HYDROGRAPHIC AND SEDIMENT THICKNESS ANALYSIS OF LAKE POINSETT AND BLUE CYPRESS LAKE WITHIN THE UPPER ST. JOHNS RIVER BASIN

PROJECT 91D159

PREPARED FOR:

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT
PALATKA, FLORIDA

APRIL 1992

COASTAL PLANNING & ENGINEERING, INC.

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EXECUTIVE SUMMARY

In December 1991 and January 1992, Hydrographic and Sediment Thickness Surveys were conducted on Lake Poinsett in Brevard County, and Blue Cypress Lake in Indian River County. Both lakes are located within the Upper St. Johns River basin. The bathymetric surveys were conducted using a state-of-the art fully automated hydrographic system. This system consisted of an Innerspace 448 Fathometer, a Trisponder 540 microwave navigation unit and a fully integrated data acquisition and reduction software package, Coastal Oceanographic HYPACK, run on a Toshiba 1600 lap-top personal computer. Sediment thickness surveys were also positioned with the system. Sediment depths were obtained using a low pressure water jet probe.

The bathymetric survey was conducted along tracklines spaced at 1000 feet with data obtained every 100 feet in open water and at no less than 500 feet across areas of aquatic vegetation. Sediment thickness surveys were conducted on a 1000 feet sampling grid. The data was edited and reduced for water elevation and squat, contoured and plotted as bathymetric and sediment thickness charts. Analysis of data included water stage area and stage volume computations. Sediment volume and surface area curves were plotted related to the sediment thickness for each lake. Water depth values and lake volumes calculated assume that the water/flocculent sediment layer interface is the bottom of the lake and do not account for interstitial water within the organic sediments.

Lake Poinsett's volume and stage area analysis included the surrounding wetlands. The calculated lake volume of Lake Poinsett is 1.2125×10^9 cubic feet (ft^3) at the reference elevation of 13 feet NGVD. Inundating the lake and marsh to a water elevation of 15 feet NGVD would increase the total lake volume by approximately 80% to 2.1738×10^9 ft^3. The average water depth of Lake Poinsett at its reference elevation is 3.8 feet.

Analysis of volume and stage area on Blue Cypress Lake did not include the surrounding wetlands due to the limited topographic data available on the USGS Topographic Charts. The calculated lake volume for Blue Cypress is 2.3048×10^9 ft^3 at its reference elevation of 23 feet NGVD. The average depth in Blue Cypress is 7.8 feet.

In Lake Poinsett, the sediment was thickest in a pocket near the center of the lake. In Blue Cypress the central basin contained the thickest sediment. This sediment generally consisted of soft flocculent material. A second area of thick sediment in both lakes occurred around the margin in the form of a shore terrace. This material encroaches into the lake and consisted of a more consolidated organic sediment than found in the center of the lakes.

The average sediment thickness in Lake Poinsett is 1.3 feet with a total volume of 0.2266×10^9 ft^3. The average sediment thickness in Blue Cypress Lake is 4.9 feet with a total volume of 1.4430×10^9 ft.

An error analysis was performed on the fathometer surveys for both lakes. The results indicated that the vertical repeatability of the fathometer soundings was very good. The fathometer was compared with a photoelectric device used to delineate the flocculent layer. The average difference was found to be 0.04 feet which indicates the fathometer was reading the top of the flocculent layer.

It is recommended that surveys of the marsh areas be conducted, in the future, to more closely quantify stage-volume at Lake Poinsett and Blue Cypress Lake. Lake Florence, adjacent to Lake Poinsett, should be surveyed to more closely measure the volume-stage relationship. To assure comparable results, future surveys should utilize positioning and depth measurement equipment of comparable accuracy as well as utilize the same tracklines.

HYDROGRAPHIC AND SEDIMENT THICKNESS
ANALYSIS OF LAKE POINSETT AND
BLUE CYPRESS LAKE WITHIN THE UPPER
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1.0 INTRODUCTION

St. Johns River Water Management District (SJRWMD) is developing data for use in restoration and management programs within the Upper St. Johns River. An important objective of this project is to determine the physical and ecological condition of the lakes in the basin. As a first step toward this objective, bathymetric and sediment thickness data are needed for the lakes along the river. This data will then be used by SJRWMD scientists to assess sedimentation rates, water quality and other water resource parameters.

