FROM: ARIZONA WET (Red Binder)

Back to the Future

Objectives

Students will be able to:

1. Understand the importance of streamflow and precipitation data collection
2. Understand how precipitation data and streamflow data is collected and used
3. Participate in a class precipitation monitoring network
4. Graph, analyze, and interpret actual streamflow and precipitation data

Environmental Education Primary Areas

Resources and Resource Management

Subject Areas

Mathematics
Science

Background

Most of Arizona's early weather history was recorded at military outposts, beginning in the 1850s. Camp Yuma, which until 1873 was known as Colorado City, provides much of the early weather data in the state. Records show that as early as January 1862, devastating floods destroyed the town and that three-fourths of it was submerged under water in January 1874.

Floods have had a long history in many areas of Arizona. Flooding in recent years has been reduced by dams, flood control channels, basins and reservoirs, but flash floods are still a threat. During the thirty-four year period from 1950 - 1984, flash floods took the lives of ninety people in Arizona.

Floods have an impact on both urban and rural communities. In 1991 flood waters tore through the village of Supai in the Grand Canyon. A twelve-foot wall of water, ripped up homes from their foundations,

Mining Memories . . .

spring to mind, but that's the general impression from random readings.

One interesting case was Tombstone, only 25 miles from Bisbee. To get its water supply, Tombstone in the 1880s laid a pipeline 30-some miles to the southern end of the Huachuca Mountains to tap a stream supplied by several large springs.

Interestingly, that pipeline was fabricated from California redwood. As old-time miners know, redwood has some unique characteristics that make it ideal for tanks holding water and some pretty corrosive liquids.

That water line remained in service until just a few years ago. Now, the community is served by several deep, nearby wells.

An interesting book could be written about some of the heroic efforts made to furnish adequate water supplies for old Western mines and their communities.

—The Calumet and Arizona Mining Company spent several years finding water so it could develop the major copper deposit discovered at Ajo by a subsidiary, the New Cornelia Copper Company.

After drillers finally found a show of water in an area north of town, the company sank a mine shaft nearly 1,000 feet deep to a layer of water-bearing sands immediately under an old lava flow. From there they drilled a number of wells, like spokes from the hub of a wheel, and developed a major water field that has supplied the mine and community ever since.

—For more than 50 years, Phelps Dodge Corporation has spent hundreds of millions of dollars developing adequate water supplies for its mighty Morenci operation, including dams, pumping stations and long pipelines.

—Bagdad Copper Company spent a lot of money securing water for its operations at Bagdad in northwestern Arizona, including buying up ranches, developing a well field along the bed of a river that runs only during the summer rainy season.

The examples could go on indefinitely, but suffice it to say here that water was and remains to this day an often very precious commodity. So, those burros in the photo, dozing in the winter sunshine, were all important to the community and its inhabitants.

Background
(cont.)

drowned livestock and dumped hundreds of tons of debris. Again in 1993, the village of Supai was inundated by floodwater from a broken earthen dam. This flood was especially destructive since the force of the water from the breaking dam carved a new path through Havasu Creek. Not only was the course of its waters permanently altered, but the scenery that allured 25,000 tourists annually, was drastically changed.

Monitoring the water flow of a river is extremely important. Not only can streamflow data provide information about potential flooding, but low discharge as well. Land near rivers provides a critical environment to many animal and plant species.

These riparian areas are used by birds for migrating, nesting and feeding. Animals and reptiles are attracted to the stream for food, water and cover from the hot and dry conditions of Arizona. When streamflow is low, their habitat can be seriously threatened.

Precipitation is also monitored. The relative amounts of rain and snow, when it falls, and the sizes and intensities of individual storms are recorded. This data has a direct affect on how a city plans for snow removal or storm sewer design. Also, information on storm water runoff can be used in urban planning, hydroelectric power forecasting and irrigation.

Water Studies & Investigations

Studies that analyze an area's flood potential are common in Arizona. The Federal Insurance Administration produces flood potential maps from this data. However, because of budget, program policy and program benefit considerations, the FIA maps do not always show the entire flood hazard potential for each community. There are many areas in Arizona, including streams within communities, where flood insurance studies have been prepared without their flood hazard potential identified. This often times results in a situation where land can be purchased in a flood area, but cannot be built upon.

Precipitation data and streamflow data form the foundation for most water investigations. Because water managers use the data to help make decisions on water problems, the accuracy of the data is critical. The number of sampling

Background
(cont.)

points and the length of time they have been collecting data will determine the usefulness of the data. Many research projects fall short of expectations because the projects' scope and anticipated results are far too ambitious for the data that has been collected. Cost usually dictates the number and type of sites in a monitoring network.

Precipitation Data Collection

Precipitation records for Arizona recording sites date back to the late 1800s. Modern precipitation data is collected by weather observers and by National Weather Service offices located across the country. The National Weather Service currently maintains a network of approximately 270 climatological stations located around the state.

Weather observers, as the name implies, are people that observe and record basic local weather characteristics such as precipitation (24-hour period) and temperature (high and low), and inclement weather (i.e., blizzards, monsoons and hailstorms). The weather observer reports are forwarded to the National Weather Service at least once a day. Thereafter, the frequency of an observer's report is determined by the changes in a region's weather conditions. For example, weather conditions like severe thunderstorms require constant monitoring and more frequent reporting. Meteorologists at the National Weather Service, with the aid of sophisticated weather monitoring equipment (i.e., radar, satellite images, and computer models), will develop reports and forecasts for the media to distribute to the public.

