UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FLORIDA DEPARTMENT OF NATURAL RESOURCES
published by BUREAU OF GEOLOGY

HYDROLOGY OF LAKE TARPON NEAR TARPON SPRINGS, FLORIDA

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Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
and the
BUREAU OF GEOLOGY
FLORIDA DEPARTMENT OF NATURAL RESOURCES
TALLAHASSEE, FLORIDA
1974

INTRODUCTION

Lake Tarpon, in northern Pinellas County, has an area of about 4 square miles and is near several urban areas. It is used principally for boating, fishing, and swimming. The lake was used for water supply only during a 4-year period between March 1926 and May 1930. It has not been used for this purpose since because of the frequent inflow of saline water through a sinkhole on the west side of the lake. To prevent this inflow, an earthen ring dike with four gated culverts was designed by the Southwest Florida Water Management District and constructed around the sinkhole in May 1969. An outlet canal leading south to Tampa Bay was completed in July 1967 as an element of the Four River Basin Project of the Southwest Florida Water Management District and the U.S. Army Corps of Engineers. An earthen dam in the canal was partly removed in July 1969 to allow discharge during high water. In August 1971 the earthen dam was replaced and gated culverts were constructed in the lower part of the dam.

Since the enclosure of the sink, the lake water has become less saline on the average although it is still more saline than at times before the enclosure. If other sinkholes with direct connections to saline water are present in the lake bottom, the lake water may never become fresh unless a high lake level is maintained. The purpose of this report is to describe the physical, geologic, and hydrologic features of the lake, in order to aid in management of the lake.

GENERAL HYDROLOGY

The lake basin is a depression in the land surface that may be a consequence of a depression in the underlying limestone. Such a depression is shown beneath or near Lake Tarpon on bedrock-surface maps by previous investigators.

The bedrock is the upper part of the Floridan Aquifer (Parker and others, 1955), an areally extensive limestone aquifer that supplies large quantities of ground water for municipal use in Pinellas and surrounding counties.

Cohesive clayey deposits as much as 70 feet thick overlie the limestone. These deposits confine water in the Floridan Aquifer and probably lie close to the lake bed in the deeper parts of Lake Tarpon. Because of its cohesiveness, this unit, where breached by collapse of solution cavities in the underlying limestone, can maintain steep-sided, small-diameter sinkholes.

A fine to medium silty sand overlies the clay and is the bed material on most of the lake bottom. The sand is as much as 50 feet thick (Heath and Smith, 1954). Where saturated the sand contributes seepage to the lake from all sides.

The lake bottom is a shallow trough modified in some places near the shore by dredging. The dredged areas were not mapped in detail, and the canals on the west side of the lake were not sounded. The maximum natural depth of the lake is 15 feet. The bottom is smooth, and the east side is slightly steeper than the west side. Mapping was done when the lake level was about 3 feet above sea level.

Lake Tarpon Sink, through which saline water entered the lake is 118 feet deep. A search was made for other sinkholes, but no others were found in the lake during this study, during an investigation by R.N. Cherry in March 1968, or during depth mapping by Kenner (1964, p. 72). Echo-sounding was done by W.O. Smith and R.L. Taylor in 1947 (Taylor, 1953, p.8). Small, steep-sided sinks are difficult to detect by echo sounding, and the probability of any being discovered with conventional depth-sounding methods is slight.

Since 1931, rainfall at Tarpon Springs ranged from 32.89 inches in 1956 to 83.20 inches in 1959 (National Oceanic and Atmospheric Administration, 1951-72). Normal rainfall is 54.56 inches. In most years, more than 50 percent of the rainfall occurred from June through September. Mann (1971, p. 28) estimates the average annual evaporation from open- water bodies in this area to be 50 inches. This nearly equals the rain that falls on the lake surface.

The drainage basin of the lake is about 60 square miles (Taylor, 1953, p. 8). Surface-water inflow is primarily from Brooker Creek. This stream has a drainage area of about 30 square miles and empties into the south end of the lake. Inflow from Brooker Creek has ranged from 0 to 1,600 cfs (cubic feet per second) and averaged 26.1 cfs during 1950-70 (U.S. Geological Survey, 1972). Other streams contribute a small amount of inflow at points shown as light areas on figure 1.

