

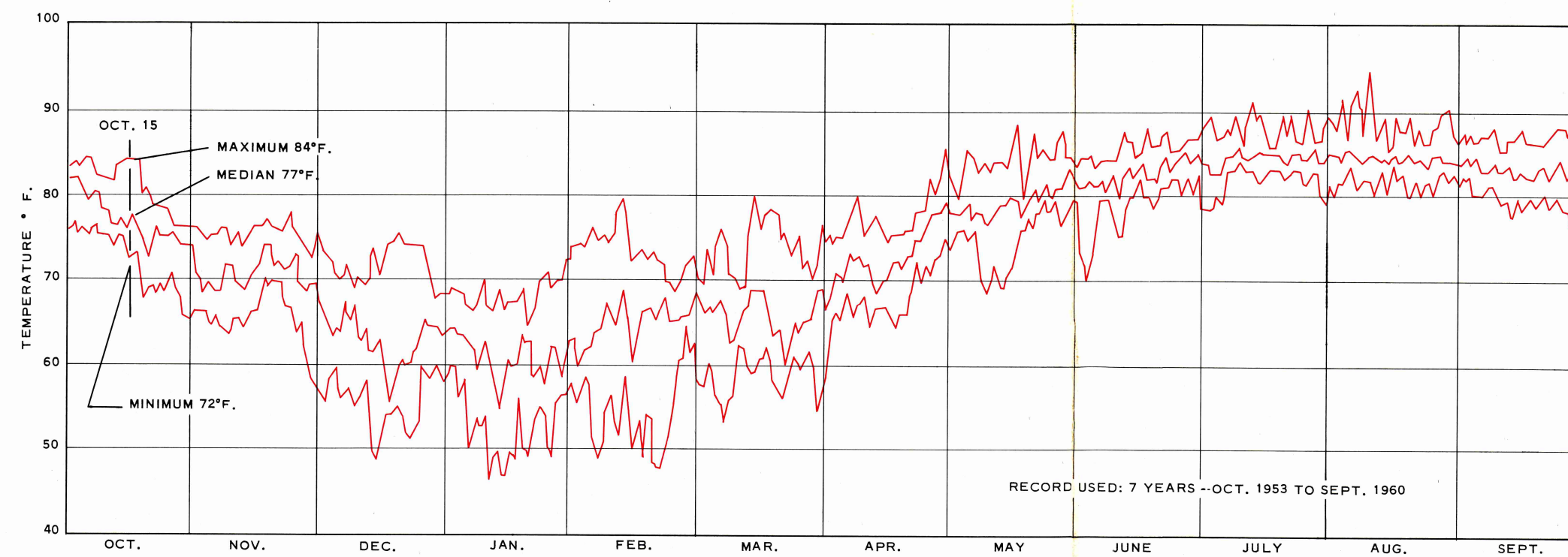


FIGURE 1. MAXIMUM, MINIMUM, AND MEDIAN DAILY TEMPERATURE.

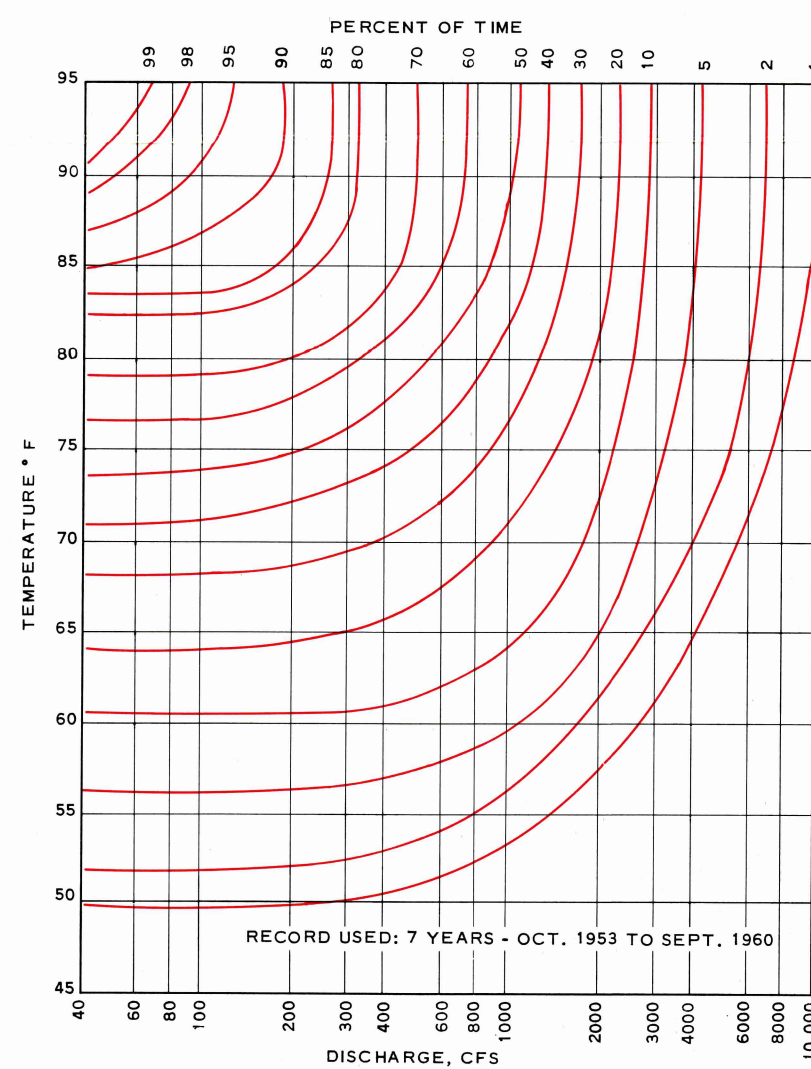


FIGURE 2. CUMULATIVE FREQUENCY OF COMBINATIONS OF TEMP. AND DISCHARGE.

