Users Manual for Program PEAKFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines

U.S. Geological Survey

Water-Resources Investigations Report _____

DRAFT

SUBJECT TO REVISION

Users Manual for Program PEAKFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines

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U.S. GEOLOGICAL SURVEY
WATER-RESOURCES INVESTIGATIONS REPORT _____

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot (ft^3)	0.0283	cubic meter (m^3)
cubic foot per second (ft^3/s)	0.0283	cubic meter per second (m^3/s)

SYMBOLS

Symbol, explanation:

c_m, centroidal position occupied by m-th largest observed peak

$\overline{G}$, generalized skew coefficient

$\tilde{G}$, historically-adjusted skew coefficient

$\tilde{G}'$, skew coefficient of frequency curve passing through $\tilde{Q}^*_{0.50}$, $\tilde{Q}^*_{0.10}$, and $\tilde{Q}^*_{0.01}$

$|G|$, absolute value of the station skew coefficient

G, station skew coefficient

G_W, Bulletin 17B skew coefficient estimate used in final log-Pearson Type III frequency curve

g, desired skew coefficient

H, historical period length

K, confidence coefficient

K_N, 10 percent significance level outlier tests K_N values for a normal distribution for sample size N

$k_{g,\,p}$, Pearson Type III standardized ordinates for desired skew (g) and exceedance probability (p)

k_p, standard normal frequency factor for probability p

$k_{p'}$, frequency factor after adjustment with Student-t

$\tilde{M}$, historically-weighted logarithmic mean

$\hat{M}$, Bulletin 17B mean

$\tilde{M}'$, mean of frequency curve passing through $\tilde{Q}^*_{0.50}$, $\tilde{Q}^*_{0.10}$, and $\tilde{Q}^*_{0.01}$

$\tilde{m}$, historically-weighted rank of the m-th largest observed peak

m, rank of the m-th largest observed peak

MSE, mean-square error (standard error of estimate squared)

$MSE_{\overline{G}}$, mean-square error of generalized skew coefficient

MSE_G, mean-square error of station skew coefficient

$\tilde{N}$, effective number of peaks above flood base, Q_O

N_{BB}, number of peaks below the flood base, including any zeros and low outliers

N_{HO}, number of high outliers

N_{HP}, number of historic peaks

N_S, number of systematic peaks

N_X, number of peaks between Q_O and Q_H

n, sample size from normal population of flood logarithms

$\tilde{P}_m$, probability plotting position of the m-th ranked observed peak

$\tilde{P}_O$, estimated probability of exceeding the flood base

p, exceedance probability

p′, normal exceedance probability corresponding to $k_{p'}$

$\tilde{Q}$, conditional frequency curve describing only those peaks above a base

$\tilde{Q}^*$, intermediate unconditional frequency curve

$\hat{Q}$, final Bulletin 17B-estimated frequency curve

Q_H, historical threshold streamflow

Q_O, flood base streamflow

$\hat{Q}_s$, systematic frequency curve

S, sample logarithmic standard deviation

$\hat{S}$, Bulletin 17B standard deviation

$\tilde{S}$, historically-weighted logarithmic standard deviation

$\tilde{S}'$, standard deviation of frequency curve passing through $\tilde{Q}^*_{0.50}$, $\tilde{Q}^*_{0.10}$, and $\tilde{Q}^*_{0.01}$

$t_{n-1,\,p}$, student's t with n-1 degrees of freedom and exceedance probability p

W, weight given to systematic peaks

X′, logarithmic magnitudes of historic peaks and high outliers

$\overline{X}$, sample logarithmic mean

X, logarithmic magnitudes of systematic peaks between Q_O and Q_H

α, confidence limit

γ, population skew coefficient

μ, population mean

σ, population standard deviation

Note: All symbols and explanations from Interagency Advisory Committee on Water Data (1982) and Lepkin and others (1979).

Users Manual for Program PEAKFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines

By Wilbert O. Thomas, Jr., Alan M. Lumb, Kathleen M. Flynn, *and* William H. Kirby

Abstract

Estimates of flood flows having given recurrence intervals or probabilities of exceedance are needed for design of hydraulic structures and floodplain management. Program PEAKFQ provides estimates of instantaneous annual peak flows having recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years (exceedance probabilities of 0.50, 0.20, 0.10, 0.04, 0.02, 0.01, 0.005, and 0.002, respectively). As implemented in program PEAKFQ, the Pearson Type III frequency distribution is fit to the logarithms of instantaneous annual peak flows following Bulletin 17B guidelines of the Interagency Advisory Committee on Water Data. The parameters of the Pearson Type III frequency curve are estimated by the logarithmic sample moments (mean, standard deviation, and coefficient of skewness). This documentation provides an overview of the computational procedures in program PEAKFQ, provides a description of the program menus, and provides an example of the output from the program.

INTRODUCTION

Program PEAKFQ performs statistical flood-frequency analyses of annual-peak flows following procedures recommended in Bulletin 17B of the Interagency Advisory Committee on Water Data (1982). The Bulletin 17B guidelines contain a complete and definitive description of the recommended procedures. The following sections document implementation of the Bulletin 17B guidelines in program PEAKFQ. This information is intended to assist the user with options to the program.

The Bulletin 17B procedures characterize the magnitude and frequency of instantaneous annual peak flows at gaging stations where these data are observed. The magnitudes of the annual events are assumed to be independent random variables following a log-Pearson Type III probability distribution; that is, the logarithms of the peak flows follow a Pearson Type III distribution. This distribution defines the probability that any single annual peak will exceed a specified streamflow. Given this annual probability, other probabilities, such as the probability that a future design period will be free of exceedances, can be calculated by standard methods. By considering only annual events, the Bulletin 17B guidelines reduce the peak-streamflow frequency problem to the problem of estimating the needed design floods using the record of annual peak flows at the site. The parameters of the Pearson Type III frequency curve are estimated from the logarithmic sample moments (mean, standard deviation, and coefficient of skewness). The needed design floods are estimated from this frequency curve computed by program PEAKFQ.

PEAK STREAMFLOW RECORDS

The peak data fall into two classes: systematic and historic. The systematic record includes all annual peaks observed in the course of one or more systematic gaging programs at the site. In a systematic gaging program, the annual peak is observed (or estimated) for each year of the program. Several systematic records at one site can be combined, provided that the hydrologic conditions during the periods of record are comparable. The gaps between distinct systematic-record periods can be ignored, provided that the lack of record in the interim was unrelated to the hydrologic conditions. Thus, if a flood record was interrupted for lack of funds for data collection, the interruption could be ignored and the available data could be used as if no interruption had occurred. On the other hand, if the record was interrupted because of prolonged

drought or excessive floodings, the interruption should not be ignored but rather should be used, if possible, as evidence for adding one or more estimated peaks to the systematic record. Thus, the systematic record is intended to constitute an unbiased and representative sample of the population of all possible annual peaks at the site.

In contrast to the systematic record, the historic record consists of annual peaks that would not have been observed except for evidence indicating their unusual magnitude. Flood information acquired from old newspaper articles, letters, personal recollections, and other historical sources almost invariably refer to floods of noteworthy, and hence, extraordinary size. Similarly, the very existence of an indirect streamflow determination outside a period of systematic record suggests that the determination was made because an unusually large streamflow had occurred. Thus, historic records, by the conditions of their collection, form a biased and unrepresentative sample of flood experience. Despite this bias, however, the historic record can be used to supplement the systematic record provided that all historic peaks above some historic threshold have been recorded.

The systematic record may contain one or more peaks for which historic information is available or which exceed the smaller historic peaks. Such peaks are called high outliers. They are used as part of the systematic record but also are treated like historic peaks in the historic-record adjustment procedure.

The U.S. Geological Survey maintains a peak flow data base. In the past, these data were stored in the WATSTORE peak flow file. The data are now maintained in the National Water Information System data base. Qualification codes may be assigned to some peaks, identifying (1) basin or environmental conditions that may have affected the magnitude or accuracy of the streamflow value or (2) historical peaks. For example, if the peak is too small to measure, then an estimate of lower bound on the magnitude may be stored (this might occur during a drought period when the actual peak was less than the gage could record). In this case, the peak-flow file would contain a qualification code of 4 (Lepkin and others, 1979) associated with the peak. Note that an individual peak flow can have more than one qualification code associated with it. Table 1 contains a description of the qualification codes that can be found in the peak-flow file. To make things interesting, peakfq recognizes a subset of peak-flow-file qualification codes and uses a different code to identify these peaks. Table 1a defines the correspondence between the peakfq and peak-flow-file qualification codes and briefly describes how the peakfq program handles the associated peaks.

Table 1. Streamflow-qualification codes for peak streamflow

Streamflow qualification code	Definition
1	Streamflow is a maximum daily average.
2	Streamflow is an estimate.
3	Streamflow affected by dam failure.
4	Streamflow less than indicated value, which is minimum recordable value at this site.
5	Streamflow affected to an unknown degree by regulation or diversion
6	Streamflow affected by regulation. At least 10 percent of basin controlled by reservoirs.
7	Streamflow is an historic peak.
8	Streamflow actually greater than indicated value.
9	Streamflow due to snow melt, hurricane, ice-jam or debris dam breakup.
A	Year of occurrence is unknown or not exact.
B	Month or day of occurrence is unknown or not exact.
C	All or part of the record affected by urbanization, mining, agricultural changes, channelization, or other activity. The urbanized basins contain at least 10 percent impervious cover.
E	Only peak streamflow recorded for this year.

Table 1a. Correspondence between qualification codes in the peak-flow file and in the peakfq program and how peakfq handles the associated peaks

peakfq program	Peak-flow file	Description
D	3	dam failure
		Peak excluded from analysis.
X	3 and 8	dam failure and discharge greater than stated
		Peak excluded from analysis.
K	6 or C	known effect of regulation or urbanization
		By default, peakfq excludes peaks with qualification codes of 6 or C. The user may include these peaks by specifying YES under the "Include urban-regulated peaks" column on the Modify/Options menu.
H	7	historic peak
		By default, peakfq will include or exclude peaks with qualification code of 7 based on the Bulletin 17-B computed high-outlier threshold and the length of the historic period. The user can modify these criteria by specifying the "Historic return period" and "Discharge threshold" on the Modify/Historic menu and the "Low outlier criteria" on the Modify/Low menu.
-	1, 2, 4, 5, 9, A, B, or E	maximum daily average, estimate, less than indicated value, unknown regulation or diversion, snowmelt/hurricane/ice-jam/debris dam breakup, year unknown or not exact, month or day unknown
		Peak always included in analysis.

PRINCIPLES OF COMPUTATION

The Bulletin 17B computational analysis is illustrated in figure 1. The following sections provide an overview of the major computational steps.

FIGURE 1 NEAR HERE

Systematic Record Analysis

The systematic record analysis involves the computation of the mean, standard deviation and coefficient of skewness ($\overline{X}$, S, and G, respectively) of the common logarithms of the annual peak flows in the systematic record. At some sites, annual peaks of magnitude zero can occur; more generally, the annual peak may occasionally fall below or be equal to some lower limit of measurement called the gage base (which may be zero). To account for this possibility, the number of peaks below the gage base is computed in addition to the mean, standard deviation, and skewness of the logarithms of the above-base systematic peaks. The statistics of the systematic peaks and the number of peaks below the gage base are used to compute the systematic record frequency curve as follows:

$$\log \hat{Q}_{s,\,p} = \overline{X} + S\, k_{G,\,p} \qquad (1)$$

where $\hat{Q}_{s,\,p}$ = systematic frequency curve at exceedance probability p, and

$k_{G,\,p}$ = the Pearson Type III standardized ordinates for station skew (G) and exceedance probability p.

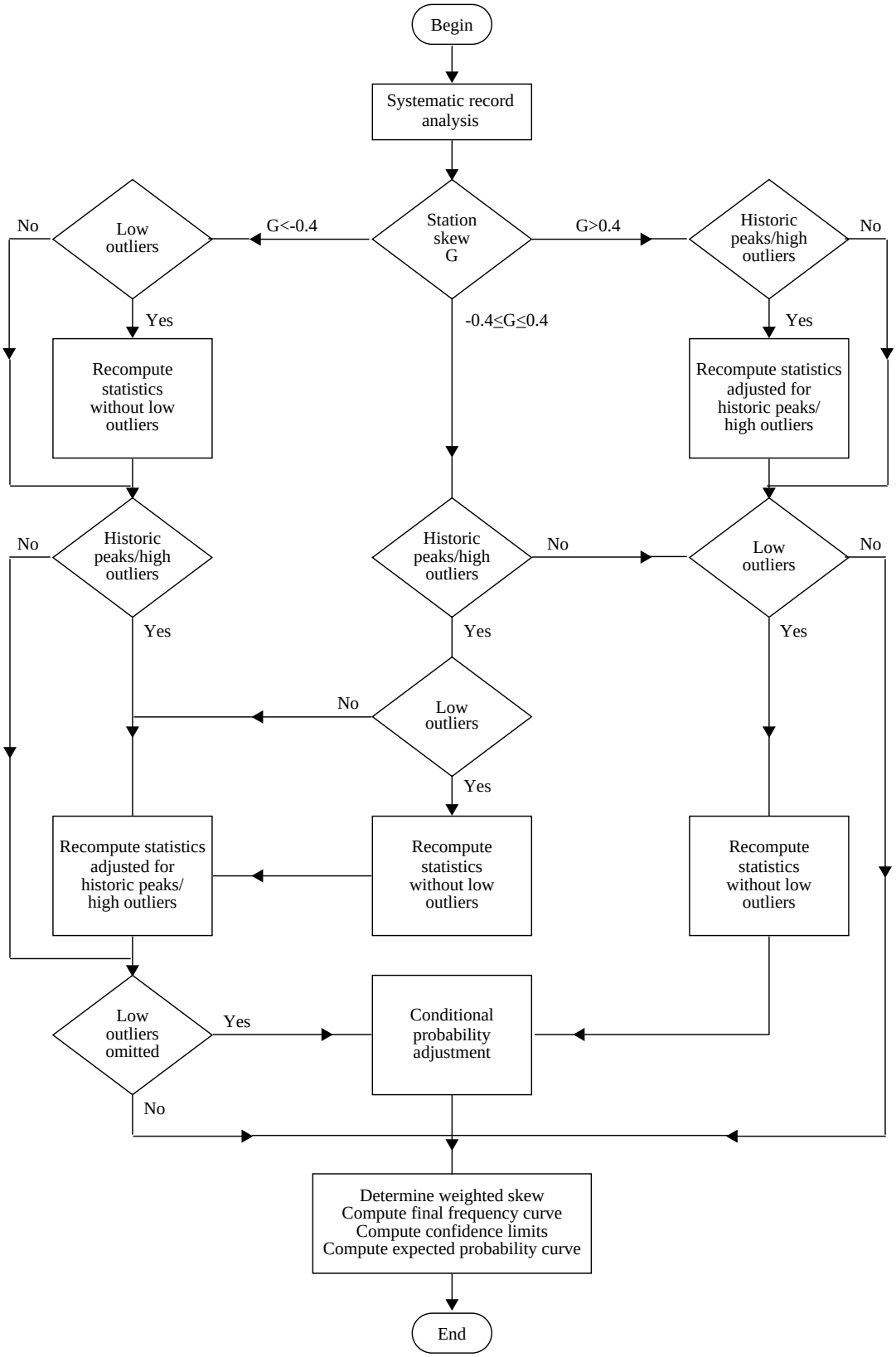

Figure 1. General flow chart for Bulletin 17B flood-frequency computations (modified from Interagency Advisory Committee on Water Data, 1982).

The systematic record frequency curve is an initial estimate of the Bulletin 17B frequency curve, which is recomputed as the systematic statistics are modified for outlier and historic data adjustments.

Outlier and Historic Record Tests

The next step in the analysis is to detect and make appropriate adjustments for low outliers, high outliers, and historic peaks. The sequence of these tests and adjustments depend on the station skew coefficient, G, computed in the first step. Because a relatively large skew coefficient of either sign (G > 0.4 or G < -0.4) is likely to be caused by an outlier on the corresponding end of the sample, this possibility is checked first and any necessary adjustment is applied before checking for outliers on the other end. If the skew coefficient is of relative moderate size (-0.4 < G < 0.4), the existence of both high and low outliers can be checked before applying any adjustments. Program PEAKFQ tests for low outliers using the following equation:

$$X_L = \bar{X} - K_N S \quad (2)$$

where X_L = low outlier threshold in log units, and

K_N = 10 percent significance levels values for normal distribution for sample size N (see table 2).

The frequency curve is automatically adjusted for the effect of low outliers using the conditional probability adjustment described later.

High outliers also are tested for but no adjustment can be applied unless the user supplies necessary information about the length of the historic period and the high outlier threshold. The equation for detecting high outliers is as follows:

$$X_H = \bar{X} + K_N S \quad (3)$$

where X_H = high outlier threshold in log units. Program PEAKFQ does not automatically use the high outlier threshold (X_H) in the analysis.

If an adjustment for historic data has previously been made, then the following equation is used to detect low outliers:

$$X_L = \tilde{M} - K_H \tilde{S} \quad (4)$$

where X_L = low outlier threshold in log units,

$\tilde{M}$ = historically-weighted logarithmic mean, and

$\tilde{S}$ = historically-weighted logarithmic standard deviation.

The computation of $\tilde{M}$ and $\tilde{S}$ is described in the next section.

Table 2.--Outlier test K_N values

The table below contains one-sided 10 percent significance level K_N values for a normal distribution (Interagency Advisory Committee on Water Data, 1982, after Grubbs and Beck, 1972).

Sample size	K_N value	Sample size	K_N value	Sample size	K_N value	Sample size	K_N value
10	2.036	45	2.727	80	2.940	115	3.064
11	2.088	46	2.736	81	2.945	116	3.067
12	2.134	47	2.744	82	2.949	117	3.070
13	2.175	48	2.753	83	2.953	118	3.073
14	2.213	49	2.760	84	2.957	119	3.075
15	2.247	50	2.768	85	2.961	120	3.078
16	2.279	51	2.775	86	2.966	121	3.081
17	2.309	52	2.783	87	2.970	122	3.083
18	2.335	53	2.790	88	2.973	123	3.086
19	2.361	54	2.798	89	2.977	124	3.089
20	2.385	55	2.804	90	2.981	125	3.092
21	2.408	56	2.811	91	2.984	126	3.095
22	2.429	57	2.818	92	2.989	127	3.097
23	2.448	58	2.824	93	2.993	128	3.100
24	2.467	59	2.831	94	2.996	129	3.102
25	2.486	60	2.837	95	3.000	130	3.104
26	2.502	61	2.842	96	3.003	131	3.107
27	2.519	62	2.849	97	3.006	132	3.109
28	2.534	63	2.854	98	3.011	133	3.112
29	2.549	64	2.860	99	3.014	134	3.114
30	2.563	65	2.866	100	3.017	135	3.116
31	2.577	66	2.871	101	3.021	136	3.119
32	2.591	67	2.877	102	3.024	137	3.122
33	2.604	68	2.883	103	3.027	138	3.124
34	2.616	69	2.888	104	3.030	139	3.126
35	2.628	70	2.893	105	3.033	140	3.129
36	2.639	71	2.897	106	3.037	141	3.131
37	2.650	72	2.903	107	3.040	142	3.133
38	2.661	73	2.908	108	3.043	143	3.135
39	2.671	74	2.912	109	3.046	144	3.138
40	2.682	75	2.917	110	3.049	145	3.140
41	2.692	76	2.922	111	3.052	146	3.142
42	2.700	77	2.927	112	3.055	147	3.144
43	2.710	78	2.931	113	3.058	148	3.146
44	2.719	79	2.935	114	3.061	149	3.148

Historic Record Adjustment

The recalculation of the statistics of the above-base peaks is required after the detection of outliers or historic information. It takes into account any zero flows or below-gage-base peaks, low outliers, high outliers, and historic peaks that have been detected, as specified in Appendix 6 of Bulletin 17B. The logical basis for the calculation is the following:

Historic adjustment criterion: Every annual peak that exceeded some historic threshold streamflow (Q_H) during the historic period (H) has been recorded as either a historic peak or a systematic peak (high outlier). In other words, the record is complete for peaks above Q_H during the time period H. The historic period H includes the systematic record period plus one or more years that have no systematic record. This criterion implies that the unrecorded portion of the historic period contains only peaks below the threshold

(Q_H). Figure 2 presents a definition sketch showing the time periods and streamflows used in the historic record adjustment.

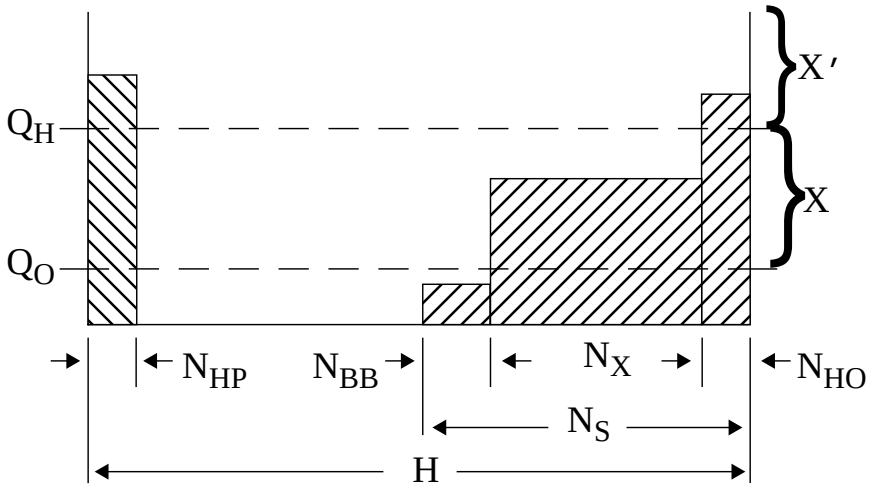

Figure 2. Definition sketch showing time periods and discharges used in historic record adjustment.

The Bulletin 17B historic adjustment, in effect, fills in the ungaged portion of the historic period with an appropriate number of replications of the below-Q_H portion of the systematic record. This filling in is accomplished by weighting the below-threshold systematic peaks in proportion to the number of the below-threshold years in the historic period as illustrated in figure 2, with the following result:

$$W = \frac{H - N_{HP} - N_{HO}}{N_S - N_{HO}} \tag{5}$$

where W is the weight to be applied to the systematic peaks and N_S, N_{HP}, and N_{HO} are the numbers of systematic peaks, historic peaks, and high outliers, respectively. Then the effective number of peaks, $\tilde{N}$, above the flood base (Q_O) is

$$\tilde{N} = N_{HP} + N_{HO} + W(N_S - N_{HO} - N_{BB}) = H - W(N_{BB}) \tag{6}$$

where N_{BB} is the number of peaks below the flood base, including any zeros and low outliers.

The corresponding estimated probability of a flood exceeding the flood base is

$$\tilde{P}_O = \frac{\tilde{N}}{H} \tag{7}$$

Applying the historic weight W to those peaks below the historic base Q_H (and above the flood base Q_O) yields the following formulas for the historically weighted mean ($\tilde{M}$), standard deviation ($\tilde{S}$), and skewness ($\tilde{G}$):

$$\tilde{M} = \frac{(W\sum X + \sum X')}{\tilde{N}} \tag{8}$$

$$\tilde{S} = \sqrt{\frac{\left[W\sum (X - \tilde{M})^2 + \sum (X' - \tilde{M})^2\right]}{(\tilde{N} - 1)}} \tag{9}$$

$$\tilde{G} = \frac{[W\sum (X - \tilde{M})^3 + \sum (X' - \tilde{M})^3]\,\tilde{N}}{(\tilde{N} - 1)\,(\tilde{N} - 2)\,\tilde{S}^3} \tag{10}$$

in which X´ denotes logarithmic magnitudes of historic peaks and high outliers and X denotes logarithmic magnitudes of systematic peaks between the flood base Q_O and the historic threshold Q_H. These formulas are equivalent to those given in Appendix 6 of Bulletin 17B.

These formulas remain correct even if there is no historic information (in which case $H = N_S$), no high or low outliers, and no below-gage-base peaks. Thus these formulas are included in PEAKFQ to calculate the Bulletin 17B statistics for all conditions including the unadjusted systematic-record statistics.

Letting each observed peak below the historic threshold Q_H represent an effective number W of "virtual" peaks yields the following formula for the probability plotting position of the m-th ranked observed peak:

$$\tilde{P}_m = \frac{\tilde{m}}{(H + 1)} \tag{11}$$

where

$$\tilde{m} = c_m + 1/2 \tag{12}$$

and

$$\begin{aligned} c_m &= m - 1/2 && \text{if } m \le Z \quad (Z = N_{HO} + N_{HP}) \\ &= Z + W\,[(m - Z) - 1/2] && \text{if } m > Z \end{aligned} \tag{13}$$

In this formula, $\tilde{m}$ is the historically weighted rank of the m-th largest observed peak and c_m is the centroidal position of a conceptual "cell" occupied by the peak. Cells above the historic threshold have unit width; those below have width W. The effective rank $\tilde{m}$ always is at the extreme end of a sub-cell of unit width centered at c_m. Equation 11 is equivalent to equation 6-8 in Appendix 6 of Bulletin 17B with "a", a constant characteristic of a given plotting position formula equal to 0.

Conditional Probability Adjustment

After the peak-streamflow frequency curve parameters have been determined, the historically-weighted frequency curve can be tabulated. If no low outliers, zero flows, or below-gage-base peaks are present, this process is simply a matter of looking up the Pearson Type III standardized ordinates, $k_{g,\,p}$ for the desired skew coefficient (g) and probability (p) and computing the logarithmic frequency curve ordinates by the formula:

$$\log \hat{Q}_p = \tilde{M} + \tilde{S}\,(k_{g,\,p}) \tag{14}$$

When peaks below the flood base are present, however, the above calculation determines a conditional frequency curve $\tilde{Q}$ describing only those peaks above the base. To account for the fraction of the population below the flood base, the following argument is used: the probability that an annual peak will exceed a streamflow x (above the flood base) is the product of the probability that the peak will exceed the base at all, times the conditional probability that it will exceed x, given that it exceeds the base. The first of these factors is just the probability $\tilde{P}_O$; the second factor is the probability on the conditional frequency curve at streamflow x. Thus the unconditional curve, $\tilde{Q}^*$, assigns a probability $\tilde{P}_O$ (p) to the streamflow having probability p on the above-base curve. Conversely, an exceedance probability p on the unconditional curve $\tilde{Q}^*$ corresponds to the probability $p/\tilde{P}_O$ on the original above-base curve $\tilde{Q}$. Thus the ordinates of the unconditional curve can be computed directly by the formula:

$$\log \tilde{Q}^*_p = \tilde{M} + \tilde{S}\left(k_{\tilde{G},\left(p/\tilde{P}_O\right)}\right) \tag{15}$$

$\tilde{M}$, $\tilde{S}$, and $\tilde{G}$ are the logarithmic mean, standard deviation and skew coefficient of the above-base distribution.

Because this distribution does not have the Pearson Type III shape, it is only used as an intermediate step in constructing an equivalent Pearson Type III curve. First, the three points $\tilde{Q}^*_{0.50}$, $\tilde{Q}^*_{0.10}$ and $\tilde{Q}^*_{0.01}$ are computed using the above formula. Then a logarithmic Pearson Type III curve is passed through these three points; its mean, standard deviation, and skew coefficient, $\tilde{M}'$, $\tilde{S}'$, and $\tilde{G}'$, are found by solving the three simultaneous equations:

$$\tilde{M}' + \tilde{S}'\left(k_{\tilde{G}',p}\right) = \log \tilde{Q}^*_p \quad \text{(for p = 0.50, 0.10, and 0.01)} \tag{16}$$

An exact solution requires a laborious interpolation in the Pearson Type III tables; the Bulletin 17B guidelines present a direct formula based on a linear approximation. Note that $\tilde{M}'$, $\tilde{S}'$, and $\tilde{G}'$ represent the contributions of all the observed peaks, those below the base as well as those above, whereas $\tilde{M}$, $\tilde{S}$, and $\tilde{G}$ did not. The resulting unconditional frequency curve, when floods below the base have been detected, then is:

$$\log \hat{Q}_p = \tilde{M}' + \tilde{S}'\left(k_{\tilde{G}',p}\right) \tag{17}$$

This defines only the part of the distribution above the flood base; the part below the flood base is not defined, but is of no practical importance.

These conditional probability adjustments are used not only to construct the final Bulletin 17B frequency curve but also to construct a systematic-record frequency curve that takes into account any zero flows or below-the-gage-base peaks but does not reflect any historic information or outlier tests.

Estimation of Generalized Skew Coefficient

The skew of a frequency distribution has a tremendous effect on the resulting shape and thus the values of the distribution. The discussion in this section concerns the development of appropriate generalized skew coefficients for the program's flood frequency analysis. The following discussion is modified from Bulletin 17B (p. 10-14).

The skew coefficient of the station record (station skew coefficient, G) is sensitive to extreme events; thus it is difficult to obtain an estimate of an accurate skew coefficient from a small sample. The accuracy of the estimated skew coefficient can be improved by weighting the station skew coefficient with a generalized skew coefficient estimated by pooling information from nearby sites. The following guidelines are recommended for estimating generalized skew.

The recommended procedure for developing generalized skew coefficients requires the use of at least 40 stations, or all stations within a 100-mile radius. The stations used should have 25 or more years of record. It is recognized that in some locations a relaxation of these criteria may be necessary. The actual procedure includes analysis by three methods: (1) skew isolines drawn on a map; (2) skew prediction equation; and (3) the mean skew coefficient from selected stations. Each of the methods are discussed separately.

To develop the isoline map, plot each station skew coefficient at the centroid of its drainage basin and examine the plotted data for any geographic or topographic trends. If a pattern is evident, then isolines are drawn and the average of the sum of the squared differences between observed and isoline values, mean-square error (MSE), is computed. The MSE will be used in appraising the accuracy of the isoline map. If no pattern is evident, then an isoline map cannot be drawn and is, therefore, not further considered.

A prediction equation should be developed that would relate either the station skew coefficients or the differences from the isoline map to predictor variables that affect the skew coefficient of the station record. These would include watershed and climatologic variables such as drainage area, channel slope, and precipitation characteristics. The prediction equation should preferably be used for estimating the skew coefficient at stations with variables that are within the range of data used to calibrate the equation. The MSE will be used to evaluate the accuracy of the prediction equation.

Determine the arithmetic mean and variance of the skew coefficients for all stations. In some cases, the variability of the runoff regime may be so large as to preclude obtaining 40 stations with reasonably homogeneous hydrology. In these situations, the arithmetic means and variance of about 20 stations may be used to estimate the generalized skew coefficient. The drainage areas and meteorologic, topographic, and geologic characteristics should be representative of the region around the station of interest.

