SURFACE WATER

This sheet describes the surface-water system in the basin. Discharge, base-flow, and flow-duration data for the Great Egg Harbor River and the results of low-flow correlations for 11 partial-record sites located throughout the basin are discussed. Climate data, including precipitation, temperature, and estimates of potential evapotranspiration, are included.

Discharge at Gaging Station

The surface-water system in the study area consists of the Great Egg Harbor River and its many tributaries, lakes, and wetland areas. From its headwaters in Berlin, N.J., the Great Egg Harbor River flows about 50 miles to Great Egg Harbor Bay and the Atlantic Ocean. It is a gaining river, deriving streamflow from the ground-water system.

The USGS has maintained a streamflow-gaging station on the Great Egg Harbor River near Folsom, N.J. (01411000), since 1927 (fig. 3-1). Although this is the only streamflow-gaging station in the study area, several partial-record crest-stage stations and partial-record low-flow stations are also present within the basin. Figure 3-2 shows the minimum, mean, and maximum monthly discharge for the Great Egg Harbor River near Folsom. The minimum, mean, and maximum daily discharge, and the 7-day, 2-year and 7-day, 10-year low-flow discharges for the period of record are listed in table 3-1.

A base-flow-separation technique described by Pettyjohn and Henning (1979) makes use of a computer program to divide stream discharge into direct-runoff and base-flow components. Direct runoff is the surface-water contribution to streamflow and base flow is the ground-water contribution. The computer program can estimate base flow and direct runoff by using three different methods. Although none of these three methods yields a better estimate of base flow than the others, the same method should be used consistently. For this study the sliding-interval analysis was used to perform the base-flow separation. Results of this analysis show that the annual base flow of the Great Egg Harbor River ranged from a low of 39 ft^3/s in 1931 to a high of 112 ft^3/s in 1973, with a mean of 73 ft^3/s. On a percentage basis, the base-flow component ranged from 77 percent in 1938 to 89 percent of total flow in 1985, with a mean of 85 percent. Annual discharge, direct runoff, and base flow in the Great Egg Harbor River are shown in figure 3-3.

A flow-duration curve is a cumulative-frequency curve showing the percentage of time that any specified discharge is exceeded (Langbein and Iseri, 1960, p. 11). The shape of the curve is determined by the hydrologic and geologic characteristics of the drainage basin. For example, a curve with a flat slope reveals the presence of substantial ground-water and surface-water storage, which tends to equalize the flow, whereas a steep curve is indicative of a stream whose flow is derived largely from direct runoff. Figure 3-4 shows the flow-duration curve for the Great Egg Harbor River at Folsom during 1927-88. The median discharge, seen on the flow-duration curve, is approximately 74 ft^3/s, the 1-percent-exceedance discharge is 270 ft^3/s, and the 99-percent-exceedance discharge is 20.5 ft^3/s.

Discharge at Low-Flow Partial-Record Stations

The magnitude and frequency of available streamflow commonly are determined from low-flow-frequency and flow-duration data by correlating low-flow discharge at the partial-record station with the same-time discharge at the index gaging station. The low-flow correlations reported here were developed by using the MOVE.1 (Maintenance of Variance Extension, Type 1) method, which makes use of geometric means to eliminate the bias of ordinary least-squares regression (Hirsch, 1982). An example of a low-flow correlation is shown in figure 3-5. The "best-fit" line is drawn through the data points that represent the measured discharge at the partial record station, QP_M, plotted against the mean daily discharge measured at the index gaging station, QI. The equation of this line, $QP_R = (0.06796)QI^{(1.0563)}$, can then be used to estimate or "predict" the discharge at the partial-record station, QP_R, for any time the discharge is known at the index gaging station. The correlation coefficient is a number less than 1 that is used to measure the degree of association between two variables, QI and QP_R. The closer the correlation coefficient is to 1, the more reliable the predicted discharge, QP_R.

