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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

HYDROLOGIC CHARACTERISTICS
OF
LAKE TARPON AREA, FLORIDA

Open-file report

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DIVISION OF WATER RESOURCES AND CONSERVATION

By

Robert L. Taylor

U. S. GEOLOGICAL SURVEY
OCALA, FLORIDA
JUNE 1953
(Reprinted 1960)

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OF
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by

Robert L. Taylor
U. S. Geological Survey
Ocala, Florida

June 1953
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Prepared by the

Geological Survey
United States Department of the Interior

in cooperation with the

Trustees of the Internal Improvement Fund
State of Florida

and the

Board of County Commissioners of Pinellas County

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HYDROLOGIC CHARACTERISTICS
of
LAKE TARPON AREA, FLORIDA

INTRODUCTION

The object of this report is to present data obtained by the Water Resources Division of the U. S. Geological Survey in its investigation of the Lake Tarpon area. Some interpretation of the basic data has been included. Additional information, with reference to the ground-water aspects, is found in a report in preparation on the ground-water resources of Pinellas County. ^{1/}

Lake Tarpon, formerly called Lake Butler, is located one and three-quarter miles east of the City of Tarpon Springs, in Pinellas County, Florida (fig. 1). It has no surface outlet; however it has a well defined tributary, Brooker Creek. For many years the lake has been subject to unusual phenomena of rather rapid draining at intervals followed by an increase in the salinity of the water in the lake, making it undependable as a fresh water supply (fig. 2). Both phenomena were believed to be due to one or more underground connections with the Gulf of Mexico. One location suspected of being an outlet was Spring Bayou at Tarpon Springs.

The investigation which preceded this report is being continued. Its purpose was to collect data concerning the surface water aspects of the situation which may be useful to those who seek to (1) eliminate salt-water contamination of the lake, and (2) prevent excessive loss in storage.

The data contained in this report were collected between April 1945 and December 1952. The collection of data and the preparation of this report were made possible by the financial cooperation of Pinellas County and the Trustees of the Florida Internal Improvement Fund. The U. S. Navy gave valuable technical assistance which was not available elsewhere.

^{1/} Heath, R. C., and Smith, P. C., Ground-water resources of Pinellas County, Fla.: U. S. Geol. Survey report, in preparation.

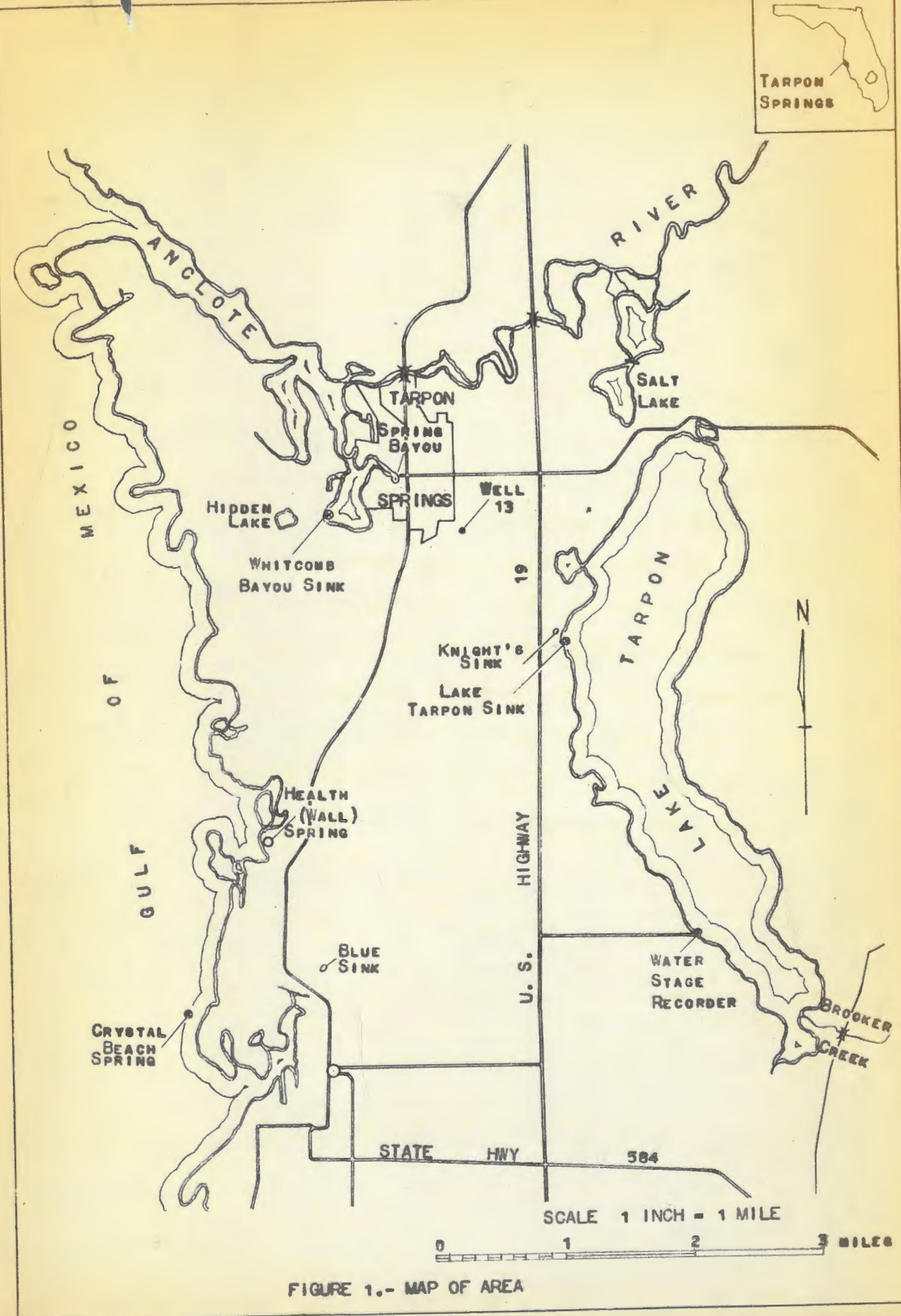


FIGURE 1.- MAP OF AREA

1945

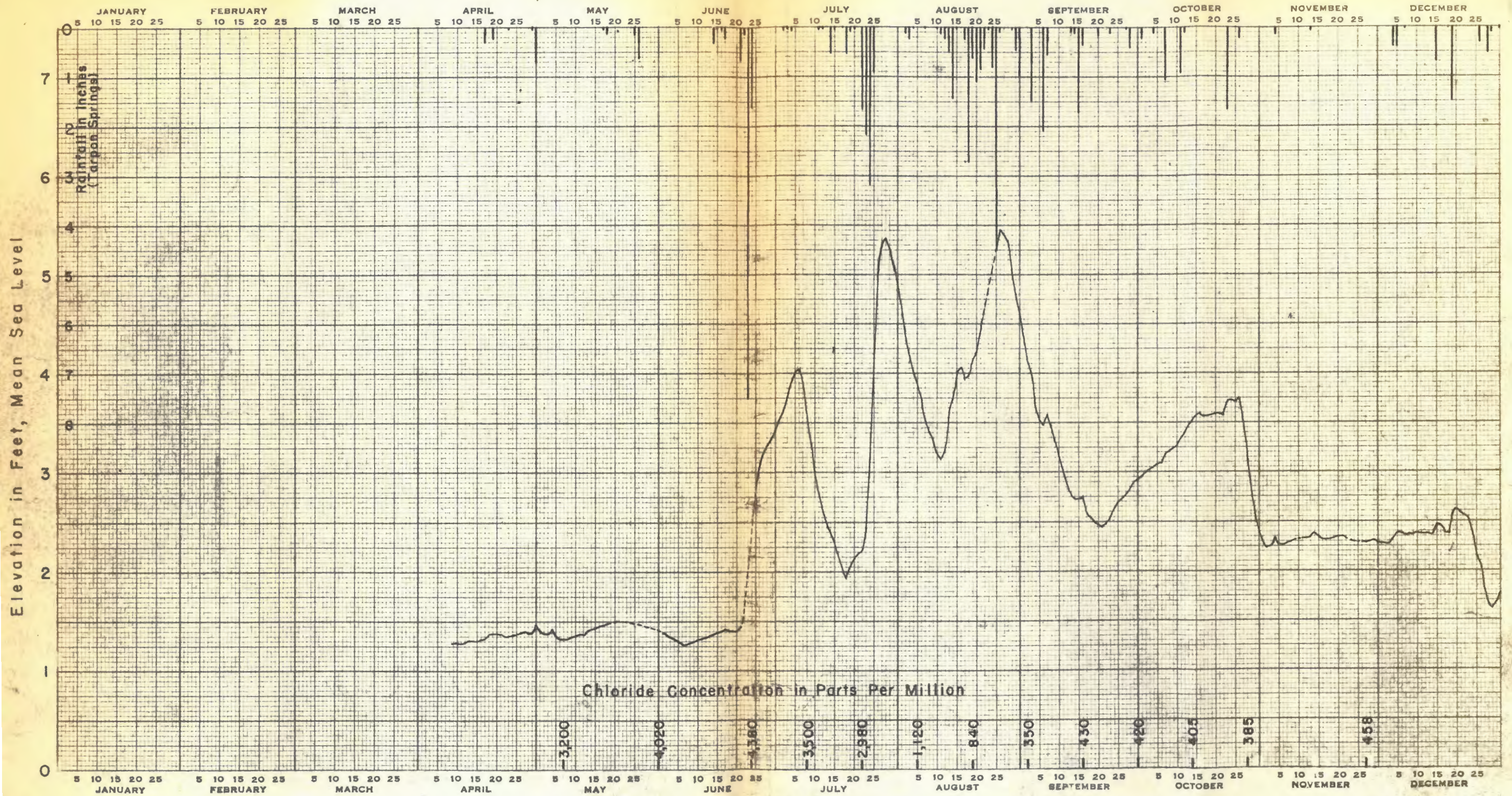


FIGURE 2.- STAGE, CHLORIDE CONCENTRATION AND RAINFALL
LAKE TARPON, PINELLAS COUNTY, FLORIDA

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1946

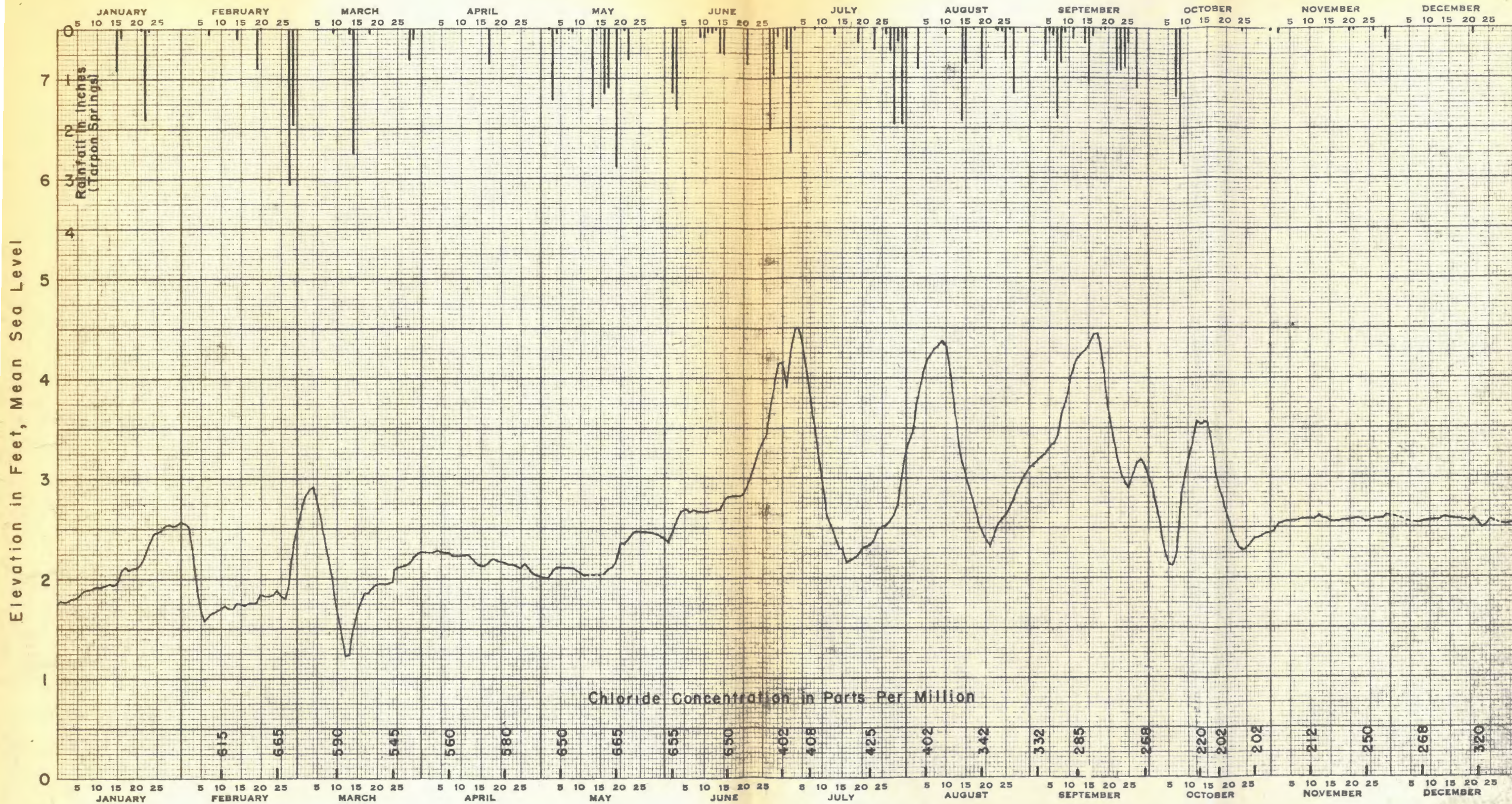


FIGURE 2.— STAGE, CHLORIDE CONCENTRATION AND RAINFALL
LAKE TARPON, PINELLAS COUNTY, FLORIDA.