Select the method that provides the most accurate estimate of the skew coefficient. Compare the MSE from the isoline map to the MSE for the prediction equation. The smaller MSE should then be compared to the variance of the data. If the MSE is significantly smaller than the variance, the method with the smaller MSE should be used and that MSE used in equation 22 to predict the weighted skew coefficient, for $MSE_{\overline{G}}$. If the smaller MSE is not significantly smaller than the variance, neither the isoline map nor the prediction equation provides a more accurate estimate of the skew coefficient than does the mean value. The mean skew coefficient should be used as it provides the most accurate estimate and the variance should be used in equation 22 for $MSE_{\overline{G}}$.

In the absence of detailed studies, the generalized skew coefficient $(\overline{G})$ can be read from Plate 1 found in the flyleaf pocket of Bulletin 17B. This map of generalized skew coefficients was developed when this bulletin was first introduced and has not been changed. The procedures used to develop the statistical analysis for the individual stations do not conform in all aspects to the procedures recommended in the current guide. However, Plate 1 is still considered an alternative for use with the guide for those who prefer not to develop their own generalized skew procedures.

The accuracy of a regional generalized skew relationship is generally not comparable to Plate 1 accuracy. While the average accuracy of Plate 1 is given, the accuracy of subregions within the United States are not given. A comparison should only be made between relationships that cover approximately the same geographical area.

Computation of Weighted Skew Coefficient

The station and generalized skew coefficient can be combined to form a better estimate of the skew coefficient for a given watershed. Under the assumption that the generalized skew coefficient is unbiased and independent of the station skew coefficient, the MSE of the weighted estimate is minimized by weighting the station and generalized skew coefficient in inverse proportion to their individual MSE's. This concept is expressed in the following equation adopted from Tasker (1978), which should be used in computing a weighted skew coefficient:

$$G_W = \frac{MSE_{\overline{G}}(G) + MSE_G(\overline{G})}{MSE_{\overline{G}} + MSE_G} \qquad (18)$$

where G_W = weighted skew coefficient,

G = station skew coefficient,

$\overline{G}$ = generalized skew coefficient,

$MSE_{\overline{G}}$ = mean-square error of generalized skew coefficient, and

MSE_G = mean-square error of station skew coefficient.

Equation 18 can be used to estimate a weighted skew coefficient regardless of the source of generalized skew coefficient, provided the MSE of the generalized skew coefficient can be estimated. When generalized skew coefficients are read from Plate 1, the value of $MSE_{\overline{G}} = 0.302$ should be used in equation 18. The MSE of the station skew for log-Pearson Type III random variables can be obtained from the results

of Monte Carlo experiment by Wallis and others (1974). Their results show that the MSE of the logarithmic station skew is a function of record length and population skew. For use in calculating $_W$, this function (MSE_G) can be approximated with sufficient accuracy by the equation:

$$MSE_G = 10^{[A - B[\log_{10}(N/10)]]} \quad (19)$$

where $A = -0.33 + 0.08\,|G|$ if $|G| \le 0.90$,

$-0.52 + 0.30\,|G|$ if $|G| > 0.90$,

$B = 0.94 - 0.26\,|G|$ if $|G| \le 1.50$, and

$= 0.55$ if $|G| > 1.50$.

in which $|G|$ is the absolute value of the station skew coefficient (used as an estimate of population skew coefficient) and N is the record length in years. If the historic adjustment (Bulletin 17B, Appendix 6) has been applied, the historically adjusted skew coefficient, $\tilde{G}$, and historic period, H, are to be used for G and N, respectively, in equation 19. Application of equation 19 to stations with absolute skew coefficients (logs) greater than 2 causes decreasing weight to be given to the station coefficient when the period of record increases. Application of equation 18 also may give improper weight to the generalized skew coefficient if the generalized and station skew coefficients differ by more than 0.5. In these situations, an examination of the data and the flood-producing characteristics of the watershed should be made and possibly greater weight given to the station skew coefficient.

Expected Probability Adjustment

The final steps in the Bulletin 17B analysis, as implemented in program PEAKFQ, are to compute the so-called expected-probability frequency curve and a set of upper and lower confidence limits. These computations are optional and are intended primarily as an aid to the interpretation of the principal Bulletin 17B-estimated frequency curve given by $\hat{Q}$ above.

The expected probability concept deals with the following problem. A sample of size n will be drawn from a normal population (of flood logarithms), and the flood having exceedance probability p will be estimated by the quantity $\bar{X} + k_p(S)$, in which $\bar{X}$ and S are the ordinary sample mean and standard deviation and k_p is the standard normal frequency factor for probability p. Because it is computed from a random sample, the estimate $\bar{X} + k_p(S)$ is a random variable, which usually will differ from the true p-probability flood. Thus one is led to ask how the probability of another flood exceeding the estimate $\bar{X} + k_p(S)$ compares with the nominal probability p. For a normal population one has:

$$P\{X > \bar{X} + (k_p)S\} = P\left\{\frac{X - \bar{X}}{S} > k_p\right\} = P\{t_{n-1} > k_p[n/(n+1)]^{0.5}\} \quad (20)$$

where t_{n-1} is Student's t with n-1 degrees of freedom. This probability has come to be known as the "expected probability" (Beard, 1960; Interagency Advisory Committee on Water Data, 1982, Appendix

11). For nominal exceedance probabilities less than 0.50—floods above the median—the expected probability exceeds the nominal probability. This bias is removed by replacing k_p by the frequency factor:

$$k'_p = t_{n-1,p}\,[(n+1)/n]^{0.5} \tag{21}$$

in which $t_{n-1,p}$ is the Student-t value with exceedance probability p. The visible effect of this adjustment is to increase the slope of the estimated frequency curve in proportion to the statistical variability of the sample statistics.

This normal-population result is applied to the Bulletin 17B-estimated Pearson Type III distribution with mean, standard deviation, and skew coefficient, $\hat{M}$, $\hat{S}$, and G_W, by first looking up the normal exceedance probability p' corresponding to k'_p and, second, applying the Pearson Type III frequency factor, $k_{G,p'}$ having this skew coefficient and probability, to the sample mean and standard deviation, as follows: $\hat{M} + \hat{S}\left(k_{G_W,p'}\right)$. Of course, even this estimate, when evaluated for any particular sample, normally will misrepresent the true p-probability flood. With respect to a number of samples, however, the fraction of floods actually exceeding the estimated p-probability floods will be correct. Nonetheless, the Bulletin 17B guidelines specify that the basic flood frequency curve (without expected probability) is the curve to be used for estimating flood risk and forming weighted averages of independent flood frequency estimates.

Confidence Limits

Finally, one-sided confidence limits for the p-probability flood are computed. A one-sided confidence limit is a sample statistic—hence a random variable—having a specified probability of exceeding (or not exceeding) a specified population characteristic. In the Bulletin 17B analysis, these statistics are of the form $\overline{X} + K \bullet S$, where $\overline{X}$ and S are the sample mean and standard deviation after all Bulletin 17B tests and adjustments and K is a confidence coefficient chosen to satisfy the following equation:

$$P\{\overline{X} + K \bullet S > \mu + k_{\gamma,p}(\sigma)\} = \alpha \tag{22}$$

In this equation, μ, σ, and γ are the population mean, standard deviation, and skew coefficient, and the right-hand side of the inequality is the population p-probability flood; these parameters are unknown and the idea is to find a K-value such that $\overline{X} + K \bullet S$, which can be computed from the sample, will almost certainly be an upper (or lower) bound on this unknown population characteristic. In any particular sample the computed value $\overline{X} + K \bullet S$ may fail to bound the population characteristic, but, over a number of samples, the specified fraction—α (or 1-α)—will yield correct bounds. A value of close to unity yields upper confidence limits and a value close to zero yields lower limits. In particular, the upper 95-percent confidence limit has $\alpha = 0.95$; the lower 95-percent limit has $\alpha = 0.05$. The value of K is found by rearranging the probability statement as follows:

$$P\left\{\frac{\left((\mu - \overline{X})/(\sigma/\sqrt{n}) + \sqrt{n}\,(k_{\gamma,p})\right)}{(S/\sigma)} < \sqrt{n}\,(K)\right\} = \alpha \tag{23}$$

in which n is the sample size. If the underlying population were normally distributed, and if $\bar{x}$ and s were the ordinary sample mean and standard deviation, then the random variable on the left-hand side of the inequality would have the noncentral t distribution with n-1 degrees of freedom and noncentrality parameter $\sqrt{n}\,(k_{\gamma,p})$. If the underlying population becomes less skewed, if the sample size increases, and if the population skew coefficient, γ, could be replaced by the Bulletin 17B estimated skew coefficient, G_W, then one might hope the variate would have approximately the noncentral-t distribution. Building upon this foundation, one obtains:

$$\sqrt{n}\,(K) \;=\; t_{n-1},\, \sqrt{n}\left(k_{G_W,\,p}\right),\, (1-\alpha) \tag{24}$$

which is the noncentral-t value with exceedance probability l-α. A standard large-sample approximation for the noncentral-t distribution then yields the result:

$$K \;=\; \frac{\left(k_{G_W,\,p}\right) + \dfrac{k_{(1-\alpha)}}{\sqrt{n}}\left\{1 + \left(nk^2_{G_W,\,p} - k^2_{(1-\alpha)}\right)/2\,(n-1)\right\}^{0.5}}{\left\{1 - k^2_{(1-\alpha)}/2\,(n-1)\right\}} \tag{25}$$

in which $k_{(1-\alpha)}$ is the standard normal deviate with exceedance probability $(1-\alpha)$ and G_W is the Bulletin 17B estimated skew coefficient. As stated above, an a-value near unity yields upper confidence limits whereas a value near zero yields lower limits. This result is equivalent to that in the Bulletin 17B guidelines.

COMPUTER PROGRAM PEAKFQ

The following sections describe the computer program PEAKFQ for performing the Bulletin 17B flood-frequency analysis. Figure 3 shows the structure of the PEAKFQ program.

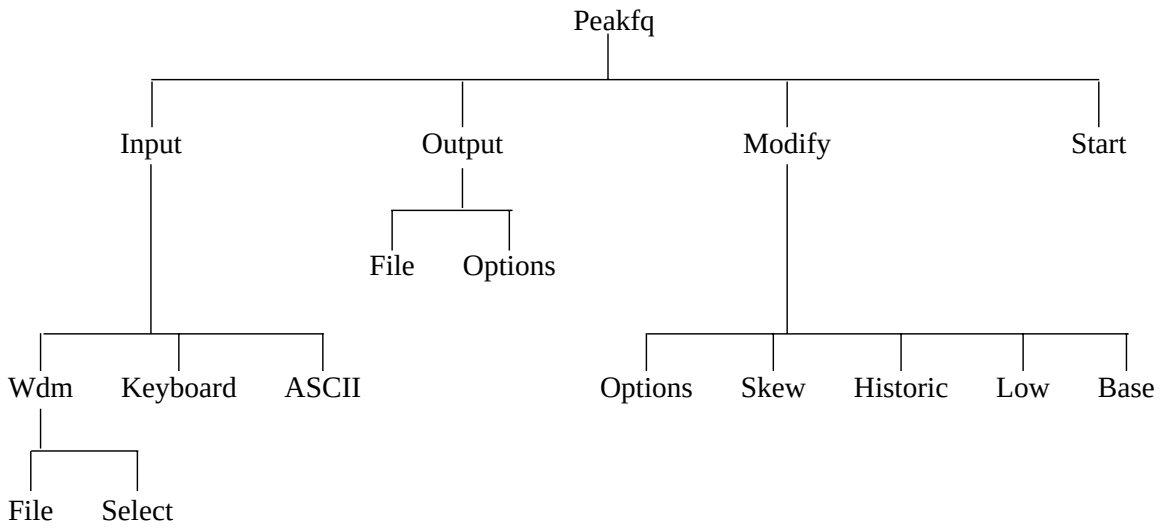

Figure 3. Structure of the PEAKFQ program.

Examples of flood-frequency analyses using program PEAKFQ are provided for five stations: Fishkill Creek at Beacon, N.Y. (fig. 4), Floyd River at James, Iowa (fig. 5), Back Creek at Jones Springs, W.Va. (fig. 6), Orestimba Creek near Newman, Calif. (fig. 7), and Sugar Creek at Crawfordsville, Ind. (fig. 8). The Floyd River example illustrates the historic adjustment for a high outlier in the systematic record. The 1953 annual peak flow (71,500 ft^3/s) is the highest known peak flow in at least 82 years. The Orestimba Creek example illustrates the detection and adjustment for a low outlier and several zero flows. Both these examples are discussed in Appendix 12 of Bulletin 17B (Interagency Advisory Committee on Water Data, 1982).

FIGURES 4, 5, 6, 7, AND 8 NEAR HERE

U. S. GEOLOGICAL SURVEY
ANNUAL PEAK FLOW FREQUENCY ANALYSIS
Following Bulletin 17-B Guidelines
Program peakfq
(Version 2.3, Jan, 1997)

--- PROCESSING DATE/TIME ---

1997 JAN 7 15:55:09

--- PROCESSING OPTIONS ---

```
Plot option         = Graphics & Printer
Basin char output   = WDM
Print option        = Yes
Debug print         = No
Input peaks listing = Long
Input peaks format  = WDM file
```

Figure 4. Example of output from PEAKFQ for the Fishkill Creek at Beacon, N.Y.

```
                    U. S. GEOLOGICAL SURVEY
                ANNUAL PEAK FLOW FREQUENCY ANALYSIS
                Following Bulletin 17-B Guidelines
                        Program peakfq
                    (Version 2.3, Jan, 1997)


             Station - 01373500  FISHKILL CR AT BEACON NY
                        1997 JAN 7 15:55:09


                  I N P U T   D A T A   S U M M A R Y

            Number of peaks in record            =       24
            Peaks not used in analysis           =        0
            Systematic peaks in analysis         =       24
            Historic peaks in analysis           =        0
            Years of historic record             =        0
            Generalized skew                     =    0.600
            Standard error of generalized skew   =    0.550
            Skew option                          =   WEIGHTED
            Gage base discharge                  =      0.0
            User supplied high outlier threshold =   --
            User supplied low outlier criterion  =   --
            Plotting position parameter          =     0.00


*********  NOTICE  --  Preliminary machine computations.        *********
*********  User responsible for assessment and interpretation.  *********

  WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                   0.0
  WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.      9425.0
  WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.            578.7
```

Station - 01373500 FISHKILL CR AT BEACON NY
1997 JAN 7 15:55:09

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.3684	0.2456	0.730
BULL.17B ESTIMATE	0.0	1.0000	3.3684	0.2456	0.668

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	95-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.9950	773.1	797.9	717.3	510.6	1019.0
0.9900	829.6	851.4	778.2	558.6	1083.0
0.9500	1038.0	1050.0	999.3	740.6	1313.0
0.9000	1192.0	1199.0	1163.0	880.1	1485.0
0.8000	1438.0	1439.0	1418.0	1106.0	1760.0
0.5000	2194.0	2181.0	2194.0	1796.0	2660.0
0.2000	3657.0	3645.0	3743.0	2996.0	4722.0
0.1000	4959.0	4966.0	5208.0	3946.0	6848.0
0.0400	7067.0	7134.0	7778.0	5358.0	10700.0
0.0200	9031.0	9181.0	10430.0	6589.0	14660.0
0.0100	11390.0	11660.0	13920.0	7995.0	19780.0
0.0050	14220.0	14670.0	18620.0	9605.0	26370.0
0.0020	18830.0	19650.0	27510.0	12100.0	38030.0

Station - 01373500 FISHKILL CR AT BEACON NY
1997 JAN 7 15:55:09

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1945	2290.0		1957	1310.0	
1946	1470.0		1958	2500.0	
1947	2220.0		1959	1960.0	
1948	2970.0		1960	2140.0	
1949	3020.0		1961	4340.0	
1950	1210.0		1962	3060.0	
1951	2490.0		1963	1780.0	
1952	3170.0		1964	1380.0	
1953	3220.0		1965	980.0	
1954	1760.0		1966	1040.0	
1955	8800.0		1967	1580.0	
1956	8280.0		1968	3630.0	

Explanation of peak discharge qualification codes

PEAKFQ CODE	WATSTORE CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

Station - 01373500 FISHKILL CR AT BEACON NY
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EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
1955	8800.0	0.0400	0.0400
1956	8280.0	0.0800	0.0800
1961	4340.0	0.1200	0.1200
1968	3630.0	0.1600	0.1600
1953	3220.0	0.2000	0.2000
1952	3170.0	0.2400	0.2400
1962	3060.0	0.2800	0.2800
1949	3020.0	0.3200	0.3200
1948	2970.0	0.3600	0.3600
1958	2500.0	0.4000	0.4000
1951	2490.0	0.4400	0.4400
1945	2290.0	0.4800	0.4800
1947	2220.0	0.5200	0.5200
1960	2140.0	0.5600	0.5600
1959	1960.0	0.6000	0.6000
1963	1780.0	0.6400	0.6400
1954	1760.0	0.6800	0.6800
1967	1580.0	0.7200	0.7200
1946	1470.0	0.7600	0.7600
1964	1380.0	0.8000	0.8000
1957	1310.0	0.8400	0.8400
1950	1210.0	0.8800	0.8800
1966	1040.0	0.9200	0.9200
1965	980.0	0.9600	0.9600

U. S. GEOLOGICAL SURVEY
ANNUAL PEAK FLOW FREQUENCY ANALYSIS
Following Bulletin 17-B Guidelines
Program peakfq
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Station - 01373500 FISHKILL CR AT BEACON NY

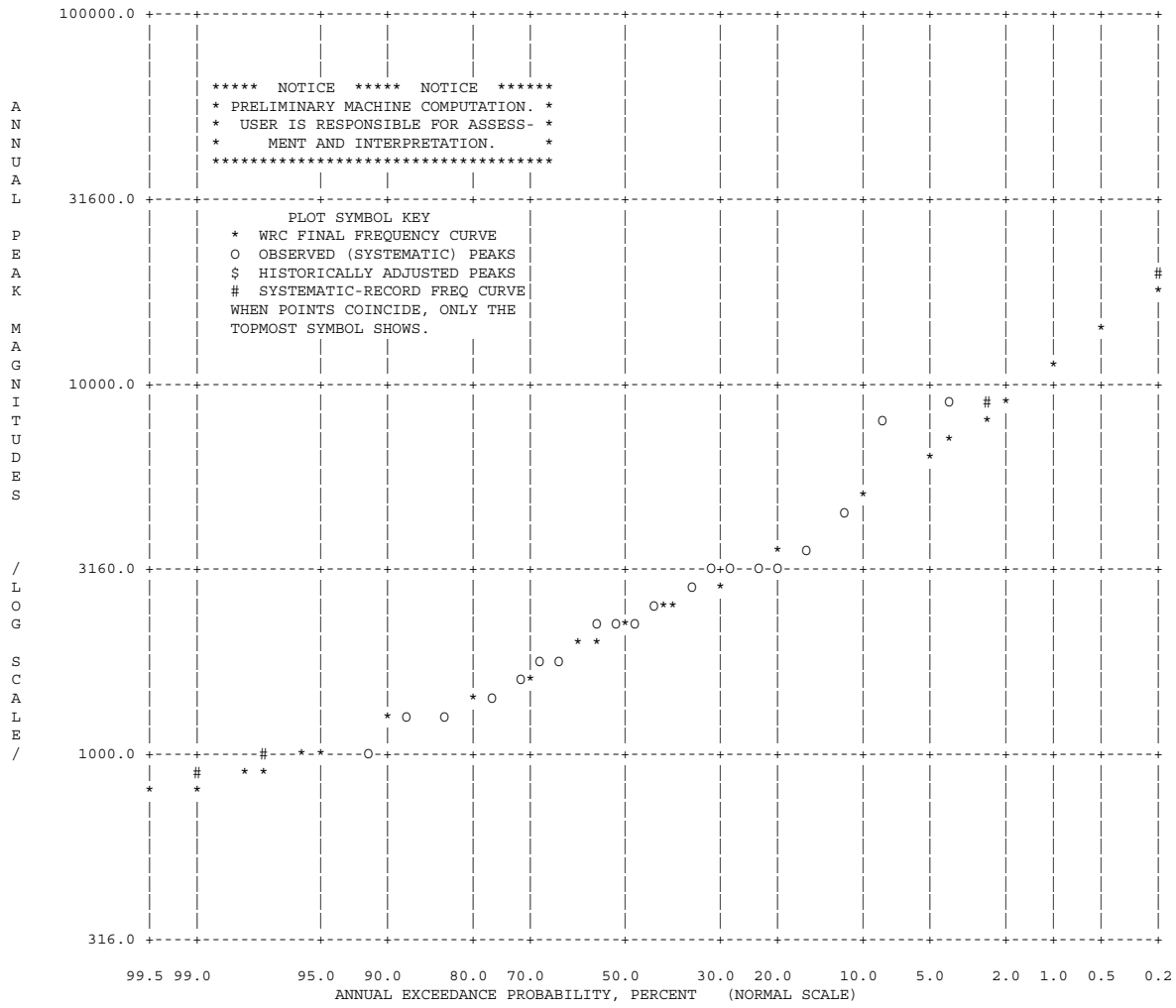

Figure 5. Example of output from PEAKFQ for the Floyd River at James, Iowa.

```
                    U. S. GEOLOGICAL SURVEY
                ANNUAL PEAK FLOW FREQUENCY ANALYSIS
                Following Bulletin 17-B Guidelines
                        Program peakfq
                    (Version 2.3, Jan, 1997)


            Station - 06600500  FLOYD RIVER AT JAMES, IOWA
                        1997 JAN 7 15:55:09


                 I N P U T   D A T A   S U M M A R Y

            Number of peaks in record            =       39
            Peaks not used in analysis           =        0
            Systematic peaks in analysis         =       39
            Historic peaks in analysis           =        0
            Years of historic record             =       82
            Generalized skew                     =   -0.300
            Standard error of generalized skew   =    0.550
            Skew option                          =   WEIGHTED
            Gage base discharge                  =      0.0
            User supplied high outlier threshold =    70000.0
            User supplied low outlier criterion  =   --
            Plotting position parameter          =     0.00


*********  NOTICE  --  Preliminary machine computations.        *********
*********  User responsible for assessment and interpretation.  *********

  WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                    0.0
  WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.             206.8
 *WCF161I-USER HIGH OUTLIER CRITERION REPLACES WRC.    70000.0    62394.9
  WCF165I-HIGH OUTLIERS AND HISTORIC PEAKS ABOVE HHBASE.  1  0    70000.0
```

Station - 06600500 FLOYD RIVER AT JAMES, IOWA
1997 JAN 7 15:55:09

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.5553	0.4642	0.357
BULL.17B ESTIMATE	0.0	1.0000	3.5374	0.4377	0.075

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	95-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.9950	275.9	327.3	234.9	143.1	441.5
0.9900	349.4	396.6	307.8	190.3	541.8
0.9500	671.3	694.5	631.5	415.6	960.9
0.9000	955.3	957.2	919.2	629.9	1318.0
0.8000	1471.0	1442.0	1442.0	1037.0	1958.0
0.5000	3404.0	3371.0	3404.0	2596.0	4458.0
0.2000	8018.0	8626.0	8187.0	6026.0	11360.0
0.1000	12640.0	14630.0	13170.0	9149.0	19220.0
0.0400	20640.0	26420.0	22270.0	14170.0	34330.0
0.0200	28430.0	39340.0	31650.0	18760.0	50340.0
0.0100	37990.0	56890.0	43840.0	24140.0	71360.0
0.0050	49610.0	80460.0	59640.0	30410.0	98530.0
0.0020	68700.0	123900.0	87760.0	40260.0	146200.0

Station - 06600500 FLOYD RIVER AT JAMES, IOWA
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I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1935	1460.0		1955	2260.0	
1936	4050.0		1956	318.0	
1937	3570.0		1957	1330.0	
1938	2060.0		1958	970.0	
1939	1300.0		1959	1920.0	
1940	1390.0		1960	15100.0	
1941	1720.0		1961	2870.0	
1942	6280.0		1962	20600.0	
1943	1360.0		1963	3810.0	
1944	7440.0		1964	726.0	
1945	5320.0		1965	7500.0	
1946	1400.0		1966	7170.0	
1947	3240.0		1967	2000.0	
1948	2710.0		1968	829.0	
1949	4520.0		1969	17300.0	
1950	4840.0		1970	4740.0	
1951	8320.0		1971	13400.0	
1952	13900.0		1972	2940.0	
1953	71500.0		1973	5660.0	
1954	6250.0				

Explanation of peak discharge qualification codes

PEAKFQ CODE	WATSTORE CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

Station - 06600500 FLOYD RIVER AT JAMES, IOWA
1997 JAN 7 15:55:09

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
1953	71500.0	0.0250	0.0120
1962	20600.0	0.0500	0.0309
1969	17300.0	0.0750	0.0566
1960	15100.0	0.1000	0.0823
1952	13900.0	0.1250	0.1080
1971	13400.0	0.1500	0.1336
1951	8320.0	0.1750	0.1593
1965	7500.0	0.2000	0.1850
1944	7440.0	0.2250	0.2107
1966	7170.0	0.2500	0.2364
1942	6280.0	0.2750	0.2620
1954	6250.0	0.3000	0.2877
1973	5660.0	0.3250	0.3134
1945	5320.0	0.3500	0.3391
1950	4840.0	0.3750	0.3648
1970	4740.0	0.4000	0.3905
1949	4520.0	0.4250	0.4161
1936	4050.0	0.4500	0.4418
1963	3810.0	0.4750	0.4675
1937	3570.0	0.5000	0.4932
1947	3240.0	0.5250	0.5189
1972	2940.0	0.5500	0.5445
1961	2870.0	0.5750	0.5702
1948	2710.0	0.6000	0.5959
1955	2260.0	0.6250	0.6216
1938	2060.0	0.6500	0.6473
1967	2000.0	0.6750	0.6730
1959	1920.0	0.7000	0.6986
1941	1720.0	0.7250	0.7243
1935	1460.0	0.7500	0.7500
1946	1400.0	0.7750	0.7757
1940	1390.0	0.8000	0.8014
1943	1360.0	0.8250	0.8270
1957	1330.0	0.8500	0.8527
1939	1300.0	0.8750	0.8784
1958	970.0	0.9000	0.9041
1968	829.0	0.9250	0.9298
1964	726.0	0.9500	0.9555
1956	318.0	0.9750	0.9811

U. S. GEOLOGICAL SURVEY
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Station - 06600500 FLOYD RIVER AT JAMES, IOWA

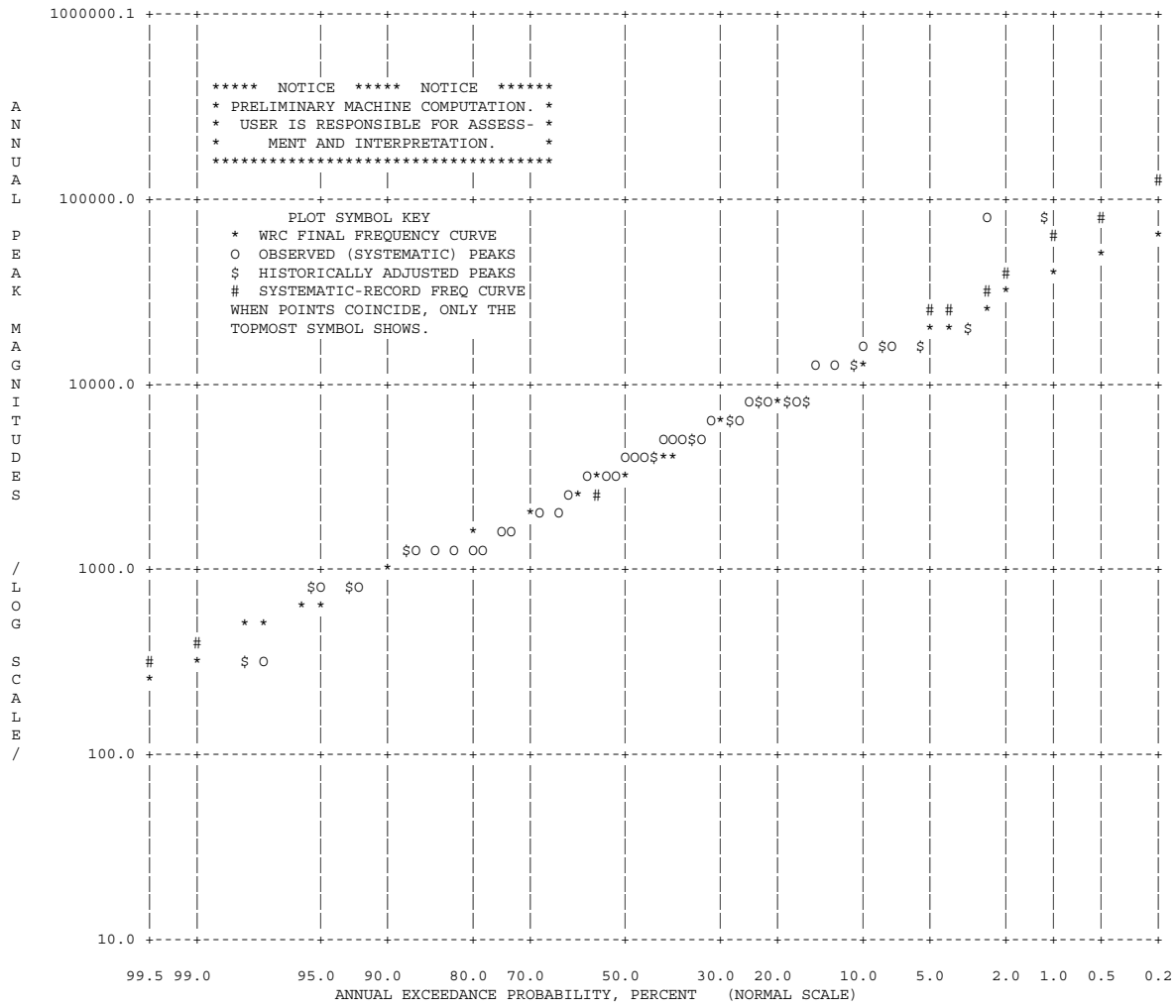

Figure 6. Example of output from PEAKFQ for the Back Creek near Jones Springs, W.Va.