Tables 1-3 contain precipitation data from Northeast, South Central and Southeast Arizona. This data will be used by students to generate graphs.

Streamflow Data Collection

Agencies such as the Arizona Geological Survey, U.S. Geological Survey, and the National Weather Service collect streamflow data at gauging sites on Arizona rivers and streams. Streamflow is a measurement of the volume of water passing a given point over a given period of time. The data is recorded at the gauging station as stream height and then is mathematically converted into cubic feet per second (cfs). Streamflow is then reported in *water years*. A water year begins in October and ends in September of the following year.

Background (cont.)

Streamflow data is collected electronically or manually. The "electronic" sites typically record streamflow data around the clock, 365 days a year. Manual sites are monitored daily or after major precipitation events. The data can then be used to develop stream hydrographs. A stream hydrograph is simply a graphical representation of its discharge or flow of water past a point over time.

Dams, water diversions, and land use changes in the river's watershed can influence streamflow. Dams tend to regulate the flow, while diversions reduce the flow. Collecting streamflow data helps to monitor these and other changes.

Historic streamflow records show that many of Arizona's rivers, or washes, fluctuate from periods of zero flow to raging floods. The knowledge of a river's extreme highs and lows is as important as knowing about more normal conditions. Hydrologists use the data to create simulation models that can help predict streamflow under various precipitation conditions.

Table 4 contains thirty years of streamflow data for the Salt River below Stewart Mountain Dam. Students will use this data to create graphs.

Materials

Hundreds of small pieces of paper (1" X 1" or smaller)
Scissors
Ruler
Paper and pencils
Graph paper (optional)

Procedure

1. Review and discuss the importance of collecting precipitation and streamflow data. Have your students think of some of the ways that the data is used.

2. Discuss the role that weather observers play in recording and reporting precipitation and temperature data. Prepare your class to become weather observers.

Procedure
(cont.)

a Each student should have a pencil and paper.

b Take your students outside and record the temperature and the precipitation for a 24-hour period. Some weather observations to record are wind (yes or no), wind direction, and cloud cover (i.e., partly cloudy, foggy, or clear).

c Repeat the outdoor exercise for two weeks, starting on a Monday and ending on a Friday.

d Save the results until the class has completed the graphing exercise. At that time, ask your students to try to remember the items that they recorded during the outdoor weather observations. This exercise should reinforce the importance of keeping good records.

3 Review the basic components of a graph.

4 Your students will now create four different line graphs.

Graph 1
Total annual precipitation for a 10-year period using data in Table 1.

Graph 2
Monthly precipitation for one year using data in Table 1.

Graph 3
Average monthly streamflow in cfs of the Salt River below Stewart Mountain Dam.

Graph 4
Average annual streamflow in cfs of the Salt River below Stewart Mountain Dam.

5 Have your students complete the ***Back to the Future*** worksheets.

6 Once the graphs are completed, arrange the maps side by side in front of the classroom.

Back to the Future

Name ______________________________

Date ______________________________

Answer the following questions on the graphs you created from the streamflow and precipitation data.

Graph 1 - Average Annual Precipitation for a 10-Year Period.

What is the largest number?

What is the smallest number?

What is the range between the high and low?

What is the average for the 10-year period?

How many years were above average?

How many years were below average?

Graph 2 - Monthly Precipitation for One Year

Which month had the highest amount of precipitation?

Which month had the lowest?

Calculate the percentage of precipitation that arrived between June and September.

Back to the Future (cont.)

Graph 3 - Average Monthly Streamflow Data for a One-Year Period

During which month was the greatest amount of water flowing in the stream?

During which month was the least amount of water flowing in the stream?

What is the range between the high and low?

Graph 4 - Average Annual Stream Flow

Which year had the highest average annual streamflow?

Which year had the lowest?

What is the range between the high and low?

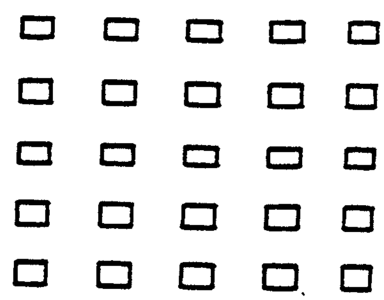
Did you notice any unusual patterns in the graphs which might indicate a change in the flow of the river?

Extension

1. Climatologists and hydrologists often use graphs and maps in the place of tables of numbers to explain and show the results of a study. Graphs and maps make the data easier to visualize and enhance understanding. For example, the map at the end of this lesson plan was developed to illustrate the regional variations in precipitation instead of asking people to review precipitation data for all of the monitoring sites in Arizona. The lines on the map showing areas of equal or similar rainfall are called isohyetal lines. In this exercise, the students will develop a similar type of map to show rainfall intensities for a simulated class rainstorm.

2. Discuss the importance of a well-developed monitoring network. Prepare by cutting or tearing hundreds of small pieces of paper and placing them in a bag or other container.

3. Arrange your students' desks in a grid pattern.



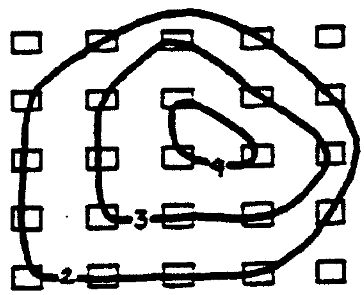
4. Have each student sit at a desk. Each student represents one point in the monitoring network. Stand near the center of the desks and throw the paper into the air; let the pieces settle to the floor, on the students, and on the desks. Have each student gather as many pieces of paper as he or she can without leaving his or her desk. Every ten pieces of paper equals one inch of rain.

