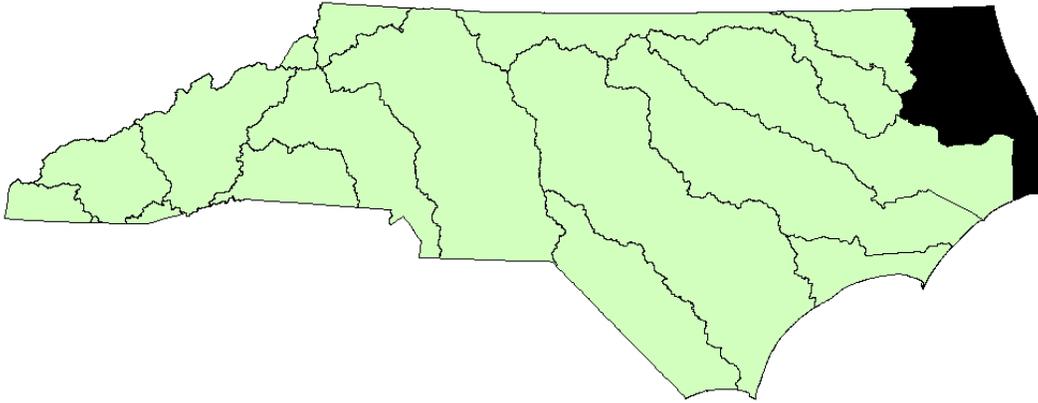


PASQUOTANK RIVER BASINWIDE ASSESSMENT
MAY, 2006

CONTENTS



This document provides overviews from four program areas within the Environmental Sciences Section . They may be considered chapters or individual reports. The contributions from each unit are provided in the following order.

BASINWIDE ASSESSMENT –Provides basin and subbasin overviews of water quality and detailed information on collections of benthic macroinvertebrates, fish community structure, and fish tissue analyses.

Biological Assessment Unit 42 pages

LAKE & RESERVOIR ASSESSMENT-Provides lake & reservoir-specific information in the Neuse River Basin, and an overview of assessment methodology.

Intensive Survey Unit 5 pages

AMBIENT MONITORING SYSTEM ASSESSMENT-Provides results of analyses from DWQ fixed station Ambient Monitoring System and Coalition Data, including temporal and spatial trends of chemical, hydrological, and physical data where appropriate.

Ecosystems Analysis Unit 52 pages

WHOLE EFFLUENT TOXICITY PROGRAM-Provides an overview of permits requiring (WET), compliance information, and brief summaries of actions by individual facilities and/or DWQ in response to WET limit failures.

Aquatic Toxicology Unit 4 pages

BASINWIDE ASSESSMENT REPORT PASQUOTANK RIVER BASIN



**NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL
RESOURCES
Division of Water Quality
Environmental Sciences Section**

March 2006



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PASQUOTANK RIVER BASIN

OVERVIEW

The Division of Water Quality uses a basinwide approach to water quality management. Activities within the Division, including permitting, monitoring, modeling, nonpoint source assessments, and planning are coordinated and integrated for each of the 17 major river basins within the state. All basins are reassessed every five years. The Pasquotank River basin was sampled by the Environmental Sciences Section for the first time in 2000 as part of the basinwide assessment program.

The Environmental Sciences Section collects a variety of biological, chemical, and physical data that can be used in a myriad of ways within the basinwide planning program. In some areas there may be adequate data from several program areas to allow a fairly comprehensive analysis of ecological integrity or water quality. In other areas, data may be limited to one program area—such as only benthic macroinvertebrate data or only fisheries data—with no other information available. Such data may or may not be adequate to provide a definitive assessment of water quality, but can provide general indications of water quality. The primary source from which data were drawn for this assessment of the Pasquotank River basin is benthic macroinvertebrate analysis for the period 2000 to 2005. Results of fish tissue analyses from samples taken in 2003 and 2004 are also included. Details of biological sampling methods and rating criteria can be found in the appendices to this report. Technical terms are defined in the glossary.

The document is structured with physical, geographical, and biological data discussions presented by subbasin. General water quality conditions are given in an upstream to downstream format. Lakes data, ambient chemistry data and aquatic toxicity data are presented in separate reports.

The Pasquotank River basin encompasses 3,697 square miles of flat lands and vast open waters (42 percent of the basin) in the far northeast outer coastal plain (Figure PAS-01). It includes all or parts of Camden, Currituck, Dare, Gates, Hyde, Pasquotank, Perquimans, Tyrell and Washington counties. A small portion of the basin extends into Virginia. Watersheds in this basin drain into sections of Albemarle, Currituck, Croatan, Roanoke and Pamlico Sounds. Urban areas include Elizabeth City, Hertford, Columbia, Manteo and the Outer Banks north of Manteo.

Located on the northwest side of Albemarle Sound, Pasquotank River is freshwater above and brackish and tidally influenced below Elizabeth City. Little River is a low-velocity freshwater stream that flows along the border of Perquimans and Pasquotank counties. Perquimans River originates in the Great Dismal Swamp, and has the town of Hertford in its watershed. On the southeast side of Albemarle Sound, Alligator River is a large blackwater river, with a surface area of 64,000 acres. The river has been designated as Outstanding Resource Waters. It is a remote area bordered by wooded swamps and pocosins. Alligator River National Wildlife Refuge extends along the entire eastern shore of the river. Scuppernong River watershed is mainly forested wetlands and agriculture with widespread use of canals which drain the wetlands.

Basinwide sampling for macroinvertebrates in 2005 was limited to subbasins 50, 52, 53, and 54. It is difficult to find flowing, wadeable or boatable, freshwater sites with relatively high pH in the basin which would allow for benthic assessment.

Three Coastal B (large-river) sites were sampled for macroinvertebrates in the Pasquotank Basin in 2005. Sites on both Pasquotank River and Perquimans River were rated as Fair, while the site on Scuppernong River was rated as Poor using draft Coastal B criteria; ratings using draft

Coastal B criteria are tentative and should not be used for use support decisions. The sites on Pasquotank River and Perquimans River were not rated in 2000. A site upstream of that sampled in 2005 on Scuppernon River rated as Poor in 2000.

Eight sites were sampled for macroinvertebrates using Swamp C criteria in 2005. All sites rated as Moderate after analysis except for the site on Main Canal in subbasin 52, which rated as Severe. This is similar to the results from 2000 considering that the two sites which rated as Natural in that year could not be sampled in 2005.

Based on the limited data available, little can be inferred regarding long-term trends in water quality in the basin.

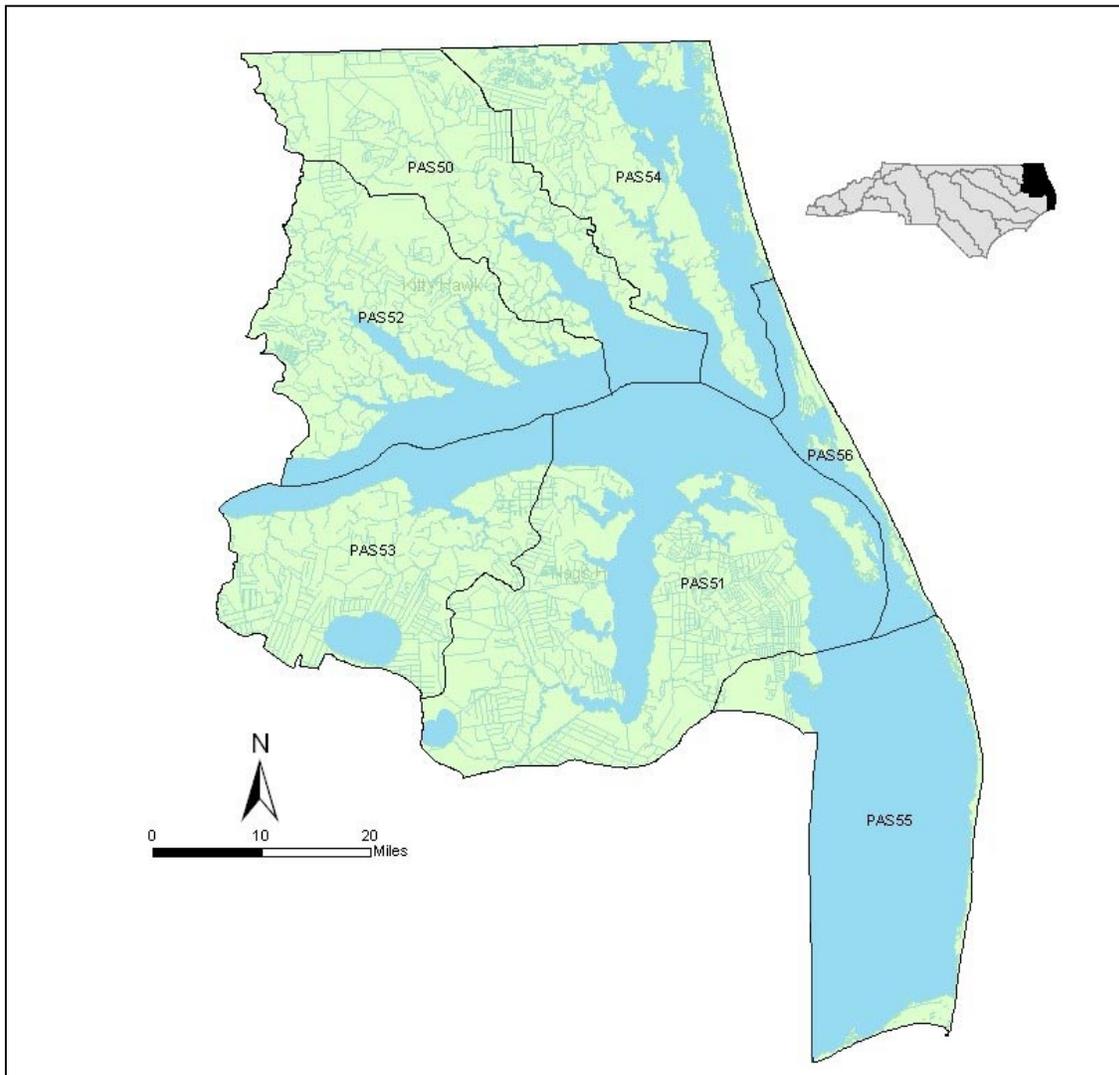


Figure PAS-01 **Location of subbasins in the Pasquotank River basin.**

PASQUOTANK RIVER SUBBASIN 50

Description

Pasquotank subbasin 50 is composed of the Chesapeake-Pamlico Lowlands and Tidal Marshes, and the Nonriverine Swamps and Peatlands ecoregions as defined by Griffith *et al.* (2002). Streams are of low relief and may be swampy. Substrate is composed of silt and sand. Channelized ditches are common. Land cover consists of evergreen forest, mixed forest, forested wetlands, and marshes. Wheat, corn, soybeans, potatoes, cotton, and peanuts are produced in the area. Pine plantations and pasture are additional land uses.

Subbasin 50 composes much of Pasquotank and Camden Counties and a small portion of eastern Gates County. Elizabeth City is the largest concentration of urbanization in the subbasin. The subbasin includes Pasquotank River and its tributaries. Pasquotank River drains much of the Great Dismal Swamp. Land cover is about one-half forest/wetland, one-third cropland, and the remainder surface water.

There are one major and five minor active NPDES permitted dischargers in the subbasin. The major facility is Elizabeth City WWTP with discharge into the Pasquotank River and limited to 4.5 MGD.

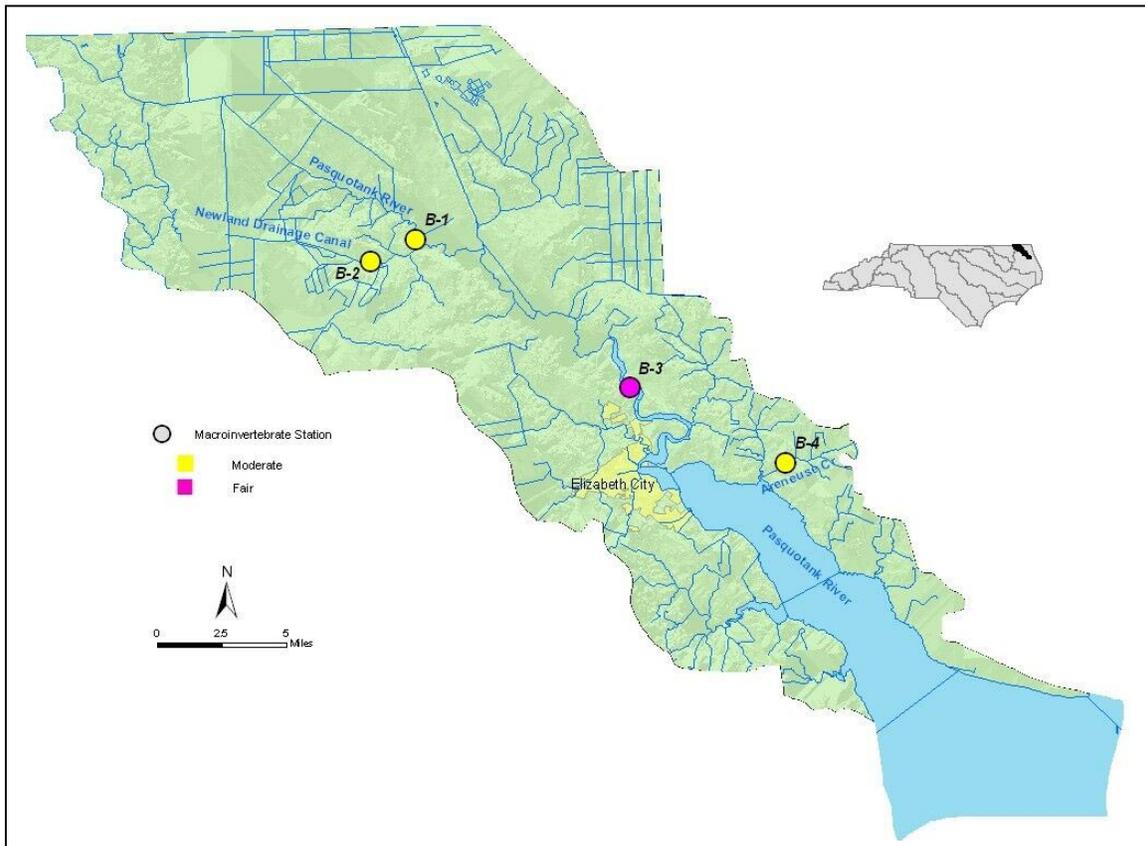


Figure PAS-02 Basinwide sampling sites in Subbasin 50 in the Pasquotank River basin.

Overview of Water Quality

Ambient monitoring of Pasquotank River at Elizabeth City (AMS M2750000) showed frequent pH measurements below standards for its stream class of SB. Pasquotank River drains much of the Great Dismal Swamp; swamps naturally show low pH levels. Therefore, low pH levels in Pasquotank River are not unexpected.

Two facilities in the subbasin are required to test the toxicity of their effluent: Camden County WTP and Elizabeth City WWTP. The NPDES permit for Elizabeth City specifies chronic toxicity testing. Between January 2000 and December 2005 Elizabeth City WWTP reported no whole effluent toxicity (WET) NPDES permit limit violations. The NPDES permit for Camden County WTP specifies acute toxicity monitoring. The WET test results submitted by Camden County WTP indicate no acute effluent toxicity for the period from January 2000 to December 2005.

Of the four sites sampled for benthic macroinvertebrates in 2005, three received bioclassifications of Moderate using swamp criteria; the other site received a classification of Fair. Areneuse Creek at NC 343 was the only current site rated for the 2000 collection after swamp criteria were developed; in both 2000 and 2005 the site rated as Moderate.

Sampling for freshwater benthic macroinvertebrates in the subbasin began with basinwide collections in 2000. Long-term changes in water quality therefore can not be addressed with the freshwater macroinvertebrate data available. Between 2000 and 2005 there is little evidence for changes in water quality.

Table PAS-01 Waterbodies monitored in Subbasin 50 in the Pasquotank River basin for basinwide assessment, 2000-2005.

Map # ¹	Waterbody	County	Location	2000	2005
B-1	Pasquotank R	Pasquotank	SR 1361	Not Rated	Moderate
B-2	Newland Drainage Canal	Pasquotank	SR 1363	---	Moderate
B-3	Pasquotank R	Pasquotank	Goat Island	Not Rated	Fair
B-4	Areneuse Cr	Camden	NC 343	Moderate	Moderate

¹B = benthic macroinvertebrate monitoring site

River and Stream Assessment

Newbegun Creek at SR 1132/Camden County was not sampled in 2005 because it was not wadeable and it lacked flow. Two other road crossings were explored for possible sampling sites; the site at the next road crossing downstream was also too deep for wading, while the site at the next upstream crossing had a drainage area that was estimated to be too small. The 2000 collection for the site was given a bioclassification of Moderate after swamp criteria were later developed. The site at SR 1132 should be attempted again in 2010.

Sawyers Creek at SR 1200/Camden County was not sampled in 2005 due to a lack of flow.

Joyce Creek was investigated for potential basinwide sites in February 2005, but the three road crossings that were checked were unwadeable because of depth.

Pasquotank River, SR 1361/Pasquotank County

There are no active permitted NPDES dischargers upstream of Pasquotank River at SR 1361.

Benthic invertebrates were collected using Swamp methods on 22 February 2005. The stream was about eight meters wide at the reach sampled, with a mean depth of one meter. Channel



modification by dredging was not evident, though a pool had been dug adjacent to a residence upstream of the collection site. Substrate was composed entirely of silt. Sticks and snags were common. Undercut banks were present but rare. Leaf packs and aquatic macrophytes were absent. Hydrologically, the stream was a run of moderate flow. The right bank had a wide intact riparian zone. A lawn created a break in an otherwise intact riparian zone on the left bank. The overall habitat score was 77. Conductivity was 88 $\mu\text{mhos/cm}$.

The site had been sampled twice prior to 2005. Both times it was not rated due to low pH (4.0). In 2005 pH measured 4.3. The resultant bioclassification for 2005 is Moderate.

Abundant taxa at the site in 2005 were a predaceous diving beetle (*Neoporus*), a dragonfly (*Pachydiplax longipennis*), three non-biting midges (*Chironomus*, *Kiefferulus*, *Zalutschia*), a water scorpion (*Ranatra*), three crustaceans (*Caecidotea forbesi*, *Lirceus*, *Crangonyx serratus*), and a snail (*Ferrissia*). Tolerance values for abundant taxa ranged from intolerant (3.0 for *Zalutschia*) to highly tolerant (9.9 for *Pachydiplax longipennis*). *Chironomus* and *Kiefferulus* are indicators of low dissolved oxygen. Most species of *Zalutschia* are adapted to low pH conditions.

Specimens of *Platycentropus*, an uncommonly collected caddisfly, were common in the 2005 sample. The only other time that the caddisfly has been collected in the Pasquotank River basin was at the same location in 2002, though cases were noted for the 2000 basinwide sample at the site.

Newland Drainage Canal, SR 1363/Pasquotank County



There are no active permitted NPDES dischargers upstream of Newland Drainage Canal at SR 1363.

A collection of benthic macroinvertebrates was made using Swamp methods on 22 February 2005. This was the first time the site had been sampled as part of the basinwide assessment program. The site was added to gain more water quality data in the middle to upper portion of the subbasin.

The stream was four meters wide at the sampling location with an average depth of 0.3 meter. The stream was a channelized ditch. Substrate was composed of silt and detritus.

Benthic sampling occurred in three distinct reaches with differing bank and riparian characteristics. Upstream of the road crossing there were erosional areas on the banks, but with trees, shrubs, and grasses present to bind the soil and reduce the effects of erosion. The riparian zone was wide and with infrequent breaks. Immediately downstream of the road crossing the banks were either grassy or bare, allowing for heightened erosion during high flows. There was no riparian zone in the open reach. Approximately 100 meters downstream of the road crossing

the stream entered a wooded area. The riparian zone in the downstream reach was wide and intact, though bank erosion was evident there as well. The overall habitat score for the site was 50.

The site had been sampled once previously in 2002 for the Wetlands Restoration Program. In both 2002 and 2005 the site was rated as Moderate. Conductivity at the site was much lower in 2005 than in 2002, measuring 54 and 181 $\mu\text{mhos/cm}$ respectively. The total number of taxa at the site was significantly greater in 2005 than 2002, with 44 and 26 taxa respectively between the two years.

Abundant taxa at the site in 2005 were a predaceous diving beetle (*Neoporus*), a dragonfly (*Tetragoneuria*), several non-biting midges (*Chironomus*, *Kiefferulus*, *Orthocladius oliveri*, *Tribelos jucundum*, *Tvetenia* sp. GA [Epler]), two black flies (*Cnephia*, *Simulium*), and two crustaceans (*Caecidotea obtusus*, *Crangonyx*). All abundant taxa are tolerant to pollutants. In general, the abundant taxa are typical for ditches. *Chironomus*, *Kiefferulus*, and *Tribelos jucundum* are indicative of organic enrichment and low dissolved oxygen.

Pasquotank River, Goat Island/Pasquotank County



Goat Island is approximately 24 stream miles upriver of the mouth of Pasquotank River.

South Mills Water Association WTP is about 13 stream miles upstream of Goat Island. The facility discharges into Dismal Swamp Canal, and is limited to 45000 gallons/day of effluent.

A collection of benthic macroinvertebrates was made using boat methods on 24 August 2005. The river was roughly 300 meters wide. Substrate was primarily silt with some detritus. Stick, snags, and logs

were abundant. Root mats were common. Aquatic macrophytes were present but rare. Leaf packs were absent. Hydrologically, the reach was a large river run. There was no evidence of bank erosion. The riparian zone was wide and intact on both banks. The overall habitat score was 70. Conductivity was 152 $\mu\text{mhos/cm}$. The only ambient monitoring station on the river is approximately 11 stream miles downstream of the benthic site and is therefore of little use for evaluating water chemistry at the benthic site.

The site was sampled for benthic invertebrates for the first time in 2000, though it was not rated. For 2005 the site received a rating of Fair using draft Coastal B criteria which are tentative and should not be used for use support decisions. The benthic community was much more diverse overall in 2005 than in 2000, with 52 and 31 total taxa respectively. Four EPT taxa were collected in both years. The biotic index was similar for both years, with a value of 8.1 in 2000 and 7.8 in 2005.

Abundant taxa at the site were two mayflies (*Caenis*, *Stenacron interpunctatum*), a caddisfly (*Oecetis cinerascens*), a whirligig beetle (*Dineutus*), two dragonflies (*Pachydiplax longipennis*, *Tetragoneuria*), three non-biting midges (*Dicrotendipes simpsoni*, *Procladius*, *Stenochironomus*), three freshwater crustaceans (*Caecidotea racovitzai*, *Hyalella*, *Lirceus*), a snail (*Micromenetus dilatatus*), and water mites (Acari). Tolerance values for abundant taxa ranged from mildly tolerant (5.5 for *Dineutus*, *Caecidotea racovitzai*, and Acari) to very highly tolerant (10.0 for

Dicrotendipes simpsoni). *Dicrotendipes* is an indicator of nutrient enrichment and low dissolved oxygen.

Areneuse Creek, NC 343/Camden County



There are no active permitted NPDES dischargers upstream of Areneuse Creek at NC 343.

A collection of benthic macroinvertebrates was made using Swamp methods on 23 February 2005. The stream was about eight meters wide, with an average depth of 0.5 meter. Channel modification was not evident in the reach sampled though downstream of the road crossing the stream was channelized. The substrate was composed of detritus. Sticks, snags and logs were abundant. Undercut banks, root mats, and leaf packs were present but rare.

Aquatic macrophytes were absent. Hydrologically, the stream reach was a run. The riparian zone was wide and intact on both banks. The overall habitat score was 76. Conductivity was 399 $\mu\text{mhos/cm}$.

The site had been sampled twice prior to 2005: in 2000 as a basinwide site; and in 2002 for the Wetlands Restoration Program. Originally in 2000 the site was not rated due to the lack of assessment criteria for swamp streams. After criteria were developed and applied, the site rated as Moderate. In 2002 the site was not rated due to two characteristics suggesting a saltwater intrusion during the winter drought that year: 1) low number of taxa (16) with respect to the previous sampling effort in 2000 (22); 2) dominance of *Gammarus* in the macroinvertebrate community. The high conductivity (477 $\mu\text{mhos/cm}$) at the site in 2002 was also noted; it was suggested that a rain event prior to sampling in 2002 would have “washed out” a saltwater intrusion. In 2005 the community was much more diverse than for either of the two previous sampling events (36 total taxa), and *Gammarus* was no longer the dominant taxon. The site rated as Moderate in 2005.

Abundant taxa in 2005 were a predaceous diving beetle (*Neoporus*), a dragonfly (*Pachydiplax longipennis*), an oligochaete (*Nais*), two crustaceans (*Caecidotea obtusus*, *C. racovitzai*), a fingernail clam (*Musculium*), and three snails (*Gyraulus deflectus*, *Micromenetus dilatatus*, *Physella*). Tolerance values for abundant taxa ranged from very slightly tolerant (5.0 for *Gyraulus deflectus*) to very highly tolerant (9.9 for *Pachydiplax longipennis*) to pollutants. Four mollusks are among the abundant taxa, indicating that low pH is not a problem for the stream site. That *Physella* and *Musculium* are among the abundant taxa indicates low dissolved oxygen levels may be occurring during the summer months. For the first time at the site a mayfly was collected (*Callibaetis*), though it was rare in the collection.

SPECIAL STUDIES

Water Restoration Project

Pasquotank River at SR 1361, Newland Drainage Canal at SR 1363, Sawyers Creek at SR 1200, and Areneuse Creek at NC343 were sampled in 2002 as part of a wetlands restoration project (Biological Assessment Unit Memorandum B-20020509). None of the streams were rated because of “naturally harsh conditions.” Saltwater intrusions in the lower part of the basin, and pH in the upper portions, are thought to be controlling the benthic invertebrate community in the subbasin according to the report.

PASQUOTANK RIVER SUBBASIN 51

Description

Pasquotank subbasin 51 is composed of the Chesapeake-Pamlico Lowlands and Tidal Marshes, and the Nonriverine Swamps and Peatlands ecoregions as defined by Griffith *et al.* (2002). Streams are of low relief and may be swampy. Substrate is composed of silt and sand. Channelized ditches are common. Land cover consists of evergreen forest, mixed forest, forested wetlands, and marshes. Wheat, corn, soybeans, potatoes, cotton, and peanuts are produced in the area. Pine plantations and pasture are additional land uses.

Subbasin 51 includes much of Dare and Tyrrell Counties and northern portions of Hyde County. Roanoke Island contains the only concentration of urbanization. Most of the Alligator River National Wildlife Refuge is included within the subbasin. The Alligator River and its tributaries are the major freshwater streams in the area. Land cover is roughly one-half forest/wetland, about 40% surface water, and most of the remainder cultivated cropland.

There are one major and five minor active NPDES permitted dischargers in the subbasin. The major discharger is Manteo WWTP which discharges to Shallowbag Bay of Roanoke Island; the facility is limited to 1.0 MGD of effluent.

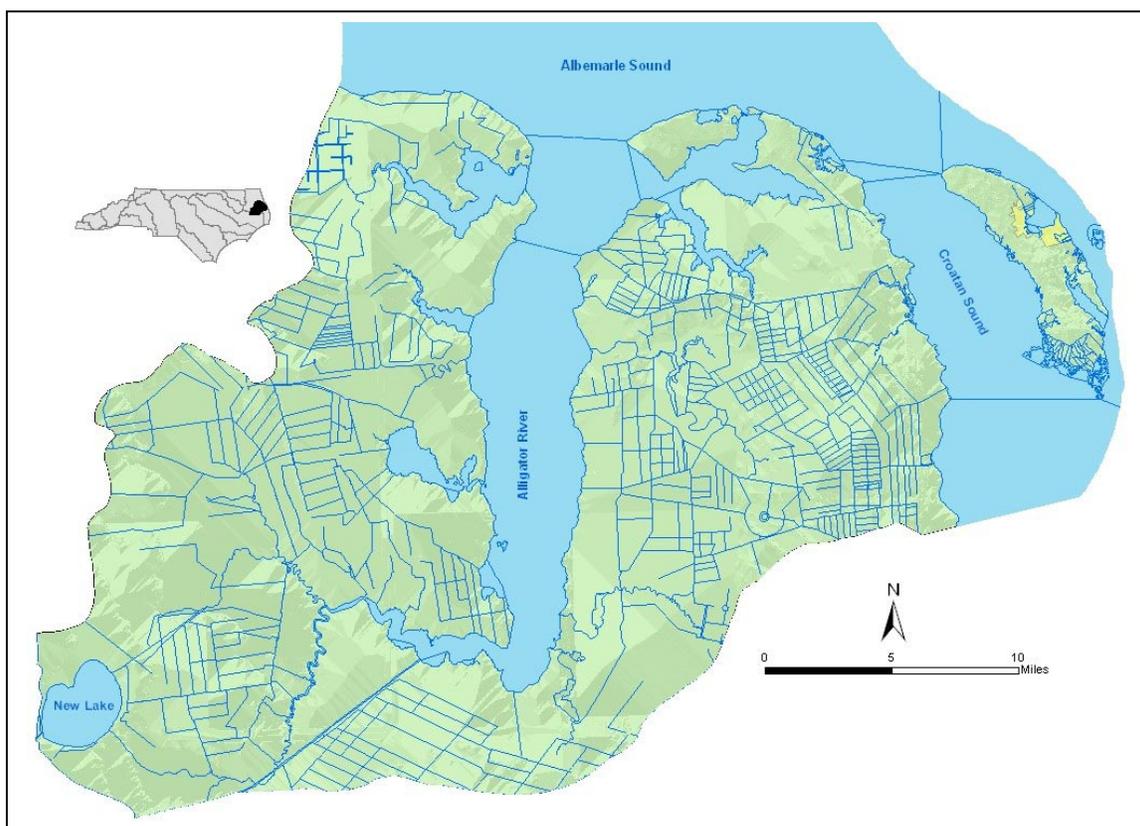


Figure PAS-03 Map of Subbasin 51 in the Pasquotank River basin.

Overview of Water Quality

There are many waterbodies within the subbasin which are impaired for the use support designation of shellfish harvesting; all impairments are due to fecal coliform standard violations. The following waterbodies are affected in whole or in part: Croatan Sound, Spencer Creek, Callaghan Creek, Baum Creek, Oyster Creek, Cut Through, water surrounding Pond Island, Johns Creek, Sand Beach Creek, Rockhall Creek, Broad Creek, and Stumpy Point Bay.

Two facilities in the subbasin are required to test the toxicity of their effluent: Manteo WWTP and Skyco Regional WTP. The NPDES permit for Manteo WWTP specifies acute toxicity testing. The whole effluent toxicity (WET) test results submitted by Manteo WWTP indicate no effluent toxicity for the period from January 2000 through December 2005. The NPDES permit for Skyco Regional WTP specifies acute toxicity monitoring. The WET test results submitted by Skyco WTP show the facility failed to meet its 90% acute toxicity target effluent concentration on three occasions between July 2004 and December 2005.

A site on each of Northwest Fork Alligator River and Southwest Fork Alligator River were sampled as potential basinwide benthic sites in 2000. Relatively few invertebrates were collected at either site. The benthic fauna at both sites are likely limited by low pH and low dissolved oxygen. Because the sites are sparsely represented by macroinvertebrates, benthic data will have little use for water quality evaluation. Neither site was sampled by the Biological Assessment Unit in 2005. In general, streams in the area are characterized by low dissolved oxygen; assessment of such streams using benthic invertebrates is of limited use.

PASQUOTANK RIVER SUBBASIN 52

Description

Pasquotank subbasin 52 is composed largely of the Chesapeake-Pamlico Lowlands and Tidal Marshes ecoregion, though it also includes small portions of the Mid-Atlantic Flatwoods, and the Nonriverine Swamps and Peatlands ecoregions as well as defined by Griffith *et al.* (2002). Streams are low-gradient with substrates composed of silt and sand. Land cover consists of evergreen forest, mixed forest, forested wetlands, and marshes. Wheat, corn, soybeans, potatoes, cotton, and peanuts are all produced in the area. Pine plantations and pasture are also present.

Subbasin 52 includes Perquimans County, the southwestern portion of Pasquotank County, and portions of Chowan and Gates Counties. Hertford contains the largest concentration of urbanization. The subbasin includes Little and Perquimans Rivers which drain a portion of the Great Dismal Swamp. The subbasin also includes Yeopim River and its tributaries. Land cover is roughly one-third forest/wetland, one-third cropland, and one-third surface water. Less than 1% of land cover is urban.

There are four active permitted NPDES dischargers in the subbasin, all of which are classified as minor.

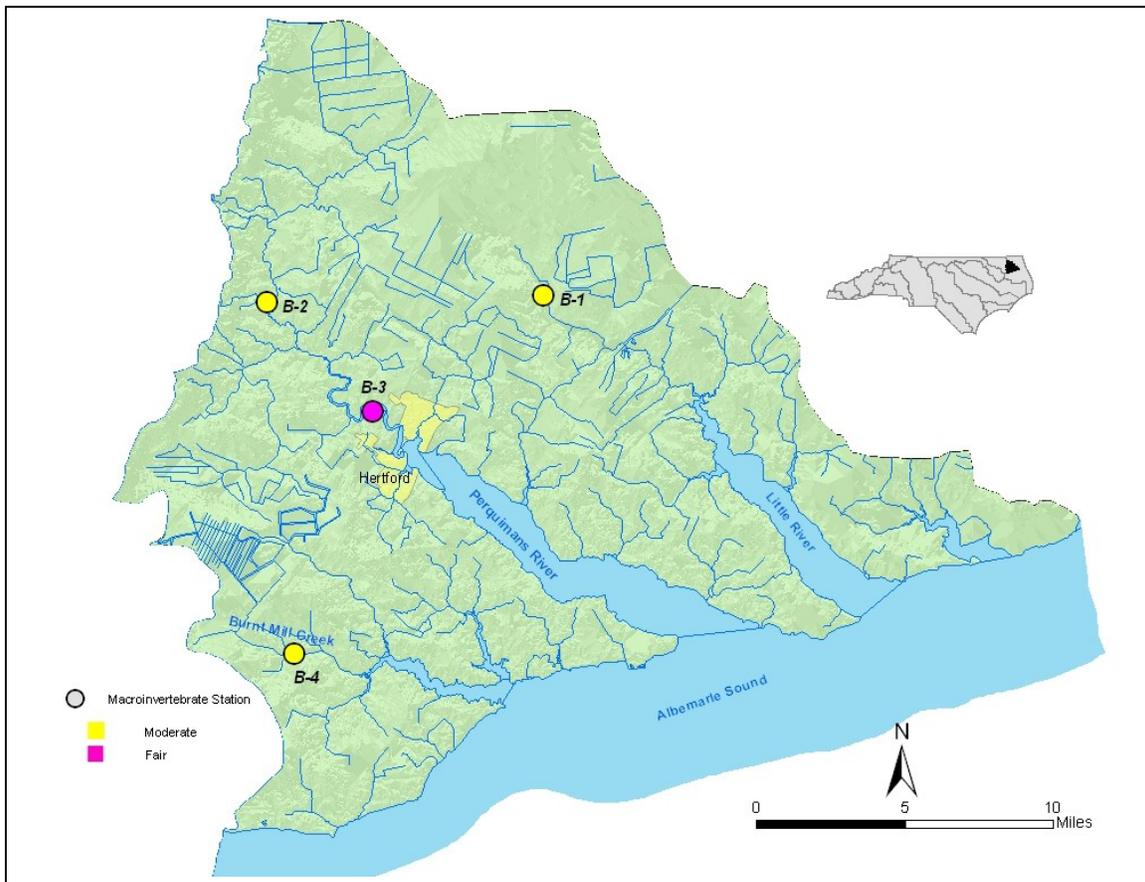


Figure PAS-04 Basinwide sampling sites in Subbasin 52 in the Pasquotank River basin.

