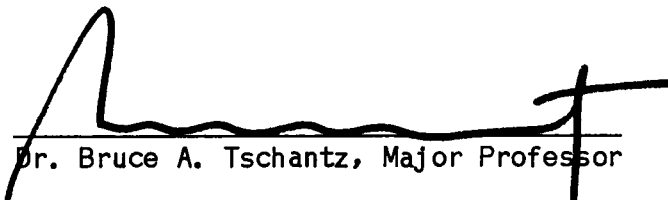


To the Graduate Council:

I am submitting herewith a dissertation written by J B Turnmire entitled "Simulated Discharge from Small Watersheds Before, During, and After Disturbance." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Civil Engineering.



Dr. Bruce A. Tschantz, Major Professor

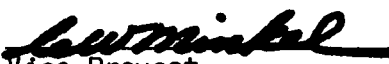
We have read this dissertation
and recommend its acceptance:

Bernard J. Frederick, P.E.

Dennis W. Woot

Henry H. Finlany

Accepted for the Council:


Vice Provost
and Dean of The Graduate School

SIMULATED DISCHARGE FROM SMALL WATERSHEDS
BEFORE, DURING, AND AFTER DISTURBANCE

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

J B Turnmire

December 1987

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ABSTRACT

This study deals with the problem of inadequate historical hydrologic data, specifically the lack of good records for small watersheds. The ability to develop effective designs for projects dealing with drainage of a small watershed and to evaluate the potential impact of these designs upon the hydrology depends upon the ability to perform an interpretive analysis of hydrologic information. The lack of a historical record limits (precludes) the evaluation of potential impacts by inferences drawn from historical trends. The most obvious impact of development on a watershed is an immediate increase in stormwater runoff and surface erosion. The driving force behind these changes is rainfall. A rainfall generator was developed during the course of this study. The rainfall generator is based on a random number process and rainfall probabilities. This rainfall generator is linked with standard Soil Conservation Service techniques used for design of drainage control facilities for small watersheds. The procedures developed allow the evaluation of probable impacts of a proposed project upon the hydrology of a small watershed under seasonal conditions. Provisions are made for generation of daily precipitation (amount) on a continuous basis for any period of interest.

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I. INTRODUCTION

The world population has reached five billion with the expectation that this number will double by 2030. The phenomenal growth in human kind's activities represents an inevitable significant impact on the global environment. The projected doubling of world population over the next 40 years (1) will result in human kind placing ever increasing demands upon limited resources. "With world population growing rapidly, the water resources of the world are becoming one of its most important assets." (2) There will be significant increases in urbanization and industrialization resulting in unprecedented deforestation and encroachment by human kind upon the natural environment. For some time, the activities of human kind have been known to affect the environment on a local and regional level. However, concerned scientists now believe that these activities have started a trend which will result in global climatic changes, popularly referred to as the "greenhouse" effect (3). Human kind is becoming aware of the global limits of the environment to absorb the impacts of their projects without showing long term adverse effects of the blatant disregard for the ecological balance which has existed for eons. The hydrologic cycle for the worlds water resources is an integral part of this balance and a major driving force in the environment.

One of human kind's first interactions is with the natural vegetative cover. The natural cover is reduced by logging, the type is changed for farming, and it is removed for urban and industrial

development. These activities have an immediate effect on the hydrologic balance by increasing the surface water runoff. The secondary impact is to the ground water by reducing the quantity of precipitation available for surface infiltration and recharge that have sustained the ground water reservoirs. The longer term impacts (to the hydrology) associated with human kind's development and utilization of the environment involve depletion and contamination of the water resources. These problems will become more acute as increased demands are exerted by the continued increase in world population.

Development historically has taken place on a relatively small scale: a new home, a new barn, a new factory. In recent times this has escalated to a subdivision here, an industrial park there, with more emphasis on substantial developments. The major design considerations being given to hydrology are associated primarily with the project at hand, and minimizing impacts to the proposed project from the elements. Minimal consideration has been given to the potential impacts that these "small" developments may have on the hydrology of the immediate watershed. This has resulted in numerous problems such as flooding, springs which cease to flow, and wells that are contaminated and have lower yields.

Statement of Problem

The major problem associated with quantifying potential impacts of "small" projects on small watersheds is the lack of recorded hydrologic data to use as a basis for evaluation. Daily rainfall is

recorded at 70+ reporting stations in the State of Tennessee (4); 30+ of these stations only report the accumulated 24-hour precipitation total. Streamflow has been recorded at 3,000+ stations (5) in the State of Tennessee; 863 of these stations provide information on watersheds of 5 sq. miles or less total drainage area. There are only 71 of these which are continuous or partial-record stations (6) with more than 10 observations. For any given water year (October 1 through September 30), there are records published for less than 200 stations (7). Even fewer stations record evaporation, relative humidity, solar radiation, and other meteorological characteristics. The evaluation of hydrologic impacts of proposed projects is imperative if we are to make rational decisions and provide designs which are cost effective and do not disrupt the local hydrologic balance. The lack of recorded hydrologic data and observed meteorological conditions to form a basis for evaluating the impact of projects on small watersheds has been a major deterrent to such evaluations by designers and regulators. Local planning commissions and state and federal agencies dealing with environmental concerns have recognized the need to evaluate the impact of development on water resources. Local building codes require drainage control during project construction which minimizes additional contributions of sediment and increased runoff (peak and volume). State agencies (Public Health, Water Resources, etc.) are concerned with the availability of water in time and space. There are numerous federal agencies (Environmental Protection Agency, Bureau of Reclamation, U.S. Geological Survey, Office of Surface Mining, etc.) involved with the

water resources of the United States. The U. S. Department of the Interior, Office of Surface Mines has promulgated regulations [30 CFR, section 780.21(f)] which require a determination of probable hydrological consequences of proposed mining and reclamation projects as follows:

The Application shall contain a determination of the probable hydrologic consequences (PHC) of the proposed operation upon the quality and quantity of surface and ground water under seasonal flow conditions The PHC determination shall be based on baseline hydrologic, . . . and other information collected . . . and may include data statistically representative of the site. (8)

Application of statistical techniques to extend historical records is one method of meeting the requirement for "data statistically representative of the site"; however, in most cases, the lack of historical data on small watersheds precludes this. The availability of digital computers has led to the development of "models" which represent the natural processes (hydrologic) within a watershed. These models are formulated to relate known (quantifiable) watershed characteristics to unknown characteristics and are as diverse as the needs (interest) of the developer. D'Appolonia (9) reported some forty available models applicable to the coal fields in the eastern United States. These models are primary surface water models capable of providing predictions of streamflow. Fourteen of these models have provisions for predicting continuous flows. The other sixteen models provide prediction of storm flows. All of these models either have limited applicability, substantial input data and

calibration requirements, or have difficulty in implementation. Huff, Luxmoore, Mankin, and Begovich (10) developed the Terrestrial Ecosystem Hydrology Model (TEHM), a comprehensive watershed model capable of dealing with intimate details of the hydrology of a watershed. "TEHM combines mechanistic algorithms for climatic and hydrologic processes with vegetation properties to explicitly simulate interception, throughfall, infiltration, root zone evaporation, transpiration, drainage, plant and soil water potential, unsaturated and saturated subsurface flow, surface runoff, and open channel flow." (10) The resources (data and computer) required to implement this model limit the application to projects of major significance (e.g., toxic waste dumps, radioactive waste disposal, etc.) in which potential impacts are enormous. This model was later modified for agricultural applications (AGTEHM) by Hetrick, Holdeman, and Luxmoore (11). The modifications include algorithms for sprinkler and flood irrigation, input data options, a variable-contributing-area function, and a model for coupling soil macropore effects on water flow. The computer and data demands remain high, making this model more suitable for helping to manage a large water resource project, such as the allocation of irrigation water by the U.S. Bureau of Reclamation, than for evaluating the impacts of a project on a small watershed. Simulating a period of one year may require as many as 8,784 values of each variable (there are 61 variables). Measured values of this order of magnitude are rarely available, and are never available on non-research watersheds. Betson, Bales, and Pratt developed TVA-HYSIM, a hydrologic program for quantifying the effects of changes

in land use within the Tennessee Valley (12). This watershed model was developed utilizing data from 48 watersheds ranging in size from 0.2 to 175 sq. miles. TVA-HYSIM consists of "regionalized" components developed by applying statistical techniques to watershed and climatological characteristics. The first step in developing TVA-HYSIM involves statistical manipulation of data and development of model parameters. The second step involves relating the parameters to some combination of watershed and/or climatological characteristics. The third step involves optimizing the chosen parameters to a set of data representing the region of interest. The advantage of this approach is that the model may be applied to watersheds which have no recorded hydrological and meteorological data. The disadvantages of this approach are that: the conditions of the watershed of interest may fall outside the conditions the model was developed for, the results cannot be verified since validation data are not used, and there are no checks and balances for the accuracy of the estimates of watershed and climatological characteristics utilized as input to the model. A sensitivity analysis of basin characteristics utilized by TVA-HYSIM indicates that the model prediction has a critical dependency upon slope, watershed shape, drainage density, curve number, sinuosity, % mined, soil permeability, available water holding capacity, bypass seepage, karst areas, and convolution time of output. Watershed slope and curve number are the only characteristics normally utilized in designing drainage facilities for small watersheds. The additional characteristics require much judgment,

experience, and field verification to provide accurate and reliable results.

The numerous watershed models available generally fall into two groups: those that are based on physical watershed characteristics and theoretical physical relationships (deterministic approach), and those that depend upon statistical techniques to provide predictive relationships. The latter group may be further divided into those models based on classical statistical techniques of frequency analysis, time series, trend analysis, (stochastic approach), and those based on statistical techniques (made practical by computer) which analyze observed data for interrelationships (parametric approach) such as regression analysis and principal component analysis. The U.S. Department of Agriculture Soil Conservation Service (SCS) techniques (13) most often used for designing projects in small watersheds have not been incorporated into models utilized for predictive purposes. Based on the above, there is a need to evaluate watershed impacts, including seasonal variations, utilizing the techniques commonly employed in drainage designs; however, these design techniques are for single events, i.e., storms. However, the need usually involves long term hydrology, i.e., providing continuous predictions.

Study Objective

The objective of this study was to develop a computer-aided procedure which could be utilized to evaluate impacts of alternate design and development philosophies having the purpose of developing

more cost effective projects and safer designs which minimize disruption of the hydrologic cycle. There was no intent to reproduce, by simulation, actual rainfall events or resulting streamflows, but rather to provide a realistic basis for comparison of alternatives in the absence of sufficient actual data to form such a basis.

This objective was accomplished by incorporating the following elements into a computer code:

1. Developing a continuous rainfall generator based upon a pseudo-random generator and actual rainfall records.
2. Computerizing the Soil Conservation Service (SCS) techniques for computing discharge from small watersheds (13, 14, 15).
3. Combining the rainfall generator with the calculation of discharge for small watersheds.
4. Applying this analysis procedure to a watershed(s) with minimal disturbance (for some period of record) and to a watershed(s) with significant disturbance (for some period of record).

II. LITERATURE REVIEW

General

There are literally thousands of articles and books dealing with hydrology and man's interaction with water. Ancient civilizations developed along major rivers in Mesopotamia, Egypt, India, and China. Lee (16) identifies "Thales (about 600 B.C.), . . . "the ancient hydrologist," as the first hydrologist. The general hydrologic cycle for the distribution of water on the earth's surface was first written in the fourth century B.C. by Theophrastus. "The roots of modern hydrology lie deeply buried in antiquity" as stated by Biswas (17). Hydrology is an earth science dealing with the natural distribution of water in our environment. The interactions of the various phases (liquid, gaseous, and solid) over continental land masses are of primary interest. Theoretical hydrology is the theoretical study of these phases and interactions, while applied hydrology is the application of hydrological principles. Chow (18) gives a good accounting of the evolution of modern hydrology and identifies the phases as: (Ancient - 1400) the period of Speculation, (1400 - 1600) the period of Observation, (1600 - 1700) the period of Measurement, (1700 - 1800) the period of Experimentation, (1800 - 1900) the period of Modernization, (1900 - 1930) the period of Empiricism, (1930 - 1950) the period of Rationalization, and (1950 - 1964) the period of Theorization.

Empirical hydrology is a product of the twentieth century and Fouse (19) was one of the first to publish (1929) a "model" of the hydrologic cycle; he initiated work on that model in 1916. This sparked interest in the mathematical development of hydrology with much work being done in the 1930's describing the individual components of the hydrologic cycle. The theory of the unit hydrograph expressed by Sherman (20) in 1932 led to numerous developments in synthetic hydrology relating to streamflow. In 1939 Horton (21) used empirical methods to develop an infiltration equation to describe subsurface flow under unsaturated conditions. This theory was extended to point infiltration by Philip (22) in 1954. These developments mark the initial era of hydrologic "modeling" and culminated in 1959 by Dooge's (23) general linear theory of flood-flow routing.

The advent and availability of digital computers mark the beginning of the current era in simulated hydrology. The Stanford Watershed Model (SWMM), developed by Crawford and Linsley (24) in the early 1960's, generally is held to be the first to combine the many approximation phases of the hydrologic cycle with the computational ability of modern computers. Following the development of SWMM, the field of computer modeling relating to the hydrologic cycle exploded with models being developed by individuals, companies, universities, and state and governmental agencies here and abroad. The diversity of techniques, approaches, and assumptions is mind-staggering, with some "models" dealing with the intimate (deterministic or physical) details of rainfall, surface- and subsurface-flow, percolation to groundwater,

soil-moisture storage, transpiration, evapotranspiration, infiltration, evaporation, etc., while others treat the whole system as a "black box" with disregard for anything other than input and output. The "best" procedures utilize a combination to represent physical conditions by deterministic description including all available physical data, incorporating stochastic processes when no data are available and constraints (time, environment, money, etc.) inhibit and/or prevent collection of actual data.

The world's leading hydrologists maintain that a simultaneous use of both deterministic and stochastic (or statistical) methods of analysis and description of hydrologic processes in nature is necessary for producing the best scientific and practical information for hydrology, in general, and for water resource development, conservation and control, in particular. (25)

The procedures in this report deal with two components of the hydrologic cycle, rainfall and watershed discharge; therefore, a specific literature review for each of these follows.

Rainfall

The first recorded measurements of rainfall were made in India by Kantilya in the fourth century B.C. (16); however, there is little record of rainfall until after Benedetto Castelli constructed the first rain gage in Europe in the early 1600's. The precipitation gage has remained basically the same since, with provisions for continuous record-keeping being incorporated. There are numerous publications providing 24-hour rainfall amounts for all reporting stations, and hourly rainfall amounts for recording stations. There are weekly,

monthly, and yearly reports by universities and state and federal agencies which relate to programs and studies on rainfall and other meteorological events. The first comprehensive rainfall study and report was made by Yarnell (26) in 1936. This work produced 56 rainfall frequency isohyetal maps of the United States which are known as the "Yarnell Rainfall Frequency Data". These maps have been superseded by the publication of rainfall frequencies in the continental United States suitable for design uses by the U. S. Weather Bureau, Technical Paper No. 40 (27). This publication provides rainfall frequencies for durations from 30 minutes to 24 hours and return periods from 1 to 100 years and is a major source for design rainfall events; however, no provisions are made for rainfall sequences. The National Weather Records Center at Asheville, North Carolina, maintains the records of reporting stations in the United States. There are about 13,000 (28) reporting rainfall stations in the United States, which means an average of one station per 230 sq. miles. The reported rainfall observations are maintained as computer files, manuscripts, and microfilm records suitable for copying and distribution.

There have been numerous reports, such as those by Hershfield (29) and Huff and Neill (30), comparing the methods for performing frequency analysis of rainfall. There are a number of methods for taking observed rainfall and analyzing it to provide average rainfall quantities over an area of interest. The method used most often is taking the arithmetic mean of all reporting stations in the vicinity. If reported rainfall shows a wide range of variability at the

reporting stations, other methods may be utilized to provide weighted distribution of the rainfall. The Thiessen and the Isohyetal are two such methods. The Thiessen method assumes that an observation is applicable for half the distance to the next observation point. Utilization of this assumption will result in construction of a "Thiessen" polygon network. The area of each polygon will be used to weight the rainfall observed at the polygon center. The Isohyetal method consists of drawing lines of equal rainfall amounts (isohyets), using observed amounts at stations, and any additional factors available, to adjust or interpolate between observation stations (31). The average depth is calculated by using the area between isohyets to provide weighting. The Guide to Hydrometeorological Practice (32), contains, the application of these and other techniques for providing rainfall depths from observed rainfall. A mathematical method of describing the rainfall patterns of rain gage catches, known as "filtered input field", was proposed in 1966 by Amorocho and Brandstetter (33).

Rainfall records with missing data and reporting stations with varying length of record have been the subject of investigation by Stidd (34), Yin Au-Yeung (35), Hoski and Yamaoka (36), and Fahlbusch and Muir (37). Their efforts led to improvements over the stochastic generation of rainfall using the classical Markov statistical approach for those sites studied. Rainfall records are used to develop probabilities associated with reoccurrence (frequencies) for an interval of time (day, week, etc.) and amount of rain. Fribourg, Strand, Vaiksnoras, and Sanders (38) successfully used the incomplete

gamma probability density function to compute the probabilities of weekly precipitation amounts in Tennessee.

Betson, Bales, and Pratt (12) developed a stochastic rainfall generator using a disaggregation approach, based on cube root transformation of normalized monthly rainfall. Random numbers from a uniform distribution were used to generate values that preserve the mean of the cube root of observed monthly rainfall. The values are converted to monthly rainfall amounts, and disaggregated into daily rainfall using transitional probabilities. The U.S. Weather Service has been forecasting expected precipitation (in inches) for areas approximately 10,000 sq. miles in size since the 1940's. The Weather Service has used two general approaches to forecasting, with better results in forecasting amounts greater than one inch. The flow of moisture is used with consideration of vertical speed, which correlates with areas of light rain and cloudiness to predict expected rainfalls of less than one inch. The interrelated movements of fronts (cold and warm air) and the development of pressure systems studied in relation to moisture flow have provided more consistent and usable predictions. Meteorologists have been successful in predicting local rainfall amounts by using statistical methods and considerable skill in interpreting the U.S. Weather Service Meteorological information. A 5-day forecast is made by the Weather Service for all areas in the United States, three times each week. The forecast reports an expected amount of precipitation and whether this is anticipated to be as much as the upper third, the middle third, or the lower third of the total experienced precipitation for this period and area in

previous years. The literature provides few reported efforts to predict daily rainfall beyond a few days and these are for limited areas (33, 34, 35, 36, 38).

Watershed Discharge

The Egyptians and Romans knew the value of water supply and drainage control projects; however, there is little evidence that they calculated the discharge from watersheds in planning and constructing their famous works. Quantifying streamflow was initiated during the seventeenth century when Mariotte (39) calculated the discharge of the Seine River at Paris, and Halley (40) calculated discharge of streams in his study of the Mediterranean Sea. The eighteenth century ushered in the era of experimentation with the hydraulic aspects of hydrology, resulting in the discovery of basic hydraulic principles. The development of Chezy's formula, the Bernoulli theorem, the rational formula, the Pitot tube, Woltman's current meter, and numerous other devices and theories was seen (41, 42). These efforts led to a quantitative basis for performing hydrologic studies. "The 19th century was in many ways the grand era of experimental hydrology" (18) The nineteenth century saw the beginning of systematic streamflow monitoring as a result of the development of measuring instruments and formulas for calculating flow. The Ellis and Price current meters (43, 44) of the late 1800's were a major step in instrumentation. The development of Francis' weir-discharge formula and Manning's flow formula provided impetus for the development of quantitative hydrology. The close of the century saw the founding of

the Weather Bureau (1891) and Geological Survey (1879) in the United States. The twentieth century saw empirical hydrology explode with hundreds of (empirical) formulas being proposed (45) to quantify all aspects of hydrology. The empirical formulas depended heavily upon judgment and experience in selection and use of the numerous parameters and coefficients. This led to many unacceptable problems associated with solution of practical problems in hydrology, which ushered in the "Period of Rationalization". (18) The use of rational analysis to solve hydrologic problems saw Sherman (20) introduce the unit hydrograph for translating rainfall excess into runoff hydrograph and Horton (21) propose a method of determining rainfall excess by infiltration theory. These events and discoveries set the stage for the current explosion in "modeling" hydrology by statistical and numerical techniques, utilizing the "great number crunchers" of our time. The proliferation of rainfall runoff simulation (computer generated) models is the current trend in developing hydrologic techniques. The same trend exists for relationships among the other hydrologic processes. The major impetus of these models is to transfer information (known) from one or more variables to another (unknown). There are as many models as there are universities and others involved in research and development related to the hydrologic response of watersheds and drainage systems.

The early efforts to "model" watershed response were by using conceptual processes to explain the observable (measurable) physical characteristics and the cause-effect relationships (i.e., rainfall-runoff). This deterministic approach was used by the early

conceptual modelers, Dawdy and O'Donnell (46), Boughton (47), Crawford and Linsley (24), Higgins and Monke (48), Sittner, Schauss, and Monro (49). These early models paved the way for the explosion in modeling the hydrologic responses of watersheds and led to the development of three schools of thought: conceptual or deterministic hydrology, stochastic or random hydrology, and parametric or optimized hydrology, with numerous mixes of these. Crawford's and Linsley's SWMM is generally accepted as the grandfather of watershed models and has been applied to and modified for application to more areas than any other model reported in the open literature. The Stanford model is composed of a number of mathematical expressions which define the relationships and interactions among the individual processes which make up the hydrologic cycle. The model is calibrated to a particular watershed by adjusting (optimizing) model parameters based on observed watershed response to input (rainfall) and output (runoff), until the predicted basin discharge and observed basin discharge meet some acceptable "fit" criteria. In order for the model to perform with a high degree of accuracy, a minimum of ten years of hourly rainfall is needed, with resulting stream discharge and potential evapotranspiration data. These historical data, in addition to watershed characteristics, are used to quantify the 28-parameter model. The model parameters may be divided into four groups: initial moisture conditions, observed (historical) interactions, watershed characteristics. The fourth and most troublesome group is based on trial and error adjustments to make the model "fit". Jackson and Aron (50) reported that rainfall is one of the most critical input variables. Shanholitz and Lillard (51),

Parmelee (52), Jackson and Aron (50), Liou (53), and others have recommended techniques for compensating for insufficient data and minimizing the difficulty of finding an optimal set of model parameters. If independent model parameters could be developed from watershed characteristics, finding a set of optimal values would be a matter of applying statistical optimization techniques to the parameters and data from which they were developed. However, there is a strong interdependence among watershed parameters as reported by Johnson (54), Mein and Brown (55), Pickup (56), and Turnmire (57). Liou (53) developed a computer program (OPSET) at the University of Kentucky for use with the Kentucky Watershed Model (KWM, a modification of the Stanford Watershed Model applicable to sites in Kentucky) which selects the most "optimal" set of model parameters. A complete evaluation of the Stanford Watershed Model and its many permutations is not within the scope of this work; however, the following is offered in an attempt to explain the comprehensive nature of this model and the required level of expertise and experience necessary for a successful application. Herricks, Shanholtz, and Contractor (58) reported application of the Stanford Watershed Model (as modified in a collaborative effort by the Departments of Agricultural and Civil Engineering at Virginia Polytechnic Institute and State University) to surface water discharge from mining operations. Table 1 provides an indication of the extensive need for watershed characterization and climatic data demands of this model.

The U.S. Army Corps of Engineers developed (1967) a flood hydrograph package HEC-1 (59) and later the Water Surface Profile

Table 1. Summary of parameters required for VPI&SU modification of Stanford Watershed Model (SWMM)

Parameter	Description
-----------	-------------

a. Initial Moisture Conditions:

1. FLZS---Current lower zone soil moisture storage
2. GWS----Current groundwater slope index
3. RI-----Discharge rate at end of previous day
4. SWG----Groundwater moisture storage
5. UZS----Current upper zone moisture storage

b. Parameters Obtained from Watershed Characteristics:

1. AREA---Watershed area (acres)
2. C-----Time delay histogram
3. ETL----Fraction of area in stream surface
4. FIA----Fraction of area having impervious area draining directly into a stream
5. FK24EL-Groundwater evaporation parameter. Equal to the fraction of area having water loss due to phreatophytes
6. LENGTH-Avg. length of travel for overland flow (ft.)
7. MANI---Avg. manning roughness coefficient for impervious surfaces
8. MANP---Avg. manning roughness coefficient for pervious surfaces
9. S-----Average watershed slope (Ft/Ft)

Table 1 (Continued)

Parameter	Description
-----------	-------------

c. Parameters Estimated from Historical Record:

1. CSSR---Stream flow channel routing parameter
2. EPXM---Maximum interception rate for dry watershed (in/hr)
3. FK1----Ratio of avg. rainfall on the watershed to the avg. rainfall at recording gauge
4. FK3----A measure of rate of loss through evapotranspiration
5. FKGS---Antecedent groundwater index
6. FLIRC--Interflow recession constant
7. FLKK4--Groundwater recession index

d. Parameters Estimated by Trial and Adjustment:

1. CBI----Infiltration index
2. CC-----Interflow index
3. CX-----Index for estimation soil surface moisture storage
4. EDF-----Index for estimation soil surface moisture storage (adjust for seasonal variations)
5. EF-----Evaporation-infiltration factor (adjust for seasonal variations)
6. FK24L--Indicator of water entering or leaving basin
7. FKV-----Index used to provide curvilinear base flow recession

Table 1 (Continued)

Parameter	Description
8. FLZSN--Nominal lower zone storage index	

Source: Herricks, E.E., V.O. Shanholtz, and D.N. Contractor, Hydrologic and Water Quality Modeling of Surface Water Discharge from Mining Operations, Department of Agricultural Engineering, Research Division Report 159, Virginia Polytechnic Institute and State University, 1975, p. 44.

model HEC-2 (60). These models provide surface (stormwater) runoff simulation with multiple options for application such as dam-break, flooding with depth and area of inundation, and others related to planning for flood damage reduction, and sizing of flood control project. Higgins and Monke (48) developed a model for small watersheds (approximately 2 acres) that predicts surface runoff and has been used in designing small agricultural structures (diversion ditches and culverts). The model is based on fixed parameters (no adjustment or calibration) with rainfall as the main input. This model is a single event (storm or design rainfall) program and limited to areas smaller than 5 acres. Boughton (47) developed a model capable of simulating continuous watershed discharge. The model has 14 parameters, of which 10 are estimated by trial and error fitting to observed data. The model has been used to simulate daily streamflow for watersheds ranging in size from 100 acres to 275 sq. miles; however, the amount of required input data and computer time is prohibitive. These data and computer demands are common to other continuous lumped parameter models including Fleming's (48) Mero Model, the UBC watershed model, and the Hydrocomp model, which are capable of simulating continuous watershed discharge. The API Model (49) generates both groundwater flow and direct runoff discharge from rainfall. The model has a deterministic structure and provides a continuous streamflow hydrograph. The model has been verified on watersheds of 68 and 817 sq. miles; however, calibration to each watershed is required for dependable predictions.