This study investigates Lake Poinsett and Blue Cypress Lake in the upper St. Johns River Basin. Locations of the lakes are shown in Figure 1 and further described in Table 1.

TABLE 1

SURVEYED LAKES IN THE UPPER ST. JOHNS RIVER BASIN

Lake	Surface Area (Square Miles)	County	Location (Latitude, Longitude)
Lake Poinsett	11.5	Brevard, Osceola and Orange	28° 20' 00", 80° 50' 00"
Blue Cypress	10.6	Indian River	27° 38' 00", 80° 45' 00"

Horizontal and vertical shore control surveys of these lakes required for the bathymetric and sediment thickness surveys were conducted in September and October of 1991. The bathymetric surveys were conducted in December of 1991 and January of 1992. Organic sediment depths and the extent of bottom coverage for each lake was also measured during the bathymetric survey.

2.0 METHODS

The scope of services for this investigation included mapping the bottom contours and sediment thickness of two lakes in the Upper St. Johns River Basin. Bathymetric data were collected along tracklines spaced at 1000 feet, with data obtained every 100 feet along the tracklines in open water and at no less than 500 feet across areas of aquatic vegetation. Sediment thickness surveys were conducted on a 1000 feet sampling grid within each lake, to compare with bathymetric data for sediment volume calculations.