Table 3-1.--Summary of discharge statistics for gaging stations in and near the Great Egg Harbor River basin

Gaging-station number	Gaging-station name	Discharge (cubic feet per second) 7-day 2-year	7-day 10-year	Maximum	Mean	Minimum	Area (square miles)
01409400	Mullica River near Batsto, N.J.	30	15	1,840	109.	7.0	46.7
01411000	Great Egg Harbor River at Folsom, N.J.	32	22	1,440	86.7	15.	57.1
01411500	Maurice River at Norma, N.J.	59	37	1,360	168.	23.	113.0
01475000	Mantua Creek at Pitman, N.J.	6.1	4.1	470	11.5	2.6	6.05

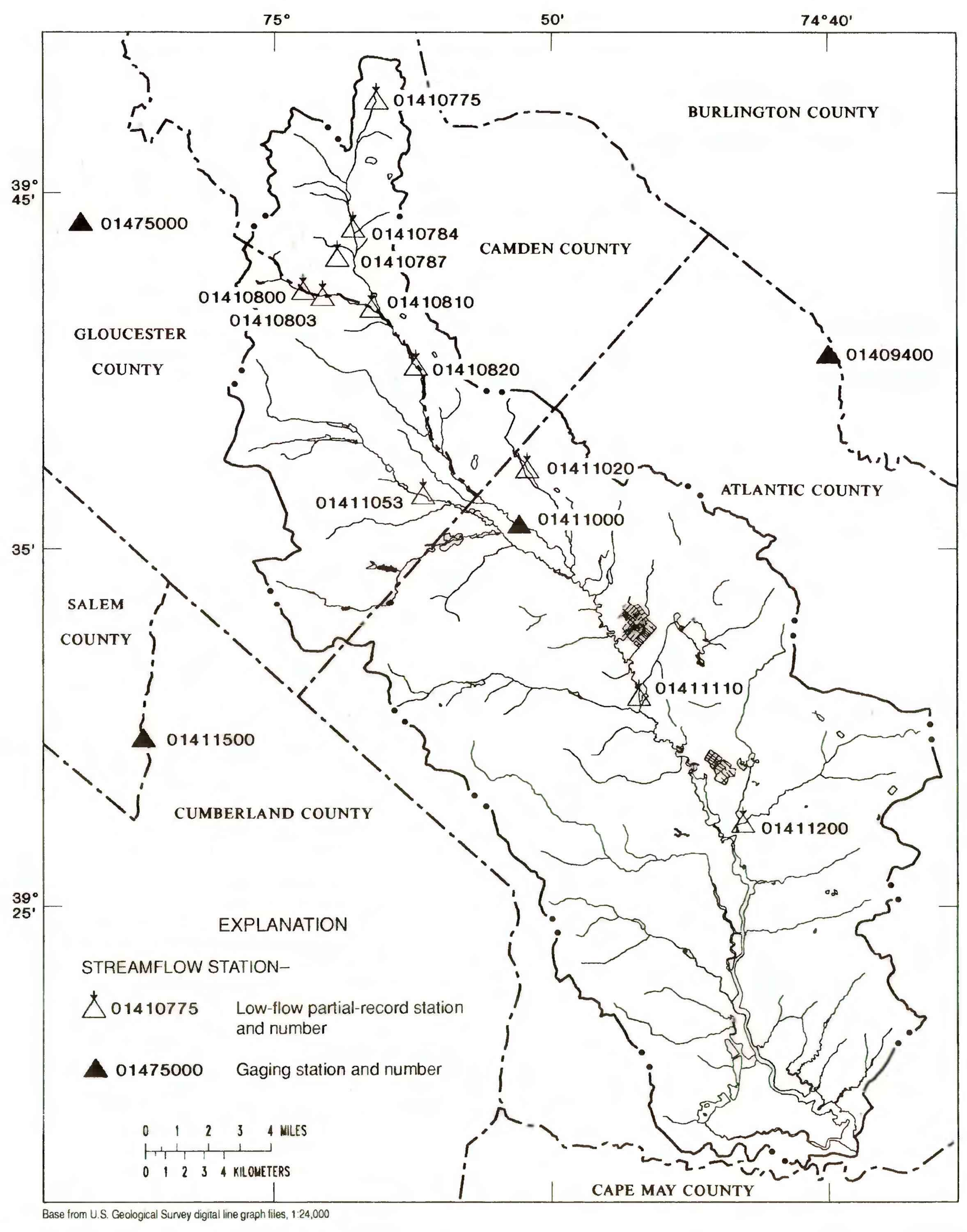

Figure 3-1.--Locations of streamflow-gaging stations and low-flow partial-record stations in and near the Great Egg Harbor River basin study area.