TVA reported (61) the development of a Daily Streamflow Model in 1972 and Tung (62) applied it in a study of the impacts of coal mining on the flow of the New River. This model was developed to provide continuous streamflow simulation and has been incorporated into TVA's Hydrologic Simulation Model, TVA-HYSIM (12). TVA-HYSIM is a hybrid model, mixing stochastic modeling (generation of rainfall) techniques with parametric modeling (optimized regional parameters) techniques to take advantage of available data bases. The TVA Stormwater Model (63) is used in TVA-HYSIM to provide initial and delayed surface runoff responses. TVA-HYSIM is not adapted to handling dynamic land-use conditions; however, it was designed to be used as a planning tool for evaluating the effect of land-use changes before the change occurs. Kasomekera (64) reported the development of a seasonal conceptual model for watershed simulation. The model is based physically and was developed for application in tropical and semi-tropical climates. The model was developed as a water resource planning tool for developing countries in Africa and uses system engineering techniques (constrained Rosenbrock Hill Algorithm) to define model parameters. The primary model output is monthly watershed discharge, although provisions are made for daily, quarterly, and yearly watershed discharges. The daily watershed discharges are recommended for use as initial planning estimates.

The 1970's saw a literal explosion of models and adaptations of models as can be seen in Table 2. There have been numerous event (storm) models reported which may be utilized to evaluate impacts of

Table 2. Hydrologic Computer Programs and Models

MODEL DESIGNATION	MODEL REFERENCE
AGTEHM	Hetrick, et al. (1982)
API	Sittner, et al. (1969)
ARM	Donigian, et al. (1977)
Boughton Model	Boughton (1966)
CERES	Dixon, et al. (1976)
Dawdy & O'Donnel Model	Dawdy, et al. (1964)
DEM	Feigner and Harris (1969)
DESIGN-I	Minear, et al. (1979)
Distributed Numerical Model for Estimating Runoff	Gupta and Solomn (1977)
DOSAG-1	Texas Water Development Board (1970)
Estuary and Lake-Ecology Model	Chen and Orlob (1972)
EXPLORE-I	Battelle (1973)
GTWS	Lumb (1972, 1975)
HEC-1	U.S. Army Corps of Engineers (1981)
HEC-2	Hydrologic Engineering Center (1971)
HEC-1C	Hydrologic Engineering Center (1973)
HELP	U.S. Corps of Engineers/ Environmental Protection Agency (1984)
HSP	Hydrocomp, Inc. (1976)
Huggins & Monke Model	Huggins and Monke (1967)

Table 2 (continued)

MODEL DESIGNATION	MODEL REFERENCE
HVM-QQS	U.S. Environmental Protection Agency (1982)
Hydrocomp Model	Hydrocomp Inc. (1978)
IIHR	Jain, et al. (1982)
KWM	University of Kentucky (1969)
Low Flow Synthesis	Duba and Pitcher (1983)
MAD	Uchida and Middleton (1978)
Mero Model	Fleming (1975)
MITCAT	Massachusetts Institute of Technology (1969)
Multi-Parameter Mathematical Model	Harper (1972)
Mining Pollution Control Model	Shumate, et al. (1975)
Missouri Model	Liu and Cheng (1978)
Modified SERATA	Onishi (1977)
MWD	Energy and Environmental Analysis, Inc. (1978)
NERO	City of Chicago (1969)
NWSRFS	National Oceanic and Atmospheric Administration (1972)
Ohio State Version of Stanford Watershed Model (OSUSM)	Ricca (1974)
OPSET	James, et al. (1970)
PIONEER-I	Battelle (1971)
PRO 751-TRIFLD	Hegarty (1972)

Table 2 (continued)

MODEL DESIGNATION	MODEL REFERENCE
QUAL-II	Water Resources Engineers (1973)
QUALITY	Lombardo and Franz (1972)
RECEIV-II(7)	Beckers, et al. (1974)
Return Flow Quality Simulation Model	Shaffer and Ribbens (1974)
Rainfall - Runoff Simulation Model	Dawdy, et al. (1972)
RIBAM	Marshall, et al. (1975)
RRL	British Road Research (1974)
RUNQUAL	Roesner, et al. (1977)
SCS-DSH/SCS-USH	Tschantz (1983)
SEDIMOT II	Wilson, et al.
SSARR	U.S. Army Corps of Engineer (1972)
STORM/WQRRS	Hydrologic Engineering Center (1977, 1978)
Surface Runoff Simulation Model	Yomtovian (1973)
SWM-IV	Stanford University (1966)
SWMM	Huber, et al. (1975)
SYSLAB	Steele (1973)
TEHM	Huff, et al. (1977)
TENN-I	Troxler, et al. (1979)
TLC-100	Henry and Haister (1972)
TR-20	MacIay (1965) SCS

Table 2 (continued)

MODEL DESIGNATION	MODEL REFERENCE
TVA-Daily Streamflow	Tennessee Valley Authority (1972)
TVA-HYSIM	Betson, et al. (1979)
TVA-Stormwater	Tennessee Valley Authority (1973)
TWM	Texas Tech University (1977)
UCUR	University of Cincinnati (1982)
USAF Runoff Model (AFRUM)	University of Tennessee ((1980)
USDAHL	Agricultural Research Service (1973)
USDAHL-70	Holtan and Lopez (1971)
USGS Rainfall - Runoff Model	U.S. Geological Survey (1981)
UTM-TOX	Oak Ridge National Laboratory (1982)
WASH	Ward, et al. (1979)
WASHMO	Ward, et al. (1980)
Water Balance Model	Richardson and Ritchie (1972)
Water Budget Model	Quick and Pipes (1973)
Water Simulation Model	Grantham, et al. (1971)
WEST	Leytham and Johanson (1979)

development upon the discharge of a watershed under flood conditions. A Stormwater Management Model (SWMM) was developed in 1971 for the U.S. EPA as a collaborative effort by Water Resources Engineers, the University of Florida, and Metcalf & Eddy, Inc. (65). SWMM is not capable of predicting continuous watershed discharge and needs observed data for calibration. Troxler (66) developed a Stormwater Simulation Model for the Tennessee Valley. This model was developed using statistical techniques to identify and optimize parameters derived from watershed characteristics. The model was regionalized by utilizing data from 24 rural and urban watersheds in the Tennessee Valley. However, there are no provisions for predicting continuous watershed discharge and the model is sensitive to rainfall distribution. Crosby (67) extended the stormwater hydrograph simulator TENN-I originally developed by Troxler (66). The applicability of the model was extended to small mountainous watersheds undergoing or having undergone surface coal mining and with the addition of a soil erosion component (ERODE-I) with an accompanying watershed suspended load component (LOAD-I). This program may be used to simulate events; however, the model is extremely sensitive to rainfall intensities and does not provide reliable predictions for low intensity, non-storm type rainfall.

III. THEORETICAL DEVELOPMENT OF PROCEDURES

Rainfall Generation

The rainfall generator developed in this study utilizes a statistical process referred to as the "Monte Carlo Method" (68,69) with modification to provide for conditional probabilities based on actual rainfall records. "Sequential generation of hydrologic information is a statistical process using Monte Carlo methods for generating sequentially synthetic hydrologic records." (18) The techniques and concept of "generating" synthetic hydrologic records has been used for many years. Hazen (70) combined the records of mean annual flow for 14 streams and generated a 300-year sequence of watershed discharge in 1914. The major application of this technique has been in the generation of streamflow, Barnes (71), Benson (72,73), Brittan (74), Sudler (75), Thomas and Fiering (76), and others. The underlying theory combined with theoretical developments in mathematics (statistics and probability) and computer techniques allows for the development of a technique for generating sequential records (events).

"The selection of an object from a group of objects will be termed random if and only if the correct model is that . . . all objects . . . are assigned the same probability---have the same chance of being selected." (77) The use of computers to generate random numbers has revolutionized probabilistic programming and sparked an unprecedented search for ways to generate sequences of numbers having

attributes (statistical) of true random sequences. A pseudo-random number generator was developed and programmed to produce a sequence of real numbers uniformly distributed over the real line (0, 1). The routine (RANF) is based on Modular Arithmetic and intrinsic Fortran functions. The following algorithm was used:

$$\text{RANF} = (\text{CHT}/\text{A})$$

where: $\text{CHT} = \text{DMOD}(\text{C}, \text{A})$
 $\text{C} = \text{CHT} * \text{FIRST}$, and CHT and FIRST = initialization values
 A is the modulus
 DMOD is an intrinsic Fortran function (78)

The product of two numbers (integers) I and J modulo K is the remainder L resulting from the division of the product of I*J by K. Utilizing the intrinsic Fortran function DMOD this can be written, $L = \text{DMOD}(\text{I} * \text{J}, \text{K})$. The sequence of numbers generated by this technique is not generated randomly (the mathematics are exact); however, when A and FIRST are properly chosen the sequence will possess attributes of randomness. The generated sequence will have a nearly uniform distribution over the range of numbers produced (i.e., each number has the same likelihood of being produced). The total number of numbers generated in a sequence is dependent upon the rainfall record to be generated.

"A random variable is a numerical-valued function of the outcomes of an experiment of chance." (77) Day-to-day rainfall (quantity) is generally held to be random, although there are distinct weather patterns (both areal and time wise). In order to incorporate

these weather patterns the value of the random variable rainfall is sequentially generated based on the cumulative distribution of observed daily precipitation amounts (in inches). The daily rainfall amounts are generated by using the pseudo-random number generator to produce a sequence of numbers large enough to ensure randomness, and relating the numbers to observed rainfall patterns. The theoretical basis for this is the probability integral transformation (79,80,81) for the case of continuous simulation, with modification to the discrete case using a random decimal value between 0 and 1 to as many digits as needed for statistical significance (82). To ensure randomness of the events the generated sequence of numbers (pseudo-random) is continually tested by applying the chi-square test for goodness of fit. The following algorithm is used for this test:

$$X = ((\text{PRN}(1) - E)^2)/E + ((\text{PRN}(2) - E)^2)/E + \dots \\ + ((\text{PRN}(n) - E)^2)/E$$

where: X = The Chi-Square Statistic (established such that there is 95% confidence that PRN(n) is a random sequence)
 PRN(n) is a sequence of pseudo-random numbers
 n is the total number of elements (members) in the sequence
 E is the expected value of the random number

If the sequence falls outside the 95% confidence interval, it is discarded without use and a new sequence is generated. This cycle continues until an acceptable sequence is generated. These tested numbers are compared sequentially to the percentage of time (on a weekly basis) that rainfall has occurred on this day over the period of observed record.

These percentages are calculated as follows:

The observed records are divided into weekly intervals.

$$X = \frac{(\text{total number of days with no rain for this week})}{(\text{total number of observed days for this week})}$$

If the random number is greater than X, then rainfall occurs; otherwise, the daily rainfall amount for this day is 0.0 inches (no rain). If the choice is "rain", a new sequence of random numbers is produced to be used as a basis for determining the amount (inches). These tested numbers are compared sequentially to the percentage of time (on a weekly basis) that an increment (rainfall divided into intervals) of rainfall has occurred on this day over the period of record (observed). These percentages are calculated as follows:

The observed records are divided into weekly intervals.
The daily rainfall is divided into intervals of: 0.01-0.24,
0.25-0.49, 0.50-0.74, 0.75-0.99, 1.00-1.99, 2.00-2.99,
3.00-3.99, 4.00-4.99, 5.00 or more (83).

$$Y(i) = (\text{total number of days of rain for this week at this level of rainfall}) / (\text{total number of days observed for this week with rain})$$

i = interval number

$$Z(i) = Y(i) / [Y(1) + Y(2) + \dots + Y(n)]$$

n = total number of intervals

The Z(i)'s are used to divide the real line defined by (0, 1) into intervals equal in length to the percentage of this line represented by each Z(i). This ensures that the integrity of the observed rainfall pattern for each week is maintained. Upon defining

the rainfall interval, the random number generator is used to generate a sequence of numbers (for test purposes) of which one is used as the amount of rainfall for that day.

Watershed Discharge

This study deals with discharge from "small" watersheds and draws upon the description of a small watershed by the Committee on Runoff, American Geophysical Union (84) in its definition of a small watershed:

From the hydrologic point of view, a distinct characteristic of the small watershed is that the effect of overland flow rather than the effect of channel flow is a dominating factor Consequently, a small watershed is very sensitive to high-intensity rainfalls of short durations, and to land use. On larger watersheds, the effect of channel flow or the basin storage effect becomes very pronounced Therefore, a small watershed may be defined as one that is so small that its sensitivities to high-intensity rainfalls of short durations and to land use are not suppressed by the channel-storage characteristics. By this definition, the size of a small watershed may be from a few acres to 1000 acres, or even up to 50 sq. mi. The upper limit of the area depends on the condition at which the above-mentioned sensitivities become practically lost due to the channel-storage effect.

The techniques used in this work to calculate watershed discharge are those developed by the U.S. Department of Agriculture, Soil Conservation Service (13, 14, 15). These techniques have been adopted generally for designing drainage (ditches, ponds, etc.) facilities for small watersheds. Therefore, utilization of these to calculate watershed discharge from the stochastic rainfall record will minimize the apparent effect upon a watershed by utilization of one

technique for project design and an alternative method for potential impact evaluation. As stated by Chow: (18)

Synthetic hydrographs are difficult to compute for small basins because of lack of rainfall and runoff records with which to compute unit hydrographs and because of the widely variable physical nature of small basins. The obstacles to use of this . . . will be surmounted, but it will require more data than are generally available . . .

Thus, the major problem in evaluating discharge from small watersheds is the lack of historical data to form a basis for predictions and/or for comparisons and calibrations. The lack of observed rainfall and/or streamflow does not prevent computing discharge for the design of drainage facilities for small watersheds: Project designs are based on a "design rainfall". These rainfall events are normally based on a perceived level of protection (i.e., probability of flooding) and economics. Once a level of protection or design frequency (10-year, 25-year, 100-year) has been decided upon, a publication such as the U.S. Weather Bureau's Rainfall Frequency Atlas is consulted for the project area and probable rainfall depths for the design frequency of interest. A family of rainfall depths associated with the frequency of interest can be found, relating to the duration (30-minute, 6-hour, 24-hour, etc.) of the rainfall. For example, one will find a rainfall amount (4.7 inches) for a "10-year, 24-hour" rainfall event. These "design" rainfalls lack an important characteristic, that is, distribution of the rainfall within the duration period (in this instance a 24-hour period).

The Soil Conservation Service analyzed the rainfall distribution patterns for rainfall in the United States and developed two dimensionless distributions which are representative of the observed distributions. These distributions are referred to as Type I and Type II and are applicable to different regions of the United States. The Type I distribution is representative of coastal climates which are heavily influenced by the ocean (the coastal side of the Cascade and Sierra mountains in California, Oregon, and Washington, Alaska, Hawaii, etc.). The Type II distribution is representative of the remaining continental United States, Puerto Rico, and Virgin Islands. The dimensionless form allows the distributions to be used with any total rainfall amount. These distributions may not be good representations for local rainfall if watersheds contain a large rise in elevation; however, they provide a uniform basis for design and evaluation of projects. The Type II distribution has been used in this work; however, the Type I may be substituted if the procedures in this work are to be utilized in the region where a Type I distribution is appropriate. The rainfall distributions were developed for a period of 24 hours; this corresponds to the observation period of most available data (i.e., 24-hour rainfall) and allows the user to apply the distribution without making time adjustments to the observed records. This procedure will not be representative of most multi-day storms; however, with proper consideration of the condition (relative moisture condition) of the watershed, discharges suitable for design and evaluation may be calculated.

The moisture condition (wet, semi-wet, dry, etc.) of the watershed soils prior to a precipitation event has a dramatic effect on the discharge (peak flow, total discharge volume). This soil condition is referred to as the "antecedent soil moisture" and the Soil Conservation Service quantified this by using three levels. The antecedent moisture condition (AMC) levels are based on the total 5-day antecedent rainfall amount and season of the year. The normal growing season runs from plowing or planting time to fallow time. The normal dormant season is the remainder of the year. "The limits for dormant season apply when the soils are not frozen and there is no snow on the ground." (13) Therefore, the procedures used in this work do not apply when the ground is frozen or covered with snow. The SCS, National Engineering Handbook, Section 4 (13), contains an indepth treatment of adjustments to curve numbers for seasonal or annual variations. Table 3 shows the rainfall amounts and seasons used in this work.

Table 3. Antecedent moisture condition (AMC) for seasonal rainfall (13)

AMC condition	5-day antecedent rainfall totals (inches)	
	Dormant Season (Nov.-Mar.)*	Growing Season (Apr.-Oct.)*
I	less than 0.5	less than 1.4
II	0.5 to 1.1	1.4 to 2.1
III	over 1.1	over 2.1

* As used in this work.

The 5-day antecedent rainfall is the sum of the rainfall for the 5-day period (in inches) preceding the day of interest. From Table 3 one can see that AMC I corresponds to dry conditions, AMC II to an average soil moisture, and AMC III to a wet or saturated soil. The antecedent moisture condition provides a method for accounting for the influence of prior rainfall on the watershed discharge. The AMC is used to make adjustments to the watershed "Curve Number" (CN).

The Soil Conservation Service developed the "Curve Number" as an index which represents the combined effects of antecedent soil moisture, land use, soil type, and vegetative (or the lack of) cover. This CN index was developed as an integral part of the rainfall-runoff relationship, which SCS derived from data taken on experimental watersheds and plots with numerous soils, vegetative covers, artificial roughness simulators, and rainulators (13). This allowed the study of a variety of idealized systems with control of various parameters (rainfall intensity, duration, amount, etc.). This was desirable since in any field or laboratory experiment dealing with hydraulic and hydrologic problems, it is impossible to have complete control of all facets of the environment in which the observations are being made. The plot and simulator data were combined with data from experimental watersheds (agricultural and urbanized) in an effort to derive a relationship which would be applicable to a wide variety of

development and conservation practices. The resulting equation is:

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \quad (1)$$

where: Q = total runoff in inches (volume per unit area)
 P = total rainfall in inches
 I_a = initial abstraction (infiltration, interception, and surface storage) in inches
 S = retention (potential maximum) in inches

This equation is the SCS rainfall-runoff relationship (13) with the initial abstraction taken into account. The major components of the initial abstraction (I_a) are infiltration, interception, and surface storage. Estimation of these (all occur before runoff begins) variables is a very complex task, therefore SCS developed a relationship between I_a and S based on rainfall and runoff data from small experimental watersheds. The empirical relationship SCS developed is:

$$I_a = 0.2 S \quad (2)$$

If one substitutes equation 2 in equation 1 this will give:

$$Q = \frac{(P - 0.2 S)^2}{P + 0.8 S} \quad (3)$$

This is the rainfall relationship (13) used in the SCS method of estimating direct runoff from rainfall on small watersheds. The SCS

method is used in this work to provide estimates of discharge from small watersheds.

In order to utilize observable watershed characteristics (soil type, vegetative cover, etc.), SCS developed the "runoff curve number" (CN) or "hydrologic soil-cover complex number". The CN is a transformation of S and has the form:

$$S = \frac{1000}{CN} - 10$$

which, with rearrangement becomes:

$$CN = \frac{1000}{S + 10}$$

The CN for a watershed may be estimated from the land use, soil type, and vegetative cover. The SCS published (Tables 4 and 5) recommended CN's for common land uses or practices, incorporating soils and hydrologic condition of the vegetative cover and surface treatment.

Table 4. Runoff curve numbers for hydrologic soil-cover complexes 40
Reproduced from SCS (13).

(Antecedent moisture condition II, and $I_a = 0.2$ S)

Land use	Cover		Hydrologic soil group			
	Treatment or practice	Hydrologic condition	A	B	C	D
Fallow	Straight row	----	77	86	91	94
Row crops	"	Poor	72	81	88	91
	"	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	"	Good	65	75	82	86
	"and terraced	Poor	66	74	80	82
	" " "	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	"and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes <u>1/</u> or rotation meadow	Straight row	Poor	66	77	85	89
		Good	58	72	81	85
	Contoured	Poor	64	75	83	85
		Good	55	69	78	83
	"and terraced	Poor	63	73	80	83
		Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
		Fair	25	59	75	83
		Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) <u>2/</u> (hard surface) <u>2/</u>		----	72	82	87	89
		---	74	84	90	92

1/ Close-drilled or broadcast.

2/ Including right-of-way.

Table 5. Runoff curve numbers for selected agricultural, suburban, and urban land use. (Antecedent moisture condition II, and Ia = 0.2S). Reproduced from SCS (15).

LAND USE DESCRIPTION	HYDROLOGIC SOIL GROUP			
	A	B	C	D
Cultivated land ^{1/} : without conservation treatment	72	81	88	91
: with conservation treatment	62	71	78	81
Pasture or range land: poor condition	68	79	86	89
good condition	39	61	74	80
Meadow: good condition	30	58	71	78
Wood or Forest land: thin stand, poor cover, no mulch	45	66	77	83
good cover ^{2/}	25	55	70	77
Open Spaces, lawns, parks, golf courses, cemeteries, etc.				
good condition: grass cover on 75% or more of the area	39	61	74	80
fair condition: grass cover on 50% to 75% of the area	49	69	79	84
Commercial and business areas (85% impervious)	89	92	94	95
Industrial districts (72% impervious).	81	88	91	93
Residential: ^{3/}				
Average lot size Average % Impervious ^{2/}				
1/8 acre or less 65	77	85	90	92
1/4 acre 38	61	75	83	87
1/3 acre 30	57	72	81	86
1/2 acre 25	54	70	80	85
1 acre 20	51	68	79	84
Paved parking lots, roofs, driveways, etc. ^{3/}	98	98	98	98
Streets and roads:				
paved with curbs and storm sewers ^{3/}	98	98	98	98
gravel	76	85	89	91
dirt	72	82	87	89

^{1/} For a more detailed description of agricultural land use curve numbers refer to National Engineering Handbook, Section 4, Hydrology, Chapter 9, Aug. 1972.

^{2/} Good cover is protected from grazing and litter and brush cover soil.

^{3/} Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

^{2/} The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

^{3/} In some warmer climates of the country a curve number of 95 may be used.

IV. RESULTS

Procedures computerized

The computational procedures and techniques described above were programmed in Microsoft Fortran (78) on a personal computer. This was done to facilitate utilization of the procedures to evaluate effects of proposed developments on small watersheds. Use of a computer allows one to consider many alternative designs, development rates, etc., in a reasonable amount of time. Figure 1 shows a flow chart of the resulting computer program.