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                    U. S. GEOLOGICAL SURVEY
                ANNUAL PEAK FLOW FREQUENCY ANALYSIS
                Following Bulletin 17-B Guidelines
                        Program peakfq
                    (Version 2.3, Jan, 1997)


        Station - 01614000  BACK CREEK NEAR JONES SPRINGS,W.VA.
                        1997 JAN 7 15:55:09

                    I N P U T   D A T A   S U M M A R Y

          Number of peaks in record            =       38
          Peaks not used in analysis           =        0
          Systematic peaks in analysis         =       38
          Historic peaks in analysis           =        0
          Years of historic record             =        0
          Generalized skew                     =    0.500
          Standard error of generalized skew   =    0.550
          Skew option                          =   WEIGHTED
          Gage base discharge                  =      0.0
          User supplied high outlier threshold =   --
          User supplied low outlier criterion  =   --
          Plotting position parameter          =     0.00


*********  NOTICE  --  Preliminary machine computations.        *********
*********  User responsible for assessment and interpretation.  *********

  WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                    0.0
  WCF198I-LOW OUTLIERS BELOW FLOOD BASE WERE DROPPED.          1     945.8
  WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.      22759.8
```

Station - 01614000 BACK CREEK NEAR JONES SPRINGS,W.VA.
1997 JAN 7 15:55:09

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.7220	0.2804	-0.731
BULL.17B ESTIMATE	945.8	0.9737	3.7407	0.2328	0.565

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	95-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.9950	--	646.2	--	--	--
0.9900	--	840.0	--	--	--
0.9500	2504.0	1622.0	2445.0	1962.0	3009.0
0.9000	2884.0	2228.0	2838.0	2317.0	3417.0
0.8000	3477.0	3172.0	3446.0	2877.0	4058.0
0.5000	5235.0	5700.0	5235.0	4514.0	6047.0
0.2000	8464.0	9168.0	8577.0	7266.0	10190.0
0.1000	11210.0	11280.0	11530.0	9402.0	14110.0
0.0400	15480.0	13670.0	16340.0	12520.0	20720.0
0.0200	19330.0	15250.0	20920.0	15190.0	27060.0
0.0100	23800.0	16670.0	26560.0	18180.0	34830.0
0.0050	29020.0	17960.0	33560.0	21550.0	44340.0
0.0020	37250.0	19460.0	45480.0	26680.0	60160.0

Station - 01614000 BACK CREEK NEAR JONES SPRINGS,W.VA.
1997 JAN 7 15:55:09

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1929	8750.0		1955	10700.0	
1930	15500.0		1956	3880.0	
1931	4060.0		1957	3420.0	
1939	6300.0		1958	3240.0	
1940	3130.0		1959	6800.0	
1941	4160.0		1960	3740.0	
1942	6700.0		1961	4700.0	
1943	22400.0		1962	4380.0	
1944	3880.0		1963	5190.0	
1945	8050.0		1964	3960.0	
1946	4020.0		1965	5600.0	
1947	1600.0		1966	4670.0	
1948	4460.0		1967	7080.0	
1949	4230.0		1968	4640.0	
1950	3010.0		1969	536.0	
1951	9150.0		1970	6680.0	
1952	5100.0		1971	8360.0	
1953	9820.0		1972	18700.0	
1954	6200.0		1973	5210.0	

Explanation of peak discharge qualification codes

PEAKFQ CODE	WATSTORE CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

Station - 01614000 BACK CREEK NEAR JONES SPRINGS,W.VA.
1997 JAN 7 15:55:09

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
1943	22400.0	0.0256	0.0256
1972	18700.0	0.0513	0.0513
1930	15500.0	0.0769	0.0769
1955	10700.0	0.1026	0.1026
1953	9820.0	0.1282	0.1282
1951	9150.0	0.1538	0.1538
1929	8750.0	0.1795	0.1795
1971	8360.0	0.2051	0.2051
1945	8050.0	0.2308	0.2308
1967	7080.0	0.2564	0.2564
1959	6800.0	0.2821	0.2821
1942	6700.0	0.3077	0.3077
1970	6680.0	0.3333	0.3333
1939	6300.0	0.3590	0.3590
1954	6200.0	0.3846	0.3846
1965	5600.0	0.4103	0.4103
1973	5210.0	0.4359	0.4359
1963	5190.0	0.4615	0.4615
1952	5100.0	0.4872	0.4872
1961	4700.0	0.5128	0.5128
1966	4670.0	0.5385	0.5385
1968	4640.0	0.5641	0.5641
1948	4460.0	0.5897	0.5897
1962	4380.0	0.6154	0.6154
1949	4230.0	0.6410	0.6410
1941	4160.0	0.6667	0.6667
1931	4060.0	0.6923	0.6923
1946	4020.0	0.7179	0.7179
1964	3960.0	0.7436	0.7436
1944	3880.0	0.7692	0.7692
1956	3880.0	0.7949	0.7949
1960	3740.0	0.8205	0.8205
1957	3420.0	0.8462	0.8462
1958	3240.0	0.8718	0.8718
1940	3130.0	0.8974	0.8974
1950	3010.0	0.9231	0.9231
1947	1600.0	0.9487	0.9487
1969	536.0	0.9744	0.9744

U. S. GEOLOGICAL SURVEY
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Following Bulletin 17-B Guidelines
Program peakfq
(Version 2.3, Jan, 1997)

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Station - 01614000 BACK CREEK NEAR JONES SPRINGS,W.VA.

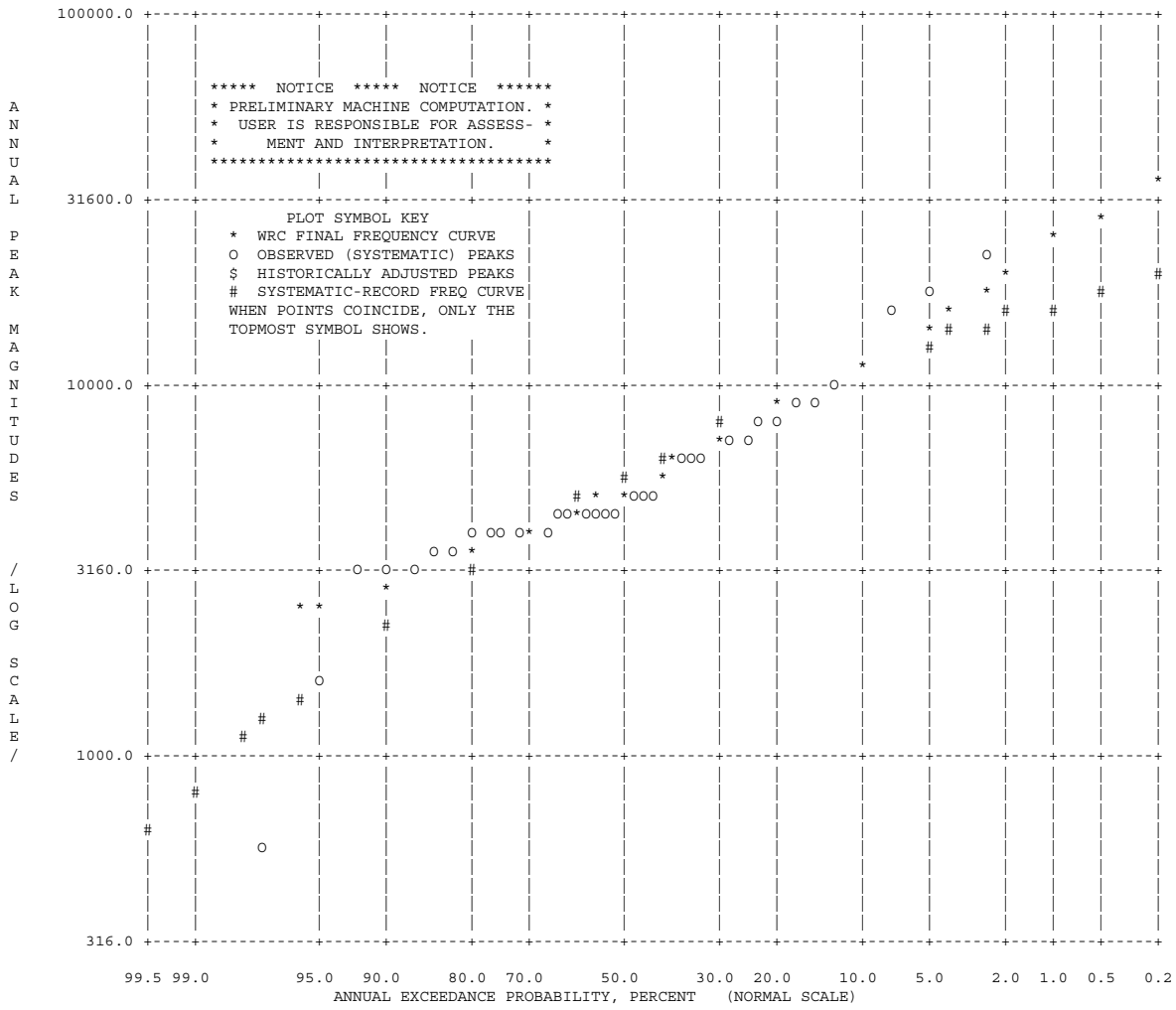

Figure 7. Example of output from PEAKFQ for the Orestimba Creek near Newman, Calif.

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                    U. S. GEOLOGICAL SURVEY
                ANNUAL PEAK FLOW FREQUENCY ANALYSIS
                Following Bulletin 17-B Guidelines
                        Program peakfq
                    (Version 2.3, Jan, 1997)


          Station - 11274500  ORESTIMBA CREEK NEAR NEWMAN CALIF
                          1997 JAN 7 15:55:09


                    I N P U T   D A T A   S U M M A R Y

          Number of peaks in record            =       42
          Peaks not used in analysis           =        0
          Systematic peaks in analysis         =       42
          Historic peaks in analysis           =        0
          Years of historic record             =        0
          Generalized skew                     =   -0.300
          Standard error of generalized skew   =    0.550
          Skew option                          =   WEIGHTED
          Gage base discharge                  =      0.0
          User supplied high outlier threshold =   --
          User supplied low outlier criterion  =   --
          Plotting position parameter          =     0.00


*********  NOTICE  --  Preliminary machine computations.        *********
*********  User responsible for assessment and interpretation.  *********

  WCF133I-SYSTEMATIC PEAKS BELOW GAGE BASE WERE NOTED.          6      0.0
  WCF198I-LOW OUTLIERS BELOW FLOOD BASE WERE DROPPED.           1     23.9
  WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.       41786.0
```

Station - 11274500 ORESTIMBA CREEK NEAR NEWMAN CALIF
1997 JAN 7 15:55:09

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	0.8571	2.9140	0.7661	-0.942
BULL.17B ESTIMATE	23.9	0.8333	2.9628	0.6749	-0.487

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	95-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.8000	260.9	213.1	252.3	156.9	398.2
0.5000	1041.0	1078.0	1041.0	699.3	1562.0
0.2000	3474.0	3695.0	3557.0	2266.0	5832.0
0.1000	6095.0	6117.0	6367.0	3804.0	11110.0
0.0400	10570.0	9521.0	11370.0	6245.0	21140.0
0.0200	14700.0	12080.0	16180.0	8371.0	31190.0
0.0100	19440.0	14530.0	21930.0	10710.0	43450.0
0.0050	24770.0	16830.0	28620.0	13250.0	57960.0
0.0020	32650.0	19590.0	39100.0	16880.0	80620.0

Station - 11274500 ORESTIMBA CREEK NEAR NEWMAN CALIF
1997 JAN 7 15:55:09

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1932	4260.0		1953	147.0	
1933	345.0		1954	0.0	
1934	516.0		1955	16.0	
1935	1320.0		1956	5620.0	
1936	1200.0		1957	1440.0	
1937	2180.0		1958	10200.0	
1938	3230.0		1959	5380.0	
1939	115.0		1960	448.0	
1940	3440.0		1961	0.0	
1941	3070.0		1962	1740.0	
1942	1880.0		1963	8300.0	
1943	6450.0		1964	156.0	
1944	1290.0		1965	560.0	
1945	5970.0		1966	128.0	
1946	782.0		1967	4200.0	
1947	0.0		1968	0.0	
1948	0.0		1969	5080.0	
1949	335.0		1970	1010.0	
1950	175.0		1971	584.0	
1951	2920.0		1972	0.0	
1952	3660.0		1973	1510.0	

Explanation of peak discharge qualification codes

PEAKFQ CODE	WATSTORE CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

Station - 11274500 ORESTIMBA CREEK NEAR NEWMAN CALIF
1997 JAN 7 15:55:09

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
1958	10200.0	0.0233	0.0233
1963	8300.0	0.0465	0.0465
1943	6450.0	0.0698	0.0698
1945	5970.0	0.0930	0.0930
1956	5620.0	0.1163	0.1163
1959	5380.0	0.1395	0.1395
1969	5080.0	0.1628	0.1628
1932	4260.0	0.1860	0.1860
1967	4200.0	0.2093	0.2093
1952	3660.0	0.2326	0.2326
1940	3440.0	0.2558	0.2558
1938	3230.0	0.2791	0.2791
1941	3070.0	0.3023	0.3023
1951	2920.0	0.3256	0.3256
1937	2180.0	0.3488	0.3488
1942	1880.0	0.3721	0.3721
1962	1740.0	0.3953	0.3953
1973	1510.0	0.4186	0.4186
1957	1440.0	0.4419	0.4419
1935	1320.0	0.4651	0.4651
1944	1290.0	0.4884	0.4884
1936	1200.0	0.5116	0.5116
1970	1010.0	0.5349	0.5349
1946	782.0	0.5581	0.5581
1971	584.0	0.5814	0.5814
1965	560.0	0.6047	0.6047
1934	516.0	0.6279	0.6279
1960	448.0	0.6512	0.6512
1933	345.0	0.6744	0.6744
1949	335.0	0.6977	0.6977
1950	175.0	0.7209	0.7209
1964	156.0	0.7442	0.7442
1953	147.0	0.7674	0.7674
1966	128.0	0.7907	0.7907
1939	115.0	0.8140	0.8140
1955	16.0	0.8372	0.8372
1947	0.0	--	--
1948	0.0	--	--
1954	0.0	--	--
1961	0.0	--	--
1968	0.0	--	--
1972	0.0	--	--

U. S. GEOLOGICAL SURVEY
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Following Bulletin 17-B Guidelines
Program peakfq
(Version 2.3, Jan, 1997)

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Station - 11274500 ORESTIMBA CREEK NEAR NEWMAN CALIF

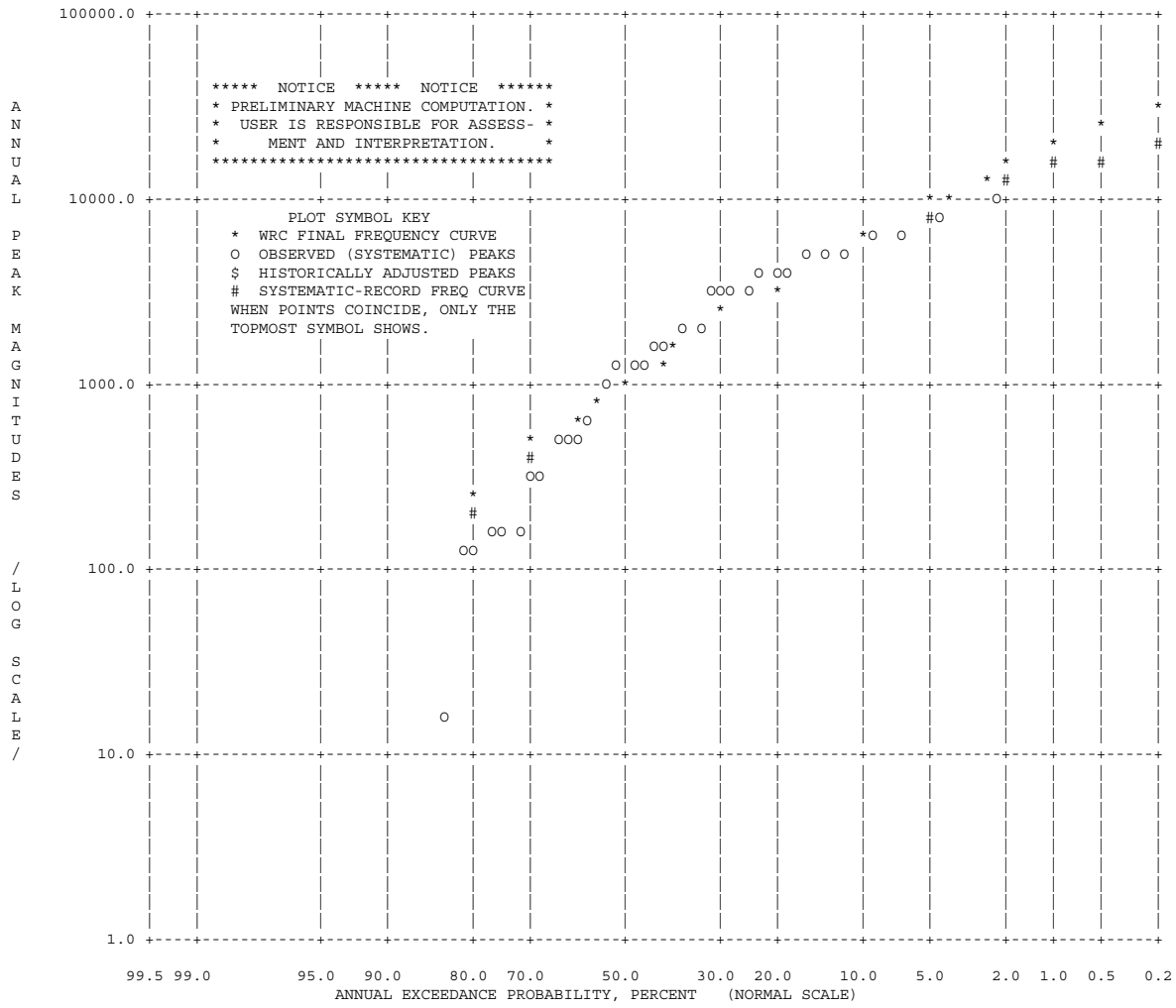

Figure 8. Example of output from PEAKFQ for the Sugar Creek at Crawfordsville, Ind.

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                    U. S. GEOLOGICAL SURVEY
                ANNUAL PEAK FLOW FREQUENCY ANALYSIS
                Following Bulletin 17-B Guidelines
                        Program peakfq
                    (Version 2.3, Jan, 1997)


          Station - 03339500  SUGAR CREEK AT CRAWFORDSVILLE, IND.
                          1997 JAN 7 15:55:09


                    I N P U T   D A T A   S U M M A R Y

               Number of peaks in record            =       42
               Peaks not used in analysis           =        2
               Systematic peaks in analysis         =       39
               Historic peaks in analysis           =        1
               Years of historic record             =      102
               Generalized skew                     =   -0.400
               Standard error of generalized skew   =    0.550
               Skew option                          =   WEIGHTED
               Gage base discharge                  =      0.0
               User supplied high outlier threshold =    35000.0
               User supplied low outlier criterion  =   --
               Plotting position parameter          =     0.00


*********  NOTICE  --  Preliminary machine computations.        *********
*********  User responsible for assessment and interpretation.  *********