1947

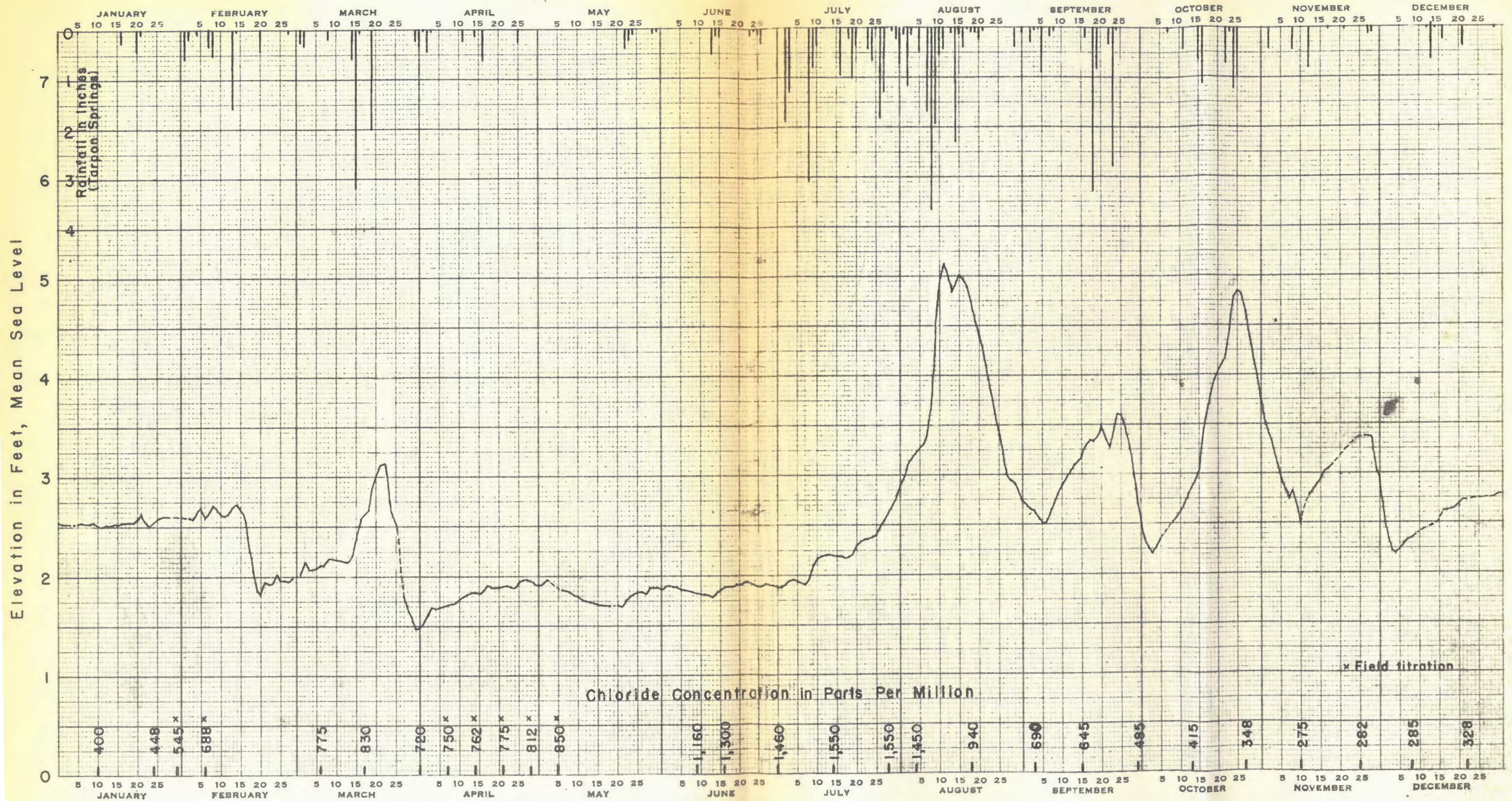


FIGURE 2.— STAGE, CHLORIDE CONCENTRATION AND RAINFALL
LAKE TARPON, PINELLAS COUNTY, FLORIDA.

1948

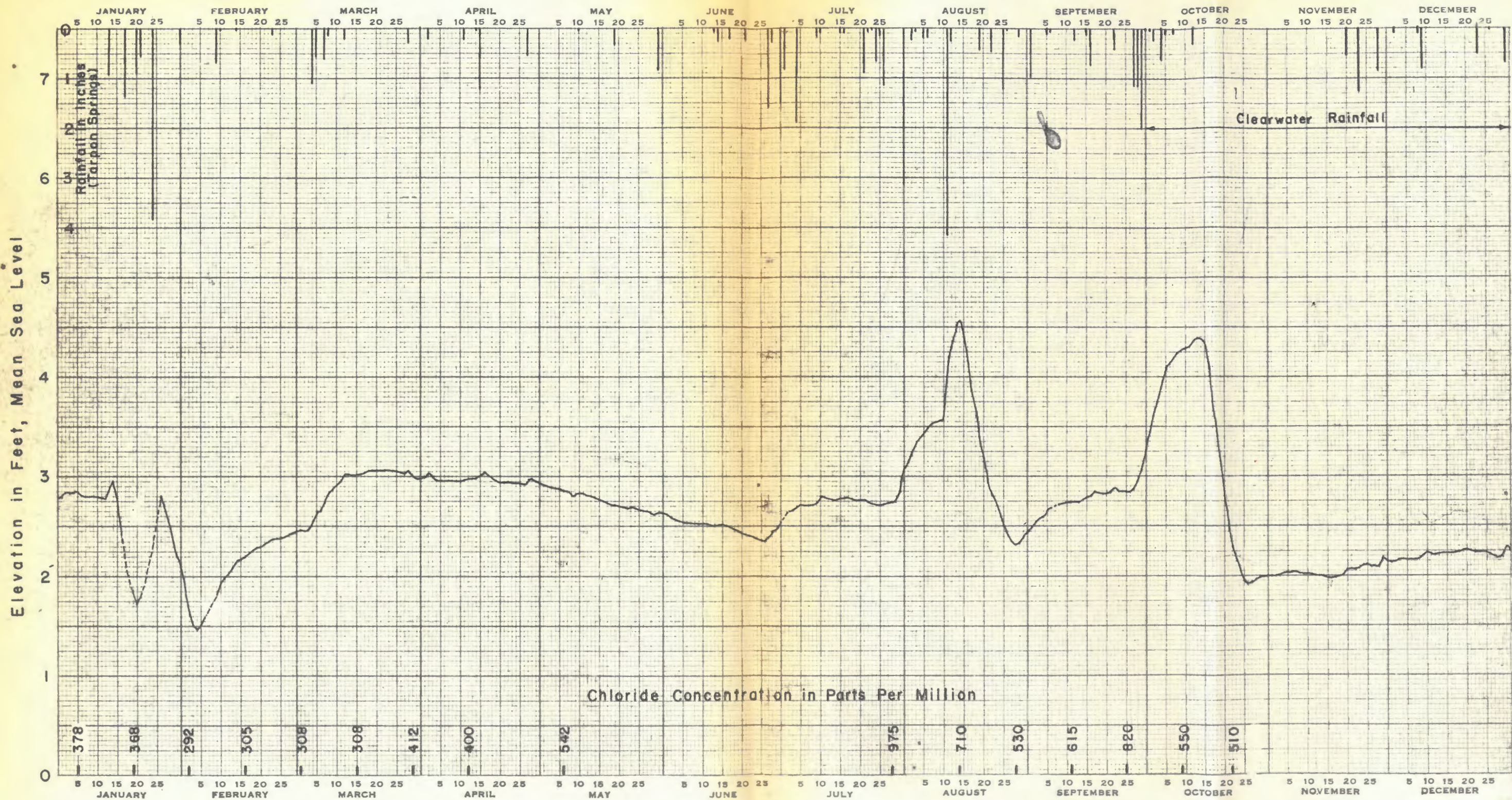


FIGURE 2.— STAGE, CHLORIDE CONCENTRATION AND RAINFALL
LAKE TARPON, PINELLAS COUNTY, FLORIDA.

1949

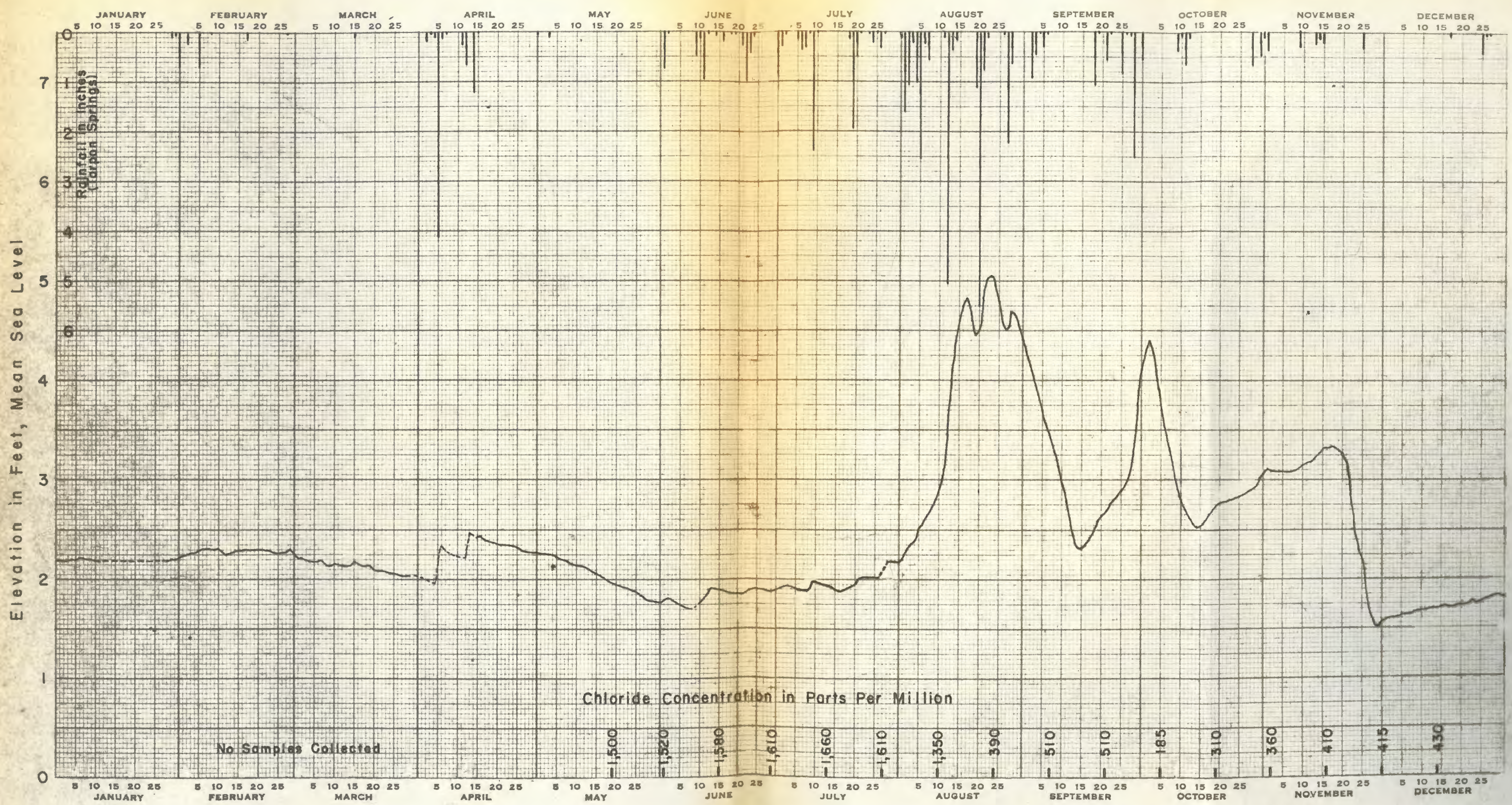


FIGURE 2.— STAGE, CHLORIDE CONCENTRATION AND RAINFALL
LAKE TARPON, PINELLAS COUNTY, FLORIDA.

