Magnitude and Frequency of Floods in the Suwannee River Water Management District, Florida

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 96-4176

Prepared in cooperation with the
Suwannee River Water Management District

U.S. DEPARTMENT OF THE INTERIOR
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By G.L. Giese and M.A. Franklin

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1996

U.S. DEPARTMENT OF THE INTERIOR
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CONTENTS

Figures

Tables

CONVERSION FACTORS AND ABBREVIATIONS

Multiply	**By**	**To obtain**
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

SYMBOLS

Symbol	Meaning
A_g	Drainage area for gaged site, in square miles
A_u	Drainage area for ungaged site, in square miles
$B1_T$, $B2_T$, $B3_T$	Partial regression coefficients
C_T	Regression constant
C_v	Coefficient of variation
DA	Drainage area, in square miles
EY	Accuracy for a flood estimate, in equivalent years of record
K_T	Pearson Type III deviate
LE	Channel length, in miles
LK	Total area of lakes and ponds, in percent of drainage area
M	Mean of logarithms of the annual peaks
N	Number of items in a data set
n	Time interval, in years
P	Exceedance probability
P_N	Probability of at least one exceedance within the specified time interval
Q_g	Estimate from log-Pearson Type III distributions of T-year flood, in cubic feet per second
Q_R	Estimate from regression equation of T-year flood for gaged site, in cubic feet per second
Q_{ru}	Regional estimate of T-year flood from regression equation for ungaged site, in cubic feet per second
Q_T	Estimate of the T-year flood from log-Pearson Type III distribution in cubic feet per second
Q_u	Adjusted estimate of T-year flood for ungaged site, in cubic feet per second
Q_{wt}	Weighted estimate of T-year flood at gaged site, in cubic feet per second
R	Multiple correlation coefficient
S	Standard deviation of the logarithms of annual peaks
SE_P	Standard-error of prediction
SL	Channel slope, in feet per mile
T	Recurrence interval, in years
X_1, X_2, X_3...	Independent variables in linear regression

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ABSTRACT

Flood-frequency statistics for 2-, 5-, 10-, 25-, 50-. 100-, 200-, and 500-year recurrence intervals, based on three methods of analysis, are presented for 25 continuous-record and seven peak flow partial-record gaging stations in the Suwannee River Water Management District. The first method, for gaged stations, utilizes station records; the second method, for ungaged sites, utilizes regional regression analysis; and the third method uses a weighted combination of the station and regional values. Because the weighted values utilize two more or less independent estimates of the peak flow statistic, they are considered more accurate than the station estimates or the regression estimates alone. Also, the use of another weighting scheme to improve estimates of flood frequency statistics at ungaged sites is demonstrated.

The karstic nature of much of the Suwannee River Water Management District significantly attenuates flood peaks in some streams by providing substantial subsurface storage when river stages are high. At such times, springs discharging into rivers may reverse flow temporarily and become sinks.

INTRODUCTION

In recent years there has developed a better awareness that natural systems such as wetlands, flood plains, native ecological communities, and aquifer recharge areas within the 7,640-square-mile SRWMD (Suwannee River Water Management District) (fig.1) provide vital water-related functions. These functions include water- quality treatment, water supply, flood water conveyance and attenuation, fish and wildlife habitat, and recreational and economic uses. These systems depend on the maintenance of the natural variability of the hydrologic cycle as reflected by the magnitude, duration, and timing of changing streamflow, rising and falling water levels of lakes, rivers, and aquifers, and interaction of surface and ground waters. Alterations to the natural hydrologic regime by human activities may have adverse effects on the natural systems and their functions. However, many aspects of natural-system requirements are poorly known and must be better understood in order to establish minimum flow and water-level requirements that will allow adequate water to balance present and future needs of the natural system with those of the human population. Quantification of the natural hydrologic regime that has shaped the current natural system is basic to developing this understanding and achieving this balance.

Accordingly, in 1994, the USGS (U.S. Geological Survey) and the SRWMD entered into a cooperative agreement wherein the USGS agreed to provide, in the course of a long-term program of investigation, the hydrologic information or tools needed for the SRWMD to establish minimum flow and water-level requirements for surface and ground waters of the SRWMD. This report, dealing only with flood magnitudes and frequency, is one of a planned series of studies intended to accomplish this goal.

The primary motivation for this particular report is to document the high-flow regime of the natural hydrologic system of the SRWMD. This information is available to researchers studying minimum inundation requirements for wetlands, estuar-