Overview of Water Quality

Little River is 303(d) listed (since 1998) for 12 miles from its source to the mouth of Halls Creek for low dissolved oxygen.

Ambient monitoring of Perquimans River at SR 1336/Perquimans County (AMS M5000000) showed frequent pH measurements below standards for its stream class of SC. Perquimans River drains swamps in much of the watershed, including a portion of the Great Dismal Swamp; swamps naturally show low pH levels. Therefore, low pH levels in Perquimans River are not unexpected.

Two facilities in the subbasin are required to test the toxicity of their effluent: Bethel WTP and Winfall WTP. The NPDES permits for both facilities specify chronic toxicity monitoring. The whole effluent toxicity test results submitted by both facilities between January 2005 and December 2005 show that they are consistently failing to meet their 90% acute toxicity target effluent concentration.

A site on each of Burnt Mill Creek and Little River were rated as Moderate after macroinvertebrate assessments in both 2000 and 2005. The Perquimans River site above Hertford was not rated in 2000; it rated Fair in 2005. The site on Perquimans River at NC 37 was sampled for the first time in 2005 and was classified as Moderate (*the original version of this document incorrectly stated the classification for the site as Fair*).

Long-term trends in water quality can not be assessed with the limited macroinvertebrate data available. Between 2000 and 2005 there is little evidence of change, with one exception; better water quality in 2005 than 2000 on Little River at SR 1221 may be indicated by greater overall taxa and EPT richness.

Table PAS-02 Waterbodies monitored in Subbasin 52 in the Pasquotank River basin for basinwide assessment, 2000-2005.

Map # ¹	Waterbody	County	Location	2000	2005
B-1	Little R	Perquimans	SR 1221	Moderate	Moderate
B-2	Perquimans R	Perquimans	NC 37	---	Moderate
B-3	Perquimans R	Perquimans	above Hertford	not rated	Fair
B-4	Burnt Mill Cr	Chowan	NC 37	Moderate	Moderate

¹B = benthic macroinvertebrate monitoring site

River and Stream Assessment

Little River, SR 1221/Perquimans County



There are no active permitted NPDES dischargers upstream of Little River at SR 1221.

A benthic macroinvertebrate collection was made on 23 February 2005 using Swamp methods. The stream was about 15 meters wide at the reach, with an average depth of 0.3 meter. There was no evidence of channel modification. The substrate was composed entirely of detritus. Sticks were common. Snags, undercut banks and root mats, and leaf packs were present but rare. Hydrologically, the stream was a slowly flowing run. The riparian zone on the right

was wide and intact. An area on the left bank had been harvested for timber. De-snagging of the stream had also occurred recently. The overall habitat score was 75.

The site had been sampled once prior to 2005, in 2000, as part of the basinwide survey. The resultant rating after both sampling events was Moderate. One of the three collection vials was lost after sampling was complete in 2005, and potentially one or more taxa were lost from the collection; therefore the Moderate rating for 2005 should be considered as a minimum. In spite of the lost vial, the total number of taxa in 2005 was 40, much greater than the 24 collected in 2000. Also, one EPT taxon was present in 2005, none in 2000. The greater number of total and EPT taxa in 2005 is in contrast to the slightly higher biotic index in 2005 than 2000 (8.3 and 7.9 respectively).

Abundant taxa in 2005 were three non-biting midges (*Orthocladius oliveri*, *Chironomus*, *Kiefferulus dux*), water boatmen (*Corixidae*), an oligochaete (*Nais*), a crustacean (*Caecidotea obtusus*), a fingernail clam (*Sphaerium*), and a snail (*Pseudosuccinea columella*). Tolerance

values for abundant taxa range from moderately tolerant (7.0 for *Caecidotea obtusus*), to very highly tolerant (10.0 for *Kiefferulus dux*) to pollutants. *Chironomus*, *Kiefferulus dux*, and *Sphaerium* are all indicators of low dissolved oxygen. The abundance of the amphibious *Pseudosuccinea columella* also provides supporting evidence of low dissolved oxygen at the site during the summer months.

Perquimans River, NC 37/Perquimans County



There are no active permitted NPDES dischargers upstream of Perquimans River at NC 37.

A benthic invertebrate sample was collected from the site on 22 February 2005 using Swamp methods. The stream was about 15 meters wide at the reach sampled, with an average depth estimated to be one meter. There was some evidence of channelization at the site. De-snagging had occurred recently upstream of the road crossing. The substrate was composed of silt and organic matter. Sticks, snags and logs, undercut banks, and root mats were all common.

Leaf packs and aquatic macrophytes were absent from the site. Hydrologically, the stream was a deepwater run. The riparian zone was wide and intact on both sides of the stream. The overall habitat score was 62. Conductivity was 185 $\mu\text{mhos/cm}$.

The basinwide site for the upper Perquimans River was moved from an upstream location at SR 1204 (identified in the prior basinwide report as SR 1111). The benthic sample in 2005 was the first collected from the NC 37 site. Though the site at SR 1204 in 2000 was very similar in total number of taxa collected to NC 37 in 2005 (27 and 25 respectively), the number of taxa in common between the two samples is only six. Therefore, a comparison of the results between the two sites is not advised.

The site at NC 37 rated as Moderate in 2005. The biotic index was 7.5. Twenty-five total taxa were present, which is near the low end for swamp sampling in the Pasquotank basin in 2000 and 2005 (range is from 24 to 54 taxa). The only abundant taxa at the site were a crustacean (*Caecidotea racovitzai*, with a tolerance value of 5.5), and a fingernail clam (*Pisidium*, with a tolerance value of 6.5). Low productivity, as illustrated by the low number of abundant taxa, is likely responsible for the low taxa richness at the site.

Perquimans River, above Hertford/Perquimans County

There are no active permitted NPDES dischargers upstream of the basinwide site above Hertford on Perquimans River.

A benthic macroinvertebrate collection was made at the site approximately 3 miles upstream of Hertford on 23 August 2005 using boat methods. The stream was approximately 100 meters wide at the site. The water was dark and tannic. Substrate was a mix of silt and detritus. Snags and logs were abundant. Sticks, undercut banks and aquatic macrophytes were common. Leaf packs and undercut banks were absent. Hydrologically, the reach was a large deep-water river. The riparian zone was intact on both banks, and moderately wide to very wide. The overall habitat score was 72. Conductivity was 303 $\mu\text{mhos/cm}$.



The site was sampled once prior to 2005 as part of the basinwide survey, in 2000; it was not rated at that time. In 2005 the site received a rating of Fair using draft Coastal B criteria which are tentative and should not be used for use support decisions. The biotic index was high for both sampling events: 8.0 in 2000 and 7.9 in 2005.

Abundant taxa at the site in 2005 were a whirligig beetle (*Dineutus*), three non-biting midges (*Ablabesmyia janta/parajanta*, *Dicrotendipes simpsoni*, *Procladius*), a phantom midge (*Chaoborus punctipennis*), worms (*Pristinella* and some unidentified Tubificidae), a crustacean (*Gammarus fasciatus*), and two snails (*Micromenetus dilatatus*, *Physella*). Tolerance values for abundant taxa ranged from slightly tolerant (5.5 for *Dineutus*) to very highly tolerant (10.0 for *Dicrotendipes simpsoni*) to pollutants. Four taxa which were abundant in 2000 were not present in 2005: a grass shrimp (*Palaemonetes paludosus*), a fingernail clam (*Musculium*), and two snails (*Amnicola*, *Laevapex fuscus*). A few of the taxa abundant in both 2000 and 2005 are indicators of low dissolved oxygen (*Dicrotendipes simpsoni*, *Chaoborus punctipennis*, *Physella*), the level of which was low (3.2 mg/L) during sampling in 2005.

An ambient monitoring station (M5000000) exists about 3.5 stream miles downstream of the benthic site at Hertford. Salinity measurements indicate an estuarine influence during drought years, with measurements of up to 5.3 parts per thousand in September 2002. More recent measurements at the ambient site in 2004 and early 2005 show values of no greater than 0.5 parts per thousand salinity. It is unknown whether salinity measurements at the ambient site reflect conditions upstream at the benthic site.

Burnt Mill Creek, NC 37/Chowan County



There are no active permitted NPDES dischargers upstream of Burnt Mill Creek at NC 37.

A benthic macroinvertebrate collection was made at the site on 21 February 2005 using Swamp methods. The stream was approximately six meters wide, with a mean depth of 0.2 meter. The stream had been channelized at some time in the past. The substrate was a mix of silt, sand and detritus. Undercut banks were common. Sticks, snags and logs, and root mats were present but rare. Leaf packs and aquatic macrophytes were absent. Pools were

present but infrequent. Erosional areas were present on both banks. The left bank had sparse vegetation, lending itself to bank failure at high flows. The right bank had some trees present to aid in the retention of the soil during high flows. The riparian zone on both sides of the stream had frequent breaks but was moderately wide. The overall habitat score was 53. Conductivity was 277 μ mhos/cm.

The site had been sampled twice prior to 2005: in 1995 the site was not rated; in 2000 a bioclassification of Moderate was the result. In 2005 the classification remained at Moderate for the site. More total taxa were collected in 2005 than in the previous two years (54 vs. 41 in 1995 and 37 in 2000). The biotic index has changed very little over the three sampling efforts, ranging from 7.7 to 7.9.

Abundant taxa at the site in 2005 were a damselfly (*Ischnura*), several non-biting midges (*Ablabesmyia mallochi*, *Chironomus*, *Dicrotendipes modestus*, *Orthocladius oliveri*), water boatmen (Corixidae), a fingernail clam (*Musculium*), and two snails (*Amnicola*, *Physella*). Tolerance values for abundant taxa ranged from slightly tolerant (5.2 for *Amnicola*) to highly tolerant (9.6 for *Chironomus*). Indications of low dissolved oxygen and enrichment are given by the abundance of *Chironomus*, *Dicrotendipes modestus*, *Musculium*, and *Physella*; with the exception of *Musculium* the taxa were present in at least one of the two previous sampling efforts. Several of the abundant taxa in 2005 in addition to *Musculium* were not noted from previous sampling (*Ischnura*, *Ablabesmyia mallochi*, *Orthocladius oliveri*, Corixidae).

PASQUOTANK RIVER SUBBASIN 53

Description

Pasquotank subbasin 53 is composed of the Chesapeake-Pamlico Lowlands and Tidal Marshes, and the Nonriverine Swamps and Peatlands ecoregions as defined by Griffith *et al.* (2002). Streams are of low relief and may be swampy. Substrate is composed of silt and sand. Channelized ditches are common. Land cover consists of evergreen forest, mixed forest, forested wetlands, and marshes. Wheat, corn, soybeans, potatoes, cotton, and peanuts are produced in the area. Pine plantations and pasture are additional land uses.

Subbasin 53 is composed of most of Washington County and most of western Tyrrell County on the south side of Albemarle Sound. The small towns of Columbia, Creswell, and Roper are the only significant areas of urbanization. The subbasin includes Scuppernon River, Deep Creek, Kendrick Creek, and their tributaries. The subbasin also includes Phelps Lake, the second largest natural lake in North Carolina. Land cover in the subbasin is approximately 40% forest/wetland, 30% cropland, and 30% surface water. Urbanization is less than one percent of the area.

There are 10 active permitted NPDES dischargers in the subbasin, all classified as minor.

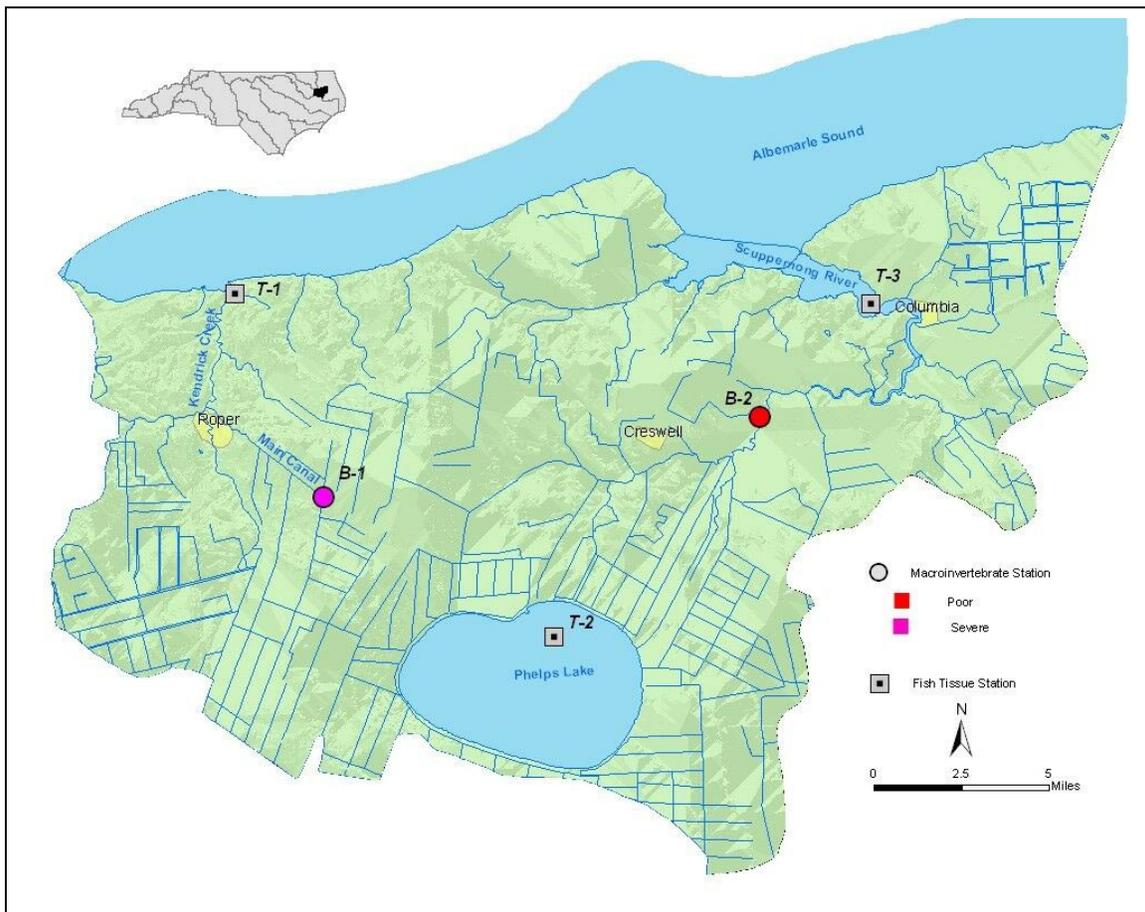


Figure PAS-05 Basinwide sampling sites in Subbasin 53 in the Pasquotank River basin.

Overview of Water Quality

Phelps Lake has been under a fish consumption advisory since 1998 for mercury. Scuppernong River is 303(d)-listed for 15 miles from its source to mouth of Riders Creek for low dissolved oxygen and pH. Kendrick Creek is listed for 13 miles from its source to US 64 for low dissolved oxygen and pH. Main Canal is listed for its entire length for impaired biological integrity. All listings have been in effect since 1998.

The ambient monitoring station on Kendrick Creek at SR 1300/Washington County (AMS M6920000) has recorded frequent levels of pH and dissolved oxygen below standards for its stream class of SC; frequent elevated levels of total nickel have been recorded as well. Kendrick Creek drains the swamps in its watershed; swamps naturally exhibit low pH levels. Therefore, it is not unexpected that Kendrick Creek should also show low pH levels.

Four facilities in the subbasin are required to test the toxicity of their effluent: Columbia WTP, Creswell WTP, Tyrrell County Bull Bay WTP, and Tyrrell County WTP. Creswell WTP and Tyrrell County WTP are required to perform chronic toxicity monitoring while Columbia WTP and Tyrrell County Bull Bay WTP are required to perform acute toxicity monitoring. The whole effluent toxicity (WET) test results submitted by Columbia WTP and Creswell WTP indicate no effluent toxicity for the period from January 2000 through December 2005. The WET test results submitted by Tyrrell County WTP between July 2004 and December 2005 show it is consistently failing to meet its 90% chronic toxicity target effluent concentration. The WET test results submitted by Tyrrell County Bull Bay WTP show the facility failed to meet its 90% acute toxicity target effluent concentration on three occasions between October 2003 and December 2005.

Two benthic sites were collected for evaluation in 2005: Main Canal at SR 1180 and Scuppernong River at SR 1105. There is no evidence of changing water quality on Main Canal; the site received ratings of Severe in both 2000 and 2005. The Scuppernong River site received a Poor rating in 2005, lower than the Fair rating received during the prior sampling event in 1995.

More benthic data are needed to address the possibility of changing water quality generally within the subbasin. Future sampling at the basinwide sites will provide those data.

Table PAS-03 Waterbodies monitored in Subbasin 53 in the Pasquotank River basin for basinwide assessment, 2000-2005.

Map # ¹	Waterbody	County	Location	2000	2005
B-1	Main Canal	Washington	SR 1180	Severe	Severe
B-2	Scuppernong R	Tyrrell	SR 1105	---	Poor

¹B = benthic macroinvertebrate monitoring site

River and Stream Assessment

Deep Creek at SR 1302, which was first sampled in 2000, was not sampled due to a lack of flow. An examination of other potential sites on the stream showed the site at the upstream road crossing to be stagnant while downstream sites were not wadeable.

Main Canal, SR 1180/Washington County

There are no active permitted NPDES dischargers above Main Canal at SR 1180.

A benthic macroinvertebrate sample was collected at the site on 21 February 2005 using Swamp methods. The channelized ditch was about four meters wide at the site, with a mean depth of 0.5 meter. The substrate was composed entirely of silt and muck, making collecting at the site very



difficult. Sticks and aquatic macrophytes were present but rare and provided the only habitat for macroinvertebrate colonization at the site. Flow was slow. Pools and riffles were absent. Both banks had erosional areas present. The left bank had some trees present to help bind the soil during high flow events. The right bank vegetation was composed primarily of grasses, making it susceptible to bank failure during high flows. There was effectively no riparian zone present. The overall habitat score for the site was 19. Conductivity was 205 $\mu\text{mhos/cm}$.

Abundant taxa at the site in 2005 were a water boatman (Corixidae) and several non-biting midges (*Ablabesmyia mallochi*, *Chironomus*, *Hydrobaenus*, *Orthocladius oliveri*, *Paratanytarsus*, *Polypedilum illinoense* group, *Procladius*, *Thienemannimyia* group). Tolerance values for abundant taxa ranged from moderately tolerant (7.2 for *Ablabesmyia mallochi*), to very tolerant (9.6 for *Chironomus*). Eight of nine of the abundant taxa were midges, which illustrates the very poor diversity of macroinvertebrates at the site. *Chironomus mentum* deformity analysis was performed, which resulted in a Poor/Toxic rating for toxicity at the site.

The site has been sampled on two occasions prior to 2005. In 1995 the site was not rated. In 2000, as in 2005, the site received a rating of Severe. The biotic index has ranged from 7.1 in 1995 to 8.6 in 2000. In 2005 the BI was 8.3.

Scuppernong River, SR 1105/Tyrrell County



There are two minor active permitted NPDES dischargers upstream of the site, Creswell WTP and Creswell WWTP, both approximately 5 stream miles away.

A benthic macroinvertebrate sample was collected on 25 August 2005 using boat methods. The stream was about 20 meters wide at the site, with a mean depth estimated at five meters. The reach lacked sinuosity. Sticks, snags and logs, undercut banks, root mats, and aquatic macrophytes were all abundant. Leaf packs were absent. Duckweed was abundant, but provided no habitat for macroinvertebrates. Alligator

weed (*Alternanthera philoxeroides*), an invasive aquatic plant, was also abundant. Hydrologically the stream reach was a deep-water run. The riparian zone on both sides of the stream was wide and intact. The overall habitat score at the site was 87. Conductivity was 173 $\mu\text{mhos/cm}$.

The benthic site coincides with an ambient monitoring station (AMS 6980000). Monthly measurements showed salinity concentrations to be less than 0.10 part per thousand for 2004 and early 2005. During drought conditions the site has the propensity to become brackish. The highest salinity concentration since 2000 was recorded in August 2002, with a measurement of 5.1 parts per thousand; this concentration is higher than most freshwater invertebrates can survive.

The site at SR 1105 is the original basinwide site on the Scuppernong River, and was sampled twice prior to 2005. In 1983 the site was rated as Poor, and in 1995 as Fair. In 2000 the river was sampled upstream of the dischargers, at SR 1155/Washington County; that site rated Poor. In 2005 at SR 1105 the site again rated Poor using draft Coastal B criteria which are tentative and should not be used for use support decisions. The biotic index at SR 1105 has ranged from 7.7 in 1995 to 8.4 in 1983. In 2005 the BI was near the high end of the range, at 8.3. Total taxa collected in 2005 (59) was greater than that collected during both of the previous sampling events (46 for each).

Abundant taxa at the site in 2005 were a mayfly (*Caenis*), two damselflies (*Enallagma*, *Ischnura*), a dragonfly (*Pachydiplax longipennis*), a burrowing water beetle (*Hydrocanthus*), three non-biting midges (*Ablabesmyia peleensis*, *Kiefferulus dux*, *Larsia*), a phantom midge (*Chaoborus*), a water bug (*Belostoma*), two crustacea (*Caecidotea* sp3 [BAU designation], *Hyalella*), a fingernail clam (*Sphaerium*), and a snail (*Micromenetus dilatatus*). Three of the abundant taxa in 2005 had not been collected at the site before (*Ischnura*, *Kiefferulus dux*, *Caecidotea* sp3). Tolerance values for abundant organisms ranged from slightly intolerant (4.0 for *Caecidotea* sp3) to very highly tolerant (10.0 for *Kiefferulus dux*) to pollutants. Three of the abundant taxa are indicative of low dissolved oxygen: *Chaoborus*, *Kiefferulus dux*, and *Sphaerium*. Ambient monitoring data for the past five years show dissolved oxygen levels typically fall below 1.0 mg/L each summer, limiting the benthic invertebrate community at the site.

Fish Tissue Assessment

Eighty-nine fish tissue samples were collected from three stations in the Pasquotank basin during 2003 and 2004 and analyzed for mercury contamination. The samples included largemouth bass, yellow perch, sunfish and catfish. Results from the period show 48 of 89 samples collected contained mercury concentrations exceeding the state criteria of 0.4 ppm (Table PAS-04; Appendix FT-2).

Table PAS-04 Fish samples and results exceeding NC criteria in Subbasin 53 in the Pasquotank River basin.

Station	Description	Years Sampled	Species	Number Samples	Samples exceeding NC Hg criteria (0.4 ppm)
FT-1	Kendricks Creek	2003	Bass, Sunfish, Catfish, Pickerel, Yellow Perch	23	7
FT-2	Lake Phelps	2003, 2004	Bass, Sunfish, Catfish, Yellow Perch	59	39
FT-3	Scuppernong River	2004	Bass, Sunfish	7	2

Presently, there are no site-specific consumption advisories for mercury-contaminated fish in the Pasquotank basin; however, an advisory for the consumption of largemouth bass, bowfin, and chain pickerel east of Interstate 85 in North Carolina was issued by NCDHHS in 2002.

PASQUOTANK RIVER SUBBASIN 54

Description

Pasquotank subbasin 54 is composed of the Chesapeake-Pamlico Lowlands and Tidal Marshes, the Nonriverine Swamps and Peatlands, and the Virginian Barrier Islands and Coastal Marshes ecoregions as defined by Griffith *et al.* (2002). Except for the barrier islands, the area contains streams of low relief that may be swampy. Substrate is composed of silt and sand. Channelized ditches are common. Land cover consists of evergreen forest, mixed forest, forested wetlands, and marshes. Wheat, corn, soybeans, potatoes, cotton, and peanuts are produced in the area. Pine plantations and pasture are additional land uses.

Land cover in the barrier islands includes marshes, forested wetlands, and evergreen forest. Land uses include urban, wildlife habitat, recreation, and fish and shellfish production. Freshwater streams are absent.

Subbasin 54 includes most of Currituck County and the eastern portion of Camden County. Major areas of urbanization are absent. The subbasin includes Northwest River (which flows from Virginia), Tull Creek, North River, and all tributaries to each. Land cover is roughly 40% forest/wetland, 40% surface water, and 20% cropland. Urbanization makes up less than 1% of area.

There are two active permitted NPDES dischargers in the subbasin, both of which are classified as minor.

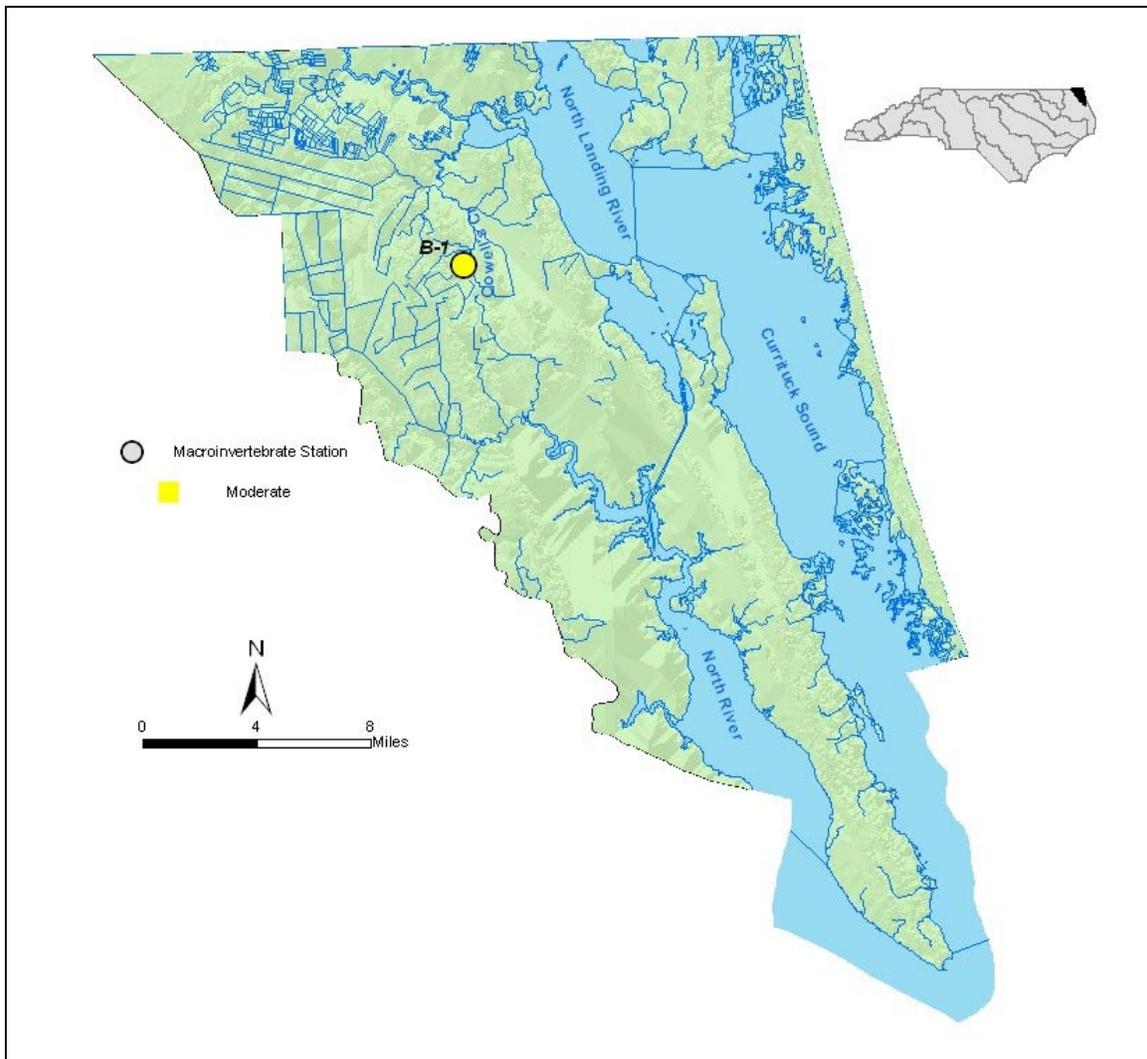


Figure PAS-06 Basinwide sampling sites in Subbasin 54 in the Pasquotank River basin.

Overview of Water Quality

There are no 303(d)-listed stream segments in the subbasin.

Southern Outer Banks Water System WTP is the only facility in the subbasin required to perform whole effluent toxicity (WET) testing. The NPDES permit for the facility specifies acute toxicity monitoring. The WET test results submitted by Southern Outer Banks Water System WTP indicate no acute effluent toxicity for the period between January 2000 and December 2005.

Water quality trends and generalizations for the entire subbasin are not possible using benthic data; the only data point for the subbasin is provided by the single sample collected in 2005 on UT Cowells Creek.

Table PAS-05

Waterbodies monitored in Subbasin 54 in the Pasquotank River basin for basinwide assessment, 2000-2005.

Map # ¹	Waterbody	County	Location	2000	2005
B-1	UT Cowells Cr	Currituck	NC 34	---	Moderate

¹B = benthic macroinvertebrate monitoring site

River and Stream Assessment

Shingle Landing Creek was investigated at two road crossings for potential basinwide sites in February 2005; both were unwadeable.

Cowells Creek was investigated for potential basinwide sites at Poyners Road and at NC 168. Both sites were unwadeable due to depth.

UT Cowells Creek, NC 34/Currituck County



There are no active permitted NPDES dischargers upstream of UT Cowells Creek at NC 34.

A benthic macroinvertebrate sample was collected on 24 February 2005 using Swamp methods. The stream was about six meters wide at the site, with a mean depth of 0.4 meter. There was no evidence of channel modification. The substrate was detritus overlying sand. Sticks, snags and logs, undercut banks and root mats were all common. Leaf packs were present but rare. Aquatic macrophytes were absent.

Hydrologically, the reach was a run. The riparian zone on both sides of the stream was wide and intact. The habitat received an overall score of 77. Conductivity was 240 µmhos/cm.

The site had not been sampled prior to 2005. In 2005 it received a rating of Moderate with a biotic index of 8.0. Thirty-six taxa were collected from the site. *Callibaetis* was the only EPT taxon collected; it was common in the sample.

Abundant taxa at the site were a whirligig beetle (*Dineutus*), a crawling water beetle (*Peltodytes*), water boatmen (Corixidae), a water scorpion (*Ranatra*), two non-biting midges (*Dicrotendipes modestus*, *Glyptotendipes*), an oligochaete (*Ilyodrilus templetoni*), a crustacean (*Gammarus fasciatus*), and a snail (*Gyraulus*). Tolerance values for abundant taxa ranged from slightly tolerant (5.5 for *Dineutus*) to highly tolerant (9.5 for *Glyptotendipes*). Two of the abundant taxa are indicators of organic enrichment and/or low dissolved oxygen: *Glyptotendipes* and *Dicrotendipes modestus*.

The site will be added to the list of basinwide sites for the Pasquotank basin; it is the only accessible freshwater site found in the subbasin to date.

PASQUOTANK RIVER SUBBASIN 55

Description

Pasquotank subbasin 55 is comprised primarily of the Carolinian Barrier Islands and Coastal Marshes ecoregion, but also includes a portion of the Nonriverine Swamps and Peatlands ecoregion on the mainland as defined by Griffith *et al.* (2002).

Land cover on the barrier islands includes beaches, marshes, forested wetlands, and evergreen forests. Land use includes wildlife habitat, urbanization, and tourism and recreation. Fish and shellfish production occur on the islands. Freshwater streams are absent.

On the mainland, streams are few and of low gradient. Channelized ditches are present. Forested wetlands, evergreen forest, and mixed forest comprise the land cover. Land uses include cropland and pine plantations.

Subbasin 55 is located in Dare County. It encompasses Stumpy Point Bay on the mainland, Pamlico Sound, and Pea Island National Wildlife Refuge and Cape Hatteras National Seashore on the outer banks. All surface water is either estuarine or oceanic. Land cover is about 90% surface water and 10% forest/wetland. There is very little urbanization or agriculture in the subbasin.

There are three active minor permitted NPDES dischargers in the subbasin.

Overview of Water Quality

There are many waterbodies within the subbasin which are impaired for the use support designation of shellfish harvesting; all impairments are due to fecal coliform standard violations. The following waterbodies are affected: Eagle Nest Bay, Mill Creek, Peters Ditch, Askins Creek, Cape Creek, Brooks Creek, Joe Saur Creek, The Slash, Sandy Bay, Austin Creek, Beach Slue, and Pamlico Sound.

Three facilities in the subbasin are required to test the toxicity of their effluent: Cape Hatteras Reverse Osmosis WTP, Stumpy Point Reverse Osmosis WTP, and Rodanthe/Waves/Salvo Reverse Osmosis WTP. The NPDES permit for Cape Hatteras Reverse Osmosis WTP specifies chronic toxicity monitoring. The whole effluent toxicity (WET) test results submitted by the facility show it failed to meet its 6.5% chronic toxicity target effluent concentration on one occasion between January 2000 and December 2005. The NPDES permits for Stumpy Point Reverse Osmosis WTP and Rodanthe/Waves/Salvo Reverse Osmosis WTP specify acute toxicity monitoring. The WET test results submitted by Stumpy Point Reverse Osmosis WTP indicate no acute effluent toxicity for the period from January 2000 through December 2005. The WET test results submitted by Rodanthe/Waves/Salvo Reverse Osmosis WTP show the facility failed to meet its 90% acute toxicity target effluent concentration on four occasions between January 2000 through December 2005.