1950

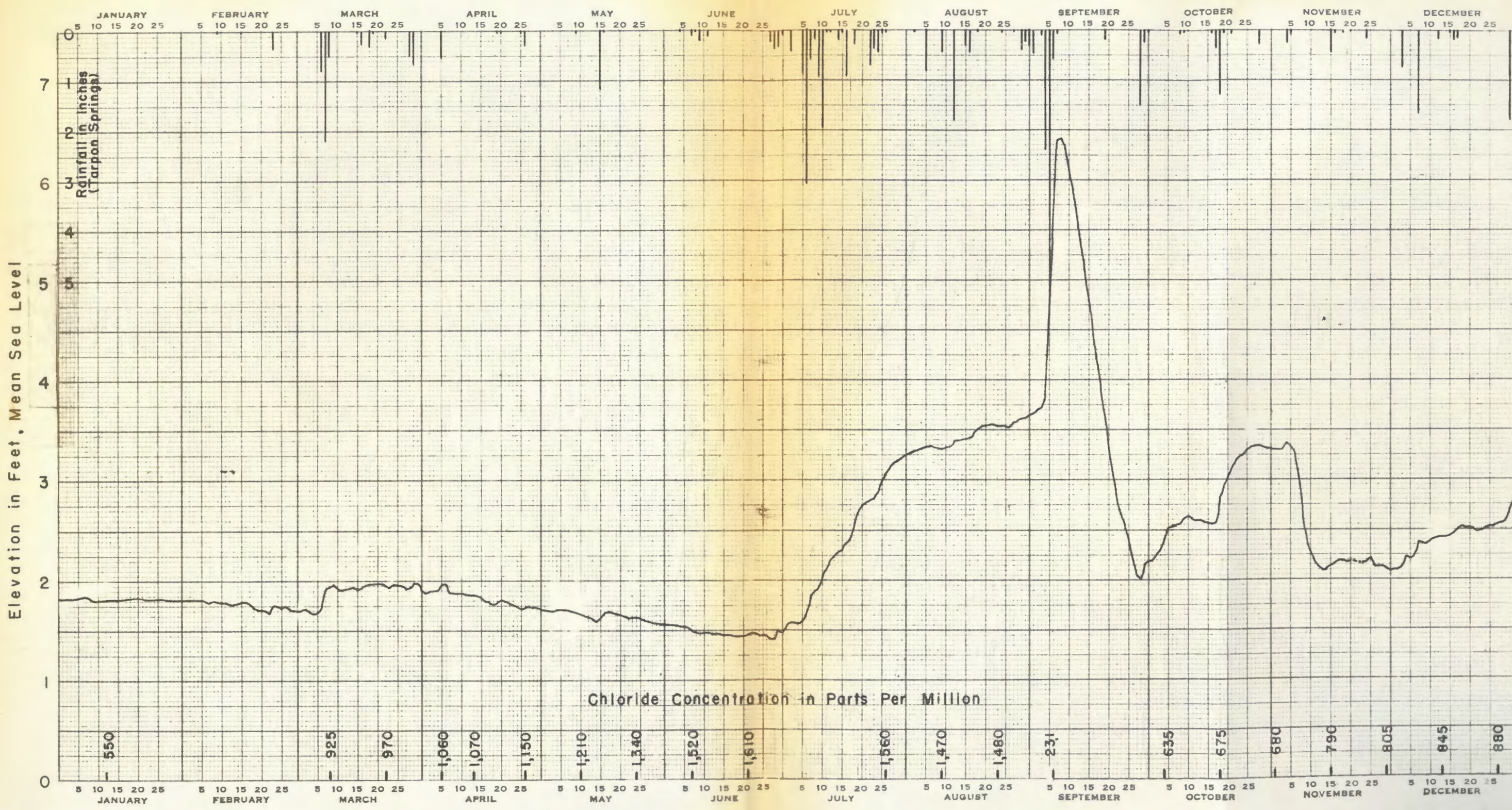


FIGURE 2.— STAGE, CHLORIDE CONCENTRATION AND RAINFALL
LAKE TARPON, PINELLAS COUNTY, FLORIDA

1951

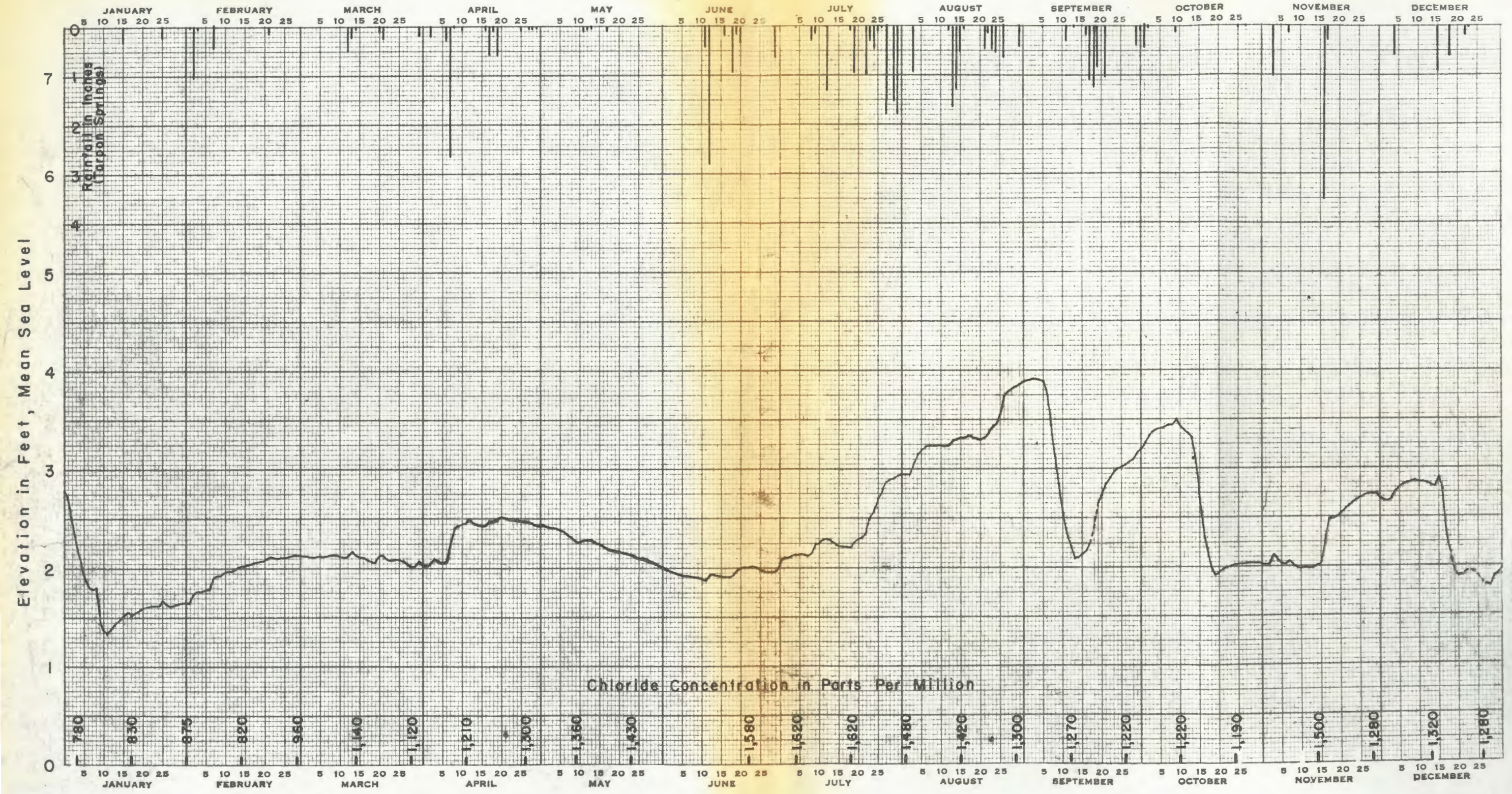


FIGURE 2.—STAGE, CHLORIDE CONCENTRATION AND RAINFALL
LAKE TARPON, PINELLAS COUNTY, FLORIDA

1952

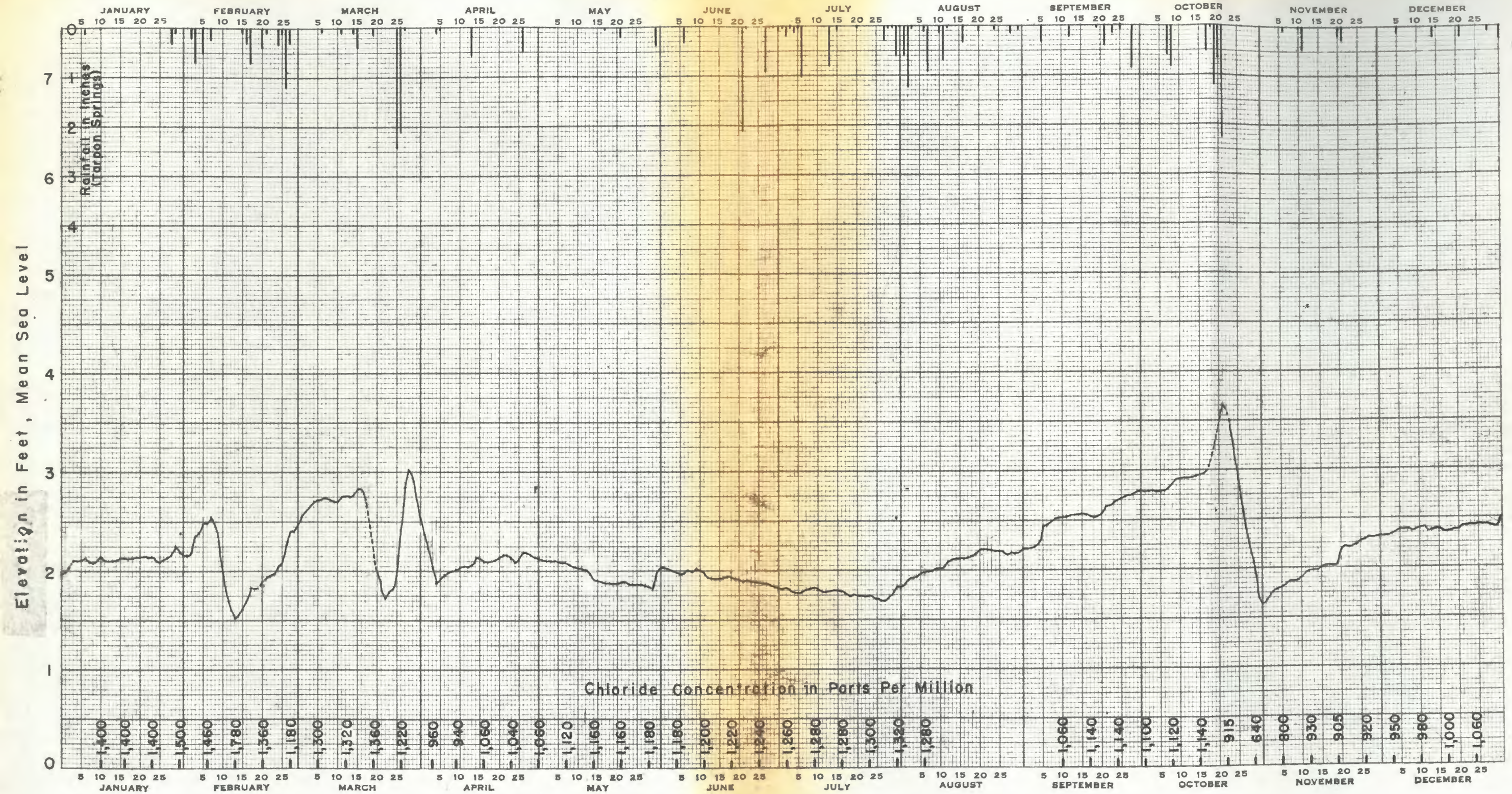


FIGURE 2.- STAGE, CHLORIDE CONCENTRATION AND RAINFALL
LAKE TARPON, PINELLAS COUNTY, FLORIDA.

DATA COLLECTED

Data collected include (1) continuous stage record of Lake Tarpon, (2) continuous stage record of Spring Bayou, (3) periodic salinity determinations of lake water, (4) results of special studies to determine distribution of salinity throughout the lake, (5) results of studies made to determine the physical and hydrologic characteristics of lakes, sinks, and springs in the area, (6) results of studies of hydrologic conditions existing during periodic lake recessions, and (7) a record of the discharge of Brooker Creek.

PHYSICAL FEATURES

Lake Tarpon

This lake lies 1-3/4 miles east of the city of Tarpon Springs and 1-1/4 miles southeast of the Anclote River (fig. 1). It is approximately 5 miles long in a north-south direction, 3/4 to 1 mile in width, and 4.0 square miles in area. Depths at usual stages vary between 11 and 13 feet, except in the sink discussed below. The bottom is composed of mud.

Land elevations around most of the lake are 10 to 20 feet above sea level and are as high as 50 feet in the area along the northern half of the west shore. There are numerous low swampy areas along the shoreline into which the lake spreads at the higher stages. The drainage area of the lake, including all tributaries, is approximately 60 square miles.