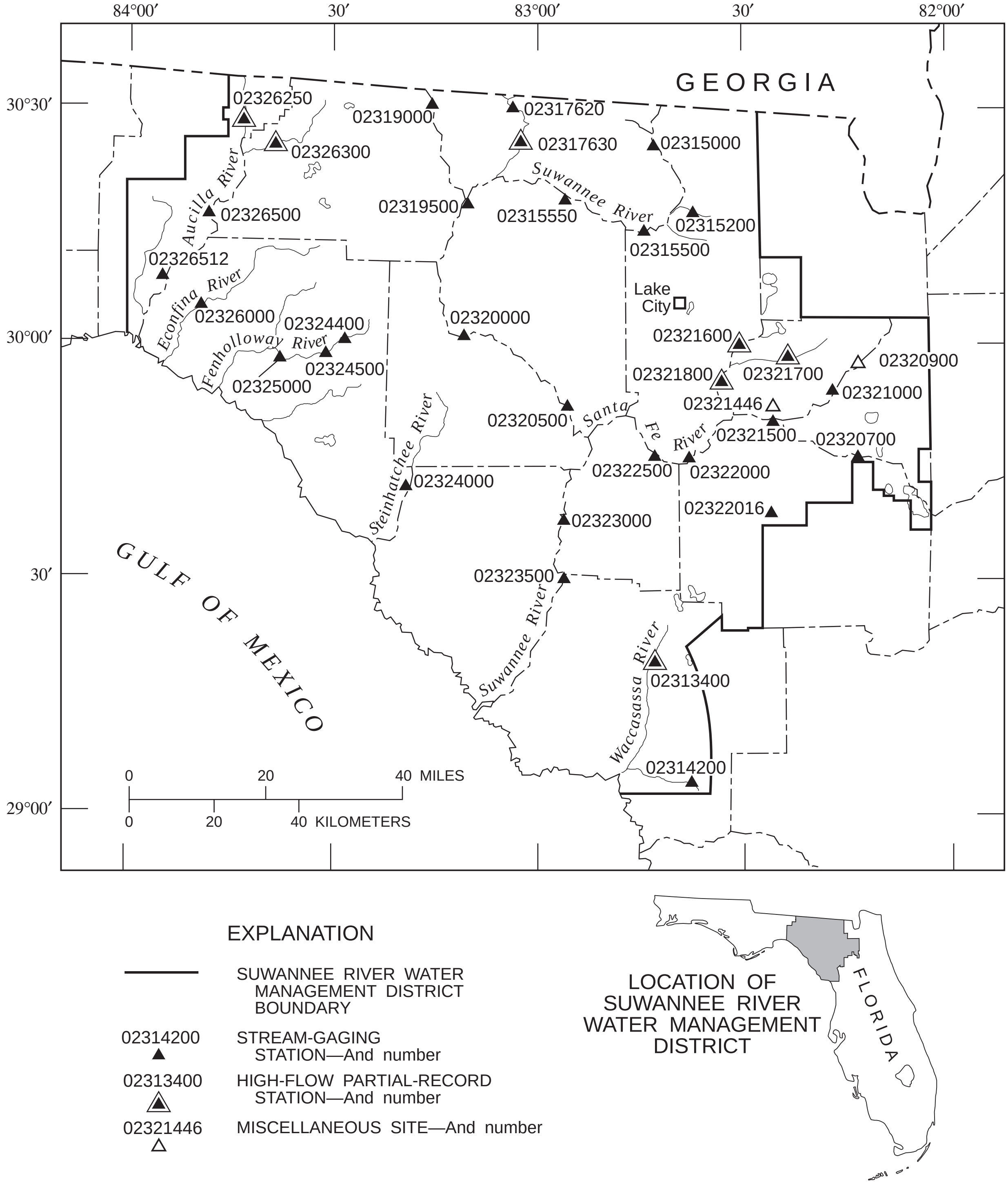

Figure 1. Location of Suwannee River Water Management District and streamgaging stations used for measuring peak discharges.

ies, riparian communities, and other ecosystems in the SRWMD. These needs are beyond the traditional needs for flood-frequency information in the design of drainage structures and bridges, flood-plain zoning, and flow regulation. These traditional needs will also be served by the information in this report.

Purpose and Scope

This report is presents flood-frequency statistics for unregulated gaged sites in the SRWMD for which 10 years or more of peak flow data were available, provides means of improving estimates at gaged sites, and presents methods for estimating peak-flow characteristics at ungaged sites. Flood magnitudes are presented for 25 continuous-record stations and 7 partial-record gaging stations for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years, utilizing log-Pearson Type III distributions. Recurrence interval here can be defined as the average number of years between flood peaks greater than, or equal to, a specified magnitude. This analysis utilized records up to and including the 1994 water year. Regression equations for estimating flood-frequency characteristics at ungaged sites are also presented. Finally, this report includes methods for improved estimates at both gaged sites and ungaged sites on gaged streams.

Previous Studies

Franklin and others (1994) listed and ranked annual peak flows and various consecutive-day high flows for the SRWMD but did not assign frequencies of occurrence. Stamey and Hess (1993) presented flood-frequency characteristics of Georgia streams and techniques for estimating magnitude and frequency of floods in rural basins in Georgia. That report included station analyses and regional regression equations for streams in the upper Suwannee River basin in Georgia. Bridges (1982) presented flood frequency analyses for Florida stations gaging natural flow, including many of the stations in the SRWMD. That study also contained regional regression equations for estimating flood-frequency characteristics of ungaged streams. Bridge’s report, which utilized records only through the 1978 water year, is superceded by this report for stations in the SRWMD. The U.S. Army Corps of Engineers (1974) delineated the areal extent of major Suwannee River flooding for the large floods of April 1948 and April 1973.

Physical Setting

The SRWMD, located in the north-central part of Florida, is one of five water management districts created by the Florida Legislature through the passage of the Water Resources Act of 1972. The SRWMD is the smallest in area and the most sparsely populated. The SRWMD is in the Southeastern Coastal Plain physiographic province of the United States, as delineated by Fenneman (1938). The SRWMD is covered by three physiographic regions of this province--the Northern Highlands, the Gulf Coastal Lowlands, and the River Valley Lowlands (fig. 2). The areal extent of overbank flooding is generally least in the Northern Highlands and greatest in the River Valley Lowlands.

The SRWMD has a humid subtropical climate. Rainfall averages about 56 inches per year. July and August are typically the wettest months; late spring and early fall are the driest. The largest floods, however, have occurred in March or April as the result of cumulative effects of several consecutive broad frontal-type rainfall events over the basin.The largest floods of record on the Suwannee River occurred in March and April of 1948, March 1959, and April 1973.

