charge relation at the gage. This feature may be a natural constriction of the channel, a long reach of the channel, or an artificial structure.

Contents is the volume of water in a reservoir. Unless otherwise indicated, volume is computed on the basis of a level pool and does not include bank storage.

The drainage area of a stream at a specified location is that area, measured in a horizontal plane, which is so enclosed by a topographic divide that direct surface runoff from precipitation normally would drain by gravity into the river above the specified point. Figures of drainage area given herein include all closed basins, or noncontributing areas, within the area unless otherwise noted.

## DOWNSTREAM ORDER OF LISTING GAGING STATIONS

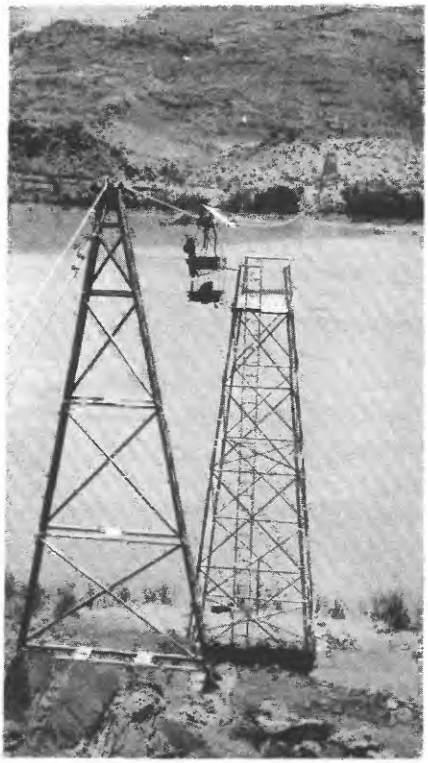
Beginning with the series of reports for the water year ending September 30, 1951, the order of listing gaging-station records was changed. In this report, in a downstream direction along the main stem all stations on a tributary entering above a main-stem station are listed before that station. If a tributary enters between two main-stem stations, it is listed between them. A similar order is followed in listing stations on first rank, second rank, and other ranks of tributaries. To indicate the rank of any tributary on which a gaging station is situated and the stream to which it is immediately tributary, each indention in the listing of gaging stations in the table of contents of this report represents one rank. This downstream order and system of indention show which gaging stations are on tributaries between any two stations on a main stem and the rank of the tributary on which each gaging station is situated.

The order of listing used before the publication of the 1951 report listed first all stations on the main stem from headwaters toward mouth, then all stations on the uppermost tributary to the main stem from the tributary's source to mouth, and then all stations from source to mouth of the uppermost tributary to the tributary.

## EXPLANATION OF DATA

The base data collected at gaging stations consist of records of stage and measurements of discharge. In addition, observations of factors affecting the stage-discharge relation, weather records, and other information are used to supplement base data in determining the daily flow. The records of stage are obtained either from direct readings on a nonrecording gage or from a water-stage recorder that gives a continuous record of fluctuations. Measurements of discharge are made with a current meter by the general methods adopted by the Geological Survey on the basis of experience in stream gaging since 1888. These methods are described in Water-Supply Paper 888 and are also outlined in standard textbooks on the measurement of stream discharge. Typical structures in use at gaging stations are shown in figure 1.

Rating tables giving the discharge for any stage are prepared from stage-discharge relation curves defined by discharge measurements. If extensions to the rating curves are necessary to define the extremes of discharge, they are made on the basis of indirect measurements of peak discharge (such as slope-area or contracted-opening measurements, computation of flow over dams or weirs, and by other methods), velocity-area studies, and logarithmic plotting. The application of the daily mean gage height to those rating



*A.* COLORADO RIVER AT LEES FERRY, ARIZ.
Note landing tower.

*B.* CRYSTAL RIVER NEAR REDSTONE, COLO.