Because of a lack of freshwater sites, no freshwater benthic invertebrate sampling has been done in the subbasin.

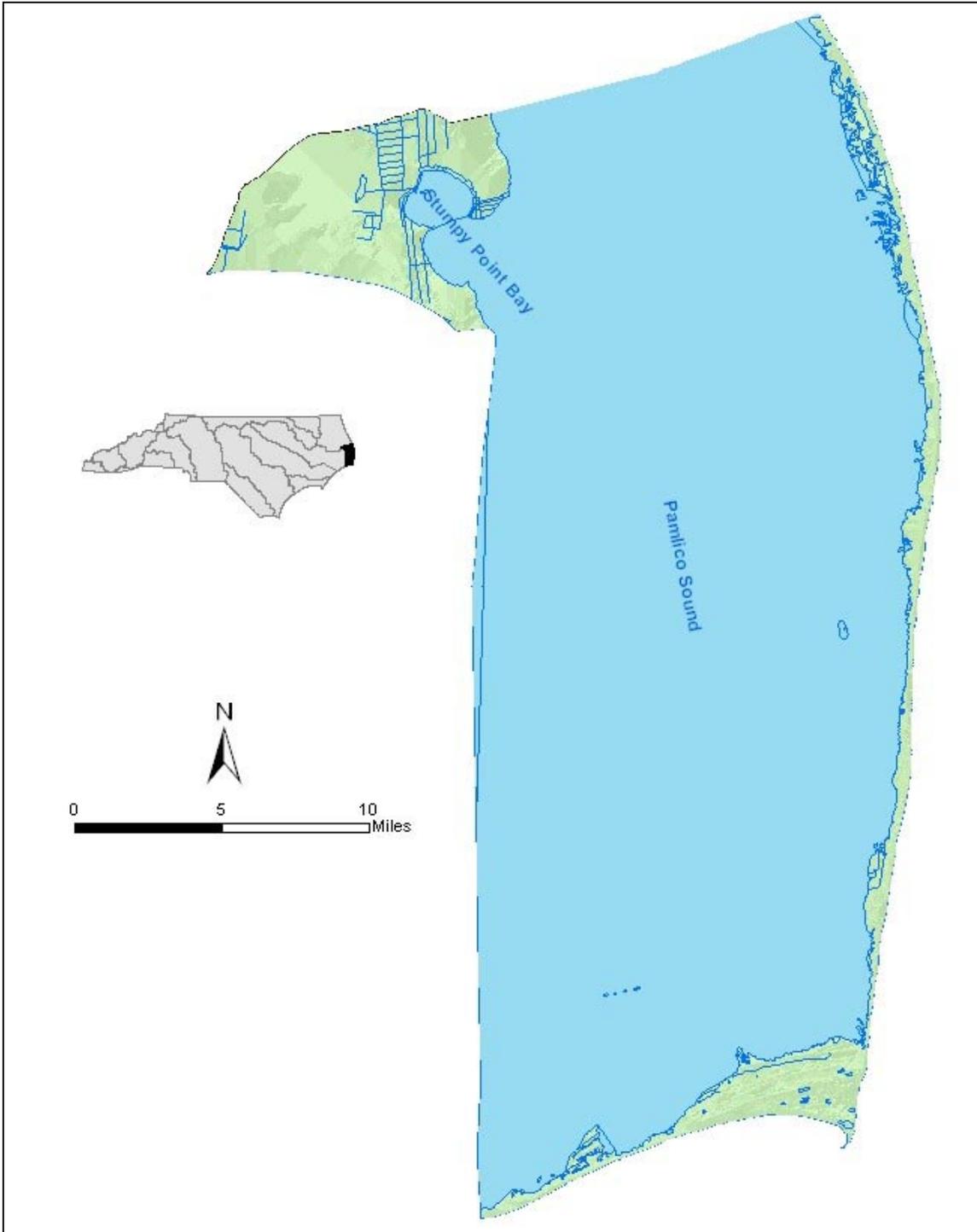


Figure PAS-07 **Map of Subbasin 55 in the Pasquotank River basin.**

PASQUOTANK RIVER SUBBASIN 56

Description

Pasquotank subbasin 56 is within the Carolinian Barrier Islands and Coastal Marshes ecoregion as defined by Griffith *et al.* (2002). Land cover includes beaches, marshes, forested wetlands, and evergreen forests. Land use includes wildlife habitat, urbanization, and tourism and recreation. Fish and shellfish production occur on the islands. Freshwater streams are absent.

Subbasin 56 is located in Dare County. The subbasin includes the outer banks from the northern portion of Dare County south to Oregon Inlet; it also includes portions of Currituck Sound, Albemarle Sound, and Roanoke Sound. Except for a few small lakes on the outer banks, waterbodies are either estuarine or oceanic. Land cover is about one-quarter forest/wetland and two-thirds surface water; most of the remainder is urban.

There are two active minor NPDES permitted dischargers in the subbasin.

Overview of Water Quality

A large portion of Roanoke Sound and an area surrounding Pond Island are impaired for the use support designation of shellfish harvesting. Also, an area of Roanoke Sound near Jockeys Ridge State Park is impaired for primary recreation. All impairments are due to fecal coliform standard violations.

Kill Devil Hills Reverse Osmosis WTP is the only facility required to test the toxicity of its effluent. The NPDES permit for the facility specifies acute toxicity monitoring. The WET test results submitted by the facility show it has failed to meet its 90% acute toxicity target effluent concentration on five occasions for outfall 001, and on 10 occasions for outfall 002, for the period of January 2000 through December 2005.

Because of the lack of freshwater streams, there have been no freshwater benthic invertebrate samples collected from the subbasin.

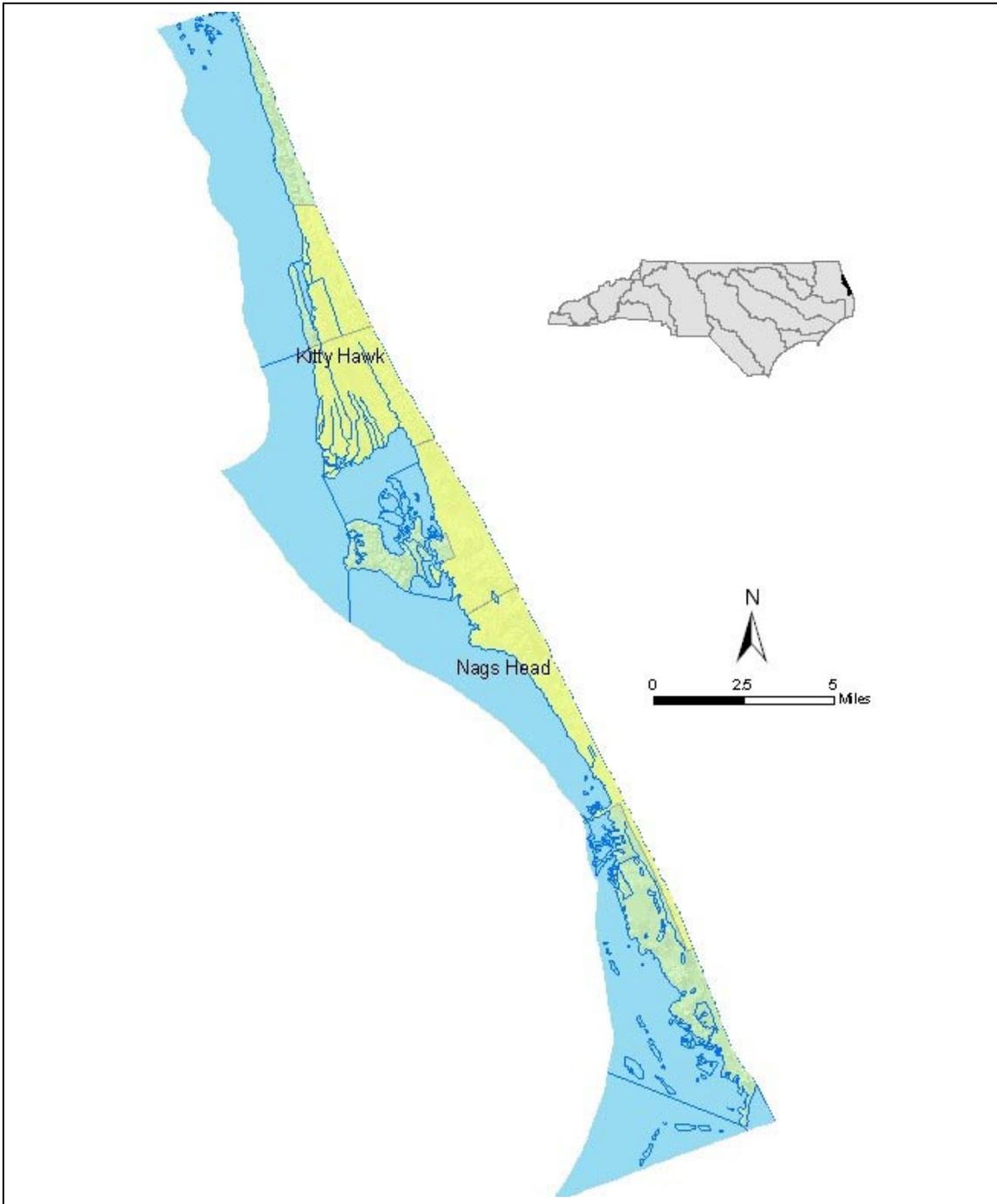


Figure PAS-08

Map of Subbasin 56 in the Pasquotank River basin.

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- NCDENR. 2003. Standard Operating Procedures for Benthic Macroinvertebrates. Environmental Sciences Branch. North Carolina Department of Environment and Natural Resources. Division of Environmental Management. Water Quality Section. Raleigh, NC.

GLOSSARY

7Q10	A value which represents the lowest average flow for a seven day period that will recur on a ten year frequency. This value is applicable at any point on a stream. 7Q10 flow (in cfs) is used to allocate the discharge of toxic substances to streams.
Bioclass	Criteria have been developed to assign bioclassifications ranging from Poor to Excellent to each benthic sample based on the number of taxa present in the intolerant groups (EPT) and the Biotic Index value.
cfs	Cubic feet per second, generally the unit in which stream flow is measured.
CHL <i>a</i>	Chlorophyll <i>a</i> .
Class C Waters	Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All freshwaters shall be classified to protect these uses at a minimum.
Conductivity	In this report, synonymous with specific conductance and reported in the units of $\mu\text{mhos/cm}$ at 25 °C. Conductivity is a measure of the resistance of a solution to electrical flow. Resistance is reduced with increasing content of ionized salts.
Division	The North Carolina Division of Water Quality.
D.O.	Dissolved Oxygen.
Ecoregion	An area of relatively homogeneous environmental conditions, usually defined by elevation, geology, and soil type. Examples include Southern Outer Piedmont, Carolina Flatwoods, Sandhills, and Slate Belt.
EPT	The insect orders (Ephemeroptera, Plecoptera, Trichoptera); as a whole, the most intolerant insects present in the benthic community.
EPT N	The abundance of Ephemeroptera, Plecoptera, Trichoptera insects present, using values of 1 for Rare, 3 for Common and 10 for Abundant.
EPT S	Taxa richness of the insect orders Ephemeroptera, Plecoptera and Trichoptera. Higher taxa richness values are associated with better water quality.

HQW	High Quality Waters. Waters which are rated as excellent based on biological and physical/chemical characteristics through Division monitoring or special studies; primary nursery areas designated by the Marine Fisheries Commission; and all Class SA waters.
IWC	Instream Waste Concentration. The percentage of a stream comprised of an effluent calculated using permitted flow of the effluent and 7Q10 of the receiving stream.
Major Discharger	Greater than or equal to one million gallons per day discharge (≥ 1 MGD).
MGD	Million Gallons per Day, generally the unit in which effluent discharge flow is measured.
Minor Discharger	Less than one million gallons per day discharge (< 1 MGD).
NPDES	National Pollutant Discharge Elimination System.
NCBI (EPT BI)	North Carolina Biotic Index, EPT Biotic Index. A summary measure of the tolerance values of organisms found in the sample, relative to their abundance. Sometimes noted as the NCBI or EPT BI.
NCIBI	North Carolina Index of Biotic Integrity (NCIBI); a summary measure of the effects of factors influencing the fish community.
NSW	Nutrient Sensitive Waters. Waters subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs.
NTU	Nephelometric Turbidity Unit.
ORW	Outstanding Resource Waters. Unique and special waters of exceptional state or national recreational or ecological significance which require special protection to maintain existing uses.
Parametric Coverage	A listing of parameters measured and reported.
SOC	A consent order between an NPDES permittee and the Environmental Management Commission that specifically modifies compliance responsibility of the permittee, requiring that specified actions are taken to resolve non-compliance with permit limits.
Total S (or S)	The number of different taxa present in a benthic macroinvertebrate sample.
UT	Unnamed tributary.
WWTP	Wastewater treatment plant.

Appendix B-1

Benthic Macroinvertebrate Sampling Methods and Criteria.

Standard Qualitative (Full Scale)

For wadeable, freshwater, flowing streams, the Biological Assessment Unit's standard qualitative (full scale) sampling procedure was used. The full scale sampling procedure produces a composite of 10 samples: two kick-net samples, three bank sweeps, two rock or log washes, one sand sample, one leaf-pack sample, and visual collections from large rocks and logs (NCDENR 2003).

Boat Sampling

Most collections are made in wadeable streams, but there are some locations where a boat is required. Such locations are usually large coastal plain rivers. In such habitats, petite ponar dredge samples replace kick-net samples, but all other standard qualitative collection techniques are used. Most of these large-river sites have little or no visible current. Coastal B criteria are used to evaluate such sites.

The standard boat method aims at a total of 10 composite samples per site. Sweeps, epifaunal collections, visual collections, and part of the leaf-pack/debris sample are performed along the edges in wadeable depths. Petite ponar samples are collected from deeper areas using the boat, along with part of the leaf-pack/debris sample, part of one epifaunal wash, and visual collections from logs in the current. Petite ponar samples are collected at three locations between midstream and the bank, with three replicates at each location (a total of nine samples). The three locations should include a variety of depths; one of those depths should be between two and three meters. No petite ponar samples are collected from the area normally sampled during shore work (i.e. areas less than two meters in depth).

Swamp Stream Method

The Biological Assessment Unit defines "swamp streams" as those streams that are within the coastal plain ecoregion and that normally have no visible flow during a part of the year. The low flow period usually occurs during the summer; flowing water should be present in swamp streams during the winter. Sampling during the winter, high-flow period provides the best opportunity for detecting differences between natural and stressed benthic communities in these systems. The swamp stream must have visible flow in this winter period, with flow comparable to a coastal plain stream that would have acceptable flow for sampling in summer. Swamp streams with pH values of 4.0 s.u. or lower can not be rated; those streams with pH values between 4.0 and 4.5 s.u. are difficult to evaluate.

The swamp sampling method utilizes a variety of collection techniques to inventory the macroinvertebrate fauna at a site. Nine sweep samples (one series of three by each field team member) are collected from each of the following habitats: macrophytes, root mats/undercut banks, and detritus deposits. If one of these habitat types is not present, a sweep from one of the other habitats is substituted. A sweep is defined as the area that can be reached from a given standing location. Each sweep should be emptied into a tub before the next sweep is collected, to prevent clogging of the net, but all three sweeps can be combined in the same tub. Three log/debris washes are also collected. Visual collections are the final technique used at each site.

For all three sampling methods (full-scale, boat, and swamp), organisms are removed from each sample at the field site and preserved in 95% ethanol. The purpose of these collections is to inventory the aquatic fauna and produce an indication of relative abundance for each taxon. Organisms are classified as Rare (1 - 2 specimens), Common (3 - 9 specimens), or Abundant (\geq 10 specimens).

Habitat Evaluation

Habitat assessment forms have been developed by the Biological Assessment Unit to evaluate the physical habitat of mountain/piedmont and coastal streams. The habitat score, which ranges

between 1 and 100, is based on the evaluation of channel modification, amount of instream habitat, type of bottom substrate, pool variety, bank stability, light penetration, and riparian zone width. Higher numbers suggest better habitat quality, but no criteria have been developed to assign impairment ratings.

Data Analysis

Standard Qualitative (Full Scale)

All standard qualitative samples were evaluated using criteria for Coastal A streams. Criteria for bioclassifications for standard qualitative samples are given in Tables B-1 and B-2. EPT S and the NCBI are used for rating standard qualitative samples.

Table B-1. Criteria for Standard Qualitative (Full Scale) Method.

Score	Biotic Index Values	EPT Values
	Coastal Plain (CA)	Coastal Plain (CA)
5	< 5.42	> 28
4.6	5.42 - 5.46	28
4.4	5.47 - 5.51	27
4	5.52 - 6.00	22 - 26
3.6	6.01 - 6.05	21
3.4	6.06 - 6.10	20
3	6.11 - 6.67	15 - 19
2.6	6.68 - 6.72	14
2.4	6.73 - 6.77	13
2	6.78 - 7.68	8 - 12
1.6	7.69 - 7.73	7
1.4	7.74 - 7.79	6
1	> 7.79	≤ 5

Table B-2. Biotic Index corrections for non-summer data. Summer = Jun – Sep; Fall = Oct – Nov; Winter = Dec – Feb; and Spring = Mar – May.

Region	Season		
	Fall	Winter	Spring
Piedmont	+0.1	+0.1	+0.2
Coastal A	+0.2	+0.2	+0.3

Both tolerance values for individual species and biotic index values evaluated for the benthic community have a range of 0 - 10, with higher numbers indicating more tolerant species or more stressed conditions. Water quality scores (5 = Excellent, 4 = Good, 3 = Good-Fair, 2 = Fair and 1 = Poor) assigned with the biotic index numbers are averaged with EPT taxa richness scores to produce a final bioclassification. EPT abundance and total taxa richness calculations also are used to help examine between-site differences in water quality.

EPT S and BI values can be affected by seasonal changes. DWQ criteria for assigning bioclassification are based on summer sampling, from June through September. For samples collected outside the summer sampling period, EPT S can be adjusted by subtracting winter/spring Plecoptera. Other adjustments may be made based on the results of resampling of the site during the summer sampling period. The BI values are also seasonally-adjusted for samples collected outside the summer season.

Boat Samples, Coastal B Rivers Criteria

The Biological Assessment Unit has limited data on Coastal B streams, therefore draft criteria have been developed based only on EPT taxa richness (Table B-3). However, biotic index values and total taxa richness values are used to evaluate between-year and among-site comparisons. The criteria that are presented here will continue to be evaluated. Any bioclassification derived from these draft criteria should be considered tentative and should not be used for use support decisions.

Table B-3. Draft Criteria for Coastal B Rivers

Bioclassification	EPT S
Excellent	> 11
Good	9-11
Good-Fair	6-8
Fair	3-5
Poor	<3

Swamp Stream Criteria

Swamp stream criteria are used to evaluate a stream based on three benthic macroinvertebrate metrics (total taxa richness, EPT taxa richness, and the Biotic Index) and the coastal plain habitat score.

In the following, raw measures for total taxa richness, EPT richness, biotic index, and habitat are referred to as “values.” After adjustments are made for swamp criteria, the measures are referred to as “scores.” The convention is made to reduce confusion.

Swamps in the Chowan and Pasquotank basins are classified as A, B, or C depending on geographic location (NCDENR 2003). The metric scores derived below depend on the swamp classification and, in some cases, pH.

If the stream channel is braided, the value for total taxa richness is increased by eight. Corrected total taxa richness is determined from Table B-4 for Swamp A and Swamp B streams. Find the pH for the collection on the left. Find the set of three columns which correspond to the stream type (Swamp A or Swamp B), the find the range which corresponds to the total taxa richness for the site (corrected for a braided stream as indicated above, if necessary). Find the corrected total taxa richness score at the top of the appropriate column.

Table B-4. Determination of Corrected Taxa Richness Scores for Swamp A and B Streams Adjusted for pH.

pH	Corrected Total Taxa Richness Score					
	Swamp A			Swamp B		
	5	3	1	5	3	1
≥5.5	>51	35-51	<35	>38	25-38	<25
5.4	>49	32-49	<32	>36	23-36	<23
5.3	>46	29-46	<29	>34	21-34	<21
5.2	>43	26-43	<26	>32	19-32	<19
5.1	>40	23-40	<23	>30	17-30	<17
5.0	>37	20-37	<20	>28	≤28	ND
4.9	>35	17-35	<17	>26	≤26	ND
4.8	>33	13-33	<13	>24	≤24	ND
4.7	>30	10-30	<10	>22	≤22	ND
4.6	>28	0-28	ND	>20	≤20	ND
4.5	>26	0-26	ND	>18	≤18	ND
4.4	>23	0-23	ND			
4.3	>20	0-20	ND			
4.2	>17	0-17	ND			
4.1	>14	0-14	ND			

Corrected total taxa richness scores are assigned as follows for Swamp C streams:
 if the total taxa richness > 34, total taxa richness score = 5
 if the total taxa richness is ≤ 34, total taxa richness score = 3

Biotic index scores for Swamp A, B, and C streams are derived using table B-5.

Table B-5. Determination of Biotic Index Scores for Swamp A, B, and C Streams

BI Score	Swamp A	Swamp B	Swamp C
5	<6.8	<7.0	<7.2
3	6.8-7.5	7.0-7.9	7.2-8.1
1	>7.5	>7.9	>8.1

For EPT taxa richness add two to the value if the channel is braided, no matter the stream type.

For Swamp A streams, the EPT richness score is determined from table B-6. Find the pH for the collection in the left column. Move to the right to find the appropriate range for the EPT Richness value. Read the corrected EPT richness score from the top of the column.

Table B-6. EPT Richness Scores for Swamp A streams adjusted for pH.

pH	Corrected EPT Richness Value		
	5	3	1
≥5.5	>17	7-17	0-6
5.4	>15	6-15	0-5
5.3	>13	5-13	0-4
5.2	>11	4-11	0-3
5.1	>9	3-9	0-2
5.0	>8	0-8	ND
4.9	>7	0-7	ND
4.8	>6	0-6	ND
4.7	>5	0-5	ND
4.6	>4	0-4	ND
4.5	>4	ND	ND

For Swamp B streams, the EPT richness score is not dependant on pH; scores are assigned as follows:

- if EPT richness value > 5, EPT richness score = 5
- if EPT richness value is between 2 and 4 inclusive, EPT richness score = 3
- if EPT richness value is 0 or 1, EPT richness score = 1

For all Swamp C streams the EPT richness score is assigned a 1. An adjustment for very low numbers of EPT taxa in Swamp C streams will be made after the site score is determined.

Habitat scores are assigned irrespective of stream type:

- if habitat value > 79, habitat score = 5
- if habitat value is between 60 and 79 inclusive, habitat score = 3
- if habitat value is < 60, habitat score = 1

The site score is calculated from the following:

$$\text{Site Score} = [(2 \times \text{BI score} + \text{habitat score} + \text{EPT S score} + \text{Taxa Richness score}) - 5] / 2$$

For Swamp C streams, add two to the site score.

Stress ratings based on the scores are: Natural (9 - 10), Moderate (4 - 8) and Severe (1 - 3).

Benthic macroinvertebrate basinwide monitoring data collected in the Pasquotank River basin, 2000-2005. No other macroinvertebrate data was collected during the basinwide cycle.

<i>Subbasin/ Waterbody</i>	<i>Location</i>	<i>County</i>	<i>Index No.</i>	<i>Date</i>	<i>ST</i>	<i>EPT</i>	<i>BI</i>	<i>EPT BI</i>	<i>BioClass</i>
30150									
Pasquotank R	SR 1361	Pasquotank	30-3-(1)	2/22/2005	30	2	7.56	6.40	Moderate
				3/6/2002	29	1	7.19	---	Not Rated
				8/3/2000	27	0	8.28	---	Not Rated
Newland Drainage Canal	SR 1363	Pasquotank	30-3-1.5	2/22/2005	44	2	7.77	6.73	Moderate
				3/6/2002	26	2	7.13	7.10	Moderate
Pasquotank R	Goat Island	Pasquotank	30-3-(3)	8/24/2005	52	4	7.79	7.20	Fair
Sawyers Cr	SR 1200	Camden	30-3-6	8/2/2000	31	4	8.09	6.83	Not Rated
				3/7/2002	29	0	6.89	---	Not Rated
Areneuse Cr	NC 343	Camden	30-3-13-(1)	2/18/2000	27	0	7.55	---	Natural
				2/23/2005	36	1	7.98	9.80	Moderate
Newbegun Cr	SR 1132	Camden	30-3-16-(1)	3/6/2002	16	0	7.88	---	Not Rated
				2/18/2000	22	0	7.82	---	Moderate
				2/23/2000	20	0	8.59	---	Moderate
30151									
NW Fk Alligator R	Canoe Trail Mile 4	Tyrrell	30-16-8	3/1/2000	13	0	8.19	---	Not Rated
SW Fk Alligator R	Canoe Trail Mile 2	Tyrrell	30-16-8-2	3/1/2000	14	0	7.19	---	Not Rated
UT Billys Ditch	off US-64 E of FWS ofc	Dare		10/10/2000	33	2	8.42	6.67	Not Rated
UT Billys Ditch	off US 64 nr landfill	Dare		10/10/2000	43	2	8.05	7.98	Not Rated
UT Callaghan Cr	ditch off Cub Rd	Dare		10/10/2000	37	2	8.87	5.46	Not Rated
UT Callaghan Cr	ditch off Long Curve Rd	Dare		10/10/2000	31	0	8.78	---	Not Rated
30152									
Little R	SR 1221	Perquimans	30-5-(1)	2/23/2005	40	1	8.35	6.40	Moderate
				2/11/2000	24	0	7.95	---	Moderate
Perquimans R	SR 1204	Perquimans	30-6-(1)	2/22/2000	26	0	7.54	---	Moderate
Perquimans R	NC 37 above Hertford	Perquimans	30-6-(1)	2/22/2005	25	0	7.53	---	Moderate
				8/23/2005	41	4	7.91	6.80	Fair
Burnt Mill Cr	NC 37	Chowan	30-8-1	8/2/2000	45	4	8.04	6.91	Not Rated
				2/21/2005	54	0	7.91	---	Moderate
				2/22/2000	37	0	7.92	---	Moderate
30153									
Kendrick Cr	US 64	Washington	30-9-(1)	10/26/2000	35	0	7.60	---	Not Rated
Main Canal	SR 1180	Washington	30-9-4	2/21/2005	33	1	8.34	6.20	Severe
				2/23/2000	31	1	8.62	9.80	Severe
Deep Cr	SR 1302	Washington	30-14-2	2/23/2000	28	1	7.06	6.40	Natural
Scuppernong R	SR 1155	Washington	30-14-4-(1)	8/3/2000	49	2	8.14	6.06	Poor
Scuppernong R	SR 1105	Tyrrell	30-14-4-(1)	8/25/2005	59	2	8.27	7.62	Poor
30154									
UT Cowells Cr	NC 34	Currituck		2/24/2005	36	1	8.02	9.80	Moderate

Appendix FT-1 Fish Tissue Criteria.

Because fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources have been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation, either directly or through aquatic food webs, and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water.

Since 1991, fish tissue surveys have been conducted as part of the Basinwide Assessment Program. Fish tissue were sampled for metals and organic contaminants throughout the year's scheduled basins with the intent of assessing as many waterbodies as possible. While this included efforts to assess suspected "trouble spots" in a basin, significant time and resources were spent in gathering data from areas where few fish tissue contaminants were historically detected. Review of data after the first round of basin assessments were completed revealed that, except for mercury, there were no widespread fish contaminant issues in the state that warranted basinwide-style investigations.

In 1999, the scope of fish tissue surveys were revised and shifted from basinwide assessments to areas where contaminants exist or are suspected. This shift has resulted in less basinwide coverage, but has focused resources on known contaminant issues within a basin.

All fish samples were collected according to standard operating procedures (NCDENR 2001). Analysis results are used as indicators for human health concerns, fish and wildlife health concerns, and the presence and concentrations of various chemicals in the ecosystem.

In evaluating fish tissue analysis results, several criteria are used. Human health concerns related to fish consumption are screened by comparing results with federal Food and Drug Administration (FDA) action levels (USFDA 1980), Environmental Protection Agency (EPA) recommended screening values, and criteria adopted by the state Health Director (Table 1). Results which seem to be of potential human health concern are evaluated by the N.C. Division of Occupational and Environmental Epidemiology by request from the DWQ.

The FDA levels were developed to protect people from the chronic effects of toxic substances consumed in foodstuffs and thus employ a "safe level" approach to fish consumption. Presently, the FDA has developed metals criteria only for mercury.

The EPA has recommended screening values for target analytes formulated from a risk assessment procedure (USEPA 1995). These are the concentrations of analytes in edible fish tissue that are of potential public health concern. The DWQ compares fish tissue results with EPA screening values to evaluate the need for further intensive site specific monitoring.

The North Carolina State Health Director has adopted a selenium limit of 5 µg/g and a mercury limit of 0.4 µg/g for issuing an advisory. North Carolina currently uses a value of 4.0 ppt in issuing a dioxin fish advisory.

Table 1

Fish tissue criteria. All wet weight concentrations are reported in parts per million (ppm, µg/g)

Contaminant	FDA Action Levels	US EPA Screening Values Recreational Fishermen	US EPA Screening Values Subsistence Fishermen	NC Health Director
Metals				
Arsenic (Inorganic)		0.026	0.00327	
Cadmium		4.0	0.491	
Mercury	1.0	0.4	0.049	0.4
Selenium		20	2.457	5.0
Tributyltin		1.2	0.147	
Organics				
Aldrin	0.3			
Chlorpyrifos		1.2	0.147	
Total chlordane		0.114	0.014	
Cis-chlordane	0.3			
Trans-chlordane	0.3			
Total DDT ¹		0.117	0.0144	
o, p DDD	5.0			
p, p DDD	5.0			
o, p DDE	5.0			
p, p DDE	5.0			
o, p DDT	5.0			
p, p DDT	5.0			
Diazinon		2.8	0.344	
Dicofol		1.6	0.196	
Dieldrin		0.0025	3.07x10 ⁻⁴	
Dioxins (total)		2.56x10 ⁻⁷	3.15x10 ⁻⁸	4.0 (ppt)
Disulfoton		0.16	0.019	
Endosulfan (I and II)		24	2.949	
Endrin	0.3	1.2	0.147	
Ethion		2.0	0.245	
Heptachlorepoxyde		0.00439	5.40x10 ⁻⁴	
Hexachlorobenzene		0.025	0.00307	
Lindane		0.0307	0.00378	
Mirex		0.8	0.098	
Oxyfluorfen		0.546	0.0671	
Total PCBs		0.02	0.00245	0.05
PCB-1254	2.0			
Terbufos		0.08	0.009	
Toxaphene		0.0363	0.00446	

¹Total DDT includes the sum of all its isomers and metabolites (i.e. p, p DDT, o, p DDT, DDE, and DDD).

²Total chlordane includes the sum of cis-and trans- isomers as well as nonachlor and oxychlordane.

Appendix FT-2 Fish Tissue Results.

The Division conducted fish tissue surveys at three stations within the Pasquotank Basin during 2003 and 2004. These surveys were conducted as part of statewide fish tissue mercury assessments. All fish samples were analyzed for concentrations of total mercury (wet weight, ppm).

Elevated mercury concentrations were measured in fish samples collected from the Kendricks Creek, Scuppernong River, and Lake Phelps (subbasin 53). Elevated levels were frequently detected in largemouth bass, a species at the top of the food chain and most often associated with mercury bioaccumulation in North Carolina. Largemouth bass, yellow perch and sunfish (48 of 89 samples) collected from the Pasquotank basin contained mercury concentrations exceeding the state criteria of 0.4 ppm. (Table 1) Presently, there are no site-specific consumption advisories for mercury contaminated fish in the Pasquotank basin; however, an advisory for the consumption of largemouth bass, bowfin, and chain pickerel east of Interstate 85 was issued by NCDHHS in 2002.

Table 1. Wet weight fish tissue concentrations of mercury (Hg) from the Pasquotank Basin, 2003 and 2004

DESCRIPTION	Species	LENGTH(cm)	WEIGHT(g)	Hg (mg/Kg)
Kendricks Creek at Mackey's	BLACK CRAPPIE	31.8	428	0.58
	BLUEGILL SUNFISH	18.6	134.5	0.19
	BLUEGILL SUNFISH	18.2	122.5	0.26
	BLUEGILL SUNFISH	16.9	102.5	0.2
	BROWN BULLHEAD	26	250	0.05
	CHAIN PICKEREL	55	1141	0.52
	CHAIN PICKEREL	41.1	433	0.39
	CHAIN PICKEREL	38.8	370	0.48
	CREEK CHUBSUCKER	29.1	374	0.23
	CREEK CHUBSUCKER	27	320	0.22
	CREEK CHUBSUCKER	24	280	0.19
	LARGEMOUTH BASS	51.8	1946	1.6
	LARGEMOUTH BASS	38.3	763	0.95
	LARGEMOUTH BASS	31.2	408	0.47
	LARGEMOUTH BASS	20.3	128	0.41
	REDEAR SUNFISH	20.1	172.5	0.3
	REDEAR SUNFISH	22.3	211	0.33
	REDEAR SUNFISH	17.7	96	0.26
	WHITE CATFISH	41.5	1075	0.21
	YELLOW PERCH	21.2	131	0.3
YELLOW PERCH	18.5	76	0.28	
YELLOW PERCH	18	82	0.19	
YELLOW PERCH	17.8	69.5	0.27	
Lake Phelps	BLUEGILL SUNFISH	21.5	252	0.5
	BLUEGILL SUNFISH	24.6	332	0.61
	BLUEGILL SUNFISH	20.5	202	0.56
	BLUEGILL SUNFISH	22.3	230	0.5
	BROWN BULLHEAD	21.5	232	0.09
	BROWN BULLHEAD	25.1	182	0.1

Table 1—continued.