 **WCF109W-PEAKS WITH MINUS-FLAGGED DISCHARGES WERE BYPASSED.        2
 **WCF113W-NUMBER OF SYSTEMATIC PEAKS HAS BEEN REDUCED TO NSYS =    39
   WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                    0.0
   WCF198I-LOW OUTLIERS BELOW FLOOD BASE WERE DROPPED.           1    1457.8
  *WCF161I-USER HIGH OUTLIER CRITERION REPLACES WRC.    35000.0     43331.8
   WCF165I-HIGH OUTLIERS AND HISTORIC PEAKS ABOVE HHBASE.  0  1     35000.0
   WCF002J-CALCS COMPLETED.  RETURN CODE =  2
```

Station - 03339500 SUGAR CREEK AT CRAWFORDSVILLE, IND.
1997 JAN 7 15:55:09

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.9501	0.2944	-1.135
BULL.17B ESTIMATE	1457.8	0.9746	3.9730	0.2562	-0.371

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	95-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.9950	--	773.7	--	--	--
0.9900	--	1083.0	--	--	--
0.9500	3360.0	2459.0	3212.0	2504.0	4179.0
0.9000	4327.0	3592.0	4209.0	3377.0	5236.0
0.8000	5798.0	5395.0	5721.0	4737.0	6849.0
0.5000	9746.0	10110.0	9746.0	8329.0	11430.0
0.2000	15560.0	15830.0	15720.0	13150.0	19100.0
0.1000	19480.0	18790.0	19850.0	16170.0	24760.0
0.0400	24390.0	21660.0	25210.0	19780.0	32270.0
0.0200	27990.0	23280.0	29250.0	22340.0	38020.0
0.0100	31520.0	24550.0	33340.0	24790.0	43820.0
0.0050	34980.0	25550.0	37470.0	27150.0	49670.0
0.0020	39500.0	26560.0	43080.0	30170.0	57490.0

Station - 03339500 SUGAR CREEK AT CRAWFORDSVILLE, IND.
1997 JAN 7 15:55:09

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
-1913	36000.0	H	1957	26300.0	
1927	-24300.0	H	1958	15100.0	
1937	-8720.0	H	1959	14600.0	
1939	17600.0		1960	7300.0	
1940	3660.0		1961	8580.0	
1941	903.0		1962	15100.0	
1942	5050.0		1963	15100.0	
1943	24000.0		1964	21800.0	
1944	11400.0		1965	6200.0	
1945	9470.0		1966	2130.0	
1946	8970.0		1967	11100.0	
1947	7710.0		1968	14300.0	
1948	14800.0		1969	11200.0	
1949	13900.0		1970	6670.0	
1950	20800.0		1971	5440.0	
1951	9470.0		1972	9370.0	
1952	7860.0		1973	6900.0	
1953	7860.0		1974	9680.0	
1954	2730.0		1975	6810.0	
1955	6480.0		1976	7730.0	
1956	18200.0		1977	5290.0	

Explanation of peak discharge qualification codes

PEAKFQ CODE	WATSTORE CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

Station - 03339500 SUGAR CREEK AT CRAWFORDSVILLE, IND.
1997 JAN 7 15:55:09

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
-1913	36000.0	--	0.0097
1957	26300.0	0.0250	0.0271
1943	24000.0	0.0500	0.0523
1964	21800.0	0.0750	0.0774
1950	20800.0	0.1000	0.1026
1956	18200.0	0.1250	0.1277
1939	17600.0	0.1500	0.1529
1958	15100.0	0.1750	0.1780
1962	15100.0	0.2000	0.2031
1963	15100.0	0.2250	0.2283
1948	14800.0	0.2500	0.2534
1959	14600.0	0.2750	0.2786
1968	14300.0	0.3000	0.3037
1949	13900.0	0.3250	0.3289
1944	11400.0	0.3500	0.3540
1969	11200.0	0.3750	0.3791
1967	11100.0	0.4000	0.4043
1974	9680.0	0.4250	0.4294
1945	9470.0	0.4500	0.4546
1951	9470.0	0.4750	0.4797
1972	9370.0	0.5000	0.5049
1946	8970.0	0.5250	0.5300
1961	8580.0	0.5500	0.5551
1952	7860.0	0.5750	0.5803
1953	7860.0	0.6000	0.6054
1976	7730.0	0.6250	0.6306
1947	7710.0	0.6500	0.6557
1960	7300.0	0.6750	0.6809
1973	6900.0	0.7000	0.7060
1975	6810.0	0.7250	0.7311
1970	6670.0	0.7500	0.7563
1955	6480.0	0.7750	0.7814
1965	6200.0	0.8000	0.8066
1971	5440.0	0.8250	0.8317
1977	5290.0	0.8500	0.8569
1942	5050.0	0.8750	0.8820
1940	3660.0	0.9000	0.9071
1954	2730.0	0.9250	0.9323
1966	2130.0	0.9500	0.9574
1941	903.0	0.9750	0.9826
1937	-8720.0	--	--
1927	-24300.0	--	--

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Following Bulletin 17-B Guidelines
Program peakfq
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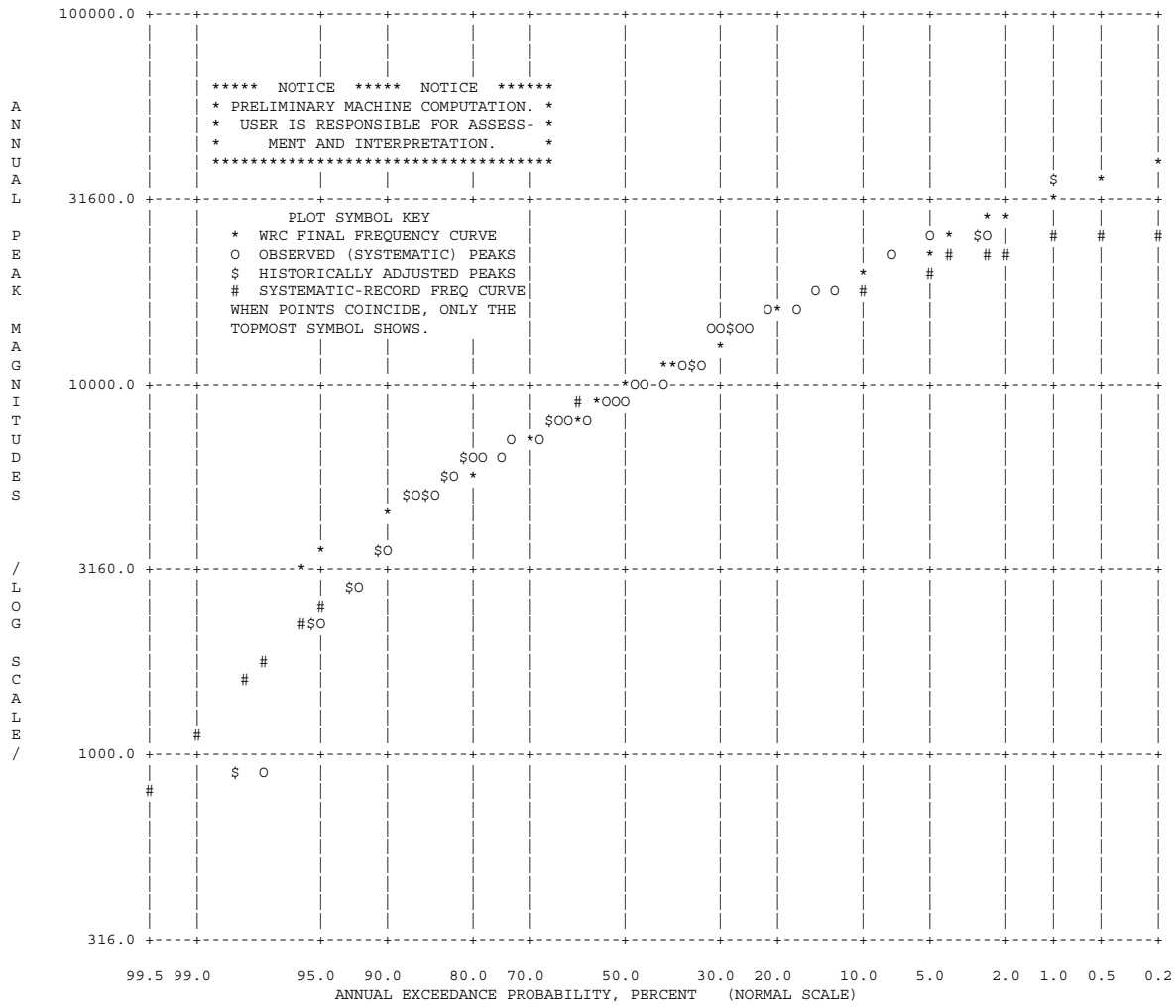
Station - 03339500 SUGAR CREEK AT CRAWFORDSVILLE, IND.



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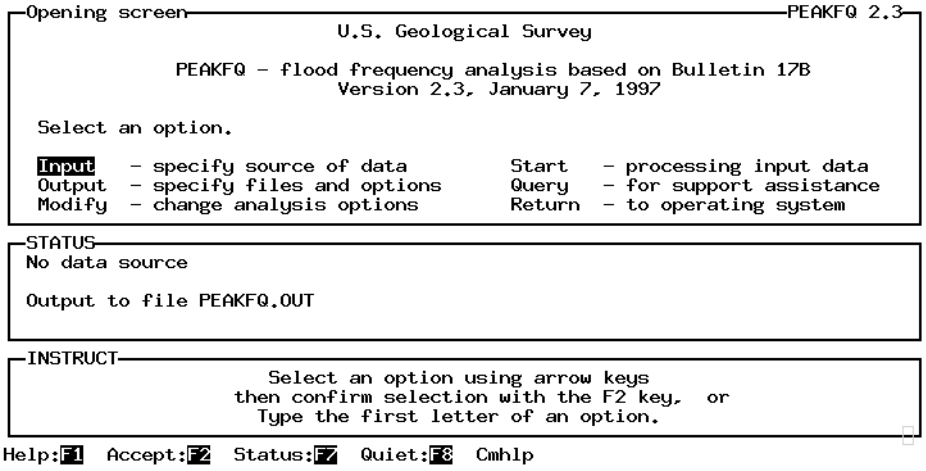
End PEAKFQ analysis.

Stations processed	:	5
Number of errors	:	0
Stations skipped	:	0
Station years	:	185

Opening Screen

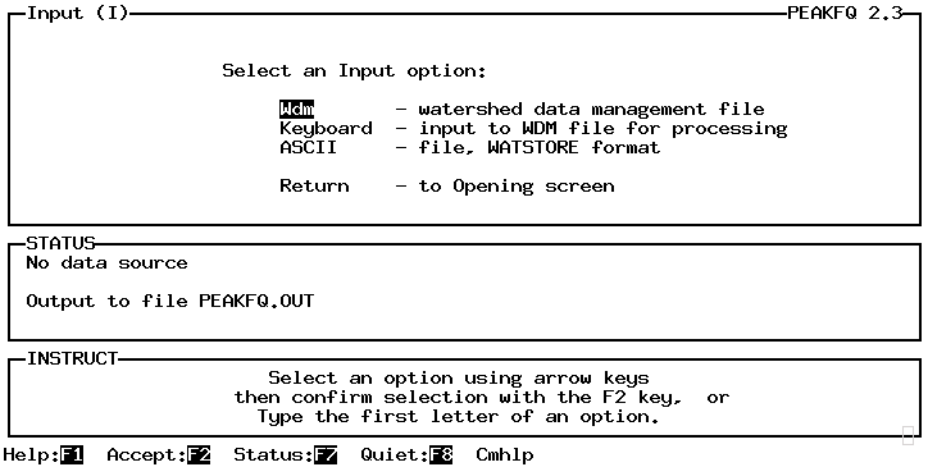
The program version number and date (2.3 and January 7, 1997, respectively) are included in the heading of the Opening screen. The program name and version number are also included in the upper right hand corner of the screen and on all subsequent screens. The primary program options are all found on the opening screen. They should be accessed in the order Input Output, Modify, and Start processing.

The STATUS window in the middle of the screen includes information on the source of the data to be analyzed, the number of stations being analyzed and the names of input and output files. This information is updated as the information is changed. Initially, the input format is unknown and the default output file is PEAKFQ.OUT.



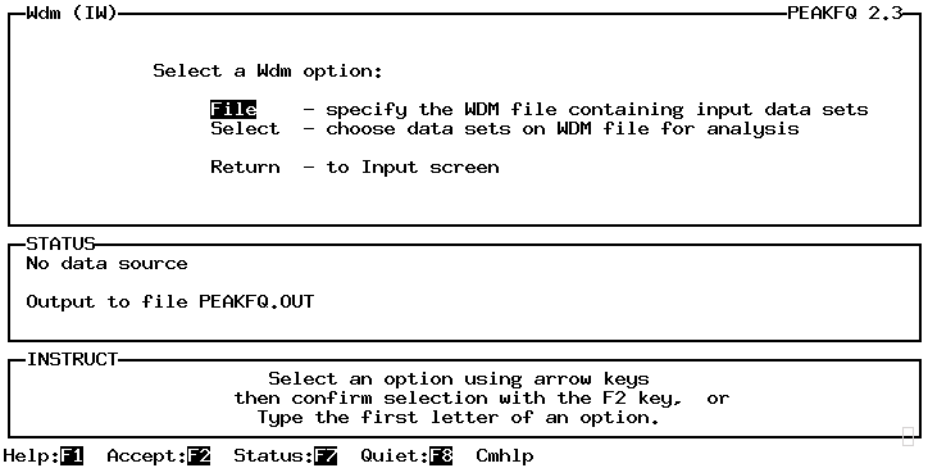
Input

Data from 3 sources can be processed: (1) Watershed Data Management (WDM) file, (2) ASCII file in the standard WATSTORE card-image format, and (3) keyboard entry. This example shows the WDM option, see Input in the next section for a complete description of the input options.



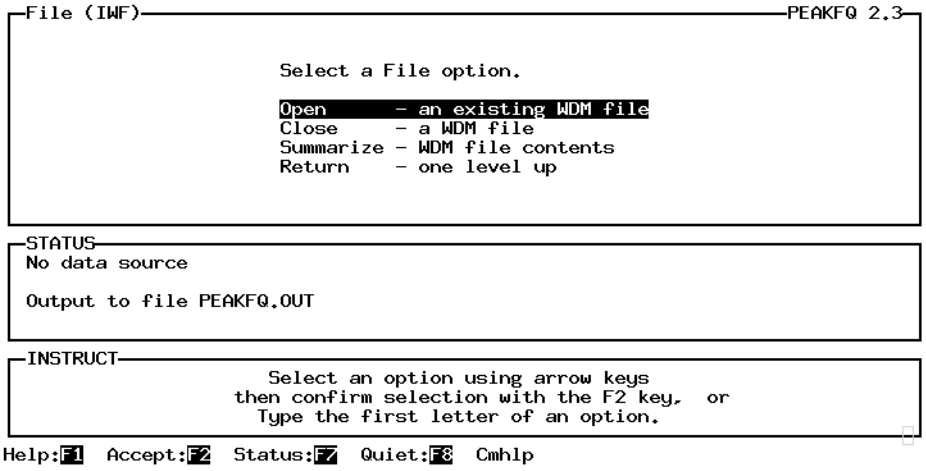
Input / Wdm

With the WDM input option, the user specifies the name of the WDM file to be used and selects the data sets to be used. A WDM file must be open before data sets can be selected.



Input / WDM / File

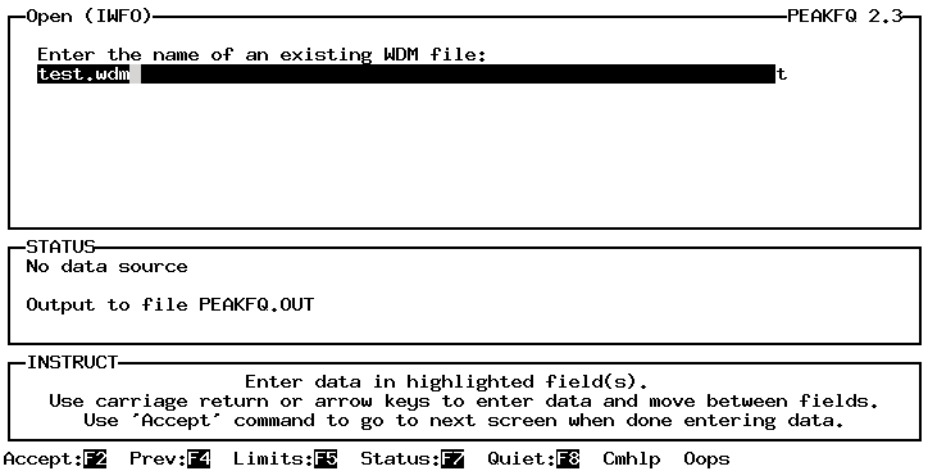
From the File menu, the user may select to Open and existing WDM file, Close a previously opened WDM file, or get a brief Summary of the contents of an open WDM file. PEAKFQ does not support accessing multiple WDM files, but an open WDM file can be closed and another opened. After opening a new WDM file, data sets must be re-selected.



Input / Wdm / File / Open

The name of an existing WDM file is entered. There are no restriction on WDM file names. Any name that is valid on the computer being used is acceptable. However, the suffix .WDM or .wdm is suggested to make the files easy to identify. If the file is not in the local directory, a full or relative path name can be included.

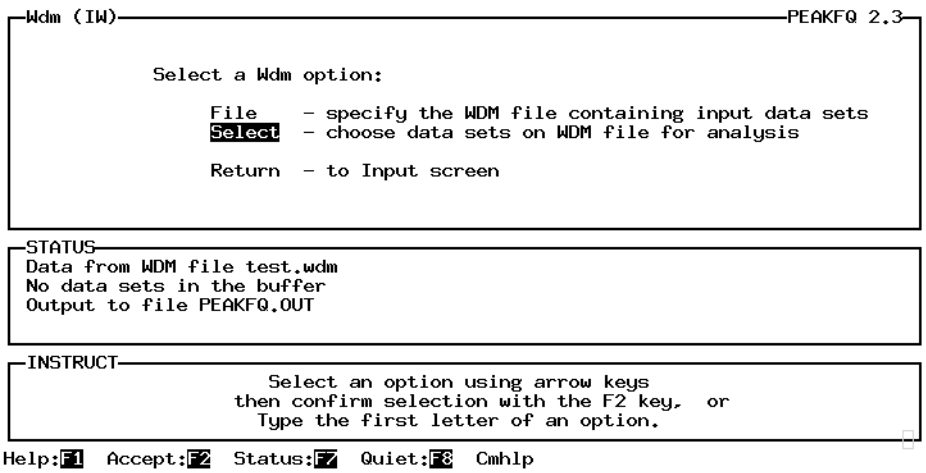
Note that once this screen is exited, the STATUS window will identify this WDM file as being the source of the data to be analyzed.



Input / Wdm / File (screen with selection of Return option not shown)

Input / Wdm

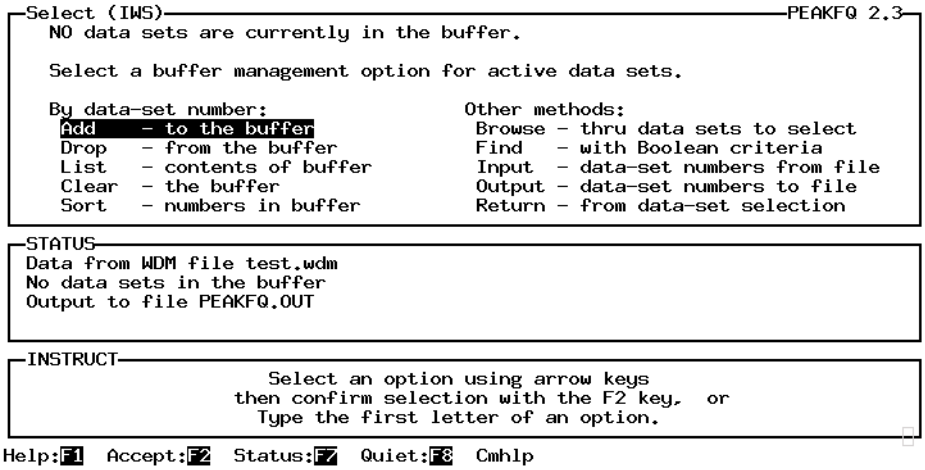
Once an existing WDM file has been opened, the data sets to be analyzed are Selected.



Input / Wdm / Select

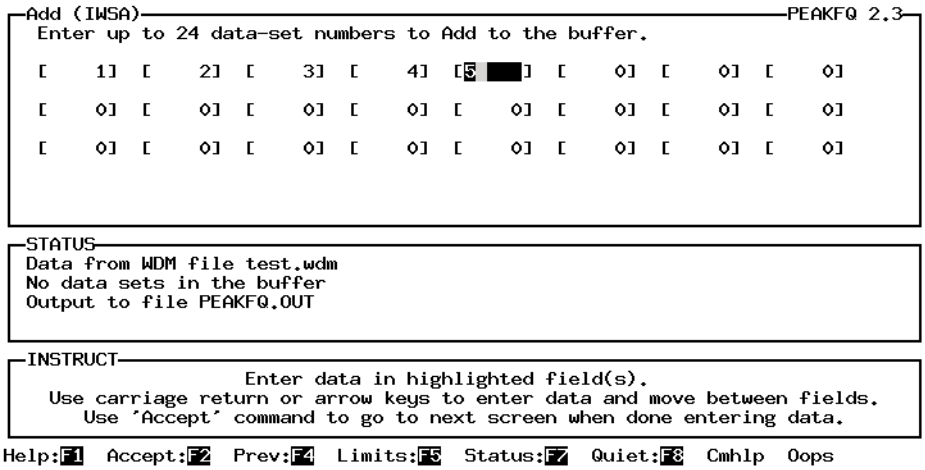
The select option offers a number of options for selecting and unselecting data sets. The data-set number (dsn) of each selected data set is stored in a buffer. The contents of the buffer determine what data sets will be analyzed by PEAKFQ. Data sets may be Added to or Dropped from the buffer by number. Data sets may also be selected by Browsing a brief description of the data sets in the wdm file or by searching the contents using Boolean criteria. For a detailed description of all of the Select options, see the next section.

Note that initially, the STATUS window indicates three are no data sets in the buffer. After the Select menu is exited the STATUS window will be updated to indicate the number of data sets in the buffer.



Input / Wdm / Select / Add

The Add option is used to add data sets to the buffer using the data-set number. Up to 24 data set can be added to the buffer at a time. The Add option may be selected as many times as needed to add all the desired data sets to the buffer.



Input / Wdm / Select (screen with selection of Return option not shown)

Opening screen (screen with selection of Output option not shown)

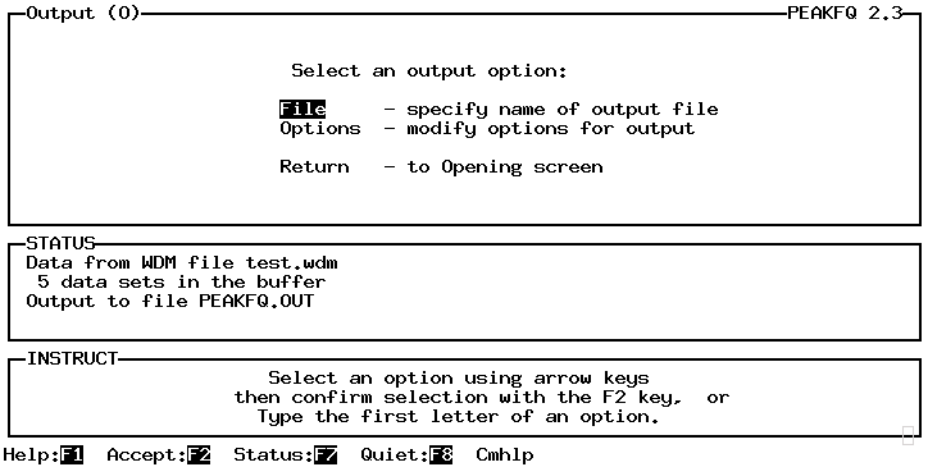
Output

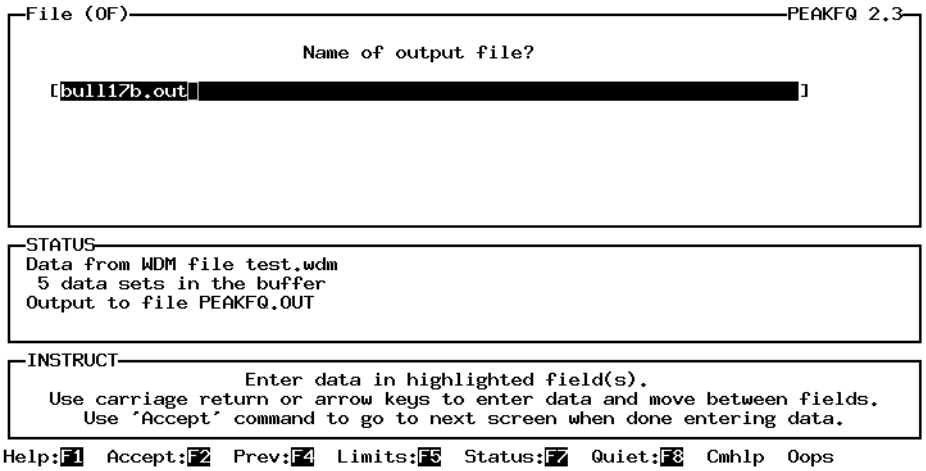
The Output option is selected to identify an output file other than the default file or to specify general processing options that will apply to all data sets being analyzed.

Output / File

Select the Output/File option to specify a different file for output. By default, the program output will be written to the file PEAKFQ.OUT. Any file name valid on the computer being used is acceptable. The file may be in the local directory or a relative or full pathname may be used.

Note that the program will close the previously opened file and open the new one. The STATUS window will be updated with the new output file name when the File form is exited.

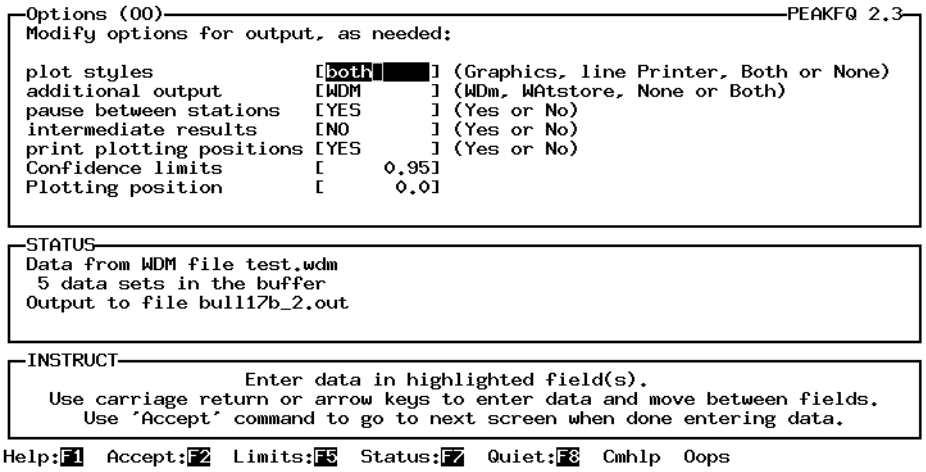




Output (screen with selection of Options option not shown)
Output/Options

Select Output/Options to modify options for output that will be used for all of the data sets processed. These include plotting styles, saving additional output to other files, having the program pause between processing each data set. and including additional information in the output file.

In the example, plot style was changed from NONE to Both, causing the print file to contain the old-fashioned line printer plots and also generating the more modern-style graphical output. The default value was used for all other options.



Options (screen with selection of Return option not shown)

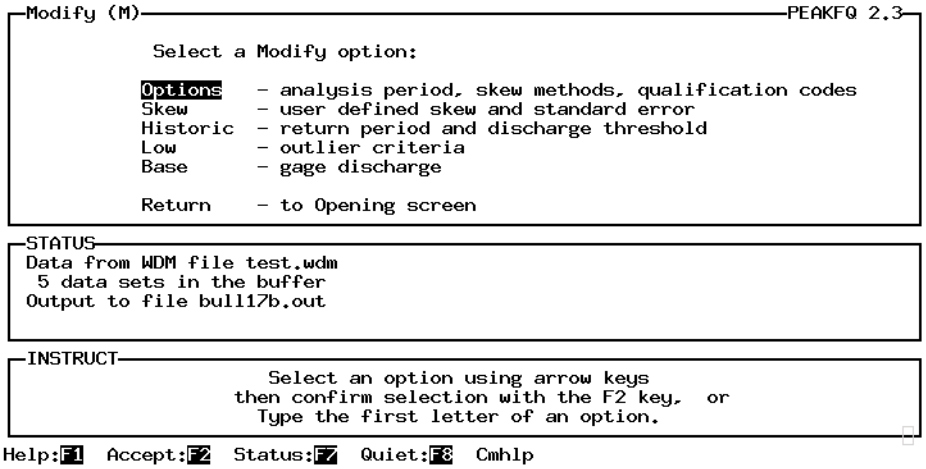
Opening Screen (screen showing selection of Modify option not shown.

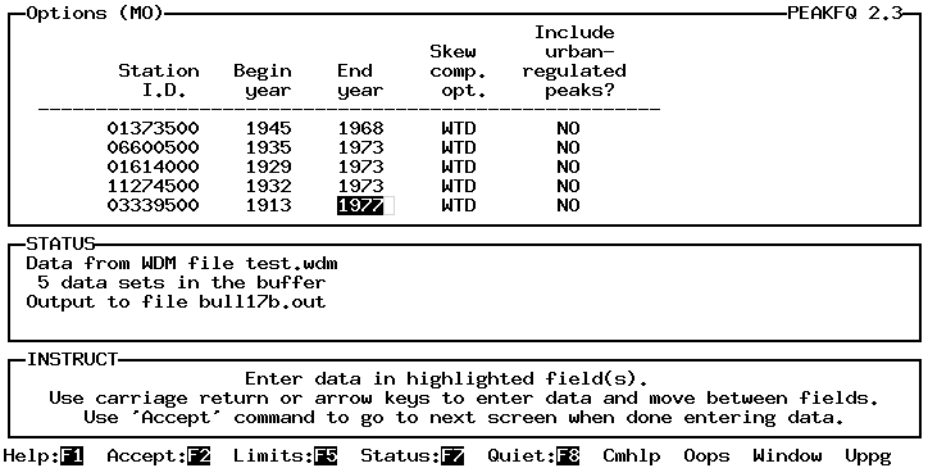
Modify
Modify / Options

The modify option is selected to change processing options that apply to the calculations for individual data sets.

Select Options to modify the analysis period, skew method, and whether or not to include urban or regulated peaks. The initial default values for the dates are based on the available period of record. The initial default for the skew computation option is weighted between station and generalized skews (WTD), with the other options being STAtion and GENeralized. By default, urban and regulated peaks are not included. When processing data from a WDM file, peakfq will save these options and they will be provided as the data sets defaults for future analyses. The first column in the table is informational and cannot be modified.

In the example, the Begin and End years were modified to correspond to the dates used in the Bulletin 17B report. The skew computation option remained as WeighTeD and urban and regulated peaks were not included (the default values.)

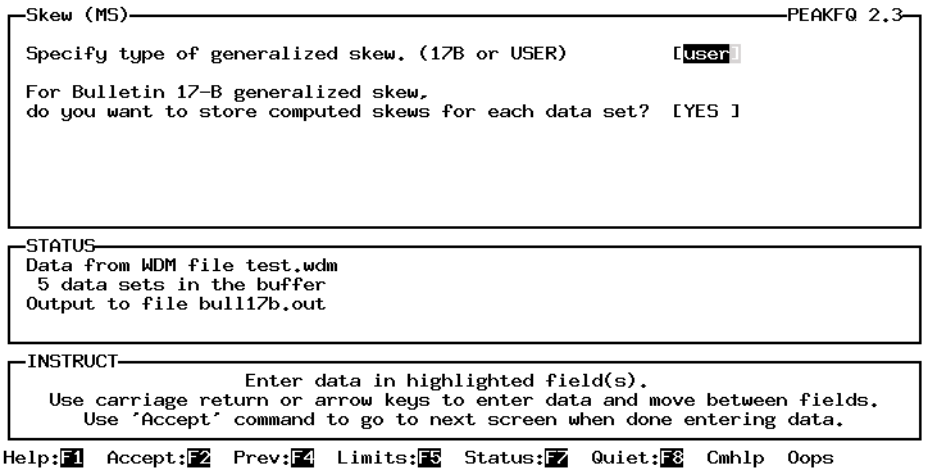


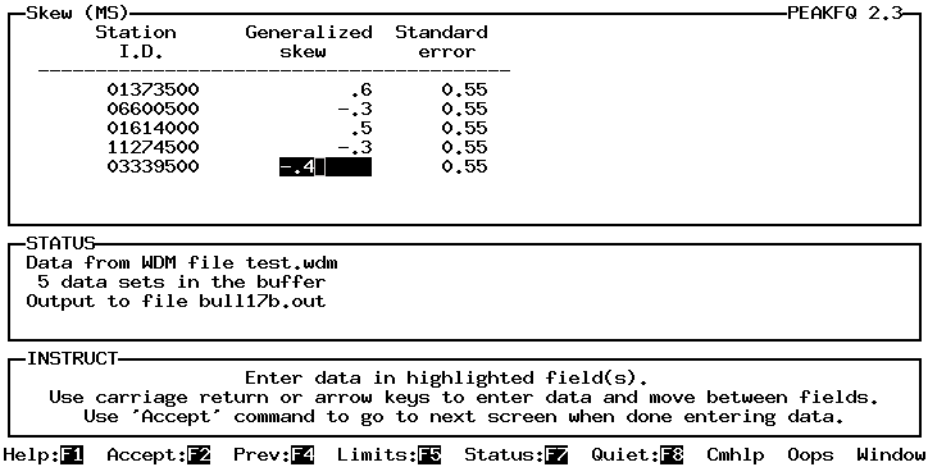


Modify (screen with selection of Skew option not shown)
Modify / Skew
Modify / Skew (User)

Select Skew to enter generalized skew and standard error, replacing the estimate for the generalized skew map of the Bulletin 17-B guidelines. By default, the Bulletin 17-B values will be used and the computed skews will be saved in each data set. If User skew is selected, the generalized skew values are entered on a second Skew screen. In the second skew screen, the first column in the table is informational and cannot be modified.

In the example, the type of generalized skew was changed from the default 17B to User and Generalized skew values were entered for each of the data sets.

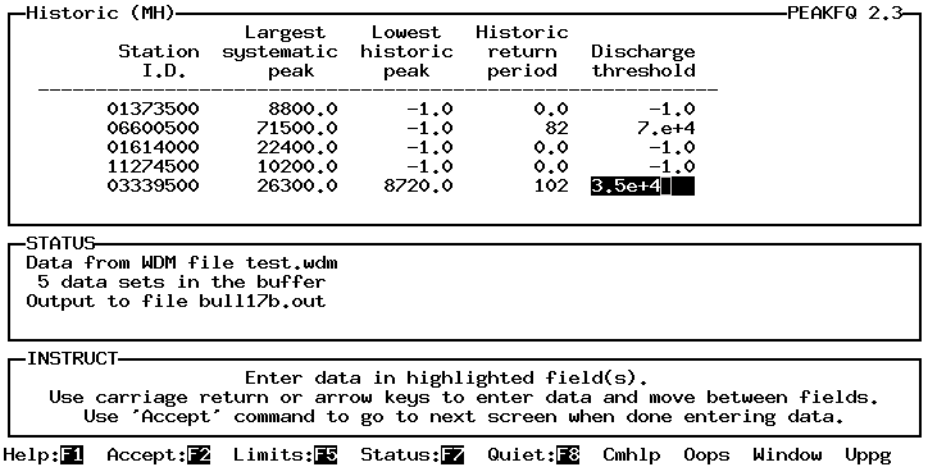




Modify (screen with selection of Historic option not shown)
Modify / Historic

The Historic option is selected to modify the length of the historic return period and (or) Bulletin 17-B computed high-outlier discharge threshold. The first three columns in the table are informational and cannot be modified.

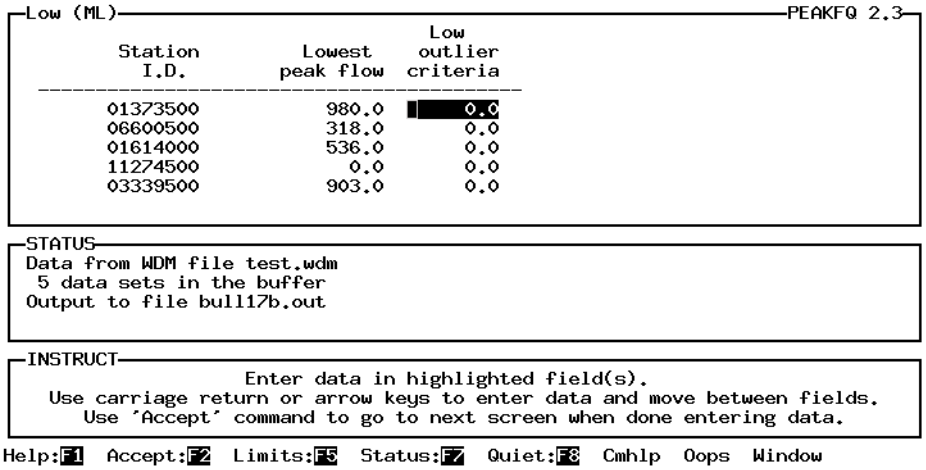
In the example, values for the second and 5th data sets were modified to correspond to the examples in the Bulletin 17-B report.



Modify (screen with selection of Low option not shown)
Modify / Low

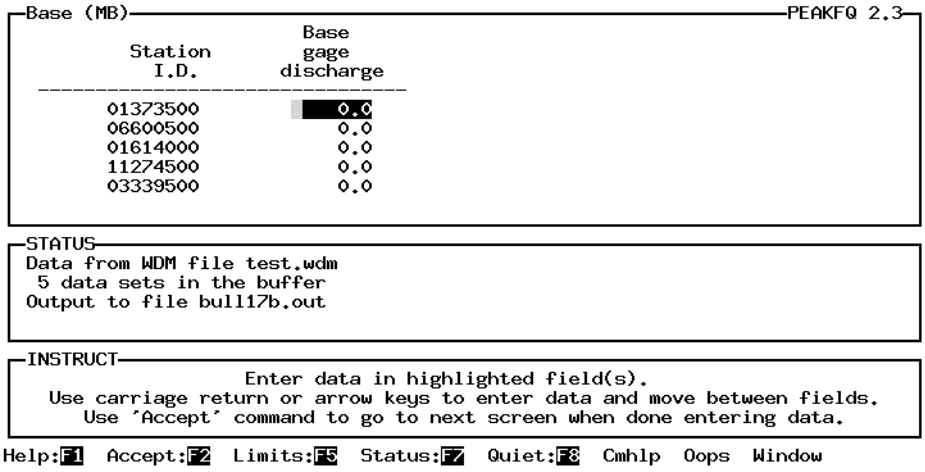
Select Low to specify a discharge below which historic peaks will not be used in the calculations. If a value greater than 0.0 is entered, this will override the Bulletin 17-B computed low-outlier criteria. The first two columns in the table are informational and cannot be changed. The lowest peak flow column contains the lowest annual peak flow in the systematic record.

In the example, no changes were made.



Modify (screen with selection of Base option not shown)
Modify / Base

Select Base to adjust the lower limit for measurable flood discharge, this is used in conjunction with the “less than” qualification code. A value greater than 0.0 will supersede the gage base discharge inferred from any “less than” qualification codes. The first column in the table in informational and cannot be modified. In the example, no values were entered.

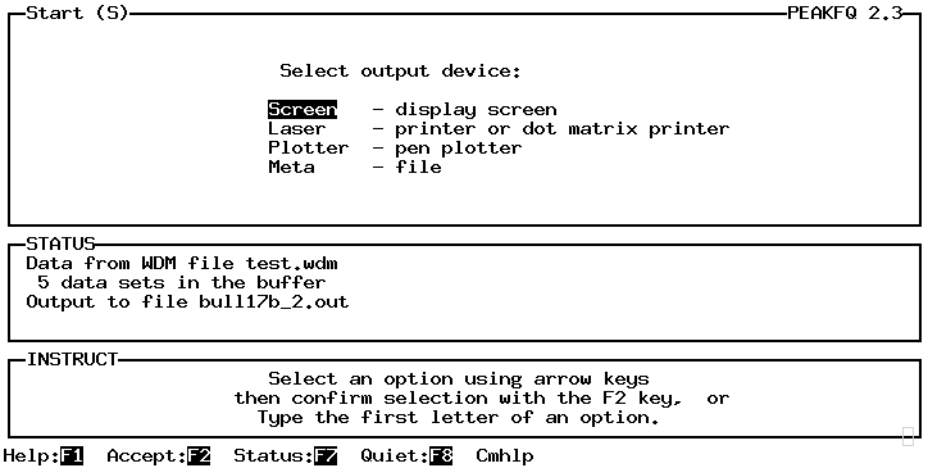


Modify (screen with selection of Return option not shown)

Opening Screen (screen with selection of Start option not shown)
Start

After the Input source has been specified and any desired Output or Modify entries have been made, select Start to perform the analysis.

If the plot style Graphics or Both was specified on the Output /Options screen, the screen for selecting the output graphics device will be displayed.



Start (results of analysis)

In the example, the computed statistics and plots for each of the data sets were displayed on the screen (on the Output/Options screen, Yes was specified for Pause between stations.)

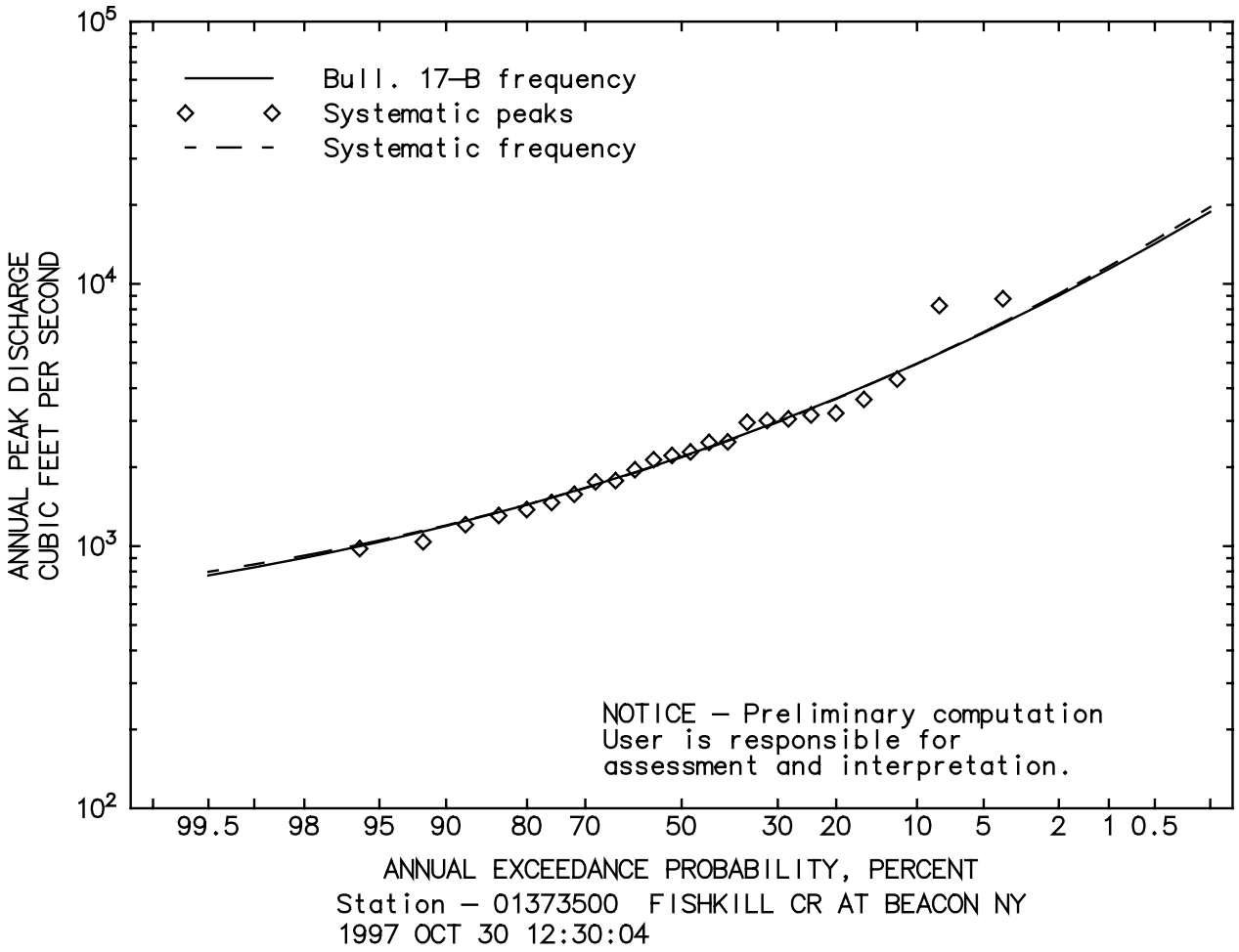
```
Start (S)                                                    PEAKFQ 2.3
Station 01373500
Data set      1 (     1 of      5)

                                          Annual flood peak recurrences
                                          ---------------------------------
                                          year   peak       year    peak
                                          ----  --------    ----  --------
      Bulletin 17-B estimate              1.25 1438.197       50  9031.32
 ---------------------------------          2 2193.822      100 11388.79
    mean of Log of peak Q: 3.36835          5 3657.278      200 14216.23
 std dev of Log of peak Q: .245614         10 4959.224      500 18829.71
    skew of Log of peak Q: .667804         25 7066.739

STATUS
Data from WDM file test.wdm
 5 data sets in the buffer
Output to file bull17b_2.out

INSTRUCT
                    View data in highlighted field.
              Use 'Help' command to see field definition(s).