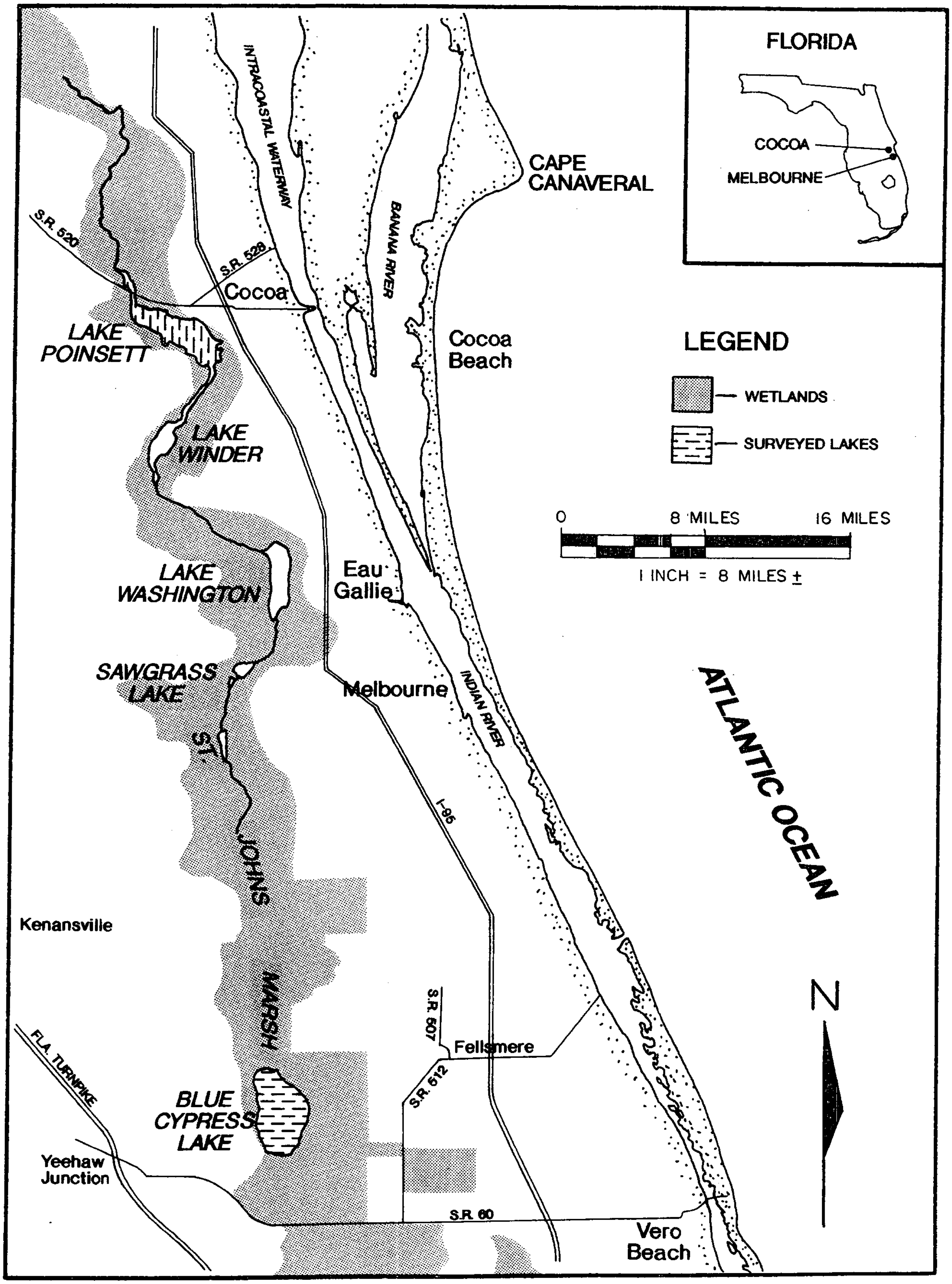

FIGURE 1

LOCATION MAP OF SURVEYED LAKES IN UPPER ST. JOHNS RIVER BASIN

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2.1 Field Measurements

2.1.1 Horizontal Control (Global Positioning System Survey - [GPS])

The location of the shore-based survey control was of primary importance and was carefully planned out prior to beginning the field operations. Potential areas for control monumentation were located using USGS Topographic Maps. The areas selected had to provide for coverage of the entire lake as well as provide the required angles between trisponder remotes. The shore control to be used for navigation had to be strategically placed around each lake to assure the accuracy of the transponder system used for the hydrographic surveys.

Establishing survey control by GPS requires an unobstructed view of available satellites. This did not pose any problem on Lake Poinsett due to the high ground of existing levees. Standard 24" x 4" x 4" concrete monuments were set at 3 locations south of the lake. The southeast and south central location were sited on levees. The southwest site was established as high up into the open marsh as was accessible by airboat during the survey. There was no dry land around Blue Cypress and an abundance of cypress trees lined most of the shoreline. This required jetting 10 foot sections of 4 inch diameter PVC pipe into the lake, for use as survey control monumentation. These pipes were filled with concrete and affixed with a standard 3 inch brass survey disc.

The control stations for the GPS survey were based on the existing survey control of the Florida High Precision Network System (a 30 mile grid network established throughout Florida) and the National Geodetic Survey (NGS). These station names and state plane coordinates are listed in Table 2, based on Florida state plane coordinate system, east zone 0901, North American Datum 1927 (NAD 27). Shore control station locations for Lake Poinsett and Blue Cypress are plotted on Figure 2 and 3, respectively.

GPS data collection was performed using three Trimble Model 4000ST receivers, simultaneously. One receiver was set on a control station while the others were set on the lake shore stations. After collecting simultaneous data from at least four satellites for a minimum of one hour, the receivers would be moved pivoting on one of the previous shore stations. This method maintained a triangular closure for each observation.

At the end of each day, the internal memory of each receiver was downloaded to a Toshiba 5200 Lap-top computer. The data would then be reviewed for satellite obstructions, movement and consistency.

These raw data were reduced using Trimble "Trimmup", version D, to produce azimuths and distances of each baseline. This information was then adjusted using Trimble "Trimnitt", version 9.110, which performs a network adjustment.