Generation of rainfall

The rainfall generator utilizes observed precipitation to provide the probabilities of precipitation or no precipitation, and the amount of precipitation for each day, based on weekly totals. Tables 6, 7, 8, 9, 10, and 11 show the observed and generated precipitation summaries for three reporting stations in Tennessee. Tables 6 and 7 are for the Knoxville-Knox County Weather Bureau City Office Station No. 40-4945. The station was located on top of the U.S. Post Office and Court House on the corner of Main and Walnut Streets in downtown Knoxville. The 32-year period of record (January 1910 through December 1941) contains 11,688 daily records which were sorted (83) to produce Table 6. Table 7 was produced by generating a 32-year record of rainfall (using rainfall probabilities from the observed record) and sorting the record. There is a total of 68 days which

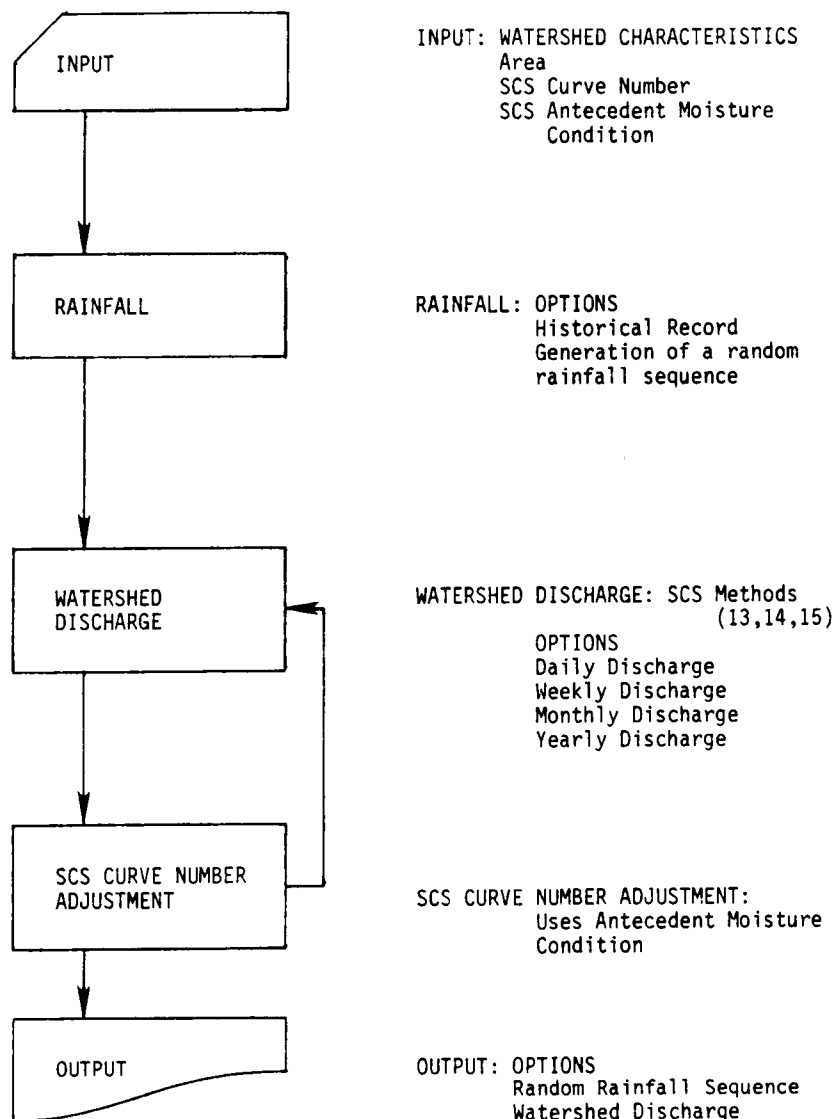


FIGURE 1. Flow Chart: For Calculation of Watershed Discharge

Table 6. Number of days with precipitation equal to at least the amount indicated and based on a period from 1910 to 1941 (32 years) for Knoxville WB City

WEEK BEGINNING	INCHES OF PRECIPITATION										4.00- 4.99	5.00 OR MORE
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99			
MAR	1	134	45	19	6	7	10	3	0	0	0	0
	8	127	60	13	11	3	8	2	0	0	0	0
	15	143	45	15	7	8	6	0	0	0	0	0
	22	137	40	18	15	2	9	3	0	0	0	0
	29	150	37	11	13	8	3	2	0	0	0	0
APR	5	131	50	24	6	9	4	0	0	0	0	0
	12	145	49	11	8	4	5	2	0	0	0	0
	19	146	42	16	5	5	9	1	0	0	0	0
	26	141	49	12	10	4	8	0	0	0	0	0
	3	143	38	25	8	3	7	0	0	0	0	0
MAY	10	140	56	10	6	7	4	1	0	0	0	0
	17	134	44	18	9	9	8	2	0	0	0	0
	24	144	50	10	7	6	6	1	0	0	0	0
	31	141	57	10	7	4	4	1	0	0	0	0
	7	129	51	19	13	4	7	0	1	0	0	0
JUN	14	135	44	26	8	3	7	1	0	0	0	0
	21	141	49	18	5	5	4	2	0	0	0	0
	28	124	54	21	7	4	11	2	0	1	0	0
	5	131	49	19	12	5	5	2	1	0	0	0
	12	131	52	17	7	5	8	3	0	0	1	0
JUL	19	157	36	9	12	3	5	2	0	0	0	0
	26	148	40	21	8	3	4	0	0	0	0	0

Table 6 (Continued)

WEEK BEGINNING	0.00	INCHES OF PRECIPITATION								4.00- 4.99	5.00 OR MORE
		0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99			
AUG	2	151	44	13	9	3	1	0	0	0	0
	9	121	55	19	13	13	2	0	0	0	0
	16	141	49	18	6	2	1	0	0	0	0
	23	152	47	6	6	7	1	0	0	0	0
	30	162	31	14	10	5	1	0	0	0	0
SEP	6	168	40	6	4	2	0	0	0	0	0
	13	171	33	8	5	3	0	0	0	0	0
	20	166	35	10	3	7	1	0	0	0	0
	27	175	30	6	6	3	0	0	0	0	0
	4	173	29	11	4	3	1	0	0	0	0
OCT	11	177	25	8	5	5	1	1	0	0	0
	18	169	25	13	8	4	0	0	0	0	0
	25	175	26	7	5	5	0	0	0	0	0
	1	174	27	13	4	4	1	0	0	0	0
	8	154	43	11	9	3	1	1	0	0	0
NOV	15	166	31	10	6	8	0	0	0	0	0
	22	153	39	21	6	3	0	0	0	0	0
	29	154	37	15	7	3	2	0	0	0	0
	6	150	43	16	5	4	2	0	0	0	0
	13	141	37	23	11	6	0	0	0	0	0
DEC	20	142	43	12	10	9	0	0	0	0	0
	27	115	60	15	17	14	0	0	0	0	0

Table 6 (Continued)

WEEK BEGINNING	INCHES OF PRECIPITATION									
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	5.00 OR MORE
JAN 3	141	42	18	12	5	6	0	0	0	0
10	149	46	11	8	5	5	0	0	0	0
17	114	64	20	8	10	8	0	0	0	0
24	129	59	11	12	4	9	0	0	0	0
31	134	52	12	13	6	7	0	0	0	0
FEB 7	132	57	11	9	8	6	1	0	0	0
14	123	56	19	7	9	9	0	1	0	0
21	137	48	14	7	12	6	0	0	0	0
28	25	11	1	1	1	1	0	0	0	0

Source: Fribourg, H.A., R.H. Strand, J.V. Vaiksnoras, and J.M. Safley, Jr., Precipitation Probability and Related Data for East Tennessee, unpublished, circa 1974, p. 164.

Table 7. Number of days with precipitation equal to at least the amount indicated and based on a generated period of 32 years for Knoxville WB City

WEEK BEGINNING	INCHES OF PRECIPITATION									
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	5.00 OR MORE
MAR	1	134	45	19	6	7	10	3	0	0
	8	129	59	12	11	3	8	2	0	0
	15	143	45	15	7	8	6	0	0	0
	22	137	40	18	15	2	9	3	0	0
	29	146	38	11	14	9	3	2	1	0
APR	5	131	50	24	6	9	4	0	0	0
	12	144	49	11	8	5	5	2	0	0
	19	146	42	16	5	5	9	1	0	0
	26	141	49	12	10	4	8	0	0	0
	3	143	38	25	8	3	7	0	0	0
MAY	10	142	55	10	5	7	4	1	0	0
	17	134	44	18	9	9	8	2	0	0
	24	143	51	10	7	6	6	1	0	0
	31	141	57	10	7	4	4	1	0	0
	7	129	51	19	13	4	7	0	1	0
JUN	14	136	43	26	8	3	7	1	0	0
	21	141	49	18	5	5	4	2	0	0
	28	124	54	21	7	4	11	2	1	0
	5	131	49	19	12	5	5	2	0	0
	12	131	52	17	7	5	8	3	0	1
JUL	19	154	37	10	13	3	5	2	0	0
	26	150	39	20	8	3	4	0	0	0

Table 7 (Continued)

WEEK BEGINNING	0.00	0.01- 0.24		0.25- 0.49		0.50- 0.74		0.75- 0.99		1.00- 1.99		2.00- 2.99		3.00- 3.99		4.00- 4.99		5.00 OR MORE	
AUG	2	151	44	13	9	3	3	1	3	1	1	0	0	0	0	0	0	0	0
	9	121	55	19	13	1	13	7	13	2	2	0	0	0	0	0	0	0	0
	16	141	49	18	6	7	2	7	2	1	1	0	0	0	0	0	0	0	0
	23	151	47	7	6	7	5	7	5	1	1	0	0	0	0	0	0	0	0
	30	162	31	14	10	5	1	5	1	1	1	0	0	0	0	0	0	0	0
SEP	6	165	41	6	5	4	2	4	2	0	0	0	0	0	0	0	0	0	0
	13	171	33	8	5	4	3	4	3	0	0	0	0	0	0	0	0	0	0
	20	168	34	9	3	2	7	2	7	1	1	0	0	0	0	0	0	0	0
	27	175	30	6	6	4	3	4	3	0	0	0	0	0	0	0	0	0	0
	4	173	29	11	4	3	3	3	3	1	1	0	0	0	0	0	0	0	0
OCT	11	177	25	8	5	2	5	2	5	1	1	1	0	0	0	0	0	0	0
	18	169	25	13	8	5	4	5	4	0	0	0	0	0	0	0	0	0	0
	25	177	25	7	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0
	1	174	27	13	4	1	4	1	4	1	1	0	0	0	0	0	0	0	0
	8	154	43	11	9	2	3	2	3	1	1	1	0	0	0	0	0	0	0
NOV	15	165	32	10	6	3	8	3	8	0	0	0	0	0	0	0	0	0	0
	22	153	39	21	6	2	3	2	3	0	0	0	0	0	0	0	0	0	0
	29	154	37	15	7	6	3	6	3	2	2	0	0	0	0	0	0	0	0
	6	151	42	16	5	4	4	4	4	2	2	0	0	0	0	0	0	0	0
	13	141	37	23	11	6	6	6	6	0	0	0	0	0	0	0	0	0	0
DEC	20	140	45	12	10	8	9	8	9	0	0	0	0	0	0	0	0	0	0
	27	115	60	15	17	3	14	3	14	0	0	0	0	0	0	0	0	0	0

Table 7 (Continued)

WEEK BEGINNING	INCHES OF PRECIPITATION									
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	5.00 OR MORE
JAN 3	141	42	18	12	5	6	0	0	0	0
10	149	46	11	8	5	5	0	0	0	0
17	117	63	18	8	10	8	0	0	0	0
24	129	59	11	12	4	9	0	0	0	0
31	133	53	12	13	6	7	0	0	0	0
FEB 7	132	57	11	9	8	6	1	0	0	0
14	125	55	18	7	9	9	0	1	0	0
21	137	48	14	7	12	6	0	0	0	0
28	25	11	1	1	1	1	0	0	0	0

Table 8. Number of days with precipitation equal to at least the amount indicated and based on a period from 1942 to 1970 (29 years) for Knoxville WB Airport

WEEK BEGINNING	INCHES OF PRECIPITATION									
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	5.00 OR MORE
MAR	1	116	48	17	8	4	8	2	0	0
	8	124	34	26	7	5	6	0	0	0
	15	118	44	20	9	6	6	0	0	0
	22	129	39	12	8	7	6	2	0	0
	29	128	37	19	9	2	8	0	0	0
APR	5	115	55	14	5	3	6	2	0	0
	12	134	38	10	7	9	5	0	0	0
	19	134	39	12	13	1	2	0	0	0
	26	115	54	13	6	8	5	1	0	0
	3	146	36	9	3	3	6	0	0	0
MAY	10	128	39	18	9	5	4	0	0	0
	17	141	36	11	7	6	1	1	0	0
	24	126	44	17	6	5	5	0	0	0
	31	131	37	16	8	6	4	1	0	0
	7	130	44	9	8	6	6	0	0	0
JUN	14	131	36	23	6	2	5	0	0	0
	21	132	42	7	11	5	6	0	0	0
	28	134	51	9	4	2	2	1	0	0
	5	125	35	16	8	6	11	1	0	0
JUL	12	127	36	19	12	4	5	0	0	0
	19	119	46	20	5	3	8	1	1	0
	26	131	41	13	6	1	10	0	0	0

Table 8 (Continued)

WEEK BEGINNING	INCHES OF PRECIPITATION										5.00 OR MORE
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99		
AUG	2	126	40	15	8	9	1	1	0	0	
	9	130	42	14	7	4	2	0	0	0	
	16	128	42	14	7	4	3	1	0	0	
	23	146	24	11	3	2	5	1	0	0	
	30	144	39	8	7	2	1	0	0	0	
SEP	6	153	30	6	8	3	3	0	0	0	
	13	143	37	5	8	3	6	1	0	0	
	20	156	26	7	9	2	3	0	0	0	
	27	146	29	7	9	5	3	1	0	0	
	4	145	28	14	5	3	3	2	0	0	
OCT	11	161	24	3	3	1	5	0	0	0	
	18	150	24	16	6	0	3	1	0	0	
	25	147	30	10	6	2	3	1	0	0	
	1	136	42	8	4	1	8	1	0	0	
	8	144	27	12	10	3	3	0	0	0	
NOV	15	126	42	12	8	2	6	2	0	0	
	22	128	37	16	9	5	3	1	0	0	
	29	148	26	14	3	2	7	0	0	0	
	6	122	44	7	10	6	8	2	0	0	
	13	140	35	9	6	0	8	1	0	0	
DEC	20	130	42	13	3	6	4	1	0	0	
	27	122	33	20	13	4	8	0	1	0	

Table 8 (Continued)

WEEK BEGINNING	INCHES OF PRECIPITATION									
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	5.00 OR MORE
JAN 3	127	43	11	13	4	3	1	1	0	0
10	125	43	15	10	4	5	0	1	0	0
17	118	40	23	10	4	8	0	0	0	0
24	115	48	15	11	6	6	2	0	0	0
31	119	32	24	13	3	10	2	0	0	0
FEB 7	125	33	17	9	7	11	1	0	0	0
14	125	35	17	13	4	9	0	0	0	0
21	121	46	16	9	4	5	2	0	0	0
28	16	10	5	3	0	2	0	0	0	0

Source: Fribourg, H.A., R.H. Strand, J.V. Vaiksnoras, and J.M. Safley, Jr., Precipitation Probability and Related Data for East Tennessee, unpublished, circa 1974, p. 174.

Table 9. Number of days with precipitation equal to at least the amount indicated and based on a generated period of 29 years for Knoxville WB Airport

WEEK BEGINNING	INCHES OF PRECIPITATION										5.00 OR MORE
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99		
MAR	1	118	47	16	8	4	8	2	0	0	0
	8	124	34	26	7	5	6	0	1	0	0
	15	116	44	21	9	6	6	1	0	0	0
	22	129	39	12	8	7	6	2	0	0	0
	29	128	37	19	9	2	8	0	0	0	0
APR	5	117	53	14	5	3	6	2	0	0	0
	12	134	38	10	7	9	5	0	0	0	0
	19	135	38	12	13	1	2	0	0	0	0
	26	115	54	13	6	8	5	1	0	0	0
	3	145	37	9	3	3	6	0	0	0	0
MAY	10	128	39	18	9	5	4	0	0	0	0
	17	144	34	10	7	6	1	1	0	0	0
	24	126	44	17	6	5	5	0	0	0	0
	31	131	37	16	8	6	4	1	0	0	0
	7	130	44	9	8	6	6	0	0	0	0
JUN	14	130	37	23	6	2	5	0	0	0	0
	21	132	42	7	11	5	6	0	0	0	0
	28	136	52	9	4	2	2	1	0	0	0
	5	125	35	16	8	6	11	1	1	0	0
	12	124	37	19	13	4	5	0	1	0	0
JUL	19	120	45	20	5	3	8	1	0	1	0
	26	131	41	13	6	1	10	0	0	0	0

Table 9 (Continued)

WEEK BEGINNING	INCHES OF PRECIPITATION									
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	5.00 OR MORE
AUG	2	126	40	8	9	1	1	0	0	0
	9	130	42	7	4	2	0	0	0	0
	16	128	42	7	4	3	1	1	0	0
	23	146	24	3	2	5	0	1	0	0
	30	146	37	7	2	1	0	0	0	0
SEP	6	153	30	8	3	3	0	0	0	0
	13	143	37	8	3	6	1	0	0	0
	20	156	26	9	2	3	0	0	0	0
	27	145	30	9	5	3	1	0	0	0
	4	145	28	5	3	3	2	0	0	0
OCT	11	161	24	3	1	5	0	0	0	0
	18	151	25	6	0	3	1	0	0	0
	25	147	30	6	2	3	1	0	0	0
	1	136	42	4	1	8	1	0	0	0
	8	144	27	10	3	3	0	0	0	0
NOV	15	128	41	8	1	6	2	0	0	0
	22	128	37	9	5	3	1	0	0	0
	29	147	27	3	2	7	0	0	0	0
	6	122	44	10	6	8	2	0	0	0
	13	140	35	6	0	8	1	1	0	0
DEC	20	130	42	3	6	4	1	0	0	0
	27	122	33	13	4	8	0	0	1	0

Table 9 (Continued)

WEEK BEGINNING	INCHES OF PRECIPITATION										5.00 OR MORE
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99		
JAN 3	127	43	11	13	4	3	1	1	0	0	
10	125	43	15	10	4	5	0	1	0	0	
17	121	39	22	9	4	8	0	0	0	0	
24	115	48	15	11	6	6	2	0	0	0	
31	119	32	24	13	3	10	2	0	0	0	
FEB 7	124	32	17	9	7	11	1	0	0	0	
14	125	35	17	13	4	9	0	0	0	0	
21	121	46	16	9	4	5	2	0	0	0	
28	15	11	5	3	0	2	0	0	0	0	

Table 10. Number of days with precipitation equal to at least the amount indicated and based on a period from 1948 to 1970 (21+ years) for Oak Ridge

WEEK BEGINNING	0.00	INCHES OF PRECIPITATION								4.00- 4.99	5.00 OR MORE
		0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99			
MAR	1	91	31	12	4	7	7	0	2	0	0
	8	92	23	17	9	5	6	2	0	0	0
	15	87	32	17	8	7	3	0	0	0	0
	22	98	30	10	4	4	6	2	0	0	0
	29	95	30	11	7	3	7	1	0	0	0
APR	5	89	37	11	7	4	6	0	0	0	0
	12	110	23	3	7	4	5	1	1	0	0
	19	103	28	10	7	5	1	0	0	0	0
	26	86	33	15	8	2	10	0	0	0	0
	3	118	22	6	2	1	5	0	0	0	0
MAY	10	96	27	17	6	5	3	0	0	0	0
	17	108	30	6	4	2	4	0	0	0	0
	24	110	32	6	8	4	4	0	0	0	0
	31	101	19	16	6	4	7	1	0	0	0
	7	98	30	15	4	4	3	0	0	0	0
JUN	14	104	26	8	8	5	2	1	0	0	0
	21	101	26	6	10	2	8	0	1	0	0
	28	110	25	10	3	2	3	1	0	0	0
	5	91	32	11	4	6	7	1	0	0	0
JUL	12	97	25	9	9	4	7	3	0	0	0
	19	87	41	6	7	6	6	0	1	0	0
	26	101	35	10	4	1	2	2	0	0	0

Table 10 (Continued)

WEEK BEGINNING	0.00	INCHES OF PRECIPITATION								4.00- 4.99	5.00 OR MORE
		0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99			
AUG	2	99	39	11	5	4	2	1	0	0	0
	9	103	33	10	6	3	3	1	0	1	1
	16	95	33	15	9	5	3	1	0	0	0
	23	122	24	4	7	3	1	0	0	0	0
	30	122	22	8	5	1	3	0	0	0	0
SEP	6	123	23	6	3	2	2	2	0	0	0
	13	118	21	7	7	2	2	3	1	0	0
	20	128	17	6	5	1	4	0	0	0	0
	27	111	25	11	3	3	7	1	0	0	0
	OCT 4	121	21	10	4	2	3	0	0	0	0
NOV	11	136	12	4	3	5	1	0	0	0	0
	18	116	24	12	2	4	3	0	0	0	0
	25	116	26	10	4	1	3	1	0	0	0
	1	111	26	13	1	5	3	2	0	0	0
	8	115	23	13	4	2	4	0	0	0	0
DEC	15	103	29	7	5	5	10	2	0	0	0
	22	94	34	13	10	0	8	2	0	0	0
	29	114	21	1	5	3	6	1	0	0	0
	6	98	31	4	12	6	7	2	1	0	0
	13	110	27	6	6	1	7	3	0	0	0
	20	104	29	9	9	3	5	2	0	0	0
	27	102	27	11	7	2	7	2	0	1	0

Table 10 (Continued)

WEEK BEGINNING	INCHES OF PRECIPITATION										5.00 OR MORE
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99		
JAN 3	93	35	7	9	3	6	1	0	0	0	
10	91	35	13	6	4	4	0	0	1	0	
17	86	27	22	12	0	5	1	1	0	0	
24	92	25	17	10	3	5	2	0	0	0	
31	88	21	19	10	4	9	3	0	0	0	
FEB 7	97	29	11	7	4	5	1	0	0	0	
14	90	32	12	8	5	7	0	0	0	0	
21	97	31	9	8	4	2	3	0	0	0	
28	11	8	4	1	0	2	1	0	0	0	

Source: Fribourg, H.A., R.H. Strand, J.V. Vaiksnoras, and J.M. Safley, Jr., Precipitation Probability and Related Data for East Tennessee, unpublished, circa 1974, p. 273.

Table 11. Number of days with precipitation equal to at least the amount indicated and based on a generated period of 21+ years for Oak Ridge

WEEK BEGINNING	0.00	INCHES OF PRECIPITATION						4.00- 4.99	5.00 OR MORE	
		0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99			3.00- 3.99
MAR	1	91	31	12	4	7	7	0	2	0
	8	92	23	17	9	5	6	2	0	0
	15	87	32	17	8	7	3	0	0	0
	22	98	30	10	4	4	6	2	0	0
APR	29	95	30	11	7	3	7	1	0	0
	5	89	37	11	7	4	6	0	0	0
	12	111	22	3	7	4	5	1	1	0
	19	103	28	10	7	5	1	0	0	0
MAY	26	86	33	15	8	2	10	0	0	0
	3	118	22	6	2	1	5	0	0	0
	10	95	28	17	6	5	3	0	0	0
	17	108	30	6	4	2	4	0	0	0
JUN	24	112	31	6	7	4	4	0	0	0
	31	101	19	16	6	4	7	1	0	0
	7	99	29	15	4	4	3	0	0	0
	14	104	26	8	8	5	2	1	0	0
JUL	21	101	26	6	10	2	8	0	1	0
	28	108	25	11	3	2	3	1	1	0
	5	91	32	11	4	6	7	1	0	0
	12	97	25	9	9	4	7	3	0	0
	19	88	41	6	6	6	6	0	1	0
	26	101	35	10	4	1	2	2	0	0

Table 11 (Continued)

WEEK BEGINNING	0.00	INCHES OF PRECIPITATION								5.00 OR MORE
		0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	
AUG	2	99	39	11	5	4	2	1	0	0
	9	103	33	10	6	3	3	1	1	1
	16	95	33	15	9	5	3	1	0	0
	23	121	25	4	7	3	1	0	0	0
	30	123	22	7	5	1	3	0	0	0
SEP	6	121	24	6	3	2	3	2	0	0
	13	118	21	7	7	2	2	3	0	0
	20	126	17	6	5	2	4	1	0	0
	27	111	25	11	3	3	7	1	0	0
	OCT	4	121	21	10	4	2	3	0	0
NOV	11	136	12	4	3	5	1	0	0	0
	18	115	24	12	3	4	3	0	0	0
	25	116	26	10	4	1	3	1	0	0
	1	113	25	12	1	5	3	2	0	0
	8	115	23	13	4	2	4	0	0	0
DEC	15	105	28	7	5	5	9	2	0	0
	22	94	34	13	10	0	8	2	0	0
	29	114	21	1	5	3	6	1	0	0
	6	98	31	4	12	6	7	2	0	0
	13	109	28	6	6	1	7	3	0	0
	20	103	30	9	9	3	5	2	0	0
	27	102	27	11	7	2	7	2	1	0

Table 11 (Continued)

WEEK BEGINNING	INCHES OF PRECIPITATION									
	0.00	0.01- 0.24	0.25- 0.49	0.50- 0.74	0.75- 0.99	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	5.00 OR MORE
JAN 3	93	35	7	9	3	6	1	0	0	0
10	91	35	13	6	4	4	0	0	1	0
17	86	27	22	12	0	5	1	1	0	0
24	92	25	17	10	3	5	2	0	0	0
31	88	21	19	10	4	9	3	0	0	0
FEB 7	96	29	12	7	4	5	1	0	0	0
14	90	32	12	8	5	7	0	0	0	0
21	97	31	9	8	4	2	3	0	0	0
28	11	8	4	1	0	2	1	0	0	0

differ in the tables (34 in 0.0, 17 in 0.01-0.24, 8 in 0.25-0.49, 4 in 0.50-0.74, 3 in 0.75-0.99, 1 in 2.00-2.99, 1 in 3.00-3.99). Tables 8 and 9 are for the Knoxville Airport, Alcoa, Blount County, NOAA-National Weather Service Office Station No. 40-4950. The station was 4.0 miles North-Northwest from the Maryville Post Office. The 29-year period of record (January 1942 through December 1970) contains 10,592 daily records which were sorted (83) to produce Table 8. Table 9 was produced by generating a 29-year record of rainfall (using rainfall probabilities from the observed record) and sorting the record. There is a total of 60 days which differ in the tables (30 in 0.0, 21 in 0.01-0.24, 4 in 0.25-0.49, 2 in 0.50-0.74, 1 in 0.75-0.99, 1 in 2.00-2.99, 1 in 3.00-3.99). Tables 10 and 11 are for the Oak Ridge, Anderson County, NOAA-National Weather Service Office Station No. 40-6750. The station is 2.0 miles Northeast from the Oak Ridge Post Office. The 21+-year period of record (August 1948 through December 1970) contains 8,035 daily records which were sorted (83) to produce Table 8. Table 9 was produced by generating a 21+-year record of rainfall (using rainfall probabilities from the observed record) and sorting the record. There is a total of 44 days which differ in the tables (22 in 0.0, 10 in 0.01-0.24, 4 in 0.25-0.49, 3 in 0.50-0.74, 1 in 0.75-0.99, 2 in 1.00-1.99, 1 in 2.00-2.99, 1 in 3.00-3.99).

These differences are within the accuracy of the resolution interval (0.001) of the sort routines. There is a difference of 0.006% (68/11,688) between Tables 6 and 7, 0.005% (60/10,592) between Tables 8 and 9, and 0.005% (22/8035) between Tables 10 and 11. The

observed record may be matched exactly if the resolution interval of the sort routines is set to 0.000001; however, this would increase the processing time by approximately 500%. This additional level of effort is not recommended nor warranted, as it will not result in any change in the actual values of daily rainfall generated, only the interval in which it falls.

The above discussion is offered to indicate how well the rainfall generator can reproduce the weekly rainfall patterns and in no way should be construed to imply that the rainfall generator can predict (with any degree of accuracy) an exact daily sequence based on an historical record. These results assure that the generated daily rainfall amounts fall within the intervals known to occur from the historical record. This will allow the generation of a random rainfall sequence which may be used for evaluation purposes, while maintaining the basic rainfall characteristics of the area of observation.

