DIGITAL FLOW MODEL OF THE CHOWAN RIVER ESTUARY, NORTH CAROLINA

U. S. GEOLOGICAL SURVEY
WATER RESOURCES INVESTIGATIONS 77-63

PREPARED IN COOPERATION WITH THE
NORTH CAROLINA DEPARTMENT OF NATURAL
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INTERNATIONAL SYSTEM UNITS

The following factors may be used to convert the English units published in this report to the International System of Units (SI).

Multiply English units	By	To obtain SI units
Length		
inches (in)	25.4	millimeters (mm)
feet (ft)	.3048	meters (m)
miles (mi)	1.609	kilometers (km)
Area		
square feet (ft^2)	.0929	square meters (m^2)
square miles (mi^2)	2.590	square kilometers (km^2)
Flow		
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
cubic feet per second per square mile [(ft^3/s)/mi^2]	.01093	cubic meters per second per square kilometer [(m^2/s)/km^2]
Velocity		
feet per second (ft/s)	.3048	meters per second (m/s)
miles per hour (mi/hr)	1.609	kilometers per hour (km/hr)
Mass		
pounds (lb avoirdupois)	.4536	kilograms (kg)

DIGITAL FLOW MODEL OF THE CHOWAN

RIVER ESTUARY, NORTH CAROLINA

By Charles C. Daniel, III

ABSTRACT

A one-dimensional deterministic flow model based on the continuity equation has been developed to provide estimates of daily flow past a number of points on the Chowan River of northeast North Carolina. The Chowan River is estuarine from its beginning at the confluence of the Blackwater and Nottoway Rivers near the North Carolina-Virginia line to its mouth in Albemarle Sound near Edenton, North Carolina. The estuary is about 50 miles long and has an open-water surface of approximately 45 square miles.

Daily average discharge is provided for nine sites; four of these represent tributary inflow at the mouths of major tributaries, the five other sites are at stage stations on the estuary. The two-year period of record generated by the model extends from April 1, 1974, to March 31, 1976.

The digital model, programmed in Fortran IV, takes as input continuous hydrologic and meteorological data from 27 sites. Component programs convert these data into rates of inflow, evaporation from the estuary surface, evapotranspiration from the adjoining swamps, and change in storage for 83 segments of the river and lower parts of four major tributaries. Using the continuity equation the model computes outflow as the algebraic sum of these values. Once calculated, the outflow from any segment becomes the inflow to the next downstream segment. Because flows within the Chowan River and the lower reaches of its tributaries are tidally affected, flows occur in both upstream and downstream directions. Lunar tide variation in the river is only about 1 foot, but wind tides cause as much as 4 feet of variation in the water surface at irregular intervals.

Determination of the change in storage corresponding to a change in stage is complicated by extensive swamps that border much of the river and its tributaries. These swamps have a total surface area nearly equivalent to that of the open-water surface, altitudes generally less than 5 feet, and are subject to frequent flooding. In order to determine the area of swamp subject to flooding and thus make an estimate of the volume of water stored in the swamps, maps were prepared using changes in vegetation as the criterion for topographic changes. Data from the maps and bathymetric data for the river channel were combined to formulate stage-storage relations.

Daily values for precipitation, evaporation, and evapotranspiration are also included in the model output. The precipitation values are a weighted average of records from twelve stations calculated by the Thiessen polygon method. The evapotranspiration and evaporation values are calculated by subprograms based on the Penman equation.

During the two years of model operation the average discharge past Edenhouse near the mouth of the estuary was 5,830 cubic feet per second. Daily average discharges during this period ranged between 55,900 cubic feet per second in the downstream direction on July 17, 1975, and 14,200 cubic feet per second in the upstream direction on November 30, 1974.

INTRODUCTION

Introduction of nutrients into the Chowan River (fig. 1) from both point and non-point sources has resulted in nuisance algal growths since 1970. An algal bloom during the summer of 1972 affected much of the river and severely limited the traditional uses of the river for commercial and sport fishing, recreation, and navigation. Fish kills and catches of fish infected with "red sore" disease were reported in mid-1975. Many of the dead fish had their gills clogged with an unidentified black organic substance. In 1972 State investigators found that large amounts of wastewater containing nitrogen were being discharged to the Chowan from a fertilizer plant at Tunis. These discharges, which were stopped by State action, appeared to have triggered the algae blooms but did not account for less serious blooms or fish kills in years when the discharges were not being made.

The deterioration in water quality has led to specialized multidisciplinary studies of the problem by several State and Federal agencies--including the North Carolina Department of Natural Resources and Community Development (formerly the North Carolina Department of Natural and Economic Resources), Virginia State Water Control Board, Water Resources Research Institute of the University of North Carolina, U.S. Environmental Protection Agency (EPA), and the U.S. Geological Survey. Also, researchers from North Carolina State University,

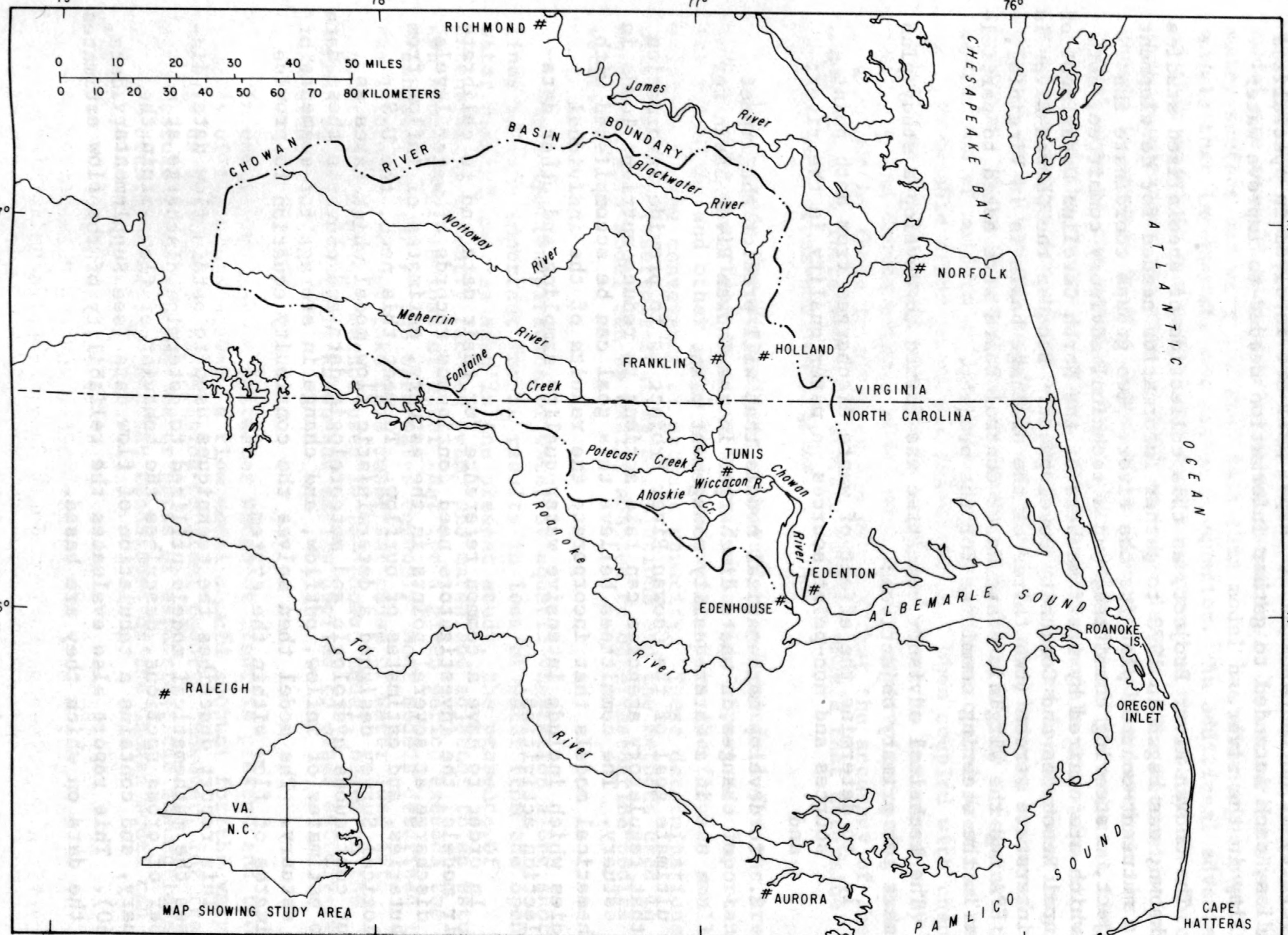

Figure 1.--The Chowan River drainage basin of northeastern North Carolina and southeastern Virginia.

Virginia Polytechnical Institute, East Carolina University, and the University of North Carolina at Chapel Hill are involved in specialized studies, each intended to gather information needed to improve water quality in the river.

The Chowan River Project, as this collection of specialized studies is known, was begun in 1973 to gather information needed for development of a nutrient-control plan for the river. Two groups coordinate the project, a steering committee, and a technical advisory committee, both of which are chaired by staff members of the North Carolina Department of Natural Resources and Community Development. Because the Chowan River is an interstate stream (two thirds of the drainage basin is in Virginia), the EPA and the Virginia State Water Control Board were asked to participate in the steering committee for the project.

The technical advisory committee was formed to develop a study plan to meet two primary objectives:

1. to determine the effect of waste discharges from both point sources and non-point sources on water quality in the river; and

2. to develop mathematical models that will predict the impact of changes in waste discharges in the Chowan River basin for use in a water-quality management plan.

The ultimate goal of the Chowan River Project is to provide information so that regulatory agencies can take actions to reduce nutrient loads in the estuary. The committees believe this goal can be accomplished with mathematical models that incorporate the results of the individual studies which include intensive water-quality sampling and other data-collection activities.

In order to have a common reference for their data and to calibrate their models, the investigators need continuous records of water levels and discharge at several points in the estuary, estimates of inflow from tributaries, and estimates of outflow. To meet this need, the U.S. Geological Survey designed a deterministic flow model which takes as input continuous hydrologic and meteorologic data and converts these data into estimates of inflow, outflow, and change in storage for segments of the estuary. The model then solves the continuity equation to provide estimates of flow within the system.

This report describes the techniques used to obtain flow data, discusses the mathematical models utilized to determine discharge at a number of cross sections, describes the behavior of flow within the estuary, and contains a tabulation of flow data (see Supplementary data, p. 60). This report also evaluates the reliability of the flow estimates and the data on which they are based.

Although the model described in this report is a deterministic model designed for a particular estuary, the techniques that are used in the model are readily adaptable to other estuaries. In estuaries where the water surface has very low gradients this model has advantages over models that incorporate the momentum equation. An additional advantage of this model is the method employed to determine the change in storage that accompanies the rise or fall of water levels. The determination of change in storage in the Chowan River estuary model is based on the actual area of the water surface, the topography of the adjacent floodplain, and the change in stage. Most existing models determine storage with the assumption of uniform cross-sectional area for a given length of channel or a linearly varying cross-sectional area between measured sections. Because estuarine shorelines are often highly irregular, the assumption of uniform or linearly varying cross-sectional area can result in considerable error in volume calculations. When coupled with changes in storage due to small changes in stage the error is increased. By designing the Chowan estuary model much like a reservoir-routing model, it was felt by those involved in the project that the accuracy of the model would be increased over storage-routing models that determine storage from cross-sectional areas.

The methods for determining evaporation and rainfall for the area of the open-water surface that are described in this report are important for estuaries and other large bodies of water where the flow is small in relation to the conveyance or storage capacity. These determinations are often seen in reservoir-routing calculations and the methods used in the Chowan estuary model can be easily adapted to other estuarine bodies of water.

The evapotranspiration of water by aquatic vegetation along shorelines is also important for it results in loss of water from the open-water channel and, as seen in the present study, the presence of extensive, frequently flooded swamp and marshland adjacent to an estuary can even result in loss of water that for a given period exceeds the freshwater inflow to the open-water channel. Most models described in the literature do not take this important cause of water loss into account, although the method used in the Chowan model, based on the Penman equation, is well known and easily applied to other estuary-swamp complexes.

In estuaries where a saltwater wedge or front is present and the density of the water varies, a flow model should account for the varying density as outlined in the section on model theory. However, for freshwater estuaries or the freshwater parts of estuaries, the assumptions of uniform density will hold and the techniques of the Chowan model can be applied.

In the early phases of the Survey investigation, E. F. Hubbard helped design and C. E. Simmons supervised the installation of water-stage recording equipment utilized throughout the study. F. E. Arteaga is responsible in large part for writing the flow model computer program in Fortran IV.

Description of the Estuary

The Chowan River is an estuary extending southward from the confluence of the Blackwater and Nottoway Rivers near the North Carolina-Virginia state line to the river's mouth at the west end of Albemarle Sound near Edenton, North Carolina (fig. 1). Two other important tributaries, the Meherrin and Wiccacon Rivers, enter the estuary from the west. The estuary is slightly more than 50 mi long and has an open-water surface of about 45 mi^2. The Chowan estuary receives fresh-water inflow from 4,943 mi^2 including, because of precipitation, the area of the estuary itself. Discharge from 3,098 mi^2 or 63 percent of the drainage area is continuously gaged. The average discharge from the gaged area during 1958-74 was 2,903 ft^3/s or 0.94 $(ft^3/sec)/mi^2$ (U.S. Geological Survey, 1975).

Extensive swamps border much of the estuary and lower parts of its tributaries (fig. 2). These swamps have a total surface area nearly equal to that of the open water, have surface altitudes generally less than 5 ft above mean sea level, and are subject to frequent flooding. The most extensive areas of swamp are upstream from Holiday Island and reach a maximum width of nearly 3 mi near Gatesville. Numerous small streams and channels cross these swamps and facilitate the interchange of water between swamps and estuary. At several locations along the west side of the estuary, bluffs as high as 40 ft rise from the water's edge.

Lunar tide variation in the estuary is generally less than 1 ft, but wind tides are much more significant--causing as much as 4 ft of variation in the water surface at irregular time intervals. The nearest connection with the Atlantic Ocean is Oregon Inlet, southeast of Roanoke Island, and about 70 mi by water from the mouth of the Chowan River (fig. 1). The annual mean tidal range at Oregon Inlet is about 2.0 ft (U.S. Dept. Commerce, 1973) and tides in Pamlico and Albemarle Sounds are less than 1 ft. The characteristic diurnal cycle of tides is approximately 24.8 hours.

Tidal incursion is also observed in the lower parts of tributaries to the Chowan River and at times causes or contributes to overbank flow into adjacent swampland. During periods of low flow, reversal of flow due to tides has been observed as far upstream on the Blackwater River as 6 mi north of Franklin, Virginia, or 78 mi above Albemarle Sound (fig. 1).

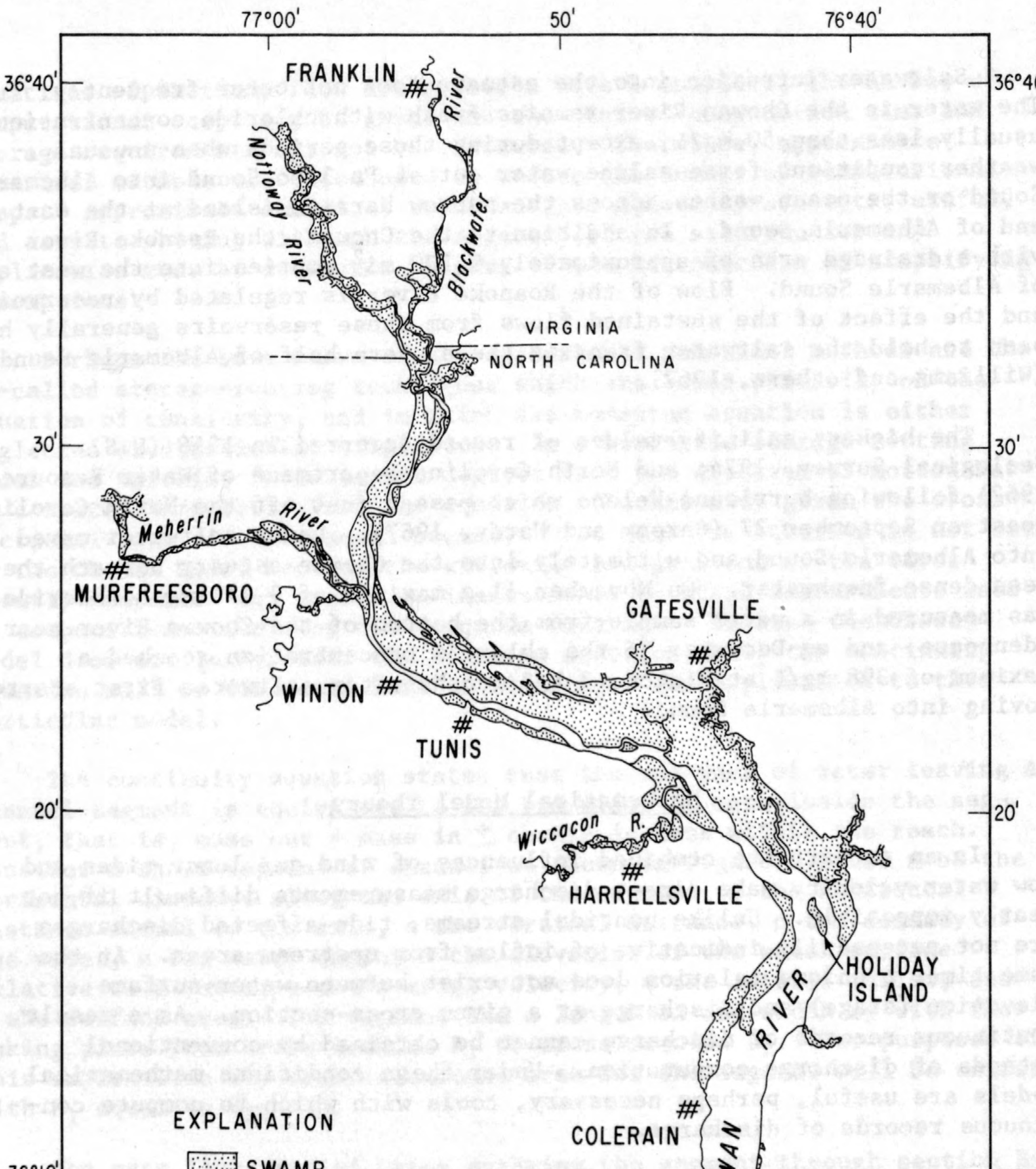

Figure 2.--Chowan River, major tributaries, and adjoining swampland.

Saltwater intrusion into the estuary does not occur frequently. The water in the Chowan River remains fresh with chloride concentrations usually less than 50 mg/L, except during those periods when unusual weather conditions force saline water out of Pamlico Sound into Albemarle Sound or the ocean washes across the narrow barrier island at the east end of Albemarle Sound. In addition to the Chowan, the Roanoke River with a drainage area of approximately 9,700 mi^2 empties into the west end of Albemarle Sound. Flow of the Roanoke River is regulated by reservoirs, and the effect of the sustained flows from these reservoirs generally has been to hold the saltwater front in the eastern half of Albemarle Sound (Williams and others, 1967).

The highest salinity values of record occurred in 1958 (U.S. Geological Survey, 1974; and North Carolina Department of Water Resources, 1962) following hurricane Helene which passed just off the North Carolina coast on September 27 (Carney and Hardy, 1967). Dense saltwater moved into Albemarle Sound and ultimately into the Chowan estuary beneath the less dense freshwater. On November 11 a maximum of 9,140 mg/L chloride was measured in a water sample from the bottom of the Chowan River near Edenhouse, and on December 15 the chloride concentration reached a maximum of 398 mg/L at Winton, 2-1/2 months after saltwater first started moving into Albemarle Sound.

Mathematical Model Theory

In an estuary the combined influences of wind and lunar tides and low water velocity make direct discharge measurements difficult if not nearly impossible. Unlike nontidal streams, tide-affected discharges are not necessarily indicative of inflow from upstream areas. At the same time, a unique relation does not exist between water-surface elevation (stage) and discharge at a given cross-section. As a result, continuous records of discharge cannot be obtained by conventional methods of discharge computation. Under these conditions mathematical models are useful, perhaps necessary, tools with which to compute continuous records of discharge.

Two basic laws of mechanics are the foundation for the mathematical analysis of unsteady flow. These laws, the law of conservation of mass and the law of conservation of momentum, are expressed in the form of partial differential equations known, respectively, as the equations of continuity and motion. Derivations of these equations are given in standard reference works (for example, Chow, 1959; Gilcrest, 1950; Henderson, 1966; Stoker, 1957).

Numerical methods for solution of these differential equations are based on the technique of writing the derivatives in finite difference form so that the differential equations are represented by corresponding algebraic equations. Although complete numerical solutions for the equations of unsteady flow are possible with a computer, the number of computational steps may be great and the cost of computation time and storage requirements may not be warranted. Therefore, approximate numerical methods are often used to reduce the number of computational steps. Approximate numerical solutions are generally accurate, useful, and easy to obtain, although the accuracy of the solution for any application must be evaluated because of the introduction of simplifying assumptions.

Perhaps the best known of the approximate numerical methods are the so-called storage-routing techniques which are based primarily on the equation of continuity, and in which the momentum equation is either neglected or drastically simplified. In a kinematic storage-routing model the velocity field is not derived from the equation of motion but is computed indirectly from the equation of continuity given the cross-sectional area of the channel segment. The momentum equation is not used in the Chowan model because the extremely low gradient of the river greatly compounds any errors or inaccuracies in stage measurements used in computations involving the momentum equation. Because the Chowan model does not incorporate the momentum equation, only the continuity equation will be discussed here to illustrate its application to this particular model.

The continuity equation states that the net mass of water leaving a channel segment is equivalent to the reduction of mass inside the segment, that is, mass out = mass in $\pm$ change in mass within the reach. Consider a short segment of channel as shown in figure 3. Let x be the horizontal distance along the axis of the segment, y the horizontal distance normal to the axis, z the vertical distance, ρ the density of the water, h the water depth, H the elevation of the water surface relative to a datum, v the average velocity, q the lateral inflow, and A the surface area. The segment has a length Δx and width Δy with flow taking place from cross section B_1 to cross section B_2. For purposes of this explanation the cross-sectional area for the segment will be uniform with B_1 equal to B_2.

The mass flow rate of water entering the segment through section B_1 is ρBv; the mass flow rate of water leaving through section B_2 is $\rho Bv + \frac{\partial}{\partial x}(\rho Bv)\Delta x$, and $\rho q \Delta x$ is the lateral mass inflow rate per unit length of channel.

The mass of water entering the channel segment during a time interval Δt will be $\rho Bv\Delta t + \rho q\Delta x\Delta t$ and the mass of water leaving the segment through B_2 during the same interval will be $\rho Bv\Delta t + \frac{\partial}{\partial x}(\rho Bv)\Delta x\Delta t$.

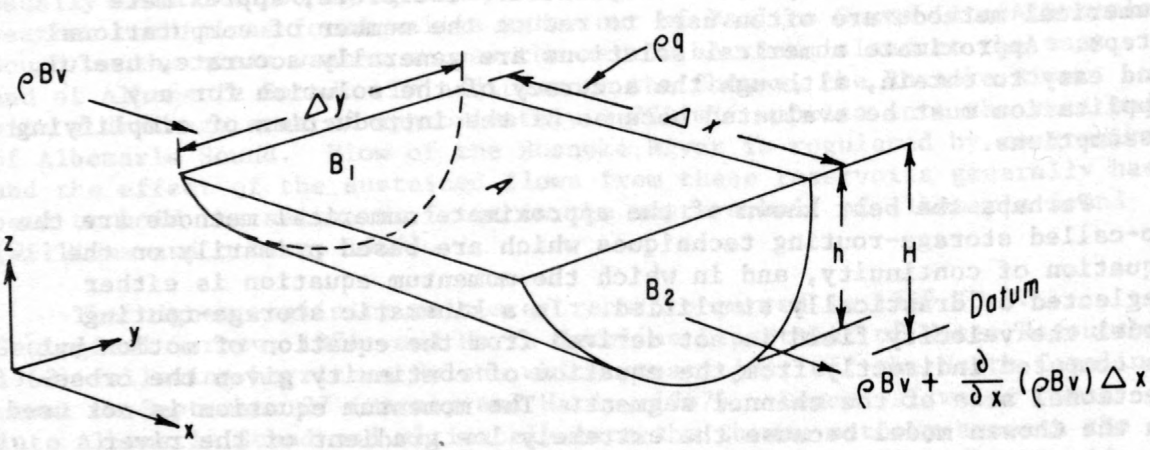

Figure 3.--Definition sketch of an idealized channel segment with mathematical notation for unsteady flow.

If the mass of water leaving the segment is greater than the mass of water entering the segment then the law of conservation of mass requires that there be a reduction of mass inside the segment over time Δt and that the water surface should fall. The mass of water inside the channel segment of length Δx is $\rho B \Delta x$ and the rate of decrease of this mass is expressed as $-\frac{\partial}{\partial t}(\rho B \Delta x)$. The reduction in mass over the interval Δt is $-\frac{\partial}{\partial t}(\rho B \Delta x)\Delta t$.

In channel segments affected by backwater or tidal flow the mass of water leaving the segment may be less than the mass of water entering the segment. When this situation arises there must be an increase of mass inside the segment over time Δt and the water surface should rise. The increase in mass over the interval Δt is $\frac{\partial}{\partial t}(\rho B \Delta x)\Delta t$.

For the conservation of mass we equate the mass inflow, mass outflow and change in mass within the segment so that

$$\rho Bv\Delta t + \rho q\Delta x\Delta t \pm \frac{\partial}{\partial t}(\rho B\Delta x)\Delta t = \rho Bv\Delta t + \frac{\partial}{\partial x}(\rho Bv)\Delta x\Delta t \qquad (1)$$

Because salt water intrusion into the Chowan River is a rare occurrence, the water density will be assumed constant and equation (1) can be simplified to

$$q \pm \frac{\partial B}{\partial t} = \frac{\partial Bv}{\partial x} \qquad (2)$$

Equation (2) is known as the equation of continuity.

In finite difference form the equation of continuity is written as

$$\Delta Bv = q\Delta x \pm \frac{\Delta B\Delta x}{\Delta t} \qquad (3)$$

Since $B\Delta x$ is the volume of water in the segment Δx, $\Delta B\Delta x$ is the change in the volume of water, or change in storage and can be represented as ΔS. Similarly, Bv is the volume rate, or discharge, of water moving in the segment and can be represented as Q. Thus the equation of continuity (3) becomes by substitution

$$\Delta Q = q\Delta x \pm \frac{\Delta S}{\Delta t} \qquad (4)$$

The change in discharge, ΔQ, equals outflow, $\emptyset$, minus inflow, I, and the equation can be rewritten as

$$\emptyset - I = q\Delta x \pm \frac{\Delta S}{\Delta t} \qquad (5a)$$

or

$$\emptyset = I + q\Delta x \pm \frac{\Delta S}{\Delta t} \qquad (5b)$$

which is true for the condition that an increase in S results in negative values of $\frac{\Delta S}{\Delta t}$ and a decrease in positive values.

A significant feature of the Chowan model is the manner in which the change in storage for the channel segments is determined. As given above, in equation (3), $\Delta S = \Delta B \Delta x$, but if the sides of the open-water channel are assumed vertical over possible intervals of h, then $\Delta B = \frac{A\Delta h}{\Delta x}$ and by substitution

$$\Delta S = A \frac{\Delta h}{\Delta x} \Delta x = A\Delta h$$

The change in storage is computed as $A\Delta h$ because the area of the water surface is easier, and perhaps more accurately, determined than the change in channel section within each segment.

All of the numerical integration methods of analysis, whether by finite differences or some other method, require a schematization of the estuary. There are usually two primary geometric simplifications: (1) the estuary is divided into sections along the axis of the estuary with the number of sections determined by the complexity of the channel geometry and other considerations, and (2) the sections across the estuary and adjacent flood plain are subdivided into conveyance and storage portions.

Further simplification of channel geometry is usually achieved by representing the volume within a section of channel and flood plain as one or more prismatic blocks. Change in storage, ΔS, within any prism is calculated using the length of the prism times the change in average cross section accompanying a change in stage. In nature, however, shorelines and flood plain topography are often irregular, especially along estuaries, and calculations of ΔS based upon changes in an average prismatic cross section may be in considerable error due to error in the cross section value. Consequently, in this model the prismatic volumes used in calculating ΔS are defined by the surface areas of swamp and open water plus topographic data for the flood-plain swamp and bathymetric data for the estuary. By subdividing the flood plain on the basis of topography, the storage capacity on slopes is represented as triangular prisms. Above the tops of slopes and in open water areas the storage capacity is represented as rectangular prisms. The area of the top, horizontal face of each prism is the actual area of swamp or open water measured from maps. The slopes of the lower faces are controlled by the topographic and bathymetric features within the section. Formulas have been derived that compute the volume of water stored in any prism at any given stage, and ΔS is computed as the difference between these volumes. This method of storage calculation is explained in greater detail in a later section.