The chief surface-water tributary to the lake is Brooker Creek which enters the lake at the south end and has a drainage area of approximately 42 square miles. In August 1950 a gaging station was established on the creek 2 miles above the mouth, to measure the runoff from 30 square miles of this basin. Discharge rates for the period of record, August 1950 to December 1952, range from zero to 1,060 cubic feet per second (685 mgd). Although the drainage area of Brooker Creek above the gaging station is only one-half of the area draining into the lake, its runoff characteristics are considered to represent those of the larger area.

The lake is unusual in that although it has several tributaries, it has no surface outlet. As well as losses by evapo-transpiration, water apparently leaves the lake by way of a sinkhole near the west shore. The sinkhole, herein referred to as Lake Tarpon Sink, or lake sink,

is the only known means whereby water is discharged. In May 1947 an echo-sounding, run about 500 feet off shore, was made completely around the lake by W. O. Smith, assisted by the author. There are several spots at which weak rock formations exist which might be potential sinks. It is not known, however, whether other sinks are present, since no detailed echo sounding or salinity surveys were made.

Lake Tarpon Sink

The sink in Lake Tarpon is 2 miles south of the north end of the lake and about 60 feet from the west shore. It is an irregular hole in the lake bottom about 90 feet in diameter at a depth of 50 feet and probably only a few feet across at the maximum depth of 115 feet below mean sea level (fig. 3); however, it is believed that the west side, which soundings indicate to be nearly vertical, is actually in the shape of an overhanging cliff and the exact shape of the bottom has not been determined. The north, east, and south sides have a slope of about 1 to 1. This sink is apparently the main adit to an underground channel, or channels, of undetermined size and shape. Leadline soundings revealed that the bottom at the lower elevations is quite uneven with abrupt changes in elevation of 5 to 10 feet. This condition, most pronounced on the deeper west side, indicates a formation through which water probably could pass.

Underwater photographs were taken in May 1947 by technical personnel of the Geological Survey and the Bureau of Ordnance, U. S. Navy. The photographs revealed that a large portion of the bottom of the sink is a honeycombed, rock formation which allows easy flow of ground water through the interstices and passages in the rock.

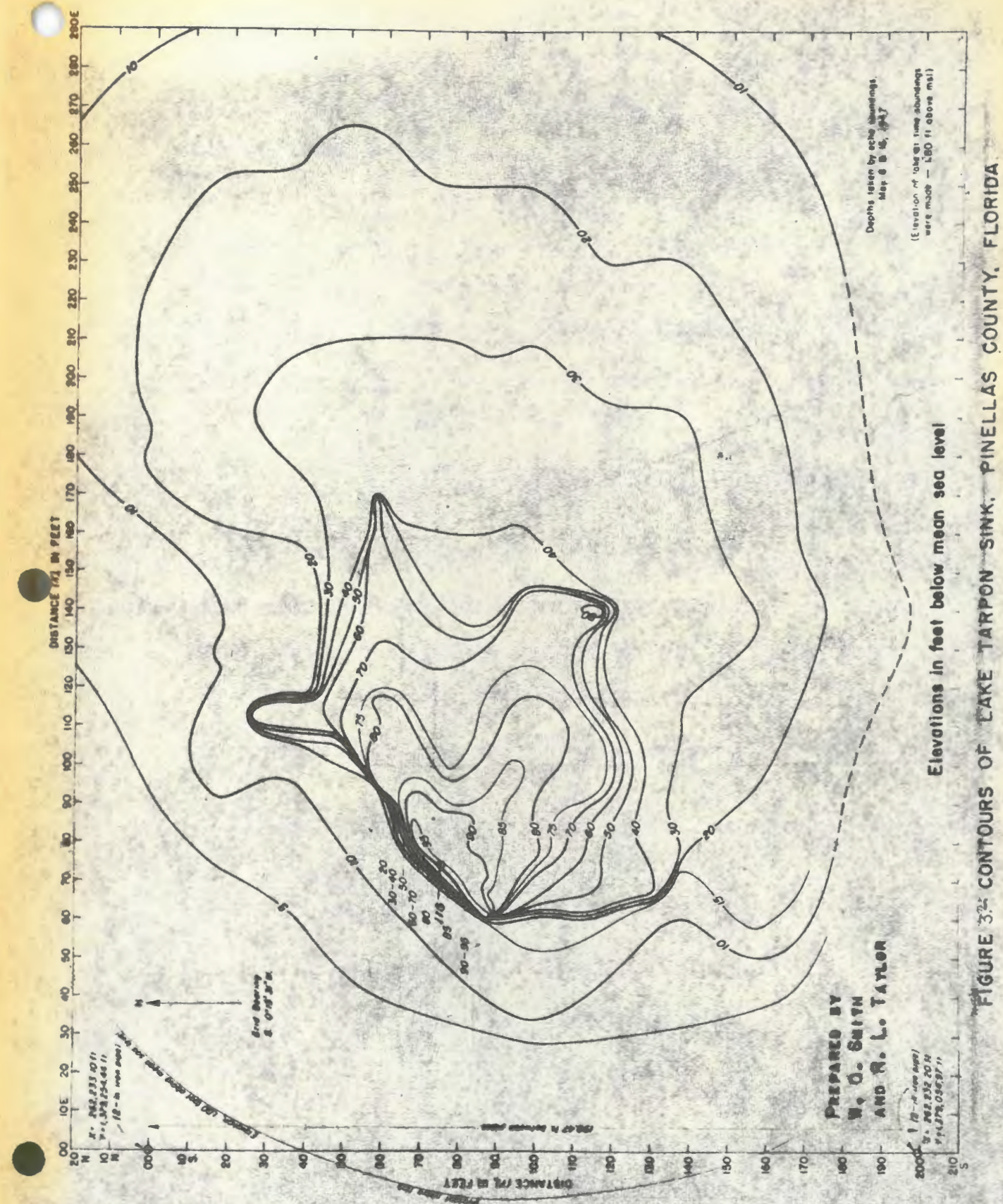


FIGURE 3. CONTOURS OF LAKE TARPON SINK, PINELLAS COUNTY, FLORIDA.

Knight's Sink

Knight's Sink is located just west of Lake Tarpon and about 200 feet northwest of Lake Tarpon Sink. It is approximately 100 feet in diameter with steep banks on the north and west sides. The average depth of the water in this sink is about 60 feet with a maximum depth of 75 feet in a depression on the northwest side, and a depth of 63 feet in a slight depression on the south side (fig. 4). All soundings indicated that the bottom is muddy.

Dye studies showed that there are connections between Knight's Sink, Lake Tarpon Sink, and the underground channels. These studies also revealed that the Knight's Sink adit is at the depression on the northwest side of the sink. This adit is in the wall rather than in the bottom.

Spring Bayou

Spring Bayou is located 2 miles northwest of Lake Tarpon, 3 miles from the Gulf of Mexico, and is connected to the Gulf through the tidal reaches of the Anclote River. It is approximately one-quarter mile long, 250 feet wide, and lies in the residential area of the city of Tarpon Springs. The terrain immediately around the bayou ranges in height from 2 feet above ordinary high tide on the east shore to 10 feet above on the south and west shores. Ordinary high tide is about 2 feet above mean sea level.

Spring Bayou derived its name from a "spring" located at the head of the bayou. This spring is apparently the primary outlet from the underground channel whose entrance is in Lake Tarpon Sink. The Spring Bayou sink is located 100 feet from the south shore of Spring Bayou, is about 30 feet by 100 feet in size and 125 feet deep at the deepest point sounded (fig. 5).

