SUSPENDED MATTER IN THE COLORADO RIVER IN 1925-1928

By C. S. HOWARD

INTRODUCTION

Determinations of the quantity of solid material carried by the Colorado River are necessary for the proper consideration of plans for the development of the resources of the river. Much of the material carried by the river will be deposited in the proposed reservoirs and eventually will occupy a large part of the capacity of the reservoirs, so that their effectiveness for flood control or river regulation will be greatly decreased. A capacity of 6,000,000 acre-feet is reserved for silt storage in plans for a reservoir in Boulder Canyon that is to have a maximum capacity of about 25,000,000 to 30,000,000 acre-feet. It has been estimated that such a silt-storage capacity will not be entirely used for nearly 100 years.[1] However, the discharge of sediment including the sediment from the Gila was reported to be more than 1,000,000 acre-feet for the four years 1909-1912[2] and a similar quantity for the four years 1912–1916.[3]

The quantity of suspended matter carried by the Colorado River varies considerably from year to year, and the uncertainty of its effect on the life of reservoirs is shown by the estimates given above. The differences in the quantities carried at different stations during a 3-year period are shown in the results given in this paper.

Practically all the samples collected from the Colorado River have represented only the suspended load and give no indication of the quantity carried as bed load. The term "bed load" is applied to material that is moved by the process of stream traction described and discussed by Gilbert.[4] It is certain that some material is transported along the bottom of the river, but there is no method known by which the quantity of material moved by a river as bed load can be measured.

Samples have been collected by the engineers stationed at the United States Geological Survey gaging stations near Grand Canyon and

[1] Problems of Imperial Valley and vicinity: 67th Cong., 2d sess., S. Doc. 142, p. 20, 1922.

[2] Sellew, F. L., Discussion on irrigation and river control [Colorado River]: Am. Soc. Civil Eng. Trans., vol. 76, pp. 1479–1480, 1913.

[3] Lawson, L. M., The Yuma project silt problem: Reclamation Record, vol. 7, p. 358, 1916.

[4] Gilbert, G. K., The transportation of débris by running water: U. S. Geol. Survey Prof. Paper 86, pp. 15–16, 26–36, 1914.

Topock, Ariz. The Grand Canyon gaging station is about 300 feet above Kaibab Bridge, Grand Canyon National Park, a quarter of a mile above Bright Angel Creek and 11 miles by trail northeast of Grand Canyon railroad station. The Topock gaging station is at the lower end of a narrow section of Mohave Canyon, 3 miles below Topock railroad station. These stations are operated under the direction of W. E. Dickinson, district engineer of the Geological Survey at Tucson, who supplied the discharge data used in the computation of the annual loads of suspended matter. The results of the determinations of suspended matter in the silt samples collected at Yuma and discharge data for that station were made available through the cooperation of P. J. Preston, superintendent of the irrigation project of the United States Bureau of Reclamation at Yuma. At Grand Canyon the samples were taken by B. S. Barnes, D. H. Barber, K. C. McCarter, A. H. Williams, and C. A. Wells. At Topock the samples were taken by J. E. Klohr, K. C. McCarter, Frank Dodge, W. E. Code, and H. S. Leak. At Yuma the samples were collected by Daniel Martinez and J. E. Klohr. The determinations were made by the writer except those on the water samples for the period June to September, 1928, which were made by S. K. Love, of the United States Geological Survey.

Complete discharge data for these stations will be published in water-supply papers. A map showing the drainage basin of the Colorado River and the points at which samples were collected is given in Figure 4.

PREVIOUS INVESTIGATIONS

Determinations of the quantity of suspended matter carried by the Colorado River at Yuma, Ariz., were made by Prof. C. B. Collingwood [5] in 1892 and by R. H. Forbes [6] in 1900 and 1904. The results of other determinations have been reported by Lippincott,[7] Stabler,[8] Sellew,[9] Dole,[10] Lawson,[11] Fortier and Blaney,[12] and others. Determinations have been made on samples collected continuously at Yuma by the United States Bureau of Reclamation since May,

[5] Collingwood, C. B., Soil and waters: Arizona Agr. Exper. Sta. Bull. 6, pp. 4–8, 1892.

[6] Forbes, R. H., The river irrigation waters of Arizona: Arizona Agr. Exper. Sta. Bull. 44, pp. 196–206, 1902; Irrigating sediments and their effects upon crops: Arizona Agr. Exper. Sta. Bull. 53, p. 60, 1906.

[7] Lippincott, J. B., Investigations in California [on Colorado River]: U. S. Reclamation Service Second Ann. Rept., pp. 153–154, 1904.

[8] Stabler, Herman, Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses: U. S. Geol. Survey Water-Supply Paper 274, pp. 25–28, 1911.

[9] Sellew, F. L., op. cit.

[10] Dole, R. B., Silt in Colorado River [extracts from an unpublished discussion], in LaRue, E. C., U. S. Geol. Survey Water-Supply Paper 395, pp. 218–226, 1916.

[11] Lawson, L. M., Silt observations at Yuma gaging station: Reclamation Record, vol. 8, pp. 240–241, 1917.

[12] Fortier, Samuel, and Blaney, H. F., Silt in Colorado River and its relation to irrigation: U. S. Dept. Agr. Tech. Bull. 67, pp. 1–27, 1928.

1909. The monthly mean percentages of silt in the samples collected at Yuma between 1912 and 1921 were reported by Rothery.[13]

RECENT INVESTIGATIONS

COLLECTION OF SAMPLES

A study of the dissolved and suspended matter carried by the Colorado River was started by the United States Geological Survey in May, 1925. Samples have been collected at regular intervals since August, 1925, at Grand Canyon and Topock and since September, 1926, at Yuma. Samples of two types have been collected—water samples and silt samples.

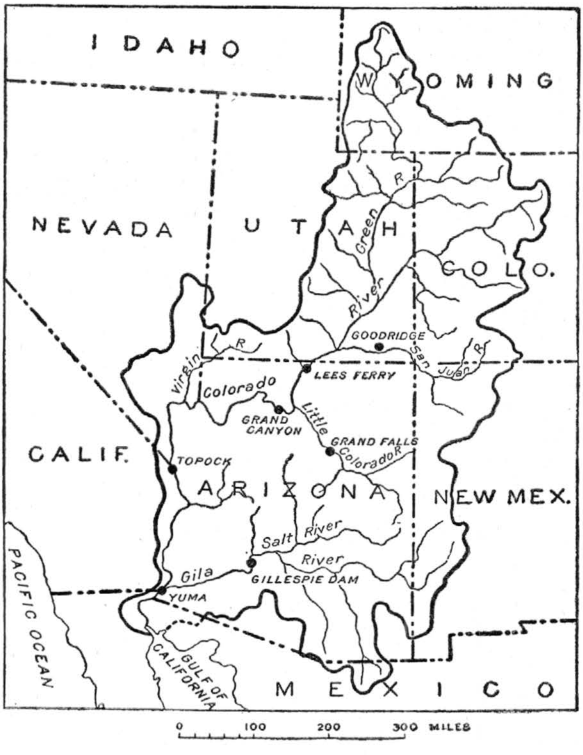


FIGURE 4.—Map of the Colorado River drainage basin, showing sampling points

WATER SAMPLES

Water samples have been collected daily in 4-ounce bottles at each of the three stations. These samples were obtained primarily to study the dissolved material, but the quantity of suspended matter in the samples was determined. The results of the analysis of these

[13] Rothery, S. L., A river diversion of Colorado River in relation to Imperial Valley, Calif.: Am. Soc. Civil Eng. Proc., vol. 49, pp. 677–678, 1923.

samples are given in other reports of the Geological Survey.[14] The quality of the water may have some bearing on the quantity of suspended matter carried by the Colorado River,[15] but it seems probable that other factors, such as velocity and slope, are of greater significance.

SILT SAMPLES

Samples of the river water for the determination of the silt content were collected at regular intervals by the observers at the gaging stations at Grand Canyon and Topock.

METHODS OF SAMPLING

Samplers used by other investigators.—The sampler used by the United States Bureau of Reclamation in the early work at Yuma consisted of a quart container with a valve that could be opened at the desired depth. In the later work the sampler consisted of a piece of 2-inch iron pipe, capped at each end, with a half-inch hole in the cap at the upper end. Fortier and Blaney[16] described a sampler used at Topock in 1918, which was similar to the one used in the more recent work at Yuma. They also described the Tait-Binckley sampler, which was used in obtaining samples from irrigation ditches and by means of which it is possible to obtain a sample of the water in its natural state as it flows through a cylinder, the sample being caught by closing the ends of the cylinder. It seems probable that this apparatus will give an accurate sample of the flow at the time of sampling. To operate this sampler it is necessary to have an auxiliary line, and because of the high velocity and large amount of drift carried by the river it seemed inadvisable to use an apparatus of this type in work done by the Geological Survey.

Geological Survey sampler.—The samples collected by the Geological Survey in 1925–1928 were obtained in pint milk bottles by means of a sampler designed by Carl H. Au, hydraulic engineer, United States Geological Survey, which is shown in Plate 1. The sampler can be attached to the cable and weight in place of the current meter used for discharge measurements. The sampler is lowered to the desired depth, and a small weight is allowed to slide down the line till it strikes the top part of the arm of the sampler and forces the knife edges through the cap of the bottle. The cap is an ordinary milk-bottle cap with a ⅝-inch hole in it. The hole is covered with a piece of rather heavy paper stuck on with rubber cement.

Sampling.—Usually three samples, as indicated below, were taken at each of three places across the river. The points chosen were

[14] Collins, W. D., and Howard, C. S., Quality of water of Colorado River in 1925–1926: U. S. Geol. Survey Water-Supply Paper 596, pp. 33–43, 1927. Howard, C. S., Quality of water of Colorado River in 1926–1928: U. S. Geol. Survey Water-Supply Paper 636, pp. 1–14, 1929.

[15] Breazeale, J. F., A study of the Colorado River silt: Arizona Univ. Tech. Bull. 8, 1926.

[16] Fortier, Samuel, and Blaney, H. F., op. cit., pp. 11–12.

about one-fourth, one-half, and three-fourths the distance across the river.

Bottom sample: The bottle was lowered to the bottom, the cap punched, and the bottle left there long enough to fill and then pulled up as rapidly as possible. The mouth of the bottle was about 18 inches from the bottom.

"Average" sample: The bottle was lowered to the bottom and the cap punched. The bottle was then pulled up at a uniform rate, so as to be full when it came to the surface.

Surface sample: The bottle was fitted with a cap having no cover on the ⅝-inch hole and lowered to about a foot below the surface, where it was left long enough to fill.

A "clear-water sample" was collected at each place where the other samples were taken. It consisted of a bottle of clear water fitted with a cap, which was broken when the bottle was at the bottom. The bottle was drawn up at the same rate as the "average" sample.

Since April, 1927, the clear-water samples have been omitted at both stations, and at Topock only three samples have been collected each sampling day—one surface and two "average" samples.

FILTRATION OF SAMPLES

All the silt samples were filtered in the field through filter papers placed in tin funnels. The sampling point and date of collection were noted on the filter paper before filtration. The samples were shaken and poured onto the paper. Any suspended matter remaining in the bottles was washed onto the papers with clear water. If the filtrates were turbid they were refiltered until clear, and the final filtrates were saved for a supply of clear water. The filter papers containing the suspended matter were allowed to dry in the air, were packed in mailing cases, and were sent to the laboratory in Washington.

QUANTITY OF SUSPENDED MATTER

DETERMINATIONS

Weighing the material.—For some of the samples the suspended matter was stripped from the paper and the weight determined. Some of the suspended matter could not be removed from the paper, but its weight was determined by burning the paper and allowing for the ash of the paper. The amount left on the papers was thus found to range from a few tenths of a gram to more than a gram. Similar suspended matter when heated to the temperature necessary for ignition of the paper lost about 5 per cent of its weight.

For most of the samples the filter papers were weighed before and after filtration. Several experiments were made to find the best conditions for obtaining a uniform weight of the filter papers. The best results were obtained by the use of desiccators containing sulphuric acid having a specific gravity of 1.329. The relative humidity in such a desiccator is about 50 per cent.[17] From 75 to 100 papers are put in the desiccator, and a few of the papers are weighed periodically until their weights remain constant. The weighed papers were used as checks during the weighing of the other papers. The filter papers containing the suspended matter were weighed under similar conditions.

Computation of percentage.—In computing the percentage of suspended matter in the samples it was assumed that each sample weighed 473 grams. The capacity of the milk bottles varied somewhat, and a few of the samples may have been of smaller volume because of splashing as the sample was drawn up. In samples containing more than 2 per cent of suspended matter the weight of 473 grams may be 1 per cent in error. It seems probable that the errors introduced by the use of this weight are much less than those caused by the assumption that the sample is truly representative of the quantity of suspended matter carried by the river.

VARIATION IN QUANTITY

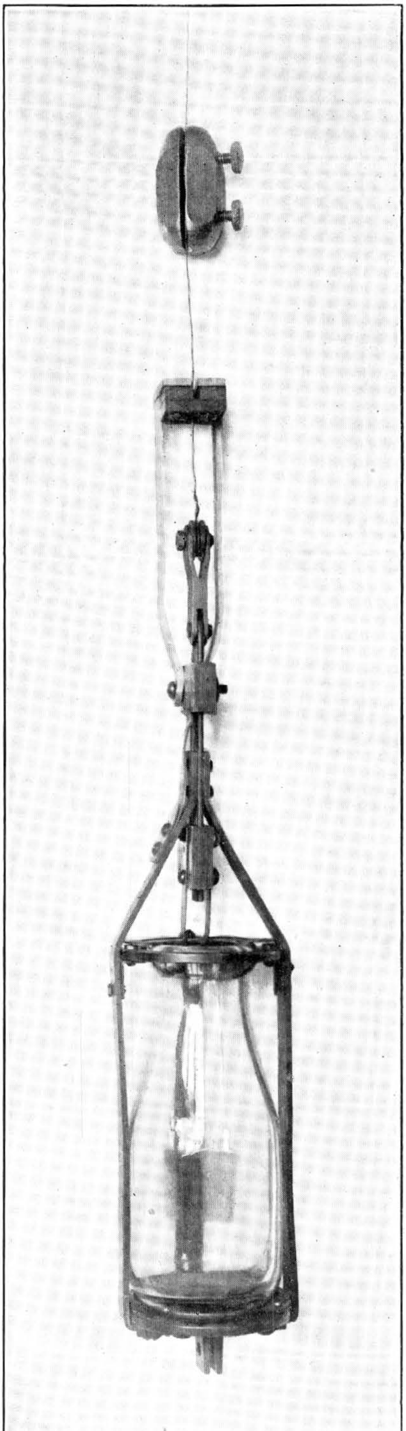
The quantity of suspended matter varies considerably for different parts of the cross section of the river and from moment to moment in any particular part of the cross section, and therefore a sample collected at any particular moment may come far from being truly representative of the river even for a short sampling period.

VARIATION ACROSS THE RIVER AND WITH DEPTH

Samples from the main current usually have more suspended matter than samples from other parts of the stream, where eddy currents have pronounced effects. For this reason many samples collected from the bank show too small a percentage of suspended matter. Simultaneous samples taken at the same point, with the sample bottles as near together as possible, show different quantities of suspended matter. Some of the differences observed at Grand Canyon were as much as 25 to 50 per cent. These conditions are of course not representative but they are not unusual.

As a rule the samples from depths near the bottom contain more suspended matter than surface samples, although some of the surface samples show a larger quantity than the bottom samples collected at the same time. For about 1,200 samples collected at Grand Canyon the average quantity of suspended matter in the surface samples was about 60 per cent of the quantity in the bottom samples.

[17] Wilson, R. E., Humidity control by means of sulphuric acid solutions, with critical compilations of vapor-pressure data: Jour. Ind. and Eng. Chemistry, vol. 13, pp. 326-331, 1921.



SAMPLER USED IN THE COLLECTION OF SILT SAMPLES FOR THE GEOLOGICAL SURVEY

The quantity of suspended matter at all depths was represented in the "average" samples, which consisted of water taken into a bottle as it was raised to the surface after the cap was broken at the bottom. For about 1,200 samples collected at Grand Canyon the quantity of suspended matter in the "average" samples was nearly the mean of the quantities in the bottom and surface samples.