STATION ANALYSIS

Frequency curves for individual gaging stations were developed following the guidelines described in Bulletin 17B, Interagency Advisory Committee on Water Data (1982). A log-Pearson Type III distribution function was used to fit annual peak discharges to log-probability curves. The distribution is defined by the equation:

$$\log Q_T = M + K_T S, \tag{1}$$

where

Q_T is the peak discharge for a selected recurrence interval T, in cubic feet per second;

M is the mean of the logarithms of the annual peaks;

K_T is the Pearson Type III frequency factor expressed in number of standard deviations from the mean for a selected recurrence interval, T; and

S is the standard deviation of the logarithm of the annual peaks.

The computer program J407 (Kirby, 1979) was used to fit the log-Pearson Type III distribution to the annual maximum discharges at each of 25 continuous-record and 7 peak-flow partial-record gaging stations (app. 1). User judgment was exercised in the use of this program in determining historic peaks, whether to use station or regional skew coefficents, and interpretation of low and high outliers.

Figures 3 and 4 were constructed to examine the consistency of flood peaks of different frequencies up to 100 years in a downstream direction on the Suwannee and Santa Fe Rivers. Weighted values of station

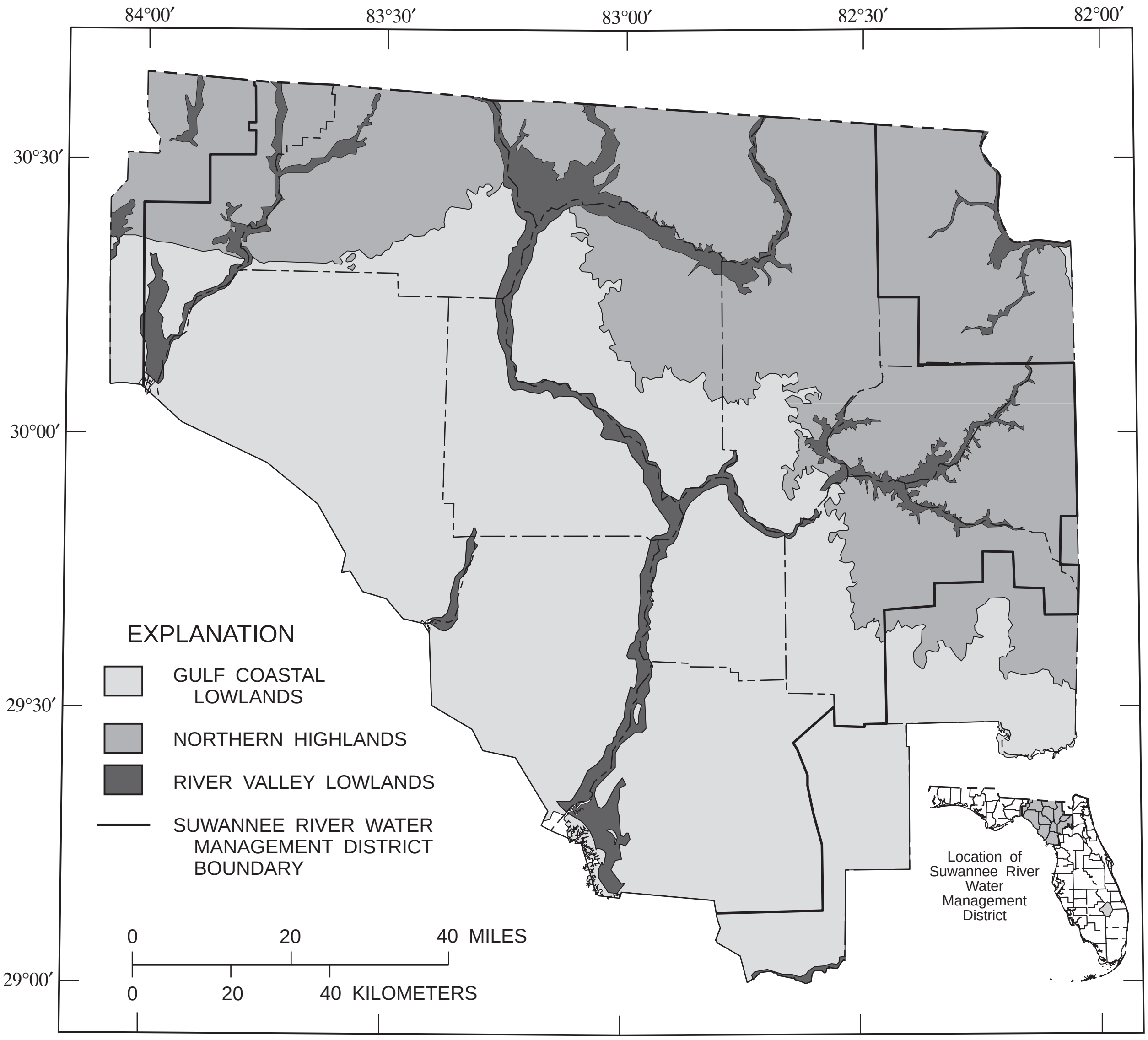

Figure 2. Physiographic regions within the Suwannee River Water Management District (after SRWMD, 1994).

and regional flood peaks were used in the plots. Generally, for rainfall equally distributed throughout a basin, it is usual to see an increase in flood magnitudes with increasing drainage area. The decrease in flood magnitude between the Luraville and Branford stations on the Suwannee River is thought to be due in part to peak attenuation along the channel as cross sectional area increases in a downstream direction. However, it is thought that a large part of the attenuation is through transient stream losses to springs which, at high stream levels, effectively become sinks.The same phenomenon of peak attenuation occurs between Worthington Springs and High Springs on the Santa Fe River.