DESCRIPTION	Species	LENGTH(cm)	WEIGHT(g)	Hg (mg/Kg)
Lake Phelps—continued	LARGEMOUTH BASS	46	1498	1.9
	LARGEMOUTH BASS	44.2	1104	1.7
	LARGEMOUTH BASS	43.7	1069	1.5
	LARGEMOUTH BASS	38.2	845	0.97
	LARGEMOUTH BASS	35	585	0.72
	LARGEMOUTH BASS	39	691	1.5
	LARGEMOUTH BASS	43.9	1105	1.7
	LARGEMOUTH BASS	40.5	1037	1.3
	LARGEMOUTH BASS	35	631	0.62
	LARGEMOUTH BASS	40.2	966	1.6
	LARGEMOUTH BASS	38	938	0.99
	LARGEMOUTH BASS	39.8	984	0.92
	LARGEMOUTH BASS	42.5	1220	1.2
	LARGEMOUTH BASS	40.8	1106	0.69
	LARGEMOUTH BASS	37	823	0.71
	LARGEMOUTH BASS	38.1	909	0.63
	LARGEMOUTH BASS	39.8	1186	1.1
	LARGEMOUTH BASS	45.2	1226	1.1
	LARGEMOUTH BASS	42.8	1123	1.2
	LARGEMOUTH BASS	29	374	0.59
	LARGEMOUTH BASS	28.5	325	0.63
	LARGEMOUTH BASS	28.8	380	0.64
	LARGEMOUTH BASS	28.1	334	0.47
	LARGEMOUTH BASS	47.6	1617	0.82
	LARGEMOUTH BASS	38.6	971	0.51
	LARGEMOUTH BASS	40.5	1106	0.52
	LARGEMOUTH BASS	39	832	0.54
	LARGEMOUTH BASS	36.3	693	0.43
	PUMPKINSEED	20.3	184	0.32
	PUMPKINSEED	19	162	0.23
	PUMPKINSEED	19	159	0.25
	PUMPKINSEED	18.9	146	0.21
	PUMPKINSEED	18.8	151	0.28
	PUMPKINSEED	19.1	158	0.31
	PUMPKINSEED	19.4	151	0.23
	PUMPKINSEED	19.5	139	0.36
	PUMPKINSEED	19.3	156	0.32
	PUMPKINSEED	17.7	123	0.18
	PUMPKINSEED	19.6	186	0.27
	PUMPKINSEED	18	135	0.38
	PUMPKINSEED	17.05	116	0.35
	PUMPKINSEED	14.6	67.5	0.23
	WHITE CATFISH	47	1154	0.32
YELLOW PERCH	25	202	0.67	
YELLOW PERCH	22.1	130	0.51	
YELLOW PERCH	22	139	0.65	
YELLOW PERCH	20	100	0.45	
YELLOW PERCH	19.5	85	0.45	
YELLOW PERCH	19.8	85	0.43	
YELLOW PERCH	20.1	106	0.24	
YELLOW PERCH	17.5	51.7	0.33	
YELLOW PERCH	20.7	109	0.35	
YELLOW PERCH	19.9	90	0.47	
Scuppernong River	BLUEGILL SUNFISH	19	165	0.09
	BLUEGILL SUNFISH	18.9	132	0.14
	LARGEMOUTH BASS	36.5	802	0.41
	LARGEMOUTH BASS	54	2491	0.73
	REDEAR SUNFISH	21	151	0.14
	REDEAR SUNFISH	20	139	0.1
REDEAR SUNFISH	20.1	130	0.23	

LAKE & RESERVOIR ASSESSMENTS – PASQUOTANK RIVER BASIN 2005



Intensive Survey Unit
Environmental Sciences Section
Division of Water Quality
April 6, 2006



Phelps Lake

Overview

Phelps Lake was the only lake sampled in the Pasquotank River Basin between October 1, 2001 and September 30, 2005. Phelps Lake is a unique Carolina Bay lake, the second largest natural lake in North Carolina. This shallow and acidic lake (pH < 5) is located at a higher elevation than the surrounding land, so most of its recharge comes from precipitation. Unlike many other coastal plain lakes, the water in Phelps is not colored due to tannins.

The lake is used recreationally for boating, sailing, skiing and fishing. Phelps Lake is a registered North Carolina Natural Area and an integral component of Pettigrew State Park. It also serves as habitat for two unusual species: the Lake Waccamaw killifish and leafless watermilfoil. In recognition of the valuable resources Phelps provides, the Environmental Management Commission reclassified Phelps from C Swamp to B Swamp Outstanding Resource Waters. This designation carries with it discharge and stormwater controls.

Assessment Methodology

For this basin, data from October 1, 2000 through September 30, 2005 were reviewed. Data were assessed for excursions of the state's class C water quality standards for chlorophyll *a*, pH, dissolved oxygen and water temperature, turbidity, and surface metals. A matrix is included at this end of this document depicting parameters evaluated and final rating.

A water quality standard is exceeded (shown on the matrix as CE) if data values are above the state's water quality standard for more than 10% of the samples where the sample size consists of ten or more observations for the basinwide assessment period. Ideally, ten observations are needed to provide enough data to reasonably interpret water quality conditions within the lake or reservoir. Fewer observations increase the possibility of misinterpreting random unusual conditions as representative of ongoing water quality trends. If the water quality standard is exceeded, either in less than 10% of the data collected during the assessment period or if the sample observation size is less than ten for the basinwide assessment period, then the water quality standard for that parameter is designated exceeded (E on the matrix).

Additional data considered as part of the use support assessment includes historic DWQ water quality data, documented algal blooms and/or fish kills, problematic aquatic macrophytes, or listing on the EPA's 303(d) List of Impaired Waters.

Lakes receive an overall rating of Supporting or Impaired when ten or more samples per water quality criteria are collected for evaluation within the basinwide assessment period. Otherwise, the lake is considered as Not Rated. The exceptions are for a lake listed on the 303(d) List of Impaired Waters or where additional data indicates water quality problems not captured during sampling. These lakes are listed as Impaired along with the reason for the impairment.

For a more complete discussion of lake ecology and assessment, please go to <http://www.esb.enr.state.nc.us/>. The 1990 North Carolina Lake Assessment Report (downloadable from this website) contains a detailed chapter on ecological concepts that clarifies how the parameters discussed in this review related to water quality and reservoir health.

For further background information on this lake (including sampling data), please go to <http://www.esb.enr.state.nc.us/>.

Assessment

Phelps Lake was sampled four times from May through August in 2005. The lake was also sampled 8 times as part of a low-level mercury study from November 2002 through September 2006. Physical water parameter values remained similar to those previously observed by DWQ staff. Water temperature was within state water quality standards and pH values ranged from 3.9 to 4.9 s.u. While these values are below the state water quality standard of 6.0 s.u., Phelps Lake is designated as a Swamp water (Sw). Surface waters designated as Swamp waters may have a naturally occurring pH as low as 4.3 s.u. The bottom of the lake has areas of exposed peat, which contributes to the naturally low pH of the lake water. There are also swampy wetlands adjacent to the lake.

Nutrient concentrations, which were generally low to moderate, were similar to those observed in previous years. The lowest nutrient values in Phelps Lake in 2005 were observed on July 5th and August 1st. Secchi depths were also greatest on these two sampling dates. Meteorological conditions prior to and during sampling (little to no

rainfall, bright sunlight, and low winds) may have contributed to these results. Due to its shallow depth and large surface area, the bottom of Phelps Lake is easily disturbed by rainfall and light winds, suspending peat particles within the water column which, in turn, influence nutrient concentrations, pH values and Secchi depth measurements.

On May 5th, a turbidity value of 30 NTU was observed at one sampling site (PAS012B). Turbidity values at the other two sampling sites, however, were well below this state water quality standard on this sampling date (both were 9.5 NTU). Field notes indicated that at the time the lake was sampled, a wind was blowing from the northeast and the lake had two to three foot waves resulting in bottom sediment being stirred up into the water column.

As part of the low-level mercury study, eight total mercury samples were analyzed. Of those, one sample was rejected due to blank contamination and one sample was recorded at 28.6 ng/L, which is above the standard of 12 ng/L. Due to the sample size, Lake Phelps is not rated for mercury.

Lake Phelps was placed on the 303(d) List in 1998 due to an advisory for the consumption of largemouth bass, chain pickerel or bowfin taken from the lake, which were found to be high in mercury (http://h2o.enr.state.nc.us/tmdl/General_303d.htm and <http://www.epi.state.nc.us/epi/fish/current.html>). The source of this mercury was determined to be from atmospheric deposition and not from a local source. The lake is not impaired for any other uses.

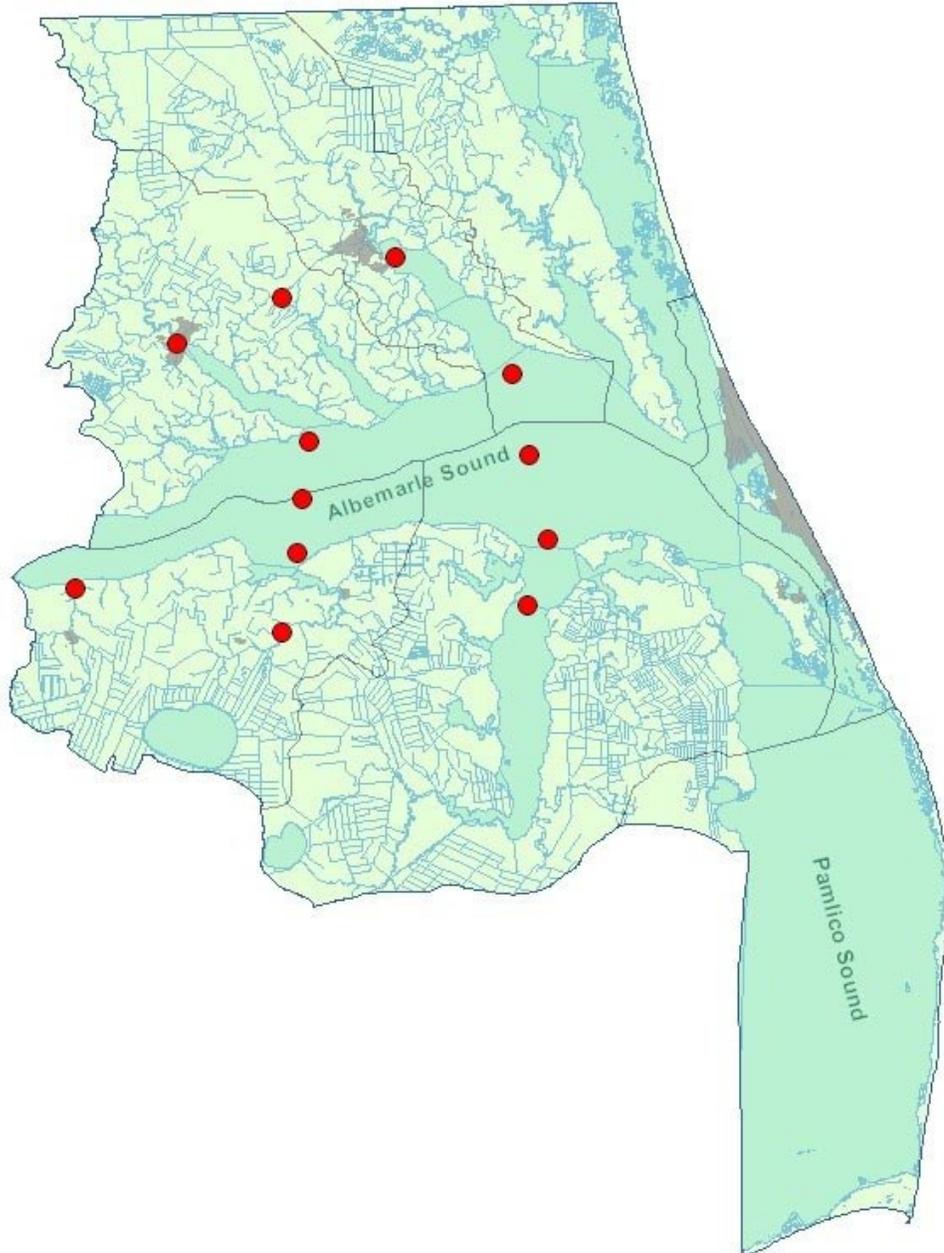
Subbasin		030153
Lakes Ambient Program Name		Phelps Lake
Trophic Status (NC TSI)		Not Calculated
Mean Depth (meters)		4.9
Volume (10⁶m³)		98.7
Watershed Area (mi²)		n/a
Assessment Unit Name		Phelps Lake
Classification		B Sw ORW
Assessment Unit		30-14-4-6-1
Stations in Assessment Unit		PAS012B, PAS012C, PAS012D
Number of Sampling Trips		13
Water Quality Standards		
Chlorophyll a	>40 ug/L	ND
Dissolved Oxygen	<4.0 mg/L	NCE
pH	<6 s.u. or > 9 s.u. (>4.3 s.u. for swamps)	5% (n=22)
Turbidity	>25 mg/L	NCE
Temperature	>32°C Lower Piedmont & Coastal Plain	NCE
Metals	15A NCAC 2B .0211	E [Mercury = 14% (n=7)]
Other Data		
% Saturation DO	>120%	N
Algae	Documented blooms during 2 or more sampling events in 1 year with historic blooms	N
Fish	Kills related to eutrophication	N
Chemically/Biologically Treated	For algal or macrophyte control - either chemicals or biologically by fish, etc.	N
Aesthetics complaints	Documented sheens, discoloration, etc. - written complaint and follow-up by a state	N
TSI	Increase of 2 trophic levels from one 5-yr period to next	N
Historic DWQ Data	Conclusions from other reports (link to other reports)	N
303(d)	Listed on 303(d) [year listed]	Fish advisory for Hg [1998]
AGPT	Algal Growth Potential Test 5-9 mg/L = concern 10 mg/L or more = problematic	ND
Macrophytes	Limiting access to public ramps, docks, swimming areas; reducing access by fish and other aquatic life to habitat	N
Taste and Odor	Public complaints or taste and odor causing algal species are dominant	N
Sediments	Clogging intakes – dredging program necessary; Frequent public/agency complaints - visual observation	NA
Aquatic Life Rating:		S

RATING KEY:

S = Supporting
I = Impaired
NR = Not Rated

Key

CE = Sample size (n) is >10 and Criteria is exceeded
E = Criteria exceeded but sample size is <10 or % not meeting <10%
NCE = Criteria not exceeded
ND = No Data – sample not taken for this parameter
NA = Standard not applicable based on Classification
Y = in Other Data portion, indicates that the parameter has exceeded target or
N = in Other Data portion, indicates that the parameter is within target per available data



Pasquotank River Basin Ambient Monitoring System Report

September 1, 2000 through August 31, 2005



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Evaluation Levels

In order to assist the reader in developing a rapid understanding of the summary statistics provided throughout this data review, concentrations of water quality variables may be compared to an Evaluation Level (EL). Evaluation levels may be a water quality standard, an action level, an ecological threshold, or simply an arbitrary threshold that facilitates a rapid data review. Evaluation levels are further examined for frequency to determine if they have been exceeded in more than 10 percent of the observed samples. This summary approach facilitates a rapid and straightforward presentation of the data but may not be appropriate for making specific use support decisions necessary for identification of impaired waters under the Clean Water Act's requirements for 303(d) listings. The reader is advised to review the states 303(d) listing methodology for this purpose. (see http://h2o.enr.state.nc.us/tmdl/General_303d.htm).

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SUMMARY

A general understanding of human activities and natural forces that affect pollution loads and their potential impacts on water quality can be obtained through routine sampling from fixed water quality monitoring stations. During this assessment period (September 1, 2000 through August 31, 2005) chemical and physical measurements were obtained by DWQ from 12 stations located throughout the Pasquotank River Basin. The N.C. Recreational Water Quality Program monitors 38 additional locations for bacterial issues; 241 locations are monitored statewide. Information on the program can be found here: http://www.deh.enr.state.nc.us/shellfish/Water_Monitoring/RWQweb/home.htm. The program meets all the requirements of the EPA national beach rule.

In order to evaluate acceptable water quality criteria at least 10 observations are desired. If at least 10 results were collected for a given site for a given parameter, the results are then compared to water quality evaluation levels. The water quality evaluation level may be an ecological evaluation level, a narrative or numeric standard, or an action level as specified in 15A NCAC 2B .0200 (Table 3). If less than 10 results were collected, then no comparison to evaluation levels was made. When more than 10 percent of the results exceeded the evaluation level, a binomial statistical test was employed to determine if there was sufficient statistical confidence (95% confidence) to conclude that the results statistically exceeded the 10% criteria. When that is found to be true, it is termed a *statistically significant exceedance* (SSE). This criterion was applied to all parameters with an evaluation level, except for fecal coliform bacteria. The criteria for fecal coliform varied based on the classification of the water body. See the Parameters section for an explanation of fecal coliform methods. The results of the data analysis are displayed in tables, box plots, scatter plots, and maps. For complete summaries on each station, reference the AMS Station Summary Sheets located in Appendix A.

All data were collected between September 1, 2000 and August 31, 2005. Stations with SSEs were found for dissolved oxygen < 5 mg/L (one site), pH (three sites), copper (8 sites), iron (two sites), and nickel (one site). For all parameters, four additional 10 percent violations (for dissolved oxygen, chlorophyll a, and two for copper) that were not SSEs also occurred.

As drought caused low flows of freshwater into Albemarle Sound in 2001-2003, a wedge of saltwater pushed in from the Atlantic, causing conductivity levels to rise. In fall 2003, heavy rains ended the drought and reduced conductivity levels. This pattern of a gradual rise and a sudden drop (or the reverse) is common across many parameters. Freshwater flow and saltwater intrusion appears to be the strongest influence in this basin during the 2000-2005 period.

Copper is the most common violation reported. Copper is naturally occurring in the ocean and estuaries. However, as noted in a review by Kennish (1998), concentrations of copper in estuarine and coastal waters in the United States ranged from 0.3 to 3.8 and 0.1 to 2.5 ug/L, respectively. For all twelve stations, at least 10% of samples were above 3.8 ug/L. For eight of 12 stations, samples were above 3.8 ug/L at least 25% of the time. Based on this, the copper concentrations detected in the Pasquotank River basin may be due to man-made sources, such as copper antifouling boat paints. These paints are designed to leach copper into the water, mostly as cuprous oxide, to reduce the fouling on the boats' bottoms with barnacles and algae.

Among the 12 stations, M6920000, Kendrik Creek at SR 1300 at Mackeys, has the lowest median dissolved oxygen and pH concentrations (among non-swamp waters), and the highest turbidity, nitrate nitrite, and iron. This station has four SSEs, for dissolved oxygen (<5), pH, copper, and nickel. This station did not have significant trends, however.

The following table gives a summary of the problem areas using these criteria. While reading the table please note the following: The majority of the parameters listed are compared directly to water quality standards, and those are highlighted in blue. There are two exceptions, however. The fecal coliform standard requires that 5 samples be taken in the span of 30 days, which was not done for this data. Therefore any fecal coliform violations should be taken as a recommendation to collect the data required

by the standard. The second exception is the dissolved oxygen (< 5 mg/l) standard. For fresh waters, the 5 mg/l standard is a daily average. The 4 mg/l standard applies to all waters and all samples.

Table 1. Exceedances in the Pasquotank River Basin

Subbasin / Station ID	Location	Class	Parameter / Evaluation Level	% Exceed	% Conf
50 Pasquotank River and Northeast Albemarle Sound					
M2750000	Pasquotank Riv At Elizabeth City	SB	pH (<6.8) Total Copper (>3)	39.1% 52.6%	100.0% 100.0%
M390000N	Albemarle Sound Nr Frog Island N Shore	SB	Total Copper (>3)	33.3%	99.8%
51 Alligator River and Southeast Albemarle Sound					
M390000C	Albemarle Sound Nr Frog Island Mid Channel	SB	Total Copper (>3)	11.8%	76.2%
M390000S	Albemarle Sound Nr Frog Island S Shore	SB	Total Copper (>3)	36.8%	100.0%
M7175000	Alligator Riv At Us 64 Nr Alligator	SC Sw ORW	Total Copper (>3)	61.1%	100.0%
52 Little River, Perquimans River, and Central Albemarle Sound					
M3500000	Little Riv At Sr 1367 At Woodville	C Sw	Total Iron (>1000) Chlorophyll A (ug/L)	71.4% 10.9%	100.0% 69.0%
M5000000	Perquimans Riv At Sr 1336 At Hertford	SC	Dissolved Oxygen* (<5) pH (<6.8) Total Copper (>3)	12.3% 45.6% 10.0%	79.3% 100.0% 67.7%
M610000N	Albemarle Sound Between Harvey Pt And Mill Pt N Shore	SB	Total Copper (>3)	31.6%	99.8%
53 Scuppernong River, Kendrick Creek, and Southwest Albemarle Sound					
M610000C	Albemarle Sound Between Harvey Pt And Mill Pt Mid Channel	SB	Total Copper (>3)	38.9%	100.0%
M610000S	Albemarle Sound Between Harvey Pt And Mill Pt S Shore	SB	Total Copper (>3)	40.0%	100.0%
M6920000	Kendrick Crk At Sr 1300 At Mackeys	SC	Dissolved Oxygen* (<5) pH (<6.8) Total Copper (>3) Total Nickel (>8.3)	43.9% 63.2% 25.0% 45.0%	100.0% 100.0% 98.9% 100.0%
M6980000	Scuppernong Riv At Sr 1105 Nr Columbia	C Sw	Total Iron (>1000)	95.0%	100.0%

Blue entries indicate violations of standards. Black entries indicate violations of action levels or evaluation levels.

* Applies to saltwater (class SA, SB, and SC) primarily, and to freshwater (class B, C, and WS) as a daily average.

INTRODUCTION

The DWQ's Ambient Monitoring System is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data. The stations are located at convenient access points (e.g. bridge crossings) that are sampled on a monthly basis. These locations were chosen to characterize the effects of point source dischargers and nonpoint sources such as agriculture, animal operations, and urbanization within watersheds. Currently the DWQ does not conduct probabilistic (random) monitoring.

The data are used to identify long term trends within watersheds, to develop Total Maximum Daily Loads (TMDLs) and to compare measured values with water quality standards to identify possible areas of impairment. Parametric coverage is determined by freshwater or saltwater waterbody classification and corresponding water quality standards. Under this arrangement, core parameters are based on Class C waters with additional parameters added when justified (Table 2).

Within this document, an analysis of how monitoring results compare with water quality standards and evaluation levels is presented. A conceptual overview of water quality standards is provided at: <http://www.epa.gov/waterscience/standards>. Specific information on North Carolina water quality standards is provided at: <http://h2o.enr.state.nc.us/csu/swstdsfaq.html>.

Water quality data are evaluated in five year periods. Some stations have little or no data for several parameters over the period. However, for the purpose of standardization, data summaries for each station are included in this report. DWQ monitored water quality and collected samples at 14 stations throughout the basin.

Table 2. Parametric coverage for the Ambient Monitoring System.¹

Parameter	All Waters	Water Supply
Dissolved oxygen (s)	✓	✓
pH (s)	✓	✓
Specific conductance	✓	✓
Temperature (s)	✓	✓
Total phosphorus ²	✓	✓
Ammonia as N ²	✓	✓
Total Kjeldahl as N ²	✓	✓
Nitrate+nitrite as N ² (s)	✓	✓
Total suspended solids	✓	✓
Turbidity (s)	✓	✓
Fecal coliform bacteria (s)	✓	✓
Aluminum	✓	✓
Arsenic (s)	✓	✓
Cadmium (s)	✓	✓
Chromium, total (s)	✓	✓
Copper, total (s)	✓	✓
Iron (s)	✓	✓
Lead (s)	✓	✓
Mercury (s)	✓	✓
Nickel (s)	✓	✓
Zinc (s)	✓	✓
Manganese (s)	---	✓
Chlorophyll a ² (s)	✓	✓

¹A check (✓) indicates the parameter is collected. 's' indicates the parameter has a standard.

²Chlorophyll a is collected in Nutrient Sensitive Waters (NSW) and some coastal areas. Since 2001, nutrient sampling likewise is only done in areas of concern, such as NSW, estuaries, and areas with known enrichment issues.

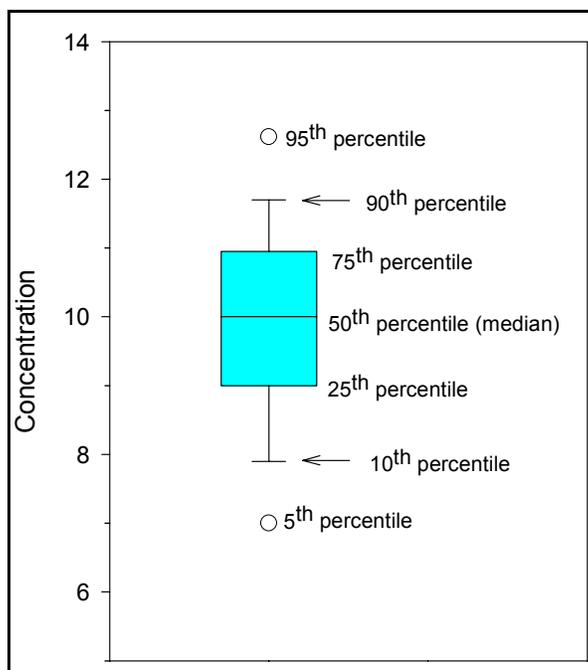


Figure 1. Explanation of box plots.

Table 3. Selected standards for parameters sampled as part of the Ambient Monitoring System.¹

Parameter (µg/L, unless noted)	Standards for All Freshwater			Standards to Support Additional Uses		
	Aquatic Life	Human Health	Water Supply Classifications	Trout Water	HQW	Swamp Waters
Arsenic		10				
Cadmium	2.0			0.4		
Chloride (mg/l)	230		250			
Chlorophyll a (corrected)	40 ²			15 ²		
Chromium, total	50					
Coliform, total (MFTCC/100 ml) ³			50 ² (WS-I only)			
Coliform, fecal (MFFCC/100 ml) ⁴		200 ²				
Copper, total	7					
Dissolved oxygen (mg/L)	4.0 ^{5,6}			6.0		2, 6
Hardness, total (mg/L)			100			
Iron	1,000					
Lead	25 ²					
Manganese			200			
Mercury	0.012					
Nickel	88		25			
Nitrate nitrogen			10,000			
pH (units)	6.0 - 9.0 ^{2, 6}					2, 6
Solids, total suspended (mg/L)					10 Trout, 20 other ⁷	
Turbidity (NTU)	50, 25 ²			10 ²		
Zinc	50					

¹Standards apply to all classifications. For the protection of water supply and supplemental classifications, standards listed under Standards to Support Additional Uses should be used unless standards for aquatic life or human health are listed and are more stringent. Standards are the same for all water supply classifications (Administrative Code 15A NCAC 2B 0200, eff. August 1, 2004).

²Refer to 2B.0211 for narrative description of limits.

³Membrane filter total coliform count per 100 ml of sample.

⁴Membrane filter fecal coliform count per 100 ml of sample.

⁵An instantaneous reading may be as low as 4.0 mg/L, but the daily average must be 5.0 mg/L or more.

⁶Designated swamp waters may have a dissolved oxygen less than 5.0 mg/L and a pH as low as 4.3, if due to natural conditions.

⁷For effluent limits only, refer to 2B.0224(1)(b)(ii).

Parameter (µg/L, unless noted)	Standards for All Saltwater			Standards To Support Additional Uses	
	Aquatic Life	Human Health ¹	Class SA ²	HQW	Swamp Waters
Arsenic		10			
Cadmium	5.0				
Chlorophyll a (corrected)	40 ³				
Chromium, total	20				
Coliform, fecal (MFFCC/100ml) ⁴		200 ³	14 ³		
Copper, total	3 ⁵				
Dissolved oxygen (mg/L)	5.0 ⁹			6.0	3, 6
Lead	25 ³				
Mercury	0.025				
Nickel	8.3				
PH (units)	6.8 - 8.5 ⁶				3, 6
Selenium	71				
Silver	0.1 ⁵				
Solids, total suspended (mg/L)				10 PNA ⁷ , 20 other ⁸	
Turbidity (NTU)	25 ³				
Zinc	86 ⁵				

¹Standards are based on consumption of fish only unless dermal contact studies are available, see 2B.0208 for equation.

²Class SA = shellfishing waters, see 2B.0101 for description.

³See 2B.0220 for narrative description of limits.

⁴MFFCC/100ml means membrane filter fecal coliform count per 100 ml of sample.

⁵Values represent action levels as specified in 2B.0220.

⁶Designated swamp waters may have a dissolved oxygen less than 5.0 mg/L and a pH as low as 4.3 s.u., if due to natural conditions.

⁷PNA = Primary Nursery Areas.

⁸For effluent limits only, see 2B.0224.

Swamp waters, poorly flushed tidally influenced streams, or embayments, or estuarine bottom waters may have lower values if caused by natural conditions.

Table 4. DWQ Monitoring stations in the Pasquotank River Basin, 2000 - 2005.

Subbasin/ Station ID	Location	Class	Lat.	Long.
50	Pasquotank River and Northeast Albemarle Sound			
M2750000	Pasquotank River at Elizabeth City	SB	36.28061	-76.17139
M390000N	Albemarle Sound near Frog Island North Shore	SB	36.15033	-76.02095
51	Alligator River and Southeast Albemarle Sound			
M390000C	Albemarle Sound near Frog Island Mid Channel	SB	36.06250	-76.00163
M390000S	Albemarle Sound near Frog Island South Shore	SB	35.96945	-75.97953
M7175000	Alligator River at US 64 near Alligator	SC Sw ORW	35.89859	-76.00978
52	Little River, Perquimans River, and Central Albemarle Sound			
M3500000	Little River at SR 1367 at Woodville	C Sw	36.24051	-76.32464
M5000000	Perquimans River at SR 1336 at Hertford	SC	36.19387	-76.46611
M610000N	Albemarle Sound btwn Harvey Point and Mill Point N Shore	SB	36.08348	-76.29288
53	Scuppernong River, Kendrick Creek, and Southwest Albemarle Sound			
M610000C	Albemarle Sound btwn Harvey Point and Mill Point Mid Channel	SB	36.02151	-76.30602
M610000S	Albemarle Sound btwn Harvey Point and Mill Point S Shore	SB	35.96353	-76.31261
M6920000	Kendrick Creek at SR 1300 at Mackeys	SC	35.92995	-76.60983
M6980000	Scuppernong River at SR 1105 near Columbia	C Sw	35.87762	-76.33761

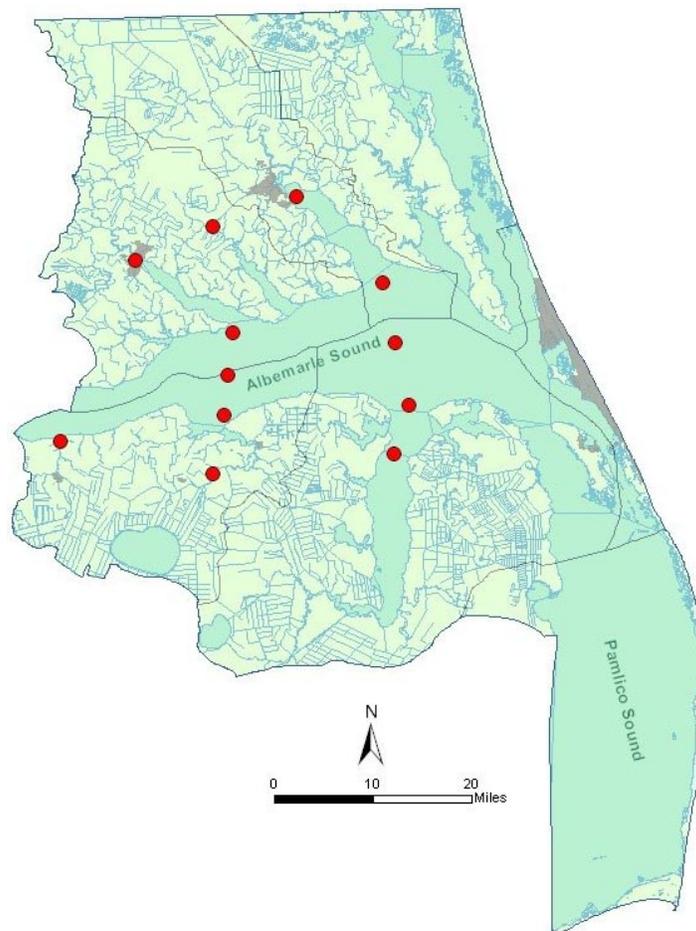


Figure 2. DWQ's Ambient Monitoring System in the Pasquotank River Basin.

DATA ASSESSMENT AND INTERPRETATION

Monitoring and sampling results considered in this report represent samples collected or measurements taken at less than one-meter depth.

Percentile statistics were calculated for most of the data using JMP statistical software (version 5.01; SAS Institute, Cary, NC). Values less than the minimum reporting level (non-detected) were evaluated as equal to the reporting level. Box and whisker plots (constructed using SigmaPlot version 8.02) and maps are presented for most water quality parameters collected at each monitoring station. Significant trends in water quality parameters (constructed using Microsoft Excel) are illustrated as scatterplots. Significant trends are found by assessing the probability that the linear model explains the data no better than chance. If that chance is 5% or less (an observed significance probability of 0.05 or less) then that is considered evidence of a regression effect in this document. The strength of the regression effect is given as an r^2 value, the portion of the data that is explained by the linear model. There are many other types of modeling (non-linear) that can be used to explore trends, but they were not used in this document.

Analytical Considerations

Three issues were noted by the DWQ Laboratory Section as part of the analytical processes during this assessment period:

- 1) Between February and April 2001, improved analytical techniques and protocols for nutrient samples were implemented. No nutrient samples were processed during the period when the techniques and protocols were being implemented.
- 2) In early 2001 the Laboratory Section reviewed their internal QA/QC programs and some of the analytical methods. This effort resulted in a temporary increase in reporting levels for certain parameters. New analytical equipment and methods were subsequently acquired to establish more accurate reporting levels and rigorous quality assurance. Because of the improvements, the reporting levels quickly declined back down to or near the previous reporting levels. Nutrients were especially affected by these changes (Table 5).
- 3) Chlorophyll a samples collected between 4/11/05 and 8/23/05 were incorrectly prepared for analysis, to the extent that the accuracy of the results is unknown. Therefore, the chlorophyll a results for this period were omitted from the dataset.

Table 5. Changes in the Laboratory Section's reporting levels for nutrients.