Because of the great variation in the quantity of suspended matter at different parts of the river several samples should be collected each sampling day, and abnormal quantities should be rejected in computing the mean quantity for the day. The quantities at different depths are probably represented in the "average" samples, so that "average" samples taken at different points across the river should represent fairly well the suspended load carried by the river.

The clear-water samples contained considerable suspended matter that dropped into the bottles of clear water as they were raised to the surface. The quantities of suspended matter in some of the clear-water samples collected at Grand Canyon were as much as 25 per cent of the quantities found in bottom samples taken the same day. However, the time required to raise the bottom sample is only about one-third the time for the clear-water sample, so that probably the error caused by suspended matter dropping into the bottle containing the bottom sample is less than 10 per cent and for most samples is less than 5 per cent. For "average" samples the error is probably slight if the samples are properly taken.

The clear-water samples showed the necessity of determining the time required for the bottles to fill and of removing the bottles from the river immediately after they are filled. The time required for the bottles to fill ranged from 15 to 30 seconds at Topock and 25 to 40 seconds at Grand Canyon, showing that it is necessary to determine the rate of filling at frequent intervals at each station.

VARIATION FROM DAY TO DAY

The daily water samples collected for the Geological Survey were as a rule taken from the bank at Grand Canyon, Topock, and Yuma. At Grand Canyon some of them were collected from midstream by lowering the bottle from the Kaibab suspension bridge, and at Yuma some were collected by tying the small bottle to the sampler when a surface sample was being taken. These samples usually showed a smaller percentage of suspended matter than the "average" samples taken on the same days, but the determinations on the water samples are of value in indicating the quantities on days that silt samples were not taken. For example, it happened that the seven silt samples collected at Grand Canyon in September, 1926, were taken on days when the silt content was low, and the weighted average for the month was 0.92 per cent, whereas the weighted average for the 30 daily water samples was 2.58 per cent. The determinations for the daily samples also serve as a check on the annual loads carried past the three stations.

VARIATION DURING THE PERIOD STUDIED

The results obtained from the silt samples collected at Grand Canyon and Topock between October 1, 1925, and September 30, 1927, and the discharge at Grand Canyon are shown in Figure 5. The percentages plotted are as a rule obtained from the "average" samples. If one or more of the "average" samples seemed erratic the mean of the bottom and surface sample was used to determine the percentage for that day. From this diagram and the data for 1927–28 given in Tables 5 and 8 (pp. 33 and 39) the larger percentage of suspended matter at Topock during the fall and early winter is apparent for each of the years. On the other hand, during the spring the larger quantities are carried at Grand Canyon. These data indicate that some of the suspended load carried by the spring floods at Grand Canyon is deposited between that station and Topock, but later some of it is picked up and carried past Topock.

RANGE IN PERCENTAGE OF SUSPENDED MATTER

The minimum and maximum percentages of suspended matter in the silt samples collected at Grand Canyon, Topock, and Yuma during the 3-year period are shown in Table 1. For this period, samples from Grand Canyon carried the highest and lowest percentages.

TABLE 1.—*Minimum and maximum percentages of suspended matter in silt samples collected between October 1, 1925, and September 30, 1928*

[Per cent by weight and date sample was taken]

	Grand Canyon		Topock		Yuma [a]	
	Per cent	Date	Per cent	Date	Per cent	Date
Minimum	0.03	Dec. 24, 1927	0.12	Feb. 7, 1927	0.15	Jan. 16, 1928
Maximum	13.81	Sept. 13, 1927	7.91	Sept. 16, 1927	5.36	Oct. 8, 1926

[a] United States Bureau of Reclamation.

On several days there was more than 5 per cent of suspended matter in samples from Grand Canyon and Topock, but the maximum reported in samples collected at Yuma for a period of 12 years was about 5.5 per cent.

VARIATION WITH DISCHARGE

There is no direct relation between the percentage of suspended matter and the discharge, although in general the percentage of suspended matter increases if the discharge increases. Water of the

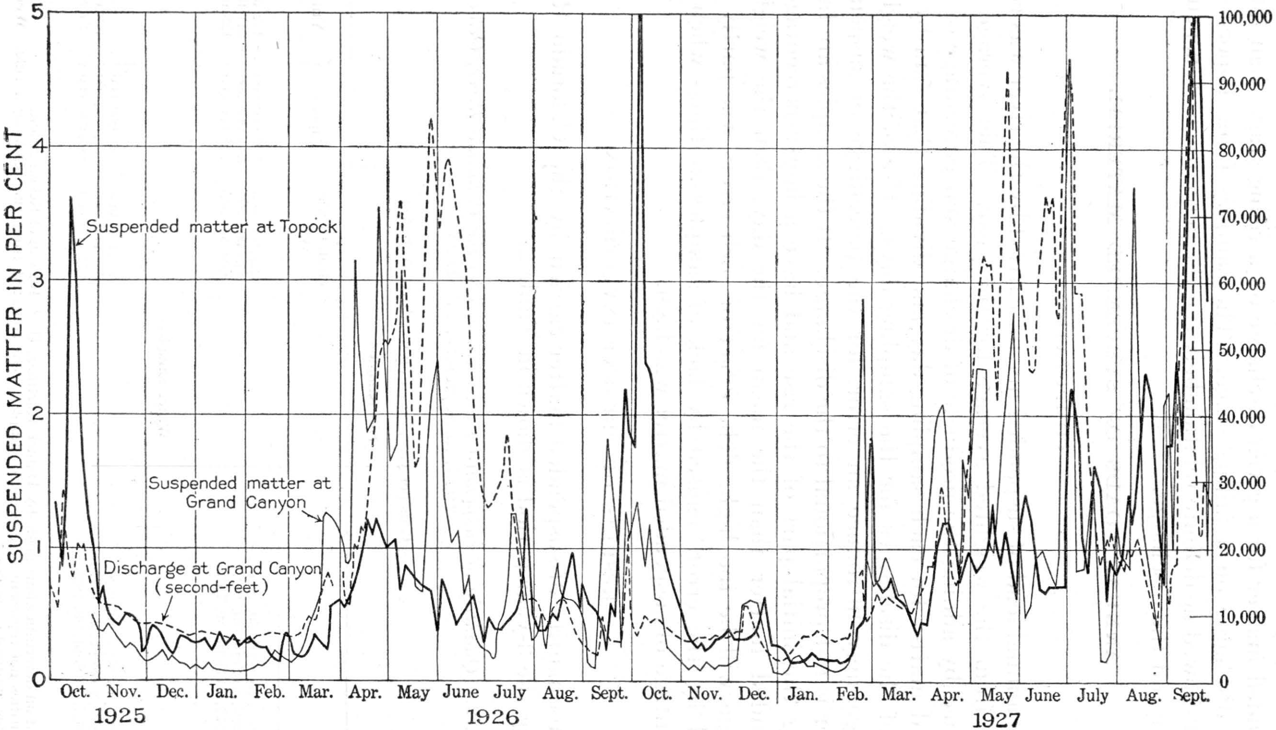


FIGURE 5.—Suspended matter in the Colorado River at Grand Canyon and Topock, Ariz., and discharge at Grand Canyon

first part of the increase in discharge often carried a higher percentage of suspended matter than water in a succeeding higher discharge. Many samples from Grand Canyon contained a higher percentage of suspended matter for a given discharge on a rising stage than for an equal discharge on a falling stage. The samples from Topock and Yuma showed no definite relation between the percentage of suspended matter and the discharge.

ANNUAL LOADS OF SUSPENDED MATERIAL

COMPUTATION

The annual load of suspended matter carried by the river was computed from the weighted average for the year. This average was obtained by adding the products of discharge and percentage of suspended matter for each sampling day and dividing that sum by the sum of the discharges for the sampling days. Use of the weighted average may introduce an error, for the percentage of suspended matter is not proportional to the discharge. If the samples are taken during the initial part of the rise and have a larger percentage of suspended matter than the mean for the day, then the weighted average will be too high. The effect of such errors was partly balanced by the errors caused by lack of samples at times when the percentage of suspended matter was high.

RESULTS OF PRESENT INVESTIGATION

The quantity of suspended matter carried by the Colorado River during the 3-year period is shown in Table 2.

TABLE 2.—*Quantity of suspended matter carried by the Colorado River, October 1, 1925, to September 30, 1928*

[Tons per year, based on weighted averages]

Silt samples

	Grand Canyon	Topock	Yuma
Oct. 1, 1925, to Sept. 30, 1926	225,000,000	140,000,000	[a] 152,000,000
Oct. 1, 1926, to Sept. 30, 1927	443,000,000	345,000,000	[a] 241,000,000
Oct. 1, 1927, to Sept. 30, 1928	189,000,000	209,000,000	128,000,000

Water samples [b]

	Grand Canyon	Topock	Yuma
Oct. 1, 1925, to Sept. 30, 1926	111,000,000	103,000,000	------------
Oct. 1, 1926, to Sept. 30, 1927	255,000,000	305,000,000	172,000,000
Oct. 1, 1927, to Sept. 30, 1928	134,000,000	186,000,000	84,800,000

[a] Based on determinations made by Daniel Martinez, U. S. Bureau of Reclamation.
[b] Quantities not representative because samples were collected from the bank as a rule. Weighted average for composite samples.

The results given in Table 2 show that for the three periods studied the suspended load carried past Grand Canyon was greater than that carried past Yuma and in the period 1925–1927 the suspended load carried past Grand Canyon was greater than that carried past Topock. The results obtained from the daily samples in 1926–1928 from Grand Canyon and Topock give a greater load for these stations than is obtained for Yuma by using the results of the silt samples. This is a check on the results obtained from the silt samples collected at Grand Canyon and Topock. The samples collected at Yuma include suspended matter brought in by the Gila, and for that reason they might be expected to contain more material than samples from stations farther upstream. The smaller loads at Topock and Yuma may be explained by assuming that material is being deposited below the Grand Canyon station, a part of which will be scoured out by some future flood and carried downstream. However, some material is transported along the bottom of the river by stream traction, and it seems possible that some of the material carried past Grand Canyon as suspended load is carried past Topock and Yuma as bed load.

RESULTS OF PREVIOUS INVESTIGATIONS

Records of the United States Bureau of Reclamation.—The average annual load of suspended matter carried past Yuma during the 10-year period 1912–1921 was about 178,000,000 tons.[19] This figure is computed from a reported volume of 948,428 acre-feet for the period and a weight of 86 pounds for a cubic foot of the material. The method of computation used by the Bureau of Reclamation consists in multiplying the discharge of water for the month by the mean percentage of silt and a factor to obtain the acre-feet discharge of suspended matter for the month. Computed by this method the suspended load at Yuma for the year ending September 30, 1926, was 151,000,000 tons and for the year ending September 30, 1927, 219,000,000 tons. These quantities are somewhat less than those computed from the weighted averages and given in Table 2.

According to these data the suspended load at Yuma was not abnormally high during the period 1925–1928, and there is no indication that the loads at Topock and Grand Canyon were unusually high during that period.

Investigation of the Bureau of Public Roads.—For 12 months in 1917 and 1918 the Bureau of Public Roads of the United States Department of Agriculture collected silt samples twice a month from the Colorado River at Topock.[20] For this period the computed suspended load carried past Topock was 205,800,000 tons, and at Yuma the suspended

[19] Rothery, S. L., op. cit., p. 678.
[20] Fortier, Samuel, and Blaney, H. F., op. cit., pp. 76–80.

load for the same period, computed from determinations of the Bureau of Reclamation, was 113,900,000 tons.

BED LOAD

The samples collected for this work represented only the suspended load carried by the river and gave no indication of the quantity carried as bed load, and there is no method known by which the amount of material moved as bed load can be measured.

Movement of the river bed is observed in making soundings in connection with discharge measurements. The change in the level of the river bed at Topock and Yuma is considerably greater than at Grand Canyon. At Yuma in 1907 and again in 1909 it was found that for an increase of 10 feet in the gage height there was a lowering of the bed of approximately 30 feet, making a total increase of depth of water about 40 feet.[21] These were extreme conditions of the scouring that is continually taking place, with subsequent filling. The quantity of material moved during the change in the level of the river bed is large, but it is not known how much becomes suspended load and how much is moved as bed load. Rothery[22] computed a removal of 105,600,000 cubic yards for a deepening of 9 feet over a distance of 100 miles.

A few samples were collected at Grand Canyon by tying the pint milk bottles to the fins of the weights used with the sampler in such a manner that the bottles would be near the bottom with their mouths pointed upstream. At the same time a sample was collected in a bottle held in the sampler in an upright position. Care was taken to avoid stirring up mud when the weight hit the bottom of the river. The mean of 16 samples collected in bottles on the fins of the weight was about 35 per cent higher than the mean of 10 samples collected in bottles held in an upright position in the sampler. The samples were in the water for about 30 seconds. Six consecutive samples were collected in bottles held in the sampler by lowering it till the weight touched bottom and then letting out more line so that the sampler would fall forward, bringing the mouth of the bottle nearer the bottom and pointed upstream. The mean of these six samples was about 40 per cent higher than the mean of two of the regular bottom samples collected within an hour after the six samples were collected. These results suggest that considerable material was carried along near the bottom at Grand Canyon, but the quantity carried as bed load is unknown. Fortier and Blaney [23] estimated that the quantity of material carried as bed load at Yuma was about 20 per cent of the total load.

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[21] Cory, H. T., Irrigation and river control in the Colorado River Delta: Am. Soc. Civ. Eng. Trans., vol. 76, p. 1214, 1913.

[22] Rothery, S. L., op. cit., p. 679.

[23] Fortier, Samuel, and Blaney, H. F., op. cit., pp. 52–53.

VOLUME THE SUSPENDED MATERIAL WILL OCCUPY IN A RESERVOIR

An accurate estimate of the volume which the suspended material will occupy in a reservoir is important but can not be obtained from the available data. The volume of the material that will be deposited by the river is computed from the determined percentages by assuming some weight for a unit volume of the deposited material.

Published estimates.—The published estimates of the volume of suspended material that would be deposited annually in reservoirs on the Colorado River have been based on weights ranging from about 33 pounds[24] to 93 pounds[25] for a cubic foot of the material as deposited in a reservoir. The Bureau of Reclamation has used 85 pounds[26] and 86 pounds[27] as the weight of a cubic foot of the material in place. Fortier and Blaney state that the average weight of suspended matter as deposited in a reservoir will not exceed 85 pounds per cubic foot and that of silt deposited on irrigated lands will not exceed 50 pounds per cubic foot.[28] As a result of these differences in regard to the weight of a cubic foot of the deposited material the estimates of the volume of material that will be deposited range from about 88,000 to over 250,000 acre-feet per year.

Weight per unit volume of the suspended matter.—Suspended matter from daily samples collected for the Geological Survey allowed to settle in tubes for a period of more than six months showed a weight equivalent to about 34 pounds per cubic foot of the deposited material. These samples of suspended matter did not contain the larger particles in their proper proportions, as the daily samples were taken from the bank. Samples of material from the bottom of the river collected in the experiments on the bed load (see p. 26) showed a weight equivalent to 98 pounds for a cubic foot of the material after settling for four months.

The weight per unit volume of the deposited material will undoubtedly be different at different points in a reservoir, as the heavier particles will settle out first and will be deposited near the head of the reservoir.

Effect of pressure on the volume.—The effect of the pressure of later deposits on the volume of the material that had settled out first is not known. It seems probable that the effect of the pressure due to the overlying water will be slight, as the water throughout the material will be under the same hydrostatic pressure.

Effect of alternate drying and wetting.—No estimate can be made concerning the quantity of material that will be affected by alternate

[24] Sellew, F. L., op. cit., p. 1479. (Computed from data in Table 3.)
[25] Dole, R. B., op. cit., p. 222.
[26] Problems of Imperial Valley and vicinity: 67th Cong., 2d sess., S. Doc. 142, p. 4, 1922.
[27] Rothery, S. L., op. cit., p. 678.
[28] Fortier, Samuel, and Blaney, H. T., op. cit., p. 4.

drying and wetting. When the water level of the reservoir is lowered 100 feet, considerable material deposited in the upper part of the reservoir will be uncovered. This material will undoubtedly shrink in volume on drying, and although it will be wet again as the water level rises, its volume then may be less than the volume of freshly deposited material.