REGIONAL ANALYSIS

Bridges (1982) performed statewide multiple regressions on 11 variables to develop relations between flood-peak discharges and basin characteristics. The variables tested were drainage area, channel slope, channel length, mean basin elevation, storage area of lakes and ponds, storage area of lakes, ponds, and swamps, forested area, maximum soil infiltration, mean annual precipitation, and maximum 24-hour precipitation intensity. The assumed form of the regression equation used by Bridges was:

$$Q_T = C_T X_1^{B1_T} X_2^{B2_T} \ldots\ldots X_N^{BN_T} \qquad (2)$$

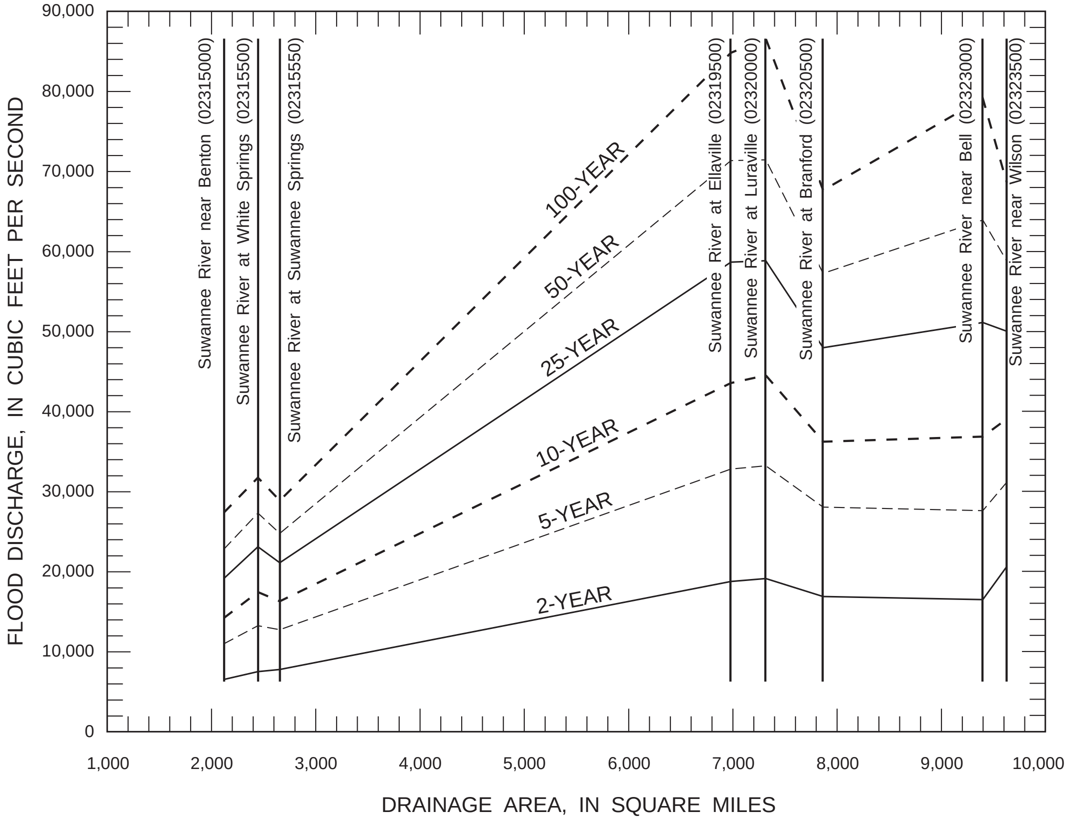

Figure 3. Relation of flood discharge to drainage area for selected frequencies on the Suwannee River.

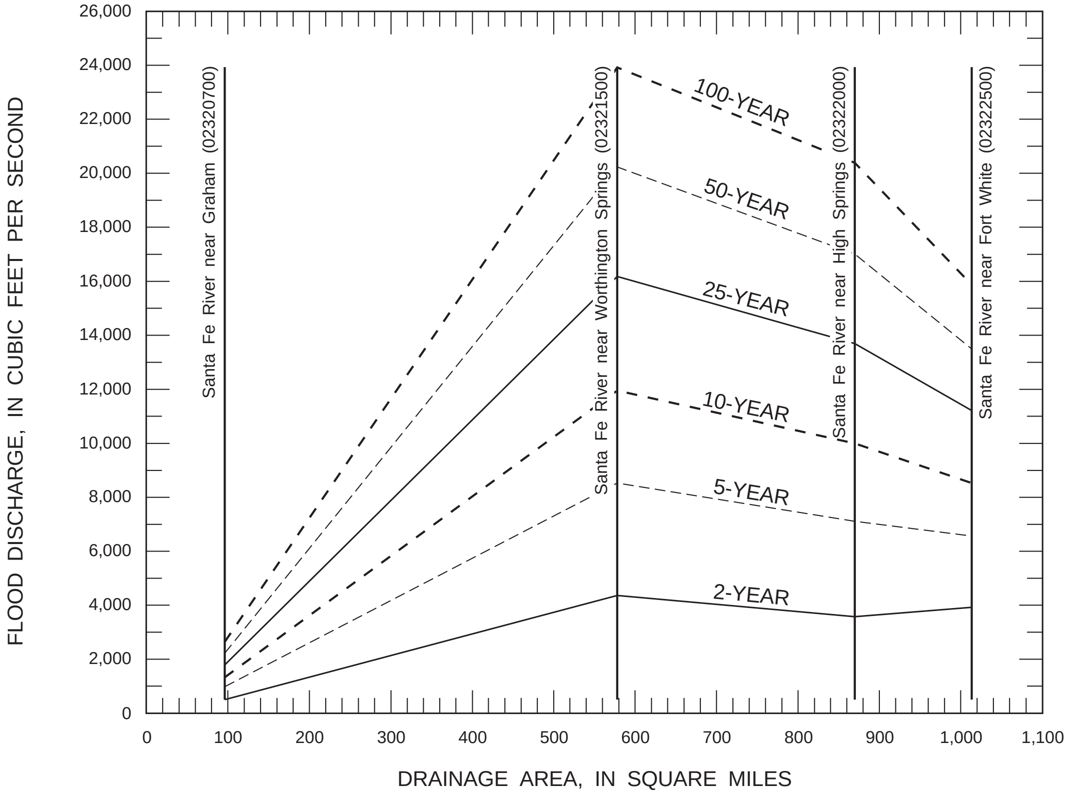

Figure 4. Relation of flood discharge to drainage area for selected frequencies on the Santa Fe River.