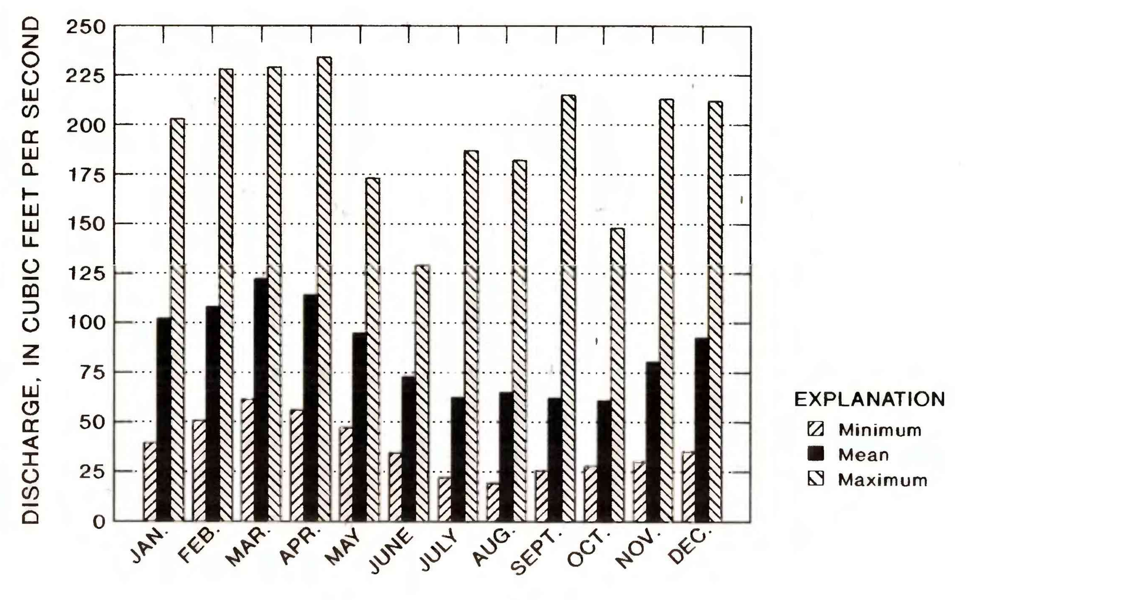

Figure 3-2.--Minimum, mean, and maximum monthly discharge at Great Egg Harbor River at Folsom, N.J.

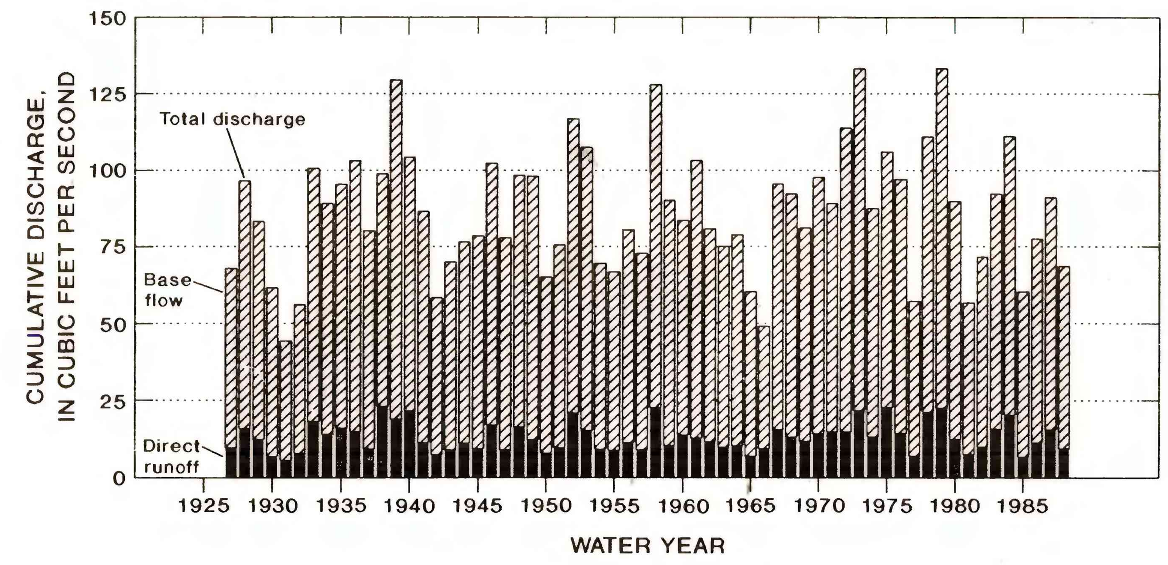

Figure 3-3.--Total annual discharge, base flow, and direct runoff at Great Egg Harbor River at Folsom, N.J.