Volume computed from data for 1925–1928.—It is evident that the volume that will be occupied by the suspended matter is unknown. It seems probable that estimates based on 33 pounds and 86 pounds for a cubic foot of the deposited material represent fairly well the extreme conditions of deposition. On the basis of 33 pounds for a cubic foot the quantity of suspended matter carried past Grand Canyon in 1925–26 would occupy 313,000 acre-feet if deposited in a reservoir, the volume for 1926–27 would be 617,000 acre-feet, and the volume for 1927–28 would be 263,000 acre-feet. On the basis of 86 pounds for a cubic foot the corresponding figures would be 120,000, 237,000, and 101,000 acre-feet.

SUMMARY

The quantity of suspended matter is quite different at different points in the river at any one station, so that a number of samples are necessary to get a representative value for the quantity carried by the river.

The annual load of suspended matter carried by the river, as calculated from the samples collected during the period studied, was greater at Grand Canyon than at Topock and at Yuma.

The volume of material that would be deposited in a reservoir is not known, but possibly some of the previous estimates have been too low, for the following reasons:

1. The annual load of suspended matter computed from samples collected at Grand Canyon was considerably larger than the average annual load computed from samples collected at Yuma.

2. For a considerable portion of the material a given weight will occupy a larger volume than has been assumed in the more recent estimates.

To make an accurate estimate of the volume of material that will be deposited in reservoirs built on the Colorado River it is necessary to study further (*a*) the magnitude of the bed load carried by the river, (*b*) the volume that will be occupied by a given weight of the material, (*c*) the distribution of the sizes of particles at different points and depths in the cross section, (*d*) the relation between the velocity and the sizes of the particles, and (*e*) the relation between the velocity and the quantity of material carried.

DETERMINED QUANTITIES OF SUSPENDED MATTER

The quantities of suspended matter in the silt samples and the daily water samples collected for the Geological Survey are given in the following tables. Tables 3 to 8 give the results obtained from the silt samples and show for each sampling day the percentage of suspended matter in each sample, the mean percentage of suspended matter carried by the river, the mean discharge of the river, and the suspended load of the river. Tables 9 to 11 give the percentage of suspended matter in each of the daily water samples collected since February 12, 1926.

TABLE 3.—*Suspended matter in silt samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the year ending September 30, 1926*

[Determinations by C. S. Howard]

	Suspended matter (per cent by weight)										Mean discharge (second-feet)	Suspended matter (tons per day)
	Bottom samples [a]			Surface samples [a]			"Average" samples [a]			Mean [b]		
	A	B	C	A	B	C	A	B	C			
Oct. 12	3.01	2.98	3.12	2.72	2.75	2.65	2.85	2.94	2.80	2.86	16,200	1,250,000
Oct. 29	.54	.63	.67	.40	.34	.43	.54	.49	.46	.50	12,600	164,000
Oct. 31	.51	.61	.38	.28	.29	.27	.30	.48	.33	.37	12,100	121,000
Nov. 2	.38	.56	.46	.26	.31	.26	.35	.37	.42	.38	11,700	120,000
Nov. 6	.57	.56	.43	.33	.39	.31	.45	.42	.77	[c] .43	11,900	138,000
Nov. 9	.41	.56	.48	.30	.27	.25	.39	.35	.37	.37	12,100	121,000
Nov. 13	.37	.49	.52	.27	.26	.22	.30	.41	.33	.34	10,800	99,000
Nov. 16	.30	.36	.32	.20	.19	.15	.23	.31	.25	.27	10,200	74,300
Nov. 18	.23	.29	.41	.22	.18	.12	.27	.29	.30	.28	9,980	75,400
Nov. 23	.25	.31	.36	.17	.19	.16	.26	.22	.26	[c] .25	9,440	63,800
Nov. 26	.20	.23	.27	.12	.15	.10	.17	.17	.15	.16	8,660	37,400
Nov. 30	.18	.22	.22	.12	.11	.08	.13	.15	.18	.15	8,630	34,900
Dec. 4	.20	.27	.20	.15	.11	.10	.18	.17	.15	.16	8,530	36,800
Dec. 10	.26	.27	.24	.16	.19	.14	.19	.23	.27	.23	8,500	52,700
Dec. 12	.15	.19	.19	.11	.10	.10	.15	.15	.12	.14	8,320	31,400
Dec. 15	.16	.21	.17	.11	.10	.09	.17	.17	.15	.16	7,830	33,800
Dec. 18	.12	.12	.12	.09	.08	.09	.10	.12	.11	.11	7,260	21,600
Dec. 22	.09	.12	.11	.09	.08	.08	.10	.11	.10	.10	6,350	17,100
Dec. 24	.07	.08	.09	.06	.06	.06	.07	.07	.07	.07	5,720	10,800
Dec. 27	.09	.11	.10	.08	.07	.07	.09	.09	.10	.09	5,980	14,500
Dec. 30	.11	.15	.16	.10	.10	.08	.12	.13	.14	.13	6,940	24,300
Jan. 4	.09	.12	.11	.08	.08	.08	.08	.10	.10	.09	6,740	16,400
Jan. 8	.11	.12	.16	.08	.09	.07	.10	.12	.14	.12	6,920	22,400
Jan. 12	.09	.10	.12	.06	.07	.07	.08	.08	.09	.08	6,400	13,800
Jan. 15	.06	.08	.08	.05	.06	.04	.07	.07	.08	.07	6,080	11,500
Jan. 19	.07	.08	.07	.05	.05	.04	.06	.07	.07	.06	5,640	9,120
Jan. 22	.05	.07	.06	.05	.04	.05	.05	.06	.05	.05	5,550	7,500
Jan. 25	.05	.06	.06	.04	.04	.04	.06	.06	.05	.05	5,320	7,170
Jan. 29	.06	.07	.07	.04	.05	.04	.05	.06	.06	.06	5,250	8,500
Feb. 4	.08	.08	.09	.04	.05	.05	.07	.07	.08	.07	5,550	10,500
Feb. 7	.12	.15	.14	.09	.07	.08	.10	.09	.11	.10	6,500	17,500
Feb. 10	.12	.14	.16	.10	.10	.08	.11	.11	.10	.11	6,680	19,800
Feb. 13	.11	.14	.12	.09	.09	.08	.10	.12	.11	.11	6,610	19,600
Feb. 16	.17	.19	.22	.14	.11	.10	.16	.15	.15	.16	7,200	31,100
Feb. 19	.23	.25	.26	.18	.18	.15	.19	.23	.23	.22	7,320	43,400
Feb. 23	.19	.20	.21	.15	.15	.06	.18	.16	.19	.18	6,900	33,500
Feb. 27	.16	.20	.23	.12	.11	.11	.14	.16	.13	.14	6,570	24,800
Mar. 4	.14	.17	.20	.11	.11	.10	.13	.15	.14	.14	6,350	24,000
Mar. 6	.19	.24	.27	.15	.15	.11	.17	.20	.18	.18	6,430	31,200
Mar. 9	.32	.39	.40	.20	.18	.09	.27	.30	.37	.32	7,830	67,600
Mar. 11	.47	.62	.57	.32	.28	.24	.40	.53	.39	.44	9,020	107,000
Mar. 16	.58	.68	.77	.41	.32	.29	.52	.55	.56	.54	9,910	144,000

[a] Sampling points: A, one-fourth; B, one-half; C, three-fourths the distance across the river, measured from the north bank.
[b] Unless otherwise indicated this mean is computed from the quantities in the three "average" samples.
[c] Based on the quantities in three bottom and three surface samples.

TABLE 3.—*Suspended matter in silt samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the year ending September 30, 1926*—Continued

	Suspended matter (per cent by weight)										Mean discharge (second-feet)	Suspended matter (tons per day)
	Bottom samples			Surface samples			"Average" samples			Mean		
	A	B	C	A	B	C	A	B	C			
Mar. 19	1.01	0.91	0.83	0.54	0.44	0.39	0.67	0.67	0.69	0.68	10,400	191,000
Mar. 22	1.27	1.22	1.50	.83	.91	.64	1.30	1.07	1.43	1.27	14,100	483,000
Mar. 26	1.47	1.24	1.60	1.05	.90	.93	1.15	1.20	1.04	1.13	16,100	491,000
Mar. 30	1.42	1.27	1.32	.94	.68	.60	1.08	1.04	1.15	1.09	15,100	444,000
Apr. 5	1.12	.95	1.48	.67	.56	.57	.89	.83	.87	.86	13,000	302,000
Apr. 9	3.20	3.54	3.41	2.89	2.30	2.34	3.22	3.07	3.11	3.15	20,000	1,700,000
Apr. 12	1.64	1.72	2.76	1.44	1.50	1.42	1.94	2.30	2.28	2.17	21,500	1,260,000
Apr. 15	2.52	2.44	2.27	1.41	1.10	1.26	2.19	1.65	1.76	1.87	24,500	1,240,000
Apr. 19	3.48	4.14	2.37	1.18	1.11	.87	2.38	1.69	1.77	1.94	26,000	1,360,000
Apr. 24	------	4.39	5.02	2.06	2.46	2.18	2.42	3.29	4.94	3.55	40,600	3,890,000
Apr. 28	3.36	3.90	3.19	2.02	1.63	1.94	2.18	1.93	3.53	2.55	49,700	3,420,000
May 1	3.20	2.57	2.45	1.33	1.36	1.46	1.67	1.59	1.70	1.65	50,200	2,230,000
May 5	2.88	2.11	1.87	1.29	1.07	1.30	1.53	1.82	1.80	1.72	52,400	2,430,000
May 8	3.69	3.28	6.56	2.02	1.92	2.07	3.15	3.01	2.89	3.02	64,700	5,260,000
May 13	1.50	1.55	1.54	1.05	.88	.93	1.46	1.23	1.36	1.35	51,000	1,860,000
May 17	.89	1.40	.90	.50	.47	.48	.71	.67	.75	.71	34,800	666,000
May 19	.39	.67	.80	.45	.44	.41	.58	.58	.86	.67	32,600	589,000
May 22	1.70	2.24	------	.75	.74	------	1.25	------	1.21	1.23	41,300	1,370,000
May 26	2.72	3.23	3.14	1.18	1.28	1.13	1.60	1.66	1.56	[c] 2.11	68,300	3,890,000
May 31	3.22	2.85	3.18	1.47	1.54	1.61	1.99	2.03	2.03	[c] 2.38	72,700	4,670,000
June 4	2.26	2.03	2.06	.81	.78	.68	1.34	1.32	1.16	1.28	72,400	2,500,000
June 8	2.59	1.98	1.68	.90	.72	.61	1.34	.95	.83	1.04	78,000	2,190,000
June 12	1.36	1.67	1.29	.57	.58	.56	1.46	1.02	1.00	1.16	74,100	2,320,000
June 16	1.26	.90	.81	.43	.38	.42	.52	.64	.75	.64	65,300	1,130,000
June 19	.81	1.19	.94	.44	.37	.34	.84	.64	.91	.80	57,500	1,240,000
June 21	.75	.57	.52	.27	.25	.27	.45	.38	.33	.39	47,000	494,000
June 24	.55	.58	.51	.21	.23	.21	.43	.34	.35	.37	38,200	381,000
June 28	.32	.28	.28	.14	.15	.13	.24	.28	.20	.24	30,900	200,000
July 2	.35	.23	.26	.14	.12	.13	.26	.18	.19	.21	27,600	156,000
July 6	.24	.18	.32	.11	.11	.11	.16	.14	.16	.15	25,800	104,000
July 9	.60	.71	.62	.40	.36	.35	.44	.42	.45	.44	26,900	319,000
July 12	.80	.67	.76	46	.40	.42	.36	.56	.54	.48	29,600	386,000
July 16	1.53	1.07	1.24	.96	.98	.94	1.13	1.09	1.06	1.09	32,400	953,000
July 19	1.56	1.35	1.30	1.18	1.26	1.24	1.16	1.30	1.28	1.25	23,200	782,000
July 22	.71	.75	.78	.66	.64	.67	.66	.73	.76	.72	18,300	356,000
July 26	.36	.27	.37	.34	.33	.33	.34	.33	.35	.34	13,800	127,000
July 30	.20	.22	.26	.19	.18	.20	.19	.20	.20	.20	13,600	73,400
Aug. 4	.50	.49	.51	.41	.52	.49	.48	.50	.51	.50	10,000	135,000
Aug. 7	.24	.26	.27	.24	.25	.24	.25	.24	.25	.24	9,060	58,600
Aug. 11	.80	.76	.76	.80	.75	.75	.78	.78	.76	.77	10,700	222,000
Aug. 15	.85	.90	.90	.88	.86	.86	.86	.90	.90	.89	12,200	293,000
Aug. 20	.61	.63	.63	.61	.59	.56	.61	.63	.61	.62	9,920	166,000
Aug. 25	.60	.30	.54	.60	.59	.59	.59	.60	.61	.60	7,380	119,000
Aug. 28	.57	.56	.55	.53	.50	.52	.56	.55	.54	.55	6,280	93,200
Sept. 3	.11	.11	.12	12	.11	.10	.12	.10	.10	[c] .11	4,790	14,200
Sept. 7	.09	.09	.07	.07	.06	.06	.09	.08	.08	[c] .07	4,220	7,970
Sept. 15	1.84	1.84	1.84	1.84	1.83	1.81	1.79	1.79	1.81	[c] 1.83	7,620	376,000
Sept. 19	1.04	1.04	1.04	1.01	1.03	1.02	1.03	1.04	1.03	1.03	5,620	156,000
Sept. 22	.27	.28	.28	.27	.26	.27	.25	.31	.27	.27	5,600	40,800
Sept. 25	1.28	1.27	1.28	1.27	1.25	------	1.26	1.23	1.26	1.25	4,500	152,000
Sept. 27	1.11	1.09	1.11	1.05	1.04	1.06	1.08	1.08	1.09	1.08	11,500	335,000

[c] Based on the quantities in three bottom and three surface samples.