where

Q_T is the flood peak discharge (dependent variable) for recurrence interval of T-years, in cubic feet per second;

X_1 to X_N are the basin characteristics (independent variables);

C_T is the regression constant for a given recurrence interval; and

$B1_T$ to BN_T are the regression coefficients for a given recurrence interval.

The regression analysis used R^2 (the square of the multiple correlation coefficient) as a performance criterion. R^2 is a measure of the amount of variation in the independent variable that can be accounted for by the model. The one-variable model with the highest R^2 was produced. Then, the variable that produced the greatest increase in R^2 was added to the equation. Each variable in the two-variable model was compared to each variable not in the model to determine if replacing one variable with another would improve the R^2 coefficient. This procedure continued until the best two-variable, three-variable, and so forth, model was developed for each interval of T years. Bridges found that, statewide, drainage area (*DA*) accounted for 62 percent of the variance of the dependent variable; combining *DA* with lake area (*LK*) accounted for 80 percent; and, adding channel slope (*SL*) added only 3 percent. (For the SRWMD area, Bridges found that adding channel slope to the regression equation produced insignificant improvement.) All three of these parameters were determined from available USGS topographic maps. Adding a fourth and fifth variable did not contribute to significant improvement of either R^2 or the standard error of the regression equations in any region of the State. The present (1996) study adopted Bridges' regression equation for Region B, one of three high flow hydrologic regions Bridges defined for Florida. Region B includes the entire SRWMD and is nearly coincident with it. The regression equation for Region B includes only *DA* and *LK* as variables. The equation is:

$$Q_T = C_T DA^{B1_T}(LK + 0.6)^{B2_T} \tag{3}$$

where

Q_T is the discharge for a recurrence interval of T-years, in cubic feet per second;

C_T is the regression constant for a recurrence interval, T;

DA is the drainage area, in square miles;

LK is percentage of drainage area covered by lakes (determined from USGS 7.5-minute or 15-minute topographic maps); and

$B1_T$ and $B2_T$ are exponents for various recurrence intervals.

The full suite of values for C_T, $B1_T$, and $B2_T$ is given in table 1 along with R^2 values and standard errors for each of the regressions. The standard error of estimate is the standard deviation of the distribution of residuals about the regression line, meaning that 68 percent of the values are within one standard deviation of the regression line and 95 percent are within two standard deviations.

Table 1. Flood-frequency regression model for the Suwannee River Water Management District

Recurrence interval, in years (*T*)	Exceedence probability	Regression constant (C_T)	Exponents		R^2	Standard error, in percent	Accuracy, in equivalent years of record (*EY*)
			$B1_T$	$B2_T$			
2	0.5	44.2	0.658	-0.561	0.876	60.9	2
5	.2	113	.614	-.573	.869	59.7	3
10	.1	182	.592	-.580	.863	59.9	3
25	.04	298	.570	-.585	.853	60.9	5
50	.02	410	.556	-.589	.845	61.9	5
100	.01	584	.543	-.591	.836	63.1	6
200	.005	694	.533	-.593	.827	64.4	6
500	.002	936	.521	-.594	.815	66.3	6

Table 1 also gives the accuracy of the regional relations in equivalent years of record, which is defined as the number of years of actual streamflow record required at a site to obtain an accuracy equal to the standard error of prediction for the regression estimate (Hardison, 1971). Hardison showed that the equivalent years of actual record required to produce an accuracy for a T-year statistic equal to that of a regional regression is given by:

$$EY = \left(\frac{100C_V}{SE_P}\right)^2 \tag{4}$$

where

EY is the accuracy of the T-year statistic at a site not used in the regression, in equivalent years of record;

C_V is the coefficient of variation of annual events, in this case, annual floods;

SE_P is the standard error of prediction in percent.

Table 2 gives the probabilities that floods of a given recurrence interval will be exceeded during indicated time periods. Note that probabilities are *not* multiplicative; that is, the probability of a flood of a given recurrence interval occurring during a 5-year period is *not* five times the probability of that magnitude flood occurring in any one year. The probabilities are computed by the formula (Interagency Advisory Committee on Water Data, March, 1982):

$$P_N=1-(1-1/T)^N \tag{5}$$

where

P_N is the probability of at least one exceedence within the specified time interval;

N is the time period in years;

T is the recurrence interval in years.

Bridges (1982) used stations with drainage areas ranging from 13.9 to 9,640 square miles in developing the regression equations for Region B. Lake areas for Region B ranged from 0 to 13.26 percent. The regression equations have not been validated outside these limits. Also, the regressions are not considered valid where anthropogehic changes have a significant effect on flood runoff, such as regulation from dams, levees, diversion canals, strip mining operation, and urban development.

It is recommended that flood frequency estimates for ungaged sites on ungaged streams be determined by direct application of the regression equation (3) alone in cases where there is no gage upstream or downstream from the site of interest within a drainage area range of greater than one-half and less than twice that of the site of interest. The use of the regional equation is illustrated a follows:

1) Determine the 50-year flood for station 02321446, Fivemile Creek near Dukes, Florida, at County Road 18A (fig. 1).