Parameter	Reporting Level By Date (mg/l)			
	Pre-2001	3/13/2001 to 3/29/2001	3/30/2001 to 7/24/2001	7/25/2001 to present
NH ₃	0.01	0.5	0.2	0.01
TKN	0.1	1.0	0.6	0.20
NO ₂ +NO ₃	0.01	0.5	0.15	0.01
TP	0.01	0.5	0.1	0.02

Providing Confidence in the Exceedances of Water Quality Standards

NC DWQ uses guidance provided by the US EPA for determining when the number of results that exceed a water quality standard indicate potential water quality issues. Historically, the US EPA has suggested that management actions be implemented when 10 percent of the results exceeded a water quality standard. This interpretation is the same whether 1 out of 10, or 5 out of 50, or 25 out of 250 results exceed a standard. Evaluating exceedances in this manner is termed the "raw-score" approach. Although this "10 percent exceedance criterion" defines a point where potential water quality issues may be present, it does not consider uncertainty. Some results are subject to chance or other factors such as calibration errors or sample mishandling. Uncertainty levels change with sample size. The smaller the sample size, the greater the uncertainty.

This document uses a nonparametric procedure (Lin *et al.* 2000) to identify when a sufficient number of exceedances have occurred that indicate a true exceedance probability of 10 percent. Calculating the minimum number of exceedances needed for a particular sample size was done using the BINOMDIST function in Microsoft Excel[®]. This statistical function suggests that at least three exceedances need to be observed in a sample of 10 in order to be [about] 95 percent confident that the results statistically exceed the water quality standard more than 10% of the time. For example, there is less statistical confidence associated with a 1 exceedance out of 10 (73 percent) than when there are 3 exceedances out of 10 (93 percent confidence (Table 7).

Table 6. Exceedance Confidence

Number of Samples	Number of Exceedances																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10	74%	93%	99%	100%													
12	66%	89%	97%	100%													
14	58%	84%	96%	99%	100%												
16	51%	79%	93%	98%	100%												
18	45%	73%	90%	97%	99%	100%											
20	39%	68%	87%	96%	99%	100%											
22	34%	62%	83%	94%	98%	100%											
24	29%	56%	79%	91%	97%	99%	100%										
26	25%	51%	74%	89%	96%	99%	100%										
28	22%	46%	69%	86%	94%	98%	100%										
30	18%	41%	65%	82%	93%	97%	99%	100%									
32	16%	37%	60%	79%	91%	96%	99%	100%									
34	13%	33%	55%	75%	88%	95%	98%	99%	100%								
36	11%	29%	51%	71%	85%	94%	98%	99%	100%								
38	10%	25%	46%	67%	83%	92%	97%	99%	100%								
40	8%	22%	42%	63%	79%	90%	96%	98%	99%	100%							
42	7%	20%	38%	59%	76%	88%	95%	98%	99%	100%							
44	6%	17%	35%	55%	73%	85%	93%	97%	99%	100%							
46	5%	15%	31%	51%	69%	83%	92%	96%	99%	100%							
48	4%	13%	28%	47%	65%	80%	90%	95%	98%	99%	100%						
50	3%	11%	25%	43%	62%	77%	88%	94%	98%	99%	100%						
52	3%	10%	22%	40%	58%	74%	86%	93%	97%	99%	100%						
54	2%	8%	20%	36%	54%	71%	83%	91%	96%	98%	99%	100%	100%	100%	100%	100%	100%
56	2%	7%	18%	33%	51%	67%	81%	90%	95%	98%	99%	100%	100%	100%	100%	100%	100%
58	2%	6%	16%	30%	47%	64%	78%	88%	94%	97%	99%	100%	100%	100%	100%	100%	100%
60	1%	5%	14%	27%	44%	61%	75%	86%	93%	97%	99%	99%	100%	100%	100%	100%	100%
62	1%	5%	12%	24%	40%	57%	72%	84%	91%	96%	98%	99%	100%	100%	100%	100%	100%
64	1%	4%	11%	22%	37%	54%	69%	81%	90%	95%	98%	99%	100%	100%	100%	100%	100%
66	1%	3%	9%	20%	34%	51%	66%	79%	88%	94%	97%	99%	99%	100%	100%	100%	100%
68	1%	3%	8%	18%	31%	47%	63%	76%	86%	93%	96%	98%	99%	100%	100%	100%	100%
70	1%	2%	7%	16%	29%	44%	60%	74%	84%	91%	96%	98%	99%	100%	100%	100%	100%
72	0%	2%	6%	14%	26%	41%	57%	71%	82%	90%	95%	97%	99%	100%	100%	100%	100%
74	0%	2%	5%	13%	24%	38%	54%	68%	80%	88%	94%	97%	99%	99%	100%	100%	100%
76	0%	1%	5%	11%	22%	35%	51%	65%	77%	86%	93%	96%	98%	99%	100%	100%	100%
78	0%	1%	4%	10%	20%	33%	48%	62%	75%	85%	91%	95%	98%	99%	100%	100%	100%
80	0%	1%	4%	9%	18%	30%	45%	59%	72%	83%	90%	95%	97%	99%	99%	100%	100%

Note: Bold and shaded entries indicate that there is at least 95% confidence that at least 10% of the possible samples exceed the standard/action level.

Methods Used to Summarize Results

Methods used to summarize the results in this report encompass both tabular and graphical formats. Individual summary sheets for each station provide details on station location, stream classification, along with specifics on what parameters were measured, the number of samples taken (i.e. sample size), the number of results below reporting levels, the number of results exceeding a water quality standard or evaluation level, statistical confidence that 10% of results exceeded the evaluation level, and a general overview of the distribution of the results using percentiles. These station summary sheets provide the greatest details on a station-by-station basis. They are included as Appendix A to this report.

Use Support Assessment Considerations

- 1) The freshwater dissolved oxygen concentrations of 5.0 mg/L and 4.0 mg/L are presented as evaluation levels. Instantaneous concentrations of 4.0 mg/L or less (5.0 mg/L in salt water) are in violation of the standard unless caused by natural (e.g. swampy) conditions. The 5.0 mg/L evaluation level is based upon a freshwater standard which specifies "not less than a daily average of 5.0 mg/L" (15A NCAC 2B.0200).
- 2) The standards specify that action levels are to be used used for copper, iron, and zinc in salt waters. Where appropriate, follow-up toxicological work may need to be conducted.
- 3) The geometric mean and median statistics were calculated for fecal coliform results for each station as appropriate for stream class.

Specific information on water quality standards and action levels can be found in 15A NCAC 2B.0200 (August 1, 2004).

PARAMETERS

Dissolved Oxygen

Dissolved oxygen is one of the most important of all the chemical measurements. Dissolved oxygen provides valuable information about the ability of the water to support aquatic life and the capacity of water to assimilate point and nonpoint discharges. Water quality standards for dissolved oxygen vary depending on the classification of the body of water [see, for example: 15A NCAC 02B.0211(1)(b) and 15A NCAC 02B.0220 (1)(b)] but generally results less than 4.0 mg/L can be problematic. Consistent patterns of low concentrations of dissolved oxygen can be subject to intense management review and corrective actions, although patterns of low dissolved oxygen can occur naturally in and near swamp waters, in estuarine waters under salt wedge conditions, or during droughts.

pH

The pH of natural waters can vary throughout the state. Low values (<< 7.0 s.u.) can be found in waters rich in dissolved organic matter, such as swamp lands, whereas high values (>> 7.0 s.u.) may be found during algal blooms. Point source dischargers can also influence the pH of a stream. The measurement of pH is relatively easy; however the accuracy of field measurements is limited by the abilities of the field equipment, which is generally accurate to within 0.2 S.U. This is due, in part, because the scale for measuring pH is logarithmic (i.e. a pH of 8 is ten times less concentrated in hydrogen ions than a pH of 7).

The water quality standards for pH in freshwaters consider values less than 6.0 s.u. or greater than 9.0 s.u. to warrant attention; whereas in salt waters pH values less than 6.8 or greater than 8.5 warrant attention.

Conductivity

In this report, conductivity is synonymous with specific conductance. It is reported in micromhos per centimeter ($\mu\text{mhos/cm}$) at 25°C. Conductivity is a measure of the ability of water to conduct an electric

current. The presence of ions and temperature are major factors in the ability of water to conduct a current. Clean freshwater has a low conductivity, whereas high conductivities may indicate polluted water or saline conditions. Measurements reported are corrected for temperature, thus the range of values reported over a period of time indicate the relative presence of ions in water. Conductivities in US fresh waters commonly vary between 50 to 1,500 $\mu\text{mhos/cm}$ (APHA 1998). North Carolina freshwater streams have a natural conductance range of 17-65 $\mu\text{mhos/cm}$, however (USGS 1992).

Conductivity can be used to evaluate variations in dissolved mineral concentrations (ions) among sites with varying degrees of impact resulting from point source discharges. Generally, impacted sites show elevated and widely ranging values for conductivity. However, water bodies that contain saltwater will also have high conductivities. Therefore those wishing to use conductivity as an indicator for problems must first account for salinity.

Turbidity

Turbidity data may denote episodic high values on particular dates or within narrow time periods. These can often be the result of intense or sustained rainfall events; however elevated values can occur at other times. Tidal surges can also disturb shallow estuarine sediments and naturally increase turbidity.

Metals

A number of metals are essential micronutrients for the support of aquatic life. However, there are threshold concentrations over which metals can be toxic. Currently the DWQ monitors total (not dissolved) concentrations for aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, manganese (Water Supply waters only), nickel, and zinc. Aluminum and iron are commonly found in North Carolina soils, therefore high aluminum and iron concentrations are typically correlated with high turbidity.

Nutrients

Compounds of nitrogen and phosphorus are major components of living organisms and thus are essential to maintain life. These compounds are collectively referred to as "nutrients." Nitrogen compounds include ammonia-nitrogen ($\text{NH}_3\text{-N}$), total Kjeldahl nitrogen (TKN) and nitrite+nitrate nitrogen ($\text{NO}_2+\text{NO}_3\text{-N}$). Phosphorus is measured as total phosphorus. When nutrients are introduced to an aquatic ecosystem from municipal and industrial treatment processes, or runoff from urban or agricultural land, the excessive growth of algae (algal blooms) and other plants may be accelerated.

In addition to the possibility of causing algal blooms, ammonia-nitrogen may combine with high pH water to form NH_4OH , a form toxic to fish and other aquatic organisms.

Bacteria

Concentrations of fecal coliform bacteria can vary greatly. The descriptive statistics used to evaluate fecal coliform bacteria data include the geometric mean and the median depending on the classification of the waterbody. For all sites in the Pasquotank River Basin, the standard specified in Administrative Code 15A NCAC 02B.0211 (3)(e) (August 1, 2005) is applicable:

"Organisms of the coliform group: fecal coliforms shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period; violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the membrane filter technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method."

The application of the standard is often hindered because the monthly (*circa* 30 day) sampling frequency employed for water quality monitoring usually does not provide more than one sample per 30-day period. However, water quality problems can be discerned using monthly sampling.

There are no SA class waters in the Pasquotank River Basin. Non-SA class sites where the geometric mean was greater than 200 colonies/100ml, or where greater than 20 percent of the results exceed 400 colonies/100ml are indicated on the respective station summary sheets.

In November 2004 the EPA promulgated a national rule for bacteria in coastal recreational waters. Instead of a rule for fecal coliform as a group, they chose to specifically target Enterococci and E. coli. EPA listed geomeans for E. coli in freshwater, and for Enterococci in both fresh and saltwater. Four levels of single sample maximum allowable densities were also given for those three (freshwater Enterococci, saltwater Enterococci, and freshwater E. coli) categories. The N.C. Recreational Water Quality Program (NCRWQP) has incorporated compliance with this national rule into their operations.

The NCRWQP began testing coastal waters in 1997. Their mission is to protect the public health by monitoring the quality of N.C.'s coastal recreational waters and notifying the public when bacteriological standards for safe bodily contact are exceeded. The coastal waters monitored include the ocean beaches, sounds, bays and estuarine rivers.

The NCRWQP tests for enterococcus bacteria, an indicator organism found in the intestines of warm-blooded animals. While it will not cause illness itself, its presence is correlated with that of organisms that can cause illness. The program tests 241 ocean and sound-side areas, most of them on a weekly basis. Swimming season runs from April 1 to Sept. 30 - all ocean beaches and high-use sound-side beaches are tested weekly. Lower-use beaches are tested twice a month. All sites are tested twice a month in October and monthly from November through March.

Table 7. Summary of Evaluation Level Exceedances at DWQ Stations

Subbasin / Station	Class	Percentage of Results that Exceeded the Evaluation Limit										
		Dissolved Oxygen (<5) ¹	Dissolved Oxygen (<4) ²	pH (combined) ³	Water Temperature	Chlorophyll A	Turbidity	Copper	Iron	Nickel	Zinc	Fecal Coliform
50	Pasquotank River and Northeast Albemarle Sound											
M2750000	SB	0%	NA	39%	2%	0%	2%	53%	NA	0%	0%	0%
M390000N	SB	0%	NA	4%	0%	BT	4%	33%	NA	0%	0%	0%
51	Alligator River and Southeast Albemarle Sound											
M390000C	SB	0%	NA	2%	0%	0%	4%	12%	NA	0%	0%	0%
M390000S	SB	0%	NA	6%	0%	BT	6%	37%	NA	0%	0%	0%
M7175000	SC Sw ORW	NA	NA	0%	0%	2%	10%	61%	NA	0%	0%	0%
52	Little River, Perquimans River, and Central Albemarle Sound											
M3500000	C Sw	NA	NA	0%	0%	11%	5%	0%	71%	0%	0%	19%
M5000000	SC	12%	0%	46%	0%	9%	2%	10%	NA	5%	5%	2%
M610000N	SB	0%	NA	2%	0%	BT	4%	32%	NA	0%	0%	0%
53	Scuppernong River, Kendrick Creek, and Southwest Albemarle Sound											
M610000C	SB	0%	NA	8%	0%	5%	4%	39%	NA	0%	0%	0%
M610000S	SB	0%	NA	4%	0%	0%	4%	40%	NA	7%	0%	0%
M6920000	SC	44%	NA	63%	0%	0%	9%	25%	NA	45%	0%	7%
M6980000	C Sw	NA	NA	0%	0%	4%	0%	0%	95%	0%	0%	3%

Notes:

Bold entries indicate at least 10% (at least 20% for fecal coliform not in SA waters; for SA fecal bold indicates at least 10%) of results exceeded the evaluation level.

Underlined entries indicate 95% confidence that site conditions exceed the evaluation level at least 10% of the time, with a minimum of 10 results required before determination.

NA: Not Applicable. The evaluation level is not applicable to this station.

BT: Below Threshold. This station was not evaluated because less than 10 samples/measurements were collected for this parameter.

¹ Applies to saltwater (class SA, SB, and SC) primarily, and to freshwater (class B, C, and WS) as a daily average. Not considered critical (therefore not bolded for violations) in freshwater areas.

² Applies to freshwater (class B, C, and WS) only.

³ If both the maximum pH (9, or 8.5 for saltwater) and the minimum pH (6, or 6.8 for saltwater) were exceeded at a site, the total of the two is displayed.

WATER QUALITY PATTERNS IN THE PASQUOTANK RIVER BASIN

Box and whisker plots, scatterplots, and maps were used to depict data for a variety of water quality parameters throughout the basin. While graphs portray information visually, specific and accurate details can only be conveyed in tables. Individual station summary sheets should be consulted when exact information is needed. For the box plots, stations with fewer than 10 data points for a given parameter were not included.

Box and whisker plots were generated for each station for each water quality parameter that has an evaluation level, plus specific conductance, total nitrate/nitrite, total kjeldahl nitrogen, total ammonia, and total phosphorus. Maps were also generated for parameters with the most exceedances. In addition, a series of change over time graphs were generated for stations which exhibit trends of interest.

Basinwide Trends and Distributions

Two basinwide patterns of interest were identified: spiking specific conductance between 2001 and 2003, and plummeting turbidity during the same time period. These patterns are related to the drought which took place in North Carolina between late 2001 and early 2003.

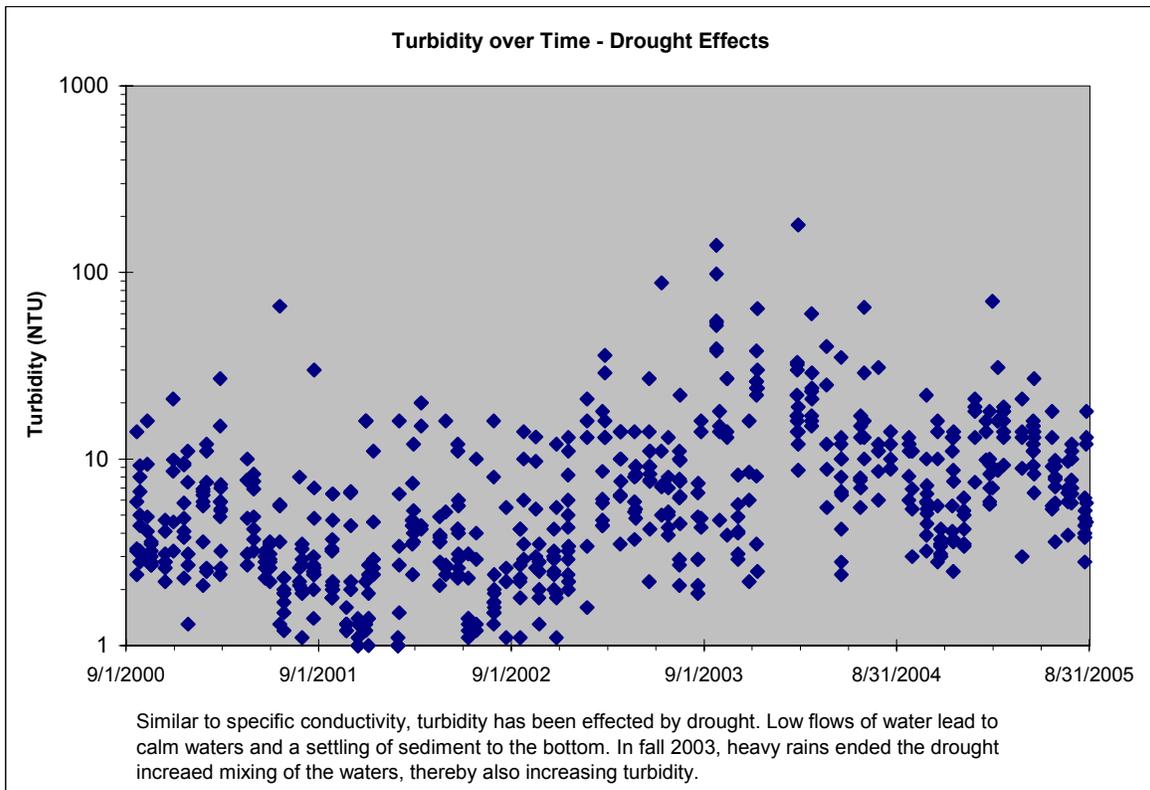
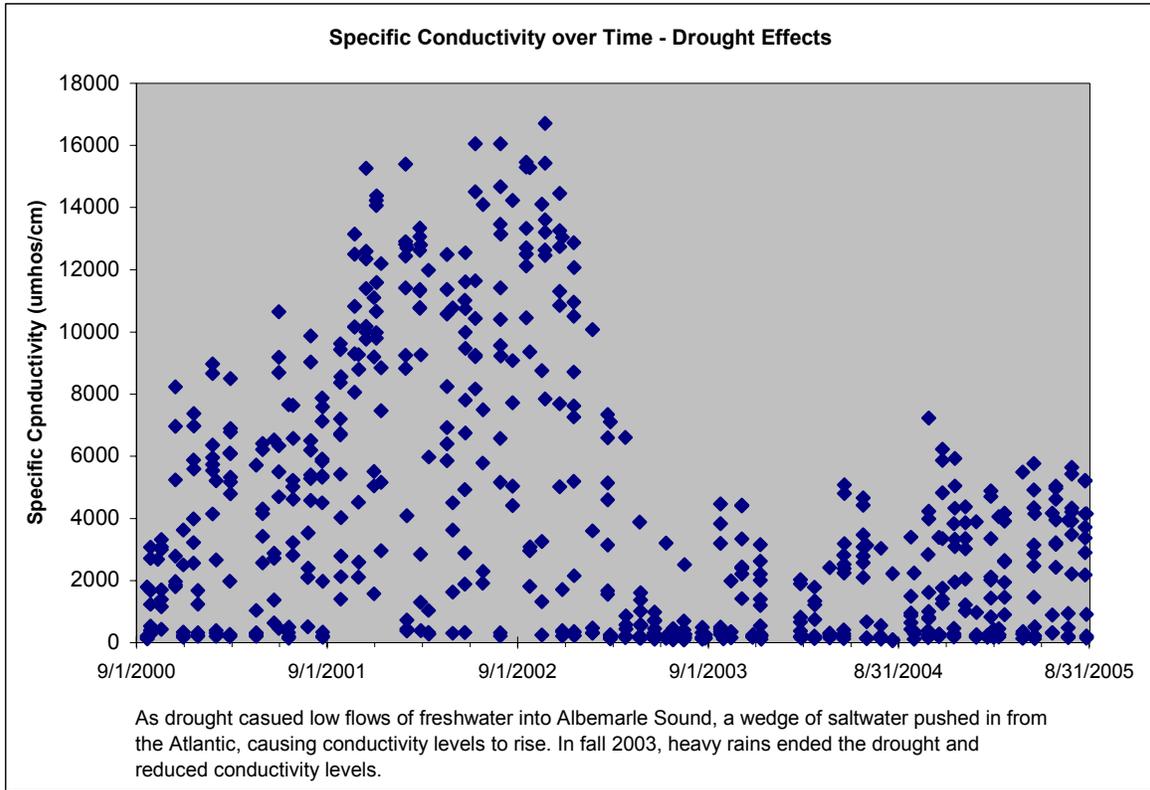


Figure 3. Specific Conductance and Turbidity over Time at 12 Stations in the Pasquotank Basin.

Maps were used to display the geographic distribution of evaluation level exceedances for dissolved oxygen, pH, iron, and fecal coliform.

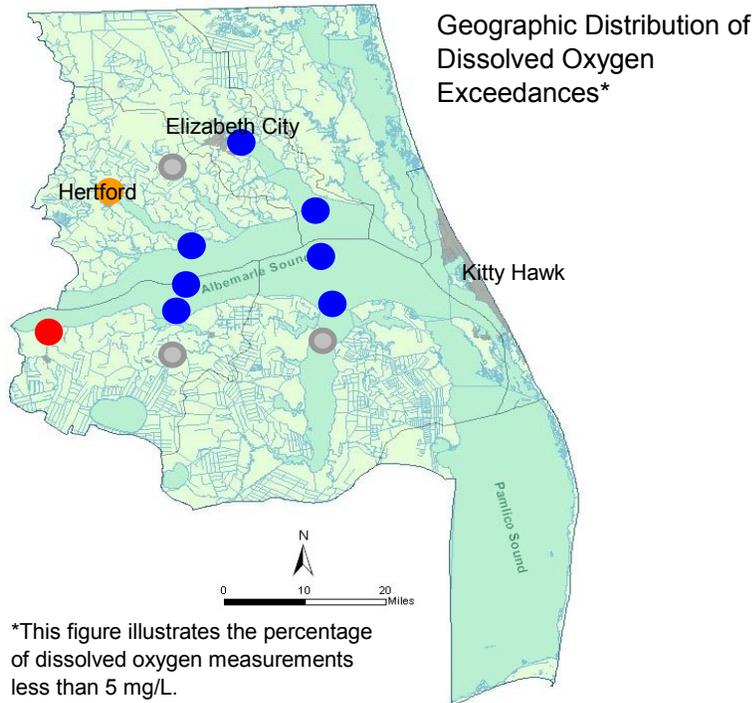


Figure 4. Geographic Distribution of Dissolved Oxygen.

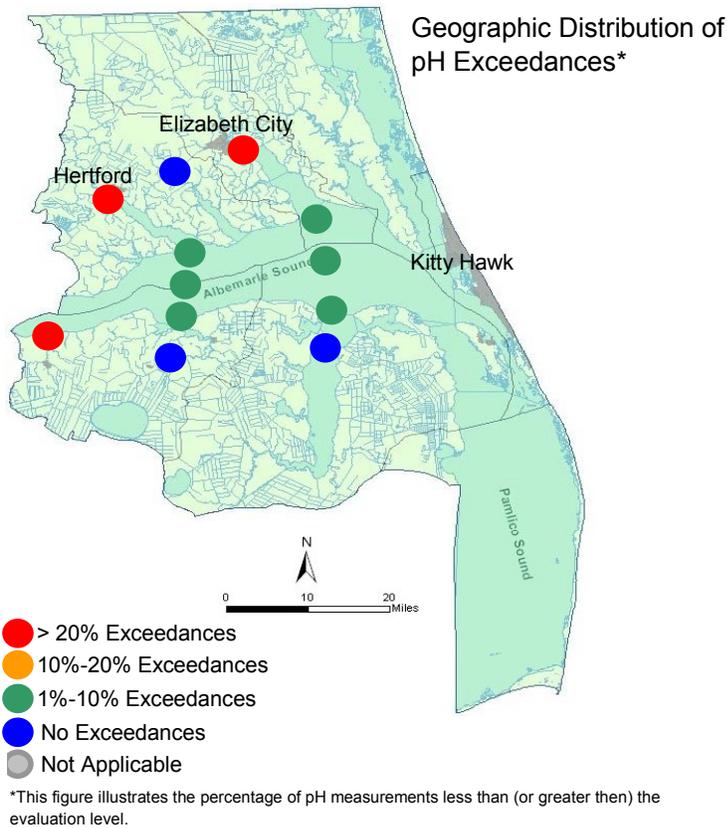


Figure 5. Geographic Distribution of pH.

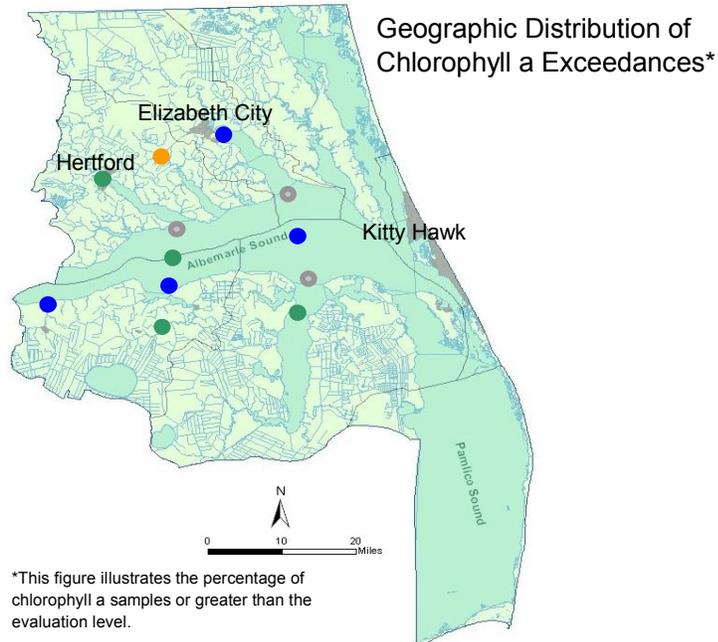


Figure 6. Geographic Distribution of Chlorophyll A.

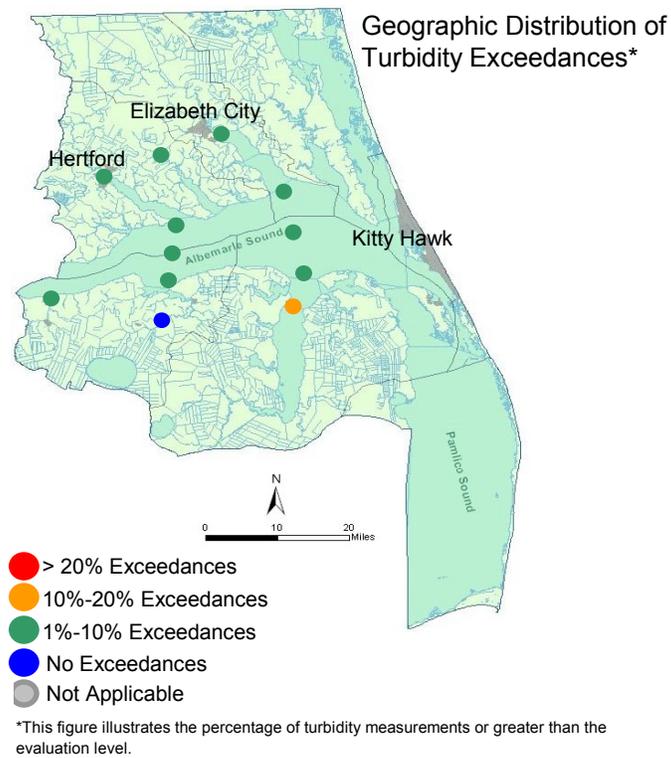


Figure 7. Geographic Distribution of Turbidity.

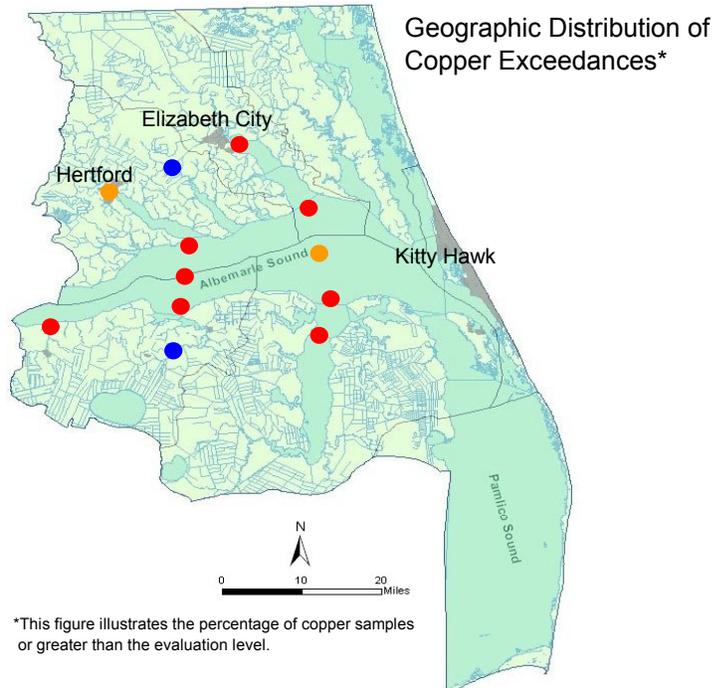


Figure 8. Geographic Distribution of Copper.

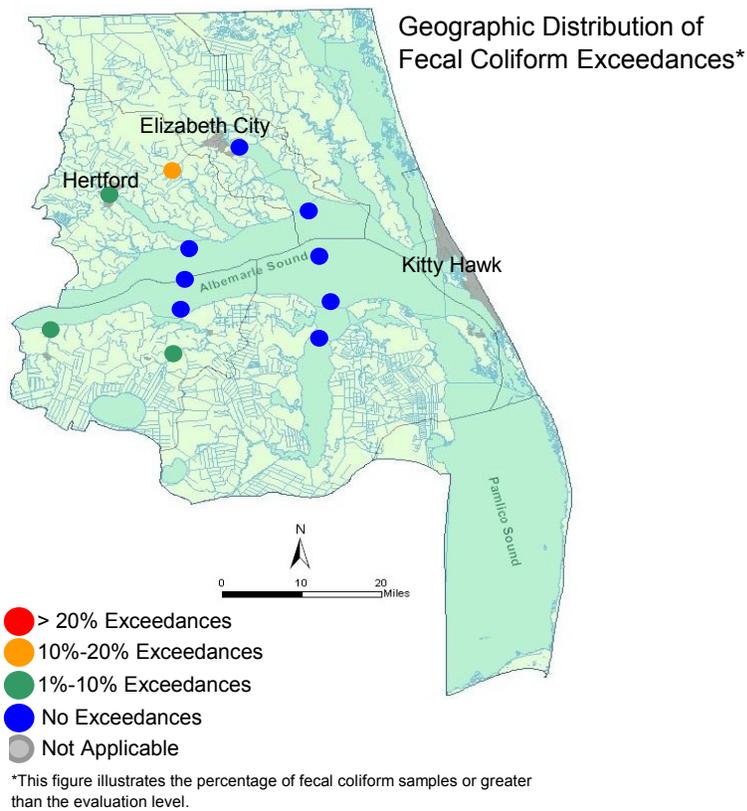


Figure 9. Geographic Distribution of Fecal Coliform.

Individual Stations

The 12 stations were compared using box plots to evaluate whether any stations are particularly troubled by comparison. Box plots are included in Appendix B of this report. Based on this, M6920000, Kendrick Creek at SR 1300 at Mackeys, bears watching. Among the 12 stations, D4150000 has the lowest median dissolved oxygen and pH concentrations (among non-swamp waters), and the highest turbidity, nitrate nitrite, and iron. This station has four SSEs, for dissolved oxygen (<5), pH, copper, and nickel. This station did not have significant trends, however.

Two stations M390000C (Albemarle Sound near Frog Island, Mid Channel) and M390000N (Albemarle Sound near Frog Island, North Shore) were found to have three significant trends of interest, each.