Before the outlet canal was opened, the only known outlet was Lake Tarpon Sink. The lake water would drain, at irregular intervals, into the sink through the Floridan Aquifer to Tarpon Spring in Spring Bayou, a small tidal estuary about 3 miles northwest of Lake Tarpon Sink in the city of Tarpon Springs. At other times salt water from Spring Bayou would move back through the aquifer, up through the sink, and into Lake Tarpon. The mechanism of the flow was confirmed by dye studies in 1946 and 1949 as reported by Taylor (1953) and was explained in detail by Cooper (in Heath and Smith, 1954, p. 39). Taylor placed dye in Lake Tarpon Sink during a high lake stage and detected it later in Spring Bayou. In March 1968, dye, which was injected into the saline water at the sink at Spring Bayou during a low stage of Lake Tarpon and at the beginning of flow back into Lake Tarpon, was detected at Lake Tarpon Sink. Results of attempts to detect the dye at other observation points in the lake were inconclusive. The calculated increase in volume of Lake Tarpon, resulting from the lake level being raised, was reasonably consistent with the measured flow into the sink at Spring Bayou.

Figure 2 shows the relation between lake level and volume. The change in total stored water with change of the lake level is somewhat greater than the graph shows, because of additional storage in the extensive swampy areas in the Brooker Creek drainage basin, in other small tributaries, and additional ground-water storage.

The salinity of the lake water has varied with inflow of saline water through the Lake Tarpon Sink. In general, the chloride content, a measure of salinity, increased when low lake levels permitted frequent inflow of saline water. The chloride content of water from the lake has ranged from near zero to nearly 5,000 mg/l (milligrams per liter), 1953-71 (fig. 3). The Floridan Aquifer contains water with a chloride content greater than 250 mg/l, beneath the lake basin and in a mile-wide zone extending from the Lake Tarpon Sink northwest to the Gulf of Mexico (Cherry, 1966).

Water levels in the Floridan Aquifer near Lake Tarpon are affected by tidal fluctuations. The pattern of the water-level fluctuations in Lake Tarpon Sink is similar to the pattern of tidal fluctuations in Spring Bayou in Tarpon Springs (fig. 4). The water level in Lake Tarpon Sink represents the potentiometric surface of the Floridan Aquifer as shown by nearly identical water-level fluctuations in the sink and at well 1, and is usually above lake level at high tide and below lake level at low tide. Tidal influence on water-level fluctuations in the aquifer diminish as distance from the gulf increases as shown by smaller amplitude and the time lag in the hydrograph of well 2 compared with hydrograph of well 1 (fig. 4).

EFFECT OF THE SINK ENCLOSURE AND THE NEW OUTLET

Since enclosure of the Lake Tarpon Sink in May 1969, the chloride content has decreased during summer rainy seasons and has increased somewhat during fall and winter dry seasons (fig. 2). This increase cannot be explained entirely by evaporation of lake water and consequent concentration of dissolved salt. The chloride analyses (table 1) show that little residual salinity remains in deeper parts of the lake, as values for samples collected at the lake surface and from near the lake bottom are nearly the same. The uniformity of the chloride content throughout the lake would suggest a general source of additional chloride rather than a point source, such as another sinkhole. On December 3, 1970 when the lake water contained about 600 mg/l chloride (fig. 2), two core samples of sediment were taken near the west shore of the lake, and the water contained in the sediment was analyzed for chloride. One sample, taken near the lake gage, contained water with 900 mg/l chloride. The other sample, taken 1,000 feet south of Lake Tarpon Sink, contained water with 2,000 mg/l chloride (W.R. Murphy, written commun., 1970). The bottom sediments, which were saturated with water having a high chloride content before the sink was enclosed, are probably the principal source of chloride contamination of the lake water at the present time and probably will continue to contaminate the lake for several years. Ground-water inflow, principally from the shallow aquifer, is the probable mechanism by which the residual saline water enters the lake. The difference between the chloride content of water in the sediment and in the lake water is attributable in part to siltation and consequent low hydraulic conductivity of the lake-bottom sediments. Ground-water inflow through these sediments is slow, and flushing of the saline water from them will take a long time.