TABLE 2

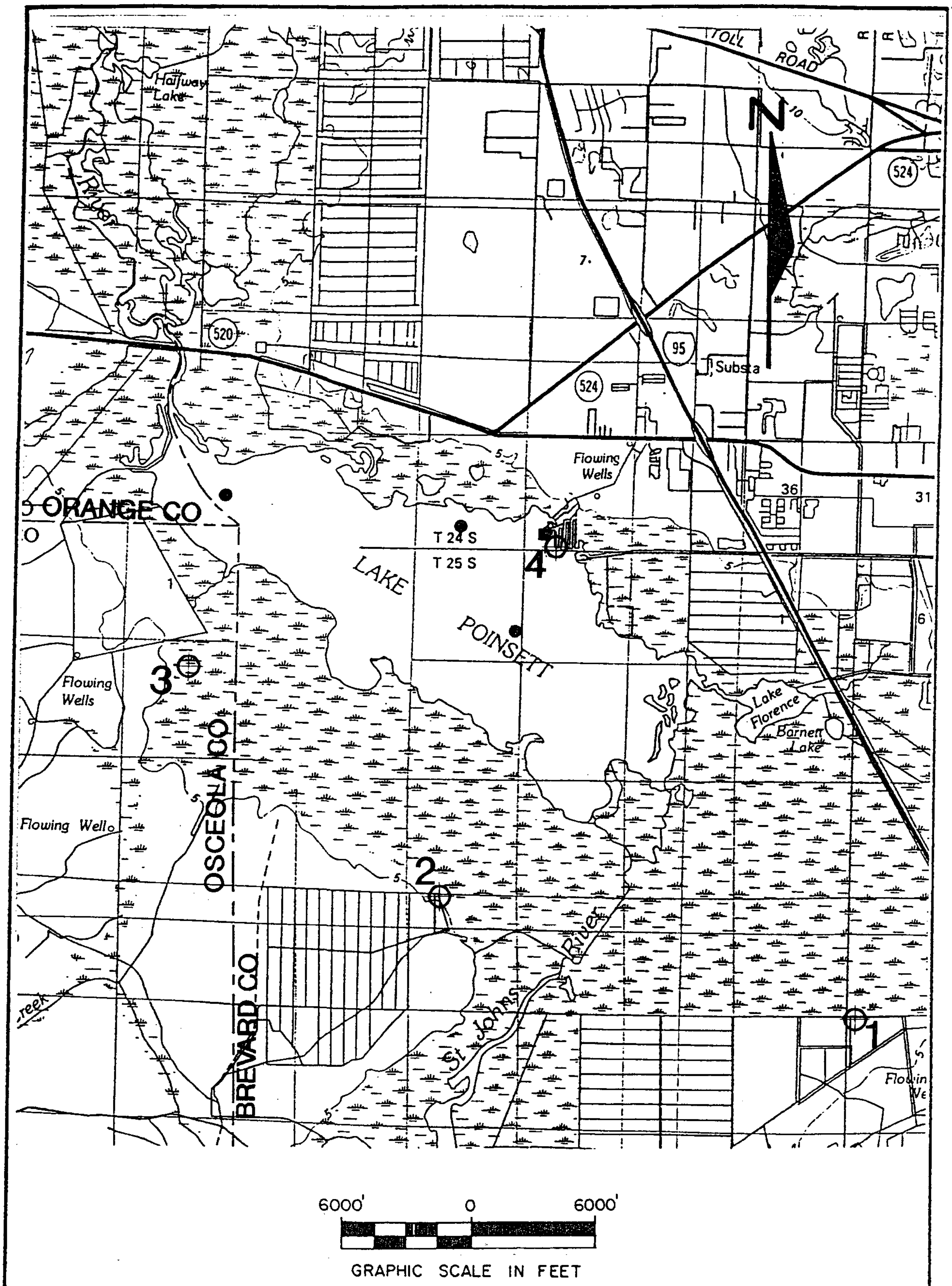
GPS CONTROL AND NAVIGATION STATIONS

Name	Geographic Coordinates (NAD 27)		State Plane Coords. (NAD 27)	
	Latitude	Longitude	X	Y
LAKE POINSETT				
CON2[1]	28°20'53.6" N	80°43'46.1" W	587013.20	1459346.93
0001	28°17'14.9" N	80°46'15.2" W	573733.23	1437232.22
0002	28°18'06.5" N	80°49'56.6" W	553934.12	1442406.64
0003	28°19'43.7" N	80°52'13.0" W	541735.52	1452204.22
0004[2]	28°20'45.8" N	80°48'59.4" W	559029.00	1458500.00
BLUE CYPRESS LAKE				
CON1[3]	27°43'15.3" N	80°54'19.6" W	530589.24	1231199.60
0001	27°45'04.8" N	80°46'28.1" W	572945.62	1242315.10
0002	27°45'25.9" N	80°44'58.4" W	580993.63	1244456.03
0003	27°43'13.0" N	80°43'53.8" W	586834.66	1231057.47
0004	27°41'59.6" N	80°44'35.8" W	583072.85	1223628.95
0005	27°41'53.7" N	80°45'56.1" W	575854.70	1223027.81
0006	27°43'36.7" N	80°46'30.1" W	572783.36	1233422.29