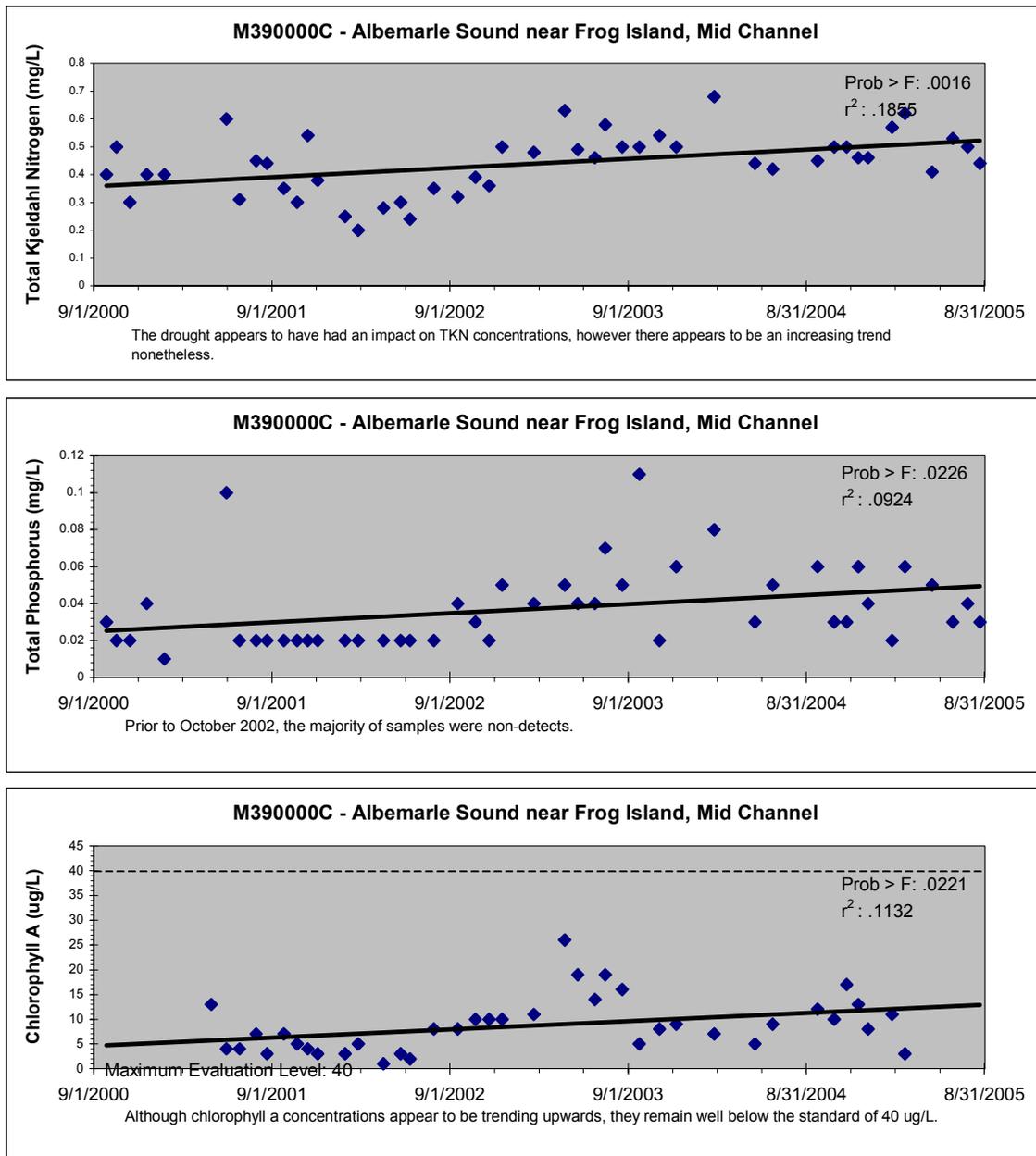


Figure 10. Selected Parameters at Station M390000C, Albemarle Sound

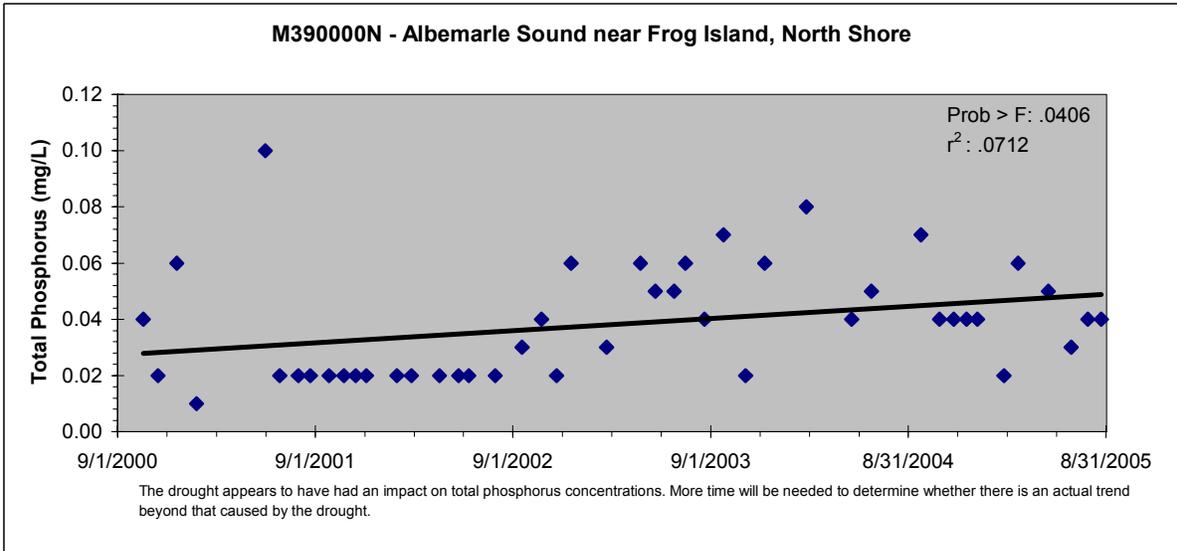
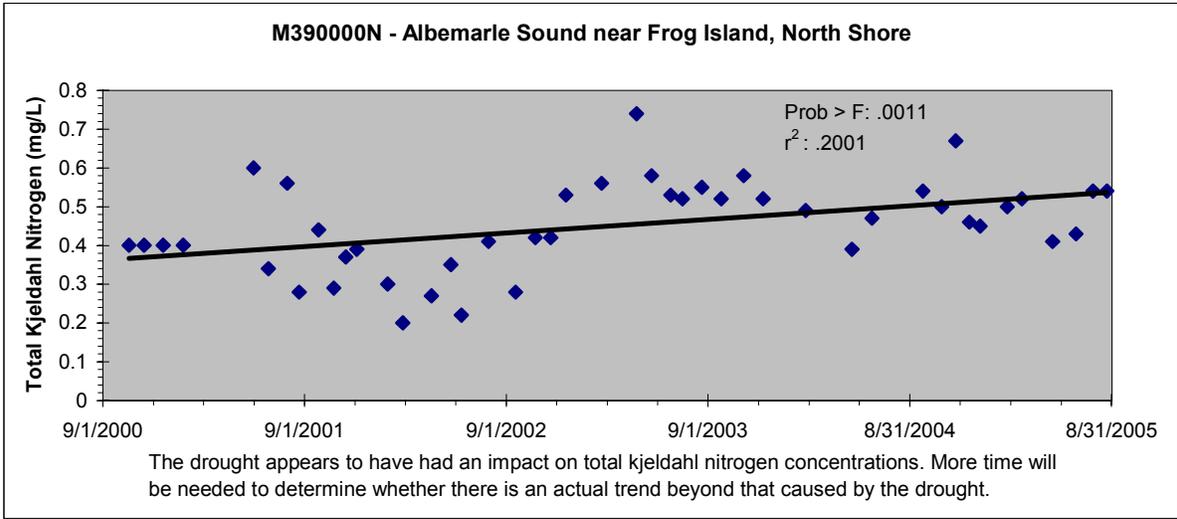
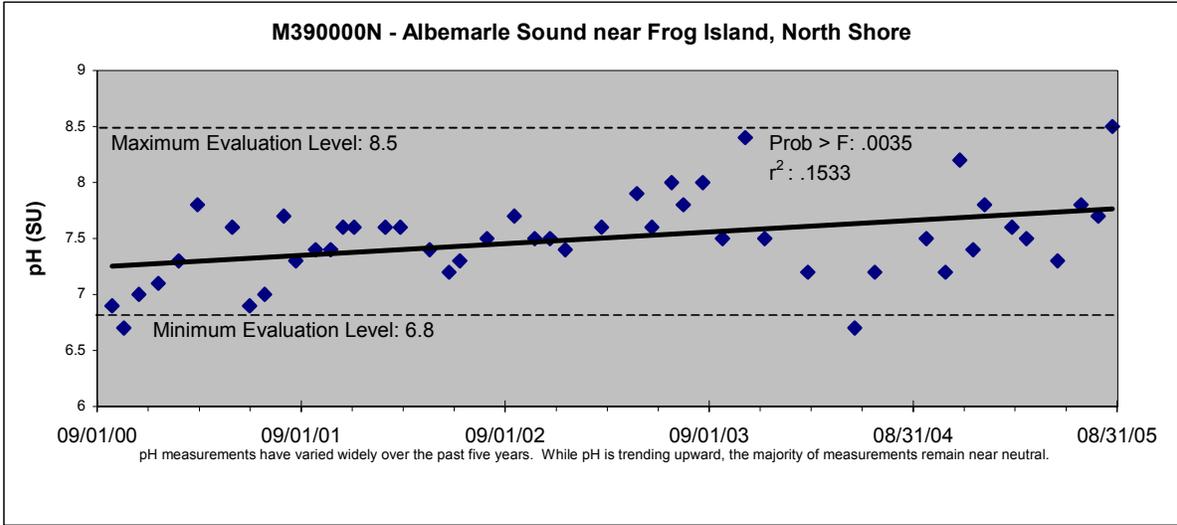


Figure 11. Selected Parameters at Station M390000N, Albemarle Sound

Appendix A: Station Summary Sheets

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: PASQUOTANK RIV AT ELIZABETH CITY

Station #: M2750000

Latitude: 36.28061

Longitude: -76.17139

Agency: NCAMBNT

Subbasin: PAS50

Stream class: SB

NC stream index: 30-3-(12)

Time period: 09/27/2000 to 08/22/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	45	0	<5	0	0		5.6	6.7	7.4	8.5	10.2	11.6	12.9
pH (SU)	46	0	<6.8	18	39.1	Yes	4.8	6.2	6.5	6.9	7.2	7.4	7.6
	46	0	>8.5	0	0		4.8	6.2	6.5	6.9	7.2	7.4	7.6
Salinity (ppt)	45	1	N/A				0.13	0.2	0.75	1.3	3.62	6.04	7.1
Spec. conductance (umhos/cm at 25°C)	46	0	N/A				276	423	1448	2719	6807	10551	12443
Water Temperature (°C)	46	0	>32	1	2.2		6.1	6.9	11.3	20	26.8	29.4	32.4
Other													
Chlorophyll A (ug/L)	38	2	>40	0	0		1	1	2	5	8	12	13
TSS (mg/L)	19	3	N/A				2	2	3	4	5	9	12
Turbidity (NTU)	47	1	>25	1	2.1		1	1	2	4	6	10	52
Nutrients (mg/L)													
NH3 as N	44	14	N/A				0.01	0.01	0.02	0.06	0.09	0.24	0.43
NO2 + NO3 as N	44	12	N/A				0.01	0.01	0.02	0.16	0.31	0.49	0.56
TKN as N	44	1	N/A				0.3	0.42	0.51	0.78	1.1	1.45	2.1
Total Phosphorus	44	5	N/A				0.02	0.02	0.03	0.06	0.09	0.13	0.26
Metals (ug/L)													
Aluminum, total (Al)	19	0	N/A				83	120	270	450	730	1300	1800
Arsenic, total (As)	19	19	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	19	19	>5	0	0		2	2	2	2	2	2	10
Chromium, total (Cr)	19	19	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	19	5	>3	10	52.6	Yes	2	2	2	3	4	7	11
Iron, total (Fe)	19	0	N/A				56	120	350	680	1300	1900	2100
Lead, total (Pb)	19	19	>25	0	0		10	10	10	10	10	50	50
Mercury, total (Hg)	19	19	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	19	19	>8.3	0	0		10	10	10	10	10	10	50
Zinc, total (Zn)	19	9	>86	0	0		10	10	10	14	29	39	57
Fecal coliform (#/100mL)													
# results:	Geomean	# > 400:		% > 400:		95%:							
47	7	0	0										

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: LITTLE RIV AT SR 1367 AT WOODVILLE

Station #: M3500000

Latitude: 36.24051

Longitude: -76.32464

Agency: NCAMBNT

Subbasin: PAS52

Stream class: C Sw

NC stream index: 30-5-(1)

Time period: 09/21/2000 to 08/25/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	56	0	N/A				0.2	0.5	1	2.6	5.3	9.1	11.5
pH (SU)	57	0	<4.3	0	0		5.9	6	6.4	6.6	7.1	7.4	7.8
	57	0	>9	0	0		5.9	6	6.4	6.6	7.1	7.4	7.8
Salinity (ppt)	56	7	N/A				0.02	0.06	0.1	0.13	0.2	1.55	2.8
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				70	141	208	251	329	2786	5161
Water Temperature (°C)	56	0	>32	0	0		0	5.4	10.4	15.5	22.6	25.1	28
Other													
Chlorophyll A (ug/L)	46	4	>40	5	10.9	No	1	1	2	4	11	45	69
TSS (mg/L)	21	6	N/A				1	2	3	6	18	35	41
Turbidity (NTU)	58	0	>50	3	5.2		1	3	4	7	16	29	88
Nutrients (mg/L)													
NH3 as N	56	7	N/A				0.01	0.02	0.04	0.16	0.35	0.9	2.4
NO2 + NO3 as N	56	24	N/A				0.01	0.01	0.02	0.03	0.25	0.72	2.1
TKN as N	56	1	N/A				0.93	1.1	1.3	1.55	1.97	2.8	4.7
Total Phosphorus	56	1	N/A				0.06	0.09	0.17	0.31	0.45	0.59	1.1
Metals (ug/L)													
Aluminum, total (Al)	21	0	N/A				70	124	165	240	905	2160	3200
Arsenic, total (As)	21	21	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	20	20	>2	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	20	20	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	13	>7	0	0		2	2	2	2	3	4	6
Iron, total (Fe)	21	0	>1000	15	71.4	Yes	570	668	960	1600	2750	4200	6200
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	21	21	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	20	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	20	8	>50	0	0		10	10	10	11	18	33	35
Fecal coliform (#/100mL)													
# results:	Geomean	# > 400:		% > 400:		95%:							
58	81	11	19										

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: Albemarle Sound nr Frog Island mid channel

Station #: M390000C

Subbasin: PAS51

Latitude: 36.06250 **Longitude:** -76.00163

Stream class: SB

Agency: NCAMBNT

NC stream index: 30

Time period: 09/27/2000 to 08/22/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	47	0	<5	0	0		7	7.7	8	9.5	11	12.4	13.1
pH (SU)	48	0	<6.8	1	2.1		6.7	7.1	7.4	7.6	7.7	8	8.2
	48	0	>8.5	0	0		6.7	7.1	7.4	7.6	7.7	8	8.2
Salinity (ppt)	47	0	N/A				0.13	0.4	2.13	3.4	6.63	8.42	9.1
Spec. conductance (umhos/cm at 25°C)	48	0	N/A				274	827	3993	6070	11373	14524	15463
Water Temperature (°C)	48	0	>32	0	0		5	6.6	10.3	19	25.3	28.2	30.9
Other													
Chlorophyll A (ug/L)	38	0	>40	0	0		1	3	4	8	11	17	26
TSS (mg/L)	16	0	N/A				3	4	6	12	18	28	42
Turbidity (NTU)	48	1	>25	2	4.2		1	1	3	5	9	15	55
Nutrients (mg/L)													
NH3 as N	46	35	N/A				0.01	0.01	0.02	0.02	0.02	0.03	0.2
NO2 + NO3 as N	46	31	N/A				0.01	0.01	0.01	0.02	0.02	0.09	0.24
TKN as N	46	2	N/A				0.2	0.29	0.36	0.45	0.5	0.59	0.68
Total Phosphorus	46	8	N/A				0.01	0.02	0.02	0.03	0.05	0.06	0.11
Metals (ug/L)													
Aluminum, total (Al)	17	0	N/A				68	102	130	490	845	1760	3200
Arsenic, total (As)	16	16	>10	0	0		5	5	6	10	10	22	50
Cadmium, total (Cd)	17	17	>5	0	0		2	2	2	2	2	4	10
Chromium, total (Cr)	17	17	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	17	11	>3	2	11.8	No	2	2	2	2	6	10	10
Iron, total (Fe)	17	2	N/A				50	50	74	440	770	1240	2200
Lead, total (Pb)	17	17	>25	0	0		10	10	10	10	10	18	50
Mercury, total (Hg)	17	17	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	17	17	>8.3	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	17	9	>86	0	0		10	10	10	10	36	44	47
Fecal coliform (#/100mL)													
# results:	Geomean	# > 400:		% > 400:		95%:							
48	2	0	0										

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: ALBEMARLE SOUND NR FROG ISLAND N SHORE

Station #: M390000N

Latitude: 36.15033 **Longitude:** -76.02095

Agency: NCAMBNT

Subbasin: PAS50

Stream class: SB

NC stream index: 30

Time period: 09/27/2000 to 08/22/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	47	0	<5	0	0		7.3	7.6	8.1	8.9	10.7	12.3	13.2
pH (SU)	48	0	<6.8	2	4.2		6.7	7	7.3	7.5	7.7	8	8.5
	48	0	>8.5	0	0		6.7	7	7.3	7.5	7.7	8	8.5
Salinity (ppt)	47	0	N/A				0.09	0.31	1.72	2.77	6.2	7.57	9
Spec. conductance (umhos/cm at 25°C)	48	0	N/A				167	616	3256	5202	9937	13158	15397
Water Temperature (°C)	48	0	>32	0	0		5.3	6.9	9.9	19.2	25	28.7	30.5
Other													
TSS (mg/L)	16	0	N/A				1	2	4	8	10	15	18
Turbidity (NTU)	48	2	>25	2	4.2		1	2	3	6	9	15	38
Nutrients (mg/L)													
NH3 as N	46	34	N/A				0.01	0.01	0.02	0.02	0.02	0.08	0.34
NO2 + NO3 as N	45	27	N/A				0.01	0.01	0.01	0.02	0.04	0.08	0.19
TKN as N	46	2	N/A				0.2	0.28	0.38	0.44	0.53	0.58	0.74
Total Phosphorus	46	9	N/A				0.01	0.02	0.02	0.04	0.05	0.06	0.1
Metals (ug/L)													
Aluminum, total (Al)	15	0	N/A				75	120	210	310	560	844	1000
Arsenic, total (As)	15	14	>10	0	0		5	5	10	10	10	50	50
Cadmium, total (Cd)	15	15	>5	0	0		2	2	2	2	2	10	10
Chromium, total (Cr)	15	15	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	15	8	>3	5	33.3	Yes	2	2	2	2	6	7	7
Iron, total (Fe)	15	1	N/A				50	62	120	330	460	832	850
Lead, total (Pb)	15	15	>25	0	0		10	10	10	10	10	32	50
Mercury, total (Hg)	15	15	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	15	15	>8.3	0	0		10	10	10	10	10	26	50
Zinc, total (Zn)	15	7	>86	0	0		10	10	10	15	35	41	43
Fecal coliform (#/100mL)													
# results:	Geomean	# > 400:	% > 400:	95%:									
48	2	0	0										

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: ALBEMARLE SOUND NR FROG ISLAND S SHORE

Station #: M390000S

Subbasin: PAS51

Latitude: 35.96945 **Longitude:** -75.97953

Stream class: SB

Agency: NCAMBNT

NC stream index: 30

Time period: 09/27/2000 to 08/22/2005

Field	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	47	0	<5	0	0		6.9	7.4	8	9.2	10.8	12.2	13
pH (SU)	48	0	<6.8	3	6.2		6.7	7	7.3	7.5	7.6	7.8	8
	48	0	>8.5	0	0		6.7	7	7.3	7.5	7.6	7.8	8
Salinity (ppt)	47	0	N/A				0.23	0.78	1.81	2.9	5.96	7.94	9.82
Spec. conductance (umhos/cm at 25°C)	48	0	N/A				449	1551	3343	5439	10375	13543	16712
Water Temperature (°C)	48	0	>32	0	0		5	7	10.2	19.2	25.1	28.5	31.6
Other													
TSS (mg/L)	19	1	N/A				2	3	5	7	11	22	26
Turbidity (NTU)	48	0	>25	3	6.2		1	2	3	5	9	18	54
Nutrients (mg/L)													
NH3 as N	45	35	N/A				0.01	0.01	0.02	0.02	0.02	0.08	0.24
NO2 + NO3 as N	45	30	N/A				0.01	0.01	0.01	0.02	0.05	0.12	0.25
TKN as N	45	1	N/A				0.2	0.3	0.38	0.44	0.58	0.72	14
Total Phosphorus	45	10	N/A				0.01	0.02	0.02	0.03	0.04	0.07	0.1
Metals (ug/L)													
Aluminum, total (Al)	19	0	N/A				50	81	160	330	540	760	1700
Arsenic, total (As)	19	19	>10	0	0		5	5	10	10	10	10	50
Cadmium, total (Cd)	19	19	>5	0	0		2	2	2	2	2	10	10
Chromium, total (Cr)	19	19	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	19	9	>3	7	36.8	Yes	2	2	2	2	5	9	16
Iron, total (Fe)	19	2	N/A				50	50	170	320	540	750	1500
Lead, total (Pb)	19	19	>25	0	0		10	10	10	10	10	50	50
Mercury, total (Hg)	19	19	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	19	19	>8.3	0	0		10	10	10	10	10	10	50
Zinc, total (Zn)	19	9	>86	0	0		10	10	10	11	25	38	47
Fecal coliform (#/100mL)													
# results:	Geomean	# > 400:	% > 400:	95%:									
48	2	0	0										

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: PERQUIMANS RIV AT SR 1336 AT HERTFORD

Station #: M5000000

Subbasin: PAS52

Latitude: 36.19387 **Longitude:** -76.46611

Stream class: SC

Agency: NCAMBNT

NC stream index: 30-6-(3)

Time period: 09/21/2000 to 08/25/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	57	0	<5	7	12.3	No	0.4	4.5	6.2	7.6	9.1	10.5	12.8
pH (SU)	57	0	<6.8	26	45.6	Yes	5.3	5.6	6.2	6.9	7.2	7.6	7.8
	57	0	>8.5	0	0		5.3	5.6	6.2	6.9	7.2	7.6	7.8
Salinity (ppt)	56	1	N/A				0.03	0.09	0.14	0.38	1.84	4.89	5.28
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				91	169	286	890	3240	8764	9356
Water Temperature (°C)	57	0	>32	0	0		2.4	7.4	11	20.3	27	29.1	31.9
Other													
Chlorophyll A (ug/L)	46	2	>40	4	8.7		1	2	4	9	24	39	87
TSS (mg/L)	20	1	N/A				2	3	4	6	7	12	19
Turbidity (NTU)	58	0	>25	1	1.7		1	2	2	4	6	13	30
Nutrients (mg/L)													
NH3 as N	56	15	N/A				0.01	0.02	0.02	0.08	0.15	0.34	1.1
NO2 + NO3 as N	55	19	N/A				0.01	0.01	0.02	0.13	0.27	0.51	1.6
TKN as N	56	2	N/A				0.2	0.46	0.81	1.1	1.4	1.73	3.1
Total Phosphorus	56	2	N/A				0.03	0.04	0.06	0.11	0.21	0.28	0.86
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				150	190	225	430	595	934	1400
Arsenic, total (As)	19	19	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	20	20	>5	0	0		2	2	2	2	2	2	10
Chromium, total (Cr)	20	20	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	10	>3	2	10	No	2	2	2	2	3	12	60
Iron, total (Fe)	20	0	N/A				240	364	482	935	1400	2330	4200
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	20	20	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	19	>8.3	1	5		10	10	10	10	10	10	230
Zinc, total (Zn)	20	6	>86	1	5		10	10	10	16	22	44	780
Fecal coliform (#/100mL)													
# results:	Geomean	# > 400:		% > 400:		95%:							
58	24	1	2										

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: ALBEMARLE SOUND BETWEEN HARVEY PT AND MILL PT MID CHANNEL

Station #: M610000C

Subbasin: PAS53

Latitude: 36.02151

Longitude: -76.30602

Stream class: SB

Agency: NCAMBNT

NC stream index: 30

Time period: 09/27/2000 to 08/22/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	48	0	<5	0	0		6.6	7.5	7.9	9.2	11.3	12.2	13.1
pH (SU)	49	0	<6.8	4	8.2		6.6	6.9	7.2	7.5	7.6	7.8	8.2
	49	0	>8.5	0	0		6.6	6.9	7.2	7.5	7.6	7.8	8.2
Salinity (ppt)	48	0	N/A				0.03	0.09	0.72	1.91	4.2	6.5	8.2
Spec. conductance (umhos/cm at 25°C)	49	0	N/A				86	192	1370	3322	7410	11369	14239
Water Temperature (°C)	49	0	>32	0	0		4.8	6.8	9.8	18	24.8	27.6	30.5
Other													
Chlorophyll A (ug/L)	38	1	>40	2	5.3		1	2	3	6	10	18	360
TSS (mg/L)	20	1	N/A				1	2	4	6	8	10	15
Turbidity (NTU)	50	1	>25	2	4		1	1	2	4	8	17	98
Nutrients (mg/L)													
NH3 as N	46	34	N/A				0.01	0.01	0.02	0.02	0.02	0.08	0.22
NO2 + NO3 as N	46	24	N/A				0.01	0.01	0.02	0.03	0.11	0.17	0.26
TKN as N	46	1	N/A				0.26	0.31	0.38	0.44	0.48	0.59	0.82
Total Phosphorus	46	5	N/A				0.02	0.02	0.02	0.04	0.06	0.08	0.21
Metals (ug/L)													
Aluminum, total (Al)	18	0	N/A				50	54	97	200	338	608	860
Arsenic, total (As)	18	18	>10	0	0		5	5	9	10	10	10	10
Cadmium, total (Cd)	18	18	>5	0	0		2	2	2	2	2	10	10
Chromium, total (Cr)	18	18	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	18	7	>3	7	38.9	Yes	2	2	2	3	6	8	8
Iron, total (Fe)	18	3	N/A				50	50	99	330	528	939	1200
Lead, total (Pb)	18	18	>25	0	0		10	10	10	10	10	50	50
Mercury, total (Hg)	18	18	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	18	18	>8.3	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	18	10	>86	0	0		10	10	10	10	30	46	65
Fecal coliform (#/100mL)													
# results:	50	2											
Geomean													
# > 400:				0									
% > 400:				0									
95%:													

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries

NCDENR, Division of Water Quality

Basinwide Assessment Report

Location: ALBEMARLE SOUND BETWEEN HARVEY PT AND MILL PT N SHORE

Station #: M610000N

Subbasin: PAS52

Latitude: 36.08348 **Longitude:** -76.29288

Stream class: SB

Agency: NCAMBNT

NC stream index: 30

Time period: 09/27/2000 to 08/22/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	49	0	<5	0	0		6.7	7.4	7.9	9	11.3	12.2	13.3
pH (SU)	50	0	<6.8	1	2		6.5	7	7.2	7.4	7.6	7.6	7.8
	50	0	>8.5	0	0		6.5	7	7.2	7.4	7.6	7.6	7.8
Salinity (ppt)	49	0	N/A				0.03	0.09	0.55	1.67	4.49	6.5	8.3
Spec. conductance (umhos/cm at 25°C)	50	0	N/A				89	212	1119	3117	7916	11325	14378
Water Temperature (°C)	50	0	>32	0	0		4.9	7	9.9	18.4	24.8	27.9	30.4
Other													
TSS (mg/L)	20	2	N/A				3	3	3	7	11	24	45
Turbidity (NTU)	50	1	>25	2	4		1	2	3	4	8	14	140
Nutrients (mg/L)													
NH3 as N	47	38	N/A				0.01	0.01	0.02	0.02	0.02	0.04	0.24
NO2 + NO3 as N	47	24	N/A				0.01	0.01	0.01	0.04	0.11	0.16	0.25
TKN as N	47	1	N/A				0.2	0.27	0.3	0.4	0.48	0.55	0.78
Total Phosphorus	47	7	N/A				0.01	0.02	0.02	0.04	0.06	0.08	0.26
Metals (ug/L)													
Aluminum, total (Al)	19	0	N/A				73	98	170	340	720	1200	12000
Arsenic, total (As)	18	18	>10	0	0		5	5	9	10	10	14	50
Cadmium, total (Cd)	19	19	>5	0	0		2	2	2	2	2	2	10
Chromium, total (Cr)	19	19	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	19	10	>3	6	31.6	Yes	2	2	2	3	5	10	10
Iron, total (Fe)	19	1	N/A				50	69	150	600	910	1600	6200
Lead, total (Pb)	19	19	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	19	19	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	19	19	>8.3	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	19	11	>86	0	0		10	10	10	10	31	37	42
Fecal coliform (#/100mL)													
# results:	Geomean	# > 400:	% > 400:	95%:									
51	2	0	0										

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: ALBEMARLE SOUND BETWEEN HARVEY PT AND MILL PT S SHORE
Station #: M610000S **Subbasin:** PAS53
Latitude: 35.96353 **Longitude:** -76.31261 **Stream class:** SB
Agency: NCAMBNT **NC stream index:** 30

Time period: 09/27/2000 to 08/22/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	49	0	<5	0	0		5.9	7.3	7.8	9.3	11.2	12.5	13.2
pH (SU)	50	0	<6.8	2	4		6.4	6.8	7.2	7.4	7.7	8	8.1
	50	0	>8.5	0	0		6.4	6.8	7.2	7.4	7.7	8	8.1
Salinity (ppt)	49	0	N/A				0.03	0.09	0.48	1.54	3.42	6.1	8.1
Spec. conductance (umhos/cm at 25°C)	50	0	N/A				85	209	854	2669	6482	10669	14077
Water Temperature (°C)	50	0	>32	0	0		5	7.1	10.1	17.8	24.8	27.8	30.6
Other													
Chlorophyll A (ug/L)	1	0	>40	0	0		5	5	5	5	5	5	5
TSS (mg/L)	15	1	N/A				1	2	3	6	7	11	15
Turbidity (NTU)	50	0	>25	2	4		1	2	2	4	8	11	39
Nutrients (mg/L)													
NH3 as N	48	34	N/A				0.01	0.01	0.02	0.02	0.02	0.07	0.73
NO2 + NO3 as N	48	22	N/A				0.01	0.01	0.02	0.03	0.14	0.17	0.3
TKN as N	48	1	N/A				0.2	0.31	0.38	0.47	0.56	0.66	1.6
Total Phosphorus	48	8	N/A				0.02	0.02	0.02	0.04	0.07	0.1	0.2
Metals (ug/L)													
Aluminum, total (Al)	15	0	N/A				58	73	94	190	280	542	560
Arsenic, total (As)	15	15	>10	0	0		5	5	10	10	10	50	50
Cadmium, total (Cd)	15	15	>5	0	0		2	2	2	2	2	10	10
Chromium, total (Cr)	15	15	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	15	6	>3	6	40	Yes	2	2	2	2	4	6	7
Iron, total (Fe)	15	1	N/A				50	54	100	240	790	998	1100
Lead, total (Pb)	15	15	>25	0	0		10	10	10	10	10	50	50
Mercury, total (Hg)	15	15	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	15	14	>8.3	1	6.7		10	10	10	10	10	50	50
Zinc, total (Zn)	15	4	>86	0	0		10	10	10	20	32	43	45
Fecal coliform (#/100mL)													
# results:	50	2											
Geomean													
# > 400:			0										
% > 400:				0									
95%:													

Key:

result: number of observations
 # ND: number of observations reported to be below detection level (non-detect)
 EL: Evaluation Level; applicable numeric or narrative water quality standard or action level
 Results not meeting EL: number and percentages of observations not meeting evaluation level
 95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)
 Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: KENDRICK CRK AT SR 1300 AT MACKEYS

Station #: M6920000

Latitude: 35.92995

Agency: NCAMBNT

Longitude: -76.60983

Subbasin: PAS53

Stream class: SC

NC stream index: 30-9-(2)

Time period: 09/21/2000 to 08/25/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	57	0	<5	25	43.9	Yes	0.6	2.6	3.6	5.5	6.9	8.4	9.7
pH (SU)	57	0	<6.8	36	63.2	Yes	5.2	5.8	6.1	6.6	6.9	7.2	7.8
	57	0	>8.5	0	0		5.2	5.8	6.1	6.6	6.9	7.2	7.8
Salinity (ppt)	56	8	N/A				0.03	0.08	0.1	0.15	0.23	1.01	2.77
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				85	162	202	237	492	1885	5038
Water Temperature (°C)	57	0	>32	0	0		3.2	7.5	11	17.9	24.3	27.1	29.5
Other													
Chlorophyll A (ug/L)	46	3	>40	0	0		1	1	2	4	11	24	38
TSS (mg/L)	21	0	N/A				3	3	5	8	8	12	34
Turbidity (NTU)	58	0	>25	5	8.6		2	6	11	14	16	25	66
Nutrients (mg/L)													
NH3 as N	56	4	N/A				0.01	0.04	0.06	0.1	0.15	0.28	0.88
NO2 + NO3 as N	56	3	N/A				0.02	0.05	0.23	0.75	1.68	3.58	5
TKN as N	55	1	N/A				0.34	0.61	0.87	1.1	1.5	1.8	2.2
Total Phosphorus	56	2	N/A				0.02	0.06	0.07	0.09	0.12	0.2	0.5
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				68	176	668	1100	1625	2520	3900
Arsenic, total (As)	20	20	>10	0	0		5	5	10	10	10	10	10
Cadmium, total (Cd)	20	20	>5	0	0		2	2	2	2	2	2	2
Chromium, total (Cr)	20	20	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	10	>3	5	25	Yes	2	2	2	2	3	4	6
Iron, total (Fe)	20	0	N/A				350	930	1450	2100	2775	3550	3900
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	20	20	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	11	>8.3	9	45	Yes	10	10	10	10	13	17	20
Zinc, total (Zn)	20	2	>86	0	0		10	10	18	20	31	40	60
Fecal coliform (#/100mL)													
# results:	Geomean		# > 400:		% > 400:		95%:						
57	51		4		7								

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: SCUPPERNONG RIV AT SR 1105 NR COLUMBIA

Station #: M6980000

Latitude: 35.87762

Longitude: -76.33761

Agency: NCAMBNT

Subbasin: PAS53

Stream class: C Sw

NC stream index: 30-14-4-(1)