Calculation of Watershed Discharge

The calculation of watershed discharge requires the quantification of physical watershed characteristics. Table 12 shows the basin characteristics needed by the computational procedures in this study and their values for three watersheds which form a portion of the headwaters of the New River (Tennessee). Figure 2 (85) shows the location of the watersheds within Tennessee and the New River basin. Figures 3 and 4 (85) show the watershed boundaries, stream location within these boundaries, location and relative size of

Table 12. Physical watershed characteristics (85)

Watershed	Area * (Areas)	SCS Curve Number (CN)	Antecedent Moisture Condition (initial)
Anderson Branch	442	84	II
Lowe Branch	588	78	II
Bowling Branch	1402	80	II

* Drainage area above monitoring station

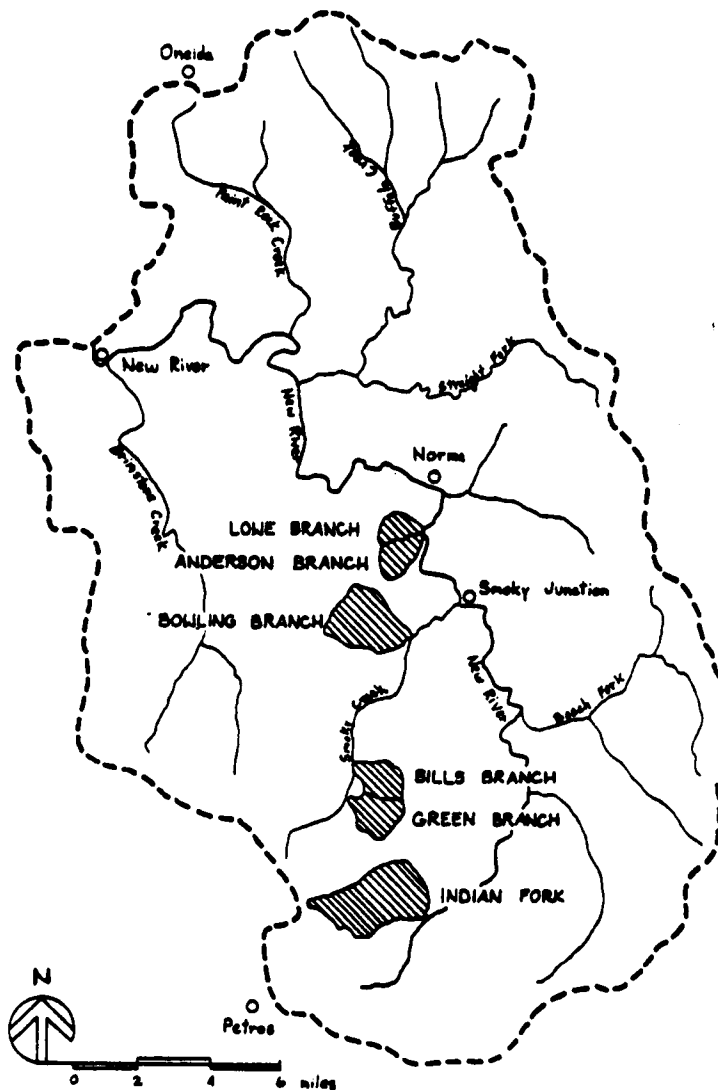
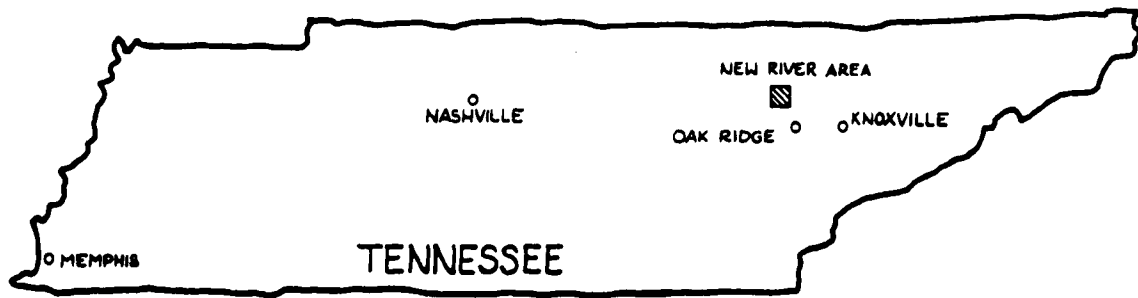


FIGURE 2. New River Basin, Location in Tennessee and Locations of New River Study Subbasins. Reproduced from Dickens et al. (85)

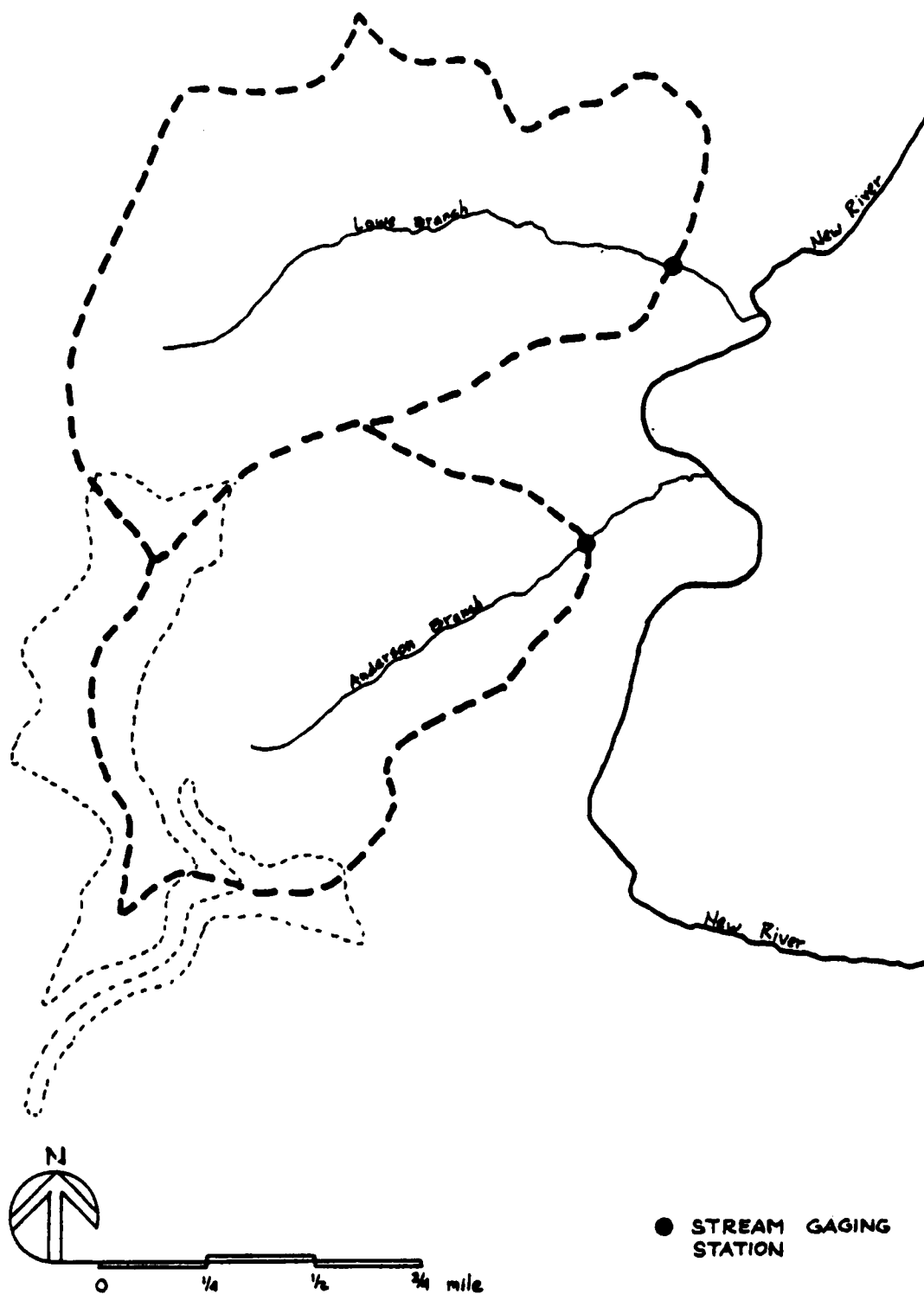


FIGURE 3. Lowe and Anderson Branches Showing Mining Disturbance as of September 1981, and Locations of Stream Gaging Stations. Reproduced from Dickens et al. (85)

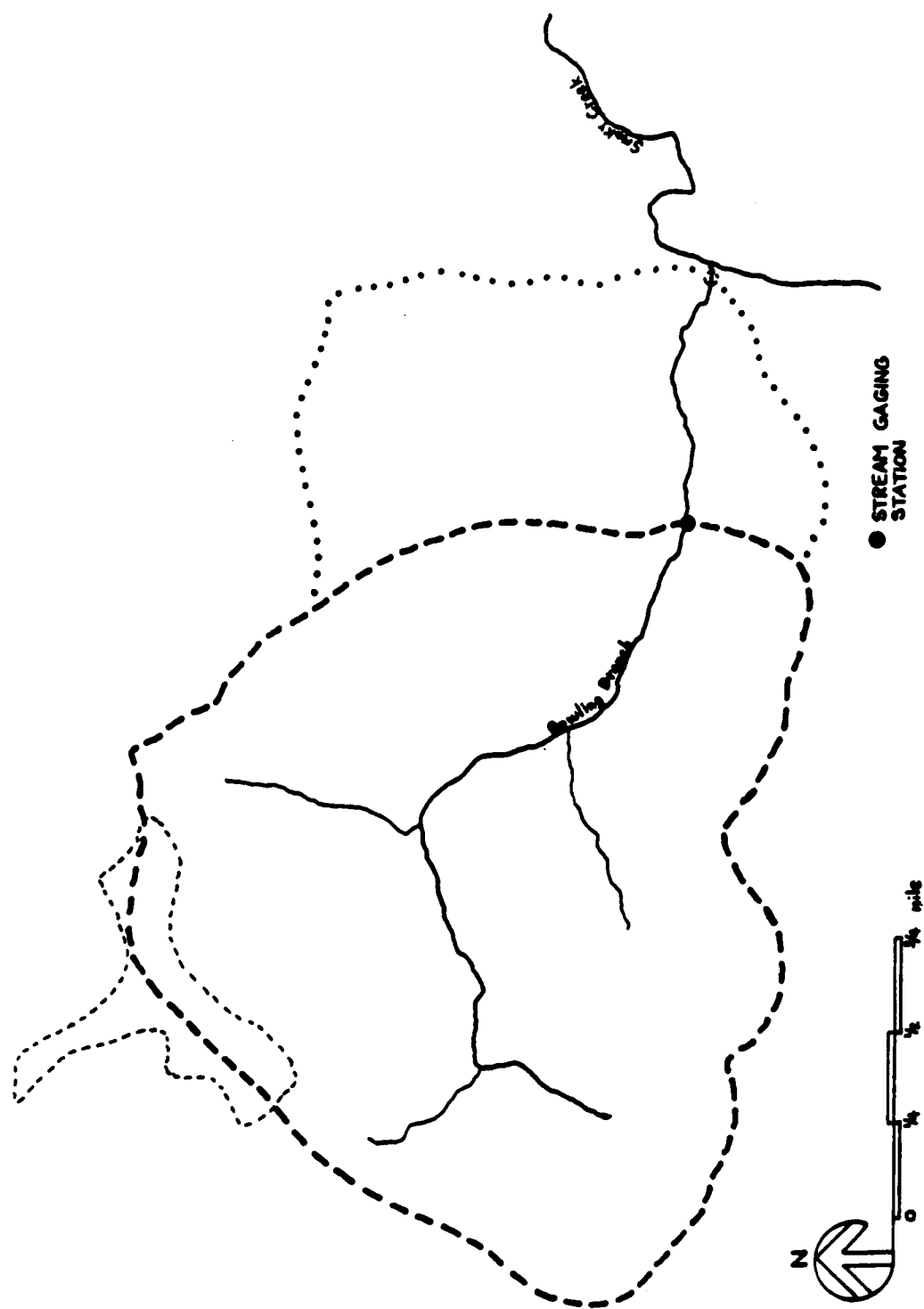


FIGURE 4. Bowling Branch Showing Mining Disturbance as of September 1982, and Locations of Stream Gaging Station (Dotted Watershed Boundary Represents Area Above Chemical Sampling Station Prior to December 1975). Reproduced from Dickens et al. (85)

surface disturbance resulting from coal mining activities. These watersheds were chosen because they met the definition of a small watershed as used in this study (i.e., channel flow does not control) and had a good historical record for both rainfall and streamflow (85). These watersheds were part of an 8-year study of the effects of surface mining by the Departments of Civil Engineering and Zoology, The University of Tennessee, Knoxville, Tennessee. The remaining information needed to complete the data required for calculation of watershed discharge (using the procedures of this study) is rainfall. Tables 13, 14, and 15, Appendix A, show observed and generated precipitation for Anderson Branch, Bowling Branch, and Lowe Branch watersheds, respectively.

A day-by-day comparison of observed and generated rainfall (rainfall characteristics of the Oak Ridge station were used) will show that there is considerable variation in daily amounts; however, the patterns from week to week and season to season match well (weekly totals). Tables 16, 17, and 18, Appendix A, show observed and calculated (from the generated precipitation) basin discharge for the same three watersheds. A day-by-day comparison of the observed and calculated discharges will show that there is considerable variation of actual daily amounts; however, the week-to-week and season-to-season patterns match well (weekly totals). The ability to produce these patterns forms a basis for using the generation of a random sequence of daily rainfall (using weekly observed rainfall characteristics) to provide a base of comparison for evaluating the probable impacts of development on small watersheds. The use of such

a generated sequence will allow the evaluation of the potential impact to seasonal variations in watershed discharge under varying developments, rates of development, or designs.

The two watersheds (Anderson and Lowe) shown in Figure 3 were chosen for application of this concept since both met the definition of a small watershed. Table 19, Appendix A, shows the watershed characteristics used to describe the watersheds without disturbance (assumed condition: unmanaged forest), with disturbance (assumed condition: total area shown affected by mining to be denuded), and post disturbance (assumed condition: project complete and area revegetated). Three years of the generated rainfall sequence (shown in Tables 13 and 15) were used in combination with the watershed characteristics (Table 19) and discharge was calculated for each of the assumed conditions (pre-project, during project construction, post-project). Figures 5 and 6 compare the results on a monthly basis.

A comparison of the before, during, and after discharges allows one to draw inferences about the probable hydrologic impact of the proposed project during and after implementation. No provisions for drainage control during project construction would represent the worst case hydrologic scenario. Implementation of drainage controls during construction would change potential project impact as well as the watershed characteristics. Alternate designs and rates of disturbance may be evaluated by quantifying their impact upon the watershed characteristics utilized to calculate the watershed discharge. It is not within the scope nor intent of this work to investigate the

BEFORE DURING

Year	Month	BEFORE (inches)	DURING (inches)
1955	MAR	0.00	0.00
	APR	0.00	0.00
	MAY	0.00	0.00
	JUN	0.00	0.00
	JUL	0.00	0.00
	AUG	0.00	0.00
	SEPT	0.00	0.00
	OCT	0.00	0.00
	NOV	0.00	0.00
	DEC	0.00	0.00
	JAN	0.00	0.00
	FEB	0.00	0.00
1956	MAR	0.00	0.00
	APR	0.00	0.00
	MAY	0.00	0.00
	JUN	0.00	0.00
	JUL	0.00	0.00
	AUG	0.00	0.00
	SEPT	0.00	0.00
	OCT	0.00	0.00
	NOV	0.00	0.00
	DEC	0.00	0.00
	JAN	0.00	0.00
	FEB	0.00	0.00
1957	MAR	0.00	0.00
	APR	0.00	0.00
	MAY	0.00	0.00
	JUN	0.00	0.00
	JUL	0.00	0.00
	AUG	0.00	0.00
	SEPT	0.00	0.00
	OCT	0.00	0.00
	NOV	0.00	0.00
	DEC	0.00	0.00
	JAN	0.00	0.00
	FEB	0.00	0.00

FIGURE 5. Monthly discharge, expressed in watershed depth, for Anderson Branch, before, during, and after disturbance by a proposed project, based on 3-years of generated precipitation

intimate details of a project and its potential impact under different design and development philosophies; however, the procedures developed here are intended to provide the user (designer, planner, regulator, etc.) with a method for quantifying the potential effects of a proposed project and its implementation on a small watershed.

V. SUMMARY AND CONCLUSIONS

Summary

The objective of this study was to develop a computer-aided procedure which may be used to help evaluate impact(s) of proposed development(s) upon the hydrologic cycle of a small watershed. This was accomplished by developing a method for generating a random rainfall and using it as a uniform basis for calculating basin discharge under varying site conditions. Soil Conservation Service (event) techniques most often used for design of drainage facilities for small watersheds were included in the computer code (Appendix B, which contains a 5.25-inch computer diskette) to provide calculation of watershed runoff and discharge. A generated rainfall sequence is used (in addition to watershed characteristics) by the Soil Conservation techniques to calculate watershed discharge on a continuous basis (each day is treated as an event). This provides a procedure for calculating daily discharge for a small watershed based on the physical watershed characteristics and a random rainfall based on observed rainfall patterns. If a suitable record of observed rainfall exists for the watershed of interest, this record may be used as a basis (input) for calculating basin discharge using the discharge calculation procedures in this work.

Conclusions

The procedures developed in this study provide a method for

evaluating alternate design and development with an eye to minimizing adverse impacts to the watershed and maximizing the return on investment in drainage control facilities. The techniques and procedures proposed in this work are reasonable and based on deterministic concepts with a stochastic element to ensure randomness of rainfall patterns. To establish a precipitation pattern representative of the area to be evaluated, a minimum of 10 years of continuous daily precipitation record is required. This historical precipitation record should be taken from the nearest reporting station with reliable, 5% or less non-record days, records. A longer period of continuous record is preferred and will result in precipitation patterns which are more representative of the general area. Precipitation patterns developed from short historical records, or records with a large number of non-record days will result in patterns not representative of the area of observation. Wet years and drought years will have a much more pronounced effect upon precipitation patterns derived from short term records or records containing a large number of non-record days. Use of precipitation patterns developed from such historical records will result in over- or under-estimating potential impacts to small watershed discharge resulting from disturbances.

The average annual precipitation calculated from the generated sequence is 60 inches per year with a range from 47 to 67 inches. This is about 20% greater than the observed average annual precipitation of 50 inches. The generated precipitation record is continuous, whereas the historical record has days in which no data

were recorded. The removal of daily records, corresponding to the non-record days of the historical record, from the generated sequence results in an average annual precipitation of 51 inches per year. This is about 2% greater than the observed average annual precipitation of 50 inches. The generated precipitation was based on rainfall characteristics of the Oak Ridge, Tennessee reporting station. Dickens et al. (85) reported annual rainfall for the Oak Ridge Station for the years 1975-1981. The average annual precipitation for this period was 53.6 inches, with a range from 40 inches to 67 inches. The generated sequence is about 12% greater. This is within the accuracy of the historical record and variability of local precipitation. Missing records are common to all recorded data and result from equipment malfunction, human error, and accidental loss.

There are no provisions for separating the precipitation into rain, snow, or other forms of precipitation. Precipitation sequences developed from historical records which contain snow and/or sleet will incorporate the reported precipitation in inches as recorded. This provides complete accounting of all reported precipitation. The inclusion of non-liquid precipitation in the development of precipitation patterns does not cause any problem(s) with accuracy or errors in the precipitation generator; however, the SCS procedures used for calculating watershed discharge in this study do not apply to frozen or snow covered soil. If frozen soil and snow cover conditions exist, the procedures used for calculating watershed discharge should be modified using snow melt functions, to provide for these

conditions. The SCS National Engineering Handbook, Section 4 (13), contains appropriate procedural modifications. Application of the procedures, without modification, presented in this work to watersheds during the winter season will result in erroneous conclusions being drawn with regard to potential impacts to watershed discharge.

This method of quantifying watershed discharge is suitable for planning and evaluating purposes and is not intended to provide design discharges. The use of a common generated precipitation sequence and of Soil Conservation Service procedures to perform all analyses, minimizes the influence of the techniques of computation on the results. The discharges should be compared among themselves with the intent of providing a basis for drawing inferences about the probable impacts (i.e., more, same or less) to the discharge from small watersheds resulting from a proposed project or design. Removal of, or changes in, vegetative cover result in an increase in watershed discharge.

If projects are designed using techniques other than those used in this work for calculating watershed discharge, the rainfall generator may be used to provide a rainfall sequence suitable for input to these alternate method(s) on a continuous daily basis. If the method used is an event technique, each rainfall amount may be used as a design event to generate a seasonal (by day) record of discharge suitable for evaluation purposes. The procedures and techniques used in this work may be refined and improved as the field of computerized applied mathematics (random-number generation and

statistics) matures and new and improved techniques are developed for calculating discharge from small watersheds.

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APPENDIXES

APPENDIX A

Precipitation and Discharge Tables

Table 13. Precipitation (observed vs. generated) Anderson Branch
For a period of Record (December 6, 1975 through August 30, 1980)

		OBSERVED			GENERATED			weekly
		daily totals (inches)			daily totals (inches)			total
DEC	6	.00	.23	.08	.00	.29	.00	.60
	13	.01	.00	.02	.65	.00	.00	.68
	20	.00	.01	.00	.03	.00	1.38	1.45
	27	.22	.01	.00	.00	.21	.01	1.60
JAN	3	.02	.43	.00	.00	.00	.02	.95
	10	.05	.00	.32	.02	.40	.01	.80
	17	.03	.00	.04	.00	.07	.00	.14
	24	.01	.12	.70	.95	.00	.05	1.83
FEB	31	.00	.00	.35	.00	.05	.07	.48
	7	.09	.00	.00	.01	.02	.00	.19
	14	.02	.01	.00	.00	.14	.03	1.57
	21	.00	.03	.00	.01	.00	.51	.55
MAR	28	.00					.38	.00
	1	.60	.04	.01	.42	.60	.01	1.70
	8	.11	.00	.01	.01	.22	.01	.36
	15	.00	.18	.87	.00	.00	.27	1.41
APR	22	.19	.07	.00	2.34	.72	.01	3.78
	29	.00	.01	.12	.00	.00	.00	.13
	5	.00	.00	.16	.00	.01	.00	.17
	12	.01	.00	.00	.00	.00	.01	.58
	19	.02	.00	.19	.06	.00	.00	.27
	26	.18	.53	.01	.00	.00	.28	1.00

Table 13 (Continued)

		OBSERVED				GENERATED					
		daily totals (inches)				daily totals (inches)				weekly total	
											total
MAY	3	.40	.00	.00	.41	.00	.19	.00	.50	.00	1.11
	10	1.39	.54	.14	.41	.01	.83	.11	.02	.00	.23
	17	.00	.00	.00	.00	.00	.06	.00	.00	.00	.00
	24	2.02	.16	.01	.40	.51	.08	.17	.00	.00	.62
	31	.00	.01	.00	.00	.00	.32	.00	.00	.05	.06
JUN	7	.00	.00	.00	.00	.00	.01	.00	.00	.00	.41
	14	.00	.64	1.51	.05	.00	.06	.89	.37	.02	.00
	21	.78	.05	.11	.15	.17	.81	.69	.22	.00	.33
	28	.01	1.67	.38	.04	.02	.92	.45	.63	.27	.00
	5	.03	.02	.02	.01	.00	.01	.00	.00	.07	.00
JUL	12	.02	.00	.00	.00	.03	.01	.00	.44	.00	.00
	19	.01	.00	.01	.13	.01	2.01	.00	.00	.00	.55
	26	.10	.02	.00	.00	.00	.01	.00	.02	.00	.00
	2	.79	.01	.00	.00	.00	.01	.00	.00	.72	.00
	9	.00	.00	.14	.01	.00	1.05	.03	.00	.00	.00
AUG	16	.00	.00	.00	.00	.00	.14	1.73	.05	.49	.66
	23	.00	.89	.00	.00	.34	.06	.00	.00	.01	.00
	30	.00	.07	.00	.00	.00	.00	.00	.71	.16	.00
	6	.26	.00	.00	.00	.21	.00	.01	.01	.00	.73
	13	.01	.00	.00	.00	.00	.00	.00	.00	.66	.03
SEP	20	.00	.00	.12	.00	.00	.00	.00	.01	.01	.12
	27	.00	.01	.01	.01	.53	.00	.01	.00	.00	.00
											.04
											.00
											.05

Table 13 (Continued)

		OBSERVED			weekly total	GENERATED			weekly total
		daily	totals (inches)			daily	totals (inches)		
MAR	1	.01	1.54	.00	.02	.00	.00	.03	.08
	8	.35	.33	.09	.16	.11	.05	.31	.77
	15	.01	.00	.02	.30	.00	.41	.81	3.17
	22	.03	1.05	2.38	.06	.36	.51	.87	1.95
	29	.00	.02	.00	---	.00	.00	.10	.58
APR	5	---	---	---	---	.20	.03	1.31	1.63
	12	---	---	---	---	.00	.02	.02	.69
	19	---	---	---	---	.02	.00	.17	.77
	26	---	---	---	---	.06	.00	.53	.62
MAY	3	.00	.00	.00	.00	.00	.00	.11	.40
	10	.01	.00	.18	.02	.00	.00	.00	.44
	17	.01	.00	.62	.01	.00	.00	.00	.55
	24	.00	.00	.00	.00	.17	.00	.00	1.45
	31	.00	.00	.08	.12	.02	.18	.00	.85
JUN	7	.04	.20	.52	.02	.00	.00	.00	1.87
	14	1.05	.82	.08	.01	.08	.00	.14	.29
	21	.60	.00	.00	.00	.19	.01	.36	1.27
	28	.00	.00	.13	.05	.06	1.01	.05	1.25
JUL	5	.00	.00	.00	.00	.06	.00	.17	.26
	12	.00	.00	.01	.01	.00	.00	.01	1.13
	19	.03	.01	.00	---	.03	.01	.00	.37
	26	---	---	---	---	.08	.00	.14	1.32

Table 13 (Continued)