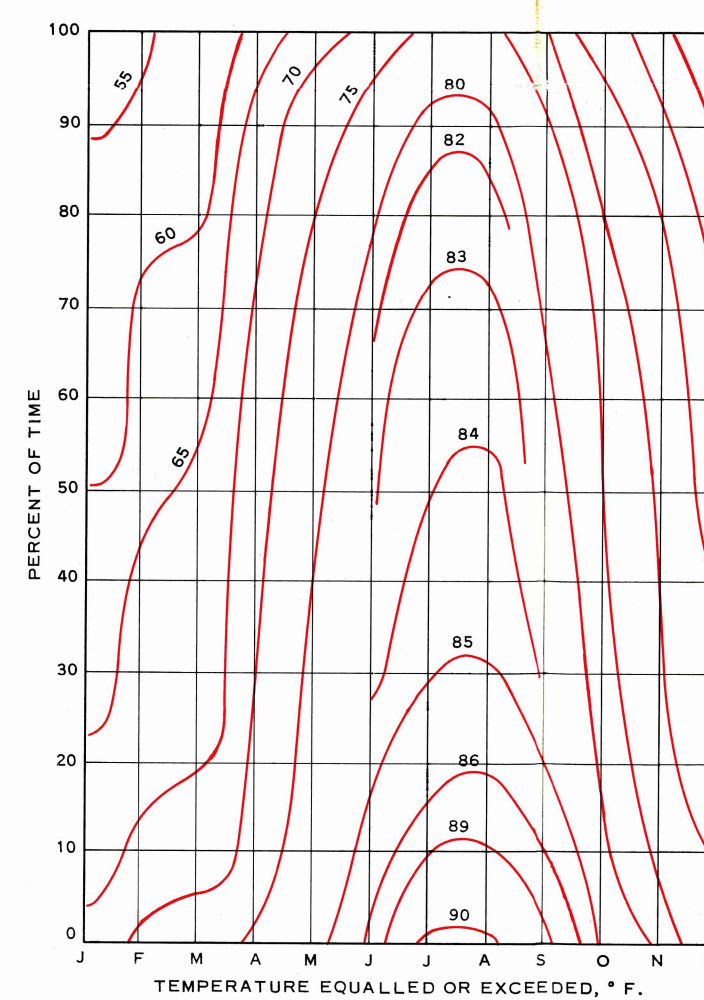


FIGURE 3. CUMULATIVE FREQUENCY OF TEMPERATURE BY MONTHS.

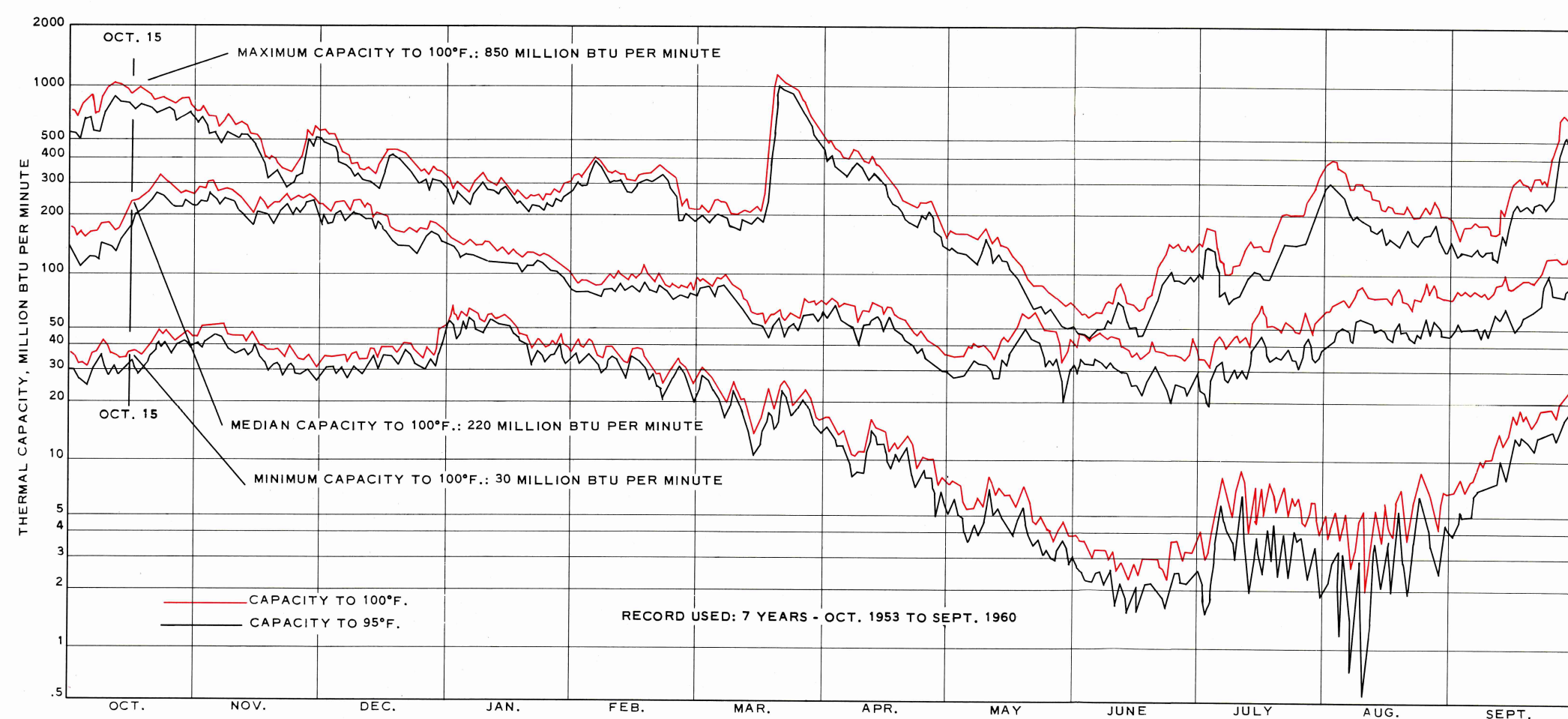
ST. JOHNS RIVER
NEAR COCOA
LOCATION MAP

FIGURE 4. MAXIMUM, MINIMUM, AND MEDIAN DAILY THERMAL CAPACITY.