The continuity equation as expressed in (5b) above was further expanded to include several modes of inflow or outflow that are significant components of the water budget in the Chowan River drainage basin. The expanded continuity equation used for the Chowan model can be expressed in the form:

$$Q_i = Q_{i-1} + I_i + P_i - E_i - ET_i \pm \Delta S_i \quad (6)$$

where Q_i is the outflow from segment i, Q_{i-1} is outflow from the adjacent upstream segment, I_i is the lateral inflow from the ungaged drainage area apportioned to segment i, exclusive of the drainage area within segment i, P_i is the precipitation that falls directly on segment i, E_i is the evaporation from the open water surface in segment i, ET_i is the evapotranspiration from the swampland in segment i, and ΔS_i is the change in storage in segment i (a falling stage contributes to a positive Q_i). Once calculated, the outflow, Q_i, from any segment becomes the inflow, Q_{i-1}, to the next downstream segment. Because flows within the Chowan and the lower reaches of its tributaries are tidally affected, flows occur in both upstream and downstream directions. By convention, upstream flow is indicated by a negative sign; downstream flow is positive.

Each of the terms in equation (6) is computed by component programs or subroutines that take as input continuous hydrologic and meteorological data gathered from 27 sites. The sources and types of data from these sites are described in detail in the following section.

Data Base

Variable input for the flow model, in the form of continuous hydrologic and meterological data, was obtained at 27 sites. The location of stations at which streamflow, estuary stages, and water temperatures were collected during the study are diagrammatically shown in figure 4. Fifteen stations for acquisition of climatological data are shown later in the report.

The estuarine portion of the Chowan River drainage system including the lower reaches of four major tributaries was divided for modeling purposes into the 83 segments shown in figure 4. Each segment is about 1 mi in length. Data obtained for each of these segments includes measurements of the areas of open water and high and low flood-plain swamps, along with estimates of the altitudes of the boundaries of these features. Values of the average channel depth within each block were determined from 87 cross-section measurements.

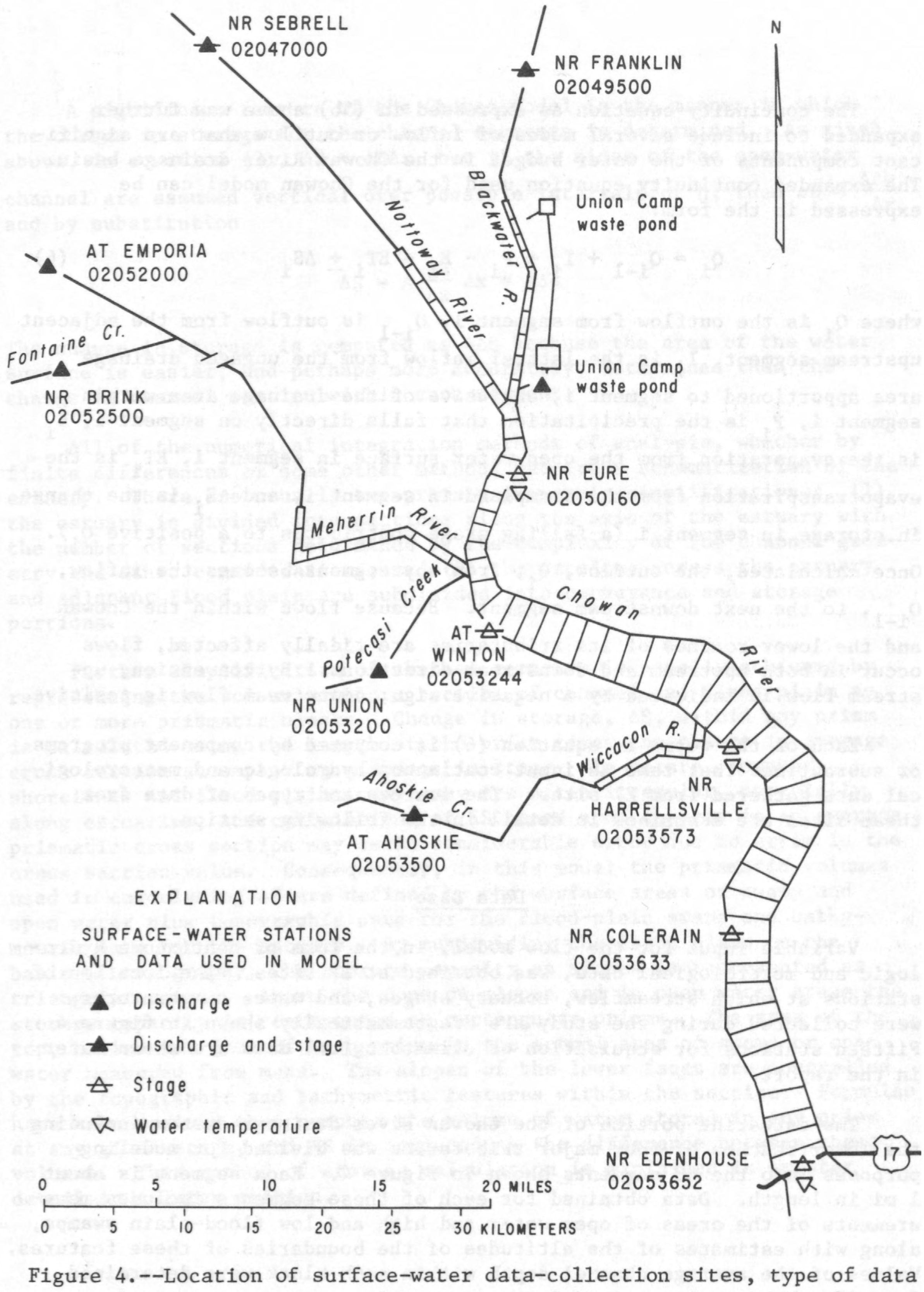

Figure 4.--Location of surface-water data-collection sites, type of data used from each station, and estuarine modeling segments in the lower part of the Chowan River basin.

At the time the model was being designed in 1973 a number of long-term discharge stations were already in operation in the Chowan River basin. Data from the six most downstream stations were used in the model. These six stations are:

Station name	Station number
Blackwater River near Franklin, Va.	02049500
Nottoway River near Sebrell, Va.	02047000
Meherrin River at Emporia, Va.	02052000
Fontaine Creek near Brink, Va.	02052500
Potecasi Creek near Union, N. C.	02053200
Ahoskie Creek at Ahoskie, N. C.	02053500

The discharges measured at these six stations represent the runoff from 3,098 mi^2 or 63 percent of the total drainage area (fig. 5).

The only other measured discharge to the estuary that was large enough to be a significant part of the total flow was the discharge from the Union Camp Paper Corporation's two waste water holding ponds south of their plant at Franklin, Virginia, and east of the Blackwater River. These ponds, surrounded by dikes, have a water-surface area of nearly 5.0 mi^2 when filled, 1.3 mi^2 in the upper pond and 3.7 mi^2 in the lower. A discharge canal from the upper pond to the Blackwater River was not used during this study, and all discharge from the upper pond was routed to the lower pond. Waste water from the lower pond is discharged through a canal to the Blackwater River at a point about 0.75 mi upstream of the confluence of the Blackwater and Nottoway Rivers. The National Pollutant Discharge Elimination System (NPDES) permit issued to Union Camp by EPA restricts the time of waste discharge to the period between December 1 and March 31. During the 2 years of model operation daily average waste discharges were as high as 515 ft^3/s (William C. Chapman, Union Camp Corp., written commun., April 7, 1976).

Since inflow from the upper part of the basin is often much smaller than tidal flow in the estuary, the accurate determination of flow by storage routing depends heavily on accurate records of water levels along the estuary. To acquire continuous records of water levels in the estuary five stations were installed for this study. These were all placed along the Chowan River (see fig. 4) and in downstream order are:

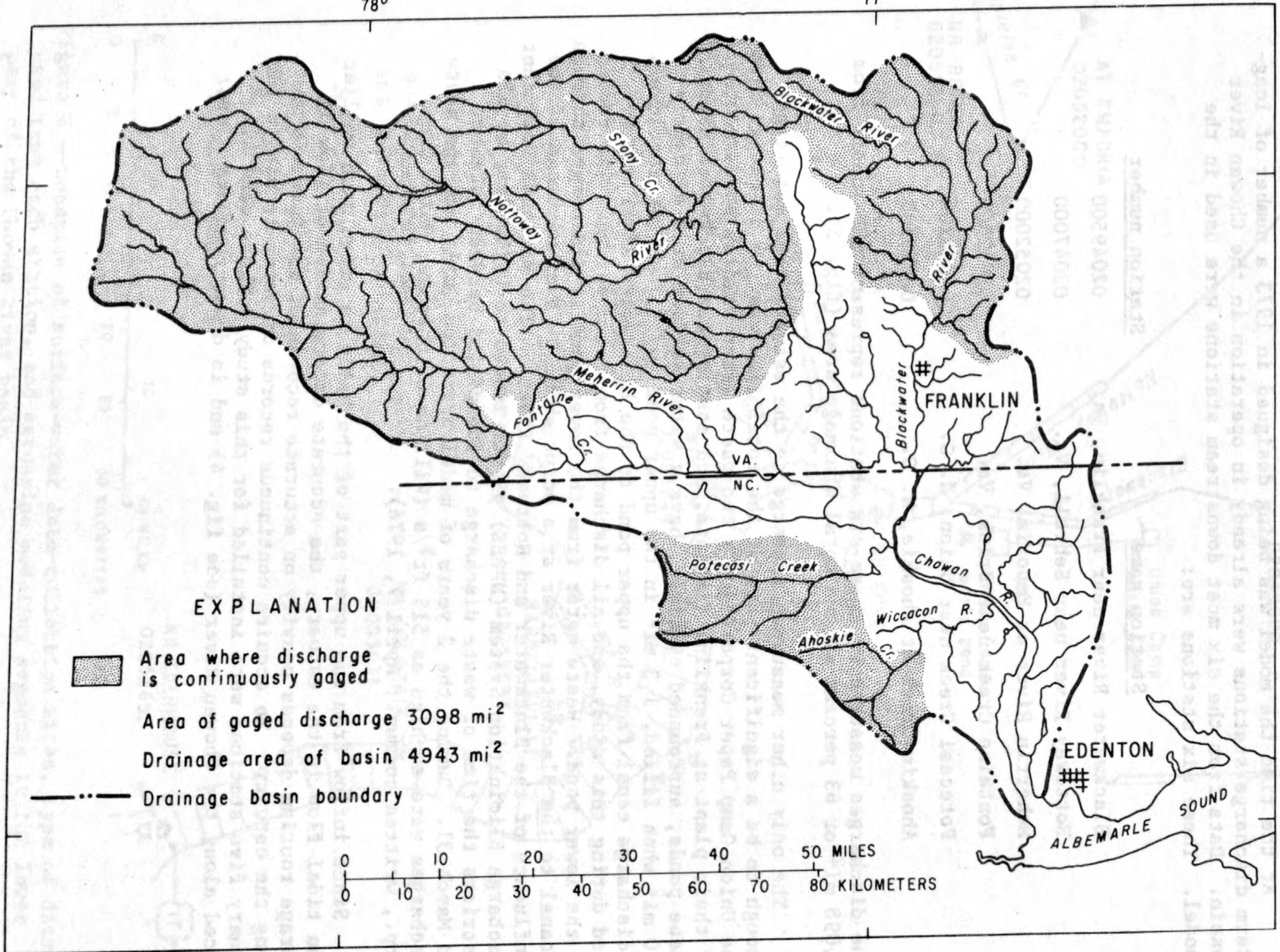

Figure 5.--The area of the Chowan River drainage basin that is continuously gaged.

Station name	Station number
Chowan River near Eure, N. C.	02050160
Chowan River at Winton, N. C.	02053244
Chowan River near Harrellsville, N. C.	02053573
Chowan River near Colerain, N. C.	02053633
Chowan River near Edenhouse, N. C.	02053652

Three of these stations, the upstream, the middle, and the downstream were equipped with graphic recorders as backup for the digital water-level recorders.

The five stations were referenced to mean sea level by the North Carolina Geodetic Survey. Levels were run twice as a check, benchmarks were established, and the stations were referenced to mean sea level from the base of 1927. The level lines were taken from second-order bench marks and surveyed using second-order methods. (Wilbur C. Fuller, N. C. Geodetic Surv., written commun., October 7, 1974). Accurate water-level elevations were critical for the calculation of the volume of water stored in the channel segments by the storage model.

Although not used directly in calculations by the flow model, water-level data from two other gages, one operated during a previous study (Jackson, 1968) and the other during a U.S. Army Corps of Engineers monitoring program, were used to define the mean annual water level and the long-term seasonal variation. This information was used to help establish boundary conditions in the stage-storage model. The station operated by the Corps of Engineers was on the U.S. Highway 17 bridge near Edenhouse, the site of one of the current stations, and provided continuous water-level data for the period November 1958 through July 1961. The other station, near Eure (Jackson, 1968), was operated from May 1966 to May 1968. This station was also reactivated for this study.

Water-temperature data were continuously recorded at three sites along the Chowan River, at the stations near Eure, Harrellsville, and Edenhouse (fig. 4). Water temperatures at or near the water surface were used in the evaporation model.

Daily records of meteorological data from fifteen stations were compiled from National Weather Service (NWS) publications. Daily rainfall reports were compiled for twelve stations--six in North Carolina and six in Virginia. One of these is the Class-A station at Norfolk, Va., which was also the source of other climatological data. Records of (1) wind speed (miles/day), (2) sunshine (percent of possible), (3) air temperature in °F (daily average of eight measurements), and (4) humidity were obtained for the Class-A stations at Norfolk, Va., Richmond, Va., Raleigh-Durham, N.C., and Cape Hatteras, N. C. These data were used in precipitation, evaporation, and evapotranspiration components of the model and will be discussed more thoroughly in later sections of the report.

THE MATHEMATICAL MODEL

Each of the terms of the continuity equation as expressed in equation (6) is calculated by component programs within the flow model. Data entered into the model are converted into rates of inflow, outflow, and change in storage for each of the 83 segments of the estuary. After first routing inflows downstream from the gaged part of the basin to the first estuarine segment in each stream, the flow model then uses the finite difference form of the continuity equation to route flows through the segments. The flow model ends at the U.S. Highway 17 bridge near Edenhouse, the location of the most downstream stage station. The drainage area at this point is 4,885 mi^2 versus 4,943 mi^2 at the mouth of the estuary.

A flow diagram outlining steps in the computer program that calculate the inflow, outflow, and change in storage terms is presented in figure 6. Each block in the diagram represents a calculation routine, and in several cases the output from one routine serves as input to another routine in a series of calculations that make up a component program. The first entry within each box in the diagram is the computer identification of the routine as used in the program. In addition, both the fixed parameters (those that do not change with time such as drainage areas and river miles) and variable-input data necessary to make a particular computation are given. In the bottom compartment of each block the method(s) of analysis is indicated. Reference to this diagram will aid in understanding the role of individual component programs that are discussed in more detail below.

Inflow

Runoff Model

The inflow to any channel segment includes (see fig. 6) the flow from the adjacent upstream channel segment, Q_{i-1}, precipitation, P_i, and lateral inflow, I_i, from the ungaged area apportioned to that segment. The runoff components of inflow, Q_{i-1} and I_i, are accounted for in several steps with the methods of accounting applied to the ungaged drainage associated with the major tributaries being somewhat different from the method applied to the ungaged drainage associated with the Chowan River.

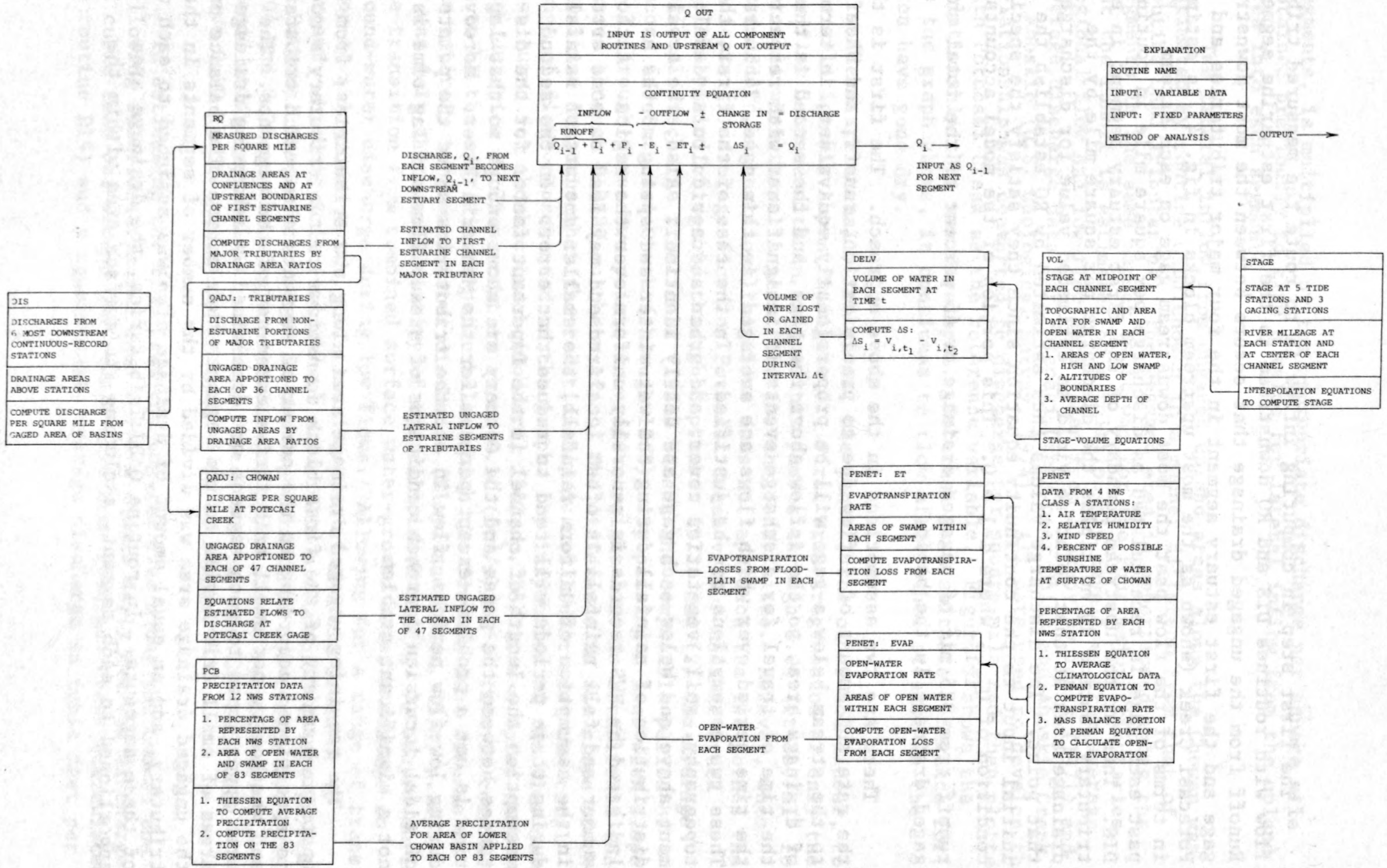

Figure 6.--Flow chart of the computational sequence in the Chowan River estuary flow model.

The first step in computing inflow is to route the measured tributary flow with routines DIS and RQ downstream to the first estuarine segment. Runoff from the ungaged drainage that occurs between the most downstream gage and the first estuary segment in the four major tributaries and Potecasi Creek (shown as the most upstream blocks in fig. 4) is estimated in terms of the flow past the most downstream gage on each stream. Flow past each gage is recalculated as discharge per square mile in routine DIS. Then at the upstream boundary of the first estuary segment in each tributary routine RQ multiples the discharge per square mile by the drainage area at that point to yield an estimated value for discharge at that point. The discharge values thus estimated by RQ establish the initial input to the continuity equation since they satisfy the specific condition of Q_{i-1}, where $i-1 = 0$. This portion of the model accounts for runoff from 825 mi^2 of ungaged drainage or 45 percent of the total ungaged drainage in the basin.

There are two assumptions in the above approach. The first is that the rate and amount of inflow due to precipitation, runoff, and baseflow to the stream below a gage will be proportionally equivalent, in terms of drainage area, to the inflow above the gage, and the second is that the time of travel for discharge events is insignificant with respect to the time period over which flows are averaged (in this case, 24 hours). These two assumptions can be justified. In the case of the first, the topography, soil, vegetation cover, and urban and agricultural development above and below each gage are nearly identical. Also, the areal distribution of rainfall during the wet winter and spring months as indicated by NWS records is generally uniform over the region. Although summer and fall rainfall is often localized and may lead to some error in the assumption of uniform rainfall, the smaller amounts of rainfall during these periods will tend to reduce that error. In the second assumption the length of channel is the important factor for the distances between the gages and the estuary are short enough so that lag time is not a problem--except perhaps for the Meherrin River. Moreover, during low-flow periods, flow in all the tributaries above the points of tidal incursion approach conditions of steady flow and lag time is not a significant problem.

The remaining ungaged drainage area along the tributaries, from the upstream boundary of the first block downstream to the tributary's mouth, is apportioned according to the number of segments along each tributary and whether or not small tributaries enter any of the segments. The area apportioned to each segment was determined by assigning drainage areas of small tributaries to the segments they enter. The balance of the ungaged drainage area was divided by the number of segments in the tributary, and an equal amount of drainage area was assigned to each one of those segments. In routine QADJ:Tributaries, the drainage area apportioned to each segment, excluding the surface area within the segments, is multiplied by the appropriate discharge per square mile obtained previously to give a value for lateral inflow from the upland area into each segment.

The lateral inflow from ungaged upland areas along the Chowan was estimated by routine QADJ:Chowan in a manner different from that of routine QADJ:Tributaries. The ungaged area is apportioned among the segments in the same manner as it was for the four major tributaries, but the runoff is estimated by a relationship developed from average regional flow and low-flow data taken from a study by Yonts (1971) and average discharge data for Potecasi Creek near Union and Ahoskie Creek at Ahoskie (U.S. Geological Survey, 1974). All data used to develop the relationship was converted to discharge per square mile and then plotted with Potecasi Creek as the reference variable. Figure 7 shows the relationship that was developed. Potecasi is a suitable reference for, as the graph shows, it continues to flow after other streams in the area have gone dry.

There are actually two parts, one linear, the other non-linear, to the relationship shown in figure 7. First order regression of only the low-flow data results in a line that passes through 0.04 $(ft^3/s)/mi^2$ for Potecasi when there is zero flow for the other sites. However, when extended to higher flows this line does not approach the two points that indicate (1) average flow for Potecasi Creek versus Ahoskie Creek for the period of record through September 1973, and (2) the average regional discharge from Yonts (1971) versus the comparable period of record for Potecasi Creek (through 1968). By passing a line with slope of 1 through these two points a second straight line is established that passes through 0.0885 on the x axis. The difference in the slope of the two lines suggests that the relationship is not linear over the total range of flows represented on the graph. By inspection of the flow duration curve for Ahoskie Creek (Goddard, 1963, p. 78) it was noted that the flow duration at 70 percent is about 0.10 $(ft^3/s)/mi^2$. This is considered to be the approximate point below which the flow in most streams is due entirely to ground-water discharge (Floyd and Peace, 1974, p. 6). It was felt that non-linearity of the relationship (fig. 7) occurs during the transition from combined surface water-ground water discharge to ground-water discharge during low flows. Allowing for a range of transition to all ground water, the flow duration of Ahoskie Creek at 68 percent, which is 0.11 $(ft^3/s)/mi^2$ and equals a flow of 0.20 $(ft^3/s)/mi^2$ on Potecasi Creek, was chosen as the upper limit of non-linearity. With 0.04 and 0.20 on the x axis as lower and upper limits respectively, a second order (parabolic) curve was fitted through the low-flow data. Above 0.20 the relationship is assumed to be linear.

In estimating the flow from the ungaged area along the Chowan the following relationships are used where x equals daily average discharge in cubic feet per second per square mile from Potecasi Creek (calculated in routine DIS) and y equals daily average discharge in cubic feet per

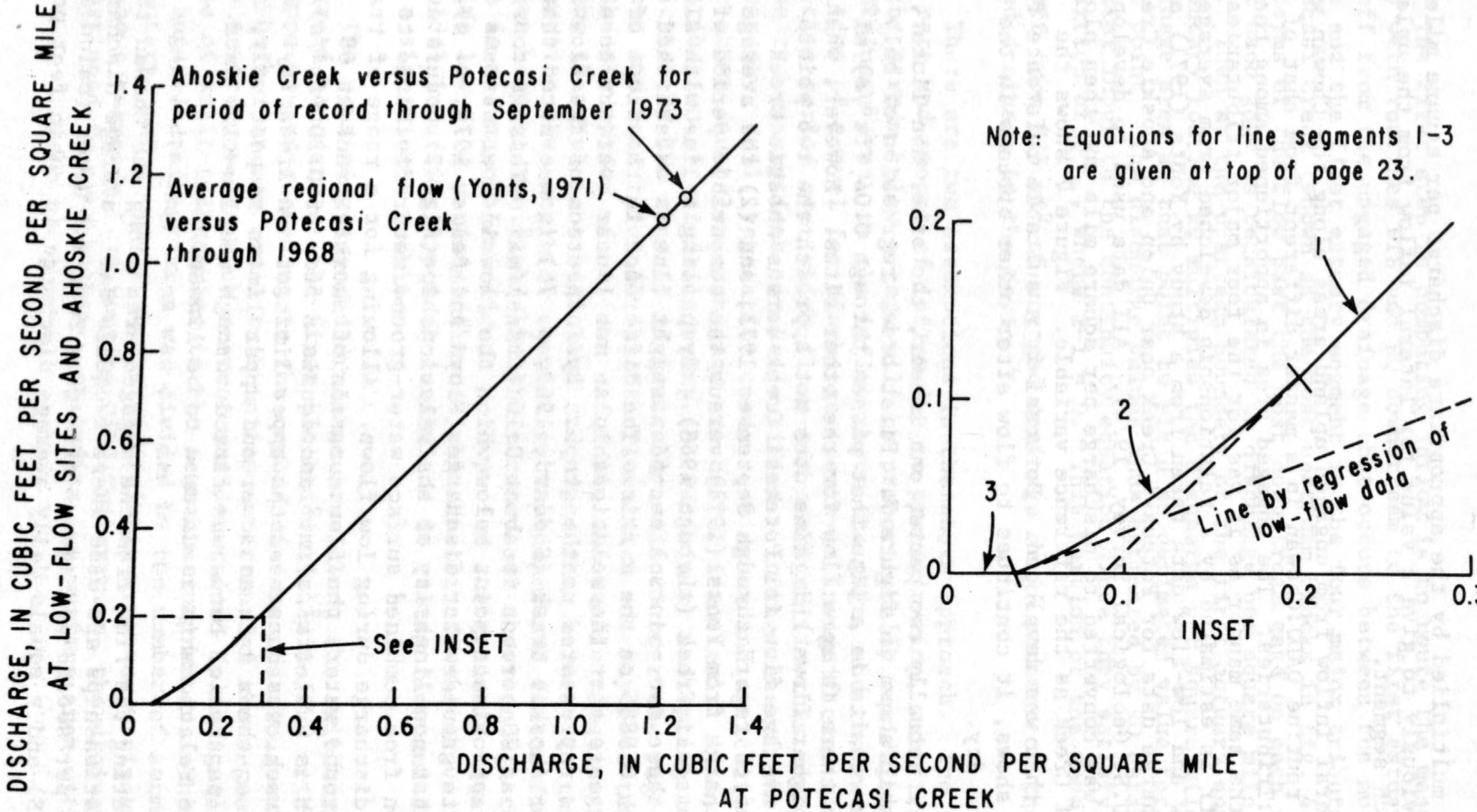

Figure 7.--Relations for estimating runoff from ungaged uplands bordering the Chowan River estuary and flood plain.

second per square mile from ungaged area:

1. if $x \geq 0.20$ then $y = x - 0.0885$

2. if $0.04 \leq x < 0.20$ then $y = -0.0156 + 0.3385x + 1.5107x^2$

3. if $x < .04$ then $y = 0$

Once y, the estimated discharge per square mile, is determined it is multiplied times the area apportioned to each segment along the Chowan to yield the estimated lateral inflow from the ungaged upland.

The inflow from the flood plain within the 83 segments is determined in the same manner for all blocks. The inflow from these flood-plain swamps is calculated as the residual of a water budget based on precipitation and evapotranspiration. The calculation of inflow from the flood plain is treated differently from the upland areas because the hydrologic conditions in the two areas are quite different. In the swamps the altitude ranges from less than 1.0 ft to about 5 ft above mean sea level. In those areas not actually flooded the water table always remains near land surface, even during dry periods. When flows in upland streams decline, the swamps remain damp with water from the estuary. In these swampy areas evapotranspiration probably remains at or near potential at all times (Schulz, 1973, p. 211), with the swamps becoming a water sink during dry spells. Thus the swamps actually serve to remove water from the river when evapotranspiration is greater than precipitation.

Rainfall Model

The precipitation component, P_1, is accounted for by the rainfall model which distributes rainfall only to the surface area within the 83 segments that constitute the estuarine portion of the drainage system. Rainfall on the remainder of the ungaged drainage area is accounted for in the major tributary routing, RQ, and lateral inflow, QADJ, routines, both of which are based on gaged runoff.