The lake level has been regulated since enclosure of the sink and construction of the new outlet and dam. Minimum levels are not as low as they had been, and maximum levels are not nearly as high (fig. 5). Flooding, which had been a problem to owners of lake-shore property in the past (Mohler and Bishop, 1961), probably will not be as frequent in the future. Before the sink was enclosed the lake level fluctuated as much as 0.05 foot in response to tides, usually twice daily, in Spring Bayou (fig. 6). Since enclosure, response to tidal fluctuation either has ceased or has diminished in magnitude below the sensitivity of the recorder gage (fig. 4).

Seiches, short-term fluctuations of the lake level (fig. 6) can be caused by wind or by the sudden inflow or outflow of water. The frequency of occurrence of seiches in Lake Tarpon may have diminished since the enclosure of the sink and construction of the outlet canal.

FUTURE DATA COLLECTION

Temporarily increasing the sensitivity of the recorder gage would be necessary to determine whether the lake is subject to very small tidal fluctuations. The time chosen for the change should be when a maximum tidal range is expected along the Gulf Coast.

Core samples of sediment taken at the same places as those taken in December 1970 would aid in assessing the amount of flushing of saline water from the lake-bottom sediment. Collection of additional water samples for chloride analysis would aid in monitoring the changes in chloride.

A plan has been finalized by the Southwest Florida Water Management District for management of the lake level. This plan includes allowing a low lake level of 1 foot above mean sea level to stand for 3 months every fifth year, beginning in 1974. During this time, if the salinity of the water at several points in the lake is found not to be uniform, an intensive search should be made for small sinks or saline springs in the area of maximum salinity. During at least the first recession to a level of 1 foot, the salinity of the lake likely will increase, because of increased ground-water inflow from sediment containing saline water. If the salinity of the lake water becomes greater than the salinity of water in the sediment then residual saline water in the sediment cannot be the only source of saline water.

SELECTED REFERENCES

Cherry, R.N.,
1966 *Florida in 1950 and 1960:* Florida Board Conserv. Div. Geology Map Series 20.

Cherry, R.N., Stewart, J.W., and Mann, J.A.
1970 *General hydrology of the Middle Gulf area, Florida:* Florida Dept. Nat. Resources, Bur. Geology Rept. Inv. 56.

Heath, R.C., and Smith, Peter C.,
1954 *Ground-water resources of Pinellas County, Florida:* Florida Geol. Survey Rept. Inv. 12.

Kenner, W.E.,
1961 *Stage characteristics of Florida lakes:* Florida Geol. Survey Inf. Circ. 31.
1964 *Maps showing depths of selected lakes in Florida:* Florida Geol. Survey Inf. Circ. 40.

Mann, J.A.,
1971 *Hydrologic aspects of freshening upper Old Tampa Bay, Florida:* Florida Dept. Nat. Resources, Bur. Geology Inf. Circ. 76.

Mohler, F.C., and Bishop, E.W.,
1961 *Gulf Coast basins reconnaissance study:* Florida Dept. Water Resources, Tallahassee, Florida.

National Oceanic and Atmospheric Administration,
1951-72
Climatological data. Florida: Annual summaries 1947-71.

Parker, Garald G., Ferguson, G.E., Love, S.K., and others,
1955 *Water resources of southeastern Florida:* U.S. Geol. Survey Water-Supply Paper 1255.

Reichenbaugh, R.C.,
1972 *Sea-water intrusion in the upper part of the Floridan aquifer in coastal Pasco County, Florida, 1969:* Florida Dept. Nat. Resources, Bur. Geology Map Series 47.

Stewart, J.W.,
1968 *Hydrologic effects of pumping from the Floridan aquifer in northwest Hillsborough, northeast Pinellas, and southwest Pasco Counties, Florida:* U.S. Geol. Survey open-file report.