Temperature and Chemical Characteristics of the St. Johns River Near Cocoa, Florida

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The temperature of the St. Johns River near Cocoa has been read daily for 7 years, more than 2,500 readings. The chemical quality of the river has been measured for 9 years, more than 3,000 readings. The purpose of this report is to present these data in a compact and readily usable form. The illustrations have been designed to answer practical and commonly asked questions about the water temperature and water quality of the St. Johns River. Figures on page 1 describe the thermal character of the stream and figures on page 2 describe the chemical constituents and physical properties of the water.

A water sample was collected and the temperature of the river was measured once a day at the bridge on State Highway 520, 8.8 miles west of Cocoa from October 1, 1953, to September 30, 1960. The specific electrical conductance of each sample was measured and a single sample was composited from groups of approximately 10 daily samples. The composite samples were analyzed for about 16 chemical and physical properties. A continuous conductivity recorder was operated at the bridge from October 1, 1960, to September 30, 1962. During this time samples were taken periodically and analyzed for approximately 16 constituents and physical properties. Discharge records have been collected at this site since October 1953.

Temperature is an important factor of water quality. This is very evident for a direct use such as a coolant. The effect of temperatures on aquatic biota is less evident but nonetheless very important. The tolerance of fish to certain toxin substances has been shown to vary widely with temperature. Oxygen is more soluble in cold water than in warm water, hence the reduction of oxygen concentrations by pollution is especially serious during periods of high temperatures when oxygen levels are already low. Increased temperature also accelerates biological activity including that of the oxygen-utilizing bacteria which decompose organic wastes. These pollutional effects may be especially serious when low flow conditions coincide with high temperatures.

The maximum, minimum, and median observed

temperatures for each day of the year are shown in figure 1. For example, 84° F. was the highest temperature observed on any October 15th. Similarly, 72° F. was the lowest temperature observed on any October 15th. The median October 15th reading was 77° F.

The cumulative frequency curve (fig. 2) shows the percent of time that two requirements were met (1) the water temperature was equal to or less than a given value and (2) the discharge was equal to or greater than a given value. For example, suppose that 600 cubic feet per second of water of less than 85° F. is needed. The 85° F. line and the 600 cubic feet per second line intersect at 61 percent of the time. Therefore, sufficient water (600 cubic feet per second or more) having a suitable temperature (85° F. or less) is available 61 percent of the time.

Sometimes water of a certain temperature is needed for part of a year. Figure 3 shows the percent of time selected temperatures are equalled or exceeded during each month. For example, a temperature of 80° F. is exceeded 92 percent of the time in July but only 19 percent of the time in October.

If water is used for cooling, it is important to know the capacity of a stream to carry away heat (thermal capacity) without exceeding a given temperature and to know the amount of heat the stream is carrying (thermal load). The thermal capacity and thermal load of the St. Johns River are expressed herewith in BTU (British Thermal Units) per minute. A BTU is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

The thermal load of the St. Johns River has been computed above a base of 40° F. The thermal capacity has been computed to 95° F. and 100° F. The thermal capacity to 95° F. or 100° F. is the number of BTU's required to raise the river's temperature from the measured temperature to 95° F. or 100° F. The maximum, minimum, and median daily thermal capacity of the river is shown in figure 4. For example, the smallest thermal capacity to 100° F. observed on any October 15th was 38 million

BTU's per minute. This means that, during the seven years of record, the St. Johns River could have carried at least 38 million additional BTU's per minute on any October 15th without the river temperature exceeding 100° F. after the water was thoroughly mixed. If a 100° F. temperature is undesirable but a 95° F. temperature is permissible, the minimum thermal capacity on any October 15th would have been 30 million BTU's per minute. Figure 5 is similar to figure 4 except it shows the maximum, minimum, and median daily thermal load.

The cumulative frequency curves of thermal capacity and thermal load (fig. 6) show that if the maximum permissible temperature of the receiving stream is 100° F., the thermal capacity equals or exceeds 200 million BTU's 25 percent of the time. Therefore, an input of 200 million BTU's per minute will overload the stream 75 percent of the time. If the maximum permissible temperature is only 95° F., the stream will be overloaded 82 percent of the time.

Figure 7a shows the percent of time selected thermal loads are equalled or exceeded during each month. Similar curves of thermal capacity for 95° F. and 100° F. are shown in figures 7b and 7c. For example, in June the thermal capacity to 100° F. equals or exceeds 20 million BTU's per minute 72 percent of the time; the addition of 20 million BTU's per minute would overload the stream 28 percent of the time.

Electrical conductivity is closely related to total dissolved solids and some of the common constituents in water. To a fair degree dissolved solids in parts per million in St. Johns River water near Cocoa can be computed by multiplying the specific conductance in micromhos at 25° C. by 0.54 and subtracting 9. Daily dissolved solids have been computed from the specific conductance readings.

The maximum, minimum, and median dissolved solids for each day of the year are shown in figure 8. For example, 1,380 ppm was the greatest concentration of dissolved solids on any May 15th. Similarly, 144 ppm was the least concentration of dissolved solids on any May