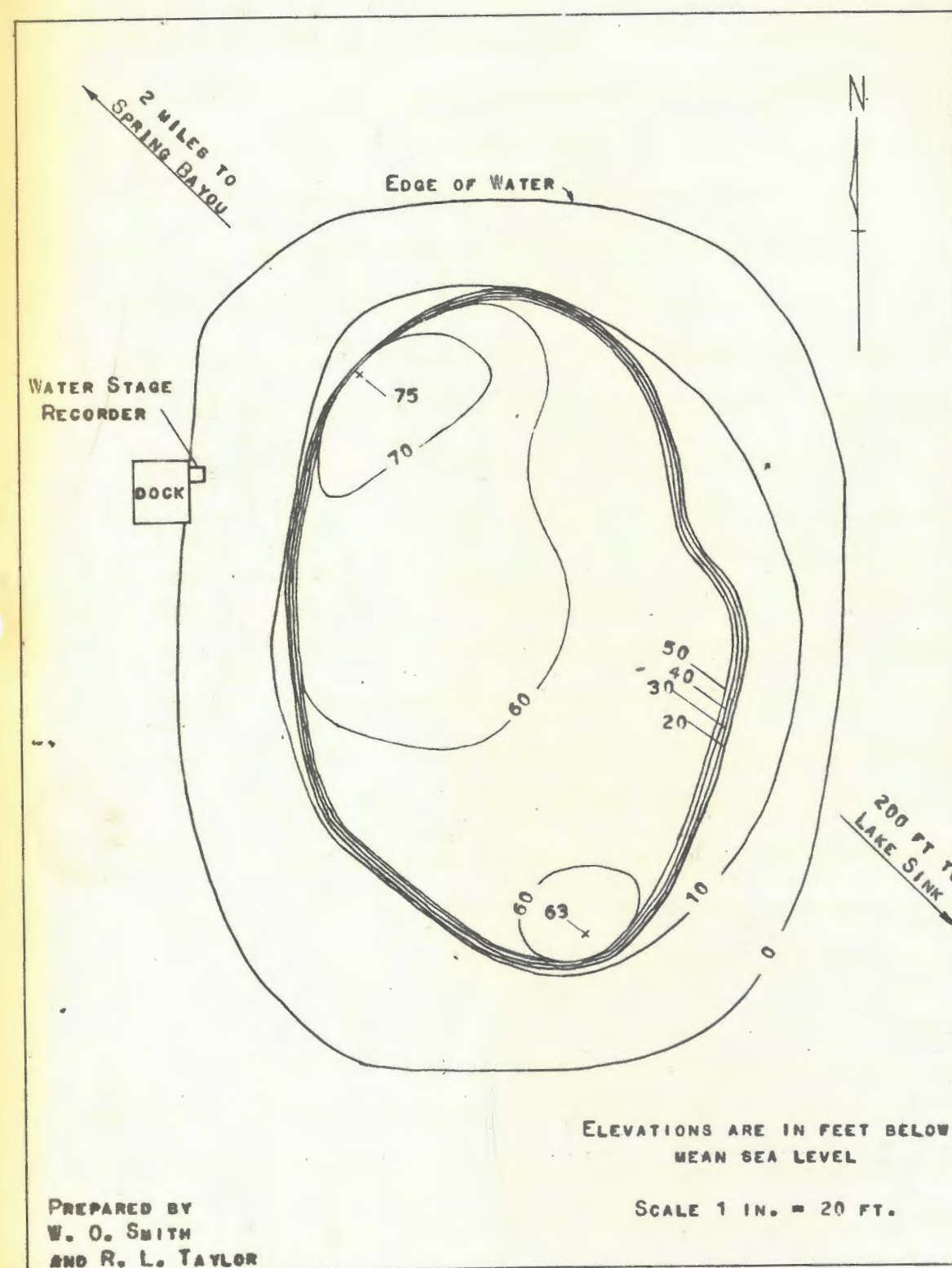


FIGURE 4.- CONTOURS OF KNIGHT'S SINK

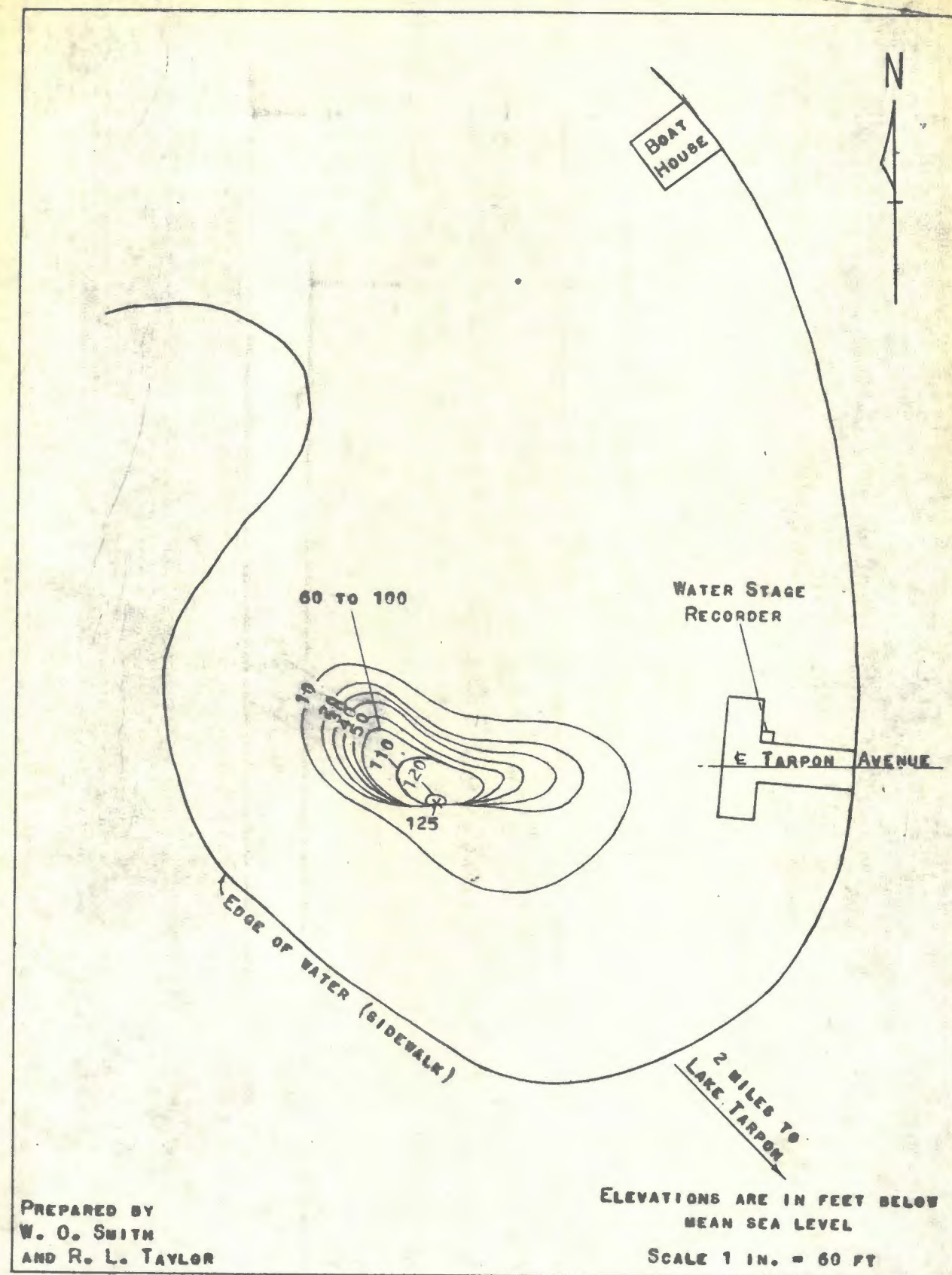


FIGURE 5 .- CONTOURS OF SPRING BAYOU

Water movement through this opening is of three distinct types, (1) large flow from the opening which occurs when the lake recedes rapidly in its characteristic manner owing to large discharge into the lake sink, (2) large flow into the openings, immediately following the end of a lake recession, and (3) small flow which occurs when the lake stage is relatively stable. In the last case the flow is materially affected by tides and may go either way in varying amounts, depending on head conditions. In subsequent reference to these conditions the three types will be referred to as (1) flushing flow, (2) reverse flow, and (3) vacillating flow.

During periods of flushing flow, water emerging from the crevices beneath the surface of the bayou causes either a boil or a slick to be noticeable on the surface over the spring opening. The flow is of sufficient magnitude to run against the tide in the reach below the spring.

Periods of reverse flow obtain for probably less than two days and are confined to times immediately following lake recessions.

During periods of vacillating flow either a boil or a slick is usually present over the sink during low tides but ordinarily is not present during medium and high tides.

It is common knowledge among the old-time residents in the area that when the lake recedes rapidly the spring begins to boil noticeably. They also refer to a pungent, disagreeable odor which envelopes the area at the time flushing flow begins. Water emerging from the bayou spring for the first few hours after flushing flow begins is very clear and is largely ground water. This water has a strong odor of hydrogen sulfide and contains white flakes and curds. A further indication of the presence of a sulphurous condition is the discoloration of light paints on boats in the area.

Blue Sink

Blue Sink was included in the investigation because of its possible connection with the underground channels affecting Lake Tarpon. It lies $3\frac{1}{4}$ miles southwest of Lake Tarpon Sink, about the same distance due west of the south end of the lake, and 1 mile inland from the tidal waters of Clearwater Harbor. The sink at the water surface averages 50 feet in diameter with the greatest depth sounded being 111 feet. The water surface lies approximately 20 feet below the surrounding land surface.

Crystal Beach Spring

Crystal Beach Spring is located in Clearwater Harbor 800 feet offshore from Crystal Beach, approximately one mile west of Blue Sink, and $4\frac{1}{2}$ miles south of Tarpon Springs.

The spring opening is approximately 50 feet in diameter. Referred to mean tide level, the opening is about 21 feet deep and the rim is at a depth of 3 to 8 feet.

Health (Wall) Spring

Health Spring is located in the community of Wall Springs, 3 miles south of Tarpon Springs. This spring also was investigated to determine the extent to which it might affect the behavior of Lake Tarpon.

The spring is approximately 10 feet deep and enclosed by a low concrete wall about 30 feet in diameter. It flows into a concrete swimming pool which formerly emptied directly into tide water. The discharge from the swimming pool now flows into a recently constructed pool approximately one acre in area with an 18-inch outlet to tide water. A flap

gate, although not completely effective, minimizes salt water encroachment into the pool. The normal stage in the pool and spring is such that the tide can be sufficiently high to back salt water into the spring if not restrained.

Whitcomb Bayou Sink

The sink here designated as Whitcomb Bayou Sink is located in the city of Tarpon Springs and in the southwest end of Whitcomb Bayou, 200 feet off shore, and lies in about 5 feet of water. This is another potential source of salt water pollution for Lake Tarpon. The bottom, approximately fourteen feet below the bottom of the bayou, is roughly 3 feet in diameter. The opening at the top is 10 to 20 feet in diameter and the east side slopes somewhat more than the west side.

Hidden Lake Sink

Hidden Lake is approximately one-quarter mile west of the south end of Whitcomb Bayou. It is roughly 10 acres in area and 5 to 6 feet deep. There is a small ditch which connects the lake with a marshy area to the west.

There is a sink in the north end of this lake a short distance from the shore. This sink is roughly 50 feet wide, 150 feet long, and 80 feet deep.

Salt Lake

Salt Lake lies at the north end of Lake Tarpon and 0.2 mile from it. The south portion of this lake is effectively cut off from the north portion by a railroad fill. There are no observable culverts or other openings in this fill. The portion of the lake south of the railroad has an average depth of 9 feet and according to local residents there are no sinks in the lake. Overflow from the lake drains west along the south side of the railroad fill and eventually into the Anclote River.

SALINITY SAMPLES

The water samples collected during the investigation were analyzed for chloride content either by titration or by conductivity cell (salinity meter). The latter method was approximate only but was within the accuracy desired and enabled more determinations to be made than would otherwise have been possible. A Foerst sampler was used for sampling below the surface.

Lake Tarpon

The only known point of entry of salt into Lake Tarpon is Lake Tarpon Sink.

The chloride concentration of samples taken from the surface along the west side of the lake has ranged from 4,380 ppm on June 24, 1945, to 185 ppm on October 5, 1949, with the median being 940 ppm. The chloride concentration of sea water is roughly 20,000 ppm. Salinity surveys of May 7, 1945, and November 27, 1945, showed the salinity distribution to be fairly uniform throughout the lake area. Distribution in the vertical was uniform. Those samples collected at the lake bottom and which contained mud were found to have a slightly higher salinity.

The maximum observed rate of increase in chloride concentration occurred in 1945 at the beginning of the investigation when the salinity increased from 3,200 ppm on May 7 to 4,020 ppm on May 31, or at the average rate of 34 ppm per day. The maximum observed rate of decrease in chloride concentration during this investigation occurred in 1950 just prior to a lake recession when the concentration decreased from 1,480 ppm on Aug. 23 to 231 ppm on Sept. 6, or at the average rate of 89 ppm per day. Decrease in chloride concentration is largely the result of dilution by surface water inflow into the lake, the maximum decreases occurring

during large inflow from the principal tributary, Brooker Creek. Periods of rapid decrease usually occur just prior to or during lake recessions since large inflow invariably causes a large rise in stage which is usually followed by the characteristic recession in lake stage.

Lake Tarpon Sink

This sink, as has been previously stated, is probably the mode of entry of chloride contamination in the lake. This contamination is most pronounced at relatively low stages during conditions of vacillating flow. The chloride concentration in the sink during low tide in the bayou becomes that of the lake as the lake water discharges through the sink. As the tide rises it forces sea water through the aquifer into the sink (fig. 6) and hence into the lake. Figure 7 shows the distribution of chloride concentration in the sink during low tide and high tide on Oct. 11, 1946. The chloride concentration near the bottom of only 3,320 ppm is the result of dilution of incoming sea water by ground water in passing through the aquifer.

The chloride concentration remained high for approximately four hours on that day (fig. 6), after which a receding tide caused the salt water to flow out of the sink. It is interesting to note the time lag between tide at the bayou and its effect at the lake.

As the lake rises from a low stage the increased head causes a larger flow from the lake on low tide and lessens the reverse flow into the lake on high tide. The salt water encroachment is thereby lessened.

A typical chloride condition in the lake sink during a period of flushing flow was that of Sept. 20, 1946 (fig. 8). No sea water infiltration is possible during these periods. Table 1 shows an analysis of a sample taken Sept. 18, 1946, during the same period of flushing flow.