FIGURE 1.—GAGING-STATION STRUCTURES

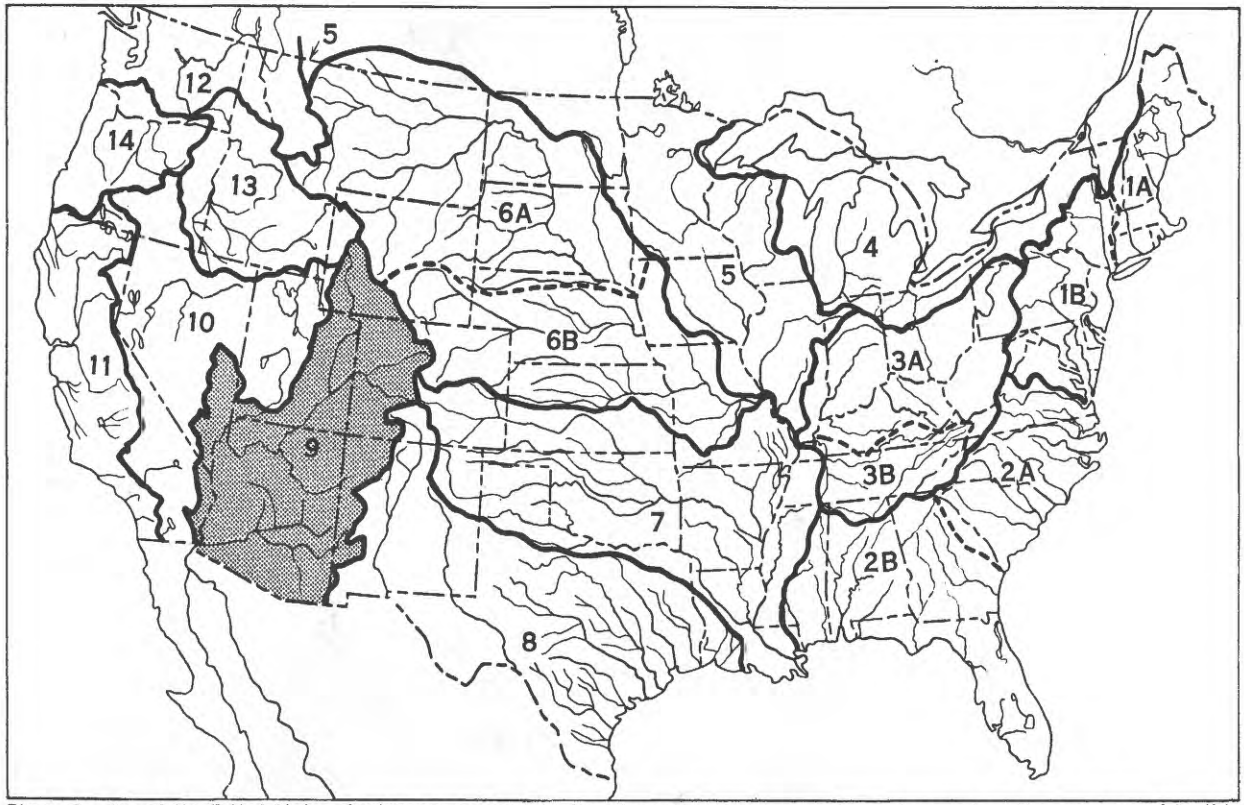



Figure 2.--Map of the United States showing areas covered by the 18 annual volumes on surface-water supply. The area covered by this report is shaded.

Streamflow data for the years 1884-1901, in reports of the Geological Survey

(A = Annual Report; B = Bulletin; W = Water-Supply Paper)

| Report | Character of data | Year |
|---|---|---|
| 10th A, pt. 2 | Descriptive information only. | |
| 11th A, pt. 2 | Monthly discharge and descriptive information..... | 1884 to September 1990. |
| 12th A, pt. 2 | ....do..... | 1884 to June 30, 1891. |
| 13th A, pt. 3 | ....do..... | 1884-92. |
| 14th A, pt. 2 | Monthly discharge..... | 1888-93. |
| B 131..... | Descriptions, measurements, gage heights, and ratings..... | 1893-94. |
| 16th A, pt. 2 | Descriptive information only. | |
| B 140..... | Descriptions, measurements, gage heights, ratings, and monthly discharge. | 1895. |
| W 11..... | Gage heights..... | 1896. |
| 18th A, pt. 4 | Descriptions, measurements, ratings, and monthly discharge.. | 1895-96. |
| W 15..... | Descriptions, measurements, and gage heights of streams east of the Mississippi River, and Missouri River and tributaries above Kansas River. | 1897. |
| W 16..... | Descriptions, measurements, and gage heights of streams west of the Mississippi River, except Missouri River and tributaries above Kansas River. | 1897. |
| 19th A, pt. 4 | Descriptions, measurements, ratings, and monthly discharge. | 1897. |
| W 27..... | Measurements, ratings, and gage heights of streams east of the Mississippi River, and Missouri River and tributaries. | 1898. |
| W 28..... | Measurements, ratings, and gage heights of streams west of the Mississippi River, except Missouri River and tributaries. | 1898. |
| 20th A, pt. 4 | Monthly discharge..... | 1898. |
| W 35 to 39... | Descriptions, measurements, gage heights, and ratings..... | 1899. |
| 21st A, pt. 4 | Monthly discharge..... | 1899. |
| W 47 to 52... | Descriptions, measurements, gage heights, and ratings..... | 1900. |
| 22d A, pt. 4. | Monthly discharge..... | 1900. |
| W 65, 66..... | Descriptions, measurements, gage heights, and ratings..... | 1901. |
| W 75..... | Monthly discharge..... | 1901. |

Reports on surface-water supply containing records from 1899 to date for drainage basins in this report are listed below. The data for any particular gaging station will, in general, be found in the reports covering the years during which the station was maintained.