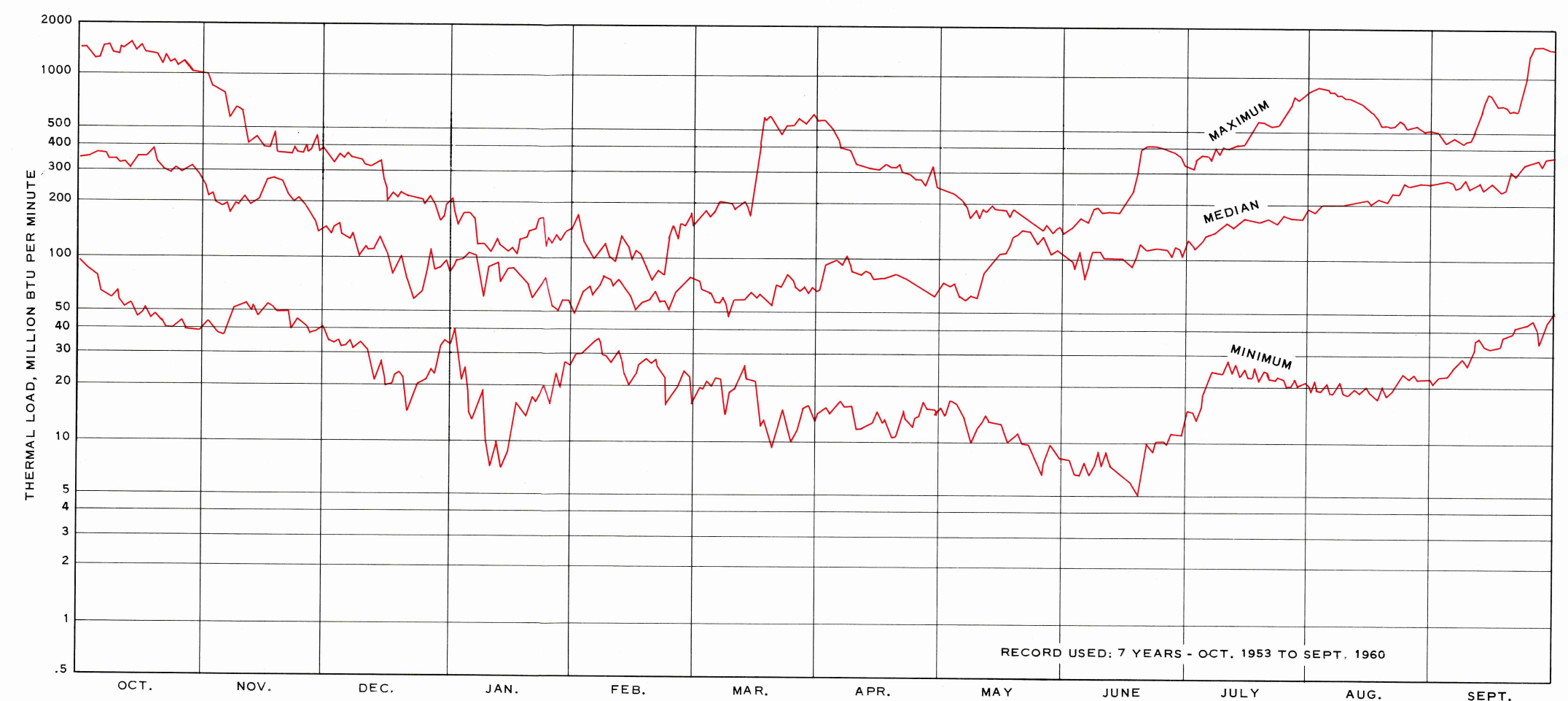


FIGURE 5. MAXIMUM, MINIMUM, AND MEDIAN DAILY THERMAL LOAD.

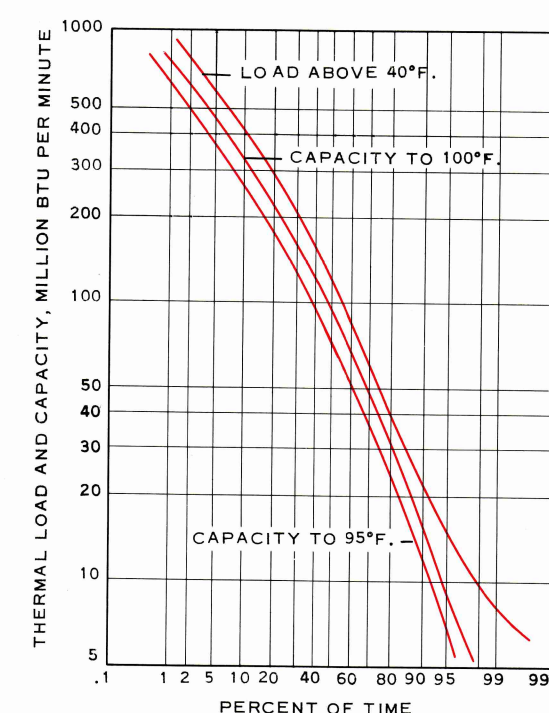


FIGURE 6. CUMULATIVE FREQUENCY OF THERMAL LOAD AND CAPACITY.