2) The DA is 11.80 mi^2. The LK is 0.90 percent of the drainage area.

3) Equation 3, as determined from table 1 for the 50-year flood, becomes:

$$Q_T = C_T DA^{B1_T}(LK + 0.6)^{B2_T}$$

$$Q_{50}=410\ (11.80)^{0.556}(0.90+0.6)^{-0.58}$$

$$Q_{50}=1{,}278 \text{ cubic feet per second}$$

Appendix 1 shows calculated values of flood magnitudes from equation 3 for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years at gaging stations. Although it is not recommended that regional values derived from equation 3 be used alone where estimates from gaged flows are also available, the fol-

Table 2. Probability that a flood of a given recurrence interval will be exceeded during indicated time period

Recurrence interval, in years (*T*)	Period of time, in years (*N*)								
	1	5	10	20	25	50	100	200	500
5	0.20[1]	0.67	0.89	0 .99	(2)	(2)	(2)	(2)	(2)
10	.10	.41	.65	.89	0.93	(2)	(2)	(2)	(2)
25	.04	.18	.34	.56	.64	0.87	0.98	(2)	(2)
50	.02	.10	.18	.33	.40	.64	.87	0.98	(2)
100	.01	.05	.10	.18	.22	.40	.63	.87	(2)

[1] Multiply probability values by 100 to obtain percent chance of exceedence.

[2] Probability greater than 0.99 but less than 1.00.

lowing section shows how weighting of station and regional values can be used to improve estimates of flood magnitude and frequency at both gaged and ungaged sites.

IMPROVED FREQUENCY ESTIMATES BY USE OF WEIGHTING

Gaged Sites

Flood-frequency estimates based on station analysis and regional regression analysis tend to be independent of one another. Therefore, it is to be expected that an estimate of frequency characteristics utilizing both estimates is more likely to be closer to the "true" frequency characteristic than either method by itself. At gaged sites, a weighting procedure is recommended which is contained in guidelines of the Interagency Advisory Committee on Water Data (1982). In this procedure, station analysis is weighted by N, the number of years of actual record, and the regression estimate is weighted by EY, the equivalent years of record of the regression analysis, according to the formula:

$$\mathrm{Log}Q_{wt}=(N\log Q_g+EY\log Q_r)\,/\,(N+EY) \qquad (6)$$

where

Q_{wt} is the weighted estimate of the T-year flood at gaged site, in cubic feet per second;

Q_g is the T-year flood estimate from log-Pearson Type III frequency distribution of annual peaks at gaged site, in cubic feet per second;

Q_r is the regional flood estimate for gaged site, computed from equation 3, in cubic feet per second;

N is the the number of annual peaks used to compute Q_g in years;

EY is the accuracy of the regional flood estimate, in equivalent years from table 1.

The weighting scheme of equation 6 is such that at longer periods of record (N) the station record value (Q_g) carries more and more weight relative to the regional value (Q_r). Appendix 1 gives weighted estimates of the T-year floods for each of the 32 gaged sites used in the regression analysis. At gaged sites, the weighted estimate is considered to be better for design or predictive purposes than either the log-Pearson Type III estimate alone or the regional estimate alone.

Ungaged Sites on Gaged Streams

Estimates for ungaged sites near gaged sites on the same stream can also be improved by weighting techniques. One method (Hannum, 1976) uses a weighted value of the ratio of the weighted and regional estimate at the gaged site to adjust the regional estimate at the ungaged site. This method is suggested when the drainage area at the ungaged site is more than half, but less than twice the drainage area of the gaged site. Equation 7 or 8 can be used to adjust the regional estimate at the ungaged site with the weighted estimate from the gaged site depending on the location of the ungaged site relative to the gaged site:

$$Q_u=Q_{ru}[((Q_{wt}/Q_r)\ \text{-}1)*((2A_g\text{-}A_u)/A_g)\ +1] \quad \text{for site downstream from gage} \qquad (7)$$

$$Q_u=Q_{ru}[((Q_{wt}/Q_r)\ \text{-}1)*((2A_u\text{-}A_g)/A_g)\ +1] \quad \text{for site upstream from gage} \qquad (8)$$

where

Q_u is the adjusted estimate for ungaged site, in cubic feet per second;

Q_{ru} is the regional estimate for ungaged site, in cubic feet per second;

Q_{wt} is the weighted estimate of the T-year flood at the gaged site, in cubic feet per second;

Q_r is the regional estimate at gaged site, in cubic feet per second;

A_u is the drainage area for ungaged site, in square miles;

A_g is the drainage area for gaged site, in square miles.

The weighting schemes for equations 7 and 8 are such that the weighted station value has full weight at the station. At sites less than one-half and greater than twice A_g, the regional value has full weight. An example of the use of this weighting technique is as follows:

1) It is desired to estimate the 100-year flood for station 02320900, New River near Raiford (fig. 1), an ungaged site on a gaged stream. Its DA is 96.0 mi^2; the percent LK is 0.01.There is a gaged site downstream, station 02321000, New River at Lake Butler. Its drainage area is 191 mi^2; the percent LK is 0.03.
2) First, determine for the site of interest the Regional estimate of the 100-year flood from equation 3 and the appropriate values from table 1:

$$Q_T = C_T DA^{B1_T}(LK + 0.6)^{B2_T}$$

$$Q_{100}=584(96.0)^{0.543}(0.03+0.6)^{-0.591}$$

$Q_{100}=Q_{ru}=9{,}150$ cubic feet per second.