Table 3-2.--Correlation equations relating low flow at partial-record stations to low flow at gaging stations in and near the Great Egg Harbor River basin

[QP_R, predicted discharge; QI, index station discharge; N.J., New Jersey; trib., tributary]

Low-flow station number		Drainage area (square miles)	Index-station number	Correlation Coefficient	Equation	Predicted discharge (QP_R) (cubic feet per second) 7-day 2-year	7-day 10-year	Mean annual	Mean base flow
01410775	Great Egg Harbor River	1.88	01409400	0.6539	$QP_R = 0.00874\ QI^{(0.9951)}$	0.258	0.129	0.93	
	at Berlin, N.J.		01411000	.6475	$QP_R = .00187\ QI^{(1.3536)}$	.204	.123	.79	0.62
			01475000	.7839	$QP_R = .00561\ QI^{(2.1396)}$	.269	.115	1.04	
01410784	Great Egg Harbor River	15.1	01409400	.8378	$QP_R = .0982\ QI^{(1.1118)}$	4.309	1.994	18.09	
	near Sicklerville, N.J.		01411000	.8497	$QP_R = .02029\ QI^{(1.4943)}$	3.601	2.057	15.97	12.35
			01411500	.7773	$QP_R = .01499\ QI^{(1.3552)}$	3.765	2.000	15.55	
01410787	Great Egg Harbor River	1.64	01409400	.9613	$QP_R = .0004586\ QI^{(1.6462)}$	.124	.04	1.04	
	trib. at Sicklerville, N.J.		01041100	.9432	$QP_R = .0000641\ QI^{(2.1226)}$	.10	.045	.83	.58
			01411500	.9108	$QP_R = .000069\ QI^{(1.7947)}$	.104	.045	.68	
01410800	Fourmile Branch near	5.34	01409400	.9008	$QP_R = .06678\ QI^{(0.9404)}$	1.636	.853	5.5	
	Williamstown, N.J.		01411000	.8833	$QP_R = .02596\ QI^{(1.1879)}$	1.593	1.021	5.21	4.24
			01411500	.8426	$QP_R = .04092\ QI^{(0.9172)}$	1.723	1.123	4.5	
01410803	Fourmile Branch at	6.22	01409400	.9695	$QP_R = .21258\ QI^{(0.778)}$	2.997	1.748	8.18	
	Winslow Crossing, N.J.		01041100	.9567	$QP_R = .06796\ QI^{(1.0563)}$	2.643	1.779	7.57	6.32
			01411500	.9445	$QP_R = .04709\ QI^{(0.9803)}$	2.564	1.623	7.15	
01410810	Fourmile Branch at	7.74	01409400	.8594	$QP_R = 1.128\ QI^{(0.5018)}$	6.216	4.39	11.87	
	New Brooklyn, N.J.		01411000	.9354	$QP_R = .44188\ QI^{(0.7268)}$	5.486	4.178	11.32	9.99
			01411500	.8297	$QP_R = .64083\ QI^{(0.5567)}$	6.202	4.783	11.11	
01410820	Great Egg Harbor River	37.3	01409400	.946	$QP_R = 1.47432\ QI^{(0.7714)}$	20.323	11.907	54.98	
	near Blue Anchor, N.J.		01411000	.9736	$QP_R = .61092\ QI^{(0.9916)}$	18.99	13.097	51.02	43.02
			01411500	.9485	$QP_R = .48378\ QI^{(0.8975)}$	18.795	12.364	48.08	
01411020	Penny Pot Stream near	5.35	01409400	.7992	$QP_R = .00196\ QI^{(1.6943)}$	.623	.193	5.55	
	Folsom, N.J.		01411000	.8584	$QP_R = .0002507\ QI^{(2.2388)}$	.587	.254	5.47	3.72
			01411500	.7502	$QP_R = .0002011\ QI^{(1.9766)}$	.636	.253	5.03	
01411053	Hospitality Branch at	20.0	01409400	.798	$QP_R = .21165\ QI^{(1.1512)}$	10.619	4.781	46.89	
	Berryland, N.J.		01411000	.9061	$QP_R = .06917\ QI^{(1.4026)}$	8.934	5.282	36.16	28.41
			01411500	.8521	$QP_R = .0421\ QI^{(1.3064)}$	8.666	4.71	34.0	
01411110	Great Egg Harbor River	154.0	01409400	.9279	$QP_R = 4.15436\ QI^{(0.9162)}$	93.729	49.667	305.66	
	at Weymouth, N.J.		01411000	.9475	$QP_R = 1.96544\ QI^{(1.0842)}$	84.209	56.095	248.13	205.91
			01411500	.9643	$QP_R = .53975\ QI^{(1.2071)}$	74.107	42.192	262.09	
01411200	Babcock Creek at	20.0	01409400	.9394	$QP_R = .12487\ QI^{(1.1399)}$	6.028	2.735	26.23	
	May's Landing, N.J.		01411000	.9442	$QP_R = .02658\ QI^{(1.5221)}$	5.193	2.936	23.67	18.23
			01411500	.8202	$QP_R = .02833\ QI^{(1.2792)}$	5.22	2.873	19.91	