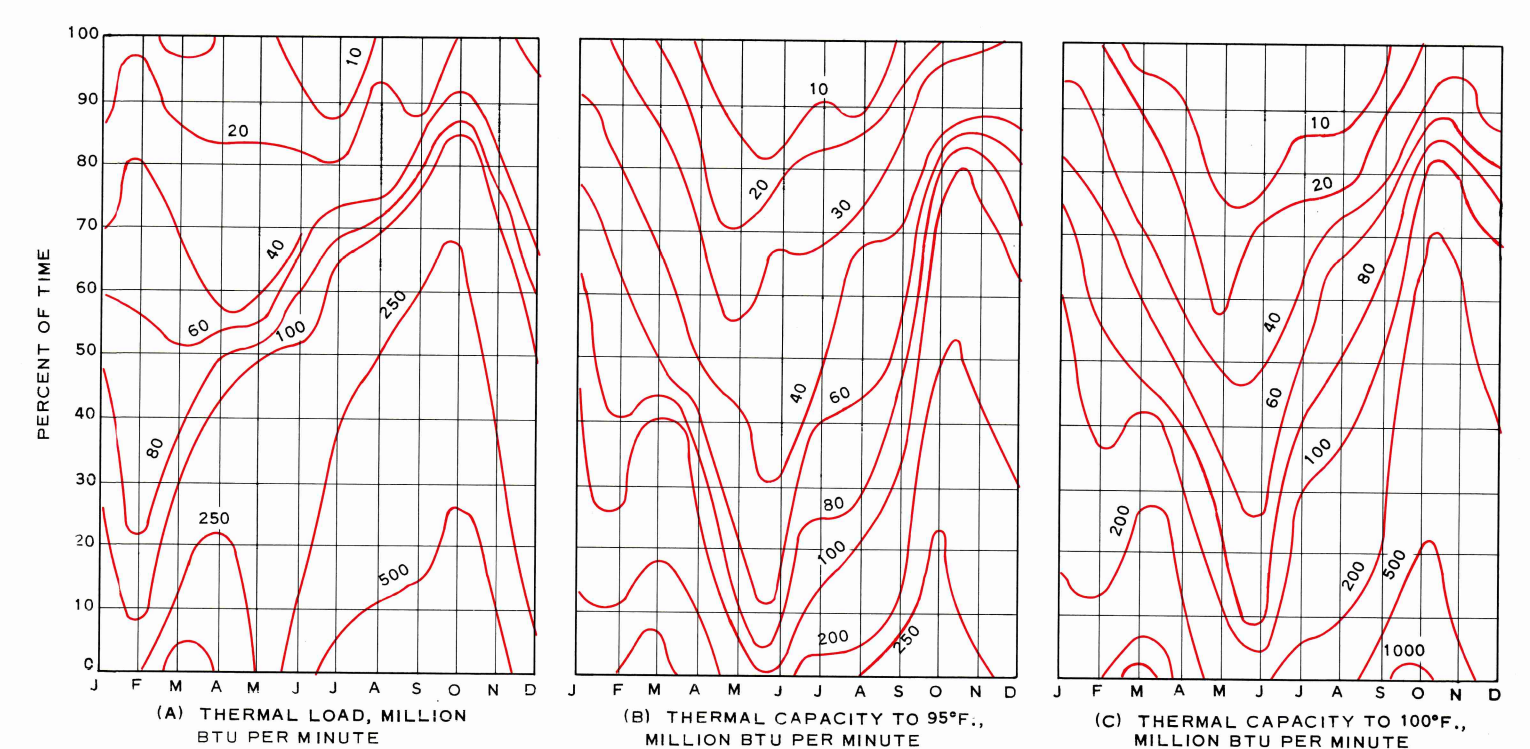


FIGURE 7. CUMULATIVE FREQUENCY OF THERMAL LOAD AND CAPACITY BY MONTHS.

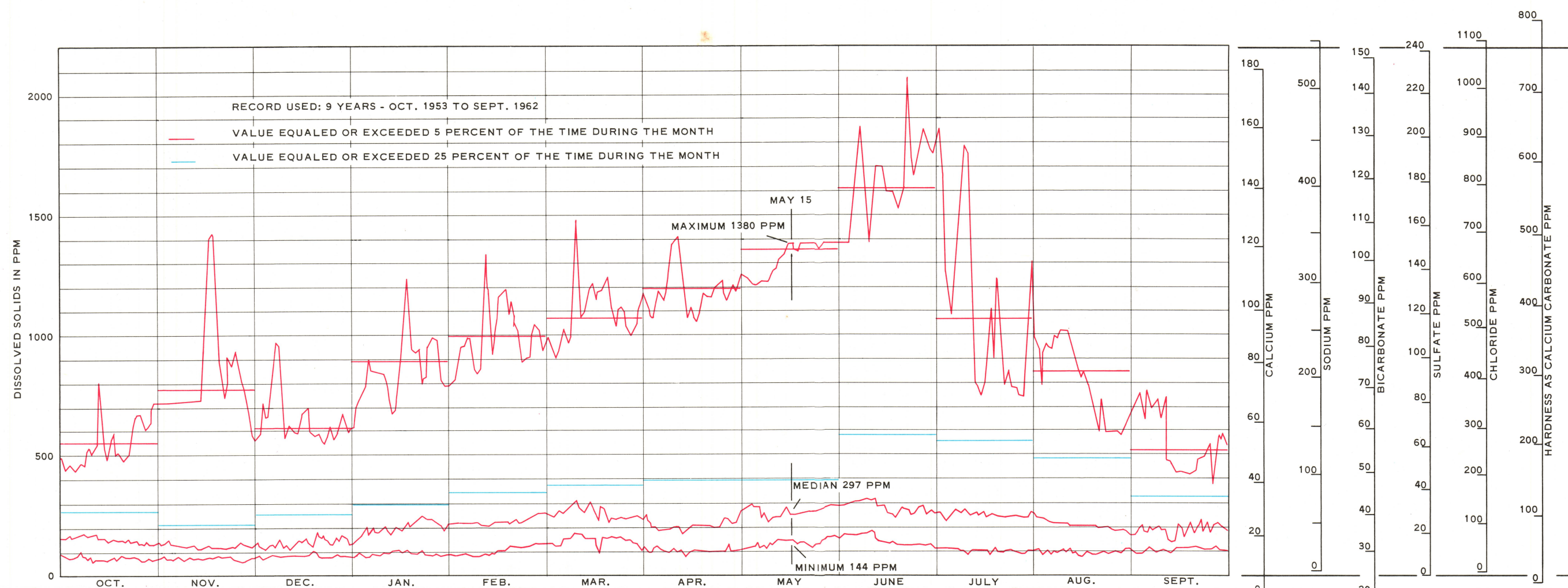


FIGURE 8. MAXIMUM, MINIMUM, AND MEDIAN DAILY DISSOLVED SOLIDS AND DISSOLVED SOLIDS EQUALED OR EXCEEDED 5 AND 25 PERCENT OF THE TIME BY MONTHS

15th. The median dissolved solids on May 15th was 297 ppm. Dissolved solids exceeded 297 ppm on May 15th in four years and were less than 297 ppm in four years.

Generally, it is most important to know the frequency of occurrence of concentrations in the high range. Therefore, the concentration of dissolved solids equaled or exceeded 5 and 25 percent of the time during each month is also shown on figure 8. For example, on 25 percent of the days in May the dissolved solids are likely to equal or exceed 400 ppm but on 5 percent of the days in May the dissolved solids are likely to equal or exceed 1,380 ppm.

The cumulative frequency curve of dissolved solids (fig. 9) shows the percent of time that the dissolved solids equal or exceed a given value. For example, the dissolved solids exceeded 500 parts per million 18 percent of the time. This means that on the average, dissolved solids will equal or exceed 500 ppm on or about 66 days per year.