	OBSERVED				weekly total	GENERATED				weekly total
	daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)		daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)	
31	.00	.00	.06	.01	.00	.03	.00	.05	.00	.10
JUN 7	.00	.00	.00	.00	.07	.00	.03	.16	.00	.07
14	.01	.02	.07	.00	.00	.01	.00	.06	.80	.19
21	.00	.11	.74	.00	.01	.08	.41	.04	.00	.01
28	.02	1.18	.97	.00	.00	.00	.91	.07	1.03	.07
JUL 5	.00	.00	1.22	1.15	.01	.00	.86	.17	.04	.00
12	.01	.01	.84	.02	.08	.05	.00	.56	.62	.09
19	.42	.70	.01	1.29	.00	.00	.08	.05	.70	.93
26	.26	.74	1.25	.00	.06	.00	.00	.00	.63	.18
AUG 2	.01	.00	.05	.00	.00	.00	.40	.00	.16	.00
9	.45	.03	.00	.28	.00	.13	.77	.00	.00	.00
16	---	---	---	---	---	.00	.38	.46	.17	.09
23	.00	.00	.00	.00	.00	.00	.00	.28	.07	.05
30	.00	.00	.00	.00	.00	.48	.50	.00	.11	.00
SEP 6	.00	.00	.00	.00	.00	.00	.04	.00	.00	.01
13	.00	.00	.00	.00	.00	.00	.00	.66	.34	.00
20	.00	.00	.00	.00	.00	.00	.24	.13	.00	.00
27	.00	.47	.01	.00	.00	.91	.61	.17	.23	.09
OCT 4	---	.00	.01	.01	.30	.00	.05	.00	.13	.00
11	.01	.00	.00	.00	.00	.02	.00	.06	.00	.00
18	.00	.00	.00	.41	.01	.00	.23	.31	.00	.00
25	.00	.00	.01	.01	.23	.00	.00	.83	.62	.22
					1.37	.00	.00	.00	.00	.21
					1.62	.00	.00	.00	.00	.21
										.90
										.26
										1.06
										.54
										2.08
										2.13
										1.32
										1.88
										2.92
										.56
										.90
										1.10
										.97
										1.09
										.05
										1.19
										.56
										2.01
										.18
										.10
										.56
										1.88

Table 13 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total						
		daily totals (inches)					daily totals (inches)										
29		.02	.01	.10	.13	.00	.34	.26	.86	.33	.41	.01	.00	.05	.06	.00	.86
APR 5		.02	.11	.02	.02	.02	.02	.58	.79	.00	.22	.04	.01	.01	.00	.00	.28
12		2.15	.00	.02	.02	.02	.05	.02	2.28	.47	.08	.00	.26	.16	.06	.49	1.52
19		.00	.00	.51	.00	.00	.00	.00	.51	.08	.00	.00	.02	.02	.01	.00	.13
26		.00	.00	.33	.82	.40	.77	.38	2.70	.70	.26	.07	.13	.00	.00	.46	1.62
MAY 3		.21	.01	.11	.07	.00	.68	.87	1.95	.81	.07	.00	.26	.48	.61	.11	2.34
10		.05	.00	.42	.00	.00	.00	.00	.47	.00	.00	.00	.05	.05	.00	.00	.10
17		.00	.00	.04	.00	.00	.00	.00	.04	.12	.00	.06	.27	.00	.09	.11	.65
24		.00	.00	.11	.00	.00	.00	.00	.11	.00	.00	.00	.41	.22	.03	.00	.66
31		.39	.22	.04	.00	.00	.00	.00	.65	.05	.07	.12	.00	.00	.07	.00	.31
JUN 7		.00	.37	.03	---	---	---	---	.40	.01	.00	.00	.00	.00	.61	.53	1.15
14		---	---	---	---	---	.00	.20	.20	.06	.00	.08	1.02	.10	.00	.27	1.53
21		.17	1.19	.10	.01	.00	.00	.62	2.09	.36	.08	.00	.20	.01	.00	.12	.77
28		1.68	.18	.05	.01	.00	.00	.00	1.92	.00	.00	.03	.04	.01	.00	.04	.12
JUL 5		.00	.01	.01	.01	.00	.00	---	.03	.00	.00	.31	.23	.63	.00	.10	1.27
12		---	---	---	---	---	---	---	---	.00	.00	.07	.03	.16	.00	.00	.26
19		---	---	---	---	---	---	---	---	.00	.01	.01	.01	.60	.00	.04	.67
26		---	---	---	---	---	---	---	---	.00	.11	.00	.00	.18	.05	.00	.34
AUG 2		---	1.19	.45	.00	.14	.33	.00	2.11	.00	.01	.70	.08	.10	.00	.33	1.22
9		.00	---	---	---	---	---	---	.00	.00	.00	.00	.00	.00	.17	.06	.23
16		---	---	---	---	.00	.00	.40	.40	.00	.00	.13	.00	.45	.15	.01	.74
23		.25	.00	.00	.00	.00	.00	.21	.46	.06	.01	.11	.00	.00	.00	.07	.25

Table 13 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total	
		daily totals (inches)					daily totals (inches)					
30	1.13	.06	.00	.01	.00	1.42	.00	.31	.47	.08	.00	.86
SEP 6	.56	.02	.00	.00	.04	.22	.00	.88	.23	.00	.00	1.45
13	.00	---	---	---	.05	.00	.84	.10	.32	.02	.21	.70
20	.18	.21	.01	.00	.00	.01	.81	.52	.14	.00	.66	2.17
27	.00	.00	.00	.21	.44	.00	.00	.00	.00	.00	.01	.02
OCT 4	.00	.00	.92	.33	.01	---	.00	.00	.48	.88	.72	2.48
11	---	---	---	---	---	---	.21	.32	.00	.41	.71	2.24
18	---	---	---	---	---	---	.10	.02	.06	.00	.01	.22
25	---	---	---	---	---	---	.17	.00	.01	.00	.67	1.73
NOV 1	---	---	---	---	---	---	.00	.04	.04	.00	.17	.73
8	.00	.02	.01	.02	.03	.00	.00	.00	.00	.00	.37	.52
15	.00	.00	.00	.00	.02	.01	.00	.00	.86	.25	.09	1.26
22	.02	.01	.00	.00	.00	.00	.01	.01	.00	.16	.00	.51
29	.01	.01	.00	.00	.00	.01	.62	.27	.03	.07	.11	1.13
DEC 6	.00	.01	.10	.00	.00	.02	.02	.91	.76	.05	.17	2.14
13	.00	.02	.00	.00	.01	.01	.08	.00	.00	.13	.00	.21
20	.00	.00	.00	.01	.01	.00	.00	.00	.23	.00	.19	.43
27	.00	---	---	---	---	.00	.01	.00	.00	.27	.03	.43
JAN 3	.00	.00	.00	.00	.01	.01	.00	.00	.07	.10	.00	.57
10	.19	.03	.00	.00	.00	.00	.04	.00	.00	1.06	.40	1.57
17	.00	.00	.00	.00	.00	.00	.00	.00	.00	.12	.03	.19
24	.00	.00	.00	.01	.00	.00	.00	.01	.05	.00	.00	.22

Table 13 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total		
		daily totals (inches)					daily totals (inches)						
31		.00	.00	.00	.00	.00	.01	.01	.00	.00	.06	.48	.56
FEB 7		.00	.00	.00	.00	.00	.00	.07	.01	.00	.00	.22	.46
14		.00	.00	.00	.00	.00	.02	.03	.02	.00	.04	.03	.14
21		.00	.00	.00	.00	.00	.00	.10	.00	.00	.00	.00	.10
28		.00				.00	.00						.00
MAR 1		.64	.01	.18	.00	.00	.88	.25	.05	.00	.00	.00	1.18
8		.00	.00	.00	.00	.00	.03	.00	.00	.20	.00	.01	.41
15		.00	.35	.77	.06	.00	.00	.00	.00	.28	.10	.00	.42
22		.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.01	.02
29		.08	.37	.32	.09	.00	.16	.22	.01	.00	.00	.00	.39
APR 5		.00	.01	.00	.00	.00	.05	.01	.00	.13	.02	.00	.21
12		.00	.00	.00	.00	.00	.00	.44	.11	.00	.00	.08	.65
19		.02	1.09	.01	.85	.00	.00	.01	.03	.00	.02	.00	.06
26		.23	.41	.24	.01	.00	.00	.01	.00	.00	.26	.10	.37
MAY 3		.11	.04	.00	.00	.00	.00	.00	.02	.00	.11	.00	.14
10		.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.10	.19
17		.00	.00	.00	.40	.00	.00	.13	.00	.00	.22	.00	.35
24		.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.38	.43
31		.01	.00	.01	.00	----	.16	.07	.00	.00	.00	.00	.23
JUN 7		----	----	----	.00	.00	.01	.07	.05	.08	.09	.00	.30
14		.00	.00	.00	.00	.00	.00	.03	.01	.00	.00	.00	.04
21		.00	.00	.00	.00	.00	.00	.25	.17	.00	.06	.00	.48

Table 13 (Continued)

[illegible]

Source of Observed Data: Dickens, P.S., C.H. Chiang, R.A. Minear, and B.A. Tschantz, New River Project Data Bases and Documentation Joint Research, Volume I, Hydrologic and Water Quality Data, The University of Tennessee, Department of Civil Engineering and Zoology, Knoxville, Tennessee, December, 1980, (85).

Table 14. Precipitation (observed vs. generated) Bowling Branch
For a period of Record (December 6, 1975 through August 30, 1980)

		OBSERVED			GENERATED			weekly
		daily totals (inches)			daily totals (inches)			total
DEC	6	.01	.00	.00	.00	.00	.00	2.23
	13	.15	.02	2.17	.03	.08	.01	.32
	20	.01	.00	.00	.44	.04	.01	.86
	27	.00	.00	.23	.08	.01	.00	1.32
JAN	3	.00	.00	.00	.00	.00	1.62	1.63
	10	.00	.30	.00	.01	.00	.00	.04
	17	.81	.01	.01	.00	.01	.11	.21
	24	.00	.01	.00	1.50	.26	.01	.00
FEB	31	.05	.21	1.20	.00	.07	.00	.66
	7	.01	.39	.04	.03	.00	.07	.17
	14	.00	.62	.00	.00	.03	.01	.60
	21	.00	.07	.00	.00	.00	.01	.11
MAR	28	1.07	.08	.00	.13	.12	.38	.38
	1	.07	.00	.11	.00	.02	.73	.13
	8	.00	.00	.00	.00	.01	.00	.06
	15	.00	.00	1.34	.00	.00	.00	.43
APR	22	.00	.00	.02	.01	.00	.81	.61
	29	.00	.00	.00	.00	.59	.00	.17
	5	.50	.52	.00	.00	.23	.01	.06
	12	.01	.11	.02	.01	.00	.00	.21
	19	.00	.00	.11	.33	.28	.16	.01
	26	2.75	.48	.41	.00	.00	.31	.00

Table 14 (Continued)

		OBSERVED			GENERATED			weekly					
		daily totals (inches)			daily totals (inches)			total					
MAY	3	.01	.00	.00	.00	.19	.00	.50	.00	.36	.00	1.11	2.16
	10	.00	.00	.00	.00	.83	.11	.02	.00	.68	1.73	.23	3.60
	17	.00	.00	.01	.00	.06	.00	.00	.00	.01	.11	.00	.18
	24	.04	.00	.00	.21	.08	.17	.00	.00	.00	1.01	.62	1.88
	31	.00	.00	.27	.28	.32	.00	.00	.05	.00	.00	.06	.43
JUN	7	.00	.85	.17	.79	.01	.00	.00	.00	.00	.00	.41	.42
	14	.08	.55	.01	.00	.06	.89	.37	.02	.00	.01	.00	1.35
	21	.00	.00	.03	2.22	.81	.69	.22	.00	.46	1.11	.33	3.62
	28	.00	.67	.01	.01	.92	.45	.63	.27	.02	.88	.00	3.17
	5	.00	.00	.00	.00	.01	.00	.00	.07	.00	.70	.00	.78
JUL	12	.00	.00	.00	.00	.01	.00	.44	.00	.01	.02	.00	.48
	19	.34	.01	.00	.84	2.01	.00	.00	.00	.00	.61	.55	3.17
	26	.12	.13	.15	.00	.01	.00	.02	.00	.01	.00	.00	.04
	2	.64	.00	.10	.37	.01	.00	.00	.72	.11	.00	.00	.84
	9	.60	.02	.00	.03	1.05	.03	.00	.00	.00	.00	.66	1.74
AUG	16	.00	.00	1.01	.01	.14	1.73	.05	.49	.01	.00	.00	2.42
	23	.00	.27	.25	.10	.06	.00	.00	.01	.00	.09	.00	.16
	30	.00	.00	.00	.55	.00	.00	.71	.16	.07	.01	.00	.95
	6	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.73	.75
	13	.00	.00	.00	.00	.00	.00	.00	.66	1.00	.40	.03	2.09
SEP	20	.00	.00	.14	.15	.00	.00	.01	.01	.00	.62	.12	.76
	27	.00	.00	.10	.00	.00	.01	.00	.00	.00	.04	.00	.05

Table 14 (Continued)

		OBSERVED			weekly total		GENERATED			weekly total	
		daily totals (inches)					daily totals (inches)				
OCT	4	.00	.00	.28	.00	1.44	.00	.73	.88	.11	.00
	11	.00	.21	.00	.00	.21	.42	.08	.10	.00	.00
	18	.43	.00	.00	.05	.49	.00	.00	.00	.01	.02
	25	1.00	.01	.01	.00	2.20	1.62	.73	.00	.06	.04
NOV	1	.00	.60	.27	---	.92	.20	.14	.01	.00	.01
	8	---	---	---	---	---	.00	.61	.99	.05	.01
	15	---	.08	.01	.50	.61	.07	.00	.00	.00	1.44
	22	2.32	.00	.01	.00	3.11	.00	1.91	.63	.19	.08
	29	.02	.01	.00	.01	.06	.00	.38	.00	.24	.00
DEC	6	.00	.00	.29	.02	.38	.00	.72	.17	.04	.00
	13	.04	.00	.00	.00	.04	.90	.35	.57	.10	.00
	20	.00	.00	.32	.40	.73	.00	.16	.00	.50	.00
	27	.00	.01	.02	.02	.31	.02	.02	.09	.01	.00
JAN	3	1.04	.43	.02	.36	2.17	.00	.17	.06	.00	.88
	10	.02	.03	.04	.03	.49	.00	.00	.00	.38	2.06
	17	.27	.01	.03	.41	.86	.00	.00	.07	.00	.00
	24	.03	.01	.00	.03	.41	.12	.00	.00	.02	.00
FEB	31	.19	.03	.02	.01	1.16	.47	1.11	.60	.02	.00
	7	.08	.02	.40	.02	.56	.10	.43	.05	.10	.00
	14	.02	.00	.02	.04	.11	.62	.31	.00	.00	.18
	21	.12	.06	.01	.02	.42	.00	.00	.00	.90	.68
	28	.02	.03	.02	.02	.05	.00	.00	.00	.00	.34
							.00	.00			.00

Table 14 (Continued)

		OBSERVED					weekly total	GENERATED					weekly total		
		daily totals (inches)						daily totals (inches)							
MAR	1	.02	.02	.03	.03	.46	.02	.61	.03	.00	.01	.03	.01	.00	.08
	8	.16	.20	.01	.03	.03	.03	.51	.31	.11	.05	.00	.06	.24	.77
	15	.02	.05	.41	.80	.06	.53	1.91	.81	.00	.41	1.61	.20	.02	3.17
	22	.03	.03	.05	.21	.03	.00	1.01	.87	.36	.51	.00	.00	.04	1.95
	29	.04	.05	.04	.04	1.69	.04	1.94	.10	.00	.00	.00	.00	.48	.58
APR	5	.05	.05	.03	.02	.35	.13	.94	1.31	.20	.03	.00	.00	.09	1.63
	12	.02	.22	.04	.04	.05	.02	.44	.02	.00	.02	.64	.00	.01	.69
	19	.20	.19	.46	.04	1.07	1.06	3.07	.17	.02	.00	.00	.42	.16	.77
	26	4.18	.12	.00	.00	.00	.00	4.30	.53	.06	.00	.02	.00	.01	.62
MAY	3	.00	.00	.00	.00	.00	.00	.00	.11	.00	.00	.00	.20	.09	.40
	10	.11	.02	.00	.00	1.36	.12	2.09	.00	.00	.00	.04	.30	.10	.44
	17	.01	.00	.00	.46	.04	.01	1.00	.00	.17	.00	.33	.00	.00	.55
	24	.00	.36	.02	.00	.20	.07	.65	.00	.00	1.23	.07	.15	.00	1.45
	31	.00	.00	.00	.00	.00	.00	.00	.00	.02	.18	.00	.53	.12	.85
JUN	7	.00	.00	.00	.19	.00	.04	.23	.00	.00	.00	.99	.28	.60	1.87
	14	.83	.00	.08	.16	.00	1.37	2.44	.14	.08	.00	.01	.00	.00	.29
	21	.00	.03	.00	.00	.00	.00	.03	.36	.19	.01	.01	.10	.00	1.27
	28	.33	.00	.00	.13	.00	.07	.53	.05	.06	1.01	.03	.00	.10	1.25
JUL	5	.13	.76	.00	.10	.02	.01	1.14	.17	.06	.00	.00	.02	.01	.26
	12	.07	.02	.02	.03	.03	.02	.21	.01	.00	.00	.15	.07	.02	1.13
	19	.03	.02	.00	.04	.01	.02	.13	.00	.03	.01	.10	.00	.23	.37
	26	.01	.00	.00	.00	.00	.09	.10	.14	.08	.00	.41	.27	.05	1.32

Table 14 (Continued)

		OBSERVED				GENERATED						
		daily totals (inches)				daily totals (inches)				weekly total		
AUG	2	.07	.00	.04	.01	.00	.00	.02	.07	.00	.02	.14
	9	.00	.00	.00	.00	.00	.00	.38	.09	.67	.01	1.41
	16	.07	.05	.04	.03	.02	.01	.00	.00	.10	.00	.12
	23	.00	.00	.00	.00	.00	.00	.66	.00	.00	.00	2.14
	30	.00	.01	.00	.01	.00	.00	.17	.00	.00	.00	1.45
SEP	6	.00	.00	.28	.00	.00	.00	.29	.00	.00	.01	.46
	13	.00	.00	.47	.00	.00	.00	.69	.00	.00	.00	.73
	20	.00	.00	.51	.01	.00	.00	.28	.63	.00	.00	2.93
	27	.73	.88	.00	---	.00	.00	2.06	.00	.00	.00	3.18
	4	.00	.48	.49	.66	.01	.00	.00	.00	.01	.00	.54
OCT	11	.03	.00	.00	.00	.00	.81	.23	.00	1.14	.03	1.46
	18	.99	.65	.00	.00	.00	.01	.00	.79	.04	.00	1.06
	25	.00	.00	.00	---	---	---	.10	.51	.48	.00	2.54
	1	---	---	---	---	---	---	.00	.00	.01	.00	.50
	8	---	---	---	---	---	---	.33	.62	.00	.03	2.14
NOV	15	---	---	---	---	---	---	.18	.00	.00	.00	1.14
	22	---	---	---	---	---	---	.23	.00	1.68	.37	2.38
	29	---	---	---	---	---	---	.51	.00	.01	.04	.76
	6	---	---	---	---	---	---	.00	.02	.02	.01	.79
	13	---	---	---	---	---	---	.48	.00	.00	.20	1.33
DEC	20	---	---	---	---	---	---	.83	.02	.00	.09	1.52
	27	---	---	---	---	---	---	.01	.00	.00	.10	.42

Table 14 (Continued)

		OBSERVED				GENERATED									
		daily totals (inches)				daily totals (inches)				weekly total					
JAN	3	---	---	.04	.01	.37	.05	.47	.77	.00	.37	.14	.00	.06	1.34
	10	.01	.06	.00	.01	1.07	.01	1.16	.00	.20	.01	.00	.00	.00	.21
	17	.01	.00	.03	.12	.03	.02	.23	.97	.00	.63	.18	.02	.00	2.12
	24	.01	.01	.04	.29	.00	1.19	1.55	.09	.00	.10	.00	.68	.00	.87
	31	.02	.04	.16	.01	.00	.09	.32	.03	.01	1.17	.31	.00	.00	1.52
FEB	7	.01	.75	.01	.00	.01	.34	1.34	.00	.40	.10	.00	.03	.44	.97
	14	.05	.80	1.27	.07	.00	.00	2.19	.00	.00	.00	.70	.00	.05	.75
	21	.01	.00	.05	.02	.25	.00	.33	.03	.00	.00	.81	.16	.00	1.00
	28	.01	.00	.01	.02	.02	.05	.72	.16	.04	.07	.29	.00	.00	.23
MAR	1	.48	.00	.14	.02	.02	.05	.72	.16	.00	.00	.00	.00	.00	.56
	8	.05	.03	.21	.14	.07	.04	.62	.00	.00	.00	.15	.00	.69	.88
	15	.05	.24	.05	.08	.02	.07	.97	1.06	.00	.48	.00	.32	.00	1.86
	22	.08	.05	.22	.40	.07	.13	1.24	.01	.19	.04	.20	.00	.03	.47
	29	.06	1.12	.08	.16	.11	.03	1.60	.16	.00	.02	.00	.55	1.38	2.52
APR	5	.02	.33	.03	.06	.86	.11	1.44	.02	.00	.17	.92	.00	.30	1.43
	12	.07	.04	.04	.05	.05	.04	.33	.00	.00	.00	.00	.00	.00	.00
	19	.04	.04	.03	.03	.06	.04	.27	.82	.67	.71	.13	.00	.00	2.33
	26	.04	.29	.00	.00	.00	.00	.33	.51	.00	.00	.18	.06	.00	.75
MAY	3	.00	1.21	.05	.10	.01	.00	1.42	2.11	.03	.00	.19	.34	.00	2.75
	10	.04	.90	.50	.01	.01	.51	1.97	.00	.04	.03	.00	.14	.07	.28
	17	.01	.00	.03	.65	.00	.10	.79	.00	.00	.00	.37	.00	.09	.46
	24	.66	.02	.01	.54	1.28	.40	2.91	.22	.08	.00	.83	1.12	1.42	3.20

Table 14 (Continued)

	OBSERVED				weekly total	GENERATED				weekly total			
	daily totals (inches)					daily totals (inches)							
31	.21	.00	.00	.00	.00	.03	.00	.00	.05	.00	.10	.72	.90
JUN 7	.00	.29	.74	.05	.00	.00	.00	.03	.16	.00	.07	.00	.26
14	.00	.00	.01	.00	.14	.01	.00	.00	.06	.80	.19	.00	1.06
21	.00	.00	.81	2.15	.00	.08	.00	.41	.04	.00	.01	.00	.54
28	.42	.00	.00	.00	.00	.00	.00	.91	.07	1.03	.00	.07	2.08
JUL 5	.02	.00	.00	.00	.00	.00	.86	.88	.17	.04	.00	.18	2.13
12	.00	.00	.00	.08	.02	.05	.00	.00	.56	.62	.09	.00	1.32
19	.07	.00	.00	.00	.06	.00	.08	.05	.00	.70	.93	.12	1.88
26	.06	.01	.00	.00	1.20	.00	.00	2.07	.00	.63	.18	.04	2.92
AUG 2	.00	.00	.00	.00	.00	.00	.00	.40	.00	.16	.00	.00	.56
9	.18	1.15	.01	.00	.00	.13	.77	.00	.00	.00	.00	.00	.90
16	.24	.00	.01	.09	.49	.00	.38	.46	.17	.00	.09	.00	1.10
23	.29	1.85	.24	.00	.60	.00	.00	.57	.28	.07	.00	.05	.97
30	.24	.00	.16	.01	.00	.48	.50	.00	.00	.11	.00	.00	1.09
SEP 6	.00	.00	.00	.00	.03	.00	.04	.00	.00	.00	.01	.00	.05
13	.00	.00	.33	.21	.01	.00	.00	.00	.66	.34	.00	.19	1.19
20	.01	.01	.00	.01	.00	.00	.24	.06	.13	.00	.00	.13	.56
27	.64	---	---	---	---	.91	.61	.00	.17	.23	.09	.00	2.01
OCT 4	---	---	.00	.00	.00	.00	.00	.05	.00	.13	.00	.00	.18
11	.00	.00	.00	.00	.52	.02	.02	.00	.06	.00	.00	.00	.10
18	.00	.03	.26	.00	.00	.00	.00	.23	.31	.00	.00	.02	.56
25	.00	.00	.00	.01	.09	.00	.00	.00	.83	.62	.22	.21	1.88

Table 14 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total			
		daily	totals (inches)				daily	totals (inches)						
NOV	1	.00	.01	.01	.01	.01	.63	.01	.00	.00	.41	.06	.39	1.50
	8	.01	.00	.00	.01	.01	.00	.32	.07	.00	.00	1.08	.06	1.53
	15	.01	.01	.01	.00	.00	.00	.00	.00	.00	.65	.34	.10	1.09
	22	.00	.29	.01	.01	.01	.00	.01	.55	.83	.33	.00	.20	1.92
DEC	29	.01	.01	.14	.01	.01	.05	.31	.00	.00	.00	.00	.00	.36
	6	.01	.03	.20	.01	.01	.27	.01	.00	.06	.00	.00	.00	.34
	13	.36	.01	.38	.00	.01	.97	.32	.14	.00	.12	.03	.28	1.86
	20	1.37	.01	.02	1.24	.68	.00	.00	.63	.00	.00	.07	.00	.70
JAN	27	.16	.02	.01	.01	.19	.14	.10	.02	.00	.07	.01	.41	.75
	3	.01	.15	.70	.14	.02	.64	.84	.00	.02	.09	.00	.61	2.20
	10	.03	.02	.01	.02	.48	.42	.00	.00	.00	.00	.12	.81	1.35
	17	1.47	.01	.04	.05	.99	.07	.00	.03	.10	.33	.01	.14	.68
FEB	24	.01	.21	.01	.00	.00	.00	.00	.00	.90	.06	.00	.82	1.78
	31	.01	.00	.08	.02	.18	.61	.17	.00	.03	.10	.00	.00	.91
	7	.18	.12	.18	.02	.27	.07	.15	.02	.00	.00	.37	.04	.65
	14	.01	.01	.00	.04	.13	.00	.05	.18	.38	.00	.00	.00	.61
MAR	21	.01	.00	.00	.09	.09	.00	.04	.01	.00	.00	.06	.00	.11
	28	.00					.03							.03
	1	.39	.01	.24	.00	1.24	.07	.03	.00	.18	.27	.00	.10	.65
	8	---	---	.00	.00	.43	.92	.00	.08	.06	.00	.10	.02	1.18
	15	.01	.01	.01	.25	.83	.00	.07	.13	.00	.03	.13	.00	.36
	22	.04	.02	.23	.01	.02	.00	.60	.11	.00	.23	.05	.00	.99

Table 14 (Continued)

		OBSERVED				GENERATED										
		daily totals (inches)				daily totals (inches)				weekly total						
					weekly total											
APR	29	.01	.02	.02	.00	1.21	.19	.07	.33	.41	.01	.00	.05	.06	.00	.86
	5	.03	.49	.00	---	---	---	---	.00	.22	.04	.01	.01	.00	.00	.28
	12	---	---	---	---	---	---	---	.47	.08	.00	.26	.16	.06	.49	1.52
	19	.01	.01	.01	1.06	.21	.02	.03	.08	.00	.00	.02	.02	.01	.00	.13
MAY	26	.02	.03	.03	.02	.03	.02	.10	.70	.26	.07	.13	.00	.00	.46	1.62
	3	.17	.00	.41	.25	.06	.07	.02	.81	.07	.00	.26	.48	.61	.11	2.34
	10	.03	.03	.03	.57	1.82	.01	.03	.00	.00	.00	.05	.05	.00	.00	.10
	17	.03	.03	.12	.02	.00	.00	.36	.12	.00	.06	.27	.00	.09	.11	.65
JUN	24	.00	.00	.00	.00	.00	.00	.32	.00	.00	.00	.41	.22	.03	.00	.66
	31	.67	.38	.85	.29	.24	.01	.12	.05	.07	.12	.00	.00	.07	.00	.31
	7	.04	.00	.63	1.19	.46	.00	.69	.01	.00	.00	.00	.00	.61	.53	1.15
	14	.01	.02	.00	.00	.00	.00	.04	.06	.00	.08	1.02	.10	.00	.27	1.53
JUL	21	.00	.00	.00	.00	.00	.00	.08	.36	.08	.00	.20	.01	.00	.12	.77
	28	.00	.00	.00	.00	.40	.35	.18	.00	.00	.03	.04	.01	.00	.04	.12
	5	.00	.00	.00	.00	.00	.29	.06	.00	.00	.31	.23	.63	.00	.10	1.27
	12	.00	.08	.17	.00	.00	.49	.18	.00	.00	.07	.03	.16	.00	.00	.26
AUG	19	.59	.03	.02	.21	.05	1.96	.69	.00	.01	.01	.01	.60	.00	.04	.67
	26	.01	.00	.01	.08	2.18	.59	.08	.00	.11	.00	.00	.18	.05	.00	.34
	2	.10	.02	.36	.14	.50	.02	.02	.00	.01	.70	.08	.10	.00	.33	1.22
	9	.02	.04	---	---	---	---	---	.00	.00	.00	.00	.00	.17	.06	.23
	16	---	---	---	---	---	---	---	.00	.00	.13	.00	.45	.15	.01	.74
	23	---	---	---	---	---	---	---	.06	.01	.11	.00	.00	.00	.07	.25

Table 14 (Continued)

[illegible]

Source of Observed Data: Dickens, P.S., C.H. Chiang, R.A. Minear, and B.A. Tschantz, New River Project Data Bases and Documentation Joint Research, Volume I, Hydrologic and Water Quality Data, The University of Tennessee, Departments of Civil Engineering and Zoology, Knoxville, Tennessee, December, 1980, (85).