TABLE 4.—*Suspended matter in silt samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the year ending September 30, 1927*

[Determinations by C. S. Howard]

	Suspended matter (per cent by weight)										Mean discharge (second-feet)	Suspended matter (tons per day)
	Bottom samples [a]			Surface samples [a]			"Average" samples [a]			Mean [b]		
	A	B	C	A	B	C	A	B	C			
Oct. 4	1.33	1.37	1.35	1.30	1.29	1.26	1.40	1.36	1.32	1.36	6,320	232,000
Oct. 9	.92	.99	.93	.88	.85	.85	.91	.88	.84	.87	8,800	206,000
Oct. 12	1.17	1.13	1.17	1.15	1.16	1.13	1.18	1.18	1.15	1.17	8,630	272,000
Oct. 16	.69	.69	.72	.63	.65	.54	.64	.57	.65	.62	8,870	148,000
Oct. 18	.50	.64	.66	.60	.60	.60	.38	.54	.62	[c] .60	8,160	132,000
Oct. 23	.25	.27	.27	.22	.20	.23	.26	.23	.21	.23	7,000	43,400
Oct. 26	.21	.19	.21	.20	.19	.18	.22	.21	.20	[c] .20	6,600	35,600
Oct. 29	.09	.14	.14	.13	.13	.13	.15	.13	.14	[c] .13	6,180	21,700
Nov. 4	.08	.07	.10	.09	.09	.10	.10	.09	.10	.10	5,830	15,700
Nov. 6	------	------	.11	------	.11	.11	------	------	.11	[d] .11	6,070	18,000
Nov. 12	.08	.08	.08	.07	.07	.07	.08	.07	.08	.08	6,120	13,500
Nov. 17	.16	.17	.16	.15	.15	.13	.15	.15	.15	.15	6,220	25,200
Nov. 21	.10	.10	.10	.08	.09	.09	.10	.07	.09	.09	6,500	15,800
Nov. 27	.13	.14	.12	.11	.10	.10	.12	.12	.12	.12	6,610	21,400
Nov. 30	.13	.12	.14	.11	.11	.11	.12	.14	.11	.12	6,780	22,000
Dec. 7	.15	.17	.16	.12	.13	.11	.14	.15	.15	.15	7,410	30,000
Dec. 10	.64	.75	.84	.52	.51	.44	.68	.56	.52	.59	11,300	180,000
Dec. 15	.63	.61	.63	.57	.55	.55	.60	.63	.57	.60	8,300	134,000
Dec. 17	.60	.57	.60	.54	.53	.54	.57	.56	.58	.57	7,460	115,000
Dec. 21	.15	.15	.14	.14	.14	.15	.15	.15	.15	.15	5,070	20,500
Dec. 27	.06	.06	.06	.06	.06	.06	.06	.06	.04	[c] .06	4,500	7,280
Dec. 31	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	2,970	4,020
Jan. 5	.04	.04	.04	.03	.04	.03	.03	.04	.03	.04	3,530	3,800
Jan. 8	.07	.07	.07	.06	.06	.06	.07	.07	.07	.07	4,640	8,770
Jan. 13	.14	.19	.19	.16	.16	.16	.18	.17	.18	[c] .17	6,720	30,500
Jan. 15	.19	.20	.19	.16	.17	.16	.18	.19	.19	.19	7,060	36,200
Jan. 19	.14	.14	.12	.12	.12	.12	.12	.13	.10	.12	6,800	22,000
Jan. 22	.13	.13	.13	.10	.10	.09	.11	.11	.11	.11	6,680	19,800
Jan. 25	.14	.14	.17	.12	.13	.11	.14	.14	.14	.14	7,570	28,600
Jan. 29	.11	.10	.11	.09	.10	.09	.10	.11	.11	.11	6,740	20,000
Jan. 31	.10	.10	.11	.09	.10	.09	.10	.10	.10	.10	6,610	17,800
Feb. 6	.08	.08	.08	.08	.08	.07	.08	.08	.08	.08	5,860	12,600
Feb. 9	.11	.09	.08	.07	.07	.08	.08	.08	.08	.08	6,210	13,400
Feb. 13	.11	.11	.12	.10	.10	.10	.10	.10	.10	.10	6,700	18,100
Feb. 17	.37	.41	.39	.34	.36	.32	.36	.37	.36	.36	7,900	76,700
Feb. 20	3.11	3.05	2.94	2.13	2.31	2.29	2.80	3.18	2.57	2.85	14,500	1,150,000
Feb. 23	1.14	1.03	1.01	.83	.88	.80	1.00	.93	.90	.94	10,600	269,000
Feb. 26	.83	.92	.92	.76	.73	.71	.84	.86	.81	.84	8,970	203,000
Feb. 28	.72	.70	.71	.64	.58	.56	.69	.68	.74	.70	9,630	182,000
Mar. 4	.92	.98	.80	.63	.66	.62	.81	1.03	.85	[c] .77	12,000	249,000
Mar. 7	1.04	.92	.89	.72	.66	.62	.89	.94	.90	.91	12,100	297,000
Mar. 11	.93	.88	1.18	.66	.67	.54	.77	.85	.88	.84	11,800	267,000
Mar. 15	.75	.75	.76	.48	.44	.41	.65	.55	.74	.65	11,600	203,000
Mar. 18	.70	.66	.84	.44	.47	.48	.68	.54	.70	.64	10,900	188,000
Mar. 22	.51	.59	.58	.38	.34	.34	.47	.53	.51	.50	9,570	129,000
Mar. 25	.40	.46	.43	.31	.30	.28	.33	.41	.38	.37	9,340	93,200
Mar. 28	.53	.49	.49	.40	.40	.37	.47	.44	.45	.45	9,140	111,000
Mar. 31	.82	1.08	.89	.60	.55	.57	.70	.77	.83	.77	12,500	260,000
Apr. 4	1.18	1.14	1.28	.92	.91	.73	1.17	1.10	1.28	1.18	16,900	538,000
Apr. 8	1.42	2.22	3.24	1.52	1.08	1.33	2.14	1.26	2.30	1.90	25,000	1,280,000
Apr. 12	3.22	2.74	4.90	1.14	1.11	1.51	1.73	2.33	2.16	2.07	28,200	1,570,000
Apr. 15	------	3.99	2.21	.90	.79	.64	1.49	1.95	1.12	1.52	23,400	959,000
Apr. 19	.84	.75	.85	.54	.45	.42	.74	.73	.72	.73	18,300	361,000
Apr. 22	.46	.63	.56	.42	.43	.50	.52	.59	.58	[c] .50	14,700	198,000
Apr. 24	.44	.48	.65	.48	.41	.46	.51	.54	.57	.54	16,300	237,000
Apr. 26	.68	.56	.65	.39	.45	.43	.64	.64	.51	.60	19,300	313,000
Apr. 27	1.14	------	------	------	------	------	1.08	.99	------	[e] 1.04	23,200	651,000
Apr. 28	1.27	1.29	------	.63	.78	.67	.96	1.04	------	[e] 1.00	27,800	750,000
Apr. 29	1.77	------	2.40	1.18	------	------	1.33	------	2.00	[e] 1.67	32,700	1,470,000
Apr. 30	------	1.67	1.70	------	1.08	1.20	------	1.27	1.49	[e] 1.38	35,900	1,340,000
May 4	3.24	4.98	3.80	1.63	1.59	1.62	2.37	2.39	2.21	2.32	54,400	3,400,000
May 8	3.66	4.56	4.69	1.36	1.32	1.20	2.50	1.67	2.93	2.34	64,000	4,040,000
May 10	1.29	3.96	3.11	1.17	1.27	1.39	1.98	2.99	1.93	2.30	61,900	3,830,000
May 13	1.48	1.93	1.14	.59	.63	.64	1.37	1.38	1.61	[c] 1.07	51,900	1,490,000
May 17	1.46	1.43	1.59	.51	.48	.57	1.11	.89	.94	.98	45,400	1,200,000

[a] Sampling points: A, one-fourth; B, one-half; C, three-fourths the distance across the river, measured from the north bank.
[b] Unless otherwise indicated this mean was computed from the quantities in the three "average" samples.
[c] Based on the quantities in three bottom and three surface samples.
[d] Based on the quantities in one bottom, one surface, and one "average" sample.
[e] Based on the quantities in two "average" samples.

TABLE 4.—*Suspended matter in silt samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the year ending September 30, 1927*—Continued.

	Suspended matter (per cent by weight)										Mean discharge (second-feet)	Suspended matter (tons per day)
	Bottom samples			Surface samples			"Average" samples			Mean		
	A	B	C	A	B	C	A	B	C			
May 20	1.05	3.26	2.21	0.95	0.74	1.19	2.43	0.92	2.36	1.90	72,600	3,720,000
May 24	3.21	3.80	2.70	.73	.87	.81	2.27	2.24	2.07	2.19	89,600	5,290,000
May 27	4.16	3.19	2.70	.64	.82	.73	2.52	1.87	3.92	2.77	75,300	5,630,000
May 31	1.39	1.13	1.26	.45	.57	.38	1.34	.99	.90	1.08	62,500	1,820,000
June 3	.90	.60	.89	.22	.23	.19	.70	.50	.27	.49	53,200	703,000
June 6	.91	.75	.66	.21	.20	.25	.60	.60	.57	.59	50,200	799,000
June 9	1.22	.83	1.19	.22	.21	.22	.74	.80	.63	.72	46,000	893,000
June 13	1.46	.90	1.24	.63	.51	.48	1.35	1.12	1.31	[c] .91	63,100	1,550,000
June 17	1.47	1.13	1.62	.60	.69	.68	.92	.90	1.16	.99	69,700	1,860,000
June 22	1.39	1.52	1.41	.44	.25	.48	1.14	.67	.68	.83	72,100	1,610,000
June 25	1.16	1.08	1.32	.35	.39	.50	.74	.61	.85	.73	62,600	1,230,000
June 28	1.37	1.25	1.20	.46	.49	.54	1.04	.88	.85	.92	55,500	1,380,000
July 2	6.89	5.40	6.32	2.86	2.88	3.78	5.67	5.52	6.08	[c] 4.69	117,000	14,800,000
July 6	1.20	1.09	1.37	.52	.53	.50	.99	.90	.58	.83	58,100	1,300,000
July 9	1.14	.99	.90	.51	.52	.51	1.02	.75	.78	.85	49,300	1,130,000
July 12	1.37	1.23	1.10	.78	.69	.75	1.05	1.02	.97	1.01	40,500	1,100,000
July 15	1.85	1.58	1.70	1.31	1.32	1.29	1.51	1.51	1.48	1.50	37,100	1,500,000
July 20	.38	.36	.37	.26	.25	.26	.32	.31	.30	.31	22,400	187,000
July 24	.22	.20	.18	.14	.14	.15	.17	.16	.15	.16	17,500	75,500
July 27	.24	.24	.25	.14	.17	.16	.21	.20	.19	.20	19,300	107,000
July 31	1.27	1.27	1.33	1.52	1.05	1.19	1.25	1.18	1.24	1.22	19,600	645,000
Aug. 4	.99	.99	1.00	.92	.94	.91	.95	.95	.97	.96	17,300	448,000
Aug. 7	.88	.85	.90	.69	.82	.78	.88	.83	.83	.85	19,800	454,000
Aug. 10	3.47	3.48	3.44	1.96	3.32	3.26	3.47	3.42	3.38	[c] 3.16	20,400	1,740,000
Aug. 13	2.15	2.22	2.19	1.94	1.98	1.99	2.13	2.10	2.05	2.09	20,400	1,150,000
Aug. 16	1.15	1.22	1.25	1.07	1.12	1.11	1.16	1.14	1.16	1.15	17,300	511,000
Aug. 19	.78	.79	.80	.75	.71	.74	.77	.72	.76	.75	14,200	287,000
Aug. 23	.43	.44	.44	.40	.42	.41	.43	.41	.40	.41	11,100	123,000
Aug. 26	.24	.24	.23	.23	.23	.23	.23	.23	.24	.23	9,570	59,400
Aug. 29	2.09	2.14	2.24	2.01	2.03	2.07	2.06	2.07	2.12	2.06	16,800	934,000
Sept. 1	2.15	2.20	2.28	2.05	2.12	2.14	2.16	2.19	2.21	2.16	16,000	932,000
Sept. 6	.99	1.02	.99	.97	.91	.83	.99	1.00	.99	.98	10,800	285,000
Sept. 9	3.88	4.22	4.48	3.62	3.62	3.78	3.57	4.02	4.15	3.86	16,400	1,720,000
Sept. 13	9.71	21.00	25.52	9.92	11.63	10.01	13.20	13.83	14.40	13.81	74,000	27,600,000
Sept. 17	5.72	6.26	7.18	4.55	4.40	4.47	4.67	4.73	4.88	[c] 5.38	65,700	9,540,000
Sept. 21	4.02	2.32	3.16	2.52	2.53	2.56	3.20	2.90	2.87	2.99	35,600	2,870,000
Sept. 24	2.24	2.76	2.13	1.76	1.73	1.66	1.95	1.86	1.86	1.89	23,600	1,200,000
Sept. 27	1.15	1.14	.92	.75	.79	.70	.94	.93	.96	.95	26,000	666,000
Sept. 30	3.10	3.11	2.84	2.50	2.19	2.36	2.55	2.86	2.91	2.77	25,900	1,940,000

[c] Based on the quantities in three bottom and three surface samples.

TABLE 5.—*Suspended matter in silt samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the year ending September 30, 1928*

[Determinations by C. S. Howard]

	Suspended matter (per cent by weight)					Mean discharge (second-feet)	Suspended matter (tons per day)
	Surface samples [a]	Average samples [a]			Mean [b]		
	C	A	B	C			
Oct. 5	0.77	0.90	0.86	0.83	0.86	20,900	480,000
Oct. 8	.31	.50	.46	.51	.49	18,300	242,000
Oct. 12	.32	.40	.40	.45	.42	17,200	195,000
Oct. 15	.32	.29	.33	.35	.32	15,400	133,000
Oct. 18	.23	.26	.23	.27	.25	14,000	94,400
Oct. 21	.17	.22	.20	.22	.21	13,000	73,600
Oct. 25	.15	.15	.16	.18	.16	11,800	50,900
Oct. 28	.14	.15	.17	.17	.16	11,300	48,800
Oct. 31	.17	.18	.18	.17	.17	13,700	62,800
Nov. 5	.69	.73	.76	.82	.77	14,000	291,000
Nov. 8	1.14	1.16	1.21	1.21	1.19	12,900	414,000
Nov. 12	.57	.60	.62	.63	.62	13,100	219,000
Nov. 15	.36	.38	.36	.39	.38	12,100	124,000
Nov. 17	.25	.24	.25	.25	.24	12,000	77,700
Nov. 20	.23	.22	.26	.32	.27	12,700	92,500
Nov. 22	.22	.26	.29	.27	.28	12,100	91,400
Nov. 24	.17	.21	.23	.22	.22	11,900	70,600
Nov. 26	.15	.16	.18	.18	.17	11,500	52,700
Nov. 28	.15	.17	.17	.14	.16	11,300	48,800
Nov. 30	.13	.15	.18	.14	.16	10,900	47,000
Dec. 4	.16	.21	.19	.18	.19	10,600	54,300
Dec. 6	.17	.16	.19	.17	.17	10,100	46,300
Dec. 8	.14	.18	.17	.14	.16	10,300	44,400
Dec. 10	.13	.14	.14	.13	.13	9,460	33,200
Dec. 12	.07	.08	.08	.08	.08	8,380	18,100
Dec. 15	.07	.07	.08	.08	.08	6,950	15,000
Dec. 17	.10	.12	.11	.11	.11	8,310	24,700
Dec. 19	.08	.10	.09	.09	.09	7,720	18,700
Dec. 22	.04	.05	.04	.04	.04	5,350	5,770
Dec. 24	.03	.03	.03	.03	.03	4,610	3,720
Dec. 27	.05	.05	.05	.05	.05	6,080	8,200
Dec. 29	.06	.08	.08	.08	.08	6,900	14,900
Jan. 1	.04	.05	.05	.05	.05	7,150	9,660
Jan. 2	.06	.10	.08	.09	.09	8,010	19,400
Jan. 5	.04	.06	.07	.06	.07	7,450	14,100
Jan. 7	.03	.05	.05	.05	.05	7,090	9,550
Jan. 9	.04	.07	.06	.06	.07	8,010	15,100
Jan. 12	.06	.08	.07	.06	.07	8,310	15,700
Jan. 14	.05	.07	.07	.08	.07	8,280	15,600
Jan. 18	.10	.11	.10	.07	.10	9,010	24,300
Jan. 20	.18	.21	.22	.21	.21	9,830	55,700
Jan. 22	.10	.10	.11	.11	.11	8,890	26,400
Jan. 24	.06	.08	.09	.09	.09	8,140	19,800
Jan. 27	.05	.05	.05	.06	.05	7,560	10,200
Jan. 29	.04	.05	.03	.05	.05	7,300	9,850
Jan. 31	.04	.05	.06	.04	.05	7,340	9,900
Feb. 4	.05	.06	.06	.06	.06	8,020	13,000
Feb. 6	.11	.11	.14	.12	.12	8,840	28,600
Feb. 8	.36	.37	.36	.41	.38	12,000	123,000
Feb. 10	.68	.78	.68	.79	.75	11,900	241,000
Feb. 12	.46	.48	.51	.47	.49	10,100	133,000
Feb. 14	.22	.23	.21	.24	.23	8,930	55,400
Feb. 16	.16	.19	.19	.18	.19	8,280	42,400
Feb. 19	.13	.14	.13	.14	.14	7,940	30,000
Feb. 21	.08	.08	.10	.10	.09	7,670	18,600
Feb. 23	.11	.11	.14	.12	.12	7,670	24,800
Feb. 28	.13	.14	.14	.13	.14	7,780	29,400
Mar. 6	.29	.37	.37	.34	.36	9,730	94,500
Mar. 7	.41	.58	.52	.58	.56	10,800	163,000
Mar. 9	.42	.54	.53	.54	.53	12,000	172,000
Mar. 11	.48	.56	.66	.59	.60	12,400	201,000
Mar. 13	.54	.56	.66	.64	.62	11,900	199,000
Mar. 15	.62	.57	.87	.88	.78	14,500	305,000
Mar. 17	.70	.78	.85	.73	.79	14,300	305,000
Mar. 19	.54	.68	.68	.64	.67	13,800	249,000
Mar. 22	.46	.55	.57	.52	.55	11,100	165,000
Mar. 24	.37	.51	.50	.56	.49	10,600	140,000
Mar. 27	.47	.73	.72	.69	.72	14,900	289,000
Mar. 30	1.26	1.57	1.50	1.64	1.57	21,300	901,000

[a] Sampling points: A, 130-foot mark on cable; B, 190-foot mark on cable; C, 250-foot mark on cable; all measured from north bank.