The use of the graphs can be illustrated by solving the following problem: Assume the St. Johns River near Cocoa is proposed for a public water supply. According to the State Board of Health, the water should not contain more than 500 ppm of dissolved solids. Will the St. Johns River at Cocoa meet this requirement? Figure 9 shows the dissolved solids equal or exceed 500 ppm 18 percent of the time. Figure 8 shows that the median dissolved solids is consistently less than 500 ppm but that dissolved solids have exceeded 500 ppm on almost every day of the year. Furthermore, the dissolved solids have exceeded 500 ppm more than 5 percent of the time in every month of the year and in June and July the dissolved solids exceeded 500 ppm more than 25 percent of the time.

Although the concentration of dissolved solids is quite variable, the composition of the dissolved solids is quite uniform. That is the percent chloride, sodium, calcium, and other major constituents is almost constant. Because the percentage of the major constituents is almost constant, their concentrations can be computed by multiplying the concentration of dissolved solids by a factor. Using

the factors shown in table 1, auxiliary scales for calcium, sodium, bicarbonate, sulfate, chloride, and hardness have been computed and plotted at the right side of figures 8 and 9. The zero of the auxiliary scales do not coincide with the zero of the dissolved solids scale because of the B value in the conversion formula.

Figures 8 and 9 become graphs of any of the six constituents listed. The auxiliary scales give approximate values. The results for individual days, such as the maximum and minimum in figure 8, are less accurate than frequencies such as given in figure 9. The results are least accurate for constituents having a small A term (table 1). For example, the auxiliary scales for calcium and bicarbonate are least accurate for this stream.

The use of the auxiliary scales can be illustrated by determining whether chloride concentrations are satisfactory for a public water supply. Chloride concentration in public supplies should not exceed 250 ppm. According to figure 9, chlorides will equal or exceed 250 ppm 15 percent of the time. Figure 8 gives additional information about the probable occurrence of chlorides exceeding 250 ppm. The chloride concentration has never exceeded 250 ppm on a few days in September and October. It was equal to or greater than 250 ppm for less than 5 percent of the time during September and was equal to or greater than 250 ppm less than 25 percent of the time in every month except June and July.

Some constituents and physical properties are either not related to conductivity or occur in small concentrations. The frequency of distribution of these constituents or properties are shown in figures 10 and 11. For example, iron concentration in public water supplies should not exceed .30 ppm. Figure 10B shows that the concentration of iron in the St. Johns River exceeded 0.30 ppm in about two percent of the samples which is about equivalent to two percent of the time. The extremes and medians of the 8 characteristics determined are given in table 2.

Figure 12 shows the maximum, minimum, and median flow in cubic feet per second on each day of the year.

TABLE 1.—Conversion factors — dissolved solids to major ionized constituents [constituent concentration = (A x dissolved solids) + B]

Constituent	A	B
Calcium (Ca)	.082	+ 7
Sodium (Na)	.25	- 7
Bicarbonate (HCO ₃)	.057	+25
Sulfate (SO ₄)	.11	- 1
Chloride (Cl)	.50	-14
Hardness as CaCO ₃	.34	+13

TABLE 2.—Maximum, minimum, and median selected chemical and physical characteristics of water from St. Johns River near Cocoa, October 1953 to September 1960.

(Results are from 10-day composites and are expressed in parts per million except pH and color)

Characteristic	Maximum	Median	Minimum
Silica (SiO ₂)	16.	4.2	0.2
Iron (Fe)	.49	.08	.00
Magnesium (Mg)	28.	4.9	.00
Potassium (K)	6.0	.5	.0
Fluoride (F)	.3	.1	.0
Nitrate (NO ₃)	3.1	.0	.0
pH	7.9	7.1	6.4
Color	280	120	45