[1]CON2 - Target 21 - Derived from NGS Station "Coates"

[2] Secondary Navigation Station

[3]CON1 - FLGPS 52 - Osceola



⊕ = SHORE CONTROL STATION

■ = TIDE STAFF

● = TIDE GAGE

FIGURE 2

LAKE POINSETT NAVIGATION AND WATER LEVEL STATIONS

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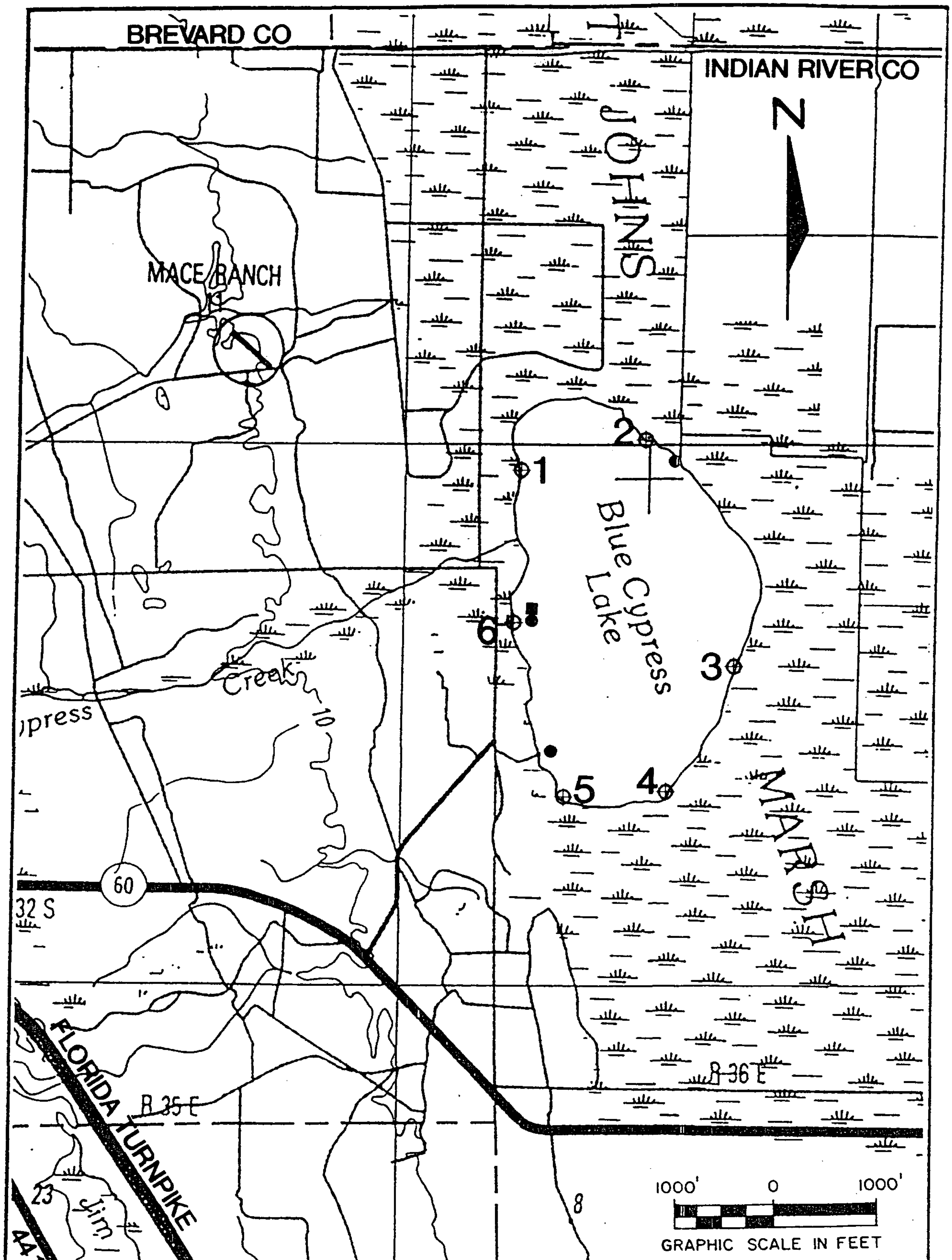