[b] Computed from the quantities in the three "average" samples.

TABLE 5.—*Suspended matter in silt samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the year ending September 30, 1928*—Continued

	Suspended matter (per cent by weight)					Mean discharge (second-feet)	Suspended matter (tons per day)
	Surface samples	Average samples			Mean		
	C	A	B	C			
Apr. 4	1.14	1.20	1.25	1.20	1.22	18,900	622,000
Apr. 7	.71	1.01	1.06	.89	.98	18,700	494,000
Apr. 8	.69	.95	.61	.90	[c] .92	19,000	471,000
Apr. 9	.55	.65	.65	.71	.67	17,800	322,000
Apr. 10	.49	.69	.63	.61	.64	17,100	295,000
Apr. 11	.38	.73	.72	.61	.68	16,400	301,000
Apr. 12	.37	.54	.55	.47	.52	15,400	216,000
Apr. 13	.46	.48	.48	.45	.47	14,100	179,000
Apr. 16	.16	.34	.37	.34	.35	12,800	121,000
Apr. 17	.20	.30	.31	.32	.31	12,600	105,000
Apr. 18	.19	.28	.32	.30	.30	12,300	99,500
Apr. 19	.18	.26	.35	.32	.31	11,800	98,700
Apr. 20	.27	.21	.24	.24	.24	11,200	72,500
Apr. 21	.15	.24	.27	.32	.28	10,900	82,300
Apr. 22	.21	.35	.38	------	[c] .36	12,100	117,000
Apr. 23	.26	.38	.46	.39	.41	13,800	153,000
Apr. 25	.37	.52	.65	.51	.56	15,800	239,000
Apr. 26	.45	.60	.57	.64	.60	16,900	273,000
Apr. 28	.39	.75	.71	.70	.72	18,200	353,000
Apr. 29	.57	.86	.87	.98	.90	23,200	563,000
May 3	2.23	2.50	2.05	1.77	2.11	41,900	2,380,000
May 4	2.76	2.91	2.55	3.31	2.92	55,900	4,400,000
May 7	1.88	2.36	2.81	6.07	[c] 2.58	65,400	4,550,000
May 8	2.38	2.49	1.66	3.71	[c] 2.62	60,500	4,280,000
May 9	1.35	2.13	2.15	1.69	1.99	59,800	3,210,000
May 10	1.23	1.80	1.79	1.62	1.74	65,000	3,050,000
May 11	1.17	1.49	.77	.36	[d] 1.49	69,400	2,790,000
May 14	1.27	2.08	1.57	1.50	1.72	87,400	4,050,000
May 15	1.69	1.33	1.77	1.24	1.45	87,200	3,410,000
May 16	1.30	1.70	1.87	2.23	1.93	84,700	4,410,000
May 17	1.41	1.19	2.66	1.28	[c] 1.24	82,000	2,740,000
May 18	1.58	1.49	1.55	.87	[c] 1.52	77,300	3,170,000
May 19	1.24	1.33	1.10	1.42	1.28	72,100	2,490,000
May 20	.78	.98	1.19	1.21	1.13	69,200	2,110,000
May 21	1.18	1.30	.86	1.12	[d] 1.12	64,600	1,950,000
May 22	.73	.96	.81	1.15	.97	60,800	1,590,000
May 24	.85	1.08	.86	------	[c] .97	59,100	1,550,000
May 28	.76	.76	1.26	1.07	1.03	78,600	2,180,000
May 29	1.54	1.07	.96	.61	.88	86,500	2,050,000
June 2	1.04	1.25	1.34	1.13	1.24	111,000	3,710,000
June 3	.96	1.43	1.45	.97	1.28	114,000	3,940,000
June 4	.82	1.35	.90	1.06	1.10	113,000	3,350,000
June 5	1.06	2.42	1.05	.73	[c] .89	109,000	2,620,000
June 6	.70	.77	1.37	.93	1.02	102,000	2,810,000
June 8	.77	.74	.78	.92	[c] .85	80,100	1,840,000
June 9	.49	.43	.47	.55	.48	71,700	928,000
June 10	.56	.85	.22	.69	[c] .77	67,400	1,400,000
June 12	.38	.62	.65	.62	.63	64,700	1,100,000
June 13	.56	.92	.74	.64	.77	62,900	1,310,000
June 15	.42	.67	.70	.63	.67	55,000	994,000
June 16	.37	.43	.43	.48	.45	50,600	614,000
June 18	.36	.55	.64	.51	.57	42,200	649,000
June 20	.29	.40	.44	.39	.41	41,700	461,000
June 21	.41	.50	.65	.53	.56	43,600	659,000
June 22	.30	.47	.48	.49	.48	43,700	566,000
June 23	.36	.45	.37	.41	.41	41,300	457,000
June 26	.20	.28	.35	.34	.32	38,000	328,000
June 27	.29	.36	.39	.40	.38	38,900	378,000
June 29	.30	.48	.46	.51	.48	39,900	517,000
June 30	.33	.50	.58	.54	.54	41,000	597,000
July 2	.30	.40	.49	.40	.43	40,500	470,000
July 5	.23	.42	.42	.39	.41	36,100	399,000
July 6	.32	.45	.60	.45	.50	34,300	463,000
July 8	.19	.27	.31	.29	.29	31,600	247,000
July 11	.14	.16	.14	.22	.17	27,300	125,000
July 13	.12	.14	.15	.15	.15	23,600	95,500
July 15	.14	.17	.15	.19	.17	21,400	98,100
July 16	.12	.16	.16	.18	.17	20,600	94,400
July 18	.48	.50	.48	.51	.50	19,700	266,000
July 20	.14	.14	.15	.14	.14	18,600	70,200

[c] Based on the quantities in two "average" samples.
[d] Based on the quantity in one "average" sample.

TABLE 5.—*Suspended matter in silt samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the year ending September 30, 1928*—Continued

	Suspended matter (per cent by weight)					Mean discharge (second-feet)	Suspended matter (tons per day)
	Surface samples	Average samples			Mean		
	C	A	B	C			
July 22	0.58	0.62	0.64	0.63	0.63	22,500	382,000
July 24	.50	.53	.51	.56	.53	22,300	319,000
July 25	.65	.64	.68	.68	.67	21,000	380,000
July 27	.70	.70	.70	.70	.70	18,400	347,000
July 29	.41	.41	.40	.40	.40	16,900	182,000
Aug. 3	.73	.73	.94	.72	[c].72	14,400	280,000
Aug. 5	.65	.64	.65	.65	.65	14,800	259,000
Aug. 7	1.12	1.14	1.12	1.14	1.13	13,300	405,000
Aug. 9	.47	.42	.43	.45	.43	13,200	153,000
Aug. 11	.33	.39	.38	.38	.38	11,600	119,000
Aug. 13	.37	.41	.39	.41	.40	10,600	114,000
Aug. 14	.38	.40	.49	.45	.45	10,300	125,000
Aug. 15	.41	.47	.47	.48	.47	10,100	128,000
Aug. 16	.29	.28	.28	.28	.28	10,900	82,300
Aug. 17	.63	.63	.62	.62	.62	9,800	164,000
Aug. 18	.79	.79	.78	.79	.79	9,040	193,000
Aug. 19	.52	.57	.56	.57	.57	8,670	133,000
Aug. 20	.40	.41	.41	.42	.41	8,790	97,200
Aug. 21	.30	.31	.33	.33	.32	8,840	76,300
Aug. 22	.34	.35	.34	.34	.34	8,860	81,200
Aug. 23	.35	.36	.35	.35	.35	8,550	80,700
Aug. 25	.24	.24	.24	.22	.23	7,430	46,100
Aug. 26	.57	.57	.55	.58	.57	7,880	121,000
Aug. 27	.21	.20	.18	.20	[e].50	8,310	112,000
Do	.80	.81	.81	.82			
Aug. 28	.55	.53	.57	.58	[f]1.30	12,800	449,000
Do	1.02	1.20	.89	1.03			
Do	1.37	1.64	1.51	1.56			
Do	1.97	2.04	2.03	1.99			
Aug. 29	2.28	2.25	2.14	2.32	[g]1.90	9,970	511,000
Do	1.54	1.48	1.56	1.60			
Aug. 30	1.90	1.91	1.85	1.88	1.88	8,750	444,000
Aug. 31	1.47	------	1.41	1.40	[c]1.40	7,610	287,000
Sept. 1	1.20	1.21	1.14	1.18	1.18	8,070	257,000
Sept. 2	1.77	1.74	1.73	1.79	1.75	8,840	417,000
Sept. 3	1.01	1.04	1.04	1.05	1.02	9,340	257,000
Do	.98	.99	.98	1.01			
Sept. 4	.71	.70	.72	.72	.71	8,220	157,000
Sept. 5	.93	.91	.94	.94	.93	7,840	197,000
Sept. 6	.76	.78	.72	.78	.76	8,170	167,000
Sept. 7	.72	.64	.72	.73	.70	7,460	141,000
Sept. 8	.69	.71	.71	.65	.69	7,000	130,000
Sept. 9	.45	.43	.46	.46	.45	6,780	82,300
Sept. 10	.33	.34	.33	.34	.34	6,510	59,700
Sept. 11	.31	.32	.31	.31	.31	6,290	52,600
Sept. 12	.24	.24	.23	.24	.24	6,100	39,500
Sept. 13	.19	.20	.20	.20	.20	5,910	31,900
Sept. 14	------	.18	.18	.18	.18	5,730	27,800
Sept. 15	.44	.44	.44	.44	.44	5,570	66,100
Sept. 16	.26	------	.26	.27	[e].26	5,430	38,100
Sept. 17	.16	.16	.16	.16	.16	5,400	23,300
Sept. 18	.15	.16	.16	.16	.16	5,440	23,500
Sept. 19	.10	.10	.10	.11	.10	5,520	14,900
Sept. 20	.10	.10	.09	.12	.10	5,410	14,600
Sept. 21	.09	.08	.09	.09	.09	5,280	12,800
Sept. 22	.08	.09	.09	.09	.09	5,270	12,800
Sept. 23	.07	.07	.06	.06	.06	5,240	8,470
Sept. 24	.06	.06	.06	.06	.06	5,220	8,440
Sept. 25	.06	.07	.07	.07	.07	5,180	9,790
Sept. 26	.06	.06	.07	.06	.06	5,170	8,360
Sept. 27	.05	.06	.06	.06	.06	5,130	8,310
Sept. 28	.05	.05	.05	.05	.05	5,540	7,470
Sept. 30	.06	.06	.06	.06	.06	5,940	9,600

[c] Based on the quantities in two "average" samples.

[e] Based on the quantities in six "average" samples, the first three collected at a gage height of 5.1 feet, the second three at gage height of 5.6 feet.

[f] Based on the quantities in twelve "average" samples; collected in four sets at the following respective gage heights: 9.1 feet, 8.6 feet, 8.4 feet, 8.2 feet.

[g] Based on the quantities in six "average" samples, the first three collected at a gage height of 6.3 feet, the second three at gage height of 5.2 feet.

TABLE 6.—*Suspended matter in silt samples collected from Colorado River near Topock, Ariz., during the year ending September 30, 1926*

[Determinations by C. S. Howard]

	Suspended matter (per cent by weight)											
	Bottom samples [a]			Surface samples [a]			"Average" samples [a]			Mean [b]	Mean discharge (second-feet)	Suspended matter (tons per day)
	A	B	C	A	B	C	A	B	C			
Oct. 3	1.70	1.49	1.54	1.25	1.19	1.21	1.44	1.25	1.23	1.31	13,300	470,000
Oct. 6	.98	1.01	.82	.88	.80	.85	.86	.94	.80	.87	13,700	322,000
Oct. 10	1.43	1.64	1.49	1.14	1.36	1.32	1.34	1.66	1.68	[c] 1.40	26,700	1,010,000
Oct. 13	4.19	4.23	3.97	3.45	3.28	3.27	3.38	3.35	3.95	3.56	17,900	1,720,000
Oct. 17	3.23	2.75	3.20	2.90	2.51	2.38	2.22	1.82	2.49	2.61	18,000	1,270,000
Oct. 21	1.54	1.88	1.62	1.55	1.38	1.42	1.65	2.07	1.66	[c] 1.56	18,600	783,000
Oct. 24	1.18	1.14	1.77	1.14	1.19	.86	1.24	1.18	1.06	1.16	15,400	482,000
Oct. 27	1.41	.97	.99	.64	------	.89	1.00	.86	.90	.92	13,400	332,000
Oct. 30	.82	.48	.53	.54	.79	.57	.52	.52	.65	.56	12,500	189,000
Nov. 2	.86	.80	.68	.53	.57	.46	.83	.69	.60	.71	11,300	216,000
Nov. 6	.82	.44	.46	.34	.37	.34	.49	.45	.49	.47	11,400	144,000
Nov. 10	.50	.57	.48	.55	.49	.48	.45	.42	.41	[c] .51	12,200	168,000
Nov. 14	.54	.46	.39	.37	.37	.39	.54	.33	.35	.40	11,500	124,000
Nov. 17	.80	.35	.77	.40	.84	.35	.37	.34	.38	[d] .51	10,400	143,000
Nov. 21	.62	.34	.54	.51	.37	.31	.60	.42	.44	.49	9,540	126,000
Nov. 25	.72	.28	.44	.20	.26	.33	.26	.39	.37	.34	9,060	83,100
Nov. 28	.33	.32	.33	.25	.28	.23	.25	.28	.27	.27	8,950	65,200
Dec. 2	.54	.28	.32	.40	.21	.20	.40	.20	.24	.28	8,010	60,500
Dec. 5	.51	.50	.36	.48	.38	.30	------	.44	.37	[e] .42	8,530	96,600
Dec. 8	.44	.36	.45	.36	.18	.22	.52	.20	.35	.36	8,180	79,400
Dec. 12	.50	.40	.21	.38	.28	.14	.36	.38	------	[c] .32	8,390	72,400
Dec. 15	.20	.20	.18	.24	.18	.14	.19	.19	.21	.20	7,770	41,900
Dec. 22	.44	.34	.39	.34	.18	.19	.36	.28	.31	.32	6,960	60,100
Dec. 29	------	------	------	------	------	------	.22	.22	.31	.25	5,860	39,500
Jan. 6	.41	.23	.28	.26	.18	.24	.36	.24	.28	.29	6,820	53,400
Jan. 10	.36	.17	.20	.17	.13	.16	.23	.18	.19	.20	6,820	36,800
Jan. 12	.33	.24	.17	.40	.24	.18	.45	.23	.18	.29	7,020	54,900
Jan. 15	.44	.31	.40	.36	.24	.32	.40	.28	.34	.34	6,360	57,500
Jan. 19	.19	.35	.22	.17	.29	.29	.19	.26	.17	[c] .25	6,090	41,000
Jan. 23	.32	.25	.41	.24	.24	.29	.26	.19	.23	[c] .29	5,630	44,000
Jan. 27	.24	.13	.28	.20	.25	.33	.23	------	.26	[e] .25	5,570	37,500
Jan. 29	.24	.24	.47	.15	.21	.24	.24	------	.25	.26	5,660	39,700
Feb. 2	.41	.31	.21	.12	.27	.53	.70	------	.32	[c] .31	5,310	44,400
Feb. 6	.25	.26	.50	.15	.27	.13	.17	------	.11	[c] .26	5,470	38,400
Feb. 9	.22	.19	.37	.11	.17	.19	.10	------	.21	[c] .21	5,930	33,600
Feb. 13	.38	.13	.28	.13	.16	.23	.12	------	.19	[c] .22	6,390	39,700
Feb. 17	.19	.10	.20	.12	.10	.10	.11	------	.11	[c] .14	6,820	25,800
Feb. 19	.13	.10	.27	.11	.12	.06	.12	------	.09	[c] .13	6,890	24,200
Feb. 23	.46	.21	.16	.11	.15	.11	.11	------	.12	[c] .20	7,130	38,500
Feb. 26	.42	.23	.40	.42	.20	.18	.18	------	.19	[c] .31	6,960	58,200
Mar. 3	.20	.16	.38	.12	.12	.16	.18	------	.12	[c] .19	6,490	20,800
Mar. 5	.45	.11	.25	.13	.13	.13	.12	------	.10	[c] .20	6,360	34,300
Mar. 8	.30	.10	.27	.12	.13	.11	.11	------	.09	[c] .17	6,320	29,000
Mar. 12	.24	.16	.33	.19	.17	.15	.21	------	.16	[c] .21	7,020	39,800
Mar. 17	.46	.26	.44	.29	.30	.27	.36	------	.37	[c] .34	8,460	77,600
Mar. 20	.41	.19	.55	.14	.19	.18	.27	------	.33	[c] .28	10,000	75,500
Mar. 23	.23	.26	.24	.19	.20	.23	.23	.19	.22	.21	10,900	61,700
Mar. 27	.77	.85	.58	.38	.38	.36	.42	.51	.70	.54	15,200	222,000
Mar. 30	.75	.59	.78	.41	.39	.41	.66	.50	.58	.58	13,700	215,000
Apr. 2	.75	.55	.54	.40	.41	.40	.55	.71	.37	.54	14,300	208,000
Apr. 6	1.07	.96	.94	.66	.63	.76	.81	.87	.42	.70	14,800	279,000
Apr. 10	1.15	.91	.85	.58	.48	.64	.79	.98	.74	.84	15,100	342,000
Apr. 13	1.25	1.01	1.04	.70	.68	.68	1.02	.94	.86	.94	20,900	530,000
Apr. 16	1.56	1.75	1.41	.98	1.10	1.15	1.18	1.30	1.35	1.28	21,900	756,000
Apr. 20	1.34	1.38	1.31	.84	.85	.84	1.16	1.07	1.06	1.10	24,900	739,000
Apr. 24	.52	1.43	1.06	.98	.88	.99	1.48	1.21	.93	1.21	35,000	1,140,000
Apr. 27	1.26	1.53	.84	1.12	1.11	1.20	1.29	.74	1.26	1.10	42,600	1,260,000
Apr. 30	1.25	1.02	1.08	.90	.99	.97	1.05	1.03	.93	1.00	49,800	1,340,000
May 4	1.22	1.02	1.17	1.01	.90	.83	.95	1.38	.85	1.06	50,800	1,450,000
May 7	1.10	.88	.88	.70	.68	.74	.88	.55	.63	.69	52,100	970,000
May 11	.82	1.04	.95	.77	.76	.68	.98	.79	.88	.88	65,400	1,550,000
May 15	.84	.87	.86	.59	.51	.61	.68	.71	.91	.77	52,400	1,090,000
May 17	.74	.97	.90	.69	.60	.66	.72	.68	.76	.72	41,900	814,000
May 23	.53	.96	.81	.36	.58	.38	.64	.72	.63	.67	35,000	633,000