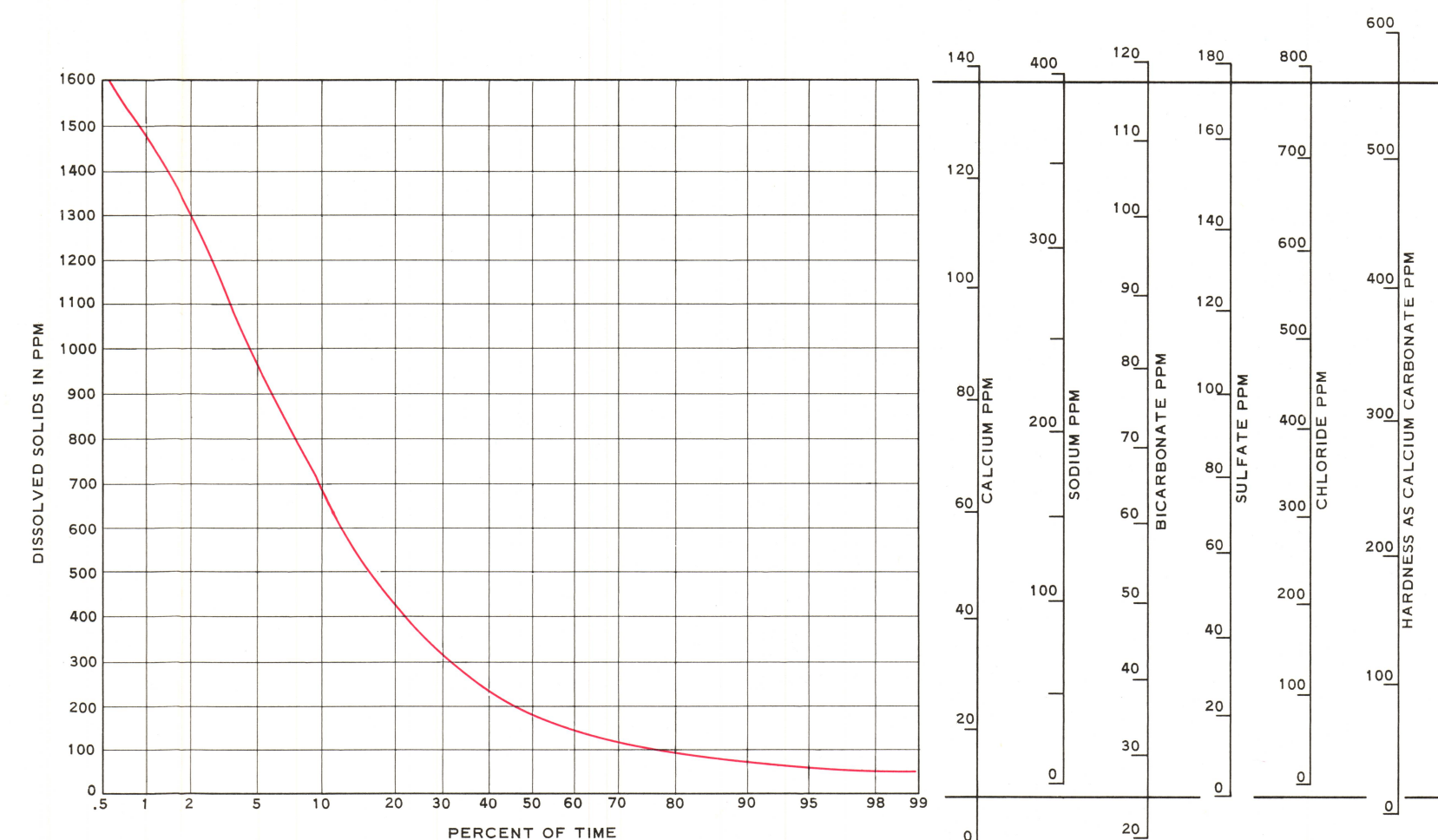


FIGURE 9. CUMULATIVE FREQUENCY CURVE OF DISSOLVED SOLIDS.

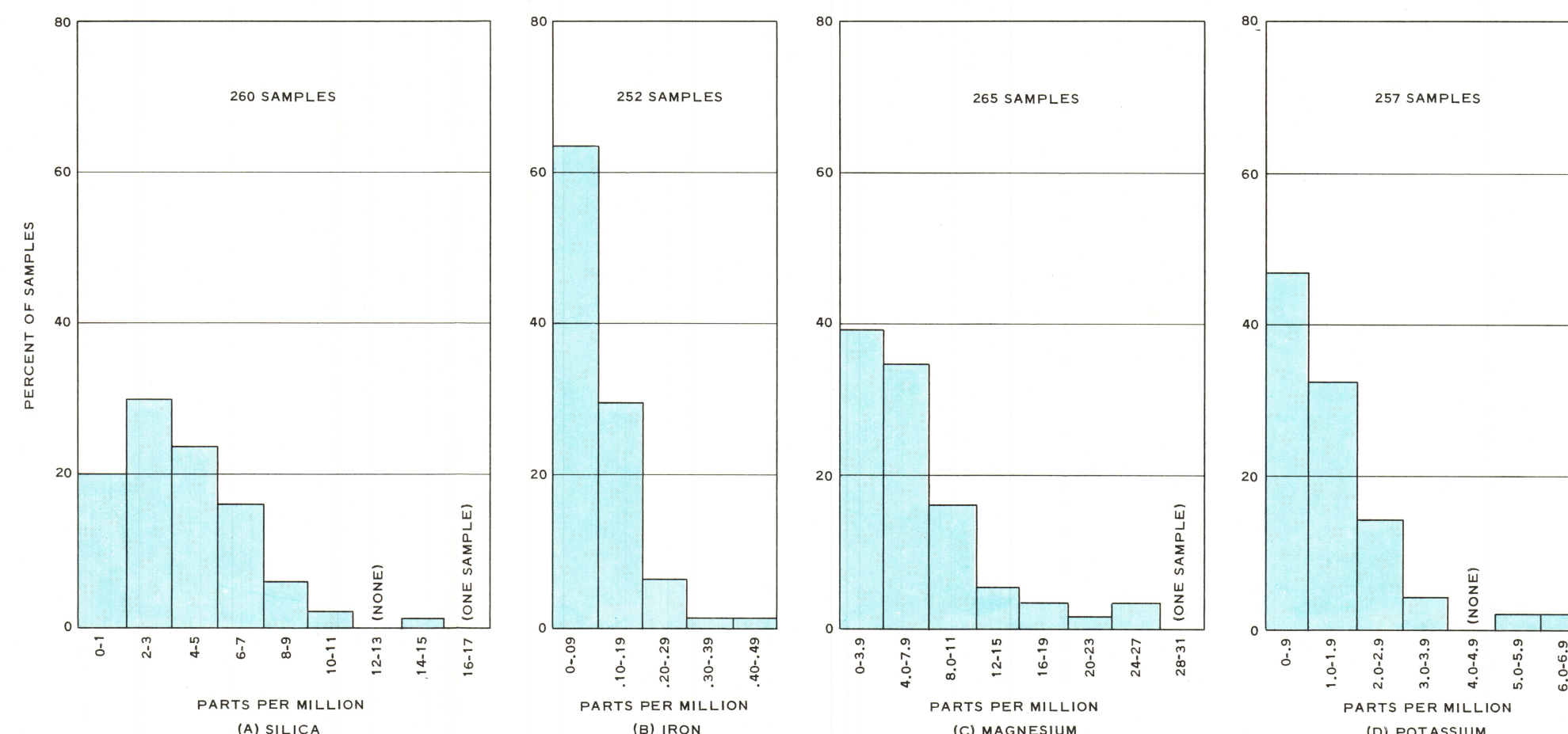


FIGURE 10. FREQUENCY GRAPHS OF SILICA, IRON, MAGNESIUM, AND POTASSIUM.