5. Now on the blackboard, draw a scale drawing of your "monitoring network." Have each student count the number of pieces of paper he or she picked up and report the number to the class. Write each student's number in the corresponding square on the blackboard model. Complete the drawing by connecting the points of similar precipitation.

Extension
(cont.)

What changes could have been made to the monitoring network to get better results? Would the results have been that much better if there had been more collection points?

6 Repeat Step 4 two or three times, throwing the paper into the air from different places in the room. This will allow the class to generate several different maps. An example is shown below.



7 Relate the above maps to the maps developed by climatologists at the National Weather Service.

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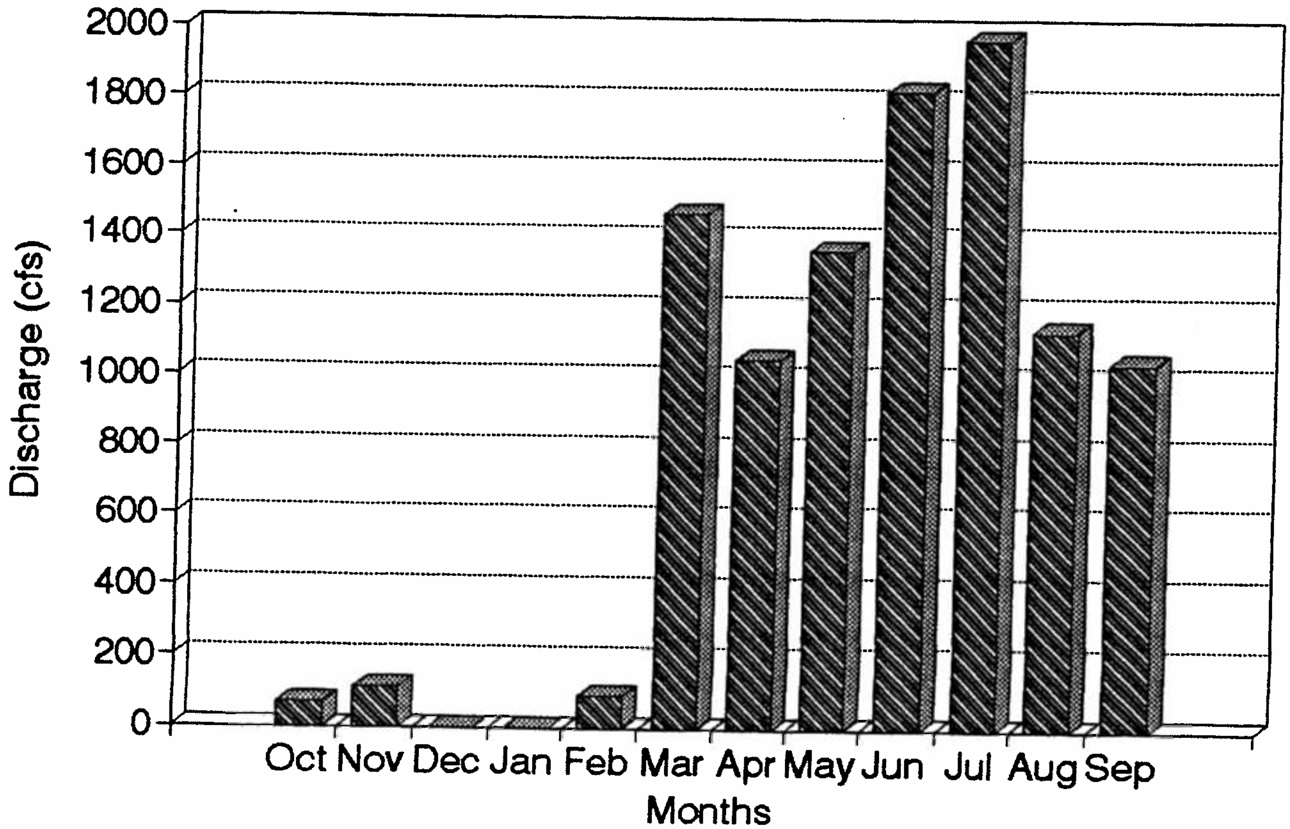
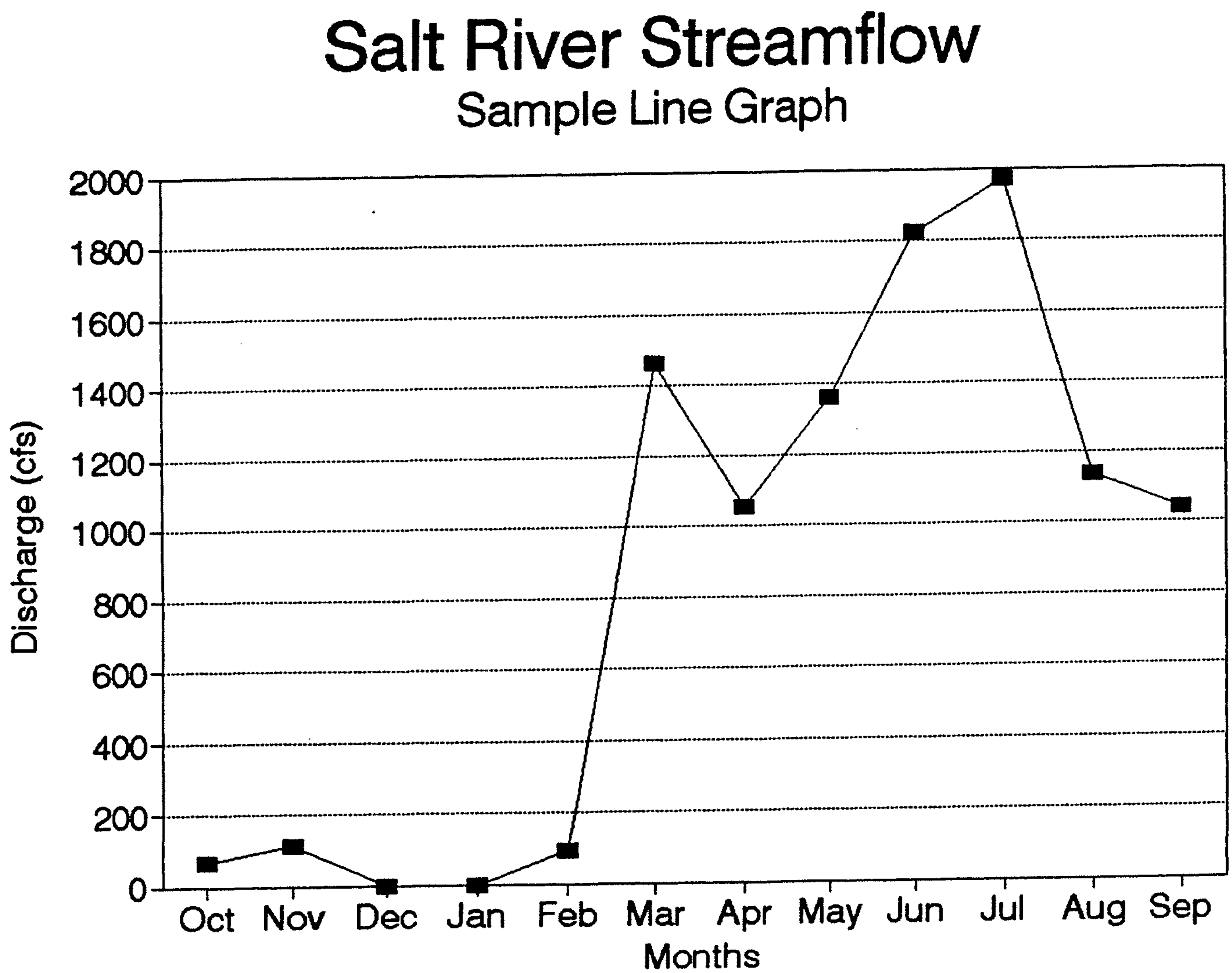
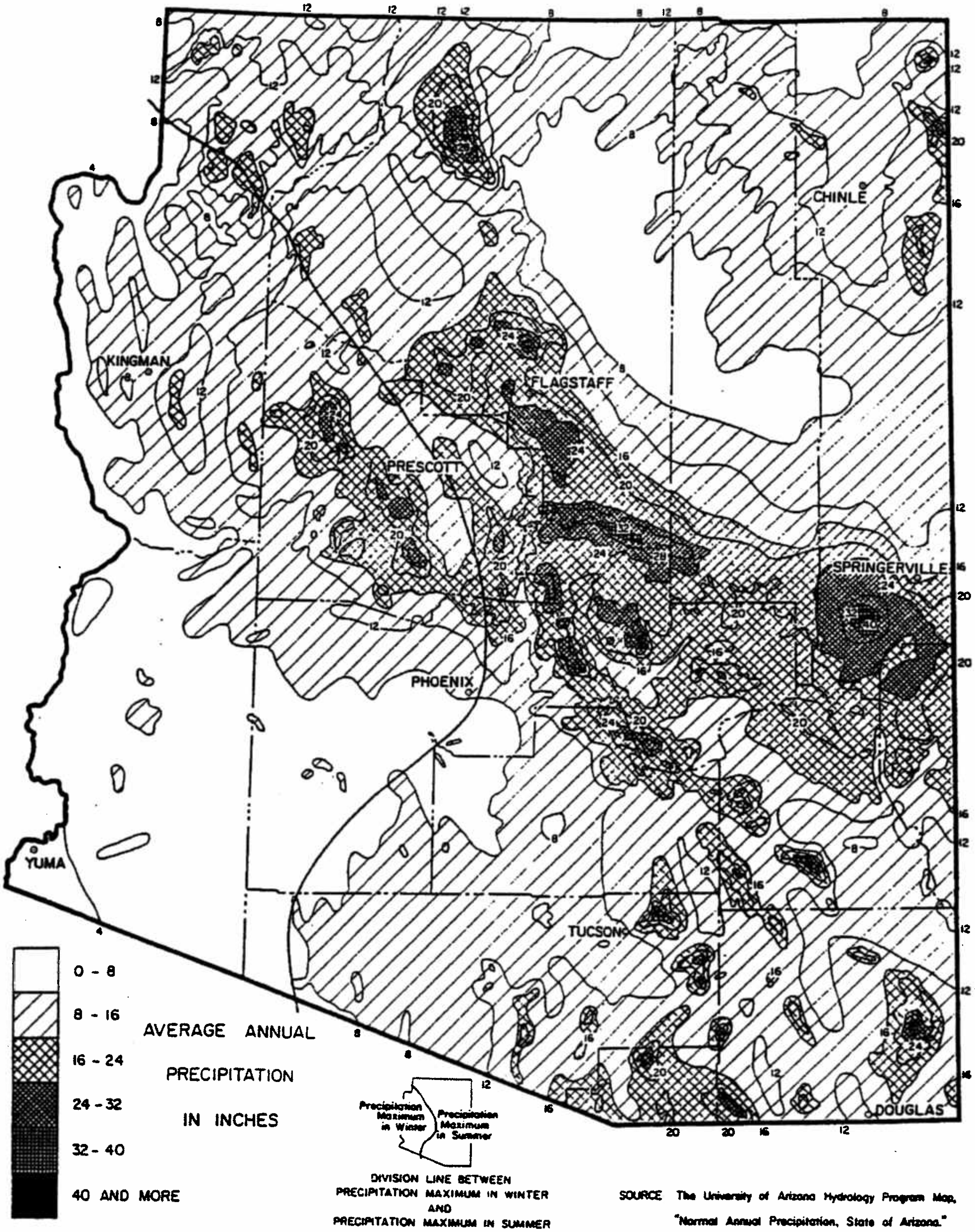
Salt River Streamflow