Stewart, J.W., Mills, L.R., Knochenmus, D.D., and Faulkner, G.L.,
1971 *Potentiometric surface and areas of artesian flow, May 1969, and change of potentiometric surface 1964 to 1969, Floridan aquifer, Southwest Florida Water Management District, Florida:* U.S. Geol. Survey Hydrol. Inv. Atlas HA-440.

Stringfield, V.T.,
1966 *Artesian water in Tertiary limestone in the southeastern states:* U.S. Geol. Survey Prof. Paper 517.

Taylor, Robert L.,
1953 *Hydrologic characteristics of the Lake Tarpon area, Florida:* U.S. Geol. Survey open-file report.

U.S. Geological Survey,
1970 *Water resources data for Florida, part 2, water quality records, 1968:* U.S. Geol. Survey, Tallahassee, Fla.
1971 *Water resources data for Florida, part 1, surface-water records, vol. 3 lakes, 1969:* U.S. Geol. Survey, Tallahassee, Fla.
1972 *Water resources data for Florida, part 1, surface-water records, vol. 1, streams--northern and central Florida, 1970:* U.S. Geol. Survey, Tallahassee, Fla.

Vernon, R.O., and Puri, H.S., compilers,
1965 *Geologic map of Florida:* Florida Board Conserv., Div. Geology Map Series 18.

Wetterhall, W.S.,
1965 *Reconnaissance of springs and sinks in west-central Florida:* Florida Geol. Survey Rept. Inv. 39.

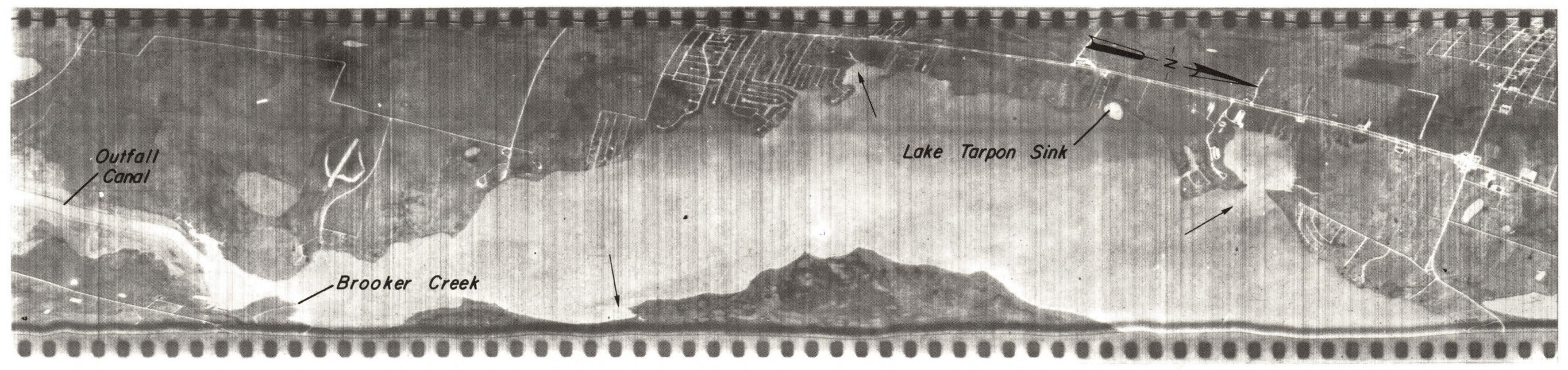


Figure 1. Infrared imagery of Lake Tarpon flown by NASA May 15, 1969. The light and dark areas indicate differences in thermal radiation, and therefore surface temperature. Dark areas are colder than light areas. Surface-water inflow from Brooker Creek and smaller tributaries (indicated by arrows) is warmer than the lake water. No indication of leakage is shown at the sink enclosure.