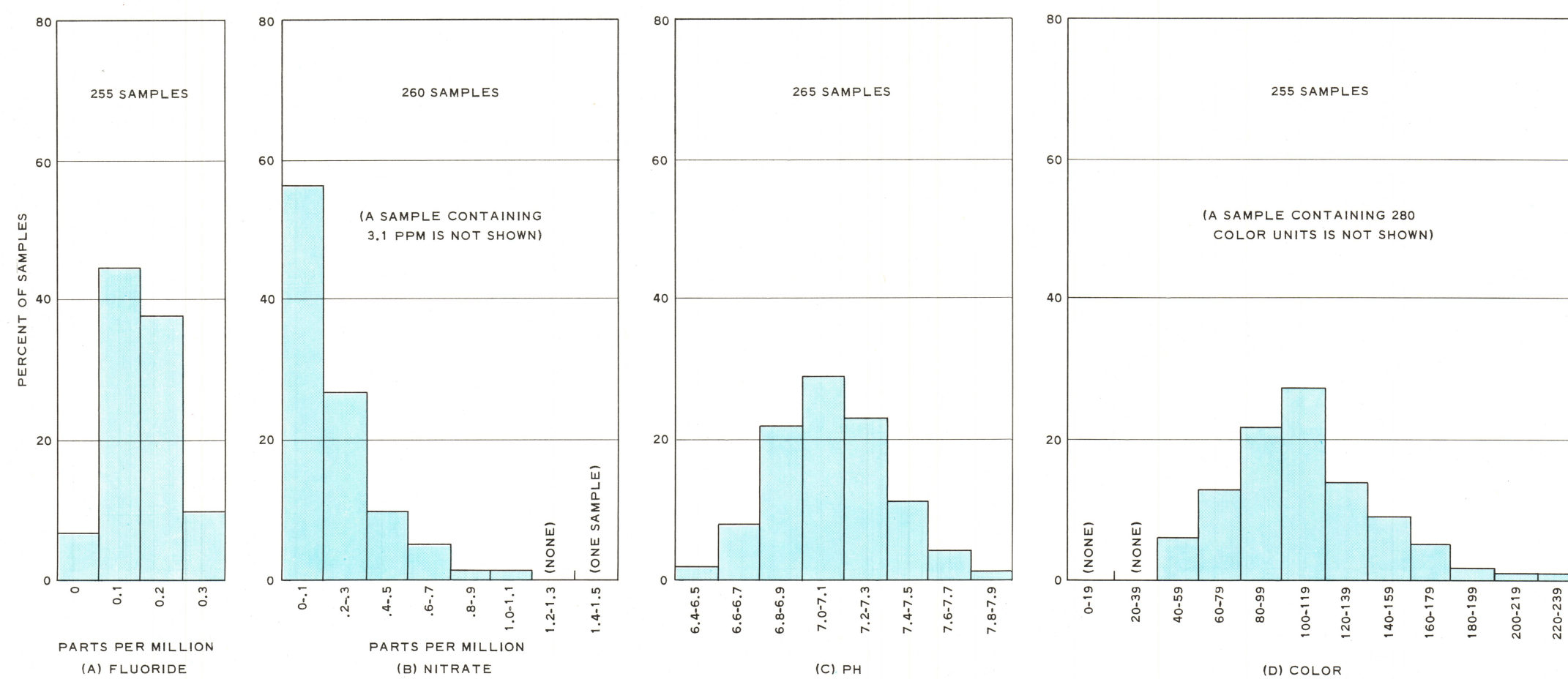


FIGURE 11. FREQUENCY GRAPHS OF FLUORIDE, NITRATE, PH, AND COLOR.

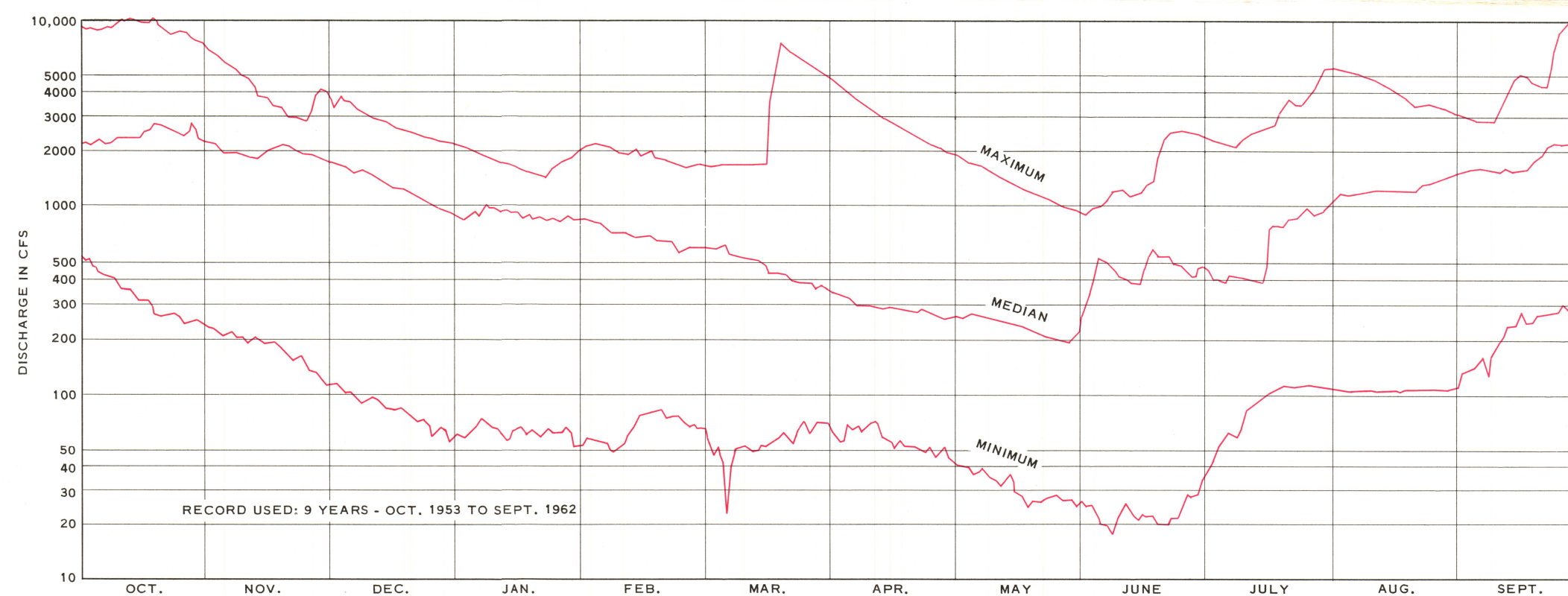


FIGURE 12. MAXIMUM, MINIMUM, AND MEDIAN DISCHARGE.