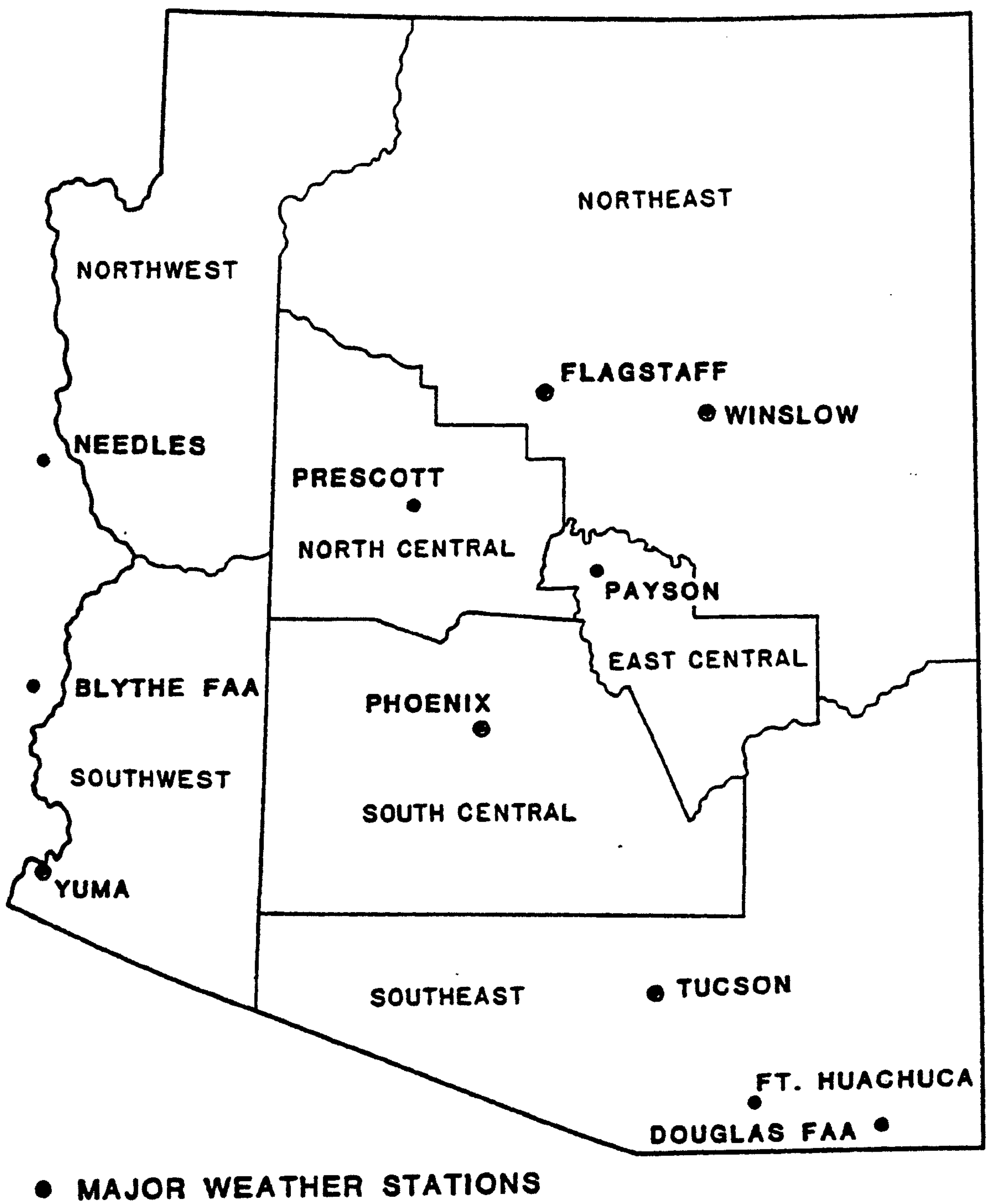
Sample Bar Graph




Salt River Streamflow
Sample Line Graph
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Discharge (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Months

Average Annual Precipitation





Boundaries indicate Climatic Divisions in Arizona

Precipitation Data

Monthly precipitation totals (in inches) are recorded for three of the seven climactic divisions in Arizona (see map provided). These are reported as averages for the entire zone in a calendar year.