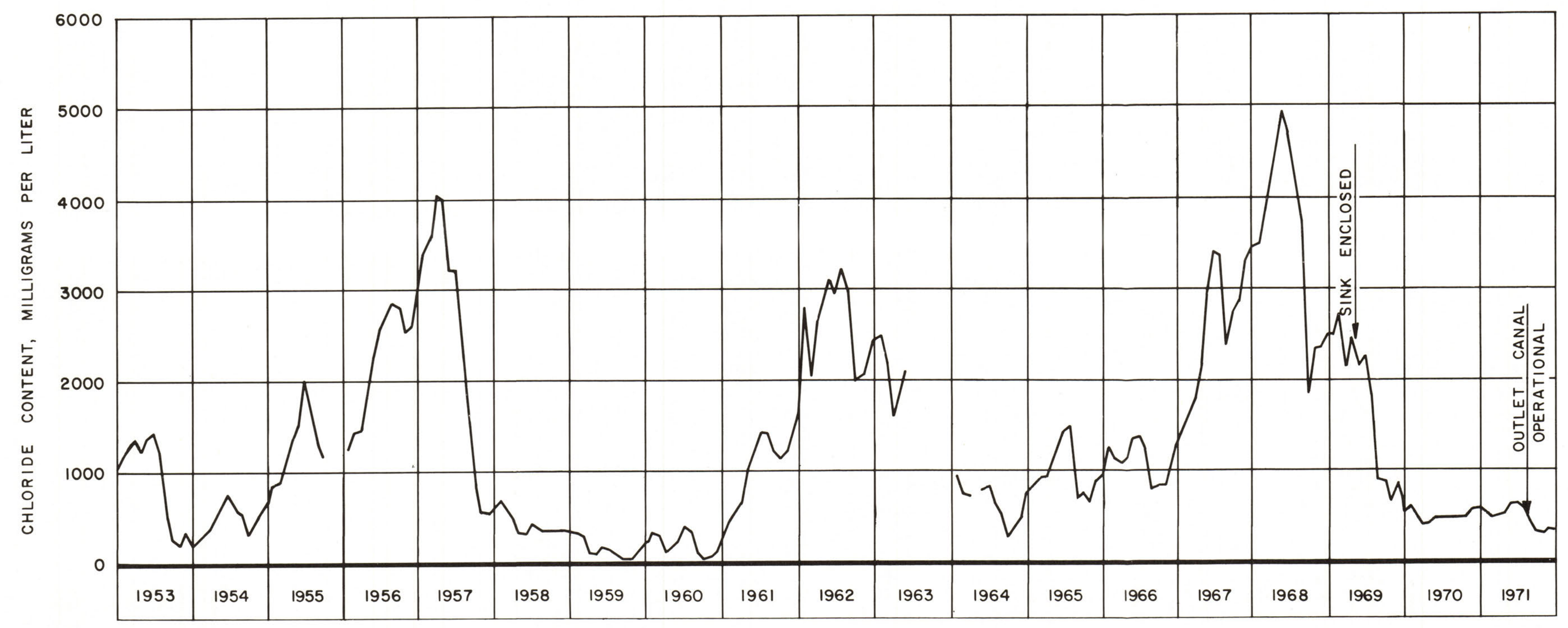


Figure 3. Graph of chloride content of month-end water samples taken near the gage in Lake Tarpon.

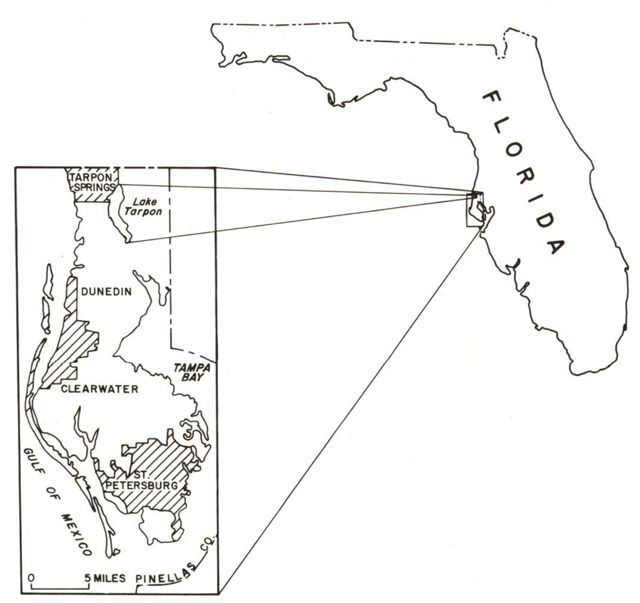


Figure 7. Location map.