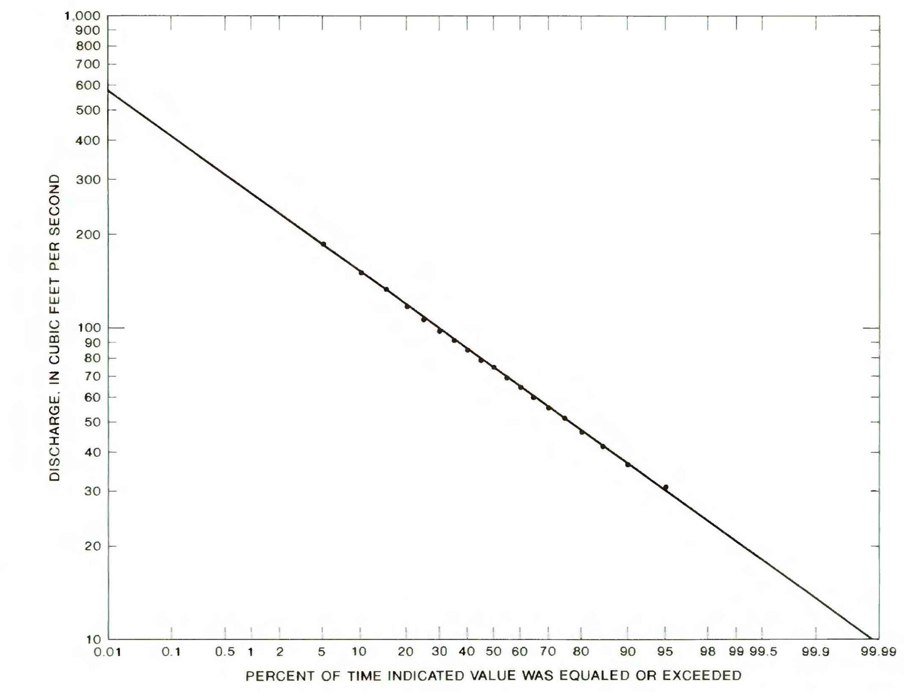

Figure 3-4.--Flow-duration curve for Great Egg Harbor River at Folsom, N.J.

Precipitation, Discharge, and Evapotranspiration

Precipitation usually is the only source of water to a surface-water basin. Figure 3-7 shows annual precipitation at the Hammonton weather station in Atlantic County for water years[2] 1931 through 1988, measured by the National Oceanic and Atmospheric Administration (1928-88, 1982). For periods for which data from the Hammonton station were missing, precipitation values were estimated by using data from several other weather stations near the study area. The annual precipitation ranged from a minimum of 31.92 inches in 1966 to a maximum of 65.07 inches in 1958, with a mean of 45.29 inches per year. Minimum, mean, and maximum monthly precipitation values are shown in figure 3-8A. Mean monthly precipitation was 3.78 inches and ranged from a minimum of 0.08 inches in September to a maximum of 14.01 inches in July.

A large percentage of water leaves the basin through stream discharge and evapotranspiration. The annual discharge of the Great Egg Harbor River ranged from a low of 10.56 inches in 1931 to a high of 31.67 inches in 1973 (fig. 3-7). The mean annual discharge was 20.52 inches per year, or 45 percent of the mean annual precipitation that fell on the basin. Figure 3-8B shows the minimum, mean, and maximum monthly air temperature at the Atlantic City airport during the reference period 1951-80 (National Oceanic and Atmospheric Administration, 1982). The mean monthly air-temperature values, latitude, and month were used in the Thornthwaite equation to estimate potential evapotranspiration (fig. 3-8) (Dunne and Leopold, 1978, p. 137-138). This is the amount of water loss that occurs if there is at no time a deficiency of water in the soil for the vegetation to use. The calculated annual potential evapotranspiration from the basin is 27.56 inches per year.