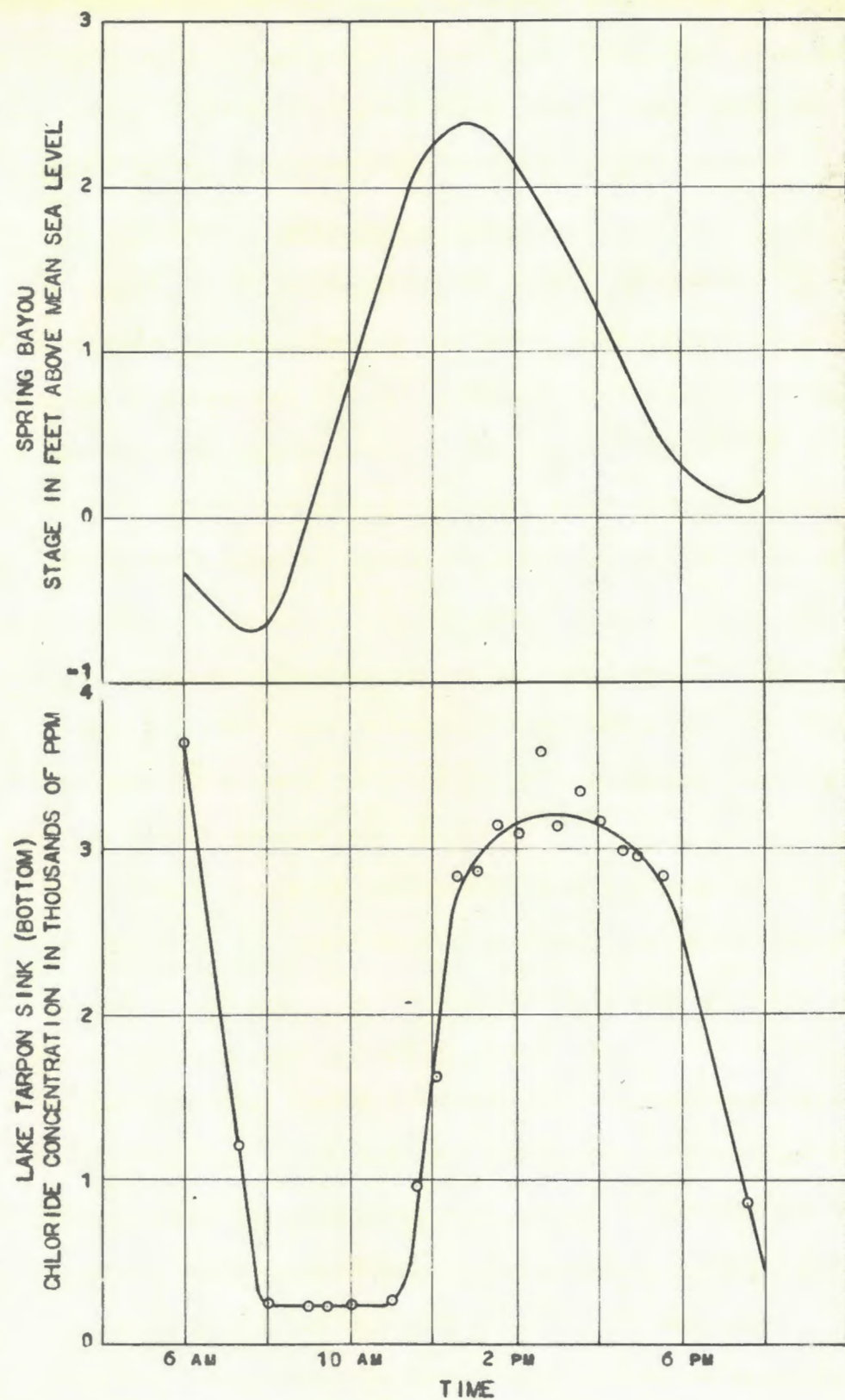


FIGURE 6.- RELATION OF CHLORIDE CONCENTRATION
IN BOTTOM OF LAKE TARPON SINK AND
STAGE OF SPRING BAYOU
OCTOBER 11, 1946

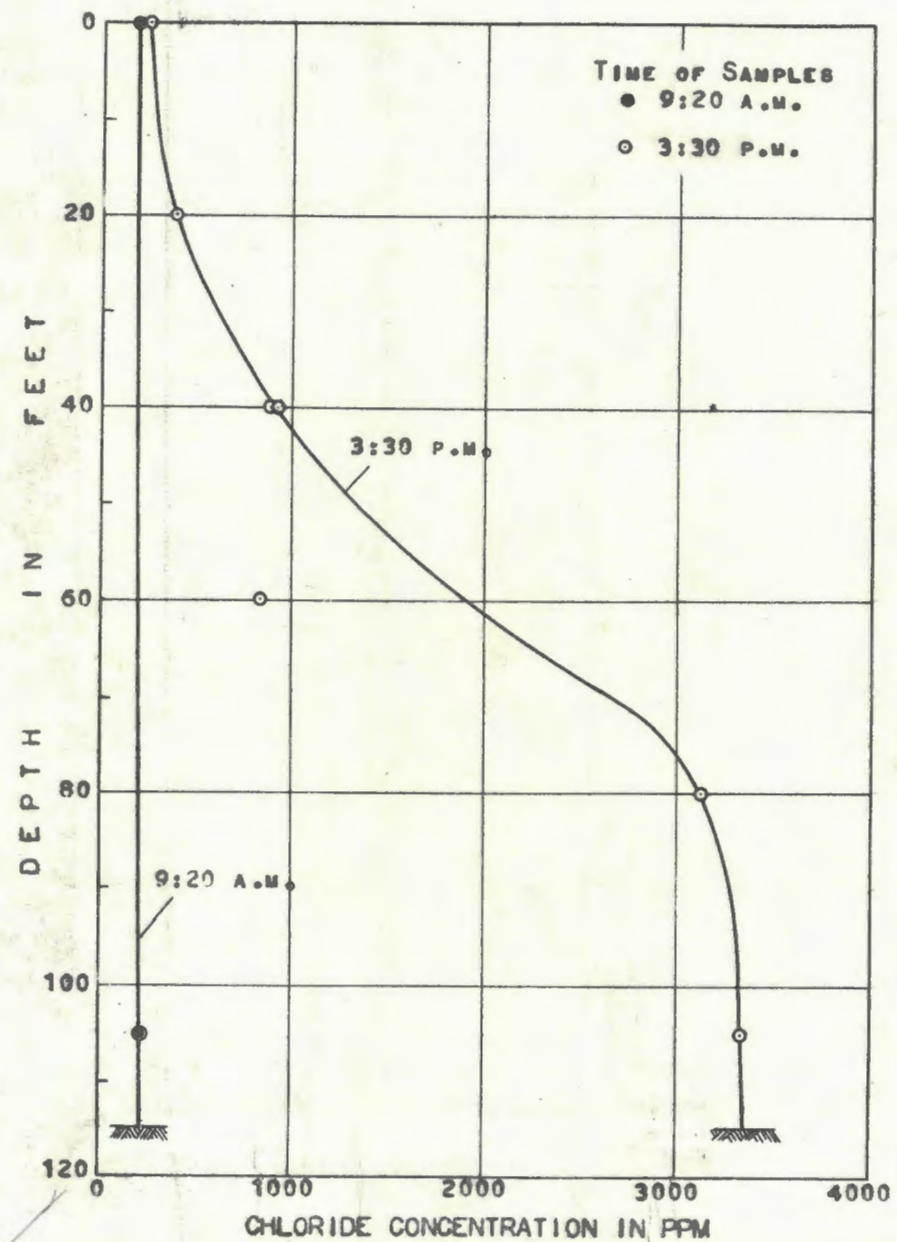


FIGURE 7.- CHLORIDE CONCENTRATION
IN LAKE TARPON SINK
OCTOBER 11, 1946

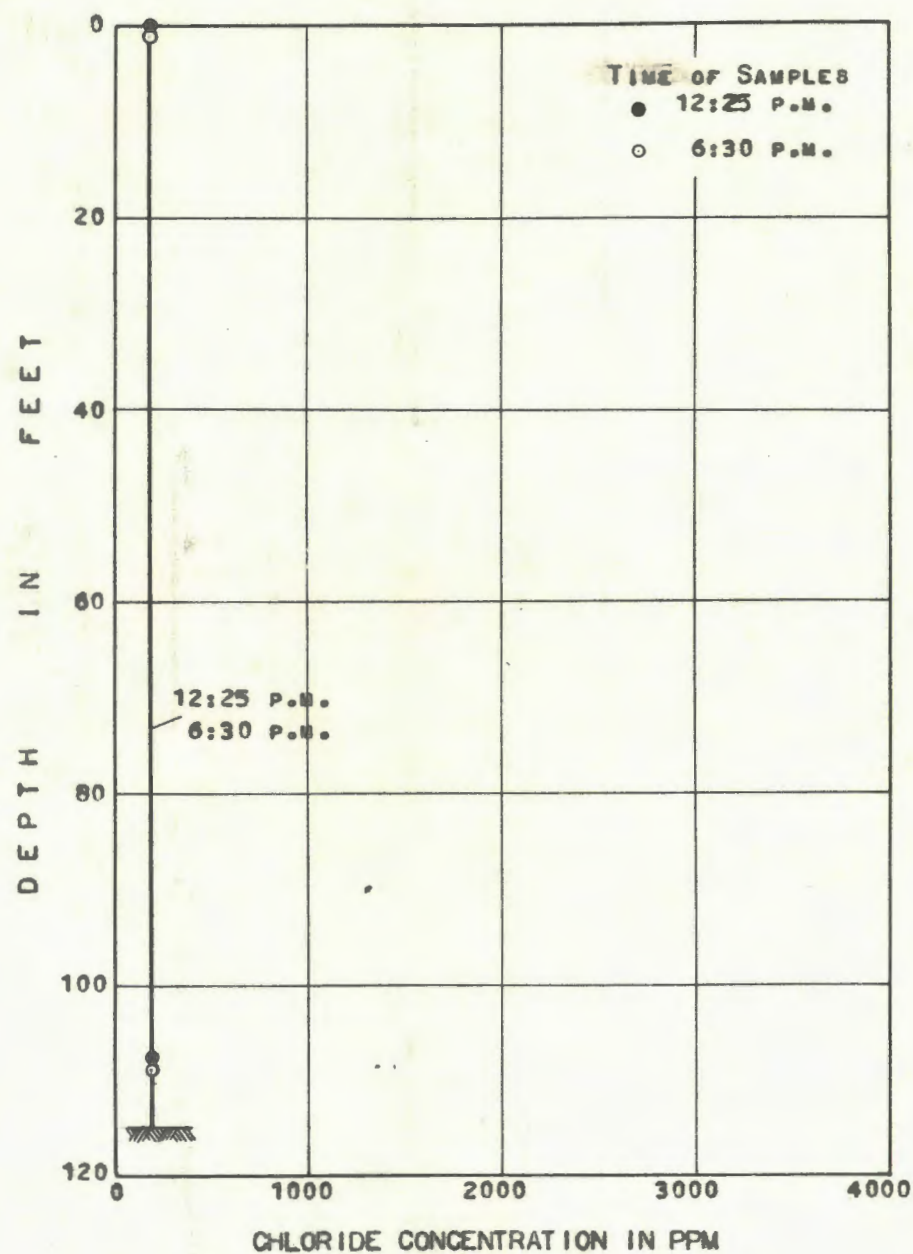


FIGURE 1.- CHLORIDE CONCENTRATION
 IN LAKE TARPON SINK
 SEPTEMBER 20, 1946

TABLE 1.- ANALYSES OF WATER SAMPLES FROM LAKE TARPON AND KNIGHT'S SINK
 PINELLAS COUNTY, FLA.

ANALYSES BY GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR
 (PARTS PER MILLION)

LOCATION:	SURFACE SAMPLES			
	KNIGHT'S SINK OCT. 13 1945	NOV. 27 1945	LAKE TARPON SEPT. 18 1946	OCT. 7 1946
DATE OF COLLECTION:				
SILICA (SiO ₂)	-	-	2.2	2.7
IRON (Fe)	-	-	.05	.03
CALCIUM (Ca)	37	21	18	16
MAGNESIUM (Mg)	29	31	19	16
SODIUM (Na)				
POTASSIUM (K)	230	256	160	135
BICARBONATE (HCO ₃)	56	31	25	22
SULFATE (SO ₄)	61	61	45	38
CHLORIDE (Cl)	425	458	285	242
FLUORIDE (F)	-	-	.1	.1
NITRATE (NO ₃)	2.6	.9	.7	.7
TOTAL DISSOLVED SOLIDS	812	843	579	496
TOTAL HARDNESS AS CaCO ₃	212	180	123	106
SPECIFIC CONDUCTANCE (Kx10 ⁵ AT 25°C.)	159	164	108	92.6
PH	7.6	6.5	7.3	7.2
COLOR	100	180	50	50

Knight's Sink

Salinity data collected at Knight's Sink were not as extensive as those collected at Lake Tarpon. Samples collected during vacillating flow in June 1945 showed a variation in chloride concentration from 432 ppm at the surface to 1,810 ppm at 40 feet and 19,300 ppm at the bottom. Since the concentration at the surface of Lake Tarpon was more than 4,000 ppm, it is evident that the sink is fed by shallow ground water. The high chloride concentration of 19,300 ppm at the bottom, compared with approximately 20,000 ppm for sea water, indicates the apparent readiness with which sea water at times moves through the aquifer.

An unusual condition existed in the sink in the middle of October 1945 when a large number of fish, including bass, died of unknown cause. Table 1 shows an analysis of a sample taken Oct. 13, 1945.

Spring Bayou

Spring Bayou is the outlet for an underground channel connecting Lake Tarpon with the Gulf and consequently the chloride content of its water is variable.

The maximum chloride concentration observed in Spring Bayou during the investigation was 16,100 ppm on June 24, 1945. This concentration was in a sample taken from the bottom during a period of vacillating flow. Surface concentration at the time of this maximum was 11,400 ppm.

During a period of flushing flow the salinity in Spring Bayou was observed to decrease appreciably and changed little with the tide. For example, the chloride concentration remained between 2,000 and 2,500 ppm throughout a tide cycle on Sept. 20, 1946.

Blue Sink

Five water samples from near the bottom of this sink and five from just below the surface were taken in a two-day period. These were analyzed and it was found that the chloride concentrations in the bottom samples ranged from 4,480 ppm to 13,400 ppm, whereas the chloride concentrations in the surface samples were less than 100 ppm. Local residents stated that irrigation pumping from the sink caused no apparent change in salinity or stage.

Crystal Beach Spring

Five samples taken from near the bottom of this spring Sept. 19, 20, 1946, showed chloride concentrations ranging from 14,000 ppm to 16,800 ppm. The high salt content of these samples is likely the result of the negative flow mentioned under the hydrologic characteristics.

Health (Wall) Springs

The chloride concentration here on Sept. 20, 1946, was 67 ppm. Very little, if any, salt water enters the ground through this spring.

Whitcomb Bayou Sink

A sample collected from this sink on Sept. 20, 1946, contained 1,840 ppm of chloride.

Hidden Lake Sink

The chloride concentration here on Sept. 20, 1946, was 105 ppm.

Salt Lake

The chloride concentration here on Sept. 20, 1946, was 173 ppm.

DYE STUDIES

Two dye studies were made during the period of the investigation to check the existence of a physical connection between Lake Tarpon and Spring Bayou, and also to obtain additional hydraulic data on the underground channels connecting them. Uranine B dye, the sodium salt of fluorescein, was used for both studies. Samples were taken from Spring Bayou and Crystal Beach Spring at approximately half-hour intervals. A few samples were taken from Blue Sink.

The first study was conducted on Sept. 20, 1946, during a recession which started on Sept. 17 and ended on Oct. 5. Dye appeared at the surface of Knight's Sink thirty-seven minutes after ten pounds of it was placed in the lake sink, and at Spring Bayou in approximately one hour and twenty minutes. The dye in Knight's Sink appeared first over the 75-foot hole before spreading over the surface. These data indicate that the water in the underground formation for the two miles between lake and bayou was moving at the rate of 2.2 feet per second. Water samples taken at Blue Sink and Crystal Beach Spring during this same period may have contained very small amounts of dye, but the visual inspection method employed was inadequate to detect it conclusively.

The presence or absence of dye in each sample was determined in the field by using 36-inch turbidity tubes. No quantitative determinations were attempted.

The second study was conducted on Aug. 23, 1949, during a recession which started Aug. 17 and ended Sept. 14. Twenty pounds of dye was used, and observations were made at Spring Bayou and Crystal Beach Spring. The rate for transit of dye from the lake to the bayou was approximately 2.3 feet per second. A quantitative laboratory analysis

showed a maximum concentration in the bayou of 0.37 part per million of dye. A trace of dye was perceptible nineteen hours after it was first observed. No field determinations were made. Analyses of Crystal Beach Spring samples taken in a manner identical to those from the Spring Bayou Sink showed no trace of dye.

The two studies proved conclusively that some of the water leaving Lake Tarpon through Lake Tarpon Sink on a recession reached Spring Bayou Sink.