Time period: 09/21/2000 to 08/25/2005

	# result	# ND	EL	Results not meeting EL			Percentiles						
				#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	57	0	N/A				0.4	0.8	1.7	3.4	5.5	7.1	8.6
pH (SU)	57	0	<4.3	0	0		5.3	5.8	6	6.4	6.7	7	7.5
	57	0	>9	0	0		5.3	5.8	6	6.4	6.7	7	7.5
Salinity (ppt)	56	5	N/A				0.01	0.06	0.07	0.12	0.62	2.6	5.11
Spec. conductance (umhos/cm at 25°C)	57	0	N/A				55	127	164	200	1020	4644	9073
Water Temperature (°C)	57	0	>32	0	0		2.8	7.9	11.2	18.5	24.9	27	29.5
Other													
Chlorophyll A (ug/L)	46	2	>40	2	4.3		1	1	2	5	9	34	45
TSS (mg/L)	19	0	N/A				1	3	3	5	8	10	11
Turbidity (NTU)	58	0	>50	0	0		1	3	5	9	13	16	27
Nutrients (mg/L)													
NH3 as N	55	3	N/A				0.01	0.05	0.12	0.19	0.32	0.44	0.58
NO2 + NO3 as N	55	8	N/A				0.01	0.02	0.06	0.33	1.1	2.86	5.2
TKN as N	54	0	N/A				0.61	0.8	1	1.35	1.63	1.9	2.6
Total Phosphorus	55	2	N/A				0.03	0.05	0.07	0.11	0.17	0.21	0.5
Metals (ug/L)													
Aluminum, total (Al)	20	0	N/A				89	100	335	770	1225	1480	1500
Arsenic, total (As)	19	18	>10	1	5.3		5	5	10	10	10	10	33
Cadmium, total (Cd)	20	20	>2	0	0		2	2	2	2	2	2	10
Chromium, total (Cr)	20	20	>50	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	20	14	>7	0	0		2	2	2	2	2	5	6
Iron, total (Fe)	20	0	>1000	19	95	Yes	410	1200	1325	1750	2150	3030	3200
Lead, total (Pb)	20	20	>25	0	0		10	10	10	10	10	10	10
Mercury, total (Hg)	20	20	>0.012	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	20	20	>88	0	0		10	10	10	10	10	10	10
Zinc, total (Zn)	20	4	>50	0	0		10	10	11	16	26	34	34
Fecal coliform (#/100mL)													
# results:	58												
Geomean	32												
# > 400:		2											
% > 400:			3										
95%:													

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Ambient Monitoring System Station Summaries
 NCDENR, Division of Water Quality
 Basinwide Assessment Report

Location: ALLIGATOR RIV AT US 64 NR ALLIGATOR

Station #: M7175000

Latitude: 35.89859 **Longitude:** -76.00978

Agency: NCAMBNT

Subbasin: PAS51

Stream class: SC Sw ORW

NC stream index: 30-16-(7)

Time period: 09/21/2000 to 08/25/2005

	# result	# ND	Results not meeting EL			Percentiles							
			EL	#	%	95%	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	51	0	N/A				5.2	7	7.4	9.1	10.4	11.5	13.8
pH (SU)	51	0	<4.3	0	0		6.7	6.9	7.1	7.3	7.5	7.6	7.7
	51	0	>8.5	0	0		6.7	6.9	7.1	7.3	7.5	7.6	7.7
Salinity (ppt)	50	0	N/A				0.99	1.19	1.69	3.06	6.45	8.11	12.4
Spec. conductance (umhos/cm at 25°C)	51	0	N/A				187	2037	3031	5210	11017	13389	15284
Water Temperature (°C)	51	0	>32	0	0		1	6.4	10.8	16.4	26.2	28.1	29.3
Other													
Chlorophyll A (ug/L)	41	0	>40	1	2.4		2	2	4	5	7	10	190
TSS (mg/L)	16	1	N/A				2	3	6	12	20	32	35
Turbidity (NTU)	52	0	>25	5	9.6		1	1	3	6	11	25	180
Nutrients (mg/L)													
NH3 as N	50	33	N/A				0.01	0.01	0.02	0.02	0.02	0.18	0.87
NO2 + NO3 as N	50	16	N/A				0.01	0.01	0.02	0.07	0.11	0.16	0.5
TKN as N	49	1	N/A				0.3	0.34	0.47	0.63	0.75	0.98	2
Total Phosphorus	50	12	N/A				0.02	0.02	0.02	0.03	0.04	0.06	0.5
Metals (ug/L)													
Aluminum, total (Al)	18	0	N/A				88	135	188	470	1025	1820	2900
Arsenic, total (As)	18	18	>10	0	0		5	5	9	10	10	14	50
Cadmium, total (Cd)	18	18	>5	0	0		2	2	2	2	2	10	10
Chromium, total (Cr)	18	18	>20	0	0		25	25	25	25	25	25	25
Copper, total (Cu)	18	7	>3	11	61.1	Yes	2	2	2	5	7	13	19
Iron, total (Fe)	18	0	N/A				68	97	178	550	838	1440	1800
Lead, total (Pb)	18	18	>25	0	0		10	10	10	10	10	14	50
Mercury, total (Hg)	18	18	>0.025	0	0		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nickel, total (Ni)	18	18	>8.3	0	0		10	10	10	10	10	14	50
Zinc, total (Zn)	18	8	>86	0	0		10	10	10	12	22	45	52
Fecal coliform (#/100mL)													
# results:	Geomean	# > 400:	% > 400:	95%:									
52	2	0	0										

Key:

result: number of observations

ND: number of observations reported to be below detection level (non-detect)

EL: Evaluation Level; applicable numeric or narrative water quality standard or action level

Results not meeting EL: number and percentages of observations not meeting evaluation level

95% : States whether there is 95% statistical confidence that the actual percentage of exceedances is at least 10% (20% for Fecal Coliform)

Stations with less than 10 results for a given parameter were not evaluated for statistical confidence

Appendix B: Box Plots

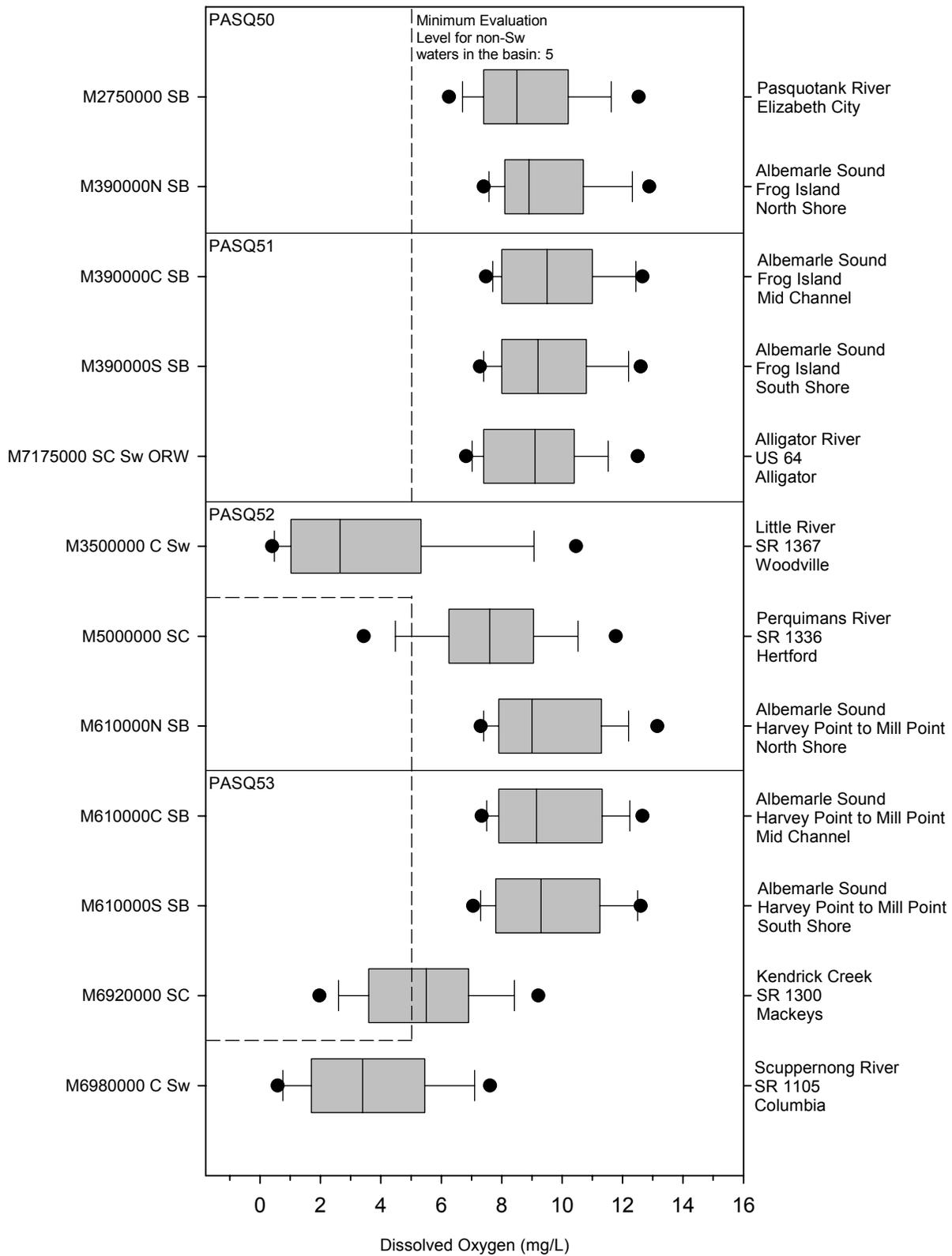


Figure 12. Box Plots of Dissolved Oxygen in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-40

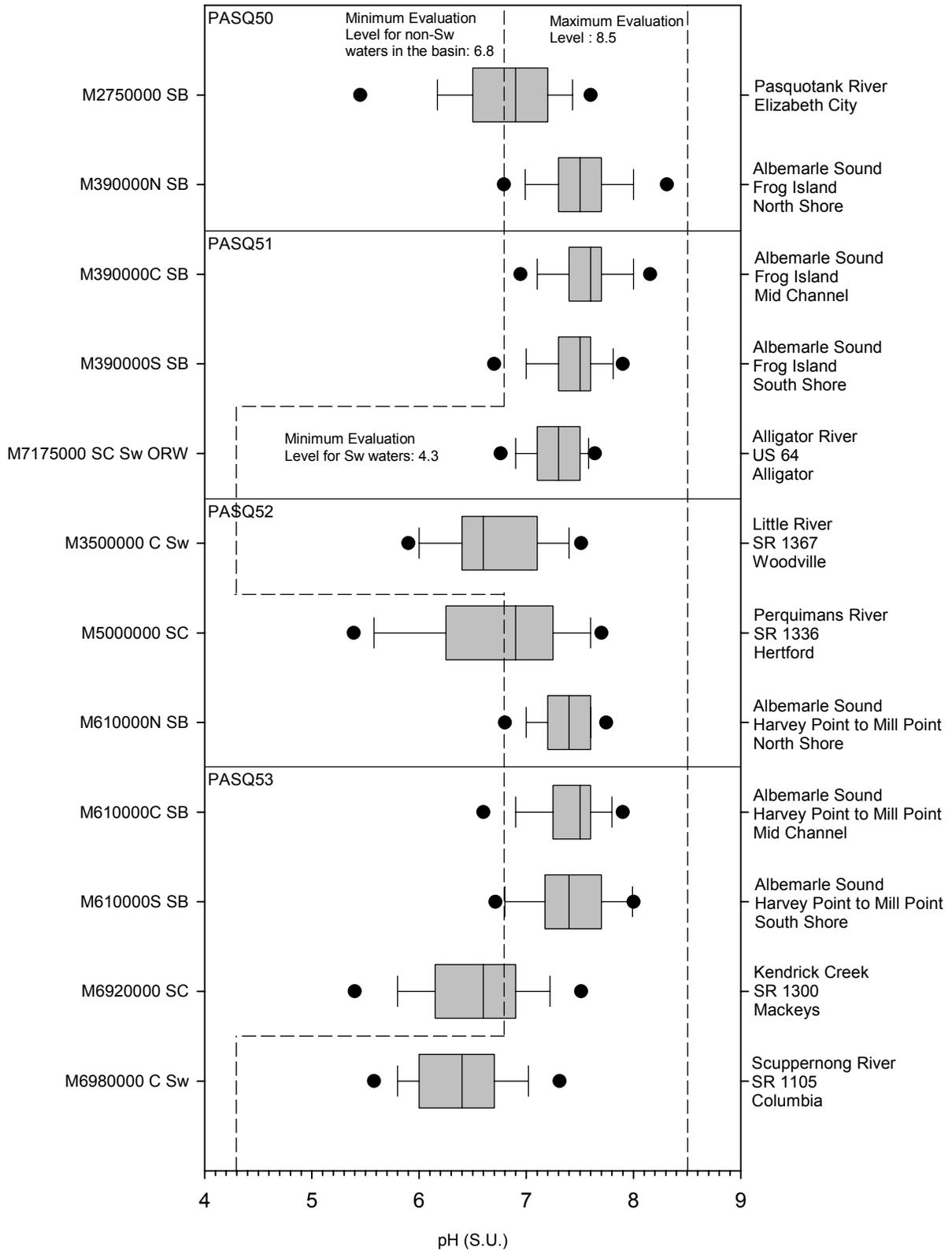


Figure 13. Box Plots of pH in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-41

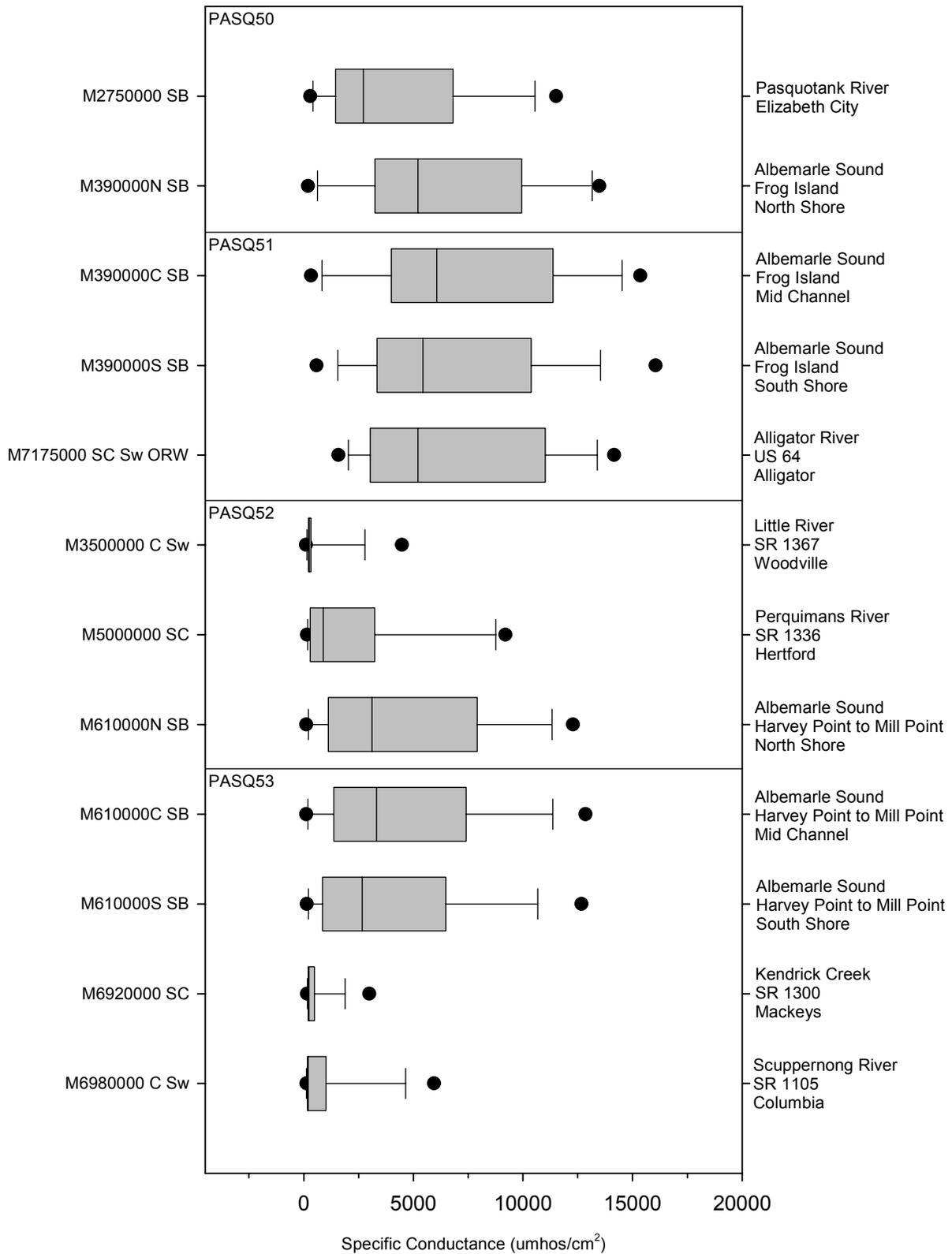


Figure 14. Box Plots of Specific Conductivity in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-42

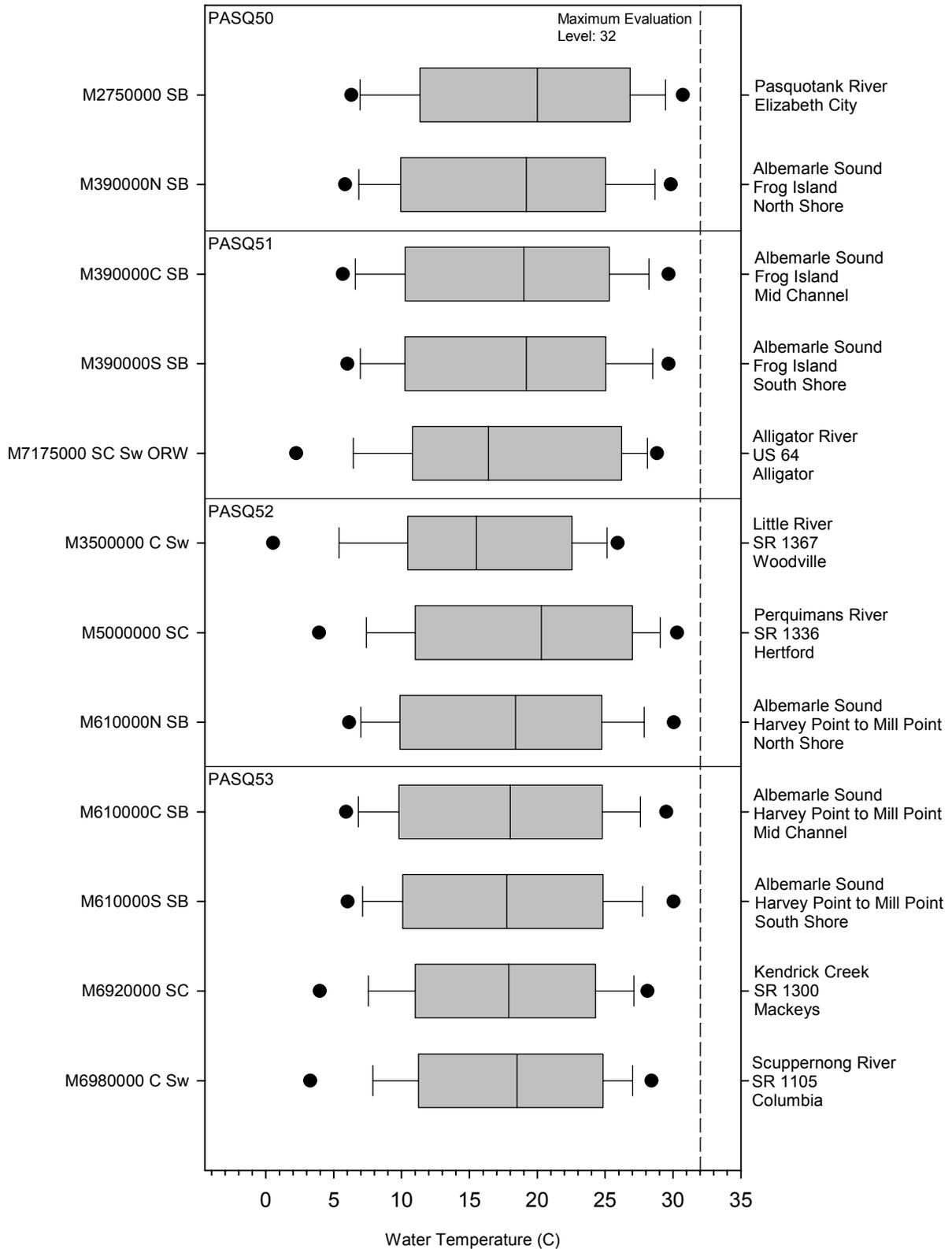


Figure 15. Box Plots of Water Temperature in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-43

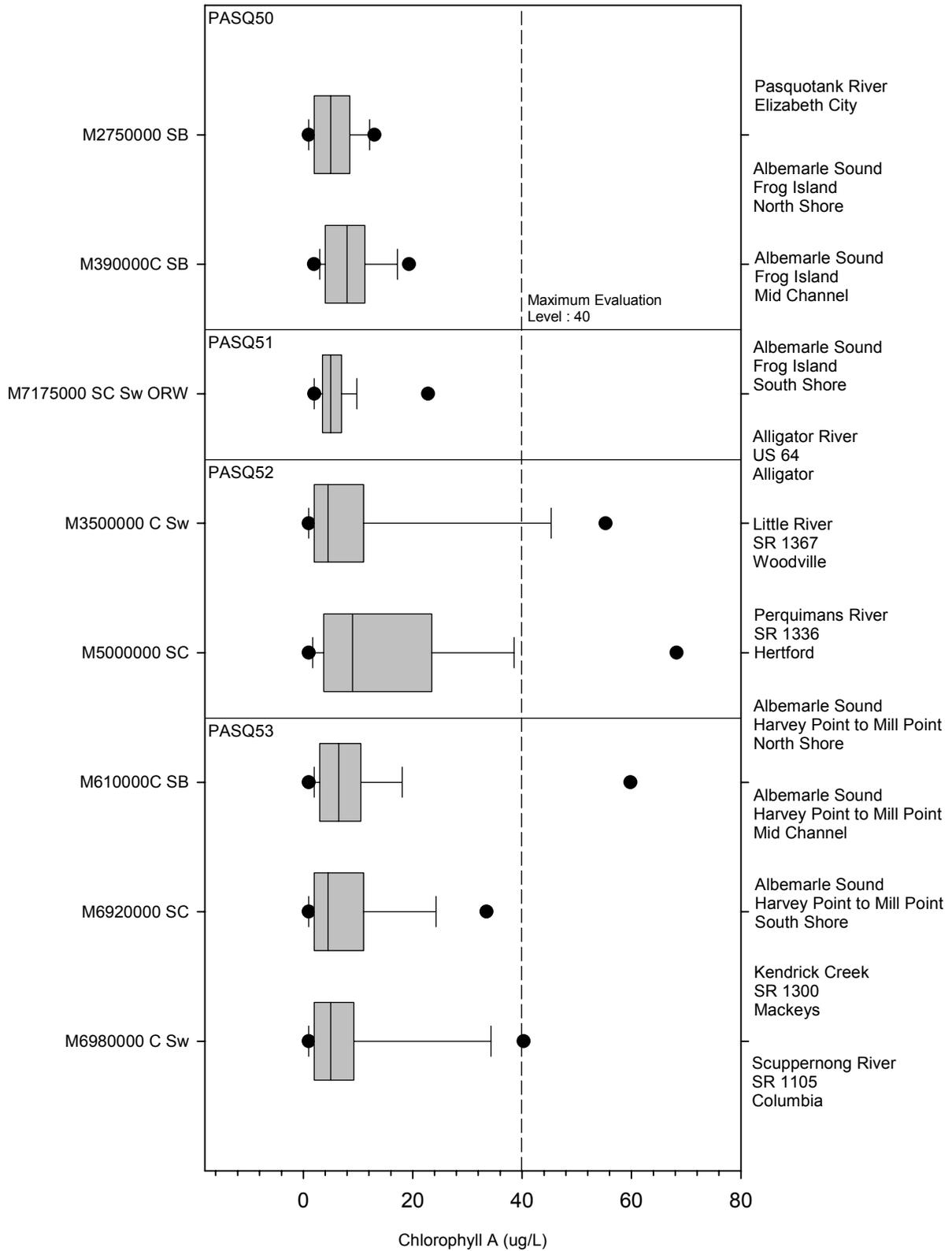


Figure 16. Box Plots of Chlorophyll A in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-44

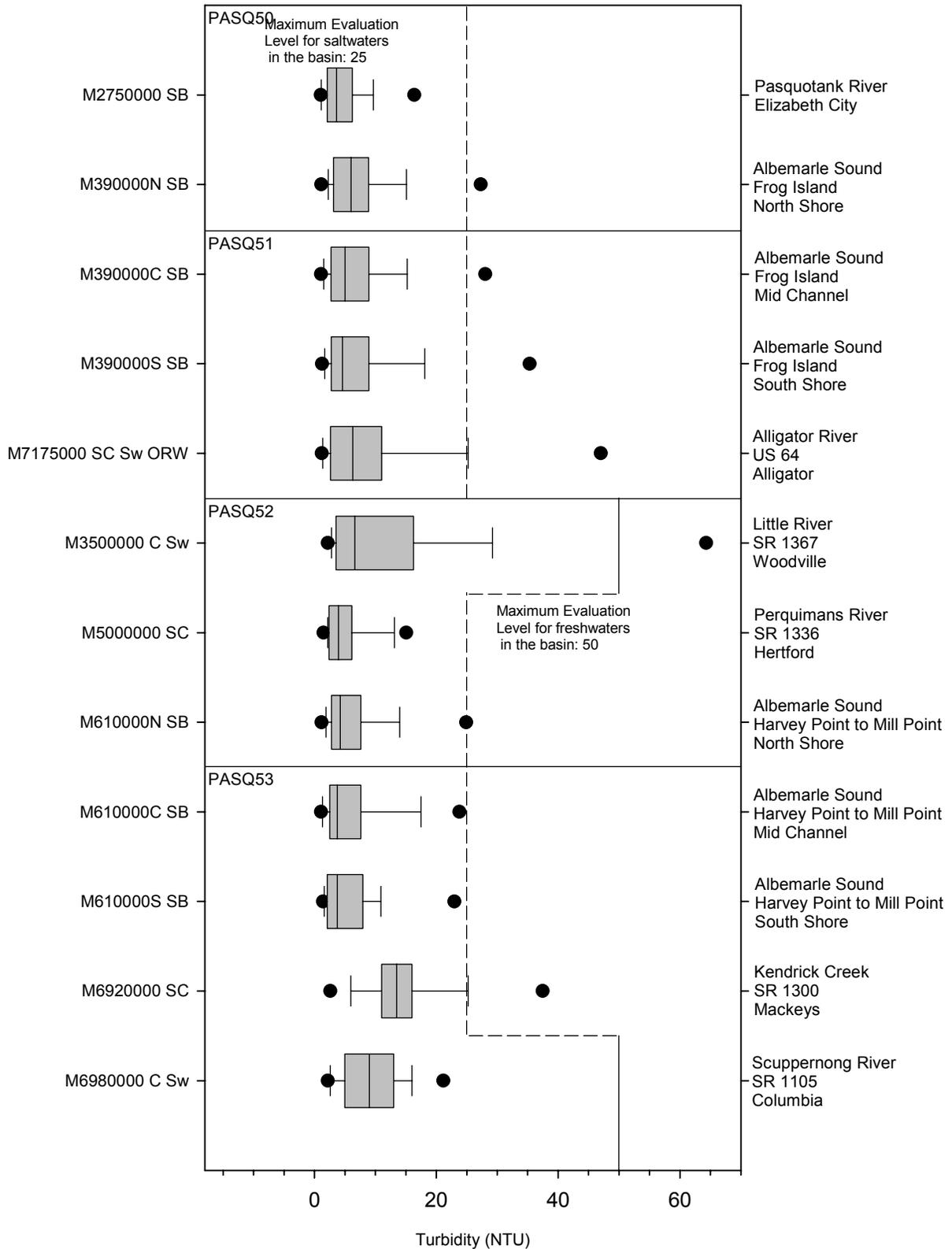


Figure 17. Box Plots of Turbidity in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-45

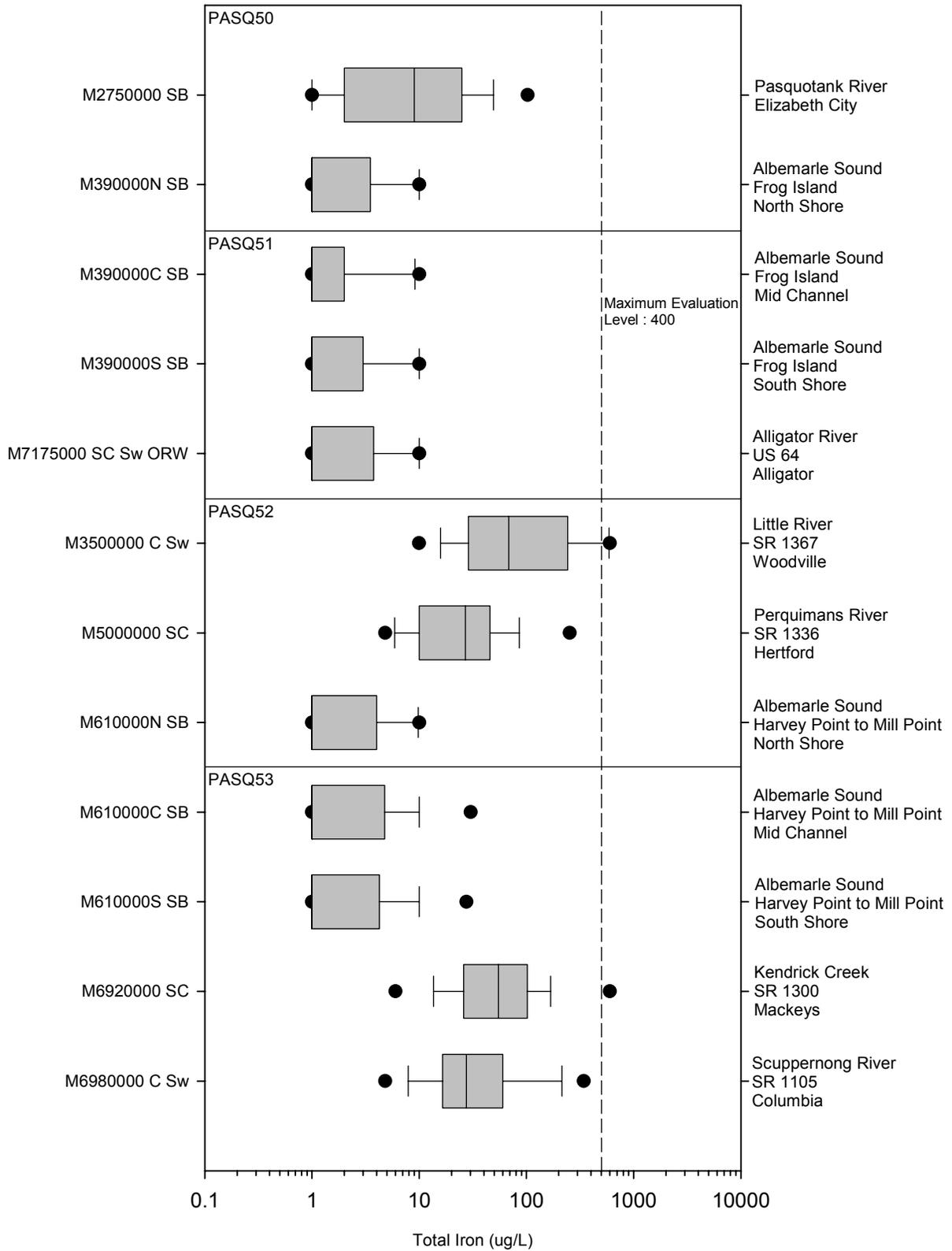


Figure 18. Box Plots of Fecal Coliform in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-46

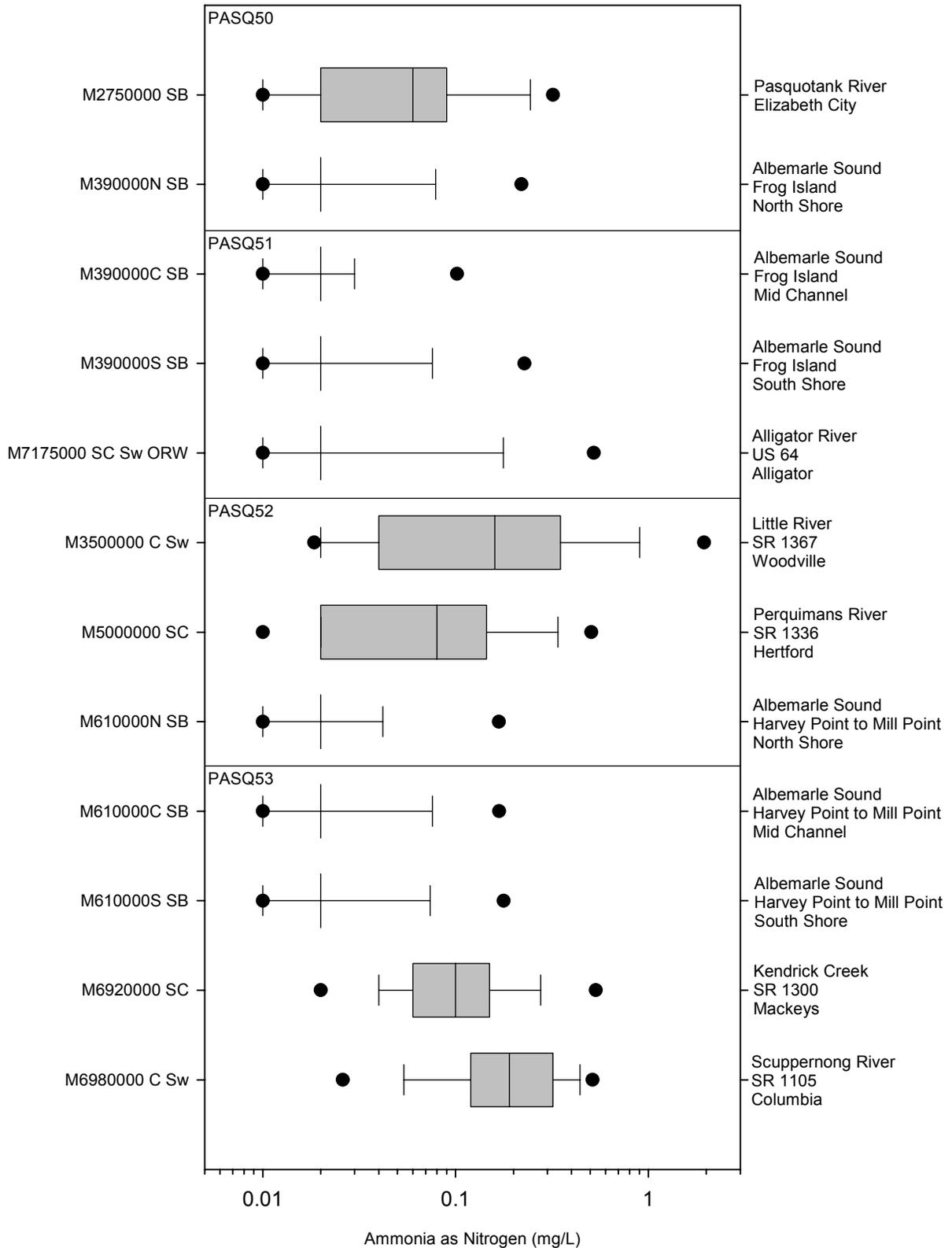


Figure 19. Box Plots of Total Ammonia in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-47

