for watersheds to ensure continued attainment of the water quality goals of the Clean Water Act.

SECTION 1

INTRODUCTION

Water pollution problems in our Nation's estuaries may affect both public health and aquatic life uses. Pollutant impacts may result in diminished recreational and commercial uses of these waters because of contact recreation restrictions, fish consumption advisories and bans, or shellfish harvesting restrictions. In addition, aquatic life uses may be lost through a loss of balanced communities, increased incidence of fish and/or shellfish diseases, and impacts to population dynamics such as reduced fecundity or reduced survival of juvenile life stages and fish kills. Many of these impacts can be caused by toxic pollutants such as heavy metals, pesticides, PCBs, and dioxins.

A study to analyze toxics data from the Albemarle-Pamlico (A/P) estuarine system was conducted by Research Triangle Institute (RTI) under contract to the North Carolina Department of Environment, Health, and Natural Resources and the U.S. Environmental Protection Agency (EPA), Region 4. Toxic inputs to the A/P estuarine system, one of 17 estuaries identified nationwide as part of the EPA's National Estuary Program (NEP), are not believed to be high relative to some of the Nation's more urbanized estuaries. However, resource managers are hampered in gaining a comprehensive understanding of the extent of the problem because toxics data are maintained in numerous databases, files, and special reports maintained by State and Federal agencies, private consulting firms, and educational institutions.

Under this contract, RTI reviewed major sources of toxics information from point source dischargers in the A/P estuarine system and in ambient water, sediment, and fish tissues sampled from the A/P Study Area. These data were then screened to identify areas where contaminant concentrations exceeded State or Federal standards and criteria and therefore warranted further examination by the State.

RTI reviewed several of the major sources of information on toxics including the following:

- Compliance Monitoring System (Discharger Monitoring Reports--DMR)
- Discharger Annual Pollutant Analysis Monitoring (APAM) program

- State ambient water quality and sediment monitoring program (Storage and Retrieval System--STORET)

- Estuarine sediment monitoring program for the Pamlico, Neuse, and Albemarle Regions (Riggs et al., 1989, 1991, 1992)

- State fish contaminant monitoring program (database includes routine State fish contaminant monitoring and special study files, EPA dioxin monitoring program files, and discharger self-monitoring dioxin sampling files).

Although other sources of information were reviewed initially, RTI, in consultation with the NC Division of Environmental Management (DEM) staff, determined that large databases of toxics information should receive primary consideration. After identifying appropriate digital toxics data sources, RTI selected for screening analysis those data files from monitoring programs that met one or more of the following criteria:

- Extensive temporal coverage

- Extensive geographic coverage in the A/P Study Area

- Monitoring targeted at sites suspected of having high levels of contamination (e.g., in exceedance of existing standards and/or criteria).

In addition, RTI was asked by DEM staff to concentrate the screening analysis on metal loading and contamination problems believed to be of greatest environmental concern to the State. After preliminary review of several data sources, RTI concurred with the State's recommendation that screening studies should be directed principally at evaluation of metal contamination issues. This concurrence was based on two practical considerations.

First, for some data sets, metals were the principal or sole pollutants being analyzed and, second, RTI found that State standards or Federal criteria were not available to evaluate many organic pollutants in some environmental matrices. RTI did evaluate organic contaminants for one major environmental matrix--fish and shellfish tissue contamination. Organic pollutant analysis was of particular importance in analyses of fish contaminant monitoring data where dioxins and various organochlorine pesticide concentrations were evaluated to determine the hazard they pose to piscivorous wildlife and human health.

The assessment of toxic pollutant impacts reported here for the Albemarle-Pamlico estuarine system has been an integral part of other National Estuary Programs. For example, the Chesapeake Bay Program included an early review of toxics data and comparison to EPA water quality criteria. Based on this review, new sampling efforts were undertaken in the mid-

1980s and toxic problem areas were identified. The 1987 Bay Agreement commits participants to "develop, adopt, and begin implementation of a basinwide strategy to achieve a reduction of toxics consistent with the Water Quality Act of 1987 which will ensure protection of human health and living resources." Likewise, the Puget Sound Study found that "toxic contaminants represent the most acute and greatest threat to the habitats and biological resources of the Sound" (Puget Sound Water Quality Authority, 1988). Toxics data for this heavily urbanized watershed were assessed thoroughly in preparing that Study's water quality management plan. By the same token, it is hoped that the examination and screening of toxics data described in this report for various point sources and environmental media will lead to a more integrated water quality management plan for the A/P Study Area.

This report focuses primarily on assessing the impact of point source discharges to the A/P estuarine system and the level of toxics contamination in ambient water, sediment, and fish tissues. Section 2 provides an analysis of toxics loading from point source dischargers and an analysis of those dischargers that have the potential to exceed water quality standards based on average and low flow (7Q10) assumptions. Sections 3, 4, and 5 provide an assessment of ambient water, sediment, and fish and shellfish tissue contamination, respectively. Each of these sections includes the following:

- Database sources accessed and the period of record evaluated in the toxics assessment
- Methodology used to screen the toxics data including sources of the screening values used to identify potential exceedances of standards/criteria or levels of concern
- Results of screenings, including identification of geographic areas of potential contamination that warrant further investigation
- Conclusions, including a discussion of the magnitude and extent of the toxics problem identified relative to the entire A/P Study Area.

Recommendations for future actions and strategies for toxics management are provided in Section 6.

Information gained by this analysis of toxics data within the A/P area can be used by the State to

- Identify dischargers that have the potential to cause water quality exceedances under specific flow conditions, and, through permit reviews, revise permit limits for toxics of concern

- Identify potential toxics problem areas and prioritize them, if possible, with respect to the severity of the contamination

- Assess the adequacy of existing data for various environmental matrixes

- Develop future monitoring and assessment strategies to ensure continued attainment of the water quality goals of the Clean Water Act.

SECTION 2

POINT SOURCE DISCHARGE ANALYSIS

2.1 ASSESSING TOXICS LOADINGS FROM POINT SOURCE DISCHARGERS

2.1.1 Data Sources

RTI used two sources of information for calculating the loadings (pounds per year) of toxics discharged to surface waters in the A/P Study Area. These two data sources were agreed upon in discussions with the NC Division of Environmental Management. Discharger self-monitoring results from the DEM's Discharge Monitoring Report (DMR) database and Annual Pollutant Analyses and Monitoring (APAM) reports were used to calculate toxics loadings.

2.1.1.1 Discharge Monitoring Reports

The primary source of effluent chemical concentration and effluent flow data was the Compliance Monitoring System maintained by DEM (specifically the DMR database). The DMR data set provided to RTI by DEM for this task contained the following:

- Facility name
- State subbasin number
- National Pollutant Discharge Elimination System (NPDES) number for each facility and pipe number
- STORET parameter code
- Parameter concentration or loading (monthly average)
- Month of the reported value.

RTI and DEM jointly generated the list of toxics (Table 2-1) for which data were accessed (extracted), and DEM performed the data retrieval from the Compliance Monitoring System (DMR database) that was provided to RTI for analysis.

A brief overview of the process by which effluent-related information moves from the discharger into the DMR database follows. Each facility has an NPDES permit, written by DEM, that specifies, for that facility, pollutants to be monitored, sampling and analysis frequency, and sampling location. Typically, major industrial and municipal facilities are required to sample pollutants, including toxic pollutants, as often as daily. Minor industrial and

Table 2-1. List of Toxic Pollutants Selected for Screening Analysis

Parameter code	Pollutant	Parameter code	Pollutant
00720	Cyanide, total	34320	Chrysene
00940	Chloride	34381	Fluorene
00951	Fluoride, total	34461	Phenanthrene
01002	Arsenic	34469	Pyrene
01007	Barium	34481	Toluene
01012	Berylium	34586	2-Chlorophenol
01027	Cadmium, total	34601	2,4-Dichlorophenol
01032	Chromium, hexavalent	34694	Phenol, total (single compound)
01034	Chromium, total	34696	Naphthalene
01042	Copper	39032	Pentachlorophenol (PCP)
01051	Lead	39350	Chlordane
01067	Nickel	39516	PCBs, total
01077	Silver	34671	Aroclor 1016
01092	Zinc, total	39488	Aroclor 1221
01097	Antimony	39492	Aroclor 1236
01105	Aluminum	39496	Aroclor 1242
01147	Selenium, total	39500	Aroclor 1248
32730	Phenols, total	39504	Aroclor 1254
34200	Acenaphthylene	39508	Aroclor 1260
34205	Acenaphthene	50060	Residual chlorine, total
34220	Anthracene	71900	Mercury, total
34230	3,4-Benzofluoranthene	81522	1,2-Dibromomethane (EDB)
34235	Benzene	81551	Xylene
34242	Benzo(k)fluoranthene	84103	Dioxin
34247	Benzo(a)pyrene		

municipal facilities are generally required to sample less frequently. The facilities are responsible for sampling and analysis and for submission of data records as specified by DEM.

Permitted facilities submit reports of all required tests to the appropriate DEM Regional Office where they are maintained for a year or more. DEM Regional Office staff review the reports and have primary responsibility for enforcing permit limits. DEM Regional Offices are also involved in writing permits and in modifying permits as required. Copies of the facility monitoring report are sent to the central DMR files at DEM in Raleigh where they are entered into the DMR database and undergo additional review. This review includes checking new data against data from a previous month's entry; if there are major differences between months, the State attempts to determine the reason for the difference and/or to correct the values.

Several additional points should be highlighted concerning the DMR database files used in this toxics loading analysis:

- Parameter values were reported by month for the 2-year period of record accessed for the analysis (January 1989 through December 1990). Monthly parameter values provided to RTI by DEM were the arithmetic mean of all the reported values provided by an individual facility in a given month for each pollutant.

- DEM assigns a value of zero to each parameter concentration listed as "below detection limits" (BDL) when computing the arithmetic mean monthly value. Such samples may not truly reflect the nature of the discharge for a large number of parameters because multiple BDLs will lower the mean monthly values below the "true" values and the true value may lie between zero and the detection limit.

- Blank values are left in the DMR database when no value is reported. These are separate from the "zero" and "BDL" values that may be found. Blank values are not used in calculating the arithmetic means.

- Quality control for the DMR database is performed at various points in the data entry process. However, RTI found obvious data errors in facilities DMR reports that did reach the State DMR database. Data errors also may enter the system during the process of data entry.

RTI performed data quality checks of all parameter data used in the loading analysis by screening for both high and low outliers. After the database was compiled, all reported monthly values for the pollutants and facilities of interest were examined. A few reported monthly values were suspicious, because of a three-order-of-magnitude difference with other reported monthly values for the same parameter. RTI contacted DEM Regional Office staff and confirmed that the units recorded for these outliers were incorrect. Typically, the facility had reported chemical concentrations in milligrams per liter instead of micrograms per liter. A second, more complete, data quality scan was performed to identify all reported discharge concentrations above 1 mg/L--suspiciously high values. In conjunction with scanning for suspiciously high values, RTI screened all DMR monthly concentrations below 1 µg/L--suspiciously low values. Reviewing these data quality scan results showed one facility with greater than 10 suspiciously high values and six facilities with greater than 10 suspiciously low values. The facility with greater than 10 suspiciously high values was the Texasgulf plant (NPDES NC0003255), and its high values were for fluoride--values confirmed to be correct by the DEM Regional Office in Washington, NC.

Mercury is the only metal in RTI's screening analysis with both standards and detection limits below 1 µg/L. Among the six facilities with suspiciously low values, two facilities reported large numbers of mercury values at the detection limit and therefore RTI did not perform further checks. Two other facilities were municipal wastewater treatment plants (WWTP) with large numbers of low values. These facilities provided the daily values for 1989 and 1990, and the low monthly (average) values were determined to be correct because they were dominated by BDL values. Data values for the two remaining facilities were checked in conversations with either the DEM Regional Office staff or the facility, and misreported parameter units were confirmed. The values were corrected in the RTI microcomputer data file.

Note: It was not feasible for RTI to verify every suspicious outlier value in the DMR database file for all facilities. Therefore, it is possible that loadings computed for some toxic contaminants from some dischargers are incorrect--either underestimating or overestimating the actual toxics loadings. Furthermore, it is possible that, because some loadings may be in error, some dischargers are flagged for potential exceedances of ambient water quality standards (see Section 2.2) based on erroneous data and other dischargers were not flagged in RTI's screening process.

A summary of the 78 facilities screened by RTI using the DMR database is provided in Appendix A. These were the facilities for which all data required for loading analysis were available. Most other facilities in the A/P Study Area were not analyzed because they are not required by permit to conduct toxics monitoring.

2.1.1.2 Annual Pollutant Analysis and Monitoring (APAM) Data

Major industrial and municipal facilities have additional permit requirements to sample annually for a broad spectrum of toxics, and priority pollutants constitute the majority of these pollutants. Analyses of additional toxic pollutants are required on a facility-specific basis as defined by DEM; typically organic pollutants used or generated by the facility must be monitored. Of all North Carolina facilities participating in the APAM program, approximately 40 are located in the A/P Study Area. The APAM files accessed for this analysis included 3 years of data from January 1989 through December 1991. Because the date of the annual pollutant scan is set by the permit requirements, data from two annual scans were available for some facilities and data from three annual scans were available for others. The APAM files accessed are maintained in the DEM central archive files in Raleigh. RTI staff extracted all available parameter data from hard-copy files and digitized the data used for this analysis.

Information collected from APAM files included the

- Facility name
- NPDES number for each facility and pipe number
- STORET parameter code
- Parameter concentration (one value per year)
- Date of reported value.

RTI recorded only parameter values above detection limits. No major problems were identified in the data set, and no additional data quality screening checks were performed.

A summary of 26 facilities screened in the APAM database is provided in Appendix A. All data required for loading analysis were available for these facilities.

2.1.2 Methodology for Loading Estimates

RTI converted the reported monthly average of daily discharge pollutant concentrations and discharge flows in DMR data to loadings (in pounds per day) using the following equation:

$$L = Q_e \times C_e \times CF \qquad (2\text{-}1)$$

where

L = Monthly average daily loading (lb/d)
Q_e = Effluent flow (mgd)
C_e = Effluent concentration (µg/L)
CF = Conversion factor (0.00834 lb/million gallons/µg/L).

Monthly average daily loadings (MADL) were averaged over the 2-year reporting period, to obtain a yearly average daily loading (YADL) estimate for each pollutant at each facility. YADL estimates were multiplied by 365 to obtain an estimate of the total annual loading of each pollutant at each facility. MADLs of zero, or those reported as being below the detection limit (BDL), were not included in calculating the yearly average daily loadings for the 2-year period. MADLs reported as zero tend to lower the YADL, resulting in a lower estimate of the total annual loading. **Because some of these zero MADLs may reflect lack of data or BDL samples that are not really zero concentration samples, RTI staff decided to drop any MADLs reported as zero in the calculation of YADLs. This conservative approach may tend to overestimate YADLs and total annual loadings.**

2.1.3 Loading Analysis Results

Table 2-2 presents the estimated annual loadings for each facility and pollutant calculated using the DMR data. Results are reported by river basin, and total annual loadings for each pollutant within the basin are summarized at the end of each basin listing. Only loadings computed from DMR data are discussed because the DMR file provides much more frequent data (e.g., daily) on effluent discharges and therefore provides a better estimate of the true loading of each pollutant than that which could be calculated from two or three annual APAM samples. APAM data are used, however, in assessing potential discharger exceedances (Section 2.2).

The relative loading contributions within each of the State-defined basins are compared in Table 2-3. The basinwide loading summaries do not imply that the reported total annual loadings are expected at the downstream point in the basin. Organic pollutants and metals can be biodegraded or transformed to other forms or become bound to sediment or detritus. Nevertheless, RTI assumed, for the purpose of this total loading analysis, that the discharged pollutants behave as conservative substances (i.e., are not degraded or transformed once discharged into receiving waters).

2.1.3.1 Albemarle Estuarine System

Toxics loadings to the Albemarle estuarine system are shown in Table 2-2 and include loadings from one industrial discharger to the Chowan River and two dischargers (one industrial and one municipal) to the Pasquotank basin but are predominated by loadings from 15 dischargers (nine industrial and six municipal facilities) to the Roanoke River basin. Point source loadings to the Albemarle estuarine system represented 99 percent of aluminum, 100 percent of arsenic, 74 percent of cadmium, 44 percent of chromium, 68 percent of copper, 52 percent of lead, 45 percent of nickel, 96 percent of selenium, 46 percent of silver, and 44 percent of zinc discharges to the combined A/P Study Area.

2.1.3.2 Pamlico Estuary

Toxics loadings for the Pamlico Estuary are shown in Table 2-2 and include loadings from seven dischargers (four industrial and three municipal facilities). Loadings to the Pamlico basin were generally lowest for all toxicants as compared to either the Albemarle or Neuse Estuaries with the exception of fluoride, mercury, cyanide, and nickel loadings. Loadings of these four toxics accounted for 99 percent (fluoride), 86 percent (mercury), 76 percent (cyanide), and 41 percent (nickel) of all discharges to the combined A/P Study Area.

Table 2-2. Average Yearly Metal Loadings by Discharger

(All loadings in pounds/year)

Basin: Chowan

NPDES	Facility Name	Aluminum	Arsenic	Cadmium	Chromium	Copper	Cyanide	Fluoride	Lead	Mercury	Nickel	Selenium	Silver	Zinc
NC0003867	United Piece Dye Works				137.10									
Total Yearly Loadings 1989-1990					137.10									

Basin: Pasquotank

NPDES	Facility Name	Aluminum	Arsenic	Cadmium	Chromium	Copper	Cyanide	Fluoride	Lead	Mercury	Nickel	Selenium	Silver	Zinc
NC0025011	Elizabeth City WWTP				134.60									408.00
NC0049140	Dare County Landfill	70.70		0.80	7.70	5.50			8.00	0.10	6.90			13.10
Total Yearly Loadings 1989-1990		70.70		0.80	142.30	5.50			8.00	0.10	6.90			421.10

Basin: Roanoke

NPDES	Facility Name	Aluminum	Arsenic	Cadmium	Chromium	Copper	Cyanide	Fluoride	Lead	Mercury	Nickel	Selenium	Silver	Zinc
NC0001643	Fieldcrest Cannon, Inc.*				2.40									
NC0001961	West Point Pepperell / Hamilton Plant				125.00									
NC0003425	CP&L / Roxboro Steam* Electric Facility		2904.40			1322.10						2455.60		
NC0003468	Duke Power/Dan River Station*		40.90			308.60						22.70		
NC0020559	Henderson-Nutbush Creek WWTP*			10.30	70.80	159.80	44.90		58.80		278.00		7.20	501.60
NC0021024	Roxboro WWTP*	3635.80			163.70	2089.50					450.20			1417.00
NC0021873	Mayodan WWTP*													184.40
NC0023710	Penn Elastic Company				79.20									
NC0024201	Roanoke Rapids SD/Roanoke Rapids WWTP			395.10	219.40	424.00			1500.70		426.80			1905.70
NC0024406	Duke Power/Belews Creek* Steam Station		175.30			15.90						43.90		2.80
NC0025071	Eden / Mebane Bridge WWTP*					3499.50	255.50		927.20		473.70		383.40	2536.10
NC0028011	Stoneville WWTP*		2.80	2.50	8.50		10.90		16.80	0.10	8.10			
NC0035173	Halstead Industries*					12.70								
NC0038377	CP&L / Mayo Steam Electric* Plant		268.90									52.90		
NC0065081	Cogentrix of NC, Inc. / Roxboro Facility*				2.20									8.60
Total Yearly Loadings 1989-1990		3635.80	3392.30	407.90	671.20	7832.10	311.30		2501.50	0.10	1636.80	2575.10	390.60	6556.20

Table 2-2. Average Yearly Metal Loadings by Discharger

(All loadings in pounds/year)

Basin: Neuse

NPDES	Facility Name	Aluminum	Arsenic	Cadmium	Chromium	Copper	Cyanide	Fluoride	Lead	Mercury	Nickel	Selenium	Silver	Zinc
NC0001376	Burlington Industries / Wake Plant				193.90									
NC0001881	Phillips Plating Company			2.00	15.40	30.30	1.40		4.60		56.80		0.90	35.40
NC0003417	CP&L / Lee											110.00		
NC0003816	Cherry Point WWTP			9.10	91.10	24.00	92.90		16.30		20.30		18.80	213.50
NC0020389	Benson WWTP				43.50	256.70	11.00		33.00					1665.10
NC0020541	Kinston-Peachtree WWTP				229.30	246.20			288.90					378.90
NC0020842	Snow Hill WWTP				25.40									
NC0023841	Durham-Northside WWTP			6.50	32.60	795.20	133.60		87.90	2.70	57.90			1887.90
NC0023906	Wilson WWTP			8.90	53.00		58.80		138.90	34.80	150.70			
NC0024236	Kinston-Northside WWTP					189.20								177.30
NC0024368	Zebulon WWTP					94.80			13.60		30.40			101.70
NC0025020	Wendell WWTP					13.30	6.60		5.00		3.40			28.70
NC0026336	Durham-Eno River WWTP			2.60	10.30	153.10			29.40		24.30		20.30	464.70
NC0026433	Hillsborough WWTP				36.30									
NC0026824	John Umstead Hospital			4.70	40.00	92.20	22.60	1829.40	58.00	0.70	31.90		68.40	250.60
NC0029572	Farmville WWTP				111.70	201.50	2.60				71.70			238.70
NC0030716	Central Johnston County WWTP			86.50		292.50			384.50					209.70
NC0032077	Contentnea Metropolitan Sewage District								76.30					
NC0048879	Cary - North WWTP				104.20	116.70				1.60			243.80	248.60
NC0074667	Worsley Oil Company / Scotchman Store #76								0.30					
NC0075281	Craven Co Wood Energy Limited Partnership					111.30		344.40						134.90
Total Yearly Loadings 1989-1990				120.30	986.70	2617.00	329.50	2173.80	1136.70	39.80	447.40	110.00	352.20	6035.70

Table 2-2. Average Yearly Metal Loadings by Discharger

(All loadings in pounds/year)

Basin: Tar-Pamlico

NPDES	Facility Name	Aluminum	Arsenic	Cadmium	Chromium	Copper	Cyanide	Fluoride	Lead	Mercury	Nickel	Selenium	Silver	Zinc
NC0001503	CSX Transportation					17.00								
NC0001627	National Spinning Company				80.70									
NC0003255	Texas Gulf							970413.30						
NC0020605	Tarboro WWTP				61.30	179.00	192.40							650.90
NC0025054	Oxford-Renovated WWTP			22.30	78.40	90.10	60.10		253.70	240.60	135.70		112.70	521.90
NC0030317	Rocky Mount WWTP					858.90	1785.40		929.30		1296.00			1535.80
NC0086854	Corry Hiebert	2.50												
	Total Yearly Loadings 1989-1990	2.50		22.30	220.40	1145.00	2037.90	970413.30	1183.00	240.60	1431.70		112.70	2708.60

* These facilities are located in the Roanoke River Basin but are not within the boundaries of the A/P Study Area.

Table 2-3. Summary of Yearly Metal Loadings in the Albemarle/Pamlico Study Area

	Aluminum	Arsenic	Cadmium	Chromium	Copper	Cyanide	Fluoride	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Chowan Total Yearly Loadings 1989-1990				137.10									
Pasquotank Total Yearly Loadings 1989-1990	70.70		0.80	142.30	5.50			8.00	0.10	6.90			421.10
Roanoke Total Yearly Loadings 1989-1990	3635.80	3392.30	407.90	671.20	7832.10	311.30		2501.50	0.10	1636.80	2575.10	390.60	6556.20
Neuse Total Yearly Loadings 1989-1990			120.30	986.70	2817.00	329.50	2173.80	1136.70	39.80	447.40	110.00	352.20	6035.70
Tar-Pamlico Total Yearly Loadings 1989-1990	2.50		22.30	220.40	1145.00	2087.90	970413.30	1183.00	240.60	1431.70		112.70	2708.60
Albemarle/Pamlico Study Area Total Yearly Loadings 1989-1990	3709.00	3392.30	551.30	2157.70	11599.60	2678.70	972587.10	4829.20	280.60	3522.80	2685.10	855.50	15721.60

(All loadings are in pounds per year)

2.1.3.3 Neuse Estuary

Toxics loadings to the Neuse Estuary are shown in Table 2-2 and include loadings from 21 dischargers (six industrial and 15 municipal facilities). Loadings to the Neuse basin were intermediate between those discharged to the Pamlico and Albemarle basins. Loadings to the Neuse estuarine system represented 22 percent of cadmium, 46 percent of chromium, 23 percent of copper, 24 percent of lead, 14 percent of mercury, 41 percent of silver, and 38 percent of zinc discharges to the combined A/P Study Area.

2.1.4 Conclusions

Loadings to the three estuarine systems are compared in Figure 2-1 for all metals, cyanide, and fluoride. Fluoride loadings to the A/P estuarine area are several orders of magnitude higher than individual loadings for all other metals and cyanide and are principally the result of discharges from the Texasgulf facility to the Pamlico Estuary. In order to compare the loadings of all pollutants on the same graph, a logarithmic scale was used. To more clearly compare the loadings for the metals and cyanide in the three estuarine systems, fluoride data were not graphed in Figure 2-2, permitting use of a linear scale.

In general, loadings to the Albemarle estuarine system are predominated by seven major metals--copper, zinc, aluminum, arsenic, selenium, lead, and nickel--and are higher overall than loadings to either the Pamlico or Neuse Estuaries. It should be noted that the sources of loadings to the Albemarle result almost solely from loadings to the Roanoke River. Loadings to the Pamlico are predominated by three pollutants--fluoride (not shown in Figure 2-2), zinc, and cyanide--and, to a lesser degree, by nickel, lead, and copper. Almost all fluoride loadings are derived from discharges from one facility, Texasgulf. Loadings to the Neuse Estuary are predominated by four metals: zinc and copper and, to a lesser degree, by lead and chromium.

As shown in Figure 2-3, zinc, copper, and lead are the three metals predominating discharges to the A/P estuarine area with aluminum, nickel, arsenic, selenium, and cyanide of secondary importance with respect to the magnitude of loading. However, fluoride loadings (see Table 2-2) of nearly 1 million lb/yr (based on 1989-1990 data) are by far the largest single source of toxics entering the A/P estuarine system.

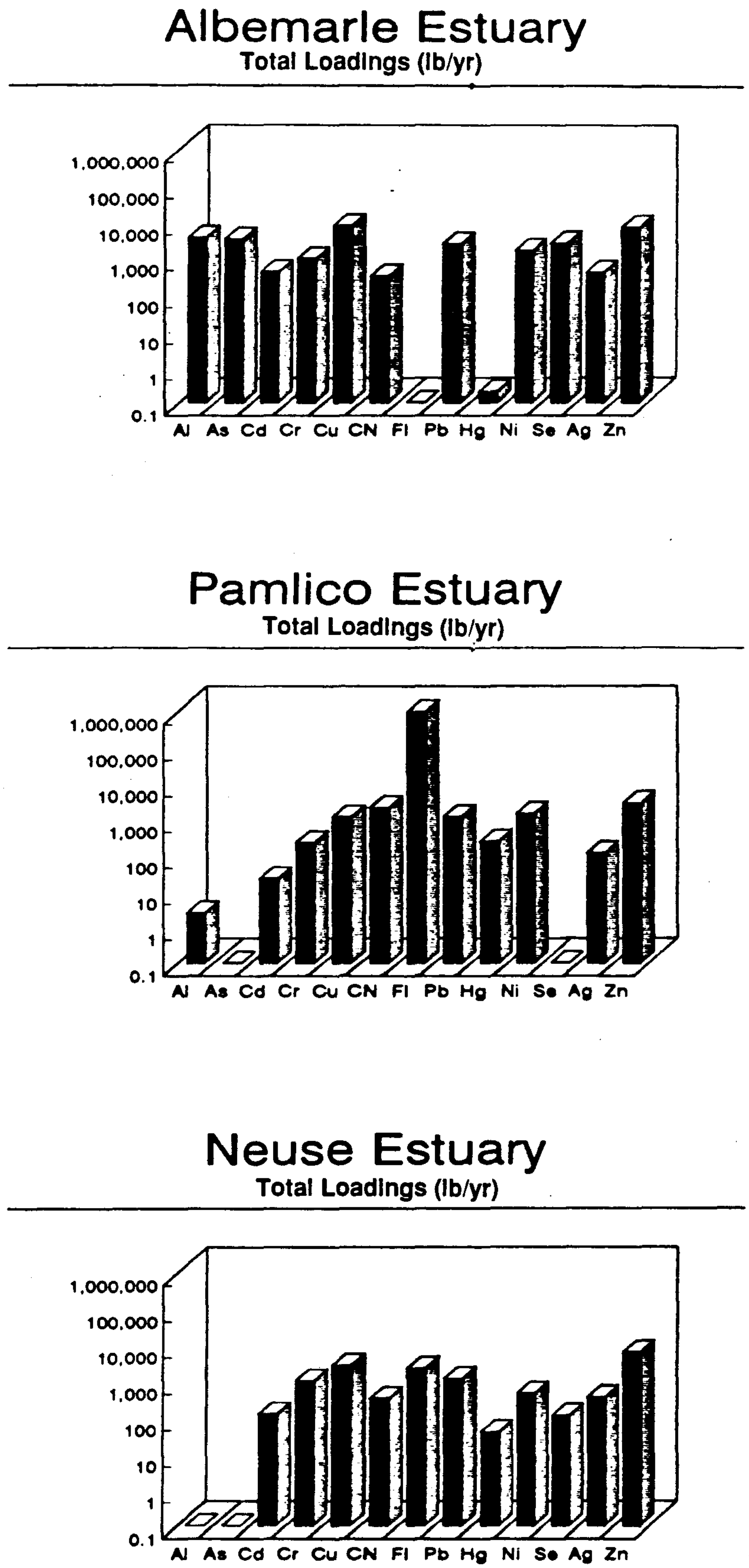


Figure 2-1. Comparison of annual loadings to the three estuarine systems (logarithmic scale).

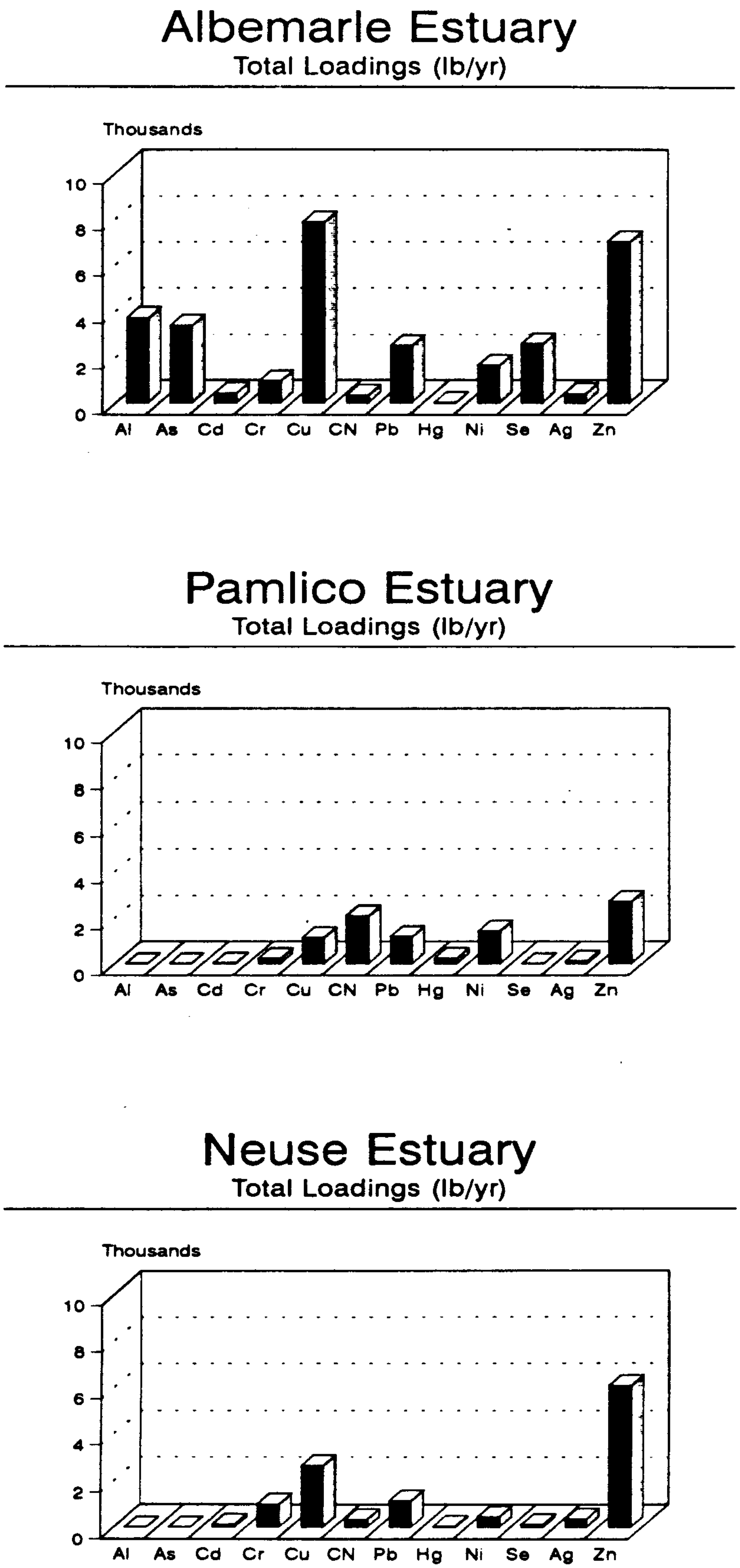


Figure 2-2. Comparison of annual loadings to the three estuarine systems.

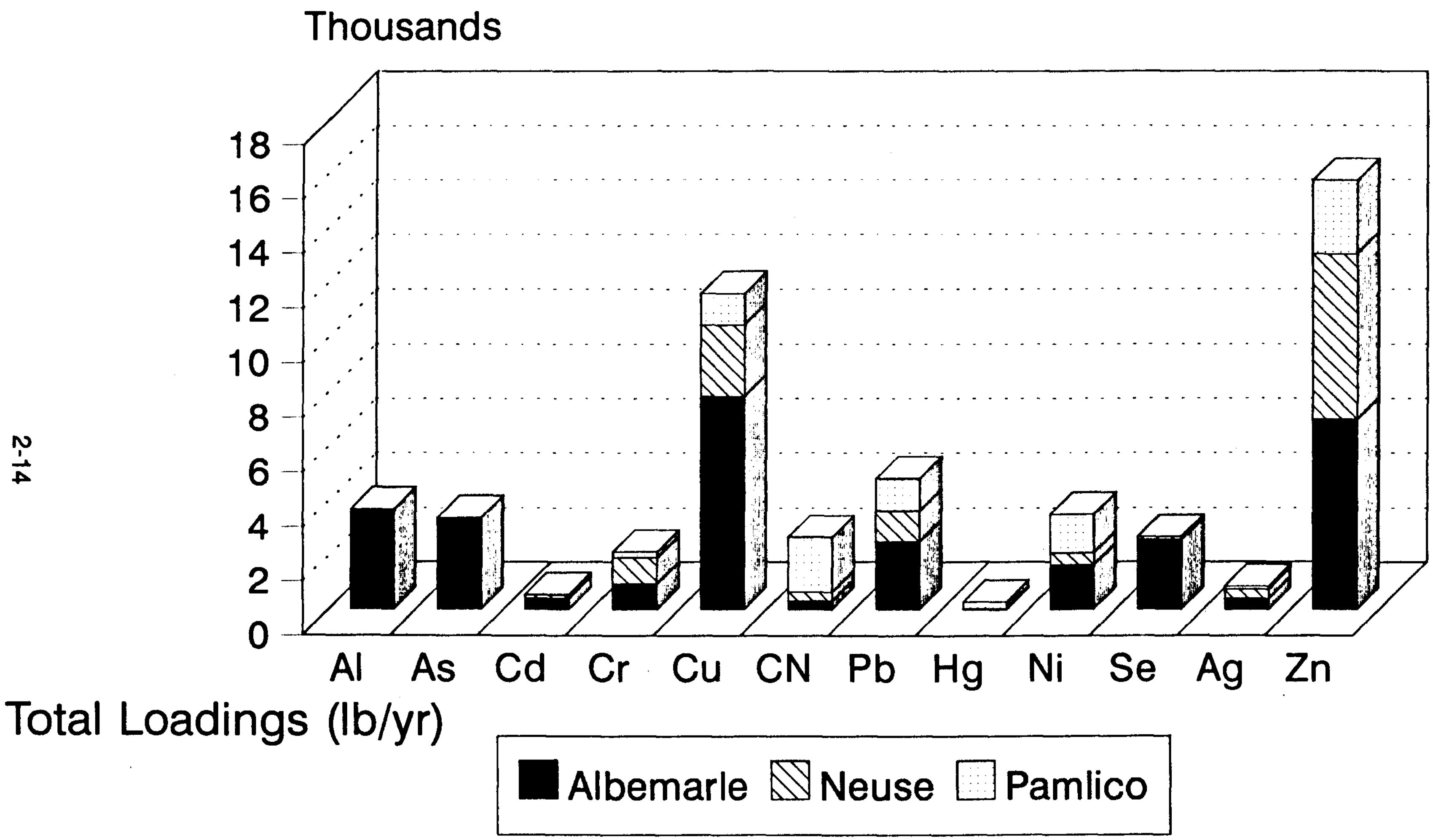


Figure 2-3. Total toxics loadings to the Albemarle/Pamlico estuarine system.

2.2 ASSESSING POTENTIAL DISCHARGER EXCEEDANCES OF WATER QUALITY STANDARDS

2.2.1 Data Sources

Data from the DMR and APAM microcomputer databases were used to determine which facilities' discharges could result in potential instream water quality standards and criteria exceedances under two different flow regimes. The methodology used to screen predicted instream concentrations against State standards and EPA criteria requires information on loadings, discharge flows, receiving stream flows, and stream classifications--freshwater or saltwater. For all toxics, North Carolina specifies that the low flow (7Q10) be used to set effluent limitations for aquatic life protection (15A NCAC 2B.0206) (NCDEM, 1991). This low flow value is also used to set effluent concentrations for protection of human health (i.e., noncarcinogens only). The 7Q10 is defined as the minimum average flow for a period of 7 consecutive days that has an average recurrence of once in 10 years (NCDEM, 1991).

DEM provided data files containing receiving stream flows and discharge flows. The receiving stream data file was not complete. There were several missing values, and followup with the State was required in some cases to determine the appropriate receiving stream flows associated with specific dischargers. Discharge flow data files were complete and required no followup with the State.

2.2.2 Methodology for Assessing Potential Water Quality Exceedances

After daily loadings were calculated for all toxics (see Section 2.1.2), RTI calculated the freshwater instream concentration of each pollutant using the following general equation:

$$ISC = \frac{L}{(Q_d + Q_r) \times CF} \qquad (2\text{-}2)$$

where

ISC = Instream concentration (µg/L)
L = MADL (lb/day) (from Equation 2-1)
Q_d = Design flow at discharge (mg/d)
Q_r = Receiving stream low flow (summer 7Q10, mg/d) or average flow (mg/d)
CF = Conversion factor (0.00834 lb/10^6 gal/µg/L).

Note: For the purpose of this analysis, single-sample APAM data were assumed to represent MADL. RTI used a conservative approach for analyzing facility impacts to receiving streams by using low flows (7Q10). This is consistent with State regulations that require dischargers to meet effluent limits (loadings) based on 7Q10 stream flow. Where the low flow condition is no flow (7Q10 = 0), the ISC is equal to the discharge concentration. Receiving stream average flows were also used to screen for dischargers whose loadings to receiving streams even under average flow conditions could also result in potential exceedances of water quality standards/criteria. It should be clearly understood, however, that legal exceedances of water quality standards criteria are calculated using 7Q10 low flow conditions only.

For dischargers located on a lake or in estuarine waters, the general equation was modified as follows:

$$ISC = \frac{L}{DF \times CF} \qquad (2\text{-}3)$$

where

ISC = Instream concentration (μg/L)
L = MADL (lb/d)
DF = Dilution factor for lakes and estuaries, assumed to be 50
CF = Conversion factor (.00834lb/10^6gal/μg/L).

Estuarine and lacustrine dischargers were screened using a 50:1 dilution factor on facility effluents. This value was agreed upon in consultation with the State.

RTI reviewed five documents to determine whether facilities were discharging into fresh waters or tidal waters:

- North Carolina Division of Environmental Management. 1985. State of North Carolina Ambient Water Quality Monitoring Program. Department of Natural Resources and Community Development, Water Quality Section, Raleigh, NC.

- State of North Carolina. 1989. Classifications and Water Quality Standards Assigned to the Waters of the Roanoke River Basin. Department of Environment, Health and Natural Resources, Raleigh, NC (NC Administrative Code: 15A NCAC 2B.0313).

- State of North Carolina. 1990. Classifications and Water Quality Standards Assigned to the Waters of the Chowan River Basin. Department of Environment, Health and Natural Resources, Raleigh, NC (NC Administrative Code: 15A NCAC 2B.0314).

- State of North Carolina. 1990. Classifications and Water Quality Standards Assigned to the Waters of the Neuse River Basin. Department of Environment, Health and Natural Resources, Raleigh, NC (NC Administrative Code: 15A NCAC 2B.0315).

- State of North Carolina. 1990. Classifications and Water Quality Standards Assigned to the Waters of the Tar-Pamlico River Basin. Department of Environment, Health and Natural Resources, Raleigh, NC (NC Administrative Code: 15A NCAC 2B.0316).

Using the NC Ambient Water Quality Monitoring Program document, a set of U.S. Geological Survey (USGS) maps (1:24,000 and 1:100,000), and the appropriate classification document descriptions for each river basin, RTI was able to assign freshwater or saltwater designations to all dischargers.

One goal of this toxics assessment was to understand the potential impacts of discharged toxics on instream concentrations of pollutants that could be harmful to aquatic life. RTI measured potential impacts by comparing the estimated instream toxics concentrations with appropriate water quality screening values. Screening values were compiled from North Carolina water quality standards and EPA water quality criteria. RTI screened each estimated instream toxics concentration against the appropriate North Carolina water quality standard for surface waters (Appendix B). Included with the State standards are the State action levels. Action levels are developed for permitting where "numbers" are needed but where a rigorous standard-setting procedure cannot be followed (State of North Carolina, 1991). Where no North Carolina State standard was available for a particular pollutant, the current EPA chronic water quality criterion (criterion continuous concentration or CCC) was used (Appendix B). If no EPA water quality criterion was available, the North Carolina human health standard or the EPA human health criterion (organism consumption only) was used, in that order. Federal water quality criteria are updated regularly by EPA's Criteria and Standards Division and a revised compilation of these criteria was provided by Region 4. RTI obtained the most current EPA water quality criteria listing dated October 1991 (U.S. EPA, 1991a; Appendix B). The final screening values used to evaluate estimated instream water quality exceedances are shown in Tables 2-4 and 2-5 for fresh waters and salt waters, respectively. For some pollutants, no State standards or Federal criteria were available and, for these pollutants, no screening for potential exceedances was performed.

After screening all estimated instream concentration data, RTI identified those dischargers that could have caused one or more exceedances of a State water quality

Table 2-4. Comparison of State Standards and EPA Criteria and Final Pollutant Screening Values Used to Identify Instream Water Quality Exceedances in Fresh Waters

Pollutant	STORET Code	Units	State Standard	EPA Gold Book	State Human Health	EPA Human Health	Final Pollutant Screening Value
1,2 Dibromoethane (EDB)	81522	ug/l					
2,4-Dichlorophenol	34601	ug/l					
2-Chlorophenol	34586	ug/l					
3,4-Benzoflouranthene	34230	ug/l				0.0311	0.031100
Acenaphthylene	34200	ug/l					
Acenapthene	34205	ug/l					
Al Aluminum	01105	ug/l		87			87.000000
Ammonia Nitrogen	00610	mg/l					
Anthracene	34220	ug/l				107692	107692.000000
Antimony	01097	ug/l				4308	4308.000000
As Arsenic	01002	ug/l	50	190		0.14	50.000000
Barium	01007	ug/l			1	2000	1000.000000
Benzene	34235	ug/l			71.4	71.28	71.400000
Benzo(a)Pyrene	34247	ug/l				0.0311	0.031100
Benzo(k)Flouranthene	34242	ug/l				0.0311	0.031100
Be Berylium	01012	ug/l			0.117	0.13	0.117000
Cd Cadmium	01027	ug/l	2	0.66			2.000000
Chlordane	39350	ug/l	0.004	0.0043	0.000588		0.004000
Cl Chloride	00940	mg/l	230	230			230.000000
TRC Chlorine, Total Resid	50060	ug/l	17	11			17.000000
Chromium, Hexavalent	01032	ug/l		11			11.000000
Cr Chromium, Total	01034	ug/l	50				50.000000
Chrysene	34320	ug/l				0.0311	0.031100
Cu Copper	01042	ug/l	7	6.54			7.000000
CN Cyanide, Total	00720	ug/l	5	5.2			5.000000
Dioxin	34675	ng/l			0.000014		0.000014
Fluorene	34381	ug/l				14358.5	14358.500000
F Fluoride, Total	00951	ug/l	1800				1800.000000
Flow, effluent	50050	cfs					
Hardness, Total	00900	mg/l					
Hexachlorobenzene	39700	ug/l				0.00077	0.000770
Pb Lead	01051	ug/l	25	1.32			25.000000
Hg Mercury, Total	71900	ug/l	0.012	0.012		0.153	0.012000
Napthalene	34696	ug/l					
Ni Nickel	01067	ug/l	88	87.7		4584	88.000000
PCB 1016	34671	ug/l		0.014			0.014000
PCB 1221	39488	ug/l					
PCB 1236	39492	ug/l					
PCB 1242	39496	ug/l		0.014			0.014000
PCB 1248	39500	ug/l		0.014			0.014000
PCB 1254	39504	ug/l		0.014			0.014000
PCB 1260	39508	ug/l		0.014			0.014000
PCBs, Total	39516	ug/l	0.001		0.000079		0.001000
Pentachlorophenol	39032	ug/l		2.1		0.16	2.100000
Phenanthrene	34461	ug/l					
Phenol (sgl. cmpd)	34694	ug/l				4615385	
Phenols, Total	32730	ug/l					
Pyrene	34469	ug/l				10769.2	10769.200000
Salinity	00096	ppt					
Salinity	00480	ppt					
Se Selenium, Total	01147	ug/l	5	5.0			5.000000
Ag Silver	01077	ug/l	0.06				0.060000
Temperature	00010	deg C					
Toluene	34481	ug/l	11			201294	11.000000
Xylene	81551	ug/l					
Zn Zinc, Total	01092	ug/l	50	58.91			50.000000
pH effluent	00400	su	6-9	6.5-9			

Table 2-5. Comparison of State Standards and EPA Criteria and Final Pollutant Screening Values Used to Identify Instream Water Quality Exceedances in Salt Waters

Pollutant	STORET Code	Units	State Standard	EPA Gold Book	State Human Health	EPA Human Health	Final Pollutant Screening Value
1,2 Dibromoethane (EDB)	81522	ug/l					
2,4-Dichlorophenol	34601	ug/l					
2-Chlorophenol	34586	ug/l					
3,4-Benzoflouranthene	34230	ug/l				0.0311	0.031000
Acenaphthylene	34200	ug/l					
Acenapthene	34205	ug/l					
Al Aluminum	01105	ug/l					
Ammonia Nitrogen	00610	mg/l					
Anthracene	34220	ug/l				107692	107692.000000
Antimony	01097	ug/l				4308	4308.000000
As Arsenic	01002	ug/l	50	36		0.14	50.000000
Barium	01007	ug/l				2000	2000.000000
Benzene	34235	ug/l			71.4	71.28	71.400000
Benzo(a)Pyrene	34247	ug/l				0.0311	0.031100
Benzo(k)Flouranthene	34242	ug/l				0.0311	0.031100
Be Berylium	01012	ug/l			0.117	0.13	0.117000
Cd Cadmium	01027	ug/l	5	9.3			5.000000
Chlordane	39350	ug/l		0.004	0.000588	0.000588	0.004000
Cl Chloride	00940	mg/l					
TRC Chlorine, Total Resid	50060	ug/l		7.5			7.500000
Chromium, Hexavalent	01032	ug/l		50			50.000000
Cr Chromium, Total	01034	ug/l	20				20.000000
Chrysene	34320	ug/l				0.0311	0.031100
Cu Copper	01042	ug/l	3	2.9			3.000000
CN Cyanide, Total	00720	ug/l	1	1			1.000000
Dioxin	34675	ng/l			0.000014		0.000014
Fluorene	34381	ug/l				14358.5	14358.500000
F Fluoride, Total	00951	ug/l					
Flow, effluent	50050	cfs					
Hardness, Total	00900	mg/l					
Hexachlorobenzene	39700	ug/l				0.00077	0.000770
Pb Lead	01051	ug/l	25	5.6			25.000000
Hg Mercury, Total	71900	ug/l		0.025		0.153	0.025000
Napthalene	34696	ug/l					
Ni Nickel	01067	ug/l	8.3	8.3		4584	8.300000
PCB 1016	34671	ug/l		0.03		0.000045	0.030000
PCB 1221	39488	ug/l					
PCB 1236	39492	ug/l					
PCB 1242	39496	ug/l		0.03		0.000045	0.030000
PCB 1248	39500	ug/l		0.03		0.000045	0.030000
PCB 1254	39504	ug/l		0.03		0.000045	0.030000
PCB 1260	39508	ug/l		0.03		0.000045	0.030000
PCBs, Total	39516	ug/l					0.001000
Pentachlorophenol	39032	ug/l		7.9		0.16	7.900000
Phenanthrene	34461	ug/l					
Phenol (sgl. cmpd)	34694	ug/l				4615385	4615385.000000
Phenols, Total	32730	ug/l					
Pyrene	34469	ug/l				10769.2	10769.200000
Salinity	00096	ppt					
Salinity	00480	ppt					
Se Selenium, Total	01147	ug/l	71	71			71.000000
Ag Silver	01077	ug/l	0.1				0.100000
Temperature	00010	deg C					
Toluene	34481	ug/l				201294	201294.000000
Xylene	81551	ug/l					
Zn Zinc, Total	01092	ug/l	86	86			86.000000
pH effluent	00400	su	6.8-8.5				

standard or Federal water quality criterion during the 2-year period analyzed if the instream flow were at 7Q10 or average flow. By EPA definition, aquatic life use is not supporting if, for any one pollutant, one or more violations of acute or chronic toxicity criteria occur within a 3-year period based on grab or 1-day composite samples (U.S. EPA, 1991c; Appendix B). If the State has collected an abundant data set (i.e., sampling monthly or more frequently over a 3-year period), a once-in-three-years violation is allowed; therefore, two or more violations of acute or chronic criteria are needed to show nonsupport (see Appendix C). The EPA 305(b) guidance further states that waters should be sampled at least quarterly to be considered monitored and sampled monthly or more frequently for monitoring data to be considered abundant. Although, in general, dischargers collected an abundant data set for DMR reports, only 2 years of data were provided to RTI by the State for analysis. **Therefore RTI screened all facilities to identify those dischargers where the calculated instream pollutant concentration exceeded a water quality standard or criterion for an individual pollutant one or more times over the 2-year period of record.** For the APAM data, only two or three annual data summaries were available for any discharger that would not have met the EPA definition of monitored data (e.g., at least quarterly sampling); however, the same criterion (one or more violations of a standard/criterion) for an individual pollutant was used.

RTI believes that reporting of potential exceedances of State standards or EPA criteria is defensible using the methods described, given the limitations of the DMR and APAM data sets. This type of approach has been used, for example, in screening for toxics impacts under 304(l) of the Clean Water Act. **It should be clearly understood, however, that this analysis is applied as a screening tool to identify the potential for exceedances rather than *actual* violations of either North Carolina water quality standards or Federal water quality criteria.** The following results suggest that further analysis and scrutiny may be appropriate for the identified facilities.

2.2.3 Results

A summary of those facilities where instream water quality exceedances were predicted to be possible under the 7Q10 and average flow regimes is presented in Tables 2-6 and 2-7 for the DMR and APAM based data, respectively. In addition, the pollutants calculated to exceed the water quality standards or EPA criteria and the number of potential exceedances predicted during the period of record analyzed are summarized for each basin.

Table 2-6. Predicted In-stream Water Quality Standards and Criteria Exceedances
At 7Q10 and Average Streamflow Conditions
Based on 1989-1990 Discharge Monitoring Data

Basin: PASQUOTANK

Subbasin: 030151

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0049140	Dare County Landfill East Lake	7Q10	14		5	2	15	6	15	1			5	

Basin: ROANOKE

Subbasin: 030201

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0024406	Duke Power / Belews Creek 002*	Lake					2							
NC0036173	Halstead Industries*	7Q10					23							
NC0036173	Halstead Industries*	Average Flow					3							

Subbasin: 030203

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0025071	Eden / Mebane Ridge Wwtp, City*	7Q10					2					1		
NC0025071	Eden / Mebane Ridge Wwtp, City*	Average Flow										1		

Subbasin: 030205

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0003425	Cp&l Roxboro Steam Elec. Fac.*	7Q10		12			3				24			
NC0003425	Cp&l Roxboro Steam Elec. Fac.*	Average Flow									13			
NC0021024	Roxboro Wwtp, City Of*	7Q10	23				24						24	
NC0021024	Roxboro Wwtp, City Of*	Average Flow	23				24						22	

Subbasin: 030206

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0020559	Nutbush Creek Wwtp / Henderson*	7Q10			1		1	1		1		3	3	1
NC0020559	Nutbush Creek Wwtp / Henderson*	Average Flow			1		1			1		3		1

Basin: TAR-PAMLICO

Subbasin: 030301

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0025054	Oxford - Southside #2, City Of	7Q10			7	2	15	12	11			14	15	7
NC0025054	Oxford - Southside #2, City Of	Average Flow			3		8	4	11			14	8	4
NC0036854	Corry Hiebert Furniture Co.	7Q10	20											

Subbasin: 030302

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0030317	Tar River Wwtp	7Q10					3							10

See note at end of table.

Table 2-6. Predicted In-stream Water Quality Standards and Criteria Exceedances
At 7Q10 and Average Streamflow Conditions
Based on 1989-1990 Discharge Monitoring Data

Basin: NEUSE

Subbasin: 030401

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0023841	Durham / Northside Wwtp	7Q10					16		5				16	2
NC0023841	Durham / Northside Wwtp	Average Flow					12		1				1	1
NC0026336	Durham Eno Wwtp, City Of	7Q10					18					8	17	
NC0026336	Durham Eno Wwtp, City Of	Average Flow										3		
NC0026824	John Umstead Hospital	7Q10					3	1	2			1	3	3
NC0026824	John Umstead Hospital	Average Flow										1		

Subbasin: 030402

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0048879	Cary, Crabtree Creek, Town Of	7Q10				1	10		8			9	3	
NC0048879	Cary, Crabtree Creek, Town Of	Average Flow										9		

Subbasin: 030404

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0020389	Benson Wwtp, Town Of	7Q10					21						23	4
NC0020389	Benson Wwtp, Town Of	Average Flow					15						13	

Subbasin: 030406

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0025020	Wendell, Town Of	7Q10					1							1

Subbasin: 030407

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0023906	Wilson Wwtp, City Of	7Q10							3					
NC0024368	Zebulon Wwtp, Town Of	7Q10					19	3					7	
NC0024368	Zebulon Wwtp, Town Of	Average Flow					16						1	
NC0029572	Farmville, Town Of	7Q10				1	7						2	

Subbasin: 030410

Predicted Number of Exceedances Based on 1989-1990 DMR Data

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn	CN
NC0001881	Phillips Plating Company	Tidal				1	18			11		7		1
NC0003816	Usmc - Cherry Point #1	Tidal										4		

Note: The above listings do not represent actual exceedances of water quality standards or criteria. Rather, they are the result of a screening analysis to show the potential for exceedances under certain flow conditions.

*These facilities are located in the Roanoke River Basin but are not within the boundaries of the A/P Study Area.

Table 2-7. Predicted In-stream Water Quality Standards and Criteria Exceedances
At 7Q10 and Average Streamflow Conditions
Based on Recent APAM Data

Basin: ROANOKE

Subbasin: 030210

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
			Predicted Number of Exceedances Based on Recent APAM Data										
NC0026751	Windsor WWTP, Town Of	7Q10	1						1				
NC0026751	Windsor WWTP, Town Of	Average Flow							1				

Basin: TAR-PAMLICO

Subbasin: 030301

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
			Predicted Number of Exceedances Based on Recent APAM Data										
NC0025054	Oxford - Southside #2, City Of	7Q10	2		1		2		1		1		1
NC0025054	Oxford - Southside #2, City Of	Average Flow					1		1		1		1

Subbasin: 030302

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
			Predicted Number of Exceedances Based on Recent APAM Data										
NC0030317	Tar River WWTP	7Q10					1						

Subbasin: 030305

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
			Predicted Number of Exceedances Based on Recent APAM Data										
NC0023931	Greenville Utilities Comm.	7Q10							1				

Basin: NEUSE

Subbasin: 030401

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
			Predicted Number of Exceedances Based on Recent APAM Data										
NC0026433	Hillsborough WWTP, Town Of	7Q10	1				1					1	1
NC0026433	Hillsborough WWTP, Town Of	Average Flow										1	
NC0026824	John Umstead Hospital	7Q10	2		1		2					1	1
NC0026824	John Umstead Hospital	Average Flow										1	

Subbasin: 030402

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
			Predicted Number of Exceedances Based on Recent APAM Data										
NC0001376	Burlington Ind. (Wake Plant)	7Q10					2						

Subbasin: 030407

NPDES	Facility Name	Flow	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
			Predicted Number of Exceedances Based on Recent APAM Data										
NC0023906	Wilson WWTP, City Of	7Q10	2				1						1

Note: The above listings do not represent actual exceedances of water quality standards or criteria. Rather, they are the result of a screening analysis to show the potential for exceedances under certain flow conditions.

Note: Only the location of those dischargers identified through analysis of the DMR database are mapped (Figures 2-4 and 2-5). Those dischargers with exceedances estimated from screening APAM files will be discussed briefly and results will be compared with those obtained in the DMR analysis.

2.2.3.1 Albemarle Estuarine System

In the Albemarle estuarine system, one discharger (Dare County Landfill) to the Pasquotank River and seven dischargers (three industrial and four municipal facilities) to the Roanoke River were identified as potentially producing instream water quality standards or criteria exceedances under 7Q10 flows (Tables 2-6 and 2-7). The Dare County Landfill was the only facility in the basin discharging to estuarine waters (Figure 2-4). Six dischargers to the Roanoke River system were also identified as potentially producing instream water quality standards or criteria exceedances under average flow conditions (Table 2-6). This latter group of dischargers is of potentially greater concern because the predicted exceedances occurred under average flow conditions that would be more typically present at a site (Figure 2-5) rather than low flow conditions.

Exceedances of instream concentrations of copper were predicted from DMR data at all facilities under 7Q10 flows; exceedances of zinc were predicted at three facilities under 7Q10 flows. Overall, potential exceedances of standards/criteria in this basin were predicted for 12 pollutants (aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc, and cyanide) under 7Q10 conditions.

2.2.3.2 Pamlico Estuary

In the Tar-Pamlico River basin, only four dischargers (two industrial and two municipal facilities) were identified as potentially producing instream water quality standards/criteria exceedances under 7Q10 flows (Tables 2-6 and 2-7) and the Oxford - Southside #2 facility was identified as potentially producing exceedances under average flow conditions as well. Overall, exceedances of standards/criteria were predicted from DMR data for aluminum, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, and cyanide for this river basin.

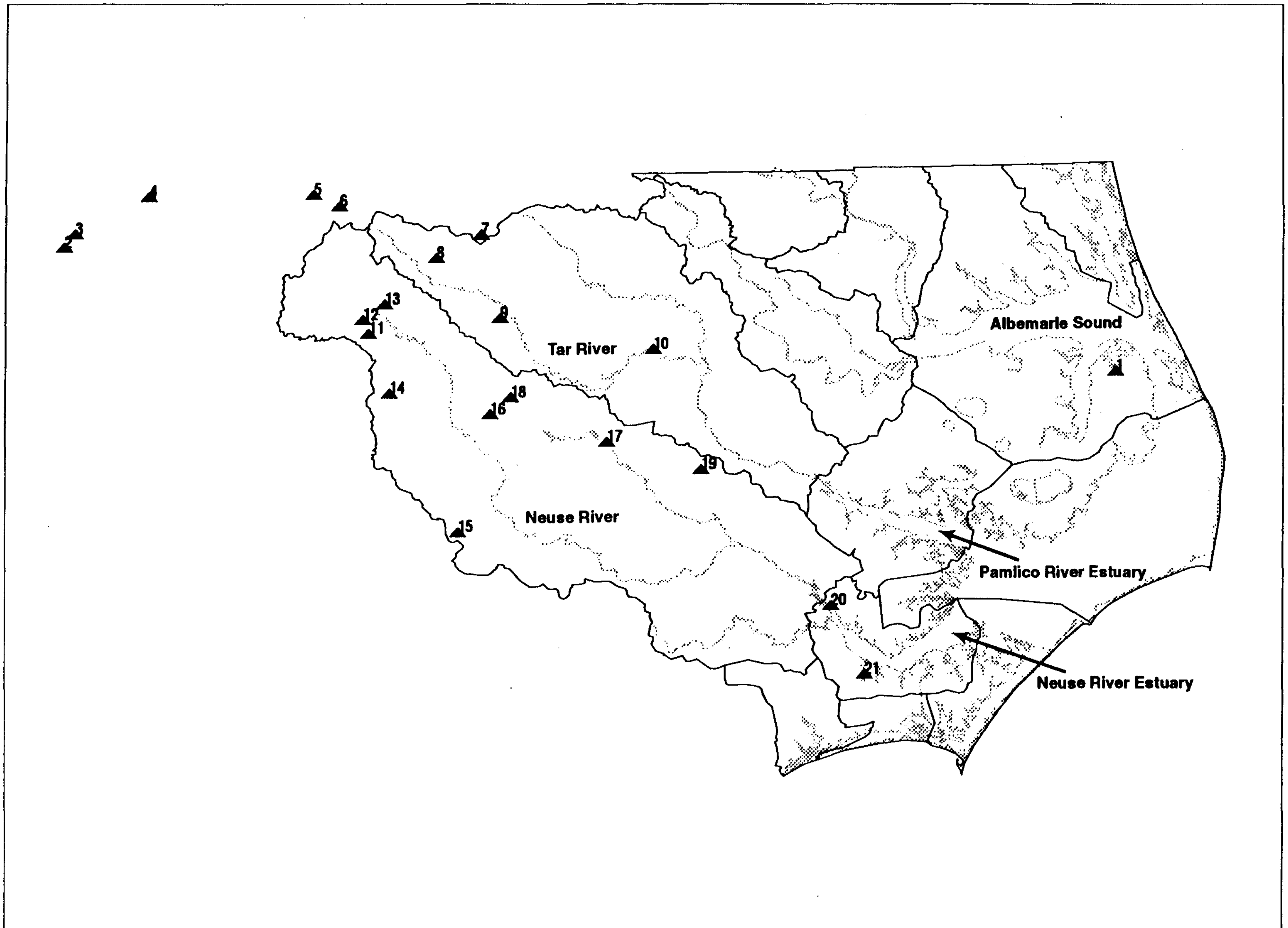


Figure 2-4 Locations of dischargers with the potential to cause exceedances of water quality standards under low flow conditions.