[a] Sampling points: A, one-fourth; B, one-half; C, three-fourths the distance across the river, measured from the north bank.
[b] Computed from the quantities in the three "average" samples.
[c] Based on the quantities in three bottom and three surface samples.
[d] Based on the quantities in three bottom, three surface, and three "average" samples.
[e] Based on the quantities in two "average" samples.

TABLE 6.—*Suspended matter in silt samples collected from Colorado River near Topock, Ariz., during the year ending September 30, 1926*—Continued

	Suspended matter (per cent by weight)										Mean discharge (second-feet)	Suspended matter (tons per day)
	Bottom samples			Surface samples			"Average" samples			Mean		
	A	B	C	A	B	C	A	B	C			
May 26	0.68	0.57	0.69	0.61	0.58	0.56	0.62	0.59	0.81	[c] 0.61	51,100	841,000
May 29	.38	.54	.51	.32	.21	.33	.31	.36	.38	.35	69,100	652,000
June 3	.79	.85	.80	.69	.62	.63	.84	.75	.70	.76	71,200	1,460,000
June 7	.91	.62	.60	.52	.46	.52	.69	.67	.50	.62	72,200	1,210,000
June 12	.63	.41	.38	.36	.38	.25	.55	.38	.38	.44	78,600	933,000
June 16	.61	.55	.57	.64	.24	.30	.48	.58	.41	.49	71,300	942,000
June 22	1.11	.73	.72	.36	.25	.49	.54	.54	.54	.54	52,800	769,000
June 26	.81	1.19	.78	.58	.51	.49	.46	.54	.44	[d] .64	37,800	652,000
June 30	.28	.75	.32	.25	.12	.16	.46	.16	.22	.28	32,000	242,000
July 2	.68	.62	.48	.26	.30	.52	.51	.43	.41	.45	28,800	350,000
July 5	.44	.41	.41	.20	.18	.24	.46	.23	.43	.37	26,700	266,000
July 10	.70	.60	.44	.24	.31	.20	.44	.36	.22	.34	25,900	238,000
July 12	.74	.51	.45	.18	.27	.33	.29	.52	.35	.39	26,300	277,000
July 18	.50	.59	.75	.34	.23	.36	.47	.52	.53	.51	34,500	475,000
July 20	1.24	1.16	1.16	1.00	1.08	1.03	1.21	1.22	.98	1.14	27,000	830,000
July 24	1.49	1.53	1.68	1.12	1.05	.91	1.72	1.28		[c] 1.30	18,600	652,000
July 28	.65	.19	.47	.61	.65	.61	.63	.42		[c] .53	15,100	216,000
Aug. 2 [f]	.25	.36	.50	.38			.30			.37	12,900	129,000
Aug. 6	.40	.41	.31	.21			.37			.37	10,600	106,000
Aug. 10	.51	.54	.55	.42			.60			.53	8,680	124,000
Aug. 14	.45	.51	.40	.35						.45	9,400	114,000
Aug. 17	.70	.80	.68							.73	10,700	211,000
Aug. 21	1.00	.97	.91	.66			.86			.96	11,100	288,000
Aug. 23	.74	.75	.76	.65			.78			.75	9,320	188,000
Aug. 27	.64	.51	.49							.55	7,210	107,000
Aug. 31	.90	.58	.67							.72	5,960	116,000
Sept. 4	.47	.58	.63							.56	4,970	75,100
Sept. 8	.47	.59	.54							.53	4,360	62,300
Sept. 11	.45	.32	.27							.35	5,420	51,200
Sept. 14	.22	.23	.20							.22	3,540	21,000
Sept. 17	.54	.53	.62	.50			.54			.56	8,800	133,000
Sept. 21	.52	.47	.45							.48	5,080	65,800
Sept. 25	1.70	2.50	2.31							2.17	4,900	287,000
Sept. 28	1.64	1.89	2.05							1.86	4,230	212,000

[c] Based on the quantities in three bottom and three surface samples.
[d] Based on the quantities in three bottom, three surface, and three "average" samples.
[f] From this date through September 28 the depth of water was so low that as a rule samples were taken at only one depth. These samples probably represent fairly well the quantity of suspended matter carried by the river.

TABLE 7.—*Suspended matter in silt samples collected from Colorado River near Topock, Ariz., during the year ending September 30, 1927*

[Determinations by C. S. Howard]

	Suspended matter (per cent by weight)							Mean discharge (second-feet)	Suspended matter (tons per day)
	Bottom samples [a]			Surface samples [a]	"Average" samples [a]		Mean [b]		
	A	B	C	A	A	A			
Oct. 2	2.11	2.17	1.72	1.09	1.36		2.03	12,600	708,000
Oct. 5	8.25	4.40	4.49	6.42	6.32		5.74	6,270	971,000
Oct. 9	3.87	2.74	2.10	3.28	2.27		[c] 2.27	6,750	413,000
Oct. 12	2.26	2.36	1.97				2.20	8,560	508,000
Oct. 16	1.09	1.53	.92				1.18	7,820	249,000
Oct. 19	.93	.98	1.12				1.01	8,200	223,000
Oct. 23	.84	.79	.88				.84	7,170	162,000
Oct. 26	.70	.85	.66				.74	6,630	132,000
Oct. 30	.57	.54	.48				.53	6,270	89,600
Nov. 2	.41	.43	.41				.42	5,490	62,200
Nov. 6	.26	.27	.32				.28	5,490	41,500
Nov. 9	.24	.26	.22				.24	5,360	34,700
Nov. 13	.25	.31	.31				.29	5,330	41,700
Nov. 15	.24	.21	.24				.23	5,430	33,700
Nov. 20	.20	.23	.28				.24	5,740	37,200

[a] Sampling points: A, one-fourth; B, one-half; and C, three-fourths the distance across the river, measured from the east bank.
[b] Based on quantities in three bottom samples.
[c] Based on the quantity in one "average" sample.

TABLE 7.—*Suspended matter in silt samples collected from Colorado River near Topock, Ariz., during the year ending September 30, 1927*—Continued

	Suspended matter (per cent by weight)							Mean discharge (second-feet)	Suspended matter (tons per day)
	Bottom samples			Surface samples	"Average" samples		Mean		
	A	B	C	A	A	A			
Nov. 23	0.40	0.32	0.30	0.28	0.26		[c] 0.26	5,740	40,200
Nov. 27	.34	.41	.24	.20	.24		[d] .27	5,710	41,600
Nov. 30	.78	.37	.38	.39	.43		[c] .43	6,540	75,800
Dec. 4	.25	.22	.20	.20	.47		.22	6,510	38,600
Dec. 7	.45	.30	.36	.17	.23		.37	6,990	69,800
Dec. 11	.37	.47	.24	.11	.25		.36	6,750	65,500
Dec. 14	.63	.32	.32	.36	.34		[d] .34	10,400	95,400
Dec. 18	.69	.44	.38	1.37	.42		[c] .42	7,630	86,400
Dec. 22	.57	.58	.73				.63	6,900	117,000
Dec. 26	.24	.29	.27				.27	4,660	34,000
Dec. 28	.27	.25	.26				.26	4,760	33,400
Dec. 31	.26	.26	.27				.26	4,780	33,500
Jan. 10	.14	.16	.14				.15	4,200	17,000
Jan. 18	.18	.16	.14				.16	6,990	30,200
Jan. 22	.17	.22	.21				.20	7,600	41,000
Jan. 25	.20	.17	.15				.17	7,050	32,300
Jan. 29	.20	.16	.17				.18	7,820	37,800
Feb. 1	.11	.13	.16				.13	7,050	24,700
Feb. 5	.15	.14	.14				.14	6,510	24,600
Feb. 7	.10	.14	.12				.12	6,390	20,700
Feb. 13	.14	.15	.17				.15	6,660	27,000
Feb. 17	.39	.42	.37				.39	8,520	69,900
Feb. 20	.45	.40	.42				.42	11,500	130,000
Feb. 23	.65	.68	.53	.42	.52	0.42	.47	16,000	203,000
Feb. 26	1.77	1.74	1.89				1.80	11,300	548,000
Mar. 1	.72	.80	.77				.76	9,270	190,000
Mar. 5	.65	.62	.70				.66	13,000	231,000
Mar. 9	.68	.62	.81				.70	12,800	242,000
Mar. 11	.80	.75	.76				.77	12,500	260,000
Mar. 15	.61	.59	.70				.64	11,400	197,000
Mar. 19	.55	.55	.63				.58	11,000	172,000
Mar. 23	.37	.35	.46				.39	10,400	109,000
Mar. 29	.35	.32	.40				.36	8,650	84,000
Mar. 31	.42	.46	.46				.45	8,460	103,000
Apr. 3	.43	.43	.46				.44	12,700	151,000
Apr. 6	.90	.92	1.04	.63			[c] .78	17,400	366,000
Apr. 9	1.94	1.23	.96	.83			[f] 1.10	20,700	614,000
Apr. 13					1.10	1.22	1.16	28,200	882,000
Apr. 14	1.35	1.14	1.38				1.29	28,900	1,010,000
Apr. 15					1.30	1.15	1.23	27,000	896,000
Apr. 16					1.31		[c] 1.31	25,000	883,000
Apr. 18	1.32			1.26	1.13		1.13	22,400	683,000
Apr. 20	.85	.96	1.18	.83	.88	1.04	.96	20,200	523,000
Apr. 21	1.22	1.00	1.40	1.07	1.22	1.23	1.22	19,100	623,000
Apr. 26				.41	.72	.66	[c] .72	15,300	297,000
Apr. 29 [g]				.40	.68	1.11	.90	20,600	500,000
May 3				.54	.90	1.02	.96	38,000	984,000
May 6				.67	.85	.80	.82	51,700	1,140,000
May 12				.71	.90	.88	.89	62,500	1,500,000
May 14				.88	1.38	1.28	1.34	60,800	2,200,000
May 18				.66	.78	.94	.86	42,300	982,000
May 22				.75	1.11	1.15	1.13	63,700	1,940,000
May 24				.56	.80	.77	.79	81,200	1,730,000
May 28				.49	.60	.70	.65	82,700	1,450,000
May 31				.62	1.30	1.05	1.18	69,400	2,210,000
June 4				.24	1.04	1.71	1.37	55,800	2,060,000
June 7				.41	.93	1.43	1.18	50,600	1,610,000
June 11				.42	.77	.61	.69	46,400	865,000
June 15				.44	.75	.58	.66	60,600	1,080,000
June 18				.38	.74	.54	.64	65,600	1,130,000
June 20				.52	.79	.64	.72	68,000	1,320,000
June 26				.44	.86	.57	.72	68,900	1,340,000
June 29				.38	.67	.77	.72	56,800	1,100,000
July 3				1.79	2.22	1.99	2.11	89,300	5,080,000
July 6				1.38	1.66	1.83	1.75	86,300	4,070,000
July 10				.76	1.24	.97	1.10	58,500	1,740,000
July 12				1.14	.84	.74	.79	45,800	1,030,000
July 16				.91	1.76	1.50	1.63	41,000	1,800,000
July 20				1.10	1.38	1.50	1.44	28,300	1,100,000

[c] Based on the quantity in one "average" sample.
[d] Based on the quantities in one bottom and one surface sample.
[e] Based on the quantities in three bottom and three surface samples; two surface samples showed 0.83 and 0.80 per cent.
[f] Based on the quantities in three bottom and three surface samples; two surface samples showed 0.67 and 0.57 per cent.
[g] Method of sampling changed, so that one surface and two "average" samples are collected; mean for day is computed from quantities in the "average" samples.

TABLE 7.—*Suspended matter in silt samples collected from Colorado River near Topock, Ariz., during the year ending September 30, 1927*—Continued

	Suspended matter (per cent by weight)							Mean discharge (second-feet)	Suspended matter (tons per day)
	Bottom samples			Surface samples	"Average" samples		Mean		
	A	B	C	A	A	A			
July 23				0.51	0.45	0.76	0.60	21,400	346,000
July 26				.27	.31	.96	[c] .96	18,800	487,000
July 30				.72	.54	.82	[c] .82	19,500	431,000
Aug. 3				.79	.93	.88	.91	19,500	478,000
Aug. 6				1.24	1.34	1.40	1.37	17,600	650,000
Aug. 10				.97	1.20	1.16	1.18	20,400	649,000
Aug. 13				1.35	1.35	1.32	1.34	18,200	658,000
Aug. 16				2.19	2.26	2.49	2.37	19,300	1,234,000
Aug. 20				1.52	2.11	2.11	2.11	16,000	910,000
Aug. 23				.83	1.26	1.06	1.16	12,600	394,000
Aug. 27				.57	.77	.67	.72	9,750	189,000
Aug. 31				1.60	1.86	1.67	1.76	14,600	693,000
Sept. 3				1.44	1.59	1.84	1.71	14,200	655,000
Sept. 6				2.13	2.39		[c] 2.39	13,800	890,000
Sept. 10				1.81	1.74	1.88	1.81	13,000	635,000
Sept. 13				4.40	4.63	4.15	4.39	37,000	4,380,000
Sept. 16				7.10	7.12	8.69	7.91	96,500	20,600,000
Sept. 20				4.38	5.18	5.42	5.30	56,600	8,090,000
Sept. 24				3.85	3.84	3.88	3.86	32,200	3,350,000
Sept. 28				1.94	2.03	2.01	2.02	21,400	1,170,000

[c] Based on the quantity in one "average" sample.