3) Since the site is upstream from a gage on the same stream, equation 8 applies. Substituting in equation 8 Q_{ru} obtained above for the ungaged station and Q_{wt} and Q_r for the gaged station as obtained from Appendix 1 for the 100-year flood for New River near Lake Butler:

$$Q_u=Q_{ru}[((Q_{wt}/Q_r) -1)*((2A_u-A_g)/A_g) +1]$$

$$Qu=9{,}150[((18{,}300/13{,}300)-1)*((2(96)-191)/191)+1]$$

$$Qu=9{,}150[(.3759)*(0.0052)+1]$$

$Qu=9{,}150[1.002]=9{,}170$ cubic feet per second.

SUMMARY

Flood-frequency statistics were presented for 25 continuous-record and 7 high-flow partial-record stations in the Suwannee River Water Management District for recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years, using three methods.The first, utilizing station analysis, applied a log-Pearson Type III function to the series of annual peaks. The second method utilized regional relations based on regression of values derived from station analysis with basin parameters.Only two basin parameters, drainage area and lake area, were significant enough to include in final regression equations. Lastly, a weighting method, utilizing both station and regional values, was used to improve estimates of flood frequency statistics at gaged sites. The weighted estimate is considered to be more accurate than either the station estimate or the regression estimate alone.

The regression equation can, of course, be used to estimate flood-frequency characteristics at ungaged as well as gaged sites. If the ungaged site is on a gaged stream, then the estimate for the ungaged site can be improved by transferring information from the gaged site to the ungaged site and applying weighting procedures.

The karstic nature of much of the Suwannee River Water Management District significantly attenuates flood peaks in some streams by providing substantial subsurface storage when river stages are high. Then, springs discharging into rivers may reverse flow temporarily and become sinks.

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APPENDIX

Appendix 1. Station, regional, and weighted T-year flood estimates for the Suwannee River Water Management District

[Discharge-frequency relations for each station are presented as follows: Top line--log-Pearson Type III analysis for the indicated period of systematic record; Middle line--regression equation; Bottom line--weighted or best estimate of T-year flood; mi^2, square miles; ft^3/s, cubic feet per second]

Station number	Name	[1]Years of record		Drainage area (mi^2)	Lake area (percent)	Discharge for recurrence interval in years (ft^3/s)							
		Systematic	Historic			2	5	10	25	50	100	200	500
[2]02313400	Waccasassa River near Bronson	23	--	220	3.50	262	613	950	1510	2030	2640	3360	4490
						697	1380	1960	2820	3580	4740	5330	6720
						283	673	1030	1690	2240	2980	3740	4980
02314200	Tenmile Creek nr Lebanon Station	29	--	26.0	1.00	607	1250	1840	2820	3730	4810	7000	8160
						290	640	954	1450	1900	2590	2980	3870
						577	1170	1730	2540	3360	4300	5870	6880
02315000	Suwannee River nr Benton	19	--	2090	0.24	6390	10400	13300	17200	20300	23600	27000	31700
						7460	13600	18600	25800	31900	41100	45300	55700
						6480	10800	13900	18700	22300	27000	31000	37500
02315200	Deep Creek nr Suwannee Valley	10	--	88.6	0.50	617	777	874	989	1070	1150	1220	1320
						800	1680	2450	3630	4690	6300	7160	9150
						644	928	1110	1530	1750	2180	2530	3120
02315500	Suwannee River at White Springs	69	--	2430	.31	7510	13200	17300	22700	26700	30800	34900	40300
						7870	14300	19400	26800	33100	42600	46800	57500
						7520	13200	17400	23000	27100	31600	35800	41800
02315550	Suwannee River at Suwannee Springs	33	--	2630	.37	7720	12500	15900	20200	23500	26800	30200	34700
						8000	14500	19600	27000	33300	42800	47000	57700
						7740	12700	16200	21000	24600	28800	32600	38300
02317620	Alapaha River nr Jennings	11	--	1680	0	8390	14800	19800	26900	32700	38900	45600	55200
						6420	11900	16200	22600	28000	36300	49200	60700
						8050	14100	19000	25500	31200	38000	47000	57500
[2]02317630	Alapaha River nr Jasper	27	47	1720	0	6920	12300	16500	22200	26900	31800	36900	44200
						7920	14700	20100	28000	34800	45100	49800	61400
						6990	12500	16800	23000	28000	34000	39200	47500
02319000	Withlacoochee River nr Pinetta	63	67	2120	.23	10400	20700	29800	43900	56300	70500	86600	111000
						7580	13900	18900	26200	32400	41700	45900	56500
						10300	20300	29200	42300	54100	67400	81300	103000
02319500	Suwannee River at Ellaville	67	--	6970	.27	19000	33200	44100	59500	72100	85400	99800	120000
						16200	28000	37200	50100	61000	77500	84300	102000
						18900	33000	43800	58800	71300	84700	98200	118000
02320000	Suwannee River at Luraville	10	--	7330	.27	19900	34900	46500	63100	76700	91300	107000	130000
						16700	28900	38300	51600	62700	79600	86600	105000
						19300	33400	44500	59000	71700	86700	98000	118000

Appendix 1. Station, regional, and weighted T-year flood estimates for the Suwannee River Water Management District --Continued

[Discharge-frequency relations for each station are presented as follows: Top line--log-Pearson Type III analysis for the indicated period of systematic record; Middle line--regression equation; Bottom line--weighted or best estimate of T-year flood; mi^2, square miles; ft^3/s, cubic feet per second]