7Q10 Exceedences

#	Latitude	Longitude	NPDES	Subbasin	Basin Name	Flow Type	Exceedence Type
1	35.8742	75.8792	NC0049140	030151	Pasquotank	7Q10	CD,CR,CU,PB,HG,NI,ZN,AL
2	36.3061	80.0806	NC0024406*	030201	Roanoke	7Q10	CU
3	36.3494	80.0383	NC0035173*	030201	Roanoke	7Q10	CU
4	36.4714	79.7431	NC0025071*	030203	Roanoke	7Q10	CU,AG
5	36.4806	79.0842	NC0003425*	030205	Roanoke	7Q10	AS,CU,SE
6	36.4447	78.9797	NC0021024*	030205	Roanoke	7Q10	CU,ZN,AL
7	36.3503	78.4111	NC0020559*	030206	Roanoke	7Q10	CD,CU,PB,NI,AG,ZN,CN
8	36.2767	78.5917	NC0025054	030301	Tar-Pamlico	7Q10	CD,CR,CU,PB,HG,AG,ZN,CN
9	36.0800	78.3358	NC0036854	030301	Tar-Pamlico	7Q10	AL
10	35.9769	77.7250	NC0030317	030302	Tar-Pamlico	7Q10	CU,CN
11	36.0311	78.8631	NC0023841	030401	Neuse	7Q10	CU,HG,ZN,CN
12	36.0769	78.8861	NC0026336	030401	Neuse	7Q10	CU,AG,ZN
13	36.1272	78.7992	NC0026824	030401	Neuse	7Q10	CU,PB,HG,AG,ZN,CN
14	35.8383	78.7806	NC0048879	030402	Neuse	7Q10	CR,CU,HG,AG,ZN
15	35.3894	78.5078	NC0020389	030404	Neuse	7Q10	CU,ZN,CN
16	35.7700	78.3775	NC0025020	030406	Neuse	7Q10	CU,CN
17	35.6769	77.9139	NC0023906	030407	Neuse	7Q10	HG
18	35.8247	78.2961	NC0024368	030407	Neuse	7Q10	CU,PB,ZN
19	35.5858	77.5417	NC0029572	030407	Neuse	7Q10	CR,CU,ZN
20	35.1386	77.0386	NC0001881	030410	Neuse	7Q10	AG,CN,CR,CU,NI
21	34.9131	76.9117	NC0003816	030410	Neuse	7Q10	AG

* Note: These dischargers are located within the Roanoke River Basin but are not located within the A/P Study Area.

Figure 2-4. (continued)

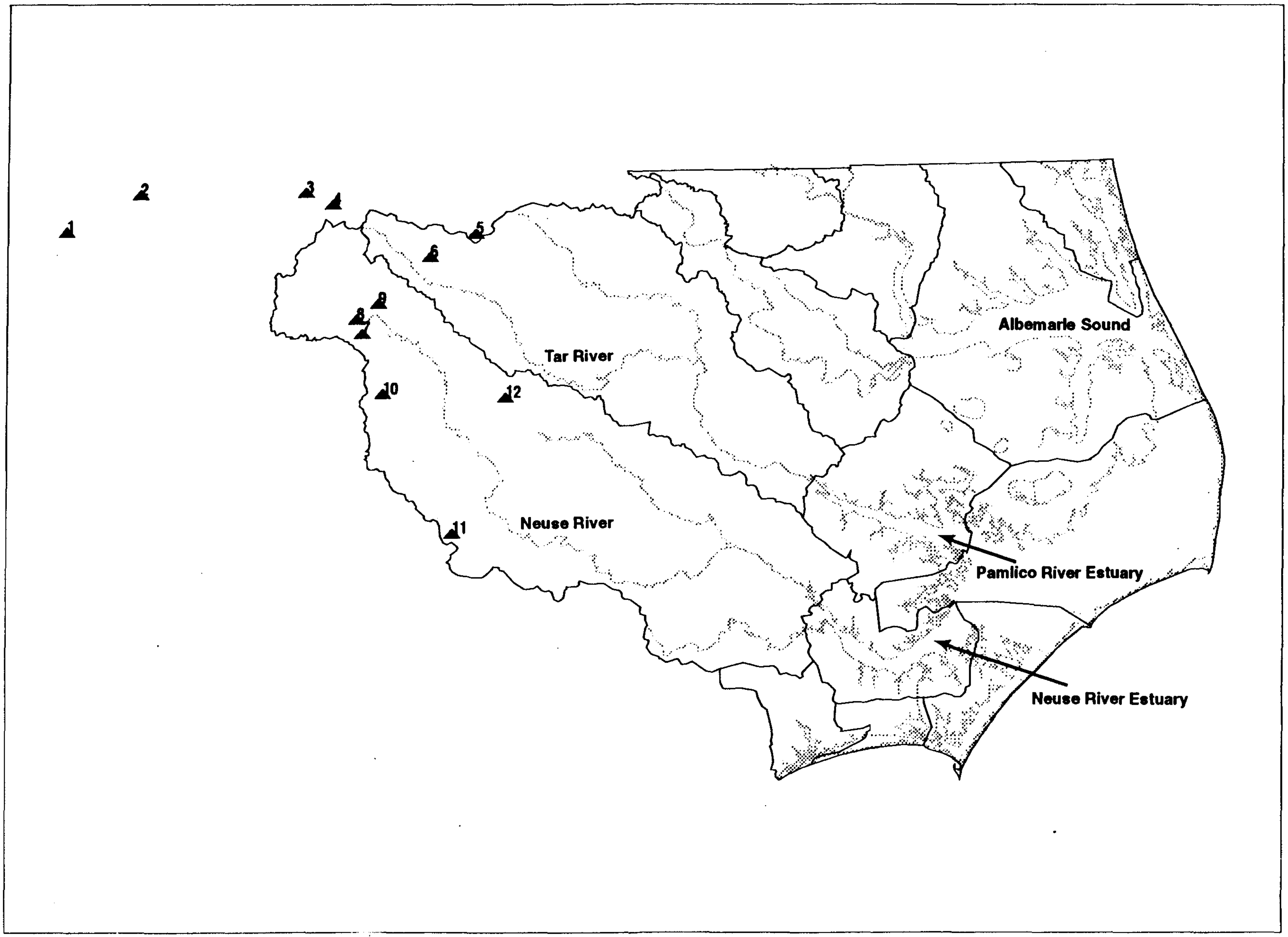


Figure 2-5. Locations of dischargers with the potential to cause exceedances of water quality standards under average flow conditions.

Exceedences under Average Flows

#	Longitude	Latitude	NPDES	Subbasin	Basin Name	Flow Type	Exceedence Type
1	80.0383	36.3494	NC0035173*	030201	Roanoke	Average Flow	CU
2	79.7431	36.4714	NC0025071*	030203	Roanoke	Average Flow	AG
3	79.0842	36.4806	NC0003425*	030205	Roanoke	Average Flow	SE
4	78.9797	36.4447	NC0021024*	030205	Roanoke	Average Flow	CU,ZN,AL
5	78.4111	36.3503	NC0020559*	030206	Roanoke	Average Flow	CD,CU,NI,AG,CN
6	78.5917	36.2767	NC0025054	030301	Tar-Pamlico	Average Flow	CD,CU,PB,HG,AG,ZN,CN
7	78.8631	36.0311	NC0023841	030401	Neuse	Average Flow	CU,HG,ZN,CN
8	78.8861	36.0769	NC0026336	030401	Neuse	Average Flow	AG
9	78.7992	36.1272	NC0026824	030401	Neuse	Average Flow	AG
10	78.7806	35.8383	NC0048879	030402	Neuse	Average Flow	AG
11	78.5078	35.3894	NC0020389	030404	Neuse	Average Flow	CU,ZN
12	78.2961	35.8247	NC0024368	030407	Neuse	Average Flow	CU,ZN

* Note: These dischargers are located within the Roanoke River Basin but are not located within the A/P Study Area.

Figure 2-5. (continued)

Note: Although fluoride loadings to the Pamlico Estuary of almost 1 million lb/yr were estimated from DMR data, no instream water quality exceedances were identified because there is no State standard or EPA criterion for fluoride in estuarine/marine waters. Therefore, RTI could not screen fluoride data to evaluate potential for exceedances.

2.2.3.3 Neuse Estuary

In the Neuse basin, 11 dischargers (three industrial and eight municipal facilities) were identified as potentially producing instream water quality standards/criteria exceedances under 7Q10 flows (Table 2-6), and seven dischargers (one industrial and six municipal facilities) were identified as potentially producing instream water quality standards/criteria exceedances under average flow conditions.

Overall, exceedances of standards/criteria were predicted from DMR data for seven pollutants (chromium, copper, lead, mercury, silver, zinc, and cyanide). Exceedances of copper, zinc, and cyanide were predicted at six, five, and four facilities, respectively, under 7Q10 flow conditions.

2.2.4 Conclusions

As shown in Tables 2-8 and 2-9, a larger number of facilities were identified from analysis of DMR data as potentially producing instream water quality exceedances than were identified from analysis of APAM data. Results are compared in Tables 2-8 and 2-9 for 7Q10 and average flow conditions, respectively. Under both 7Q10 and average flow conditions, water quality exceedances predicted for the A/P estuarine system were generally produced by municipal rather than industrial facilities. Of the facilities predicted to produce instream water quality exceedances at 7Q10 flow conditions, 64 percent were municipal WWTP facilities; under average flow conditions, 79 percent were municipal WWTP facilities. Inadequate pretreatment of industrial wastes discharged into some of these municipal facilities is a likely source for toxics discharges by the municipals.

Table 2-8. Facilities with Predicted Instream Water Quality Exceedances Under 7Q10 Flow Conditions[a]

Facilities	Discharger type	DMR[b]	APAM[c]	Total number of potential exceedances
Roanoke River Basin				
Duke Power/Belews Creek 002*	I	•		2
Halstead Industries*	I	•		23
Eden/Mebane Ridge WWTP*	M	•		3
CP&L Roxboro Steam Electric*	I	•		39
Roxboro WWTP*	M	•		70
Nutbush Creek WWTP*	M	•		11
Windsor WWTP	M		•	
Pasquotank River Basin				
Dare County Landfill/East Lake	I	•		63
Tar-Pamlico River Basin				
Oxford- Southside #2	M	•	•	83
Corry Hiebert Furniture Company	I	•		20
Tar River WWTP	M	•	•	13
Greenville Utilities	M		•	
Neuse River Basin				
Durham/Northside WWTP	M	•		39
Durham/Eno WWTP	M	•		43
Hillsborough WWTP	M		•	
John Umstead Hospital	I	•	•	13
Cary Crabtree Creek	M	•		31
Benson WWTP	M	•		48
Wendell, Town of	M	•	•	2
Burlington Industries (Wake)	I		•	
Wilson WWTP	M	•	•	3
Zebulon WWTP	M	•		29
Farmville, Town of	M	•		10
Phillips Plating Company	I	•		38
USMC - Cherry Point #1	I	•		4

APAM = Annual Pollutant Analysis Monitoring program.
DMR = Discharger Monitoring Reports.
I = Industrial.
M = Municipal.
WWTP = Wastewater treatment plant.

[a]The above listings do not represent **actual** exceedances of water quality standards or criteria. Rather, they are the result of a screening analysis to show the **potential** for exceedances under 7Q10 low flow conditions.
[b]Predicted instream water quality exceedances based on 1/89-12/90 DMR data analysis.
[c]Predicted instream water quality exceedances based on 1989 to 1991 APAM data analysis. For some facilities this represents two annual scans and for some facilities it represents three annual scans depending on permit-specified sampling date.
* This facility discharges to the Roanoke River Basin but is outside the A/P Study Area.

Table 2-9. Facilities with Predicted Instream Water Quality Exceedances Under Average Flow Conditions[a]

Facilities	Discharger type	DMR[b]	APAM[c]	Total number of potential exceedances
Roanoke River Basin				
Halstead Industries*	I	•		3
Eden/Mebane Ridge WWTP*	M	•		1
CP&L Roxboro Steam Electric*	I	•		13
Roxboro WWTP*	M	•		68
Nutbush Creek WWTP*	M	•		7
Windsor WWTP	M		•	
Tar-Pamlico River Basin				
Oxford-Southside #2	M	•	•	52
Neuse River Basin				
Durham/Northside WWTP	M	•		15
Durham/Eno WWTP	M	•		3
Hillsborough WWTP	M		•	
John Umstead Hospital	I	•	•	1
Cary Crabtree Creek	M	•		9
Benson WWTP	M	•		28
Zebulon WWTP	M	•		17

APAM = Annual Pollutant Analysis Monitoring program.
DMR = Discharger Monitoring Reports.
I = Industrial.
M = Municipal.
WWTP = Wastewater treatment plant.

[a]The above listings do not represent **actual** exceedances of water quality standards or criteria. Rather, they are the result of a screening analysis to show the **potential** for exceedances under average flow conditions.

[b]Predicted instream water quality exceedances based on 1/89-12/90 DMR data analysis.

[c]Predicted instream water quality exceedances based on 1989 to 1991 annual pollutant analysis. For some facilities this represents two annual scans and for some facilities it represents three annual scans depending on permit-specified sampling date.

* This facility discharges to the Roanoke Basin but is outside the A/P Study Area.

SECTION 3

AMBIENT WATER QUALITY ANALYSIS

3.1 DATA SOURCES

The EPA Storage and Retrieval (STORET) System was the primary source of chemical analysis data collected from freshwater and saltwater sites within the A/P Study Area. No attempt was made to judge the quality of these data or the accuracy and precision of the analytical techniques used to obtain the reported values.

Ambient water quality data from STORET for the 3-year period from July 1, 1988, to July 1, 1991, were retrieved for analysis (see Appendix D). This time period is the same as that used for assessing ambient sediment quality (Section 4.1). Freshwater stations selected for screening were located in major tributary rivers to the A/P Study Area. Saltwater stations were located in tidal waters of the A/P Study Area.

3.2 METHODOLOGY

All water quality data were screened against current North Carolina State Standards for Surface Waters and Tidal Salt Waters as shown in Appendix B. If no North Carolina State standard was available for a particular pollutant, the current EPA chronic freshwater or saltwater quality criterion was used. If no EPA water quality criterion was available, the North Carolina human health standard or the EPA human health criterion was used. Federal water quality criteria are updated regularly by EPA's Criteria and Standards Division and a revised compilation of these criteria was provided by EPA Region 4. RTI obtained the most current EPA water quality criteria listing dated October 1991 (Appendix B). The freshwater and saltwater screening values used to evaluate ambient water quality exceedances are shown in Tables 2-4 and 2-5, respectively.

RTI reviewed five documents to identify freshwater and saltwater monitoring stations:

- North Carolina Division of Environmental Management. 1985. State of North Carolina Ambient Water Quality Monitoring Program. Department of Natural Resources and Community Development, Water Quality Section, Raleigh, NC.

- State of North Carolina. 1989. Classifications and Water Quality Standards Assigned to the Waters of the Roanoke River Basin. Department of Environment, Health and Natural Resources, Raleigh, NC (NC Administrative Code: 15A NCAC 2B.0313).

- State of North Carolina. 1990. Classifications and Water Quality Standards Assigned to the Waters of the Chowan River Basin. Department of Environment, Health and Natural Resources, Raleigh, NC (NC Administrative Code: 15A NCAC 2B.0314).

- State of North Carolina. 1990. Classifications and Water Quality Standards Assigned to the Waters of the Neuse River Basin. Department of Environment, Health and Natural Resources, Raleigh, NC (NC Administrative Code: 15A NCAC 2B.0315).

- State of North Carolina. 1990. Classifications and Water Quality Standards Assigned to the Waters of the Tar-Pamlico River Basin. Department of Environment, Health and Natural Resources, Raleigh, NC (NC Administrative Code: 15A NCAC 2B.0316).

Approximately 80 percent of the STORET stations evaluated were identified in the ambient water quality monitoring program report by location (NCDEM, 1985). Using this document, a set of USGS maps (1:24,000 and 1:100,000), and the classification and water quality standards document descriptions for each river basin, RTI was able to assign freshwater/saltwater designations to nearly all STORET sites. This assignment was necessary because saltwater standards and criteria are different from standards and criteria used to screen freshwater sites (see Appendix B). Several of the more recently established ambient water quality monitoring stations were assigned a classification based on the best professional judgment of RTI Water Quality staff.

After screening all ambient water quality data, RTI identified sites with more than one exceedance of a State water quality standard or Federal water quality criterion during a 3-year period (U.S. EPA, 1991c). EPA's 1992 305(b) guidelines specify that aquatic life use is not supporting if, for any one pollutant, one or more violations of acute or chronic toxicity criteria occur within a 3-year period based on grab or 1-day composite samples. If the State has collected an abundant data set (i.e., sampling monthly or more frequently over a 3-year period), a once-in-three-years violation is allowed; therefore two or more violations of acute or chronic criteria are needed to show nonsupport (see Appendix C). The EPA 305(b) guidance further states that waters should be sampled at least quarterly to be considered monitored and sampled monthly or more frequently for monitoring data to be considered abundant. In general, North Carolina has collected an abundant data set with respect to ambient water quality assessments; therefore RTI screened ambient stations to identify those stations that had **more than one violation of a water quality standard or criterion for an individual pollutant over the 3-year period.**

3.3 RESULTS

3.3.1 Fresh Water

Results of ambient water quality screening analysis in the A/P estuarine system are summarized in Table 3-1 by basin. A total of 24 freshwater stations were identified as having ambient water column pollutant concentrations that exceeded State standards and/or EPA criteria more than once for the same pollutant over the 3-year sampling period. The location of these sites is shown in Figure 3-1.

3.3.1.1 Albemarle Estuary and Associated Tributaries

In the Chowan River only two stations were identified with pollutant concentrations exceeding State standards and/or EPA criteria as described above. Exceedances were found for aluminum (two sites), copper (one site), and zinc (one site).

In the Roanoke River, three stations were identified with concentrations of pollutants exceeding State standards and/or EPA criteria. Exceedances were found for aluminum (two stations) and copper (one station).

3.3.1.2 Pamlico River

In the Tar-Pamlico River system, only one station was identified with pollutant concentrations exceeding freshwater State standards and/or EPA criteria. The exceedance was for copper.

3.3.1.3 Neuse River

In the Neuse River system, 18 stations were identified with pollutant concentrations exceeding State freshwater standards and/or criteria. Of these, exceedances were found for aluminum (17 stations), copper (11 stations), lead (three stations), mercury (two stations), nickel (one station), and zinc (four stations).

3.3.2 Saltwater

Results of ambient water quality screening analysis at estuarine/marine sites are summarized in Table 3-1 by basin. A total of six estuarine/marine stations were identified as having water column pollutant concentrations that exceeded State standards and/or EPA criteria. The location of these sites is shown in Figure 3-1.

3.3.2.1 Albemarle Sound and Associated Tributaries

In both the Chowan and Roanoke Rivers, no stations located in tidal waters were identified with pollutant concentrations exceeding State standards and/or EPA criteria.

Table 3-1. Ambient Water Quality Standards and Criteria Exceedances Stations with More Than One Exceedance in 3 Years for Any One Pollutant 1988 to 1991

Basin: Chowan USGS Cataloging Unit: 03010203

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
D5000000	Fresh	2				1					
D8353000	Fresh	3									2

Basin: Roanoke USGS Cataloging Unit: 03010107

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
N7300000	Fresh	21									
N8200000	Fresh	29									
N8300000	Fresh					3					

Basin: Tar-Pamlico USGS Cataloging Unit: 03020103

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
O6450000	Fresh					3					

Basin: Tar-Pamlico USGS Cataloging Unit: 03020104

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
O8495000	Salt					2					
O9750500	Salt					5					
O9751000	Salt					3			2		
O9758500	Salt					2					

Table 3-1. (continued)

Basin: Neuse   USGS Cataloging Unit: 03020201

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
02085000	Fresh	7									
02085500	Fresh	3				2					
02087570	Fresh	4				1					
J0770000	Fresh	2									
J0810000	Fresh	2									
J1100000	Fresh	2									
J1330000	Fresh	2				5					2
J1530000	Fresh	1				5					
J1890000	Fresh	3									
J2850000	Fresh	4				1					
J2860000	Fresh	3									
J3270000	Fresh	2				2	1				2
J3300000	Fresh	3				19	2				22
J4170000	Fresh	2				1					
J4370000	Fresh	1				2					
02086490	Fresh	5						1			
J1210000	Fresh	2				13	1	1	1		3

Basin: Neuse   USGS Cataloging Unit: 03020203

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
J6740000	Fresh	1				2					

Basin: Neuse   USGS Cataloging Unit: 03020202

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
J8170000	Fresh					2					

Basin: Neuse   USGS Cataloging Unit: 03020204

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
J8840000	Salt	33									
J9690000	Salt					2		1			

Note: Stations 02087570 and J4370000 are the same geographic location. Only the location of station 02087570 is mapped in Figure 3-1.

Table 3-1. (continued)

Basin: Neuse — USGS Cataloging Unit: 03020201

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
02085000	Fresh	7									
02085500	Fresh	3				2					
02087570	Fresh	4				1					
J0770000	Fresh	2									
J0810000	Fresh	2									
J1100000	Fresh	2									
J1330000	Fresh	2				5					2
J1530000	Fresh	1				5					
J1890000	Fresh	3									
J2850000	Fresh	4				1					
J2860000	Fresh	3									
J3270000	Fresh	2				2	1				2
J3300000	Fresh	3				19	2				22
J4170000	Fresh	2				1					
J4370000	Fresh	1				2					
02086490	Fresh	5						1			
J1210000	Fresh	2				13	1	1	1		3

Basin: Neuse — USGS Cataloging Unit: 03020203

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
J6740000	Fresh	1				2					

Basin: Neuse — USGS Cataloging Unit: 03020202

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
J8170000	Fresh					2					

Basin: Neuse — USGS Cataloging Unit: 03020204

Station	Type	Al	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Zn
J8840000	Salt	33									
J9690000	Salt					2		1			

Note: Stations 02087570 and J4370000 are the same geographic location. Only the location of station 02087570 is mapped in Figure 3-1.

#	Longitude	Latitude	Station	Basin	Cat. Unit	Type	Exceedence Type
1	76.9533	36.4378	D5000000	Chowan	03010203	F	CU,AL
2	76.8564	36.2600	D8353000	Chowan	03010203	F	ZN,AL
3	79.1039	36.0717	02085000	Neuse	03020201	F	AL
4	78.8789	36.1825	02085500	Neuse	03020201	F	CU,AL
5	78.3500	35.5128	02087570	Neuse	03020201	F	CU,AL
6	78.9083	36.0722	J0770000	Neuse	03020201	F	AL
7	78.8631	36.0719	J0810000	Neuse	03020201	F	AL
8	78.8306	36.1306	J1100000	Neuse	03020201	F	AL
9	78.8328	36.0592	J1330000	Neuse	03020201	F	CU,ZN,AL
10	78.7992	35.9867	J1530000	Neuse	03020201	F	CU,AL
11	78.5756	35.9400	J1890000	Neuse	03020201	F	AL
12	78.7783	35.8375	J2850000	Neuse	03020201	F	CU,AL
13	78.7439	35.8408	J2860000	Neuse	03020201	F	AL
14	78.6111	35.8042	J3270000	Neuse	03020201	F	CU,PB,ZN,AL
15	78.6431	35.7936	J3300000	Neuse	03020201	F	CU,PB,ZN,AL
16	78.4058	35.6472	J4170000	Neuse	03020201	F	CU,AL
17	78.1106	35.6914	J6740000	Neuse	03020203	F	AL,CU
18	77.1958	35.3450	J8170000	Neuse	03020202	F	CU
19	77.0489	34.9689	J8840000	Neuse	03020204	S	AL
20	76.6222	34.8917	J9690000	Neuse	03020204	S	CU,HG
21	77.6344	36.4603	N7300000	Roanoke	03010107	F	AL
22	77.3842	36.2094	N8200000	Roanoke	03010107	F	AL
23	77.2153	36.0139	N8300000	Roanoke	03010107	F	CU
24	78.8303	36.1506	02086490	Neuse	03020201	F	HG,AL
25	78.8153	36.0931	J1210000	Neuse	03020201	F	CU,PB,HG,NI,ZN,AL
26	77.2286	35.5631	O6450000	Tar-Pamlico	03020103	F	CU
27	76.8181	35.4750	O8495000	Tar-Pamlico	03020104	S	CU
28	76.6722	35.4972	O9750500	Tar-Pamlico	03020104	S	CU
29	76.6375	35.5417	O9751000	Tar-Pamlico	03020104	S	CU,NI
30	76.5000	35.5736	O9758500	Tar-Pamlico	03020104	S	CU

Figure 3-1. (continued)

3.3.2.2 Pamlico River

In the Tar-Pamlico River system, four saltwater stations were identified with pollutant concentrations exceeding State standards and/or EPA criteria. Exceedances were found for copper (four stations) and nickel (one station).

3.3.2.3 Neuse River

In the Neuse River system, two saltwater stations were identified with pollutant concentrations exceeding State standards and/or EPA criteria. Of these, exceedances were found for aluminum (one station), copper (one station), and mercury (one station).

3.4 CONCLUSIONS

In general, ambient water quality exceedances were detected in headwater reaches of major tributary rivers to the Albemarle-Pamlico Estuary System. This predominance was particularly striking in the upper Neuse River Basin. Ambient freshwater quality exceedances were minimal in the Chowan, Roanoke, and Tar-Pamlico Rivers. Of all the stations where freshwater quality exceedances were detected, 75 percent occurred in the Neuse River, 21 percent in the Chowan and Roanoke Rivers, and 4 percent in the Tar-Pamlico River.

Saltwater quality exceedances were detected at four sites on lateral tributaries of the lower Pamlico Estuary, including one site on Pungo Creek, one site on Pantego Creek, one site on Bath Creek, and one site on the Pungo River, and two sites on the lower Neuse River, including one site on the West Prong of Brice Creek and one site on Adams Creek (see Figure 3-1). In general all the exceedances were detected in small estuaries lateral to the Pamlico and Neuse basins.

In most cases, there appeared to be no definitive correlation between exceedances of water quality standards/criteria at ambient saltwater monitoring stations and the location of dischargers to the respective river/estuarine systems (Figures 2-4 and 2-5). Nonpoint sources of pollution (e.g., urban storm runoff, agricultural runoff, runoff from mining activities, or leachates from landfill or hazardous wastes sites) are possible sources for the identified ambient water quality standards exceedances that were not evaluated in the scope of this analysis.

SECTION 4

AMBIENT SEDIMENT QUALITY ANALYSIS

4.1 ASSESSING AMBIENT FRESHWATER SEDIMENT QUALITY

4.1.1 Data Sources

The EPA STORET system was the primary source of freshwater sediment data used to evaluate sediment quality at sites within the A/P Study Area. No attempt was made to judge the quality of these data or the accuracy and precision of the analytical techniques used to obtain the values.

Sediment data from STORET for the 3-year period from July 1, 1988, to July 1, 1991, were retrieved for analysis (Appendix E). This time period is the same as that used for assessing ambient water quality (Section 3). All stations were located in the Chowan, Pasquotank, Roanoke, Tar-Pamlico, and Neuse River Basins.

Note: Only metals were evaluated because DEM did not conduct analyses of organic pollutants in sediments at any of the State's routine ambient monitoring stations within the A/P Study Area.

4.1.2 Methodology for Screening Freshwater Sediment Data

Currently, there are no State standards or EPA criteria for freshwater sediment, therefore alternative screening values were identified by RTI. All sediment data were screened against threshold concentrations developed by the U.S. EPA (1985b) and summarized in Table 4-1. These values were calculated using the sediment-water equilibrium partitioning approach. It is not the purpose of this report to judge the adequacy of this approach for setting target concentrations as compared to alternative approaches but rather to assume that the threshold values are useful for screening and assessment of the pollutant concentrations in freshwater sediments. A short discussion of the EPA approach is provided here and is given in detail in U.S. EPA (1985b).

This EPA approach assumes that the distribution of a chemical between the organic carbon phase of the sediment and the soluble phase in interstitial water in equilibrium with the solid phase is described by the organic carbon-water partition coefficient (K_{oc}) for the chemical. If the water quality criterion value for the chemical is taken to be the maximum acceptable concentration of the chemical in solution in the interstitial water, then the threshold concentration of the chemical in the bulk sediment is calculated based on the sediment organic carbon-normalized K_{oc} for the chemical.

Table 4-1. Comparison of Threshold Concentrations for Selected Heavy Metals in Freshwater Sediments

Metal	EPA/OWRS threshold concentrations[a] (ppm; dry weight)
Arsenic	33
Cadmium	31
Chromium	25[b]
Copper	136
Lead	132
Mercury	0.8[c]
Nickel	20[b]
Silver	--
Zinc	760

OWRS = Office of Water Regulations and Standards.

[a]Threshold concentrations are those determined by EPA/OWRS unless otherwise noted. Source: U.S. EPA. 1985b. National Perspective on Sediment Quality, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC.

[b]EPA Region 5 guidelines for designating contaminated vs. noncontaminated sediments. Source: U.S. Army Corps of Engineers. 1977. Ecological Evaluation of Proposed Discharge of Dredged or Fill Material into Navigable Waters. Interim Guidance for Section 404(b) of Public Law 92-500 (Federal Water Pollution Control Act Amendments of 1972). Misc. Paper D-76-17. Waterways Experiment Station, Vicksburg, MS:1-EZ.

[c]The value of 0.8 was not corrected for organic carbon. Correction of this value would have resulted in a mercury concentration of 0.03 ppm, which is considerably lower than the concentration of this metal in most sediments.

The methodology for derivation of threshold concentrations using this approach is presented in *Background and Review Document on the Development of Sediment Criteria* (JRB Associates, 1984a) and *Development and Testing of the Sediment-Water Equilibrium Partitioning Approach* (JRB Associates, 1984b). The advantages and disadvantages of this methodology are summarized here so that the reader may judge its relevancy to biological thresholds (U.S. EPA, 1985b).

Advantages

- The large toxicologic database incorporated in the EPA water quality criteria is used directly for sediment quality criteria. Sediment quality criteria (threshold concentrations) can be readily developed for those compounds for which EPA water quality criteria currently are available and for those compounds that are assigned water quality criteria in the future.

- "First-cut" criteria are available that can then be verified in future field and laboratory studies.

Disadvantages

- No sediment criteria can be established for those compounds for which EPA water quality criteria have not been developed.

- The approach does not account for any increase in contaminant burden that may result from ingestion of, or direct body contact with, contaminated sediments above that which is attained simply by absorption from the interstitial/overlying water.

- The assumption of contaminant equilibrium between sediment and interstitial water, inherent in the approach, may not always hold in natural systems (Prahl and Carpenter, 1983).

- The method does not consider the effect of interstitial water-dissolved organic carbon on partitioning and bioavailability of highly hydrophobic chemicals.

- Criteria developed for metals have a very high associated uncertainty, making their regulatory application difficult.

The sediment-water equilibrium partitioning approach allows a numerical "threshold concentration" to be established for each pollutant against which available monitoring data can be compared (U.S. EPA, 1985b). If a measured ambient concentration (mg/kg dry weight) exceeds the EPA threshold concentration for any pollutant, the site is identified as being potentially contaminated and warranting further examination.

Threshold values derived from this sediment-water partitioning approach are based on the organic carbon content of the particular sediment and are adjusted to a whole sediment basis on the assumption that an average sediment contains 4 percent total organic carbon (TOC) (U.S. EPA, 1985b). The 4 percent value for average TOC is high for many freshwater sediments. A more typical value may be in the 1 to 2 percent range. If 2 percent TOC had been chosen for calculation of TOC-normalized sediment threshold concentrations for chemicals, the values in Table 4-1 would have been half those listed (i.e., more sites would have been identified with sediment chemical concentrations above the threshold values) (U.S. EPA, 1985b).

An even greater source of uncertainty in generating sediment threshold values using this method, however, is the wide variation in published K_{oc} values for each chemical. K_{oc} values calculated for the same chemical by different investigators and/or under different physical/chemical parameter regimes may differ by several orders of magnitude. For instance, the threshold value for zinc originally was calculated as 19,000 ± 38,000 mg/kg, based on the uncertainty of the K_{oc} value for zinc. Because TOC-based sediment normalization theory has been more completely validated for nonpolar organic compounds than for heavy metals and polar organics, threshold values for nonpolar organics probably are more reliable than those for the metals (U.S. EPA, 1985b).

Freshwater threshold values for two metals, chromium and nickel, were obtained from guidelines developed by EPA Region 5 (U.S. Army Corps of Engineers, 1977). These concentrations were intended for the classification of polluted sediments and are of limited applicability (Table 4-1). Additional test data are required for a thorough evaluation of the significance of the observed sediment contamination levels.

Despite the variability inherent in the threshold concentrations, these values can be applied objectively to evaluate freshwater sediments from all A/P Study Area basins in the absence of State standards or formal EPA sediment criteria.

4.1.3 Results

Results of screening the STORET sediment data against the U.S. EPA (1985b) threshold concentrations for nine metals showed that the threshold concentrations were not exceeded at any station in the A/P Study Area in North Carolina. Only three stations, however, were sampled during the 3-year period evaluated (July 1988 to July 1991):

- Chinkapin Creek Tributary (Chowan River Basin) near Harrellsville
- Flat River (Neuse River Basin) near Bahama
- West Prong of Brice Creek (Neuse River Basin) near Riverdale.

Metal contaminant concentrations for these sites are provided in Appendix F.

4.1.4 Conclusions

With respect to freshwater sites in North Carolina, no metal contamination was evident at the three stations accessed in STORET. However, the State conducted minimal sediment sampling within the A/P Study Area during the 3-year period evaluated. In addition, the State sediment sampling program does not routinely analyze for organic contaminants that might be a problem at stations near some point source discharges. Threshold concentrations for a wide range of organic pollutants including pesticides, polynuclear aromatic hydrocarbons (PAHs), monoaromatic hydrocarbons, and phthalates are available for screening sediment contaminant data (U.S. EPA, 1985b). And, interim sediment criteria values for 17 nonpolar hydrophobic organic contaminants have been issued by EPA (1988). Sediment contaminant monitoring in the A/P Study Area appears to be inadequate at present.

4.2 ASSESSING AMBIENT ESTUARINE/MARINE SEDIMENT QUALITY

4.2.1 Data Sources

The primary sources of estuarine/marine sediment data used to evaluate sediment quality at sites within the A/P Study Area were three studies funded jointly by the U.S. EPA, Region 4, and the North Carolina Department of Environment, Health, and Natural Resources as part of the National Estuary Program. All of the sediment data analyzed were derived from the following sources:

- Riggs, S. R., J. T. Bray, J. C. Hamilton, D. V. Ames, C. R. Klingman, R. A. Wyrick and J. R. Watson. In preparation. Heavy Metals in Organic-Rich Muds of the Albemarle Sound and Estuarine System. Report No. 92-10. Albemarle-Pamlico Estuarine Study, Raleigh, NC.

- Riggs, S. R., J. T. Bray, E. R. Powers, J. C. Hamilton, D. V. Ames, K. L. Owens, D. D. Yeates, S. L. Lucas, J. R. Watson, and H. M. Williamson. 1991. Heavy Metals in Organic-Rich Muds of the Neuse River Estuarine System. Report No. 90-07. Albemarle-Pamlico Estuarine Study, Raleigh, NC.

- Riggs, S. R., E. R. Powers, J. T. Bray, P. M. Stout, C. Hamilton, D. Ames, R. Moore, J. Watson, S. Lucas, and M. Williamson. 1989. Heavy Metal Pollutants in Organic-Rich Muds of the Pamlico River Estuarine System: Their Concentration, Distribution, and Effects upon Benthic Environments and Water Quality. Report No. 89-06. Albemarle-Pamlico Estuarine Study, Raleigh, NC.

No attempt was made to judge the quality of these data or the accuracy and precision of the analytical techniques used to obtain the reported values. The chemical digestion/extraction procedures used in the three Riggs et al. studies were not as vigorous as those used by the National Oceanic and Atmospheric Association (NOAA) in the National Status and Trends Program, which employed a 100 percent digestion procedure. Sediment contaminant concentrations reported by Riggs et al. (1989, 1991, and in preparation) will therefore underestimate the actual sediment concentrations that would have been found had a more vigorous digestion procedure been employed. Therefore, fewer sites will be identified as exceeding NOAA criteria. Despite this, however, the same chemical procedures were used in all three studies, which provides excellent comparability of results and allowed for an objective comparison of all sediment contaminant data within the Albemarle-Pamlico estuarine system to the NOAA criteria.

4.2.2 Methodology for Screening Estuarine Sediment Data

Currently, there are no State standards or EPA criteria for estuarine/marine sediment, therefore alternative screening values were identified by RTI. All sediment data were screened against effects range--low effects range (ER-L) and medium effects range (ER-M) values derived by NOAA for evaluating sediment data as part of their National Status and Trends Program (Long and Morgan, 1990) (Table 4-2).

Note: RTI did not screen the three Riggs et al. data sets for exceedances of ER-L or ER-M values for silver. Many silver values were found to be below detection limits and some problems with the analytical procedures were suspected (personal communication, Stan Riggs, Department of Geology, East Carolina University, 1992).

The development of the ER-L and ER-M values used in the screening analysis is described briefly below and a detailed discussion is provided in Long and Morgan (1990).

Uptake (and therefore effects) of sediment-associated contaminants is largely a function of bioavailability. Bioavailability is strongly influenced by a complex set of physical, chemical, and biological factors in the sediments. Trace metals can be adsorbed onto particle surfaces, carbonate-bound, occluded in iron and/or manganese oxyhydroxides, bound to organic matter, sulphide-bound, matrix-bound, or dissolved in the interstitial water (Tessier and Campbell, 1987). The relative bioavailability of trace metals associated with these complex phase associations has the effect of hindering the prediction of effects based on bulk sediment chemical analyses. Possibly as a result of these complex phase associations, Lee and Mariani (1977) observed very little concordance between measures of bulk sediment chemical concentrations and measures of toxicity, using the shrimp *Palaemonetes pugio*, in surveys performed nationwide. These authors concluded that the bioassays clearly demonstrate the lack of validity of bulk chemical criteria for judging the significance of contaminants associated with dredged sediments. The NOAA method was developed with knowledge of the complexities and uncertainties involved in attempting to associate bulk chemical data with various measures of biological effects. DiToro (1989) argued that it is essential to understand the reasons for varying bioavailability before broadly applicable criteria can be established. His argument was based on the observation that the concentration-response curve for toxicity could be correlated with the chemical concentration in the pore water and not the total (bulk) sediment.

Table 4-2. Summary of NOAA Biological Effects Range-Low (ER-L) and Effects Range-Medium (ER-M) Values for Various Heavy Metals in Sediment (Dry Weight)

Metal	Concentration (ppm)		Subjective degree of confidence in ER-L/ER-M value
	ER-L value[a,b]	ER-M value[b,c]	
Arsenic	33	85	Low/moderate
Cadmium	5	9	High/high
Chromium	80	145	Moderate/moderate
Copper	70	390	High/high
Lead	35	110	Moderate/high
Mercury	0.15	1.3	Moderate/high
Nickel	30	50	Moderate/moderate
Zinc	120	270	High/high

[a]ER-L values were concentrations equivalent to the lower 10th percentile of the screened available data and indicate the low end of the range of concentrations in which biological effects were observed.

[b]The ER-L and ER-M values were developed by NOAA to be used as general guidelines for evaluating the National Status and Trends Program sediment data and were not developed to be standards or criteria.

[c]ER-M values were concentrations equivalent to the 50th percentile of the screened available data and indicate the median of the range of concentrations in which biological effects were observed.

Source: Long, E. R., and L. G. Morgan. 1990. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration, Seattle, Washington.

With no nationally adopted, official, final effects-based standards available, however, the use of a preponderance of evidence derived from many approaches was judged by NOAA to be the best method for developing guidance for interpreting the National Status and Trends (NS&T) Program sediment data. Furthermore, in order to develop a preponderance of evidence, many data sets were used that did not include measures that could have been used to explain varying toxicity (e.g., TOC content).

Approximately 150 reports were reviewed by NOAA staff for possible use in assigning ER-L and ER-M values. In about half the reports, there were either no biological data to accompany the sediment chemistry data or vice versa, there was no discernible gradient in contamination for any of the analytes among samples (less than a tenfold difference), the biological or chemical analytical methods were poorly documented, or the biological and chemical data were not derived from the same sampling locations. The reports in which the data did not satisfy these criteria were not used (Long and Morgan, 1990).

The data from the remaining 85 reports were assembled and listed for each of the NS&T Program analytes (both metals and organic compounds) according to the categorical type of approach that was used. They were then subjected to a screening step. In this step, the data for each analyte were evaluated concerning the methods used, the type and magnitude of biological endpoint measured, and the degree of concordance between the chemical and biological data. Using these evaluation factors, best professional judgment was used to eliminate some values for those chemicals that did not appear to be likely contributors to the gradient in biological effects.

The data then were sorted in ascending order for each chemical as shown in Table 4-3 for arsenic. Next, two values were determined from the remaining data for each chemical: an ER-L value, a concentration at the low end of the range of concentrations in which effects had been observed, and an ER-M value, a concentration approximately midway in the range of reported values associated with biological effects. For each chemical of interest, NOAA assembled available data from spiked-water bioassays, examined the distribution of the reported LC50 values, and determined the lower 10th and 50th percentile concentrations among the ranges of values. **The ER-L value for each pollutant was used as the concentration above which adverse effects may begin or are predicted among sensitive life stages and/or species or as determined in sublethal tests. The ER-M value for each pollutant was used as the concentration above which toxic effects were frequently or always observed or predicted among most species** (Long and Morgan, 1990).

Table 4-3. Sediment Effects Data Available for Arsenic Arranged in Ascending Order with Remarks Regarding Use of Concentrations to Determine ER-L and ER-M Values

Concentration (ppm)	Biological Test	Remarks
1	Stamford not toxic–shrimp	No effect
1.3	Duwamish River nontoxic–shrimp	No effect
1.36	Georgetown benthic community	No effect
1.9	Black Rock Harbor toxic–*Nereis*	Small gradient
2.2 ± 1.2	Trinity River not toxic–*Daphnia*	No effect
2.7 ± 0.2	Sheboygan River significantly toxic–prawn	Small gradient
2.8	Newport not toxic–shrimp	No effect
3.4 ± 1.8	Trinity River significant toxic–*Daphnia*	Small gradient
3.4	Norwalk not toxic–shrimp	No effect
3.7 ± 1	Kishwaukee River least taxa	No effect
5 ± 1.8	Kishwaukee River most taxa	Small gradient
5.8 ± 6.4	Southern California not toxic–amphipod	No effect
5.9 ± 1.1	DuPage River most taxa	Small gradient
7.4 ± 2.2	DuPage River least taxa	Small gradient
8.32 ± 5.2	Southern California significantly toxic–amphipod	Small gradient
10.4 ± 13.4	San Francisco Bay moderately toxic–amphipod	No concordance
12.8	Los Angeles Harbor toxic–shrimp	Small gradient
13.7 ± 14.8	San Francisco Bay least toxic–bivalve	No effect
14.6 ± 13.8	San Francisco Bay significantly toxic–amphipod	No concordance
17.5 ± 14.1	San Francisco Bay highly toxic–amphipod	No concordance
22 ± 18.7	San Francisco Bay not toxic–bivalve	No effect
22.1 ± 19.4	San Francisco Bay moderately toxic–bivalve	*
22.6 ± 28.1	Puget Sound non-toxic–amphipod	No effect
22.8 ± 22.1	San Francisco Bay significantly toxic–bivalve	No gradient
25.1 ± 23.1	Puget Sound moderately toxic–amphipod	Small gradient
27.8 ± 30.8	Commencement Bay least toxic–oyster	No effect
28 ± 21.5	San Francisco Bay least toxic–amphipod	No effect
28.3 ± 26.6	Commencement Bay least toxic–amphipod	No effect
30.3 ± 22.4	San Francisco Bay not toxic–amphipod	No effect
32 ± 14.3	Baltimore Harbor least toxic–fish	No effect
33	**ER-L**	**10 percentile**
33	EP chronic marine	*
<47.2	Waukegan Harbor highly toxic–amphipod	Below detection
50.7 ± 29.3	San Francisco Bay highly toxic–bivalve	*
54	San Francisco Bay AET–bivalve	*
57	1988 Puget Sound AET–benthic	*
58.7 ± 148.1	Commencement Bay moderately toxic–oyster	*
63.2 ± 148	Commencement Bay moderately toxic–amphipod	*
64	EP acute marine	*
70	PSDDA screening level	No effect
70	San Francisco Bay AET–amphipod	No concordance
85	**ER-M**	**50 percentile**
85	1986 Puget Sound AET–benthic	*
91.9 ± 78.6	Baltimore Harbor most toxic–fish	*
93	1986 Puget Sound AET–amphipod	*
689.9 ± 2350.9	Commencement Bay highly toxic–oyster	*
700	1986 Puget Sound AET–oyster	*
700	1986 Puget Sound AET–Microtox™	*
1005 ± 2777	Puget Sound highly toxic–amphipod	*
2257.1 ± 4213.7	Commencement Bay highly toxic–amphipod	*

* 16 concentrations used to determine ER-L and ER-M values

Source: Long and Morgan, 1990.

The NOAA method makes the assumption that the patterns established between biological effects and chemical concentrations would be more credible if based on data from several sediment quality criteria rather than on data from only one approach or experiment. The ER-L and ER-M values were established objectively by determining the lower 10th and 50th percentiles in the data set for each pollutant. No other more rigorous statistical procedures were used because the consensus ER-L and ER-M values were intended only for use by NOAA as general guidance in evaluating the NS&T Program data (Long and Morgan, 1990).

The relative degrees of confidence in the accuracy of the ER-L and ER-M values are described for each analyte (Table 4-2). Values for which NOAA had relatively high confidence were those that were supported by

- Clusters of data with similar concentrations
- Data derived from more than one approach
- A data set that included more than results from the use of the bioeffects/contaminant co-occurrence analysis (COA) approach
- Data derived from multiple geographic areas
- Data for which the overall apparent effects threshold was similar to, or within the range of, the ER-L and ER-M values (Long and Morgan, 1990).

Although the consensus of ER-L and ER-M concentrations may be used as guidance in evaluating sediment contamination data, there is no intent expressed or implied that these values represent official NOAA standards (Long and Morgan, 1990). In lieu of any existing State standards or Federal criteria for estuarine/marine sediments, RTI believes that the ER-L and ER-M values used are a reasonable approach for screening contaminant concentrations in estuarine/marine sediments.

4.2.3 Results

Results of screening the Riggs et al. (1989, 1991, 1992) data sets against the NOAA ER-L and ER-M values are shown in Tables 4-4 and 4-5 for the Albemarle estuarine system, Tables 4-6 and 4-7 for the Pamlico Estuary, and Tables 4-8 and 4-9 for the Neuse Estuary.

Table 4-4. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Metals in Albemarle Estuary

Core	Metal	Concentration	ER-L
ALBE-13	HG	0.16	0.15
ALBE-16	HG	0.24	0.15
ALBE-17	HG	0.16	0.15
ALBI-10	HG	0.52	0.15
ALBI-11	HG	0.34	0.15
ALBI-12	HG	0.51	0.15
ALBI-1	HG	0.23	0.15
ALBI-2	HG	0.40	0.15
ALBI-3	HG	0.17	0.15
ALBI-4	HG	0.23	0.15
ALBI-5	HG	0.26	0.15
ALBI-5	PB	35.00	30.00
ALBI-6	HG	0.16	0.15
ALBI-7	HG	0.40	0.15
ALBI-7	PB	32.20	30.00
ALBI-8	HG	0.32	0.15
ALBW-18	HG	0.68	0.15
ALBW-19	HG	0.34	0.15
ALBW-1	HG	0.31	0.15
ALBW-20	HG	0.47	0.15
ALBW-2	HG	0.30	0.15
ALBW-9	HG	0.28	0.15
ALG-7	PB	30.30	30.00
CHN-10	PB	68.00	30.00
CHN-1	HG	0.17	0.15
CHN-1	PB	31.90	30.00
CHN-4	HG	0.20	0.15
CHN-6	HG	0.21	0.15
CHN-8	HG	0.20	0.15
EDN-1	CU	76.22	70.00
EDN-1	PB	39.30	30.00
EDN-2	HG	0.17	0.15
EDN-2	PB	44.90	30.00
EDN-3	PB	48.80	30.00
EDN-4	HG	0.18	0.15
EDN-5	PB	57.50	30.00
EDN-6	HG	0.18	0.15
LIT-3	PB	30.90	30.00
PAS-10	HG	0.18	0.15
PAS-10	PB	43.00	30.00
PAS-12	PB	60.30	30.00
PAS-13	HG	0.42	0.15
PAS-13	PB	49.20	30.00
PAS-14	HG	0.25	0.15
PAS-14	PB	57.40	30.00
PAS-15	HG	0.17	0.15
PAS-15	PB	58.90	30.00
PAS-16	HG	0.44	0.15
PAS-16	PB	77.60	30.00
PAS-17	HG	0.25	0.15
PAS-17	PB	74.90	30.00
PAS-19	PB	658.90	30.00
PAS-19	ZN	668.50	120.00
PAS-20	HG	0.48	0.15
PAS-20	PB	69.30	30.00
PAS-21	HG	0.38	0.15
PAS-21	PB	76.20	30.00
PAS-22	PB	66.80	30.00
PAS-23	HG	0.34	0.15
PAS-23	PB	95.00	30.00
PAS-24	PB	40.10	30.00

Source: Based on RTI's analysis of data from Riggs et al., in preparation.

Table 4-4. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Metals in Albemarle Estuary

Core	Metal	Concentration	ER-L
PAS-25	HG	0.63	0.15
PAS-25	PB	183.30	30.00
PAS-25	ZN	326.00	120.00
PAS-26	HG	0.29	0.15
PAS-26	PB	63.30	30.00
PAS-27	HG	0.47	0.15
PAS-27	PB	74.60	30.00
PAS-28	HG	0.17	0.15
PAS-28	PB	55.60	30.00
PAS-4	PB	34.10	30.00
PAS-5	HG	0.19	0.15
PAS-5	PB	54.90	30.00
PAS-5	ZN	144.60	120.00
PAS-6	PB	32.00	30.00
PAS-9	PB	32.20	30.00
PER-4	PB	31.00	30.00
PER-5	PB	30.10	30.00
PER-6	PB	38.30	30.00
PER-7	PB	45.30	30.00
PER-8	PB	35.40	30.00
RKE-11	HG	0.19	0.15
RKE-13	HG	1.75	0.15
RKE-9	HG	0.89	0.15
SCP-10	PB	226.90	30.00
SCP-6	HG	0.17	0.15
SCP-6	PB	33.80	30.00
SCP-8	ZN	121.90	120.00
SCP-9	PB	38.10	30.00
WEL-1	HG	0.35	0.15
WEL-2	HG	1.03	0.15
WEL-2	PB	32.40	30.00
WEL-2	ZN	136.10	120.00
WEL-3	HG	0.45	0.15
WEL-4	CR	415.61	80.00
WEL-4	HG	3.32	0.15
WEL-4	NI	52.51	35.00
WEL-5	CR	494.38	80.00
WEL-5	CU	90.37	70.00
WEL-5	HG	5.54	0.15
WEL-5	NI	58.93	35.00
WEL-5	ZN	244.00	120.00

Source: Based on RTI's analysis of data from Riggs et al., in preparation.

Table 4-5. Exceedances of NOAA ER-M Sediment Values (ppm dry weight) for Various Heavy Metals in the Albemarle Estuary

Core	Metal	Concentration	ER-M
CHN-10	PB	68.00	50.00
EDN-5	PB	57.50	50.00
PAS-12	PB	60.30	50.00
PAS-14	PB	57.40	50.00
PAS-15	PB	58.90	50.00
PAS-16	PB	77.60	50.00
PAS-17	PB	74.90	50.00
PAS-19	PB	658.90	50.00
PAS-19	ZN	668.50	270.00
PAS-20	PB	69.30	50.00
PAS-21	PB	76.20	50.00
PAS-22	PB	66.80	50.00
PAS-23	PB	95.00	50.00
PAS-25	PB	183.30	50.00
PAS-25	ZN	326.00	270.00
PAS-26	PB	63.30	50.00
PAS-27	PB	74.60	50.00
PAS-28	PB	55.60	50.00
PAS-5	PB	54.90	50.00
RKE-13	HG	1.75	1.30
SCP-10	PB	226.90	50.00
WEL-4	CR	415.61	145.00
WEL-4	HG	3.32	1.30
WEL-5	CR	494.38	145.00
WEL-5	HG	5.54	1.30

Source: Based on RTI's analysis of data from Riggs et al., in preparation.

Table 4-6. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Metals in the Pamlico Estuary

Core	Metal	Concentration	ER-L
BRD-1	CU	194.000	70.00
BRD-1	PB	81.000	35.00
BRD-1	HG	0.196	0.15
BRD-1	ZN	132.800	120.00
BRD-2	PB	44.400	35.00
BRD-2	HG	0.166	0.15
BRD-3	PB	42.900	35.00
BRD-4	PB	40.200	35.00
BRD-5	PB	39.200	35.00
BRD-6	PB	36.100	35.00
BTH-1	PB	44.100	35.00
BTH-2	PB	45.700	35.00
BTH-3	PB	45.700	35.00
BTH-4	PB	42.000	35.00
DHM-2	PB	36.400	35.00
NAT-1	AS	34.200	33.00
NAT-1	PB	76.500	35.00
NAT-1	HG	0.446	0.15
NAT-1	ZN	396.800	120.00
NAT-10	PB	81.300	35.00
NAT-10	HG	0.460	0.15
NAT-10	ZN	449.200	120.00
NAT-11	PB	78.900	35.00
NAT-11	HG	1.297	0.15
NAT-11	ZN	481.800	120.00
NAT-11	AG	1.400	1.00
NAT-12	PB	83.300	35.00
NAT-12	HG	0.553	0.15
NAT-12	ZN	438.300	120.00
NAT-13	PB	37.900	35.00
NAT-13	HG	0.175	0.15
NAT-13	ZN	154.500	120.00
NAT-14	PB	46.300	35.00
NAT-14	HG	0.178	0.15
NAT-14	ZN	292.900	120.00
NAT-15	HG	0.162	0.15
NAT-15	ZN	151.200	120.00
NAT-2	PB	79.900	35.00
NAT-2	HG	0.602	0.15
NAT-2	ZN	444.400	120.00
NAT-3	PB	64.200	35.00
NAT-3	HG	0.353	0.15
NAT-3	ZN	358.600	120.00
NAT-4	PB	61.200	35.00
NAT-4	HG	0.295	0.15
NAT-4	ZN	359.800	120.00
NAT-5	AS	35.400	33.00
NAT-5	PB	71.400	35.00
NAT-5	HG	0.337	0.15
NAT-5	ZN	349.800	120.00
NAT-6	PB	71.000	35.00
NAT-6	HG	0.312	0.15
NAT-6	ZN	335.800	120.00
NAT-8	PB	75.200	35.00
NAT-8	HG	0.508	0.15
NAT-8	ZN	490.300	120.00
NAT-9	CU	84.400	70.00
NAT-9	PB	83.200	35.00
NAT-9	HG	0.430	0.15
NAT-9	ZN	479.400	120.00

Source: Based on RTI's analysis of data from Riggs et al., 1989.

Table 4-6. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Metals in the Pamlico Estuary

Core	Metal	Concentration	ER-L
PAM-10	PB	42.300	35.00
PAM-11	PB	37.400	35.00
PAM-11	HG	0.190	0.15
PAM-12	PB	46.900	35.00
PAM-13	PB	52.600	35.00
PAM-14	PB	47.900	35.00
PAM-15	PB	53.700	35.00
PAM-16	PB	38.000	35.00
PAM-17	PB	47.800	35.00
PAM-18	PB	35.500	35.00
PAM-19	PB	54.100	35.00
PAM-20	PB	45.700	35.00
PAM-21	PB	38.300	35.00
PAM-22	PB	53.100	35.00
PAM-24	PB	45.600	35.00
PAM-25	PB	42.800	35.00
PAM-26	PB	45.100	35.00
PAM-27	PB	45.600	35.00
PAM-28	PB	39.100	35.00
PAM-30	PB	43.600	35.00
PAM-30	PB	42.800	35.00
PAM-33	PB	44.200	35.00
PAM-34	PB	49.600	35.00
PAM-35	PB	50.000	35.00
PAM-36	PB	46.200	35.00
PAM-39	PB	36.200	35.00
PAM-40	PB	38.700	35.00
PAM-41	PB	37.000	35.00
PAM-42	PB	40.700	35.00
PAM-43	PB	40.200	35.00
PAM-44	PB	43.500	35.00
PAM-7	PB	59.700	35.00
PAM-7	HG	0.183	0.15
PAM-8	HG	0.169	0.15
PAM-9	PB	47.100	35.00
PAM-9	HG	0.176	0.15
PAM-V2	PB	45.800	35.00
PAM-V2	AS	34.000	33.00
PAM-V2	PB	44.600	35.00
PAM-V3	PB	51.700	35.00
PTG-1	PB	51.300	35.00
PTG-3	PB	48.200	35.00
PTG-6	PB	41.600	35.00
PUN-11	CU	72.400	70.00
PUN-11	PB	48.700	35.00
PUN-11	ZN	193.000	120.00
PUN-11	AG	1.200	1.00
PUN-12	PB	35.900	35.00
PUN-18	PB	37.200	35.00
PUN-19	PB	50.600	35.00
PUN-8	PB	36.100	35.00
PUN-9	PB	38.200	35.00
STH-10	PB	40.700	35.00
STH-9	PB	35.500	35.00
TAR-10	PB	52.700	35.00
TAR-10	HG	0.190	0.15
TAR-10	ZN	154.700	120.00
TAR-19	HG	0.158	0.15
TAR-22	PB	144.700	35.00
TAR-23	PB	56.200	35.00

Source: Based on RTI's analysis of data from Riggs et al., 1989.

Table 4-6. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Metals in the Pamlico Estuary

Core	Metal	Concentration	ER-L
TAR-23	HG	0.159	0.15
TAR-8	ZN	139.400	120.00
TAR-9	PB	53.700	35.00
TAR-9	HG	0.155	0.15
TAR-9	ZN	135.700	120.00
WHD-1	PB	41.500	35.00
WHD-2	PB	50.200	35.00

Source: Based on RTI's analysis of data from Riggs et al., 1989.

Table 4-7. Exceedances of NOAA ER-M Sediment Values (ppm dry weight) for Various Metals in the Pamlico Estuary

Core	Metal	Concentration	ER-M
NAT-1	ZN	396.800	270.00
NAT-10	ZN	449.200	270.00
NAT-11	ZN	481.800	270.00
NAT-12	ZN	438.300	270.00
NAT-14	ZN	292.900	270.00
NAT-2	ZN	444.400	270.00
NAT-3	ZN	358.600	270.00
NAT-4	ZN	359.800	270.00
NAT-5	ZN	349.800	270.00
NAT-6	ZN	335.800	270.00
NAT-8	ZN	490.300	270.00
NAT-9	ZN	479.400	270.00
TAR-22	PB	144.700	110.00

Source: Based on RTI's analysis of data from Riggs et al., 1989.

Table 4-8. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Heavy Metals in the Neuse Estuary

Core	Metal	Concentration	ER-L
BROD-1	PB	39.80	35.00
BROD-1	ZN	122.70	120.00
BROD-2	PB	44.20	35.00
BROD-3	PB	35.80	35.00
CMP-1	CU	185.30	70.00
CMP-1	PB	47.50	35.00
CMP-1	HG	0.34	0.15
CMP-1	ZN	274.80	120.00
CMP-2	CU	75.70	70.00
CMP-2	ZN	154.20	120.00
DUC-1	PB	43.90	35.00
DUC-1	ZN	122.10	120.00
FFD-1	ZN	122.50	120.00
HCK-3	PB	35.10	35.00
LSN-1	PB	201.80	35.00
LSN-1	HG	0.38	0.15
LSN-1	ZN	329.00	120.00
LSN-2	CU	87.60	70.00
LSN-2	PB	203.00	35.00
LSN-2	HG	0.33	0.15
LSN-2	ZN	326.20	120.00
NBNE-10	PB	50.90	35.00
NBNE-10	HG	0.16	0.15
NBNE-10	ZN	153.10	120.00
NBNE-11	PB	44.70	35.00
NBNE-11	HG	0.18	0.15
NBNE-11	ZN	131.40	120.00
NBNE-12	PB	47.30	35.00
NBNE-12	HG	0.19	0.15
NBNE-12	ZN	162.60	120.00
NBNE-2	PB	38.70	35.00
NBNE-2	ZN	137.60	120.00
NBNE-3	PB	46.20	35.00
NBNE-3	HG	0.18	0.15
NBNE-3	ZN	134.60	120.00
NBNE-4	HG	0.23	0.15
NBNE-5	HG	0.24	0.15
NBNE-6	PB	51.00	35.00
NBNE-6	HG	0.25	0.15
NBNE-6	ZN	128.30	120.00
NBNE-7	PB	55.20	35.00
NBNE-7	HG	0.33	0.15
NBNE-7	ZN	145.50	120.00
NBNE-8	PB	55.30	35.00
NBNE-8	ZN	159.30	120.00
NBNE-9	PB	58.30	35.00
NBNE-9	HG	0.20	0.15
NBNE-9	ZN	140.40	120.00
NBNW-1	CU	96.10	70.00
NBNW-1	PB	81.60	35.00
NBNW-1	ZN	187.10	120.00
NBNW-10	PB	68.20	35.00
NBNW-10	HG	0.19	0.15
NBNW-10	ZN	218.50	120.00
NBNW-10	PB	59.60	35.00
NBNW-10	ZN	197.70	120.00
NBNW-11	HG	0.22	0.15
NBNW-12	PB	35.30	35.00
NBNW-12	ZN	137.70	120.00
NBNW-13	PB	52.50	35.00

Source: Based on RTI's analysis of data from Riggs et al., 1991.