[2] Water year, typically used in hydrologic analyses, is the 12-month period from October 1 through September 30. It is designated by the calendar year in which it ends.

Eleven low-flow partial-record stations in the basin were selected for low-flow-correlation analyses. Three relations were developed for each partial-record station chosen--one to the gaging station in the study area and two to gaging stations in adjacent basins. The results of the three analyses were compared for discrepancies in order to minimize error. The locations of the gaging stations and low-flow stations are shown in figure 3-1. From these relations, the mean discharge; 7-day, 2-year and 7-day, 10-year low-flow discharges; and mean base flow for each partial-record station were calculated. These statistics, along with the predicting equations, are listed in table 3-2. An example of the use of a low-flow correlation equation is given below.

To convert figure 3-3, the graph of annual discharge of the Great Egg Harbor River at Folsom (01411000), to a graph of the annual discharge of Babcock Creek at May's Landing (01411200), use the low-flow correlation equation for the station given in table 3-2. This equation is

$$QP_R = 0.02658\ QI^{(1.5221)} .$$

By substituting the various discharge measurements of the Great Egg Harbor River at Folsom (25,50,75....) from figure 3-3 for QI in the above equation, it is possible to calculate QP_R, the range of discharges of Babcock Creek at May's Landing. Therefore, when QI = 25,

$$QP_R = 0.02658\ (25)^{(1.5221)}, \text{ and}$$

$$QP_R = 3.57\ ft^3/s .$$

By inserting the base-flow value for QI into this equation, the average base flow at each partial-record station in table 3-2 also can be calculated.

The low-flow data also can be used to estimate the n-day, t-year low-flow discharges. As an example, the 7-day, 10-year low-flow discharges as a function of drainage area for the 11 partial-record low-flow stations and 4 index stations are shown in figure 3-6. The line drawn through the data points is the "best-fit" line. In sub-basins for which the size of the drainage area is known, the 7-day, 10-year low-flow discharge can be estimated by using this "best fit" line. For example, the 7-day, 10-year low-flow discharge for a stream draining a basin area of about 4 mi^2 would be approximately 0.5 ft^3/s.

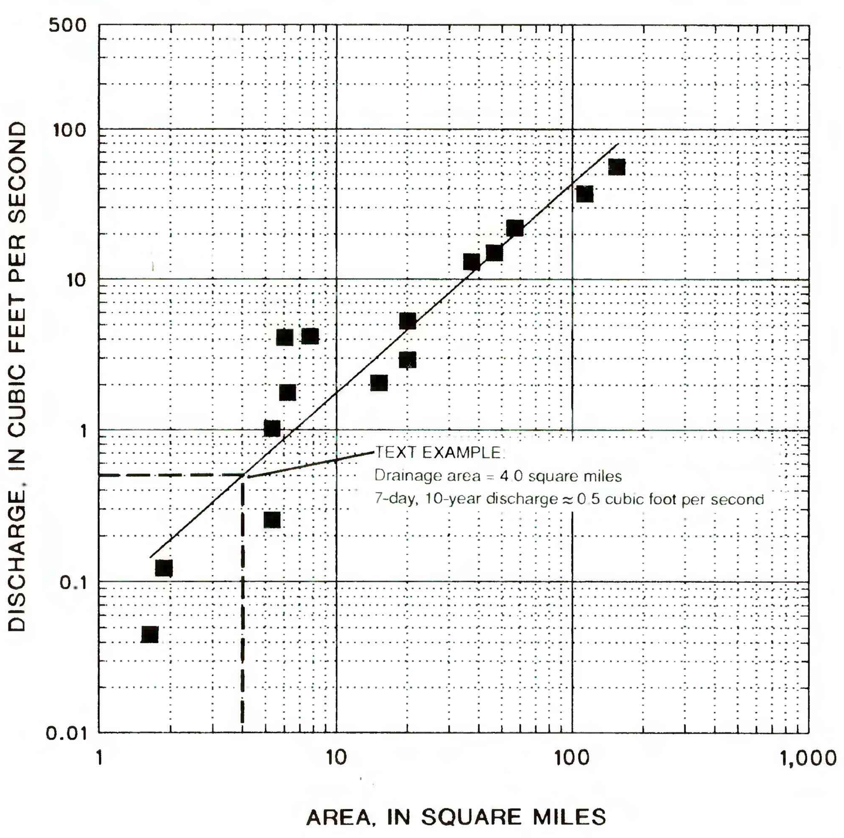

Figure 3-6.--Low-flow (7-day, 10-year) discharge as a function of drainage area for the Great Egg Harbor River basin study area.