Table 1 - Precipitation, Northeast Arizona

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1951	1.24	0.67	0.58	1.32	0.55	0.00	1.47	3.77	0.72	1.39	0.90	2.59	15.20
1952	2.41	0.51	1.99	1.91	0.10	0.64	2.03	2.06	1.98	0.00	2.02	0.80	16.45
1953	0.43	0.41	0.94	0.87	0.14	0.26	3.17	2.22	0.05	0.35	0.75	0.43	10.02
1954	0.96	0.57	2.72	0.11	0.63	0.62	2.74	1.77	2.00	0.59	0.18	0.49	13.38
1955	1.36	0.89	0.11	0.26	0.31	1.77	2.11	3.21	0.08	0.22	0.85	0.71	11.88
1956	1.42	0.88	0.11	0.65	0.29	0.43	1.89	1.38	0.09	0.67	0.06	0.28	8.15
1957	3.22	0.69	0.86	0.68	1.57	0.77	2.03	3.21	0.09	2.59	1.46	0.46	17.63
1958	0.33	1.59	2.28	0.91	0.50	0.45	0.81	2.43	2.99	1.02	0.74	0.08	14.13
1959	0.33	1.40	0.02	0.82	0.23	0.56	1.65	2.74	0.34	2.67	0.67	2.34	13.77
1960	1.19	0.97	0.62	0.49	0.48	0.34	0.68	1.31	0.85	2.80	0.53	0.95	11.21
1961	0.55	0.27	2.07	0.26	0.14	0.15	1.67	2.65	1.41	1.57	0.84	1.54	13.12
1962	1.37	1.43	0.61	0.07	0.29	0.45	0.75	0.75	1.83	1.51	1.09	0.63	10.78
1963	0.68	0.99	0.56	0.51	0.03	0.03	0.81	4.53	1.35	1.00	0.91	0.24	11.64
1964	0.49	0.26	1.41	1.14	0.26	0.22	2.50	2.52	1.84	0.10	0.93	1.18	12.85
1965	1.65	1.34	1.21	1.73	1.09	0.62	2.35	1.16	1.80	0.66	1.91	3.27	18.79

Table 1 - Precipitation, Northeast Arizona (cont.)

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1966	0.56	0.90	0.34	0.27	0.18	0.34	2.16	1.94	1.13	0.64	0.94	2.08	11.48
1967	0.38	0.06	0.61	0.43	0.52	0.92	2.77	2.50	1.57	0.13	0.52	3.49	13.90
1968	0.51	0.63	0.97	0.90	0.24	0.22	2.30	2.06	0.17	0.93	0.87	1.22	11.02
1969	1.56	1.17	1.13	0.20	1.02	0.21	2.25	2.15	0.91	1.53	1.06	0.46	13.65
1970	0.37	0.30	2.35	0.77	0.06	0.20	1.52	2.03	2.06	0.63	0.53	0.79	11.61
1971	0.22	0.64	0.22	0.48	0.34	0.04	1.10	3.56	1.91	2.70	0.58	1.94	13.73
1972	0.03	0.03	0.01	0.17	0.19	1.90	1.37	1.65	0.80	6.53	1.29	1.78	15.75
1973	1.05	1.98	3.45	0.88	0.99	0.62	1.44	1.25	0.22	0.07	1.09	0.14	13.18
1974	2.34	0.28	0.67	0.32	0.02	0.02	2.24	1.18	0.96	2.86	0.54	0.53	11.96
1975	0.96	1.43	1.95	1.18	0.37	0.04	2.48	0.84	2.06	0.14	1.26	1.02	13.73
1976	0.23	2.10	0.97	0.96	1.48	0.13	2.94	1.07	2.00	0.71	0.26	0.24	13.09
1977	1.32	0.50	0.61	0.68	0.41	0.55	2.43	2.25	1.76	1.20	0.59	0.64	12.94
1978	2.56	2.46	3.60	0.68	0.74	0.09	1.18	1.51	0.97	1.39	4.18	3.43	22.79
1979	3.27	0.99	2.19	0.37	1.94	0.43	0.69	1.84	0.28	0.92	1.00	1.08	15.00
1980	3.64	4.05	2.01	0.95	0.44	0.07	1.90	2.05	1.19	0.81	0.09	0.65	17.85