Table 4-8. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Heavy Metals in the Neuse Estuary

Core	Metal	Concentration	ER-L
NBNW-13	HG	0.26	0.15
NBNW-13	ZN	149.00	120.00
NBNW-14	PB	48.00	35.00
NBNW-14	HG	0.21	0.15
NBNW-14	ZN	154.90	120.00
NBNW-15	HG	0.17	0.15
NBNW-16	CU	89.40	70.00
NBNW-16	PB	75.90	35.00
NBNW-16	HG	0.66	0.15
NBNW-16	ZN	219.60	120.00
NBNW-17	PB	41.30	35.00
NBNW-17	HG	0.58	0.15
NBNW-17	ZN	268.90	120.00
NBNW-18	PB	38.20	35.00
NBNW-18	HG	0.27	0.15
NBNW-18	ZN	128.00	120.00
NBNW-18	ZN	139.90	120.00
NBNW-20	PB	35.40	35.00
NBNW-20	HG	0.27	0.15
NBNW-21	PB	40.70	35.00
NBNW-21	HG	0.20	0.15
NBNW-21	ZN	125.50	120.00
NBNW-23	PB	41.40	35.00
NBNW-23	HG	0.18	0.15
NBNW-23	ZN	148.10	120.00
NBNW-23	PB	35.60	35.00
NBNW-23	ZN	170.00	120.00
NBNW-25	CR	117.80	80.00
NBNW-25	NI	30.70	30.00
NBNW-25	ZN	272.20	120.00
NBNW-26	CD	23.40	5.00
NBNW-26	CU	440.30	70.00
NBNW-26	PB	63.60	35.00
NBNW-26	NI	829.10	30.00
NBNW-26	ZN	428.30	120.00
NBNW-27	NI	48.10	30.00
NBNW-28	PB	35.40	35.00
NBNW-28	ZN	130.70	120.00
NBNW-3	PB	48.70	35.00
NBNW-3	HG	0.22	0.15
NBNW-3	ZN	144.20	120.00
NBNW-4	PB	69.30	35.00
NBNW-4	HG	0.21	0.15
NBNW-4	ZN	184.50	120.00
NBNW-5	PB	57.80	35.00
NBNW-5	HG	0.17	0.15
NBNW-5	ZN	165.30	120.00
NBNW-6	PB	68.90	35.00
NBNW-6	ZN	145.30	120.00
NBNW-6	PB	45.60	35.00
NBNW-6	ZN	157.30	120.00
NBNW-7	PB	60.00	35.00
NBNW-7	ZN	186.40	120.00
NBNW-8	PB	42.40	35.00
NBNW-8	HG	0.20	0.15
NBNW-8	ZN	139.90	120.00
NBNW-9	PB	58.50	35.00
NBNW-9	HG	0.16	0.15
NBNW-9	ZN	180.10	120.00
NBNW-9	PB	56.70	35.00

Source: Based on RTI's analysis of data from Riggs et al., 1991.

Table 4-8. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Heavy Metals in the Neuse Estuary

Core	Metal	Concentration	ER-L
NBNW-9	ZN	176.00	120.00
NP-10	PB	37.00	35.00
NP-3	PB	38.10	35.00
NP-4	PB	38.80	35.00
NP-4	HG	0.19	0.15
NP-5	PB	37.90	35.00
NP-5	HG	0.19	0.15
NP-6	PB	42.70	35.00
NP-6	HG	0.20	0.15
NP-7	PB	41.20	35.00
NP-7	HG	0.20	0.15
NP-8	PB	41.30	35.00
NP-8	HG	0.19	0.15
NP-9	PB	42.50	35.00
NP-9	HG	0.20	0.15
NUS-1	PB	42.30	35.00
NUS-1	HG	0.18	0.15
NUS-1	ZN	121.10	120.00
NUS-10	PB	43.10	35.00
NUS-10	HG	0.21	0.15
NUS-11	PB	39.40	35.00
NUS-11	ZN	123.40	120.00
NUS-12	PB	44.30	35.00
NUS-15	PB	42.60	35.00
NUS-15	HG	0.16	0.15
NUS-15	PB	35.80	35.00
NUS-16	HG	0.16	0.15
NUS-17	PB	35.30	35.00
NUS-3	PB	47.50	35.00
NUS-3	HG	0.25	0.15
NUS-3	PB	44.70	35.00
NUS-3	ZN	155.00	120.00
NUS-4	HG	0.18	0.15
NUS-5	PB	43.20	35.00
NUS-5	HG	0.17	0.15
NUS-5	ZN	132.20	120.00
NUS-6	PB	51.40	35.00
NUS-6	HG	0.19	0.15
NUS-6	ZN	139.80	120.00
NUS-8	PB	39.60	35.00
NUS-8	HG	0.20	0.15
NUS-9	PB	43.10	35.00
NUS-9	HG	0.25	0.15
NUS-9	PB	44.10	35.00
NUS-9	ZN	126.40	120.00
NUSE-1	PB	38.90	35.00
ORL-1	CU	81.00	70.00
ORL-1	PB	37.60	35.00
RIV-3	PB	41.90	35.00
RIV-3	ZN	121.50	120.00
SCT-1	PB	54.10	35.00
SCT-1	ZN	173.00	120.00
SCT-2	PB	39.40	35.00
SCT-2	ZN	133.00	120.00
SLO-1	CD	8.70	5.00
SLO-1	PB	50.50	35.00
SLO-1	HG	0.22	0.15
SLO-1	ZN	134.90	120.00
SLO-10	CD	5.70	5.00
SLO-10	PB	49.30	35.00

Source: Based on RTI's analysis of data from Riggs et al., 1991.

Table 4-8. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Heavy Metals in the Neuse Estuary

Core	Metal	Concentration	ER-L
SLO-10	HG	0.61	0.15
SLO-11	CD	7.00	5.00
SLO-11	PB	73.30	35.00
SLO-11	HG	0.50	0.15
SLO-11	ZN	144.50	120.00
SLO-12	PB	70.90	35.00
SLO-12	HG	0.40	0.15
SLO-13	PB	35.60	35.00
SLO-14	PB	35.10	35.00
SLO-16	CU	409.40	70.00
SLO-16	PB	75.50	35.00
SLO-16	HG	0.44	0.15
SLO-16	ZN	201.00	120.00
SLO-17	CU	101.20	70.00
SLO-17	PB	59.50	35.00
SLO-17	HG	0.18	0.15
SLO-18	CD	6.60	5.00
SLO-18	CU	105.60	70.00
SLO-18	PB	158.90	35.00
SLO-18	HG	0.41	0.15
SLO-18	ZN	248.40	120.00
SLO-19	CD	10.60	5.00
SLO-19	CR	108.70	80.00
SLO-19	CU	184.50	70.00
SLO-19	PB	187.90	35.00
SLO-19	HG	0.21	0.15
SLO-19	ZN	324.20	120.00
SLO-2	CD	20.30	5.00
SLO-2	CR	156.60	80.00
SLO-2	PB	123.50	35.00
SLO-2	HG	0.83	0.15
SLO-2	ZN	215.50	120.00
SLO-20	CD	12.60	5.00
SLO-20	CR	97.10	80.00
SLO-20	CU	79.80	70.00
SLO-20	PB	149.50	35.00
SLO-20	ZN	238.60	120.00
SLO-21	CD	9.70	5.00
SLO-21	CR	83.60	80.00
SLO-21	CU	76.70	70.00
SLO-21	PB	117.20	35.00
SLO-21	HG	0.20	0.15
SLO-21	ZN	226.30	120.00
SLO-22	CD	7.90	5.00
SLO-22	CR	83.00	80.00
SLO-22	PB	77.30	35.00
SLO-22	HG	0.24	0.15
SLO-22	ZN	136.50	120.00
SLO-23	PB	84.50	35.00
SLO-23	ZN	130.70	120.00
SLO-24	PB	73.70	35.00
SLO-24	HG	0.18	0.15
SLO-24	ZN	155.60	120.00
SLO-25	CD	12.80	5.00
SLO-25	CR	126.10	80.00
SLO-25	PB	118.00	35.00
SLO-25	HG	0.50	0.15
SLO-25	ZN	206.20	120.00
SLO-3	CD	7.60	5.00
SLO-3	PB	46.30	35.00

Source: Based on RTI's analysis of data from Riggs et al., 1991.

Table 4-8. Exceedances of NOAA ER-L Sediment Values (ppm dry weight) for Various Heavy Metals in the Neuse Estuary

Core	Metal	Concentration	ER-L
SLO-3	HG	0.32	0.15
SLO-5	CD	7.70	5.00
SLO-5	PB	71.00	35.00
SLO-5	HG	0.66	0.15
SLO-5	ZN	157.90	120.00
SLO-6	CD	8.50	5.00
SLO-6	PB	67.00	35.00
SLO-6	HG	10.90	0.15
SLO-6	ZN	170.70	120.00
SLO-9	PB	56.40	35.00
SLO-9	HG	0.33	0.15
STH-3	HG	0.17	0.15
STH-3	PB	68.90	35.00
SWT-2	HG	0.25	0.15
TNT-11	CU	248.00	70.00
TNT-11	PB	241.70	35.00
TNT-11	HG	0.42	0.15
TNT-11	NI	32.50	30.00
TNT-11	ZN	1104.00	120.00
TNT-12	CU	195.00	70.00
TNT-12	PB	147.00	35.00
TNT-12	HG	0.65	0.15
TNT-12	ZN	366.90	120.00
TNT-14	PB	49.80	35.00
TNT-14	HG	0.17	0.15
TNT-14	ZN	161.10	120.00
TNT-16	CU	85.80	70.00
TNT-16	PB	120.10	35.00
TNT-16	HG	0.46	0.15
TNT-16	ZN	270.40	120.00
TNT-16	CU	81.00	70.00
TNT-16	PB	86.60	35.00
TNT-16	ZN	248.30	120.00
TNT-17	PB	82.70	35.00
TNT-17	HG	0.27	0.15
TNT-17	ZN	215.50	120.00
TNT-18	HG	0.72	0.15
TNT-2	HG	0.24	0.15
TNT-5	PB	37.30	35.00
TNT-5	HG	0.16	0.15
TNT-6	HG	0.17	0.15
TNT-9	PB	59.50	35.00
TNT-9	HG	0.28	0.15
TNT-9	ZN	138.50	120.00
TNT-9	PB	53.50	35.00
TNT-9	ZN	145.30	120.00
WKR-1	CU	104.60	70.00

Source: Based on RTI's analysis of data from Riggs et al., 1991.

Table 4-9. Exceedances of NOAA ER-M Sediment Values (ppm dry weight) for Various Metals in the Neuse Estuary

Core	Metal	Concentration	ER-M
CMP-1	ZN	274.80	270.00
LSN-1	PB	201.80	110.00
LSN-1	ZN	329.00	270.00
LSN-2	PB	203.00	110.00
LSN-2	ZN	326.20	270.00
NBNW-25	ZN	272.20	270.00
NBNW-26	CD	23.40	9.00
NBNW-26	CU	440.30	390.00
NBNW-26	NI	829.10	50.00
NBNW-26	ZN	428.30	270.00
SLO-16	CU	409.40	390.00
SLO-18	PB	158.90	110.00
SLO-19	CD	10.60	9.00
SLO-19	PB	187.90	110.00
SLO-19	ZN	324.20	270.00
SLO-2	CD	20.30	9.00
SLO-2	CR	156.60	145.00
SLO-2	PB	123.50	110.00
SLO-20	CD	12.60	9.00
SLO-20	PB	149.50	110.00
SLO-21	CD	9.70	9.00
SLO-21	PB	117.20	110.00
SLO-25	CD	12.80	9.00
SLO-25	PB	118.00	110.00
SLO-6	HG	10.90	1.30
TNT-11	PB	241.70	110.00
TNT-11	ZN	1104.00	270.00
TNT-12	PB	147.00	110.00
TNT-12	ZN	366.90	270.00
TNT-16	PB	120.10	110.00
TNT-16	ZN	270.40	270.00

Source: Based on RTI's analysis of data from Riggs et al., 1991.

The geographic locations of those stations exceeding the appropriate ER-M values (i.e., the concentration above which biological effects were frequently or always observed or predicted among most species) are shown in Figures 4-1 and 4-2 for the Albemarle estuarine system and the Pamlico and Neuse Estuaries, respectively.

4.2.2.1 Albemarle Estuarine System

Of the 196 sediment stations sampled by Riggs et al. (1992) in the Albemarle estuarine system and its tributaries, 71 sites were found to have sediment metal concentrations in exceedance of ER-L values for the metals evaluated (Table 4-4). Six metals were found to exceed their respective ER-L values: chromium, copper, lead, mercury, nickel, and zinc. Lead and mercury accounted for the largest number of exceedances at 40 and 50 stations, respectively. Only 22 sites were found to have sediment concentrations of metals in exceedance of ER-M values: chromium, lead, mercury, and zinc (Table 4-5). Two metals, lead and mercury, accounted for the majority of these exceedances at 18 and 3 sites, respectively. Four sites in the Albemarle Region have sediment concentrations in exceedance of ER-M values for more than one metal (PAS-19, PAS-25, WEL-4, and WEL-5). The locations of these sites exceeding ER-M values are shown in Figure 4-1.

4.2.2.2 Pamlico Estuary

Of the 153 sediment stations sampled by Riggs et al. (1989) in the Pamlico estuarine system, 78 sites were found to have sediment metal concentrations in exceedance of ER-L values for the metals evaluated (Table 4-6). Five metals were found to exceed their respective ER-L values: arsenic, copper, lead, mercury, and zinc. Lead, mercury, and zinc accounted for the largest number of exceedances at 76, 24, and 19 stations, respectively. Only 13 sites were found to have sediment concentrations of metals in exceedance of the ER-M values (Table 4-7), and only two metals were found at concentrations in exceedance of ER-M values: lead and zinc. Zinc accounted for 12 of the 13 ER-M exceedances. No sites in the Pamlico Estuary have sediment concentrations in exceedance of ER-M values for more than one metal. The locations of sites exceeding the ER-M values are shown in Figure 4-2.

4.2.2.3 Neuse Estuary

Of the 203 sediment stations sampled by Riggs et al. (1991) in the Neuse estuarine system, 105 sites were found to have sediment metal concentrations in exceedance of ER-L values for the metals evaluated (Table 4-8). Seven metals were found to exceed their respective ER-L value: cadmium, chromium, copper, lead, mercury, nickel, and zinc. Lead, mercury, and zinc accounted for the largest number of exceedances at 99, 73, and 72 stations, respectively. Only 16 sites were found to have sediment concentrations of metals in

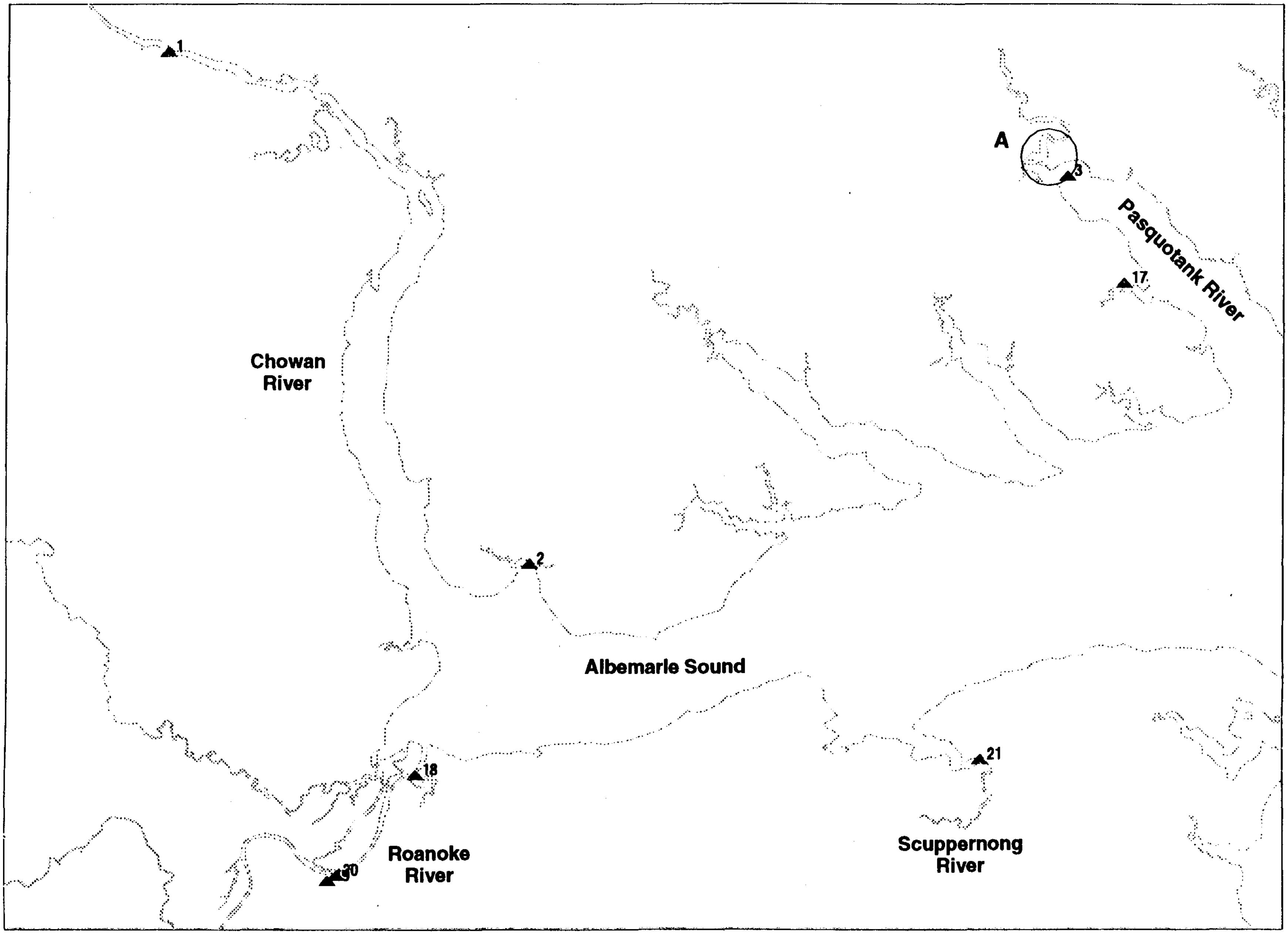


Figure 4-1. Sites where NOAA ER-M sediment values were exceeded.

NOAA ER-M Sediment Exceedances in the Albemarle Estuarine System.

#	Longitude	Latitude	Core	AG	AS	CD	CR	CU	NI	PB	SE	ZN	HG
1	76.8858	36.3835	CHN-10							2			
2	76.6105	36.0554	EDN-5							2			
3	76.1830	36.2917	PAS-12							2			
4	76.2053	36.2996	PAS-14							2			1
5	76.2119	36.3000	PAS-15							2			1
6	76.2093	36.2974	PAS-16							2			1
7	76.2142	36.2981	PAS-17							2			1
8	76.2176	36.3010	PAS-19							2		2	
9	76.2112	36.2966	PAS-20							2			1
10	76.2130	36.2968	PAS-21							2			1
11	76.2144	36.2968	PAS-22							2			
12	76.2174	36.2971	PAS-23							2			1
13	76.2177	36.2990	PAS-25							2		2	1
14	76.2024	36.3086	PAS-26							2			1
15	76.2038	36.3061	PAS-27							2			1
16	76.2150	36.3037	PAS-28							2			1
17	76.1404	36.2233	PAS-5							2		1	1
18	76.7037	35.9234	RKE-13										2
19	76.7739	35.8578	WEL-4				2		1				2
20	76.7671	35.8611	WEL-5				2	1	1			1	2
21	76.2633	35.9243	SCP-10							2			

Note: Area A includes the following stations: PAS-14 through 17; PAS-19 through 23; and PAS-25 through 28.

Figure 4-1 (continued)

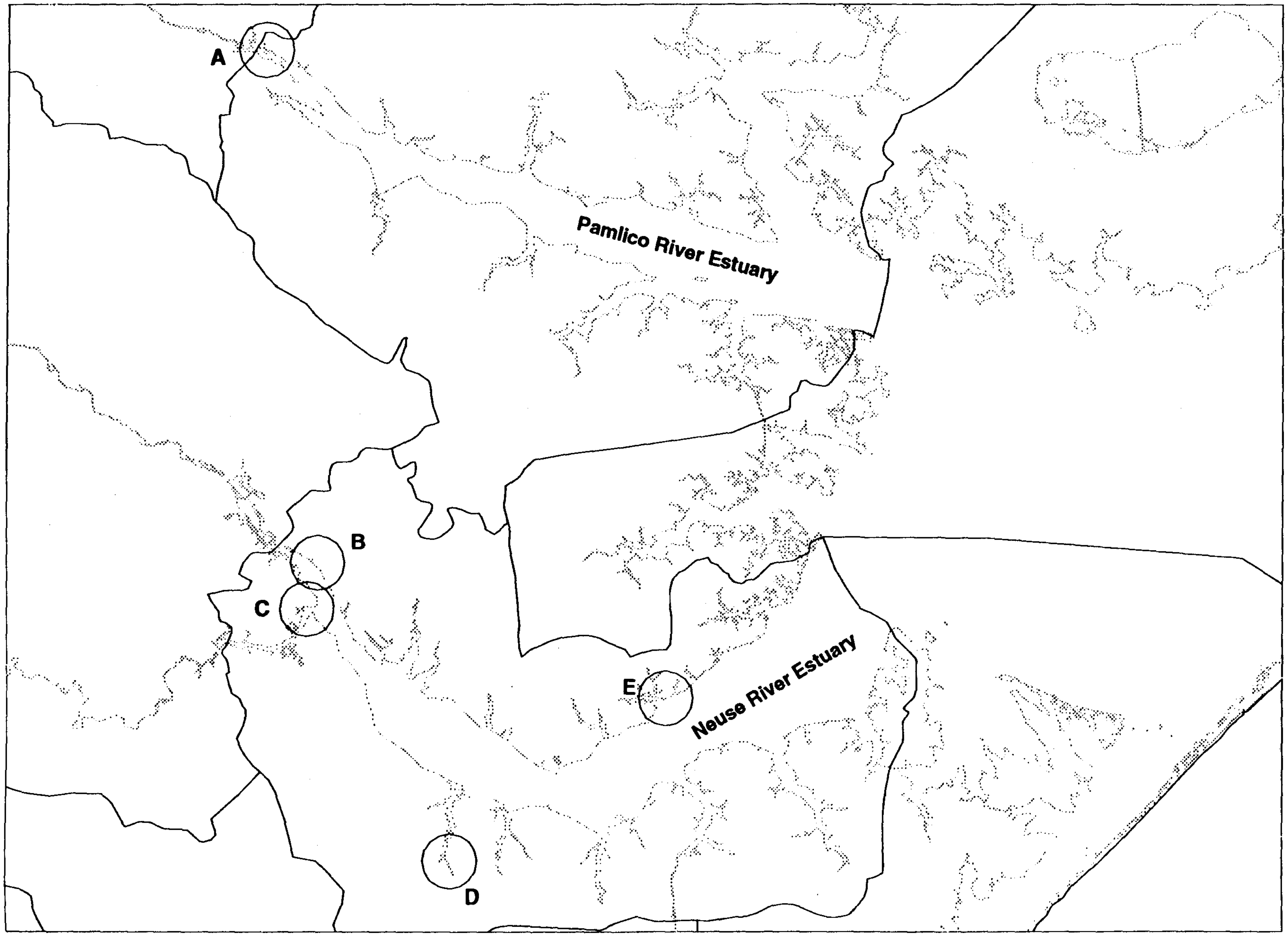


Figure 4-2. Sites where NOAA ER-M sediment values were exceeded.

NOAA Sediment ER-M Exceedances in the Pamlico River Estuary

#	Latitude	Longitude	Core	AG	AS	CD	CR	CU	NI	PB	SE	ZN	HG
117	77.0669	35.5447	TAR-22							2			
118	77.0697	35.5483	NAT-14							1		2	1
119	77.0731	35.5503	NAT-12							1		2	1
120	77.0736	35.5500	NAT-10							1		2	1
121	77.0744	35.5497	NAT-11	1						1		2	1
122	77.0756	35.5511	NAT-9					1		1		2	1
123	77.0761	35.5506	NAT-8							1		2	1
124	77.0778	35.5517	NAT-2							1		2	1
125	77.0778	35.5519	NAT-6							1		2	1
126	77.0781	35.5514	NAT-1		1					1		2	1
127	77.0781	35.5519	NAT-5		1					1		2	1
128	77.0783	35.5513	NAT-3							1		2	1
129	77.0783	35.5522	NAT-4							1		2	1

Note: Area A includes stations NAT-1 through 6; NAT-8 through 12; NAT-14; and TAR-22 in Kennedy Creek and the Washington waterfront.

NOAA Sediment ER-M Exceedances in the Neuse River Estuary

#	Latitude	Longitude	Core	AG	AS	CD	CR	CU	NI	PB	SE	ZN	HG
101	34.8864	76.9064	SLO-16					2		1		1	1
102	34.8895	76.9087	SLO-18			1		1		2		1	1
103	34.8907	76.9092	SLO-19			2	1	1		2		2	1
104	34.8931	76.9109	SLO-20			2	1	1		2		1	
105	34.8972	76.9130	SLO-21			2	1	1		2		1	1
106	34.9033	76.9144	SLO-25			2	1			2		1	1
107	34.9075	76.9147	SLO-2			2	2			2		1	1
108	34.9117	76.9118	SLO-6			1				1		1	2
109	35.0243	76.6956	CMP-1					1		1		2	1
110	35.1019	77.0513	LSN-1							2		2	1
111	35.1024	77.0411	TNT-16					1		2		2	1
112	35.1027	77.0428	TNT-11					1	1	2		2	1
113	35.1032	77.0440	TNT-12					1		2		2	1
114	35.1040	77.0460	LSN-2					1		2		2	1
115	35.1327	77.0317	NBNW-25				1		1			2	
116	35.1423	77.0384	NBNW-26			2		2	2	1		2	

Note: Area B includes stations NBNW-25 and 26 in the Neuse River (New Bern/Bridgeton area).
Area C includes stations LSN-1 and 2 in Lawson Creek; and TNT-11, 12, and 16 in the Trent River.
Area D includes stations SLO-2, 6, 16, 18 through 21, and 25 in Slocum Creek.
Area E includes station CMP-1 in Oriental Harbor.

Figure 4-2 (continued)

exceedance of their respective ER-M values (Table 4-9). Seven metals were found at concentrations in exceedance of ER-M values (cadmium, chromium, copper, lead, mercury, nickel, and zinc). Two metals, lead and zinc, accounted for the majority of these exceedances at 11 and 9 sites, respectively. Eleven sites in the Neuse River had exceedances for more than one metal (LSN-1, LSN-2, NBNW-26, SLO-2, SLO-19, SLO-20, SLO-21, SLO-25, TNT-11, TNT-12, and TNT-16). In addition, at two sites (SLO-2 and SLO-19), ER-M values for three metals were exceeded and at one site (NBNW-26), ER-M values for four metals were exceeded. The locations of sites exceeding ER-M values are shown in Figure 4-2.

4.2.4 Conclusions

With respect to estuarine/marine sites in North Carolina, metal contamination appears to be most significant in the Neuse and Albemarle Estuaries as compared to the Pamlico Estuary with respect to the number of sites exceeding ER-L and ER-M values and the number of different metals found at high concentrations (e.g., >ER-M values) (Table 4-10). The Pamlico Estuary contained fewer sites (13) that exceeded ER-M values than either the Neuse (16 sites) or Albemarle (21 sites) (Figure 4-3) and in the Pamlico only one metal was found in exceedance of ER-M values at each site. In the Albemarle, only four stations had two metals exceeding ER-M values. In the Neuse, 11 stations had two metals exceeding ER-M values and three stations had more than two metals exceeding ER-M values. Although the three predominant heavy metal contaminants exceeding ER-L values in all three estuarine areas were lead, mercury, and zinc, the sediments at several sites in the Neuse basin also exceeded ER-M values for four other metals--cadmium, copper, chromium, and nickel--and in the Albemarle, several sites also exceeded ER-M values for chromium. In the Pamlico Estuary, only lead and zinc contamination levels exceeded ER-M values.

Exceedances of NOAA sediment values are summarized in Appendix G for each estuarine system. Metal contamination at each site has been scored as follows: each ER-L exceedance is scored with 1 point and each ER-M exceedance is scored with 2 points. Total scores at each site are shown in the right column. This scoring system can be used to prioritize sites for further study on the basis of their level of contamination and will be discussed further in Section 6 (Recommendations).

Annual loadings of metals calculated in Section 2 of this report generally support the sediment contamination findings. The Roanoke and Neuse basins are more highly industrialized than either the Tar-Pamlico or Chowan basins. A wider variety of metals are also discharged to the Albemarle estuarine system via the Roanoke River basin and Neuse River basin at higher loading rates than those discharged to the Pamlico River basin.

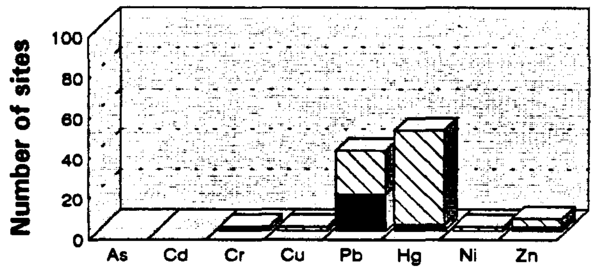
Table 4-10. Summary of Sediment Quality Exceedances in Albemarle-Pamlico Estuarine Area[a]

	Albemarle	Pamlico	Neuse
Number of sites			
Total sites sampled	196	153	203
Sites with ER-L and ER-M exceedances	71	78	105
Sites with ER-M exceedances	22	13	15
Sites with two ER-M exceedances	4	0	11
Sites with more than two ER-M exceedances	0	0	3
Number of metals			
Above ER-L values	6	5	7
Above ER-M values	4	2	7

[a]RTI evaluated only surface core samples in the toxics screening analysis. Riggs et al. (1989, 1991, and in preparation) data included chemical analysis data on deep core samples of sediment as well as surface core samples.

Albemarle Estuary

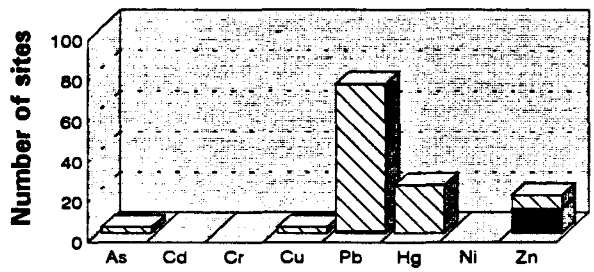
Contaminated Sediment Sites



	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Total Sites	0	0	2	2	40	50	2	6
ER-L Sites ▨	0	0	0	2	22	47	2	4
ER-M Sites ■	0	0	2	0	18	3	0	2

Pamlico Estuary

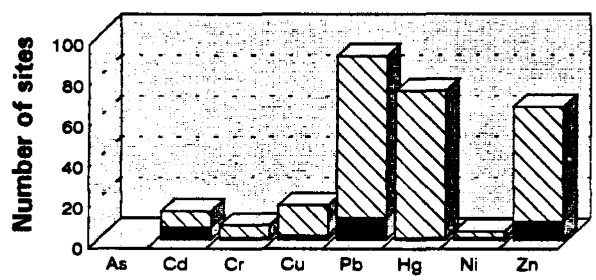
Contaminated Sediment Sites



	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Total Sites	3	0	0	3	74	24	0	19
ER-L Sites ▨	3	0	0	3	73	24	0	7
ER-M Sites ■	0	0	0	0	1	0	0	12

Neuse Estuary

Contaminated Sediment Sites



	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Total Sites	0	14	7	17	90	73	4	65
ER-L Sites ▨	0	8	6	15	79	72	3	56
ER-M Sites ■	0	6	1	2	11	1	1	9

Figure 4-3. Comparison of contaminated sediment sites.

SECTION 5

FISH AND SHELLFISH TISSUE CONTAMINATION ANALYSIS

5.1 ASSESSING HAZARDS TO WILDLIFE FROM CONSUMPTION OF CONTAMINATED FISH

5.1.1 Data Sources

The North Carolina Department of Environmental Management was the primary source of fish contaminant monitoring data used to evaluate hazards to wildlife from consumption of contaminated fish. The State provided a digital copy of their Fish Contaminant Monitoring database for this analysis. This database included fish contaminant monitoring data derived from three distinct sources including the

- DEM fish contaminant monitoring program
- U.S. EPA dioxin monitoring program
- Discharger-conducted dioxin monitoring program.

No attempt was made to judge the quality of these data or the accuracy and precision of the analytical techniques used to obtain the reported values. The State database contained information on concentrations of toxic pollutants in whole fish samples and both individual fish data and composite data on contamination for a variety of fish species were available.

Whole fish contaminant data from the State database from January 1980 to January 1990 were evaluated to assess the potential hazards to wildlife. All fish contaminant monitoring stations within the major river systems of the A/P Study Area were evaluated (Appendix H).

5.1.2 Methodology for Screening Whole Fish Data

No State standards or EPA criteria are currently available to screen whole fish data to determine contaminant tissue concentrations that may be injurious to wildlife (piscivorous birds, reptiles, and mammals). RTI staff are currently providing technical support to the EPA Fish Contaminant Workgroup and, in that context, contacted U.S. Fish and Wildlife Service (U.S. FWS) personnel to determine whether this Federal agency, which currently conducts the National Contaminant Biomonitoring Program (NCBP), has established criteria for screening whole fish data for hazards to wildlife. Christopher Schmitt of the U.S. FWS who directs the NCBP indicated that currently there are no Federal criteria available to screen whole fish contaminant data; however, he recommended that RTI screen the whole fish database file against the 85th percentile values obtained during the 1985 National Contaminant Biomonitoring Program (Schmitt and Brumbaugh, 1990; Schmitt et al., 1990).

> **Note: These values were derived from results obtained in a national U.S. FWS network of freshwater fish contaminant monitoring stations. During the most recent NCBP sampling period (fall of 1984 and spring of 1985), fish were collected at 112 stations nationwide and concentrations of seven metals and 23 organochlorine compounds were analyzed in whole fish samples.**

Levels of concern from a variety of sources including the NCBP are compared in Table 5-1 for both metal and organic contaminants in whole fish. These include

- Recommended guidelines from the National Academy of Science (NAS, 1973)
- Recommended concentrations for protection of wildlife from U.S. FWS Contaminant Hazard Reviews (Eisler, 1985, 1986, 1987, and 1990)
- Fish flesh criteria for the protection of piscivorous wildlife developed by the New York Department of Environmental Conservation (Newell et al., 1987).
- Levels of concern from the NCBP (Schmitt and Brumbaugh, 1990; Schmitt et al., 1990).

After reviewing available levels of concern for metals, RTI decided that to best evaluate the hazards to wildlife from consumption of metal-contaminated fish, the U.S. FWS NCBP 85th percentile values should be used. The NCBP provided values for screening seven of the nine metals of concern. No levels of concern were available for chromium and nickel so they could not be evaluated. With the exception of mercury, the U.S. FWS 85th percentile value was, in every case, the most conservative value available (Table 5-1). For mercury, RTI chose to use the 85th percentile value to be consistent with the other levels of concern despite the fact that this value was not the most conservative value available. The State of North Carolina analyzes for the nine metals shown in Table 5-1 in its fish contaminant monitoring program although not all metals are analyzed in all samples from all stations.

In an earlier U.S. FWS study, May and McKinney (1981) reported that, although the 85th percentile value may not be meaningful biologically, it was considered to be above the normal background range for whole fish metal concentrations, and sites where concentrations exceeded this value potentially warranted further study. All whole fish samples were screened against the 85th percentile concentration for each of the metals and against the maximum concentration reported during the 1984-1985 reporting period. For metals, those stations

Table 5-1. Comparison of Various Levels of Concern for Selected Contaminants in Fish (Whole Body) for Screening Hazards to Wildlife

Chemical	NAS[a] (ppm)	U.S. FWS[b,c] Geometric mean (ppm)	U.S. FWS[b,c] 85% Percentile (ppm)	U.S. FWS[b,c] Maximum (ppm)	Other recent values (ppm)
Metals					
Arsenic		0.14	0.27	1.50	
Cadmium		0.03	0.05	0.22	0.1[d]
Chromium					
Copper		0.65	1.00	23.10	
Lead		0.11	0.22	4.88	
Mercury	0.5	0.10	0.17	0.37	0.1[e]
Nickel					
Selenium		0.42	0.73	2.30	
Zinc		21.70	34.20	118.40	
Aldrin	0.1				
Chlordane (total)					0.5[f]
cis-chlordane		0.03		0.66	
trans-chlordane		0.02		0.35	
cis-nonachlor		0.02		0.45	
trans-nonachlor		0.03		1.00	
DDT (total)	1.0	0.26		9.08	
p,p'-DDE		0.19		0.74	0.2[g]
p,p'-DDD		0.06		2.55	
p,p'-DDT		0.03		1.79	
Dieldrin	0.1	0.04		1.39	0.12[g]
Dioxin (2,3,7,8-TCDD)					1×10^{-5}[h]
Endosulfan	0.1				
Endrin	0.1	0.01*		0.22	0.025[g]

See footnotes at end of table.

(continued)

Table 5-1 (continued)

Chemical	NAS[a] (ppm)	U.S. FWS[b,c] Geometric mean (ppm)	85% Percentile (ppm)	Maximum (ppm)	Other recent values (ppm)
Heptachlor		0.01		0.29	
Hexachlorobenzene		0.01*		0.41	
Lindane (γ-BHC)	0.1	0.01*		0.04	
PCB (total)	0.51	0.39		6.70	0.13[g]
Aroclor 1248		0.06		4.30	
Aroclor 1254		0.21		4.00	
Aroclor 1260		0.15		2.30	
Toxaphene		0.14		8.20	

*Geometric mean for this contaminant was actually less than 0.01 ppm.

[a]National Academy of Science (NAS). 1973. Water Quality Criteria 1972, Ecological Research Series, EPA-R3-73-003. U.S. Environmental Protection Agency, Washington, DC. The NAS developed recommended guidelines for water quality to protect aquatic organisms that contain the toxic compounds and the species that consume the contaminated organisms.

[b]Source: Schmitt, C. J., and W. G. Brumbaugh. 1990. National Contaminant Biomonitoring Program: Concentrations of arsenic, cadmium, copper, lead, mercury, selenium and zinc in U.S. freshwater fish, 1976-1984. Arch. Environ. Contam. Toxicol. 19:731-747. Geometric means, 85% percentile and maximum values used were those from the most recent U.S. FWS fish monitoring program conducted in 1984.

[c]Source: Schmitt, C. J., J. L. Zajicek, and P. H. Peterman. 1990. National Contaminant Biomonitoring Program: Residues of organochlorine chemicals in U.S. freshwater fish, 1976-1984. Arch. Environ. Contam. Toxicol. 19:748-781. Geometric mean and maximum values used were those from the most recent U.S. FWS fish monitoring program conducted in 1984.

[d]Eisler, R. 1985. Cadmium Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. Biological Report 85(1.2). U.S. Department of the Interior, Fish and Wildlife Service, Laurel, MD.

[e]Eisler, R. 1987. Mercury Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. Biological Report 85(1.10). U.S. Department of the Interior, Fish and Wildlife Service, Laurel, MD.

[f]Eisler, R. 1990. Chlordane Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. Biological Report 85(1.21). U.S. Department of the Interior. Fish and Wildlife Service, Laurel, MD.

[g]Newell, A. J., D. W. Johnson and L. K. Allen. 1987. Niagara River Biota Contamination in Project: Fish Flesh Criteria for Piscivorous Wildlife. Tech. Report 87-3. New York Department of Environmental Conservation, Division of Fish Wildlife Bureau. Bureau of Environmental Protection, Albany, NY.

[h]Eisler, R. 1986. Dioxin Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. Biological Report 85(1.8). U.S. Department of the Interior. Fish and Wildlife Service, Laurel, MD.

where whole fish concentrations exceeded the 85th percentile value from the NCBP were mapped as potentially contaminated areas warranting additional study.

After reviewing available levels of concern for organic pollutants, RTI staff determined that to best evaluate the hazards to wildlife from consumption of organics-contaminated fish, levels of concern from a variety of sources should be used. This was necessary because, for the NCBP, Schmitt et al. (1990) reported only the geometric mean and maximum concentrations for each of 23 organochlorine compounds analyzed; no 85th percentile values were reported. All organochlorine compound contaminant data were evaluated against the screening values summarized in Table 5-1. The final screening values used to evaluate organic contaminant levels in fish that might be hazardous to piscivorous wildlife were chosen using the following method:

- If the U.S. FWS geometric mean and maximum concentrations were the only values available, RTI judged that no appropriate screening value was available for that particular pollutant. This judgment was made because using the geometric mean value would be overly conservative in identifying sites with only average contaminant concentrations. Likewise, using the maximum concentration would have identified only the most contaminated sites but would not be comparable to the procedure used for metals. **NOTE: RTI prescreened the data set using the U.S. FWS maximum concentrations and determined that no stations in the A/P Study Area exceeded these maxima for any organic pollutant.**

- If an NAS-recommended value was available, this concentration became the screening value unless a more recent criterion was available.

- In all cases, the most recently published level of concern was used. With the exception of dieldrin, the most recently published values were also the most conservative values available for screening.

Using this method, screening values for 10 organic pollutants were identified as shown in Table 5-2. It is important to note that the final screening values selected (with the exception of the value for total PCBs) were between the U.S. FWS geometric mean and maximum values. All of these organic compounds were also analyzed as part of DEM's fish contaminant monitoring program (NCDEM, 1986, 1990, 1991). Unfortunately, appropriate screening values were not available for nine organic pollutants (or their metabolites) that are analyzed as part of DEM's monitoring program. These pollutants are methoxychlor, α-BHC, endosulfan sulfate, o,p'-DDD, p,p'-DDD, o,p'-DDE, o,p'-DDT, p,p'-DDT, and hexachlorobenzene. Despite the fact that some pollutants could not be screened and screening values had to be drawn from a variety of sources, RTI determined that this was the

Table 5-2. Screening Values Used to Evaluate Contaminant Concentrations in Fish (Whole Body) for Hazards to Wildlife

Chemical	Screening values (ppm)
Metals	
Arsenic	0.27[a]
Cadmium	0.05[a]
Chromium	NA
Copper	1.00[a]
Lead	0.22[a]
Mercury	0.17[a]
Nickel	NA
Selenium	0.73[a]
Zinc	34.20[a]
Organics	
Aldrin	0.1[b]
Chlordane (total)[c]	0.5[d]
DDT (total)[e]	1.0[b]
p,p'-DDE	0.2[f]
Dieldrin	0.12[f]
Dioxin (2,3,7,8-TCDD)	1×10^{-5}[g]
Endosulfan	0.1[b]
Endrin	0.025[f]
Lindane (γ-BHC)	0.1[b]
PCB (total)	0.13[f]

NA = No screening value was available.

(See footnotes on next page.)

Table 5-2 (continued)

[a] Source: Schmitt, C. J., and W. G. Brumbaugh. 1990. National Contaminant Biomonitoring Program: Concentrations of arsenic, cadmium, copper, lead, mercury, selenium and zinc in U.S. freshwater fish, 1976-1984. Arch. Environ. Contam. Toxicol. 19:731-747. The 85th percentile values used were those from the most recent U.S. FWS fish monitoring program conducted in 1984-1985. No values were available for chromium or nickel.

[b] National Academy of Science (NAS). 1973. Water Quality Criteria 1972, Ecological Research Series, EPA-R3-73-003. U.S. Environmental Protection Agency, Washington, DC. The NAS developed recommended guidelines for water quality to protect aquatic organisms that contain the toxic compounds and the species that consume the contaminated organisms.

[c] Chlordane (total) is the sum of the concentrations of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane.

[d] Eisler, R. 1990. Chlordane Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. Biological Report 85(1.21). U.S. Department of the Interior, Fish and Wildlife Service, Laurel, MD.

[e] DDT (total) is the sum of all the metabolites of DDT (o,p-DDE; p,p'-DDE; o,p'-DDD; p,p'-DDD; o,p'-DDT; p,p'-DDT).

[f] Newell, A. J., D. W. Johnson, and L. K. Allen. 1987. Niagara River Biota Contamination Project: Fish Flesh Criteria for Piscivorous Wildlife. Technical Report 87-3. New York Department of Environmental Conservation, Division of Fish and Wildlife Bureau, Bureau of Environmental Protection, Albany, NY.

[g] Eisler, R. 1986. Dioxin Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. Biological Report 85(1.8). U.S. Department of the Interior, Fish and Wildlife Service, Laurel, MD.

only appropriate course to take to screen the State's database objectively. For organochlorine compounds, only those stations where whole fish concentrations exceeded the selected screening values were mapped as potentially contaminated areas warranting additional study.

It should be noted that the NCBP targets freshwater fish species primarily rather than freshwater, estuarine, and marine species, which are represented in the DEM fish contaminant database. Despite this difference in the nature of the fish populations sampled, RTI believes that the values used are appropriate to screen the State's extensive database in the absence of any other existing State standards or Federal criteria.

5.1.3 Results

A detailed summary of the fish contaminant monitoring stations where exceedances of levels of concern (e.g., derived from U.S. FWS 85th percentile values or other recently published values) for the protection of piscivorous wildlife were detected is presented in Appendix I for metals and organochlorine pesticides. The location of these stations is shown in Figure 5-1 and the specific pollutants causing these exceedances are summarized in Table 5-3. A summary of stations where exceedances of the level of concern for dioxin (2,3,7,8-TCDD) were detected is shown in Table 5-4 and the location of these stations is shown in Figure 5-2.

Note: All stations where contaminant concentrations exceeded levels of concern for wildlife are reported in this toxics analysis; however, because fish are mobile, the location(s) where they are exposed to, and bioaccumulate contaminants in, their tissues may be distant from the location where they were collected (the only exception to this is lake ecosystems). Therefore, the reader is cautioned not to attach undue significance to the fact that contaminant concentrations in a single fish sample collected at a given site exceeds levels of concern for wildlife. Rather, the reader should focus attention on those monitoring stations where numerous fish samples collected over several years were found to contain contaminant concentrations exceeding levels of concern for wildlife.

5.1.3.1 Albemarle Estuary

Metals and Organochlorine Pesticides

Whole fish samples collected at 23 sites in the Albemarle estuarine system were found to exceed levels of concern for piscivorous wildlife. These sites included 3, 14, and 6 stations in the Chowan, Pasquotank, and Roanoke basins, respectively (Table 5-3).

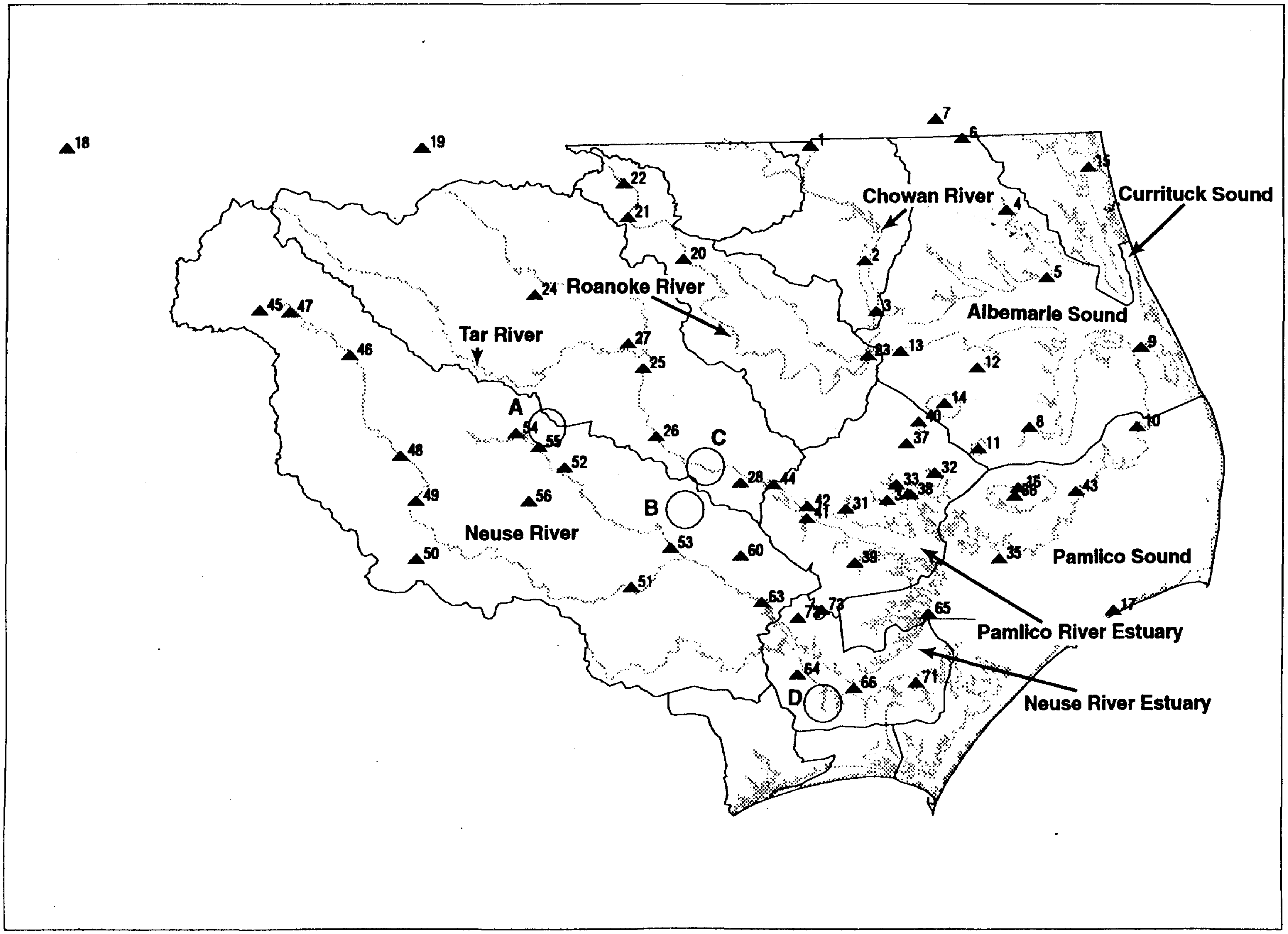


Figure 5-1. Sites where fish contaminant concentrations of metals and organochlorines exceeded levels of concern for wildlife.

Whole Fish

#	Longitude	Latitude	Station	Basin	Basin #	Exceedence Type
1	76.9214	36.5317	02050079	Chowan	030101	CU,HG,PB
2	76.7347	36.1950	02053632	Chowan	030103	CU,HG
3	76.6972	36.0472	02053652	Chowan	030104	CU,HG,PB,DDE
4	76.2186	36.3333	02043862	Pasquotank	030150	CU,HG
5	76.0792	36.1333	02081179	Pasquotank	030150	CU,HG,DDE
6	76.3722	36.5431	DS-10	Pasquotank	030150	HG,PB,ZN
7	76.4667	36.6000	DS-3/5	Pasquotank	030150	HG
8	76.1556	35.6994	0208117810	Pasquotank	030151	CD,CU,PB
9	75.7433	35.9217	0208117950	Pasquotank	030151	AS,CU
10	75.7661	35.6906	STUMPY-1	Pasquotank	030151	AS,CU,HG
11	76.3417	35.6417	TSPASNL1	Pasquotank	030151	CD,HG,PB
12	76.3375	35.8775	02081166	Pasquotank	030153	CU,PB
13	76.6111	35.9292	02081185	Pasquotank	030153	PB,ZN
14	76.4583	35.7750	PAS012	Pasquotank	030153	CD,CU,HG,PB
15	75.9167	36.4500	CURRITUCK-1	Pasquotank	030154	CU
16	76.2015	35.5239	PAS02A	Pasquotank	030154	CU
17	75.8694	35.1583	02084633	Pasquotank	030155	AS,CD,CU
18	79.6058	36.5414	02074218*	Roanoke	030203	CD,CU,HG,PB
19	78.3250	36.5417	0207933350*	Roanoke	030206	CU,HG,PB,DDE
20	77.3842	36.2094	02081000	Roanoke	030208	CD,CU,HG,PB,ZN,DDE
21	77.5833	36.3333	TSROARR30	Roanoke	030208	CD,CU,HG
22	77.5972	36.4306	WELDON-HATC	Roanoke	030208	AS,CU,HG,PB
23	76.7292	35.9194	02081141	Roanoke	030209	CU,HG
24	77.9211	36.1117	02082770	Tar-Pamlico	030302	CU,HG
25	77.5333	35.8944	02082823	Tar-Pamlico	030302	CU,HG,PB,DDE
26	77.4903	35.6958	02083692	Tar-Pamlico	030303	HG,DDE
27	77.5867	35.9667	02082812	Tar-Pamlico	030304	HG,ZN
28	77.1917	35.5583	02084171	Tar-Pamlico	030305	CD,CU,HG,PB,DDE
29	77.3303	35.6072	TSTAR120	Tar-Pamlico	030305	HG,PB,SE,ZN,CD,CU
30	77.3111	35.5986	TSTAR120D	Tar-Pamlico	030305	CU,HG,PB
31	76.8181	35.4750	02084534	Tar-Pamlico	030307	CD,CU,PB
32	76.5000	35.5736	0208455650	Tar-Pamlico	030307	CD,CU,PB
33	76.6375	35.5417	0208455850	Tar-Pamlico	030307	AS,CD,CU,PB
34	76.6722	35.4972	0208457020	Tar-Pamlico	030307	CD,PB,DDE
35	76.2769	35.3189	02092690	Tar-Pamlico	030307	AS,CU,SE
36	76.2153	35.5014	MT-1	Tar-Pamlico	030307	HG
37	76.5986	35.6611	PUNGO-1	Tar-Pamlico	030307	HG
38	76.5889	35.5125	PUNGO-17	Tar-Pamlico	030307	AS,CU,HG,SE
39	76.7917	35.3167	SOUTH-CR	Tar-Pamlico	030307	AS,PB
40	76.5533	35.7228	TAR0628A	Tar-Pamlico	030307	CD,CU,HG,ZN
41	76.9583	35.4492	TAR56B	Tar-Pamlico	030307	AS,CU
42	76.9550	35.4853	TSTARBC5	Tar-Pamlico	030307	AS,CU
43	75.9767	35.5106	TSTARFC10[a]	Tar-Pamlico	030307	DDE
44	77.0767	35.5503	TSTARKDY	Tar-Pamlico	030307	CU,HG
45	78.9083	36.0722	02085070	Neuse	030401	CD,CU,PB
46	78.5833	35.9417	NEU020D	Neuse	030401	CU,ZN

Figure 5-1 (continued)

Whole Fish

#	Longitude	Latitude	Station	Basin	Basin #	Exceedence Type
47	78.8028	36.0667	TSNEUFNR2	Neuse	030401	HG
48	78.4058	35.6472	02087500	Neuse	030402	CU,HG,PB
49	78.3500	35.5156	NEU055	Neuse	030402	CD,CU,HG
50	78.3500	35.3472	TSNEU100	Neuse	030402	CU,HG
51	77.5858	35.2581	02089500	Neuse	030405	CD,CU,HG,PB,DDE
52	77.8183	35.6083	02090634	Neuse	030407	CD,HG,PB
53	77.4444	35.3708	0209176690	Neuse	030407	CD,HG,ZN
54	77.9931	35.7111	TSNEUCC1C	Neuse	030407	HG
55	77.9111	35.6694	TSNEUCC4	Neuse	030407	CD,CU,HG,ZN
56	77.9486	35.5125	TSNEUNS4	Neuse	030407	HG,PB
57	77.9014	35.7417	TSNEUTS1	Neuse	030407	HG,PB
58	77.8917	35.7417	TSNEUTS3	Neuse	030407	HG,PB,ZN
59	77.8875	35.7347	TSNEUTS5	Neuse	030407	CU,HG,PB
60	77.1958	35.3450	02092000	Neuse	030409	CD,HG,PB
61	77.3667	35.4889	TSNEUFS03	Neuse	030409	CU,HG
62	77.4181	35.4708	TSNEUSC03	Neuse	030409	CD,CU,HG
63	77.1222	35.2083	02092162	Neuse	030410	CD,CU,HG,PB,DDE
64	77.0014	34.9958	0209257120	Neuse	030410	HG
65	76.5333	35.1639	02092682	Neuse	030410	AS,CU
66	76.8028	34.9528	NEU 139	Neuse	030410	CU
67	76.9208	34.8958	NEUSC-4	Neuse	030410	CD,CU,PB,ZN
68	76.9083	34.9278	NEUSC-5	Neuse	030410	AS,CD,CU,PB
69	76.9125	34.9167	NEUSC1	Neuse	030410	HG
70	76.9153	34.8989	NEUSC2	Neuse	030410	CD,CU,HG
71	76.5833	34.9639	SOUTHRIVER-	Neuse	030410	AS,CU,HG
72	76.9944	35.1611	TSNEUMS1	Neuse	030410	HG
73	76.9111	35.1819	TSNEUPC2	Neuse	030410	HG,ZN

Note: Area A includes stations 57, 58, and 59—TSNEUTS1, TSNEUTS3, and TSNEUTS5 in Toisnot Swamp.

Area B includes stations 61 and 62—TSNEUFSO3 and TSNEUSCO3 in Fork Swamp and Swift Creek.

Area C includes stations 29 and 30—TSTAR120 and TSTAR120D in the Tar River and Hardee Mill Creek.

Area D includes stations 67, 68, 69 and 70—NEUSC-4, NEUSC-5, NEUSC1, and NEUSC2 in Slocum Creek.

[a]Station TSTARFC10 and TSTARFC15 were the same location and only the former is plotted on the map.

*Note: These station are located within the Roanoke River Basin but are not located within the A/P Study Area.

Figure 5-1. (continued)

Table 5-3. Summary of Pollutants Causing Exceedances of Levels of Concern for Wildlife

Basin station numbers	Pollutants							
	As	Cd	Cu	Pb	Hg	Se	Zn	DDE
Chowan								
02050079			•	•	★			
02053632			•		•			
02053652			★	•	•			•
Pasquotank								
02043862			•		★			
02081179			•		•			•
DS-10				•	•		•	
DS-3/5					•			
0208117810		★	•	★				
0208117950	•		•					
STUMPY-1	•		•		•			
TSPASNL1		•		•	★			
02081166			•	•				
02081185				•			•	
PAS012		★	•	★	★			
Currituck-1			•					
PAS02A	★	★	•					
02084633	★	★	•					
Roanoke								
02074218		•	•	•	•			
0207933350			•	•	•			•
02081000		•	•	•	★		•	•
TSR0ARR30		•	•		★			
WELDON-HATC	•		•	•	•			
02081141			•		★			
Tar-Pamlico								
02082770			•		•			
02082823			•	•	•			•

See notes at end of table.

(continued)

Table 5-3 (continued)

Basin station numbers	Pollutants							
	As	Cd	Cu	Pb	Hg	Se	Zn	DDE
02083692					•			•
02082812					•		•	
02084171		•	•	•	•			•
TSTAR120		*	•	•	*	•	•	
TSTAR120D			•	•	*			
02084534		*	•	•				
0208455650		•	•	•				
0208455850	•	*	•	•				
0208457020		*		•				•
02092690	•		•			•		
MT-1					*			
PUNGO-1					*			
PUNGO-17	*		•		•	•		
SOUTH-CR	•			•				
TAR0628A		*	•		*		•	
TAR56B	•		•					
TSTARBC5	•		•					
TSTARKDY			•		•			
TSTARFC10[a]					•			•
Neuse								
02085070		•	•	•				
NEU020D			•				•	
TSNEUFNR2					*			
02087500			•	•	*			
NEU055		*	•		*			
TSNEU100			•		*			
02089500		*	•	•	*			•
02090634		*		•	•			
0209176690		*			*		*	
TSNEUCC1C					*			

(continued)

Table 5-3 (continued)

Basin station numbers	Pollutants							
	As	Cd	Cu	Pb	Hg	Se	Zn	DDE
TSNEUCC4		*	•		*		•	
TSNEUNS4				•	•			
TSNEUTS1				•	•			
TSNEUTS3				•	•		•	
TSNEUTS5			•	•	•			
02092000		*		•	•			
TSNEUFS03			•		•			
TSNEUSCO3		•	•		•			
02092162		•	*	•	*			•
0209257120					•			
02092682	•		•					
NEU139			•					
NEUSC-4		*	*	•	•			•
NEUSC-5	•	*	•	•				
NEUSC1					*			
NEUSC2		•	•		*			
South River	•		•		•			
TSNEUMS1					•			
TSNEUPC2					•		•	

As = Arsenic
Cd = Cadmium
Cu = Copper
Pb = Lead
Hg = Mercury
Se = Selenium
Zn = Zinc
DDE = 2,2-Bis(4-chlorophenyl) 1,1-dichloroethene

[a]Station TSTARFC10 is the same sampling site location as TSTARFC15. Data from these two stations were combined and are listed under TSTARFC10.

•Contaminant concentrations for metals exceed the U.S. FWS 85th percentile value from the 1984-85 NCBP; contaminant concentrations for organic compounds exceed selected screening values (see Table 5-2).

*Contaminant concentrations exceed the U.S. FWS national maximum values from the 1984-85 NCBP (see Table 5-1).