Accept:F2  Limits:F5  Status:F7  Quiet:F8  Cmhlp
```



Start (S) PEAKFQ 2.3

Station 06600500
Data set 2 (2 of 5)

Bulletin 17-B estimate

mean of Log of peak Q:	3.53741
std dev of Log of peak Q:	.437678
skew of Log of peak Q:	.074845

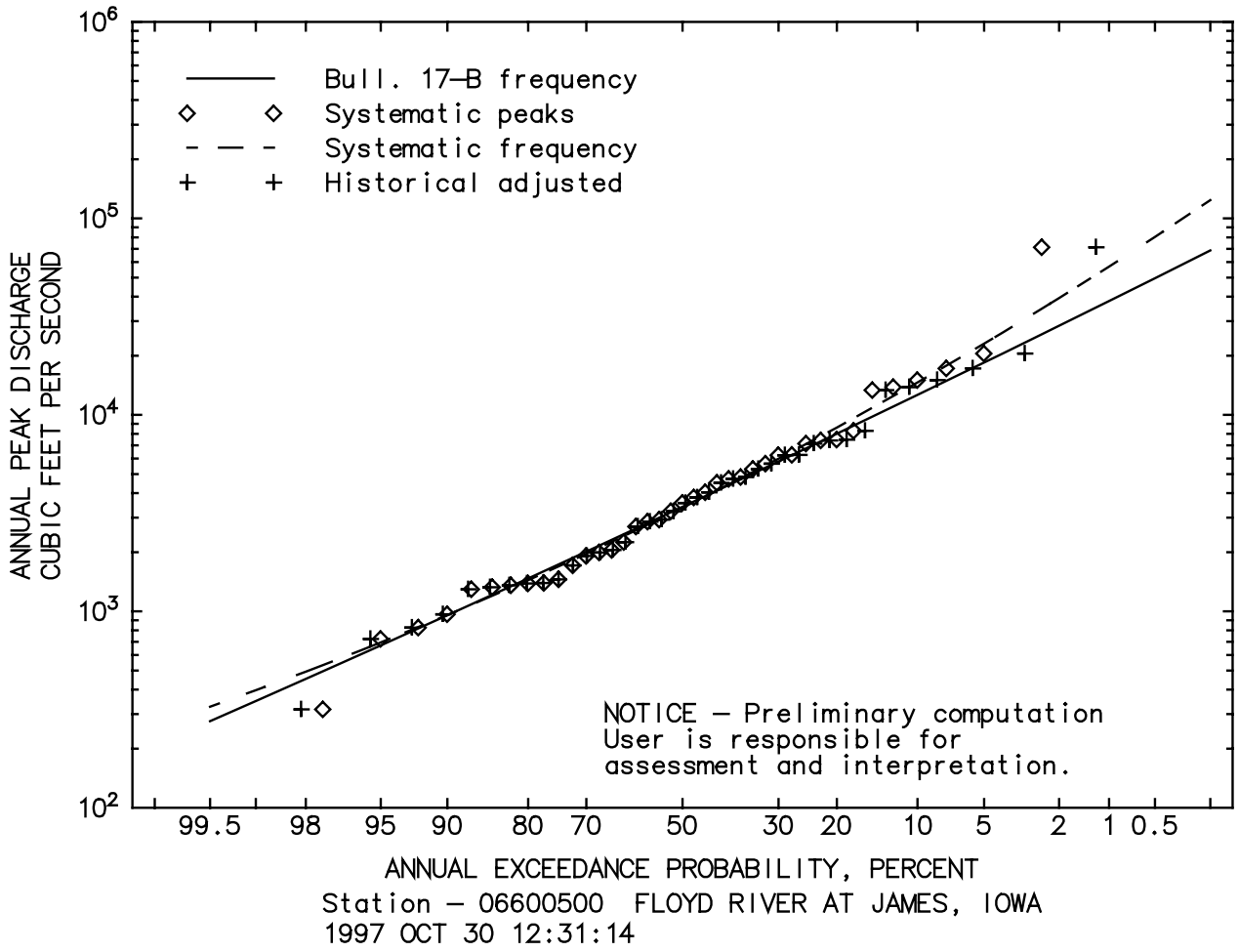
Annual flood peak recurrences

year	peak	year	peak
1.25	1470.786	50	28428.84
2	3403.812	100	37986.11
5	8018.35	200	49606.41
10	12638.82	500	68698.16
25	20644.46		

STATUS
Data from WDM file test.wdm
5 data sets in the buffer
Output to file bull17b_2.out

INSTRUCT
View data in highlighted field.
Use 'Help' command to see field definition(s).

Accept:F2 Limits:F5 Status:F7 Quiet:F8 Cmhlp



Start (S) PEAKFQ 2.3

Station 01614000
Data set 3 (3 of 5)

Bulletin 17-B estimate

mean of Log of peak Q:	3.74071
std dev of Log of peak Q:	.232844
skew of Log of peak Q:	.565304

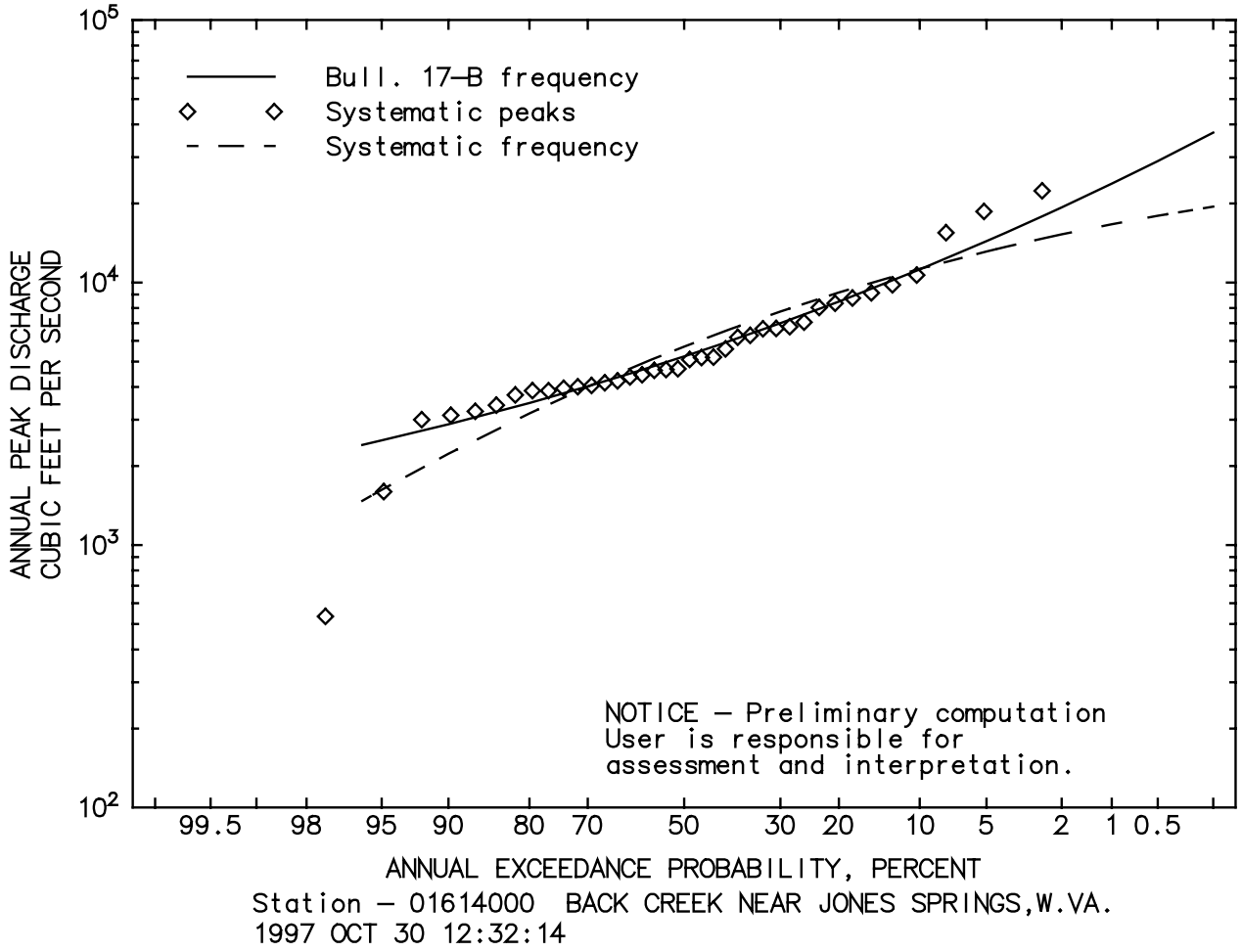
Annual flood peak recurrences

year	peak	year	peak
1.25	3476.542	50	19327.22
2	5234.479	100	23803.5
5	8464.331	200	29019.72
10	11210.56	500	37254.95
25	15484.17		

STATUS
Data from WDM file test.wdm
5 data sets in the buffer
Output to file bull17b_2.out

INSTRUCT
View data in highlighted field.
Use 'Help' command to see field definition(s).

Accept:F2 Limits:F5 Status:F7 Quiet:F8 Cmhlp



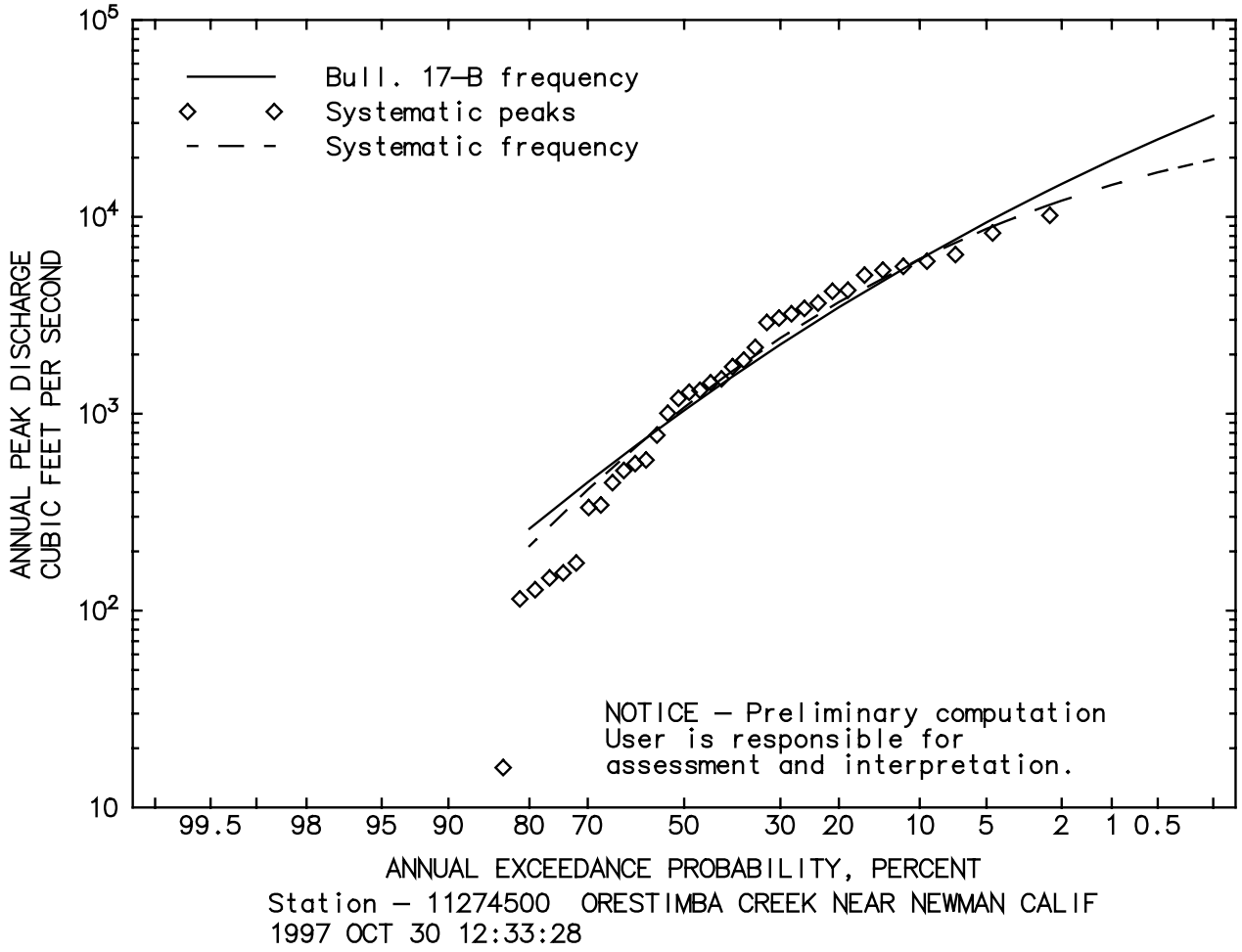
```
Start (S)                                                    PEAKFQ 2.3
Station 11274500
Data set      4 (     4 of      5)

      Bulletin 17-B estimate                  Annual flood peak recurrences
 ---------------------------------      ---------------------------------
    mean of Log of peak Q: 2.96278      year   peak       year    peak
 std dev of Log of peak Q: .674932      ----  --------    ----  --------
    skew of Log of peak Q: -.48689      1.25 260.9111       50  14697.72
                                           2 1040.761      100  19439.12
                                           5 3473.592      200  24766.88
                                          10 6095.031      500  32654.04
                                          25 10570.32

STATUS
Data from WDM file test.wdm
 5 data sets in the buffer
Output to file bull17b_2.out

INSTRUCT
                    View data in highlighted field.
              Use 'Help' command to see field definition(s).

Accept:F2  Limits:F5  Status:F7  Quiet:F8  Cmhlp
```



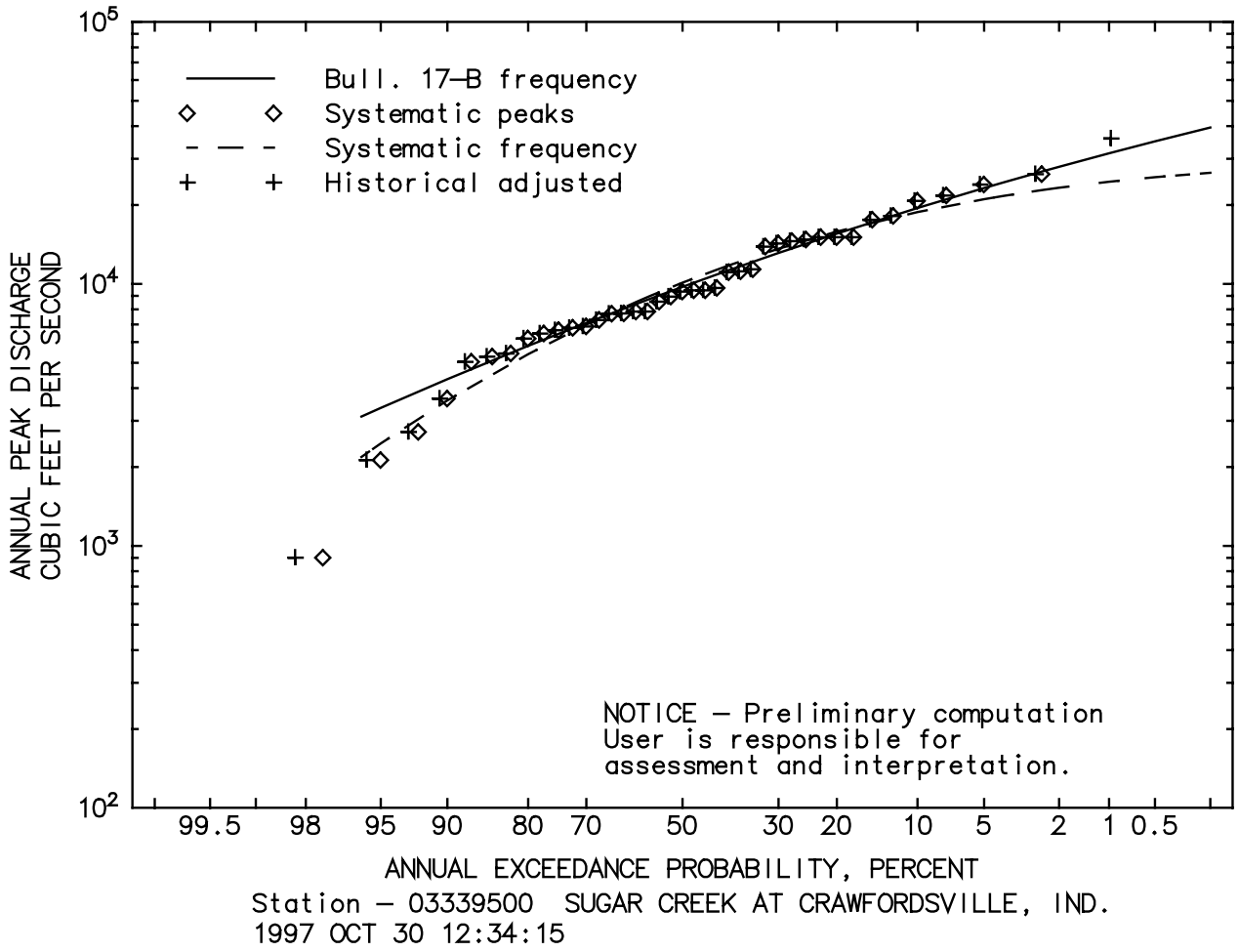
```
Start (S)                                                    PEAKFQ 2.3
Station 03339500
Data set      5 (     5 of      5)

      Bulletin 17-B estimate                  Annual flood peak recurrences
 ---------------------------------          ---------------------------------
                                            year   peak       year    peak
                                            ----  --------    ----   --------
    mean of Log of peak Q: 3.97303          1.25 5798.212      50   27990.43
 std dev of Log of peak Q: 0.25621             2 9746.165     100   31516.15
    skew of Log of peak Q: -.37087             5 15558.35     200   34984.52
                                              10  19477.4     500   39495.55
                                              25  24392.7

STATUS
Data from WDM file test.wdm
 5 data sets in the buffer
Output to file bull17b_2.out

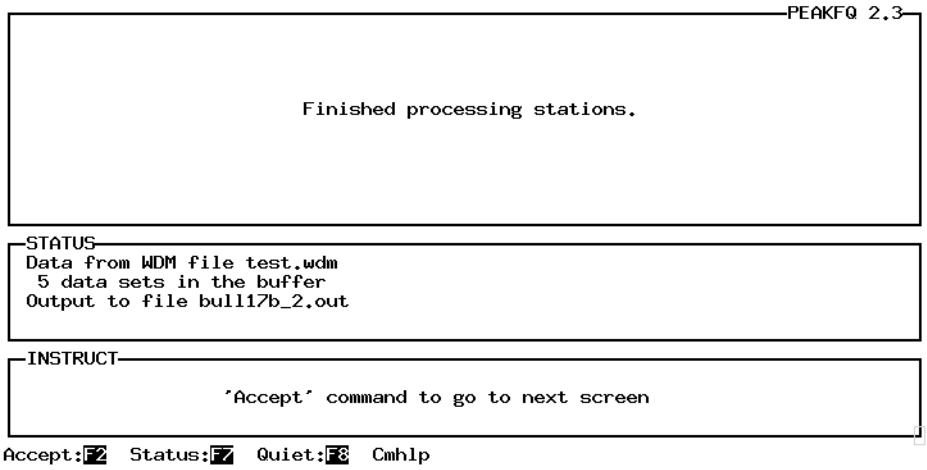
INSTRUCT
                    View data in highlighted field.
              Use 'Help' command to see field definition(s).