UNDERWATER PHOTOGRAPHIC STUDIES - LAKE TARPON SINK

The underwater photographic studies in the Lake Tarpon sink were made, as a part of the investigation, by W. O. Smith, Lt. W. R. Brooks, U. S. N. R., Chief J. M. Dickinson, U. S. N., and the author. Garald G. Parker assisted in the analysis of the photographs.

Information which the Geological Survey hoped to collect included (1)) the approximate location and size of the openings from the sink to any underground channel or channels, and (2) the type of rock formation in the sink.

A series of thirteen spot photographs is shown in the Appendix. These photographs, all made at close range, show the nature of some of the limestone formations in the sink. Two pictures showed white streamers, which were lowered into the sink, being agitated by the movement of water into the hole.

This portion of the study provided information for more thorough field investigation should enclosure of the sink ever be considered in a plan to prevent salt water intrusion.

HYDROLOGIC CHARACTERISTICS

The information gained through the salinity, dye, photographic, and physical studies has been consolidated with the data obtained from stage and discharge studies.

Lake Tarpon and Lake Tarpon Sink

Lake Tarpon flushed with appreciable lowering of stage 34 times during the period of the investigation, April 1945 to December 1952. In some years there were as many as six of these occurrences and in one year (1950) only two. These recessions started at stages ranging from 2.5 to 6.4 feet. Both the dye and salinity studies indicate beyond doubt that most of the water passing into Lake Tarpon Sink emerges in Spring Bayou. A current meter lowered into the sink on Sept. 21, 1946, during a period of flushing flow, indicated water movement at all depths from 1 foot under the water surface to 107 feet, the deepest point sounded.

The data collected have not revealed the exact combination of ground and surface water conditions that permit this discharge of water at one period and prevent its discharge during another. The factors involved are (1) stage of Lake Tarpon, (2) stage of Spring Bayou, (3) stage of the ground water in the formation through which the underground channel passes, and (4) the differences in the density of the waters involved.

When the lake is not flushing, the aquifer is evidently not totally blocked to the passage of water from the lake sink. During these periods there is usually a small flow from the lake sink on low tide and into the lake sink on high tide, this flow being that referred to earlier as vacillating flow. A typical example of this

condition is shown in figure 9. There was no inflow from Brooker Creek at the time. As water flows inward the water surface in the lake and aquifer rise until equilibrium is reached and flow stops. As the tide in the Bayou falls, the water flows out of Lake Tarpon Sink.

The characteristic recession in stage for which this lake is noted usually occurs following a rise in lake stage (fig. 2). The head of fresh water thus created by the differences between the elevation of the lake and ground water at the higher level, and tide elevation at Spring Bayou at the lower, forces the denser salty water in the aquifer downward and causes the lake to "trip," which results in water flowing through the lake sink to the aquifer and out into Spring Bayou. The average rate of fall is about 0.3 foot per day. As the lake recedes, the tide effect in the lake becomes more pronounced, indicating more fluctuation of flow caused by tide changes in Spring Bayou.

The recession beginning on Sept. 8, 1950 (table 2) started at the highest stage during the period of record. The maximum discharge out of Spring Bayou at the beginning of this recession was approximately 1,000 cubic feet per second. Data collected indicate that another factor which influences the recessions is the ground-water level along the route of the underground channel through which discharge from the lake passes. For the period of record the ground-water level always had dropped below the lake level when flushing began. Most of the time during the period of record ground-water level was above that of the lake. Flow at Spring Bayou has been observed to increase considerably just prior to a recession in lake stage.

The lake stage fluctuations on figure 10 are seiches and are not uncommon on a lake of this elongated shape. They can be caused by wind or other forces. Although some of the seiches on Lake Tarpon are

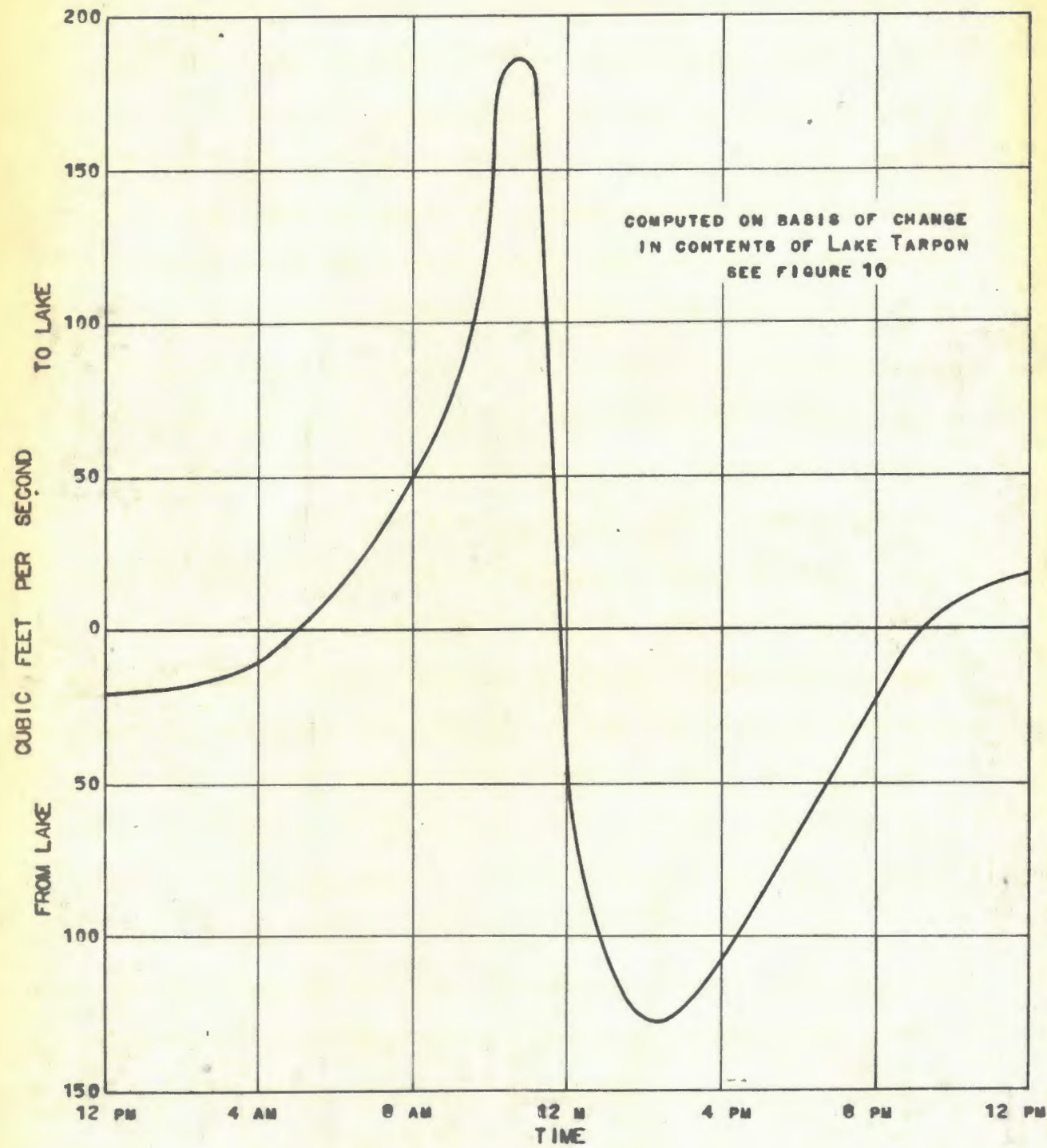


FIGURE 9 .- FLOW OF WATER IN AND OUT OF LAKE TARPON SINK
JUNE 17, 1951

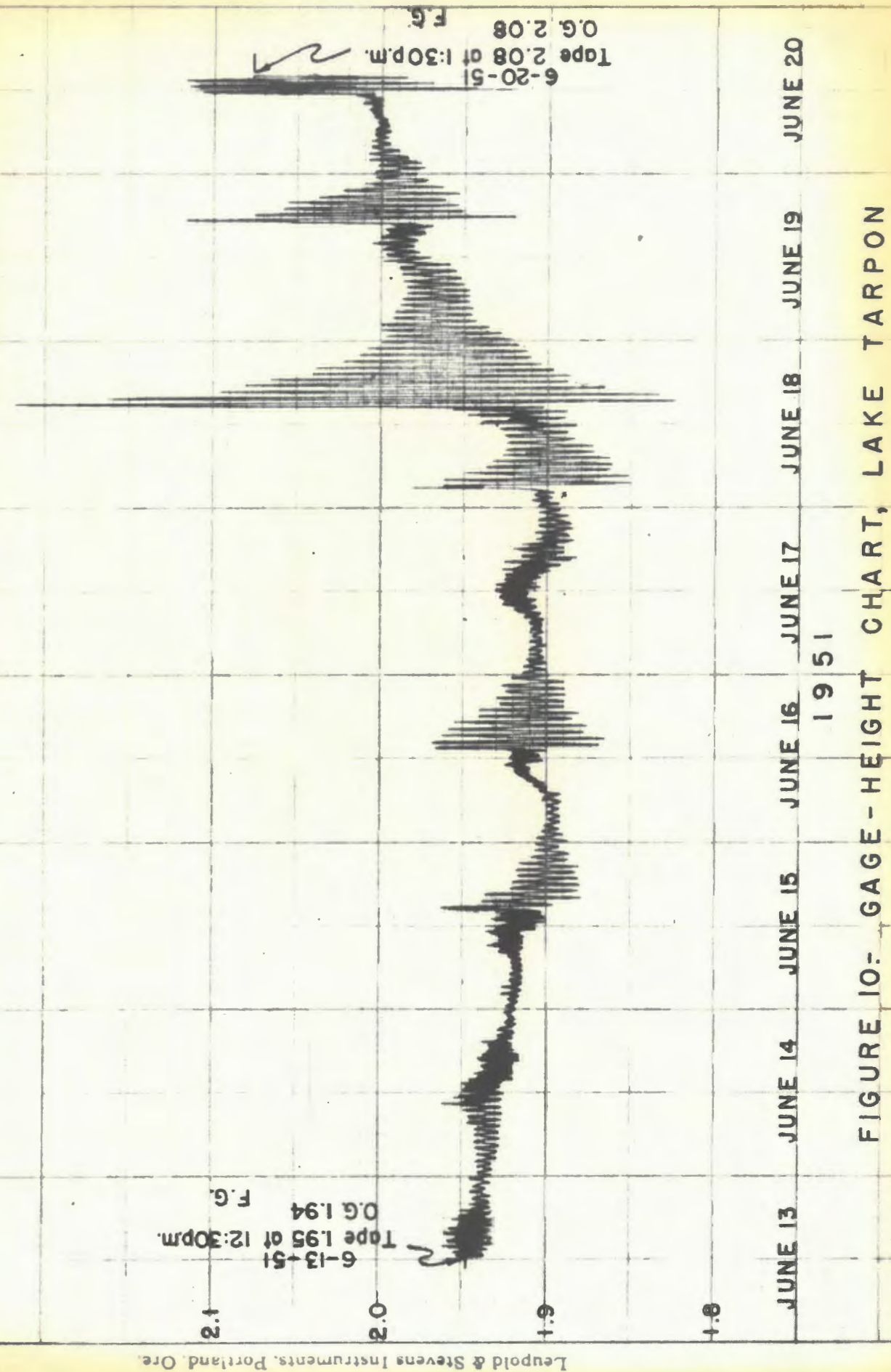


FIGURE 10:- GAGE-HEIGHT CHART, LAKE TARPON
1951

TABLE 2.- DAILY DISCHARGE FROM SPRING BAYOU DURING FLUSHING

SEPTEMBER 7-22, 1950

DATE	LAKE TARPON DAILY STAGE IN FEET	SPRING BAYOU DISCHARGE IN CUBIC FEET PER SECOND	DATE	LAKE TARPON DAILY STAGE IN FEET	SPRING BAYOU DISCHARGE IN CUBIC FEET PER SECOND
7	6.40	861	15	4.79	717
8	6.42	894	16	4.52	689
9	6.32	882	17	4.23	677
10	6.19	865	18	3.94	668
11	5.90	824	19	3.63	649
12	5.64	814	20	3.33	562
13	5.37	780	21	3.07	503
14	5.08	755	22	2.85	455

caused by wind, the chart record indicates that sudden fluctuations in the level of the water in the lake sink are the cause of many. The chart record shows these fluctuations are brought about largely by tide effect, which causes a flow into or from the lake sink. The large seiche on June 18, 1951, was of this nature. The time of oscillation was found to agree closely with Whipple's $\frac{1}{2}$ formula. Seiches having an amplitude of 1.0 foot have been recorded in the lake.

Knight's Sink

The stage of Knight's Sink is influenced by the bayou and the lake, as shown on figure 11.

The stage in the sink fluctuates with the tide in Spring Bayou. The maximum range in the tide cycle during a period of low lake stage was 2.45 feet on July 3, 1947, as compared with a 3.53-foot range at the bayou. This tide at Knight's Sink occurred three-quarters of an hour after that at the bayou and is typical for periods of low lake stage.