Runoff from the flood plain within the 83 segments is considered independently of the simulated upland runoff primarily because of differences in the hydrology of the two areas. Numerous stream channels on the flood plain rapidly transmit changes in water levels from the river to the swamps and carry runoff back to the river. Even when not actually flooded, the water table in the swamps is almost always near land surface and there is little available storage capacity for new inputs of water from precipitation. Most of the swampy land along the Chowan River is perhaps not due to poor or confined drainage so much as to the periodic wetting that maintains a high water table. Because of the high water table, large flooded areas, and many stream channels, precipitation falling on the flood plain is incorporated into river flow very rapidly.

Another important factor that was considered in the decision to develop a rainfall model was the large open-water area in the estuary that would receive precipitation directly. With a surface area of about 45 mi^2, precipitation of only 0.1 in/day would contribute 120 (ft^3/s)/day to discharge past Edenhouse. In the non-estuarine areas of the basin where the river channels are much narrower, the amount of rain falling directly on the open water surface is insignificant by comparison.

The rainfall model uses a modified form of the Thiessen polygon method (Johnstone and Cross, 1949, p. 45) to average rainfall for an area of northeastern North Carolina and southeastern Virginia that includes the lower Chowan River basin (fig. 8). Because only a few stations are within the basin boundary in the southern part of the basin and none are in the areas of swamps or open water, additional stations in the immediate vicinity of the basin were selected for incorporation into the model so that a regionally representative value could be obtained. The Thiessen method is favored over the arithmetic mean because it has the theoretical advantage of making allowance for irregularities in gage spacing by weighting the value from each gage in proportion to the area which that gage is assumed to represent.

The model uses data from twelve National Weather Service rainfall stations (see fig. 8), six in North Carolina and six in Virginia, and computes a regional daily average value (PCB), in computer routine PCB, according to the equation:

$$\begin{aligned} PCB = \; & 0.1486\ PEN + 0.1026\ PEY + 0.0314\ PJN + 0.0667\ PLN \\ & + 0.1105\ PMO + 0.0138\ PPH + 0.0956\ PBS + 0.1239\ PHD \\ & + 0.0498\ PNK + 0.0414\ PSK + 0.1483\ PSY + 0.0675\ PWD \end{aligned}$$

The modified method generates a weighted average for the area within the large polygon which includes the lower Chowan River basin to which the value of PCB is applied. The rainfall per day in inches is converted to cubic feet per second per day for the areas of swamp and open water within each of the 83 segments.

Outflow

Evaporation and Evapotranspiration Models

Loss of water from each segment due to evaporation from the open-water surface and evapotranspiration from the adjacent swampland is estimated by subroutines, PENET, PENET:EVAP, and PENET:ET, (fig. 6), based on the Penman method (Criddle, 1958). The Penman method is one of the so-called complex methods (Schulz, 1973, table 52, p. 214) that requires as input a variety of climatological data including mean daily

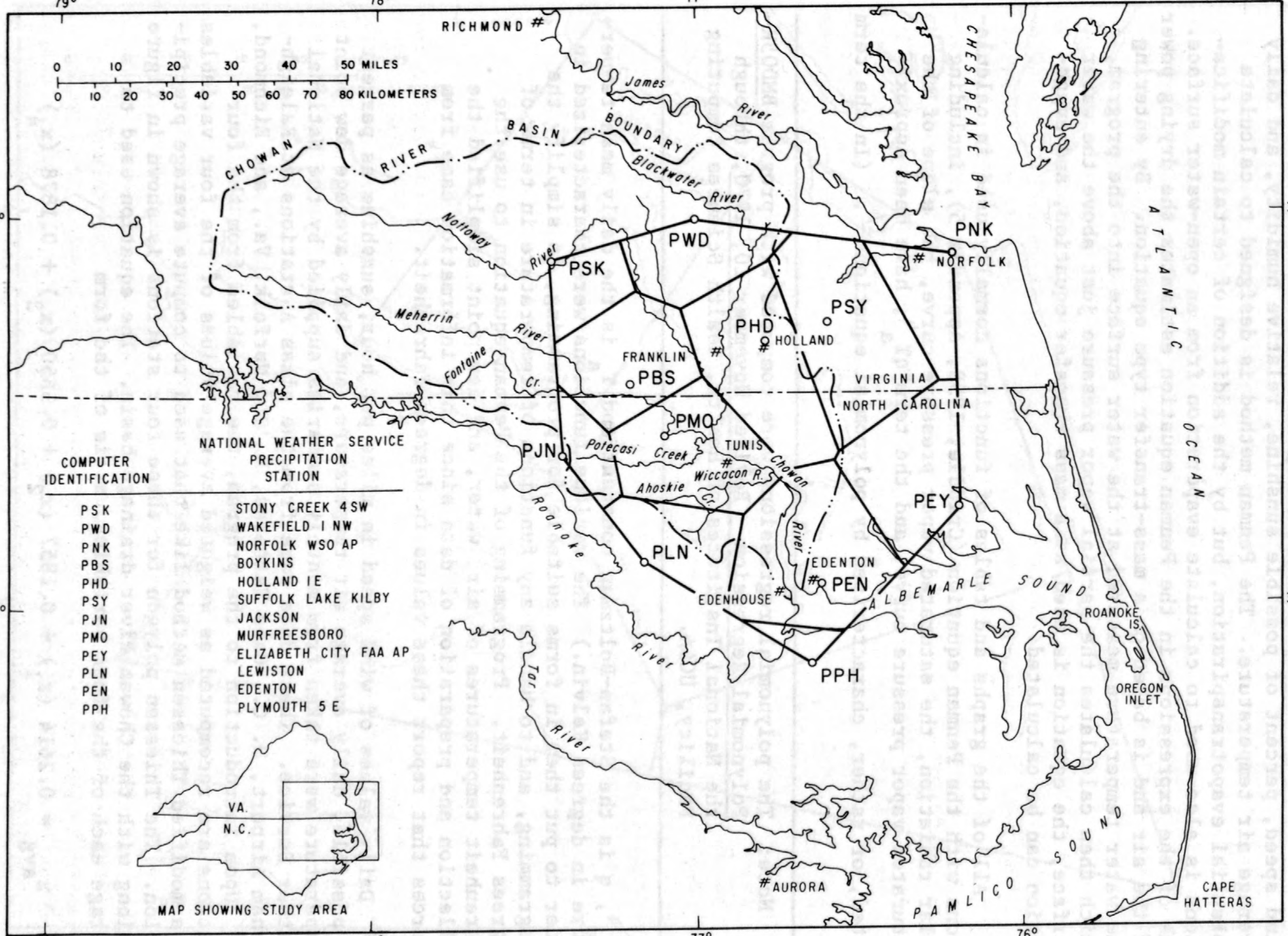

Figure 8.--Modified Thiessen polygon used in calculation of weighted average rainfall for the area that includes the lower part of the Chowan River basin.

wind speed, percent of possible sunshine, relative humidity, and daily average air temperature. The Penman method is designed to calculate potential evapotranspiration, but by the addition of certain modifications is also used to calculate evaporation from an open-water surface. One of the expressions in the Penman equation estimates the drying power of the air and is based on a mass-transfer type equation. By entering the water temperature measured at the water surface into the program, which then calculates the partial vapor pressure just above the water surface, the equation is used as a mass transfer equation, and evaporation can be calculated.

All of the graphs and tables of functions normally used in calculations with the Penman equation (Criddle, 1958, Appendix 5), including solar radiation, the saturated vapor pressure curve, the slope of the saturated vapor pressure curve, and the term qT_a^4, have been approximated, or rather, characterized by polynomial equations[1/]. (In the term

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1/ Note: The polynomial regressions were computed with program BMD05R-Polynomial Regression - Revised November 10, 1970, through the National Institutes of Health, Health Sciences Computing Facility, UCLA.

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qT_a^4, q is the Stefan-Boltzman constant and T_a is the daily mean temperature in degrees Kelvin.) The various functions were characterized in order to put them in forms suitable for programming, to simplify the programming, and to handle any functions of temperature in terms of degrees Fahrenheit. Programming of the Penman equation to use the Fahrenheit temperatures of air, water, and dew point simplified the collection and preparation of data since this information came from sources that report these values in degrees Fahrenheit.

Daily values of wind speed in miles per hour, sunshine as percent of possible, daily average air temperature, and daily average dew point temperature were taken from monthly summaries supplied by the National Weather Service. These data came from the class A stations at Raleigh-Durham Airport, N. C., Cape Hatteras, N. C., Norfolk, Va., and Richmond, Va. Upon introduction to the program, the variables from the four stations are recomputed as weighted average values of the four variables by a modified Thiessen method like that used to compute average precipitation. The Thiessen polygon for these four stations is shown in figure 9 along with the Chowan River drainage basin. The equation used to average each of the four variables, x, is of the form

$$x_{avg} = 0.2614\ (x_1) + 0.1857\ (x_2) + 0.3650\ (x_3) + 0.1878\ (x_4)$$

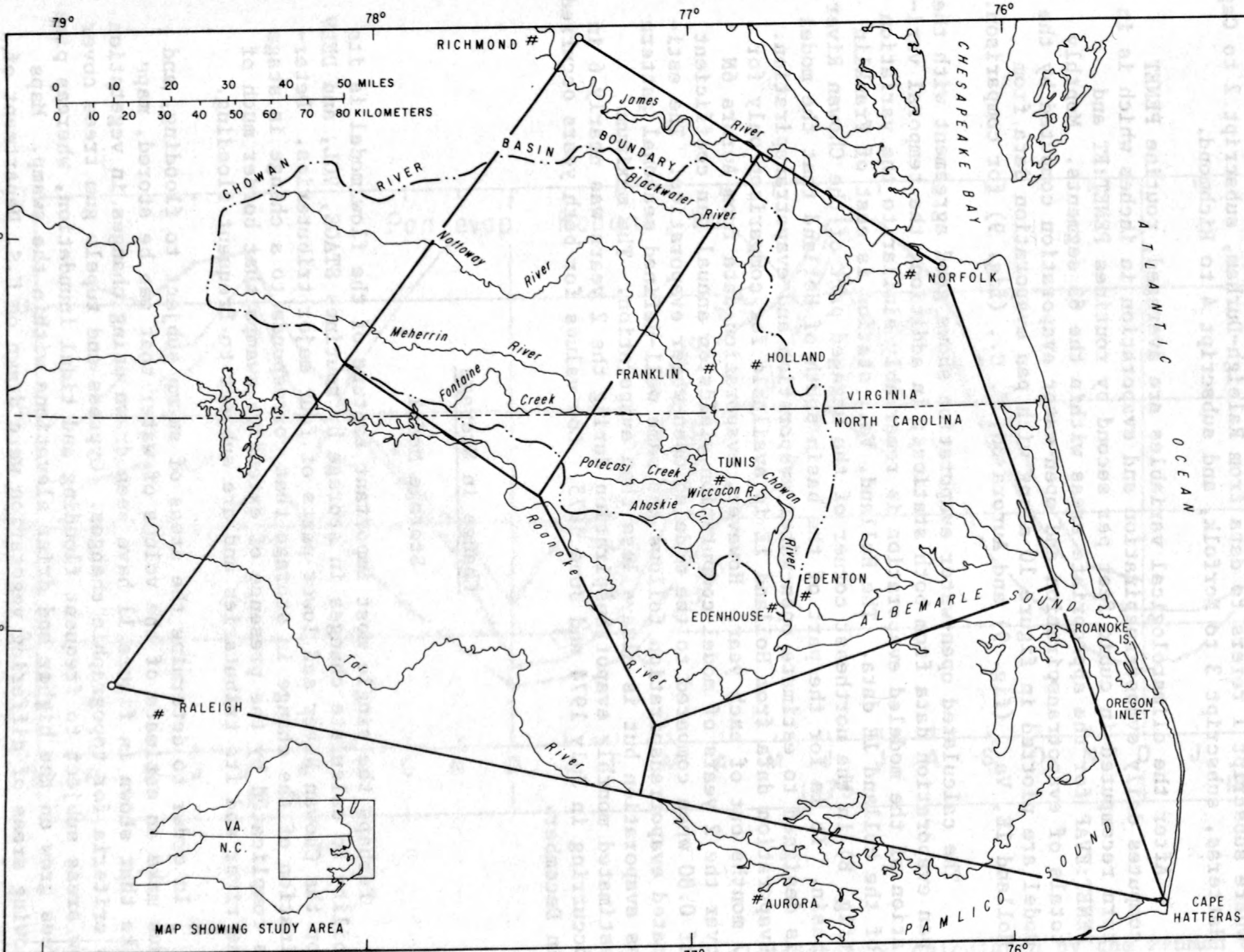


Figure 9.--Modified Thiessen polygon for averaging climatological data from Raleigh-Durham, Cape Hatteras, Norfolk, and Richmond.

where subscript 1 refers to data from Raleigh-Durham, subscript 2 to Cape Hatteras, subscript 3 to Norfolk, and subscript 4 to Richmond.

After the climatological variables are averaged, routine PENET computes daily evapotranspiration and evaporation in inches which is in turn recomputed in cubic feet per second by routines PENET:ET and PENET:EVAP for the appropriate areas within the 83 segments. Monthly totals of evapotranspiration and open-water evaporation computed by the model are plotted in figure 10 along with pan evaporation data from Holland 1E, Va., (fig. 9) and Aurora 6N, N. C., (fig. 9) for comparison.

The calculated open-water evaporation shows good agreement with the pan evaporation data from both stations; in addition, the temporal variation of the modeled evaporation is remarkably similar to the variation of the Holland 1E data. The Holland, Va., station is east of Franklin (fig. 8) in the northeast corner of the ungaged part of the Chowan River basin. It is for the part of the basin south of Holland that the model is designed to estimate open-water evaporation and evapotranspiration. Evaporation data from Holland 1E is available for comparison only for 7 months out of each year. However, evaporation data from Aurora 6N over the 2 years of model computation yields an annual pan coefficient of 0.80 when compared to the modeled open-water evaporation. The estimated evapotranspiration follows the same well-defined seasonal pattern as evaporation but is always less than evaporation. The maximum estimated monthly evapotranspiration during the 2 years was nearly 6 in occurring in July 1974 and June 1975. Low values for both years occurred in December.

Change in Storage

Storage Model

Perhaps the single most important feature of the flow model is its ability to calculate changes in storage by routines STAGE, VOL, and DELV for the Chowan River and lower parts of four major tributaries. Determination of the change in storage that corresponds to a change in stage is complicated by the presence of extensive swamps that border much of the river and its tributaries and are subject to frequent flooding.

In order to determine the areas of swamp subject to flooding, and thus make an estimate of the volume of water that can be stored, maps like that shown in figure 11 have been drawn using changes in vegetation as criteria for topographic changes. Cypress and tupelo gum trees cover low areas subject to frequent flooding and tidal inundation, whereas pine trees grow on the higher and drier elevations within the swamp. Maps showing areas of differing vegetation were drawn on U.S. Department of

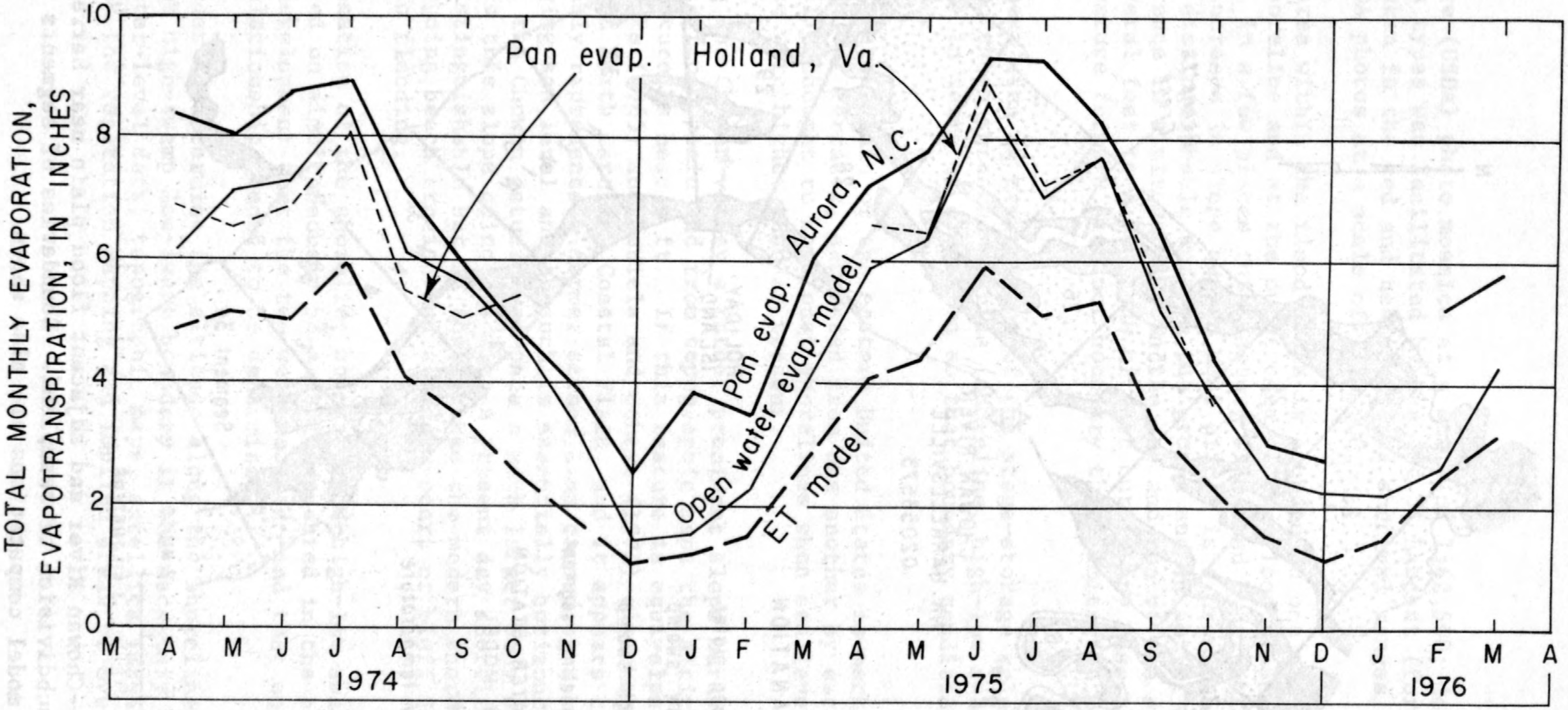


Figure 10.--Monthly total evapotranspiration and open-water evaporation calculated by the Penman method compared to monthly total pan evaporation at Holland, Virginia, and Aurora, North Carolina.

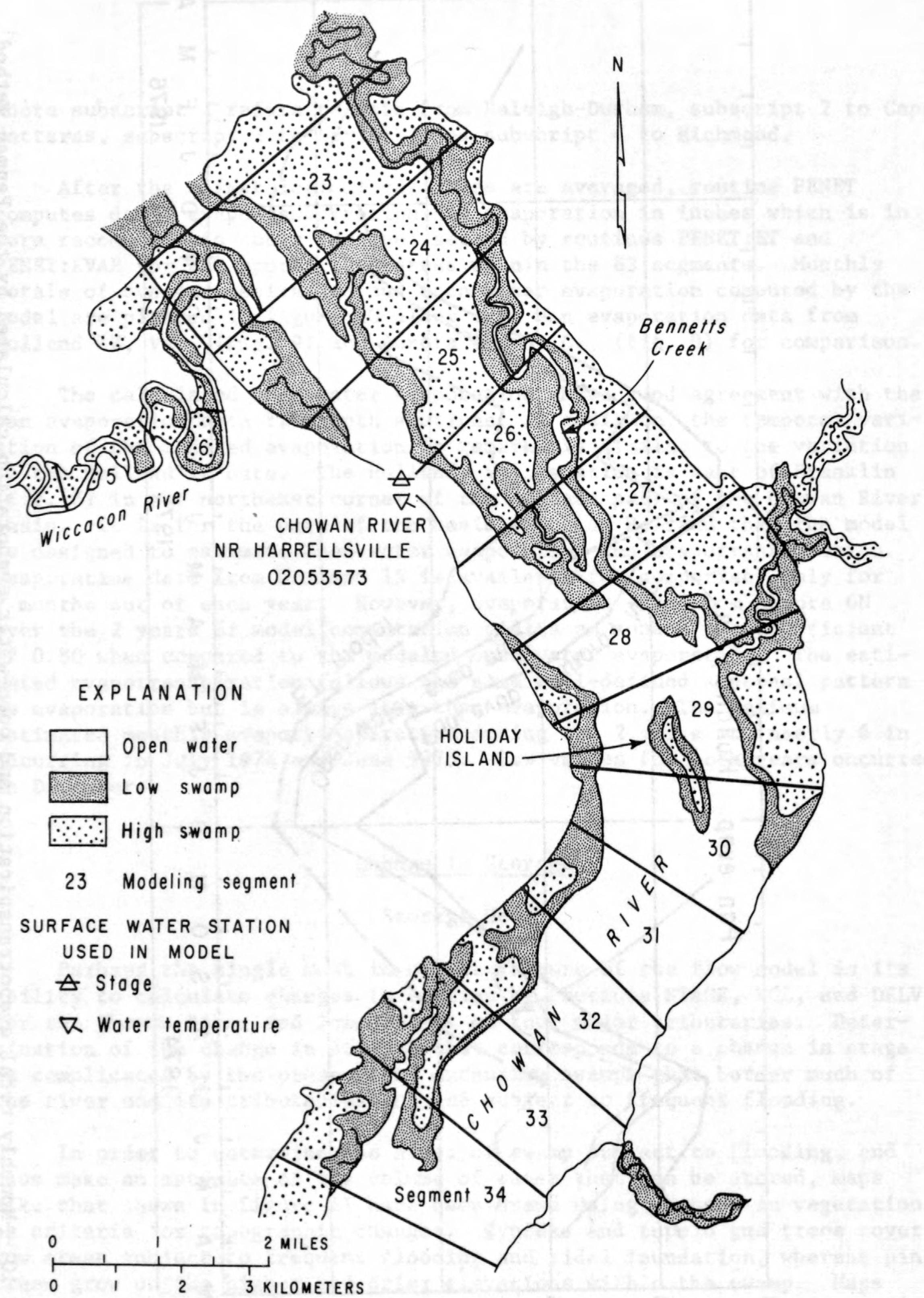


Figure 11.--Chowan River and adjacent flood plain near Harrellsville showing subdivision of swampland. Boundaries of segments used in the flow model computations are also shown.

Agriculture (USDA) photo mosaics at a scale of 1:62,500; delineation of vegetation types was facilitated by the use of Landsat (formerly ERTS) imagery taken in the red and near-infrared spectral ranges (bands 5 and 7) and USDA photos at a scale of 1:20,000.

The area within the flood plain is bounded on one side by the channel shoreline and at the outer edge of the flood plain by a low scarp or bluff. In a few places this feature is marked by a gentle rise with a slight increase in slope but in most places is a prominent feature that is easily distinguishable both on the ground and in aerial photography. The difference in altitude between the toe and top of the scarp or bluff may be several feet to a few tens of feet but in any case this topographic feature forms a distinct boundary that limits the extent of flooding.

The next step in preparation of the stage-storage relationships was to evaluate these three boundaries (shoreline, high-low swamp, toe of escarpment) in terms of elevation so that boundary conditions could be established.

The Coastal Plain of the eastern United States is marked by a series of surfaces, or terraces, separated from one another by escarpments that are generally thought to mark past shorelines when sea levels during the Pleistocene were higher than at present.

Along the Chowan valley a rather prominent slope marks the outer edge of the flood plain and from topographic maps the altitude of the toe of this feature is near 5 ft. If this feature is equivalent to those noted by Oaks (1965) and Daniels and others (1972) elsewhere on the Virginia and North Carolina Coastal Plain, and it appears to be, then this probably represents a former strand line caused by a temporary pause in a changing sea level and as such is essentially horizontal. This also means that the Chowan estuary was once a much larger body of water. In some places this slope coincides with a present day shoreline and the two are not distinguishable but in these cases the modern shoreline is usually undergoing beach erosion and a modern scarp or bluff forms the boundary to flooding.

Delineation of the shoreline boundary and high-low swamp boundary were carried on simultaneously because it appeared in the early stages of model development that the two were related--and that only the nature of this relationship needed to be determined.

In order to determine the altitude along the shoreline-swamp boundary and the high-swamp low-swamp boundary it was necessary to obtain and analyze water-level data, topographic maps, satellite imagery and finally field check the vegetation mapping and implied areas of over-bank flooding.

Analysis of water-level data from an earlier study on the Chowan (Jackson, 1968) and records kept by the U.S. Army Corps of Engineers provided insight into the long-term as well as short-term behavior of water levels in the river and helped define the long-term average gradient of the river's surface. Monthly average stage was computed from the data collected by Jackson and the Corps of Engineers and is plotted in figures 12A and 12B. The plots demonstrate a cyclic annual pattern which can be approximated by the sine curves fitted through the scattered points. An interesting feature of the two plots, representing data collected over different periods at opposite ends of the estuary, is the repeated occurrence of high water levels in the summer and low water levels in the winter. This is nearly the exact opposite of the rainfall pattern during the year which produces high water levels in upland streams during late winter and early spring and low levels during summer and fall. This pattern is best explained by the seasonal pattern of the prevailing winds. Monthly average wind data collected at Cape Hatteras from May 1966 through May 1968 is plotted in figure 12A for comparison with monthly average stages from the station Chowan River near Eure. Winds during the fall and winter are generally out of the north and northwest and result in lower water levels than in the summer when the wind direction is more variable but generally out of the south and southwest. Similar patterns have been identified in water-level data collected during the present study. The seasonal range in all the water-level data thus examined averages approximately 0.8 ft at both ends of the Chowan River.

There is one other cyclic pattern in the fluctuation of stage that ensures the wetting of adjacent swampland on a regular basis. This is the daily cycle of rising and falling lunar tides that is superimposed on the seasonal cycle. (See fig. 12C.) The range in lunar tide varies between 0.5 and 0.8 ft on a monthly basis in response to the monthly cycle of the moon. However, for purposes of identifying the altitude of the low swamp-high swamp boundary a daily tide range of 0.8 ft is used. If it can be assumed that the low swamp-high swamp boundary represents the upper limit to which the swamp is flooded on a regular basis due to cyclic fluctuations in stage, then the boundary is approximately 0.8 ft above the mean annual water level along the length of the Chowan. In the tributaries the amount of tidal fluctuation decreases due to friction and wave interference patterns and finally disappears.

A simple sketch will demonstrate the relationships that have been discussed above. Figure 13 is a diagrammatic longitudinal section of the estuary and illustrates the relationships of the major boundaries used in the stage-storage formulas. On the basis of these relationships it was concluded that the open-water low-swamp boundary (z_1) would be set at the mean annual water level; the low-swamp high-swamp boundary (z_2) would be set 0.8 ft above the mean annual water level. Once the

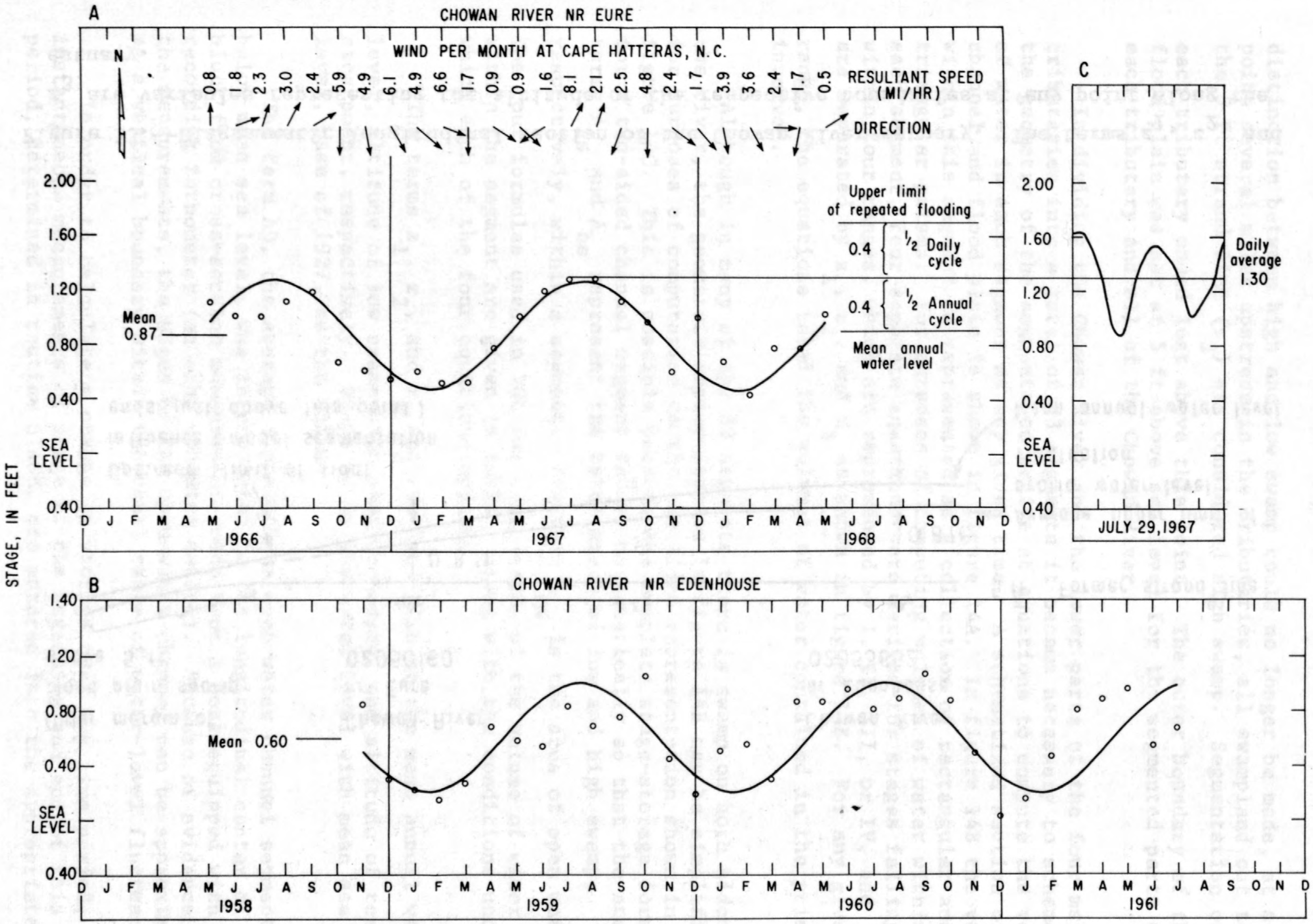


Figure 12 A-B.--Monthly average stages for the two stations Chowan River near Eure and Chowan River near Edenhouse. The solid lines are sine curve approximations of the annual cycle of water levels.