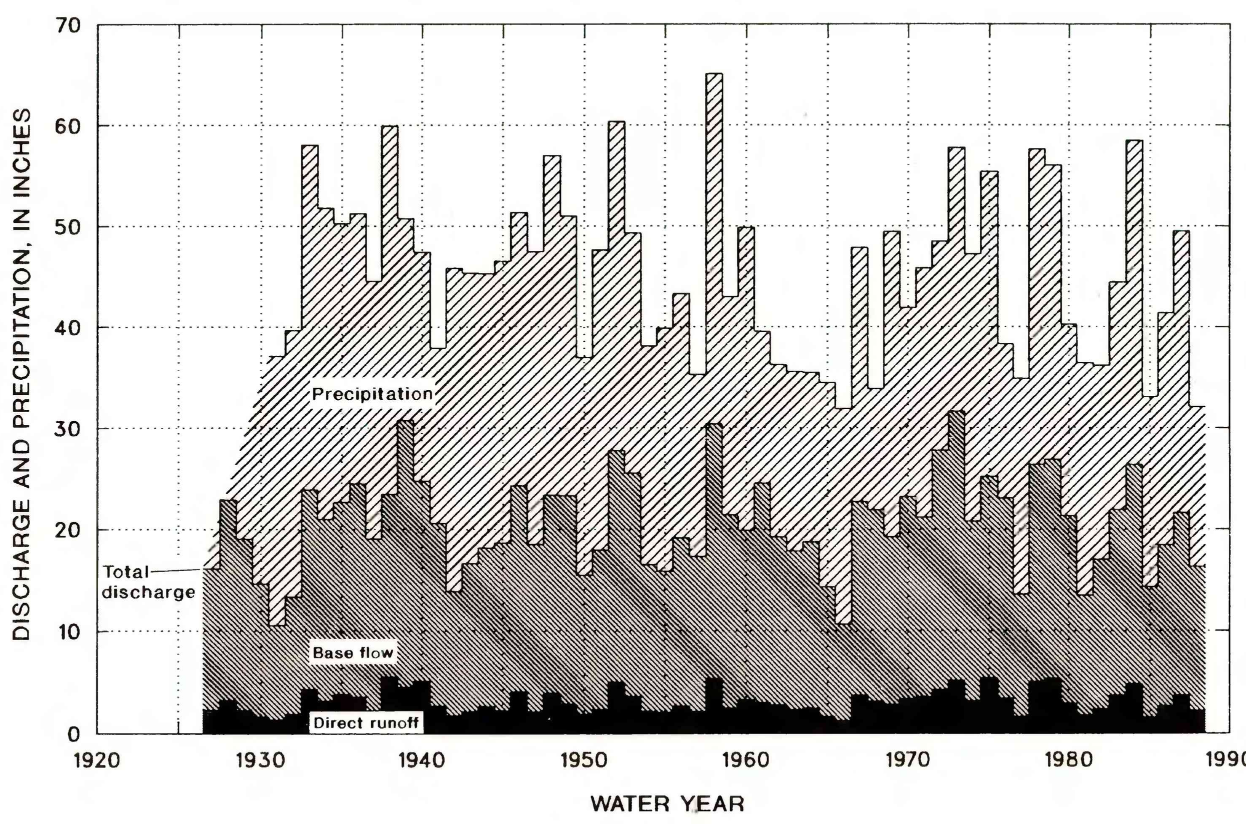

Figure 3-7.--Annual precipitation at Hammonton, N.J.; and total discharge and base flow of Great Egg Harbor River at Folsom, N.J., water years 1927-88.

QI - Discharge, measured in cubic feet per second (ft^3/s), at Great Egg Harbor River at Folsom, New Jersey (01411000)

QP_M - Discharge, measured in ft^3/s, at Fourmile Branch at Winslow Crossing, New Jersey (01410803)

DATE	QI	QP_M
1972/04/27	140	13.30
1973/05/07	122	10.90
1973/10/16	40	3.26
1974/04/19	104	8.91
1974/06/08	73	6.83
1974/09/19	52	4.51
1975/09/09	52	6.73
1976/05/10	92	7.05
1976/09/22	33	2.73
1977/08/30	27	2.23
1978/09/14	50	3.68
1980/07/02	87	5.85

Equation is $QP_R = (0.06796)\ QI^{(1.0563)}$

where
QI - Index station discharge
QP_R - Predicted discharge
QP_M - Discharge measured at the partial-record station.