Accept:F2  Limits:F5  Status:F7  Quiet:F8  Cmhlp
```



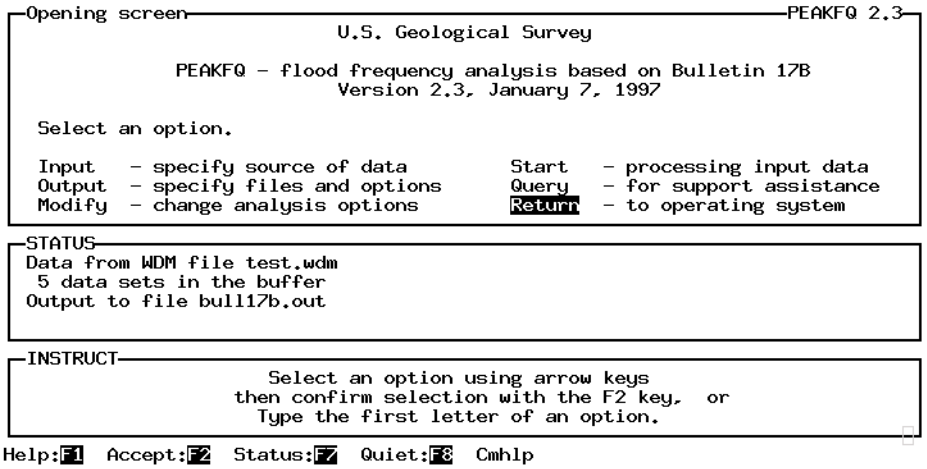
(finished processing)

A screen indicating that all of the stations have been processed is displayed.



Opening screen

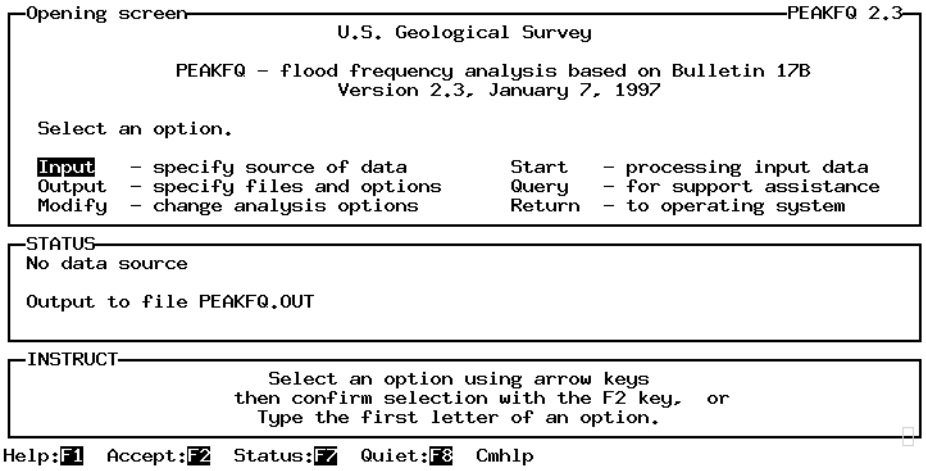
After all of the stations have been processed, the user can change the general Output options, Modify the processing options for selected data sets, or select new Input to analyze a different set of data.



Opening screen

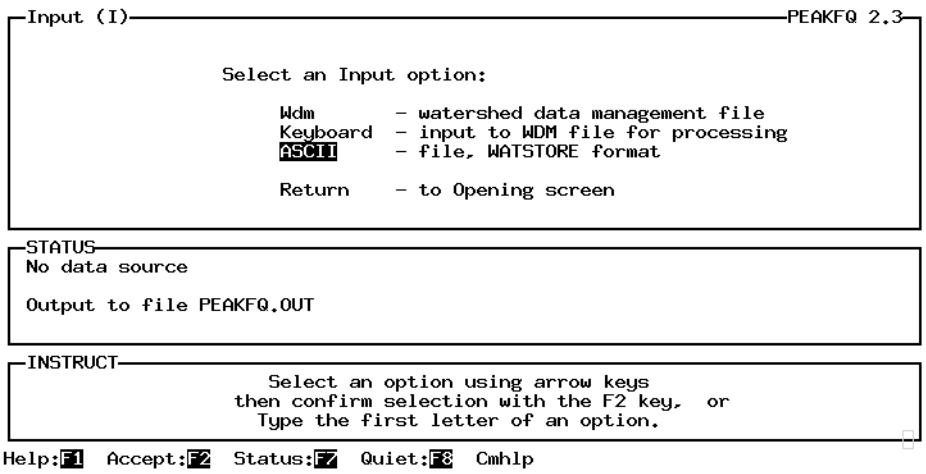
The program version number and date (2.3 and January 7, 1997, respectivley) are included in the heading of the Opening screen. The program name and version number are also included in the upper right hand corner of the screen and on all subsequent screens. The primary program options are all found on the opening screen. They should be accessed in the order Input Output, Modify, and Start processing.

The STATUS window in the middle of the screen includes information on the source of the data to be analyzed, the number of stations being analyzed and the names of input and output files. This information is updated as the information is changed. Initially, the input format is unknow and the default output file is PEAKFQ.OUT.



Input

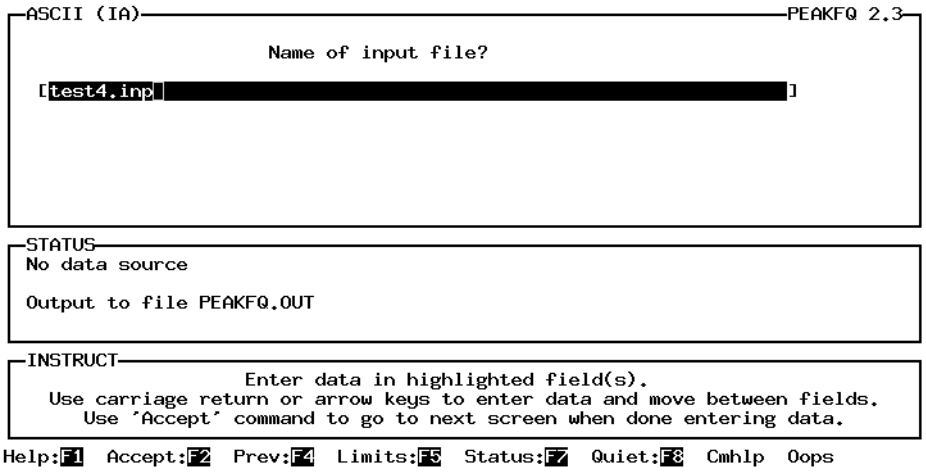
Data from 3 sources can be processed: (1) Watershed Data Management (WDM) file, (2) ASCII file in the standard WATSTORE card-image format, and (3) keyboard entry. This example shows the ASCII option.

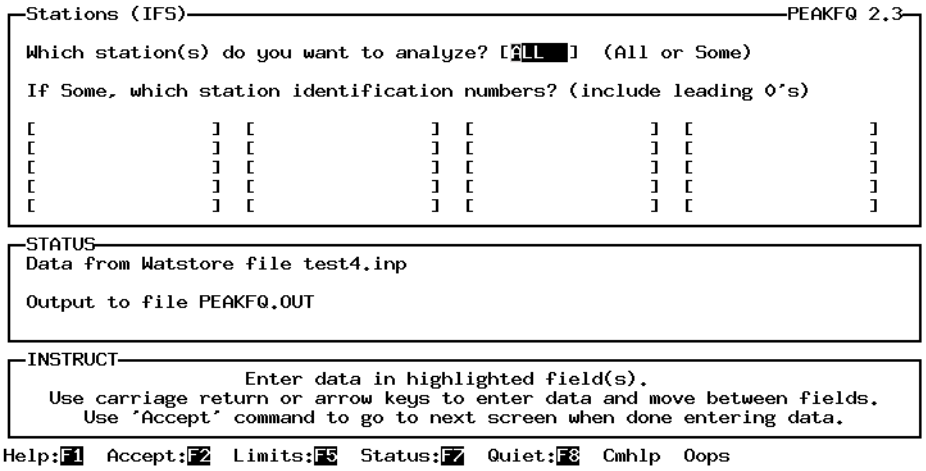


Input / ASCII

With the ASCII input option, the user supplies the name of the file containing the peak flow data to be analyzed. This file must be in the standard, WATSTORE card-image format, as described in Appendix B. This file may contain data for one or more stations. After the file has been opened, the user specifies whether ALL or SOME of the stations in the file are to be analyzed. If ALL is specified, all stations in the file will be analyzed. If SOME is specified, the station numbers for up to 20 stations to be analyzed are entered, including any leading zeros as appropriate.

Note that once the input file has been opened, the STATUS window is updated to indicate input is from the Watstore-formatted file test4.inp.





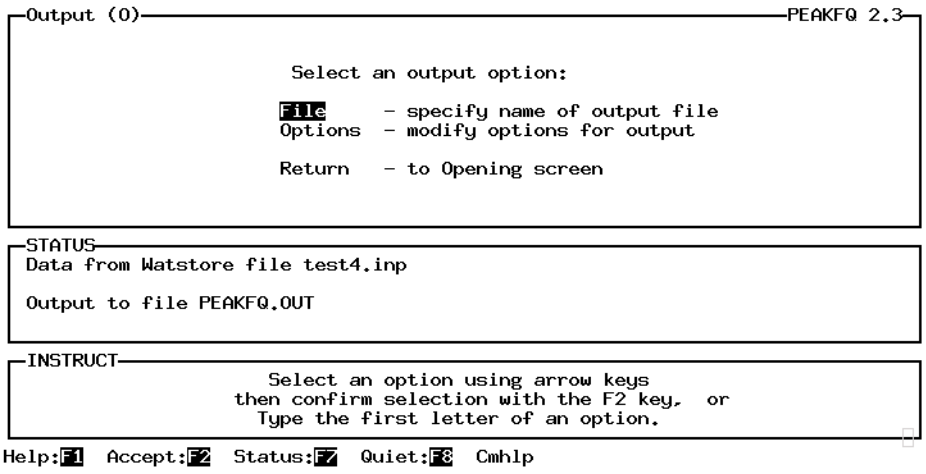
Opening screen (screen with selection of Output option not shown)
Output

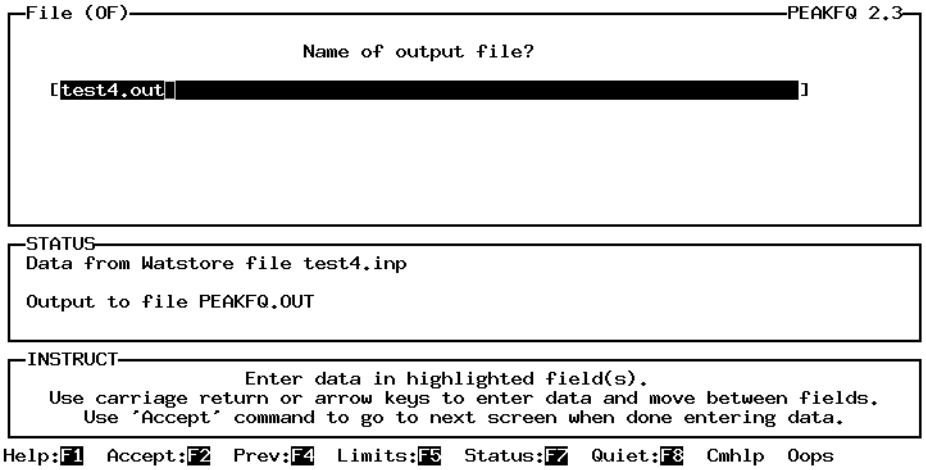
The Output option is selected to identify an output file other than the default file or to specify general processing options that will apply to all stations being analyzed.

Output / File

Select the Output/File option to specify a different file for output. By default, the program output will be written to the file PEAKFQ.OUT. Any file name valid on the computer being used is acceptable. The file may be in the local directory or a relative or full pathname may be used.

Note that the program will close the previously opened file and open the new one. The STATUS window will be updated with the new output file name when the File form is exited.

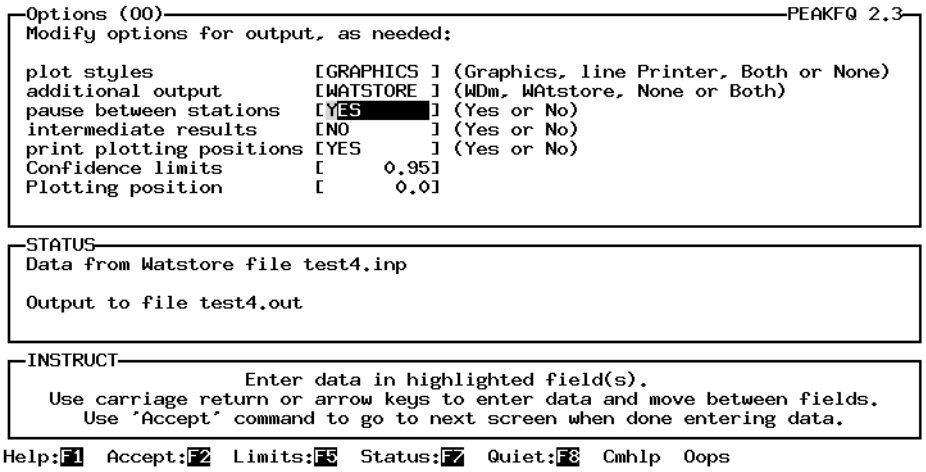


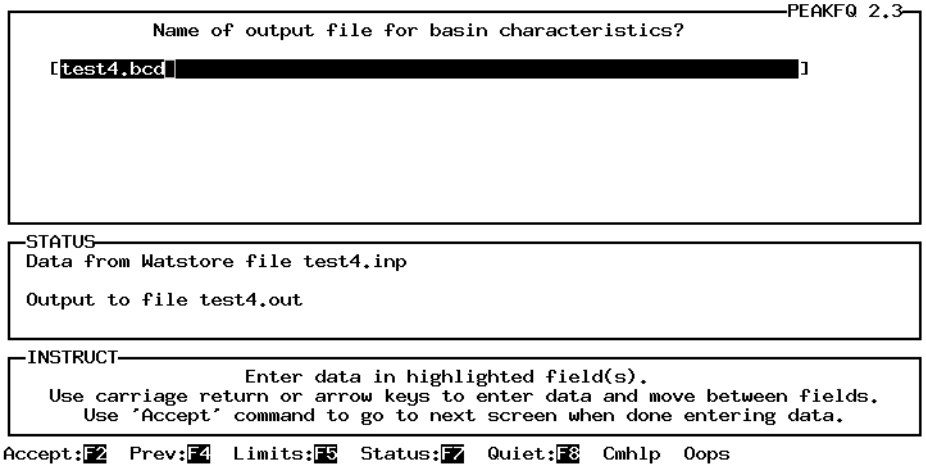


Output (screen with selection of Options option not shown)
Output/Options

Select Output/Options to modify options for output that will be used for all of the stations processed. These include plotting styles, saving additional output to other files, having the program pause between processing each data set. and including additional information in the output file. If WAtstore or Both is specified for additional output, the name for the output file is entered in a separate screen.

In the example, plot style was changed from NONE to GRAPHICS and additional output was specified in the WAtstore format. This will produce the more modern-style graphical output and a file containing the computed basin characteristics statistics. The default value was used for all other options. Since WAtstore output was specified, the file name is entered.



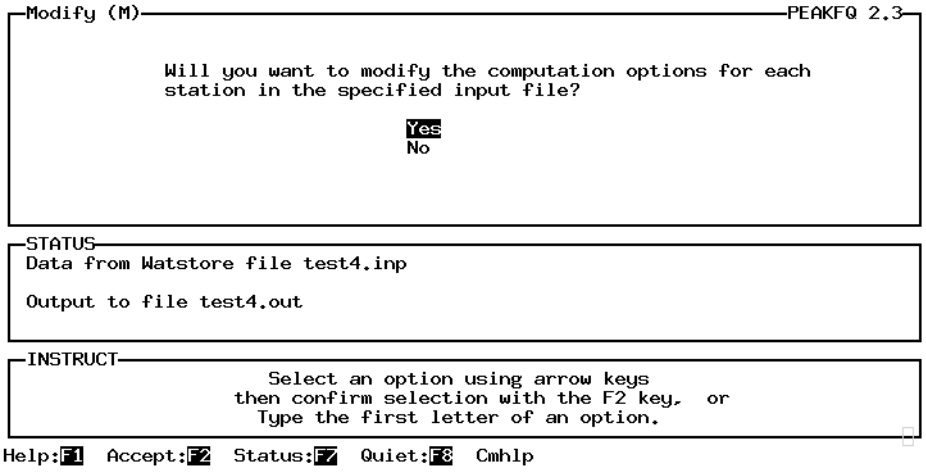


Options (screen with selection of Return option not shown)

Opening Screen (screen showing selection of Modify option not shown.
Modify

The modify option is selected to specify whether or not computational options will need to be modified for any of the stations. If Yes is selected, modifications may be made for each station as it is processed. If No is selected, the default processing options will be used. This differs from processing data input from a WDM file, where the computational options are specified for all data sets before processing begins.

Computational options that may be modified during processing include analysis period, skew methods, historic return periods, discharge threshold , and low outlier criteria. The default computational options are determined by the contents of the input file, including any “I” records that may be present. See the Start / Modify description of this example for details of the computational options.

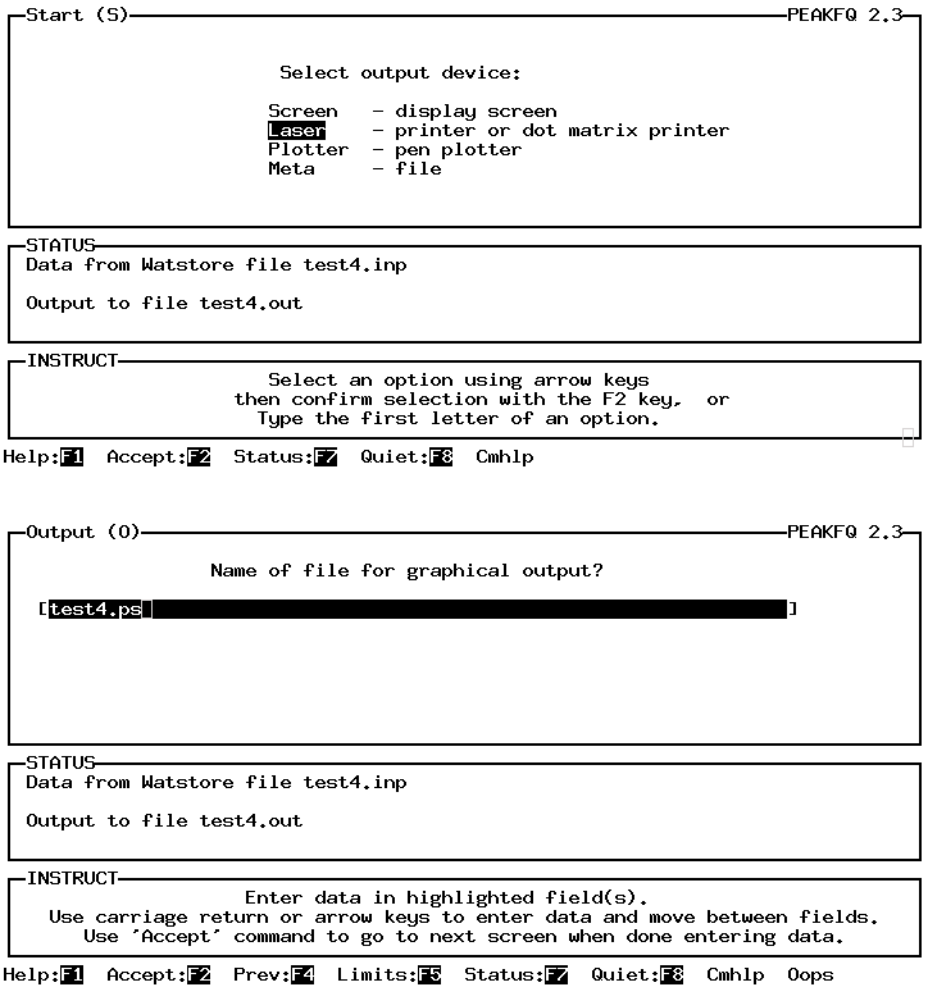


Opening screen (screen with selection of Start option not shown)
Start

After the Input source has been specified and any desired Output or Modify entries have been made, select Start to perform the analysis.

If the plot style Graphics or Both was specified on the Output /Options screen, the screen for selecting the output graphics device will be displayed. For some output graphics devices, the name of a file for graphical output may need to be entered.

In the example, the Laser option generates a PostScript file that can be printed on a laser printer or other device that recognizes the PostScript language.



Start - Modify

If Yes was specified under the Modify option on the Opening Screen, a Modify screen will be presented for each station from the ASCII input file, as it is processed. This is in contrast to the WDM Input option, where all computation modifications are made for all data sets being processed before any processing starts. The default values on the Modify screen are determined by the contents of the input file, including any "I" records that may be present. All of the computation options can be changed by the user.

By default, the begin and end year fields contain the water years of the first and last, respectivley, peaks in the input file for the station. If an "I" record is present, positive values in the begin and (or) end year fields will be provided as the defaults. This will determine the period of record to be used in the calculations.

By default, the length of the historic period is zero; no historic adjustment is applied during computation, the historic peaks are ignored, and any high outliers are treated as normal systematic peaks. If an "I" record is present, a positive value in the length of historic period field will be provided as the default. If positive, the historic period contains the systematic record as a subset.

The skew computation option is, by default, weighted between station and generalized skews (WTD, Bulletin 17B weighted skew.) If an "I" record is present with a station option code of S or G, the default skew option code will be be STAtion or GENeralized.

By default, the Bulletin 17B computed low-outlier criterion will be applied during computation, This is indicated by a 0.0 in the low-outlier threshold field. If an "I" record is present, a positive value in the low-outlier discharge criterion field will be provided as the default. Historic peaks with discharges below the low-outlier threshold will not be used in the calculations.

The gage base discharge represents the lower limit of measureable flood peak at a station; this is 0.0 by default. If an "I" record is present, a positive value in the gage base discharge field will be provided as the default. A negative or zero value will be ignored by the program. If positive, this gage base discharge will supersede the gage base inferred from any "less than" qualification code (4) in the peak record. Note that this gage base discharge is not the same as the partial-duration base discharge that may be in the station header "Y" record.

The Latitude and Longitude fields contain, by default, the values from the station header "H" record. They are used to compute the generalized skew if it is not entered.

By default, the Hi-outlier threshold field is 0.0. If an "I" record is present, a positive value in the historic-high-outlier discharge threshold field will be provided as the default. If a positive value is specified in this field, it will override the Bulletin-17B computed high-outlier threshold, with all historic peaks that are less than this ignored in the computations. If this field is blank or negative, the threshold will be set to the value of the lowest historic peak.

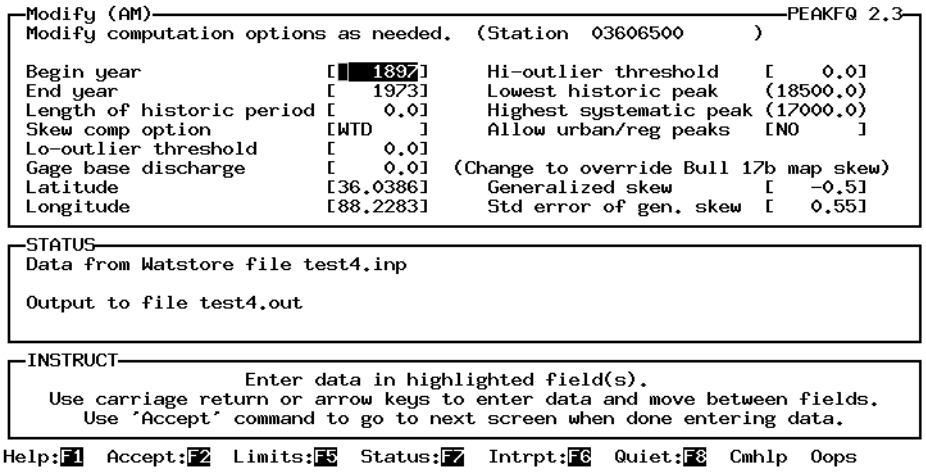
The Lowest historic peak and Highest systematic peak fields are informational and cannot be modified. These values are determined from the peak record for the station.

By default, urban and (or) regulated peaks are not (NO) included in the computations . These peaks are indicated by a “6” or “C” in the qualification code field. If an “I” record is present, this field will default to YES if the Station option field contains a “K”.

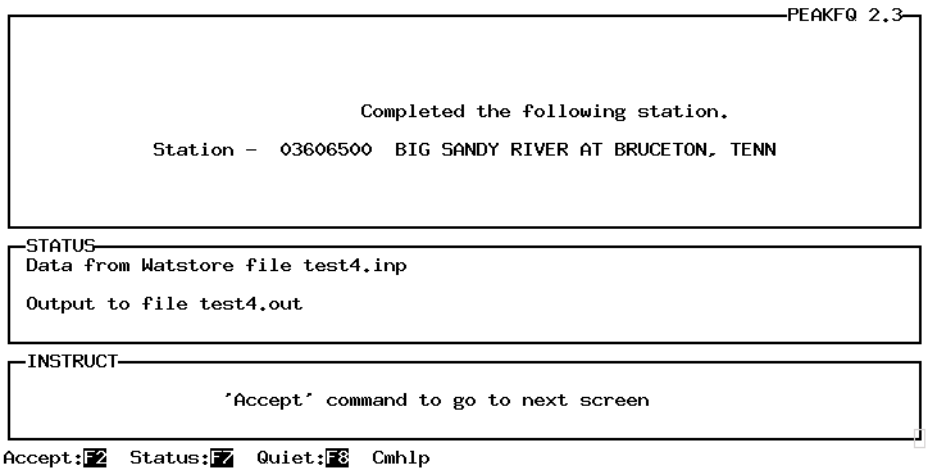
The Generalized skew is, by default, based on the station latitude and longitude using the generalized skew map accompanying the Bulletin 17B guidelines. If an “I” record is present and the generalized skew field is non-blank, that vavlue will be provided as the default.

The Std error of gen. skew field is, by default, 0.55, corresponding to the standard error of the generalized skew map accompanying the Bulletin 17B Guidelines. If an “I” record is present and the the standard error of generalized skew field is non-blank, that value will be provided as the default.

For the first set of peaks in the input file, the Generalized skew was provided on an “I” record. All other fields contain the standard default values. After the computation options have been accepted, the program will do the calculations and report when they are completed.Processing will then continue to the next set of peaks.

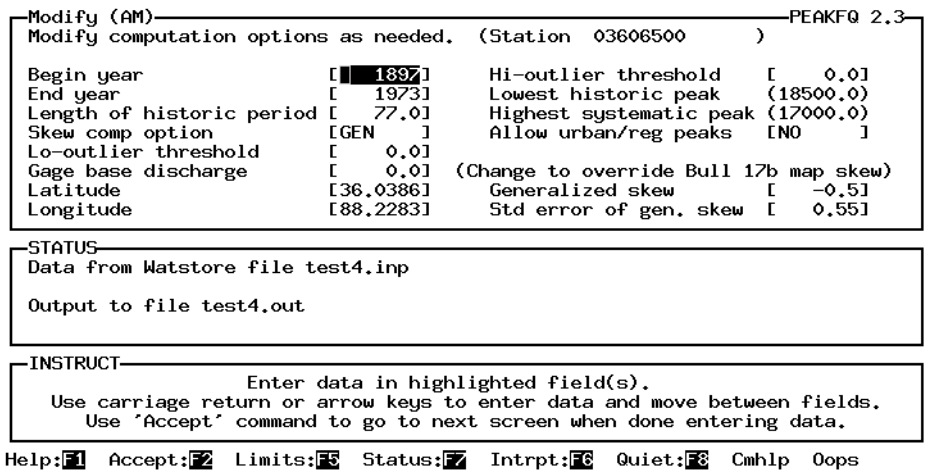


```
  H 03606500      360219088134200474701 7SW 6040005 205.00         380.58
  N 03606500      BIG SANDY RIVER AT BRUCETON, TENN
  Y 03606500      2000.00
  I               -.5
  2 03606500
  3 03606500      189703    250007              18.00
  3 03606500      191903    210007              17.00
  3 03606500      192612    185007              16.50
  3 03606500      19300109   9100               13.98
  3 03606500      19310327   2060               11.20
  3 03606500      19320113   7820               13.60
  3 03606500      19330321   3220               11.95
  3 03606500      19331218   5580               12.94
  3 03606500      19350121  17000               16.16
  3 03606500      19360704   6740               13.28
  3 03606500      19370121  13800               14.86
  3 03606500      19380123   4270               12.67
             ...
  3 03606500      19700403   4330               13.11
  3 03606500      19710824   5080               13.36
  3 03606500      19720717  12000               15.14
  3 03606500      19730421   7640               14.88
```

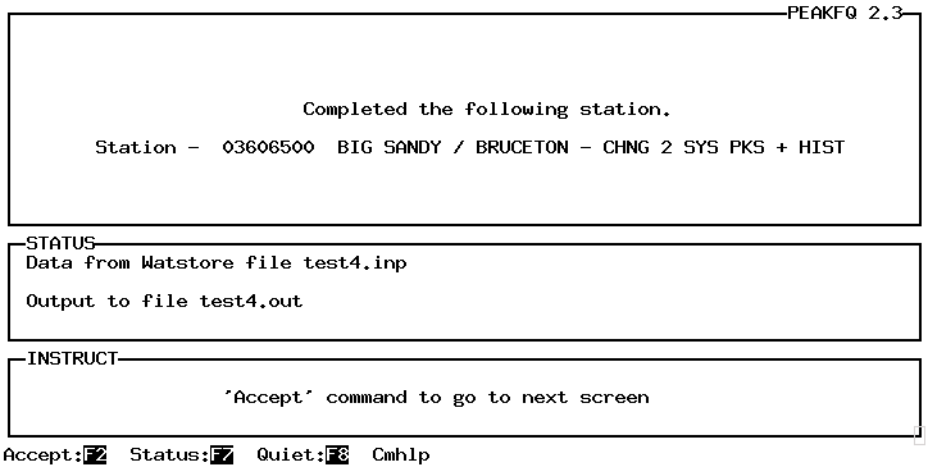


The second set of peaks in the test4.inp file is a repeat of the first set of peaks, this time with a different set of options specified on the “I” record. In this case, the “I”: record contains values for the Generalized skew (-.5), Lentht of historic period (77), and the Skew computation option (G). The standard defaults are provided for all other options. After the computation options have been accepted, the program will do the calculations and report when they are completed.Processing will then continue to the next set of peaks.

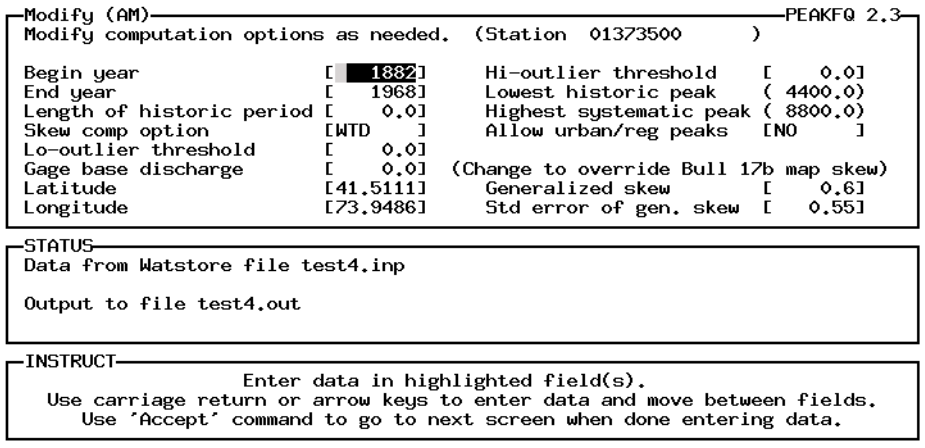
(NOTE: Sets of data with the same station number can only be processed if the ALL option is selected for which stations to be analyzed on the Inut / ASCII / Stations screen.)

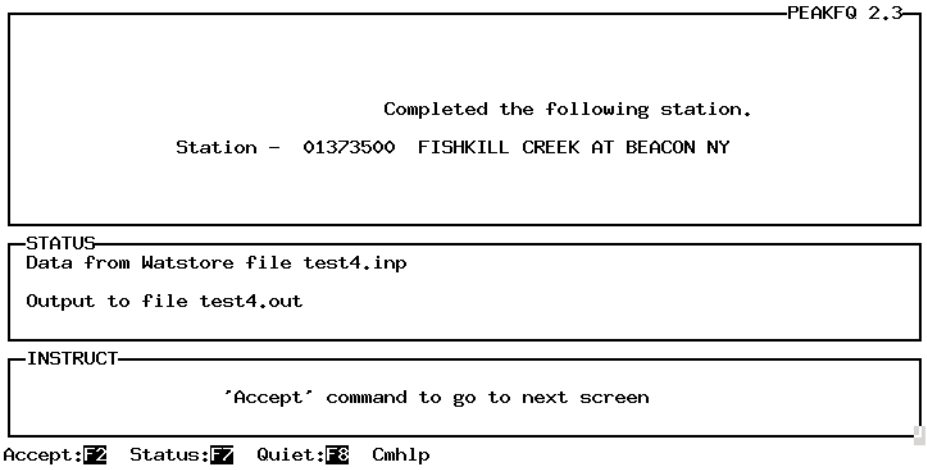