12 C.--Continuous stage record from Chowan River near Eure on July 29,1967.

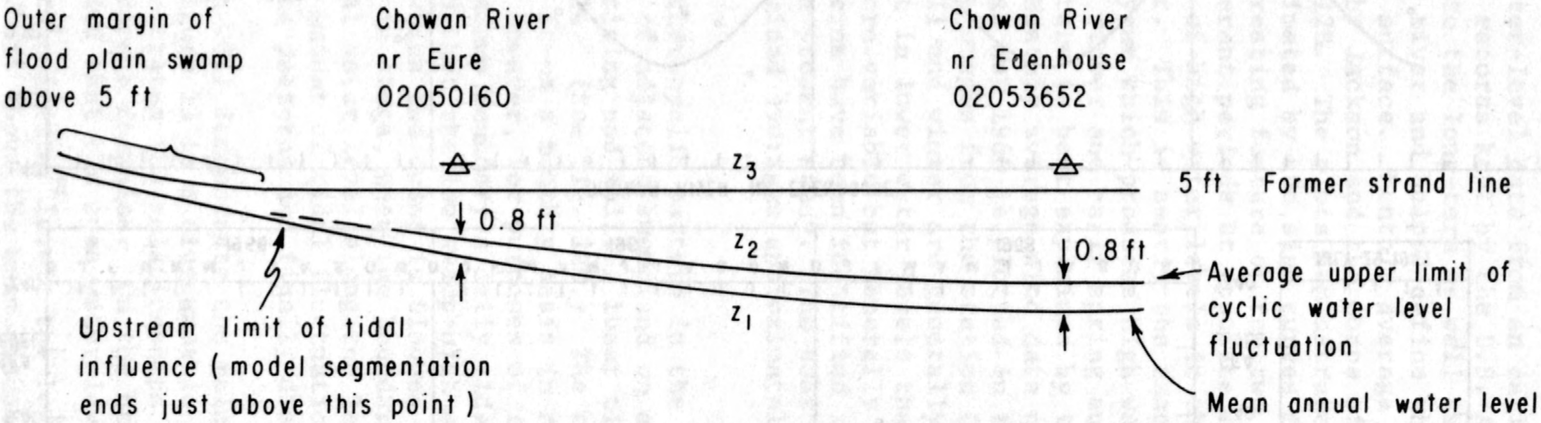


Figure 13.--Diagrammatic longitudinal section of the Chowan River estuary. The terms z_1, z_2, and z_3 are variables representing the altitude of the respective boundaries at any point along the estuary.

distinction between high and low swamp could no longer be made, at a point several miles upstream in the tributaries, all swampland out to the 5 ft strand line (z_3) was considered high swamp. Segmentation of each tributary ended just above this point. The outer boundary of the flood plain was set at 5 ft above sea level for the segmented parts of each tributary and all of the Chowan River.

In dividing the Chowan River and the lower parts of the four major tributaries into a total of 83 segments it became necessary to schematize the geometry of the segments to arrive at equations to compute the volume of water in each segment at any given time. A schematized section of channel and flood plain is shown in figure 14A. In figure 14B the volume within this segment is represented as a collection of rectangular and triangular prisms. For purposes of computing volumes of water within each segment, four separate equations were derived for stages falling within four ranges, which are represented by I, II, III, or IV, and are separated by z_1, z_2, and z_3 as shown in figure 14B. For any given range, the equations total the volumes of water contained in the prisms involved.

Although in many of the 83 segments there is swamp on both sides of the river, the geometric representation in figure 14B can be simplified for purposes of computation to the one-sided representation shown in figure 14C. This is possible because the complete stage-storage formulas for a two-sided channel segment reduce mathematically so that the area terms A_{ls} and A_{hs} represent the total areas of low and high swamp, respectively, within a segment. The term A_{ow} is the area of open water. The four formulas used in VOL for calculation of the volume of water within the segment are given in table 1 along with the conditions under which each of the four equations applies.

The terms z_1, z_2, and z_3 are the altitudes of the mean annual water level, altitude of low swamp-high swamp boundary, and altitude of toe of escarpment, respectively. Stage H, is the water level with mean sea level, base of 1927, as the datum.

The term AD, the average depth of the open-water channel segment below mean sea level, was interpolated to the longitudinal center of each block from cross-section measurements made from a boat equipped with a recording fathometer (an echo sounding device). Because of evidence from the measurements, the edges of the open-water channel can be approximated as a vertical boundary within the usual range of water-level fluctuation.

In order to calculate a change in storage over any time period, instantaneous measurements of stage at the beginning and end of this period, determined in routine STAGE, are entered into the appropriate

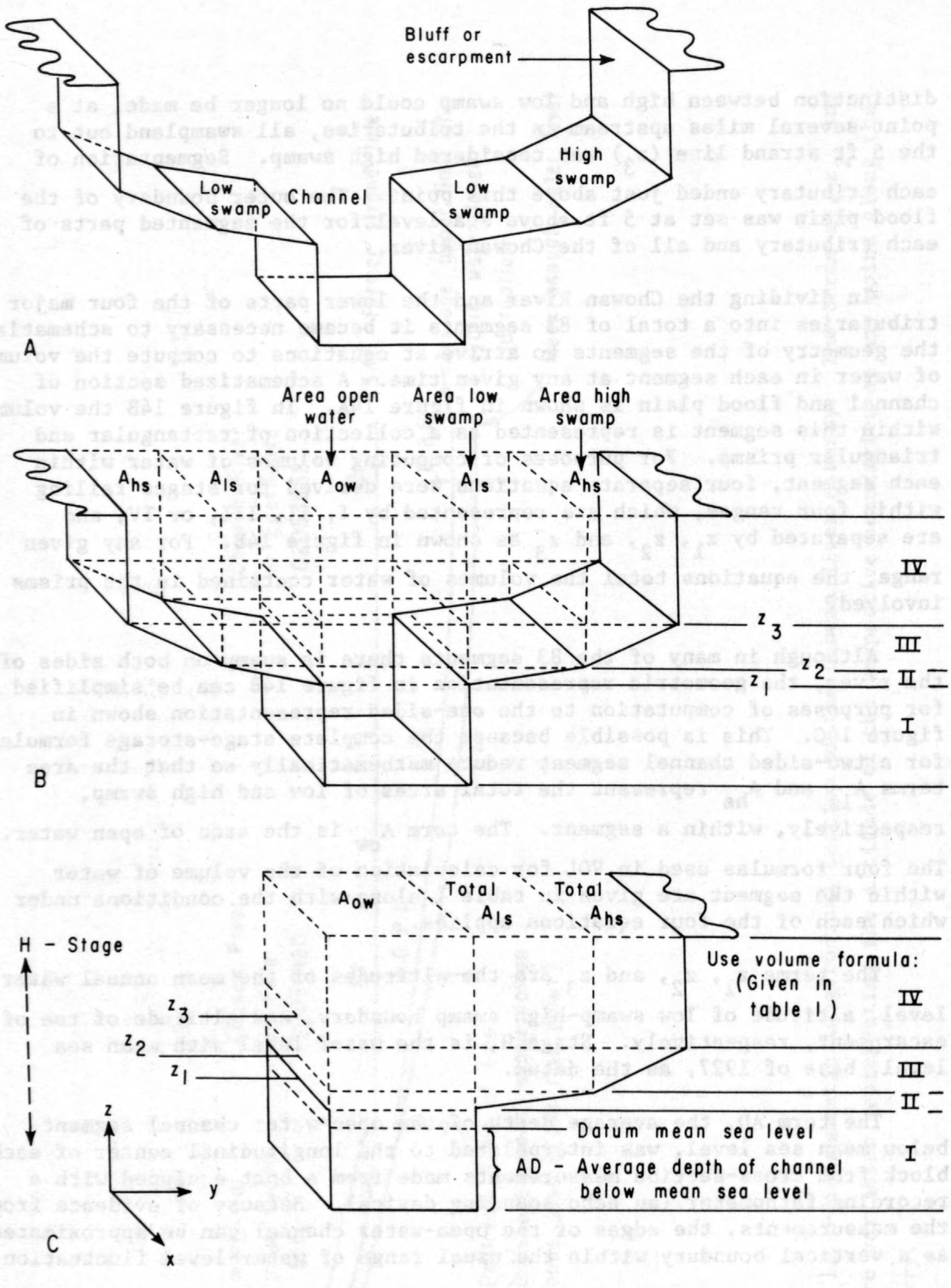


Figure 14 A-C.--Schematized channel segment showing, in A, the major physical features within the segment and, in B, the subdivision of the volume within the segment into rectangular and triangular prisms. Figure C is a simplification of B showing the parameters utilized in calculation of the volume of water within the section.

Table 1.--Formulas for calculating volume (V) of water within any of the 83 channel segments

I. If the stage, H, is at an altitude such that $H \leq z_1$ then:

$$V = (AD + H)A_{ow}$$

II. If the stage, H, is at an altitude such that $z_1 < H \leq z_2$ then:

$$V = (AD + H)A_{ow} + 0.5(H - z_1)\,[(H - z_1)/(z_2 - z_1)]A_{1s}$$

III. If the stage, H, is at an altitude such that $z_2 < H \leq z_3$ then:

$$V = (AD + H)A_{ow} + 0.5(z_2 - z_1)A_{1s} + (H - z_2)A_{1s} + 0.5(H - z_2)\,[(H - z_2)/(z_3 - z_2)]A_{hs}$$

IV. If the stage, H, is at an altitude such that $H > z_3$ then:

$$V = (AD + H)A_{ow} + 0.5(z_2 - z_1)A_{1s} + (H - z_2)A_{1s} + 0.5(z_3 - z_2)A_{hs} + (H - z_3)A_{hs}$$

Note in figure 14C that AD + H = h in the notation used in figure 3.

equation; two volumes are calculated in routine VOL, and then the ending volume is subtracted from the beginning volume in routine DELV. A positive ΔS means water has flowed out of the segment during the given time interval. A negative ΔS means that water has been stored. The Chowan model is usually set up to calculate daily average flows; therefore, only measurements of stage at 2400 hours (midnight) are entered into the change-in-storage calculations. During testing of the model, however, calculation of hourly flows over several short periods (up to 2 weeks in length) became desirable and the program was modified. Hourly measurements of stage were entered into the modified program.

FLOW CHARACTERISTICS OF THE ESTUARY

During the 2 years of record synthesized by model operation the average discharge past Edenhouse was 5,834 ft^3/s. Daily average discharges during this period ranged between a maximum of 55,900 ft^3/s on July 17, 1975 and a minimum of -14,200 ft^3/s on November 30, 1974.

In figure 15 A-E, values of monthly average discharge as well as monthly maximum and minimum daily average discharge have been plotted for each of the five stations on the Chowan River. Comparison of the five diagrams reveals that the range of maximum and minimum flows increases in the downstream direction, as might be anticipated due to the widening of the estuary and the increasing influence of wind and lunar tides in its lower reaches. At the same time, the monthly average discharges past the four downstream stations are remarkably similar. The difference between the flow past Chowan River near Eure, and the other four stations is attributed to the inflow from the Meherrin River which joins the Chowan 2.5 mi upstream from Winton. With a drainage area of 1,616 mi^2 the Meherrin River represents 33 percent of the total Chowan basin and is equivalent to 63 percent of the area of Chowan River near Eure. (See fig. 4.) Thus a sizable increase in average discharge below the mouth of the Meherrin is to be expected. No other tributary of comparable size enters the Chowan below Winton, and only the Wiccacon River, with a drainage area of 271 mi^2, is of any consequence. The Wiccacon River flows into the Chowan from a southwesterly direction near Harrellsville, at a point about 2 mi upstream from the Harrellsville station. Inspection of figures 15B and 15C however, does not indicate an appreciable increase in the monthly averages at Harrellsville over those at Winton. In fact, in some months the averages at Winton are slightly higher than those at Harrellsville. This may be due either to loss of water by evaporation during dry months or the effects of tides near the beginning and end of the computation interval--in this instance 1 month.

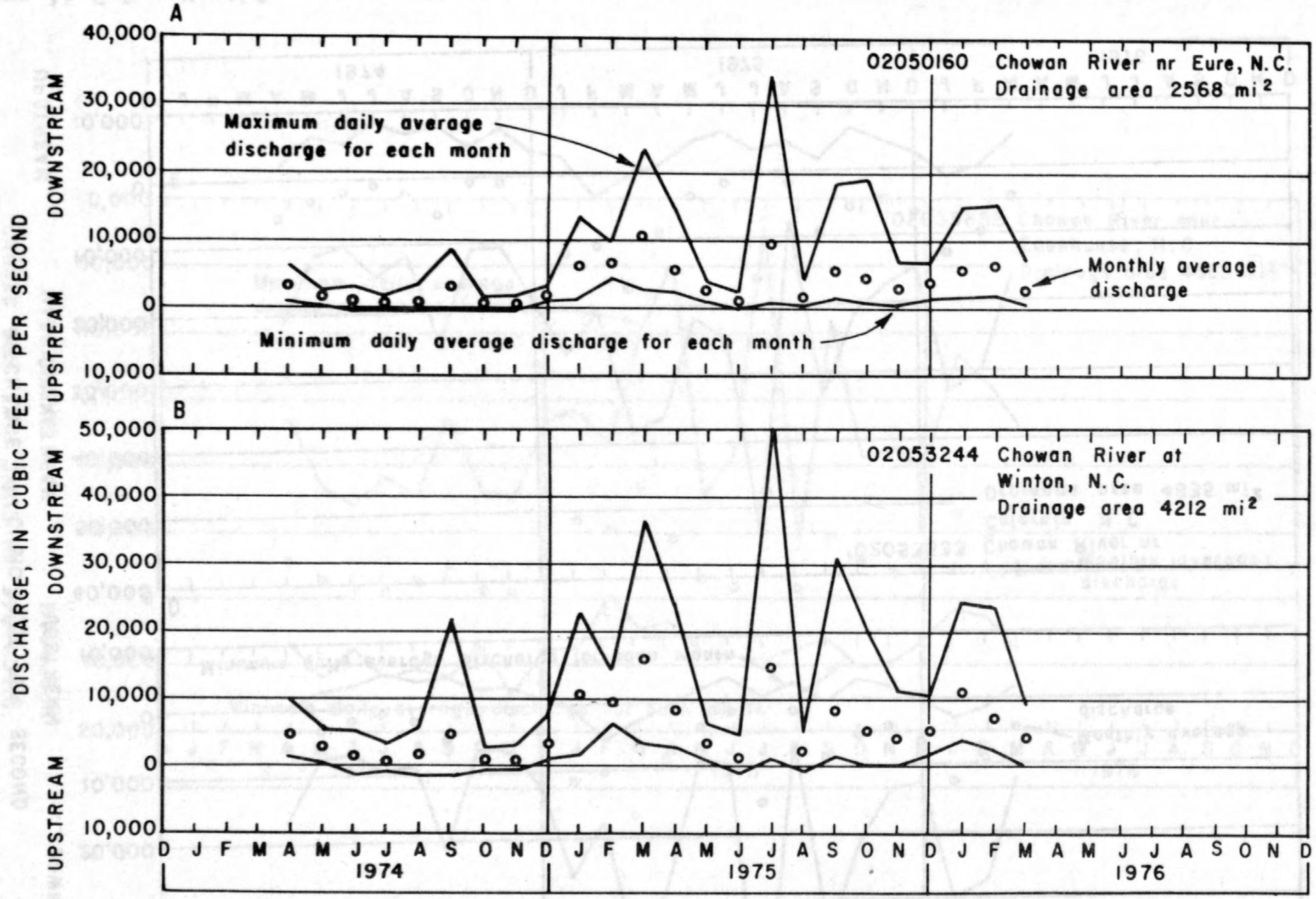


Figure 15 A-B.--Monthly average discharge and maximum and minimum daily average discharge for each month at Chowan River near Eure and Chowan River at Winton.

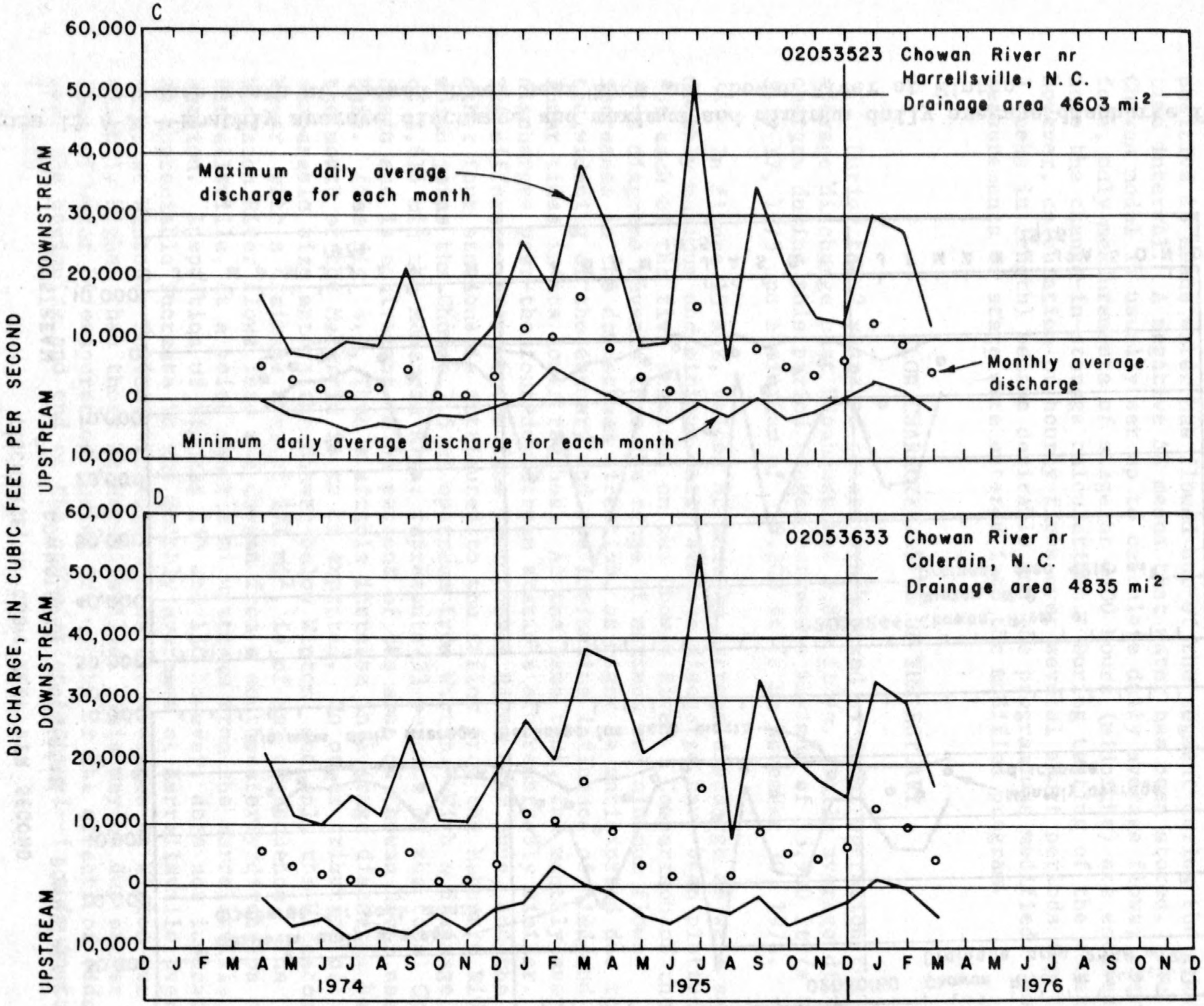


Figure 15 C-D.--Monthly average discharge and maximum and minimum daily average discharge for each month at Chowan River near Harrellsville and Chowan River near Colerain.

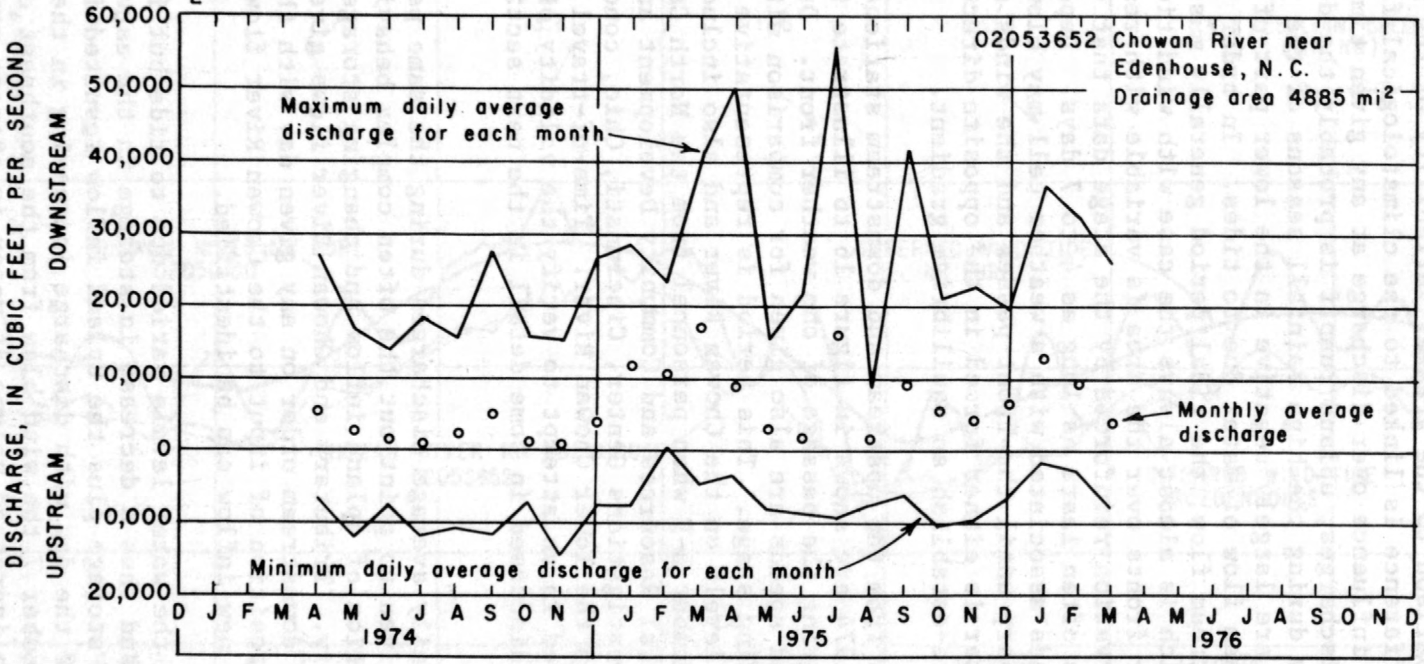


Figure 15 E.--Monthly average discharge and maximum and ninimum daily average discharge for each month at Chowan River near Edenhouse.

An interesting feature of the monthly maximum and minimum daily average discharges is the relatively low variability of the minimum discharges in comparison to the greater variability of the maximum discharges. This difference is linked to the climatological factors that have the dominant influence over discharge at any given time. In the case of maximum discharges, upland runoff is probably the dominant factor, especially during the high rainfall seasons of the year. Minimum discharges, which are largely negative in the lower part of the estuary, reflect the upstream flow of water due to tides. In order to have a net daily average upstream flow, the tidal period generally must be longer than 24 hours, which is almost always the case with wind tides. The passage of weather fronts over the area is variable with respect to time but it is an observation reinforced by the stage data that the influence of weather systems often lasts as long as 4 to 7 days. Depending on direction, the winds associated with a weather cell may blow water into or out of the estuary until the front passes and the winds shift, at which time the water is either forced in the opposite direction or flows under gravity to re-establish an equilibrium gradient.

Stage records from the upstream and downstream stations during 7 days in December 1974 are shown in figure 16 to illustrate the behavior of water levels during the passage of one weather front. Daily resultant wind directions and speeds are also given for comparison with the pattern of rising and falling stage. This period is representative of the behavior of water levels on the Chowan River and also includes the 4-day period between December 6-9 when personnel from the North Carolina Department of Natural Resources and Community Development and the EPA National Field Investigations Center, Cincinnati, Ohio, conducted a dye-dispersion study in the lower Chowan River. Time-of-travel data from this study were used in an attempt to verify the validity of the flow model and will be discussed in some detail in the next section of this report.

In table 2, daily average discharges during the same period covered by figure 16 are given to point out the often complex behavior of flow due to the interaction of upland inflow and changing storage due to tides on the estuary. Tributary and Chowan River flows given in table 2 are presented in downstream order on any given day with the tributary flows in relative position of input to the Chowan River flows so that the impact of each new inflow can be identified.

On December 6 the water levels varied due to tide but for the day showed a net drop and thus a decrease in storage in the estuary. The loss of water from storage plus the upland inflow resulted in a net downstream flow for the day with discharge increasing in the downstream direction. On December 7 the wind blew from the southeast causing water levels to rise; the increased volume of water in storage came from upland

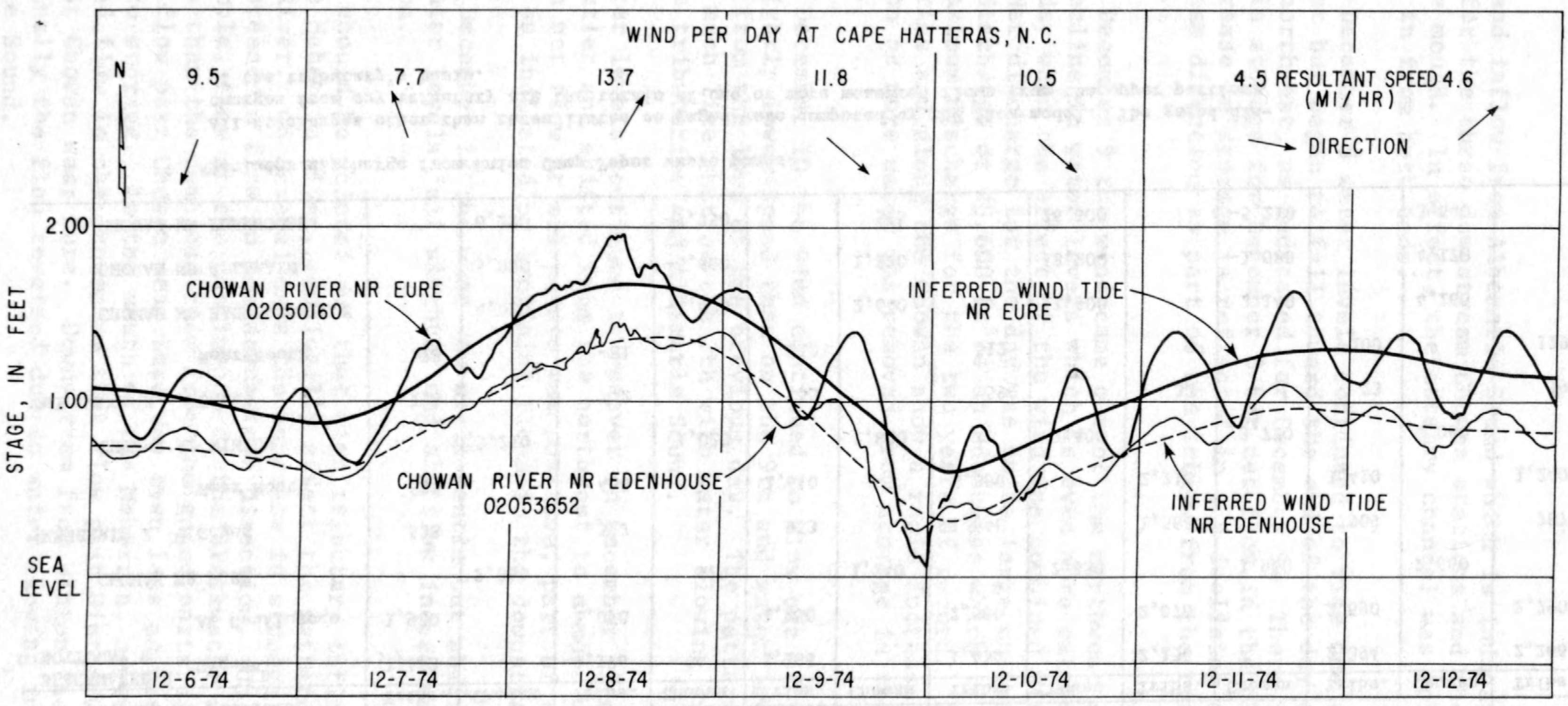


Figure 16.--Continuous water-level records from Chowan River near Eure and Chowan River near Edenhouse for December 6-12, 1974.