Table 5-4. Whole Fish Samples Exceeding the Dioxin Level of Concern for Wildlife

Station		Sampling Date	Species	Measured Value (ng/l)	Whole Fish Dioxin Screening Value (ng/l)
40	Neuse River near Weyerhaeuser Eff	9/1/88	Redhorse Sucker	79.10	10.0
56	Broad Cr. Slough (Roanoke River)	April/May 1989	Gizzard Shad	43.40	10.0
57	Welch Creek at Highway 64	April/May 1989	Herring	12.70	10.0
57	Welch Creek at Highway 64	April/May 1989	Gizzard Shad	69.60	10.0
57	Welch Creek at Highway 64	April/May 1989	Chub Sucker	81.20	10.0
58	Welch Creek Old Discharge Trowbridge Rd.	April/May 1989	Gizzard Shad	110.00	10.0
58	Welch Creek Old Discharge Trowbridge Rd.	April/May 1989	Gizzard Shad	108.80	10.0
58	Welch Creek Old Discharge Trowbridge Rd.	April/May 1989	Gizzard Shad	88.60	10.0
58	Welch Creek Old Discharge Trowbridge Rd.	April/May 1989	Chub Sucker	52.80	10.0
58	Welch Creek Old Discharge Trowbridge Rd.	April/May 1989	Golden Shiner	45.50	10.0
59	Welsh Cr at old Weyerhaeuser discharge	12/14/87	Cr Chub	180.17	10.0
75	Meherrin River Rt 258 just below Murfreesboro	5/8/90	Channel Catfish	28.00	10.0
76	Chowan River at Winton	May 20-June 4,1989	Channel Catfish	13.70	10.0
76	Chowan River at Winton	May 20-June 4,1989	Channel Catfish	12.60	10.0
76	Chowan River at Winton	Feb 22-23,1990	Channel Catfish	73.20	10.0
77	Chowan River Near Marker 16	11/30/89	Channel Catfish	37.90	10.0
77	Chowan River Near Marker 16	2/13/90	Channel Catfish	22.30	10.0
77	Chowan River Near Marker 16	6/27/90	Channel Catfish	12.00	10.0
78	Chowan River Near Marker 9	12/5/89	Channel Catfish	70.20	10.0
78	Chowan River Near Marker 9	6/27/90	Channel Catfish	47.10	10.0
78	Chowan River Near Marker 9	9/14/90	Channel Catfish	78.60	10.0
80	Chowan River Near Marker 5	12/5/89	Channel Catfish	39.10	10.0
80	Chowan River Near Marker 5	2/14/90	Channel Catfish	12.10	10.0
80	Chowan River Near Marker 5	6/27/90	Channel Catfish	57.80	10.0
80	Chowan River Near Marker 5	9/14/90	Channel Catfish	50.00	10.0
81	Chowan River Near Hwy 17 Bridge	12/5/89	Channel Catfish	53.10	10.0
81	Chowan River Near Hwy 17 Bridge	2/13/90	Channel Catfish	59.80	10.0
81	Chowan River Near Hwy 17 Bridge	6/27/90	Channel Catfish	48.00	10.0
81	Chowan River Near Hwy 17 Bridge	9/14/90	Channel Catfish	74.90	10.0
82	Albemarle Snd @ Norfolk & Southern	6/8/89	Redhorse Sucker	50.50	10.0
CR-2	Chowan River near Marker 2	6/27/90	Channel Catfish	78.90	10.0
CR-2	Chowan River near Marker 2	9/14/90	Channel Catfish	37.60	10.0

Note: Stations 58 and 59 are the same geographic location. Only the location of station 58 is mapped on Figure 5-2.

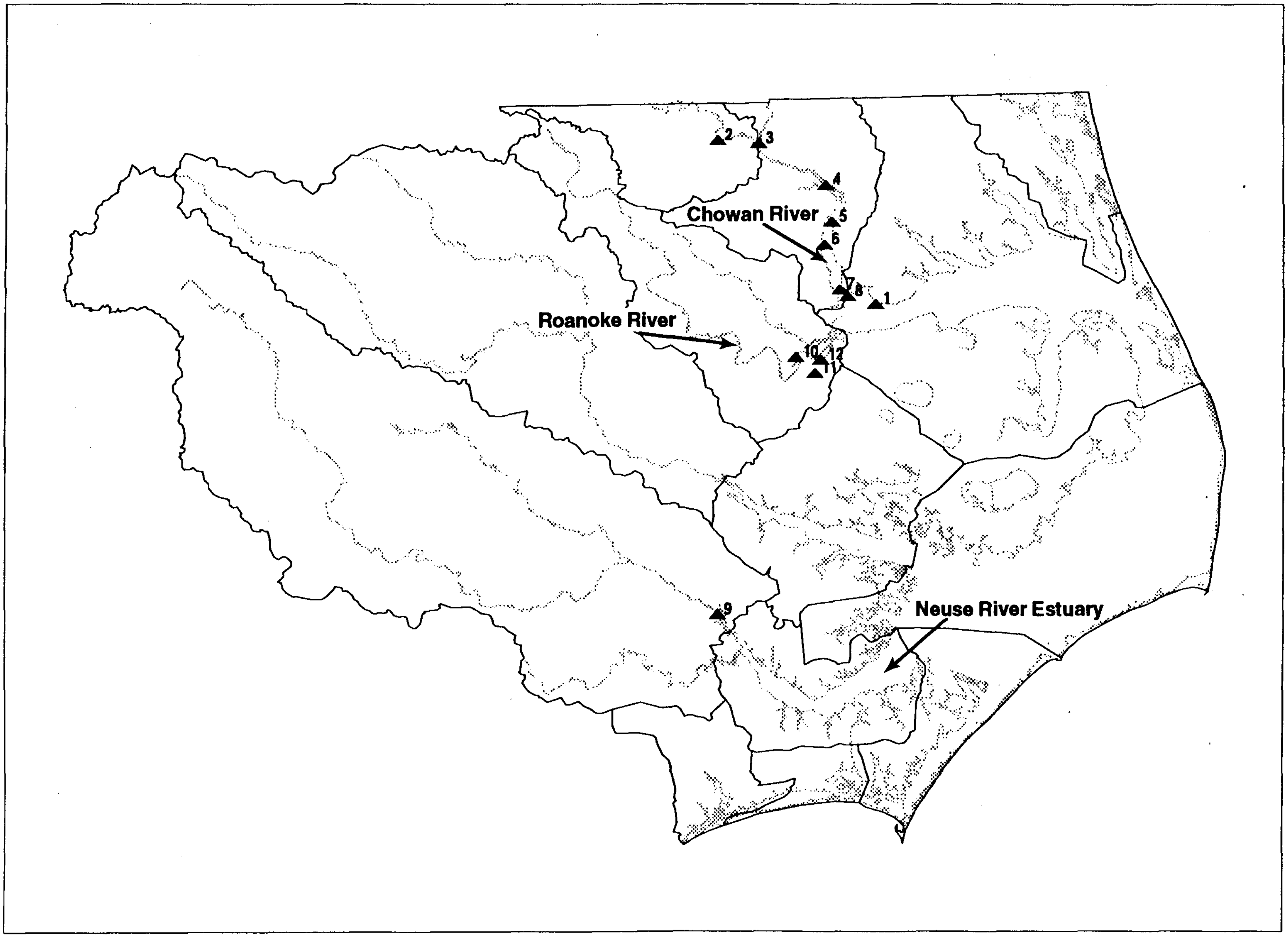


Figure 5-2. Sites where dioxin concentrations in fish exceeded the level of concern for wildlife.

Dioxin Exceedences in Whole Fish

#	Longitude	Latitude	Station	Basin	Exceedences Number	Exceedences Type
1	76.5819	36.0069	82	Albemarle	1	W
2	77.0861	36.4472	75	Chowan	1	W
3	76.9542	36.4361	76	Chowan	3	W
4	76.7347	36.3236	77	Chowan	3	W
5	76.7181	36.2250	78	Chowan	3	W
6	76.7444	36.1667	80	Chowan	4	W
7	76.6972	36.0472	81	Chowan	4	W
8	76.6722	36.0292	CR-2	Chowan	2	W
9	77.1139	35.1972	40	Neuse	1	W
10	76.8444	35.8722	56	Roanoke	1	W
11	76.7847	35.8292	57	Roanoke	3	W
12	76.7639	35.8639	58	Roanoke	6	W

Figure 5-2 (continued)

Whole fish samples from the Chowan exceeded levels of concern for four contaminants (copper, lead, mercury, and DDE). Levels of concern were exceeded at all three stations for copper and mercury. Concentrations of mercury (one station) and copper (one station) also exceeded the U.S. FWS national maxima. One station in the Chowan River, station 02050079 (19 exceedances) at Riddicksville was the most contaminated riverine site in the Chowan basin.

In the Pasquotank, whole fish samples exceeded levels of concern for seven contaminants (arsenic, cadmium, copper, lead, mercury, zinc, and DDE). Levels of concern were exceeded at ten, seven, and six stations for copper, mercury, and lead, respectively. Concentrations of cadmium (four stations), lead (two stations), and mercury (three stations) exceeded U.S. FWS maxima. Mercury exceedances (85th percentile) were identified in three basin lakes: Lake Drummond (one exceedance), Alligator Lake (five exceedances), and Lake Phelps (17 exceedances). In addition, fish samples from Alligator Lake exceeded the level of concern for cadmium and lead and some samples exceeded the U.S. FWS national maximum for mercury. Fish samples from Lake Phelps exceeded the level of concern for copper, and the U.S. FWS maxima for cadmium, lead, and mercury and was the single most contaminated site in the entire A/P Study Area. These three lakes are all located in relatively pristine areas and receive no direct discharges from industrial or municipal facilities.

In the Roanoke, whole fish samples exceeded levels of concern for seven contaminants (arsenic, cadmium, copper, lead, mercury, zinc, and DDE). Levels of concern were exceeded at all six stations for copper and mercury, and concentrations of mercury at three stations exceeded the U.S. FWS maximum. Fish from one site (02081000-Roanoke River at Scotland Neck) exceeded levels of concern for five pollutants and the U.S. FWS maximum for mercury.

Dioxin (2,3,7,8-TCDD)

Whole fish samples collected at 12 sites in the Albemarle estuarine system were found to exceed the level of concern for 2,3,7,8-TCDD for piscivorous wildlife (Table 5-4). These sites included seven sites distributed throughout the Chowan basin from the Meherrin River in North Carolina to the mouth of the Chowan, three sites in the lower Roanoke basin primarily in the vicinity of Welch Creek, and one site in western Albemarle Sound (Figure 5-2). The most contaminated dioxin site with respect to total number of dioxin exceedances was station 58 on Welch Creek in the lower Roanake River basin.

Overall, channel catfish *(Ictalurus punctatus)* were the predominant species for which exceedances were detected although levels of concern were also detected in five other fish species: redhorse sucker *(Moxostoma erythrurum)*, gizzard shad *(Dorosoma cepedianum)*, creek chubsucker *(Erimyzon oblongus)*, golden shiner *(Notemigonus crysoleucus)*, and creek chub *(Semotilus atromaculatus)* (Table 5-4).

5.1.3.2 <u>Pamlico Estuary</u>

Metals and Organochlorine Pesticides

Whole fish samples in the Pamlico were found to exceed levels of concern for eight contaminants (arsenic, cadmium, copper, lead, mercury, selenium, zinc, and DDE) at 21 stations. Levels of concern were exceeded at 14, 13, 9, 7, and 6 stations for copper, mercury, lead, cadmium, and arsenic, respectively. Concentrations of cadmium (five stations), mercury (five stations), and arsenic (one station) also exceeded U.S. FWS maxima. The most contaminated riverine site in the Pamlico basin was station 0208455850, Pantego Creek near Belhaven. At this site, 27 exceedances of levels of concern were detected.

Fish from one lake in the basin, Pungo Lake, exceeded U.S. FWS maxima for cadmium and mercury and exceeded levels of concern for copper and zinc while fish from another lake, Lake Mattamuskeet, exceeded the U.S. FWS maximum for mercury. Both of these lakes are located in pristine areas of the State and receive no direct industrial or municipal discharges.

Dioxin (2,3,7,8-TCDD)

The level of concern for dioxin in whole fish samples was not exceeded at any site in the Pamlico basin.

5.1.3.3 <u>Neuse Estuary</u>

Metals and Organochlorine Pesticides

Whole fish samples were found to exceed levels of concern for wildlife for seven contaminants (arsenic, cadmium, copper, lead, mercury, zinc, and DDE) at 29 stations in the Neuse basin. Levels of concern were exceeded at 24, 17, 12, and 12 stations for the four major contaminants to this system— mercury, copper, lead, and cadmium, respectively. In addition, concentrations of mercury (11 stations), cadmium (eight stations), copper (two stations), and zinc (one station) also exceeded the U.S. FWS maxima.

The three most contaminated sites in the Neuse basin with respect to the number of exceedances detected included

- Contentnea Creek at Wilson (TSNEUCC4)
- Neuse River at New Bern (02092162)
- Neuse River in Kinston (02089500).

Fish samples from all three sites exceeded levels of concern for three pollutants (cadmium, copper, and mercury) and exceeded the U.S. FWS maxima for mercury. The U.S. FWS maxima was exceeded at two of these stations for cadmium and at one station for copper.

Dioxin (2,3,7,8-TCDD)

Whole fish samples at one site in the Neuse basin were found to exceed the level of concern for 2,3,7,8-TCDD for piscivorous wildlife. This site (station 40) was located on the Neuse River near the Weyerhaeuser effluent near New Bern (Table 5-4).

5.1.4 Conclusions

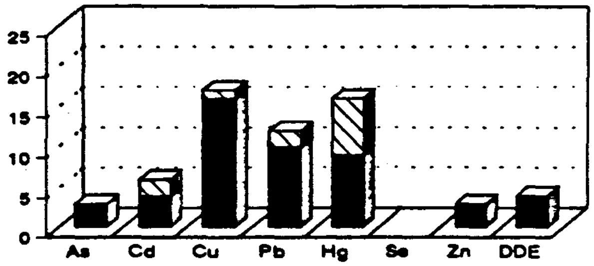
In general, within the A/P Study Area, contamination of fish that might pose a hazard to wildlife appears to be slightly more severe in the Neuse and Albemarle basins as compared to the Pamlico basin (Figure 5-3) from the 10 years of data evaluated.

Mercury was found to exceed levels of concern at 53 sites in the A/P Study Area followed by exceedances for copper (50 sites), lead (33 sites), and cadmium (27 sites). Mercury was also the contaminant found in exceedance of the U.S. FWS maximum at over 40 percent of the sites (23 sites) where it was detected. Mercury is of special concern to wildlife because it is a fetal and neurological toxicant. Severe exposures can affect viability of offspring and can affect neurological function and therefore behavior in adults (Eisler, 1987).

Loadings of mercury from point source dischargers to the A/P area are relatively minor in comparison to other metals; however, mercury loadings from facilities discharging to the Meherrin and Blackwater Rivers in Virginia were not evaluated in this study. Mercury may have entered the system from both point source discharges and nonpoint source discharges. Several pulp and paper mills in the A/P Study Area may have released mercury, which historically has been used as a fungicide at many U.S. pulp and paper mills. Atmospheric deposition of mercury from municipal incinerators has also been reported as a major source of increased environmental mercury and is thought to be responsible for many fish contaminant problems in inland lakes of several Great Lakes States (Glass et al., 1990). Mercury leaching from landfills or from urban or agricultural runoff may also have contributed to loadings of this metal.

Albemarle Estuary

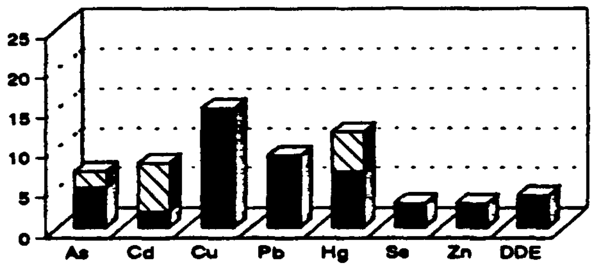
Sites Exceeding Levels of Concern and National Maxima for Wildlife



	As	Cd	Cu	Pb	Hg	Se	Zn	DDE
Total Sites	3	6	17	12	16	0	3	4
MAX	0	2	1	2	7	0	0	0
LOC	3	4	16	10	9	0	3	4

Pamlico Estuary

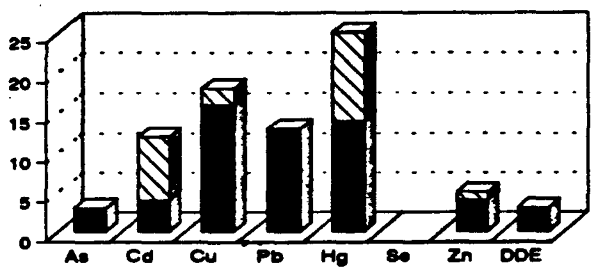
Sites Exceeding Levels of Concern and National Maxima for Wildlife



	As	Cd	Cu	Pb	Hg	Se	Zn	DDE
Total Sites	7	8	15	9	12	3	3	4
MAX	2	6	0	0	5	0	0	0
LOC	5	2	15	9	7	3	3	4

Neuse Estuary

Sites Exceeding Levels of Concern and National Maxima for Wildlife



	As	Cd	Cu	Pb	Hg	Se	Zn	DDE
Total Sites	3	12	18	13	25	0	5	3
MAX	0	8	2	0	11	0	1	0
LOC	3	4	16	13	14	0	4	3

Figure 5-3. Comparison of the number of sites exceeding levels of concern for wildlife and U.S. FWS national maxima.

In general, within the A/P Study Area, contamination of fish that might pose a hazard to wildlife appears to be almost exclusively a problem within the Albemarle estuarine system (Figure 5-4), particularly within the Chowan and Roanoke River basins. Dioxin contamination is presumed to be associated principally with three major pulp and paper mills discharging to the Albemarle and Neuse basins. Two of these facilities ultimately discharge to the Albemarle estuary--Union Camp discharges to the Blackwater River in Virginia which flows into the Chowan basin, and Weyerhaeuser discharges into the lower Roanoke River in the vicinity of Welch Creek. Another Weyerhaeuser plant in New Bern discharges to the Neuse basin. This is the primary reason why no dioxin-contaminated fish samples exceeding the level of concern were detected in the Pamlico basin. Dioxin is a byproduct of the bleach kraft process used in the pulp and paper industry. The use of alternative technologies can substantially reduce dioxin discharges and ultimately reduce contamination in fish tissues.

5.2 ASSESSING HUMAN HEALTH CONCERNS ASSOCIATED WITH CONSUMPTION OF CONTAMINATED FISH AND SHELLFISH

5.2.1 Data Sources

The NCDEM was the primary source of fish contaminant monitoring data used to evaluate the human health risks associated with consumption of contaminated fish and shellfish. The State provided a copy of their database for this analysis. This database included fish contaminant monitoring data derived from three distinct sources including the

- DEM fish contaminant monitoring program
- U.S. EPA dioxin monitoring program
- Discharger-conducted dioxin monitoring program.

No attempt was made to judge the quality of these data or the accuracy and precision of the analytical techniques used to obtain the reported values. For this analysis, only data on concentrations of toxic pollutants in fish fillet samples or shellfish were evaluated. Both individual and composite samples of a variety of fish and shellfish species were assessed.

Fish contaminant data from the State database from 1980 to the present (January 1992) were selected for screening to assess the health risks of consuming chemically contaminated fish tissues. Stations selected for screening included all those within the A/P Study Area (Appendix H) and included both routine fish contaminant monitoring data as well as special study data associated with monitoring industrial dischargers (e.g., pesticide manufacturing/formulation facilities or pulp and paper companies employing a bleach kraft

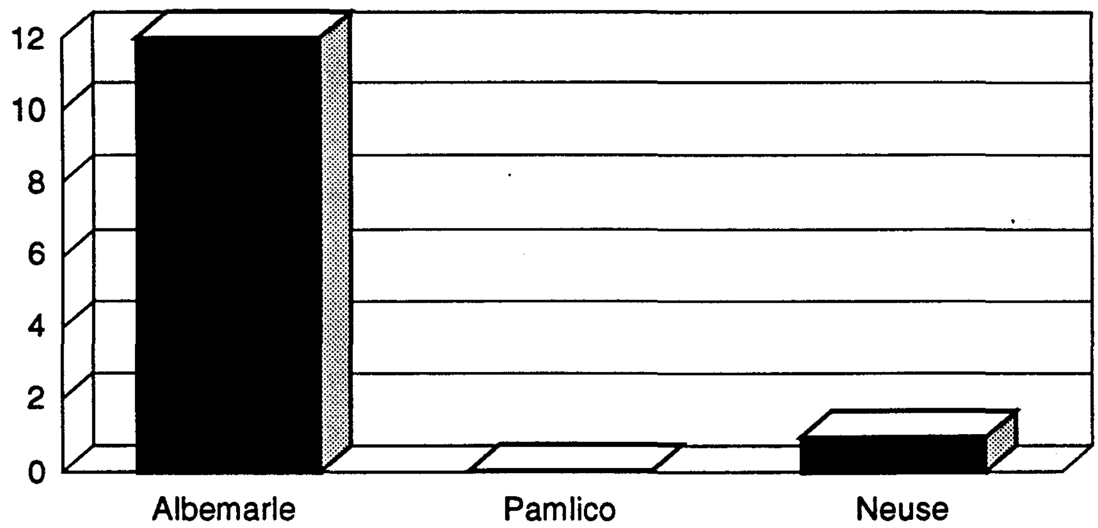


Figure 5-4. Comparison of the number of sites where dioxin concentrations exceeded the level of concern for wildlife.

process). The State also provided three reports that covered the majority of monitoring conducted over the past 7 years:

- North Carolina Division of Environmental Management. 1991. Albemarle-Pamlico Estuarine Study--Fish Tissue Baseline Study 1989. Report No. 91-05. North Carolina Department of Environmental Health and Natural Resources, Raleigh, NC.

- North Carolina Division of Environmental Management. 1990. Fish Tissue Dioxin Levels in North Carolina. North Carolina Department of Environment, Health and Natural Resources, Raleigh, NC.

- North Carolina Division of Environmental Management. 1986. Monitoring Pesticides in Fish Tissue. North Carolina Department of Natural Resources and Community Development, Raleigh, NC.

5.2.2 Methodology for Screening Fish Fillet and Shellfish Data

In 1991, EPA's Office of Science and Technology Division, Human Health Risk Branch, created a Fish Contaminant Workgroup to evaluate a risk assessment procedure that States could use to develop screening values (SVs) for protection of human health from consumption of chemically contaminated fish and shellfish. These SVs could then be used to evaluate State fish/shellfish contaminant monitoring data and ultimately determine the need for issuing fish consumption advisories (U.S. EPA, 1991b). Although the Food and Drug Administration (FDA) has responsibility for ensuring the quality of fish in interstate commerce, States have sole responsibility for protecting their residents from health risks associated with consumption of locally caught fish and shellfish.

The EPA-recommended risk assessment method for developing SVs is described briefly in this section and in greater detail in U.S. EPA (1989, 1991b). **Screening values** are defined as the concentrations of contaminants in edible fish or shellfish tissue associated with limits of acceptable health risk. The EPA risk assessment method is considered to be most appropriate for protecting the health of fish/shellfish consumers for the following reasons (Reinert et al., 1991):

- It gives full priority to the protection of public health.

- It provides a direct link between fish consumption rate and risk levels (i.e., dose and response).

- It generally leads to the most conservative estimates of increased cancer risk.

- It is designed for long-term protection of consumers of locally caught fish and shellfish, including susceptible subpopulations such as sport and subsistence fishermen who are at potentially greater risk than the general U.S. population because they tend to consume greater quantities of fish and because they frequently fish the same sites repeatedly.

5.2.2.1 Development of Screening Value Equations

Risk-based SVs are derived from the general model for calculating the effective ingested dose of a chemical *m* (E_m) (U.S. EPA, 1989, 1991b):

$$E_m = (C_m \cdot CR \cdot X_m) / BW \quad (5\text{-}1)$$

where

E_m = Effective ingested dose of chemical *m* in the population of concern averaged over a 70-yr lifetime (mg/kg/d)

C_m = Concentration of chemical *m* in the edible portion of the species of interest (mg/kg; ppm)

CR = Mean daily consumption rate of the general population or subpopulation of concern averaged over a 70-yr lifetime (kg/d)

X_m = Relative absorption coefficient, or the ratio of human absorption efficiency to test animal absorption efficiency for chemical *m* (dimensionless)

BW = Mean body weight of the general population or subpopulation of concern (kg).

Using this model, the SV for the chemical *m* (SV_m) is equal to C_m when the appropriate measure of toxicologic potency of the chemical *m* (P_m) is substituted for E_m. Rearrangement of Equation (5-1), with these substitutions, gives

$$SV_m = (P_m \cdot BW) / (CR \cdot X_m) \quad (5\text{-}2)$$

where

P_m = Toxicologic potency for chemical *m*; the effective ingested dose of chemical *m* associated with a specified level of health risk as estimated from dose-response studies; dose-response variable.

In most instances, relative absorption coefficients (X_m) are assumed to be 1.0 (i.e., human absorption efficiency is assumed to be equal to that of the test animal), so that

$$SV_m = (P_m \cdot BW) / CR . \quad (5\text{-}3)$$

Because of the fundamental differences between the carcinogenic and noncarcinogenic dose-response variables used in the EPA risk assessment method, SVs must be calculated separately for potential carcinogens and noncarcinogens as shown below.

Noncarcinogens

The measure of toxicologic potency (dose-response variable) for noncarcinogens is the **reference dose (RfD)**, which is defined as the estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subpopulations) that is likely to be without appreciable risk of deleterious effects during a lifetime. RfDs are determined from threshold doses (i.e., no observed adverse effect level [NOAEL], or lowest observed adverse effect level [LOAEL] if the NOAEL is indeterminate) observed in chronic animal bioassays by applying uncertainty or modifying factors ranging from 1 to 10,000 to account for uncertainties in interspecies extrapolation; high to low dose extrapolation; short-term to lifetime exposure extrapolation; sensitivity differences among human subpopulations; and, where applicable, the use of a LOAEL instead of a NOAEL (U.S. EPA, 1989, 1991b).

The following equation is used to calculate SVs for noncarcinogens:

$$SV_n = (RfD \cdot BW) / CR \qquad (5\text{-}4)$$

where

SV_n = Screening value for a noncarcinogen (mg/kg, ppm)
RfD = Reference dose (mg/kg/d)

and BW and CR are defined as in Equation (5-1).

Carcinogens

According to the 1986 *Guidelines for Carcinogen Risk Assessment* (US EPA, 1987), the default model for low-dose extrapolation of carcinogens is a version of the linearized, multistage no-threshold model developed by Crump et al. (1976) and generally results in extremely conservative (i.e., highest) estimates of cancer risk (Reinert et al., 1991; U.S. EPA 1989). Screening values for carcinogens are derived from: (1) the **carcinogenic potency factor (q1*)** or **oral slope factor**, a measure of the cancer-causing potential of a carcinogen estimated as the upper 95-percent confidence limit of the slope of the low-dose linear portion of the dose-response function; and (2) a **risk level (RL)**, an assigned level of maximum acceptable individual lifetime risk (e.g., RL = 10^{-5} for a level of risk not to exceed one excess case of cancer per 100,000 individuals exposed over a 70-yr lifetime) (U.S. EPA, 1989, 1991b).

The following equation is used to calculate SVs for carcinogens:

$$SV_c = [(RL / q1^*) \cdot BW] / CR \qquad (5\text{-}5)$$

where

SV_c = Screening value for a carcinogen (mg/kg, ppm)
RL = Maximum acceptable risk level (dimensionless)
q1* = Carcinogenic potency factor or oral slope factor $(mg/kg/d)^{-1}$

and BW and CR are defined as in Equation (5-1).

5.2.2.2 Recommended Values for Variables in Screening Value Equations

Dose-Response Variables

EPA has developed RfDs and/or q1*s for many environmental contaminants and these values are maintained in the EPA Integrated Risk Information System (IRIS, 1989), an electronic database containing health risk and EPA regulatory information on approximately 400 different chemicals. The IRIS RfDs and q1*s are reviewed regularly and updated as necessary when new or more reliable information on the toxic or carcinogenic potency of chemicals becomes available. **When IRIS values for RFDs and q1*s are available, EPA recommends they should be used to calculate SVs for contaminants from Equations (5-4) and (5-5), respectively. It is important to note that the most current IRIS values for RfDs and q1*s were used to calculate SVs for the contaminants evaluated in this toxics analysis.** A summary description of IRIS and instructions for accessing information in IRIS are found in U.S. EPA (1989).

In cases where IRIS values for RFDs or q1*s are not available for calculating SVs for contaminants, estimates of these variables were derived from the most recent water quality criteria (U.S. EPA, 1991a) according to procedures described in U.S. EPA (1991e) or from other sources as noted in Table 5-5.

Exposure Factors

Recommended values for the variables BW and CR in Equations (5-4) and (5-5) are given in Table 5-6 for various subpopulations. The EPA has recently published detailed guidance on exposure factors (U.S. EPA, 1990a). EPA recommends that this document be consulted to ensure that appropriate values are selected for BWs and CRs to calculate SVs for site-specific exposure scenarios.

5.2.2.3 Selection of Screening Values for Assessing Health Risks

Screening values, and the dose-response variables used to calculate them, are given in Table 5-5. Unless otherwise noted, these SVs were calculated from Equations (5-4) or (5-5) using the values below for BW, CR, and RL and the most current IRIS values for RfDs and q1*s:

Table 5-5. Dose-Response Variables and Recommended Screening Values (SVs) for the 50th Percentile of Recreational Fishermen

Target analyte	RfD[b] (noncarcinogens)	q1*[b] (carcinogens)	SV[a] (ppm) Noncarcinogens	SV[a] (ppm) Carcinogens ($RL=10^{-5}$)
Metals				
Arsenic (inorganic)	3×10^{-4}	N	**0.7**	--
Cadmium	1×10^{-3}	N	**2.3**	--
Chromium (VI)	5×10^{-3}	N	**12**	--
Copper	4×10^{-2} [c]	N	**93**	--
Lead	2×10^{-3} [d]	N	**1.0**	--
Mercury (methyl mercury)	3×10^{-4} [e]	N	**0.7 (0.5)**[f]	--
Nickel (soluble salts)	2×10^{-2}	N	**47**	--
Selenium	5×10^{-3} [g]	N	**12**	--
Zinc	2×10^{-1} [h]	N	**467**	--
Pesticides				
Total chlordane (sum of cis- and trans-chlordane, cis- and trans-nonachlor, and oxychlordane)[i]	6×10^{-5}	1.3	0.14	**0.02**
Total DDT (sum of 4,4'- and 2,4'-isomers of DDT, DDE, and DDD)[j]	5×10^{-4}	0.34	1.17	**0.07**
Dieldrin	5×10^{-5}	16	0.12	**1.5×10^{-3}**
Endosulfan (I and II)	5×10^{-5}	N	**0.12**	--
Endrin	3×10^{-4}	N	**0.69**	--
Hexachlorobenzene	8×10^{-4}	1.6	1.86	**0.015**
Lindane (γ-hexachlorocyclohexane, γ-HCH)	3×10^{-4}	1.3[k]	0.69	**0.018**
Mirex	2×10^{-6}	N[l]	**0.004**	--
Toxaphene	N	1.1	--	**0.021**

See notes at end of table. (continued)

Table 5-5. (continued)

Target analyte	RfD[b] (noncarcinogens)	q1*[b] (carcinogens)	SV[a] (ppm)	
			Noncarcinogens	Carcinogens ($RL=10^{-5}$)
Base/Neutral Organic Compounds				
PCBs	N[m]	7.7[n]	--	**0.003**
Dioxins				
Dioxins/dibenzofurans	N	1.56×10^{5} [o]	--	**1.5×10^{-7}**

RfD = Reference dose (mg/kg/d).
q1* = Carcinogenic potency factor or oral slope factor (risk[mg/kg/d]$^{-1}$).
RL = Risk level (dimensionless).
N = Not in EPA's Integrated Risk Information System (IRIS) at this time (IRIS, 1992).

[a] Screening values (SVs) are target analyte concentrations in fish tissue that equal exposure levels at either the RfD for noncarcinogens or the q1* and an $RL=10^{-5}$ for carcinogens, given average consumption rates (CRs) and body weights (BWs) of 30 g/d and 70 kg, respectively, for the 50th percentile of recreational fishermen population (U.S. EPA, 1989). When both noncarcinogen and carcinogen SVs are available for a target analyte, the lower of the two values should be used. **Values in bold are maximum SVs recommended for use to protect the 50th percentile of recreational fishermen.**

[b] Unless otherwise noted, values listed are the most current oral RfDs and q1*s in EPA's IRIS (IRIS, 1992).

[c] Drawn from an action level of 1.3 mg/L (IRIS, 1992)

[d] Derived from target blood level of 5 µg/dL using EPA Uptake/Biokinetic Model (W.L. Marcus, 1987). Lead value using this surrogate RfD was calculated for children only; SV shown calculated for 15-kg child.

[e] The RfD for mercury is the IRIS (1992) value for methyl mercury. For cost considerations, it is recommended that total mercury be analyzed and the assumption made that all mercury is present as methyl mercury to be most protective of human health.

[f] SV = 0.5, is currently used for mercury (as methyl mercury) by the majority of the Great Lakes jurisdictions (Hesse, 1990) and is being reviewed for use by all States. This SV is based on a World Health Organization (WHO) recommendation that daily consumption not exceed 35 µg of total mercury or 30 µg of methyl mercury (WHO, 1976) and a consumption rate of 60 g/d for the general public. It is intended to be sufficiently protective for pregnant women, nursing mothers, women who intend to have children, and children under the age of 15 who are more vulnerable than the general population. The EPA feels that it is prudent to use this lower SV because of the widespread issuance of fish consumption advisories triggered by mercury (RTI, 1991) and the increased toxicity of methyl mercury in the fetus and in young children (Tollefson, 1989; Skerfving, 1988; Clarkson, 1990).

[g] The RfD for selenium is the IRIS (1992) value for selenious acid.

[h] This RfD value was used. Note: There is currently no EPA-sanctioned RFD value for zinc in IRIS (from HEAST, 1992).

Table 5-5 (continued)

[i] The RfD and q1* values listed are derived from studies using technical grade chlordane (purity ~95%) or a 90:10 mixture of chlordane:heptachlor or analytical grade chlordene (IRIS, 1992). No RfD or q1* values are given in IRIS (1992) for cis- and trans-chlordane or oxychlordane. It is recommended that the total concentration of chlordane and its metabolites be determined for comparison with the recommended SV.

[j] The RfD value listed is for DDT; the q1* value is for DDT or DDE; the q1* value for DDD is 0.24 (IRIS, 1989). The U.S. EPA Carcinogenicity Assessment Group recommends the use of q1* = 0.34 for any combination of DDT, DDE, DDD, and dicofol (Holder, 1986). It is recommended that the total concentration of DDT and its metabolites, DDE and DDD, be determined for comparison with the recommended SV.

[k] IRIS (1992) has not provided a q1* for lindane. The q1* value listed for lindane was calculated from the water quality criteria (0.063 µg/L) (U.S. EPA, 1991a).

[l] The National Bioaccumulation Study (U.S. EPA, 1991d) used a value of q1* = 1.8 for mirex from HEAST (1989).

[m] The National Bioaccumulation Study (U.S. EPA, 1991d) used a value of RfD = $1x10^{-4}$ for Aroclor 1016 from ATSDR (1987).

[n] The q1* is based on a carcinogenicity assessment of Aroclor 1260. Although it is known that PCB congeners vary greatly in their toxicological potency, the q1* of Aroclor 1260 is intended to represent the upper bound risk for all PCB mixtures (IRIS, 1992).

[o] The q1* value listed is for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)(U.S. EPA, 1991a). The National Bioaccumulation Study (U.S. EPA, 1991d) used a value of RfD = $1x10^{-9}$ for 2,3,7,8-TCDD from ATSDR (1987). It is recommended that the tetra- through octa-chlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) be determined and a toxicity-weighted total concentration be calculated for each sample for comparison with the recommended SV, using the revised interim method for estimating Toxicity Equivalency Concentration (TECs) (Barnes and Bellin, 1989; U.S. EPA, 1991d). If resources are limited, the 2,3,7,8-TCDD and 2,3,7,8-TCDF congeners should be determined at a minimum.

Table 5-6. Recommended Values for Mean Body Weights (BWs) and Fish Consumption Rates (CRs) for Selected Subpopulations

Variable	Recommended value	Subpopulation
BW	70 kg	All adults (U.S. EPA, 1990a)
	78.1 kg	Adult males (U.S. EPA, 1985a; 1990a)
	65.4 kg	Adult females (U.S. EPA, 1985a; 1990a)
	11.6 kg	Children <3 yr (U.S. EPA, 1985a; 1990a)
	17.4 kg	Children 3 to <6 yr (U.S. EPA, 1985a; 1990a)
	25.0 kg	Children 6 to <9 yr (U.S. EPA, 1985a; 1990a)
	36.0 kg	Children 9 to <12 yr (U.S. EPA, 1985a; 1990a)
	50.6 kg	Children 12 to <15 yr (U.S. EPA, 1985a; 1990a)
	61.2 kg	Children 15 to <18 yr (U.S. EPA, 1985a; 1990a)
CR	6.5 g/d (0.0065 kg/d)	Estimate of the average consumption of fish and shellfish from estuarine and fresh waters by the **general U.S. population** (U.S. EPA, 1980b)
	14.3 g/d (0.143 kg/d)	Estimate of the average consumption of fish and shellfish from marine, estuarine, and fresh waters by the **general U.S. population** (U.S. EPA, 1980b)
	20 g/d (0.20 kg/d)	Estimate of the average consumption of fish and shellfish from marine, estuarine, and fresh waters by the **general U.S. population** (USDA, 1984)
	30 g/d (0.030 kg/d)	Estimate of the average consumption of fish and shellfish from marine, estuarine, and fresh waters by the **50th percentile of recreational fishermen** (U.S. EPA, 1990a)
	140 g/d (0.140 kg/d)	Estimate of the average consumption of fish and shellfish from marine, estuarine, and fresh waters by the **90th percentile of recreational fishermen (i.e., subsistence fishermen)** (U.S. EPA, 1990a)

Sources:

U.S. EPA (U.S. Environmental Protection Agency). 1985a. *Development of Statistical Distributions for Ranges of Standard Factors Used in Exposure Assessment.* EPA-600/8-85-010. Office of Health and Environmental Assessment, Washington, DC.

U.S. EPA (U.S. Environmental Protection Agency). 1990a. *Exposure Factors Handbook.* EPA-600/8-89/043. Office of Health and Environmental Assessment, Washington, DC.

U.S. EPA (U.S. Environmental Protection Agency). 1980b. Water quality criteria documents: Availability. *Federal Register,* Vol. 45, No. 231, Part V, pp. 79318-79379. Washington, DC.

USDA (U.S. Department of Agriculture). 1984. *Agriculture Statistics.* Washington, DC. p 506.

- For noncarcinogens: BW = 70 kg, average body weight
  CR = 30 g/d (0.030 kg/d), estimate of average consumption of fish and shellfish from marine, estuarine and fresh waters by the 50th percentile of recreational fisherman (U.S. EPA, 1990a)

- For carcinogens: BW and CR, as above
  RL = 10^{-5}, a risk level corresponding to one excess case of cancer per 100,000 individuals exposed over a 70-yr lifetime.

Where both RfD and q1* values are available for a given analyte, both noncarcinogenic and carcinogenic SVs are listed in Table 5-5. Unless otherwise indicated, the lower of the two SVs was used. **Screening values in bold-face type in Table 5-5 are the maximum values recommended for use to protect the 50th percentile of recreational fishermen.** It should be noted that States may choose to adjust SVs at specific sites for specific contaminants or for the protection of specific local subpopulations known to be at increased risk (e.g., pregnant women, nursing mothers, children, or extremely heavy consumers of fish or shellfish such as recreational or subsistence fishermen).

The need to characterize the subpopulation of interest accurately in order to establish sufficiently protective SVs cannot be overemphasized. To conservatively evaluate the NCDEM database screened in this analysis, RTI used the EPA-recommended consumption rate of 30 g/d to represent the 50th percentile of recreational fishermen rather than the consumption rate of 6.5 g/d for the general U.S. population. This latter consumption rate is currently under review by the EPA Fish Contaminant Workgroup and may be increased to 15 g/d. Examples of screening values calculated for various subpopulations and risk levels are provided in Table 5-7 to show how SVs change based on the selection of CR, BW, and RL values.

5.2.2.4 Application of Screening Values

As defined in the previous sections, the SV of a specific contaminant is the concentration in edible fish/shellfish tissue that is associated with a maximum limit of acceptable health risk to the population of concern (e.g., 50th percentile of recreational fishermen). EPA recommends the use of screening values to determine the need for additional fish contaminant monitoring and/or for issuing consumption advisories (U.S. EPA, 1991b).

Table 5-7. Example Screening Values (SVs) for Various Subpopulations and Risk Levels (RLs)[a]

Chemical	Subpopulation[b]	CR	BW	RfD	q1*	RL	SV (ppm)
Noncarcinogens							
Hexachlorobenzene	Standard adults	6.5	70	8×10^{-4}			8.6
	Children	6.5	20	8×10^{-4}			2.5
	Subsistence fishermen	140	70	8×10^{-4}			0.40
Cadmium	Standard adults	6.5	70	1×10^{-3}			11
	Children	6.5	20	1×10^{-3}			3.1
	Subsistence fishermen	140	70	1×10^{-3}			0.50
Carcinogens							
Lindane	Standard adults	6.5	70		1.3 1.3	10^{-5} 10^{-6}	8.3×10^{-2} 8.3×10^{-3}
	Children	6.5	20		1.3 1.3	10^{-5} 10^{-6}	2.4×10^{-3} 2.4×10^{-4}
	Subsistence fishermen	140	70		1.3 1.3	10^{-5} 10^{-6}	3.8×10^{-3} 3.8×10^{-4}
Toxaphene	Standard adults	6.5	70		1.1 1.1	10^{-5} 10^{-6}	9.8×10^{-2} 9.8×10^{-3}
	Children	6.5	20		1.1 1.1	10^{-5} 10^{-6}	2.8×10^{-2} 2.8×10^{-3}
	Subsistence fishermen	140	70		1.1 1.1	10^{-5} 10^{-6}	4.5×10^{-3} 4.5×10^{-4}

CR = Mean daily fish/shellfish consumption rate, averaged over a 70-yr lifetime for the population of concern (g/d).
BW = Mean body weight, estimated for the population of concern (kg).
RfD = Reference dose for noncarcinogens (mg/kg/d).
q1* = Carcinogenic potency factor, or oral slope factor $(mg/kg/d)^{-1}$.
RL = Maximum acceptable risk level for carcinogens (dimensionless).

[a]See Equations (5-4) and (5-5).

[b]See Table 5-6 for definitions of subpopulations.

Metals

For each of the metals, the **total metal** tissue concentration was compared with the appropriate SV to detect exceedances. It should be noted that, because of the relatively high analytical cost, the determination of methyl mercury concentrations in fish tissue is not recommended by EPA even though the recommended SV is for methyl mercury (see Table 5-5). Rather, as the most conservative and cost-effective approach to protecting human health, it is recommended that total mercury be determined and the assumption made that all mercury present in fish/shellfish tissue is present as methyl mercury.

Organics

For each of the organics that are single compounds, the fish tissue concentration was compared with the appropriate SV to detect exceedances. However, for those organic compounds that represent classes of compounds (e.g., dioxins/dibenzofurans, PCBs) or include a parent compound and its metabolites (e.g., total chlordane, total DDT), the following approach was used to evaluate tissue concentrations against SVs.

Dioxins/Dibenzofurans

EPA recommends that the tetra- through octa-chlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) be determined and a toxicity-weighted total concentration be calculated for each sample for comparison with the SV for 2,3,7,8-TCDD (see Table 5-5). The revised interim method for estimating toxicity equivalency concentration (TECs) (Barnes and Bellin, 1989) should be used to estimate TCDD equivalent concentrations according to the following equation:

$$TEC = \sum_{i} (TEF_i \cdot C_i) \qquad (5\text{-}6)$$

where

TEF_i = Toxicity equivalency factor for the ith congener (relative to 2,3,7,8-TCDD)
C_i = Concentration of the ith congener.

TEFs for the tetra- through octa- PCDDs and PCDFs are shown in Table 5-8. If resources are limited, the 2,3,7,8-TCDD and 2,3,7,8-TCDF congeners should be determined and the calculated TEC concentration compared with the recommended SV for 2,3,7,8-TCDD.

Note: RTI used the TEC values calculated by the NCDEM in the database to screen dioxin contamination in fish/shellfish samples to detect exceedances. As noted in Table 5-9, however, the SV for dioxin calculated using the EPA risk-based approach (1.45 x 10^{-7} ppm) was below the detection limit for the EPA chemical analysis procedure used; therefore RTI used the method detection limit (1 x 10^{-6} ppm) as the dioxin screening value.

Table 5-8. Toxicity Equivalency Factors for Tetra- through Octa-Chlorinated Dibenzo-p-Dioxins and Dibenzofurans

Analyte	TEF
2,3,7,8-TCDD	1.00
1,2,3,7,8-PeCDD	0.50
1,2,3,4,7,8-HxCDD	0.10
1,2,3,6,7,8-HxCDD	0.10
1,2,3,7,8,9-HxCDD	0.10
1,2,3,4,6,7,8-HpCDD	0.01
OcCDDs	0.001
2,3,7,8-TCDF	0.10
1,2,3,7,8-PeCDF	0.05
2,3,4,7,8-PeCDF	0.50
1,2,3,4,7,8-HxCDF	0.10
1,2,3,6,7,8-HxCDF	0.10
1,2,3,7,8,9-HxCDF	0.10
2,3,4,6,7,8-HxCDF	0.10
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OcCDFs	0.001

Source: Barnes, D.G., and J.S. Bellin. 1989. Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs). U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC.

Table 5-9. Comparison of FDA Action Levels with EPA Screening Values

Chemical	FDA action levels[a] (ppm)	EPA risk-based SVs for the general population[b,c] (ppm)	EPA risk-based SVs for the 50th percentile of recreational fishermen[b,d] (ppm)
Metals			
Arsenic		3.2	0.7
Cadmium		11	2.3
Chromium		54	12
Copper		431	93
Lead		4.6	1.0
Mercury	1.0	3.2	0.7
Nickel		221	47
Selenium		54	12
Zinc		2154	467
Organics			
Aldrin	0.3	0.0063	0.0014
Chlordane (total)	0.3	0.083[e]	0.018
DDT (total)	5.0	0.32[f]	0.069
Dieldrin	0.3	0.0067	0.0015
Dioxins/furans	2.5×10^{-5}	6.9×10^{-7}	1.45×10^{-7}[g]
Endosulfan I		0.54	0.12
Endosulfan II		0.54	0.12
Endrin	0.3	3.2	0.69
Heptachlor		0.023	0.005
Heptachlor epoxide		0.012	0.0026
Hexachlorobenzene		8.6	1.86
Lindane (γ-BHC)		0.082	0.018
Methoxychlor		53.85	11.67
PCB (total)	2.0	0.014	0.003

(continued)

Table 5-9. (continued)

Chemical	FDA action levels[a] (ppm)	EPA risk-based SVs for the general population[b,c] (ppm)	EPA risk-based SVs for the 50th percentile of recreational fishermen[b,d] (ppm)
Pentachlorophenol (PCP)		0.90	0.20
Toxaphene		0.098	0.02

[a] Food and Drug Administration (FDA) action levels were developed to protect humans from the chronic effects of toxic substances consumed in food stuffs (U.S. FDA. 1984. Shellfish Sanitation Interpretation: Action Levels for Chemical and Poisonous Substances. Shellfish Sanitation Branch, Washington, DC).

[b] EPA risk-based screening values (SVs) were calculated using the following equations:

For carcinogens - $SV_c = [(RL/q1^*) \times BW]/CR$

where

SV_c = Screening values for a carcinogen (mg/kg, ppm)
RL = Maximum acceptable risk level (10^{-5})
$q1^*$ = Carcinogenic potency factor $(mg/kg/d)^{-1}$
BW = Mean body weight, estimated for the general population (70 kg)
CR = Mean daily fish/shellfish consumption rate averaged over a 70-year lifetime for the general population (kg/d).

For noncarcinogens - $SV_n = (RfD \times BW)/CR$

where

SV_n = Screening value for a noncarcinogen (mg/kg, ppm)
RfD = Reference dose (mg/kg/d).

[c] Consumption rate, CR, used in equations in Footnote b was 6.5 g/d for the general population.

[d] Consumption rate, CR, used in equations in Footnote b was 30 g/d for the 50th percentile of recreational fishermen.

[e] EPA screening value for total chlordane is sum of cis- and trans-chlordane, cis- and trans-nonachlor, and oxychlordane.

[f] EPA screening value for total DDT is sum of DDT, DDE, and DDD.

[g] The actual screening value used in RTI's analysis was 1×10^{-6} ppm since the detection limit for the current EPA dioxin procedure used by the State is 1×10^{-6} ppm in fish tissue.

PCBs

EPA currently recommends that total PCB concentrations be estimated as the sum of Aroclor concentrations for comparison with the recommended SV based on a q1* for Aroclor 1260 (see Table 5-5). Although at present there is no information about which congeners in Aroclor 1260 or any other PCB mixtures are carcinogenic, EPA bases this recommendation on the assumption that Aroclor 1260 is representative of other PCB mixtures, i.e., that the q1* for Aroclor 1260 is an upper limit for other PCB mixtures as well (U.S. EPA, 1988). RTI used this procedure to evaluate exceedances of PCB concentrations in fish tissue.

Chlordane

The concentrations of cis- and trans-chlordane and the chlordane metabolites, cis- and trans-nonachlor and oxychlordane, were summed to give a **total chlordane** concentration for comparison with the SV (see Table 5-5). RTI used this EPA-recommended procedure to evaluate chlordane exceedances.

DDT

Because the metabolites of DDT (i.e., the 4,4′- and 2,4′-isomers of DDE and DDD) are also highly potent toxicants, EPA recommends that the concentrations of DDT and its metabolites be determined and a **total DDT** concentration be compared with the recommended SV (see Table 5-5). RTI used this procedure to evaluate DDT exceedances.

5.2.2.5 Comparison of EPA Screening Values with U.S. FDA Health Protection Criteria

The FDA has developed **levels of concern**, **action levels**, and **tolerance levels** to protect the general U.S. population from the chronic effects of toxic substances consumed in foodstuffs shipped in interstate commerce (U.S. FDA, 1984). FDA health protection criteria have sometimes been used, solely or in combination with the EPA risk assessment procedures (U.S. EPA, 1989), by States as the basis for developing fish/shellfish consumption advisories (Reinert et al., 1991). The FDA and EPA approaches are not consistent, however, and have resulted in significant differences among States in issuing advisories even for the same water body.

Note: In the past, North Carolina like many other States has been using FDA levels of concern to screen fish contaminant monitoring data; however, as shown in Table 5-8, FDA levels of concern are available only for eight contaminants monitored by North Carolina. Currently, the EPA does not recommend the use of FDA health protection criteria as screening values or in developing fish/shellfish consumption advisories (U.S. EPA, 1991b).

An excellent comparison of the FDA and EPA procedures for formulating fish consumption advisories has recently been published (Reinert et al., 1991) and is summarized briefly here. First, although the FDA health protection criteria are based on data from analysis of the edible portions of fish and shellfish, in developing them, the FDA usually considers both the health risks posed to consumers and the economic costs of banning a foodstuff from a specific source. This is in direct contrast to the recommended EPA risk assessment procedure, which considers only the health risks and thus gives full priority to the protection of public health (Reinert et al., 1991). Second, in practice, FDA health protection criteria have been developed on a national rather than a regional or local basis; that is, they are not intended to protect local consumers of fish and shellfish, such as subsistence or sport fishermen who often consume more of a particular fish than the national average, or susceptible subpopulations, such as small children or pregnant women. Finally, the FDA approach does not provide the same correlation between risk level and dose (consumption rate) as does the EPA risk assessment approach. Consumption advisories based on FDA procedures employ a "safe level" approach in which consumption of fish with contaminant residues that exceed FDA action levels is banned, while consumption of fish with contaminant residues below FDA action levels is unrestricted.

Table 5-9 lists the contaminants for which FDA action levels are available for comparison with EPA risk-based SVs calculated for the general population (consumption rate of 6.5 g/d) and for the 50th percentile of recreational fishermen (consumption rate of 30 g/d). **To conservatively screen the State fish contaminant database, RTI used the SVs calculated for protection of the 50th percentile of recreational fishermen in this toxics analysis.**

5.2.3 Results

Fish contaminant monitoring stations where exceedances of human health SVs were detected are listed in Appendix J for metals and organochlorine pesticides. The locations of these stations are shown in Figure 5-5. Contaminants causing these exceedances are summarized in Table 5-10. A detailed listing of stations where exceedances of human health SVs for metals and organochlorine pesticides were detected in shellfish are listed in Appendix J. The locations of these stations are shown in Figure 5-6 and contaminants causing these exceedances are summarized in Table 5-11. A detailed listing of stations where exceedances of the human health SV for dioxin were detected is provided in Appendix J and the location of these stations is shown in Figure 5-7.

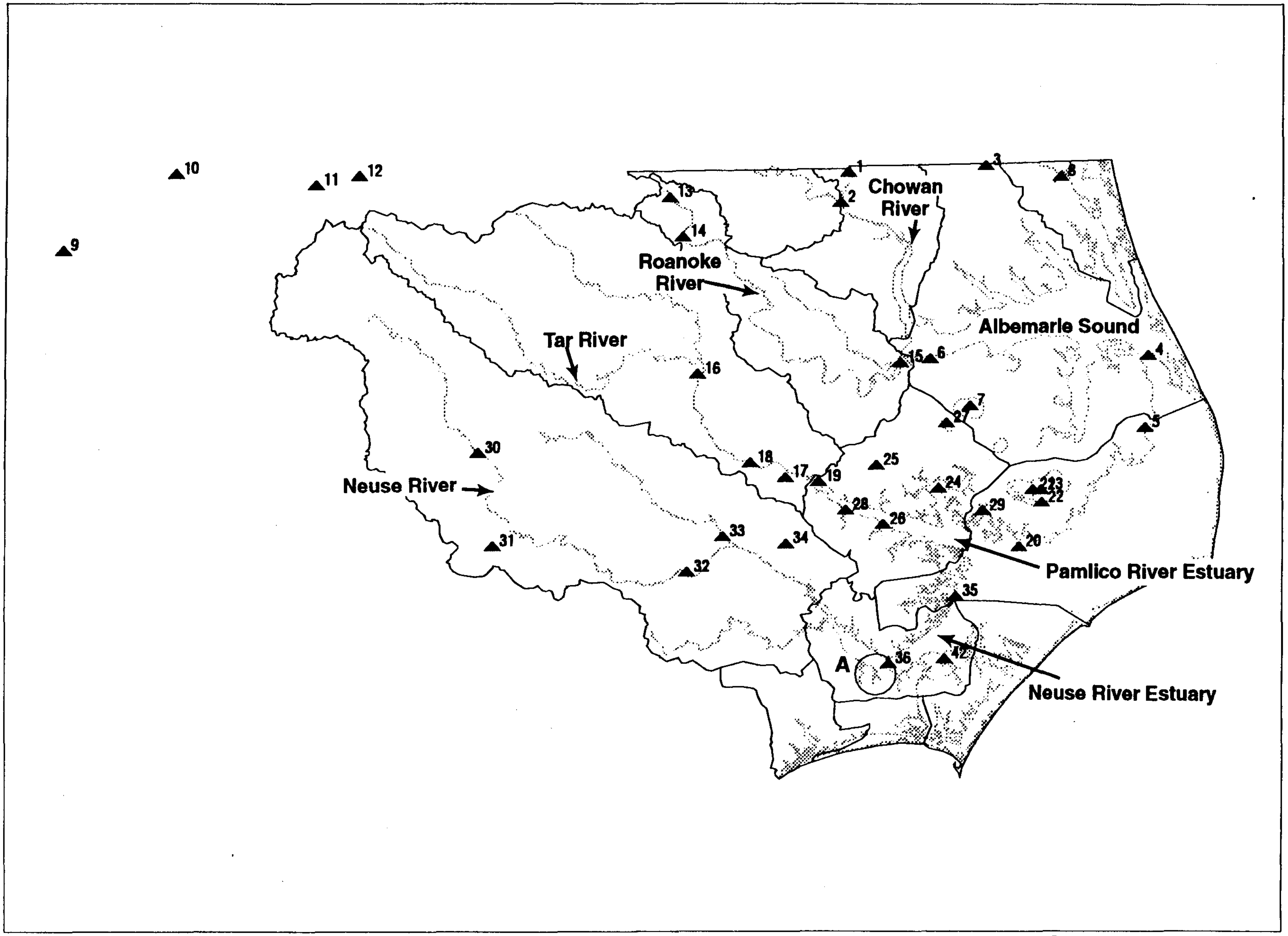


Figure 5-5. Sites where fish contaminant concentrations exceeded human health SVs for metal and organochlorine pesticides.

Fish Filet

#	Longitude	Latitude	Station	Basin Name	Basin	Exceedence Type
1	76.9214	36.5317	02050079	Chowan	030101	HG
2	76.9542	36.4361	0205324450	Chowan	030101	AS
3	76.3722	36.5431	DS-10	Pasquotank	030150	HG
4	75.7433	35.9217	0208117950	Pasquotank	030151	AS
5	75.7661	35.6906	STUMPY-1	Pasquotank	030151	AS
6	76.6111	35.9292	02081185	Pasquotank	030153	HG,TOT_DDT
7	76.4583	35.7750	PAS012	Pasquotank	030153	HG,PB
8	76.0708	36.5014	Currituck-2	Pasquotank	030154	AS
9	80.0500	36.2931	BELEWS-10*	Roanoke	030201	SE
10	79.6058	36.5414	02074218*	Roanoke	030203	HG
11	79.0472	36.5053	HYCO-1*	Roanoke	030205	SE
12	78.8753	36.5356	MAYO-1*	Roanoke	030205	HG
13	77.6344	36.4603	02080500	Roanoke	030208	HG
14	77.5833	36.3333	TSROARR30	Roanoke	030208	HG
15	76.7292	35.9194	02081141	Roanoke	030209	HG
16	77.5333	35.8944	02082823	Tar-Pamlico	030302	HG
17	77.1917	35.5583	02084171	Tar-Pamlico	030305	HG
18	77.3303	35.6072	TSTAR120	Tar-Pamlico	030305	HG
19	77.0622	35.5431	02084472	Tar-Pamlico	030307	DIELDRIN
20	76.2769	35.3189	02092690	Tar-Pamlico	030307	AS
21	76.2153	35.5014	MT-1	Tar-Pamlico	030307	HG
22	76.1833	35.4583	MT-2	Tar-Pamlico	030307	HG
23	76.1833	35.5000	MT-3	Tar-Pamlico	030307	HG
24	76.5889	35.5125	PUNGO-17	Tar-Pamlico	030307	AS
25	76.8333	35.5917	PUNGO-7/8	Tar-Pamlico	030307	HG
26	76.8133	35.4014	TAR 58	Tar-Pamlico	030307	AS
27	76.5533	35.7228	TAR0628A	Tar-Pamlico	030307	HG
28	76.9583	35.4492	TAR56B	Tar-Pamlico	030307	PB
29	76.4194	35.4375	TSTARR3	Tar-Pamlico	030307	PB
30	78.4058	35.6472	02087500	Neuse	030402	HG
31	78.3500	35.3472	TSNEU100	Neuse	030402	HG
32	77.5858	35.2581	02089500	Neuse	030405	HG
33	77.4444	35.3708	0209176690	Neuse	030407	HG
34	77.1958	35.3450	NEU-119	Neuse	030409	HG
35	76.5333	35.1639	02092682	Neuse	030410	AS
36	76.8028	34.9528	NEU 139	Neuse	030410	AS
37	76.9131	34.9144	NEUSC-1	Neuse	030410	AS
38	76.9208	34.8958	NEUSC-4	Neuse	030410	AS
39	76.9083	34.9278	NEUSC-5	Neuse	030410	AS,CU,PB
40	76.9111	34.9181	NEUSC4A	Neuse	030410	PB
41	76.9125	34.9194	NEUSC5	Neuse	030410	AS,HG
42	76.5833	34.9639	SOUTHRIVER-	Neuse	030410	AS

Note: Area A includes stateions 37, 38 39, 40 and 41—NEUSC-1, NEUSC-4, NEUSC-5, NEUSC4A, and NEUSC5 in Slocum Creek.

*These stations are located within the Roanoke River Basin but are not located within the A/P Study Area.

Figure 5-5. (continued)

Table 5-10. Summary of Pollutants Causing Exceedances of Human Health Screening Values in Fish

	As	Cd	Cu	Pb	Hg	Se	Zn	DDT	Dieldrin
Chowan									
02050079					•				
0205324450	•								
Pasquotank									
DS-10					•				
0208117950	•								
STUMPY-1	•								
02081185					•			•	
PAS012				•	•				
Currituck-2	•								
Roanoke									
Belews-10						•			
02074218					•				
HYCO-1						•			
MAYO-1					•				
02080500					•				
TSROARR30					•				
02081141					•				
Tar-Pamlico									
02082823					•				
02084171					•				
TSTAR120					•				
02084472									•
02092690	•								
MT-1					•				
MT-2					•				

(continued)

Table 5-10 (continued)

	As	Cd	Cu	Pb	Hg	Se	Zn	DDT	Dieldrin
MT-3					•				
Pungo-17	•								
Pungo-7/8					•				
TAR58	•								
TAR0628A					•				
TAR56B				•					
TSTARR3				•					
Neuse									
02087500					•				
TSNEU100					•				
02089500					•				
0209176690					•				
NEU-119					•				
02092682	•								
NEU139	•								
NEUSC-1	•								
NEUSC-4	•								
NEUSC-5	•		•	•					
NEUSC4A				•					
NEUSC5	•				•				
South River	•								

As = Arsenic
Cd = Cadmium
Cu = Copper
Pb = Lead
Hg = Mercury
Se = Selenium
Zn = Zinc
DDE = 2,2-Bis(4-chlorophenyl)1,1-dichloroethene

• Contaminant concentrations exceed the EPA risk-based SVs for the 50th percentile of recreational fishermen (see Table 5-9).