```
H 03606500      360219088134200474701 7SW 6040005 205.00         380.58
N 03606500      BIG SANDY RIVER AT BRUCETON, TENN
Y 03606500      2000.00
I                -.5      77.                                     G
2 03606500
3 03606500      189703    250007             18.00
3 03606500      191903    210007             17.00
3 03606500      192612    185007             16.50
3 03606500      19300109   9100              13.98
3 03606500      19310327   2060              11.20
3 03606500      19320113   7820              13.60
3 03606500      19330321   3220              11.95
3 03606500      19331218   5580              12.94
3 03606500      19350121  17000              16.16
3 03606500      19360704   6740              13.28
3 03606500      19370121  13800              14.86
3 03606500      19380123   4270              12.67
          ...
3 03606500      19700403   4330              13.11
3 03606500      19710824   5080              13.36
3 03606500      19720717  12000              15.14
3 03606500      19730421   7640              14.88
```

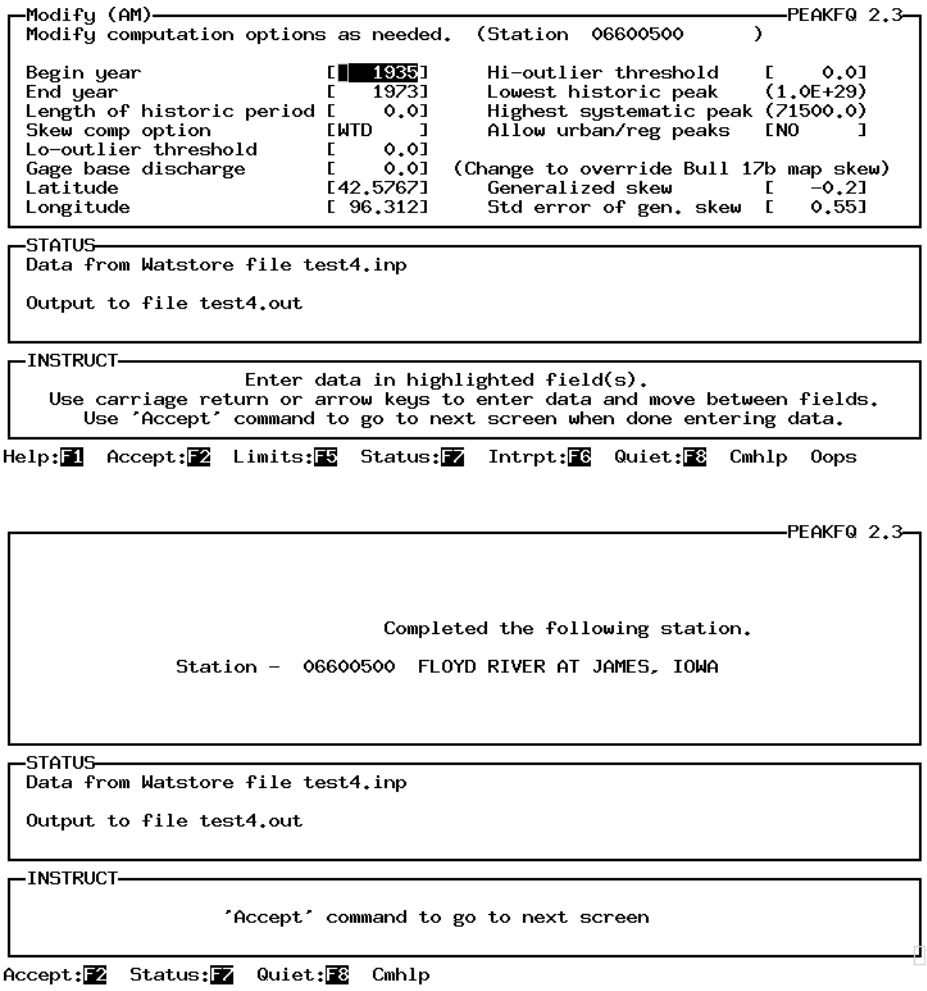


For Fishkill Creek at Beacon, NY, the third set of data in the input file, the "I" record provides the default value for the Generalized skew (0.6). The standard defaults are provided for all other options.

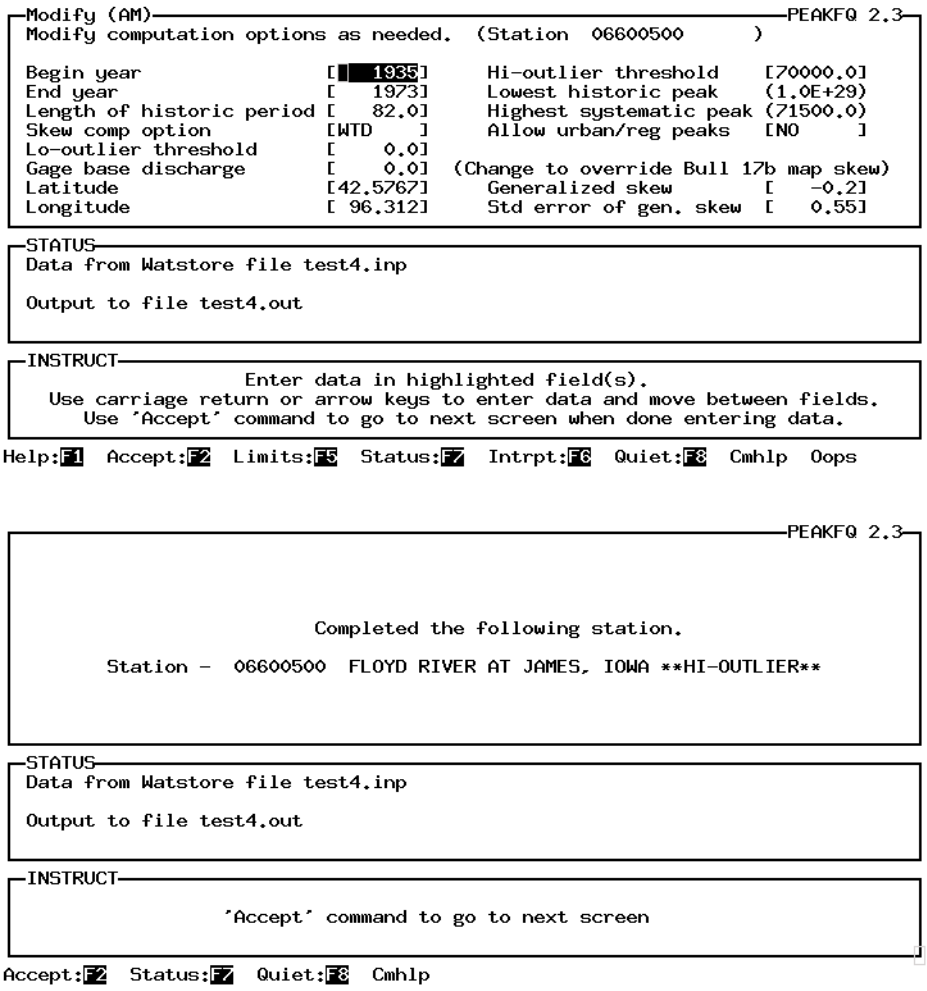




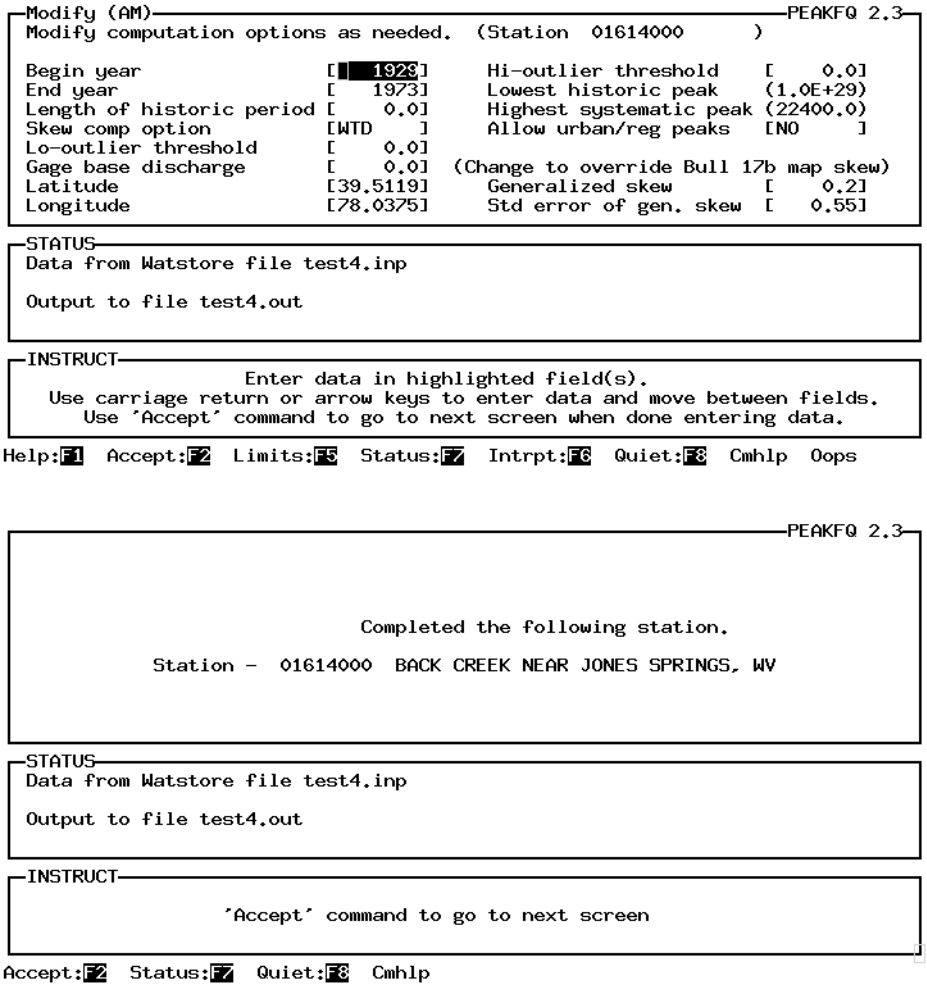
For Floyd River at James, Iowa, the fourth and fifth sets of peaks in the input file, the "I" record first provides the default for Generalizced skew (-.2). The standard defaults are provided for the rest of the options.



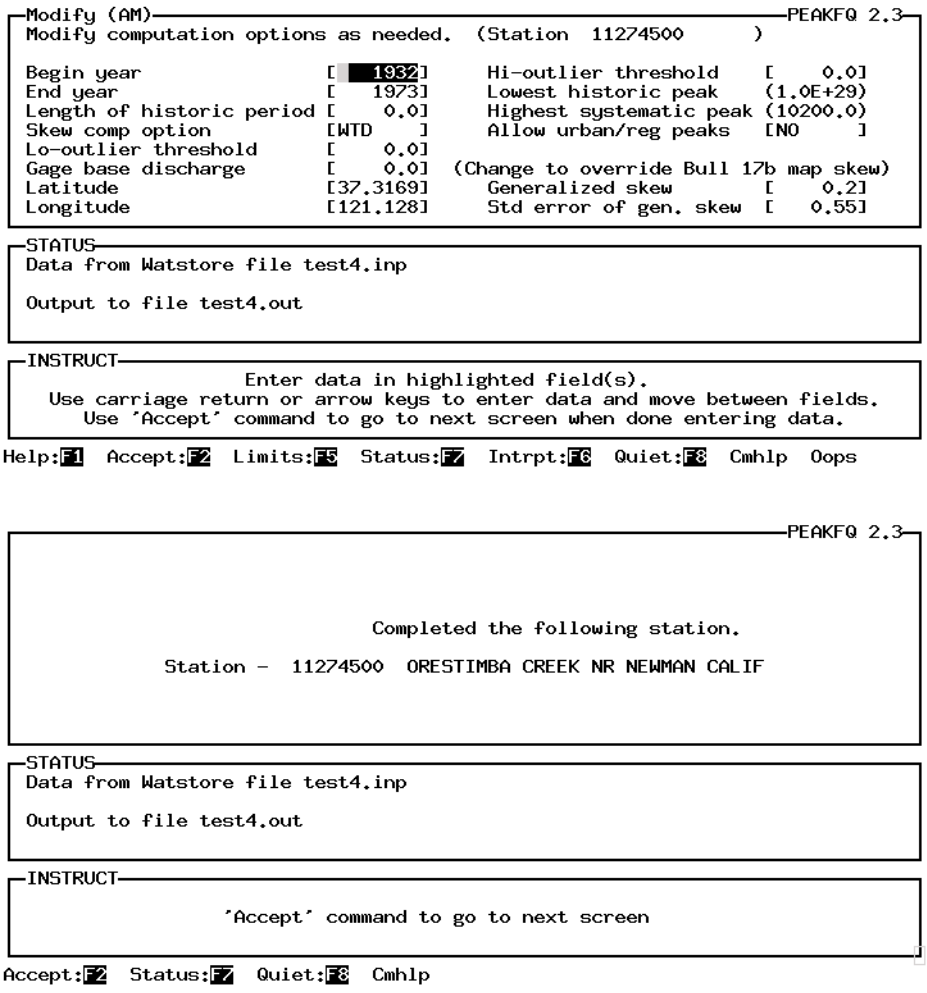
The “I” record for the second set of peaks provides defaults for Generalized skew (-2), Lenth of historic period (82), and the Hi-outlier threshold (70000.). The standard defaults are provided for the rest of the options.



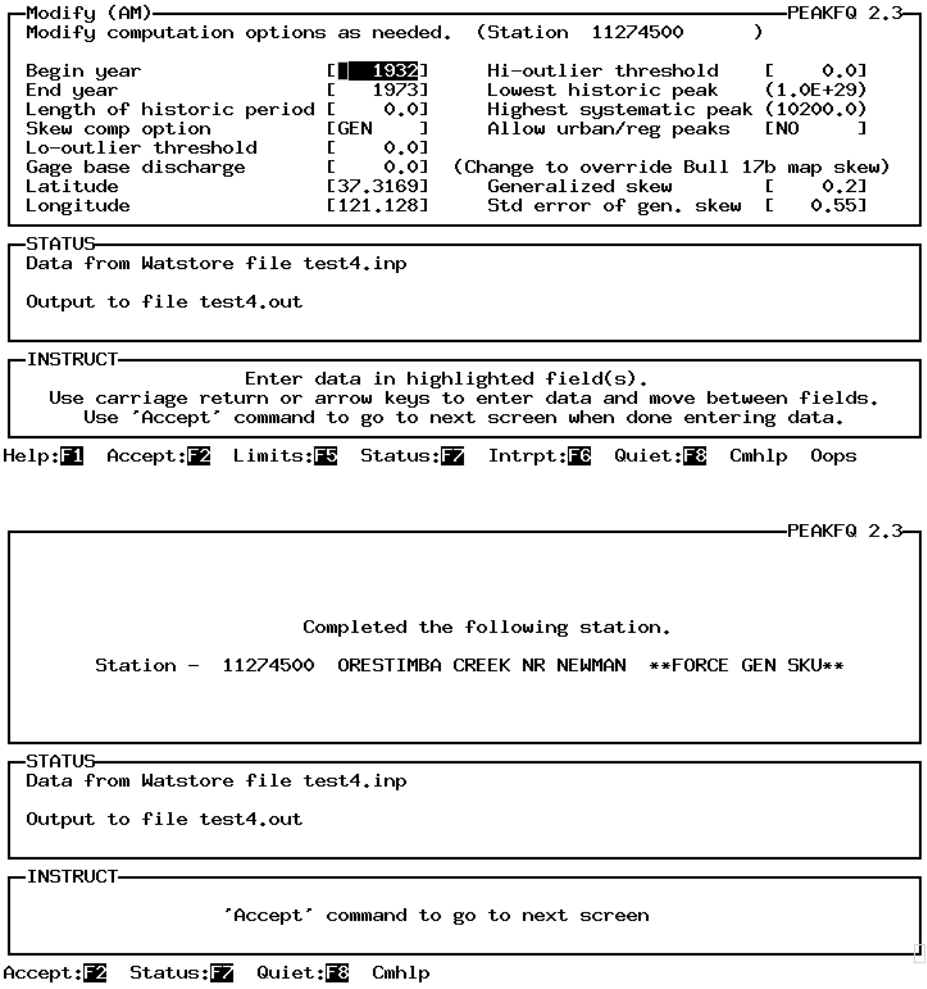
For the Back Creek near Jones Springs, WV, te “I” record provides the default for Generalized skew (0.2).



For the fist set of data for Orestimba Creek near Newman, California, the “I” record provides the default for Generalized skew (.2), with the standard defaults provided for the rest of the options.

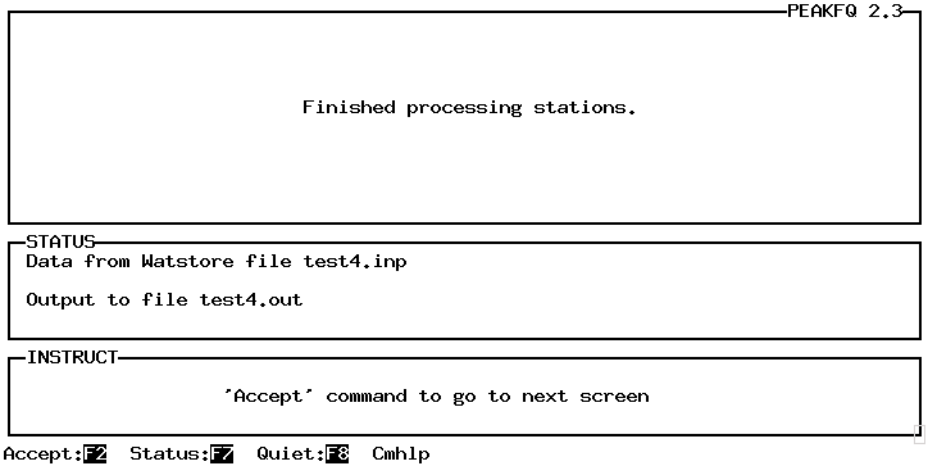


For the second set of data for Orestimba Creek, the “I” record provides the default for Generalized skew (.2) and the Skew computation option (G).



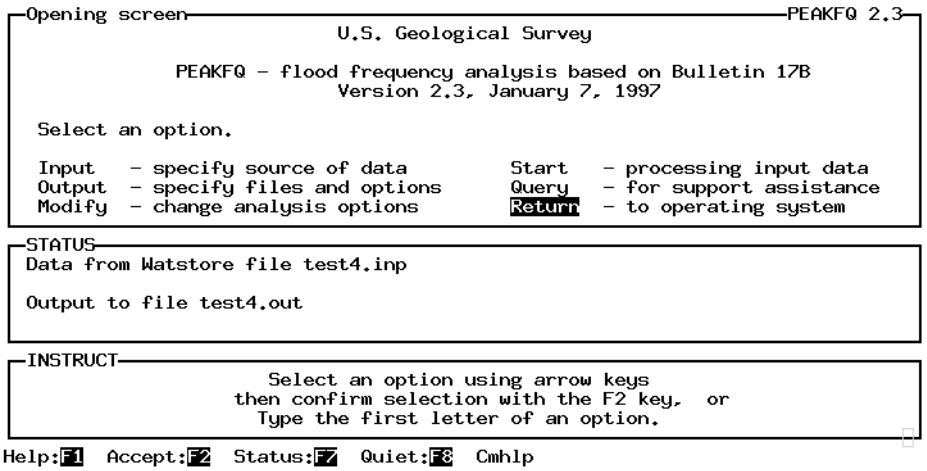
(finished processing)

A screen indicating that all of the stations have been processed is displayed.



Opening screen

After all of the stations have been processed, the user can change the general Output options, Modify the processing options for selected data sets, or select new Input to analyze a different set of data.



Program Diagnostics

Some common problems and suggested actions associated with running program PEAKFQ are described in table 4.

Table 3. Symptoms and courses of action for troubleshooting PEAKFQ

Symptom	Suggested courses of action
1. Error involving high-memory allocation occurs at startup.	This error may be occurring because other devices or programs addressed in the AUTOEXEC.BAT and CONFIG.SYS root directory files may be interfering. Alter the AUTOEXEC.BAT and CONFIG.SYS files to alleviate this problem. Consult the DOS manual for further instruction.
2. Program is accessed, but the first data screen is scrambled.	This problem is caused by problems with the AUTOEXEC.BAT and CONFIG.SYS files. These must be altered as stated in 1.
3. Program did accept data in the START menu on the first attempt, but on additional attempts it did not.	This problem has been found to occur when running program from the WINDOWS environment. Either exit WINDOWS and try running from DOS or select the RETURN menu to exit program and begin the program again.
4. Program running from WINDOWS environment but became inoperative when tried to plot frequency curve to the screen.	While PEAKFQ will usually work from WINDOWS, the plotting will interfere with the SVGA. Sometimes a simple error message is displayed and user can continue working in WINDOWS. At other times, however, DOS becomes inoperative. Do not plot with PEAKFQ while in WINDOWS to avoid this problem.

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Lepkin, W.D., DeLapp, M.M., Kirby, W.H., and Wilson, T.A., 1979, National Water Data Storage and Retrieval System WATSTORE User's Guide: U.S. Geological Survey Open-File Report 79-1336-I, v. 4, ch. I, secs. A, B, and C.

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APPENDIX A. DESCRIPTION OF THE AIDE CHARACTER-BASED USER INTERFACE

User Interface

There are four types of screens that make up PEAKFQ: menu, form fill-in, file name, and informational text screens. Commands for displaying help information, moving to previous or following screens, and displaying allowable ranges for input values are available on each screen as applicable.

Each screen consists of at least two boxed-in regions, or windows. These two regions are the data window and the instruction window. A third region, the assistance window, can be displayed or removed from the screen as desired. Beneath the windows, the available commands appear, with their associated function keys. Figure A.1 shows the basic layout of the screens found in PEAKFQ.

All three windows and the line of available commands can be viewed on an 80x24 character screen. Each window has a distinct purpose. User interaction with the program takes place in the data window where menus, input forms, and informational text are displayed. The instruction window contains information on the keystrokes necessary to interact with the program. Error messages related to invalid keystrokes are also displayed in the instruction window. When error messages are displayed, the instruction type in the upper left-hand corner of the window changes from the usual "INSTRUCT" to "ERROR." In the assistance window, help information, valid ranges for input values, and details on program status can be displayed.

Each screen has a name, which is placed where the words screen name appear in figure A.1. The first screen is called the opening screen. All subsequent screens are given a name based on the menu option selected. Screen names are followed by a path—a list of characters that represent the keystrokes made to arrive at the current screen. This list of keystrokes can aid in keeping track of where the current screen falls in the menu hierarchy.

Assistance Window

The assistance window appears when the commands Help, Limits, Status, or Cmhlp are chosen. The name of the command chosen is placed in the upper left-hand corner of the assistance window, where the words assistance type appear in figure A.1. The assistance window can be closed by choosing the Quiet command.

Command Line

Figure A.1 describes each of the commands available in PEAKFQ. Most commands are invoked by pressing a single function key. The Accept command, associated with the F2 function key, is used most frequently in the process of using the program. Those commands not invoked by a single function key are chosen by pressing the F3 function key or the semicolon key (";") followed by the first letter of the command. Pressing either the F3 key or the semicolon key causes the cursor to be placed at the bottom of the screen; any command can then be invoked by typing its first letter. Pressing either of these keys a second time without invoking any command will reactivate the data window. The F3 key and the semicolon key are also used to reactivate the data window when the assistance window becomes the active window on the screen. This occurs when a command has been chosen that opens the assistance window and there is more information to be displayed than can be viewed at one time in the four-line window. The line of commands at the bottom of the screen disappears and directions are given in the instruction window as to how to scroll through the text displayed in the assistance window. Pressing the F3 key or the semicolon key at this point restores the line of commands and reactivates the data window.

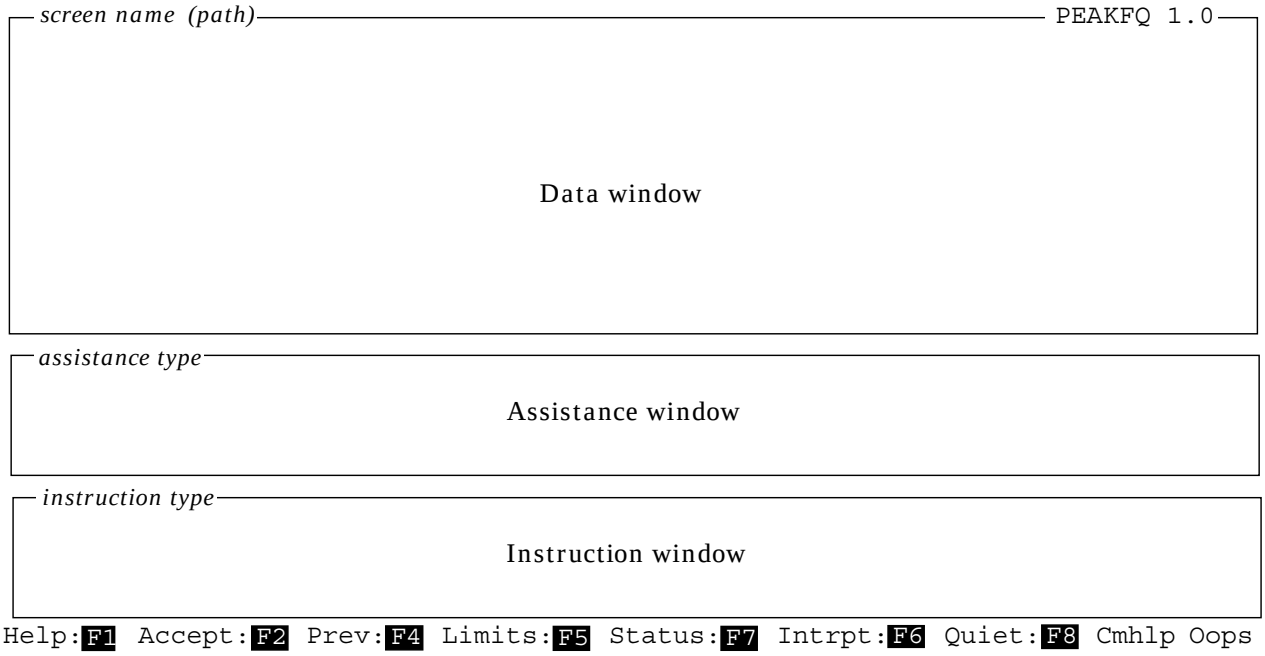
Data Window

Menu selections in the data window can be made by highlighting the desired option through use of the arrow keys and then invoking the **Accept** command. Alternatively, the first letter of the desired menu option can be typed. If more than one menu option begins with the same letter, enough characters must be typed to uniquely identify the desired option.

Form fill-in screens may require character input, such as a yes/no response or numeric input. There are also option fields that can be toggled on or off by pressing the space bar. Movement of the cursor around these screens is accomplished through use of the arrow keys or the Enter key.

File name screens contain one input field into which a file name is typed. These file names are checked for validity; warnings are issued for invalid file names, and opportunity is given to enter a valid file name.

Informational text screens are displayed to give information on tasks in progress or already completed, as well as to give explanatory information or error messages. When these screens are displayed, use the **Accept** command to continue.



Command	Keys pressed to invoke[a]	Function
Help	F1 *or* ;h	Displays help information in the assistance window. Help information is available for menu options and for input fields on form fill-in and file name screens. Once Help has been chosen, the help information displayed is updated as different screen elements are highlighted and as different screens are displayed. The program automatically closes the assistance window if a screen is reached for which there is no help information.
Accept	F2 *or* ;a	Indicates that you have "accepted" the input values, menu option currently highlighted, or text message in the data window. Causes program execution to continue.
Cmhlp	F3 c *or* ;c	Displays brief descriptions of the commands available on the current screen.
Oops	F3 o *or* ;o	Redraws screen. Default values replace any values that have been entered. Available on form fill-in and file name screens.
Prev	F4 *or* ;p	Re-displays the previous screen. Available on most form fill-in screens and file name input screens. The program does not read any input values previously entered if Prev is chosen.
Limits	F5 *or* ;l	Displays valid ranges for numeric input and possible responses for character input on form fill-in and file name screens. As with the Help command, information on input limits is updated as different screen elements are highlighted by using the arrow keys or the Enter key.
Intrpt	F6 *or* ;i	Interrupts current processing loop, returning program to point of execution previous to current process.
Status	F7 *or* ;s	Displays current status information including name of input source, number of stations selected for processing, and hydrograph separation method chosen.
Quiet	F8 *or* ;q	Closes the assistance window. Only available if the assistance window is open.

a. The function keys will work to invoke the commands on most systems. For those systems where this is not the case, the semicolon key (";") followed by the first letter of the command can be pressed instead.

Figure A.1. Basic PEAKFQ screen layout.

APPENDIX B.1. STATION HEADER RECORDS.

record	column	format	WDM attribute	description
Z	1	"Z"	--	Record identifier.
	33-37	A5	AGENCY	Agency code as assigned by WATSTORE.
H	1	"H"	--	Record identifier.
	2-16	A15	STAID or ISTAID	Station identification number.
	17-31	---		Station locator
		3I2	LATDEG	Latitude, DDMMSS
		I3,2I2	LNGDEG	Longitude, DDDMMSS
		I2		Sequence number
	32-33	A2	STFIPS	Numeric state code where station is located.
	34-35	A2	DSCODE	For USGS sites only, the district (numeric state code) or the alpha project code of the office responsible for collecting and storing the data.
	36-38	A3	COCODE	FIPS county code where the station is located.
	39-40	A2	SITECO	Site code indicating the major class of data collected at the site: SW - stream GW - well SP - spring LK - lake or reservoir ES - estuary ME - meteorological
	41-48	I8	HUCODE	Hydrologic unit code from the USGS state hydrologic unit maps.
	49-55	F7.0	DAREA	Total drainage area, in square miles.
	56-62	F7.0	CONTDA	Contributing drainage area, in square miles.
	63-70	F8.0	DATUM	Datum, feet above mean sea level.
	71-79	F9.0	WELLDP	Well depth, in feet.
N	1	"N"	--	Record identifier.
	2-16	A15	STAID or ISTAID	Station identification number.
	17-64	A64	STANAM	Station name.
	65-72	A8	GUCODE	Major geologic unit codes as assigned by WATSTORE.
	73	A1	AQTYPE	Aquifer type code assigned by WATSTORE: U - unconfined single aquifer N - unconfined multiple aquifers C - confined single aquifer M - confined multiple aquifers X - mixed multiple aquifers
Y	1	"Y"	--	Record identifier.
	2-16	A15	STAID or ISTAID	Station identification number.
	17-23	F7.0	BASEQ	Base discharge.

APPENDIX B.2. STATION OPTION RECORDS.

record	column	format	WDM attribute	description
I	1	"I"	--	Record identifier
	2-16	A15	STAID or ISTAID	Station identification number
	17-24			Generalized skew. If not specified, the generalized skew will be determined based on gage latitude and longitude using the generalized skew map accompanying the Bulletin 17B guidelines.
	25-32			Length of historic period in years. A positive value must be supplied in order for the historic adjustment to be applied. The historic period contains the systematic record period as a subset. If this field is left blank, any input historic peaks will be ignored and any high outliers will be treated as normal systematic peaks.
	33-40			User-specified historic-high-outlier discharge threshold. Used only in conjunction with the historic period, this threshold is used to override the Bulletin 17B-computed high-outlier threshold. If this field is left blank, the Bulletin 17B threshold will be lowered automatically to equal the smallest historic peak(s) is one is known. If a positive value is specified in this field, all peaks that exceed this value will be used in the historic adjustment. Any historic peaks lying below this value will be ignored.
	41-48			User-specified low-outlier discharge criterion. This criterion, if a postive number, will override the Bulletin 17B-computed low-outlier criterion. A blank, negative value, or zero will be ignored.
	49-56			Gage base discharge, representing a lower limit of measurable flood peak discharge at the site. This discharte, if a positive number, will supersede the gage base inferred from any "less than" qualification codes of the input peak flow records. A blank, negative value, or zero will be ignored. (The gage base discharge is not the same as the partial-duration base discharge that may be recorded in the Station Header record.
	57-64			Standard error fo the generalized skew. If not specified, a value of 0.55, corresponding to the standard error of the generalized skew map accompanying the Bulletin 17B guidelines, will be used.
	65-69			Station-option codes selected from the following list. The codes may be in any order or combination and may be in any available column. In case of conflict, the rightmost code is used. The available options are: S - Station-skew option. Causes the station skew, adjusted for outliers

	and historic data, rather than the Bulletin 17B weighted skew, to be used for the final frequency curve. G - Generalized-skew options. Causes the generalized skew, rather than the Bulletin 17B weighted skew, to be used in the final frequency curve. K - Known regulation/urbanization input option. Allows peaks with the known regulation or urbanization codes (6 or C) to be included in the statistical analysis.
71-74	Begin year: first water year of retrieved records to be included in the statistical analysis; earlier years are ignored. This value must be either blank or a four-digit number. If blank or less than the first year of the input record, no years will be dropped from the beginning of the record.
75-78	End year: last water year of retrieved records to be included int the statistical analysis; later years will be ignored. This value must be either blank or a four-digit number. If blank or greater than the last year of the input record, no years will be dropped from the end of the record.
xx-xx	

APPENDIX B.3. PEAK-FLOWS RECORDS.

The peak-flows records may be preceded by station header records.

record	column	format	WDM attribute	description
3	1	"3"	--	Record identifier.
	2-16	A15	STAID or ISTAID	Station identification number.
	17-20	I4	--	Year peak occurred: o Calendar year if columns 21-22 contain a valid month o Water year if columns 21-22 are blank or 99
	21-22	I2	--	Month the annual peak discharge occurred. Blank if month is not known.
	23-24	I2	--	Day of the month the annual peak discharge occurred. Blank if day is not known.
	25-31	F7.0	--	Annual peak discharge, right justified.
	32-43	A12	--	Annual peak discharge qualification codes. More than one code may be associated with a peak, except as noted below. 1 - discharge is a maximum daily average 2 - discharge is an estimate 3 - discharge affected by dam failure 4 - discharge less than indicated value, which is minimum recordable discharge at this site * 5 - discharge affected to unknown degree by regulation or diversion ** 6 - discharge affected by regulation or diversion ** 7 - discharge is a historic peak *** 8 - discharge actually greater than indicated value 9 - discharge due to snowmelt, hurricane, ice-jam or debris dam breakup A - year of occurrence is unknown or not exact B - month or day of occurrence is unknown or not exact C - all or part of the record affected by urbanization, mining, agricultural changes, channelization, or others D - base discharge changed during this year E - only annual maximum peak available for this year * Code 4 cannot occur simultaneously with codes 1, 2, 3, 7, or 8. ** Codes 5 and 6 cannot occur simultaneously *** Code 7 should indicate that the value for the particular year is a historic peak and the particular year occurred before or after the systematic record, or during a break in the systematic record.
	44-51	F8.0	--	Gage height associated with annual peak discharge, right justified in field.
	52-55	A4		Gage height qualification codes. More than one code may be associated with a gage height. 1 - gage height affected by backwater

				2 - gage height not the maximum for the year 3 - gage height at different site and/or datum 4 - gage height below minimum recordable elevation 5 - gage height is an estimate 6 - gage datum changed during this year * If code 2 is given here, then a date and data entries should be made for the maximum annual gage height (cols 60-75).
	56-59	I4		"Highest since" year -- representing the calendar year after which the given peak discharge (cols 25-31) is known to be the highest. This year is determined from historic newspaper accounts, local information, or other sources.
	60-61	I2	--	Month in which the annual peak gage height occurred. While this month may not be in the same calendar year as the annual peak, it is that it is in the same water year.
	62-63	I2	--	Day of the month of the annual peak gage height.
	64-71	F8.0		Annual peak gage height.
	72-75	A4	--	Annual peak gage height qualification codes 1 - gage height affected by backwater 3 - gage height at different site and/or datum 5 - gage height is an estimate 6 - gage datum changed during this year
4	1	"4"	--	Record identifier.
	2-16	A15	STAID or ISTAID	Station identification number.
	17-20	I4	--	Year data on this record occurred o Calendar year if columns 21-22 contain a valid month o Water year if columns 21-22 are blank or 99 This entry may or may not be the same as on the preceding type 3 record if one is present, but the month and year must have occurred in water year as the peak discharge.
	21-22	I2	--	Month the partial duration peak occurred. Blank if month is not known.
	23-24	I2	--	Day of the month the partial duration peak occurred. Blank if day is not known.
	25-31	F7.0	--	Partial duration peak discharge, right justified.
	32-43	A12	--	Partial duration peak discharge qualification codes. More than one code may be associated with a peak. 1 - discharge is a maximum daily average 2 - discharge is an estimate 3 - discharge affected by dam failure 4 - discharge less than indicated value, which is minimum recordable discharge at this site * at this site * 5 - discharge affected to unknown degree by regulation or diversion ** 6 - discharge affected by regulation or

		diversion ** 7 - discharge is an historic peak *** 8 - discharge actually grater than indicated value 9 - discharge due to snowmelt, hurricane, ice-jam or debris dam breakup A - year of occurrence is unknown or not exact B - month or day of occurrence is unknown or not exact C - all or part of the record affected by urbanization, mining, agricultural changes, channelization, or others D - base discharge changed during this year E - only annual maximum peak available for this year * Code 4 cannot occur simultaneously with codes 1, 2, 3, 7, or 8. ** Codes 5 and 6 cannot occur simultaneously. *** Code 7 should indicate that the value for the particular year is a historic peak and the particular year occurred before or after the systematic record, or during a break in the systematic record.
44-51 F8.0	--	Partial duration peak gage height.
52-55 A4		Partial duration peak gage height qualification codes. More than one code may be associated with a gage height. 1 - gage height affected by backwater 3 - gage height at different site and/or datum 4 - gate height below minimum recordable elevation 5 - gage height is an estimate 6 - gage datum changed during this year

APPENDIX C. DATA-SET ATTRIBUTES

Data-set attributes in a Watershed Data Management (WDM) file are used to describe the data sets. Attributes may describe how the data is stored in the data set, where the data was gathered, physical features of the associated data, and statistics computed from the associated data.Over 300 attributes are available for describing data sets. Only a fraction of these attributes are used by PEAKFQ, but any attribute may be present in the data set.

Table C.1 contains a listing and description of the data-set attributes frequently found in annual peak flow data sets. Table C.2 contains a listing of the attributes that PEAKFQ reads and (or) writes or that are frequently associated with annual peak flow data sets and how these attributes are used by the PEAKFQ program. The IOWDM program is usually used to add most of these attributes to the data sets, but they can be manually entered using the ANNIE program. The basin characteristic and station header formats are described in Appendixes B.1 and B.2 or see the IOWDM and ANNIE documentation for additional details. Some of these attributes may be modified each time the PEAKFQ program is run. Some of these attributes are output from PEAKFQ. Some of these attributes are ignored by PEAKFQ.

Table C.1. Attributes associated with annual peak-flow data sets

				Data-set type		
Name	**Type**	**Length**	**Update**	**Time**	**Table**	**Description**
AGENCY	Char	8	Yes	Opt	Opt	Agency code.
AQTYPE	Char	4	Yes	Opt	Opt	Aquifer type. U - unconfined single aquifer N - unconfined multiple aquifers C - confined single aquifer M - confined multiple aquifers X - mixed multiple aquifers
BASEQ	Real	1	Yes	Opt	Opt	Base discharge, in cubic feet per second.
COCODE	Int	1	Yes	Opt	Opt	County or parish code.
COMPFG	Int	1	No	Opt	No	Compression flag. 1 - yes, data are compressed (default) 2 - no, data are not compressed Compressed data will take up less space in the WDM file but may require a COPY operation to update data values.
CONTDA	Real	1	Yes	Opt	Opt	Drainage area, in square miles, that contributes to surface runoff.
DAREA	Real	1	Yes	Opt	Opt	Total drainage area, in square miles, including noncontributing areas.
DATUM	Real	1	Yes	Opt	Opt	Reference elevation, to mean sea level.
DSCODE	Int	1	Yes	Opt	Opt	State code of the Geological Survey office that operates the station. Usually the same as the state code (STFIPS).
GUCODE	Char	12	Yes	Opt	Opt	Geologic unit code.
HUCODE	Int	1	Yes	Opt	Opt	Hydrologic unit code (8 digits). These codes are given in the U.S. Geological Survey map series "State Hydrologic Unit Maps," Open-File Report 84-708.
ISTAID	Int	1	Yes	Opt	Opt	Station identification number, as an integer.
J407BQ	Real	1	Yes	Opt	Opt	Base gage discharge.
J407BY	Int	1	Yes	Opt	Opt	Year to begin analysis, used to identify subset of available record.
J407EY	Int	1	Yes	Opt	Opt	Year to end analysis, used to identify subset of available record.
J407GS	Real	1	Yes	Opt	Opt	Generalized skew.
J407HO	Real	1	Yes	Opt	Opt	High outlier discharge criterion.
J407LO	Real	1	Yes	Opt	Opt	Low outlier discharge criterion.
J407NH	Int	1	Yes	Opt	Opt	Number of historic peaks.
J407SE	Real	1	Yes	Opt	Opt	Root mean square error of generalized skew.
J407SO	Int	1	Yes	Opt	Opt	Generalized skew option. -1 - station skew 0 - weighted skew 1 - generalized skew

T**able C.1**. Attributes associated with annual peak-flow data sets—continued

Name	Type	Length	Update	Data-set type		Description