Numbers of water-supply papers containing results of stream measurements in Colorado River basin, 1899-1952.

| Year | W.S.P. | Year | W.S.P. | Year | W.S.P. | Year | W.S.P. | Year | W.S.P. |
|---|---|---|---|---|---|---|---|---|---|
| 1899 | a37, 38 | 1911 | 309 | 1923 | 569 | 1933 | 749 | 1943 | 979 |
| 1900 | 50 | 1912 | 329 | 1924 | 589 | 1934 | 764 | 1944 | 1009 |
| 1901 | 66, 75 | 1913 | 359 | 1925 | 609 | 1935 | 789 | 1945 | 1039 |
| 1902 | 85 | 1914 | 389 | 1926 | 629 | 1936 | 809 | 1946 | 1059 |
| 1903 | 100 | 1915 | 409 | 1927 | 649 | 1937 | 829 | 1947 | 1089 |
| 1904 | 133 | 1916 | 439 | 1928 | 669 | 1938 | 859 | 1948 | 1119 |
| 1905 | 175, b177 | 1917 | 459 | 1929 | 689 | 1939 | 879 | 1949 | 1149 |
| 1906 | 211, b213 | 1918 | 479 | 1930 | 704 | 1940 | 899 | 1950 | 1179 |
| 1907-8 | 249 | 1919-20 | 509 | 1931 | 719 | 1941 | 929 | 1951 | 1213 |
| 1909 | 269 | 1921 | 529 | 1932 | 734 | 1942 | 959 | 1952 | 1243 |
| 1910 | 289 | 1922 | 549 | | | | | | |

a Green and Gunnison Rivers and Colorado River above Gunnison River.
b Below mouth of Gila River.

The records at most of the stations discussed in these reports extend over many years. Miscellaneous measurements at many points other than regular gaging stations have been made each year and are published under "Miscellaneous discharge measurements" at the end of each report. The streams and points of measurement are listed in the same order as the streams and gaging stations in the body of the report. An index of the records obtained before 1904 has been published in Water-Supply Paper 119.

Each of the reports on the surface-water supply for the year 1939 (Water-Supply Paper 879 for the Colorado River basin) contains, for the area included in that report, a summary of yearly discharge at gaging stations at which 10 or more complete years of record had been collected. These summaries were reprinted separately.

Reports also have been published that are compilations of records for various areas, usually a single State or drainage basin. These reports contain records previously pub-

lished (some of which may have been revised), as well as some records not contained in the annual series of water-supply papers. The following table lists reports of this type for the Colorado River basin.

Reports containing compilations of records of discharge by States and drainage basins

| Water-Supply Paper | Period | Report |
|---|---|---|
| 74..... | 1884-1900 | Water resources of Colorado. |
| 395..... | 1888-1914 | Colorado River (Ariz., Colo., N. Mex., Utah, Wyo.) and its utilization. |
| 617..... | 1897-1927 | Upper Colorado River (Colo., Utah) and its utilization. |
| 618..... | 1894-1926 | Green River (Colo., Utah, Wyo.) and its utilization. |
| 918..... | 1891-1938 | Surface waters at base stations in Colorado River basin (Ariz., Calif., Colo., Utah, Wyo.). |
| 1049..... | 1888-1938 | Surface waters at stations on tributaries in lower Colorado River basin (Ariz., Calif., Nev., N. Mex., Utah). |

Records of discharge have been published also in State reports. Some of these are not contained in the publications of the Geological Survey or are revisions of records previously published in its water-supply papers. The following table contains a list of these reports for the area covered by this report.

State reports containing compilations of records of discharge

| State | Period | Report | Issued by |
|---|---|---|---|
| Colorado..... | 1881-1935 | Water resources of Colorado, Appendix 2, Data on stream-gaging stations of Colorado. a/ | State Planning Commission, Water Conservation Board, State engineer. |
| Do..... | 1881-1938 | Water resources of Colorado, Appendix 3, vols. 1 and 2, Stream-flow data of Colorado. | Do. |
| New Mexico.... | 1888-1925 | Surface water supply of New Mexico..... | Office of the State Engineer. |
| Utah..... | 1889-1905 | 5th biennial report..... | Do. |
| Do..... | 1906-10 | 7th biennial report..... | Do. |
| Do..... | 1910-16 | 10th biennial report..... | Do. |

a/ Contains records of yearly discharge only.

Note.--In addition to the records contained in the reports listed above, the States of Colorado, New Mexico, and Wyoming have issued annual or biennial reports in which are contained records of discharge.