Table 1. Chloride content of water samples taken April 25, 1972
(values in milligrams per liter)

Site number and description	1 Dredged hole depth: 18 feet	2 Dredged hole depth: 20 feet	3 Near sink depth: 10 feet	4 Dredged hole depth: 18 feet	5 Dredged hole depth: 30 feet	6 Natural depression depth: 13 feet
Surface	300	300	300	300	300	300
Bottom	310	320	300	350	330	310

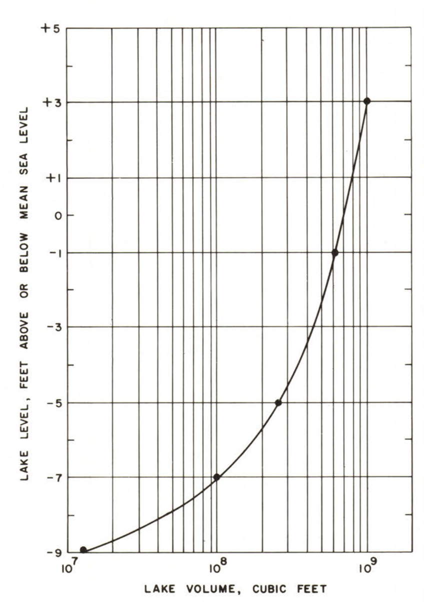


Figure 2. Graph of stage-volume relation for Lake Tarpon.

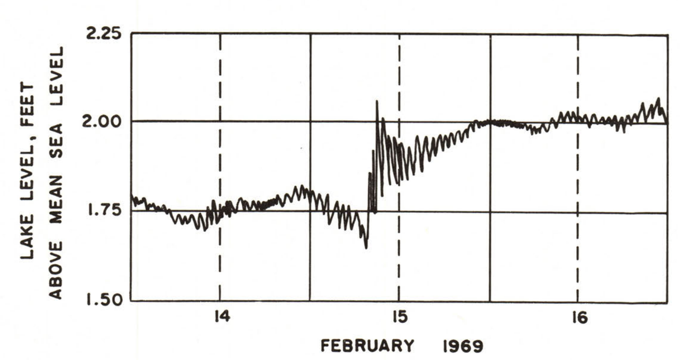


Figure 6. Graph showing example of seiches and tidal fluctuations of the level of Lake Tarpon before enclosing the sink.