				Time	Table	
J407UR	Int	1	Yes	Opt	Opt	Include urban regulated peaks. 1 - no 2 - yes
LATDEG	Real	1	Yes	Opt	Opt	Latitude in decimal degrees.
LATDMS	Int	1	Yes	Opt	Opt	Latitude in degrees, minutes, seconds (dddmmss).
LNGDEG	Real	1	Yes	Opt	Opt	Longitude in decimal degrees.
LNGDMS	Int	1	Yes	Opt	Opt	Longitude in degrees, minutes, seconds (dddmmss).
P1.25	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 1.25-year recurrence interval.
P10.	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 10-year recurrence interval.
P100.	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 100-year recurrence interval.
P2.	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 2-year recurrence interval.
P200.	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 200-year recurrence interval.
P25.	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 25-year recurrence interval.
P5.	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 5-year recurrence interval.
P50.	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 50-year recurrence interval.
P500.	Real	1	Yes	Opt	Opt	Annual flood peak, in cubic feet per second, 500-year recurrence interval.
SITECO	Char	4	Yes	Opt	Opt	Site code. SW - stream SP - spring ES - estuary GW - well LK - lake or reservoir ME - meteorological
STAID	Char	16	Yes	Opt	Opt	Station identification, up to 16 alpha-numeric characters.
STANAM	Char	48	Yes	Opt	Opt	Station name or description of the data set.
STFIPS	Int	1	Yes	Opt	Opt	State FIPS code.
TCODE	Int	1	No	Reqd	Opt	Time units code. 1 - seconds 4 - days 2 - minutes 5 - months 3 - hours 6 - years Used in combination with TSSTEP.
TGROUP	Int	1	No	Reqd	No	Unit for group pointers, depending on the time step of the data, may effect the speed of data retrievals. The default group pointer is 6 (years). See table 1 in users manual for recommended values. 3 - hours 6 - years 4 - days 7 - centuries 5 - months
TSBYR	Int	1	No	Reqd	No	Starting year for time-series data in a data set. Defaults to year 1900.
TSFILL	Real	1	No	Opt	Opt	Time-series filler value. This value will be used for missing values. The default is 0.0.
TSFORM	Int	1	No	Reqd	No	Form of data. 1 - mean over the time step (default) 2 - total over the time step 3 - instantaneous @ time (end of time step) 4 - minimum over the time step 5 - maximum over the time step
TSPREC	Int	1	No	Opt	No	New group, new record flag. 0 - start new group at the end of the last group (default) 1 - start new group at the beginning of a record
TSSTEP	Int	1	No	Reqd	Opt	Time step, in TCODE units (used in combination with TCODE).

T**able C.1**. Attributes associated with annual peak-flow data sets—continued

Name	Type	Length	Update	Data-set type		Description
				Time	Table	
TSTYPE	Char	4	Yes	Opt	Opt	User-defined four-character descriptor. Used to describe the contents of the data set, for example: PRCP, RAIN, SNOW - precipitation FLOW, DISC, PEAK - discharge TEMP, TMIN, TMAX - temperature EVAP, PET - evapotranspiration Some models and application programs may require a specific TSTYPE for data sets they use.
VBTIME	Int	1	No	Reqd	No	Variable time-step option for the data set 1 - all data are at the same time step 2 - time step may vary (default)
WELLDP	Real	1	Yes	Opt	Opt	Depth of well, in feet. The greatest depth at which water can enter the well.
WRCMN	Real	1	Yes	Opt	Opt	Mean of logarithms, base 10, of annual peak discharges after outlier and historic-peak adjustments.
WRCSD	Real	1	Yes	Opt	Opt	Standard deviation of logarithms, base 10, of annual peak discharges after outlier and historic-peak adjustments.
WRCSKW	Real	1	Yes	Opt	Opt	Skew of logarithms, base 10, of annual peak discharge after outlier and historic-peak adjustments and generalized skew weighting.
YRSHPK	Int	1	Yes	Opt	Opt	Number of consecutive years used for historic-peak adjustment to flood-frequency data.

Table C.2. Sources of attributes associated with peak-flow data sets

WDM file attribute		as processed by IOWDM basin charac		statn header		PEAKFQ use *			
name	no.	name	no.	name	rec	i	r	w	p
istaid	51	sta id	--	sta id	N		x		
staid	2	sta id	--	sta id	N	x	x		
stanam	45	sta name	--	sta name	N	x	x		
latdms	54						x		
lngdms	55						x		
latdeg	8	lat gage	22	latitude	H	x	x		
lngdeg	9	lng gage	23	longitude	H	x	x		
yrshpk	81	yrshispk	197				x	x	
j407by	278						x	x	
j407ey	279						x	x	
j407lo	269						x	x	
j407ho	270						x	x	
j407so	271						x	x	
j407gs	272						x	x	
j407bq	273						x	x	
j407se	275						x	x	
j407ur	276						x	x	
j407nh	274							x	
wrcmn	78	wrc mn	180					x	x
wrcsd	79	wrc sd	181					x	x
wrcskw	77	wrc skew	179					x	x
p1.25	65	p1,25	75					x	x
p2.	66	p2	76					x	x
p5.	67	p5	77					x	x
p10.	68	p10	78					x	x
p25.	69	p25	79					x	x
p50.	70	p50	80					x	x
p100.	71	p100	81					x	x
p200.	72	p200	82					x	x
p500.	73	p500	178					x	x
meanpk	74	meanpk	83					x	
sdpk	75	sdpk	84					x	
skewpk	76	skewpk	85					x	
tmtopk	98	timetopk	21						
yrspk	80	yrspk	196					x	
darea	11	area	1	area	H				
contda	43	contda	2	cont area	H				
agency	40			agency	Z				
stfips	41	state c	--	state code	H				
dscode	42	dist c	--	dist code	H				
siteco	44			site code	H				
hucode	4			hyd unit c	H				
datum	264			datum	H				
welldp	47			well dpth	H				
gucode	46			geol unit	N				
aqtype	48			aquifer tp	N				
baseq	49			base q	Y				

* i - input by user
r - read from WDM
w - written to WDM
p - written to "punch"

PEAKFQ Diagnostic Messages

The diagnostic messages included in the peakfq output file are the same as those included in the original J407 procedure in WATSTORE. Diagnostic messages are produced when real or potential errors are detected. These messages are listed and are briefly explained below. (Taken directly from Kirby, W.H., 1981, Annual flood frequency analysis using U.S. Water Resources Council guidelines (program J407): U.S. Geological Survey Open-File Report 79-1336-I, WATSTORE User's Guide, v. 4, chap. I, sec. C, 56 p.)

Note: In peakfq, references to Water Resources Council guidelines have been replaced with references to Bulletin 17B. With respect to the messages listed below, WRC may be replaced with 17B in the peakfq output.

Most of the messages have the following general format:

***iiinnnn - text data

in which:

***	represents a variable number, possibly zero, of asterisks, to call attention to the message
iii	identifies the general part of the program producing the message as follows: INP - input processing PKF - reading the peak flow file retrieval records or the log-Pearson cards WCF - flood frequency calculations following WRC guidelines
nnn	is a message number. The messages are listed below approximately in alphabetic and numerical order by identifier and number
s	is a severity indicator. E means error, W means warning, I and J mean routine information, and L means listing of data or results
text	is the text of the message
data	is a list of numbers or words generally in the same order as items mentioned in the text

J407 MESSAGES

FRQPLT WILL DROP POINTS BELOW PLOT BASE.

One or more points on the computed empirical frequency curves fall below the lower boundary of the plot. These points will not be plotted.

INP104 STA HAS INVALID AUX DATA CODE. station-ident code

Columns 63-67 (Code) of the station name card contain characters not accepted by J407. The station is rejected.

INP112E GEN SKEW OUT OF RANGE station-ident gs

Input generalized skew gs has absolute value greater than 2.5. Probable error in input data. The station is rejected and the next input data set is sought, unless this message is followed by INP119E.

INP119E ATTEMPTED FIXUP--NEW GEN SKEW = gs

This message follows INP112 if it seems possible that the input generalized skew has a misplaced decimal point. The value gs is assumed to be the intended input skew.

INP923 STA HAS INVALID PEAK COUNTS NHIST, NSYS station-ident nhist nsys

Either the number of historic peaks (nhist) or the number of systematic peaks (nsys) was less than zero or their sum was less than or equal to zero. Probable cause--invalid input peak counts or input cards out of order. The station is rejected.

INP971 END OF INPUT/CMD STREAM.

The end of the input data has been reached. This marks the normal end of the job.

INPD11W UNDEFINED CONTROL CARD FLUSHED. card

A control card of undefined type has been encountered. The first 52 characters of the card are printed. The card type ($JOB, $OPT) will appear in columns 1-4 and the XJ407 field in columns 5-9. Probable cause - misspelled card type or station name card with no systematic record (zero in cols 68-70). The card is ignored.

INPD18W UNDEFINED OPTIONS IGNORED. n card

A control card has been recognized and processed, but it contains one or more (n) undefined option fields. The card image is printed. The card type ($JOB, $OPT) will appear in columns 1-4 and the XJ407 field in columns 5-9. Probable cause - misspelled or misaligned options. The options that were correctly specified are in effect.

INPF13 INVALID PLOT CARD IGNORED. card

A "plot card" of the type formerly used by J407 and other programs has been prepared incorrectly. Replace it by $JOB and $OPT cards of the current type.

INPUT3 HISTORIC PEAKS OVERFLOWED - nhp i sta_id

The number of historic peaks (nhp) retrieved for station (sta-id) exceeds the capacity of program J407. Probable system error; notify WATSTORE user assistance.

INPUT3 INVALID BEGIN OR END YEAR FROM I-CARD 'years' sta-id

The begin-year or end-year field on the I-card for the station (sta-id) contains illegal decimal characters; these fields are displayed between single quotes (years). Probable user error.

INPUT3 INVALID STATION OPTIONS FROM I-CARD = 'options' sta-id

Probable user error. The options specified are displayed between single quotes. Check for invalid station options on the I card for the station (sta-id) printed.

INPUT3 PEAK COUNT EXCEEDS STORAGE CAPACITY n sta-id

The number of peaks (n) retrieved from station (sta-id) exceeds the storage capacity of program J407. Probable system error; notify WATSTORE User assistance.

INPUT3 REQUESTED YEARS NOT IN RECORD - beg-yr end-yr first-yr last-yr sta-id

Probable user error. The years requested on the I-card (beg-yr, end-yr) do not overlap the years available in the record (first-yr, last-yr) at the station (sta-id).

PKF messages

PKF000L card image

A listing of input data cards produced when PKF reader is in print mode (When J407 is in DBUG mode.)

PKF001E ILLEGAL DECIMAL CHARS ON STA-NAME CARD, n

One or more (n) non-numeric characters have been found in one of the numeric fields of the station name card. See also message PKF011E.

PKF002E INVALID STATION NAME.

The station name does not begin with an alphabetic character or dollar sign or asterisk. See message PKF011E.

PKF003E ITEM COUNT NQ OUT OF BOUNDS. nq

Columns 68-70 of the station name card contain a number nq which is less than zero or greater than the maximum number of peaks that can be stored in the program. Probable cause -- items count not right-justified on column 70. See also message PKF011E.

PKF004E ILLEGAL DECIMAL CHARACTERS ON I-TH Q-DATA CARD. n i station-ident

One or more (n) non-numeric characters have been detected in columns 1-70 of the i-th systematic record data card for the station identified. See also message PKF011E.

PKF005E ID-FIELDS MISMATCH I-TH Q-DATA CARD. i station-id

Columns 71-80 of the i-th systematic record data card do not agree with columns 71-80 of the station name card (station id). The offending systematic record data card is printed immediately above or below this message. See also PKF011E.

PKF006E DATA ENDED BEFORE I-TH Q-DATA CARD. i station-ident

The end of the input data set was encountered while attempting to read the i-th systematic record data card for the indicated station. Probable cause: invalid item count or lost input cards. The reader cannot recover from this error. It return the available data and an error indicator to the calling program.

PKF008W IGNORED FLDS J-10 I-TH Q-DATA CARD. j i station-ident.

Warning only. the item count on the station name card indicated that the j-th through 10-th fields of the i-th systematic record data card contained no data, but these fields were not blank. The item count may be incorrect or the cards may be out of order. The number of data items indicated by the item count is returned to the calling program; the excess information is ignored.

PKF011E SKIPPING FOR NEXT STATION.

An error in the input data has been detected, as explained in the preceding PKFxxx messages. The card on which the error was found is displayed in message PKF000L or PKF015E. The probable cause of all these errors is invalid item counts on the station name card or cards out of order in the input deck. The reader begins searching for the next valid station name card.

PKF015E card image.

Listing of input cards on which errors were detected, as explained by preceding messages. See also PKF011E.

PKF203E HIST PEAK COUNT OUT OF BOUNDS. n station-ident

The historic peak count in the historic/outlier data card is less than zero or greater than the maximum allowable number of historic peaks. See also message PKF211E.

PKF204E ILLEGAL DECIMAL CHARS ON THE I-TH H-DATA CARD n i station-ident.

One or more (n) non-numeric characters have been detected in columns 1-70 of the i-th historic/outlier data card of the station identified. See also message PKF211E.

PKF205E ID-FIELD MISMATACH I-TH H-DATA CARD i station-ident.

Columns 71-78 of the i-th historic/outlier data card conflict with the corresponding columns on the station name card for the station identified. The offending historic/outlier card is printed immediately above or below this message. See also message PKF211E.

PKF206E DATA ENDED BEFORE I-TH H-DATA CARD i station -ident

The end of the input data set was encountered while attempting to read the i-th historic/outlier data card for the station identified. See also message PKF211E.

PKF211E HISTORIC DATA RETRIEVAL FAILED.

An error in the historic outlier data has been detected, as explained in preceding messages. The card in which the error was found is displayed by message PKF0001 or PKF015E. The probable cause of all these

errors is incorrect counting of historic peaks, incorrect placement of data on the cards, or cards out of order. The reader passes the available data and an error indicator back to the calling program (J407 rejects the station and searches for the next station.)

PKFQV3 ERROR-END OF VECTOR FILE.

Data sets received from the peak file retrieval program do not conform to the expected format. Check the retrieval program and JCL listings for error messages before calling WATSTORE user assistance.

PKFQV3 ERROR-FILES SCRAMBLED.

Data sets received from the peak file retrieval program do not conform to the expected format. Check the retrieval program and JCL listings for error messages before calling WATSTORE user assistance.

PKFQV3 ERROR-UNKNOWN CONTROL RECORD.

Data sets received from the peak file retrieval program do not conform to the expected format. Check the retrieval program and JCL listings for error messages before calling WATSTORE user assistance.

WCF--- MESSAGES

WCF001J FLOOD FREQUENCY, WRC BULL. 17. VER n.n(dddddd).

Unedited machine computations. User is responsible for interpretation and use. n.n (dddddd) = version number and data of last revision. Normal beginning-of-job message, if requested.

WCF002J CALCS COMPLETED. RETURN CODE = n

Normal end-of-job message . Return codes: 0 = no error detected. 1 = non-standard data accepted, 2 = warning -- calculations completed, but results may be incorrect.

WCF003E CALCS ABORTED. RETURN CODE = 3.

WCF … Routines were unable to complete the calculations for reasons explained in previous messages.

WCF004* INTERNAL PROGRAM LOGIC ERROR. Location-code data

This message should not occur. If it does, contact h2osoft@usgs.gov

WCF101L INPUT PARAMETERS - GENSKU OPT GS.ERR GAGEB QLWOUT QHIOUT NHIST HISTPD
xxx xxx xxx xxx xxx xxx xxx xxx

Routine listing of input data, if requested.

WCF1O2E INVALID INPUT PEAK COUNTS. NPK, NHIST = nnn nnn

Either the number of historic peaks (HNIST) is negative or the total number of input peaks is less than NHIST. Probable error in counting input peaks.

WCF103L INPUT PEAKS, HISTORIC FIRST. TOTAL NO. = nnn

Routine listing of input data, if requested.

WCF104L INPUT LOG PKS, HISTORIC FIRST. TOTAL NO. = nnn

Routine listing of input data, if requested.

WCF107I ACCEPTED GENSKEW OUTSIDE MAP LIMITS GS m1 m2

Input generalized skew GS was outside range of values (m1, m2) set at program installation time. (Limits of WRC skew map.)

WCF109W PEAKFS WITH MISSING-DISCHARGE CODES WERE BYPASSED. nnn

nnn negative input peaks were found. These are assumed to be codes for unknown discharges. These peaks are ignored in the computations, but large negative values are stored in corresponding locations in output logarithm vector. If the input has any unknown discharges coded as negative values, ensure that

these peaks legitimately can be ignored. Otherwise, incorrect input peak counts may cause this message. Warning only--analysis continues.

WCF111E HISTORIC PEAK HAD MISSING DISCHARGE CODE.

One of the historic peaks was negative. Probable error in input data value or count.

WCF113W NUMBER SYSTEMATIC PEAKS HAS BEEN REDUCED TO NSYS - nnn

Missing-discharge peaks were noted and have been omitted from the sample (WCF109). The correct sample size for analysis is nnn.

WCF117E NO DATA IN SYST RECORD. NSYS NPK NHIST NMISS
xxx xx xxx xxx

There is no systematic record at this station. Possible error in input data or input peak count. NPK = total number of input peaks. Other as in list of variables.

WCF118W SYSTEMATIC RECORD SHORTER THAN WRC SPEC. nnn

Systematic record length nnn is less than that specified in WRC BULL 17. Analysis proceeds, but sample size may be too small for reliable conclusions.

WCF133I SYST PEAKS BELOW GAGE BASE WERE NOTED. nnn bbb

nnn = number of below-gage-base peaks. bbb = gage-base-discharge.

WCF134I NO SYST PEAKS WERE BELOW GAGE BASE. bbb

WCF141E SAMPLE SIZE TOO SMALL TO CALC STATS. lll nnn
NSYS, NBG, NLWOUT, NHIOUT, NHISTN, HISTPN
xxx xx xx xx xx xx

Either the systematic or the WRC-adjusted record is too short for calculation of mean, variance, and skew (less than 3 items). Probable cause -- insufficient record length or excessively high gage base or user low-outlier criterion. lll = either SYS (systematic) or WRC. nnn = effective sample size. Others as in list of variables.

WCF143E NEGATIVE VARIANCE OF LOGS. lll vvv

lll = either SYS (systematic) or WRC. vvv = the computed variance (should be near zero). Probable cause -- roundoff error in computing near-zero variance when all input peaks are (nearly) equal.

WCF151I WRC WEIGHTED SKEW REPLACED BY USER OPTION. www uuu igsopt

WRC weighted skew calculation (www) has been superseded by user-specified skew uuu. An igsopt value of 1 means generalized skew; -1 means station skew.

WCF156I WRC HIGH-OUTLIER TEST SUPERSEDED BY MIN HIST PK. www

Routine information report of WRC high-outlier test criterion (www). Historic peaks were present below this threshold, so the historic-high-outlier threshold was lowered to the level of the smallest historic peak.

WCF157W USER HIGH-OUTLIER CRIT LOWERED TO MIN HIST PK. uuu hhh

Probable user error -- if historic peaks are given. The high-outlier base need not be set unless peaks smaller than the smallest historic peak are to be treated as high outliers. uuu = user high outlier criterion. hhh - minimum historic peak.

WCF159E HIGH-OUT/HIST-PK BASE BELOW LOW-OUT/GAGE BASE. hhh lll

Probable user error--perhaps the high-outlier and low-outlier or gage-base data have been entered in the wrong order. hhh = high-outlier or historic base. lll = low-outlier or gage base.

WCF161I USER HIGH-OUTLIER CRITERION REPLACES WRC. uuu www

The user-specified historic-peak-high-outlier discharge threshold (uuu) has been noted. Its value supersedes the WRC-recommended value (www).

WCF162I SYSTEMATIC PEAKS EXCEEDED BY HIGH-OUTLIER CRITERION. nho hhb

One or more (nho) systematic peaks exceeded the high-outlier discharge criterion (hhb) No historic adjustment was applied because the user did not specify the length of the historic period.

WCF163I NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE. hhb

No high outliers or historic peaks were detected. The historic-peak-high-outlier discharge threshold is hhb.

WCF164W HISTORIC PERIOD IGNORED. histpd

A historic period length (histpd) was specified, but no high outliers or historic peaks were found. The historic period length is ignored and no WRC historic adjustment is attempted. Probable user error--the historic period length should not be specified unless one or more historic peaks or high outliers are present.

WCF165I HIGH OUTLIERS AND HISTORIC PKS ABOVE HHBASE. nho nhp hhb

Historic adjustment was applied. nho = number high outliers noted, nhp = number historic peaks, hhb = high outlier/historic base flow.

WCF167E HSIST PERIOD NO LONGER THAN SYS+HIST PEAKS. hhh nnn

Stated historic period hhh is no longer than actual count of observed peaks nnn. Probable user error - if both hhh and nnn are correct there is no point in doing the historic adjustment.

WCF169I ACCEPTED HISTORIC PERIOD GTR THAN T hhh ttt

The historic period hhh may be longer than can be justified under the WRC criteria for historic information. T = 5 * systematic record, up to max of 300 yrs.

WCF171W NUMBER HI-OUT + HIST PKS EXCEEDS 10PCT OF SYS.PKS. nho nhp

Excessive number of historic peaks nhp and high outliers nho suggest that historic base may be set too low to ensure that every peak exceeding it has been recorded.

WCF191I USER LOW-OUTLIER CRITERION REPLACES WRC. uuu www

uuu = user low-outlier criterion, www = WRC low-outlier criterion

WCF193E LOW OUTLIER CRITERION EXCEEDS HIGH HIST lll hhh

Probable user error--perhaps the high-outlier and low-outlier or gage-base data have been entered in the wrong order. hhh = high-outlier or historic base. lll - low-outlier or gage base.

WCF195I NO LOW OUTLIERS DETECTED BELOW CRITERION xxxxx

No peaks above the gage base were below the low-outlier criterion. xxxxx = low outlier criterion adopted (user or WRC).

WCF198I LOW OUTLIERS BELOW FLOOD BASE WERE DROPPED nnn bbb

Peaks above the gage base and below the low-outlier criterion were noted. The flood base of the WRC frequency curve has been set at the low-outlier criterion. nnn = number of low outliers dropped. bbb = WRC flood base.

WCF199W NUMBER OF PEAKS BELOW FLOOD BASE EXCEEDS WRC SPEC. nbb bbb maxnbb

WRC Bull 17 specifies a maximum number of peaks that may fall below the flood base for this length of systematic record. The actual number nbb of below-base peaks exceeds this limit (maxnbb). The flood base = bbb. Warning - the calculation proceeds but the results may be unreliable.

WCF213E COND PROB ADJUST FAILED - EXCESSIVE lll PROB BELOW BASE. ppp

The conditional probability adjustment described in appendix 4 of WRC Bull 17 cannot be performed when ppp fraction of the peaks are below the flood base. lll = (SYS for systematic rec freq curve, in which case flood base = gage base) or WRC.

WCF215E SKEW OUT OF TABLE RANGE. lll skew-a skew-u gensku

One or more of the skews to be used in constructing the Pearson Type III curve for either the systematic or WRC record is out of the range of the WRC Pearson Type III table (+ or - 9.0). lll = either SYS or WRC. Skew-a is the skew of the above base peaks. Skew-u and gensku may not be present. Skew-u is the unconditional skew after any conditional probability adjustment or weighted-skew calculation. gensku is the generalized skew, and is printed only if the error is detected after the WRC weighted-skew calculations.

WCF217L FREQUENCY CURVE PARAMS lll xxx xxxxx xxxxx xxxxx
xxxxx xxxxx xxxxx

Routine report of frequency curve parameters for curve lll (SYS or WRC). Parameters are -- probability of exceeding base; mean, standard deviation, and skew of frequency curve (unconditional -- after a conditional probability adjustment, if P (BASE) is less than 1.0); mean, standard deviation, and skew of above-base peaks (before conditional probability adjustment).

WCF219J FREQ CURVE ORDINATES lll 2-YR (.50) 10-YR (.10) 100-YR (.01)
xxxxxxx xxxxxxx xxxxxxx

Routine report of frequency curve ordinates at 2-yr, 10-yr, and 100-yr levels for lll (SYS or WRC) frequency curve.

WCF233W EXPECTED PROB OUT OF RANGE AT TAB PROB xxxxx yyyyy

Expected-probability calculation called for table lookup at expected probability xxxxx beyond the limits of the computed WRC frequency curve. This message normally occurs several times when sample size is less than about 10 years and tabular probability yyyyy is less than about 0.10.

WCF238J FREQ CURVE WRC-EXPECT PROB xxxxxxx xxxxxxx xxxxxxx

Routine report of 'expected-probability' frequency curve ordinates at 2-, 10-, and 100-yr levels. 'Expected-probability' curve is based on WRC frequency curve.

WCF239J FREQ CURVE CONF LIMS WRC xx.x xxxxxxx xxxxxxx xxxxxxx
xxxxxxx xxxxxxx xxxxxxx

Upper and lower confidence limits for WRC frequency curve ordinates reported in WCF219. xx.x = one-sided confidence level.