Station number	Name	[1]Years of record		Drainage area (mi^2)	Lake area (percent)	Discharge for recurrence interval in years (ft^3/s)							
		Systematic	Historic			2	5	10	25	50	100	200	500
02320500	Suwannee River at Branford	63	67	7880	.30	17000 17200 17000	28000 29600 28100	36300 39200 36400	47700 52700 48000	56900 64000 57400	66600 80100 67700	76800 88200 77900	91300 107000 92900
02320700	Santa Fe River nr Graham	37	--	94.9	13.26	466 202 446	934 410 878	1310 587 1230	1830 858 1670	2260 1100 2070	2700 1460 2480	3170 1650 2860	3810 2100 3400
02321000	New River nr Lake Butler	25	--	191	.03	2770 1820 2680	5740 3700 5480	8340 5330 7950	12300 7800 11400	15900 9980 14700	19800 13300 18300	24300 15000 21900	31000 19000 27500
02321500	Santa Fe River at Worthington Springs	63	--	575	2.64	4440 1500 4290	8890 2900 8450	12500 3960 11900	17600 5600 16200	21800 7020 20100	26200 9190 23900	30900 10200 27700	37600 12800 33300
[2]02321600	Olustee Creek nr Lulu	19	--	49.1	.04	735 736 735	1480 1590 1490	2130 2360 2160	3110 3560 3200	3970 4650 4100	4920 6300 5220	5990 7210 6300	7580 9280 8050
[2]02321700	Swift Creek nr Lake Butler	25	--	46.0	8.67	486 157 447	790 331 720	1010 482 4770	1320 718 1190	1560 928 1430	1800 1250 1680	2070 1430 1910	2430 1830 2270
[2]02321800	Olustee Creek nr Providence	12	--	163	.88	2820 1010 2440	4320 2060 3730	5380 2960 4770	6770 4320 5930	7840 5530 7080	8940 7360 8380	10100 8310 9400	11600 10500 11100
02322000	Sante Fe River nr High Springs	41	--	868	1.90	3560 2270 3490	7290 4260 7030	10300 5870 9910	14600 8250 13700	18100 10300 17000	21700 13400 20400	25600 14800 23600	30900 18400 28400
02322016	Blues Creek nr Gainesville	10	--	5.12	.05	125 131 126	221 318 240	297 500 335	404 798 507	492 1080 639	587 1510 837	689 2140 1100	835 2830 1440
02322500	Santa Fe River nr Fort White	64	--	1017	1.73	3940 2620 3890	6540 4890 6460	8510 6720 8420	11300 9410 11200	13500 11700 13400	15900 15200 15800	18400 16800 18200	22000 20900 21900
02323000	Suwannee River nr Bell	25	29	9390	0.49	16400 17300 16500	27500 29600 27800	36900 38900 37100	51400 52100 51500	64500 63000 64300	79500 79700 79500	97000 86400 94600	124000 104000 119000

Appendix 1. Station, regional, and weighted T-year flood estimates for the Suwannee River Water Management District --Continued

[Discharge-frequency relations for each station are presented as follows: Top line--log-Pearson Type III analysis for the indicated period of systematic record; Middle line--regression equation; Bottom line--weighted or best estimate of T-year flood; mi^2, square miles; ft^3/s, cubic feet per second]

Station number	Name	[1]Years of record		Drainage area (mi^2)	Lake area (percent)	Discharge for recurrence interval in years (ft^3/s)							
		Systematic	Historic			2	5	10	25	50	100	200	500
02323500	Suwannee River nr Wilcox	53	--	9640	.54	20900	31700	39600	50200	58600	67500	76900	90100
						17200	29300	38500	51500	62300	78700	85300	103000
						20800	31600	39500	50300	58900	68600	77800	91700
02324000	Steinhatchee River nr Cross City	44	--	350	.53	2030	3940	5550	7990	10100	12400	15000	19000
						1950	3840	5440	7820	9910	13100	14700	18400
						2030	3930	5540	7970	10100	12500	15000	18900
02324400	Fenholloway River nr Foley	39	--	60.0	.04	368	762	1140	1790	2410	3180	4120	5680
						840	1800	2660	3990	5200	7020	8020	10300
						383	810	1210	1960	2630	3640	4500	6290
02324500	Fenholloway River at Foley	46	--	120	.37	570	1180	1760	2770	3740	4940	6420	8890
						1050	2170	3150	4650	5980	8000	9070	11500
						585	1220	1820	2910	3920	5220	6720	9240
02325000	Fenholloway River nr Perry	29	--	160	.42	687	1090	1380	1780	2090	2420	2770	3250
						1230	2520	3630	5310	6810	9080	10300	13000
						713	1180	1510	2090	2490	3040	3580	4390
02326000	Econfina River nr Perry	44	--	198	.85	643	1190	1600	2140	2540	2950	3360	3910
						1160	2350	3360	4890	6230	8280	9330	11800
						660	1240	1680	2330	2780	3340	3870	4630
[2]02326250	Aucilla River nr Aucilla	11	--	345	2.00	1980	2990	3700	4640	5370	6120	6890	7960
						1210	2360	3320	4760	6020	7930	8870	11100
						1840	2840	3620	4680	5560	6710	7600	9160
[2]02326300	Little Aucilla River nr Greenville	14	--	90.7	3.12	437	796	1090	1510	1860	2250	2680	3300
						411	847	1220	1800	2320	3100	3520	4490
						434	805	1110	1580	1970	2480	2930	2690
02326500	Aucilla River at Lamont	38	--	747	3.00	1990	5020	7680	11600	14800	18200	21800	26600
						1670	3150	4350	6120	7630	9950	11000	13700
						1970	4850	7370	10800	13700	16800	19600	23700
02326512	Aucilla River nr Scanlon	20	--	805	3.00	2590	4380	5750	7700	9290	11000	12900	15500
						1760	3300	4550	6380	7960	10400	11500	14300
						2500	4220	5580	7420	9010	10800	12500	15100

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[1] Years of historic record include the period of systematic measurements as well as the intervening years to major flood events.

[2] Peak-flow partial-record gaging station.