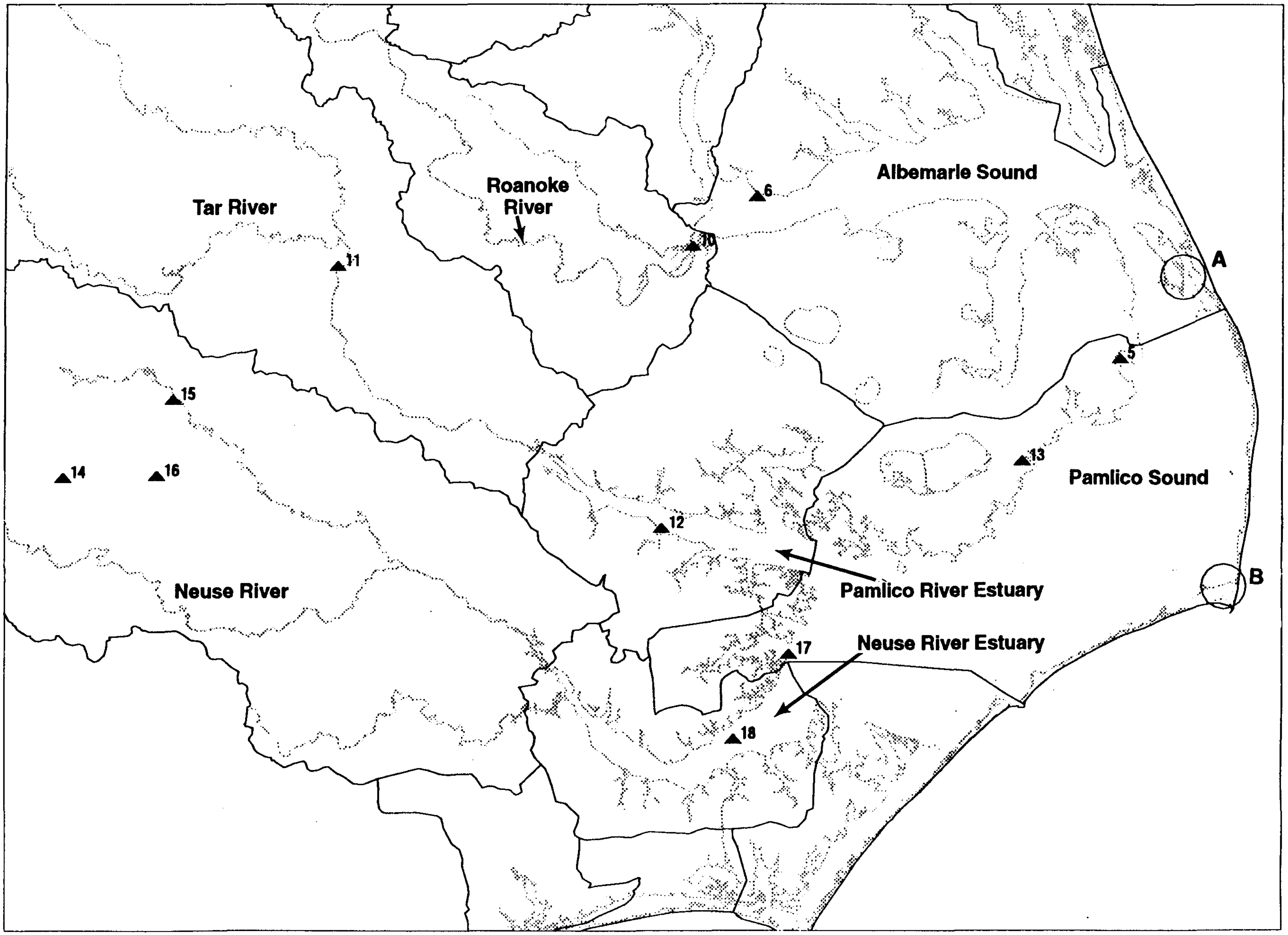


Figure 5-6. Sites where shellfish contaminant concentrations exceeded human health SVs for metals and pesticides.

Shellfish

#	Longitude	Latitude	Station	Basin Name	Basin #	Exceedence Type
1	75.6181	35.8403	MC-6	Pasquotank	030151	ZN
2	75.6083	35.8333	MC-8	Pasquotank	030151	ZN
3	75.6167	35.8472	MC-9	Pasquotank	030151	ZN
4	75.6250	35.8431	Mill-2	Pasquotank	030151	ZN
5	75.7661	35.6906	STUMPY-1	Pasquotank	030151	AS
6	76.5819	36.0069	02081145	Pasquotank	030152	AS
7	75.5569	35.2639	BUX-1-IN	Pasquotank	030155	AS,ZN
8	75.5569	35.2681	BUX-1-OUT	Pasquotank	030155	AS
9	75.5500	35.2694	BUX-1	Pasquotank	030155	AS
10	76.7292	35.9194	02081141	Roanoke	030209	PB
11	77.5333	35.8944	02082823	Tar-Pamlico	030302	PB
12	76.8133	35.4014	TAR 58	Tar-Pamlico	030307	AS
13	75.9767	35.5106	TSTARFC15	Tar-Pamlico	030307	ZN
14	78.1600	35.5111	02088500	Neuse	030406	PB
15	77.9111	35.6528	TSNEUCC5	Neuse	030407	PB
16	77.9486	35.5125	TSNEUNS4	Neuse	030407	PB
17	76.5333	35.1639	02092682	Neuse	030410	AS
18	76.6625	35.0100	NEU-OR	Neuse	030410	PB

Note: Area A includes stations 1,2,3, and 4--MC-6, MC-8, MC-9, and MILL-2 in Roanoke Sound at Mill Creek and Broad Creek. Area B includes stations 7,8, and 9--BUV-1-IN, BUX-1-OUT, and BUX-1 in Pamlico Sound near Scott's Boatyard.

Figure 5-6 (continued)

Table 5-11. Summary of Pollutants Causing Exceedances of Human Health Screening Values in Shellfish

Basin station numbers	Pollutants						
	As	Cd	Cu	Pb	Hg	Se	Zn
Pasquotank							
MC-6							•
MC-8							•
MC-9							•
MILL-2							•
STUMPY-1	•						
02081145	•						
BUX-1	•						
BUX-1-IN	•						•
BUX-1-OUT	•						
Roanoke							
02081141				•			
Tar-Pamlico							
02082823				•			
TAR 58	•						
TSTARFC15							•
Neuse							
02088500				•			
TSNEUCC5				•			
TSNEUNS4				•			
02092682	•						
NEU-OR				•			

As = Arsenic
Cd = Cadmium
Cu = Copper
Pb = Lead
Hg = Mercury
Se = Selenium
Zn = Zinc

• Contaminant concentrations exceed the EPA risk-based SVs for the 50th percentile of recreational fishermen (see Table 5-9).

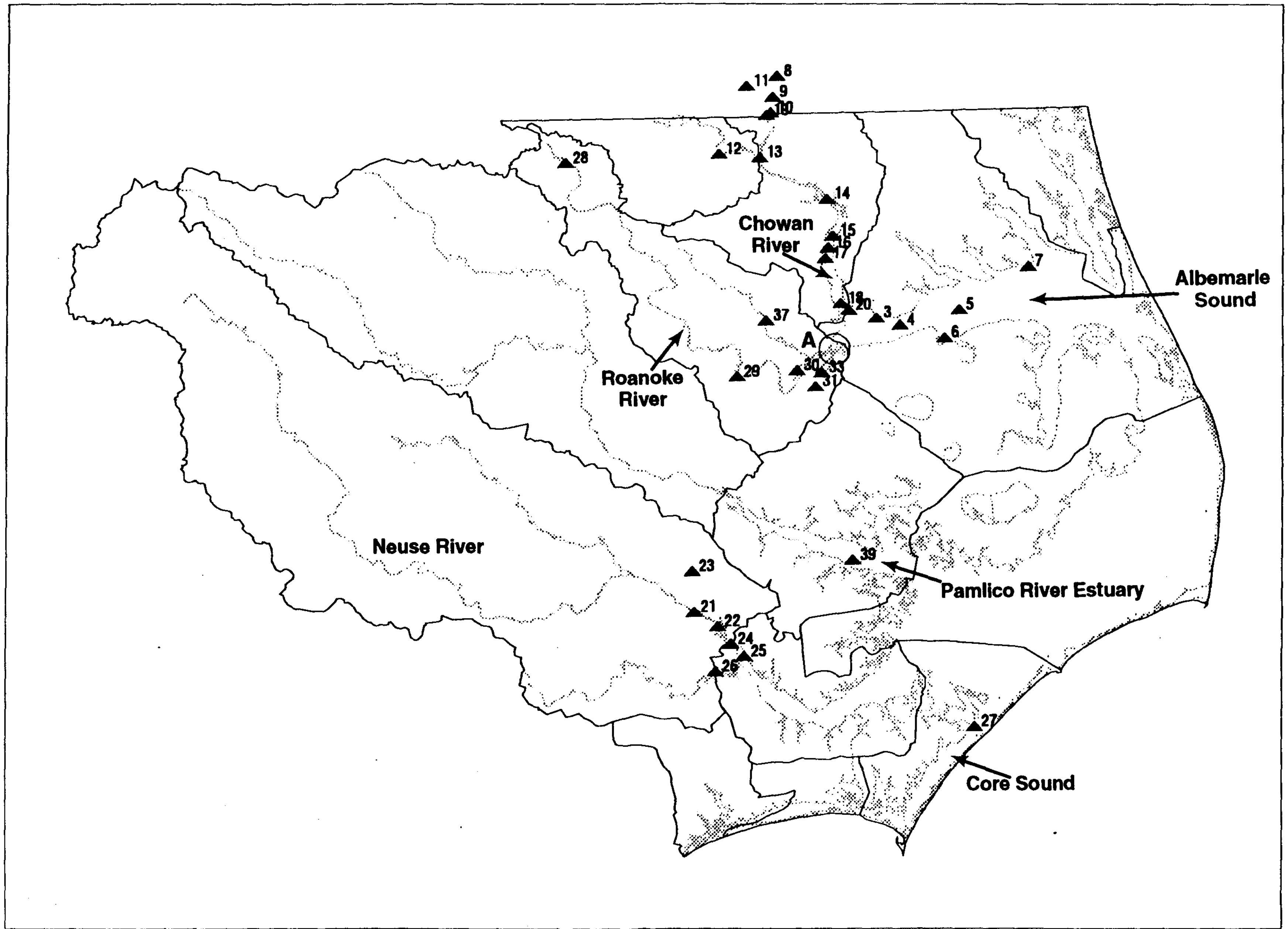


Figure 5-7. Sites where dioxin concentrations in fish tissue exceeded the human health SV.

Dioxin Exceedences in Filets

#	Longitude	Latitude	Station	Basin	Exceedences Number	Exceedences Type
1	76.7306	35.9403	62	Albemarle	1	F
2	76.6639	35.9556	68	Albemarle	6	F
3	76.5819	36.0069	82	Albemarle	6	F
4	76.5056	35.9861	83	Albemarle	5	F
5	76.3083	36.0222	84	Albemarle	3	F
6	76.3583	35.9500	85	Albemarle	5	F
7	76.0792	36.1333	87	Albemarle	4	F
8	76.8917	36.6500	69*	Chowan	5	F
9	76.9083	36.5944	70*	Chowan	5	F
10	76.9153	36.5542	71*	Chowan	4	F
11	76.9917	36.6250	73*	Chowan	4	F
12	77.0861	36.4472	75	Chowan	3	F
13	76.9542	36.4361	76	Chowan	17	F
14	76.7347	36.3236	77	Chowan	5	F
15	76.7181	36.2250	78	Chowan	5	F
16	76.7347	36.1950	79	Chowan	4	F
17	76.7444	36.1667	80	Chowan	5	F
18	76.6972	36.0472	81	Chowan	14	F
19	76.9292	36.5472	CR-1*	Chowan	2	F
20	76.6722	36.0292	CR-2	Chowan	3	F
21	77.1917	35.2361	39	Neuse	6	F
22	77.1139	35.1972	40	Neuse	8	F
23	77.1958	35.3450	41	Neuse	1	F
24	77.0736	35.1500	42	Neuse	6	F
25	77.0306	35.1167	43	Neuse	1	F
26	77.1250	35.0778	44	Neuse	2	F
27	76.2917	34.9167	95	Pasquotank	1	F
28	77.5917	36.4306	52	Roanoke	2	F
29	77.0389	35.8583	55	Roanoke	1	F
30	76.8444	35.8722	56	Roanoke	4	F
31	76.7847	35.8292	57	Roanoke	3	F
32	76.7639	35.8639	58	Roanoke	17	F
33	76.7639	35.8653	60	Roanoke	6	F
34	76.7292	35.9194	61	Roanoke	2	F
35	76.6958	35.9417	63	Roanoke	21	F
36	76.7250	35.9111	64	Roanoke	6	F
37	76.9417	36.0056	66	Roanoke	1	F
38	76.7444	35.9222	67	Roanoke	1	F
39	76.6750	35.3667	91	Tar-Pamlico	1	F

Note: Area A includes stations 61, 62, 63, 64, 67, and 68. Stations 63 and 65 were the same location and only the former is plotted on the map.

*These stations are located within the Virginia portion of the A/P Study Area.

Figure 5-7. (continued)

Note: All stations where contaminant concentrations in the edible portions of fish or shellfish exceeded human health SVs for recreational fishermen are reported in this toxics analysis; however, because fish are mobile, the location(s) where they are exposed to and bioaccumulate contaminants in their tissues may be distant from the location where they were collected (the only exception to this is lake ecosystems). Therefore, the reader is cautioned not to attach undue significance to the fact that contaminant concentrations in a single sample collected at a given site exceed the selected human health screening value. Rather, the reader should focus attention on those monitoring stations where numerous fish/shellfish samples collected over several years were found to contain contaminant concentrations in exceedance of human health SVs.

5.2.3.1 Albemarle Estuary

Metals and Organochlorine Pesticides

Fish fillet samples collected at 15 sites in the Albemarle estuarine system were found to exceed EPA human health SVs. These sites included two stations in the Chowan, six stations in the Pasquotank, and seven stations in the Roanoke basin (Table 5-10). Shellfish samples collected at 10 sites in the Albemarle estuarine system were found to exceed EPA human health SVs. These sites included nine stations in the Pasquotank basin and one station in the Roanoke basin (Table 5-11).

In the Chowan, fish fillet samples exceeded human health SVs for two contaminants (arsenic and mercury). Human health SVs were exceeded at one station for mercury and at one station for arsenic. Shellfish samples from the Chowan did not exceed human health SVs for any pollutant at any station. The most contaminated riverine site in the Chowan River was basin station 02050079 near Riddickville where four exceedances of human health SVs were detected.

In the Pasquotank, contaminant concentrations in fish fillet samples exceeded human health SVs for four contaminants: arsenic (three stations), mercury (three stations), lead (one station), and DDT (one station). The most contaminated site in the Pasquotank basin was station PASO12 on Lake Phelps where eight exceedances of human health SVs were detected (seven exceedances for mercury; one exceedance for lead).

Shellfish samples from the Pasquotank exceeded human health SVs for two contaminants--arsenic and zinc. Zinc exceedances were detected at five sites and arsenic exceedances were also detected at five sites.

In the Roanoke, contaminant concentrations in fish fillet samples exceeded human health SVs for two contaminants--mercury and selenium. Concentrations of mercury exceeded SVs at five stations; concentrations of selenium exceeded SVs at two stations. The two most contaminated sites in the Roanoke River basin were stations HYCO-1 on Hyco Lake and BELEWS-10 on Belews Lake with seven and six exceedances detected, respectively. All exceedances at these two stations were a result of selenium contamination from electric power generating facilities on these lakes.

Contaminant concentrations in shellfish samples from one station (Roanoke River near Sans Souci) exceeded the human health SV for lead.

Dioxin

Dioxin concentrations in fish fillet tissue were highest in samples from the Albemarle estuarine system. Fish fillet samples collected at 13 sites in the Chowan basin, 11 sites in the Roanoke basin, and at 7 stations in western Albemarle Sound exceeded the screening value (1 part per trillion [ppt]).

In the Chowan basin, fillet samples from three tributary rivers to the Chowan--the Blackwater, Nottoway and Meherrin Rivers exceeded the 1-ppt screening value. In general, dioxin tissue contaminations were highest in fish samples from the following stations:

- Chowan River at Winton (station 76)
- Chowan River near Highway 17 bridge (station 81)
- Chowan River near Marker 16 (station 77)
- Chowan River near Marker 5 (station 80).

Channel catfish *(Ictalurus punctatus)* was the fish species most frequently identified as having the highest level of dioxin contamination at each site. Several other species were also found to have elevated tissue concentrations of dioxin including largemouth bass (*Micropterus salmoides),* bluegill *(Lepomis macrochirus),* white catfish (*Ictalurus catus),* bullhead (*Ictalurus ssp),* mullet (*Mugil cephalus*), striped bass (*Morone saxatilis*), white perch (*Morone americana*), and pumpkinseed (*Lepomis gibbosus*); however, dioxin concentrations overall at each station were generally highest in channel catfish.

In the Roanoke basin, fillet samples from the Roanoke River at Welch Creek downstream to its mouth in Albemarle Sound exceeded the dioxin SV. In general, the number of dioxin exceedances was highest in fish samples from the following stations:

- Roanoke River at Marker 15 (station 63)
- Welch Creek old discharge at Trowbridge Road (stations 58 and 59).

As in the Chowan basin, channel catfish was the species most frequently identified as having the highest level of dioxin contamination at sites where it was collected; however, tissue concentrations in several other species were also elevated. These species included white perch (*Morone americana*), bluegill (*Lepomis gibbosus)*, brown bullhead (*Ictalurus nebulosus*), white catfish (*Ictalurus catus*), black crappie (*Pomoxis nigromaculatus*), and largemouth bass (*Micropterus salmoides*).

In Albemarle Sound, fillet samples from seven stations exceeded the dioxin SV. In general, the highest number of exceedances of the dioxin SV occurred at

- Albemarle Sound at Norfolk and South (station 82)
- Albemarle Sound at Marker 1 (station 68)
- Albemarle Sound at Bull Bay (station 85)
- Albemarle Sound at Highway 32 (station 83).

Channel catfish and white catfish were the species with the highest levels of dioxin contamination; however, white perch (*Morone americana*) were also contaminated to a comparable degree at two stations.

5.2.3.2 **<u>Pamlico Estuary</u>**

Metals and Organochlorine Pesticides

Fish fillet samples collected at 14 sites in the Tar-Pamlico basin were found to exceed human health SVs for metals and organochlorine pesticides. Fish fillet samples exceeded human health criteria for four contaminants (arsenic, lead, mercury, and dieldrin); however, mercury contamination at eight sites was the single most frequent cause of the exceedances. The highest numbers of mercury exceedances were detected at the following sites:

- Lake Mattamuskeet (MT-2)
- Lake Mattamuskeet (MT-1)
- Tar River near Grimesland (02084171)
- Tar River in Greenville (TSTAR120)
- Pungo Lake (TAR0628A).

Both Lake Mattamuskeet and Pungo Lake are located in relatively pristine areas of the State and receive no direct discharges from industrial or municipal facilities.

Shellfish samples collected at three sites in the Pamlico contained contaminant concentrations in exceedance of human health criteria for arsenic (Tar River at Tarboro), for lead (Pamlico River near Garrison Point), and zinc (Far Creek near Englehard).

Dioxin

One exceedance of the human health SV for dioxin was detected in a sample of blue crabs from the Pamlico River near South Creek.

5.2.3.3 Neuse Estuary

Metals and Organochlorine Pesticides

Fish fillet samples collected at 13 sites in the Neuse basin were found to exceed human health SVs for metals and organochlorine pesticides. Fish fillet samples exceeded human health SVs for four contaminants (arsenic, copper, lead, and mercury); however, mercury and arsenic criteria exceedances were detected at six and seven stations, respectively. Mercury exceedances were detected at the following stations:

- Neuse River near Clayton (02087500)
- Neuse River near Goldsboro (TSNEU100)
- Neuse River in Kinston (02089500)
- Contentnea Creek at Grifton (0209176690)
- Swift Creek at Vanceboro (NEU-119)
- Slocum Creek (NEUSC5).

Arsenic exceedances were detected at the following sites:

- Neuse River near Pamlico (02092682)
- Neuse River at Minnesott Beach (NEU-139)
- Slocum Creek off Cherry Point (NEUSC-1)
- West Prong of Slocum Creek (NEUSC-4)
- Slocum Creek off Mill Creek (NEUSC-5)
- Slocum Creek (NEUSC5)
- South River at Southriver (Southriver).

The two most contaminated sites in the Neuse basin that had the largest number of fish samples exceeding human health SVs were located in Slocum Creek. Fillet samples exceeded three human health SVs (arsenic, lead, and mercury) at Slocum Creek off Mill Creek (NEUSC-5) and exceeded two human health SVs (arsenic and mercury) at NEUSC5 on Slocum Creek.

Shellfish samples collected at five stations in the Neuse basin contained contaminant concentrations in exceedance of human health SVs. Shellfish samples from the mouth of the

Neuse River near Pamlico exceeded the arsenic SV. Shellfish samples from the following four sites exceeded the lead SVs:

- Contentnea Creek at Hominy Swamp (TSNEUCC5)
- Nahunta Swamp at SR-1537 (TSNEUNS4)
- Neuse River near Oriental (NEU-OR).
- Little River at Princeton (02088500)

Dioxin

Dioxin concentrations in fish fillet tissue from six sites in the Neuse basin were found to exceed the selected SV. Tissue contamination was highest at the following sites:

- Neuse River near Weyerhaeuser effluent (40)
- Neuse River above Cowpens (39)
- Neuse River at Marker 52 (42).

White catfish (*Ictalurus catus)* and white perch (*Morone americana)* fillet tissue contained the highest levels of dioxin contamination.

5.2.4 Conclusions

5.2.4.1 Metals and Organochlorine Pesticides

In general, within the A/P Study Area, mercury contamination of fish fillet samples was detected at the largest number of sites of any contaminant and could potentially pose a risk to human health. Mercury concentrations were found to exceed the SV (based on a fish consumption rate for the 50th percentile of recreational fishermen) at 23 sites in the A/P estuarine system as shown in Figure 5-8. The widespread distribution of sites throughout this estuarine system and particularly within the three lakes in proximity to the Mattamuskeet Wildlife Refuge (Lake Phelps, Pungo Lake, and Lake Mattamuskeet) that do not receive effluent loadings from industrial or municipal point sources is of concern. Primary points of entry of mercury into the environment may include industrial discharges, nonpoint source runoff, and atmospheric deposition resulting from combustion of coal and municipal refuse incinerators (Glass et al., 1990).

The State of Florida has 25 fish consumption advisories currently in effect statewide including several presumed pristine areas in the Everglades National Park (RTI, 1991), and Michigan sampled fish from lakes in presumably unpolluted areas but discovered mercury contamination in fish from many of these areas and subsequently issued a fish consumption advisory for all its inland lakes (U.S. EPA, 1991b). Mercury, the only metal analyzed in the National Bioaccumulation Study was detected at 92 percent of the 374 sites surveyed nationwide (U.S. EPA, 1991d).

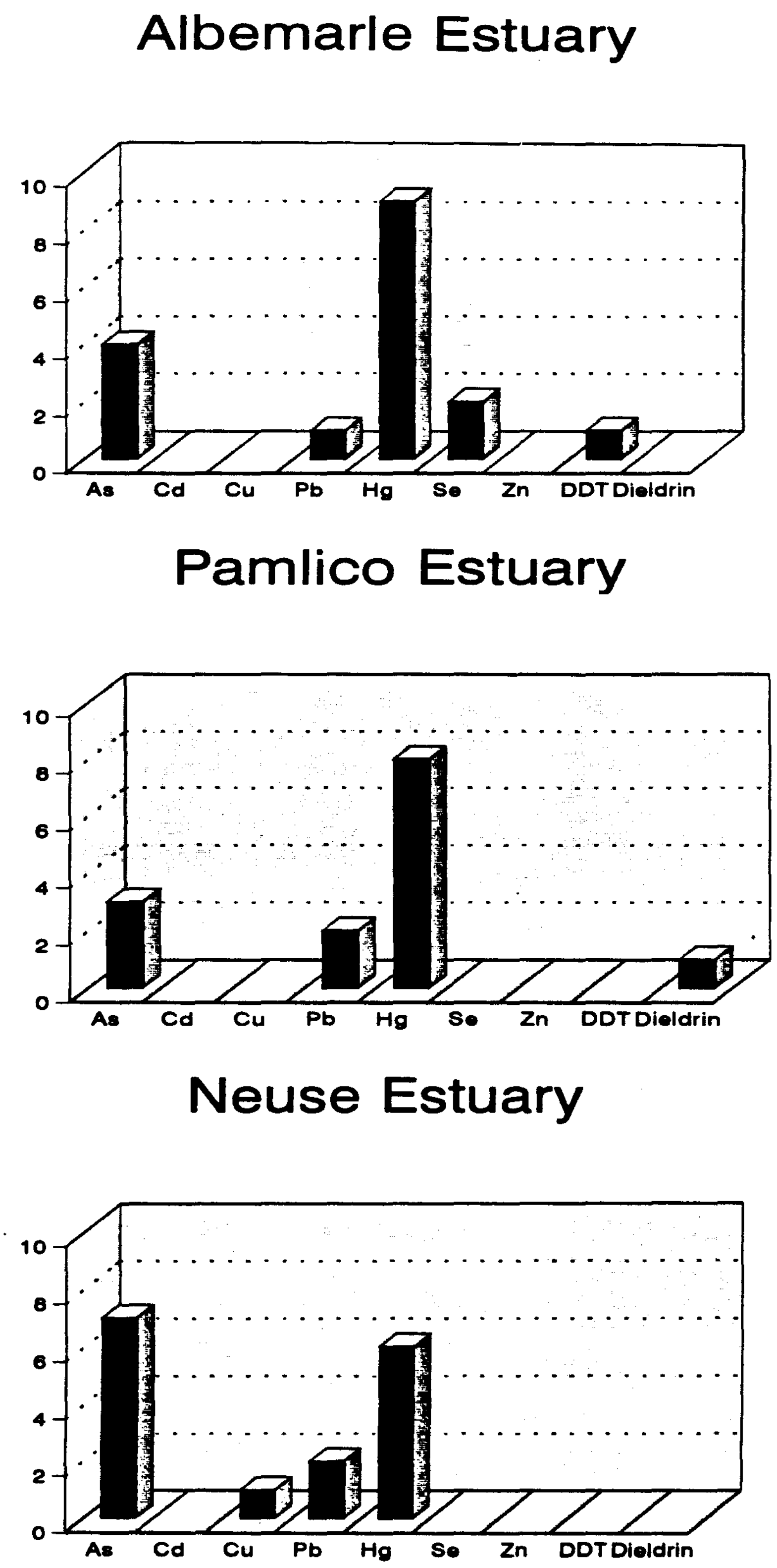


Figure 5-8. Comparison of the number of sites exceeding the human health screening screening values for metals and organochlorine pesticides.

Identification of the sources of mercury contamination in the A/P Study Area should be secondary to the problem of protection of public health once areas of contamination have been identified. This report has identified exceedances of health criteria for the 50th percentile of recreational fishermen. Heavier consumers of fish (e.g., subsistence fishermen) would be at additional risk from consuming mercury-contaminated fish. Although the mercury SV used by RTI (0.7 ppm) was more conservative than the FDA value (1.0 ppm) currently used for fish in interstate commerce and currently used by North Carolina, it is less conservative than the 0.5 ppm mercury criterion adopted by the Great Lakes States. In addition, the EPA Fish Contaminant Workgroup is currently reviewing whether the 0.5 ppm criterion should be adopted nationwide. If a criterion of 0.5 ppm mercury is recommended by EPA for adoption by States, additional sites within the A/P area would be found in exceedance. The extent of mercury contamination in whole fish samples (see Section 5.1.3) adds additional evidence for a mercury contamination problem in some waterbodies in the A/P Study Area. Unlike the results found for mercury contamination in fish tissues, no mercury exceedances were identified for shellfish samples (Figure 5-9).

Arsenic contamination in fish tissues was identified at four, three, and seven sites within the A/P estuarine area in the Albemarle, Pamlico, and Neuse basins, respectively. A cautionary note must be given here, however, because the arsenic RfD value is based on inorganic arsenic, which is not the chemical form of arsenic that accumulates in fish tissues. Arsenic is generally present in the edible parts of fish as arsenic-containing organic compounds--either arsenobetaine or arsenocholine (NAS, 1991).

These organic arsenic compounds are much less toxic than inorganic forms and are not generally considered a risk to human health (ATSDR, 1989). However, to the degree that inorganic forms of arsenic, upon consumption, may be produced as metabolites of organic arsenic in seafood, some health risk would be expected (NAS, 1991). Although there is still some question as to the severity of the risk with respect to human health, the exceedances for arsenic for both fish and shellfish do serve to identify where arsenic contamination within the estuary may be occurring or to identify sites of in-place sediment contamination.

Selenium contamination in fish tissue was identified at two sites (Belews-10 and HYCO-1). The State has issued fish consumption advisories for these two lakes as shown in Appendix K. **Note: These two sites are located within the Roanoke Basin but are not within the A/P Study Area.**

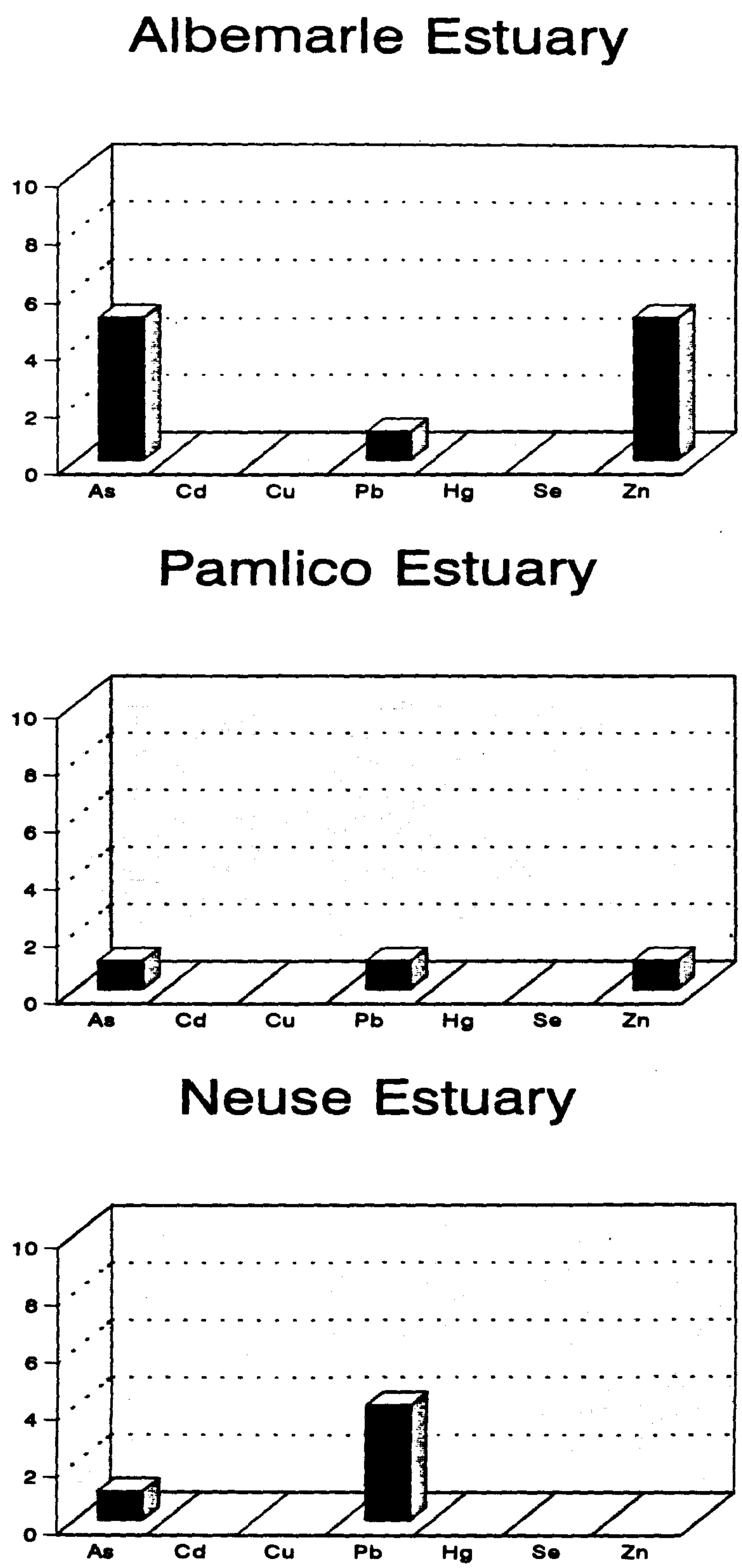


Figure 5-9. Comparison of the number of sites exceeding the human health screening values for metals in shellfish tissue.

Lead contamination in fish and shellfish was identified at several sites in all three estuaries. The RfD value used to calculate the screening value was not an EPA-sanctioned value as it does not appear in IRIS; however, it has been used by EPA as a surrogate RfD for lead. It should be noted that the RfD value is calculated for a 15-kg child and cannot be directly converted to adult body weight. The EPA Fish Contaminant Workgroup is currently reviewing the RfD for lead. Until some EPA-sanctioned RfD value is available for lead, users of the EPA risk assessment procedure have no way of calculating SVs for this contaminant because no human health criterion for consumption (fish only) is available (see Appendix B). RTI used the only value available for use in the EPA risk-based approach for calculating the SV.

Zinc contamination was not detected widely in fish tissue but was a contaminant found in estuarine shellfish samples. Zinc contamination was primarily limited to six sites in this estuarine system. A cluster of exceedances was noted in the Pasquotank at the following stations (MC-6, MC-8, MC-9, and MILL-2). Very few samples at each site were found in exceedance, but this cluster of exceedances warrants further study.

Copper contamination in fish fillet tissue was detected only at one site (Slocum Creek off Mill Creek) and this site has also produced exceedances of arsenic and lead.

DDT contamination was detected at only one site in the Pasquotank basin (02081185) and this value occurred in a 1983 fillet sample. It is likely that in the intervening 10 years, DDT contamination may no longer be a problem. Schmitt et al. (1990) reported that mean concentrations of total DDT and all p,p' homologs (collected as part of the U.S. FWS NCBP) declined significantly over the period 1976 to 1984. Because the use of DDT was banned in 1973, no additional direct inputs from agricultural use are occurring and fish tissue concentrations are expected to continue to decline.

Dieldrin contamination was also detected at one site (Pamlico River at Great Island), but occurred in only one fish sample.

5.2.4.2 Dioxins

In general, within the A/P Study Area, dioxin contamination of fish fillet samples was detected at the largest number of sites (39) of any contaminant found in exceedance of the selected SVs (Figure 5-10).

Dioxin contamination was most pronounced and widespread in the Chowan and Roanoke basins and Western Albemarle Sound. The primary sources for this contamination are presumed to be the Union Camp Paper Mill on the Blackwater River in Virginia (Chowan

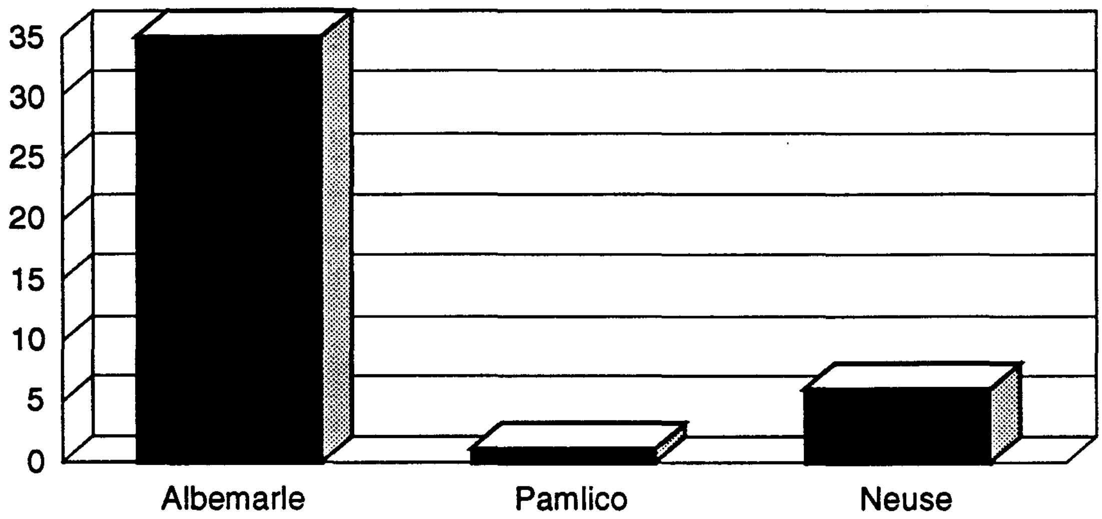


Figure 5-10. Comparison of the number of sites where dioxin concentrations exceeded the human health screening value.

basin) and the Weyerhaeuser Paper Mill at Plymouth, North Carolina (Roanoke basin). The State of North Carolina has taken action to issue fish consumption advisories for the entire length of the Chowan, the lower portion of the Roanoke, and Western Albemarle Sound as described in Appendix K. In the past, an advisory was in effect for a small segment of the Neuse River associated with the Weyerhaeuser paper mill in New Bern; however, this advisory has since been rescinded. Contamination in the Neuse was not of the magnitude of that in the Albemarle Region and the Weyerhaeuser facility at New Bern switched from the bleach kraft process to an alternative technology so that dioxin discharges have been minimized.

SECTION 6

RECOMMENDATIONS

6.1 ASSESSMENT OF DISCHARGERS' POTENTIAL FOR EXCEEDANCES

The State-maintained DMR file is a valuable data information source for evaluating toxics loading and assessing the potential of each discharger to produce exceedances of instream water quality standards or criteria under specific flow conditions. Pollutant loadings can be used to evaluate the magnitude of toxics inputs in each river basin system so that total maximum daily loadings or average annual loading can be calculated. In addition, the resulting loading data can be used to evaluate hydrologic conditions (low flow scenarios) that could lead to potential water quality standards/criteria exceedances. However, quality assurance/quality control (QA/QC) at all points in the data management process should be scrutinized if this data resource is to be used as a valuable tool in water quality management. RTI encountered a significant number of apparent errors in units and other data errors in the DMR database files provided by the State for this analysis.

The following recommendations are made based on RTI's analysis of point source dischargers' data files:

1. The State should evaluate pretreatment technologies of industrial facilities discharging to municipal wastewater treatment plants (WWTPs). WWTPs account for the majority of dischargers identified as having the potential to cause water quality exceedances under both average and 7Q10 flow conditions.

2. DEM should review estimated annual loadings for dischargers identified in Table 2-2 as part of the State's basinwide water quality management approach to determine where further reductions in loadings can be achieved to minimize total toxics loadings to the A/P estuarine system.

3. DEM should review permits and effluent data for all facilities identified in this study whose effluent concentrations could result in potential instream water quality exceedances under the flow regimes evaluated. Primary attention should be given to those facilities where effluent concentrations could potentially produce water quality exceedances under average flow as well as 7Q10 low flow conditions. The list of dischargers that could potentially produce exceedances of water quality standards/criteria has been prioritized based on the total number of exceedances calculated for the 2 years evaluated in this toxics study (Tables 6-1 and 6-2).

Table 6-1. Ranking of Dischargers with Potential to Produce Exceedances of Water Quality Standards/Criteria under Average Flow Conditions[a]

Estuarine system	Facility	Times potential for exceedance existed[b]
A	Roxboro WWTP*	68
P	Oxford-Southside #2 WWTP	52
N	Benson WWTP	28
N	Zebulon WWTP	17
N	Durham/Northside WWTP	15
A	CP&L Roxboro Steam Electric*	13
N	Cary Crabtree Creek WWTP	9
A	Nutbush Creek WWTP*	7
A	Halstead Industries*	3
N	Durham/Eno WWTP	3
A	Eden/Mebane Ridge WWTP*	1
N	John Umstead Hospital	1

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a] Based on RTI's point source discharge analysis.
[b] Sum of exceedances for all pollutants evaluated.
* These stations are located within the Roanoke River Basin but are not located within the A/P Study Area.

Table 6-2. Ranking of Dischargers with Potential to Produce Exceedances of Water Quality Standards/Criteria under 7Q10 Low Flow Conditions[a]

Estuarine system	Facility name	Times potential for exceedance existed [b]
P	Oxford - Southside #2 WWTP	83
A	Roxboro WWTP*	70
A	Dare County Landfill/East Lake	63
N	Benson WWTP	48
N	Durham/Eno WWTP	43
N	Durham/Northside WWTP	39
A	CP&L Roxboro Steam Electric*	39
N	Phillips Plating Company	38
N	Cary Crabtree Creek WWTP	31
N	Zebulon WWTP	29
A	Halstead Industries*	23
P	Corry Hiebert Furniture Co.	20
P	Tar River WWTP	13
N	John Umstead Hospital	13
A	Nutbush Creek WWTP*	11
N	Farmville, Town of	10
N	USMC - Cherry Point #1	4
A	Eden/Mebane Ridge WWTP*	3
N	Wilson WWTP	3
A	Duke Power/Belews Creek*	2
N	Wendell, Town of	2

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a] Based on RTI's point source discharge analysis.
[b] Sum of exceedances for all pollutants evaluated.
* These stations are located within the Roanoke River Basin but are not located within the A/P Study Area.

4. More intensive QA/QC checks by the DEM Regional Offices would help to ensure that data errors in the facility reports are corrected promptly and are not transmitted to the main database in Raleigh.

6.2 AMBIENT WATER QUALITY MONITORING

The STORET data file for ambient water quality monitoring provides frequent toxics monitoring (e.g., monthly) at many freshwater and tidal stations. The following recommendations are made based on RTI's analysis of the STORET data file:

1. DEM should consider increasing the number of estuarine stations sampled and ensure that data are collected monthly to meet EPA's definition of an abundant data set. The State has conducted special water quality monitoring studies (NCDEM, 1990b) at coastal sites; however, routine monitoring at additional key estuarine sites, particularly in estuaries lateral to the major basins would provide better information for evaluating changes in ambient water quality in these ecologically critical areas.

2. Monitoring sites where exceedances of ambient water quality standards or criteria were detected have been prioritized based on the total number of pollutant exceedances detected over the 3-year period evaluated (Table 6-3). The State should review these exceedances and try to find a cause for the exceedance particularly at stations where the exceedances of standards/criteria for a specific pollutant or pollutants repeatedly occurs.

3. Ambient water quality exceedances were most frequently detected in headwater reaches of the Neuse River. Basin-wide planning should incorporate information on facilities discharging toxics into these headwater areas as well as information on NPS pollution that might be responsible for these exceedances (e.g., landfill, Superfund or treatment storage and disposal [TSDF] sites). See Dodd et al. (1992) for additional information on basin-wide planning using various GIS data layers.

6.3 SEDIMENT QUALITY MONITORING

Results of the survey of 3 years of sediment monitoring data in STORET suggest that sediment monitoring is the least emphasized facet of the State's routine monitoring programs. Data on only three freshwater stations were found in STORET for the 3-year period accessed and no routine estuarine monitoring was conducted by the State from 1989 to 1991.

The following recommendations are made based on RTI's analysis:

1. The State should consider implementing a sediment contaminant monitoring program directed at sites in both freshwater streams and lakes that possess sediment and hydrologic characteristics (e.g., areas with organic-rich muds where flow is minimal and deposition could produce pollutant sinks) that could potentially result in sediment contamination.

Table 6-3. Ranking of Ambient Water Quality Monitoring Sites Where Water Quality Standards/Criteria Were Exceeded[a]

Estuarine system	Station number	Total number of exceedances
N	J3300000	46
N	J8840000	33
A	N8200000	29
A	N7300000	21
N	J1210000	21
N	J1330000	9
N	02087570	8
N	02085000	7
N	J3270000	7
N	J1530000	6
N	02086490	6
A	D8353000	5
P	09750500	5
P	09751000	5
N	02085500	5
N	J2850000	5
A	D5000000	3
A	N8300000	3
P	06450000	3
N	J1890000	3
N	J2860000	3
N	J4170000	3
N	J6740000	3
N	J9690000	3
P	08495000	2
P	09758500	2
N	J0770000	2
N	J0810000	2
N	J1100000	2
N	J8170000	2

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a] Rankings based on the total number of exceedances detected in RTI's analysis of STORET data from June 1989 through June 1991. Stations 02087570 and J4370000 are the same geographic location; only the ranking for the former is given.

2. The State should use analytical procedures recommended by the EPA for analysis of toxics in freshwater sediments and use the EPA threshold concentrations as screening values.

3. The State should adopt EPA freshwater sediment criteria for toxics when they are promulgated.

4. In estuarine areas, State sediment monitoring efforts should build on the monitoring data obtained by Riggs et al. (1989, 1991, and in preparation) for the Pamlico, Neuse, and Albemarle Estuaries and should concentrate monitoring efforts especially in the estuaries lateral to the major estuarine systems.

5. The State should consider adoption of the analytical procedures currently used in NOAA's Status and Trends program and adopt the NOAA ER-M concentrations as screening values for evaluating estuarine sites. Because Riggs et al. (1989, 1991, and in preparation) did not use the total digestion/extraction procedure recommended by NOAA, RTI's evaluation probably underestimates the number of sites were ER-M values would be exceeded.

6. RTI has ranked all of the Riggs et al. (1989, 1991, and in preparation) sites that had an ER-M exceedance for at least one metal (Table 6-4). The State could first focus its monitoring efforts on those estuarine stations with the highest number of ER-M value exceedances. The highest sediment toxics score attained at any station was a score of 9 at NBNW-26 on the Neuse River. It is apparent from Table 6-4 that the first tier of sites with scores greater than 5 are almost all found in the Neuse Estuary, the next tier of sites with scores of 5 are found primarily in the Neuse and Pamlico Estuaries, and the stations with the fewest number of ER-M exceedances (sediment toxics scores of <5) are found primarily in the Albermarle and Pamlico Estuaries.

7. The State should conduct monitoring at estuarine sites determined to be most contaminated and should evaluate the use of simultaneously conducted sediment residue analysis and sediment toxicity testing using appropriate benthic species at the most contaminated sites.

8. Overall, the State should consider expanding its sediment monitoring program to

   - Encompass more sampling sites in both freshwater and estuarine areas of the A/P Study Area that may be potential sinks for environmental pollutants

   - Monitor for both metals and toxic organic compounds on a site-specific basis based on priority pollutant scan data from point source discharges

Table 6-4. Ranking of Contaminated Sediment Sites Exceeding the ER-M Value[a] for at Least One Metal

Estuarine system	Site	Sediment toxics score	Number of ER-M exceedances	Number of ER-L exceedances
N	NBNW-26	9	4	1
N	SLO-19	9	3	3
N	SLO-2	8	3	2
N	SLO-21	8	2	3
N	TNT-11	7	2	3
N	SLO-25	7	2	3
N	SLO-20	7	2	3
A	WEL-5	7	2	3
N	LSN-2	6	2	2
N	TNT-12	6	2	2
N	SLO-18	6	1	4
N	LSN-1	5	2	1
A	WEL-4	5	2	1
A	PAS-25	5	2	1
N	CMP-1	5	1	3
N	SLO-16	5	1	3
N	SLO-6	5	1	3
P	NAT-1	5	1	3
P	NAT-11	5	1	3
P	NAT-5	5	1	3
P	NAT-9	5	1	3
A	PAS-19	4	2	0
A	PAS-5	4	1	2
P	NAT-10	4	1	2
P	NAT-12	4	1	2
P	NAT-14	4	1	2
P	NAT-2	4	1	2
P	NAT-3	4	1	2
P	NAT-4	4	1	2
P	NAT-6	4	1	2
P	NAT-8	4	1	2
N	NBNW-25	4	1	2

See notes at end of table.

Table 6-4 (continued)

Estuarine system	Site	Sediment toxics score	Number of ER-M exceedances	Number of ER-L exceedances
A	PAS-14	3	1	1
A	PAS-15	3	1	1
A	PAS-16	3	1	1
A	PAS-17	3	1	1
A	PAS-20	3	1	1
A	PAS-21	3	1	1
A	PAS-23	3	1	1
A	PAS-26	3	1	1
A	PAS-27	3	1	1
A	PAS-28	3	1	1
P	TAR-22	2	1	0
A	CHN-10	2	1	0
A	EDN-5	2	1	0
A	PAS-12	2	1	0
A	PAS-22	2	1	0
A	RKE-13	2	1	0
A	SCP-10	2	1	0

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a]Rankings based on RTI's analysis of Riggs et al. (1989, 1991, in preparation) sediment data.

- Adopt EPA threshold values for screening freshwater data and NOAA ER-M values for screening estuarine data until the EPA Criteria and Standards Division issues formal criteria for heavy metals and organic pollutants in sediment.

6.4 FISH AND SHELLFISH CONTAMINATION

6.4.1 Protection of Wildlife

The four primary pollutants that are found at concentrations that may be hazardous to piscivorous wildlife include mercury, copper, lead, and cadmium. Mercury is of particular concern because concentrations in whole fish samples were found in exceedance of the U.S. FWS national maximum (based on the 1984-1985 National Contaminant Biomonitoring Program) at over 40 percent of the 23 sites where it was detected. A map is provided in Appendix L that gives the location of sites where the level of concern for wildlife was exceeded for mercury.

The following recommendations are made based on RTI's analysis:

1. The State needs to continue sampling whole fish to determine the level of contamination these food sources pose to various wildlife (fish-eating birds, reptiles, and mammals) in the A/P Study Area.

2. As resources permit, the State should not only target its monitoring efforts to those sites with the highest potential for contamination, but also sample presumed "clean" areas where contamination is not expected. Several States, including Michigan and Florida, have found widespread contamination problems in areas such as inland lakes and the Everglades that were not suspected of having mercury contaminant problems (RTI, 1991).

3. In lieu of any existing standards or Federal criteria, the State should consider using values reported in the U.S. FWS National Contaminant Biomonitoring Program, the U.S. FWS Hazard Review Documents, and other appropriate values from the recent scientific literature to screen all future monitoring data.

4. Ranking of all stations where whole fish samples were found in exceedance is provided in Table 6-5 for heavy metal and organochlorine pesticides and in Table 6-6 for dioxin. This ranking is based on the total number of samples found to be in exceedance of levels of concern. The most contaminated of these sites warrant further review. The State should review all available monitoring data to determine the source for the exceedances identified and, where contaminant sources are identified, initiate remedial actions.

6.4.2 Protection of Human Health

The three primary human health problems associated with consumption of chemically contaminated fish/shellfish in the A/P Study Area are related to dioxin, selenium, and mercury

Table 6-5. Ranking of Sites Where Levels of Concern for Wildlife Were Exceeded for Metals and Organochlorine Pesticides [a]

Estuarine system	Station number	Total samples exceeding levels of concern
A	PAS012	57
P	0208455850	27
A	WELDON-HATC	25
A	02050079	19
N	TSNEUCC4	19
N	02092162	19
N	02089500	18
P	02084171	18
A	TSPASNL1	13
A	02081000	13
P	TSTAR120	13
P	02084534	13
P	TAR0628A	13
N	TSNEUFS03	12
P	02082823	12
P	0208457020	9
N	NEUSC-4	8
A	02081179	8
A	0208117810	8
A	02081185	8
A	02074218*	8
N	TSNEUTS3	8
A	02081141	8
A	02053652	7
A	02084633	7
N	02087500	7
N	TSNEUTS5	7
A	02053632	6
P	TSTARI2OD	6
N	0209176690	6
N	02092000	6
N	NEUSC-5	6

See notes at end of table. (continued)

Table 6-5 (continued)

Estuarine system	Station number	Total samples exceeding levels of concern
A	DS-10	5
A	STUMPY-1	5
A	0207933350[a]	5
A	TSROARR30	5
P	PUNGO-17	5
N	02085070	5
N	02090634	5
P	02083692	4
P	020845560	4
P	02092690	4
P	MT-1	4
N	TSNEUFNR2	4
N	TSNEUTS1	4
N	TSNEUSC03	4
N	NEUSC2	4
N	TSNEUPC2	4
A	0208117950	3
A	02081166	3
A	02082812	3
P	TAR56B	3
P	TSTARKDY	3
P	TSTARFC10[b]	3
N	NEU055	3
N	TSNEUSTCZ	3
N	TSNEUNS4	3
N	South River	3

See notes at end of table. (continued)

Table 6-5 (continued)

Estuarine system	Station number	Total samples exceeding levels of concern
A	02043862	2
P	Currituck-1	2
P	02082770	2
P	South-CR	2
N	TSTARBC5	2
N	NEU020D	2
N	TSNEU100	2
N	TSNEUCC1C	2
N	02092682	2
N	NEU139	2
N	NEUSC1	2
	TSNEUMS1	2
A	DS-3/5	1
A	PAS02A	1
P	PUNGO-1	1
N	0209257120	1
N	NEUSC-2	1

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a] Rankings based on RTI's analysis of DEM's fish contaminant monitoring database from 1980 to 1990.
[b] Stations TSTARFC15 and TSTARFC10 were the same location. Data from these two stations were combined and are presented for station TSTARFC10 only.
* These stations are located in the Roanoke River Basin but are not within the A/P Study Area.

Table 6-6. Ranking of Sites Where Level of Concern for Wildlife Was Exceeded for Dioxin [a]

Estuarine system	Station number	Total samples exceeding level of concern
A	58[b]	6
A	80	4
A	81	4
A	57	3
A	76	3
A	77	3
A	78	3
A	CR-2	2
N	40	1
A	56	1
A	75	1
A	82	1

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a] Rankings based on RTI's analysis of DEM's fish contaminant monitoring database from 1980 to 1990.
[b] Stations 58 and 59 were the same location. Data from these two stations were combined and are presented for station 58 only.

contamination. The State currently has advisories on the major waterbodies affected by dioxin (i.e., Chowan, lower Roanoke, and western Albemarle Sound) and has advisories on Hyco and Belews Lakes for selenium (see Appendix K); however, no fish consumption advisories for mercury are currently in effect for the A/P Study Area. A map is provided in Appendix L that gives the location of sites where the human health SV for mercury was exceeded.

With respect to mercury, the State has used the FDA level of concern (1 ppm) for evaluating mercury contamination in fish and shellfish; however, the EPA is currently recommending that risk-based procedures be used to calculate mercury concentrations. The State has screened its fish tissue data using 1 ppm; RTI chose a more conservative mercury SV (0.7 ppm) for protection of recreational fishermen who consume fish at a higher consumption rate than the general public and frequently eat fish from the same waters. Mercury accounted for exceedances at more than 50 percent of the sites where exceedances of human health SVs occurred (see Appendix J). Note: The EPA Fish Contaminant Workgroup is considering recommending that States adopt an SV of 0.5 ppm for mercury (which is currently in use by several Great Lakes States) because mercury is both a fetal (developmental) and neurological toxicant.

The following recommendations are made based on RTI's analysis:

1. State staff should review screening data on mercury contamination presented here and evaluate the potential human health risks not only to recreational fishermen but to heavier consumers of fish (subsistence fishermen) as well as to pregnant women, nursing mothers, and children in light of the latest EPA recommendations (U.S. EPA, 1991b).

2. All stations where edible portions of fish/shellfish samples were found in exceedance of SVs are ranked in Tables 6-7 through 6-9 based on the total number of samples found to be in exceedance of SVs at each site. The most contaminated of these sites warrant further review. The State should review all available monitoring data to determine the sources for the exceedances identified and, where contaminant sources are identified, initiate remedial actions.

3. Risk communication of fishing advisories for specific subpopulations should be evaluated to ensure that the State is communicating the risk of consuming contaminated fish effectively so that the consumer can make an informed choice on fish consumption. In addition, the State should communicate alternate risk management strategies to its residents including

   - Eating smaller (less contaminated) fish
   - Eating a wider variety of species, some of which may be less contaminated
   - Fishing in different waterbodies.

Table 6-7. Ranking of Sites Where Human Health SVs Were Exceeded for Metals and Organochlorine Pesticides[a]

Estuarine system	Station number	Total number of samples exceeding SVs
P	T-2	8
A	PAS012	8
A	HYCO-1*	7
N	NEUSC-5	7
A	BELEWS-10*	6
N	NEUSC5	5
A	02050079	4
P	MT-1	4
N	02087500	3
N	NEU139	3
A	DS-10	3
A	STUMPY-1	3
A	02081141	3
A	0208117950	2
A	02081185	2
A	02074218*	2
P	02084171	2
P	TSTAR120	2
P	MT-3	2
P	TAR0628A	2
N	02089500	2
N	0209176690	2
N	NEUSC4A	2
N	South River	2

See notes at end of table. (continued)

Table 6-7. (continued)

Estuarine system	Station sumber	Total number of samples exceeding VSs
A	0205324450	1
A	Currituck-2	1
A	MAYO-1*	1
A	02080500	1
A	TSROARR30	1
P	02082823	1
P	02084472	1
P	02092690	1
P	PUNGO-17	1
P	PUNGO-7/8	1
P	TAR58	1
P	TAR56B	1
P	TSTARR3	1
N	TSNEU100	1
N	NEU-119	1
N	02092682	1
N	NEUSC-1	1
N	NEUSC-4	1

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a] Rankings based on RTI's analysis of DEM's fish contaminant monitoring database from 1980 to 1990.
* These stations are located in the Roanoke River Basin but are not within the A/P Study Area.

Table 6-8. Ranking of Sites Where Human Health SV for Dioxin Was Exceeded[a]

Estuarine system	Station number	Total number of samples in exceedance of SV
A	76	27
A	63[b]	21
A	81	18
A	58	15
A	77	11
A	80	9
A	78	9
A	59	9
A	69*	9
N	40	9
A	82	8
A	70*	7
A	75	7
A	68	6
A	60	6
A	64	6
A	56	6
A	57	6
N	39	6
N	42	6
A	CR-2	5
A	73*	5
A	85	5
A	83	5
A	CR-1*	4
A	79	4
A	87	4
A	71*	4
A	84	3

See notes at end of table. (continued)

Table 6-8 (continued)

Estuarine system	Station number	Total number of samples in exceedance of SV
A	61	2
N	44	2
A	52	2
A	62	1
A	95	1
N	41	1
N	43	1
A	55	1
A	60	1
A	66	1
A	67	1
P	91	1

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a] Rankings based on RTI's analysis of DEM's fish contaminant monitoring database from 1980 to 1990.
[b] Stations 63 and 65 were the same location. Data from both stations were combined and are presented for station 63 only.
* These stations are located in the Virginia portion of the A/P Study Area.

Table 6-9. Ranking of Sites Where Human Health SVs in Shellfish Were Exceeded for Metals[a]

Estuarine system	Station number	Total number of samples in exceedance of SVs
A	MC-6	4
A	MC-8	3
P	BUX-1-IN	2
N	TSNEUCC5	2
N	02092682	2
A	MC-9	1
A	Mill-2	1
A	STUMPY-1	1
A	02081145	1
P	BUX-1	1
P	BUX-1-OUT	1
A	02081141	1
P	02082823	1
P	TAR 58	1
P	TSTARFC15	1
N	02088500	1
N	TSNEUNS4	1
N	NEU-OR	1

A = Albemarle Estuary and its associated tributary rivers.
N = Neuse River Estuary.
P = Pamlico River Estuary.

[a] Rankings based on RTI's analysis of DEM's fish contaminant monitoring database from 1980 to 1990.

4. The State needs to continue sampling edible portions of fish and shellfish species to determine the level of contamination that those food sources pose to human health. Currently, the fish contaminant monitoring program targets sites suspected of having contamination problems. Ideally, the State should target its monitoring efforts to those sites with the highest contamination, including sites associated with contaminated sediment; areas near dischargers identified as potentially producing water quality standards and criteria exceedances or areas where repeated ambient water quality standard and criteria exceedances have been reported; and clean areas where contamination is not expected.

5. As recommended in the draft EPA *Fish Sampling and Analysis: A Guidance Document* (U.S.EPA, 1991b), the State should no longer use FDA action levels to screen contaminant data but should adopt the EPA risk assessment approach, which provides a consistent procedure for calculating screening values for direct protection of public health and allows States the flexibility to adjust various parameters (e.g., consumption rate, body weight, risk level) to provide better protection for heavy fish consumers (e.g., sport and subsistence fishermen) and sensitive subpopulations (e.g., pregnant women, nursing women, and children).

6. The State should consider establishing in written protocols the procedures to be used in issuing a fish consumption advisory, including the SVs for each contaminant of concern, and ensure that laboratories engaged in chemical analyses of fish tissue use methods that have detection limits lower than the respective contaminant SVs to be used. The State should further ensure that laboratories that provide data on fish tissue analyses to be used in human risk assessment calculations use good laboratory practices, have an adequate QA/QC program, and participate in a certification program to ensure that the accuracy, precision, and comparability of results meet project objectives.