The reports listed in the foregoing tables contain the customary records of discharge collected during the systematic operation of gaging stations. Detailed information on the stage and discharge of many streams during major floods has been included in special reports on these floods published by the Geological Survey. The more recent of these special reports also contain other pertinent hydrologic information and analyses and compilations of data relating to earlier notable floods. The following list gives the numbers and titles of these reports.

| Water-Supply Paper | Title |
|---|---|
| 147..... | Destructive floods in the United States in 1904. |
| 162..... | Destructive floods in the United States in 1905. |
| 771..... | Floods in the United States, magnitude and frequency. |
| 847..... | Maximum discharges at stream-measurement stations through September 1938. |
| 967-A..... | Floods of September 1939 in Colorado River basin below Boulder (Hoover) Dam. |
| 994..... | Cloudburst floods in Utah, 1950 to 1938. |
| 997..... | Floods in Colorado. |

## RECORDS OF DISCHARGE COLLECTED BY AGENCIES OTHER THAN THE GEOLOGICAL SURVEY

The Western Colorado Power Co. continued, during the water year October 1951 to September 1952, to collect records of daily discharge for Cascade Creek near Tacoma, Colo., which now cover the years 1915-52. The records for the years 1934-40 are published in the surface water-supply papers of the Geological Survey covering the Colorado River basin for those years, and the records for the entire period are on file at the Office of the State Engineer of Colorado.

## HYDROLOGIC CONDITIONS

Although runoff for the water year 1952 as a whole was well above normal over most of the Colorado River basin, drought conditions occurred for extended periods within the year over large parts of the area. A drought in the lower basin continuing from the last part of the previous water year was brought to an end by storms late in December. Drought conditions returned to part of the lower basin and extended to part of the upper basin in February and remained until snowmelt from high elevations relieved the situation in April. Again in July drought conditions returned to part of the lower basin and remained through the end of the water year. Floods occurred in the west-central part of Colorado and the north-central part of Utah during April. For three key gaging stations in the area covered by this report, a comparison of monthly and annual mean discharges during the 1952 water year with the median discharges for the 25-year period 1921-45 is shown in figure 3 below:

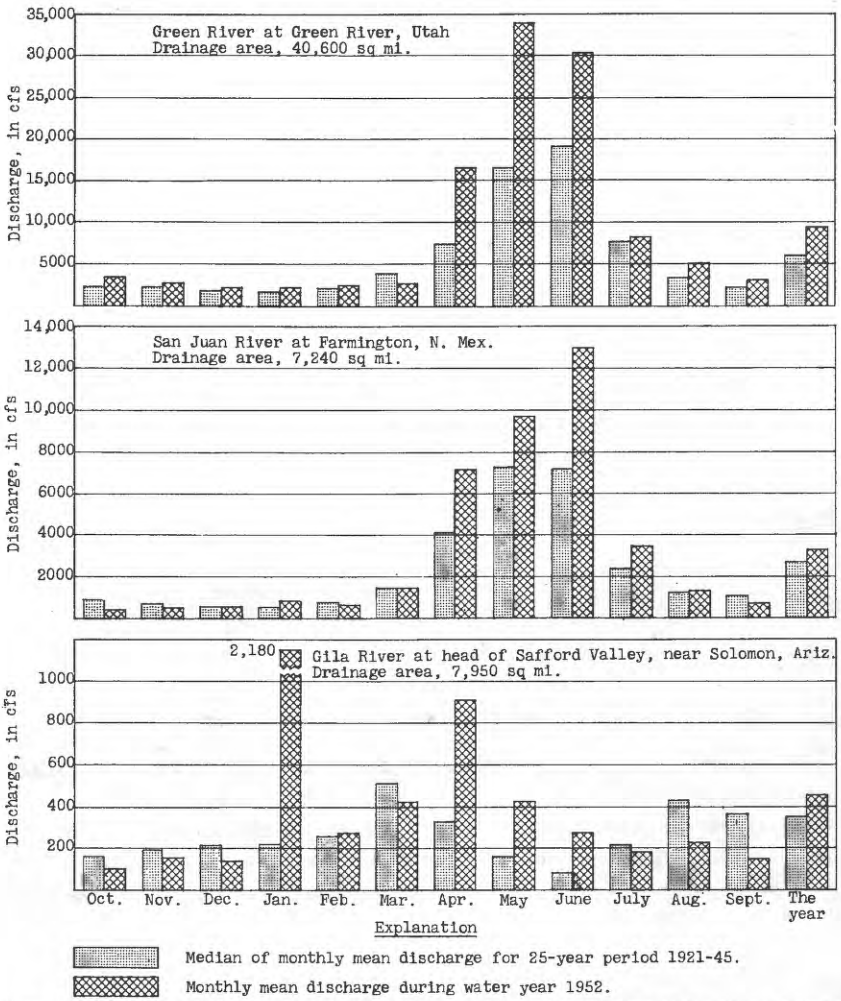



Figure 3.--Comparison of discharge at three key gaging stations during 1952 water year with median discharge for 25-year period.