**Table 15. Precipitation (observed vs. generated) Lowe Branch
For a period of Record (April 26, 1975 through September 5, 1980)**

		OBSERVED				GENERATED				weekly total				
		daily totals (inches)				daily totals (inches)				weekly total				
APR	26	.00	.00	.00	.00	.01	.01	.00	.00	.10	.00	.01	.00	.12
MAY	3	.01	.14	.00	.00	.00	.00	.66	.02	.20	.11	.02	.54	.92
	10	.00	.00	.00	.00	.00	.12	3.68	.00	.00	.01	.30	.51	1.53
	17	.36	.14	.01	.01	.25	.00	.00	1.13	.41	.06	.12	.08	1.80
	24	.00	.00	.73	.01	1.74	---	.03	.00	.22	.00	.98	.02	1.61
	31	---	---	---	---	.01	.01	.34	.00	1.52	.45	.81	.03	3.15
JUN	7	.00	.00	.03	.42	---	---	.00	.00	.48	.00	.00	.00	.52
	14	.02	.11	.01	.01	.00	.00	.04	.09	.81	.11	.00	.00	1.73
	21	.00	.00	.00	.02	.10	.13	.73	.00	.01	.31	.01	.12	1.18
JUL	28	.01	.00	.00	.28	.03	.03	.20	.02	.00	.31	.00	.01	.54
	5	.01	.50	.00	.52	.05	.01	.07	1.81	.02	.25	.03	.00	2.24
	12	.22	.22	.02	.01	.00	.00	.01	.04	.00	.00	.02	.00	.07
AUG	19	.04	.00	.00	.00	.00	.01	.11	.00	.00	.01	.47	.73	1.40
	26	.00	.00	.01	.00	.53	.02	.00	.00	.30	.03	.02	.00	.35
	2	.00	.00	.01	.40	.01	.00	.01	.00	.00	.36	.17	.00	.54
SEP	9	.11	.24	.00	.00	.01	.13	.04	.00	.00	.03	.15	.00	.22
	16	.03	.11	1.58	.01	.00	.00	.01	.38	.01	.00	.00	.00	.40
	23	.00	.00	.00	.00	.01	.00	.00	.00	.02	.00	.00	.20	.23
	30	.00	.00	.00	.00	.00	.00	2.05	.11	.24	.08	.62	.34	3.10
	6	.00	.00	.00	.00	.00	.00	.00	.03	.10	.21	.00	.00	.34
	13	.00	.00	.00	.00	.00	.04	.01	.03	.00	.00	.00	.06	.10
	20	.15	.01	.96	2.18	.04	.06	.22	.04	.63	.92	.14	.09	2.55

Table 15 (Continued)

		OBSERVED			GENERATED				
		daily totals (inches)			daily totals (inches)			weekly total	
				weekly total					total
OCT	27	.00	.01	.00	.28	.03	.01	.33	.15
	4	.00	.00	.02	.80	.02	.01	.85	.88
	11	.01	.01	.01	.02	1.07	1.29	2.42	1.25
	18	.05	.07	.00	.00	.00	.00	.12	3.17
NOV	25	.14	.40	.01	.14	.01	.00	.70	1.77
	1	.00	.00	.00	.00	.01	.52	.53	.36
	8	.00	.11	.00	2.16	.02	.11	2.50	3.05
	15	.00	.01	.00	.00	.32	.01	.34	.31
DEC	22	.00	.00	.00	.08	.11	.01	.20	.55
	29	.00	.68	.01	.00	.00	.00	.69	1.83
	6	.20	.09	.27	.00	.00	.00	.56	2.23
	13	.01	.00	.63	.01	.00	.01	.66	.32
JAN	20	.00	.00	.00	.00	.00	.15	1.28	.86
	27	.00	.00	.05	.06	.00	.00	.11	1.32
	3	.00	.00	.00	.00	.00	.00	.00	1.63
	10	.00	.00	.00	.00	.00	.00	.00	.04
FEB	17	.00	.00	.00	.00	.00	.00	.00	.79
	24	.00	.00	.00	.00	.00	.00	.00	.67
	31	.00	.00	.05	.08	.05	.09	.27	.25
	7	.00	.01	.02	.06	.01	.02	.13	.30
	14	.00	.00	.10	1.11	.02	.02	1.26	1.03
	21	.36	.01	.02	.02	.01	.00	.42	.30

Table 15 (Continued)

		OBSERVED			GENERATED			weekly	total
		daily totals (inches)			daily totals (inches)				
26		.01	.00	.00	.00	.00	.01	.00	.00
AUG 2		.02	.00	.00	.00	.00	.01	.00	.00
9		.00	.11	.00	.01	.00	1.05	.03	.66
16		.00	.00	.00	.00	.00	.14	1.73	.00
23		.00	.00	.00	.29	.16	.06	.00	.00
30		.05	.00	.00	.01	.85	.00	.00	.00
SEP 6		.00	.00	.00	.00	.25	.00	.71	.01
13		.00	.00	.00	.00	.00	.00	.01	.00
20		.00	.08	.32	.01	.56	.00	.00	.40
27		.00	.00	.00	.72	.04	.00	.01	.62
OCT 4		.54	.00	.00	.00	.24	.00	.01	.00
11		---	.00	.00	.00	.00	.00	.73	.00
18		.00	.32	1.58	.01	.00	.42	.08	.20
25		.59	.00	.00	.01	.01	.00	.00	.96
NOV 1		.00	.00	.00	.00	.10	1.62	.73	.00
8		.01	.05	.04	.00	.29	.20	.14	.00
15		.00	.00	.00	.00	.00	.00	.61	.53
22		.01	.36	.00	.01	.02	.07	.00	.00
29		.00	.00	1.02	.40	.03	.00	1.91	.00
DEC 6		.20	.37	.00	.00	.01	.00	.38	.01
13		.00	.10	.29	.00	.00	.00	.72	.00
20		.39	.03	.00	.00	.26	.90	.35	.00
							.00	.16	.00

Table 15 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total		
		daily totals (inches)					daily totals (inches)						
27	JAN	.03	.10	.15	.09	.16	.02	.02	.09	.01	.00	.00	.16
3		.17	.13	.02	.01	.03	.00	.17	.06	.00	.88	.00	1.11
10		.14	.00	.00	.00	.00	.00	.00	.00	.38	2.06	.47	3.04
17		.00	.03	.19	.05	.00	.00	.00	.07	.00	.00	.80	.89
24		.00	.00	.00	---	---	.12	.00	.00	.02	.00	.01	.15
31		---	---	---	.00	.00	.47	1.11	.60	.02	.00	.00	2.20
7	FEB	.27	.00	.20	.01	.01	.10	.43	.05	.10	.00	.00	.68
14		.01	.04	.00	.02	.65	.62	.31	.00	.00	.18	.36	1.56
21		.02	.41	.00	.03	.13	.00	.00	.00	.90	.68	.34	1.93
28		.01	.01				.00	.00					.00
1	MAR	1.07	.01	.02	.03	.01	.03	.00	.00	.01	.03	.01	.08
8		.27	.07	.01	.13	.01	.31	.11	.05	.00	.00	.24	.77
15		.01	.01	.11	.23	.00	.81	.00	.41	.12	1.61	.20	3.17
22		.92	.21	.43	.09	.01	.87	.36	.51	.17	.00	.00	1.95
29		.00	.00	.00	.01	.00	.10	.00	.00	.00	.00	.48	.58
5	APR	.00	.00	.08	.02	.00	1.31	.20	.03	.00	.00	.00	1.63
12		1.12	.07	.01	.00	.52	.02	.00	.02	.64	.00	.01	.69
19		.01	.00	.00	.32	.01	.17	.02	.00	.00	.00	.42	.77
26		.33	.01	.00	.00	.00	.53	.06	.00	.02	.00	.01	.62
3	MAY	.00	.00	.00	.00	.00	.11	.00	.00	.00	.00	.20	.40
10		.00	.17	.48	.12	.07	.00	.00	.00	.00	.04	.30	.44
17		.11	.20	.00	.00	.00	.00	.17	.00	.00	.33	.05	.55

Table 15 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total							
		daily totals (inches)					daily totals (inches)											
NOV	25	.15	1.27	.25	.00	.10	.04	.00	.00	1.81	.07	.51	.48	.10	.00	.65	.73	2.54
	1	.01	.01	.00	.00	.14	.52	.00	.00	.68	.31	.00	.01	.00	.00	.00	.18	.50
	8	.01	.10	.82	1.21	.02	.02	.08	.08	2.26	.98	.62	.00	.33	.18	.00	.03	2.14
	15	.00	.53	.11	1.44	.04	.03	.00	.00	2.15	.17	.00	.00	.61	.09	.27	.00	1.14
	22	.00	.64	.06	.14	.00	.20	.22	.22	1.26	.00	.00	1.68	.23	.00	.10	.37	2.38
	29	.00	.02	.00	.00	---	.00	.00	.00	.02	.06	.00	.01	.51	.14	.00	.04	.76
DEC	6	.34	.04	.00	.04	.00	.00	.00	.00	.42	.00	.02	.02	.00	.74	.00	.01	.79
	13	.81	.00	.00	.00	.00	.00	.10	.10	.91	.00	.02	.00	.48	.63	.00	.20	1.33
	20	.03	.02	.00	.00	.00	.04	.28	.28	.37	.36	.02	.00	.83	.22	.00	.09	1.52
	27	.00	.91	.00	.00	.05	.01	.02	.02	.99	.16	.00	.00	.01	.12	.03	.10	.42
JAN	3	.00	.00	.09	.85	.00	.19	.00	.00	1.13	.77	.00	.00	.37	.14	.00	.06	1.34
	10	.00	.10	.30	.57	1.25	.00	.00	.00	2.22	.00	.20	.01	.00	.00	.00	.00	.21
	17	.00	.00	.01	.00	.03	.05	.04	.04	.13	.97	.00	.63	.18	.02	.00	.32	2.12
	24	.11	.00	.00	.00	.01	.00	.00	.00	.12	.09	.00	.10	.00	.68	.00	.00	.87
	31	.00	.00	.49	.01	.01	.13	.00	.00	.64	.03	.01	1.17	.31	.00	.00	.00	1.52
FEB	7	.03	.00	.00	.03	.01	.05	.28	.28	.40	.00	.40	.10	.00	.00	.03	.44	.97
	14	.02	.00	.01	.19	.07	.42	.09	.09	.80	.00	.00	.00	.00	.70	.00	.05	.75
	21	.00	.01	.01	.02	.18	.34	.27	.27	.83	.03	.00	.00	.00	.81	.16	.00	1.00
	28	.01								.01	.23							.23
MAR	1	.11	.02	.02	.35	.02	.03	.90	.90	1.45	.16	.04	.07	.29	.00	.00	.00	.56
	8	1.00	.15	.09	.03	.03	.03	.03	.03	1.36	.00	.00	.00	.04	.15	.00	.69	.88
	15	.02	.03	.02	.05	.02	.02	.03	.03	.19	1.06	.00	.48	.00	.32	.00	.00	1.86

Table 15 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total		
		daily totals (inches)					daily totals (inches)						
22		.04	.03	.03	.19	.00	.00	.01	.19	.04	.20	.00	.47
29		.00	.00	.00	1.06	.06	.14	.16	.00	.02	.00	.55	2.52
5	APR	.22	.23	.42	1.29	.00	.00	.02	.00	.17	.92	.00	1.43
12		.01	.27	.00	.00	.66	.00	.00	.00	.00	.00	.00	.00
19		.00	.06	.44	.01	.00	.39	.82	.67	.71	.13	.00	2.33
26		1.12	.37	.20	.00	.00	.00	.51	.00	.00	.18	.06	.75
3	MAY	.00	.01	.00	.68	.01	2.00	2.11	.03	.00	.19	.34	2.75
10		.01	.00	.17	.00	.00	.05	.00	.04	.03	.00	.00	.28
17		.16	.00	.00	.00	1.37	.15	.00	.00	.00	.00	.37	.46
24		.00	.00	.69	.00	.00	.00	.22	.08	.00	.83	.12	3.20
31		.00	.00	.05	.00	.00	.00	.03	.00	.00	.05	.00	.90
7	JUN	.00	.00	.00	.00	.07	.01	.00	.00	.03	.16	.00	.26
14		.02	.84	.06	.00	.00	.00	.01	.00	.00	.06	.80	1.06
21		.08	.36	.76	.01	.00	.00	.08	.00	.41	.04	.00	.54
28		1.07	.83	.00	.00	.00	.00	.00	.00	.91	.07	1.03	2.08
5	JUL	.00	.00	.73	.93	.00	.00	.00	.86	.88	.17	.04	2.13
12		.00	.00	.69	.00	.04	.50	.05	.00	.00	.56	.62	1.32
19		.50	.08	.02	.96	.00	.21	.00	.08	.05	.00	.70	1.88
26		.60	1.03	.00	.00	.22	.00	.00	.00	2.07	.00	.63	2.92
2	AUG	.00	.04	.00	.00	.00	.39	.00	.00	.40	.00	.16	.56
9		.03	.00	.00	.00	.19	.00	.13	.77	.00	.00	.00	.90
16		.00	.00	.00	.00	.00	.00	.00	.38	.46	.17	.00	1.10

Table 15 (Continued)

		OBSERVED				weekly total	GENERATED					weekly total
		daily	totals (inches)				daily	totals (inches)				
24		.04	.37	.10	.00	.00	.00	.90	.06	.00	.82	1.78
31		.00	.00	.16	.25	.16	.61	.03	.10	.00	.00	.91
7	FEB	.80	.86	.00	.26	.01	.07	.00	.00	.37	.04	.65
14		.20	.80	.00	.00	.00	.00	.38	.00	.00	.00	.61
21		.01	.00	.00	.00	.02	.00	.00	.00	.06	.00	.11
28		.02			.08		.03					.03
1	MAR	.01	.01	.01	.14	.00	.07	.18	.27	.00	.10	.65
8		.00	.19	.01	.00	.01	.92	.06	.00	.10	.02	1.18
15		.02	.03	.10	.01	.00	.00	.00	.03	.13	.00	.36
22		.01	.00	.00	.00	.00	.00	.00	.23	.05	.00	.99
29		.00	.08	.12	.00	.33	.41	.00	.05	.06	.00	.86
5	APR	.09	.00	.00	.01	2.02	.22	.04	.01	.00	.00	.28
12		.00	.00	.00	.01	.00	.47	.26	.16	.06	.49	1.52
19		.00	.37	.01	.00	.00	.08	.00	.02	.01	.00	.13
26		.00	.33	.76	.40	.18	.70	.13	.00	.00	.46	1.62
3	MAY	.00	.10	.07	.00	.00	.81	.26	.48	.61	.11	2.34
10		.00	.01	.03	.00	.00	.00	.05	.05	.00	.00	.10
17		.00	.02	.00	.00	.00	.12	.27	.00	.09	.11	.65
24		.00	.06	.06	.06	.26	.00	.41	.22	.03	.00	.66
31		.12	.06	.00	.00	.00	.05	.12	.00	.07	.00	.31
7	JUN	.34	.02	.00	.42	.00	.01	.00	.00	.61	.53	1.15
14		.35	.12	.50	.03	.17	.06	1.02	.10	.00	.27	1.53

Table 15 (Continued)

		OBSERVED				GENERATED				weekly				
		daily totals (inches)				daily totals (inches)				total				
22		.00	.12	.47	1.06	.25	.98	2.88	.01	.00	.16	.00	.33	.51
29		.10	.00	.00	.01	.00	.00	.30	.62	.27	.07	.11	.03	1.13
6	DEC	.00	---	---	---	---	---	.00	.02	.91	.05	.17	.23	2.14
13		---	---	---	---	---	---	---	.08	.00	.13	.00	.00	.21
20		---	---	---	---	---	---	---	.00	.00	.23	.00	.01	.43
27		---	---	---	.00	.01	.00	.01	.01	.00	.27	.03	.11	.43
3	JAN	.00	.00	.00	.00	.00	.00	.00	.00	.07	.10	.00	.40	.57
10		.00	.34	.08	---	---	---	.52	.18	.00	.02	.01	.00	.41
17		---	---	---	---	---	---	---	.04	.00	1.06	.40	.07	1.57
24		---	---	---	---	---	---	---	.00	.00	.12	.03	.04	.19
31		---	---	---	---	---	---	---	.00	.01	.05	.00	.00	.22
7	FEB	---	---	---	---	---	---	---	.00	.01	.00	.00	.06	.56
14		---	---	---	---	---	---	---	.16	.00	.07	.01	.00	.46
21		---	---	---	---	---	---	---	.00	.88	.25	.05	.00	1.18
28		---	---	---	---	---	---	---	.11	.00	.00	.28	.10	.11
1	MAR	.01	.00	.00	.00	.02	.01	.11	.04	.00	.00	.10	.00	.42
8		.00	.00	.23	.00	.00	.00	.23	.01	.00	.00	.00	.01	.02
15		.28	.73	.06	.01	---	.00	1.09	.00	.16	.22	.00	.00	.39
22		.00	.00	.00	.00	.18	.03	.21	.05	.01	.00	.13	.02	.21
29		.31	.19	.13	.01	.00	.00	.66	.00	.44	.11	.02	.00	.65
5	APR	.00	.00	.01	.00	.00	.00	.01	.00	.00	.03	.00	.02	.06
12		.00	.00	.21	---	---	---	.21	.00	.01	.00	.26	.10	.37

Table 15 (Continued)

		OBSERVED			weekly total		GENERATED			weekly total	
		daily totals (inches)					daily totals (inches)				
	19	---	---	---	.07	.26	.00	.02	.00	.11	.00
	26	.11	.02	.02	.05	.23	.00	.03	.02	.04	.03
MAY	3	---	---	---	.00	.00	.00	.10	.00	.00	.00
	10	.00	.00	.00	.00	.00	.01	.08	.00	.00	.10
	17	.00	.04	.03	.00	.09	.00	.13	.00	.22	.00
	24	.00	.00	.00	.00	.04	.00	.05	.00	.00	.35
	31	.00	.00	.00	.03	.04	.00	.07	.00	.00	.43
	7	.05	.04	.04	.00	.21	.01	.05	.08	.00	.23
JUN	14	.00	.00	.00	.00	.00	.00	.03	.01	.09	.30
	21	.00	.11	---	.29	.40	.00	.25	.17	.00	.04
	28	.01	.00	.00	.02	.04	.00	.01	.00	.06	.48
	5	.00	.14	.01	.00	.22	.19	.05	.00	.00	.02
JUL	12	.05	.00	.23	.04	.32	.00	.11	.00	.00	.38
	19	.06	.00	.46	.00	1.55	.00	.05	.06	.03	.64
	26	.00	.00	.00	.00	.00	.00	.01	.02	.33	.71
	2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01
AUG	9	---	---	---	---	.00	.00	.63	.07	.00	1.15
	16	.00	.00	1.10	.00	1.10	.02	.00	.00	.20	.46
	23	.30	.15	.00	.00	.00	.00	.00	.05	.00	.07
	30	.00	.27	.15	.00	1.29	.00	.05	.54	.00	.90
				.04	.00	.46	.14	.00	.04	.00	.20

Source of Observed Data: Dickens, P.S., C.H. Chiang, R.A. Minear, and B.A. Tschantz, New River Project Data Bases and Documentation Joint Research, Volume I, Hydrologic and Water Quality Data, The University of Tennessee, Departments of Civil Engineering and Zoology, Knoxville, Tennessee, December, 1980, (85).

Table 16. Discharge (observed vs. generated) Anderson Branch
For a period of Record (December 6, 1975 through August 30, 1980)

		OBSERVED			weekly total	GENERATED			weekly total	
		daily	totals (inches)			daily	totals (inches)			
DEC	6	.04	.04	.04	.05	.05	.00	.00	.00	.01
	13	.05	.04	.05	.12	.09	.00	.01	.00	.12
	20	.07	.05	.04	.03	.15	.00	.00	.00	.19
	27	.59	.24	.15	.09	.44	.42	.07	.00	.00
JAN	3	.20	.19	.17	.10	.11	.00	.00	.01	.00
	10	.11	.09	.09	.11	.13	.05	.00	.02	.33
	17	.12	.09	.08	.06	.04	.00	.00	.09	.24
	24	.04	.03	.05	.70	.15	.00	.00	.10	.00
FEB	31	.11	.08	.08	.06	.06	.00	.18	.24	.01
	7	.08	.07	.06	.07	.09	.00	.20	.00	.00
	14	.04	.04	.03	.04	.23	.00	.02	.00	.04
	21	.17	.13	.15	.12	.06	.00	.00	.88	.00
MAR	28	.05			.08	.06	.00	.00	.00	.00
	1	.03	.03	.04	.20	.15	.00	.00	.04	.00
	8	.12	.09	.05	.05	.04	.00	.00	.00	.06
	15	.04	.04	.17	.12	.09	.00	.00	.00	.01
APR	22	.07	.07	1.62	1.83	.30	.00	.00	.06	.00
	29	.18	.12	.10	.07	.05	.00	.00	.00	.00
	5	.04	.03	.03	.02	.02	.00	.00	.01	.03
	12	.02	.02	.02	.02	.03	.00	.00	.00	.02
	19	.02	.02	.02	.01	.01	.00	.00	.00	.00
	26	.01	.02	.02	.02	.01	.02	.00	.16	.30
							.02	.00	.11	.01

Table 16 (Continued)

		OBSERVED			weekly total	GENERATED			weekly total
		daily	totals (inches)			daily	totals (inches)		
MAY	3	.03	.02	.01	.02	.00	.00	.00	.00
	10	.02	.38	.18	.10	.00	.00	.24	.00
	17	.06	.05	.04	.02	.00	.00	.00	.12
	24	.07	.29	.15	.06	.00	.00	.16	.28
	31	.06	.05	.04	.03	.00	1.12	.18	1.33
JUN	7	.02	.01	.01	.01	.00	.00	.00	.75
	14	.01	.04	.31	.20	.00	.00	.00	.04
	21	.09	.11	.09	.05	.00	.79	.01	1.12
	28	.03	.18	.33	.29	.00	.00	.00	.02
JUL	5	.06	.05	.03	.03	.00	.00	.03	.05
	12	.02	.02	.01	.01	.00	.79	.01	.79
	19	.02	.01	.01	.01	.01	.00	.00	1.06
	26	.01	.01	.01	.01	.00	.00	.00	.03
AUG	2	.03	.01	.01	.01	.00	.00	.20	.21
	9	.00	.00	.00	.00	.00	.33	.05	.38
	16	.00	.00	.00	.00	.74	.00	.00	.74
	23	.00	.01	.00	.00	.00	.00	.00	.00
	30	.01	.01	.00	.00	.01	.09	.02	.12
SEP	6	.02	.01	.01	.00	.00	.00	.00	.17
	13	.00	.00	.00	.00	.00	.00	.00	.02
	20	.00	.00	.00	.01	.00	.00	.01	.02
	27	.02	.01	.01	.00	.00	.00	.14	.21
						.02	.00	.00	.02

Table 16 (Continued)