SECTION 7

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APPENDIX A

Facilities Screened in the DMR Database

Basin: Chowan

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0003867	UNITED PIECE DYE WORKS	CHOWAN RIVER	0.000	0.00

Basin: Pasquotank

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0025011	ELIZABETH CITY WWTP, CITY OF	PASQUOTANK RIVER	0.000	0.00
NC0049140	DARE COUNTY LANDFILL EAST LAKE	UT DEER CREEK/SOUTH LAKE	0.000	0.00

Basin: Neuse

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0023841	DURHAM - NORTHSIDE WWTP, CITY OF	ELLERBE CREEK	0.075	17.40
NC0026336	DURHAM ENO WWTP, CITY OF	ENO RIVER	0.400	143.00
NC0026433	HILLSBOROUGH WWTP, TOWN OF	ENO RIVER	0.180	67.30
NC0026824	JOHN UMSTEAD HOSPITAL	KNAP OF REEDS CREEK	0.090	43.00
NC0001376	BURLINGTON IND. (WAKE PLANT)	NEUSE RIVER	71.000	0.00
NC0003549	SHELL OIL COMPANY	UT NEUSE RIVER	0.000	0.15
NC0021954	CITGO PETROLEUM - SELMA	UT NEUSE RIVER	0.000	0.00
NC0030716	JOHNSTON, COUNTY OF	NEUSE RIVER	0.000	0.00
NC0036145	BP OIL CO - GULF PRODUCTS DIV.	MILL CREEK	0.000	0.23
NC0048879	CARY, CRABTREE CREEK, TOWN OF	CRABTREE CREEK	0.300	57.00
NC0076457	HILL PETROLEUM/SELMA TERMINAL	UT NEUSE RIVER	0.000	0.03
NC0020389	BENSON WWTP, TOWN OF	HANNAH CREEK	0.000	10.50
NC0003417	CP&L-LEE STEAM ELECTRIC PLT #1	NEUSE RIVER	263.000	0.00
NC0003417	CP&L-LEE STEAM ELECTRIC PLT #2	NEUSE RIVER	265.000	0.00
NC0003417	CP&L-LEE STEAM ELECTRIC PLT #3	NEUSE RIVER	263.000	0.00
NC0020541	KINSTON-PEACHTREE WWTP	NEUSE RIVER	282.760	2505.30
NC0024236	KINSTON NORTHSIDE WWTP	NEUSE RIVER	313.200	2758.00
NC0025020	WENDELL, TOWN OF	BUFFALO CREEK	0.200	17.00
NC0020842	SNOW HILL WWTP, TOWN OF	CONTENTNEA CREEK	31.400	703.00
NC0023906	WILSON WWTP, CITY OF	CONTENTNEA CREEK	0.000	0.00
NC0024368	ZEBULON WWTP, TOWN OF	UT MOCCASIN CREEK	0.100	1.81
NC0029572	FARMVILLE, TOWN OF	LITTLE CONTENTNEA CREEK	0.070	78.00
NC0032077	CONTENTNEA METROPOLITAN SEWAGE	CONTENTNEA CREEK	36.000	1010.00
NC0001881	PHILLIPS PLATING COMPANY	NEUSE RIVER	0.000	0.00
NC0003816	USMC - CHERRY POINT #1	SLOCUM CREEK	0.000	35.00

Facilities Screened in the DMR Database

Basin: Roanoke

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0024406	DUKE POWER / BELEWS CREEK 002	BELEWS LAKE	0.000	0.00
NC0024406	DUKE POWER / BELEWS CREEK 003A	BELEWS LAKE	0.000	0.00
NC0024406	DUKE POWER / BELEWS CREEK 003B	DAN RIVER	24.000	501.00
NC0035173	HALSTEAD INDUSTRIES	UT DAN RIVER	0.075	1.60
NC0021873	MAYODAN, TOWN OF	MAYO RIVER	76.600	312.00
NC0028011	STONEVILLE WWTP	MAYO RIVER	58.600	305.00
NC0001643	FIELDCREST CANNON, INC.	DAN RIVER	314.000	1706.00
NC0003468	DUKE POWER / DAN RIVER #001	DAN RIVER	314.000	1706.00
NC0003468	DUKE POWER / DAN RIVER #002	DAN RIVER	314.000	1706.00
NC0003468	DUKE POWER / DAN RIVER #003	DAN RIVER	314.000	1706.00
NC0025071	EDEN / MEBANE RIDGE WWTP, CITY	DAN RIVER	313.000	1701.00
NC0003425	CP&L ROXBORO STEAM ELEC. FAC.	HYCO RESERVOIR	1.000	220.00
NC0021024	ROXBORO WWTP, CITY OF	MARLOWE CREEK	0.000	4.70
NC0038377	CP&L - MAYO S.E. PLANT #001	MAYO RESERVOIR	0.000	0.00
NC0038377	CP&L - MAYO S.E. PLANT #002	MAYO RESERVOIR	0.000	0.00
NC0038377	CP&L - MAYO S.E. PLANT #003	MAYO RESERVOIR	0.000	0.00
NC0020559	NUTBUSH CREEK WWTP / HENDERSON	NUTBUSH CREEK	0.000	4.20
NC0024201	ROANOKE RAPIDS SANITARY DIST.	ROANOKE RIVER	1502.000	0.00
NC0001961	WEST POINT PEPPERELL/HAMILTON	ROANOKE RIVER	1560.000	0.00
NC0020044	WILLIAMSTON WWTP	ROANOKE RIVER	1887.000	9070.00
NC0023710	PENN ELASTIC COMPANY	ROANOKE RIVER	1910.000	9400.00
NC0023710	LIBERTY FABRICS-JAMESVILLE PLT	ROANOKE RIVER	1910.000	9600.00
NC0026751	WINDSOR WWTP, TOWN OF	UT CASHIE RIVER	0.000	4.10

Basin: Tar-Pamlico

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0025054	OXFORD RENOVATED WWTP, CITY OF	FISHING CREEK	0.050	6.65
NC0036854	CORRY HIEBERT FURNITURE CO.	WOLFPEN BRANCH	0.000	0.00
NC0030317	ROCKY MOUNT WWTP, CITY OF	TAR RIVER	40.700	930.00
NC0020605	TARBORO WWTP, TOWN OF	TAR RIVER	90.000	2180.00
NC0001627	NAT'L SPINNING CO/WASHINGTON	TAR RIVER	0.000	0.00
NC0003255	TEXAS GULF #002	UT PAMLICO RIVER	0.000	0.00
NC0003255	TEXAS GULF #003	UT PAMLICO RIVER	0.000	0.00
NC0003255	TEXAS GULF #004	UT PAMLICO RIVER	0.000	0.00
NC0003255	TEXAS GULF #005	UT PAMLICO RIVER	0.000	0.00
NC0003255	TEXAS GULF #006	UT PAMLICO RIVER	0.000	0.00
NC0003255	TEXAS GULF #007	PAMLICO RIVER	0.000	0.00
NC0003255	TEXAS GULF #008	PAMLICO RIVER	0.000	0.00
NC0003255	TEXAS GULF #009	PAMLICO RIVER	0.000	0.00
NC0003255	TEXAS GULF #011	BOND CREEK	0.000	0.00
NC0003255	TEXAS GULF #012	SOUTH CREEK	0.000	0.00
NC0003255	TEXAS GULF #013	SOUTH CREEK	0.000	0.00
NC0003255	TEXAS GULF #021	FLANNIGAN CUT	0.000	0.00
NC0003255	TEXAS GULF #031	LONG CREEK	0.000	0.00
NC0003255	TEXAS GULF #032	LONG CREEK	0.000	0.00
NC0003255	TEXAS GULF #041	LONG CREEK	0.000	0.00
NC0003255	TEXAS GULF #042	BOND CREEK	0.000	0.00
NC0003255	TEXAS GULF #043	BOND CREEK	0.000	0.00
NC0003255	TEXAS GULF #051	LONG CREEK	0.000	0.00
NC0003255	TEXAS GULF #052	SOUTH CREEK	0.000	0.00
NC0003255	TEXAS GULF #053	SOUTH CREEK	0.000	0.00
NC0003255	TEXAS GULF #054	LITTLE CREEK	0.000	0.00

Facilities Screened in the APAM Database

Basin: CHOWAN

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0003867	United Piece Dye Works	CHOWAN RIVER	TIDAL	
NC0001490	West Point Pepperell	UT SNAKE BRANCH	0.0	

Basin: NEUSE

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0020362	Walstonburg WWTP	THOMPSON SWAMP	0.0	4.3
NC0001376	Burlington Ind. Wake Finishing	NEUSE RIVER	71.0	
NC0003417	CP&L - H.F. Lee	NEUSE RIVER	263.0	
NC0003816	USMC Cherry Point	SLOCUM CREEK	0.0	35.0
NC0020541	Kinston Peachtree	NEUSE RIVER	282.8	2505.3
NC0021253	Havelock WWTP	EAST PRONG OF SLOCUM CREEK		
NC0023906	Wilson WWTP	CONTENTNEA CREEK		
NC0023949	GOLDSBORO WWTP	NEUSE RIVER	273.0	2427.0
NC0024236	Kinston Northside	NEUSE RIVER	313.2	2758.0
NC0025348	New Bern	NEUSE RIVER	TIDAL	
NC0026433	Hillsboro WWTP	ENO RIVER	0.18	67.3
NC0026824	J. Umstead Hospital WWTP	KNAP OF REEDS CREEK	0.09	43.0
NC0030759	Town of Wake Forest	NEUSE RIVER	72.1	840.0
NC0032077	CMSD	CONTENTNEA CREEK	36.0	1000.0
NC0064050	Apex	UT MIDDLE CREEK	0.0	0.5

Basin: Roanoke

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0000752	Champion Int. Halifax Co.	ROANOKE RIVER	1500.0	
NC0020044	Williamston	ROANOKE RIVER	1887.0	9070.0
NC0026751	Town of Windsor	UT CASHIE RIVER	0.0	4.1

Basin: Tar-Pamlico

NPDES	Facility Name	Receiving Stream	7Q10 (cfs)	Avg (cfs)
NC0020605	Town of Tarboro	TAR RIVER	90.0	2180.0
NC0020648	City of Washington WWTP	KENNEDY CREEK	TIDAL	
NC0023931	Greenville Utilities	TAR RIVER	166.0	0.0
NC0025054	Oxford WWTP	UT FISHING CREEK	0.0	3.5
NC0026042	Town of Robersonville	FLAT SWAMP	0.27	18.0
NC0030317	City of Rocky Mount WWTP	TAR RIVER	83.0	0.0

APPENDIX B

NORTH CAROLINA WATER QUALITY STANDARDS

WATER QUALITY STANDARDS FOR FRESHWATER CLASSES

Parameters	Standards For All Freshwater		More Stringent Standards To Support Additional Uses	
	Aquatic Life	Human Health	WS Classes	Trout
Arsenic (ug/l)	50			
Barium (mg/l)			1.0	
Benzene (ug/l)		71.4	1.19	
Beryllium (ng/l)		117	6.8	
Cadmium (ug/l)	2.0			0.4
Carbon tetrachloride (ug/l)		4.42	0.254	
Chloride (mg/l)	230 (AL)		250	
Chlorinated benzenes (ug/l)			488	
Chlorine, total residual (ug/l)	17 (AL)			17
Chlorophyll a, corrected (ug/l)	40 (N)			15 (N)
Chromium, total (ug/l)	50			
Coliform, total (MFTCC/100ml)			50 (N)(2)	
Coliform, fecal (MFTCC/100ml)		200 (N)		
Copper (ug/l)	7 (AL)			
Cyanide (ug/l)	5.0			
Dioxin (ng/l)		0.000014	0.000013	
Dissolved gases	(N)			
Dissolved oxygen (mg/l)	5.0 (Sw)(1)			6.0
Fluoride (mg/l)	1.8			
Hardness, total (mg/l)			100	
Hexachlorobutadiene (ug/l)		49.7	0.445	
Iron (mg/l)	1.0 (AL)			
Lead (ug/l)	25 (N)			
Manganese (ug/l)			50 (WSII & III:200)	
MBAS (ug/l) (Methylene-Blue-Active Substances)	500			
Mercury (ug/l)	0.012			
Nickel (ug/l)	88		25	
Nitrate nitrogen (mg/l)			10	
Pesticides				
Aldrin (ng/l)	2.0	0.136	0.127	
Chlordane (ng/l)	4.0	0.588	0.575	
DDT (ng/l)	1.0	0.591	0.588	
Demeton (ng/l)	100			
Dieldrin (ng/l)	2.0	0.144	0.135	
Endosulfan (ng/l)	50			
Endrin (ng/l)	2.0			
Guthion (ng/l)	10			
Heptachlor (ng/l)	4.0	0.214	0.208	
Lindane (ng/l)	10			
Methoxychlor (ng/l)	30			
Mirex (ng/l)	1.0			
Parathion (ng/l)	13			
Toxaphene (ng/l)	0.2			
2,4-D (ug/l)			100	
2,4,5-TP (Silvex) (ug/l)			10	
pH (units)	6.0-9.0 (Sw)			
Phenolic compounds (ug/l)		(N)	1.0 (N)	
Polychlorinated biphenyls (ng/l)	1.0	0.079		
Polynuclear aromatic hydrocarbons (ng/l)		31.1	2.8	
Radioactive substances		(N)		
Selenium (ug/l)	5			
Silver (ug/l)	0.06 (AL)			
Solids, total dissolved (mg/l)			500	
Solids, suspended	(N)			
Sulfates (mg/l)			250	
Temperature	(N)			
Tetrachloroethane (1,1,2,2) (ug/l)		10.8	0.172	
Tetrachloroethylene (ug/l)			0.8	
Toluene (ug/l)	11			0.36
Toxic Substances	(N)			
Trialkyltin (ug/l)	0.008			
Trichloroethylene (ug/l)		92.4	3.08	
Turbidity (NTU)	50; 25 (N)			10 (N)
Vinyl chloride (ug/l)		525	2	
Zinc (ug/l)	50 (AL)			

Note:
- (N) See 2B .0211 (b), (c), (d), or (e) for narrative description of limits.
- (AL) Values represent action levels as specified in .0211 (b)(4).
- (Sw) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.
- (1) An instantaneous reading may be as low as 4.0 ug/l but the daily average must be 5.0 ug/l or more.
- (2) Applies only to unfiltered water supplies.

WATER QUALITY STANDARDS FOR TIDAL SALTWATER CLASSIFICATIONS

Parameters	Standards For All Tidal Saltwaters		More Stringent Standards To Support Additional Uses
	Aquatic Life	Human Health	Class SA
Arsenic (ug/l)	50		
Benzene (ug/l)		71.4	
Beryllium (ng/l)		117	
Cadmium (ug/l)	5.0		
Carbon tetrachloride (ug/l)		4.42	
Chlorophyll a (ug/l)	40 (N)		
Chromium, total (ug/l)	20		
Coliform, fecal (MFFCC/100ml)		200 (N)	14 (N)
Copper (ug/l)	3 (AL)		
Cyanide (ug/l)	1.0		
Dioxin (ng/l)		0.000014	
Dissolved gases	(N)		
Dissolved oxygen (mg/l)	5.0 (1)		
Hexachlorobutadiene (ug/l)		49.7	
Lead (ug/l)	25 (N)		
Mercury (ug/l)	0.025		
Nickel (ug/l)	8.3		
Phenolic compounds		(N)	
Polychlorinated biphenyls (ng/l)	1.0	0.079	
Polynuclear aromatic hydrocarbons (ng/l)		31.1	
Pesticides (ng/l)			
Aldrin	3.0	0.136	
Chlordane	4.0	0.588	
DDT	1.0	0.591	
Demeton	100		
Dieldrin	2.0	0.144	
Endosulfan	9.0		
Endrin	2.0		
Guthion	10		
Heptachlor	4.0	0.214	
Lindane	4.0		
Methoxychlor	30		
Mirex	1.0		
Parathion	178		
Toxaphene	0.2		
pH (units)	6.8-8.5 (1)		
Radioactive substances		(N)	
Salinity	(N)		
Selenium (ug/l)	71		
Silver (ug/l)	0.1 (AL)		
Solids, suspended	(N)		
Temperature	(N)		
Tetrachloroethane (1,1,2,2) (ug/l)		10.8	
Toxic substances	(N)		
Trialkyltin (ug/l)	0.002		
Trichloroethylene (ug/l)		92.4	
Turbidity (NTU)	25 (N)		
Vinyl chloride (ug/l)		525	
Zinc (ug/l)	86 (AL)		

Note: (N) See 2B .0212 (b), (c), or (d) for narrative description of limits.
(AL) Values represent action levels as specified in .0212(b)(4).
(1) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.

RWQ3.STA

U.S. ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY CRITERIA
TOXICS SUBSTANCES SPREADSHEET

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

OCT 29 1991

Dear Colleague:

EPA Region IV, Water Quality Standards Unit, has prepared the attached "Toxic Substance Spreadsheet" to provide a complete and comprehensive listing of EPA published criteria for toxic substances under Section 304(a) of the Clean Water Act (CWA), and to include other related, relevant information.

This summary table reflects a current listing of all EPA published criteria with adjusted criteria for human health based on revised reference dose factors (RfD) or cancer potency factors (q_1*) obtained from IRIS (EPA's Integrated Risk Information System) and, where appropriate, revised MCLs published under the Safe Drinking Water Act. These values are current as of October 1991. While the table should be self explanatory in many respects, certain items may require further explanation.

- o Date Revised Column - This column is intended to indicate the last date EPA Region IV revised an entry for a particular pollutant We intend to update the table periodically.

- o EPA Detection Level - Generally two methods are listed, both of which are found in 40 CFR 136.

- o Bioconcentration Factor - All BCF values printed and used in the human health criteria calculations are from the 1980 Ambient Water Quality Criteria Documents.

- o Human Health Criteria are expressed at the 1:1,000,000 ($1X10^{-6}$) risk level for carcinogens. Pollutants considered possible carcinogens are noted with a "c" next to the compound name.

- o EPA Fish Tissue Concentrations - These are the fish tissue values from which the EPA Human Health water quality criteria are calculated using the bioconcentration factors listed in the previous column. These values can be used in evaluating the health risk associated with fish tissue data for priority pollutants. These values are based on the same exposure calculations outlined in EPA's criteria documents for consumption of aquatic organisms.

- o Criteria Dates - This column contains the date of the applicable EPA criteria document and if appropriate the date of the most recent RfD, q_1*, and MCL used to adjust the criteria document values.

Although this table was originally prepared as Region IV guidance to it's states, based on numerous requests from other EPA Regions and interested parties, it will be distributed periodically to all those who have received previous versions or have requested to be added to our (somewhat informal) mailing list. Please feel free to share this table with others as you see fit.

The following are recent changes for Region IV's Toxic Substance Spreadsheet:

October 1991 changes:

- P-Chloro-M-Cresol was added as a synonym for 3-Methyl-4-Chlorophenol (compound #8a).

- 4,6-Dinitro-O-Cresol was added as a synonym for 2-Methyl-4,6-Dinitrophenol (compound #4a).

- MCLs were published for Toluene, Ethylbenzene, and 1,2-dichlorobenzene. These compounds were noted as having an MCL that is more stringent than its human health water and organisms criterion.

- An MCL was published for 1,2-Trans-dichloroethlyene. On the screening chart, this compound was noted as having an MCL that is more stringent than the human health water and organisms criterion.

- A revised MCL for Selenium was included on both charts.

- A revised MCL for Methoxychlor was included on both charts.

- A revised MCL for Barium was included on both charts.

- A revised MCL for Cadmium was included on both charts.

- The oral reference dose for Silver has been withdrawn by the RfD/RfC Workgroup. The human health organisms only criteria and fish tissue criteria were changed to the 1980 criteria document walues.

- The oral reference dose for 1,1,1-Trichloroethane has been withdrawn by the RfD/RfC Workgroup. The human health organisms only and fish tissue criteria were changed to the 1980 criteria document values.

- An oral RfD assessment for Selenium has been added to IRIS. The fish tissue and human health organisms only criteria were recalculated.

- Pentachlorophenol has been classified as a probable carcinogen. The human health and fish tissue criteria were recalculated.

- o The fish tissue criterion for Chromium (VI) was corrected.
- o The carcinogenic assessment for Hexachlorobenzene has been added to IRIS. The human health and fish tissue criteria were recalculated.
- o A revised MCL for 2,4-Dichlorophenoxyacetic acid was included in the charts.
- o A revised MCL for 2-(2,4,5,-trichlorophenoxy)propionic acid was included in both charts.

Any questions or comments regarding the tables can be addressed to Fritz Wagener at (404) 347-3396.

Sincerely yours,

Karen Gourdine
Office of Water Quality Standards
Water Management Division

TSC1001 CRITERIA CHART
UPDATED: OCTOBER 1991
EPA REG IV - WATER MANAGEMENT DIVISION
304(a) CRITERIA AND RELATED INFORMATION
FOR TOXIC POLLUTANTS

DATE REVISED		COMPOUND	EPA DETECTION LEVEL (40 CFR 136) (ug/l)	EPA Ref. Method	(ug/l)	EPA Ref. Method	FRESHWATER Criterion Maximum Conc. (ug/l)	FRESHWATER Criterion Continuous Conc. (ug/l)	SALTWATER Criterion Maximum Conc. (ug/l)	SALTWATER Criterion Continuous Conc. (ug/l)	HUMAN HEALTH (10 -6 risk factor for carcinogens) Consumption of: Water & Organisms (ug/l)	HUMAN HEALTH Organisms Only (ug/l)	BIO CONCENTRATION FACTOR (3% Lipid) Weighted Avg. (l/kg)	EPA FISH TISSUE CONCENTRATION (ppm) (mg/kg)	CRITERIA DATES
							Hardness(mg/l as CaCO3): 50 pH: 8								
		PRIORITY POLLUTANTS													
4/89	1	m Antimony (D)	300	204.1	3	204.2			—	—	14 *	4300 *	1	4.31	10/88, 1/87:RfD 0.0004
7/89	2	m Arsenic (c)	1	206.3	1	206.2	360 *III	190 *III	69 *III	36 *III	0.018 *	0.14 *	44	0.0062	1/85:aq life, 6/21/88:q1* 1.75 Admin. memo
7/90	3	m Beryllium (c)	5	210.1	0.2	210.2			—	—	0.0077 *	0.13 *	19	0.0025	10/88, 1/90:q1* 4.3
10/91	4	m Cadmium (H)	5	213.1	0.1	213.2	1.79 *	0.66 *	43 *	9.3 *	5 *MCL	—	64	10.77	10/88, 1/85:aq life, 10/88:RfD 0.0005(water),0.001(food),1/91:MCL 5
12/89	5	m Chromium (III) (H)	50	218.1	1	218.2	984.32 *	117.32 *			33300 *	673077 *	16	10760	10/88, 1/85:aq life,3/88:RfD 1
10/91	5	m Chromium (VI)	5	218.4			16 *	11 *	1100 *	50 *	50 *MCL	—	16	53.0	10/88, 1/85:aq life, 3/88:RfD 0.005
1/91	6	m Copper (H)	20	220.1	1	220.2	9.22 *	6.54 *	2.9 *	2.9 *	1000 * O	—	36	—	10/88, 1/85:aq life
6/89	7	m Lead (H)	100	239.1	1	239.2	33.78 *	1.32 *	140 *	5.6 *	50 *MCL	—	49	—	10/88, 1/85:aq life
6/89	8	m Mercury	0.2	245.1	—		2.40 *	0.012 *F	2.1 *	0.025 *F	0.151 *	0.153 *	5500 f 3760 a/o 8000 sw	1 (F)	10/88, 1/85:aq life, 2/88:RfD 0.0003
4/89	9	m Nickel (H)	40	249.1	1	249.2	789.00 *	87.71 *	75 *	8.3 *	607 *	4584 *	47	215.4	10/88, 8/86:aq life, 3/88:RfD 0.02
10/91	10	m Selenium	2	270.3	2	270.2	20.00 *	5.00 *	300 *	71 *	50 *MCL		6	5.4	10/88, 9/87:aq life, 1/91:MCL 50
10/91	11	m Silver (H, D)	10	272.1	0.2	272.2	1.23 *		2.3 *		50 *MCL		0.5	—	10/88
4/89	12	m Thallium	100	279.1	1	279.2					13 *	48 *	119	5.71	10/88
1/91	13	m Zinc (H)	5	289.1	0.05	289.2	65.04 *	58.91 *	95 *	86 *	5000 * O	—	47	—	10/88, 2/87:aq life
7/90	14	m Cyanide	5	335.3	--		22 *	5.2 *	1 *	1 *	200 *MCL		1.0	215.4	10/88, 1/85:aq life, 3/88:RfD 0.02
4/89		Asbestos (c)					—	—	—	—	30,000 *f/l	—			10/88
7/89		2,3,7,8-TCDD-Dioxin (c)	0.00001 hrms		0.002	613			—		0.000000013 *	0.000000014 *	5000	0.0000007	2/84:q1* 156000
4/89	1	v Acrolein	nr	624m	0.7	603					320 *	780 *	215	—	10/88
4/89	2	v Acrylonitrile (c)	nr	624m	0.5	603			—	--	0.059 *	0.665 *	30	0.02	10/88, 3/89:q1* 0.54
4/89	3	v Benzene (c)	4.4	624	0.2	602					1.19 *	71.28 *	5.2	0.37	10/88, 12/88:q1* 0.029
1/91	5	v Bromoform (c)	4.7	624	0.2	601					4.38 *	363.8 *	3.75	1.36	10/88, 6/88:q1* CHCl3, 1/91:q1*0.0079
6/89	6	v Carbon Tetrachloride (c)	2.8	624	0.12	601					0.254 *	4.42 *	18.75	0.083	10/88, 3/88:q1* 0.13
1/91	7	v Chlorobenzene	6	624	0.25	601					20 * O	—	10.3	215.4	10/88, 11/90:RfD 0.02
1/91	8	v Chlorodibromomethane (c)	3.1	624	0.09	601	—	—	—	—	0.412 *	34.2 *	3.75	0.128	10/88, 6/88:q1* CHCl3, 11/90:q1*0.084
4/89	9	v Chloroethane	nr	624	0.52	601	—	—	—	—	—	—	—	—	10/88
7/90	10	v 2-Chloroethylvinyl Ether (c)	nr	624	0.13	601			—	—	—	—	0.357	—	10/88
6/89	11	v Chloroform (HM, c)	1.6	624	0.05	601					5.67 *	470.8 *	3.75	1.77	10/88, 6/88:q1* 0.0061
1/91	12	v Dichlorobromomethane (c)	2.2	624	0.1	601	—	—	—	—	0.266 *	22.00 *	3.75	0.083	10/88, 6/88:q1* CHCl3, 10/90:q1* 0.13
6/89	14	v 1,1-Dichloroethane	4.7	624	0.07	601	—	—	—	—	—	—	—	—	10/88
6/89	15	v 1,2-Dichloroethane (c)	2.8	624	0.03	601					0.38 *	98.6 *	1.2	0.118	10/88, 3/88:q1* 0.091
4/89	16	v 1,1-Dichloroethylene (c)	2.8	624	0.13	601					0.057 *	3.2 *	5.6	0.018	10/88, 12/88:q1* 0.6
6/89	17	v 1,2-Dichloropropane	6	624	0.04	601					—	—	4.11	—	10/88
11/88	18	v 1,3-Dichloropropylene (Cis)	5		0.34						10.4 *	1681 *	1.91	3.33	10/88, 3/88:RfD 0.0003
4/85		v 1,3-Dichloropropylene (Trans)	nr	624	0.2	601					10.4 *	1681 *	1.91	3.33	10/88, 3/88:RfD 0.0003
10/91	19	v Ethylbenzene	7.2	624	0.2	602					3120 * y	28718 *	37.5	1077	10/88, 3/88:RfD 0.1
7/90	20	v Methyl Bromide	nr	624	1.18	601					48 *	4028 *	3.75	15.1	10/88, 8/90:RfD 0.0014

TA:1091 CRITERIA CHART
UPDATED: OCTOBER 1991
EPA REG IV - WATER MANAGEMENT DIVISION
304(a) CRITERIA AND RELATED INFORMATION
FOR TOXIC POLLUTANTS

DATE REVISED	COMPOUND	EPA DETECTION LEVEL (40 CFR 136) (ug/l)	EPA Ref. Method	(ug/l)	EPA Ref. Method	FRESHWATER Criterion Maximum Conc. (ug/l)	FRESHWATER Criterion Continuous Conc. (ug/l)	SALTWATER Criterion Maximum Conc. (ug/l)	SALTWATER Criterion Continuous Conc. (ug/l)	HUMAN HEALTH (10 -6 risk factor for carcinogens) Consumption of: Water & Organisms (ug/l)	HUMAN HEALTH Organisms Only (ug/l)	BIO CONCENTRATION FACTOR (3% Lipid) Weighted Avg. (l/kg)	EPA FISH TISSUE CONCENTRATION (ppm) (mg/kg)	CRITERIA DATES
4/89	21 v Methyl Chloride (HM, c)	nr	624	0.08	601					5.67 *	470.8 *	3.75	1.77	10/80, 6/88:q1* CHCl3
4/89	22 v Methylene Chloride (c)	2.8	624	0.25	601					4.66 *	1578 *	0.9	1.44	10/80, 1/89:q1* 0.0075
6/89	23 v 1,1,2,2-Tetrachloroethane (c)	6.9	624	0.03	601					0.172 *	10.8 *	5	0.054	10/80, 3/88:q1* 0.2
4/89	24 v Tetrachloroethylene (c)	4.1	624	0.03	601					0.8 *	8.85 *	30.6	0.27	10/80
10/91	25 v Toluene	6	624	0.2	602					6764.0 * y	301294 *	10.7	2194	10/80, 3/88:RfD 0.3, 8/90:RfD 0.2
10/91	26 v 1,2-Trans-Dichloroethylene	1.6	624	0.1	601			—	—	—	—	1.58	215.6	10/80, 1/89:RfD 0.02
10/91	27 v 1,1,1-Trichloroethane	3.8	624	0.03	601					30400 * y	1030000 *	5.6	5700	10/80
4/89	28 v 1,1,2-Trichloroethane (c)	5	624	0.02	601			—	—	0.608 *	41.90 *	4.5	0.100	10/80, 3/88:q1* 0.057
7/89	29 v Trichloroethylene (c)	1.9	624	0.12	601			—	—	2.7 *	80.7 *	10.6	0.855	10/80
4/89	31 v Vinyl Chloride (c)	nr	624	0.18	601	—	—	—	—	2 *	525 *	1.17	0.614	10/80
1/91	1 a 2-Chlorophenol	3.3	625	0.31	604			—	—	0.1 * @	—	134	83.8	10/80, 6/88:RfD 0.005
1/91	2 a 2,4-Dichlorophenol	2.7	625	0.39	604			—	—	0.3 * @	—	40.7	33.3	10/80, 6/88:RfD 0.003
1/91	3 a 2,4-Dimethylphenol	2.7	625	0.32	604			—	—	400 * @	—	93.8	215.4	10/80, 11/90:RfD 0.02
10/91	4 a 2-Methyl-4,6-Dinitrophenol (4,6-Dinitro-O-Cresol)	24	625	16	604			—	—	13.4 *	765 *	5.5	4.3	10/80
4/89	5 a 2,4-Dinitrophenol	42	625	13	604					69.7 *	14264 *	1.5	21.4	10/80, 3/88:RfD 0.002
4/89	6 a 2-Nitrophenol	3.6	625	0.45	604	—		—	—	—	—	2.33	—	10/80
4/89	7 a 4-Nitrophenol	2.4	625	2.8	604			—	—	—	—	3.31	—	10/80
10/91	8 a 3-Methyl-4-Chlorophenol (P-Chloro-M-Cresol)	3	625	0.36	604			—	—	3000 * @	—	—	—	10/80
10/91	9 a Pentachlorophenol (pH,c)	3.6	625	7.4	604	3.32 *	2.10 *	13 *	7.9 *	0.282 *	8.16 *	11	0.00	10/80, 9/86:aq life, 6/88:RfD 0.03, 3/91:q1* 0.12
1/91	10 a Phenol	1.5	625	0.14	604					300 * @	4615308 *	1.4	6462	10/80, 6/88:RfD 0.6
7/89	11 a 2,4,6-Trichlorophenol (c)	2.7	625	0.64	604			—	—	2.1 *	6.5 *	150	0.00	10/80, 6/90: q1* 0.011
1/91	1 bn Acenaphthene	1.9	625	1.8	610					20 * @	—	242	646.2	10/80, 11/90:RfD 0.06
1/91	2 bn Acenaphthylene	3.5	625	2.3	610	—	—	—	—	—	—	30	—	10/80
1/91	3 bn Anthracene	1.9	625	0.66	610	—	—	—	—	9667.2 *	107083 *	30	3230.0	10/80, 9/90:RfD 0.3
4/89	4 bn Benzidine (c)	44	625	--		—	—	—	—	0.000110 *	0.000538 *	87.5	0.0000468	10/80, 3/88:q1* 230
4/89	5 bn Benzo(a)Anthracene (PAH, c)	7.8	625	0.013	610	—	—	—	—	0.0028 *	0.0311 *	30	0.000933	10/80
4/89	6 bn Benzo(a)Pyrene (PAH, c)	2.5	625	0.023	610	—	—	—	—	0.0028 *	0.0311 *	30	0.000933	10/80
4/89	7 bn 3,4-Benzofluoranthene (PAH, c)	2.5	625	0.018	610	—	—	—	—	0.0028 *	0.0311 *	30	0.000933	10/80
1/91	8 bn Benzo(ghi)Perylene	4.1	625	0.076	610	—	—	—	—	—	—	30	—	10/80
4/89	9 bn Benzo(k)Fluoranthene (PAH, c)	2.5	625	0.017	610	—	—	—	—	0.0028 *	0.0311 *	30	0.000933	10/80
4/89	10 bn Bis(2-Chloroethoxy)Methane	5.3	625	0.5	611	—	—	—	—	—	—	0.64	—	10/80
4/89	11 bn Bis(2-Chloroethyl)Ether (c)	5.7	625	0.3	611			—	—	0.031 *	1.42 *	6.9	0.0080	10/80, 3/88:q1* 1.1
11/89	12 bn Bis(2-Chloroisopropyl)Ether	5.7	625	0.8	611	—	—	—	—	1300 *	174400 *	2.47	431	10/80, 10/89:RfD 0.04
4/89	13 bn Bis(2-Ethylhexyl)Phthalate (c,B)	2.5	625	2	606			—	—	1.76 *	5.92 *	130	0.77	10/80, 2/89:q1* 0.014
4/89	14 bn 4-Bromophenyl Phenyl Ether	1.9	625	2.3	611			—	—	—	—	1640	—	10/80
11/89	15 bn Butylbenzyl Phthalate	2.5	625	0.34	606					3004 *	5202 *	414	2154	10/80, 9/89:RfD 0.2
1/91	16 bn 2-Chloronaphthalene	1.9	625	0.94	612	—	—	—	—	—	—	202	861.5	10/80, 11/90:RfD 0.08
4/89	17 bn 4-Chlorophenyl Phenyl Ether	4.2	625	3.9	611	—	—	—	—	—	—	1200	—	10/80
1/91	18 bn Chrysene (PAH, c)	2.5	625	0.15	610	—	—	—	—	0.0028 *	0.0311 *	30	0.00003	10/80
4/89	19 bn Dibenz(a,h)Anthracene (PAH, c)	2.5	625	0.03	610	—	—	—	—	0.0028 *	0.0311 *	30	0.00003	10/80
10/91	20 bn 1,2-Dichlorobenzene	nr	624	1.9	625					2667 * y	17432 *	55.6	960	10/80, 8/89:RfD 0.09

TSC1091 CRITERIA CHART
UPDATED: OCTOBER 1991
EPA REG IV - WATER MANAGEMENT DIVISION
304(a) CRITERIA AND RELATED INFORMATION
FOR TOXIC POLLUTANTS

DATE REVISED	COMPOUND	EPA DETECTION LEVEL (40 CFR 136) (ug/l)	EPA Ref. Method	(ug/l)	EPA Ref. Method	FRESHWATER Criterion Maximum Conc. (ug/l)	FRESHWATER Criterion Continuous Conc. (ug/l)	SALTWATER Criterion Maximum Conc. (ug/l)	SALTWATER Criterion Continuous Conc. (ug/l)	HUMAN HEALTH (10 -6 risk factor for carcinogens) Consumption of: Water & Organisms (ug/l)	HUMAN HEALTH Consumption of: Organisms Only (ug/l)	BIO CONCENTRATION FACTOR (3% Lipid) Weighted Avg. (l/kg)	EPA FISH TISSUE CONCENTRATION (ppm) (mg/kg)	CRITERIA DATES
4/88	21 bn 1,3-Dichlorobenzene	nr	624	1.9	625					400 *	2600 *	55.6	145	10/80
7/90	22 bn 1,4-Dichlorobenzene	nr	624	4.4	625					400 * y	2600 *	55.6	145	10/80
1/91	23 bn 3,3'-Dichlorobenzidine (c)	16.5	625	0.13	605	—	—	—	—	0.039 *	0.77 *	312	0.024	10/80, 6/90:q1* 0.45
11/89	24 bn Diethyl Phthalate	1.9	625	0.49	606					22631 *	110019 *	73	8615	10/80, 9/87:RfD 0.8
4/89	25 bn Dimethyl Phthalate	1.6	625	0.29	606					313000 *	2900000 *	36	104400	10/80
4/89	26 bn Di-n-Butyl Phthalate	2.5	625	0.36	606			—		2715 *	12100 *	89	1077	10/80, 1/87:RfD 0.1
4/89	27 bn 2,4-Dinitrotoluene (c)	5.7	625	0.02	609-GC			—	—	0.11 *	9.1 *	3.8	0.0346	10/80
4/89	28 bn 2,6-Dinitrotoluene	1.9	625	0.01	609-GC	—	—	—	—	—	—	—	—	10/80
4/89	29 bn Di-n-Octyl Phthalate	2.5	625	3	606	—	—	—	—	—	—	—	—	10/80
4/89	30 bn 1,2-Diphenylhydrazine (c)	20	1625	-	-			—	—	0.041 *	0.54 *	24.9	0.013	10/80, 3/88:q1* 0.8
1/91	31 bn Fluoranthene	2.2	625	0.21	610		—			300.3 *	374.6 *	1150	430.8	10/80, 9/90:RfD 0.04
1/91	32 bn Fluorene	1.9	625	0.21	610	—	—	—	—	1278.6 *	14350.5 *	30	430.8	10/80, 9/90:RfD 0.04
10/91	33 bn Hexachlorobenzene (c, B)	1.9	625	0.08	612	—	—	—	—	0.00075 *	0.00077 *	8690	0.00673	10/80
7/89	34 bn Hexachlorobutadiene (c)	0.9	625	0.34	612					0.45 *	49.7 *	2.78	0.138	10/80, 3/88:q1*, 6/88:q1* 0.078
1/91	35 bn Hexachlorocyclopentadiene	nr	625	0.4	612					1 * O	—	4.34	75.4	10/80, 3/88:RfD 0.007
4/89	36 bn Hexachloroethane (c)	1.6	625	0.03	612					1.98 *	8.85 *	86.9	0.77	10/80, 3/88:q1* 0.014
4/89	37 bn Indeno(1,2,3-cd)Pyrene (PAH, c)	3.7	625	0.043	610	—	—	—	—	0.0028 *	0.0311 *	30	0.000033	10/80
1/91	38 bn Isophorone (c)	2.2	625	15.7	609-GC					8.42 *	589.7 *	4.38	2.63	10/80, 9/88:RfD 0.2, 8/90:q1* 0.0041
4/89	39 bn Naphthalene	1.6	625	1.8	610					—	—	10.5	—	10/80
12/89	40 bn Nitrobenzene	1.9	625	13.7	609-GC					17.3 *	1983 *	2.89	5.38	10/80, 5/88:RfD 0.0005
4/89	41 bn N-Nitrosodimethylamine (c)	nr	625	0.15	607	—	—	—	—	0.000686 *	8.12 *	0.026	0.000211	10/80, 3/88:q1* 51
1/91	42 bn N-Nitrosodi-n-Propylamine (c)	nr	625	0.46	607	—	—	—	—	—	—	—	—	10/80, 3/88:q1* 7.0
4/89	43 bn N-Nitrosodiphenylamine (c)	1.9	625	0.81	607					4.95 *	16.2 *	136	2.2	10/80, 3/88:q1* 0.0049
1/91	44 bn Phenanthrene (B)	5.4	625	0.64	610	—	—	—	—	—	—	30	—	10/80
1/91	45 bn Pyrene	1.9	625	0.27	610	—	—	—	—	956.7 *	10760.2 *	30	323	10/80, 9/90:RfD 0.03
11/89	46 bn 1,2,4-Trichlorobenzene	1.9	625	0.08	612							14		10/80
7/90	1 p Aldrin (c)	1.9	625	0.004	608	3 *		1.3 *		0.00013 *	0.00014 *	4670	0.000604	10/80, 12/88:q1* 17
4/89	2 p a-BHC (c)	nr	625	0.003	608	—		—		0.0039 *	0.0131 *	130	0.0017	10/80, 3/88:q1* 6.3
4/89	3 p b-BHC (c)	4.2	625	0	608	—		—	—	0.0137 *	0.046 *	130	0.006	10/80, 8/87:q1* 1.8
4/89	4 p g-BHC (c)	nr	625	0	608	2 *	0.08 *	0.16 *		0.0186 *	0.0625 *	130	0.0081	10/80
4/89	5 p d-BHC (c)	3.1	625	0.009	608	—	—	—	—	—	—	130	—	10/80
4/89	6 p Chlordane (c)	nr	625	0.014	608	2.4 *	0.0043 *T	0.09 *	0.004 *T	0.000575 *	0.000588 *	14100	0.0083	10/80, 3/88:q1* 1.3
6/89	7 p 4-4'-DDT (c)	4.7	625	0.012	608	1.1 *	0.001 *W	0.13 *	0.001 *W	0.00059 *	0.00059 *	53600	0.0316	10/80, 8/88:q1* 0.34
7/90	8 p 4,4'-DDE (c)	5.6	625	0.004	608					0.00059 *	0.00059 *	53600	0.0316	10/80, 8/88:q1* 0.34
7/90	9 p 4,4'-DDD (c)	2.8	625	0.011	608					0.00083 *	0.00083 *	53600	0.0449	10/80, 9/88:q1* 0.24
4/89	10 p Dieldrin (c)	2.5	625	0.002	608	2.5 *	0.0019 *T	0.71 *	0.0019 *T	0.000135 *	0.000144 *	4670	0.00067	10/80, 9/88:q1* 16
4/89	11 p a-Endosulfan	—a	625	0.014	608	0.22 *	0.056 *	0.034 *	0.0087 *	0.933 *	1.99 *	270	0.54	10/80, 3/88:RfD 0.00005
4/89	12 p b-Endosulfan	—b	625	0.004	608	0.22 *	0.056 *	0.034 *	0.0087 *	0.933 *	1.99 *	270	0.54	10/80, 3/88:RfD 0.00005
4/89	13 p Endosulfan Sulfate	5.6	625	0.066	608	—	—	—	—	—	—	—	—	10/80
7/90	14 p Endrin	nr	625	0.006	608	0.18 *	0.0023 *T	0.037 *	0.0023 *T	0.2 *MCL	—	3970	3.23	10/80, 9/88:RfD 0.0003
7/90	15 p Endrin Aldehyde	nr	625	0.023	608	—	—	—	—	—	—	3970	3.23	10/80, 9/88:RfD 0.0003
4/89	16 p Heptachlor (c)	1.9	625	0.003	608	0.52 *	0.0038 *T	0.053 *	0.0036 *T	0.000208 *	0.000214 *	11200	0.0024	10/80, 3/88:q1* 4.5
12/89	17 p Heptachlor Epoxide (c)	2.2	625	0.083	608	0.52 *	0.0038 *T	0.053 *	0.0036 *T	0.0001 *	0.0001 *	11200	0.0012	10/80, 3/88:q1* 9.1
4/89	18 p PCB-1242 (PCB, c)	nr	625	0.065	608		0.014 *W		0.03 *W	0.000044 *	0.000045 *	31200	0.0014	10/80, 5/89:q1* 7.7
5/89	19 p PCB-1254 (PCB, c)	36	625	nr	608		0.014 *W		0.03 *W	0.000044 *	0.000045 *	31200	0.0014	10/80, 5/89:q1* 7.7

TAC1001 CRITERIA CHART
UPDATED: OCTOBER 1991
EPA REG IV - WATER MANAGEMENT DIVISION
304(a) CRITERIA AND RELATED INFORMATION
FOR TOXIC POLLUTANTS

DATE REVISED	COMPOUND	EPA DETECTION LEVEL (40 CFR 136) (ug/l)	EPA Ref. Method	(ug/l)	EPA Ref. Method	FRESHWATER Criterion Maximum Conc. (ug/l)	FRESHWATER Criterion Continuous Conc. (ug/l)	SALTWATER Criterion Maximum Conc. (ug/l)	SALTWATER Criterion Continuous Conc. (ug/l)	HUMAN HEALTH (10 -6 risk factor for carcinogens) Consumption of: Water & Organisms (ug/l)	HUMAN HEALTH Organisms Only (ug/l)	BIO CONCENTRATION FACTOR (3% Lipid) Weighted Avg. (l/kg)	EPA FISH TISSUE CONCENTRATION (ppm) (mg/kg)	CRITERIA BASIS
6/89	21 p PCB-1232 (PCB, c)	nr	625	nr	608		0.014 *W		0.03 *W	0.000044 *	0.000045 *	31200	0.0014	10/80, 5/80:ql* 7.7
6/89	22 p PCB-1248 (PCB, c)	nr	625	nr	608		0.014 *W		0.03 *W	0.000044 *	0.000045 *	31200	0.0014	10/80, 5/80:ql* 7.7
6/89	23 p PCB-1260 (PCB, c)	nr	625	nr	608		0.014 *W		0.03 *W	0.000044 *	0.000045 *	31200	0.0014	10.80, 5/80:ql* 7.7
6/89	24 p PCB-1016 (PCB, c)	nr	625	nr	608		0.014 *W		0.03 *W	0.000044 *	0.000045 *	31200	0.0014	10/80, 5/80:ql* 7.7
4/89	25 p Toxaphene (c)	nr	625	0.24	608	0.73 *	0.0002 *T	0.21 *	0.0002 *T	0.00073 *	0.00075 *	13100	0.0096	10/80, 9/86:aq life, 8/80:ql* 1.1
	NON-PRIORITY POLLUTANTS													
	Aluminum (pH 6.5-9.0)	3	202.2	100	202.1	750 *	87 *	—	—	—	—	—	—	8/88
	Ammonia	50	350.3	30	350.2					—	—	—	—	1/85
	Barium					—	—	—	—	2000 *MCL	—	—	—	7/76, 8/90:RfD 0.07, 7/91:MCL 2000
	Bis(chloromethyl)Ether (c)	nr	—	nr	—	—	—	—	—	0.000159 *	0.0777 *	0.63	0.000040	10/80, 8/80:ql* 220
	Boron					—	750 *Ir	—	—	—	—	—	—	7/76, 10/90:RfD 0.09
	Chloride	nr	325.3	1000	325.1	860000 *	230000 *	—	—	—	—	—	—	2/88
	Chlorine(TRC)	200	330.5	100	330.3	19 *	11 *	13 *	7.5 *	—	—	—	—	1/85
	Chlorpyrifos					0.083 *	0.041 *	0.011 *	0.0056 *	—	—	—	—	9/86
	Demeton					—	0.1 *	—	0.1 *	—	—	—	—	7/76
	Dichlorodifluoromethane (HM, c)	—		1.01	601	—	—	—	—	5.67 *	470.8 *	3.75	1.77	10/80
	2,4-dichlorophenoxy acetic acid					—	—	—	—	70 *MCL	—	—	—	7/76, 1/91:MCL 70
	Dissolved Gases					—	110% saturation *	—	110% saturation *	—	—	—	—	7/76
	Dissolved Solids (chlorides,sulfides)					—	—	—	—	500000 *MCL	—	—	—	7/76
	Guthion					—	0.01 *	—	0.01 *	—	—	—	—	7/76
	Iron					—	1000 *	—	—	300 *MCL	—	—	—	7/76
	Malathion					—	0.1 *	—	0.01 *	—	—	—	—	7/76
	Manganese					—	—	—	—	50 *MCL	100 Marine *		—	7/76
	Methoxychlor					—	0.03 *	—	0.03 *	100 *MCL	—	—	—	7/76, 8/90:RfD 0.005, 1/91:MCL 40
	Mirex					—	0.001 *	—	0.001 *	—	—	—	—	7/76
	Nitrates (as N)					—	—	—	—	10000 *MCL	—	—	—	7/76
	N-nitrosopyrrolidine (c)									0.016 *	91.9 *			10/80
	Oil and Grease					—	0.01 lw LC50 *	—	0.1 lw LC50 *	—	—	—	—	7/76
	Parathion					0.065 *	0.013 *			—	—	—	—	7/76
	Pentachlorobenzene									74 *	85 *	2125	180.0	10/80
	pH					—	6.5-9 *	—		5.0-9 *	—	—	—	7/76
	Phosphorus (elemental)					—	—	—	0.1 *	—	—	—	—	7/76
	Solids (Turbidity)					—	<10% comp. pt. *	—	<10% comp. pt. *	—	—	—	—	7/76
	Sulfide (S2-, HS-)					—	2 *	—		—	—	—	—	7/76
	1,2,4,5-tetrachlorobenzene									38 *	48 *	1125	54	10/80
	Trichlorofluoromethane	nr	624	nr	601	—	—	—	—	5.67 *	470.8 *	3.75	1.77	10/80, 8/80:ql* CHCl3
	2,4,5-trichlorophenol									1 * O				10/80
	2-(2,4,5-trichlorophenoxy)propionic acid					—	—	—	—	50 *MCL	—	—	—	7/76, 1/91:MCL 50

(D.O. and Bacteria are not included)

KEY

- m: metal
- c: carcinogen, 10-6 risk level
- O: based on organoleptic data
- MCL: SDWA value
- W: Final Residue Value based on wildlife feeding study
- T: based on marketability of fish
- X: not recommended if compound known to be present in sample
- nr: not reported
- hrms: high resolution mass spectroscopy
- HM: halomethane, human health criteria apply to total halomethanes
- PAH: polynuclear aromatic hydrocarbon, human health criteria apply to total PAHs
- V: volatile compounds
- a: acidic compounds
- EC: electron capture detector
- FI: flame ionization detector
- PCB: polychlorinated biphenyl criteria apply to total PCBs
- TRC: measured as total residual chlorine
- q1*: Cancer Potency Factor
- *: criterion
- III: trivalent species
- VI: hexavalent species
- s: number of species
- lr: for long term irrigation of sensitive crops (minimum standard)
- p: lowest plant value reported
- BCF: bioconcentration factor = tissue concentration divided by water concentration
- d: see table Ambient Water Quality Criteria for Ammonia-1984 EPA 440/5-84-001
- CHCl3 based on chloroform criteria
- RfD: verified Reference Dose for Noncarcinogens
- e: see table Ambient Water Quality Criteria for Ammonia (Saltwater) EPA 440/5-88-004
- f/l: number of fibers per liter of water - based on consumption of water only
- H: based on hardness equations
- pH: based on pH equation
- bn: base neutral compounds
- f: freshwater organisms
- e/c: estuarine/coastal organisms
- oo: open ocean (marine) organisms
- n: newly calculated values based on IRIS RfD
- y: more stringent MCL exists
- D: Draft EPA water quality criteria documents for these pollutants are available. Refer to the Federal Register (May 14, 1990, Vol. 55, No. 93, page 19987) for draft aquatic life criteria.

HARDNESS EQUATIONS:

COMPOUND	CMC	CCC	95% LC50
Cadmium	e(1.128(lnH)-3.828)	e(0.7852(lnH)-3.49)	2e(1.128(lnH)-3.828)
Chromium III	e(0.819(lnH)+3.688)	e(0.819(lnH)+1.561)	2e(0.819(lnH)+3.688)
Copper	e(0.9422(lnH)-1.464)	e(0.8545(lnH)-1.465)	2e(0.9422(lnH)-1.464
Lead	e(1.273(lnH)-1.46)	e(1.273(lnH)-4.705)	2e(1.273(lnH)-1.46)
Nickel	e(0.846(lnH)+3.3612)	e(0.846(lnH)+1.1645)	2e(0.846(lnH)+3.3612
Silver	e(1.72(lnH)-6.52)		e(1.72(lnH)-6.52)
Zinc	e(0.8473(lnH)+0.8604)	e(0.8473(lnH)+0.7614)	2e(0.8473(lnH)+0.8604)

pH EQUATIONS

Pentachlorophenol	e(1.005pH-4.83)	e(1.005pH-5.29)	2e(1.005pH-4.83)

APPENDIX C

MAKING USE SUPPORT DECISIONS USING CHEMICAL DATA AND OTHER INDICATORS

This guidance is provided to encourage the best and most nationally consistent use of chemical data. EPA does not intend to imply that States should use only chemical monitoring data in making use support decisions.

EPA recognizes that many States may not always collect a broad spectrum of chemical data (and data on additional indicators such as fishing restrictions) for every waterbody. Therefore, States are expected to apply the following guidance to whatever data are available, and to use a "worst case" approach where multiple types of data are available. (If, for example, pathogen conditions indicate impairment of recreational use but no bathing area closures are in effect, the waterbody is still considered impaired).

3. Aquatic Life Use

3.1. Toxicants (including chlorine and ammonia)

A. Fully Supporting: For any one pollutant, no violations of acute toxicity criteria (EPA's criteria maximum concentration or applicable State criteria) within a 3-year period, based on grab or 1-day composite samples. If 4-day composite data are available, no violations of chronic toxicity criteria within a 3-year period. Exception to this rule is possible if the State has collected an abundant data set (i.e., sampling on monthly or more frequent basis over a 3-year period). In that case, one violation of acute or chronic toxicity criteria is allowable as a once-in-three-years occurrence.

B. Not Supporting: For any one pollutant, one or more violations of acute or chronic toxicity criteria within a 3-year period (based on sampling type mentioned above). Exception to this rule is possible if the State has collected an abundant data set; in that case, two or more violations of acute or chronic criteria are needed to show nonsupport, as a once-in-three-years violation is allowable.

The following considerations apply to this approach:

- States should document their sampling frequency. Waters should have at least quarterly data to be considered monitored; monthly or more frequent data are considered abundant. More than 3 years of data may be used, although the once-in-3-years consideration still applies (i.e., 2 violations are allowed in 6 years of abundant data).

- The once-in-3-years goal is not intended to include spurious violations resulting from lack of precision in analytical tests. Therefore, using documented QA/QC assessments, States may consider the effect of laboratory imprecision on the observed frequency of violations.

- If the duration and frequency specifications of EPA criteria change in the future, these recommendations should be changed accordingly.

APPENDIX D

STORET RETRIEVALS FOR A/P STUDY AREA

WATER COLUMN TOXICS--FRESHWATER AND SALTWATER STATIONS

Separate retrievals were made to obtain freshwater and saltwater data for all parameters. Request options were equivalent except for water type--fresh or salt.

1. REQUEST OPTIONS

   a) OPTION 6 - WITHIN SPECIFIC EPA BASINS

      BS=0301
      BS=0302
      BS=0303
      BS=0304
      BS=0305

   b) STATION TYPES AND/OR PARAMETER ATTRIBUTES

      ONLYATTR=AMBNT AND STREAM,
      GRAB AND COMPOSITE SAMPLES
      SAMPTYPE=ALL,
      COMPOSITE SAMPLES
      ALL OF THE ABOVE

   c) DATE RANGES: Begin Date = 880701, End Date = 910630,

   d) UNREMARKED SAMPLES ONLY, R=*,

2. PARAMETER TABLE

Parameter Name	Unit	STORET Parameter Code
PH	STANDARD UNITS	00400
SALINITY	PARTS PER THOUSAND	00480
HARDNESS, TOTAL	MG/L AS CAC03	00900
CHLORIDE, TOTAL	MG/L	00940
CYANIDE, TOTAL	MG/L AS CN	00720
FLUORIDE, TOTAL	MG/L AS F	00951
ARSENIC, TOTAL	UG/L AS AS	01002
BARIUM, TOTAL	UG/L AS BA	01007
BERYLLIUM, TOTAL	UG/L AS BE	01012
CADMIUM, TOTAL	UG/L AS CD	01027
CHROMIUM, HEXAVALENT	UG/L AS CR	01032
CHROMIUM, TOTAL	UG/L AS CR	01034

Parameter Name	Unit	STORET Parameter Code
COPPER, TOTAL	UG/L AS CU	01042
LEAD, TOTAL	UG/L AS PB	01051
NICKEL, TOTAL	UG/L AS NI	01067
SILVER, TOTAL	UG/L AS AG	01077
ZINC, TOTAL	UG/L AS ZN	01092
ANTIMONY, TOTAL	UG/L AS SB	01097
ALUMINUM, TOTAL	UG/L AS AL	01105
SELENIUM, TOTAL	UG/L AS SE	01147
MERCURY, TOTAL	UG/L AS HG	71900
PHENOLICS, TOTAL, RECOVERABLE	UG/L	32730
ACENAPHTHENE, TOTAL, WATER	UG/L	34205
ANTHRACENE, TOTAL, WATER	UG/L	34220
BENZO(B)FLUORANTHENE, TOTAL, WATER	UG/L	34230
BENZENE, DISSOLVED	UG/L	34235
BENZO(K)FLUORANTHENE, TOTAL, WATER	UG/L	34242
BENZO-A-PYRENE, TOTAL, WATER	UG/L	34247
CHRYSENE, TOTAL, WATER	UG/L	34320
FLUORENE, TOTAL, WATER	UG/L	34381
PHENANTHRENE, TOTAL, WATER	UG/L	34461
PYRENE, TOTAL, WATER	UG/L	34469
TOLUENE, DISSOLVED	UG/L	34481
2-CHLOROPHENOL, TOTAL, WATER	UG/L	34586
2,4-DICHLOROPHENOL, TOTAL, WATER	UG/L	34601
PHENOL(C6H50H)-SINGLE COMPOUND TOTAL, WATER	UG/L	34694
NAPHTHALENE, TOTAL, WATER	UG/L	34696
PCP (PENTACHLOROPHENOL) TOTAL WATER SAMPLE	UG/L	39032
CHLORDANE (TECHNICAL MIXTURE AND METABOLITES), TOTAL WATER	UG/L	39350
PCBS IN TOTAL WATER SAMPLE	UG/L	39516
PCB - 1016, TOTAL, WATER	UG/L	34671
PCB - 1242, TOTAL, WATER	UG/L	39496
PCB - 1248, TOTAL, WATER	UG/L	39500
PCB - 1254, TOTAL, WATER	UG/L	39504
PCB - 1260, TOTAL, WATER	UG/L	39508
HEXACHLOROBENZENE, TOTAL, WATER	UG/L	39700
CHLORINE, TOTAL, RESIDUAL	MG/L	50060
DIBROMOETHANE, TOTAL, WATER	UG/L	81522
XYLENE, TOTAL, WATER	UG/L	81551
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN(TCDD), TOTAL, WATER	UG/L	34675

APPENDIX E

STORET RETRIEVALS FOR A/P STUDY AREA

SEDIMENT TOXICS--FRESHWATER AND SALTWATER STATIONS

All sediment station data were obtained for the following retrieval options.

1. REQUEST OPTIONS

   a) OPTION 6 - WITHIN SPECIFIC EPA BASINS

      BS=0301
      BS=0302
      BS=0303
      BS=0304
      BS=0305

   b) STATION TYPES AND/OR PARAMETER ATTRIBUTES

      ONLYATTR=AMBNT AND STREAM,
      GRAB AND COMPOSITE SAMPLES
      SAMPTYPE=ALL,
      COMPOSITE SAMPLES
      ALL OF THE ABOVE

   c) DATE RANGES: Begin Date = 880701, End Date = 910630,

   d) UNREMARKED SAMPLES ONLY, R=*,

2. PARAMETER TABLE

Parameter Name	Unit	STORET Parameter Code	Screening Value* (mg/kg)
ARSENIC IN BOTTOM DEPOSITS	MG/KG DRY WGT	01003	33
CADMIUM, TOTAL IN BOTTOM DEPOSITS	MG/KG DRY WGT	01028	5
CHROMIUM, TOTAL IN BOTTOM DEPOSITS	MG/KG DRY WGT	01029	80
COPPER IN BOTTOM DEPOSITS	MG/KG CU DRY WGT	01043	70
LEAD IN BOTTOM DEPOSITS	MG/KG PB DRY WGT	01052	35
NICKEL, TOTAL IN BOTTOM DEPOSITS	MG/KG DRY WGT	01068	30
ZINC IN BOTTOM DEPOSITS	MG/KG ZN DRY WGT	01093	120
MERCURY, TOTAL IN BOTTOM DEPOSITS	MG/KG HG DRY WGT	71921	0.15

*Only values above the screening value were downloaded.

APPENDIX F

02085500
36 10 57.0 078 52 44.0 2
FLAT RIVER AT BAHAMA, N. C.
37063 NORTH CAROLINA DURHAM
030493

SEDIMENT STANDARDS RETRIEVAL
ER-L NOAA CRITERIA
SEDIMENT SAMPLES

/TYPA/AMBNT/STREAM

112WRD HQ 03020201043 0009.180 OFF
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (FT)	U S G S	01003 ARSENIC SEDMG/KG DRY WGT	01028 CD MUD DRY WGT MG/KG-CD	01029 CHROMIUM SEDMG/KG DRY WGT	01043 COPPER SEDMG/KG DRY WGT	01052 LEAD SEDMG/KG DRY WGT	01068 NICKEL SEDMG/KG DRY WGT	01093 ZINC SEDMG/KG DRY WGT	71921 MERCURY SEDMG/KG DRY WGT
88/09/23	1045	WATER			4.00		6.00	4.00			10.00	.02
88/12/06	1230	WATER			5.00		8.00	3.00		10.00	20.00	.01
89/04/04	1300	WATER			2.00	1.00	7.00	6.00			18.00	.02

J8840000 0209257120
34 58 08.0 077 02 56.0 1
W PRONG BRICE CK @ SR 1101 NR RIVERDALE NC PS10
37049 NORTH CAROLINA CRAVEN
SOUTHEAST 030410
NEUSE
21NC01WQ 860614 03020204
0001 FEET DEPTH

SEDIMENT STANDARDS RETRIEVAL
ER-L NOAA CRITERIA
SEDIMENT SAMPLES

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (FT)	01003 ARSENIC SEDMG/KG DRY WGT	01028 CD MUD DRY WGT MG/KG-CD	01029 CHROMIUM SEDMG/KG DRY WGT	01043 COPPER SEDMG/KG DRY WGT	01052 LEAD SEDMG/KG DRY WGT	01068 NICKEL SEDMG/KG DRY WGT	01093 ZINC SEDMG/KG DRY WGT	71921 MERCURY SEDMG/KG DRY WGT
88/07/11	1445	WATER								11.00	
88/09/26	1223	WATER	0.327999				1.30	5.90		.40	.02

D8353000 0205356401
36 15 36.0 076 51 23.0 1
CHINKAPIN CK TRB @ SR1432 N HARRELLSVILLE PS-10
37091 NORTH CAROLINA HERTFORD
SOUTHEAST 030101
CHOWAN
21NC01WQ 860614 03010203
0001 FEET DEPTH

SEDIMENT STANDARDS RETRIEVAL
ER-L NOAA CRITERIA
SEDIMENT SAMPLES

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	MEDIUM	SMK OR DEPTH (FT)	01003 ARSENIC SEDMG/KG DRY WGT	01028 CD MUD DRY WGT MG/KG-CD	01029 CHROMIUM SEDMG/KG DRY WGT	01043 COPPER SEDMG/KG DRY WGT	01052 LEAD SEDMG/KG DRY WGT	01068 NICKEL SEDMG/KG DRY WGT	01093 ZINC SEDMG/KG DRY WGT	71921 MERCURY SEDMG/KG DRY WGT
88/07/13	1130	WATER		8.00		12.00	3.60	9.90	2.80	17.00	.03
88/09/12	1100	WATER	0.327999	4.80		5.80	2.40	2.90	1.80	13.00	

APPENDIX G

Summary of Exceedances of NOAA Sediment Values in Albemarle Sound

Core	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Totals
ALBE-13						1			1
ALBE-16						1			1
ALBE-17						1			1
ALBI-1						1			1
ALBI-10						1			1
ALBI-11						1			1
ALBI-12						1			1
ALBI-2						1			1
ALBI-3						1			1
ALBI-4						1			1
ALBI-5					1	1			2
ALBI-6						1			1
ALBI-7					1	1			2
ALBI-8						1			1
ALBW-1						1			1
ALBW-18						1			1
ALBW-19						1			1
ALBW-2						1			1
ALBW-20						1			1
ALBW-9						1			1
ALG-7					1				1
CHN-1					1	1			2
CHN-10					2				2
CHN-4						1			1
CHN-6						1			1
CHN-8						1			1
EDN-1				1	1				2
EDN-2					1	1			2
EDN-3					1				1
EDN-4						1			1
EDN-5					2				2
EDN-6						1			1
LIT-3					1				1
PAS-10					1	1			2
PAS-12					2				2
PAS-13					1	1			2
PAS-14					2	1			3
PAS-15					2	1			3
PAS-16					2	1			3
PAS-17					2	1			3
PAS-19					2			2	4
PAS-20					2	1			3
PAS-21					2	1			3
PAS-22					2				2
PAS-23					2	1			3
PAS-24					1				1
PAS-25					2	1		2	5
PAS-26					2	1			3
PAS-27					2	1			3
PAS-28					2	1			3
PAS-4					1				1

Note: Exceedances of ER-L values count as one (1) and exceedances of both ER-L and ER-M values count as two (2).