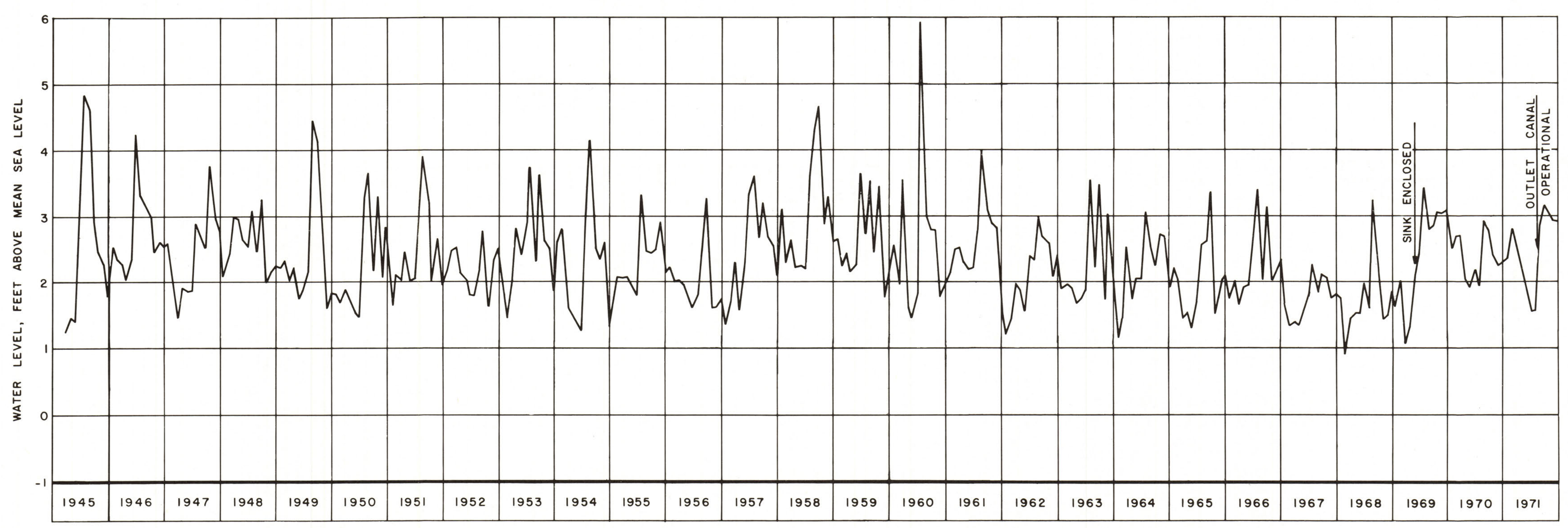


Figure 5. Graph of month-end water levels in Lake Tarpon, 1945-71.