TABLE 8.—*Suspended matter in silt samples collected from Colorado River at Topock, Ariz., during the year ending September 30, 1928*

[Determinations by C. S. Howard]

	Suspended matter (per cent by weight)				Mean discharge (second-feet)	Suspended matter (tons per day)
	Surface samples [a]	"Average" samples [a]		Mean [b]		
Oct. 1	0.92	1.09	1.54	[c] 1.09	28,300	832,000
Oct. 5	1.05	1.22	1.37	1.30	20,700	726,000
Oct. 8	.85	.97	1.14	1.06	20,000	572,000
Oct. 11	.64	.93	.50	.72	17,800	346,000
Oct. 16	.42	.41	.45	.43	16,300	189,000
Oct. 19	.37	.36	.47	.42	14,200	161,000
Oct. 21	.42	.52	.48	.50	13,800	186,000
Oct. 26	.39	.58	.63	.61	12,600	207,000
Oct. 29	.30	.35	.35	.35	12,000	113,000
Nov. 2	1.13	.93	1.31	1.12	14,400	435,000
Nov. 5	1.15	1.85	1.41	1.63	14,000	615,000
Nov. 8	.57	.67	.67	.67	14,200	257,000
Nov. 12	.76	1.00	.90	.95	12,500	320,000
Nov. 15	.76	.81	.94	.87	12,800	300,000
Nov. 19	.64	1.03	.93	.98	11,500	304,000
Nov. 23	.74	.72	.97	.85	12,200	280,000
Nov. 26	.30	.31	.28	.29	11,700	92,000
Nov. 29	.19	.18	.21	.20	10,800	58,300
Dec. 3	.22	.21	.21	.21	10,200	57,800
Dec. 8	.32	.47	.60	.53	9,540	136,000
Dec. 13	.18	.19	.24	.21	9,070	51,400
Dec. 16	.34	.35	.34	[c] .34	7,850	72,000
Dec. 20	.18	1.20	.24	[c] .24	7,720	50,000
Dec. 24	.28	.35	.30	.32	6,690	57,700
Dec. 26	.26	.28	.24	.26	5,490	38,500
Dec. 31	.23	.58	.70	.64	6,220	107,000
Jan. 3	.26	.85	.65	.75	6,780	137,000
Jan. 7	1.03	1.33	.60	[d] 1.03	7,690	214,000
Jan. 11	.31	.62	.87	.74	6,840	137,000
Jan. 14	.14	.19	.19	.19	7,820	40,800
Jan. 17	.32	.34	.38	.36	8,080	78,500
Jan. 21	.26	.50	.31	.41	8,560	94,700
Jan. 25	.06	.31	.32	.32	8,490	73,300
Jan. 28	.24	.24	.33	.29	7,660	59,900
Feb. 4	.74	.72	.68	.70	7,600	143,000
Feb. 7	.39	.41	1.09	[c] .41	10,800	119,000

[a] Most of the samples were taken at the 120-foot mark on the cable.
[b] Based on the quantities in the two "average" samples.
[c] Based on the quantity in one "average" sample.
[d] Based on the quantity in the one surface sample.

TABLE 8.—*Suspended matter in silt samples collected from Colorado River at Topock, Ariz., during the year ending September 30, 1928*—Continued

	Suspended matter (per cent by weight)				Mean discharge (second-feet)	Suspended matter (ton per day)
	Surface samples	"Average" samples		Mean		
Feb. 11	0.39	0.39	0.41	0.40	11,400	123,000
Feb. 14	.20	.43	.52	.47	10,500	133,000
Feb. 18	.53	.68	.80	.74	7,950	159,000
Feb. 21	.35	.32	.40	.36	7,410	72,000
Feb. 24	.15	.28	.29	.28	7,170	54,200
Feb. 28	.19	.26	.27	.26	7,140	50,100
Mar. 3	.20	.48	.96	[c].48	7,470	96,700
Mar. 6	.24	.44	.38	.41	7,320	80,900
Mar. 10	.18	.22	.21	.21	9,710	55,000
Mar. 13	.31	.31	.38	.34	11,900	109,000
Mar. 17	.49	.47	.44	.46	11,500	143,000
Mar. 20	.38	.44	.45	.45	12,800	155,000
Mar. 24	.23	.34	.34	.34	10,600	97,200
Mar. 27	.42	.43	.43	.43	9,750	113,000
Mar. 31	.49	.50	1.07	.78	16,400	345,000
Apr. 4	.63	.88	.80	.83	24,400	546,000
Apr. 7	1.09	2.04	2.12	2.08	17,600	987,000
Apr. 10	.66	1.07	.97	1.02	18,300	503,000
Apr. 15	.34	.59	.53	.56	15,600	236,000
Apr. 19	.35	.76	.80	.78	13,400	282,000
Apr. 23	.24	.67	.60	.64	11,700	202,000
Apr. 25	.56	1.20	.69	[c].69	11,800	220,000
Apr. 29	.22	.98	.91	.94	17,400	441,000
May 2	.37	.58	.52	.55	23,900	355,000
May 5	.78	1.03	.77	[c].77	41,900	870,000
May 9	1.35	.99	1.35	1.17	66,100	2,090,000
May 13	.77	1.27	1.13	1.20	67,600	2,190,000
May 15	.67	.72	.73	.72	79,600	1,550,000
May 19	.90	1.70	1.55	1.63	80,300	3,530,000
May 23	.68	2.24	1.47	1.85	62,400	3,110,000
May 26	.68	2.26	2.54	2.40	59,500	3,850,000
May 30	.66	1.02	1.03	1.03	72,700	2,020,000
June 3	.54	.83	.96	.89	95,700	2,300,000
June 6	.34	.81	.81	.81	108,000	2,360,000
June 10	.61	1.61	.67	1.14	86,700	2,670,000
June 13	.72	5.82	3.01	[c]3.01	66,100	5,370,000
June 16	.58	1.18	1.48	1.33	58,200	2,090,000
June 19	.34	1.94	1.26	1.60	47,300	2,040,000
June 23	.65	.94	.95	.94	42,400	1,080,000
June 26	.31	1.04	.91	.97	38,400	1,000,000
June 30	.38	1.11	.56	.84	37,800	856,000
July 3	.36	.38	.64	[c].64	41,400	715,000
July 7	.27	.72	.43	.58	35,300	552,000
July 10	.30	1.02	.93	.98	31,900	843,000
July 14	.29	.66	.60	.63	26,400	448,000
July 17	.27	.52	1.32	[c].52	21,800	306,000
July 21	.17	.56	.45	.51	19,500	268,000
July 24	.19	.73	.58	.65	20,000	351,000
July 27	.59	1.31	1.10	1.20	21,400	693,000
July 31	.76	1.16	1.27	1.22	16,500	543,000
Aug. 3	.41	.83	.82	.83	14,400	322,000
Aug. 7	.33	.74	.77	.76	13,800	283,000
Aug. 10	.46	.74	.78	.76	12,800	262,000
Aug. 14	.98	1.12	1.19	1.16	11,100	347,000
Aug. 18	.37	.46	.59	.53	9,750	139,000
Aug. 22	.32	.51	.46	.49	8,460	112,000
Aug. 25	.72	.75	.84	.80	8,330	180,000
Aug. 28	.45	.55	.54	.55	7,350	109,000
Aug. 31	.53	.74	.74	.74	12,000	240,000
Sept. 4	.44	.49	.48	.48	7,080	91,700
Sept. 8	1.18	1.23	1.26	1.25	7,410	250,000
Sept. 11	.98	1.07	1.05	1.06	6,600	189,000
Sept. 15	.67	.70	.72	.71	6,100	117,000
Sept. 18	.58	.65	.63	.64	5,570	96,200
Sept. 22	.28	.33	.33	.33	5,230	46,600
Sept. 26	.33	.43	.42	.42	5,150	58,300
Sept. 29	.29	.33	.34	.34	5,230	48,000

[c] Based on the quantity in one "average" sample.

TABLE 9.—*Suspended matter in water samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the period February 12, 1926, to September 30, 1928*

[Determinations by C. S. Howard. Per cent by weight]

Day	Feb., 1926	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	--------	0.07	0.63	0.79	0.67	0.12	0.87	0.16	2.66	0.10
2	--------	.07	.75	1.65	.25	--------	.38	.13	2.86	.09
3	--------	.08	.48	1.10	.35	.07	.68	.10	1.97	.09
4	--------	.09	.74	1.01	.59	.07	.49	.09	1.01	.08
5	--------	.08	.49	.63	.39	.07	.35	.08	1.01	.08
6	--------	.10	.58	.52	.43	.13	.37	.07	.97	.08
7	--------	.07	.68	.72	--------	.10	.26	.05	1.56	.10
8	--------	.07	.68	.64	.14	.11	.20	.05	.86	.07
9	--------	.09	1.79	--------	.21	--------	.57	.05	.86	.08
10	--------	.14	1.60	--------	.19	.41	.82	.05	.84	.07
11	--------	.17	1.13	.92	.23	.37	.82	.04	.94	.07
12	0.06	.18	1.00	.64	.31	.46	.81	.11	1.11	.08
13	.06	.20	.72	.43	.20	.29	--------	.21	.72	.06
14	.07	.26	--------	.38	.19	.23	--------	8.32	.54	.07
15	.07	.32	.69	.46	.27	1.15	--------	1.90	.68	.07
16	.13	.34	.77	--------	.18	1.02	--------	1.91	.64	.18
17	.10	.39	.75	.31	.24	1.27	--------	1.72	.55	.11
18	.11	.22	.62	.43	--------	.67	--------	1.51	.65	.09
19	.13	.21	.98	.17	--------	1.33	--------	1.32	.45	.10
20	.12	.32	.76	.51	--------	.97	--------	.65	.39	.09
21	.10	.83	1.69	.44	--------	.81	.78	.39	.21	.09
22	.10	.69	--------	.43	.22	.64	.81	.25	.20	.07
23	.10	.75	1.31	.30	.11	.51	--------	.26	.21	.07
24	.09	.58	1.06	.38	.22	.41	.79	1.05	.20	.06
25	.09	.71	1.61	.32	.13	.41	.61	1.22	.24	.08
26	.07	.77	1.52	.57	.13	.25	.40	.77	.20	.07
27	.08	.77	1.31	.55	.15	.33	.44	1.00	.17	.08
28	.08	.74	1.54	.61	.18	.19	.48	10.30	.15	.08
29	--------	.62	1.27	.61	.19	.15	.43	6.06	.13	.08
30	--------	.74	.85	1.03	.18	.19	.27	2.94	.12	.10
31	--------	.79	--------	.85	--------	.20	.20	--------	.11	--------

Day	Dec., 1926	Jan., 1927	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	0.08	0.03	0.07	0.66	0.73	1.19	0.16	2.06	1.45	1.99
2	.12	.03	.06	.59	.66	1.54	.13	2.12	1.80	--------
3	.09	--------	.07	.58	.63	1.65	.15	1.87	.93	1.43
4	.09	.03	.07	.59	.82	1.32	.14	1.05	.90	1.30
5	.08	.02	.06	.67	.81	2.04	.12	.78	.72	1.12
6	.12	.02	.07	.60	.74	1.23	.09	.47	1.47	.98
7	.13	.05	.04	.71	.62	1.32	.09	.38	.67	1.08
8	.11	.04	.05	.66	.87	1.27	.13	.39	1.17	4.62
9	.13	.04	.06	.63	1.10	1.36	.16	.43	1.64	3.20
10	.39	.07	.06	.75	.99	.83	.10	1.43	1.82	2.91
11	.45	.06	.06	.60	.89	.95	.13	.79	2.62	5.38
12	.64	.06	.07	.54	.99	.38	.13	.77	1.46	8.91
13	.50	.09	.08	.57	.72	.26	.13	.86	1.21	9.79
14	.37	.16	.09	.60	.71	.30	.20	.72	1.42	6.78
15	.49	.15	.08	.50	.58	.29	.24	1.49	1.93	7.28
16	.52	.16	.07	.46	.42	.36	.55	.77	1.01	5.81
17	.30	.13	.35	.51	.31	.42	.30	.57	.96	3.04
18	.30	.11	.60	.40	.36	.25	.41	.49	.89	5.62
19	.24	.09	--------	.41	.33	.14	.37	.26	.71	4.34
20	.18	.12	2.89	.47	.39	.35	.25	.28	.53	2.54
21	.13	.09	1.17	.29	.36	.63	.31	.22	.50	2.19
22	.13	.10	.94	.34	.27	.50	.34	.22	.61	2.11
23	--------	.09	.91	.37	.28	.63	.20	.16	.38	2.12
24	.06	.08	.88	.33	.31	.43	.20	.13	.32	1.68
25	.07	.10	--------	.27	.30	.47	.20	.17	.36	1.03
26	.07	.09	.67	.31	.30	.40	.22	.12	.21	.83
27	.07	.10	.68	.33	.43	.29	.18	.16	.35	.65
28	.05	.08	.59	.26	.55	.26	.43	.31	.39	.82
29	--------	.08	--------	.51	.91	.24	.16	.70	1.82	1.95
30	.03	.08	--------	.52	.84	.18	3.21	1.64	1.84	1.23
31	--------	.07	--------	.50	--------	.15	--------	1.09	2.93	--------

TABLE 9.—*Suspended matter in water samples collected from Colorado River at Bright Angel Creek, near Grand Canyon, Ariz., during the period February 15, 1926, to September 30, 1928*—Continued

Day	Oct., 1927	Nov.	Dec.	Jan., 1928	Feb.	Mar.	Apr.	May	June [a]	July [a]	Aug.[a]	Sept.[a]
1	1.36	0.40	0.15	0.05	0.04	0.10	1.42	1.07	1.21	0.28	-------	0.95
2	1.07	.34	.16	.06	.06	.11	.93	1.20	.98	.24	0.16	1.64
3	.99	-------	.12	.08	.05	.12	.77	1.70	.90	.23	.70	.99
4	.83	1.25	-------	.06	.06	.13	.74	1.38	1.02	.25	.43	.66
5	.80	.87	-------	.05	.07	.20	.68	2.38	.74	.23	.59	.82
6	.70	.64	-------	.04	.10	.32	-------	1.86	.72	.24	.54	.74
7	.62	1.13	-------	.03	.33	.43	.42	1.68	.57	.16	1.20	.68
8	.44	1.09	.13	.04	.31	.52	.41	1.31	-------	.19	-------	.64
9	-------	.54	-------	.05	1.05	.45	.36	1.06	.38	.19	.46	.44
10	-------	.43	-------	.06	.85	.40	.44	-------	.33	.15	.38	.32
11	.38	.41	-------	.07	.63	.51	.40	1.12	.48	.11	.38	.25
12	.31	.53	-------	.06	.45	.55	.26	-------	.39	.10	.22	.22
13	.27	.44	-------	-------	.30	.51	.29	1.33	.35	.09	.29	.18
14	.25	.36	-------	.06	.23	.48	.40	1.44	.37	.08	.23	.16
15	.28	.32	-------	.08	.18	.61	.26	1.22	.34	.09	.17	.41
16	.21	.28	-------	.08	.15	.51	.28	.92	.36	.08	.28	.24
17	.20	.21	-------	.08	.13	.52	.21	1.26	.26	.09	.62	.14
18	.20	.20	-------	.11	.12	.52	.20	.92	.25	.38	.80	.13
19	.20	.26	-------	.10	.10	.48	.18	.93	.38	.14	.54	.10
20	.19	.25	-------	.17	.10	.45	.17	.84	.31	.14	.61	.08
21	.17	.28	-------	.14	.09	.38	-------	.77	.41	.13	.32	.08
22	.14	.24	-------	.09	.11	.35	.22	.62	.35	.29	.33	.07
23	.14	.21	-------	.10	.10	.34	.35	.57	.27	.80	.32	.06
24	.15	.20	.03	.08	.10	.31	.34	.47	.24	.66	-------	.06
25	.14	.19	.02	.08	.08	.34	.32	.64	.25	.60	.17	05
26	.14	.17	.04	.06	.09	.45	.24	.84	.29	.93	.55	.05
27	.14	.17	.04	.06	.09	.44	.28	-------	.26	.67	.18	.05
28	.15	.14	.05	.04	.11	.49	.26	.72	.31	.38	1.47	.04
29	.12	.18	.05	.05	.11	.77	.37	.80	.16	.28	1.45	.05
30	.16	.15	.06	.05	-------	-------	.46	.81	-------	.30	2.28	.05
31	.17	-------	.04	.05	-------	.93	-------	1.31	-------	.25	1.88	-------

[a] Determinations by S. K. Love.