Table 2.--Daily average discharge in cubic feet per second from the gaged part of the Chowan River basin, from mouths of tributaries, and along the Chowan River

TRIBUTARIES CHOWAN R. STATIONS	Dec. 6, 1974		Dec. 7, 1974		Dec. 8, 1974		Dec. 9, 1974		Dec. 10, 1974		Dec. 11, 1974		Dec. 12, 1974	
	Tribs.	Chowan	Tribs.	Chowan	Tribs.	Chowan	Tribs.	Chowan	Tribs.	Chowan	Tribs.	Chowan	Tribs.	Chowan
BLACKWATER R. NOTTOWAY R. Gaged*	1,443		1,176		1,166		1,435		2,136		2,394		2,266	
At Confluence	1,980		1,070		1,250		2,560		2,070		2,690		2,790	
CHOWAN NR EURE		2,060		979		1,240		2,830		1,960		2,660		2,830
MEHERRIN R. Gaged	538		527		953		1,846		1,568		909		787	
Near Mouth	898		460		1,610		3,590		2,210		1,410		1,240	
CHOWAN AT WINTON		3,210		1,020		2,820		7,400		3,720		4,060		4,230
WICCACON R. Gaged	7.8		7.2		55		59		32		23		19	
Near Mouth	78		-81		213		512		0		100		129	
CHOWAN NR HARRELLSVILLE		4,020		-1,020		2,640		11,900		2,140		4,260		5,040
CHOWAN NR COLERAIN		5,030		-3,660		1,820		18,200		-1,080		4,120		6,070
CHOWAN NR EDENHOUSE		6,290		-7,350		545		26,600		-5,210		3,640		7,160

*Includes discharge from Union Camp Paper waste ponds.

All discharges other than those listed as gaged were computed by the flow model. The gaged discharges from any tributary are the totals of one or more measured flows from the upper portions of the tributary's basin.

inflow and inflow from Albemarle Sound which is indicated by the negative values for the three downstream Chowan stations and the Wiccacon River near the mouth. In effect, the estuary channel was being filled by water flowing in from both ends.

On December 8 water levels continued to rise due to wind out of the southwest but began to fall toward the end of the day as the wind shifted to the northwest, as indicated for December 9. There is a slight increase in storage for December 8 but net flow in the Chowan was positive. The increase in storage is reflected in the declining discharges in the downstream direction as part of the inflow from the tributaries went into storage.

On December 9 the wind came out of the northwest resulting in a rapid decline in water levels which is even more extreme towards the end of the day when the effect of the wind was combined with a falling lunar tide. Net discharge for the day was quite large on the lower Chowan with a discharge of 26,600 ft^3/s at Edenhouse which is nearly half the daily maximum discharge for the two years of record. All flows from the tributaries and along the Chowan show a rapid increase in the downstream direction as more water was removed from storage in the wider downstream reaches.

On December 10 the wind continued to blow out of the northwest but at a slightly lower speed than on the 9th and water levels started to recover from the lows of the previous day. The pattern of flow for the day was much like that on the 7th with water flowing into the Chowan from both the tributaries and Albemarle Sound.

Water levels continued to recover on December 11 as the winds became much gentler and shifted from the northwest to a more westerly direction. Although net flow at all points was positive, part of the water goes into storage as indicated by declining flows in the downstream direction.

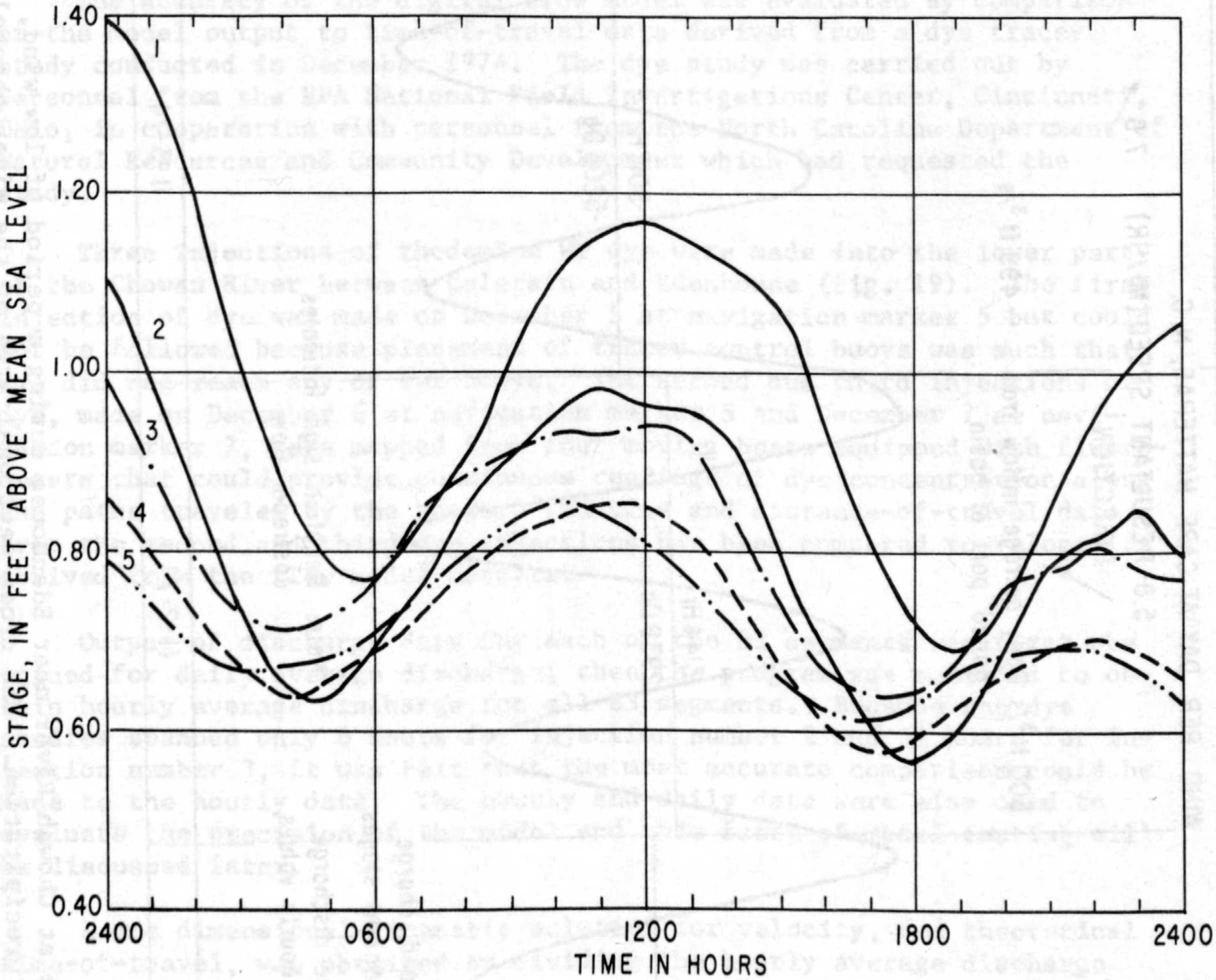
On December 12 the wind was still gentle but shifted to the southwest; water levels fell slightly and all flow increased in the downstream direction.

It should be pointed out that high tributary inflow, particularly from the Meherrin River, can locally affect the pattern of flow along the Chowan River. On several days the increase in storage resulted in a general decrease in flow in the downstream direction. On December 7 and 10, for example, flow at the confluence of the Blackwater and Nottoway Rivers was less than the combined flow from the gaged parts of these two rivers and the flow past Chowan near Eure was even less as more of the inflow went into storage. At the mouth of the Meherrin, however, high inflow increased flow in the Chowan so that flow past Winton was greater than that past Chowan near Eure. Downstream from Winton the flows declined until finally the flow reversed due to water flowing into the Chowan from Albemarle Sound.

Depending on the change in storage in the Chowan and lower parts of the tributaries and how much of this storage is accounted for by inflow from the upper parts of the tributaries, any of the tributaries may have net upstream flow in their lower reaches. Flow near the mouth of the Wiccacon for December 7 is one example; at other times net daily upstream flow has been computed for the lower reaches of all four of the major tributaries but not necessarily for all four on the same day.

Lunar tides within any 24-hour period cause water levels to rise and fall within the estuary and often are superimposed on the wind tides as shown in figure 16. Depending on the direction and intensity of the wind and the flow direction of the lunar tide, the effect of the wind may be either to moderate the amplitude of the lunar tide or to increase it. During periods of low wind velocity or when the wind blows in a direction such that there is little wind tide, the lunar tide causes the cyclic flow of water into and out of the estuary. The major features of tidal motion in the estuary can be pointed out with the aid of figure 17, which shows the water-level records collected at the five gaging stations on December 6, 1974. Although there is a slight decline in water levels during the day due to a northeast wind as shown in figure 16, the behavior of the lunar tide is well illustrated. The amplitude of the tidal cycle increases in the upstream direction as the channel narrows from a width of 1.5 - 2 mi in the lower part of the river to about 500 ft at Chowan near Eure. (See fig. 2.) Below Holiday Island the width of the river does not change a great deal and the stages at Colerain and Edenhouse are quite similar. Above Holiday Island the river narrows appreciably and the increasing amplitude due to the funneling effect is obvious at the three upstream stations. As indicated by the time lag in figure 17, the passage of high or low tides through the estuary from Chowan near Edenhouse to Chowan near Eure, a distance of about 45.5 mi, takes about 2 hours.

In order to evaluate the short-term effects of the lunar tide on discharge and the magnitude of the tidal flow, the computer program was modified to operate on hourly data. A period in early November 1974 was picked for the evaluation because upland inflow was low and nearly steady; the wind was low to moderate, and there was no rainfall. The hourly average discharges past Edenhouse from November 1-3, 1974 are plotted in figure 18. Daily average discharges computed by the modified program as the averages of 24 hourly values are given for comparison with the daily averages calculated by the original program. Although the daily averages are not very large, the outgoing and incoming tides peak in the range of 30-45 thousand cubic feet per second depending on the tide (high-high, low-high, high-low, low-low). The average cross sectional area at the US Highway 17 bridge near Edenhouse is 136,300 ft^2. At a flow of 40,000 ft^3/s the average velocity across the section will be 0.29 ft/s.



STATION NAME AND NUMBER	RIVER MILES ABOVE CHOWAN RIVER NR EDENHOUSE	RIVER WIDTH IN FEET
1. Chowan River nr Eure 02050160	45.46	480
2. Chowan River at Winton 02053244	35.49	800
3. Chowan River nr Harrellsville 02053573	22.29	1620
4. Chowan River nr Colerain 02053633	11.38	8900
5. Chowan River nr Edenhouse 02053652	0.00	8650

Figure 17.--Continuous water-level records from the five gaging stations on the Chowan River for December 6, 1974.

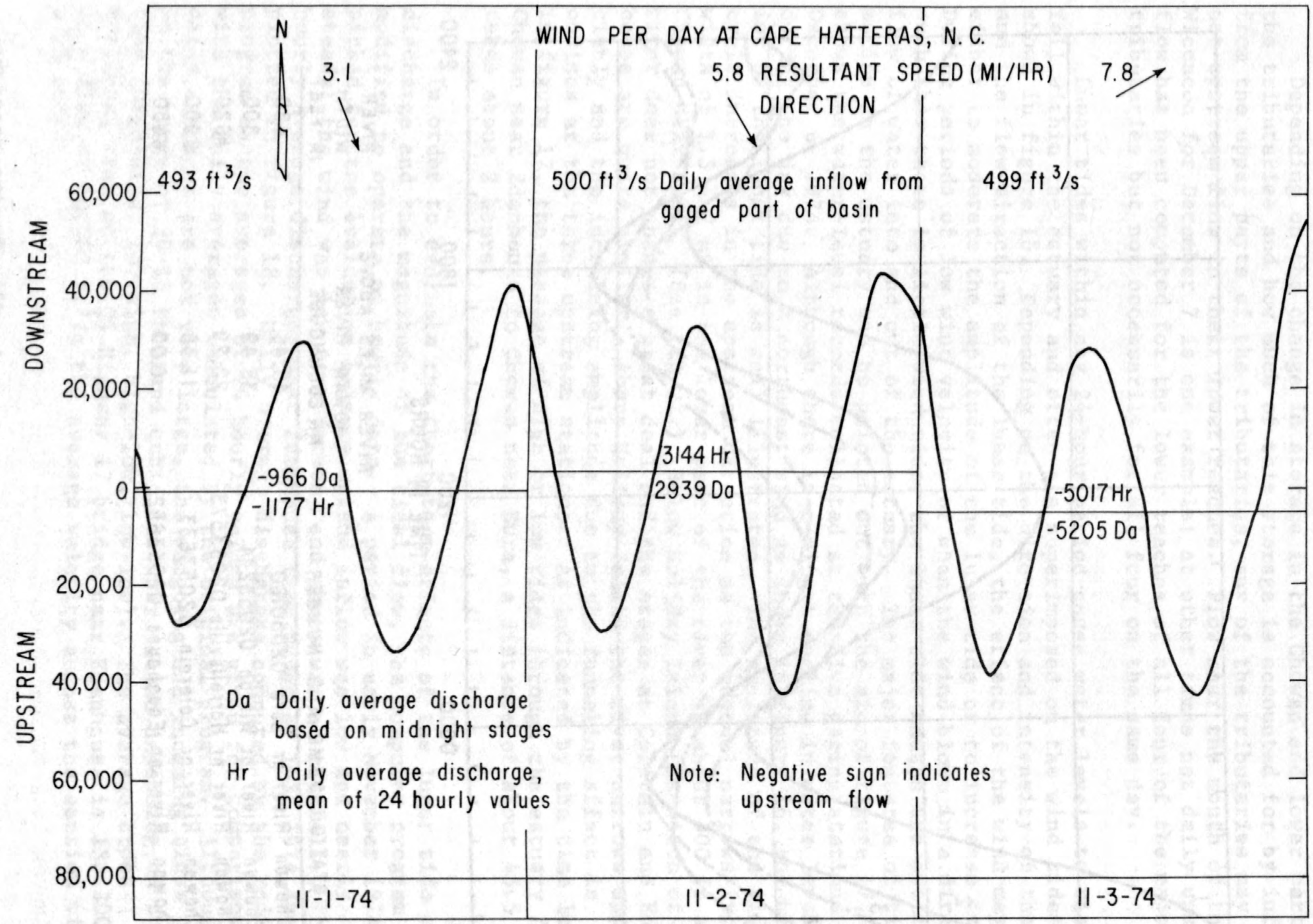


Figure 18.--Hourly discharge at Chowan River near Edenhouse during a period of low wind, low upland inflow, and no precipitation. The cross-sectional area of the river channel is 136,300 ft^2.

VALIDITY OF MODEL OUTPUT

The accuracy of the digital flow model was evaluated by comparison of the model output to time-of-travel data derived from a dye tracer study conducted in December 1974. The dye study was carried out by personnel from the EPA National Field Investigations Center, Cincinnati, Ohio, in cooperation with personnel from the North Carolina Department of Natural Resources and Community Development which had requested the study.

Three injections of rhodamine WT dye were made into the lower part of the Chowan River between Colerain and Edenhouse (fig. 19). The first injection of dye was made on December 5 at navigation marker 5 but could not be followed because placement of tracer control buoys was such that dye did not reach any of the buoys. The second and third injections of dye, made on December 6 at navigation marker 5 and December 7 at navigation marker 7, were mapped from four moving boats equipped with fluorometers that could provide continuous readings of dye concentration along the paths traveled by the boats. The time and distance-of-travel data from the second and third dye injections has been compared to velocities derived from the flow model results.

Output of discharge data for each of the 83 segments was first obtained for daily average discharge; then the program was modified to obtain hourly average discharge for all 83 segments. Because the dye studies spanned only 6 hours for injection number 2 and 51 hours for injection number 3, it was felt that the most accurate comparison could be made to the hourly data. The hourly and daily data were also used to evaluate the precision of the model and this facet of model testing will be discussed later.

A one dimensional kinematic solution for velocity, and theoretical time-of-travel, was obtained by dividing the hourly average discharge through a segment by the average cross sectional area for the conveyance portion of the segment. By multiplying the velocity in feet per second by 3,600 seconds per hour, the theoretical position of a particle of water at the end of each hour could be determined. Once a boundary of a segment was reached, the discharge and average cross section of the next segment were used to continue the calculations.

In figure 20 the hourly average discharge past Edenhouse is plotted for the period December 6-9, 1974, which spans the interval of the second and third dye injections. The discharge past this station is also the discharge from segment number 47, the most downstream segment in the Chowan River model. The position of navigation markers used as reference points for the dye study are shown in figure 19 along with the channel segments in the lower Chowan River.

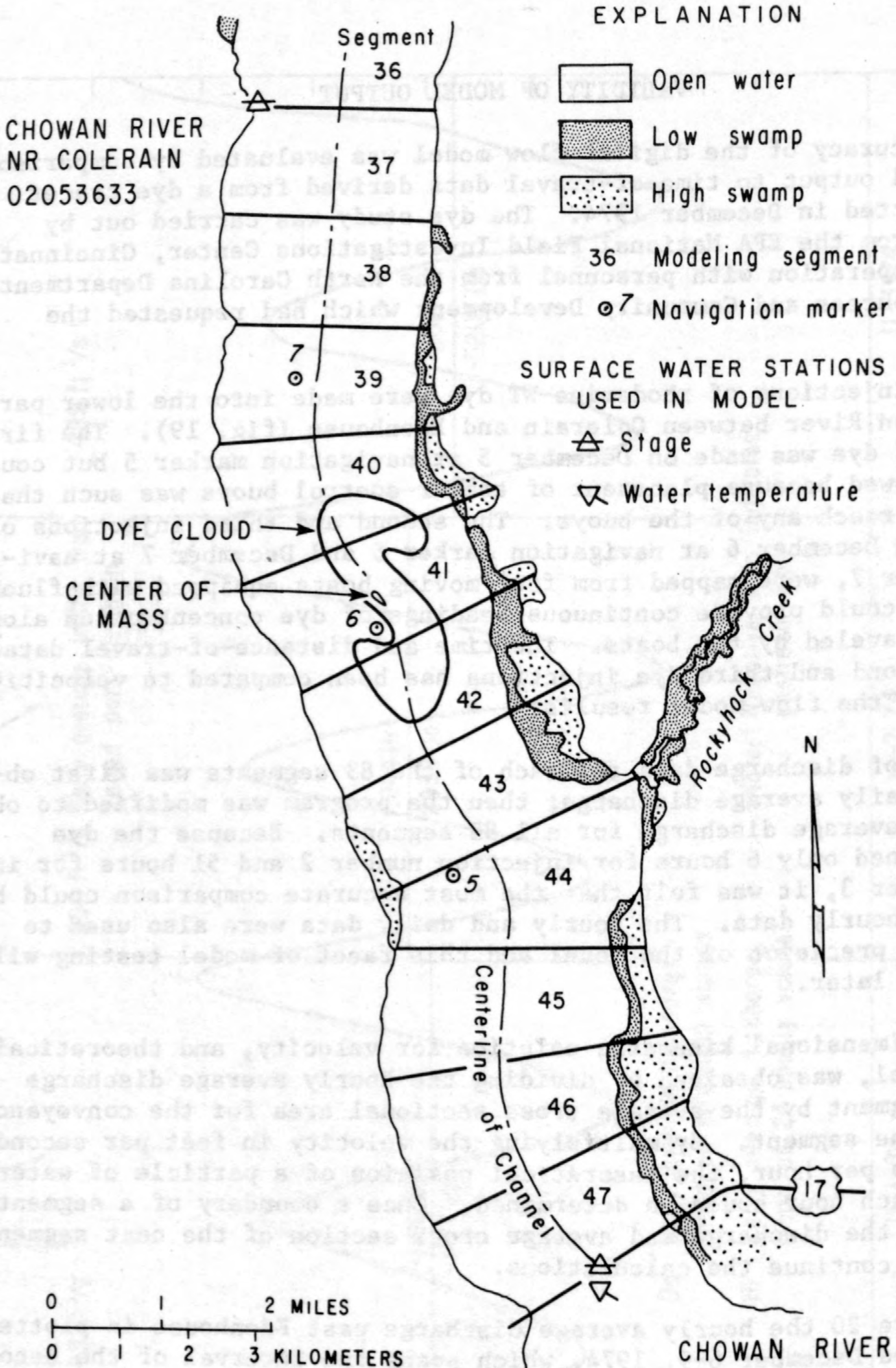


Figure 19.--Map of the lower Chowan River between Colerain and Edenhouse showing the dye cloud during an EPA dye study and navigation markers used as fixed reference points. Dye cloud shown as mapped between 1000 and 1400 hours on December 9, 1974. Dye was injected instantaneously at navigation marker 7 at 1113 hours on December 7, 1974.

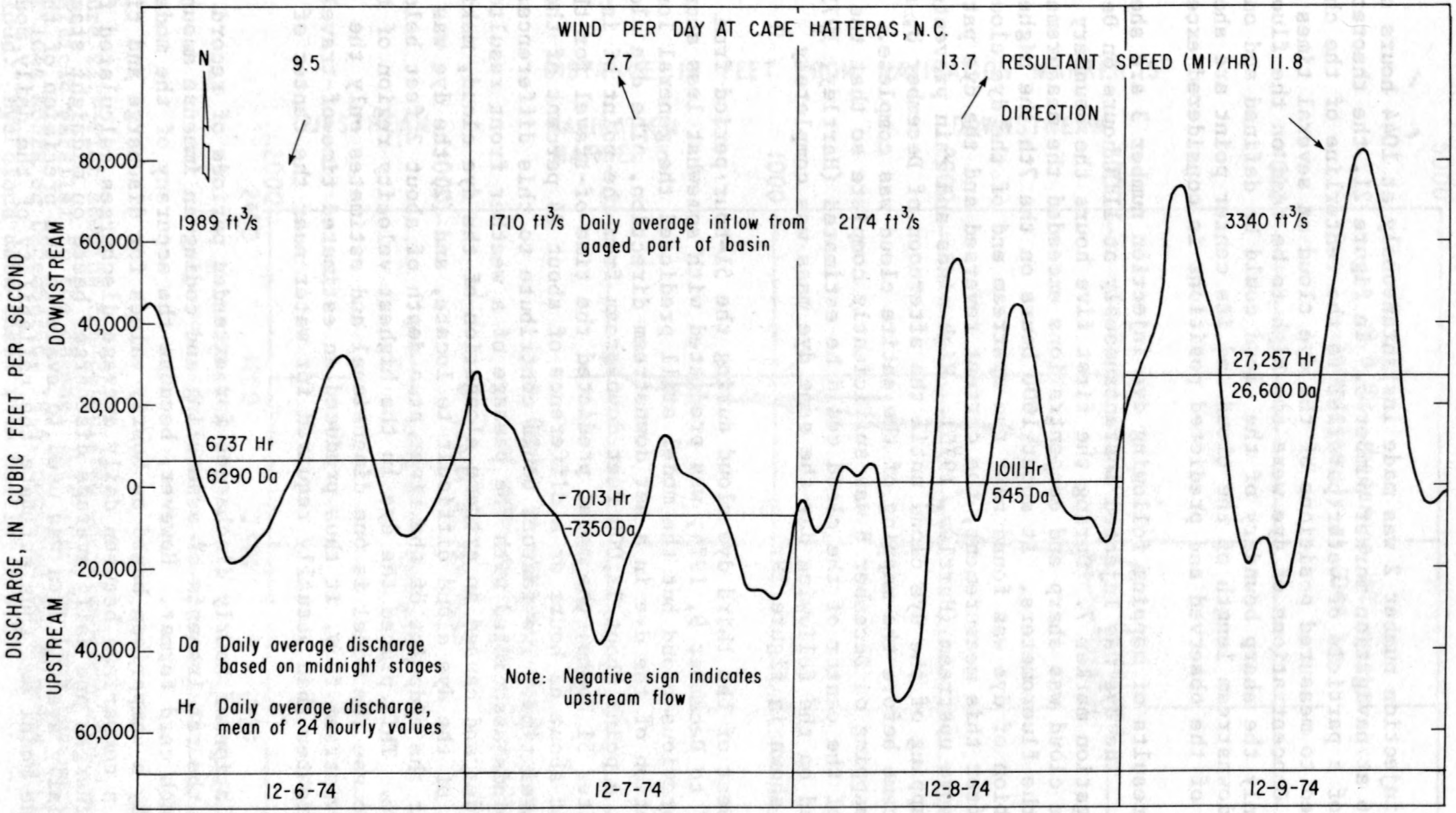


Figure 20.--Hourly discharge at Chowan River near Edenhouse, December 6-9, 1974. "The morning of December 8, several rain storms passed through the area with southerly winds estimated at 30-35 mph" (Hartley, 1975).

Dye injection number 2 was made instantaneously at 1044 hours on December 6 at navigation marker number 5. In figure 21, the theoretical movement of a particle of water parallel to the centerline of the channel is compared to measured positions of the dye cloud at several times during the day. Concentrations of dye were too high to be read on the fluorometer, so only the sharp boundary of the cloud could be defined and only the upstream-downstream length of the cloud and its center point are shown. Agreement of the observed and predicted positions is considered excellent.

The results of mapping following dye injection number 3 are shown in figure 22. The dye was injected instantaneously at 1113 hours on December 7 at navigation marker 7. During the first five hours the boundary of the dye cloud was sharp and concentrations exceeded the measurement range of the fluorometers. At about 1600 hours on the 7th the highest concentration of dye was found near the upstream end of the dye cloud. Shortly after this measurement, the current reversed and the dye patch began to move upstream (Hartley, 1975). High winds and rain prevented further mapping of the dye cloud until the afternoon of December 8, and darkness came before the mapping of the entire cloud was complete. However, mapping on December 8 was sufficiently complete so that the position of the center of the cloud could be estimated (Hartley, 1975, p. 15), and on the following day the same dye mass was completely mapped as shown in figure 19.

Movement of the third dye cloud during the 51-hour period from December 7 to December 9, 1974, was predicted with somewhat less accuracy than the previous cloud but the model still predicted the general longitudinal motion of the dye in a net downstream direction. The dye cloud arrived at a point about 12,000 feet downstream from the point of injection after 51 hours; the model predicted the time-of-travel for this distance at about 63 hours or a difference of about 24 percent of the actual travel time. Two factors could contribute to this difference: (1) high winds associated with the passage of a weather front resulted in unusual tides and caused an extreme elongation of the dye cloud, making the center of the dye cloud difficult to locate, and (2) the dye was injected near the midpoint of the river at a depth of about 2 feet below the surface. This placed the dye in the highest velocity region of the river. Because the model is one dimensional and estimates only the average downstream flow, it thus produced an estimated time-of-travel somewhat greater than actually required for water near the center of the river.

Calculation of hourly discharges for extended periods of record was limited by the requirements of assembling and coding an immense amount of data in punch card format. However, because the accuracy of the model was evaluated by a comparison based on hourly values for discharge and time-of-travel, a comparison between daily average discharges calculated from hourly discharges and daily average discharges based on midnight stages and other daily average data was used to evaluate the precision of the two forms of the model and thus estimate the reliability of the daily model.