The mean stage in Knight's Sink is usually approximately the same as the stage of the lake. Knight's Sink is more tidal than the lake although they are only 200 feet apart. One possible explanation is that the underground connection between Knight's Sink and Lake Tarpon Sink is small or is so formed that it will not permit a free interchange of water.

During lake recessions the stage of the sink approximates that of the lake, and the tidal fluctuations are dampened out considerably.

Water-level recorder graphs of Knight's Sink during periods of vacillating flow compared with those during periods of flushing show similar surge lines verifying movement of water in the underground channels at periods other than during recessions.

$\frac{1}{2}$ Whipple, G. C., The Microscopy of Drinking Water, 4th Ed., John Wiley and Sons, Inc., p. 162

ELEVATION IN FEET ABOVE MEAN SEA LEVEL

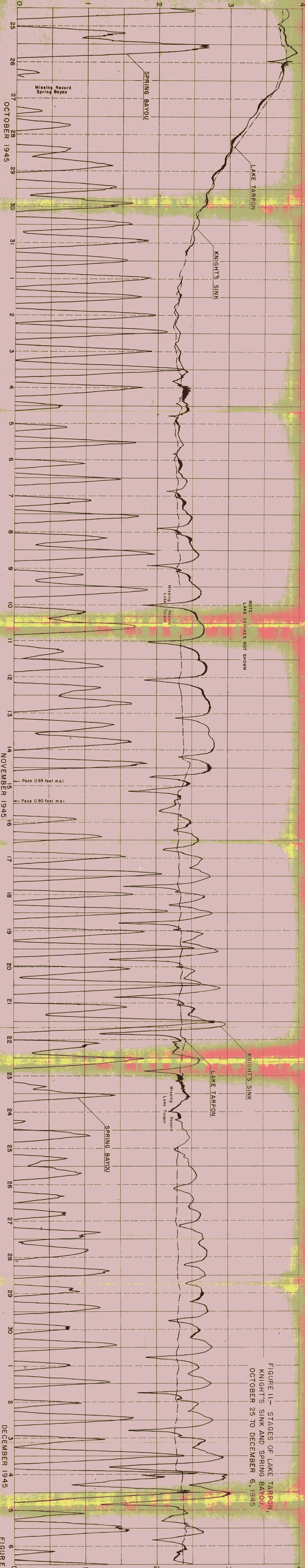


FIGURE 11.— STAGES OF LAKE TARPON, KNIGHT'S SINK AND SPRING BAYOU, OCTOBER 25 TO DECEMBER 6, 1945

ELEVATION IN FEET ABOVE MEAN SEA LEVEL

Spring Bayou

Spring Bayou is unusual in that this so-called spring is probably the physical connection between the tidal reaches of the Anclote River and an underground channel to Lake Tarpon. The forces acting to create flow in Spring Bayou consist of a tidal head of salt water opposed by a combined lake and ground water head of relatively fresh water, variation of these factors determining the direction and magnitude of the flows.

During low lake stage a part of the incoming tide is discharged into the spring and hence to underground formations. As the tide recedes, some of this water reappears in Spring Bayou mixed with the ground and lake waters for which this opening is a natural outlet. At lower stages of the tide, the discharge from the aquifer into the bayou is shown by a boil or slick on the water surface over the spring. During periods of rainfall, the lake and ground-water stages rise and create an additional head on the spring at the bayou which probably increases the discharge of the spring.

The discharge of Spring Bayou during periods of lake recession increases appreciably because of increased flow from the lake and ground water. Inspection of the record for well 13, located between the two sinks, shows that the well stage during a recession stays approximately one foot below that of the lake, indicating the gradient of flow. Well 13 was established by the U. S. Geological Survey as one of the points of observation required for the investigation of the ground-water resources of Pinellas County.

Two sets of measurements were made of the discharge of Spring Bayou, one on the recession of July 6-18, 1945, and the other on the recession of Sept. 17 to Oct. 5, 1946. These measurements were used to

develop a head-discharge relationship (fig. 12), plotting the head between the lake and the bayou at the mean time of the measurements against discharge from the bayou. The relationship is good in spite of the changing stage encountered during the measurements. This relationship varies slightly for individual recessions since it does not take into account ground water head and densities.

The Spring Bayou discharge rating indicates that the maximum discharge of Spring Bayou during the period of the study was approximately 1,000 cubic feet per second (646 mgd) on Sept. 8, 1950. This discharge occurred at low tide on the first day of the recession.

Following recessions, the saline water from Spring Bayou has been observed to flow back into the bayou sink. The rate of flow of this water was measured on Oct. 10, 1946, on a falling tide, at which time it was 146 cubic feet per second or 94 mgd.

Blue Sink

It is thought locally that this sink is directly connected by an underground channel with Crystal Beach Spring, but this has not been verified. Observations during the study showed tidal fluctuations in the sink with a maximum range of approximately one foot. Velocity observations at 10-foot intervals in the vertical were made during the October 1946 recession, but no horizontal or vertical movement of water was detected.

Crystal Beach Spring

A boil at this spring, which indicated flow, was observed here many times during the period of the investigation. When inspections were made during the recession of Sept. 17 to Oct. 4, 1946, water was observed flowing out of the spring. These observations, made on the perimeter of

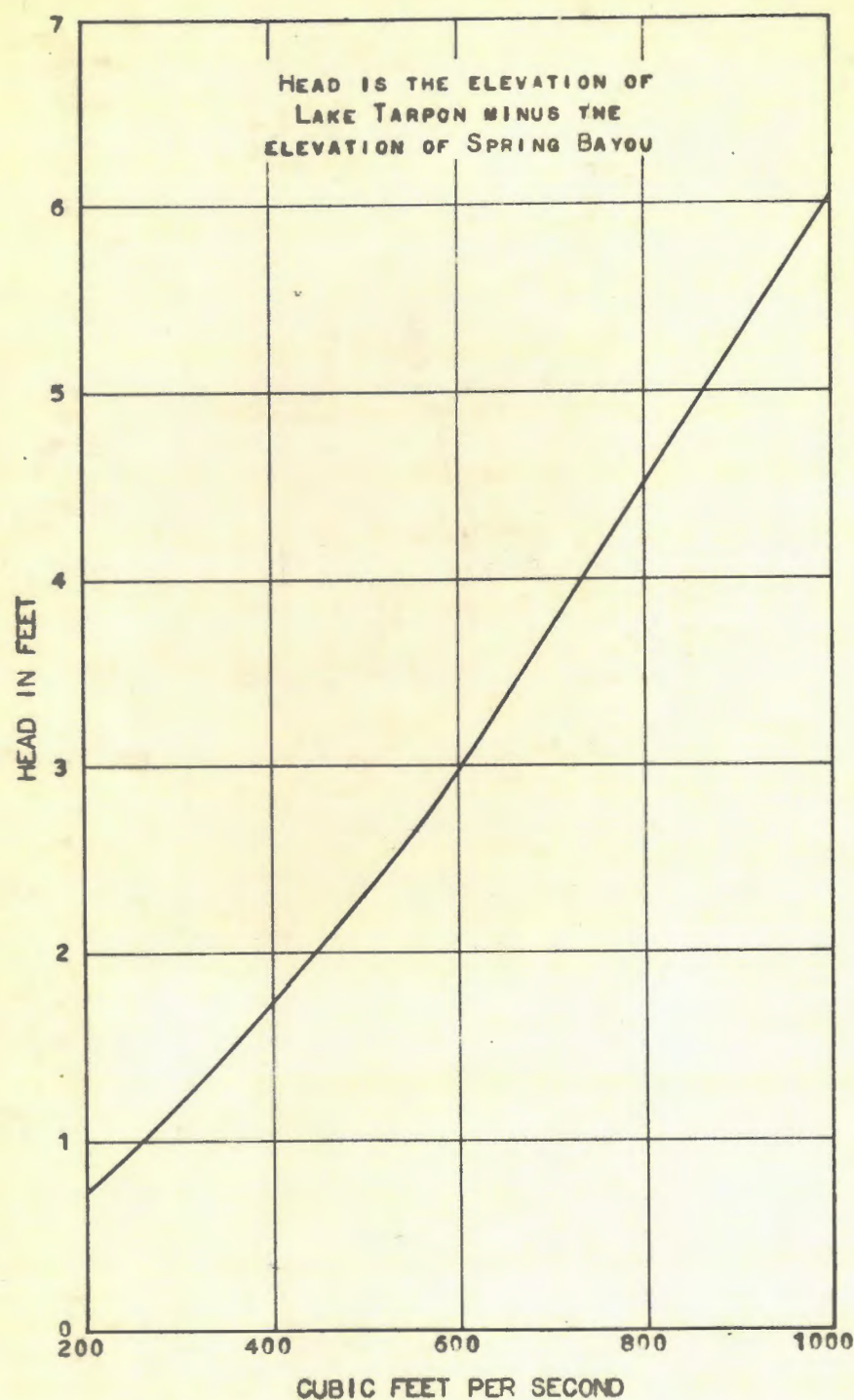


FIGURE 12.- RATING CURVE, SPRING BAYOU

the opening, revealed that flow at the top was positive, or away from the spring, and at the bottom was negative. This negative flow was due to the local circulation caused by the outrushing waters.

A study of all the data collected tends to indicate that Crystal Beach Spring is not materially affected, if at all, during the periods when the water in Spring Bayou is flowing into the Bayou sink. It is believed that water continues to flow from this spring even though the tide may be relatively high. There is only a slight possibility, therefore, that salt water enters the ground through this opening.

Health (Wall) Spring

Measurements of Nov. 10, 1947, and Aug. 22, 1949, show discharges of 6.1 and 11.2 cubic feet per second, respectively.

Whitcomb Bayou Sink

On Sept. 20, 1946, at low tide, a small amount of water was observed to be flowing from this sink; however, the small slick over the sink usually disappears on ordinary high tides. At the time of observation the water flowing from the sink contained white, flaky particles. This sink is so small that there is very likely little, if any, salt-water contamination of Lake Tarpon through it.

Hidden Lake Sink

Observations over a two-day period showed no significant tidal fluctuation.

CONSLUSIONS

The dye study of September 1949 proved conclusively that water passes from Lake Tarpon Sink to Spring Bayou.

Observations of the changes in lake salinity at numerous times indicate that the primary source of chloride contamination of the lake is through sea water infiltration. This contamination takes place on high tide during periods when the lake is sufficiently low to permit sea water intrusion from the bayou through the underground channel or channels to the lake. During low tide the flow through the connections reverses and the lake discharges through the lake sink to Spring Bayou. Thus there is a constant ebb and flow of water in the underground channels at low lake stages, the sea water moving toward the lake on high tide and from the lake on low. The discharge into and from the lake sink during these periods is relatively small in comparison with that from the lake during periods of recession.

Thirty-four recessions have occurred in Lake Tarpon during the period April 1945 to December 1952. The exact combination of factors bringing about these recessions has not been determined but it is known that (1) the stage of the lake, (2) the ground water level between the lake and bayou, (3) the tide, and (4) the densities of the waters, are primary factors. These recessions occurred at lake stages ranging from 2.5 to 6.4 feet and stopped at stages ranging from 1.2 to 3.1 feet. The stage at the end of each recession is influenced largely by ground water conditions and the tide in Spring Bayou.

The flow between the lake and bayou at low stages and from the lake into the bayou during recessions includes a varying amount of ground water which lies adjacent to the connections through which this water flows.

During periods of sea water encroachment into the lake this ground water is probably also contaminated, while during recessions the contaminated water is partially flushed out through Spring Bayou. Comparison of stage records for the lake and the observation well lying between the lake and bayou show that the ground-water level following a recession rises much more rapidly than that of the lake.

Little has been determined regarding the size or structure of the underground channel or channels. The aquifer undoubtedly is quite permeable to permit the rapid passage and volume of water measured during the study.

Two methods for preventing salt water contamination and for controlling the storage of Lake Tarpon have been considered by county officials. One plan is to construct a dam around the lake sink. Excess water could flow over a spillway and out through the sink. The spillway should be designed to prevent salt water encroachment and also to maintain the lake at the desired height. Some idea of the size of the sink may be gained by noting that the length of the 10-foot contour is 800 feet (fig 3).

A sheet piling control dam in Spring Bayou below the spring was proposed as a second plan, with the thought that this dam would prevent salt water encroachment into the lake, raise the minimum lake stage, and decrease salt water contamination of ground water in the area.

Obviously the first plan - that of constructing a dam in Lake Tarpon - would be successful only if the lake sink is the only opening through which salt water could enter. There is, though, the possibility that other connections exist or would develop in the future if present channels were stopped.

The second proposed plan - placing a dam at Spring Bayou - would be successful only if Spring Bayou is the primary source of salt contamination of the lake water and the ground water. The only other known spring in the area that might become a source of chloride contamination to the lake is Crystal Beach Spring, but it is believed that this possibility is a slight one.

Study and interpretation of the data collected during this investigation indicate that Spring Bayou is the principal point of entry of salt water to Lake Tarpon and that none of the other features investigated could contribute materially to the contamination of the lake.

Appendix omitted from 1960 reprinted copies.

~~Photographs~~ are available in Ocala office file.