CORRELATION COEFFICIENT = 0.9567

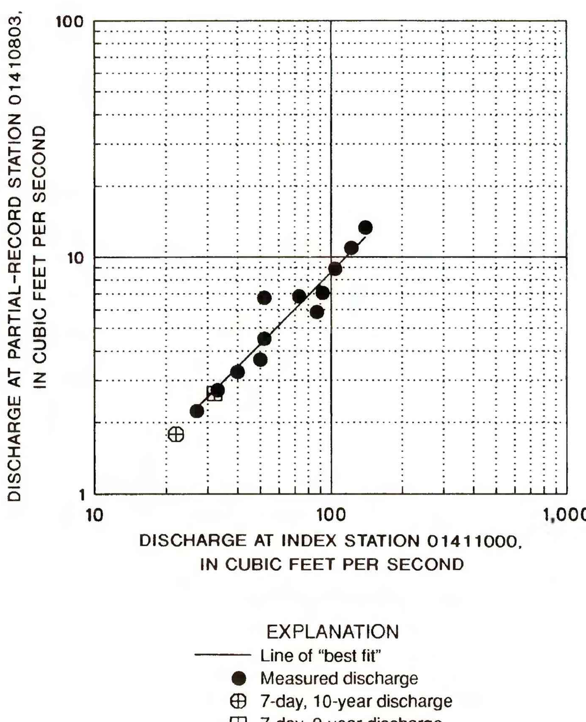

Figure 3-5.--Low-flow correlation of Fourmile Branch at Winslow Crossing, N.J. (01410803) and Great Egg Harbor River at Folsom, N.J. (01411000).

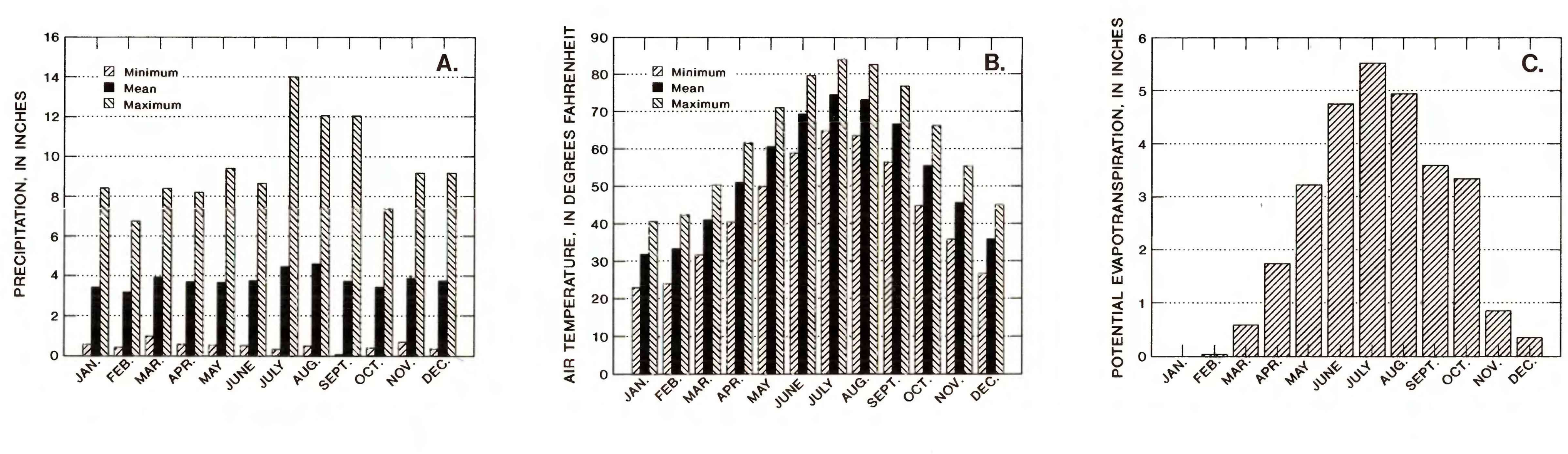

Figure 3-8.--Minimum, mean, and maximum monthly (a) precipitation and (b) temperature, and (c) monthly potential evapotranspiration at Hammonton, N.J.

WATER RESOURCES OF THE UNCONFINED AQUIFER SYSTEM OF THE GREAT EGG HARBOR RIVER BASIN, NEW JERSEY, 1989-90

By
Martha K. Watt and Melissa L. Johnson
1992