Table 2 - Precipitation, South Central Arizona

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1951	1.93	0.30	0.38	1.27	0.26	0.00	1.31	5.03	0.36	0.87	1.02	1.05	13.78
1952	0.99	0.31	2.38	1.87	0.01	0.22	1.10	1.28	0.52	0.00	2.79	0.83	12.30
1953	0.30	0.59	1.00	0.09	0.09	0.02	2.06	0.81	0.00	0.01	0.18	0.12	5.27
1954	1.27	0.60	1.97	0.00	0.27	0.24	1.79	1.51	1.24	0.14	0.01	0.10	9.14
1955	2.52	0.13	0.01	0.02	0.01	0.67	3.43	2.78	0.05	0.17	0.21	0.33	10.33
1956	0.86	0.73	0.00	0.16	0.01	0.16	0.98	0.74	0.08	0.52	0.00	0.10	4.34
1957	2.37	0.53	0.77	0.18	0.52	0.26	1.14	1.29	0.03	3.06	0.30	0.38	10.83
1958	0.02	1.44	2.01	0.92	0.12	0.30	0.61	0.99	1.76	0.65	0.48	0.00	9.30
1959	0.24	1.08	0.00	0.09	0.02	0.07	0.96	2.48	0.09	2.20	0.52	3.58	11.33
1960	1.43	0.32	0.40	0.01	0.14	0.01	0.70	1.23	0.36	1.11	0.08	0.16	5.95
1961	0.52	0.04	0.69	0.00	0.00	0.03	0.92	1.97	0.73	0.30	0.22	1.76	7.18
1962	1.65	0.94	0.72	0.01	0.01	0.21	0.44	0.20	1.11	0.16	0.27	0.78	6.50
1963	0.72	1.31	0.58	0.32	0.00	0.00	0.21	3.86	0.43	1.11	1.26	0.08	9.88
1964	0.27	0.03	0.77	0.21	0.01	0.04	1.62	2.65	1.44	0.54	0.68	1.06	9.32
1965	1.59	1.65	1.19	1.62	0.27	0.37	0.88	0.54	0.74	0.21	1.24	5.23	15.53
1966	0.78	1.52	0.32	0.01	0.27	0.11	0.65	1.74	2.27	0.50	0.60	0.60	9.37
1967	0.29	0.03	0.63	0.37	0.16	0.49	1.78	0.88	0.79	0.46	1.41	4.94	12.23
1968	0.33	1.40	1.58	0.13	0.01	0.01	1.56	1.63	0.04	0.52	1.28	1.19	9.68
1969	1.57	0.98	0.68	0.10	0.41	0.01	0.61	1.35	1.37	0.23	1.21	0.84	9.36

Table 2 - Precipitation, South Central Arizona (cont.)

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1970	0.05	0.37	2.68	0.13	0.01	0.06	0.65	1.32	2.77	0.35	0.10	0.52	8.99
1971	0.23	0.46	0.02	0.22	0.05	0.00	0.49	3.21	1.41	1.28	0.17	0.91	8.45
1972	0.00	0.00	0.00	0.00	0.13	1.09	0.70	1.23	0.46	4.71	1.32	1.59	11.23
1973	0.31	2.04	2.54	0.06	0.38	0.24	1.00	0.32	0.01	0.00	1.20	0.00	8.10
1974	1.26	0.04	1.42	0.04	0.00	0.00	1.64	1.35	1.01	2.33	0.35	0.68	10.12
1975	0.16	0.70	1.32	0.78	0.00	0.00	1.09	0.24	0.82	0.25	0.97	1.04	7.37
1976	0.07	1.09	0.34	0.92	0.79	0.03	1.13	0.58	2.27	0.85	0.48	0.59	9.14
1977	1.12	0.06	0.48	0.20	0.26	0.10	0.74	0.84	0.96	0.93	0.24	0.80	6.73
1978	2.97	2.96	2.89	0.43	0.23	0.20	0.84	1.24	0.14	1.07	2.58	3.17	18.72
1979	3.28	0.28	2.36	0.08	0.75	0.15	0.47	1.59	0.07	0.20	0.19	0.19	9.61
1980	2.33	3.11	1.33	0.47	0.20	0.03	0.80	0.86	0.42	0.14	0.00	0.16	9.85

Table 3 - Precipitation, Southeast Arizona

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1951	1.26	0.40	0.62	1.65	0.06	0.01	2.18	3.57	0.54	1.79	0.87	1.49	
1952	0.92	0.21	2.17	1.42	0.09	1.15	2.13	2.88	0.65	0.00	1.75	0.85	14.54
1953	0.07	1.06	1.18	0.24	0.07	0.20	3.93	1.04	0.01	0.12	0.17	0.16	14.22
1954	0.92	0.36	1.92	0.01	0.53	0.79	3.71	3.82	1.68	0.43	0.00	0.07	8.25
1955	1.91	0.26	0.31	0.01	0.09	0.30	4.69	4.76	0.17	0.60	0.08	0.34	14.24
1956	0.83	0.64	0.00	0.22	0.04	0.42	3.17	1.44	0.15	0.39	0.03	0.26	13.52
1957	2.09	0.43	1.21	0.22	0.51	0.42	2.69	3.72	0.14	2.46	0.46	0.53	7.59
1958	0.08	1.61	2.79	0.80	0.07	0.78	3.55	3.52	2.44	1.17	0.77	0.00	14.88
1959	0.05	0.85	0.01	0.16	0.00	0.65	3.64	4.86	0.21	1.76	0.80	2.08	17.58
1960	2.53	0.51	0.26	0.00	0.10	0.10	2.07	2.33	1.33	1.45	0.06	0.94	15.07
1961	1.17	0.12	0.38	0.01	0.00	0.52	2.59	3.94	1.54	1.59	1.06	2.32	11.61
1962	1.75	0.38	0.72	0.05	0.00	0.32	2.40	0.93	2.75	0.54	0.60	1.50	15.24
1963	0.74	0.38	0.72	0.05	0.00	0.32	2.40	0.93	2.75	0.54	0.60	1.50	11.94
1964	0.21	0.10	0.82	0.47	0.01	0.14	3.78	3.21	3.43	0.92	0.82	0.66	11.94
1965	0.02	0.48	1.57	0.26	0.05	0.32	2.36	3.05	2.48	0.61	0.06	0.50	14.57
1966	1.42	1.98	0.14	0.17	0.04	0.55	3.15	4.08	3.07	0.30	0.56	0.34	11.76
1967	0.08	0.25	0.36	0.40	0.36	0.67	4.16	3.08	2.12	0.52	0.69	4.87	15.80
1968	0.60	1.39	1.52	0.39	0.02	0.07	3.21	2.79	0.25	0.21	0.96	1.15	17.56
1969	0.76	0.63	0.43	0.10	0.57	0.02	3.31	2.99	1.18	0.26	1.08	1.00	12.56
													12.33

Table 3 - Precipitation, Southeast Arizona (cont.)