Based on RTI's analysis of data from Riggs et al., in preparation.

Summary of Exceedances of NOAA Sediment Values in Albemarle Sound

Core	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Totals
PAS-5					2	1		1	4
PAS-6					1				1
PAS-9					1				1
PER-4					1				1
PER-5					1				1
PER-6					1				1
PER-7					1				1
PER-8					1				1
RKE-11						1			1
RKE-13						2			2
RKE-9						1			1
SCP-1Ø					2				2
SCP-6					1	1			2
SCP-8								1	1
SCP-9					1				3
WEL-1						1			1
WEL-2					1	1		1	3
WEL-3						1			1
WEL-4			2			2	1		5
WEL-5			2	1		2	1	1	7

Note: Exceedances of ER-L values count as one (1) and exceedances of both ER-L and ER-M values count as two (2).

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Totals
Totals	Ø	Ø	4	2	58	53	2	8	129

Note: Based on RTI's analysis of data from Riggs et al., in preparation.

Summary of Exceedances of NOAA Sediment Values in the Pamlico Estuary

Core	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Totals
BRD-1				1	1	1		1	4
BRD-2					1	1			2
BRD-3					1				1
BRD-4					1				1
BRD-5					1				1
BRD-6					1				1
BTH-1					1				1
BTH-2					1				1
BTH-3					1				1
BTH-4					1				1
DHM-2					1				1
NAT-1	1				1	1		2	5
NAT-10					1	1		2	4
NAT-11					1	1		2	5
NAT-12					1	1		2	4
NAT-13					1	1		1	3
NAT-14					1	1		2	4
NAT-15						1		1	2
NAT-2					1	1		2	4
NAT-3					1	1		2	4
NAT-4					1	1		2	4
NAT-5	1				1	1		2	5
NAT-6					1	1		2	4
NAT-8					1	1		2	4
NAT-9				1	1	1		2	5
PAM-10					1				1
PAM-11					1	1			2
PAM-12					1				1
PAM-13					1				1
PAM-14					1				1
PAM-15					1				1
PAM-16					1				1
PAM-17					1				1
PAM-18					1				1
PAM-19					1				1
PAM-20					1				1
PAM-21					1				1
PAM-22					1				1
PAM-24					1				1
PAM-25					1				1
PAM-26					1				1
PAM-27					1				1
PAM-28					1				1
PAM-30					1				1
PAM-33					1				1
PAM-34					1				1
PAM-35					1				1
PAM-36					1				1
PAM-39					1				1
PAM-40					1				1
PAM-41					1				1

Note: Exceedances of ER-L values count as one (1) and exceedances of both ER-L and ER-M values count as two (2).

Based on RTI's analysis of data from Riggs et al., 1989.

Summary of Exceedances of NOAA Sediment Values in the Pamlico Estuary

Core	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Totals
PAM-42					1				1
PAM-43					1				1
PAM-44					1				1
PAM-7					1	1			2
PAM-8						1			1
PAM-9					1	1			2
PAM-V2	1				1				2
PAM-V3					1				1
PTG-1					1				1
PTG-3					1				1
PTG-6					1				1
PUN-11				1	1			1	4
PUN-12					1				1
PUN-18					1				1
PUN-19					1				1
PUN-8					1				1
PUN-9					1				1
STH-10					1				1
STH-9					1				1
TAR-10					1	1		1	3
TAR-19						1			1
TAR-22					2				2
TAR-23					1	1			2
TAR-8								1	1
TAR-9					1	1		1	3
WHD-1					1				1
WHD-2					1				1

Note: Exceedances of ER-L values count as one (1) and exceedances of both ER-L and ER-M values count as two (2).

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Totals
Totals	3	0	0	3	75	24	0	31	138

Note: Based on RTI's analysis of data from Riggs et al., 1989.

Summary of Exceedances of NOAA Sediment Values in the Neuse Estuary

Core	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total
BROD-1					1			1	2
BROD-2					1				1
BROD-3					1				1
CVP-1				1	1	1		2	5
CVP-2				1				1	2
DUC-1					1			1	2
FFD-1								1	1
HCK-3					1				1
LSN-1					2	1		2	5
LSN-2				1	2	1		2	6
NBNE-10					1	1		1	3
NBNE-11					1	1		1	3
NBNE-12					1	1		1	3
NBNE-2					1			1	2
NBNE-3					1	1		1	3
NBNE-4						1			1
NBNE-5						1			1
NBNE-6					1	1		1	3
NBNE-7					1	1		1	3
NBNE-8					1			1	2
NBNE-9					1	1		1	3
NBNW-1				1	1			1	3
NBNW-10					1	1		1	3
NBNW-11						1			1
NBNW-12					1			1	2
NBNW-13					1	1		1	3
NBNW-14					1	1		1	3
NBNW-15						1			1
NBNW-16				1	1	1		1	4
NBNW-17					1	1		1	3
NBNW-18					1	1		1	3
NBNW-20					1	1			2
NBNW-21					1	1		1	3
NBNW-23					1	1		1	3
NBNW-25			1				1	2	4
NBNW-26		2		2	1		2	2	9
NBNW-27							1		1
NBNW-28					1			1	2
NBNW-3					1	1		1	3
NBNW-4					1	1		1	3
NBNW-5					1	1		1	3
NBNW-6					1			1	2
NBNW-7					1			1	2
NBNW-8					1	1		1	3
NBNW-9					1	1		1	3
NP-10					1				1
NP-3					1				1
NP-4					1	1			2
NP-5					1	1			2
NP-6					1	1			2
NP-7					1	1			2

Note: Exceedances of ER-L values count as one (1) and exceedances of both ER-L and ER-M values count as two (2).

Based on RTI's analysis of data from Riggs et al., 1991.

Summary of Exceedances of NOAA Sediment Values in the Neuse Estuary

Core	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total
NP-8					1	1			2
NP-9					1	1			2
NUS-1					1	1		1	3
NUS-10					1	1			2
NUS-11					1			1	2
NUS-12					1				1
NUS-15					1	1			2
NUS-16						1			1
NUS-17					1				1
NUS-3					1	1		1	3
NUS-4						1			1
NUS-5					1	1		1	3
NUS-6					1	1		1	3
NUS-8					1	1			2
NUS-9					1	1		1	3
NUSE-1					1				1
ORL-1				1	1				2
RIV-3					1			1	2
SCT-1					1			1	2
SCT-2					1			1	2
SLO-1		1			1	1		1	4
SLO-10		1			1	1			3
SLO-11		1			1	1		1	4
SLO-12					1	1			2
SLO-13					1				1
SLO-14					1				1
SLO-16				2	1	1		1	5
SLO-17				1	1	1			3
SLO-18		1		1	2	1		1	6
SLO-19		2	1	1	2	1		2	9
SLO-2		2	2		2	1		1	8
SLO-20		2	1	1	2			1	7
SLO-21		2	1	1	2	1		1	8
SLO-22		1	1		1	1		1	5
SLO-23					1			1	2
SLO-24					1	1		1	3
SLO-25		2	1		2	1		1	7
SLO-3		1			1	1			3
SLO-5		1			1	1		1	4
SLO-6		1			1	2		1	5
SLO-9					1	1			2
STH-3					1	1			2
SWT-2						1			1
TNT-11				1	2	1	1	2	7
TNT-12				1	2	1		2	6
TNT-14					1	1		1	3
TNT-16				1	2	1		2	6
TNT-17					1	1		1	3
TNT-18						1			1
TNT-2						1			1
TNT-5					1	1			2

Note: Exceedances of ER-L values count as one (1) and exceedances of both ER-L and ER-M values count as two (2).

Based on RTI's analysis of data from Riggs et al., 1991.

Summary of Exceedances of NOAA Sediment Values in the Neuse Estuary

Core	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total
TNT-6						1			1
TNT-9					1	1		1	3
WKR-1				1					1

Note: Exceedances of ER-L values count as one (1) and exceedances of both ER-L and ER-M values count as two (2).

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Totals
Totals	0	20	8	19	101	74	5	74	301

Note: Based on RTI's analysis of data from Riggs et al., 1991.

APPENDIX H

Albemarle/Pamlico Fish and Shellfish Tissue Sampling Stations

Station	Description of Station	County	Basin
02043862	Pasquotank River at Elizabeth City	Pasquotank	030150
02050079	Chowan River at Riddicksville near Como	Hertford	030101
0205324450	Chowan River at Winton	Hertford	030101
02053632	Chowan River at Colerain	Bertie	030103
02053652	Chowan River at US-17 at Edenhouse	Bertie	030104
0207052850	Paw Paw Creek	Rockingham	030202
02074218	Dan River at SR-1716 near Mayfield	Rockingham	030203
0207933350	Nutbush Creek at NC-VA Stateline NR Townsville	Vance	030206
02080500	Roanoke River at NC-48 at Roanoke Rapids	Halifax	030208
02081000	Roanoke River at Scotland Neck (HWY 258)	Halifax	030208
02081141	Roanoke River at NC-45 near Sans Souci	Washington	030209
02081141MTH	Roanoke River at Mouth near Louise Island	Washington	030209
02081145	Albemarle Sound at Norfolk and Southern RR Trestle	Chowan	030152
02081166	Scuppernong River near Columbia	Tyrrell	030153
02081172	Albemarle Sound near Harvey's Point	Perquimans	030152
0208117810	Alligator River below Gum Neck landing near Gum Ne	Tyrrell	030151
02081179	Albemarle Sound at Wade Point	Pasquotank	030150
0208117950	Croatan Sound at Manns Harbor	Dare	030151
02081185	Kendricks Creek at SR-1300	Washington	030153
02081933	Tar River at US-64 business near Spring Hope	Nash	030202
02082770	Swift Creek at SR-1310	Nash	030302
02082812	Swift Creek at SR-1253 near Tarboro	Edgecombe	030304
02082823	Tar River at Tarboro at NC-44	Edgecombe	030302
02083692	Tar River at SR-1400 near Falkland	Pitt	030303
02084171	Tar River at SR-1565 near Grimesland	Pitt	030305
02084472	Tar River at Washington	Beaufort	030307
02084534	Bath Creek at NC-92 near Bath	Beaufort	030307
0208455650	Pungo River at US-264 near Belhaven	Beaufort	030307
0208455850	Pantego Creek at NC-92 near Belhaven	Beaufort	030307
0208457020	Pungo Creek at NC-92 at Sydney's Crossroads	Beaufort	030307
02084633	Pamlico Sound at Knoll Island near Ocracoke	Hyde	030155
02085070	Eno River at US-501 near Durham	Durham	030401
02087500	Neuse River at NC-42 near Clayton	Johnston	030402
02087823	Tar River at Tarboro	Edgecombe	030303
02088000	Middle Creek near Clayton	Johnston	030402
02088500	Little River at Princeton	Johnston	030406
02089500	Neuse River at US-70 bypass in Kinston	Lenoir	030405
02090634	Contentnea Creek at Stantonsburg	Wilson	030407
0209176690	Contentnea Creek at Grifton	Pitt	030407
02092000	Swift Creek at Vanceboro	Craven	030409
02092162	Neuse River at New Bern	Craven	030410
02092500	Trent River at Trenton	Jones	030411
02092549	Island Creek at SR-1004	Jones	030411
02092551	Crooked Creek at Trenton	Jones	030411
0209257120	West Prong Brice Creek at SR-1101 near Riverdale	Craven	030410
02092682	Neuse River at Mouth near Pamlico	Pamlico	030410
02092690	Pamlico River at Great Island	Pamlico	030307
0209270940	Bogue Sound at Emerald Isle	Carteret	030503

Albemarle/Pamlico Fish and Shellfish Tissue Sampling Stations

Station	Description of Station	County	Basin
02093000	New River near Gum Branch	Onslow	030502
02093197	New River near Sneads Ferry	Onslow	030502
OF-1	Little River at Orange Factory	Durham	030401
ALBE-1	Albemarle Sound near mouth of Alligator River	Tyrrell	030151
ALBETERP	Albemarle Sound across from Terrapin Point	Washington	030209
BARRIS CR	Pamlico River off Barris Creek	Beaufort	030307
BELEWS-10	Belews Lake near Plant/trailing Ponds	Rockingham	030201
BUX-1	Pamlico Sound near Scott's Boatyard	Dare	030155
BUX-1-IN	Pamlico Sound near Scott's Boatyard - Inside	Dare	030155
BUX-1-OUT	Pamlico Sound near Scott's Boat - Outside	Dare	030155
Belews-15	Belews Lake near Outfall	Rockingham	030201
BullBay01	Albemarle Sound at Bull Bay	Washington	030153
CORE PT	Pamlico River off Core Point	Beaufort	030307
CURRITUCK-1	Currituck Sound near Currituck	Currituck	030154
Currituck 2	Currituck Sound at Tull's Bay	Currituck	030154
Currituck-2	Currituck Sound at Tull's Bay	Currituck	030154
DR-1	Dan River at Madison	Rockingham	030202
DR-2	Dan River at US-311 near Pine Hall	Stokes	030201
DR-3	Dan River at Danbury	Stokes	030201
DR-4	Snow Creek near Danbury	Stokes	030201
DS-1	Dismal Swamp Canal at Douglas Ldg	Chesapeake	030150
DS-10	Corapeake Ditch off Dismal Swamp Canal	Camden	030150
DS-3/5	Lake Drummond	Chesapeake	030150
DS-7	Feeder Ditch from Lake Drummond to Dismal Swamp Ca	Chesapeake	030150
DURHAM-1	Durham Creek at Mouth - east side	Beaufort	030307
DURHAM-2	Durham Creek at Mouth - west side	Beaufort	030307
ENO-1	Eno River at US-15/501 near Durham	Durham	030401
ENO1	Eno River near Durham	Durham	030401
H-1	Great Lake	Craven	030501
H-5/H-6	Hunters Creek near Stella	Jones	030501
HYCO CR	Hyco Creek at Leasburg	Caswell	030205
HYCO-1	Hyco Lake	Person	030205
ISNEUDC02	Deep Creek at SR-1734	Person	030401
KL-0	Kernersville Lake	Forsyth	030201
M-1	Mayo Lake	Person	030205
MAYO-1	Mayo Lake	Person	030205
MC-6	Mill Landing Creek at Mouth	Dare	030151
MC-8	Roanoke Sound just below Mill Landing Creek	Dare	030151
MC-9	Broad Creek at Mouth	Dare	030151
MT-1	Lake Mattamuskeet at center canal	Hyde	030307
MT-2	Lake Mattamuskeet - south side	Hyde	030307
MT-3	Lake Mattamuskeet - Center	Hyde	030307
MT-5	Lake Mattamuskeet - East side	Hyde	030307
MTK-1	Lake Mattamuskeet	Hyde	030307
MTK-2	Lake Mattamuskeet - Waterfowl Impoundment	Hyde	030307
Mill-2	Mill Creek near Wawchese	Dare	030151
NEU 139	Neuse River at Minnesott Beach	Pamlico	030410
NEU-119	Swift Creek at Vanceboro	Craven	030409

Albemarle/Pamlico Fish and Shellfish Tissue Sampling Stations

Station	Description of Station	County	Basin
NEU-128	Trent River at Pollocksville	Jones	030411
NEU-OR	Neuse River near Oriental	Pamlico	030410
NEU020D	Neuse River (Falls Lake) at Water Intake	Wake	030401
NEU055	Neuse River at US-70 in Smithfield	Johnston	030402
NEU139	Neuse River at Minnesott Beach	Pamlico	030410
NEU51	Neuse River at SR-1908 near Wilson Mills	Johnston	030402
NEUSC-1	Slocum Creek off Cherry PT	Craven	030410
NEUSC-2	East Prong Slocum Creek	Craven	030410
NEUSC-4	West Prong Slocum Creek	Craven	030410
NEUSC-5	Slocum Creek off Mill Creek	Craven	030410
NEUSC1	Slocum Creek downstream of Cherry Point WWTP	Craven	030410
NEUSC2	East Prong Slocum Creek upstream Sandy Beach	Craven	030410
NEUSC3	East Prong Slocum Creek downstream of Sandy Beach	Craven	030410
NEUSC4A	Slocum Creek between boat ramp & bridge	Craven	030410
NEUSC5	Slocum Creek	Craven	030410
NEVIL PT	Pamlico River at Nevil's Point	Beaufort	030307
OF-1	Little River at Orange Factory	Durham	030401
PAS012	Lake Phelps	Washington	030153
PAS02A	Currituck Sound at Harbor Point	Currituck	030154
PAS012	Lake Phelps	Washington	030153
PUNGO-1	Pungo River at SR-1300 near Pantego	Hyde	030307
PUNGO-11		Hyde	030307
PUNGO-17	Pungo River near Durants Point	Hyde	030307
PUNGO-2	Pungo River Canal above Pungo Lake Canal	Hyde	030307
PUNGO-3	Pungo Lake Canal	Hyde	030307
PUNGO-30	Pungo River 1.0 miles above Wadespoint	Hyde	030307
PUNGO-31	Fortescue Creek near Mouth	Hyde	030307
PUNGO-4	Pungo River above Canal B	Hyde	030307
PUNGO-6	Canal B	Hyde	030307
PUNGO-7/8	Pungo River below canal B near Pantego	Hyde	030307
ROA030M	Hyco Lake in Hyco Creek Arm near Hyco Lake Road	Person	030205
ROA030P	Hyco Lake in South Hyco Creek Arm below NC-57	Person	030205
ROA030R	Hyco Lake in Hyco Creek Arm above NC-57	Person	030205
SOUTH-CR	South Creek Near Aurora	Beaufort	030307
SOUTHRIVER-	South River near South River	Carteret	030410
STUMPY-1	Stumpy Point Bay near Stumpy Point	Dare	030151
SouthRiver	South River at SouthRiver	Carteret	030410
TAR 58	Pamlico River near Garrison Point	Beaufort	030307
TAR0628A	Pungo Lake	Washington	030307
TAR56B	Pamlico River at Blounts Bay	Beaufort	030307
TRIPP PT	Pamlico River off Tripp Point	Beaufort	030307
TSNEU10	Neuse River at US-401	Wake	030402
TSNEU100	Neuse River above US-117 at near Goldsboro	Wayne	030402
TSNEUCC1C	Contentnea Creek at SR-1162	Wilson	030407
TSNEUCC4	Contentnea Creek at SR-1606 near Wilson	Wilson	030407
TSNEUCC5	Contentnea Creek at Hominy Swamp	Wilson	030407
TSNEUDC02	Deep Creek at SR-1734 near Rougemont	Person	030401
TSNEUFNR2	Falls of the Neuse Reservoir near mouth of Ellerbe	Durham	030401

Albemarle/Pamlico Fish and Shellfish Tissue Sampling Stations

Station	Description of Station	County	Basin
TSNEUFNR5	Falls of the Neuse Reservoir at Raleigh Water Inta	Wake	030402
TSNEUFS03	Fork Swamp at SR-1700	Pitt	030409
TSNEUKP1	Koppers Pond near Morrisville	Wake	030402
TSNEULR5	Little River at SR-1234	Wayne	030406
TSNEUMC01	Middle Creek below Lufkin Rule near Apex	Wake	030403
TSNEUMP1	Medlin Pond near Morrisville	Wake	030402
TSNEUMS1	Mill Creek Swamp at SR-1611	Craven	030410
TSNEUNS4	Nahunta Swamp at SR-1537	Wayne	030407
TSNEUPC2	Possum Creek at SR-1126	Pamlico	030410
TSNEUSC02	Swift Creek at SR-1152	Wake	030402
TSNEUSC03	Swift Creek at NC-102	Pitt	030409
TSNEUSTC2	Stony Creek at SR-1920	Wayne	030405
TSNEUTS1	Toisnot Swamp at SR-1332 below Lake Wilson	Wilson	030407
TSNEUTS3	Toisnot Swamp tributary at SR-1327	Wilson	030407
TSNEUTS5	Toisnot Swamp at NC-42 near Wilson	Wilson	030407
TSPASNL1	Alligator (New) Lake	Hyde	030151
TSPS-5	Pamlico Sound near Frisco	Dare	030155
TSROARR30	Roanoke River near Halifax	Halifax	030208
TSROAWEY2	Roanoke River at Weyerhauser near Plymouth	Washington	030209
TSTAR120	Tar River at US-264 Bypass in Greenville	Pitt	030305
TSTAR120D	Hardee Mill Creek at Mouth	Pitt	030305
TSTAR25	Tar River at US-1 near Franklinton	Franklin	030301
TSTARBC5	Broad Creek near Washington	Beaufort	030307
TSTARFC1	Far Creek near Englehard	Hyde	030307
TSTARFC10	Far Creek near Englehard	Hyde	030307
TSTARFC15	Far Creek near Englehard	Hyde	030307
TSTARKDY	Kennedy Creek at Washington	Beaufort	030307
TSTARR3	Rose Bay Creek	Hyde	030307
TSWOKNR1	North River near Simpson	Carteret	030504
WB1	Sleepy Creek at Mouth near Willis Boatworks	Carteret	030504
WELDON-HATC	Roanoke River at Weldon Fish Hatchery	Halifax	030208

APPENDIX I

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Basin: CHOWAN

Subbasin 030101

Station 02050079 Chowan River at Riddicksville near Como

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/17/80	CU	Lepomis macrochirus	1.40	1.00	994
07/17/80	CU	Micropterus salmoides	2.20	1.00	879
07/17/80	CU	Moxostoma sp.	2.30	1.00	999
10/16/86	CU	Amia calva	2.00	1.00	3851
01/18/89	CU	Amia calva	1.10	1.00	4243
01/18/89	CU	Cyprinus carpio	3.50	1.00	4234
01/18/89	CU	Moxostoma sp.	1.70	1.00	4240
07/17/80	HG	Micropterus salmoides	0.30	0.17	879
07/17/80	HG	Moxostoma sp.	0.24	0.17	999
10/16/86	HG	Amia calva	0.84	0.17	3851
10/16/86	HG	Amia calva	0.78	0.17	3850
10/16/86	HG	Esox niger	0.39	0.17	3523
10/16/86	HG	Micropterus salmoides	0.33	0.17	3525
10/16/86	HG	Micropterus salmoides	0.31	0.17	3526
10/16/86	HG	Ictalurus natalis	0.37	0.17	3522
01/18/89	HG	Amia calva	1.00	0.17	4242
01/18/89	HG	Amia calva	0.37	0.17	4243
01/18/89	HG	Moxostoma sp.	0.23	0.17	4236
07/17/80	PB	Lepomis macrochirus	1.90	0.22	994

Subbasin 030103

Station 02053632 Chowan River at Colerain

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/09/80	CU	Ictalurus nebulosus	3.10	1.00	944
07/09/80	CU	Ictalurus catus	5.70	1.00	939
07/09/80	CU	Morone americana	4.90	1.00	949
07/15/80	CU	Micropterus salmoides	1.80	1.00	934
01/21/81	CU	Morone americana	2.70	1.00	156
07/15/80	HG	Micropterus salmoides	0.19	0.17	934

Subbasin 030104

Station 02053652 Chowan River at US-17 at Edenhouse

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/08/80	CU	Ictalurus punctatus	1.30	1.00	904
07/08/80	CU	Morone americana	2.80	1.00	899
07/22/81	CU	Morone americana	15.00	1.00	2843
03/15/89	CU	Morone americana	81.00	1.00	4275
07/15/80	HG	Micropterus salmoides	0.28	0.17	894
07/08/80	PB	Morone americana	2.70	0.22	899

Note: DEM staff indicated that, for some fish samples, duplicate data were entered into the database under different sample numbers. DEM is currently attempting to remove these duplicate values from their fish contaminant monitoring database.

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Basin: PASQUOTANK

Subbasin 030150

Station 02043862 Pasquotank River at Elizabeth City

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/09/89	CU	Lepisosteus osseus	1.40	1.00	4320
05/09/89	HG	Lepisosteus osseus	1.10	0.17	4320

Station 02081179 Albemarle Sound at Wade Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/10/80	CU	Micropterus salmoides	1.40	1.00	954
09/29/80	CU	Ictalurus nebulosus	2.30	1.00	974
09/29/80	CU	Ictalurus catus	1.40	1.00	989
06/09/89	CU	Lepisosteus osseus	1.80	1.00	4218
08/10/80	HG	Micropterus salmoides	0.32	0.17	954

Station DS-10 Corapeake Ditch off Dismal Swamp Canal

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/27/83	HG	Esox niger	0.18	0.17	1421
07/27/83	HG	Esox niger	0.27	0.17	1429
07/27/83	PB	Esox niger	2.00	0.22	1424
07/27/83	PB	Esox niger	2.00	0.22	1421
07/27/83	ZN	Esox niger	49.00	34.20	1424

Station DS-3/5 Lake Drummond

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/26/83	HG	Ictalurus natalis	0.24	0.17	1373

Subbasin 030151

Station 0208117810 Alligator River below Gum Neck landing near Gum Ne

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/16/83	CD	Ictalurus catus	0.25	0.05	1408
06/16/83	CD	Morone americana	0.25	0.05	1410
06/16/83	CD	Morone americana	0.22	0.05	1409
06/16/83	CU	Morone americana	1.70	1.00	1410
06/16/83	CU	Morone americana	4.10	1.00	1409
06/16/83	PB	Ictalurus catus	3.10	0.22	1408
06/16/83	PB	Morone americana	5.30	0.22	1410
06/16/83	PB	Morone americana	3.60	0.22	1409

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station 0208117950 Croatan Sound at Manns Harbor

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/10/89	AS	Brevoortia tyrannus	0.93	0.27	4340
05/10/89	CU	Brevoortia tyrannus	1.40	1.00	4340
05/10/89	CU	Mugil cephalus	3.90	1.00	4339

Station STUMPY-1 Stumpy Point Bay near Stumpy Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/10/89	AS	Brevoortia tyrannus	1.40	0.27	4205
05/10/89	AS	Pomatomus saltatrix	0.30	0.27	4202
05/10/89	CU	Brevoortia tyrannus	2.20	1.00	4205
05/10/89	CU	Bairdiella chrysura	1.10	1.00	4204
05/10/89	HG	Pomatomus saltatrix	0.21	0.17	4202

Station TSPASNL1 Alligator (New) Lake

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
10/16/86	CD	Lepomis cyanellus	0.20	0.05	3854
10/23/86	CD	Notemigonus crysoleucas	0.20	0.05	3535
10/16/86	HG	Lepomis cyanellus	0.42	0.17	3854
10/23/86	HG	Perca flavescens	0.23	0.17	3857
10/23/86	HG	Pomoxis nigromaculatus	0.74	0.17	3243
10/23/86	HG	Ictalurus nebulosus	0.20	0.17	3242
10/23/86	HG	Notemigonus crysoleucas	0.42	0.17	3535
10/23/86	PB	Lepomis macrochirus	0.77	0.22	3855
10/23/86	PB	Lepomis gibbosus	1.50	0.22	3856
10/23/86	PB	Perca flavescens	0.74	0.22	3857
10/23/86	PB	Lepomis macrochirus	0.77	0.22	3536
10/23/86	PB	Pomoxis nigromaculatus	1.10	0.22	3243
10/23/86	PB	Lepomis gibbosus	1.50	0.22	3537

Subbasin 030153

Station 02081166 Scuppernong River near Columbia

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/08/83	CU	Dorosoma cepedianum	1.10	1.00	1403
06/08/83	PB	Pomoxis nigromaculatus	2.10	0.22	1404
06/08/83	PB	Dorosoma cepedianum	1.80	0.22	1403

Station 02081185 Kendricks Creek at SR-1300

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/08/83	PB	Lepomis macrochirus	3.10	0.22	1419
06/08/83	PB	Lepomis macrochirus	3.00	0.22	1418

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station 02081185 Kendricks Creek at SR-1300

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/08/83	PB	Lepomis macrochirus	2.10	0.22	1417
06/08/83	PB	Lepomis macrochirus	2.10	0.22	1416
06/08/83	PB	Pomoxis nigromaculatus	1.80	0.22	1413
06/08/83	PB	Lepomis gibbosus	2.40	0.22	1420
06/08/83	PB	Perca flavescens	2.60	0.22	1415
06/08/83	ZN	Lepomis gibbosus	35.00	34.20	1420

Station PAS012 Lake Phelps

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/18/86	CD	Amia calva	0.21	0.05	3829
09/18/86	CD	Erimyzon oblongus	0.18	0.05	3810
09/18/86	CD	Lepomis gibbosus	0.20	0.05	3806
09/18/86	CD	Amia calva	0.21	0.05	3510
09/18/86	CD	Erimyzon oblongus	0.18	0.05	3491
09/18/86	CD	Erimyzon oblongus	0.41	0.05	3492
09/18/86	CD	Lepomis gibbosus	0.20	0.05	3487
09/18/86	CD	Erimyzon oblongus	0.41	0.05	3811
09/18/86	CU	Amia calva	2.70	1.00	3829
09/18/86	CU	Amia calva	5.60	1.00	3830
09/18/86	CU	Amia calva	1.90	1.00	3827
09/18/86	CU	Amia calva	1.20	1.00	3828
09/18/86	CU	Amia calva	2.70	1.00	3510
09/18/86	CU	Amia calva	5.60	1.00	3511
09/18/86	CU	Amia calva	1.90	1.00	3508
09/18/86	CU	Amia calva	1.20	1.00	3509
09/18/86	HG	Amia calva	0.29	0.17	3829
09/18/86	HG	Amia calva	1.00	0.17	3830
09/18/86	HG	Amia calva	1.10	0.17	3827
09/18/86	HG	Amia calva	2.20	0.17	3828
09/18/86	HG	Micropterus salmoides	0.32	0.17	3823
09/18/86	HG	Micropterus salmoides	0.53	0.17	3822
09/18/86	HG	Lepomis gibbosus	0.25	0.17	3806
09/18/86	HG	Amia calva	0.29	0.17	3510
09/18/86	HG	Amia calva	1.00	0.17	3511
09/18/86	HG	Amia calva	1.10	0.17	3508
09/18/86	HG	Amia calva	2.20	0.17	3509
09/18/86	HG	Erimyzon oblongus	0.22	0.17	3492
09/18/86	HG	Micropterus salmoides	0.32	0.17	3504
09/18/86	HG	Micropterus salmoides	0.53	0.17	3503
09/18/86	HG	Lepomis gibbosus	0.25	0.17	3487
09/18/86	HG	Lepomis gibbosus	0.18	0.17	3269
09/18/86	HG	Erimyzon oblongus	0.22	0.17	3811
09/18/86	PB	Micropterus salmoides	0.79	0.22	3823
09/18/86	PB	Micropterus salmoides	1.20	0.22	3822
09/18/86	PB	Lepomis gibbosus	4.90	0.22	3806
09/18/86	PB	Ictalurus natalis	1.90	0.22	3817
09/18/86	PB	Ictalurus natalis	1.00	0.22	3818
09/18/86	PB	Erimyzon oblongus	0.53	0.22	3492
09/18/86	PB	Micropterus salmoides	0.79	0.22	3504
09/18/86	PB	Micropterus salmoides	1.20	0.22	3503
09/18/86	PB	Lepomis gibbosus	4.90	0.22	3487
09/18/86	PB	Lepomis gibbosus	6.30	0.22	3269
09/18/86	PB	Ictalurus natalis	1.90	0.22	3498
09/18/86	PB	Ictalurus natalis	0.92	0.22	3497
09/18/86	PB	Ictalurus natalis	1.00	0.22	3499

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station PAS012 Lake Phelps

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/18/86	PB	Erimyzon oblongus	0.53	0.22	3811

Subbasin 030154

Station CURRITUCK-1 Currituck Sound near Currituck

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/31/89	CU	Strongylura marina	2.10	1.00	4175
05/31/89	CU	Lepisosteus osseus	1.40	1.00	4174

Station PAS02A Currituck Sound at Harbor Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/31/89	CU	Lepisosteus osseus	4.60	1.00	4469

Subbasin 030155

Station 02084633 Pamlico Sound at Knoll Island near Ocracoke

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/29/89	AS	Tylosurus crocodilus	18.00	0.27	4187
06/29/89	AS	Brevoortia tyrannus	2.30	0.27	4188
06/29/89	AS	Trinectes maculatus	2.40	0.27	4192
06/29/89	AS	Mustelus canis	14.00	0.27	4184
06/29/89	CD	Tylosurus crocodilus	0.45	0.05	4187
06/29/89	CD	Mustelus canis	0.33	0.05	4184
06/29/89	CU	Brevoortia tyrannus	1.40	1.00	4188

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Basin: ROANOKE

Subbasin 030203

Station 02074218 Dan River at SR-1716 near Mayfield

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/12/86	CD	Lepomis auritus	0.10	0.05	3887
04/23/81	CU	Ictalurus platycephalus	1.30	1.00	164
07/06/82	CU	Ictalurus punctatus	1.40	1.00	1221
09/12/86	HG	Moxostoma sp.	0.31	0.17	3886
09/12/86	HG	Moxostoma sp.	0.31	0.17	3587
04/23/81	PB	Ictalurus platycephalus	2.90	0.22	164
07/06/82	PB	Lepomis auritus	2.40	0.22	1223
09/12/86	PB	Lepomis auritus	0.50	0.22	3887

Subbasin 030206

Station 0207933350 Nutbush Creek at NC-VA Stateline NR Townsville

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/03/80	CU	Dorosoma cepedianum	2.40	1.00	66
06/03/80	CU	Micropterus salmoides	1.40	1.00	71
02/25/82	HG	Micropterus salmoides	0.18	0.17	1070
02/25/82	PB	Dorosoma cepedianum	1.90	0.22	1093

Subbasin 030208

Station 02081000 Roanoke River at Scotland Neck (HWY 258)

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/06/90	CD	Cyprinus carpio	0.12	0.05	7091
06/03/80	CU	Amia calva	5.30	1.00	91
06/03/80	CU	Dorosoma cepedianum	2.30	1.00	101
06/03/80	CU	Ictalurus catus	1.10	1.00	96
09/22/81	CU	Amia calva	3.50	1.00	2842
09/22/81	CU	Cyprinus carpio	2.20	1.00	1517
09/06/90	CU	Cyprinus carpio	2.00	1.00	7091
06/03/80	HG	Amia calva	0.25	0.17	91
09/22/81	HG	Amia calva	0.40	0.17	2842
06/03/80	PB	Ictalurus catus	2.00	0.22	96
09/22/81	ZN	Cyprinus carpio	79.00	34.20	1517
09/06/90	ZN	Cyprinus carpio	45.00	34.20	7091

Station TSROARR30 Roanoke River near Halifax

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/19/86	CD	Amia calva	0.14	0.05	3455
06/19/86	CU	Amia calva	12.00	1.00	3455
06/19/86	CU	Amia calva	1.10	1.00	3786

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station TSROARR30 Roanoke River near Halifax

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/19/86	HG	Amia calva	0.25	0.17	3455
06/19/86	HG	Amia calva	0.38	0.17	3786

Station WELDON-HATC Roanoke River at Weldon Fish Hatchery

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
04/23/81	AS	Morone saxatilus	0.50	0.27	113
04/27/81	AS	Morone saxatilus	0.50	0.27	123
04/27/81	AS	Morone saxatilus	0.40	0.27	118
05/05/81	AS	Morone saxatilus	0.50	0.27	117
05/08/81	AS	Morone saxatilus	0.50	0.27	121
04/23/81	CU	Morone saxatilus	1.30	1.00	113
04/23/81	CU	Morone saxatilus	1.30	1.00	110
04/27/81	CU	Morone saxatilus	1.30	1.00	116
04/27/81	CU	Morone saxatilus	1.50	1.00	120
04/27/81	CU	Morone saxatilus	1.10	1.00	119
04/27/81	CU	Morone saxatilus	1.10	1.00	118
05/05/81	CU	Morone saxatilus	1.90	1.00	111
05/08/81	CU	Morone saxatilus	1.70	1.00	114
05/08/81	CU	Morone saxatilus	2.30	1.00	121
05/08/81	CU	Morone saxatilus	1.60	1.00	122
04/27/81	HG	Morone saxatilus	0.22	0.17	116
05/05/81	HG	Morone saxatilus	0.18	0.17	111
05/05/81	HG	Morone saxatilus	0.22	0.17	117
05/05/81	HG	Morone saxatilus	0.20	0.17	124
05/08/81	HG	Morone saxatilus	0.22	0.17	115
05/08/81	HG	Morone saxatilus	0.20	0.17	122
04/27/81	PB	Morone saxatilus	1.90	0.22	120
04/27/81	PB	Morone saxatilus	1.90	0.22	119
04/27/81	PB	Morone saxatilus	1.70	0.22	118
05/05/81	PB	Morone saxatilus	1.90	0.22	117

Subbasin 030209

Station 02081141 Roanoke River at NC-45 near Sans Souci

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/22/80	CU	Morone americana	4.60	1.00	884
07/28/86	CU	Amia calva	1.20	1.00	3902
07/28/86	CU	Amia calva	2.00	1.00	3432
07/28/86	HG	Amia calva	0.37	0.17	3541
07/28/86	HG	Amia calva	0.41	0.17	3902
07/28/86	HG	Lepomis microlophus	0.19	0.17	3553
12/14/87	HG	Amia calva	0.38	0.17	4064
12/14/87	HG	Esox niger	0.23	0.17	4068

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Basin: TAR-PAMLICO

Subbasin 030302

Station 02082770 Swift Creek at SR-1310

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/27/90	CU	Amia calva	1.60	1.00	5049
07/27/90	HG	Anguilla rostrata	0.20	0.17	5050

Station 02082823 Tar River at Tarboro at NC-44

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/02/80	CU	Anguilla rostrata	1.10	1.00	76
06/02/80	CU	Micropterus salmoides	1.30	1.00	86
06/02/80	CU	Moxostoma sp.	1.50	1.00	81
09/22/81	CU	Morone americana	3.70	1.00	1956
06/02/80	HG	Micropterus salmoides	0.20	0.17	86
09/22/81	PB	Morone americana	2.90	0.22	1956

Subbasin 030303

Station 02083692 Tar River at SR-1400 near Falkland

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/10/86	HG	Ictalurus punctatus	0.28	0.17	3273

Subbasin 030304

Station 02082812 Swift Creek at SR-1253 near Tarboro

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/02/86	HG	Esox niger	0.28	0.17	3447
07/02/86	HG	Micropterus salmoides	0.25	0.17	3448
07/02/86	ZN	Esox niger	46.00	34.20	3447

Subbasin 030305

Station 02084171 Tar River at SR-1565 near Grimesland

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/01/85	CD	Micropterus salmoides	0.10	0.05	2753
07/01/85	CD	Micropterus salmoides	0.10	0.05	2745
07/01/85	CD	Ictalurus catus	0.10	0.05	2743
06/12/80	CU	Micropterus salmoides	5.10	1.00	1004
06/12/80	CU	Moxostoma sp.	12.00	1.00	1010

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station 02084171 Tar River at SR-1565 near Grimesland

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/02/80	CU	Ictalurus catus	3.10	1.00	1015
07/01/85	CU	Moxostoma anisurum	1.40	1.00	2735
06/12/80	HG	Micropterus salmoides	0.34	0.17	1004
06/12/80	HG	Moxostoma sp.	0.25	0.17	1010
10/06/81	HG	Micropterus salmoides	0.21	0.17	1622
07/01/85	HG	Micropterus salmoides	0.21	0.17	2753
07/01/85	HG	Moxostoma anisurum	0.23	0.17	2735
08/05/86	HG	Micropterus salmoides	0.26	0.17	3223
08/05/86	HG	Moxostoma anisurum	0.25	0.17	3226
07/02/80	PB	Ictalurus catus	2.50	0.22	1015

Station TSTAR120 Tar River at US-264 Bypass in Greenville

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
01/19/89	CD	Cyprinus carpio	0.34	0.05	4252
07/24/86	CU	Amia calva	3.80	1.00	3435
02/10/88	CU	Amia calva	2.00	1.00	4052
01/19/89	CU	Amia calva	1.70	1.00	4254
01/19/89	CU	Cyprinus carpio	1.20	1.00	4252
07/24/86	HG	Amia calva	0.32	0.17	3435
02/10/88	HG	Amia calva	0.41	0.17	4052
02/10/88	HG	Amia calva	0.42	0.17	4051
01/19/89	HG	Amia calva	0.52	0.17	4254
01/19/89	HG	Moxostoma sp.	0.19	0.17	4256
01/19/89	PB	Cyprinus carpio	0.79	0.22	4252
01/19/89	SE	Cyprinus carpio	1.10	0.73	4252
07/24/86	ZN	Anguilla rostrata	40.00	34.20	3436

Station TSTAR120D Hardee Mill Creek at Mouth

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/10/87	CU	Amia calva	1.30	1.00	4046
09/10/87	HG	Amia calva	0.42	0.17	4046
09/10/87	HG	Amia calva	0.53	0.17	4045
09/10/87	HG	Lepisosteus osseus	0.24	0.17	4047
09/10/87	PB	Amia calva	0.50	0.22	4046
09/10/87	PB	Lepisosteus osseus	0.57	0.22	4047

Subbasin 030307

Station 02084534 Bath Creek at NC-92 near Bath

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
01/10/84	CD	Lepomis macrochirus	0.30	0.05	1579
01/10/84	CD	Lepomis gibbosus	0.28	0.05	1577
01/11/84	CD	Micropterus salmoides	0.30	0.05	1596
01/10/84	CU	Lepomis macrochirus	1.20	1.00	1579
01/10/84	CU	Morone americana	2.10	1.00	1581

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station 02084534 Bath Creek at NC-92 near Bath

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
01/10/84	CU	Morone americana	4.20	1.00	1610
01/10/84	PB	Lepomis macrochirus	1.90	0.22	1580
01/10/84	PB	Lepomis macrochirus	1.60	0.22	1578
01/10/84	PB	Lepomis macrochirus	2.00	0.22	1579
01/10/84	PB	Ictalurus nebulosus	1.80	0.22	1583
01/10/84	PB	Lepomis gibbosus	2.80	0.22	1577
01/10/84	PB	Lepomis gibbosus	2.20	0.22	1576
01/10/84	PB	Morone americana	1.90	0.22	1581

Station 0208455650 Pungo River at US-264 near Belhaven

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/14/82	CD	Micropterus salmoides	0.21	0.05	2858
06/15/83	CU	Lepisosteus osseus	3.50	1.00	1354
09/14/82	PB	Lepomis macrochirus	1.90	0.22	2860
06/15/83	PB	Lepisosteus osseus	1.10	0.22	1354

Station 0208455850 Pantego Creek at NC-92 near Belhaven

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/15/83	AS	Mugil cephalus	0.62	0.27	1350
06/15/83	CD	Mugil cephalus	0.20	0.05	1351
06/15/83	CD	Morone americana	0.26	0.05	1349
06/15/83	CD	Morone americana	0.28	0.05	1346
06/15/83	CD	Morone americana	0.26	0.05	1348
06/15/83	CD	Morone americana	0.21	0.05	1345
06/15/83	CD	Morone americana	0.28	0.05	1343
06/15/83	CD	Morone americana	0.23	0.05	1347
06/15/83	CD	Morone americana	0.23	0.05	1344
06/15/83	CU	Mugil cephalus	2.10	1.00	1351
06/15/83	CU	Mugil cephalus	2.20	1.00	1350
06/15/83	CU	Morone americana	6.20	1.00	1349
06/15/83	CU	Morone americana	7.30	1.00	1346
06/15/83	CU	Morone americana	3.70	1.00	1348
06/15/83	CU	Morone americana	2.30	1.00	1345
06/15/83	CU	Morone americana	5.20	1.00	1343
06/15/83	CU	Morone americana	11.00	1.00	1347
06/15/83	CU	Morone americana	2.70	1.00	1344
06/15/83	PB	Mugil cephalus	2.80	0.22	1351
06/15/83	PB	Mugil cephalus	1.40	0.22	1350
06/15/83	PB	Morone americana	2.10	0.22	1349
06/15/83	PB	Morone americana	2.70	0.22	1346
06/15/83	PB	Morone americana	1.40	0.22	1348
06/15/83	PB	Morone americana	1.30	0.22	1345
06/15/83	PB	Morone americana	3.10	0.22	1343
06/15/83	PB	Morone americana	1.90	0.22	1347
06/15/83	PB	Morone americana	2.60	0.22	1344

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station 0208457020 Pungo Creek at NC-92 at Sydney's Crossroads

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
01/11/84	CD	Ictalurus catus	0.30	0.05	1565
06/16/83	PB	Morone saxatilus	1.80	0.22	1353
06/16/83	PB	Morone americana	1.90	0.22	1352
01/11/84	PB	Lepomis macrochirus	2.80	0.22	1572
01/11/84	PB	Ictalurus nebulosus	1.90	0.22	1571
01/11/84	PB	Lepomis gibbosus	1.90	0.22	1574
01/11/84	PB	Lepomis gibbosus	2.50	0.22	1573
01/11/84	PB	Lepomis gibbosus	2.00	0.22	1575

Station 02092690 Pamlico River at Great Island

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/05/89	AS	Brevoortia tyrannus	0.96	0.27	4332
05/05/89	AS	Trinectes maculatus	1.40	0.27	4331
05/05/89	CU	Mugil cephalus	5.70	1.00	4329
05/05/89	SE	Brevoortia tyrannus	0.75	0.73	4332

Station MT-1 Lake Mattamuskeet at center canal

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/20/86	HG	Micropterus salmoides	0.58	0.17	3761
08/20/86	HG	Micropterus salmoides	0.31	0.17	3759
08/20/86	HG	Micropterus salmoides	0.45	0.17	3760
08/20/86	HG	Micropterus salmoides	0.71	0.17	3758

Station PUNGO-1 Pungo River at SR-1300 near Pantego

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
03/03/83	HG	Micropterus salmoides	0.78	0.17	7

Station PUNGO-17 Pungo River near Durants Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
03/28/89	AS	Brevoortia tyrannus	1.80	0.27	4232
03/28/89	CU	Mugil cephalus	1.60	1.00	4230
03/28/89	CU	Morone americana	3.10	1.00	4228
03/28/89	HG	Lepisosteus osseus	0.19	0.17	4225
03/28/89	SE	Morone americana	1.30	0.73	4228

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station SOUTH-CR South Creek Near Aurora

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
12/31/81	AS	Paralichthys lethostigma	0.60	0.27	134
12/31/81	PB	Paralichthys lethostigma	1.60	0.22	134

Station TAR0628A Pungo Lake

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/09/86	CD	Cyprinus carpio	0.11	0.05	3233
07/09/86	CD	Cyprinus carpio	0.13	0.05	3232
07/09/86	CD	Lepisosteus osseus	0.52	0.05	3238
07/09/86	CU	Cyprinus carpio	1.10	1.00	3233
07/09/86	CU	Lepisosteus osseus	1.10	1.00	3238
07/09/86	HG	Cyprinus carpio	0.20	0.17	3232
07/09/86	HG	Cyprinus carpio	0.18	0.17	3234
07/09/86	HG	Lepisosteus osseus	0.64	0.17	3237
07/09/86	HG	Lepisosteus osseus	3.80	0.17	3238
07/09/86	HG	Lepisosteus osseus	0.53	0.17	3239
07/09/86	ZN	Cyprinus carpio	38.00	34.20	3233
07/09/86	ZN	Cyprinus carpio	58.00	34.20	3232
07/09/86	ZN	Cyprinus carpio	100.00	34.20	3234

Station TAR56B Pamlico River at Blounts Bay

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
04/26/89	AS	Mugil cephalus	1.10	0.27	4474
04/26/89	CU	Cyprinus carpio	1.50	1.00	4471
04/26/89	CU	Mugil cephalus	3.10	1.00	4474

Station TSTARBC5 Broad Creek near Washington

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
04/06/89	AS	Mugil cephalus	1.30	0.27	4292
04/06/89	CU	Mugil cephalus	3.30	1.00	4292

Station TSTARKDY Kennedy Creek at Washington

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
01/27/89	CU	Amia calva	1.10	1.00	4278
01/27/89	HG	Amia calva	0.22	0.17	4279
01/27/89	HG	Amia calva	0.22	0.17	4278

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Basin: NEUSE

Subbasin 030401

Station 02085070 Eno River at US-501 near Durham

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
06/29/82	CD	Anguilla rostrata	0.20	0.05	2824
06/29/82	CU	Cyprinus carpio	1.10	1.00	2823
06/29/82	PB	Anguilla rostrata	1.00	0.22	2824
06/29/82	PB	Cyprinus carpio	1.90	0.22	2823
06/29/82	PB	Lepomis auritus	1.80	0.22	2822

Station NEU020D Neuse River (Falls Lake) at Water Intake

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/31/90	CU	Cyprinus carpio	1.20	1.00	6087
08/31/90	ZN	Cyprinus carpio	55.00	34.20	6087

Station TSNEUFNR2 Falls of the Neuse Reservoir near mouth of Ellerbe

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/02/86	HG	Amia calva	0.40	0.17	3798
07/02/86	HG	Amia calva	0.33	0.17	3799
07/02/86	HG	Amia calva	0.40	0.17	3477
07/02/86	HG	Amia calva	0.33	0.17	3478

Subbasin 030402

Station 02087500 Neuse River at NC-42 near Clayton

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/04/85	CU	Lepomis auritus	2.50	1.00	2976
09/04/85	CU	Lepomis auritus	1.40	1.00	2977
09/04/85	HG	Micropterus salmoides	0.27	0.17	2978
09/04/85	HG	Micropterus salmoides	0.92	0.17	3023
09/04/85	HG	Moxostoma sp.	0.36	0.17	3019
09/04/85	HG	Moxostoma pappillosum	0.24	0.17	2972
09/04/85	PB	Lepomis auritus	1.50	0.22	2977

Station NEU055 Neuse River at US-70 in Smithfield

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/06/86	CD	Lepisosteus osseus	0.39	0.05	3190
08/06/86	CU	Lepisosteus osseus	1.90	1.00	3190
08/06/86	HG	Lepisosteus osseus	0.94	0.17	3190

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station TSNEU100 Neuse River above US-117 at near Goldsboro

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/10/86	CU	Amia calva	2.50	1.00	3272
07/10/86	HG	Amia calva	0.85	0.17	3272

Subbasin 030405

Station 02089500 Neuse River at US-70 bypass in Kinston

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/10/86	CD	Anguilla rostrata	0.49	0.05	3270
11/05/87	CD	Anguilla rostrata	0.12	0.05	4071
11/05/87	CD	Lepisosteus osseus	0.18	0.05	4069
05/19/80	CU	Ictalurus catus	3.70	1.00	1025
07/03/80	CU	Micropterus salmoides	9.60	1.00	1026
11/05/87	CU	Anguilla rostrata	1.10	1.00	4071
05/19/80	HG	Ictalurus catus	0.28	0.17	1025
07/03/80	HG	Micropterus salmoides	0.31	0.17	1026
07/03/80	HG	Moxostoma sp.	0.24	0.17	1027
11/05/87	HG	Amia calva	0.73	0.17	4074
11/05/87	HG	Ictalurus punctatus	0.18	0.17	4073
11/05/87	HG	Ictalurus punctatus	0.20	0.17	4072
11/05/87	HG	Lepisosteus osseus	0.64	0.17	4070
11/05/87	HG	Lepisosteus osseus	2.60	0.17	4069
07/07/82	PB	Micropterus salmoides	1.00	0.22	2874

Station TSNEUSTC2 Stony Creek at SR-1920

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/13/87	HG	Micropterus salmoides	0.26	0.17	3630
08/13/87	PB	Lepomis macrochirus	0.79	0.22	3631
08/13/87	PB	Lepomis auritus	2.30	0.22	3629

Subbasin 030407

Station 02090634 Contentnea Creek at Stantonsburg

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/08/82	CD	Erimyzon oblongus	0.28	0.05	2825
07/08/82	CD	Micropterus salmoides	0.28	0.05	2827
07/08/82	CD	Lepomis auritus	0.38	0.05	2826
07/08/82	HG	Micropterus salmoides	0.19	0.17	2827
07/08/82	PB	Lepomis auritus	1.90	0.22	2826

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station 0209176690 Contentnea Creek at Grifton

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/06/86	CD	Cyprinus carpio	0.90	0.05	3250
08/06/86	HG	Lepomis macrochirus	0.23	0.17	3254
08/06/86	HG	Cyprinus carpio	0.27	0.17	3250
08/06/86	HG	Lepisosteus osseus	0.70	0.17	3187
08/06/86	HG	Lepisosteus osseus	1.30	0.17	3186
08/06/86	ZN	Cyprinus carpio	150.00	34.20	3250

Station TSNEUCC1C Contentnea Creek at SR-1162

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
10/13/87	HG	Micropterus salmoides	0.40	0.17	4038
10/13/87	HG	Moxostoma sp.	0.39	0.17	4037

Station TSNEUCC4 Contentnea Creek at SR-1606 near Wilson

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
11/18/86	CD	Cyprinus carpio	0.37	0.05	3883
11/18/86	CD	Moxostoma sp.	0.13	0.05	3882
11/18/86	CD	Cyprinus carpio	0.37	0.05	3584
11/18/86	CD	Moxostoma sp.	0.13	0.05	3583
11/18/86	CU	Cyprinus carpio	2.00	1.00	3883
11/18/86	CU	Cyprinus carpio	2.00	1.00	3584
03/08/88	CU	Cyprinus carpio	2.20	1.00	4033
11/18/86	HG	Cyprinus carpio	0.29	0.17	3883
11/18/86	HG	Micropterus salmoides	0.59	0.17	3881
11/18/86	HG	Moxostoma sp.	0.35	0.17	3882
11/18/86	HG	Cyprinus carpio	0.29	0.17	3584
11/18/86	HG	Micropterus salmoides	0.59	0.17	3582
11/18/86	HG	Moxostoma sp.	0.35	0.17	3583
10/13/87	HG	Micropterus salmoides	0.23	0.17	4036
10/13/87	HG	Micropterus salmoides	0.36	0.17	4035
10/13/87	HG	Moxostoma sp.	0.34	0.17	4034
03/08/88	HG	Cyprinus carpio	0.31	0.17	4033
11/18/86	ZN	Cyprinus carpio	52.00	34.20	3883
11/18/86	ZN	Cyprinus carpio	52.00	34.20	3584

Station TSNEUNS4 Nahunta Swamp at SR-1537

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/13/87	HG	Micropterus salmoides	0.25	0.17	3764
08/13/87	HG	Lepomis auritus	0.23	0.17	3768
08/13/87	PB	Lepomis auritus	0.61	0.22	3768

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station TSNEUTS1 Toisnot Swamp at SR-1332 below Lake Wilson

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/14/87	HG	Lepomis macrochirus	0.18	0.17	3751
09/14/87	HG	Lepomis auritus	0.19	0.17	3750
09/14/87	HG	Lepomis auritus	0.29	0.17	3753
09/14/87	PB	Lepomis auritus	0.67	0.22	3750

Station TSNEUTS3 Toisnot Swamp tributary at SR-1327

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/14/87	HG	Pomoxis nigromaculatus	0.18	0.17	3736
09/14/87	HG	Esox americanus	0.23	0.17	3739
09/14/87	PB	Pomoxis nigromaculatus	0.60	0.22	3736
09/14/87	PB	Lepomis auritus	0.55	0.22	3738
09/14/87	PB	Esox americanus	0.94	0.22	3739
09/14/87	PB	Lepomis gibbosus	0.80	0.22	3737
09/14/87	PB	Lepomis gibbosus	0.67	0.22	3735
09/14/87	ZN	Esox americanus	53.00	34.20	3739

Station TSNEUTS5 Toisnot Swamp at NC-42 near Wilson

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/14/87	CU	Erimyzon oblongus	1.10	1.00	3962
09/14/86	HG	Anguilla rostrata	0.24	0.17	3909
09/14/86	PB	Anguilla rostrata	1.40	0.22	3909
09/14/87	PB	Erimyzon oblongus	0.64	0.22	3962
09/14/87	PB	Notemigonus crysoleucas	0.76	0.22	3734
09/14/87	PB	Lepomis auritus	0.88	0.22	3963
09/14/87	PB	Lepomis gibbosus	0.71	0.22	3732

Subbasin 030409

Station 02092000 Swift Creek at Vanceboro

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
07/02/82	CD	Lepomis macrochirus	0.28	0.05	2828
07/02/82	CD	Ictalurus nebulosus	0.29	0.05	2829
07/02/82	HG	Micropterus salmoides	0.30	0.17	2862
07/02/82	PB	Lepomis macrochirus	1.90	0.22	2828
07/02/82	PB	Ictalurus nebulosus	2.90	0.22	2829
07/02/82	PB	Micropterus salmoides	1.80	0.22	2862

Station TSNEUFS03 Fork Swamp at SR-1700

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
12/01/86	CU	Anguilla rostrata	1.60	1.00	3896

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station TSNEUFS03 Fork Swamp at SR-1700

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
12/01/86	CU	Erimyzon oblongus	1.70	1.00	3894
12/01/86	CU	Notemigonus crysoleucas	1.20	1.00	3897
12/01/86	CU	Anguilla rostrata	1.60	1.00	3598
12/01/86	CU	Erimyzon oblongus	1.70	1.00	3598
12/01/86	CU	Notemigonus crysoleucas	1.20	1.00	3599
12/01/86	HG	Anguilla rostrata	0.18	0.17	3898
12/01/86	HG	Notemigonus crysoleucas	0.22	0.17	3897
12/01/86	HG	Lepomis auritus	0.18	0.17	3895
12/01/86	HG	Anguilla rostrata	0.18	0.17	3598
12/01/86	HG	Notemigonus crysoleucas	0.22	0.17	3599
12/01/86	HG	Lepomis auritus	0.18	0.17	3597

Station TSNEUSC03 Swift Creek at NC-102

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
12/01/86	CD	Anguilla rostrata	0.17	0.05	3893
12/01/86	CU	Anguilla rostrata	1.40	1.00	3893
12/01/86	HG	Anguilla rostrata	0.24	0.17	3893
12/01/86	HG	Lepomis auritus	0.29	0.17	3593

Subbasin 030410

Station 02092162 Neuse River at New Bern

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
02/15/89	CD	Cyprinus carpio	0.21	0.05	4285
07/09/80	CU	Dorosoma cepedianum	4.30	1.00	1021
07/09/80	CU	Morone saxatilus	2.30	1.00	1019
07/17/80	CU	Ictalurus catus	3.20	1.00	1020
08/22/85	CU	Lepisosteus osseus	1.60	1.00	2936
10/17/85	CU	Morone americana	15.00	1.00	2939
10/17/85	CU	Morone americana	27.00	1.00	2941
10/17/85	CU	Morone americana	8.50	1.00	2940
09/16/86	CU	Lepisosteus osseus	1.40	1.00	3561
02/15/89	CU	Cyprinus carpio	1.20	1.00	4285
02/15/89	CU	Moxostoma sp.	1.20	1.00	4282
07/09/80	HG	Morone saxatilus	0.22	0.17	1019
07/17/80	HG	Ictalurus catus	0.34	0.17	1020
08/22/85	HG	Lepisosteus osseus	0.79	0.17	3007
09/16/86	HG	Ictalurus punctatus	0.18	0.17	3562
09/16/86	HG	Lepisosteus osseus	0.76	0.17	3561
02/15/89	HG	Cyprinus carpio	0.24	0.17	4285
07/20/82	PB	Morone saxatilus	1.80	0.22	2877

Station 0209257120 West Prong Brice Creek at SR-1101 near Riverdale

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
09/04/87	HG	Lepomis cyanellus	0.18	0.17	3632

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station 02092682 Neuse River at Mouth near Pamlico

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
03/21/89	AS	Mugil cephalus	1.30	0.27	4487
03/21/89	CU	Mugil cephalus	1.70	1.00	4487

Station NEU 139 Neuse River at Minnesott Beach

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
04/27/89	CU	Mugil cephalus	2.40	1.00	4483
04/27/89	CU	Lepisosteus osseus	1.90	1.00	4484

Station NEUSC-2 East Prong Slocum Creek

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/22/90	CU	Amia calva	2.20	1.00	4538

Station NEUSC-4 West Prong Slocum Creek

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/22/90	CD	Cyprinus carpio	0.21	0.05	4547
05/22/90	CD	Cyprinus carpio	0.23	0.05	4548
05/22/90	CD	Lepisosteus osseus	0.30	0.05	4568
05/22/90	CU	Notemigonus crysoleucas	25.00	1.00	4567
05/22/90	CU	Lepisosteus osseus	1.10	1.00	4568
05/22/90	PB	Notemigonus crysoleucas	0.91	0.22	4567
05/22/90	ZN	Cyprinus carpio	45.00	34.20	4547
05/22/90	ZN	Cyprinus carpio	49.00	34.20	4548

Station NEUSC-5 Slocum Creek off Mill Creek

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
05/22/90	AS	Lepisosteus osseus	1.00	0.27	4506
05/22/90	CD	Lepisosteus osseus	0.25	0.05	4507
05/22/90	CU	Lepisosteus osseus	1.10	1.00	4506
05/22/90	CU	Lepisosteus osseus	13.10	1.00	4507
05/22/90	PB	Lepisosteus osseus	0.70	0.22	4507
05/22/90	PB	Dorosoma cepedianum	0.26	0.22	4512

Station NEUSC1 Slocum Creek downstream of Cherry Point WWTP

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/08/85	HG	Lepisosteus osseus	0.37	0.17	2888

Whole Fish Samples Exceeding the Pollutant Levels of Concern for Wildlife

Station NEUSC1 Slocum Creek downstream of Cherry Point WWTP

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/08/85	HG	Lepisosteus osseus	0.29	0.17	2887

Station NEUSC2 East Prong Slocum Creek upstream Sandy Beach

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
08/08/85	CD	Lepisosteus osseus	0.15	0.05	2893
08/08/85	CU	Lepisosteus osseus	1.40	1.00	2893
08/08/85	HG	Lepisosteus osseus	0.50	0.17	2892
08/08/85	HG	Lepisosteus osseus	0.51	0.17	2893

Station SOUTHRIVER- South River near South River

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
03/02/89	AS	Alosa mediocris	1.00	0.27	4310
03/02/89	CU	Mugil cephalis	1.10	1.00	4312
03/02/89	HG	Alosa mediocris	0.18	0.17	4310

Station TSNEUMS1 Mill Creek Swamp at SR-1611

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
12/03/86	HG	Erimyzon oblongus	0.28	0.17	3898
12/03/86	HG	Erimyzon oblongus	0.28	0.17	3600

Station TSNEUPC2 Possum Creek at SR-1126

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	85%ile Whole Fish Screening Value (ppm)	Sample No.
12/03/86	HG	Esox americanus	0.32	0.17	3899
12/03/86	HG	Esox americanus	0.32	0.17	3601
12/03/86	ZN	Esox americanus	52.00	34.20	3899
12/03/86	ZN	Esox americanus	52.00	34.20	3601

Whole Fish Samples Exceeding Screening Values for Organochlorine Pesticides

State Subbasin Ø3Ø1Ø4

Ø2Ø53652 Chowan River at US-17 at Edenhouse

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
Ø7/Ø8/8Ø	P_P_DDE	Ictalurus punctatus	Ø.27	Ø.2Ø

State Subbasin Ø3Ø15Ø

Ø2Ø81179 Albemarle Sound at Wade Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
Ø8/1Ø/8Ø	P_P_DDE	Micropterus salmoides	Ø.53	Ø.2Ø
Ø9/29/8Ø	P_P_DDE	Ictalurus nebulosus	Ø.44	Ø.2Ø
Ø6/29/81	P_P_DDE	Micropterus salmoides	Ø.36	Ø.2Ø

State Subbasin Ø3Ø2Ø6

Ø2Ø793335Ø Nutbush Creek at NC-VA Stateline NR Townsville

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
Ø2/25/82	P_P_DDE	Micropterus salmoides	Ø.49	Ø.2Ø

State Subbasin Ø3Ø2Ø8

Ø2Ø81ØØØ Roanoke River at Scotland Neck (HWY 258)

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
Ø9/22/81	P_P_DDE	Cyprinus carpio	Ø.32	Ø.2Ø

State Subbasin Ø3Ø3Ø2

Ø2Ø82823 Tar River at Tarboro at NC-44

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
Ø7/Ø1/86	P_P_DDE	Ictalurus punctatus	Ø.27Ø	Ø.2Ø
Ø7/Ø1/86	P_P_DDE	Lepisosteus osseus	Ø.79Ø	Ø.2Ø
Ø6/Ø2/8Ø	P_P_DDE	Anguilla rostrata	Ø.33	Ø.2Ø
Ø6/Ø2/8Ø	P_P_DDE	Micropterus salmoides	Ø.26	Ø.2Ø
Ø6/Ø2/8Ø	P_P_DDE	Moxostoma sp.	Ø.26	Ø.2Ø
Ø9/22/81	P_P_DDE	Moxostoma sp.	Ø.22	Ø.2Ø

Whole Fish Samples Exceeding Screening Values for Organochlorine Pesticides

State Subbasin 030303

02083692 Tar River at SR-1400 near Falkland

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
07/10/86	P_P_DDE	Ictalurus punctatus	0.220	0.20
07/10/86	P_P_DDE	Micropterus salmoides	0.860	0.20
07/10/86	P_P_DDE	Moxostoma sp.	0.260	0.20

State Subbasin 030305

02084171 Tar River at SR-1565 near Grimesland

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
06/12/80	P_P_DDE	Moxostoma sp.	0.93	0.20
07/02/80	P_P_DDE	Ictalurus catus	0.30	0.20
10/06/81	P_P_DDE	Micropterus salmoides	0.26	0.20

State Subbasin 030307

0208457020 Pungo Creek at NC-92 at Sydney's Crossroads

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
06/16/83	P_P_DDE	Morone americana	0.57	0.20

State Subbasin 030307

* TSTARFC10 Far Creek near Englehard

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
07/02/86	P_P_DDE	Moxostoma sp.	0.250	0.20

State Subbasin 030307

* TSTARFC15 Far Creek near Englehard

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
07/02/86	P_P_DDE	Anguilla rostrata	0.380	0.20
07/02/86	P_P_DDE	Micropterus salmoides	0.330	0.20

*Stations TSTARFC10 and TSTARFC15 were the same location. Only one station (TSTARFC10) was plotted on the accompanying map.