		OBSERVED					GENERATED					weekly	
		daily totals (inches)					daily totals (inches)					total	
MAR	1	.05	.34	.46	.17	.11	.10	.09	1.32	.00	.00	.00	.00
	8	.08	.06	.10	.10	.09	.07	.06	.58	.00	.00	.00	.00
	15	.05	.05	.04	.04	.04	.05	.04	.31	.37	.00	.00	.17
	22	.04	.11	.43	6.57	.65	.20	.12	8.12	.01	.82	.00	.00
APR	29	.09	.06	.05	.04	.03	.03	.03	.32	.00	.00	.00	.00
	5	.02	.02	.02	.02	.02	.01	.01	.12	.00	.00	.00	.00
	12	.01	.05	.11	.08	.05	.05	.04	.39	.00	.00	.00	.00
	19	.15	.11	.08	.06	.05	.04	.03	.53	.00	.00	.00	.00
MAY	26	.03	.03	.03	.03	.03	.02	.02	.19	.00	.00	.00	.00
	3	.02	.02	.02	.01	.01	.01	.01	.10	.00	.00	.00	.00
	10	.01	.01	.01	.01	.01	.01	.02	.08	.00	.20	.00	.00
	17	.01	.01	.08	.02	.02	.01	.01	.17	.08	.00	.00	.00
JUN	24	.01	.01	.01	.06	.02	.01	.01	.12	.00	.00	.00	.00
	31	.01	.01	.01	.01	.02	.01	.01	.08	.74	.20	.00	.00
	7	.01	.01	.02	.02	.01	.02	.03	.12	.02	.01	.00	.00
	14	.09	.12	.10	.05	.04	.03	.02	.44	.00	.15	.34	.00
JUL	21	.04	.01	.01	.01	.01	.00	.00	.08	.00	.00	.00	.00
	28	.00	.00	.00	.01	.00	.00	.00	.02	.00	.96	.16	.00
	5	.00	.00	.00	.00	.00	.00	.00	.00	.00	.06	.00	.00
	12	.00	.00	.00	.02	.01	.00	.00	.03	.00	.20	.01	.00
	19	.00	.00	.00	.00	.00	.00	.00	.01	.29	.05	.13	.00
	26	.00	.00	.00	.00	.00	.00	.00	.01	.00	.01	.00	.00

Table 16 (Continued)

		OBSERVED			weekly total	GENERATED			weekly total
		daily totals (inches)	daily totals (inches)	daily totals (inches)		daily totals (inches)	daily totals (inches)	daily totals (inches)	
JAN	3	.10	.08	.08	.93	.00	.00	.00	.00
	10	.15	.13	.09	2.36	.00	.00	.00	.01
	17	.48	.29	.13	1.33	.00	.00	.34	.14
	24	.06	.06	.08	.47	.01	.00	.00	.00
	31	.06	.05	.06	.49	.06	.00	.14	.00
FEB	7	.08	.08	.07	.48	.00	.00	.00	.00
	14	.05	.05	.05	.42	.01	.00	.00	.00
	21	.16	.17	.12	.99	.00	.00	.00	.00
	28	.38	.11	.09	.38	.00	.00	.01	.00
MAR	1	.13	.11	.08	.68	.01	.00	.07	.00
	8	.09	.15	.27	1.44	.00	.00	.00	.00
	15	.11	.09	.06	.47	.00	.00	.06	.00
	22	.05	.04	.04	.26	.00	.00	.00	.00
	29	.03	.02	.02	.24	.02	.00	.17	.00
APR	5	.05	.05	.04	.80	.00	.00	.01	.08
	12	.16	.12	.10	.73	.01	.00	.04	.00
	19	.15	.11	.09	.66	.00	.00	.18	.00
	26	.06	.47	.40	1.72	.88	.16	.04	.00
MAY	3	.07	.05	.04	.56	.00	.00	1.07	.04
	10	.10	.07	.05	.37	.00	.00	.00	.01
	17	.02	.02	.02	.42	.00	.00	.02	.00
	24	.23	.11	.05	.53	.00	.23	.00	.02

Table 16 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total			
		daily totals (inches)					daily totals (inches)							
31		.02	.01	.01	.01	.01	.00	.11	.10	.00	.00	.17	.20	.58
JUN 7		.01	.01	.01	.01	.00	.04	.00	.00	.00	.00	.00	.02	.06
14		.00	.00	.02	.01	.00	.33	.15	.00	.05	.02	.00	.00	.55
21		.00	.00	.01	.01	.01	.01	.00	.00	.15	.00	.03	.00	.20
28		.01	.05	.15	.03	.01	.00	.00	.79	.02	.00	.00	.06	.88
JUL 5		.01	.01	.01	.03	.06	.00	.00	.00	.11	.01	.00	.00	.12
12		.02	.01	.01	.02	.01	.00	.00	.00	.00	.21	.00	.00	.21
19		.01	.05	.02	.02	.12	.00	.00	.00	.10	.16	.00	.02	.27
26		.07	.12	.70	.18	.05	.06	.00	.00	.25	.02	.00	.00	.34
AUG 2		.02	.01	.01	.01	.01	.01	.00	.00	.00	.01	.00	.00	.03
9		.01	.02	.01	.01	.01	.22	.00	.00	.06	.01	.00	.00	.29
16		.01	.01	.01	.01	.00	.00	.02	.00	.00	.00	.00	.00	.02
23		.00	.00	.00	.01	.00	.33	.00	.16	.02	.00	.00	.05	.55
30		.00	.00	.00	.00	.00	.00	.00	.00	.00	.18	.00	.00	.19
SEP 6		.00	.00	.00	.00	.00	.00	.00	.45	.04	.00	.00	.00	.49
13		.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.00	.08	.16
20		.00	.00	.00	.00	.00	.00	.00	.00	.00	.19	.00	.00	.19
27		.00	.00	.00	.00	.00	.00	.00	.00	.00	.24	.01	.00	.25
OCT 4		.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.03
11		.00	.00	.00	.00	.00	.01	.00	.00	.04	.00	.00	.00	.05
18		.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.20
25		.00	.00	.00	.00	.00	.38	.00	.10	.00	.05	.00	.00	.52

Table 16 (Continued)

		OBSERVED			weekly total		GENERATED					weekly total	
		daily totals (inches)					daily totals (inches)						
NOV	1	.02	.01	.00	.00	.00	.00	.02	.00	.02	.00	.00	.04
	8	.01	.01	.00	.02	.01	.01	.00	.00	.00	.00	.58	.79
	15	.01	.01	.02	.37	.05	.00	.00	.01	.30	.00	.04	.35
	22	.22	1.40	.24	.13	.06	.00	.00	.00	.00	.00	.00	.00
	29	.05	.05	.05	.04	.48	.25	.17	.19	.01	.00	.00	.62
DEC	6	.22	.15	.12	.11	.05	.11	.00	.00	.02	.00	.00	.13
	13	.05	.05	.09	.81	.18	1.11	.00	.00	.02	.05	.00	1.18
	20	.12	.16	1.35	.48	.12	.00	.00	.00	.00	.00	.01	.01
	27	.09	.09	.08	.06	.05	.00	.00	.00	.00	.06	.00	.06
JAN	3	.05	.92	1.02	.29	.16	.02	.00	.00	.25	.01	.61	1.01
	10	.12	.11	.11	.09	.06	.00	.00	.00	.00	.00	.00	.20
	17	.05	.05	.05	.04	.05	.00	.00	.00	.01	.00	.00	.02
	24	.04	.05	.04	.04	.26	.00	.00	.00	.00	.24	.02	.26
	31	.26	.15	.11	.09	.15	.00	.00	.07	.00	.00	.00	.08
FEB	7	.15	.65	2.10	.48	.18	.00	.00	.29	.00	.36	.00	.66
	14	.13	.11	.70	.26	.10	.00	.27	.28	.01	.00	.00	.58
	21	.07	.17	.23	.15	.08	.00	.00	.00	.13	.15	.00	.28
	28	.06					.00					.00	.00
MAR	1	.19	.30	.19	.12	.12	.00	.00	1.08	.00	.16	.02	1.25
	8	.09	.08	.08	.13	.15	.00	.00	.07	.00	.01	.00	.08
	15	.09	.06	.06	.53	.17	.01	.22	.00	.00	.00	.00	.23
	22	.30	.22	.15	.10	.05	.00	.06	.09	.01	.00	.00	.17

Table 16 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total	
		daily totals (inches)					daily totals (inches)					
29		.04	.04	.03	.03	.23	.00	.00	.13	.04	.00	.00
APR 5		.03	.03	.02	.02	.19	.10	.00	.00	.00	.01	.00
12		.92	.39	.19	.11	1.83	.00	.00	.00	.00	.00	.00
19		.06	.05	.06	.05	.32	.00	.00	.00	.17	.05	.02
26		.02	.02	.03	.11	.78	.00	.03	.00	.01	.00	.01
MAY 3		.26	.18	.13	.09	1.07	.29	.15	.00	.01	.02	.00
10		.16	.11	.11	.09	.62	.00	.00	.00	.00	.01	.00
17		.04	.03	.02	.02	.17	.00	.00	.00	.00	.00	.00
24		.01	.01	.01	.01	.09	.00	.00	.02	.04	.00	.00
31		.01	.02	.02	.01	.08	.00	.00	.00	.25	.15	.02
JUN 7		.01	.01	.01	.01	.07	.16	.00	.00	.00	.07	.07
14		.01	.01	.01	.04	.11	.00	.05	.00	.00	.00	.39
21		.01	.15	.06	.04	.35	.00	.00	.00	.00	.17	.05
28		.37	.27	.18	.09	1.03	.00	.00	.12	.25	.05	.00
JUL 5		.03	.02	.02	.02	.13	.00	.04	.00	.00	.00	.00
12		.01	.01	.01	.01	.07	.03	.00	.00	.00	.00	.00
19		.01	.01	.01	.01	.04	.33	.05	.01	.00	.01	.00
26		.00	.00	.00	.00	.02	.00	.00	.16	.00	.00	.00
AUG 2		.00	.01	.02	.02	.09	.01	.00	.00	.00	.00	.00
9		.02	.01	.01	.00	.07	.16	.26	.00	.00	.00	.00
16		.01	.01	.00	.00	.03	.08	.00	.00	.00	.00	.01
23		.01	.01	.01	.00	.04	.00	.00	.00	.00	.05	.00

Table 16 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total
		daily	totals (inches)	daily	totals (inches)		daily	totals (inches)	daily	totals (inches)	
30		.01	.01	.01	.01	.10	.00	.29	.00	.25	.54
SEP 6		.08	.04	.03	.03	.26	.15	.00	.00	.00	.17
13		.02	.01	.01	.02	.13	.00	.00	.00	.06	.07
20		.02	.02	.02	.02	.12	.00	.06	.00	.00	.08
27		.01	.01	.01	.02	.08	.00	.00	.00	.00	.00
OCT 4		.01	.01	.01	.05	.29	.00	.00	.00	.00	.01
11		.65	.12	.06	.04	.94	.00	.02	.03	.00	.06
18		.05	.45	.17	.09	.90	.30	.00	.00	.00	.31
25		.03	.02	.02	.02	.15	.00	.00	.00	.01	.02
NOV 1		.02	.40	.59	.16	1.87	.00	.00	.02	.00	.18
8		.05	.04	.03	.02	.20	.05	.07	.00	.00	.12
15		.02	.02	.02	.01	.12	.00	.00	.00	.00	.02
22		.02	.02	.02	.02	.15	.09	.02	.00	.00	.24
29		.02	.02	.03	.39	1.12	.00	.00	.00	.00	.00
DEC 6		.10	.08	.07	.06	.47	.19	.03	.00	.00	.32
13		.08	.11	.10	.12	.73	.24	.00	.10	.01	.53
20		.16	.19	.15	.15	1.04	.00	.00	.00	.00	.00
27		.36	.26	.16	.11	1.90	.01	.03	.00	.01	.05
JAN 3		.16	.10	.08	.06	.55	.00	.00	.00	.00	.10
10		.04	.04	.03	.03	.22	.00	.01	.00	.00	.01
17		.03	.02	.02	.02	.17	.00	.00	.00	.15	.26
24		.05	.36	.22	.13	1.02	.00	.36	.00	.00	.40

Table 16 (Continued)

		OBSERVED					weekly total	GENERATED					weekly total		
		daily totals (inches)						daily totals (inches)							
	31	.06	.05	.04	.04	.04	.03	.31	.06	.00	.00	.02	.00	.01	.09
FEB	7	.03	.03	.03	.03	.27	.23	.65	.00	.00	.00	.00	.00	.00	.00
	14	.22	.29	.17	.12	.10	.08	1.24	.00	.00	.04	.02	.16	.00	.23
	21	.06	.05	.54	.46	.40	.92	2.47	.00	.00	.00	.00	.01	.00	.02
	28	1.02						1.02	.00						.00
MAR	1	.21	.19	.12	.09	.08	.06	.91	.00	.01	.00	.00	.02	.00	.02
	8	.06	.05	.04	.05	.04	.04	.32	.00	.00	.19	.00	.00	.05	.25
	15	.03	.04	.13	.15	.10	.07	.76	.00	.00	.00	.00	.00	.01	.00
	22	.06	.05	.04	.04	.04	.04	.32	.00	.00	.01	.00	.09	.01	.11
	29	.04	.04	.02	.02	.02	.02	.20	.00	.00	.01	.00	.00	.00	.01
APR	5	.02	.01	.01	.01	.01	.01	.09	.00	.04	.09	.00	.00	.00	.14
	12	.01	.01	.01	.01	.01	.00	.05	.00	.28	.02	.00	.03	.00	.34
	19	.00	.03	.04	.05	.04	.03	.23	.00	.00	.05	.00	.00	.00	.07
	26	.04	.07	.09	.05	.03	.02	.38	.24	.11	.01	.00	.00	.17	.53
MAY	3	.02	.02	.01	.01	.01	.01	.10	.00	.00	.00	.00	.00	.00	.00
	10	.01	.01	.01	.00	.00	.00	.04	.00	.00	.10	.28	.20	.00	.64
	17	.00	.00	.01	.01	.01	.00	.03	.02	.05	.00	.07	.19	.00	.44
	24	.00	.00	.00	.00	.01	.00	.02	.00	.00	.00	.00	.00	.00	.01
	31	.00	.00	.00	.00	.00	.08	.09	.01	.00	.00	.00	.17	.24	.43
JUN	7	.02	.01	.01	.01	.00	.00	.09	.00	.00	.00	.00	.01	.08	.10
	14	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.06	.00	.07
	21	.00	.00	.00	.00	.00	.00	.01	.00	.00	.27	.03	.00	.00	.30

Table 16 (Continued)

	OBSERVED			weekly total	GENERATED			weekly total		
	daily totals (inches)				daily totals (inches)					
JUL	28	.00	.00	.00	.00	.00	.01	.00	.05	.06
	5	.00	.00	.00	.00	.03	.15	.00	.01	.20
	12	.00	.00	.00	.00	.29	.00	.00	.01	.02
	19	.00	.00	.01	.00	.00	.00	.00	.00	.00
	26	.00	.00	.00	.00	.00	.00	.02	.00	.04
AUG	2	.00	.00	.01	.00	.00	.00	.03	.00	.04
	9	.00	.00	.02	.00	.00	.00	.00	.00	.07
	16	.00	.00	.00	.00	.01	.00	.00	.19	.22
	23	.00	.00	.03	.00	.00	.00	.38	.07	.00
	30	.00	.00	.00	.00	.00	.00	.01	.00	.00

Source of Observed Data: Dickens, P.S., C.H. Chiang, R.A. Minear, and B.A. Tschantz, New River Project Data Bases and Documentation Joint Research, Volume I, Hydrologic and Water Quality Data, The University of Tennessee, Departments of Civil Engineering and Zoology, Knoxville, Tennessee, December, 1980, (85).

**Table 17. Discharge (observed vs. generated) Bowling Branch
For a period of Record (December 6, 1975 through August 30, 1980)**

		OBSERVED						weekly total	GENERATED						weekly total	
		daily totals (inches)							daily totals (inches)							
DEC	6	.09	.06	.04	.03	.02	.03	.02	.03	.00	.00	.00	.00	.00	.00	.00
	13	.04	.05	.04	.03	.02	.02	.03	.02	.00	.00	.00	.01	.00	.10	.12
	20	.11	.10	.06	.05	.07	.04	.04	.04	.00	.00	.00	.00	.03	.09	.28
	27	.04	.03	.20	.66	.29	.19	.14	.14	.35	.06	.00	.00	.01	.00	.42
JAN	3	.13	.49	.44	.22	.24	.22	.15	.15	.00	.00	.05	.02	.00	.28	.34
	10	.11	.10	.11	.11	.10	.08	.07	.07	.04	.00	.00	.57	.07	.20	.88
	17	1.07	.20	.15	.12	.10	.09	.07	.07	.00	.00	.00	.08	.00	.00	.08
	24	.05	.04	.03	.04	.03	.05	.78	.05	.00	.00	.15	.20	.00	.00	.35
	31	.44	.19	.13	.09	.06	.05	.04	.04	.00	.16	.00	.00	.03	.00	.20
FEB	7	.04	.03	.03	.03	.03	.02	.02	.02	.00	.01	.00	.00	.03	.00	.05
	14	.02	.03	.03	.03	.03	.02	.02	.02	.00	.00	.76	.00	.02	.00	.79
	21	.02	.31	.34	.14	.11	.13	.10	.10	.00	.00	.00	.00	.00	.00	.00
	28	.08								.00	.00					.00
MAR	1	.03	.03	.03	.03	.04	.03	.04	.03	.00	.00	.00	.03	.00	.00	.03
	8	.24	.20	.14	.10	.10	.06	.05	.05	.00	.00	.00	.00	.05	.01	.06
	15	.04	.03	.03	.03	.03	.14	.14	.14	.00	.00	.00	.00	.00	.01	.01
	22	.10	.08	.08	.08	.09	.09	1.12	.09	.00	.00	.05	.00	.00	.00	.05
	29	1.00	.39	.29	.17	.11	.08	.06	.06	.00	.00	.00	.00	.00	.01	.02
APR	5	.05	.04	.03	.03	.02	.02	.02	.02	.00	.00	.92	.00	.02	.00	1.07
	12	.02	.02	.02	.01	.01	.01	.01	.01	.00	.00	.00	.00	.02	.00	.02
	19	.01	.01	.02	.01	.01	.01	.01	.01	.00	.00	.00	.00	.00	.00	.00
	26	.01	.01	.01	.01	.01	.01	.01	.01	.02	.00	.13	.25	.09	.01	.49

Table 17 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total
		daily totals (inches)					daily totals (inches)				
MAY	3	.01	.01	.01	.01	.01	.00	.00	.00	.00	.00
	10	.03	.02	.51	.20	.11	.00	.00	.20	.00	.00
	17	.15	.16	.06	.04	.02	.00	.00	.00	.13	.10
	24	.02	.01	.06	.37	.08	.01	.00	.00	.15	.00
	31	.06	.10	.11	.07	.04	.00	.00	.64	.00	1.15
JUN	7	.02	.02	.01	.01	.01	.03	.00	.00	.00	.00
	14	.01	.01	.01	.03	.32	.21	.00	.68	.01	.00
	21	.24	.10	.09	.14	.07	.00	.00	.00	.00	.01
	28	.06	.04	.02	.08	.32	.00	.00	.00	.01	.00
JUL	5	.22	.09	.05	.03	.03	.00	.00	.68	.01	.00
	12	.02	.02	.01	.01	.01	.00	.00	.00	.00	.91
	19	.00	.00	.03	.01	.00	.02	.00	.00	.00	.00
	26	.00	.00	.01	.01	.00	.00	.00	.00	.16	.00
AUG	2	.00	.00	.01	.01	.00	.00	.00	.28	.04	.00
	9	.00	.00	.00	.00	.00	.00	.64	.00	.00	.00
	16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	23	.00	.00	.00	.01	.00	.00	.00	.07	.02	.00
SEP	30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.14
	6	.00	.01	.02	.00	.00	.00	.00	.00	.00	.01
	13	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00
	20	.00	.00	.00	.00	.00	.00	.00	.00	.12	.05
	27	.01	.01	.02	.01	.00	.01	.00	.00	.00	.00

Table 17 (Continued)

		OBSERVED				GENERATED					
		daily totals (inches)				daily totals (inches)				weekly total	

Table 17 (Continued)

		OBSERVED			weekly total	GENERATED			weekly total	
		daily	totals (inches)			daily	totals (inches)			
AUG	2	.00	.00	.00	.02	.00	.00	.00	.00	.00
	9	.00	.00	.00	.02	.00	.00	.23	.00	.24
	16	.00	.00	.00	.01	.00	.05	.93	.07	1.06
	23	.00	.00	.00	.04	.00	.00	.00	.19	.20
	30	.05	.03	.00	.09	.01	.00	.00	.00	.01
SEP	6	.00	.01	.02	.07	.34	.12	.00	.00	.53
	13	.01	.00	.00	.10	.06	.00	.00	.00	.07
	20	.05	.05	.04	.23	.03	.00	.01	.05	.22
	27	.02	.01	.00	.83	.00	.24	.15	.04	.42
	4	.07	.04	.03	.25	.00	.00	.70	.02	.74
OCT	11	.02	.02	.01	.10	.00	.00	.00	.00	.00
	18	.09	.22	.12	.64	.03	.00	.00	.00	.06
	25	.04	.03	.04	1.50	.20	.06	.01	.63	.91
	1	.37	.25	.15	1.39	.22	.05	.01	.00	.37
	8	.11	.11	.24	1.35	.00	.00	.00	.00	.08
	15	.87	.65	.36	3.02	.45	.01	.00	.00	.47
	22	.93	.42	.20	2.21	.00	.13	.00	.00	.13
	29	.19	.14	.13	.90	.01	.00	.00	.06	.08
	6	.10	.09	.08	.46	.09	.00	.00	.00	.09
	13	.06	.04	.03	.87	.00	.00	.00	.01	.02
DEC	20	.12	.08	.06	.44	.00	.00	.00	.03	.04
	27	.02	.02	.06	.78	.00	.01	.04	.00	.05

Table 17 (Continued)

		OBSERVED				GENERATED				weekly total	
		daily totals (inches)				daily totals (inches)				weekly total	
JUN	31	.03	.02	.01	.01	.01	.09	.08	.00	.13	.47
	7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05
	14	.00	.00	.00	.00	.00	.12	.00	.28	.00	.45
	21	.00	.00	.00	.00	.00	.00	.00	.01	.03	.16
JUL	28	.00	.00	.00	.03	.04	.00	.68	.00	.00	.75
	5	.01	.01	.01	.01	.01	.00	.00	.00	.00	.10
	12	.04	.01	.01	.01	.01	.00	.00	.00	.00	.17
	19	.01	.01	.01	.01	.01	.00	.00	.00	.00	.22
AUG	26	.10	.03	.04	.07	.16	.00	.00	.05	.00	.27
	2	.03	.02	.02	.01	.01	.00	.00	.01	.00	.02
	9	.01	.01	.00	.01	.01	.00	.00	.18	.00	.24
	16	.00	.01	.01	.00	.00	.01	.00	.00	.00	.01
SEP	23	.00	.00	.00	.00	.00	.00	.13	.27	.00	.45
	30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.15
	6	.00	.00	.00	.00	.00	.00	.37	.00	.00	.41
	13	.00	.00	.00	.00	.01	.06	.00	.00	.00	.13
OCT	20	.00	.00	.00	.00	.00	.00	.00	.00	.00	.15
	27	.00	.00	.00	.00	.00	.00	.00	.00	.01	.21
	4	.00	.00	.00	.00	.00	.00	.00	.02	.00	.02
	11	.00	.00	.00	.00	.00	.00	.00	.01	.00	.04
	18	.00	.00	.00	.00	.00	.00	.00	.00	.00	.16
	25	.00	.00	.00	.00	.00	.00	.08	.32	.00	.43

Table 17 (Continued)

		OBSERVED				GENERATED					
		daily totals (inches)				daily totals (inches)				weekly total	
											total
NOV	1	.00	.00	.03	.02	.02	.01	.01	.09	.00	.03
	8	.00	.00	.01	.02	.01	.03	.01	.10	.01	.66
	15	.03	.02	.02	.01	.04	.44	.58		.00	.29
	22	.20	.08	.06	.25	.19	.10	1.53		.00	.00
	29	.07	.05	.04	.03	.02	.02	.26		.20	.51
DEC	6	.02	.03	.32	.15	.09	.07	.74		.09	.10
	13	.04	.04	.03	.03	.09	.46	.72		.97	1.02
	20	.49	.19	.11	.07	.76	.34	2.07		.00	.01
	27	.15	.11	.08	.06	.05	.04	.53		.00	.05
	3	.03	.03	.02	.02	.54	.25	1.50		.02	.84
JAN	10	.16	.19	.14	.11	.10	.08	.85		.00	.17
	17	.07	.07	.06	.05	.05	.04	.38		.00	.01
	24	.04	.05	.05	.04	.05	.05	.33		.00	.21
	31	.05	.05	.22	.25	.14	.08	.90		.00	.06
	7	.07	.15	.15	.14	.46	.39	1.99		.00	.55
FEB	14	.22	.19	.14	.11	.09	.25	1.48		.00	.47
	21	.14	.10	.08	.06	.15	.16	.93		.00	.23
	28	.11						.11		.00	.00
	1	.04	.03	.03	.19	.34	.27	1.20		.00	1.08
	8	.22	.20	.17	.16	.14	.12	1.14		.00	.06
MAR	15	.39	.27	.15	.11	.08	.34	1.40		.01	.19
	22	.29	.24	.25	.34	.31	.24	1.94		.00	.14

Table 17 (Continued)