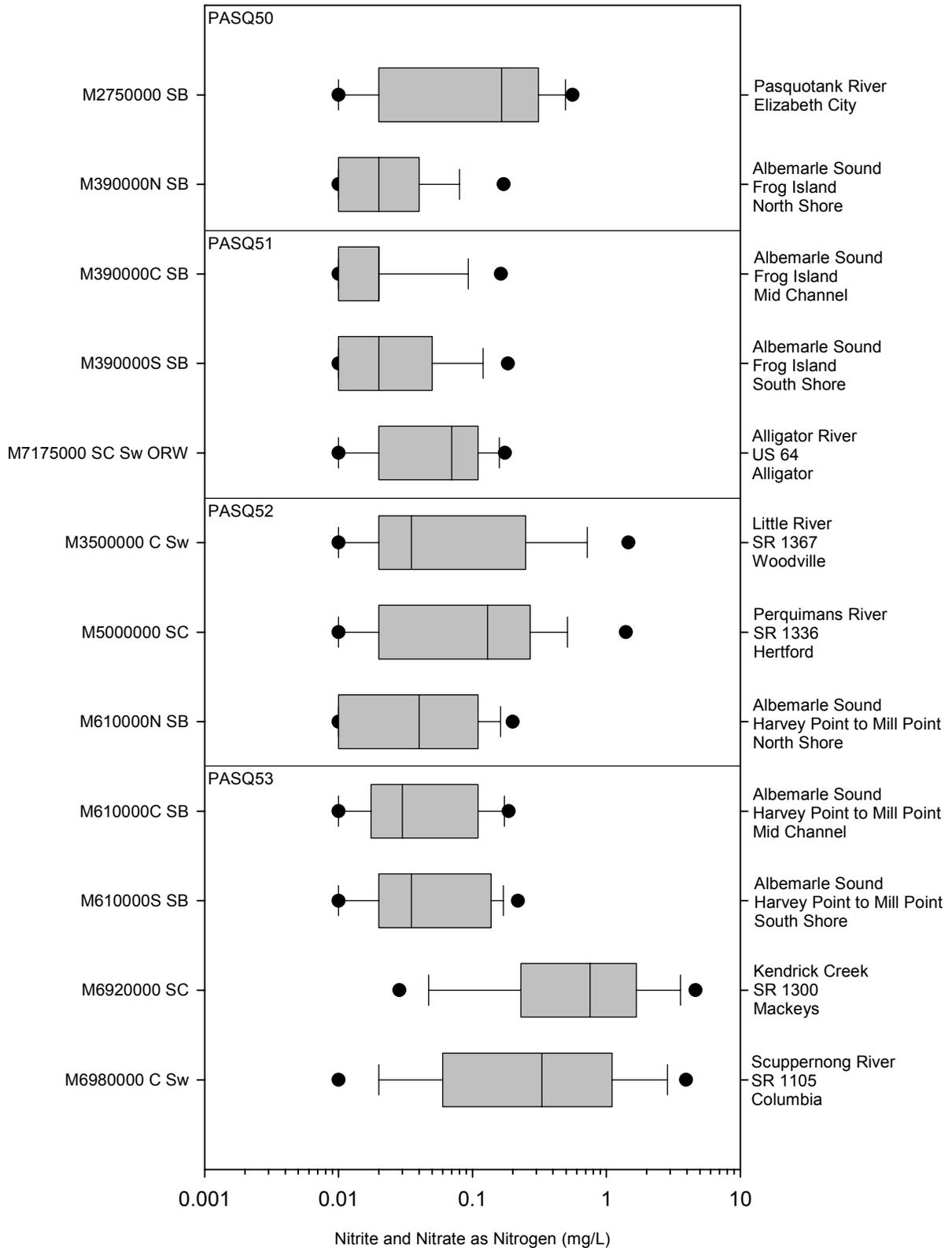


Figure 20. Box Plots of Total Nitrate/Nitrite in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-48

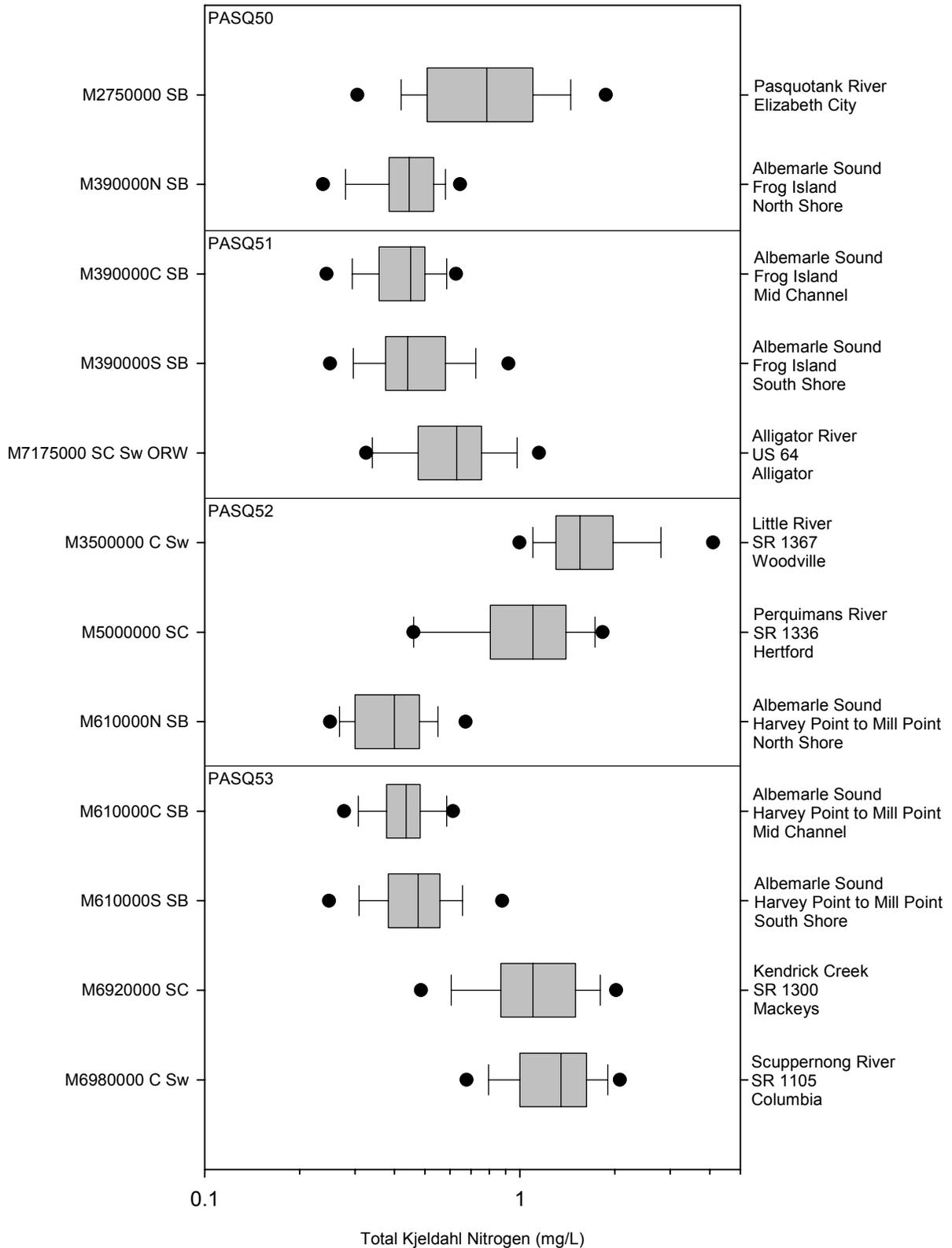


Figure 21. Box Plots of Total Kjeldahl Nitrogen in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-49

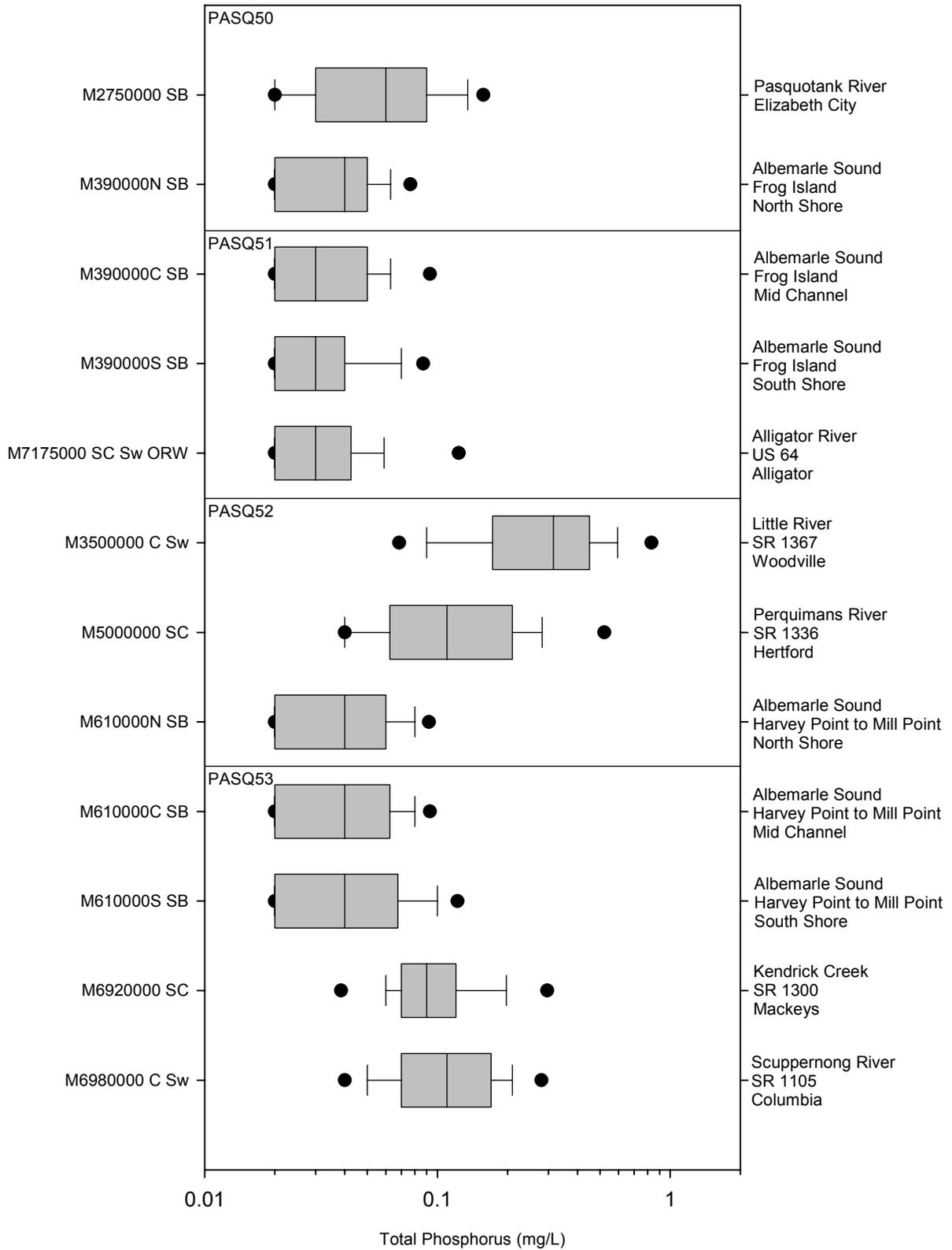


Figure 22. Box Plots of Total Phosphorus in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-50

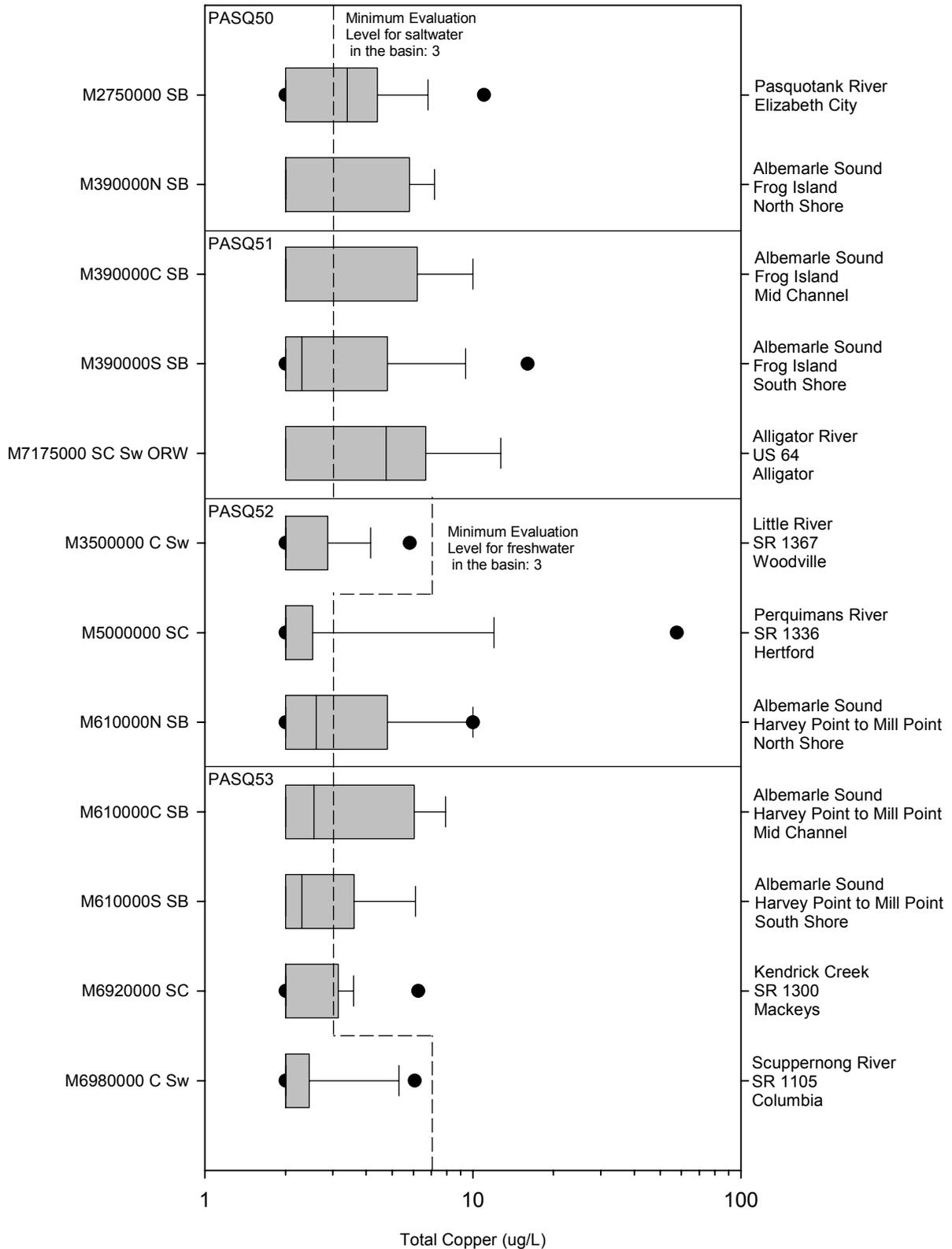


Figure 23. Box Plots of Total Copper in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-51

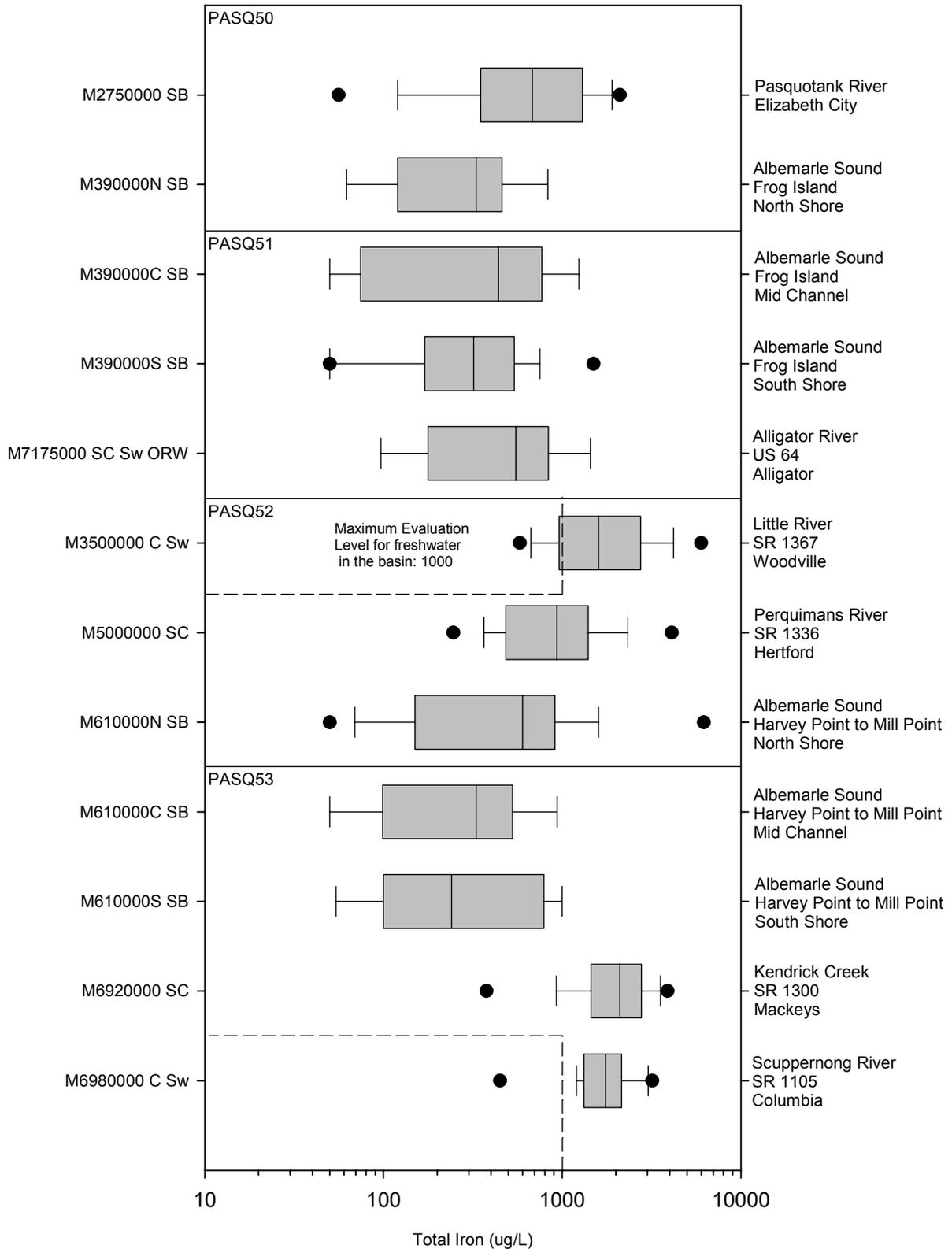
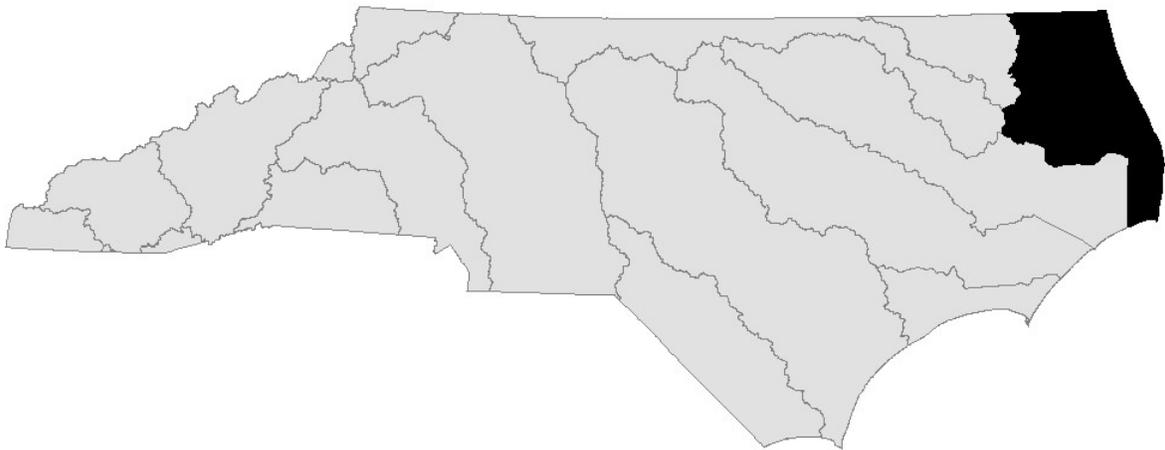


Figure 24. Box Plots of Total Iron in the Pasquotank River Basin
 NCDENR, Division of Water Quality
 Ambient Monitoring System Report
 Pasquotank River Basin – April 2006
 AMS-52

**Pasquotank River Basin
Basinwide Assessment Report
Whole Effluent Toxicity Program
2001-2005**



The Division of Water Quality's Whole Effluent Toxicity Monitoring Program

Acute and/or chronic toxicity tests are used to determine toxicity of discharges to sensitive aquatic species (usually fathead minnows or the water flea, *Ceriodaphnia dubia*). Results of these tests have been shown by researchers to be predictive of discharge effects to receiving stream populations.

Many facilities are required to monitor whole effluent toxicity (WET) by their NPDES permit. Facilities without monitoring requirements may have their effluents evaluated for toxicity by DWQ's Aquatic Toxicology Laboratory. If toxicity is detected, DWQ may include aquatic toxicity testing upon permit renewal.

DWQ's Aquatic Toxicology Unit maintains a compliance summary for all facilities required to perform tests and provides a monthly update of this information to regional offices and WQ administration. Ambient toxicity tests can be used to evaluate stream water quality relative to other stream sites and/or a point source discharge.

WET Monitoring in the Pasquotank River Basin – 2001-2005

Sixteen facility permits in the Pasquotank River basin currently require whole effluent toxicity (WET) monitoring (Figure 1 and Table 1). Two facility permits have a WET limit while fourteen require monitoring without a limit; all of these facilities are drinking water treatment plants discharging filter backwash or reverse osmosis reject water.

Figure 1. Pasquotank River basin facilities required to conduct whole effluent toxicity testing

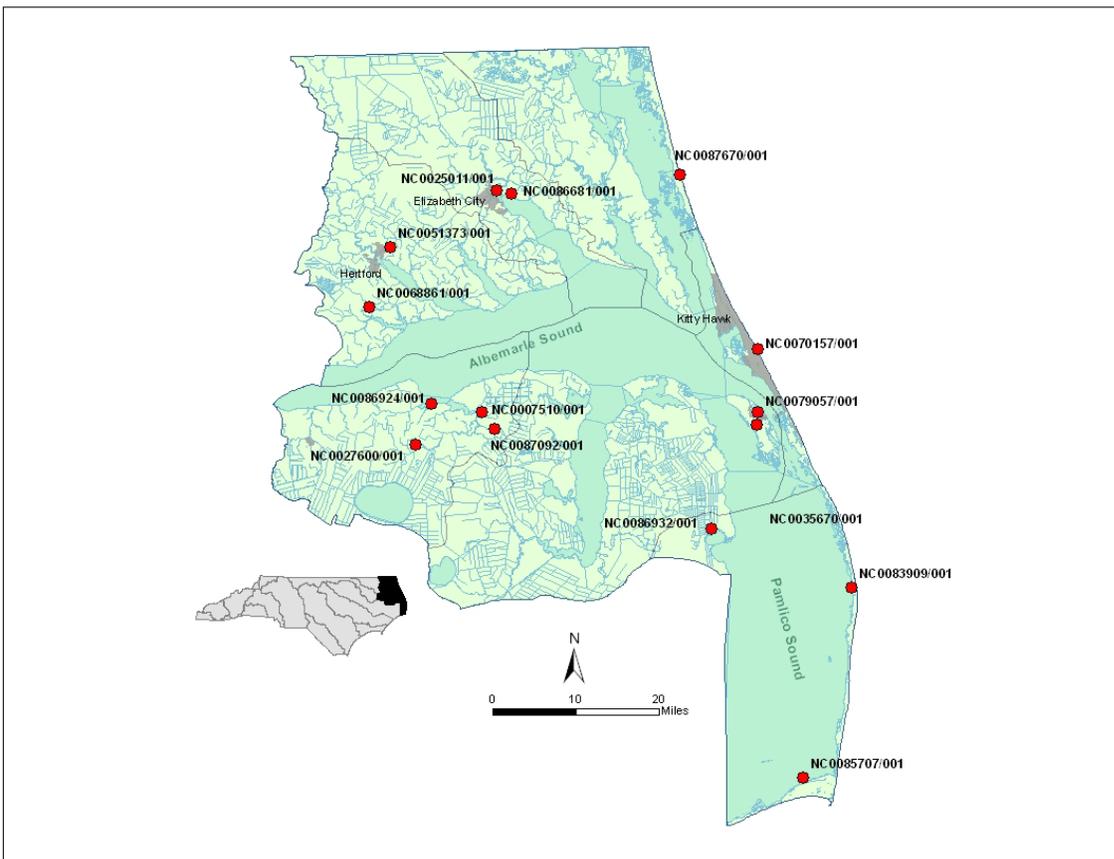


Table 1. Pasquotank River basin facilities required to conduct whole effluent toxicity testing

Subbasin/Facility	NPDES Permit No.	Receiving Stream	County	Flow (MGD)	IWC (%)	7Q10 (cfs)
03-01-50						
Camden Co. WTP	NC0086681/001	Pasquotank R.	Camden	0.432	100	Tidal
Elizabeth City WWTP	NC0025011/001	Pasquotank R.	Pasquotank	4.5	10.0	Tidal
03-01-51						
Manteo WWTP	NC0079057/001	Shallowbag Bay	Dare	0.6	NA	Tidal
Skyco WTP	NC0035670/001	UT Croatan Sound	Dare	0.192	NA	Tidal
03-01-52						
Perquimans Co. - Bethel WTP	NC0068861/001	Bethel Cr.	Perquimans	NA	NA	Tidal
Perquimans Co. - Winfall WTP	NC0051373/001	UT Mill Cr.	Perquimans	NA	100	0
03-01-53						
Columbia WTP	NC0007510/001	UT Scuppernong R.	Tyrrell	0.02	NA	Tidal
Creswell WTP	NC0027600/001	UT Scuppernong R.	Washington	0.011	100	0
Tyrrell County Bull Bay WTP	NC0086924/001	Bull Bay	Tyrrell	0.216	100	0
Tyrrell County WTP	NC0087092/001	UT Riders Cr.	Tyrrell	0.053	NA	Tidal
03-01-54						
Southern Outer Banks WTP	NC0087670/001	Atlantic Ocean	Currituck	0.6	NA	Tidal
03-01-55						
Cape Hatteras Water Assoc. WTP	NC0085707/001	Pamlico Sound	Dare	1.8	6.5	Tidal
Rodanthe/Waves/Salvo WTP	NC0083909/001	Blackmar Gut	Dare	0.3	NA	Tidal
Stumpy Point WTP	NC0086932/001	Stumpy Point Bay	Dare	0.0432	100	0
03-01-56						
Dare County WTP/001	NC0070157/001	UT Atlantic Ocean	Dare	NA	NA	Tidal
Dare County WTP/002	NC0070157/002	UT Atlantic Ocean	Dare	0.9	NA	Tidal

Only two facilities in this basin have whole effluent toxicity limits. The compliance rate of those facilities has been perfect (100%) since 1999 (Figure 2 and Table 2).

Given the rate of development in this area of the state in recent history, sources of drinking water are at a premium; several new treatment facilities have opened over the last few years. In addition, concerns have been raised by State and Federal natural resource agencies concerning the impact on receiving waters of these facilities' discharges given their highly ionic nature. Since 2000, the Division's permitting policy for WET monitoring of drinking water treatment plant discharges has evolved with the objective of gathering data. The current permitting strategy was developed by an interagency workgroup tasked to study this problem. Generally, these data from the Pasquotank Basin indicate that these briny discharges are less toxic to salt water organisms, as would be expected. Facilities with consistent WET failures (the Perquimans Co. facilities and the Tyrrell Co. facility) discharge to freshwater receiving streams and therefore must use the freshwater water flea for their test organisms. The inter-agency workgroup produced one other major recommendation: the initial planning stage of these facilities should incorporate location of discharge outfalls such that the effluents produce minimal water quality impacts. WET data collected in this basin strongly supports that recommendation.

Figure 2. NPDES facility whole effluent toxicity compliance in the Pasquotank River basin, 1990-2005. The compliance values were calculated by determining whether facilities with WET limits were meeting their ultimate permit limits during the given time period, regardless of any SOCs in force.

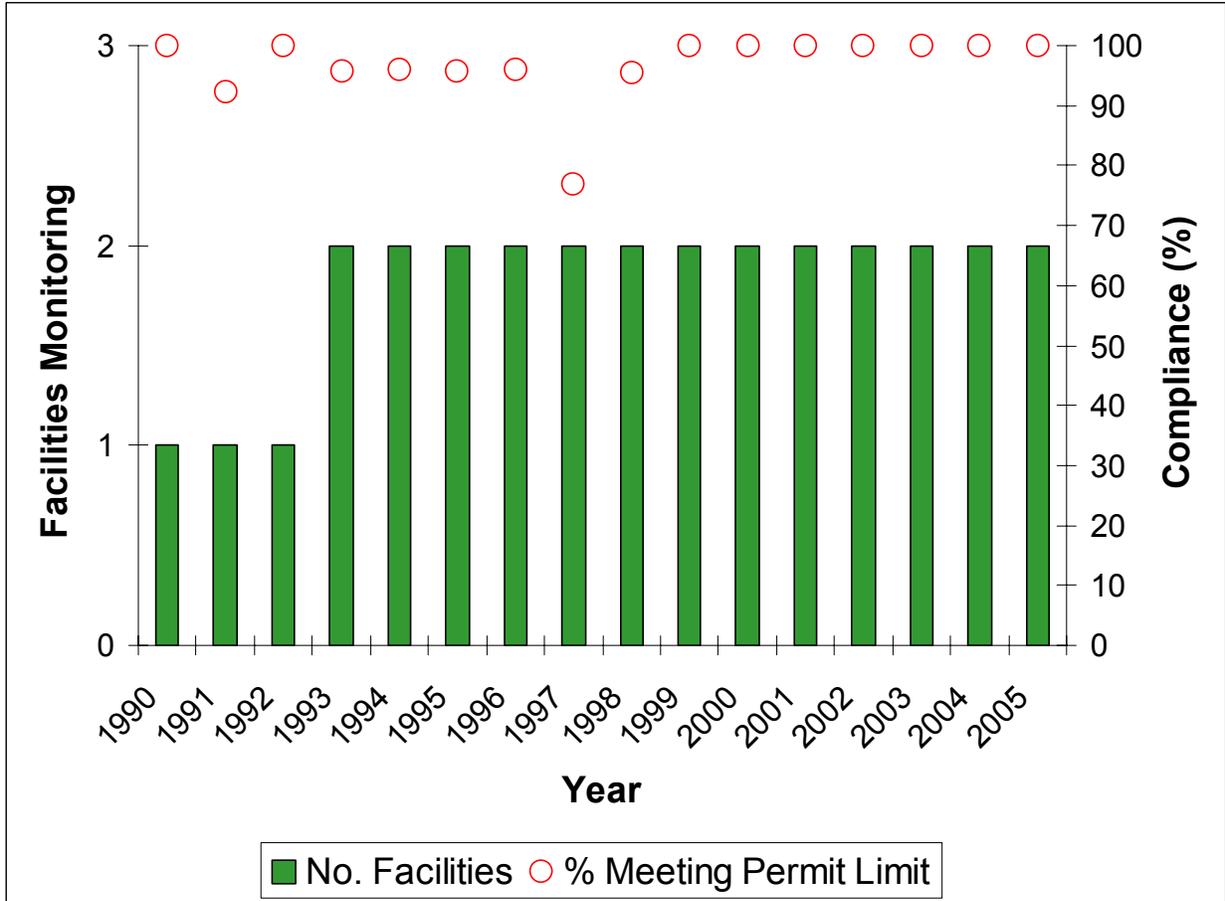


Table 2. Recent compliance record of facilities performing whole effluent toxicity testing in the Pasquotank River basin

Subbasin/Facility	NPDES Permit No.	2001- 2004 Passes	2001- 2004 Fails	2005 Passes	2005 Fails
03-01-50					
Camden County WTP	NC0086681/001	9	0	4	0
Elizabeth City WWTP	NC0025011/001	18	0	4	0
03-01-51					
Manteo WWTP	NC0079057/001	16	0	4	0
Skyco WTP	NC0035670/001	1	1	2	2
03-01-52					
Perquimans County - Bethel WTP	NC0068861/001	0	0	0	4
Perquimans County - Winfall WTP	NC0051373/001	0	0	0	4
03-01-53					
Columbia WTP	NC0007510/001	2	0	4	0
Creswell WTP	NC0027600/001	2	0	4	0
Tyrrell County Bull Bay WTP	NC0086924/001	6	2	3	1
Tyrrell County WTP	NC0087092/001	0	2	0	4
03-01-54					
Southern Outer Banks WTP	NC0087670/001	1	0	4	0
03-01-55					
Cape Hatteras Water Assoc. WTP	NC0085707/001	16	1	4	0
Rodanthe/Waves/Salvo WTP	NC0083909/001	15	4	4	0
Stumpy Point WTP	NC0086932/001	8	0	4	0
03-01-56					
Dare County WTP/001	NC0070157/001	15	2	1	3
Dare County WTP/002	NC0070157/002	15	5	3	1

Note that "pass" denotes meeting a permit limit or, for those facilities with a monitoring requirement, meeting a target value. The actual test result may be a "pass" (from a pass/fail acute or chronic test), LC₅₀, or chronic value. Conversely, "fail" means failing to meet a permit limit or target value.