TABLE 10.—*Suspended matter in water samples collected from Colorado River at Topock, Ariz., during the period February 19, 1926, to September 30, 1928*

[Determinations by C. S. Howard. Per cent by weight]

Day	Feb., 1926	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	-------	0.13	0.51	0.77	0.32	0.18	0.47	0.61	1.15	0.28
2	-------	.13	.45	.88	.41	.14	.36	.67	1.30	.30
3	-------	.20	.49	.69	.71	.18	-------	.53	3.30	.29
4	-------	.24	.52	.68	.40	.11	.27	.51	6.15	.25
5	-------	.13	.53	.68	.38	.16	.17	.46	5.77	.23
6	-------	.14	.58	.61	.36	.17	.27	.31	4.69	.25
7	-------	.12	.53	.54	.31	.10	.22	.50	3.60	.20
8	-------	.13	.60	.50	.29	.13	.65	.59	2.61	.19
9	-------	.18	.75	.53	.36	.14	.45	.44	2.26	.21
10	-------	.16	.65	.52	.33	.16	.38	.32	2.48	.19
11	-------	.13	.67	.58	-------	.33	.53	.25	1.89	.20
12	-------	.12	.78	.70	.21	.19	.44	.37	2.08	.19
13	-------	-------	.79	.77	-------	.17	.42	.19	1.81	-------
14	-------	.11	1.38	.64	.22	.37	.42	.19	1.57	.22
15	-------	.17	1.18	.61	.27	.30	.34	.19	.95	.20
16	-------	.19	1.08	.47	.31	.28	.60	.42	.93	.16
17	-------	-------	1.04	.48	.15	.38	.69	.55	1.04	.22
18	-------	.17	.83	.42	.29	.25	1.04	.28	.82	.25
19	0.12	-------	.81	.35	.44	-------	.56	.27	.97	.23
20	.11	.19	.80	-------	.26	-------	.88	.27	.89	.24
21	.13	.14	.85	.34	.37	1.19	1.15	.27	.62	.20
22	.13	.17	.79	.31	.32	.86	.72	.39	.66	.17
23	.14	.19	.87	.32	.36	.72	.88	4.35	.69	.14
24	.14	.21	.84	.38	.32	1.21	.60	2.49	.59	.19
25	.13	.25	1.02	.33	.25	1.05	.76	1.52	.49	.19
26	.19	.36	.93	.40	.23	.77	.67	1.52	.61	.19
27	.18	.35	1.02	.34	.20	.75	.48	1.82	.48	.19
28	.15	.36	1.02	.33	.15	.66	.45	1.76	.43	.19
29	-------	.61	.88	.30	.17	.52	.56	.95	.48	.19
30	-------	.44	.80	.33	.11	-------	.49	.96	.39	.19
31	-------	.41	-------	.25	-------	.41	.62	-------	.40	-------

TABLE 10.—*Suspended matter in water samples collected from Colorado River at Topock, Ariz., during the period February 19, 1926, to September 30, 1928*—Continued

Day	Dec., 1926	Jan., 1927	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	0.32	0.19	0.10	0.83	0.47	0.83	1.02	1.24	0.56	1.61
2	--------	.17	.12	.76	.45	.88	1.13	.91	.91	1.16
3	.19	.13	.11	.68	.43	.94	1.11	1.94	1.04	1.00
4	.20	.11	.09	.81	.46	.89	1.06	1.61	1.92	2.59
5	.21	.13	.10	.81	.55	1.00	1.56	1.68	1.33	2.13
6	--------	.10	.09	.64	.59	1.16	1.10	1.64	2.11	2.70
7	.22	.11	.09	.59	.62	.89	.92	1.56	1.87	2.21
8	.12	--------	.10	.61	.72	.88	.72	--------	1.91	1.80
9	.21	.16	.12	.57	.76	.91	.72	.99	1.85	1.27
10	.23	.15	.10	.66	.77	.96	.80	.83	1.58	1.58
11	.23	.15	.09	.61	.79	.93	.87	1.10	2.05	1.92
12	.11	.16	.10	.66	.89	.88	.94	1.04	1.28	1.37
13	.28	.13	.09	.57	.94	.77	.88	1.67	1.82	--------
14	.24	.13	.11	.63	.93	.94	.71	1.45	1.59	--------
15	.31	.11	.10	.67	1.00	1.04	.61	1.19	2.39	6.59
16	.37	.11	.19	.55	.88	1.37	.56	1.53	3.16	6.87
17	.27	.14	.14	.61	1.26	.89	.52	1.50	2.22	5.96
18	.27	.13	.35	.51	1.30	.90	.62	1.84	1.55	5.56
19	.32	.12	.90	.61	1.06	1.00	.79	1.70	1.84	5.41
20	.35	.12	.55	.59	1.19	.97	.80	1.00	2.02	5.13
21	.33	.12	.48	.54	1.26	.95	.86	1.19	1.56	5.37
22	.17	.15	.53	.42	.99	.91	.88	1.17	1.59	3.29
23	.26	.17	.39	.43	.91	.83	.82	.96	1.17	3.91
24	--------	.16	.44	.43	.91	.60	.73	.35	1.07	4.24
25	.30	.16	1.79	.46	.70	.61	.75	.26	1.07	3.29
26	.30	.15	1.87	.46	.73	.61	.69	1.13	.95	2.95
27	.28	.14	1.25	.43	.78	.51	.75	.83	.71	2.78
28	.30	.15	1.05	.44	.82	.48	.74	.80	1.07	2.61
29	--------	.13	--------	.39	1.01	.64	.71	.54	.77	2.33
30	--------	.14	--------	.39	1.09	.80	.84	.61	1.08	2.18
31	.22	.13	--------	.32	--------	.76	--------	.57	1.13	--------

Day	Oct., 1927	Nov.	Dec.	Jan., 1928	Feb.	Mar.	Apr.	May	June [a]	July [a]	Aug. [a]	Sept. [a]
1	0.72	0.80	0.54	0.46	0.51	0.33	0.74	0.94	0.82	0.86	1.04	0.60
2	.79	.86	.69	.41	.50	.59	1.07	1.11	.72	.77	1.29	.59
3	.72	2.26	.58	.48	.43	.53	.88	.85	.55	.64	.86	.38
4	.74	.90	.64	.53	.55	.47	1.03	.94	.52	.78	.71	.55
5	.61	.83	.59	.47	.55	.36	1.18	1.00	.40	.64	.75	1.00
6	.45	1.21	.82	.75	.39	.36	1.12	1.05	.47	.73	.71	1.78
7	.57	.86	.61	.73	.66	.41	1.22	1.12	.44	.69	.66	1.79
8	.42	.82	.88	.63	.54	.46	1.29	1.17	.45	.74	.51	2.04
9	.50	1.21	.95	.37	--------	.40	1.27	1.20	.52	.66	1.05	1.16
10	.46	1.44	.73	.55	.46	.45	1.07	1.30	1.10	.78	.63	1.89
11	1.24	1.05	.75	.50	1.23	.55	1.08	1.18	1.08	.69	.90	1.12
12	.98	1.21	.70	.48	.87	.51	.87	1.38	1.17	.56	.83	.91
13	1.08	1.61	--------	.64	.82	.89	1.00	.92	1.83	.64	.77	.93
14	.82	1.50	--------	.43	.63	.56	.85	.98	1.43	.63	1.34	1.07
15	.80	1.06	--------	.52	.66	.88	.76	.90	1.37	.43	.80	.94
16	.77	.79	--------	.45	.49	.59	.64	.95	1.46	.46	.60	.84
17	.76	.80	--------	.52	.45	.72	.64	.90	1.34	.40	.53	.75
18	.89	.93	--------	.41	.40	.70	.62	.90	1.29	.53	.52	.70
19	.68	1.09	--------	.57	.66	.64	.55	1.00	1.30	.57	.54	.61
20	.80	.76	--------	.59	.74	.64	.63	1.23	1.17	.47	.66	.45
21	.63	1.04	.48	.41	.68	.60	.69	1.37	1.27	.55	.65	.48
22	.62	.94	.50	.58	.57	.70	.60	1.43	1.02	.40	.50	.43
23	.69	.94	.80	.53	.55	.69	.64	1.67	.88	.88	.81	.37
24	.65	.90	.64	.43	.53	.59	.54	1.53	1.09	.56	.57	.34
25	.82	.79	.60	.68	.39	.63	.58	1.32	1.03	.66	.85	.34
26	.71	.76	.50	.34	.73	.62	.51	1.91	.88	.56	.89	.33
27	.73	.86	.67	.47	.48	.58	.76	1.31	.78	.66	.86	.46
28	.80	.67	.59	.45	.52	.60	.73	1.20	.88	.90	.55	.49
29	.73	.60	.66	.46	.51	.63	.71	1.20	1.29	.70	.41	.49
30	.56	.66	.51	.42	--------	.70	.56	1.11	.83	1.02	.39	.30
31	.70	--------	.59	.46	--------	.92	--------	1.03	--------	1.29	1.52	--------

[a] Determinations by S. K. Love.

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TABLE 11.—*Suspended matter in water samples collected from Colorado River at Yuma, Ariz., during the years ending September 30, 1927, and September 30, 1928*

[Determinations by C. S. Howard. Per cent by weight]

Day	Oct., 1926	Nov.	Dec.	Jan., 1927	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	2.17	0.43	0.16	0.23	0.17	1.33	0.28	0.55	0.16	0.41	0.27	0.46
2	6.47	.35	.20	.23	.16	.98	.27	.58	.22	.51	.27	.75
3	3.02	.30	.20	.23	.22	1.03	.28	.70	.18	.50	.27	1.06
4	1.97	.25	.22	.21	.14	.81	.42	.69	.23	.70	.31	.70
5	2.25	.23	.22	.17	.16	.62	.44	.65	.39	1.08	.41	.63
6	1.92	.21	.22	.23	.12	.63	.43	.63	.45	.85	.51	.72
7	3.39	.22	.25	.14	.13	.69	.55	.63	.40	.94	1.11	1.71
8	4.88	.20	.20	.17	.13	.82	.77	.69	.52	.78	.85	1.47
9	4.50	.20	.25	.15	.12	-------	.59	-------	.35	.57	1.20	1.92
10	4.03	.20	1.11	.13	.18	.85	.78	.43	.27	.55	1.22	1.72
11	2.89	.21	.86	.11	.12	.66	.97	.52	.21	.53	1.33	1.49
12	2.10	.21	-------	.11	.11	.80	.87	.43	.50	.30	1.25	1.22
13	1.91	.18	.42	.14	.14	.54	.91	.40	.56	1.01	1.14	1.34
14	2,63	.20	.33	.13	.13	.68	.98	.53	.43	.36	.82	1.11
15	1.89	.18	.32	.13	.14	.65	.93	.39	.42	.65	.82	4.58
16	1.45	.19	.42	.16	.14	.58	.93	.40	.43	.85	-------	3.22
17	1.09	.19	.40	.15	1.76	.68	.92	-------	.34	.82	1.12	4.66
18	1.01	.21	.36	.12	1.80	.63	.86	.55	.24	.92	1.59	3.66
19	.93	.14	.41	.15	1.54	.57	.89	.64	.25	.67	1.89	2.60
20	.89	.15	.37	.20	1.40	.42	.59	.64	.31	.60	-------	2.54
21	.90	.17	.35	.18	1.07	.43	.61	.54	.35	-------	1.24	-------
22	.82	.19	.32	.16	1.02	.10	.54	.54	.41	.99	1.26	2.55
23	-------	.17	.41	.14	.73	.05	.49	.38	.38	.71	1.61	3.00
24	-------	.16	.38	.13	.71	.24	.50	34	.46	.58	1.16	3.15
25	.51	.20	.28	.18	.60	.28	.48	.37	.37	.51	.86	2.42
26	.53	.15	.29	.17	.53	.23	.40	.33	.41	.38	.89	3.44
27	.49	.16	.26	.16	.57	.37	-------	.32	.34	.38	.51	2.27
28	.53	.21	.29	.15	.95	.28	.40	.31	.29	.31	.68	1.79
29	.42	.17	.33	.18	-------	.30	.42	.24	.34	.29	.98	1.96
30	.41	.18	.33	.15	-------	.34	.52	-------	.38	.29	-------	2.13
31	.48	-------	.24	.15	-------	.36	-------	.19	-------	.27	.45	-------

Day	Oct., 1927	Nov.	Dec.	Jan., 1928	Feb.	Mar.	Apr.	May	June [a]	July [a]	Aug. [a]	Sept. [a]
1	1.87	-------	0.31	0.14	0.16	0.22	0.56	0.38	0.56	0.35	0.49	0.20
2	1.32	-------	.28	.14	.21	.29	.58	.32	.61	.33	.47	.37
3	.85	-------	.23	.15	.18	.20	.65	.47	.43	.46	.67	.37
4	.89	-------	.31	.16	.22	.22	.55	.60	.40	.46	.55	.34
5	.86	-------	.28	.23	.23	.28	.81	.65	.29	.41	.48	.19
6	1.04	-------	.21	.15	.17	.19	.87	.92	.28	.40	.35	.19
7	1.83	-------	.26	.13	-------	.16	.84	.84	.26	.34	.35	.13
8	1 35	-------	.32	.17	.35	.17	-------	.76	.46	.24	.27	.26
9	1.13	0.48	.28	.21	.44	.31	.75	.77	.17	.32	.36	.59
10	.78	.39	.26	.15	.41	.16	.85	.96	.46	.32	.31	.87
11	1.52	.45	.25	.25	.50	.21	.16	.83	.27	.38	.25	1.04
12	1.45	.52	.30	.22	.41	.45	.67	.62	.30	.30	.41	1.39
13	1.77	.76	.28	.29	.36	.35	.56	.82	.31	.18	.37	.71
14	2.12	.68	.26	.14	.34	.29	.60	.79	.35	.31	.48	1.17
15	2.62	.61	.29	.16	.30	.32	.52	.64	.74	.27	.44	.66
16	1.80	.97	.25	.23	.32	.40	.41	.62	.62	.26	.44	.63
17	1.70	.99	.26	-------	.27	.33	.44	.48	-------	.40	.72	.45
18	1.56	.48	.22	.16	.30	.29	.34	.57	.66	.38	.52	-------
19	1.26	.43	.22	.31	.66	.33	.32	.64	.54	.30	.36	.45
20	1.28	.38	.15	.25	.46	.42	.35	.54	.41	.18	.27	.51
21	.41	.44	.14	-------	.42	.39	.30	.87	.56	.25	.26	.35
22	.44	.47	.21	.19	.36	.37	.31	.51	.43	.24	.21	.43
23	.36	.40	.17	.22	.36	.32	.28	.54	.43	.20	.28	.41
24	.41	.41	.25	.23	.28	.33	.30	.58	.31	.43	.26	.28
25	.29	.45	.19	.19	.22	.40	.26	.46	.41	.43	.20	.24
26	.31	.38	.18	.29	.25	.50	.25	.85	.42	.43	.21	.35
27	.31	.29	-------	.24	.31	.37	.32	.80	.69	.27	.22	.21
28	.30	.31	-------	.21	-------	.33	.28	.90	.45	.26	.21	.13
29	.31	.31	-------	.17	.20	.37	.29	.53	.36	.22	.30	.25
30	.35	.29	.13	.15	-------	.45	.39	.64	.22	.54	.48	.11
31	-------	-------	-------	.16	-------	.34	-------	.79	-------	.38	.34	-------

[a] Determinations by S. K. Love.