	OBSERVED					weekly total	GENERATED					weekly total			
	daily totals (inches)						daily totals (inches)								
29	.20	.17	.14	.12	.10	.08	.07	.89	.00	.11	.03	.00	.00	.00	.14
APR 5	.07	.06	.06	.05	.05	.05	.04	.38	.08	.00	.00	.00	.00	.00	.17
12	.04	.04	.04	.49	.29	.19	.12	1.20	.00	.00	.00	.00	.00	.00	.00
19	.07	.06	.05	.04	.03	.04	.03	.32	.00	.00	.14	.04	.00	.01	.19
26	.02	.02	.02	.01	.01	.01	.06	.16	.00	.02	.01	.00	.00	.01	.04
MAY 3	.03	.12	.31	.20	.15	.10	.07	.98	.24	.12	.01	.02	.00	.00	.40
10	.05	.05	.36	.27	.19	.20	.22	1.33	.00	.00	.00	.01	.00	.00	.01
17	.12	.07	.04	.03	.03	.02	.02	.32	.00	.00	.00	.00	.00	.00	.00
24	.01	.01	.01	.01	.01	.01	.01	.05	.00	.02	.03	.00	.00	.00	.05
31	.00	.00	.00	.01	.02	.02	.01	.06	.00	.00	.21	.12	.02	.02	.36
JUN 7	.01	.00	.00	.00	.01	.00	.00	.04	.13	.00	.00	.06	.00	.05	.24
14	.00	.00	.00	.00	.01	.01	.02	.05	.00	.04	.00	.00	.33	.00	.37
21	.01	.01	.01	.01	.20	.31	.31	.85	.00	.00	.00	.13	.04	.00	.18
28	.27	.24	.19	.36	.32	.27	.12	1.76	.00	.10	.21	.04	.00	.01	.36
JUL 5	.06	.05	.04	.06	.09	.06	.04	.39	.00	.03	.00	.00	.00	.00	.04
12	.03	.02	.02	.01	.01	.01	.01	.10	.03	.00	.00	.00	.00	.00	.03
19	.01	.01	.00	.00	.00	.01	.01	.03	.27	.04	.01	.00	.01	.03	.35
26	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.13	.00	.00	.00	.13
AUG 2	.00	.00	.00	.00	.01	.02	.02	.06	.01	.00	.00	.00	.00	.06	.07
9	.02	.02	.02	.02	.01	.01	.00	.09	.13	.21	.00	.00	.00	.12	.46
16	.00	.03	.02	.02	.01	.01	.01	.10	.06	.00	.00	.00	.01	.20	.26
23	.01	.01	.01	.01	.01	.01	.01	.06	.00	.00	.00	.04	.00	.01	.05

Table 17 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total		
		daily totals (inches)					daily totals (inches)						
30		.01	.00	.01	.01	.01	.05	.00	.00	.24	.00	.20	.44
SEP	6	.01	.01	.07	.09	.07	.32	.12	.01	.00	.00	.00	.13
13		.04	.03	.02	.02	.01	.15	.00	.01	.00	.00	.05	.06
20		.02	.04	.02	.02	.02	.14	.00	.00	.01	.00	.00	.06
27		.01	.01	.01	.01	.01	.07	.00	.00	.00	.00	.00	.00
OCT	4	.07	.04	.03	.02	.07	.45	.00	.01	.00	.00	.00	.01
11		.14	.08	.11	.16	.07	1.06	.00	.00	.01	.03	.00	.04
18		.02	.02	.01	.37	.22	.81	.25	.00	.00	.00	.00	.26
25		.08	.05	.04	.03	.02	.24	.00	.00	.01	.00	.01	.02
NOV	1	.01	.01	.01	.32	.37	1.14	.00	.12	.00	.02	.00	.14
8		.25	.16	.11	.06	.05	.75	.04	.06	.00	.00	.00	.10
15		.03	.03	.03	.02	.02	.18	.00	.02	.00	.00	.00	.02
22		.02	.02	.04	.04	.04	.22	.07	.00	.00	.01	.08	.19
29		.04	.03	.03	.02	.02	.36	.00	.00	.00	.00	.00	.00
DEC	6	.36	.29	.20	.11	.09	1.26	.15	.02	.00	.00	.07	.26
13		.07	.06	.05	.09	.10	.53	.20	.00	.00	.08	.12	.43
20		.10	.11	.10	.13	.13	.78	.00	.00	.00	.00	.00	.00
27		.13	.12	.11	.31	.24	1.37	.01	.00	.00	.00	.00	.04
JAN	3	.24	.34	.27	.15	.11	1.39	.00	.00	.00	.02	.00	.08
10		.07	.05	.05	.04	.03	.31	.00	.00	.01	.00	.00	.01
17		.03	.03	.03	.02	.02	.16	.00	.00	.00	.00	.12	.21
24		.01	.01	.01	.02	.05	.16	.00	.00	.00	.00	.00	.33

Table 18. Discharge (observed vs. generated) Lowe Branch
For a period of Record (April 26, 1975 through September 5, 1980)

		OBSERVED				weekly total		GENERATED				weekly total	
		daily totals (inches)						daily totals (inches)					
APR	26	.11	.10	.08	.06	.05	.04	.04	.04	.00	.00	.00	.00
MAY	3	.04	.04	.04	.04	.04	.06	.08	.01	.00	.00	.00	.00
	10	.03	.02	.01	.01	.01	.13	.45	.00	.00	.00	.00	.10
	17	.16	.14	.09	.06	.04	.03	.03	.00	.00	.00	.14	.25
	24	.02	.02	.04	.03	.02	.02	.03	.00	.05	.00	.00	.38
	31	.02	.02	.01	.01	.01	.01	.01	.02	.00	.00	.00	.31
JUN	7	.01	.00	.00	.01	.01	.11	.05	.07	.00	.00	.00	.81
	14	.03	.02	.02	.01	.01	.01	.00	.18	.00	.00	.00	.07
	21	.00	.00	.00	.00	.00	.00	.00	.00	.13	.00	.00	.32
	28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.19
JUL	5	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.04
	12	.00	.00	.00	.00	.00	.00	.00	.71	.00	.00	.00	.73
	19	---	---	.00	---	---	---	---	.00	.00	.00	.00	.00
	26	---	---	---	.00	---	.00	.00	.00	.00	.00	.15	.22
AUG	2	---	---	---	---	---	.00	.00	.03	.00	.00	.00	.03
	9	---	---	---	---	---	---	---	.00	.00	.00	.00	.05
	16	.00	.00	.04	.02	.00	.00	.00	.00	.00	.00	.00	.01
	23	.00	.00	.00	---	---	---	---	.05	.00	.00	.00	.05
	30	---	---	---	---	.00	.00	.00	.00	.00	.00	.01	.01
SEP	6	.00	.00	.00	.00	.00	.00	.00	.86	.00	.00	.11	1.00
	13	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02
	20	.00	.00	.00	.14	.08	.01	.01	.23	.00	.00	.00	.00
									.12	.08	.01	.00	.45

Table 18 (Continued)

	OBSERVED				weekly total	GENERATED				weekly total
	daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)		daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)	
27	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00
OCT 4	.00	.00	---	.00	.02	.00	.00	.18	.00	.18
11	.01	.00	.00	.00	.41	.00	.00	.00	.12	.09
18	.13	.04	.02	.01	.24	.01	.00	.00	.92	1.07
25	.01	.01	.01	.01	.06	.00	.00	.00	.00	.59
NOV 1	.01	.01	.01	.01	.05	.03	.00	.00	.00	.03
8	.01	.01	.01	.01	2.45	.19	.00	.63	.05	.87
15	.08	.06	.04	.03	.32	.00	.00	.00	.00	.01
22	.03	.03	.03	.03	.19	.00	.00	.00	.01	.03
29	.02	.04	.12	.10	.44	.00	.00	.63	.00	.63
DEC 6	.03	.03	.03	.04	.27	.00	.00	.00	.00	.86
13	.04	.03	.04	.09	.42	.02	.00	.00	.00	.02
20	.04	.04	.03	.02	.60	.00	.00	.00	.15	.15
27	.18	.10	.08	.07	1.18	.00	.00	.25	.04	.29
JAN 3	.11	.11	.09	.08	.63	.00	.59	.00	.00	.59
10	.08	.07	.07	.05	.43	.00	.00	.00	.00	.00
17	.04	.04	.03	.03	.21	.00	.00	.07	.01	.09
24	.02	.04	.38	.15	1.08	.00	.00	.00	.13	.13
31	.06	.06	.05	.04	.32	.00	.00	.00	.00	.01
FEB 7	.03	.03	.03	.02	.19	.00	.00	.00	.01	.01
14	.02	.02	.02	.19	.62	.00	.00	.00	.11	.15
21	.09	.09	.08	.06	.47	.01	.00	.00	.00	.01

Table 18 (Continued)

		OBSERVED			GENERATED			weekly
		daily totals (inches)			daily totals (inches)			total

Table 18 (Continued)

		OBSERVED			GENERATED			weekly total	
		daily totals (inches)			daily totals (inches)			weekly total	
AUG	26	---	---	---	---	---	---	---	---
	2	.00	.00	.00	.00	.00	.00	.00	.00
	9	.00	.00	.00	.00	.00	.00	.00	.00
	16	.00	.00	.00	.00	.00	.00	.00	.00
	23	.00	.00	.00	.00	.00	.00	.00	.00
SEP	30	.00	.00	.00	.00	.00	.00	.00	.00
	6	.00	.00	.00	.00	.00	.00	.00	.00
	13	.00	.00	.00	.00	.00	.00	.00	.00
	20	.00	.00	.00	.00	.00	.00	.00	.00
	27	.00	.00	.00	.00	.00	.00	.00	.00
OCT	4	.01	.00	.00	.00	.00	.00	.00	.00
	11	.00	.00	.00	.00	.00	.00	.00	.00
	18	.00	.00	.00	.00	.00	.00	.00	.00
	25	.00	.00	.00	.00	.00	.00	.00	.00
	1	.01	.01	.00	.00	.00	.00	.00	.00
NOV	8	.00	.00	.00	.00	.00	.00	.00	.00
	15	.00	.00	.00	.00	.00	.00	.00	.00
	22	.00	.00	.00	.00	.00	.00	.00	.00
	29	.01	.01	.06	.53	.08	.09	.07	.08
	6	.03	.07	.09	.08	.02	.02	.02	.02
DEC	13	.02	.02	.02	.02	.02	.02	.02	.02
	20	.02	.07	.08	.07	.04	.03	.03	.03

Table 18 (Continued)

	OBSERVED			weekly total	GENERATED					weekly total
	daily totals (inches)	daily totals (inches)	daily totals (inches)		daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)	
24	.00	.00	.01	.03	.00	.37	.00	.00	.01	.38
31	.00	.00	.01	.03	.00	.01	.00	.00	.08	.10
JUN 7	.00	.01	.01	.07	.00	.00	.00	.26	.03	.39
14	.10	.09	.01	.22	.00	.00	.00	.00	.00	.01
21	.00	.00	.00	.01	.04	.01	.00	.11	.00	.16
28	.00	.00	.00	.00	.00	.00	.27	.00	.00	.27
JUL 5	.00	.00	.00	.00	.01	.00	.00	.00	.00	.01
12	.00	.00	.00	.00	.00	.00	.01	.21	.00	.22
19	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02
26	.00	.00	.00	.00	.01	.00	.05	.04	.02	.13
AUG 2	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
9	.00	.00	.00	.00	.00	.13	.05	.00	.01	.19
16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
23	.00	.00	.00	.00	.01	.00	.13	.30	.02	.45
30	.00	.00	.00	.01	.00	.01	.00	.00	.16	.23
SEP 6	.00	.00	.00	.01	.01	.00	.03	.00	.00	.04
13	.00	.00	.04	.12	.00	.00	.14	.00	.00	.14
20	.00	.00	.00	.00	.71	.12	.03	.00	.01	.86
27	.00	.40	.04	.47	.00	.00	.87	.18	.00	1.08
OCT 4	.00	.00	.00	.01	.00	.00	.00	.00	.03	.04
11	.00	.00	.01	.11	.00	.00	.02	.00	.00	.35
18	.01	.01	.01	.06	.00	.17	.00	.00	.00	.19

Table 18 (Continued)

		OBSERVED				GENERATED											
		daily totals (inches)				daily totals (inches)				weekly total							
NOV	25	.01	.38	.28	.16	.08	.06	.03	.99	.00	.08	.07	.00	.00	.12	.15	.42
	1	.02	.01	.01	.01	.01	.03	.03	.11	.03	.00	.00	.00	.00	.00	.01	.04
	8	.03	.02	.04	.65	.49	.15	.09	1.47	.25	.11	.00	.03	.01	.00	.00	.41
	15	.07	.04	.09	.73	.37	.14	.08	1.53	.01	.00	.00	.11	.00	.02	.00	.14
	22	.07	.06	.19	.11	.09	.07	.06	.66	.00	.00	.63	.02	.00	.00	.04	.69
DEC	29	.04	.04	.03	.03	.02	.02	.01	.19	.00	.00	.00	.08	.01	.00	.00	.09
	6	.01	.03	.03	.04	.03	.02	.02	.18	.00	.00	.00	.00	.15	.00	.00	.15
	13	.03	.16	.12	.08	.06	.04	.03	.52	.00	.00	.00	.07	.12	.00	.01	.20
	20	.02	.01	.01	.01	.01	.01	.01	.08	.04	.00	.00	.19	.02	.00	.00	.25
	27	.01	.19	.28	.20	.16	.11	.04	.99	.01	.00	.00	.00	.00	.00	.00	.02
JAN	3	.02	.01	.01	.04	.08	.08	.07	.33	.17	.00	.00	.04	.01	.00	.00	.22
	10	.04	.03	.02	.08	.85	.57	.14	1.74	.00	.01	.00	.00	.00	.00	.00	.01
	17	.10	.08	.06	.04	.03	.02	.01	.35	.25	.00	.12	.01	.00	.00	.03	.41
	24	.01	.01	.01	.01	.01	.01	.01	.05	.00	.00	.00	.00	.13	.00	.00	.14
	31	.01	.01	.01	.03	.03	.03	.03	.15	.00	.00	.34	.03	.00	.00	.00	.37
FEB	7	.03	.03	.03	.02	.02	.01	.01	.15	.00	.05	.00	.00	.00	.00	.06	.11
	14	.01	.01	.01	.01	.02	.03	.08	.17	.00	.00	.00	.00	.14	.00	.00	.14
	21	.08	.08	.06	.05	.07	.09	.19	.62	.00	.00	.00	.00	.18	.01	.00	.19
	28	.16							.16	.02						.02	.02
	1	.04	.03	.02	.03	.03	.03	.03	.20	.01	.00	.00	.03	.00	.00	.00	.04
MAR	8	.04	.20	.15	.10	.09	.07	.05	.71	.00	.00	.00	.00	.01	.00	.14	.14
	15	.03	.02	.01	.01	.01	.01	.01	.11	.29	.00	.07	.00	.03	.00	.00	.39

Table 18 (Continued)

		OBSERVED				weekly total	GENERATED				weekly total
		daily totals (inches)					daily totals (inches)				
22		.01	.00	.00	.00	.03	.00	.01	.00	.00	.03
29		.00	.00	.00	.08	.21	.01	.00	.09	.45	.60
5	APR	.02	.01	.01	.12	.40	.00	.00	.00	.00	.27
12		.07	.05	.03	.01	.29	.00	.00	.00	.00	.00
19		.06	.06	.05	.03	.30	.00	.00	.00	.00	.46
26		.26	.21	.17	.09	.94	.18	.13	.00	.00	.09
3	MAY	.02	.01	.00	.04	.20	.08	.00	.01	.00	.95
10		.02	.01	.00	.00	.04	.90	.00	.01	.00	.01
17		.00	.00	.00	.00	.19	.00	.00	.00	.01	.05
24		.08	.02	.01	.01	.15	.00	.00	.04	.00	.77
31		.00	.00	.00	.00	.00	.02	.00	.00	.48	.15
7	JUN	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01
14		.00	.00	.00	.00	.00	.00	.00	.18	.01	.19
21		.00	.00	.00	.00	.00	.00	.00	.00	.00	.05
28		.01	.03	.00	.00	.05	.00	.00	.28	.00	.50
5	JUL	.00	.00	.00	.00	.02	.00	.00	.00	.00	.43
12		.00	.00	.00	.00	.00	.00	.21	.01	.00	.21
19		.00	.00	.00	.08	.21	.00	.00	.09	.00	.38
26		.11	.45	.17	.02	.84	.00	.00	.14	.23	1.00
2	AUG	.01	.01	.01	.01	.05	.00	.00	.12	.00	.06
9		.01	.01	.00	.01	.04	.00	.00	.01	.00	.17
16		.00	.00	.00	.00	.01	.01	.00	.00	.00	.12

Table 18 (Continued)

	OBSERVED			GENERATED			weekly total
	daily	totals (inches)	weekly total	daily	totals (inches)	weekly total	
23	.00	.00	.00	.00	.10	.03	.00
30	.00	.00	.00	.07	.00	.00	.00
6	.00	.00	.00	.08	.00	.00	.00
13	.00	.00	.00	.00	.00	.00	.00
20	.00	.00	.00	.00	.00	.13	.01
27	.00	.00	.00	.00	.00	.01	.01
4	.00	.00	.00	.22	.01	.02	.00
11	.00	.00	.00	.11	.00	.00	.00
18	.00	.00	.00	.00	.00	.01	.00
25	.00	.00	.00	.00	.00	.00	.00
1	.00	.00	.01	.00	.02	.03	.00
8	.00	.00	.01	.00	.00	.19	.01
15	.00	.00	.01	.12	.00	.00	.05
22	.77	.21	.49	.03	.00	.00	.33
29	.05	.24	1.79	.00	.00	.12	.16
6	.10	.04	.66	.03	.09	.19	.33
13	.01	.03	.29	.02	.00	.00	.03
20	.12	.57	1.60	.03	.01	.00	.02
27	.05	.40	1.08	.00	.12	.00	.32
3	.73	.35	2.82	.01	.00	.00	.12
10	.10	.09	.56	.12	.00	.00	.06
17	.05	.03	.22	.05	.00	.00	.42
				.00	.03	.00	.24
				.00	.00	.00	.05

Table 18 (Continued)

OBSERVED										GENERATED		weekly total		
daily totals (inches)										daily totals (inches)				
24	.02	.02	.03	.04	.04	.29	.33	.78	.00	.00	.22	.00	.18	.40
31	.20	.13	.08	.08	.19	.20	.16	1.05	.11	.01	.00	.00	.00	.12
FEB 7	.61	1.58	.61	.31	.23	.19	.13	3.66	.00	.01	.00	.04	.00	.05
14	.11	.61	.29	.17	.12	.09	.06	1.45	.00	.00	.01	.00	.00	.06
21	.17	.28	.19	.12	.10	.08	.06	1.00	.00	.00	.00	.00	.00	.00
28	.05							.05	.00					.00
MAR 1	.39	.24	.14	.13	.16	.14	.10	1.31	.00	.00	.01	.02	.00	.04
8	.08	.08	.20	.77	.37	.20	.13	1.84	.23	.00	.00	.00	.00	.23
15	.10	.08	.57	.28	.16	.23	.37	1.79	.00	.00	.01	.00	.01	.01
22	.31	.20	.13	.09	.07	.05	.03	.89	.00	.11	.00	.02	.00	.13
29	.03	.02	.02	.02	.02	.03	.03	.16	.03	.05	.00	.00	.00	.09
APR 5	.03	.02	.02	.02	.02	.03	2.10	2.24	.00	.02	.00	.00	.00	.02
12	.61	.26	.13	.08	.05	.04	.03	1.19	.07	.00	.02	.01	.07	.17
19	.02	.02	.01	.01	.01	.01	.00	.08	.00	.00	.00	.00	.00	.00
26	.00	.01	.04	.02	.09	.37	.29	.83	.14	.02	.00	.00	.06	.23
MAY 3	.21	.13	.08	.06	.05	.35	.31	1.20	.18	.00	.02	.07	.11	.39
10	.17	.12	.08	.06	.04	.03	.02	.52	.00	.00	.00	.00	.00	.00
17	.01	.01	.01	.01	.01	.00	.00	.05	.00	.00	.02	.00	.00	.04
24	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.05	.02	.00	.07
31	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.01
JUN 7	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.11	.19
14	.00	.00	.01	.01	.00	.00	.00	.03	.00	.00	.27	.00	.00	.30

Table 18 (Continued)

	OBSERVED				weekly total	GENERATED				weekly total
	daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)		daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)	
21	.08	.01	.01	.00	.26	.04	.00	.00	.01	.00
28	.40	.14	.07	.03	.69	.00	.00	.00	.00	.00
JUL 5	.01	.01	.01	.01	.05	.00	.00	.03	.02	.00
12	.01	.01	.01	.00	.04	.00	.00	.00	.00	.00
19	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00
26	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00
AUG 2	.00	.00	.00	.00	.03	.00	.00	.14	.00	.00
9	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00
23	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00
30	.01	.01	.01	.01	.13	.00	.03	.07	.00	.00
SEP 6	.03	.02	.01	.01	.08	.00	.21	.02	.00	.00
13	.00	.00	.00	.00	.02	.00	.00	.03	.00	.00
20	.00	.00	.00	.00	.03	.18	.08	.01	.00	.00
27	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00
OCT 4	.00	.00	.01	.01	.61	.00	.00	.07	.21	.00
11	.10	.04	.02	.01	.27	.01	.03	.00	.05	.00
18	.40	.10	.06	.03	.63	.00	.00	.00	.00	.00
25	.01	.01	.01	.01	.10	.01	.00	.00	.00	.00
NOV 1	.49	.61	.53	.06	1.80	.00	.00	.00	.00	.00
8	.01	.00	.00	.01	.06	.00	.00	.00	.00	.00
15	.01	.01	.01	.01	.07	.00	.00	.20	.02	.00

Table 18 (Continued)

	OBSERVED				weekly total	GENERATED				weekly total
	daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)		daily totals (inches)	daily totals (inches)	daily totals (inches)	daily totals (inches)	
22	.01	.01	.01	.01	.07	.00	.00	.01	.00	.03
29	.01	.57	.24	.15	1.63	.11	.02	.00	.00	.00
DEC 6	.14	.12	.11	.21	.95	.00	.22	.00	.01	.02
13	.20	.18	.20	.24	1.34	.00	.00	.01	.00	.00
20	.24	.23	.19	.40	1.68	.00	.00	.02	.01	.00
27	.33	.19	.49	.12	2.00	.00	.00	.02	.00	.00
JAN 3	.08	.04	.03	.02	.27	.00	.00	.00	.00	.05
10	.02	.01	.01	.01	.07	.00	.01	.00	.00	.16
17	.01	.00	.00	.02	.05	.00	.00	.29	.05	.34
24	.22	.15	.08	.04	.71	.00	.00	.00	.00	.01
31	.03	.02	.02	.01	.14	.00	.00	.00	.00	.01
FEB 7	.01	.01	.11	.12	.42	.00	.00	.00	.00	.07
14	.39	.28	.10	.06	1.10	.01	.00	.00	.00	.03
21	.01	.02	.17	.49	4.01	.00	.21	.02	.00	.23
28	.17				.17	.01				.01
MAR 1	.10	.08	.07	.06	.52	.00	.00	.00	.03	.03
8	.04	.02	.02	.01	.14	.00	.00	.00	.00	.00
15	.01	.01	.07	.06	.30	.00	.01	.02	.00	.02
22	.04	.04	.03	.02	.21	.00	.00	.00	.01	.01
29	.02	.02	.02	.01	.11	.00	.06	.00	.00	.07
APR 5	.01	.01	.01	.00	.04	.00	.00	.00	.00	.00
12	.00	.00	.00	.00	.02	.00	.00	.00	.02	.03

Table 18 (Continued)

	OBSERVED				weekly total	GENERATED				weekly total
	daily	totals	(inches)			daily	totals	(inches)		
19	.02	.02	.03	.02	.01	.00	.00	.00	.00	.00
26	.02	.02	.03	.02	.01	.00	.00	.00	.00	.00
MAY 3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01
17	.00	.00	.00	.00	.00	.00	.01	.00	.02	.02
24	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05
31	.00	.00	.00	.00	.00	.01	.00	.00	.00	.01
JUN 7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01
14	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
21	.00	.00	.00	.00	.00	.00	.02	.01	.00	.03
28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
JUL 5	.00	.00	.00	.00	.00	.01	.00	.00	.00	.02
12	.00	.00	.00	.00	.00	.00	.04	.00	.00	.05
19	.00	.00	.00	.00	.00	.00	.00	.00	.03	.07
26	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
AUG 2	.00	.00	.00	.00	.00	.00	.12	.05	.00	.17
9	.00	.00	.00	.00	.00	.00	.00	.00	.02	.03
16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
23	.00	.00	.00	.00	.00	.00	.00	.09	.00	.12
30	.00	.00	.00	.00	.00	.01	.00	.00	.00	.01

Source of Observed Data: Dickens, P.S., C.H. Chiang, R.A. Minear, and B.A. Tschantz, New River Project Data Bases and Documentation Joint Research, Volume I, Hydrologic and Water Quality Data, The University of Tennessee, Departments of Civil Engineering and Zoology, Knoxville, Tennessee, December, 1980, (85).

Table 19. Physical watershed characteristics under varying vegetative cover

Watershed	Area *	SCS Curve Number			Antecedent Moisture Condition
		Undisturbed	Disturbed	Revegetated	
Anderson Branch	518	77	90	82	II
Lowe Branch	598	77	87	80	II

* Total watershed drainage area

APPENDIX B
Fortran Program

FORTRAN SOURCE CODE

The enclosed diskette in the pocket on the back cover contains a copy of the original source code and supporting data set used in this work.

The code is documented throughout and users are encouraged to print a copy for reference and guidance purposes. The code was programmed in Microsoft Fortran (78) on a personal computer utilizing Microsoft MS-DOS operating system, version 2.11.

The code is interactive with input format and error detection programmed to minimize input data errors. This code can take advantage of, but does not require, an 8087 numeric coprocessor. The minimum system configuration requirements are:

- 1.) 640 K memory
- 2.) 1 - 360 K floppy disk drive
- 3.) 1 - 10 Meg hard disk drive

The code is written in modular form with section function identified and variables defined. The fortran code is provided due to the diversity of available computers. An executable image should be prepared according to the instructions accompanying the user's compiler and operating system.

This code has been copyrighted and is available through the Department of Civil Engineering, The University of Tennessee, Knoxville, Tennessee 37916.

VITA

J B Turnmire was born in Hancock County, Tennessee, on March 18, 1951. He graduated from Hancock County High School in June 1968. He received a Bachelor of Science degree in Civil Engineering in December 1973 and a Master of Science degree in Environmental Engineering in December 1974 from the University of Tennessee, Knoxville, Tennessee.

He was a Civil Engineer for the State of Tennessee, Department of Conservation, Division of Water Resources from December 1973 until June 1975. He was a Civil Engineer for the Tennessee Valley Authority from June 1975 until June 1979. He was a graduate student at the University of Tennessee from June 1979 until June 1980. He was a Director of Engineering and Resource Development for Dan Branch Holding Company from June 1980 until June 1982. He was a Business Manager for Science Applications Incorporated from June 1982 until May 1984. He assumed the position of President of Applied Engineering and Management Corporation in May 1984 and currently holds this position. He received his Doctor of Philosophy degree with a major in Civil Engineering in December 1987.

He is married to the former Christine Anne Henry, of Rosewell, New Mexico, and has three sons, Jeffry Bryson, Jonathan Logan, and Dusty Brandon.