Whole Fish Samples Exceeding Screening Values for Organochlorine Pesticides

State Subbasin Ø3Ø4Ø5

Ø2Ø895ØØ   Neuse River at US-7Ø bypass in Kinston

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
Ø7/Ø3/8Ø	P_P_DDE	Moxostoma sp.	Ø.21	Ø.2Ø
Ø9/25/81	P_P_DDE	Moxostoma sp.	Ø.32	Ø.2Ø
Ø7/1Ø/86	P_P_DDE	Ictalurus punctatus	Ø.34Ø	Ø.2Ø

State Subbasin Ø3Ø41Ø

Ø2Ø92162   Neuse River at New Bern

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Whole Fish Screening Value (ppm)
Ø7/17/8Ø	P_P_DDE	Ictalurus catus	Ø.21	Ø.2Ø

* Only one station (TSTARFC1Ø) was plotted on the accompanying map as these two stations were geographically the same site.

APPENDIX J

Fish Fillet Samples Exceeding Human Health Screening Values for Metals and Organochlorine Pesticides

Basin: CHOWAN

Subbasin 030101

02050079 Chowan River at Riddicksville near Como

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
10/16/86	HG	Amia calva	1.50	0.70	3853
10/16/86	HG	Amia calva	1.20	0.70	3852
10/16/86	HG	Amia calva	2.50	0.70	3901
10/16/86	HG	Micropterus salmoides	1.50	0.70	3529

0205324450 Chowan River at Winton

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/06/90	AS	Micropterus salmoides	1.2	0.70	7067

Subbasin 030150

DS-10 Corapeake Ditch off Dismal Swamp Canal

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/27/83	HG	Esox niger	0.81	0.70	1428
07/27/83	HG	Esox niger	0.96	0.70	1427
07/27/83	HG	Esox niger	1.3	0.70	1425

Subbasin 030151

0208117950 Croatan Sound at Manns Harbor

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
05/10/89	AS	Micropogon undulatus	1.20	0.70	4336
05/10/89	AS	Leiostomus xanthurus	0.83	0.70	4335

STUMPY-1 Stumpy Point Bay near Stumpy Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
05/10/89	AS	Micropogon undulatus	0.92	0.70	4201
05/10/89	AS	Micropogon undulatus	1.20	0.70	4200
05/10/89	AS	Cynoscion nebulosus	0.78	0.70	4203

Fish Fillet Samples Exceeding Human Health Screening Values
for Metals and Organochlorine Pesticides

Subbasin 030153

02081185 Kendricks Creek at SR-1300

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
06/08/83	HG	Amia calva	1.3	0.70	1411
06/08/83	TOT_DDT	Lepisosteus osseus	0.17	0.07	1412

PAS012 Lake Phelps

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/18/86	HG	Amia calva	1.70	0.70	3834
09/18/86	HG	Amia calva	1.90	0.70	3831
09/18/86	HG	Amia calva	2.80	0.70	3832
09/18/86	HG	Micropterus salmoides	0.93	0.70	3824
09/18/86	HG	Amia calva	1.70	0.70	3515
09/18/86	HG	Amia calva	1.90	0.70	3512
09/18/86	HG	Amia calva	2.80	0.70	3513
09/18/86	PB	Erimyzon oblongus	1.10	1.00	3494

Subbasin 030154

Currituck-2 Currituck Sound at Tull's Bay

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/07/90	AS	Perca flavescens	.94	0.70	7081

Fish Fillet Samples Exceeding Human Health Screening Values for Metals and Organochlorine Pesticides

Basin: ROANOKE

Subbasin 030201

BELEWS-10 Belews Lake near Plant/trailing Ponds

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
03/29/88	SE	Cyprinus carpio	13.0	12.00	4120
03/29/88	SE	Cyprinus carpio	14.0	12.00	4119
03/29/88	SE	Ictalurus punctatus	14.0	12.00	4115
03/29/88	SE	Ictalurus catus	17.0	12.00	4116
03/29/88	SE	Ictalurus catus	16.0	12.00	4117
03/29/88	SE	Ictalurus catus	13.0	12.00	4118

Subbasin 030203

02074218 Dan River at SR-1716 near Mayfield

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/12/86	HG	Micropterus salmoides	0.83	0.70	3884
09/12/86	HG	Micropterus salmoides	0.83	0.70	3585

Subbasin 030205

HYCO-1 Hyco Lake

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
03/22/88	SE	Cyprinus carpio	13.0	12.00	4093
03/22/88	SE	Cyprinus carpio	14.0	12.00	4096
03/22/88	SE	Cyprinus carpio	13.0	12.00	4091
03/22/88	SE	Tilapia sp.	16.0	12.00	4108
03/22/88	SE	Tilapia sp.	18.0	12.00	4107
03/22/88	SE	Tilapia sp.	20.0	12.00	4101
03/22/88	SE	Tilapia sp.	16.0	12.00	4106

MAYO-1 Mayo Lake

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
03/08/88	HG	Esox niger	1.30	0.70	4020

Subbasin 030208

Fish Fillet Samples Exceeding Human Health Screening Values for Metals and Organochlorine Pesticides

02080500 Roanoke River at NC-48 at Roanoke Rapids

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
10/30/86	HG	Amia calva	0.79	0.70	3776

TSROARR30 Roanoke River near Halifax

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
06/19/86	HG	Amia calva	0.88	0.70	3783

Subbasin 030209

02081141 Roanoke River at NC-45 near Sans Souci

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/05/84	HG	Amia calva	0.81	0.70	2279
09/05/84	HG	Lepomis macrochirus	0.78	0.70	2301
07/28/86	HG	Amia calva	0.86	0.70	3539

Fish Fillet Samples Exceeding Human Health Screening Values
for Metals and Organochlorine Pesticides

Basin: TAR-PAMLICO

Subbasin 030302

02082823 Tar River at Tarboro at NC-44

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/07/90	HG	Micropterus salmoides	.74	0.70	7084

Subbasin 030305

02084171 Tar River at SR-1565 near Grimesland

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
08/08/84	HG	Micropterus salmoides	1.0	0.70	2269
07/01/85	HG	Micropterus salmoides	0.89	0.70	2883

TSTAR120 Tar River at US-264 Bypass in Greenville

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/24/86	HG	Amia calva	0.72	0.70	3255
01/19/89	HG	Micropterus salmoides	0.92	0.70	4257

Subbasin 030307

02084472 Tar River at Washington

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
01/27/89	DIELDRIN	Morone saxatilis	0.007	0.00	4251

02092690 Pamlico River at Great Island

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
05/05/89	AS	Leiostomus xanthurus	1.20	0.70	4326

Fish Fillet Samples Exceeding Human Health Screening Values for Metals and Organochlorine Pesticides

MT-1 Lake Mattamuskeet at center canal

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
08/20/86	HG	Micropterus salmoides	0.77	0.70	3757
08/20/86	HG	Micropterus salmoides	0.77	0.70	3756
08/20/86	HG	Micropterus salmoides	0.86	0.70	3755
08/20/86	HG	Micropterus salmoides	0.78	0.70	3754

MT-2 Lake Mattamuskeet - south side

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
01/11/84	HG	Amia calva	1.4	0.70	1605
01/11/84	HG	Amia calva	0.90	0.70	1607
01/11/84	HG	Amia calva	1.0	0.70	1606
01/11/84	HG	Amia calva	0.97	0.70	3106
01/11/84	HG	Amia calva	1.3	0.70	1603
01/11/84	HG	Lepisosteus osseus	1.0	0.70	1601
02/22/84	HG	Esox niger	0.71	0.70	1658
02/22/84	HG	Lepisosteus osseus	1.0	0.70	1661

MT-3 Lake Mattamuskeet - Center

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
01/11/84	HG	Lepisosteus osseus	0.84	0.70	1609
01/11/84	HG	Lepisosteus osseus	0.86	0.70	1608

PUNGO-17 Pungo River near Durants Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
03/28/89	AS	Leiostomus xanthurus	1.80	0.70	4229

PUNGO-7/8 Pungo River below canal B near Pantego

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
03/04/83	HG	Amia calva	1.7	0.70	415

TAR 58 Pamlico River near Garrison Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
04/26/89	AS	Leiostomus xanthurus	0.75	0.70	4349

Fish Fillet Samples Exceeding Human Health Screening Values
for Metals and Organochlorine Pesticides

TAR0628A Pungo Lake

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/09/86	HG	Amia calva	1.80	0.70	3241
07/09/86	HG	Amia calva	1.10	0.70	3240

TAR56B Pamlico River at Blounts Bay

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
04/26/89	PB	Ictalurus catus	1.80	1.00	4472

TSTARR3 Rose Bay Creek

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
04/03/85	PB	Morone americana	1.9	1.00	2330

Fish Fillet Samples Exceeding Human Health Screening Values for Metals and Organochlorine Pesticides

Basin: NEUSE

Subbasin 030402

02087500 Neuse River at NC-42 near Clayton

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/04/85	HG	Micropterus salmoides	0.77	0.70	3020
09/04/85	HG	Micropterus salmoides	0.81	0.70	3021
09/04/85	HG	Micropterus salmoides	0.75	0.70	3022

TSNEU100 Neuse River above US-117 at near Goldsboro

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/10/86	HG	Lepisosteus osseus	0.75	0.70	3275

Subbasin 030405

02089500 Neuse River at US-70 bypass in Kinston

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
10/23/84	HG	Amia calva	0.77	0.70	2221
10/23/84	HG	Micropterus salmoides	0.83	0.70	2203

Subbasin 030407

0209176690 Contentnea Creek at Grifton

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
08/06/86	HG	Amia calva	1.20	0.70	3252
08/06/86	HG	Amia calva	1.50	0.70	3253

Subbasin 030409

NEU-119 Swift Creek at Vanceboro

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/05/90	HG	Micropterus salmoides	.75	0.70	7061

Fish Fillet Samples Exceeding Human Health Screening Values for Metals and Organochlorine Pesticides

Subbasin 030410

02092682 Neuse River at Mouth near Pamlico

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
03/21/89	AS	Paralichthys lethostigma	1.50	0.70	4486

NEU 139 Neuse River at Minnesott Beach

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
04/27/89	AS	Leiostomus xanthurus	1.8	0.70	4481
09/07/90	AS	Mugil cephalus	1.0	0.70	5086
09/07/90	AS	Mugil cephalus	.81	0.70	5087

NEUSC-1 Slocum Creek off Cherry PT

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
05/22/90	AS	Morone americana	1.2	0.70	4524

NEUSC-4 West Prong Slocum Creek

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
05/22/90	AS	Mugil cephalus	1.0	0.70	4563

NEUSC-5 Slocum Creek off Mill Creek

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
05/22/90	AS	Mugil cephalus	1.3	0.70	4516
05/22/90	AS	Mugil cephalus	1.0	0.70	4517
05/22/90	CU	Lepisosteus osseus	97.00	93.00	4508
05/22/90	CU	Dorosoma cepedianum	160.00	93.00	4513
05/22/90	PB	Lepisosteus osseus	3.40	1.00	4508
05/22/90	PB	Dorosoma cepedianum	6.20	1.00	4513
05/22/90	PB	Dorosoma cepedianum	3.10	1.00	4514

NEUSC4A Slocum Creek between boat ramp & bridge

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
12/13/90	PB	Micropterus salmoides	2.7	1.00	4967
12/13/90	PB	Micropterus salmoides	3.1	1.00	4970

Fish Fillet Samples Exceeding Human Health Screening Values for Metals and Organochlorine Pesticides

NEUSC5 Slocum Creek

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/06/90	AS	Mugil cephalus	1.8	0.70	4962
09/06/90	AS	Mugil cephalus	1.3	0.70	4963
12/13/90	AS	Leiostomus xanthurus	1.6	0.70	5027
12/13/90	AS	Leiostomus xanthurus	.90	0.70	5028
12/13/90	HG	Lepomis gibbosus	1.02	0.70	5025

SOUTHRIVER- South River at SouthRiver

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/18/90	AS	Leiostomus xanthurus	1.5	0.70	7065
09/07/90	AS	Micropogon undulatus	1.8	0.70	7066

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

River Basin: CHOWAN

69 Blackwater R. app 15 mi UPS Union Camp discharge

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Aug 18-25 1989	Channel Catfish	6.70	1.00	366.0
2/13/90	Channel Catfish	4.00	1.00	369.0
3/13/90	Blueback Herrin	1.40	1.00	371.0
3/13/90	Blueback Herrin	1.90	1.00	372.0
4/9/90	Channel Catfish	1.90	1.00	
4/9/90	Channel Catfish	2.20	1.00	
7/10/90	Channel Catfish	1.60	1.00	
7/10/90	Channel Catfish	2.50	1.00	
11/7-8/90	Channel Catfish	6.60	1.00	

70 Blackwater R. app 5 mi UPS Union Camp discharge

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Feb-88	Bullhead	1.20	1.00	373.0
Feb-88	Catfish	1.80	1.00	374.0
Feb-88	Catfish	2.10	1.00	375.0
May 2-12,1989	Channel Catfish	1.30	1.00	376.0
May 2-12,1989	Channel Catfish	1.50	1.00	377.0
May 2-12,1989	Channel Catfish	1.40	1.00	378.0
May 2-12,1989	Channel Catfish	1.60	1.00	379.0

71 Blackwater R. at Union Camp discharge*

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
10/6/88	Bullhead	1.90	1.00	380.0
9/20/88	Largemouth Bass	1.50	1.00	381.0

72 Blackwater Mill Site*

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
4/15/90	Blueback Herrin	1.20	1.00	382.0
4/15/90	Blueback Herrin	1.30	1.00	383.0

*Note: Stations 71 and 72 are the same site; station 71 is the station code used on the GIS map.

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

73 Nottoway River Below Rt 671

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Nov 10-29,1989	Channel Catfish	2.20	1.00	384.0
4/26/90	Channel Catfish	9.20	1.00	
4/26/90	Channel Catfish	3.30	1.00	
7/25/90	Channel Catfish	1.60	1.00	
11/14/90	Channel Catfish	1.70	1.00	

75 Meherrin River Rt 258 just below Murfreesboro

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
12/8/89	Channel Catfish	13.50	1.00	390.0
12/8/89	Channel Catfish	1.10	1.00	391.0
2/2/90	Channel Catfish	4.10	1.00	393.0
5/8/90	Channel Catfish	5.00	1.00	
5/8/90	Channel Catfish	28.00	1.00	
8/15/90	Channel Catfish	2.20	1.00	
8/15/90	Channel Catfish	1.10	1.00	

76 Chowan River at Winton

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Feb-88	Catfish	4.50	1.00	394.0
Feb-88	Catfish	5.60	1.00	395.0
3/18/89	Channel Catfish	32.00	1.00	396.0
3/18/89	Channel Catfish	21.10	1.00	397.0
3/18/89	Channel Catfish	28.00	1.00	398.0
3/18/89	Channel Catfish	26.40	1.00	
May 20-June 4,1989	Channel Catfish	36.30	1.00	399.0
May 20-June 4,1989	Channel Catfish	29.30	1.00	400.0
May 20-June 4,1989	Channel Catfish	31.30	1.00	401.0
May 20-June 4,1989	Channel Catfish	30.90	1.00	402.0
May 20-June 4,1989	Channel Catfish	13.70	1.00	403.0
May 20-June 4,1989	Channel Catfish	12.60	1.00	407.0
May 20-June 4,1989	Channel Catfish	5.90	1.00	404.0
May 20-June 4,1989	Channel Catfish	7.20	1.00	405.0
May 20-June 4,1989	Channel Catfish	4.90	1.00	406.0
Oct 5-27,1989	Channel Catfish	12.00	1.00	408.0
Feb 22-23,1990	Channel Catfish	49.80	1.00	415.0
Feb 22-23,1990	Channel Catfish	73.20	1.00	416.0
4/5/90	Bluegill	1.10	1.00	

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

4/11/90	Blueback Herrin	1.40	1.00	418.0
4/11/90	Blueback Herrin	1.30	1.00	419.0
4/18/90	Channel Catfish	13.70	1.00	
4/18/90	Channel Catfish	5.90	1.00	
9/6/90	White Catfish	1.20	1.00	421.0
9/28/90	Channel Catfish	3.40	1.00	
9/28/90	Channel Catfish	3.70	1.00	
12/7/90	Channel Catfish	34.80	1.00	

77 Chowan River Near Marker 16

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
11/30/89	Channel Catfish	11.80	1.00	422.0
11/30/89	Channel Catfish	37.90	1.00	423.0
2/13/90	Channel Catfish	24.20	1.00	424.0
2/13/90	Channel Catfish	22.30	1.00	425.0
4/18/90	Blueback Herrin	1.50	1.00	426.0
4/18/90	Blueback Herrin	1.20	1.00	427.0
6/27/90	Channel Catfish	9.20	1.00	
6/27/90	Channel Catfish	12.00	1.00	
9/14/90	Channel Catfish	1.20	1.00	
9/14/90	Channel Catfish	2.70	1.00	
12/7/90	Channel Catfish	20.30	1.00	

78 Chowan River Near Marker 9

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
12/5/89	Channel Catfish	28.20	1.00	428.0
12/5/89	Channel Catfish	70.20	1.00	429.0
2/13/90	Channel Catfish	11.30	1.00	430.0
2/13/90	Channel Catfish	5.20	1.00	431.0
6/27/90	Channel Catfish	30.60	1.00	
6/27/90	Channel Catfish	47.10	1.00	
9/14/90	Channel Catfish	2.90	1.00	
9/14/90	Channel Catfish	78.60	1.00	
12/7/90	Channel Catfish	10.10	1.00	

79 Chowan River at Colerain

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
9/12/90	Mullet	7.60	1.00	432.0
9/11/90	Channel Catfish	9.30	1.00	433.0
9/11/90	Striped Bass	2.50	1.00	434.0

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

9/11/90	White Perch	2.00	1.00	435.0

80 Chowan River Near Marker 5

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
12/5/89	Channel Catfish	37.00	1.00	436.0
12/5/89	Channel Catfish	39.10	1.00	437.0
2/14/90	Channel Catfish	24.30	1.00	438.0
2/14/90	Channel Catfish	12.10	1.00	439.0
6/27/90	Channel Catfish	79.00	1.00	
6/27/90	Channel Catfish	57.80	1.00	
9/14/90	Channel Catfish	2.80	1.00	
9/14/90	Channel Catfish	50.00	1.00	
12/7/90	Channel Catfish	23.60	1.00	

81 Chowan River Near Hwy 17 Bridge

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
9/11/90	White Perch	9.30	1.00	440.0
9/11/90	White Perch	3.80	1.00	441.0
9/11/90	Striped Bass	2.80	1.00	442.0
9/11/90	Channel Catfish	4.70	1.00	443.0
12/5/89	Channel Catfish	57.80	1.00	444.0
12/5/89	Channel Catfish	53.10	1.00	445.0
2/13/90	Channel Catfish	24.60	1.00	446.0
2/13/90	Channel Catfish	59.80	1.00	447.0
11/14/89	White Perch	3.40	1.00	448.0
11/14/89	Pumpkinseed	2.10	1.00	449.0
10/6/90	Channel Catfish	4.90	1.00	450.0
Sept 26-27, 1990	White Perch	2.50	1.00	453.0
Sept 26-27, 1990	White Perch	3.80	1.00	454.0
6/27/90	Channel Catfish	39.20	1.00	
6/27/90	Channel Catfish	48.00	1.00	
9/14/90	Channel Catfish	29.00	1.00	
9/14/90	Channel Catfish	74.90	1.00	
12/7/90	Channel Catfish	31.70	1.00	

CR Chowan River at Gatlington

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
6/15/90	Channel Catfish	2.50	1.00	
6/15/90	Channel Catfish	3.60	1.00	
9/28/90	Channel Catfish	4.20	1.00	

11/20/90	Channel Catfish	2.50	1.00	

CR Chowan River Near Marker 2

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
6/27/90	Channel Catfish	56.50	1.00	
6/27/90	Channel Catfish	78.90	1.00	
9/14/90	Channel Catfish	28.00	1.00	
9/14/90	Channel Catfish	37.60	1.00	
12/13-14/90	Channel Catfish	28.70	1.00	

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

River Basin: ROANOKE

52 Roanoke River at Weldon (Hatch)

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
5/6/89	Striped Bass	14.70	1.00	253.0
5/6/89	Striped Bass	11.20	1.00	254.0

55 Roanoke River at Williamston

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
10/6/89	Channel Catfish	28.30	1.00	266.0

56 (Roanoke River) Broad Cr. Slough

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
April/May 1989	Black Crappie	14.20	1.00	273.0
April/May 1989	Black Crappie	1.90	1.00	274.0
April/May 1989	White Perch	34.70	1.00	275.0
April/May 1989	White Perch	4.10	1.00	276.0
April/May 1989	Chubsucker	1.40	1.00	278.0
April/May 1989	Gizzard Shad	43.40	1.00	279.0

57 Welch Creek at Highway 64

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
April/May 1989	Bluegill	20.70	1.00	280.0
April/May 1989	Black Crappie	10.70	1.00	281.0
April/May 1989	Herring	12.70	1.00	283.0
April/May 1989	Gizzard Shad	69.60	1.00	284.0
April/May 1989	Chub Sucker	81.20	1.00	285.0
10/23/89	Bluegill	1.40	1.00	287.0

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

58 Welch Creek Old Discharge Trowbridge Rd.

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
April/May 1989	Brown Bullhead	30.10	1.00	288.0
April/May 1989	Brown Bullhead	77.90	1.00	289.0
April/May 1989	White Catfish	73.90	1.00	290.0
April/May 1989	White Catfish	45.50	1.00	291.0
April/May 1989	Bluegill	60.50	1.00	292.0
April/May 1989	Largemouth Bass	33.80	1.00	293.0
April/May 1989	Largemouth Bass	19.20	1.00	294.0
April/May 1989	Herring	4.30	1.00	295.0
April/May 1989	Gizzard Shad	110.00	1.00	296.0
April/May 1989	Gizzard Shad	108.80	1.00	297.0
April/May 1989	Gizzard Shad	88.60	1.00	298.0
April/May 1989	Chub Sucker	52.80	1.00	299.0
April/May 1989	Golden Shiner	45.50	1.00	300.0
Sept 27,29,1989	Black Crappie	44.70	1.00	301.0
Sept 27,29,1989	Channel Catfish	123.10	1.00	302.0

59 Welch Cr at old Weyerhaeuser discharge

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
12/14/87	Largemouth Bass	20.30	1.00	303.0
12/14/87	Cr Chub	180.17	1.00	304.0
May 23-Sept 21, 1990	Black Crappie	7.30	1.00	305.0
Sept 19-21, 1990	Channel Catfish	11.40	1.00	306.0
23-May-90	Largemouth Bass	5.00	1.00	307.0
May 23-June 5, 1990	Pumpkinseed	4.60	1.00	308.0
June 5-Sept 27, 1990	White Catfish	6.40	1.00	309.0
June 5-Sept 27, 1990	White Catfish	6.50	1.00	310.0
5-Jun-90	White Catfish	5.50	1.00	311.0

60 Roanoke River at Plymouth

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
10/11/90	Blue Crab	6.00	1.00	312.0

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

6Ø Roanoke River near Weyerhaeuser discharge

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
12/2Ø/88	Largemouth Bass	23.2Ø	1.ØØ	313.Ø
April/May 1989	White Catfish	26.2Ø	1.ØØ	314.Ø
April/May 1989	Bluegill	18.5Ø	1.ØØ	315.Ø
April/May 1989	Bluegill	18.2Ø	1.ØØ	316.Ø
April/May 1989	Black Crappie	7.ØØ	1.ØØ	317.Ø
April/May 1989	Yellow Perch	7.6Ø	1.ØØ	318.Ø

61 Middle River at NC 45

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
5/2/89	Largemouth Bass	9.5Ø	1.ØØ	32Ø.Ø
5/2/89	Channel Catfish	94.2Ø	1.ØØ	321.Ø

63 Roanoke River at Marker 15

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
April/May 1989	White Catfish	14.6Ø	1.ØØ	323.Ø
April/May 1989	White Catfish	14.1Ø	1.ØØ	324.Ø
April/May 1989	White Catfish	18.9Ø	1.ØØ	325.Ø
April/May 1989	Bluegill	16.9Ø	1.ØØ	326.Ø
April/May 1989	Bluegill	8.ØØ	1.ØØ	327.Ø
April/May 1989	Black Crappie	21.ØØ	1.ØØ	328.Ø
April/May 1989	Black Crappie	27.6Ø	1.ØØ	329.Ø
April/May 1989	Black Crappie	36.9Ø	1.ØØ	33Ø.Ø
April/May 1989	Yellow Perch	16.3Ø	1.ØØ	331.Ø
1Ø/2/89	Bluegill	2Ø.8Ø	1.ØØ	332.Ø
Sept 27,29,1989	Black Crappie	4.8Ø	1.ØØ	333.Ø
Sept 27,29,Oct4,1989	Channel Catfish	43.7Ø	1.ØØ	334.Ø
Sept 11-13, 199Ø	Black Crappie	1.5Ø	1.ØØ	335.Ø
Sept 11-13, 199Ø	Channel Catfish	26.4Ø	1.ØØ	336.Ø
Sept 11-12, 199Ø	Largemouth Bass	2.4Ø	1.ØØ	337.Ø
Sept 11-12, 199Ø	Largemouth Bass	1.9Ø	1.ØØ	338.Ø
Sept 11-13, 199Ø	White Catfish	8.ØØ	1.ØØ	339.Ø

Note: Stations 63 and 65 are the same geographic location. Only the location of station 63 is mapped on Figure 5-7.

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

64 Roanoke River at Sans Souci

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
5/2/89	Largemouth Bass	10.80	1.00	340.0
5/2/89	Largemouth Bass	21.80	1.00	341.0
5/2/89	Redear	6.70	1.00	342.0
12/20/88	Largemouth Bass	29.00	1.00	343.0
5/2/89	Largemouth Bass	13.60	1.00	344.0
5/2/89	Largemouth Bass	24.00	1.00	345.0

65 Roanoke River at Mouth

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
5/2/89	Largemouth Bass	9.10	1.00	346.0
5/2/89	Largemouth Bass	10.70	1.00	348.0
5/2/89	Largemouth Bass	11.30	1.00	349.0
5/2/89	Largemouth Bass	12.00	1.00	350.0

66 Cashie River at Windsor

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Oct 6-7, 1990	Channel Catfish	1.60	1.00	352.0

67 Cashie River at San Souci Ferry

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Sept 19-20, 1990	Channel Catfish	1.40	1.00	356.0

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

River Basin: ALBEMARLE

62 Albemarle Snd @ Terrapin Pt

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
5/2/89	Largemouth Bass	8.10	1.00	322.0

68 Albemarle Sound at Marker 1

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Sept 11-13, 1990	Channel Catfish	16.70	1.00	359.0
Sept 11-13, 1990	Channel Catfish	21.50	1.00	360.0
Sept 11-13, 1990	Channel Catfish	10.10	1.00	361.0
Sept 11-13, 1990	Largemouth Bass	1.80	1.00	362.0
Sept 12-21, 1990	White Perch	7.90	1.00	363.0
1/24/90	White Perch	30.50	1.00	

82 Albemarle Snd @ Norfolk & Southern

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
6/8/89	Redhorse Sucker	50.50	1.00	455.0
9/6/90	Mullet	8.50	1.00	456.0
9/6/90	White Perch	5.20	1.00	457.0
9/6/90	Atl Sturgeon	2.40	1.00	458.0
9/6/90	Atl Sturgeon	2.20	1.00	459.0
9/6/90	Blue Crab	3.40	1.00	460.0
9/6/90	Channel Catfish	12.30	1.00	461.0
9/6/90	Striped Bass	7.40	1.00	462.0

83 Albemarle Sound at Hwy 32

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
25-Oct-90	Striped Bass	7.80	1.00	464.0
25-Oct-90	Striped Bass	8.70	1.00	465.0
31-Jan-90	Yellow Perch	4.90	1.00	
24-Jan-90	White Catfish	13.20	1.00	
24-Jan-90	White Catfish	12.40	1.00	

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

84 Albemarle Snd @ Harvey's Point

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
6/9/89	Striped Bass	8.70	1.00	468.0
9/10/90	White Cat	1.90	1.00	469.0
9/10/90	White Perch	2.40	1.00	471.0

85 Albemarle Snd @ Bull Bay

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
9/6/90	Striped Bass	5.70	1.00	472.0
9/6/90	Channel Catfish	14.60	1.00	473.0
1/31/90	White Catfish	7.70	1.00	
1/31/90	White Perch	42.40	1.00	
1/31/90	White Perch	14.80	1.00	

87 Albemarle Snd @ Wade Point

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
6/9/89	White Cat	11.50	1.00	481.0
9/11/90	Striped Bass	4.30	1.00	483.0
9/11/90	Striped Bass	2.30	1.00	484.0
9/11/90	Spot	2.90	1.00	485.0

95 Core Sound

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
11/7/89	Blue Crab	4.59	1.00	509.0

Shellfish Samples Exceeding Human Health Screening Values for Metals

Basin: PASQUOTANK

Subbasin 030151

MC-6 Mill Landing Creek at Mouth

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/23/85	ZN	Crassostrea virginica	830.0	467.0000	2579
07/23/85	ZN	Crassostrea virginica	880.0	467.0000	2580
07/23/85	ZN	Crassostrea virginica	1300.0	467.0000	2582
07/23/85	ZN	Crassostrea virginica	730.0	467.0000	2581

MC-8 Roanoke Sound just below Mill Landing Creek

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/23/85	ZN	Crassostrea virginica	850.0	467.0000	2576
07/23/85	ZN	Crassostrea virginica	790.0	467.0000	2577
07/23/85	ZN	Crassostrea virginica	590.0	467.0000	2578

MC-9 Broad Creek at Mouth

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/23/85	ZN	Crassostrea virginica	490.0	467.0000	2586

Mill-2 Mill Creek near Wawchese

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
01/19/89	ZN	Crassostrea virginica	1100	467.0000	7055

STUMPY-1 Stumpy Point Bay near Stumpy Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
05/10/89	AS	Callinictes sapidus	1.50	0.7000	4207

Subbasin 030152

02081145 Albemarle Sound at Norfolk and Southern RR Trestle

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/06/90	AS	Callinectes sapidus	1.2	0.7000	6036

Subbasin 030155

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

River Basin: TAR-PAMLICO

91 Pamlico River near South Creek

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
10/12/89	Blue Crab	3.19	1.00	498.0

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

River Basin: NEUSE

39 Neuse R at Greens Thoroughfare above Cowpens

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Mr-May 1989	Brown Bullhead	1.30	1.00	180.0
Mr-May 1989	Brown Bullhead	3.50	1.00	181.0
Mr-May 1989	White Catfish	11.40	1.00	182.0
Mr-May 1989	White Catfish	10.10	1.00	183.0
Mr-May 1989	Blue Catfish	7.20	1.00	184.0
Mr-May 1989	Blue Catfish	9.90	1.00	185.0

40 Neuse River near Weyerhaeuser Eff

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
9/1/88	Largemouth Bass	6.58	1.00	187.0
9/1/88	Redhorse Sucker	79.10	1.00	188.0
Mr-May 1989	Brown Bullhead	4.80	1.00	189.0
Mr-May 1989	Brown Bullhead	3.30	1.00	190.0
Mr-May 1989	Brown Bullhead	3.70	1.00	191.0
Mr-May 1989	Bluegill	7.00	1.00	192.0
Mr-May 1989	Pumpkinseed	2.50	1.00	194.0
Mr-May 1989	Largemouth Bass	9.70	1.00	195.0
Mr-May 1989	Yellow Perch	1.40	1.00	196.0

41 Swift Creek at Vanceboro

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
9/5/90	White Catfish	1.90	1.00	204.0

42 Neuse River at Marker 52

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Mr-May 1989	Brown Bullhead	10.70	1.00	206.0
Mr-May 1989	Brown Bullhead	4.80	1.00	207.0
Mr-May 1989	White Catfish	14.10	1.00	208.0
Mr-May 1989	Bluegill	7.30	1.00	209.0
Mr-May 1989	Pumpkinseed	2.70	1.00	210.0

Fish Fillet Samples Exceeding the Human Health Screening Value for Dioxin

Mr-May 1989	Pumpkinseed	4.50	1.00	211.0

43 Neuse River at Marker 38

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
2-Oct-90	Striped Mullet	1.30	1.00	220.0

44 Trent River at Hayward Creek

Sampling Date	Species	Total Dioxin (ppt)	Fish Filet Dioxin Screening Value (ppt)	Sample No.
Mr-May 1989	Pumpkinseed	4.20	1.00	222.0
Mr-May 1989	White Perch	13.40	1.00	223.0

Shellfish Samples Exceeding Human Health Screening Values for Metals

BUX-1 Pamlico Sound near Scott's Boatyard

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
01/18/89	AS	Crassostrea virginica	1.4	0.7000	6064

BUX-1-IN Pamlico Sound near Scott's Boatyard - Inside

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
01/19/89	AS	Crassostrea virginica	1.2	0.7000	7057
01/19/89	ZN	Crassostrea virginica	900	467.0000	7057

BUX-1-OUT Pamlico Sound near Scott's Boat - Outside

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
01/19/89	AS	Crassostrea virginica	1.2	0.7000	7056

Basin: ROANOKE

Subbasin 030209

02081141 Roanoke River at NC-45 near Sans Souci

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
10/11/90	PB	Callinectes sapidus	2.8	1.0000	7054

Basin: TAR-PAMLICO

Subbasin 030302

02082823 Tar River at Tarboro at NC-44

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/06/87	PB	Elliptio complanata	1.10	1.0000	3977

Subbasin 030307

TAR 58 Pamlico River near Garrison Point

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
04/26/89	AS	Callinictes sapidus	0.75	0.7000	4352

TSTARFC15 Far Creek near Englehard

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
04/05/85	ZN	Crassostrea virginica	480.0	467.0000	2513

Shellfish Samples Exceeding Human Health Screening Values for Metals

Basin: NEUSE

Subbasin 030406

02088500 Little River at Princeton

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/07/87	PB	Elliptio complanata	1.10	1.0000	3981

Subbasin 030407

TSNEUCC5 Contentnea Creek at Hominy Swamp

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
09/24/85	PB	Elliptio complanata	1.60	1.0000	3034
09/24/85	PB	Elliptio complanata	1.10	1.0000	3033

TSNEUNS4 Nahunta Swamp at SR-1537

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
08/13/87	PB	Elliptio complanata	1.10	1.0000	3983

Subbasin 030410

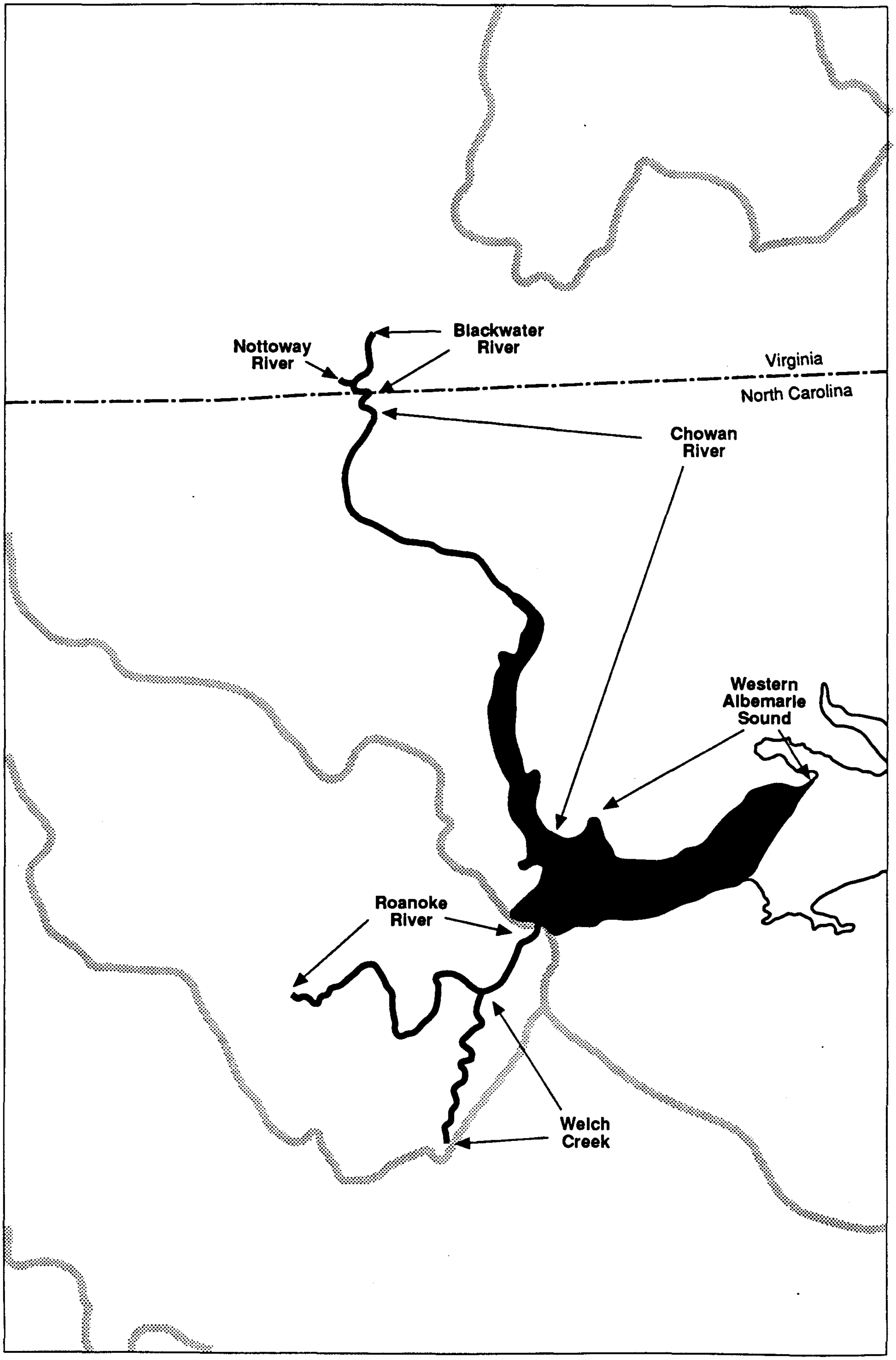
02092682 Neuse River at Mouth near Pamlico

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
03/21/89	AS	Callinictes sapidus	1.90	0.7000	4344
03/21/89	AS	Crassostrea virginica	1.00	0.7000	4345

NEU-OR Neuse River near Oriental

Sampling Date	Pollutant	Genus/Species	Measured Value (ppm)	Fish Filet Screening Value (ppm)	Sample No.
07/23/87	PB	Callinictes sapidus	2.5	1.0000	3949

APPENDIX K


Blackwater River
Nottoway River
Virginia
North Carolina
Chowan River
Western Albemarle Sound
Roanoke River
Welch Creek

CURRENT STATE FISH AND SHELLFISH CONSUMPTION ADVISORIES AND BANS

STATE	POLLUTANT	NATURE OF ADVISORY	FISH (common name)	WATERBODY NAME	GEOGRAPHIC EXTENT
VA	PCBs	NCGP	All fish species	N. F. Shenandoah River	Passage Cr to confl. with Shenandoah R
VA	Dioxins *	NCGP	Bottom feeding species	Blackwater River	Union Camp plant to Nottoway R (5 mi)
VA	Dioxins *	NCGP	All fish species	Jackson River	From dam above Dunlap Cr to James River
VA	Dioxins *	NCGP	Bottom feeding species	Nottoway River	Gen. Vaughan Bridge (U.S. 258) to NC border
VA	Dioxins *	NCGP	All fish species	James River	Confluence with Jackson River downstream to Snowden Dam
NC	Dioxins *	NCGP	All fish species	Pigeon River	From Canton NC to TN State Line
NC	Dioxins *	NCsp, RCP	All fish species except herring, shad, and shellfish	Albemarle Sound	All waters west of a line from Harvey Point to Laurel Point
NC	Dioxins *	NCsp, RCP	All fish species except herring, shad, and shellfish	Welch Creek	Beaufort, Martin, & Washington Cos.
NC	Dioxins *	NCsp, RCP	All fish species except herring, shad, and shellfish	Roanoke River	Hwy 17 in Williamston to mouth at Albemarle Sound
NC	Dioxins *	NCsp, RCP	All fish species except herring, shad, and shellfish	Chowan River	Virginia border to mouth at Albemarle Sound
NC	Mercury	NCGP	All fish species	High Rock Lake	Abbotts Creek Arm
NC	Selenium	NCGP	All fish species	Belews Lake	All waters
NC	Selenium	NCGP	All fish species	Hyco Lake	All waters

K-4

DEFINITIONS FOR FISH ADVISORIES AND BANS

NCGP No consumption fish advisory or ban
"Advises against consumption of fish or shellfish species by the general population."

NCsp No consumption fish advisory or ban for a sub-population:
"Advises against consumption of fish or shellfish species by a subpopulation that could be at potentially greater risk (e.g., pregnant women, nursing mothers or children)."

RCP Restricted consumption fish advisory or ban:
"Advises restricted consumption (e.g., a limited number of meals or size of meals per unit time) of fish or shellfish species by the general population."

Rsp Restricted consumption fish advisory or ban for a subpopulation:
"Advises restricted consumption (e.g., limited number of meals or size of meals per unit time) of fish or shellfish species by a subpopulation that could be at potentially greater risk (e.g., pregnant women, nursing mothers, or children)."

CFB . Commercial fishing ban:
"Prohibits commercial fishing, commercial harvesting, and/or the sale of fish and shellfish."

* Indicates dioxins and/or dibenzofurans may be present.

Note: MN, IL, WI, IN, MA are states that have multiple entries for some waterbodies where different advisories are listed for different fish species.

APPENDIX L

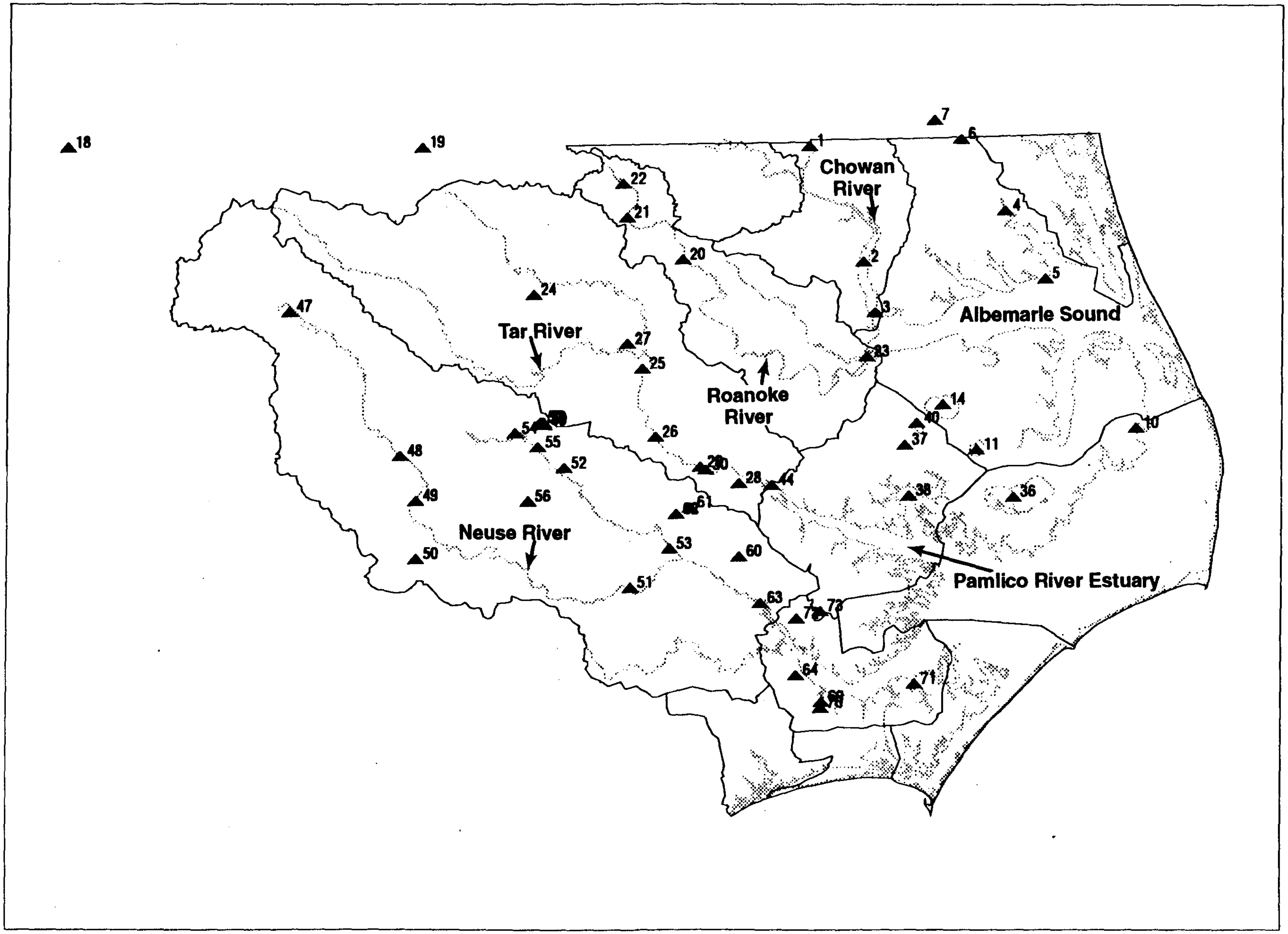


Figure L-1. Sites where mercury concentrations in whole fish exceeded the level of concern.

Whole Fish -- HG

#	Longitude	Latitude	Station	Basin	Basin #	Exceedence Type
1	76.9214	36.5317	02050079	Chowan	030101	CU,HG,PB
2	76.7347	36.1950	02053632	Chowan	030103	CU,HG
3	76.6972	36.0472	02053652	Chowan	030104	CU,HG,PB,DDE
4	76.2186	36.3333	02043862	Pasquotank	030150	CU,HG
5	76.0792	36.1333	02081179	Pasquotank	030150	CU,HG,DDE
6	76.3722	36.5431	DS-10	Pasquotank	030150	HG,PB,ZN
7	76.4667	36.6000	DS-3/5	Pasquotank	030150	HG
10	75.7661	35.6906	STUMPY-1	Pasquotank	030151	AS,CU,HG
11	76.3417	35.6417	TSPASNL1	Pasquotank	030151	CD,HG,PB
14	76.4583	35.7750	PAS012	Pasquotank	030153	CD,CU,HG,PB
18	79.6058	36.5414	02074218*	Roanoke	030203	CD,CU,HG,PB
19	78.3250	36.5417	0207933350*	Roanoke	030206	CU,HG,PB,DDE
20	77.3842	36.2094	02081000	Roanoke	030208	CD,CU,HG,PB,ZN,DDE
21	77.5833	36.3333	TSROARR30	Roanoke	030208	CD,CU,HG
22	77.5972	36.4306	WELDON-HATC	Roanoke	030208	AS,CU,HG,PB
23	76.7292	35.9194	02081141	Roanoke	030209	CU,HG
24	77.9211	36.1117	02082770	Tar-Pamlico	030302	CU,HG
25	77.5333	35.8944	02082823	Tar-Pamlico	030302	CU,HG,PB,DDE
26	77.4903	35.6958	02083692	Tar-Pamlico	030303	HG,DDE
27	77.5867	35.9667	02082812	Tar-Pamlico	030304	HG,ZN
28	77.1917	35.5583	02084171	Tar-Pamlico	030305	CD,CU,HG,PB,DDE
29	77.3303	35.6072	TSTAR120	Tar-Pamlico	030305	HG,PB,SE,ZN,CD,CU
30	77.3111	35.5986	TSTAR120D	Tar-Pamlico	030305	CU,HG,PB
36	76.2153	35.5014	MT-1	Tar-Pamlico	030307	HG
37	76.5986	35.6611	PUNGO-1	Tar-Pamlico	030307	HG
38	76.5889	35.5125	PUNGO-17	Tar-Pamlico	030307	AS,CU,HG,SE
40	76.5533	35.7228	TAR0628A	Tar-Pamlico	030307	CD,CU,HG,ZN
44	77.0767	35.5503	TSTARKDY	Tar-Pamlico	030307	CU,HG
47	78.8028	36.0667	TSNEUFNR2	Neuse	030401	HG
48	78.4058	35.6472	02087500	Neuse	030402	CU,HG,PB
49	78.3500	35.5156	NEU055	Neuse	030402	CD,CU,HG
50	78.3500	35.3472	TSNEU100	Neuse	030402	CU,HG
51	77.5858	35.2581	02089500	Neuse	030405	CD,CU,HG,PB,DDE
52	77.8183	35.6083	02090634	Neuse	030407	CD,HG,PB
53	77.4444	35.3708	0209176690	Neuse	030407	CD,HG,ZN
54	77.9931	35.7111	TSNEUCC1C	Neuse	030407	HG
55	77.9111	35.6694	TSNEUCC4	Neuse	030407	CD,CU,HG,ZN
56	77.9486	35.5125	TSNEUNS4	Neuse	030407	HG,PB
57	77.9014	35.7417	TSNEUTS1	Neuse	030407	HG,PB
58	77.8917	35.7417	TSNEUTS3	Neuse	030407	HG,PB,ZN
59	77.8875	35.7347	TSNEUTS5	Neuse	030407	CU,HG,PB
60	77.1958	35.3450	02092000	Neuse	030409	CD,HG,PB
61	77.3667	35.4889	TSNEUFS03	Neuse	030409	CU,HG
62	77.4181	35.4708	TSNEUSC03	Neuse	030409	CD,CU,HG
63	77.1222	35.2083	02092162	Neuse	030410	CD,CU,HG,PB,DDE
64	77.0014	34.9958	0209257120	Neuse	030410	HG
69	76.9125	34.9167	NEUSC1	Neuse	030410	HG
70	76.9153	34.8989	NEUSC2	Neuse	030410	CD,CU,HG
71	76.5833	34.9639	SOUTHRIVER-	Neuse	030410	AS,CU,HG
72	76.9944	35.1611	TSNEUMS1	Neuse	030410	HG
73	76.9111	35.1819	TSNEUPC2	Neuse	030410	HG,ZN

Figure L-1 (continued)

Whole Fish -- HG

#	Longitude	Latitude	Station	Basin	Basin #	Exceedence Type
6	76.3722	36.5431	DS-10	Pasquotank	030150	HG,PB,ZN
59	77.8917	35.7417	TSNEUTS3	Neuse	030407	HG,PB,ZN
27	77.5867	35.9667	02082812	Tar-Pamlico	030304	HG,ZN
74	76.9111	35.1819	TSNEUPC2	Neuse	030410	HG,ZN

Figure L-1 (continued)

*Note: These stations are located within the Roanoke River Basin, but are not located within the Albemarle-Pamlico Study Area.

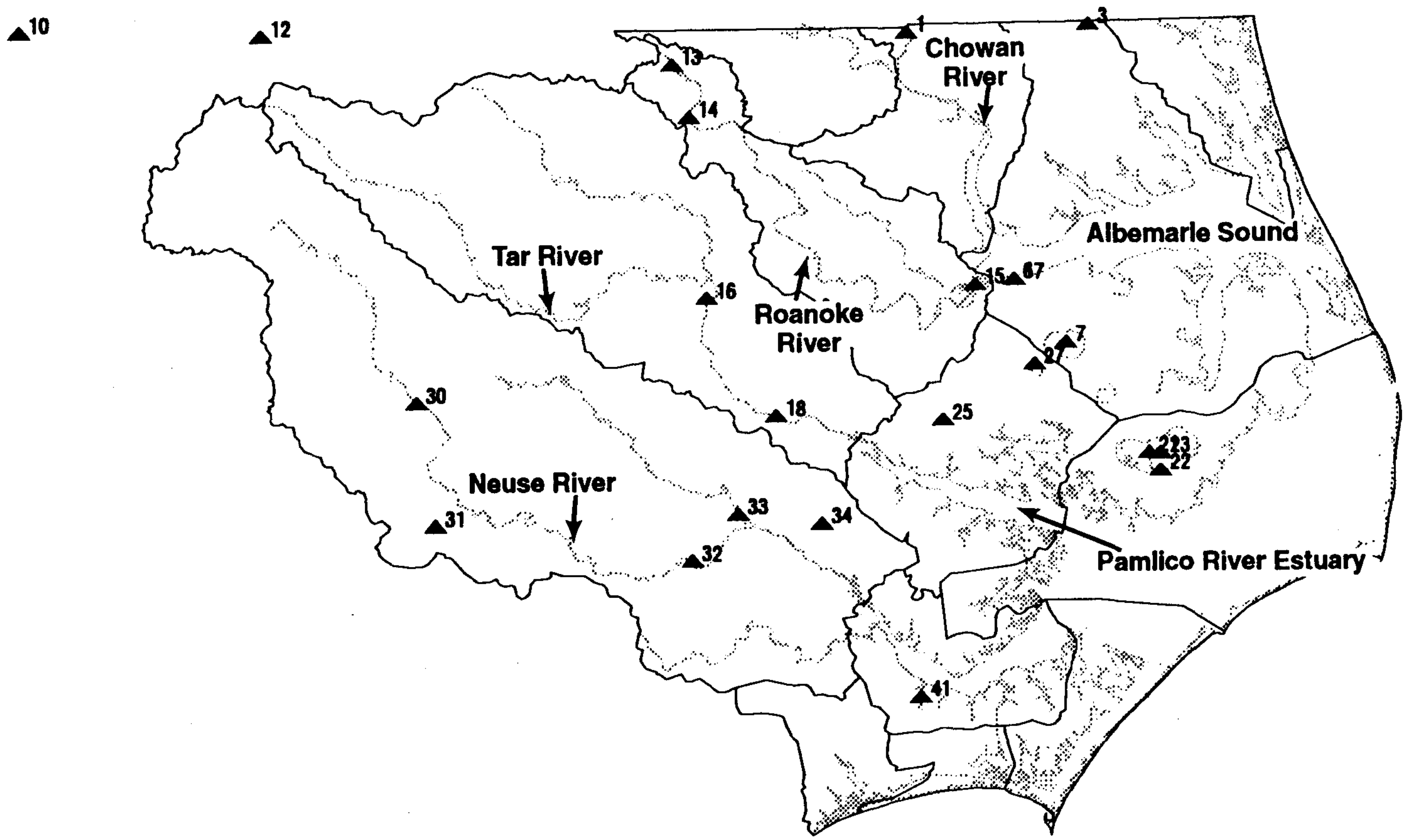


Figure L-2. Sites where mercury concentrations in fish tissue exceeded the human health SV.

Fish Filet-HG

#	Longitude	Latitude	Station	Basin Name	Basin	Exceedence Type
1	76.9214	36.5317	02050079	Chowan	030101	HG
3	76.3722	36.5431	DS-10	Pasquotank	030150	HG
6	76.6111	35.9292	02081185	Pasquotank	030153	HG,TOT_DDT
7	76.4583	35.7750	PAS012	Pasquotank	030153	HG,PB
10	79.6058	36.5414	02074218*	Roanoke	030203	HG
12	78.8753	36.5356	MAYO-1*	Roanoke	030205	HG
13	77.6344	36.4603	02080500	Roanoke	030208	HG
14	77.5833	36.3333	TSROARR30	Roanoke	030208	HG
15	76.7292	35.9194	02081141	Roanoke	030209	HG
16	77.5333	35.8944	02082823	Tar-Pamlico	030302	HG
17	76.6100	35.9297	02084171	Tar-Pamlico	030305	HG
18	77.3303	35.6072	TSTAR120	Tar-Pamlico	030305	HG
21	76.2153	35.5014	MT-1	Tar-Pamlico	030307	HG
22	76.1833	35.4583	MT-2	Tar-Pamlico	030307	HG
23	76.1833	35.5000	MT-3	Tar-Pamlico	030307	HG
25	76.8333	35.5917	PUNGO-7/8	Tar-Pamlico	030307	HG
27	76.5533	35.7228	TAR0628A	Tar-Pamlico	030307	HG
30	78.4058	35.6472	02087500	Neuse	030402	HG
31	78.3500	35.3472	TSNEU100	Neuse	030402	HG
32	77.5858	35.2581	02089500	Neuse	030405	HG
33	77.4444	35.3708	0209176690	Neuse	030407	HG
34	77.1958	35.3450	NEU-119	Neuse	030409	HG
41	76.9125	34.9194	NEUSC5	Neuse	030410	AS,HG

Figure L-2 (continued)

*Note: These stations are within the Roanoke River Basin, but are not located within the Albemarle-Pamlico Study Area.