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1970	0.02	0.48	1.57	0.26	0.05	0.32	2.36	3.05	2.48	0.61	0.06	0.50	11.76
1971	0.16	0.66	0.01	0.33	0.01	0.05	2.53	5.14	1.91	2.25	0.64	1.85	15.54
1972	0.02	0.00	0.02	0.00	0.35	1.49	2.43	2.93	1.44	4.61	1.10	0.81	15.20
1973	0.57	2.08	2.51	0.06	0.48	0.59	2.88	1.22	0.14	0.01	0.59	0.01	11.14
1974	1.41	0.06	0.56	0.07	0.03	0.10	4.03	2.29	2.38	2.47	0.37	0.34	14.11
1975	0.79	0.29	1.31	0.66	0.04	0.01	3.78	0.98	2.72	0.18	0.82	0.75	12.33
1976	0.30	1.28	0.40	0.85	0.51	0.22	3.98	1.31	2.08	1.07	0.59	0.37	12.96
1977	2.09	0.05	0.55	0.25	0.04	0.44	3.23	2.88	1.60	3.11	0.34	1.18	15.76
1978	2.72	2.22	1.74	0.11	0.54	0.41	2.54	1.93	0.89	2.41	2.68	4.01	22.20
1979	3.43	0.77	1.19	0.11	0.73	0.84	2.23	2.52	0.33	0.21	0.23	0.57	13.16
1980	1.21	2.90	1.07	0.18	0.08	0.31	1.94	2.64	1.20	0.29	0.18	0.29	12.29

Streamflow Data for the Salt River below Stewart Mountain Dam

Flow is regulated on the Salt River at Stewart Mountain Dam and three other dams. The entire flow is divert at Granite Reef Dam, ten miles downstream, for the irrigation of the Salt River Valley and for municipal use in Phoenix. Discharge measurements (in ccf) are generally made four times per month.

Table 4 - Streamflow

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1961	232	3.36	65.1	5.12	316	1340	867	1231	1480	1650	1174	979
1962	261	47.3	8.0	36.2	151	152	971	1120	1320	1315	1926	1363
1963	66.5	112.0	0.0	0.0	91.2	1465	1050	1359	1822	1969	1134	1038
1964	132	6.91	104	26.4	199	1206	928	999	1298	1343	590	517
1965	349	90.9	1.58	1.17	29.7	104	4.47	266	569	749	535	652
1966	164	191	1823	3984	1238	1600	1607	775	818	1253	1213	1125
1967	299	29.5	1193	77.0	22.6	940	821	867	993	848	1167	1147
1968	537	5.05	34.9	7.68	1992	2238	2566	1278	1236	1106	1177	1775
1969	924	423	799	188	475	611	1388	2147	2269	1129	205	1310
1970	866	13.6	796	172	757	649	1445	1605	2048	1603	1283	1108
1971	315	6.19	4.42	4.08	579	1324	1113	1213	1061	1288	608	585
1972	140	6.97	8.45	5.36	5.15	466	1204	1344	1492	1482	1166	860
1973	697	459	8.94	7.92	156	3273	6452	5261	1911	1785	1831	1881
1974	1207	84.2	9.66	1.73	1.21	942	1313	1414	17.62	1632	1749	1310

Table 4 - Streamflow (cont.)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1975	38.3	.11	3.13	2.76	15.8	517	334	1258	1661	1669	1680	1434
1976	327	1.26	1.16	198	108	18.7	400	810	1236	1445	1742	1219
1977	391	5.31	2.06	0	0	457	1157	1254	1904	2067	1940	1098
1978	416	2.02	.45	0	1.06	980	1115	1517	1714	1694	1681	1562
1979	734	155	7169	9747	1489	6874	4851	2993	2026	2088	2067	1834
1980	962	6.81	0	109	18950	1592	3118	2803	2124	2590	2208	2283
1981	455	3.23	2.77	408	748	1319	1485	1139	1742	1763	1801	1244
1982	269	5.45	3.56	3.60	1.15	1.53	114	919	1811	1767	1679	1463
1983	377	5.92	244	916	4213	5313	4332	2698	1664	1494	1430	1031
1984	7128	150	986	1650	743	668	489	773	1485	983	1291	1343
1985	204	15.6	3501	3410	2492	5460	2567	2325	1767	1711	1761	1258
1986	261	5.84	1397	514	5.09	574	1815	1486	1719	1625	1625	1055
1987	18.3	6.97	7.60	708	686	1153	1791	1539	1739	1648	1631	1255
1988	48.4	10.6	9.23	10.8	540	1487	718	1130	1721	1744	1617	1358
1989	379	42.2	3.13	27.6	0	1031	1531	1906	2122	2106	1838	1263
1990	263	1.68	69.5	0	61.0	53.1	705	1035	1569	1305	967	473