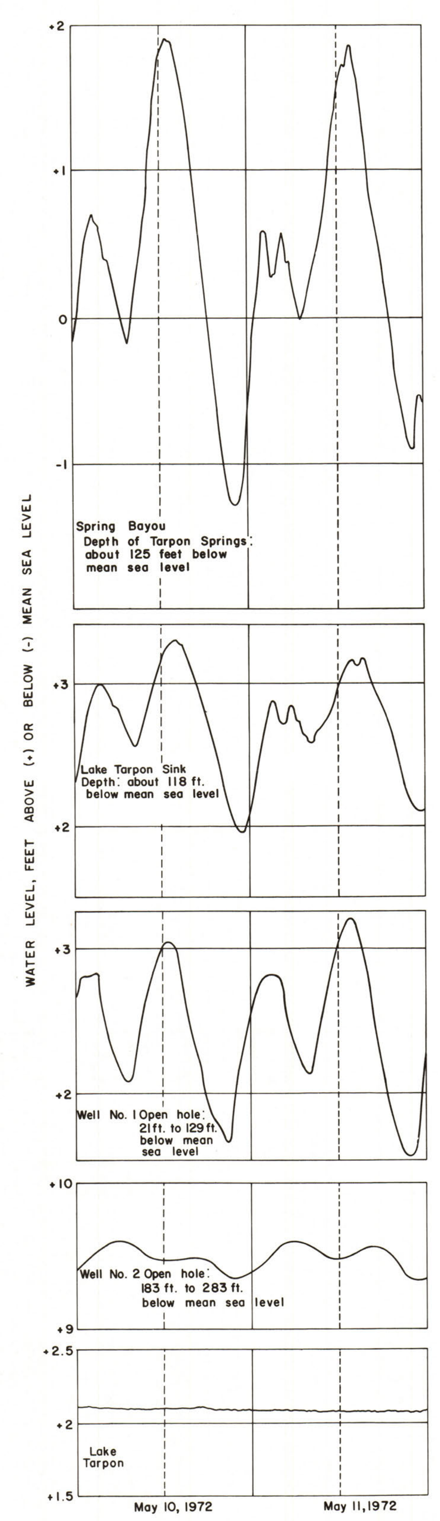
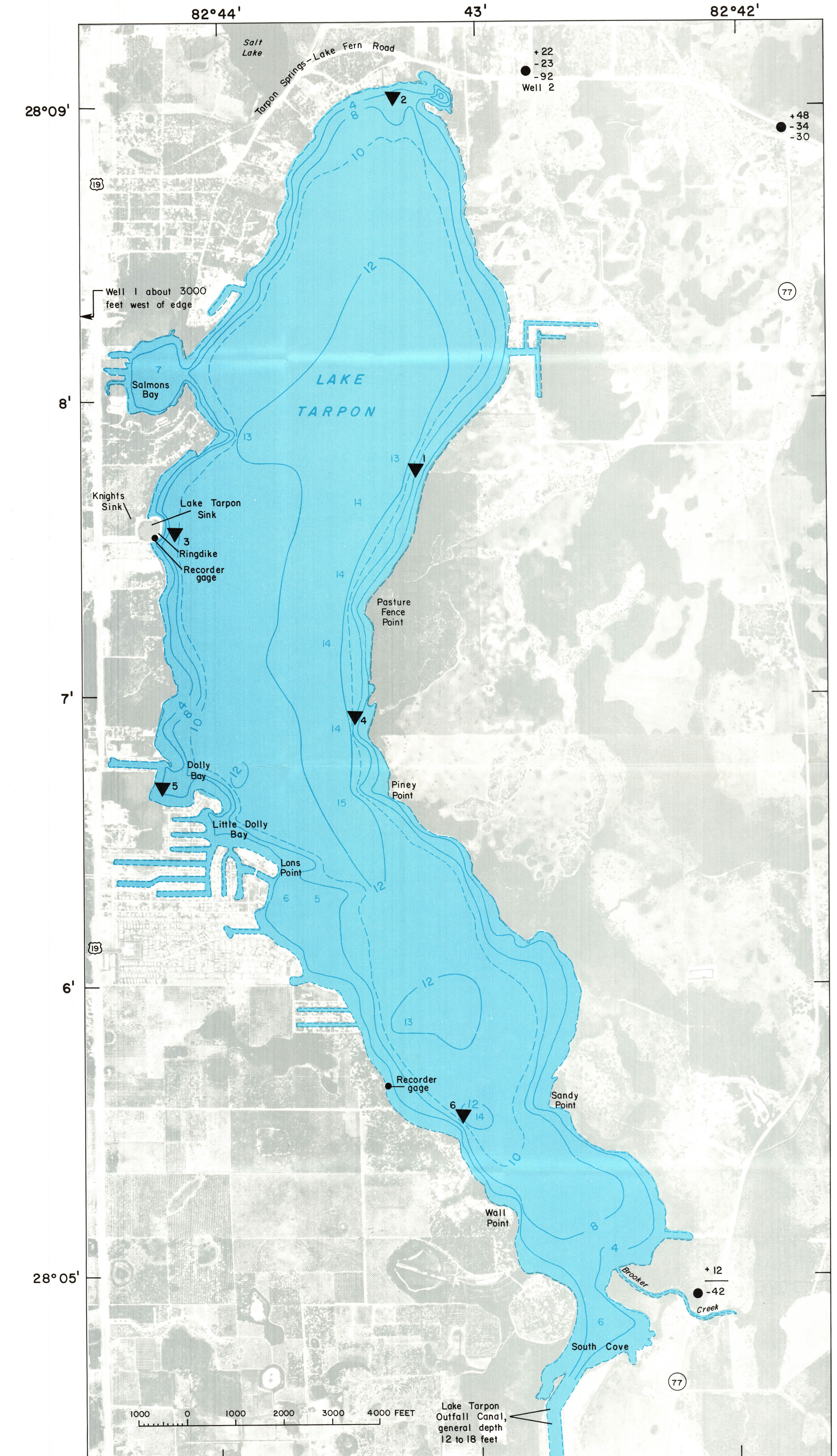


Figure 4. Graphs showing comparison of tidal fluctuations in Spring Bayou with water levels in Lake Tarpon Sink, observation wells and Lake Tarpon.



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EXPLANATION

8 — Depth contour, May, 1972.

Contour interval 4 feet. Dashed supplementary 10-foot contour.

Datum is lake stage of 3 feet above mean sea level.

6 ▼ Sampling site and number shown in table 1.

+22 land surface
● -23 top, confining bed
-92 top, Floridan aquifer

Altitude in feet above (+) or below (-) mean sea level

Geologic datum point. Detailed log available.

624,Photography May 5, 1972, by Kucera and Associates, Inc., Lakeland, Florida