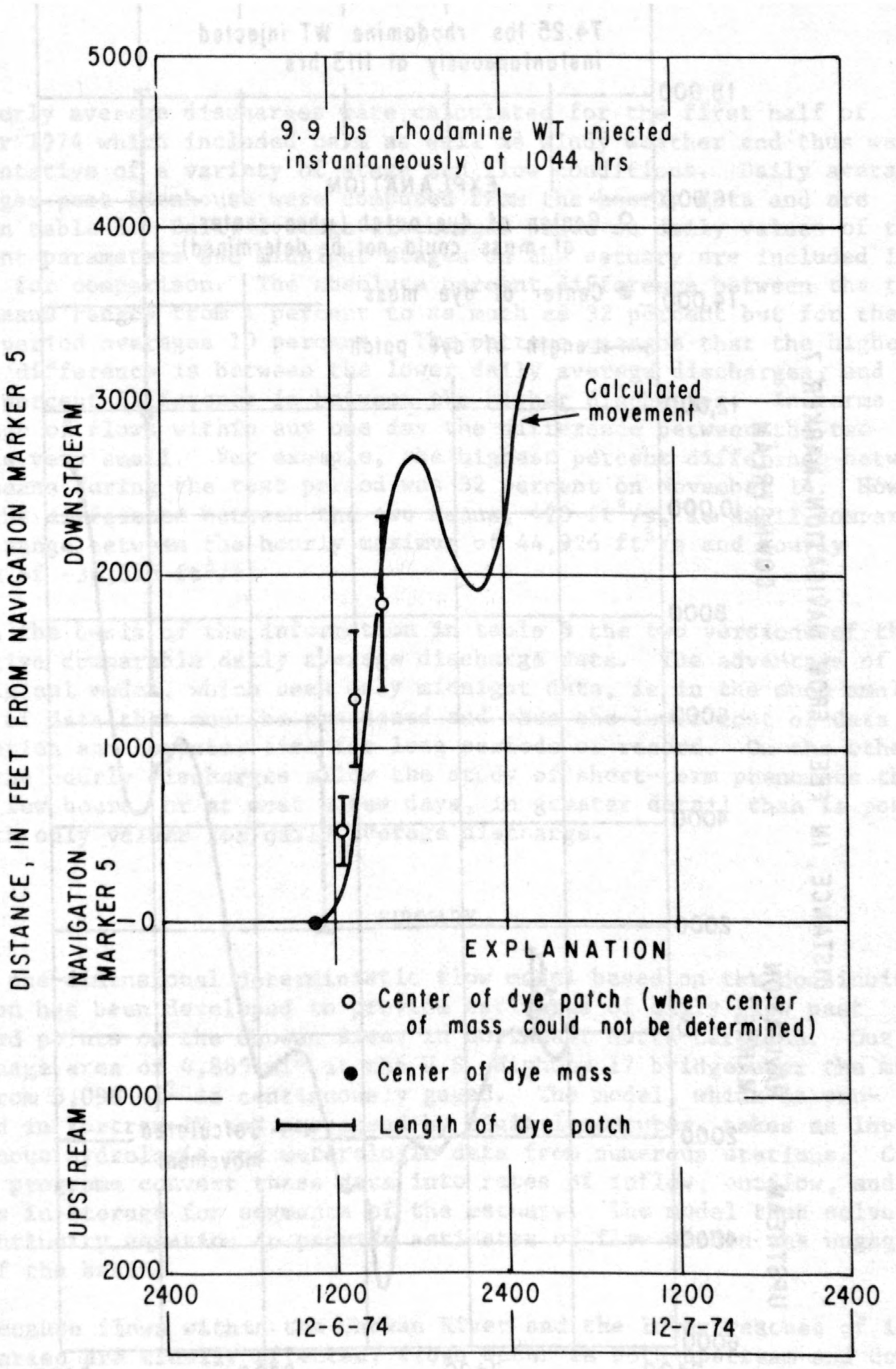


Figure 21.--Plot showing the calculated one-dimensional motion of a water particle parallel to the channel axis starting from navigation marker 5 at 1044 hours on December 6, 1974, compared to observed motion of dye cloud. Dye cloud data taken from Hartley (1975).

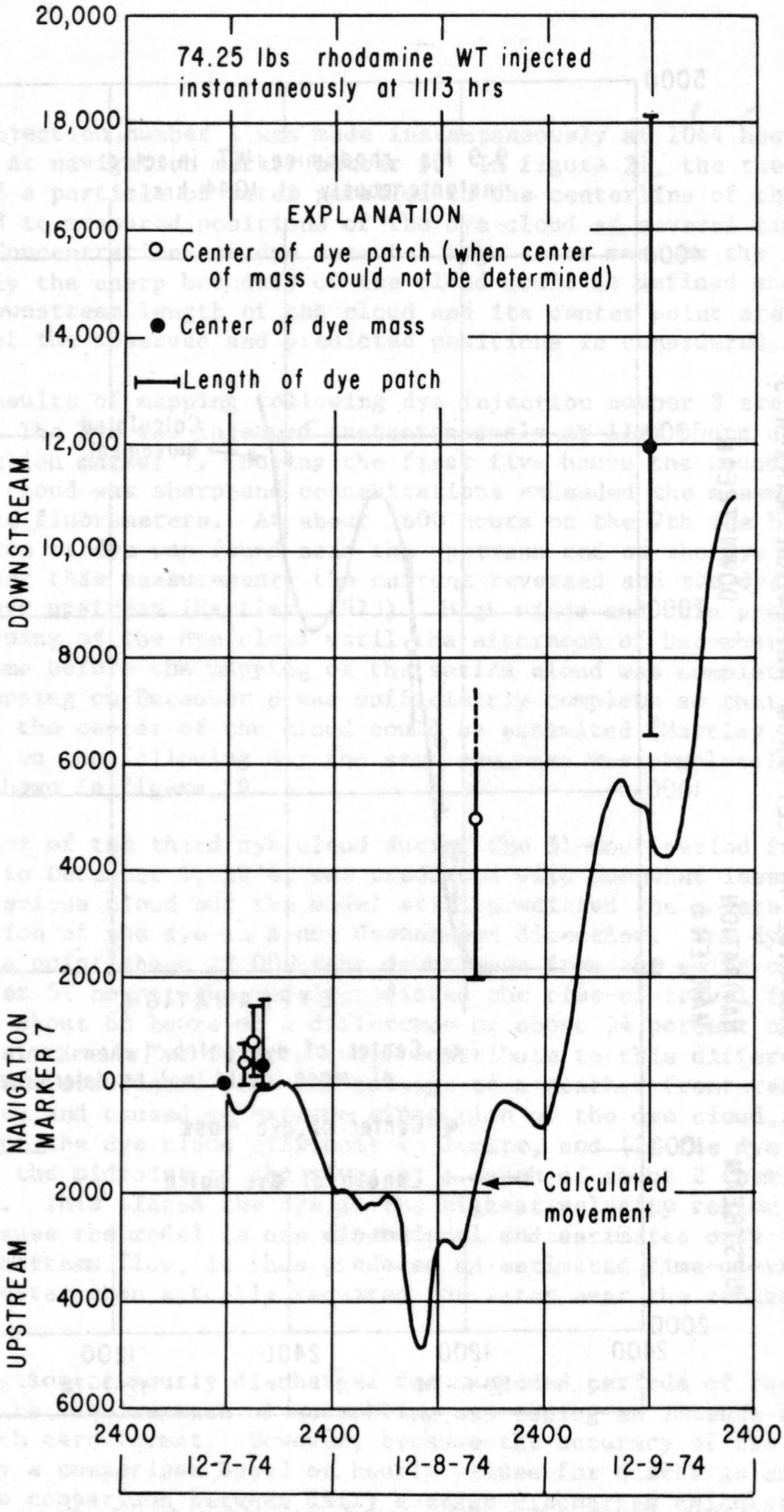


Figure 22.--Plot showing the calculated one-dimensional motion of a water particle parallel to the channel axis starting from navigation marker 7 at 1113 hours on December 7, 1974, compared to observed motion of dye cloud. Dye cloud data taken from Hartley (1975).

Hourly average discharges were calculated for the first half of November 1974 which included calm as well as windy weather and thus was representative of a variety of stage and flow conditions. Daily average discharges past Edenhouse were computed from the hourly data and are shown in table 3. Daily average discharges based on daily values of the different parameters and midnight stages on the estuary are included in table 3 for comparison. The absolute percent difference between the two daily means ranges from 1 percent to as much as 32 percent but for the 15-day period averages 10 percent. The pattern emerges that the highest percent difference is between the lower daily average discharges, and the lowest percent difference is between the higher discharges. In terms of the range of flows within any one day the difference between the two means is very small. For example, the highest percent difference between daily means during the test period was 32 percent on November 14. However, the difference between the two means, 420 ft^3/s, is small compared to the range between the hourly maximum of 44,926 ft^3/s and hourly minimum of -36,385 ft^3/s.

On the basis of the information in table 3 the two versions of the model give comparable daily average discharge data. The advantage of the original model, which uses only midnight data, is in the much smaller volume of data that must be processed and thus the lower cost of data compilation and computer time for long periods of record. On the other hand, the hourly discharges allow the study of short-term phenomena that span a few hours, or at most a few days, in greater detail than is possible with only values for daily average discharge.

SUMMARY

A one-dimensional deterministic flow model based on the continuity equation has been developed to provide estimates of daily flow past selected points on the Chowan River in northeast North Carolina. Out of a drainage area of 4,885 mi^2 at the U.S. Highway 17 bridge near the mouth, flow from 3,098 mi^2 is continuously gaged. The model, which is programmed in Fortran IV and processed by digital computer, takes as input continuous hydrologic and meterologic data from numerous stations. Component programs convert these data into rates of inflow, outflow, and changes in storage for segments of the estuary. The model then solves the continuity equation to provide estimates of flow within the ungaged part of the basin.

Because flows within the Chowan River and the lower reaches of its tributaries are tidally affected, flows occur in both upstream and downstream directions. Lunar tide variation in the river is only about 1 ft, but wind tides are much more significant--causing as much as 4 ft of variation in the water surface at irregular time intervals.

Table 3.--Comparison of daily average discharges past Chowan River near Edenhouse, station 02053652, calculated by two forms of the flow model

Date	Daily average discharge based on midnight stages	Daily average discharge as the mean of 24 hourly values	Absolute percent difference	Maximum hourly value	Minimum hourly value
11- 1-74	-966	-1,177	22	41,149	-33,614
11- 2-74	2,939	3,144	7	43,963	-42,295
11- 3-74	-5,205	-5,017	4	50,704	-42,717
11- 4-74	-4,307	-4,015	7	61,763	-67,193
11- 5-75	1,502	1,895	26	47,050	-58,043
11- 6-74	6,718	7,067	5	42,417	-23,201
11- 7-74	11,612	11,820	2	40,806	-33,403
11- 8-74	-3,577	-3,391	5	35,678	-43,337
11- 9-74	-1,310	-1,125	14	20,111	-23,361
11-10-74	-2,744	-2,561	7	36,176	-50,674
11-11-74	-12,396	-12,213	1	19,957	-43,978
11-12-74	2,511	2,805	12	57,387	-51,552
11-13-74	-4,540	-4,202	7	76,201	-71,267
11-14-74	-1,317	-897	32	44,926	-36,385
11-15-74	15,072	15,518	3	69,781	-55,151
			mean 10		

Note: Negative sign indicates upstream flow.

On a routine basis the model provides estimates of daily average flow within the estuary; however, the model can be modified to calculate hourly flow upon input of hourly stage, inflow, and climatological data. But, because of the large volume of data that must be compiled to generate estimates of hourly discharges, the periods of hourly record have been restricted to those necessary to test the model and evaluate the magnitude of flows due to wind and lunar tides.

In terms of short-term estimates of flow (hourly, daily) the change in storage due to wind and lunar tides is the dominant factor influencing the magnitude of the flow. For longer periods (weekly or longer), the amount of fresh water inflow (including that from upland parts of the basin and from precipitation directly on the estuary and adjacent swampland) is the dominant factor influencing the magnitude of the flow.

The hourly discharges have been compared with time-of-travel data from a dye study conducted in early December 1974. Comparison of the data gave generally good results with the model accurately predicting the movement of one dye cloud over a five-hour period. The overall movement of another dye cloud during a 51-hour period from December 7 to December 9, 1974, was predicted with somewhat less accuracy than the first cloud, but the model still predicted the general longitudinal motion of the dye in a net downstream direction.

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SUPPLEMENTARY DATA

Daily average discharges at the mouths of 4 major tributaries and at 5 stage stations on the Chowan River estuary, April 1974 through March 1976.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
4/ 1/74	1529.	2961.	4764.	942.		4369.	8972.	9209.	8217.	6756.
4/ 2/74	1453.	3476.	2289.	522.		4626.	6453.	5400.	4266.	3429.
4/ 3/74	1536.	4236.	1987.	479.		5810.	8061.	10300.	11790.	13210.
4/ 4/74	1308.	3979.	1352.	365.		4939.	5733.	3474.	879.	-1843.
4/ 5/74	1363.	3523.	1711.	2283.		4713.	6115.	7350.	6334.	4808.
4/ 6/74	1839.	3575.	2684.	2852.		6110.	9822.	16933.	21479.	27288.
4/ 7/74	1567.	2381.	1665.	1154.		3675.	5041.	5535.	5161.	5238.
4/ 8/74	1763.	2444.	1159.	507.		4206.	5053.	2790.	-323.	-3773.
4/ 9/74	2101.	2857.	2208.	959.		5770.	9305.	16134.	22047.	27510.
4/10/74	1611.	2001.	3502.	527.		3542.	6948.	7282.	7364.	8115.
4/11/74	1405.	1965.	2251.	281.		3059.	4828.	3511.	1856.	326.
4/12/74	1477.	2714.	1501.	257.		4307.	5853.	5683.	5038.	4306.
4/13/74	1385.	2627.	1795.	438.		4204.	6318.	7897.	8673.	8810.
4/14/74	1138.	1904.	1203.	737.		2916.	3853.	3454.	2657.	2434.
4/15/74	1133.	1889.	1785.	443.		3014.	4712.	4602.	3887.	2633.
4/16/74	1000.	1663.	1321.	269.		2485.	3498.	2877.	2810.	3448.
4/17/74	1182.	1923.	1459.	370.		3459.	5611.	9048.	12421.	16373.
4/18/74	1045.	1484.	1114.	173.		2628.	3844.	4103.	4379.	4989.
4/19/74	940.	1310.	1057.	19.		2338.	3385.	2123.	-1402.	-6965.
4/20/74	743.	1040.	1033.	251.		1684.	2745.	4366.	8489.	15013.
4/21/74	621.	917.	730.	-0.		1383.	1814.	720.	-1407.	-4343.
4/22/74	602.	913.	742.	13.		1448.	2000.	808.	-1079.	-3313.
4/23/74	667.	1053.	1128.	173.		1896.	3316.	4816.	6766.	7970.
4/24/74	596.	1039.	1326.	203.		1768.	3402.	4721.	8096.	13775.
4/25/74	434.	965.	1091.	2.		1268.	2096.	1338.	-228.	-1806.
4/26/74	405.	1046.	767.	-38.		1309.	1780.	601.	-2298.	-6882.
4/27/74	408.	1006.	815.	73.		1332.	2079.	2210.	2735.	3319.
4/28/74	338.	817.	573.	-24.		1004.	1273.	-85.	-1938.	-4224.
4/29/74	408.	941.	727.	34.		1479.	2274.	1952.	1641.	1521.
4/30/74	322.	778.	766.	97.		1109.	1982.	2886.	3838.	4713.
TOTAL =	32318.	59431.	46504.	14361.		91847.	138165.	152036.	152147.	152835.
MEAN =	1077.	1981.	1550.	479.		3062.	4606.	5068.	5072.	5094.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
5/ 1/74	333.	862.	1001.	156.		1228.	2263.	2581.	3269.	4749.
5/ 2/74	166.	581.	912.	50.		611.	1331.	982.	272.	-731.
5/ 3/74	298.	889.	1781.	151.		1426.	3553.	4558.	5073.	4788.
5/ 4/74	180.	736.	1832.	59.		764.	2427.	2266.	2481.	3190.
5/ 5/74	228.	1391.	1373.	8.		1582.	2771.	1723.	300.	-1400.
5/ 6/74	356.	1783.	2716.	242.		2335.	5441.	7305.	9246.	11753.
5/ 7/74	266.	1497.	2756.	73.		1531.	4010.	3283.	2103.	504.
5/ 8/74	329.	1993.	1802.	42.		2183.	3727.	2846.	1364.	-935.
5/ 9/74	291.	1837.	1195.	33.		1883.	2681.	1171.	-277.	-1794.
5/10/74	415.	1743.	1607.	174.		2276.	3967.	4287.	4318.	3843.
5/11/74	385.	1428.	2045.	118.		1887.	4040.	4405.	4758.	5725.
5/12/74	369.	1521.	1445.	29.		1998.	3442.	2378.	863.	-1915.
5/13/74	292.	1337.	1901.	93.		1504.	3263.	3397.	3890.	5609.
5/14/74	322.	1309.	2634.	17.		1537.	3965.	2863.	1570.	-166.
5/15/74	368.	1825.	1779.	111.		2263.	4218.	5416.	6775.	8590.
5/16/74	359.	1726.	1341.	80.		2203.	3695.	4400.	4848.	5036.
5/17/74	320.	1280.	1214.	76.		1703.	3084.	3828.	4477.	5242.
5/18/74	178.	811.	1054.	74.		806.	1802.	2483.	3453.	5027.
5/19/74	361.	1104.	1532.	214.		1829.	3835.	5401.	7415.	9588.
5/20/74	237.	832.	2383.	154.		1179.	3712.	4152.	5083.	6223.
5/21/74	26.	943.	1373.	-55.		757.	1686.	-11.	-3124.	-6657.
5/22/74	-21.	1339.	877.	-46.		966.	1300.	-720.	-2674.	-5060.
5/23/74	163.	1592.	1280.	166.		1988.	3711.	5766.	7720.	9882.
5/24/74	73.	1039.	957.	86.		1102.	2009.	1861.	1693.	1854.
5/25/74	53.	864.	941.	87.		883.	1796.	1894.	1805.	1336.
5/26/74	50.	791.	732.	25.		843.	1386.	201.	-1789.	-5138.
5/27/74	171.	1018.	1464.	980.		1520.	3671.	7448.	11112.	16876.
5/28/74	13.	550.	793.	484.		300.	388.	-2595.	-6647.	-12042.
5/29/74	105.	722.	997.	241.		689.	1464.	420.	-1075.	-2960.
5/30/74	158.	1040.	1249.	303.		1274.	2875.	5576.	7432.	8654.
5/31/74	140.	1004.	960.	155.		1220.	2216.	2511.	3359.	5166.
TOTAL =	6982.	37386.	45927.	4383.		44268.	89730.	92076.	89090.	84836.
MEAN =	225.	1206.	1482.	141.		1428.	2895.	2970.	2874.	2737.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
6/ 1/74	196.	1047.	767.	253.		1289.	2177.	3156.	3488.	3002.
6/ 2/74	44.	523.	935.	-43.		196.	706.	-383.	-1273.	-1745.
6/ 3/74	319.	1256.	1665.	151.		2023.	4256.	6013.	7508.	9310.
6/ 4/74	257.	1297.	1966.	158.		1679.	3946.	5567.	7739.	10273.
6/ 5/74	145.	1152.	845.	-21.		1231.	1907.	959.	-609.	-2113.
6/ 6/74	123.	1032.	723.	84.		1167.	1953.	2516.	3498.	4568.
6/ 7/74	144.	919.	638.	75.		1178.	1955.	2298.	3232.	4933.
6/ 8/74	37.	614.	329.	-40.		545.	558.	-663.	-2403.	-4569.
6/ 9/74	5.	470.	396.	-20.		271.	391.	-581.	-1924.	-3704.
6/10/74	-14.	395.	204.	-84.		134.	-146.	-2638.	-4994.	-7584.
6/11/74	67.	594.	620.	89.		719.	1583.	3068.	4311.	5630.
6/12/74	43.	490.	348.	24.		499.	728.	381.	-99.	-1019.
6/13/74	93.	613.	562.	59.		905.	1686.	2329.	3103.	3906.
6/14/74	81.	525.	533.	78.		758.	1563.	2616.	3615.	4711.
6/15/74	-67.	121.	2.	-82.		-311.	-946.	-3324.	-5402.	-7312.
6/16/74	88.	517.	501.	48.		829.	1658.	2374.	2494.	2638.
6/17/74	26.	331.	365.	59.		342.	742.	1269.	1920.	2111.
6/18/74	74.	440.	509.	89.		680.	1502.	2711.	3900.	5261.
6/19/74	-89.	73.	66.	-42.		-338.	-768.	-2144.	-3273.	-4272.
6/20/74	16.	286.	232.	10.		280.	416.	-90.	-738.	-1521.
6/21/74	-3.	229.	171.	-46.		134.	92.	-1449.	-3075.	-4725.
6/22/74	111.	468.	1222.	59.		815.	2398.	3343.	3535.	3295.
6/23/74	136.	67.	338.	-27.		-119.	-254.	-1758.	-2787.	-3960.
6/24/74	578.	667.	830.	215.		1504.	2910.	6332.	9731.	13728.
6/25/74	633.	654.	377.	25.		1312.	1682.	1458.	975.	397.
6/26/74	478.	577.	170.	-35.		894.	778.	-589.	-2091.	-4238.
6/27/74	210.	28.	139.	59.		-465.	-1071.	-1227.	613.	4176.
6/28/74	791.	1491.	1229.	36.		3057.	5091.	5733.	4147.	142.
6/29/74	493.	918.	562.	-60.		1363.	1780.	183.	-1644.	-3310.
6/30/74	522.	965.	985.	72.		1693.	3025.	4267.	5310.	6929.
TOTAL =	5534.	18761.	18233.	1231.		24266.	42296.	41723.	38804.	34939.
MEAN =	184.	625.	608.	41.		809.	1410.	1391.	1293.	1165.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
7/ 1/74	305.	715.	341.	111.		755.	682.	-212.	-1089.	-2385.
7/ 2/74	291.	727.	479.	90.		1125.	1772.	3062.	4808.	7189.
7/ 3/74	221.	555.	400.	35.		868.	1408.	1834.	2368.	3356.
7/ 4/74	89.	255.	172.	-2.		160.	62.	-547.	-932.	-1490.
7/ 5/74	126.	373.	263.	22.		547.	807.	621.	352.	-6.
7/ 6/74	165.	515.	571.	179.		947.	2026.	4436.	6925.	9624.
7/ 7/74	103.	382.	331.	129.		588.	1058.	1267.	1010.	902.
7/ 8/74	0.	201.	985.	25.		19.	719.	252.	236.	461.
7/ 9/74	-8.	303.	648.	-62.		101.	370.	-1416.	-3233.	-5140.
7/10/74	64.	688.	459.	2.		778.	1282.	1040.	261.	-1105.
7/11/74	152.	703.	639.	146.		1167.	2361.	4695.	7241.	10099.
7/12/74	-0.	250.	125.	-23.		126.	1.	-825.	-1521.	-1950.
7/13/74	37.	276.	249.	9.		327.	598.	487.	164.	-311.
7/14/74	-14.	140.	56.	-69.		2.	-209.	-1787.	-3916.	-6588.
7/15/74	-23.	92.	3.	-63.		-80.	-408.	-2170.	-3745.	-5449.
7/16/74	15.	170.	293.	121.		179.	592.	2490.	4933.	7573.
7/17/74	70.	279.	359.	73.		527.	1201.	2260.	3528.	5415.
7/18/74	-5.	92.	77.	-39.		1.	-100.	-1005.	-2292.	-3947.
7/19/74	-48.	-26.	-40.	-50.		-316.	-765.	-2236.	-3617.	-5252.
7/20/74	85.	320.	454.	127.		687.	1641.	3712.	6164.	9047.
7/21/74	-19.	62.	69.	-35.		-48.	-159.	-945.	-2101.	-3499.
7/22/74	3.	116.	192.	49.		117.	342.	786.	1741.	3159.
7/23/74	-55.	-41.	-81.	-89.		-323.	-849.	-2728.	-4982.	-7679.
7/24/74	-7.	80.	109.	-39.		26.	33.	-913.	-2194.	-3714.
7/25/74	-3.	62.	66.	3.		-31.	-154.	-838.	-1356.	-2240.
7/26/74	64.	246.	416.	98.		468.	1205.	2747.	3855.	4848.
7/27/74	94.	312.	528.	163.		629.	1582.	3649.	5272.	6651.
7/28/74	38.	268.	635.	75.		401.	1217.	2135.	3435.	5483.
7/29/74	23.	1081.	671.	-9.		1161.	1892.	1591.	792.	56.
7/30/74	-108.	718.	-143.	-189.		164.	-816.	-5120.	-8901.	-11875.
7/31/74	146.	1033.	831.	313.		1635.	3445.	9158.	14429.	18221.
TOTAL =	1801.	10946.	10158.	1100.		12704.	22834.	25478.	27635.	29454.
MEAN =	58.	353.	328.	35.		410.	737.	822.	891.	950.

DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
8/ 1/74	28.	502.	68.	-11.		438.	181.	-1779.	-4126.	-6171.
8/ 2/74	55.	367.	294.	34.		495.	870.	911.	232.	-1329.
8/ 3/74	-84.	-56.	-61.	-68.		-561.	-1287.	-3558.	-4951.	-5942.
8/ 4/74	111.	409.	440.	46.		724.	1321.	1047.	486.	24.
8/ 5/74	95.	414.	953.	522.		637.	2094.	6677.	11012.	15297.
8/ 6/74	136.	765.	1424.	111.		1202.	2942.	3067.	2684.	2336.
8/ 7/74	-12.	879.	4326.	177.		654.	4763.	4622.	4317.	3853.
8/ 8/74	362.	1857.	2987.	311.		2448.	5933.	8657.	11174.	14213.
8/ 9/74	317.	2384.	1033.	82.		2528.	3199.	1577.	-298.	-2651.
8/10/74	395.	2646.	1533.	249.		3168.	5023.	7116.	9191.	11577.
8/11/74	504.	2169.	950.	135.		2901.	4135.	5018.	6272.	8371.
8/12/74	299.	1131.	260.	-101.		1259.	1082.	-1666.	-5581.	-10687.
8/13/74	294.	832.	439.	41.		1088.	1493.	1596.	1629.	1216.
8/14/74	316.	711.	486.	26.		1154.	1781.	1871.	1832.	2132.
8/15/74	249.	520.	601.	102.		845.	1663.	3190.	4949.	6870.
8/16/74	133.	282.	771.	19.		270.	847.	625.	680.	780.
8/17/74	122.	246.	357.	-63.		210.	287.	-1281.	-3189.	-5348.
8/18/74	245.	434.	605.	104.		851.	1759.	3388.	5261.	7286.
8/19/74	79.	-1.	-48.	160.		-328.	-1129.	-4050.	-6896.	-9928.
8/20/74	322.	529.	758.	851.		1214.	2638.	6321.	8879.	11722.
8/21/74	126.	172.	267.	346.		206.	259.	-656.	-2373.	-4584.
8/22/74	81.	136.	307.	767.		100.	181.	-69.	-946.	-1747.
8/23/74	132.	338.	673.	556.		566.	1337.	1584.	948.	345.
8/24/74	109.	614.	633.	402.		753.	1472.	2200.	2483.	2766.
8/25/74	400.	597.	660.	280.		1111.	2030.	3960.	5643.	7307.
8/26/74	518.	526.	583.	155.		1232.	2106.	3247.	4156.	5091.
8/27/74	583.	386.	355.	62.		893.	1135.	861.	667.	785.
8/28/74	601.	467.	396.	97.		1054.	1414.	1989.	2809.	2954.
8/29/74	348.	343.	168.	-82.		526.	366.	-2023.	-4787.	-7079.
8/30/74	282.	458.	394.	87.		808.	1312.	2275.	3451.	4868.
8/31/74	199.	434.	555.	137.		783.	1696.	3718.	5806.	7797.
TOTAL =	7342.	21491.	23167.	5533.		29228.	52901.	60434.	61414.	62124.
MEAN =	237.	693.	747.	178.		943.	1706.	1949.	1981.	2004.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
9/ 1/74	176.	462.	440.	150.		740.	1305.	1789.	2506.	3737.
9/ 2/74	58.	194.	136.	-69.		151.	1.	-1657.	-3763.	-5648.
9/ 3/74	-39.	86.	141.	-42.		-351.	-755.	-2423.	-3979.	-6150.
9/ 4/74	493.	910.	3472.	201.		1880.	6150.	9540.	13142.	17021.
9/ 5/74	503.	1557.	5654.	84.		2132.	7924.	8534.	10123.	12603.
9/ 6/74	324.	2125.	2325.	-51.		2071.	3927.	2678.	-88.	-3821.
9/ 7/74	820.	2864.	8004.	159.		3718.	11591.	10241.	8321.	5830.
9/ 8/74	1456.	3338.	13312.	402.		4987.	18720.	21484.	24073.	27082.
9/ 9/74	1776.	3836.	15184.	225.		5755.	21065.	21528.	21839.	22311.
9/10/74	1758.	3908.	10748.	-12.		5325.	15493.	12841.	9918.	6390.
9/11/74	1859.	5389.	2763.	105.		7350.	10294.	11123.	11522.	11576.
9/12/74	1584.	6643.	1310.	94.		8336.	9804.	10679.	11417.	12123.
9/13/74	1143.	6543.	814.	-3.		7504.	8023.	6952.	6326.	6036.
9/14/74	1007.	5298.	908.	94.		6445.	7563.	8766.	9796.	10613.
9/15/74	848.	2787.	765.	46.		3821.	4765.	5130.	5468.	6162.
9/16/74	626.	932.	440.	9.		1333.	1427.	755.	400.	-274.
9/17/74	779.	842.	702.	37.		1808.	2750.	3071.	3093.	3362.
9/18/74	569.	422.	392.	-22.		771.	827.	-361.	-1548.	-2971.
9/19/74	559.	465.	510.	22.		953.	1367.	1238.	1257.	1246.
9/20/74	476.	436.	413.	-30.		852.	1086.	-115.	-1528.	-3096.
9/21/74	385.	404.	361.	-50.		739.	903.	-603.	-2084.	-3737.
9/22/74	520.	817.	1064.	348.		1850.	3867.	8984.	13789.	19031.
9/23/74	378.	563.	738.	195.		1166.	2289.	3832.	6607.	10416.
9/24/74	202.	333.	417.	36.		460.	771.	560.	-82.	-954.
9/25/74	187.	377.	388.	-36.		562.	873.	-31.	-2378.	-5500.
9/26/74	33.	93.	50.	-81.		-245.	-876.	-3464.	-6003.	-9220.
9/27/74	242.	574.	782.	124.		1160.	2561.	4782.	6561.	8478.
9/28/74	-27.	-12.	-4.	-118.		-509.	-1309.	-4596.	-7697.	-11358.
9/29/74	99.	276.	460.	46.		325.	698.	841.	1275.	1711.
9/30/74	243.	637.	884.	163.		1335.	2990.	6064.	9103.	12955.
TOTAL =	19036.	53101.	73575.	2027.		72422.	146093.	148160.	147386.	145955.
MEAN =	635.	1770.	2452.	68.		2414.	4870.	4939.	4913.	4865.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
10/ 1/74	33.	196.	146.	25.		-80.	-506.	-2562.	-4631.	-6919.
10/ 2/74	216.	616.	864.	215.		1250.	2897.	6192.	10456.	15470.
10/ 3/74	97.	337.	431.	63.		492.	1024.	1365.	2584.	5090.
10/ 4/74	10.	178.	245.	-20.		85.	139.	-382.	-1312.	-2150.
10/ 5/74	26.	206.	291.	-10.		172.	350.	-20.	-1066.	-2914.
10/ 6/74	56.	244.	379.	32.		312.	717.	784.	1003.	1266.
10/ 7/74	43.	219.	345.	10.		254.	573.	414.	-137.	-1438.
10/ 8/74	74.	277.	442.	72.		416.	979.	1424.	2944.	5834.
10/ 9/74	-15.	128.	239.	-42.		3.	35.	-657.	-2337.	-4791.
10/10/74	-4.	133.	173.	-66.		5.	-117.	-1538.	-3691.	-6524.
10/11/74	56.	274.	460.	60.		412.	1054.	1810.	2625.	3292.
10/12/74	45.	246.	370.	13.		326.	737.	661.	477.	403.
10/13/74	-4.	144.	268.	28.		47.	157.	71.	220.	340.
10/14/74	17.	178.	341.	-6.		160.	466.	150.	-470.	-1158.
10/15/74	15.	166.	303.	10.		133.	349.	116.	-80.	-549.
10/16/74	31.	168.	416.	55.		118.	423.	529.	355.	-674.
10/17/74	112.	394.	785.	77.		741.	1903.	2986.	4068.	6399.
10/18/74	64.	339.	646.	80.		479.	1314.	2162.	3262.	4369.
10/19/74	138.	524.	730.	157.		856.	1960.	3360.	6451.	11179.
10/20/74	-31.	257.	317.	-62.		64.	32.	-963.	-3000.	-5820.
10/21/74	99.	462.	643.	99.		677.	1566.	2348.	4202.	7204.
10/22/74	25.	298.	321.	-33.		271.	450.	-155.	-1660.	-3824.
10/23/74	31.	278.	355.	4.		262.	545.	328.	-491.	-2106.
10/24/74	52.	279.	366.	18.		314.	644.	549.	472.	539.
10/25/74	32.	232.	277.	-40.		190.	281.	-615.	-2145.	-4214.
10/26/74	103.	350.	523.	90.		549.	1286.	2191.	3605.	5181.
10/27/74	54.	261.	364.	-3.		303.	632.	379.	-520.	-2015.
10/28/74	52.	259.	376.	15.		299.	654.	551.	301.	-124.
10/29/74	75.	298.	441.	70.		408.	934.	1392.	2663.	4477.
10/30/74	40.	238.	343.	22.		247.	533.	471.	601.	1168.
10/31/74	51.	261.	373.	18.		314.	686.	641.	576.	588.
TOTAL =	1594.	8437.	12572.	952.		10079.	22697.	23984.	25323.	27579.
MEAN =	51.	272.	406.	31.		325.	732.	774.	817.	890.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
11/ 1/74	46.	273.	303.	74.		257.	431.	167.	-409.	-966.
11/ 2/74	60.	290.	426.	51.		383.	874.	1139.	1861.	2939.
11/ 3/74	-22.	136.	194.	-61.		-62.	-199.	-1305.	-3080.	-5205.
11/ 4/74	-23.	99.	210.	-28.		-158.	-301.	-1321.	-2529.	-4307.
11/ 5/74	68.	339.	482.	36.		505.	1155.	1568.	1675.	1502.
11/ 6/74	110.	426.	563.	88.		766.	1681.	2760.	4392.	6718.
11/ 7/74	140.	441.	626.	150.		793.	1824.	3141.	6520.	11612.
11/ 8/74	-9.	187.	274.	-24.		85.	194.	-301.	-1622.	-3577.
11/ 9/74	27.	248.	332.	4.		258.	546.	356.	-257.	-1310.
11/10/74	10.	214.	289.	-14.		171.	351.	-25.	-990.	-2744.
11/11/74	-41.	114.	68.	-133.		-125.	-511.	-2759.	-6771.	-12396.
11/12/74	19.	205.	305.	30.		138.	310.	222.	936.	2511.
11/13/74	-7.	115.	266.	-28.		-94.	-111.	-1177.	-2610.	-4540.
11/14/74	16.	193.	361.	-1.		109.	334.	-193.	-638.	-1317.
11/15/74	209.	679.	890.	199.		1398.	3135.	6518.	10322.	15072.
11/16/74	-27.	180.	186.	-47.		-71.	-280.	-1503.	-2837.	-4241.
11/17/74	78.	403.	508.	89.		583.	1301.	2323.	3848.	6052.
11/18/74	92.	410.	508.	90.		617.	1335.	2060.	3391.	5130.
11/19/74	34.	295.	343.	-28.		291.	520.	-34.	-1541.	-3565.
11/20/74	87.	381.	505.	52.		547.	1185.	1566.	2027.	2899.
11/21/74	117.	424.	661.	161.		651.	1575.	2897.	6607.	12717.
11/22/74	65.	328.	440.	-29.		336.	642.	69.	-2069.	-6164.
11/23/74	83.	391.	442.	-7.		420.	751.	395.	-521.	-1817.
11/24/74	79.	407.	361.	-17.		424.	653.	149.	-1040.	-3005.
11/25/74	218.	636.	726.	180.		1110.	2344.	4046.	7484.	11812.
11/26/74	51.	328.	319.	-18.		275.	387.	-90.	-1035.	-1497.
11/27/74	89.	358.	406.	7.		394.	711.	472.	-485.	-2251.
11/28/74	170.	489.	503.	53.		747.	1381.	1660.	2131.	2844.
11/29/74	105.	386.	371.	17.		439.	733.	608.	551.	491.
11/30/74	55.	279.	86.	-139.		155.	-226.	-2595.	-7234.	-14246.
TOTAL =	1900.	9654.	11954.	709.		11342.	22724.	20812.	16078.	9150.
MEAN =	63.	322.	398.	24.		378.	757.	694.	536.	305.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
12/ 1/74	265.	781.	1404.	367.		1240.	3133.	6153.	11060.	19335.
12/ 2/74	230.	861.	1837.	114.		1082.	2896.	2999.	2210.	-229.
12/ 3/74	302.	1590.	1704.	103.		2005.	3860.	4342.	5169.	5871.
12/ 4/74	248.	1804.	981.	4.		2023.	2874.	2483.	1707.	888.
12/ 5/74	208.	1524.	656.	-46.		1647.	1972.	835.	-1010.	-3197.
12/ 6/74	353.	1432.	898.	78.		2063.	3212.	4024.	5029.	6285.
12/ 7/74	215.	835.	460.	-81.		979.	1015.	-1015.	-3664.	-7350.
12/ 8/74	297.	869.	1613.	213.		1236.	2817.	2641.	1820.	545.
12/ 9/74	697.	1467.	3586.	512.		2831.	7404.	11909.	18184.	26629.
12/10/74	425.	1548.	2206.	-0.		1959.	3724.	2135.	-1082.	-5211.
12/11/74	541.	1978.	1407.	100.		2663.	4055.	4259.	4124.	3644.
12/12/74	646.	1790.	1236.	129.		2833.	4225.	5039.	6066.	7156.
12/13/74	645.	1304.	1075.	95.		2300.	3441.	3789.	4403.	5437.
12/14/74	643.	1086.	970.	66.		2059.	3048.	3092.	3219.	3875.
12/15/74	503.	864.	817.	31.		1519.	2176.	1894.	1169.	-365.
12/16/74	417.	703.	823.	-10.		1058.	1494.	148.	-1816.	-4383.
12/17/74	583.	1088.	1871.	219.		2113.	4451.	6600.	9890.	14444.
12/18/74	370.	1160.	1648.	-39.		1563.	2819.	1027.	-1798.	-5341.
12/19/74	334.	1540.	1226.	45.		1831.	2868.	2490.	2029.	1306.
12/20/74	527.	1931.	1377.	149.		2973.	4874.	6644.	8571.	11170.
12/21/74	423.	1351.	1148.	116.		1943.	3165.	3688.	4185.	4732.
12/22/74	451.	1147.	1099.	142.		1706.	2748.	2681.	2374.	2037.
12/23/74	465.	1091.	1039.	107.		1545.	2516.	2391.	1973.	1143.
12/24/74	569.	1189.	1130.	143.		1918.	3284.	4109.	5234.	6857.
12/25/74	430.	897.	800.	41.		1227.	1782.	951.	-17.	-1054.
12/26/74	566.	1061.	1201.	239.		1952.	3609.	5284.	7725.	10936.
12/27/74	384.	775.	852.	111.		1204.	1991.	2072.	2167.	2328.
12/28/74	467.	877.	1037.	308.		1537.	2734.	3513.	3814.	3778.
12/29/74	438.	770.	928.	280.		1280.	2137.	2174.	1493.	595.
12/30/74	414.	765.	877.	223.		1227.	1995.	2116.	2111.	1968.
12/31/74	526.	925.	991.	203.		1702.	2832.	3244.	3658.	4596.
TOTAL =	13581.	37002.	38896.	3960.		55217.	95151.	103711.	109999.	118428.
MEAN =	438.	1194.	1255.	128.		1781.	3069.	3346.	3548.	3820.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
1/ 1/75	582.	1076.	1723.	412.		2012.	4201.	6229.	10831.	17440.
1/ 2/75	356.	714.	1119.	20.		1075.	1781.	483.	-2923.	-7463.
1/ 3/75	330.	773.	1187.	51.		1154.	2065.	1331.	-819.	-4119.
1/ 4/75	407.	953.	1512.	237.		1631.	3286.	4161.	5246.	6569.
1/ 5/75	442.	936.	1528.	386.		1645.	3198.	3431.	2791.	2012.
1/ 6/75	482.	1016.	1600.	347.		1812.	3567.	4361.	5347.	6717.
1/ 7/75	431.	969.	1912.	402.		1595.	3456.	3783.	3215.	2130.
1/ 8/75	439.	1152.	2285.	274.		1777.	3839.	3173.	1440.	-848.
1/ 9/75	571.	1674.	3058.	634.		2623.	5812.	7069.	7528.	7885.
1/10/75	617.	2008.	2814.	424.		2965.	5734.	5730.	4747.	3136.
1/11/75	576.	2159.	2993.	546.		2914.	5701.	5538.	4667.	3448.
1/12/75	764.	2600.	8295.	862.		3848.	12350.	14262.	15680.	17695.
1/13/75	993.	3508.	13051.	2553.		5118.	18686.	23308.	25536.	27525.
1/14/75	1517.	4489.	16136.	2947.		6375.	22561.	25800.	26633.	28286.
1/15/75	1871.	5919.	12668.	1554.		7830.	19984.	19674.	16982.	13944.
1/16/75	2422.	8894.	6675.	796.		11915.	18876.	20896.	22450.	24228.
1/17/75	2428.	10369.	3307.	504.		13193.	16511.	17401.	18346.	19607.
1/18/75	2416.	10532.	2485.	283.		13260.	15555.	14996.	13556.	11751.
1/19/75	2429.	9152.	2261.	291.		11805.	13834.	13943.	14051.	14267.
1/20/75	2849.	7868.	3174.	505.		11695.	15644.	18391.	22483.	27067.
1/21/75	2707.	5390.	4096.	540.		8637.	12831.	13528.	13805.	15085.
1/22/75	2525.	4178.	3879.	303.		7069.	10805.	10453.	8412.	5327.
1/23/75	2484.	4163.	2922.	289.		7127.	10082.	10348.	10168.	10042.
1/24/75	2263.	4001.	2545.	201.		6472.	8947.	8763.	7602.	5839.
1/25/75	1964.	3364.	4200.	1741.		5052.	8627.	9140.	7941.	6218.
1/26/75	2268.	3953.	7157.	2092.		6390.	13410.	14599.	13528.	12381.
1/27/75	2614.	4769.	6556.	1122.		7960.	15110.	18205.	20121.	22511.
1/28/75	2535.	4851.	3543.	628.		7584.	11242.	12402.	13185.	13983.
1/29/75	2373.	4987.	2552.	350.		7291.	9526.	8773.	7627.	6908.
1/30/75	2355.	5243.	2514.	365.		7799.	10401.	11239.	11751.	11945.
1/31/75	2168.	4538.	2352.	308.		6992.	9531.	10369.	10735.	10423.
TOTAL =	49177.	126197.	132098.	21969.		184614.	317154.	341777.	342661.	341939.
MEAN =	1586.	4071.	4261.	709.		5955.	10231.	11025.	11054.	11030.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH	CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63					
RIVER MILES ABOVE US 17					45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.	2564.	4212.	4603.	4835.	4885.
DATE :									
2/ 1/75	2173.	3992.	2166.	411.	6626.	9120.	10300.	12063.	14877.
2/ 2/75	1775.	2809.	2276.	378.	4919.	7394.	8498.	10213.	12859.
2/ 3/75	1621.	2742.	2880.	440.	4660.	7640.	8282.	8897.	10070.
2/ 4/75	1527.	2920.	2989.	311.	4550.	7323.	7117.	5228.	1599.
2/ 5/75	1666.	3365.	5483.	2350.	5070.	10322.	11865.	9690.	7472.
2/ 6/75	2124.	4001.	6962.	1823.	6244.	13062.	14116.	12678.	10041.
2/ 7/75	2465.	4897.	5732.	1066.	7746.	13815.	16508.	19147.	22999.
2/ 8/75	2317.	5146.	4302.	465.	7355.	11121.	9169.	5971.	1822.
2/ 9/75	2604.	6554.	3809.	618.	9664.	14045.	17302.	20146.	21354.
2/10/75	2280.	6125.	2541.	284.	8391.	10634.	9966.	9296.	10776.
2/11/75	2213.	5698.	2243.	245.	7905.	9890.	9073.	7721.	6006.
2/12/75	2098.	4720.	2074.	207.	6805.	8536.	7116.	5782.	4592.
2/13/75	2012.	3820.	2672.	363.	5863.	8718.	10902.	13056.	15715.
2/14/75	2098.	3606.	2808.	253.	6191.	9472.	10351.	10229.	9385.
2/15/75	1735.	2898.	2183.	228.	4669.	6843.	7321.	8099.	9429.
2/16/75	1547.	2609.	2380.	350.	4073.	6189.	5162.	3130.	403.
2/17/75	1819.	3220.	4403.	2651.	5212.	9868.	13701.	14778.	16058.
2/18/75	2084.	3815.	3507.	1718.	5920.	9349.	10631.	10161.	9726.
2/19/75	2107.	4159.	2943.	984.	6020.	8562.	8671.	8023.	6537.
2/20/75	2580.	5305.	3232.	905.	8511.	12522.	15920.	18520.	22226.
2/21/75	2323.	4474.	2399.	540.	6720.	9031.	9698.	9915.	10139.
2/22/75	2420.	4332.	2204.	397.	7013.	9361.	9797.	9717.	9510.
2/23/75	2073.	3228.	1882.	248.	5172.	6728.	5517.	3575.	1045.
2/24/75	1905.	2719.	2159.	337.	4486.	6378.	5429.	4500.	4133.
2/25/75	1834.	2861.	2967.	926.	4531.	7162.	6825.	5466.	3980.
2/26/75	2123.	3902.	3190.	688.	6424.	10209.	13381.	15533.	17630.
2/27/75	2122.	4154.	2960.	505.	6624.	10056.	12607.	15443.	18834.
2/28/75	1864.	3502.	1891.	237.	5247.	6869.	6061.	4685.	3212.
TOTAL =	57508.	111574.	87234.	19928.	172609.	260217.	281287.	281662.	282431.
MEAN =	2054.	3985.	3116.	712.	6165.	9293.	10046.	10059.	10087.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR FURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
3/ 1/75	1794.	3251.	1363.	289.		4813.	5657.	4279.	3299.	2556.
3/ 2/75	2049.	3440.	2354.	752.		6166.	9564.	13839.	18631.	25250.
3/ 3/75	1698.	2703.	1923.	562.		4561.	6760.	7969.	9381.	10949.
3/ 4/75	1404.	2305.	1389.	224.		3559.	4549.	3477.	141.	-4986.
3/ 5/75	1316.	2087.	1346.	222.		3306.	4445.	3917.	2506.	793.
3/ 6/75	1335.	2029.	1481.	257.		3455.	5039.	5659.	6362.	7207.
3/ 7/75	1066.	1641.	1316.	221.		2550.	3710.	4047.	4998.	6688.
3/ 8/75	1317.	2075.	1768.	321.		3855.	6290.	8049.	11419.	15084.
3/ 9/75	878.	1562.	1207.	60.		2323.	3273.	2494.	387.	-1431.
3/10/75	840.	1661.	1386.	131.		2515.	3877.	3981.	3265.	1339.
3/11/75	782.	1670.	1685.	153.		2411.	3988.	4007.	4121.	4831.
3/12/75	797.	1970.	1887.	109.		2761.	4563.	4189.	2664.	1064.
3/13/75	841.	2341.	3635.	509.		3180.	6811.	7684.	7518.	5556.
3/14/75	1334.	3295.	14883.	2253.		4397.	19034.	21064.	21176.	22282.
3/15/75	2956.	5574.	20571.	3186.		8455.	28919.	32096.	31930.	31518.
3/16/75	4061.	7808.	19726.	2844.		12070.	32065.	35747.	36103.	35845.
3/17/75	4646.	10512.	17415.	2674.		15309.	32926.	36744.	38137.	40050.
3/18/75	4939.	13902.	12455.	1998.		18530.	30392.	30825.	28855.	26111.
3/19/75	5143.	15331.	12968.	2324.		19725.	31693.	31878.	30327.	28462.
3/20/75	6441.	17385.	12918.	3263.		23837.	36465.	38447.	36805.	35029.
3/21/75	7086.	16730.	10499.	3197.		23285.	32966.	35203.	35402.	36014.
3/22/75	7714.	15719.	5173.	1489.		23535.	28773.	31010.	31512.	31863.
3/23/75	7536.	14341.	3652.	731.		22082.	25699.	26683.	27472.	28319.
3/24/75	6961.	12927.	3336.	329.		20434.	24017.	21707.	18516.	16357.
3/25/75	6165.	11042.	3899.	717.		17799.	22332.	25336.	26406.	26001.
3/26/75	5276.	8971.	3839.	557.		14886.	19398.	22896.	25958.	28769.
3/27/75	4307.	7274.	2940.	377.		12181.	15783.	18073.	20111.	23115.
3/28/75	3364.	5914.	2242.	172.		9670.	12082.	11293.	9680.	7985.
3/29/75	2594.	4690.	1939.	115.		7398.	9149.	7418.	5719.	3794.
3/30/75	1971.	3512.	2955.	242.		5095.	7564.	7764.	8571.	8840.
3/31/75	2369.	4468.	9060.	254.		7278.	16774.	17343.	17306.	18199.
TOTAL =	100980.	208129.	183208.	30534.		311419.	494555.	525119.	524677.	523451.
MEAN =	3257.	6714.	5910.	985.		10046.	15953.	16939.	16925.	16886.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
4/ 1/75	2621.	5315.	13134.	365.		8118.	21496.	22590.	22887.	23025.
4/ 2/75	2907.	6336.	13592.	227.		9264.	22970.	23949.	24475.	25046.
4/ 3/75	3659.	9448.	5417.	629.		14058.	20882.	26319.	36181.	50353.
4/ 4/75	2862.	9289.	2607.	236.		12015.	14406.	14194.	13057.	10590.
4/ 5/75	2662.	9065.	2298.	175.		11771.	14053.	13957.	13629.	14052.
4/ 6/75	2336.	7454.	1923.	109.		9764.	11572.	11214.	9960.	7924.
4/ 7/75	2020.	5395.	1546.	-39.		7294.	8435.	6718.	2561.	-2736.
4/ 8/75	1605.	3401.	1267.	16.		4423.	4881.	2881.	807.	-2518.
4/ 9/75	1869.	3441.	1966.	194.		5792.	8433.	10449.	12098.	13915.
4/10/75	1425.	2475.	1522.	88.		3908.	5428.	5408.	4820.	3549.
4/11/75	1248.	2232.	1508.	97.		3498.	4984.	4994.	5136.	5933.
4/12/75	1055.	2059.	1516.	100.		3023.	4470.	4535.	4351.	3868.
4/13/75	1041.	2182.	1421.	50.		3284.	4655.	3956.	2410.	-90.
4/14/75	848.	1933.	1381.	107.		2620.	3918.	4357.	5055.	6088.
4/15/75	1120.	2432.	2461.	560.		3862.	6731.	8654.	9811.	11109.
4/16/75	1344.	2668.	3600.	727.		3866.	7257.	7392.	7035.	7031.
4/17/75	1570.	3222.	2756.	323.		4447.	6604.	4494.	2266.	-395.
4/18/75	1813.	3932.	1912.	177.		5599.	7247.	5342.	3046.	1642.
4/19/75	1800.	4049.	1761.	153.		5491.	6606.	4825.	2911.	-1633.
4/20/75	2117.	4786.	2103.	302.		7381.	10269.	13382.	15600.	18560.
4/21/75	1876.	3709.	1692.	213.		5777.	7751.	9494.	11309.	13667.
4/22/75	1710.	2792.	1611.	174.		4608.	6427.	7823.	9098.	10541.
4/23/75	1526.	2225.	1310.	47.		3754.	5002.	4317.	3620.	3688.
4/24/75	1238.	1617.	926.	12.		2499.	2808.	893.	-192.	-1396.
4/25/75	1496.	2237.	1822.	206.		4321.	7058.	10177.	11899.	12418.
4/26/75	985.	1455.	1282.	79.		2132.	3079.	2949.	3484.	4730.
4/27/75	1026.	1802.	1214.	-57.		2762.	3642.	1308.	-1151.	-3638.
4/28/75	1068.	2101.	1553.	150.		3439.	5447.	7454.	9180.	10963.
4/29/75	935.	1799.	1305.	77.		2843.	4231.	4476.	4844.	5722.
4/30/75	823.	1561.	1286.	81.		2330.	3605.	3991.	4397.	4591.
TOTAL =	50604.	112414.	79693.	5579.		163943.	244349.	252491.	254579.	256598.
MEAN =	1687.	3747.	2656.	186.		5465.	8145.	8416.	8486.	8553.

DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
5/ 1/75	794.	1662.	1326.	64.		2314.	3333.	1874.	-252.	-3135.
5/ 2/75	838.	1688.	1595.	139.		2614.	4402.	5860.	7813.	10516.
5/ 3/75	832.	1674.	1412.	6.		2556.	3975.	3303.	1627.	-1090.
5/ 4/75	853.	1653.	1809.	162.		2523.	4421.	5784.	8063.	10226.
5/ 5/75	1023.	1686.	1810.	36.		2600.	4250.	3666.	3011.	3485.
5/ 6/75	1176.	1971.	1942.	-30.		3095.	4884.	3396.	1257.	-1065.
5/ 7/75	1146.	1766.	1174.	41.		2675.	3482.	2830.	2661.	1849.
5/ 8/75	1362.	2065.	1643.	162.		3852.	6154.	8639.	10801.	13361.
5/ 9/75	1164.	1546.	1331.	87.		2870.	4414.	5050.	5952.	7309.
5/10/75	930.	1198.	1161.	63.		2109.	3253.	3372.	3814.	4286.
5/11/75	758.	984.	999.	-12.		1611.	2379.	1605.	208.	-1580.
5/12/75	597.	698.	848.	-44.		937.	1284.	-348.	-2194.	-4262.
5/13/75	796.	1122.	1203.	-8.		2235.	3764.	3387.	1715.	-749.
5/14/75	483.	627.	732.	20.		858.	1105.	82.	828.	3037.
5/15/75	521.	751.	1018.	30.		1260.	2302.	2364.	1888.	772.
5/16/75	384.	520.	707.	-64.		659.	858.	-1533.	-3652.	-6136.
5/17/75	566.	984.	1741.	213.		1914.	4323.	7663.	11013.	15042.
5/18/75	383.	718.	1852.	71.		994.	2743.	2715.	2289.	1229.
5/19/75	591.	1347.	3375.	618.		2269.	6187.	8508.	9891.	11765.
5/20/75	467.	1952.	2679.	338.		2367.	5010.	5647.	6195.	6543.
5/21/75	472.	3029.	1643.	111.		3506.	5054.	4232.	2831.	1125.
5/22/75	347.	3294.	1191.	37.		3488.	4419.	3211.	1846.	9.
5/23/75	441.	3208.	1468.	209.		3902.	5868.	8474.	10987.	13949.
5/24/75	261.	1865.	903.	15.		2013.	2692.	1951.	1303.	670.
5/25/75	371.	1579.	1160.	157.		2133.	3616.	5093.	7396.	9635.
5/26/75	399.	1190.	958.	52.		1612.	2595.	2654.	3149.	5075.
5/27/75	258.	776.	771.	-10.		734.	1053.	144.	-2468.	-8310.
5/28/75	550.	984.	1043.	290.		1669.	2906.	3466.	4438.	7649.
5/29/75	499.	635.	724.	39.		990.	1461.	357.	-1304.	-3324.
5/30/75	445.	538.	622.	-81.		835.	1071.	-1761.	-4769.	-8196.
5/31/75	336.	384.	738.	10.		474.	825.	-302.	-1136.	-1892.
TOTAL =	20038.	44090.	41576.	2721.		63672.	104082.	101381.	95199.	87792.
MEAN =	646.	1422.	1341.	88.		2054.	3357.	3270.	3071.	2832.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
6/ 1/75	480.	887.	639.	161.		1489.	2166.	1889.	1059.	-34.
6/ 2/75	465.	898.	1799.	299.		1821.	4466.	9024.	13458.	18247.
6/ 3/75	235.	740.	1292.	12.		966.	2187.	1590.	835.	77.
6/ 4/75	183.	958.	732.	15.		1097.	1728.	1282.	846.	460.
6/ 5/75	95.	691.	402.	-55.		564.	591.	-1190.	-2848.	-4337.
6/ 6/75	105.	587.	624.	113.		588.	1298.	3044.	4722.	5980.
6/ 7/75	78.	444.	143.	-125.		417.	80.	-3193.	-6107.	-8633.
6/ 8/75	140.	586.	656.	112.		912.	1913.	3828.	5627.	7240.
6/ 9/75	-10.	184.	219.	-5.		-118.	-306.	-1180.	-1550.	-1977.
6/10/75	138.	562.	636.	69.		953.	2022.	3379.	3826.	3973.
6/11/75	25.	224.	181.	-75.		100.	-52.	-2055.	-4040.	-5763.
6/12/75	-44.	65.	66.	-79.		-307.	-826.	-3251.	-5285.	-8116.
6/13/75	152.	985.	897.	159.		1446.	2919.	5851.	8859.	12668.
6/14/75	-69.	999.	424.	-66.		686.	712.	-1125.	-2817.	-4748.
6/15/75	294.	1029.	438.	-22.		1229.	1541.	854.	-112.	-1513.
6/16/75	703.	820.	436.	21.		1536.	1991.	2128.	2183.	2105.
6/17/75	742.	720.	607.	72.		1674.	2619.	3782.	4638.	5594.
6/18/75	491.	536.	562.	88.		1161.	1941.	3247.	4113.	4575.
6/19/75	360.	537.	507.	75.		1054.	1797.	2895.	4390.	6712.
6/20/75	200.	292.	303.	31.		369.	555.	664.	1286.	2441.
6/21/75	288.	259.	410.	62.		445.	921.	1710.	2540.	3157.
6/22/75	348.	241.	192.	-29.		513.	509.	-276.	-1210.	-2185.
6/23/75	352.	283.	207.	3.		659.	755.	348.	388.	769.
6/24/75	262.	283.	260.	9.		593.	830.	656.	864.	1514.
6/25/75	129.	213.	242.	-21.		306.	472.	-70.	-958.	-2041.
6/26/75	43.	131.	342.	38.		25.	387.	987.	1285.	1119.
6/27/75	61.	210.	213.	-57.		237.	191.	-1222.	-2699.	-4752.
6/28/75	54.	263.	749.	-94.		267.	776.	-1493.	-4169.	-7814.
6/29/75	197.	1576.	1721.	233.		2273.	4917.	9245.	14382.	21614.
6/30/75	26.	2187.	1455.	51.		2211.	3693.	3976.	5122.	6633.
TOTAL =	6521.	18392.	17355.	998.		25166.	42792.	45324.	48628.	52966.
MEAN =	217.	613.	578.	33.		839.	1426.	1511.	1621.	1766.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
7/ 1/75	51.	2990.	1014.	98.		3037.	4029.	4071.	4464.	5422.
7/ 2/75	-16.	3055.	607.	-153.		2905.	3154.	1055.	-3268.	-9325.
7/ 3/75	-31.	2025.	526.	-112.		1707.	1755.	-627.	-3460.	-7488.
7/ 4/75	28.	752.	722.	84.		583.	1142.	2061.	3550.	5247.
7/ 5/75	245.	982.	1230.	152.		1717.	3714.	6317.	8529.	11463.
7/ 6/75	39.	435.	1311.	-27.		334.	1370.	47.	-1434.	-3252.
7/ 7/75	43.	626.	1046.	-21.		429.	1174.	116.	-1158.	-2855.
7/ 8/75	199.	1375.	1767.	43.		1642.	3353.	3315.	4089.	4776.
7/ 9/75	195.	1847.	1156.	-102.		1803.	2653.	581.	-2317.	-5680.
7/10/75	519.	1950.	1024.	206.		2430.	3490.	4550.	5675.	7123.
7/11/75	538.	1398.	699.	574.		1753.	2090.	908.	-748.	-2647.
7/12/75	711.	1352.	1375.	1873.		2054.	3299.	3832.	1927.	-362.
7/13/75	1129.	2427.	5170.	2944.		3571.	8861.	12571.	13340.	14033.
7/14/75	1592.	4020.	18362.	2788.		5953.	24942.	30358.	32501.	34772.
7/15/75	2086.	5028.	28980.	1357.		7301.	36794.	41156.	44104.	47538.
7/16/75	2738.	9327.	29790.	1416.		12295.	42300.	44000.	44142.	44204.
7/17/75	3282.	19126.	25064.	2048.		22584.	47969.	51832.	53703.	55893.
7/18/75	4670.	27230.	18363.	886.		31755.	50098.	52316.	53889.	55535.
7/19/75	7082.	28146.	10394.	457.		34418.	43982.	43516.	43274.	43330.
7/20/75	7968.	25202.	3315.	232.		32307.	34573.	32927.	31766.	30667.
7/21/75	7617.	20462.	2400.	229.		27908.	30139.	30748.	31186.	31340.
7/22/75	6424.	15486.	1968.	127.		22258.	24499.	24713.	24359.	23596.
7/23/75	5273.	11435.	4605.	126.		17225.	22178.	22521.	23224.	24809.
7/24/75	4163.	7870.	3092.	328.		12520.	15899.	15343.	13859.	11909.
7/25/75	3439.	5174.	2156.	267.		9278.	12100.	12751.	12042.	10988.
7/26/75	3088.	3212.	2274.	332.		6844.	9860.	13236.	16664.	20730.
7/27/75	2858.	2303.	1580.	117.		5371.	7085.	7019.	6800.	6928.
7/28/75	2153.	1480.	965.	-47.		3308.	3660.	788.	-2026.	-5287.
7/29/75	1654.	1768.	1397.	123.		3719.	5475.	6777.	7502.	7748.
7/30/75	1023.	1351.	1313.	128.		2461.	4008.	5565.	7311.	9406.
7/31/75	685.	1065.	1099.	77.		1744.	2834.	3248.	4208.	5722.
TOTAL =	71448.	210896.	174763.	16549.		283210.	458478.	477610.	477698.	476282.
MEAN =	2305.	6803.	5638.	534.		9136.	14790.	15407.	15410.	15364.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
8/ 1/75	601.	1250.	685.	134.		2014.	2858.	3126.	3031.	3014.
8/ 2/75	372.	901.	596.	26.		1331.	1981.	1882.	1463.	814.
8/ 3/75	246.	728.	409.	-19.		886.	1098.	138.	-862.	-1669.
8/ 4/75	290.	725.	484.	25.		994.	1437.	1285.	1063.	625.
8/ 5/75	258.	638.	390.	-2.		817.	1069.	476.	-141.	-790.
8/ 6/75	299.	803.	593.	10.		1177.	1844.	1565.	722.	-393.
8/ 7/75	332.	1155.	2040.	110.		1440.	3504.	4725.	6415.	8045.
8/ 8/75	725.	2408.	1843.	76.		3169.	5115.	5864.	7087.	8674.
8/ 9/75	899.	2545.	837.	-34.		3238.	3766.	2695.	1346.	-287.
8/10/75	846.	1922.	575.	-2.		2664.	3060.	2470.	1968.	1637.
8/11/75	817.	1197.	507.	-67.		1963.	2361.	837.	-1347.	-3476.
8/12/75	844.	981.	526.	83.		1891.	2437.	3253.	4564.	5856.
8/13/75	784.	741.	397.	-21.		1447.	1662.	666.	-500.	-2046.
8/14/75	832.	780.	548.	28.		1700.	2385.	2665.	2760.	2496.
8/15/75	665.	627.	306.	17.		1242.	1368.	827.	900.	1454.
8/16/75	566.	755.	607.	44.		1486.	2406.	3221.	3128.	2753.
8/17/75	389.	757.	2261.	95.		1262.	3727.	5043.	6582.	8500.
8/18/75	178.	1145.	1308.	72.		1020.	2070.	2518.	3750.	4614.
8/19/75	692.	2547.	809.	-13.		3513.	4574.	4319.	3358.	2368.
8/20/75	650.	1960.	372.	-50.		2332.	2294.	880.	-470.	-1740.
8/21/75	930.	1253.	475.	46.		2199.	2674.	3046.	3714.	4671.
8/22/75	546.	955.	469.	13.		1617.	2215.	2261.	1960.	1379.
8/23/75	530.	714.	388.	43.		1243.	1633.	1945.	2645.	3715.
8/24/75	492.	604.	339.	2.		1047.	1315.	1046.	638.	187.
8/25/75	382.	457.	191.	-25.		656.	548.	-370.	-1063.	-1845.
8/26/75	369.	612.	453.	16.		1058.	1600.	1736.	1760.	1827.
8/27/75	276.	690.	543.	69.		1064.	1790.	2727.	3894.	5066.
8/28/75	223.	843.	470.	40.		1251.	1964.	2358.	2900.	3756.
8/29/75	23.	428.	114.	-98.		215.	-95.	-1856.	-4320.	-7041.
8/30/75	81.	497.	241.	-20.		492.	557.	-159.	-608.	-937.
8/31/75	22.	332.	34.	-69.		90.	-339.	-2263.	-4247.	-7307.
TOTAL =	15160.	31950.	19809.	531.		46517.	64879.	58926.	52094.	43922.
MEAN =	489.	1031.	639.	17.		1501.	2093.	1901.	1680.	1417.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
9/ 1/75	297.	1663.	1303.	307.		2385.	4391.	7444.	9426.	11301.
9/ 2/75	148.	1217.	2866.	101.		1601.	4831.	6300.	7723.	9430.
9/ 3/75	63.	1761.	1437.	-39.		1665.	2863.	1640.	273.	-1239.
9/ 4/75	591.	2449.	508.	-69.		2660.	2631.	578.	-1285.	-3570.
9/ 5/75	1585.	3415.	757.	81.		5146.	6142.	7531.	9084.	11006.
9/ 6/75	1441.	2898.	527.	-51.		4070.	4206.	2721.	863.	-1719.
9/ 7/75	1359.	1727.	2085.	17.		3197.	5318.	5204.	6036.	8359.
9/ 8/75	1047.	1205.	1865.	99.		2389.	4535.	6230.	7646.	8687.
9/ 9/75	822.	1758.	1518.	18.		2462.	3877.	3876.	3797.	3483.
9/10/75	1068.	2800.	1213.	36.		4120.	5613.	6209.	6403.	6508.
9/11/75	916.	2430.	514.	-97.		3097.	3155.	771.	-1430.	-3612.
9/12/75	1185.	1859.	854.	44.		3101.	4082.	4723.	5051.	4894.
9/13/75	1580.	1547.	1264.	169.		3590.	5514.	8519.	11631.	15496.
9/14/75	1449.	1123.	1176.	101.		2712.	4125.	5268.	7557.	10885.
9/15/75	1247.	1058.	958.	69.		2385.	3499.	4016.	5062.	6342.
9/16/75	904.	876.	626.	-54.		1654.	1994.	906.	-1952.	-6097.
9/17/75	964.	1166.	1095.	154.		2242.	3544.	4578.	5828.	7433.
9/18/75	715.	955.	976.	-16.		1441.	2099.	1097.	-495.	-2782.
9/19/75	842.	2070.	1126.	12.		2867.	3918.	3538.	3009.	2466.
9/20/75	830.	3012.	801.	-56.		3587.	3978.	2207.	841.	-320.
9/21/75	1046.	4389.	1204.	91.		5694.	7328.	8958.	9792.	10267.
9/22/75	886.	4976.	827.	13.		5696.	6246.	5675.	5935.	6719.
9/23/75	921.	5038.	3719.	-117.		5606.	8689.	5538.	1848.	-3053.
9/24/75	1578.	4910.	12542.	53.		6591.	19298.	19895.	20404.	20963.
9/25/75	2214.	4637.	7785.	60.		6815.	14630.	15320.	15999.	16751.
9/26/75	2864.	6563.	16744.	333.		9565.	26478.	27204.	33772.	41608.
9/27/75	3798.	10448.	16041.	782.		14549.	31157.	34792.	31301.	26891.
9/28/75	4319.	11802.	5393.	137.		16072.	21321.	20917.	20512.	20078.
9/29/75	4667.	12187.	2127.	109.		16751.	18884.	19926.	20765.	21572.
9/30/75	4794.	13444.	1540.	49.		18112.	19513.	19629.	20075.	20842.
TOTAL =	46141.	115383.	91391.	2338.		161820.	253858.	261208.	265472.	269587.
MEAN =	1538.	3846.	3046.	78.		5394.	8462.	8707.	8849.	8986.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
10/ 1/75	4849.	14074.	1432.	154.		19146.	20777.	21371.	21270.	20911.
10/ 2/75	4149.	11165.	1160.	65.		15192.	16219.	16624.	18296.	20509.
10/ 3/75	3758.	8664.	1178.	19.		12710.	14139.	14169.	13240.	12161.
10/ 4/75	3060.	5595.	941.	45.		8724.	9665.	9809.	10583.	11811.
10/ 5/75	2570.	3588.	798.	-36.		6290.	7019.	5903.	4007.	1235.
10/ 6/75	2091.	2236.	865.	27.		4404.	5291.	5199.	5088.	4898.
10/ 7/75	1616.	1505.	676.	-12.		3006.	3430.	2438.	1657.	934.
10/ 8/75	1265.	1275.	589.	-79.		2416.	2698.	496.	-2069.	-4881.
10/ 9/75	1210.	1620.	1336.	161.		3163.	5042.	7604.	9932.	12334.
10/10/75	983.	1693.	2352.	108.		2915.	5596.	7034.	8606.	10884.
10/11/75	624.	1495.	1042.	-96.		1739.	2137.	-736.	-3462.	-6559.
10/12/75	812.	2079.	1285.	128.		3147.	4865.	6977.	8693.	10154.
10/13/75	698.	1766.	933.	24.		2579.	3616.	3542.	3262.	3202.
10/14/75	602.	1404.	779.	13.		1985.	2712.	2339.	1820.	1014.
10/15/75	543.	1190.	702.	28.		1696.	2310.	2084.	2160.	2676.
10/16/75	535.	1122.	794.	79.		1683.	2567.	3409.	4274.	5092.
10/17/75	394.	828.	499.	-37.		959.	1018.	-976.	-3153.	-5722.
10/18/75	574.	1593.	1668.	376.		2261.	4207.	6052.	7269.	8189.
10/19/75	704.	2465.	2173.	265.		3342.	5784.	7389.	9055.	11254.
10/20/75	835.	3015.	1466.	143.		4023.	5725.	6761.	7945.	9329.
10/21/75	807.	2667.	740.	-32.		3157.	3437.	1723.	-226.	-2573.
10/22/75	1065.	2490.	815.	28.		3552.	4313.	3941.	3559.	3334.
10/23/75	1153.	1867.	970.	123.		3189.	4461.	6147.	7773.	9257.
10/24/75	1136.	1515.	912.	85.		2909.	4117.	4926.	6092.	7975.
10/25/75	681.	715.	291.	-116.		874.	350.	-2796.	-6334.	-10793.
10/26/75	1008.	1376.	1099.	119.		2784.	4500.	6540.	7605.	7767.
10/27/75	936.	1271.	991.	124.		2457.	3784.	5189.	7345.	11173.
10/28/75	554.	734.	373.	-88.		818.	452.	-2247.	-5093.	-8663.
10/29/75	840.	1243.	827.	40.		2280.	3307.	3512.	3278.	2544.
10/30/75	875.	1248.	1096.	236.		2365.	4044.	7410.	12355.	18695.
10/31/75	770.	1077.	646.	-19.		1894.	2502.	1947.	605.	-616.
TOTAL =	41696.	84577.	31429.	1875.		127657.	160084.	163780.	165432.	167528.
MEAN =	1345.	2728.	1014.	60.		4118.	5164.	5283.	5337.	5404.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
11/ 1/75	646.	908.	469.	27.		1346.	1419.	-156.	-2520.	-5934.
11/ 2/75	604.	821.	627.	2.		1252.	1719.	1188.	489.	-328.
11/ 3/75	689.	976.	766.	86.		1764.	2671.	3584.	4698.	6135.
11/ 4/75	1297.	769.	622.	16.		1946.	2400.	1965.	1532.	1078.
11/ 5/75	590.	928.	824.	84.		1631.	2658.	3599.	4633.	6020.
11/ 6/75	468.	742.	566.	-8.		1103.	1463.	626.	-293.	-1324.
11/ 7/75	444.	742.	562.	-15.		1098.	1455.	408.	-691.	-2028.
11/ 8/75	412.	721.	662.	35.		1045.	1606.	1519.	1475.	1435.
11/ 9/75	518.	1033.	903.	96.		1826.	3106.	4447.	5699.	7159.
11/10/75	378.	811.	639.	1.		1147.	1665.	977.	230.	-636.
11/11/75	507.	999.	984.	137.		1777.	3206.	5095.	7531.	10637.
11/12/75	251.	529.	575.	-73.		436.	454.	-1657.	-4234.	-7380.
11/13/75	589.	1774.	4419.	295.		2795.	7973.	11141.	13950.	17017.
11/14/75	782.	2989.	6964.	288.		4021.	11447.	13248.	17213.	22932.
11/15/75	800.	3594.	3519.	-30.		4264.	7485.	6505.	4191.	1194.
11/16/75	1329.	4135.	1666.	4.		5328.	6810.	6321.	4937.	2440.
11/17/75	1890.	4992.	1422.	99.		6984.	8549.	9169.	10602.	12842.
11/18/75	1812.	4738.	1106.	10.		6512.	7524.	7219.	6351.	4998.
11/19/75	1701.	3752.	1080.	41.		5472.	6552.	6588.	6607.	6644.
11/20/75	1460.	2437.	912.	-5.		3787.	4515.	3930.	2835.	1326.
11/21/75	1443.	1966.	1094.	97.		3504.	4752.	5465.	6914.	8417.
11/22/75	1232.	1500.	881.	-2.		2639.	3334.	2810.	1883.	1108.
11/23/75	1381.	1718.	1251.	177.		3412.	5171.	6798.	9653.	12340.
11/24/75	1185.	1627.	1541.	104.		2898.	4573.	5138.	6428.	10229.
11/25/75	894.	1596.	1140.	-92.		2174.	2778.	1134.	-2984.	-9632.
11/26/75	1018.	2225.	1179.	-30.		3241.	4338.	3228.	1177.	-1584.
11/27/75	751.	1752.	676.	-87.		2033.	1942.	-1171.	-4024.	-7363.
11/28/75	1046.	2280.	1501.	232.		3757.	6001.	9830.	13860.	18610.
11/29/75	799.	1694.	895.	-33.		2452.	3173.	1797.	-65.	-2142.
11/30/75	1196.	1621.	965.	32.		2828.	3813.	3713.	3460.	3326.
TOTAL =	28111.	56368.	40409.	1486.		84472.	124551.	124459.	121535.	117535.
MEAN =	937.	1879.	1347.	50.		2816.	4152.	4149.	4051.	3918.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
12/ 1/75	731.	1555.	1236.	192.		2083.	3056.	3494.	4138.	4239.
12/ 2/75	934.	1805.	1696.	143.		3283.	5662.	7642.	10007.	13843.
12/ 3/75	593.	1168.	1109.	-61.		1624.	2372.	538.	-2236.	-6229.
12/ 4/75	688.	1306.	1357.	98.		2177.	3651.	4641.	6070.	7984.
12/ 5/75	640.	1173.	1280.	68.		1990.	3321.	3808.	4491.	5412.
12/ 6/75	547.	1020.	1123.	7.		1599.	2508.	1892.	1380.	1038.
12/ 7/75	731.	1342.	1545.	130.		2531.	4473.	5908.	7519.	9412.
12/ 8/75	621.	1329.	3742.	122.		1932.	5382.	4024.	1318.	-2678.
12/ 9/75	913.	2493.	6162.	393.		3729.	9959.	10749.	11067.	11513.
12/10/75	1176.	3629.	4902.	386.		5404.	10570.	12267.	14412.	17496.
12/11/75	1024.	3586.	3300.	37.		4568.	7177.	4083.	308.	-4665.
12/12/75	1311.	4590.	2694.	168.		6420.	9299.	10262.	10890.	11556.
12/13/75	1356.	4808.	2286.	178.		6828.	9439.	11204.	12974.	15177.
12/14/75	1287.	4268.	1937.	91.		6099.	8143.	8530.	8740.	9097.
12/15/75	1140.	3005.	1578.	10.		4237.	5419.	4096.	2928.	1611.
12/16/75	1436.	2901.	2049.	173.		5159.	7818.	10129.	12240.	14535.
12/17/75	1256.	2115.	1651.	75.		3893.	5537.	5645.	5863.	6110.
12/18/75	1394.	2119.	1899.	448.		4151.	6506.	8577.	12369.	17923.
12/19/75	1070.	1639.	1411.	155.		2919.	4113.	3612.	1920.	-295.
12/20/75	936.	1458.	1306.	84.		2565.	3617.	2989.	1443.	-1212.
12/21/75	1121.	1761.	1852.	316.		3567.	6083.	8415.	13462.	19941.
12/22/75	748.	1232.	1238.	-22.		2160.	3074.	1938.	-584.	-2522.
12/23/75	671.	1199.	1286.	43.		1731.	2797.	2389.	1294.	-786.
12/24/75	713.	1266.	1322.	45.		1962.	3223.	3020.	2333.	1333.
12/25/75	574.	1034.	1090.	-52.		1388.	2092.	287.	-2744.	-6873.
12/26/75	637.	1178.	2124.	386.		1691.	3585.	2887.	1714.	-88.
12/27/75	960.	2198.	5415.	763.		3473.	9394.	12122.	14031.	16636.
12/28/75	1081.	3027.	4662.	442.		4324.	9352.	11340.	13377.	15935.
12/29/75	1014.	3413.	2496.	248.		4504.	6996.	7369.	7759.	8306.
12/30/75	993.	3617.	1873.	101.		4665.	6258.	5030.	2793.	-420.
12/31/75	1106.	3677.	2572.	531.		5069.	7882.	10112.	12486.	15797.
TOTAL =	29405.	70912.	70192.	5697.		107725.	178758.	188997.	193760.	199127.
MEAN =	949.	2287.	2264.	184.		3475.	5766.	6097.	6250.	6423.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH	CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63					
RIVER MILES ABOVE US 17					45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.	2564.	4212.	4603.	4835.	4885.
DATE :									
1/ 1/76	1503.	3749.	8624.	1494.	5597.	14191.	15378.	14889.	13983.
1/ 2/76	1796.	3594.	11891.	674.	5581.	17368.	17620.	16970.	16178.
1/ 3/76	2192.	4161.	12039.	440.	6629.	18708.	19260.	18912.	17673.
1/ 4/76	2511.	5148.	6427.	426.	8106.	14786.	16367.	18663.	22239.
1/ 5/76	2535.	6303.	4828.	275.	9196.	14109.	14547.	14967.	15921.
1/ 6/76	2391.	6841.	4174.	227.	9522.	13733.	14205.	14944.	15859.
1/ 7/76	2090.	5990.	3676.	75.	8081.	11343.	10110.	7756.	4445.
1/ 8/76	2273.	5360.	4998.	866.	8214.	13700.	16406.	19124.	21837.
1/ 9/76	2164.	4166.	5589.	693.	6705.	12344.	12866.	12473.	13319.
1/10/76	1965.	3584.	4546.	355.	5703.	10013.	9421.	7608.	5104.
1/11/76	1875.	3531.	3993.	315.	5566.	9447.	9657.	9684.	9793.
1/12/76	1862.	3520.	4126.	345.	5794.	10151.	11367.	12660.	13913.
1/13/76	1553.	2758.	3622.	94.	4382.	7554.	5355.	2502.	205.
1/14/76	1657.	2977.	4155.	370.	5238.	9924.	12562.	15260.	17459.
1/15/76	1336.	2425.	3730.	182.	4018.	7639.	7273.	6379.	5229.
1/16/76	1283.	2403.	3864.	275.	4050.	8137.	9325.	10898.	12626.
1/17/76	1288.	2344.	3964.	381.	4114.	8558.	10292.	13368.	18325.
1/18/76	1122.	1987.	3438.	212.	3348.	6641.	6421.	5995.	5712.
1/19/76	1001.	1709.	3193.	124.	2909.	5895.	5467.	4043.	1918.
1/20/76	866.	1457.	3088.	62.	2478.	5343.	4686.	2438.	-1212.
1/21/76	942.	1517.	3634.	231.	2743.	6591.	7665.	10575.	15706.
1/22/76	783.	1460.	3402.	81.	2367.	5647.	5259.	3775.	1333.
1/23/76	738.	1476.	3298.	75.	2341.	5517.	5118.	3684.	1278.
1/24/76	614.	1280.	3096.	24.	1811.	4473.	3083.	1091.	-1705.
1/25/76	892.	1768.	3651.	192.	3173.	7308.	8863.	10786.	13258.
1/26/76	630.	1365.	3513.	44.	2047.	5338.	4618.	3062.	707.
1/27/76	796.	1895.	9464.	1853.	2817.	12383.	14774.	14912.	14794.
1/28/76	1743.	4051.	17866.	3635.	6160.	24489.	30146.	32999.	36963.
1/29/76	2627.	5931.	16066.	3562.	8570.	24550.	28008.	27807.	27255.
1/30/76	3453.	8646.	12557.	2809.	12111.	24545.	27116.	26886.	26710.
1/31/76	3820.	11467.	6094.	1070.	15320.	21359.	22565.	22986.	23563.
TOTAL =	52301.	114861.	186607.	21462.	174691.	361784.	385800.	388098.	390389.
MEAN =	1687.	3705.	6020.	692.	5635.	11670.	12445.	12519.	12593.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
2/ 1/76	3680.	12116.	2258.	650.		15456.	16974.	15416.	12541.	8664.
2/ 2/76	3871.	11360.	7740.	2916.		15249.	23086.	27742.	29768.	32104.
2/ 3/76	4345.	10034.	9412.	2926.		14477.	23889.	26961.	27194.	27700.
2/ 4/76	4606.	8873.	5305.	1444.		13704.	19091.	20604.	20820.	21476.
2/ 5/76	4613.	8686.	3278.	847.		13700.	17348.	19045.	20180.	21864.
2/ 6/76	4332.	8909.	2722.	657.		13839.	17022.	18413.	19806.	21119.
2/ 7/76	3778.	8109.	2294.	474.		12380.	14827.	15311.	15387.	16174.
2/ 8/76	3063.	6249.	1800.	278.		9352.	10815.	9940.	7314.	3494.
2/ 9/76	2856.	5233.	1881.	341.		8576.	10603.	11174.	12011.	13695.
2/10/76	2417.	3907.	1742.	289.		6543.	8339.	8969.	9403.	9477.
2/11/76	2173.	3339.	1541.	159.		5810.	7227.	6300.	4530.	1939.
2/12/76	2001.	3030.	1752.	311.		5391.	7455.	9030.	11505.	14880.
2/13/76	1646.	2571.	1463.	140.		4380.	5789.	5619.	4554.	2854.
2/14/76	1487.	2432.	1507.	209.		4142.	5718.	6239.	7473.	9565.
2/15/76	1254.	2212.	1381.	160.		3621.	4956.	5043.	4968.	4711.
2/16/76	1112.	2096.	1341.	105.		3270.	4516.	4145.	2920.	1263.
2/17/76	1021.	2027.	1368.	133.		3135.	4490.	4511.	4327.	3982.
2/18/76	830.	1754.	1281.	140.		2424.	3506.	3568.	4050.	4620.
2/19/76	931.	1991.	1342.	78.		3093.	4470.	4102.	3131.	2289.
2/20/76	810.	1804.	1377.	149.		2657.	4086.	4616.	5357.	6096.
2/21/76	699.	1631.	1095.	10.		2221.	3012.	1750.	-122.	-2107.
2/22/76	748.	1740.	1417.	161.		2560.	4076.	4989.	6163.	6942.
2/23/76	737.	1816.	1719.	163.		2625.	4397.	4493.	4005.	3813.
2/24/76	725.	1925.	1647.	178.		2710.	4409.	4819.	5703.	7125.
2/25/76	742.	2010.	1462.	150.		2869.	4468.	4842.	4729.	4034.
2/26/76	710.	1842.	1307.	135.		2605.	3972.	4216.	4941.	6482.
2/27/76	738.	1758.	1368.	181.		2601.	4180.	4996.	6652.	8954.
2/28/76	613.	1487.	1018.	29.		1998.	2751.	1986.	269.	-2281.
2/29/76	625.	1435.	1135.	67.		2037.	3099.	2882.	2169.	1128.
TOTAL =	57164.	122375.	64951.	13480.		183423.	248571.	261721.	261744.	262055.
MEAN =	1971.	4220.	2240.	465.		6325.	8571.	9025.	9026.	9036.

***** DAILY DISCHARGES, IN CUBIC FEET PER SECOND, AT SELECTED POINTS ALONG THE CHOWAN RIVER *****

	BLACKWATER RIVER NR MOUTH	NOTTOWAY RIVER NR MOUTH	MEHERRIN RIVER NR MOUTH	WICCACON RIVER NR MOUTH		CHOWAN R. NR EURE 02050160	CHOWAN R. AT WINTON 02053244	CHOWAN R. NR HARLSV. 02053573	CHOWAN R. NR COLERAIN 02053633	CHOWAN R. NR EDENHOUSE 02053652
RIVER MILES ABOVE MOUTH	1.27	1.99	0.47	1.63	RIVER MILES ABOVE US 17	45.46	35.49	22.29	11.38	0.00
DRAINAGE AREA IN SQ.MI.	743.5	1700.5	1616.	271.		2564.	4212.	4603.	4835.	4885.
DATE :										
3/ 1/76	682.	1509.	1134.	193.		2220.	3382.	3699.	4312.	5247.
3/ 2/76	585.	1315.	1089.	72.		1912.	2995.	2923.	2694.	2642.
3/ 3/76	312.	817.	679.	-45.		588.	505.	-1608.	-4196.	-7541.
3/ 4/76	646.	1483.	1315.	149.		2438.	4205.	5654.	6745.	8011.
3/ 5/76	428.	1049.	919.	31.		1278.	1904.	1076.	288.	-702.
3/ 6/76	636.	1505.	1357.	156.		2480.	4299.	5691.	6573.	6722.
3/ 7/76	589.	1426.	1185.	124.		2192.	3588.	4091.	5641.	8779.
3/ 8/76	460.	1221.	925.	39.		1609.	2392.	2049.	1223.	-180.
3/ 9/76	567.	1467.	2081.	202.		2137.	4426.	5678.	7788.	10278.
3/10/76	778.	2322.	4652.	357.		3136.	7839.	8328.	7841.	7567.
3/11/76	898.	2991.	4033.	233.		3625.	7293.	6806.	5104.	2086.
3/12/76	1291.	3960.	2192.	100.		5226.	7146.	5273.	3029.	1265.
3/13/76	1637.	4896.	2175.	316.		6867.	9528.	11937.	14499.	16440.
3/14/76	1417.	4274.	1622.	121.		5640.	7180.	7064.	6402.	6046.
3/15/76	1420.	3411.	1522.	126.		4872.	6412.	6554.	6521.	6509.
3/16/76	1445.	2669.	1723.	345.		4320.	6478.	8777.	15565.	25890.
3/17/76	1321.	2114.	1503.	173.		3479.	4836.	3965.	-431.	-7534.
3/18/76	1162.	1778.	1257.	147.		2739.	3620.	2642.	510.	-1672.
3/19/76	1155.	1650.	1125.	146.		2585.	3360.	2459.	959.	-1443.
3/20/76	1199.	1764.	1279.	173.		3096.	4448.	4751.	5086.	5904.
3/21/76	983.	1491.	998.	21.		2455.	3155.	1100.	-1594.	-5671.
3/22/76	892.	1485.	1520.	281.		2464.	4463.	7650.	11534.	16583.
3/23/76	791.	1396.	1186.	147.		2291.	3587.	4141.	5431.	7590.
3/24/76	668.	1230.	985.	42.		1900.	2752.	2280.	1128.	-520.
3/25/76	716.	1360.	1059.	62.		2347.	3456.	3233.	2625.	1878.
3/26/76	495.	1024.	1156.	156.		1432.	2595.	3405.	5132.	7393.
3/27/76	570.	1164.	913.	-46.		1858.	2531.	1126.	-1839.	-5709.
3/28/76	544.	1153.	1199.	160.		1818.	3193.	4230.	6510.	9569.
3/29/76	456.	1014.	1053.	100.		1456.	2484.	2776.	3355.	3993.
3/30/76	611.	1405.	1163.	56.		2352.	3681.	3703.	2480.	459.
3/31/76	385.	1162.	1013.	-73.		1227.	1635.	-718.	-3860.	-7293.
TOTAL =	25739.	57505.	46010.	4063.		84039.	129369.	130731.	127055.	122587.
MEAN =	830.	1855.	1484.	131.		2711.	4173.	4217.	4099.	3954.

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