FIGURE 3

⊕ = SHORE CONTROL STATION

■ = TIDE STAFF

● = TIDE GAGE

BLUE CYPRESS NAVIGATION AND WATER LEVEL STATIONS

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During the Lake Poinsett hydrographic survey, vandals repeatedly stole batteries from the shore control stations. To maintain a network of a minimum of three shore stations, a secondary station was established in a more secure area. It was located at the southernmost end of Clifton's Cove Court, south of Poinsett Lodge. The values of this secondary station were generated using the GPS control network and the navigation system used for the bathymetric survey. The accuracy of the location of the secondary station would be ± 1 meter, which maintained the required accuracy for vessel position within Third-Order, Class II Standards.

2.1.2 Vertical Control

Vertical control was needed at the lakes' edge at various locations to place elevations for water level measurements.

Lake Poinsett

For Lake Poinsett, the elevations of the water level recording gauges were established using nearby benchmarks, based on National Geodetic Vertical Datum, 1929 (NGVD). The westerly gauge elevation was established from a Florida Department of Transportation (FDOT) disc (elevation +21.388) set in the southwest corner of the bridge on Route 520 crossing the St. Johns River. The central and easternmost gauges were surveyed from a benchmark supplied by the Brevard County Surveying Department. The benchmark (elevation +19.46) was the north bolt, on the top flange, of the fire hydrant at the northeast corner of the intersection of 520A and Mallard Road.

A temporary water level staff gauge was set on a wooden pier extending into the lake near Poinsett Lodge which was read periodically throughout the survey. The location of these gauges and staff are shown on Figure 2.

Blue Cypress Lake

The elevations of the three tide recording gauges within Blue Cypress Lake were established from benchmarks supplied by SJRWMD Survey Division. The northernmost gauge was established using SJRWMD BM No. 787-20, a standard SJRWMD monument having an elevation of +20.94 feet (NGVD 1929). The central gauge elevation was established from SJRWMD BM No. 754-20 having an elevation of +26.021 feet (NGVD 1929). The southernmost gauge elevation was established from a Coastal Planning & Engineering, Inc. (CPE) monument with an elevation of +25.996. This monument was set at the east end of the outfall canal that runs from the pump station at the Holman Ranch (southwestern corner of the lake). The elevation was established by a closed bench loop from SJRWMD BM #752-20.

The elevation was verified on an existing staff gauge on the SJRWMD automated weather and water level recording station situated east of the Indian River County public boat ramp. The staff was read periodically throughout the entire survey. The locations of these gauges and staff are shown in Figure 3.

2.1.3 Hydrographic Navigation

A digital distance measuring unit (DDMU Del Norte Trisponder 540) which has an accuracy of ± 1 meter, was used for navigation of the bathymetric and sediment thickness surveys.

The Del Norte trisponder system is a 8,800 to 9,500 Mhz microwave line-of-sight positioning system. This system utilizes the transmission of electromagnetic (EM) waves from a boat mounted transmitter (master) and two or more shore stations (remotes) to fix the vessel's locations. Distances and thus positioning are determined by measuring differences in signal travel time from the master transmitter to the remote location and back. The trisponder consists of a digital distance-measuring unit (DDMU), a master (transmitter/receiver) mounted on the survey boat and two to four remote units (receivers/transmitters) which are positioned over known geographic locations. The master antenna is omni directional, while the remote antennas are directional and must be positioned toward the survey area.

The configuration used for this study consisted of a master unit mounted on the mast of the survey vessel and up to four (4) shore-based remotes (Figure 4). Three to four remotes were utilized concurrently. The master unit interrogated each remote individually. The return signals were deskewed by the 540 DDMU to the same point of time, so that the output data was the same as being simultaneously obtained. The range information received from the remote locations was then trilaterated to obtain the position or fix of the survey vessel.

The redundancy of more than two remotes provides more data for computation of the boat's location which in turn results in a more accurate survey. The redundancy allows the survey to continue even during a temporary loss of a range. It also filters out inaccurate range measurements which may periodically occur due to reflections of the signal.

In the field, the trisponder system was interfaced with the Coastal Oceanographic Navigational HYPACK software, run on a Toshiba 1600 lap-top personal computer. The Coastal Oceanographic, Hydrographic Data Collecting/Processing program is a state-of-the-art navigation and hydrographic surveying system. The

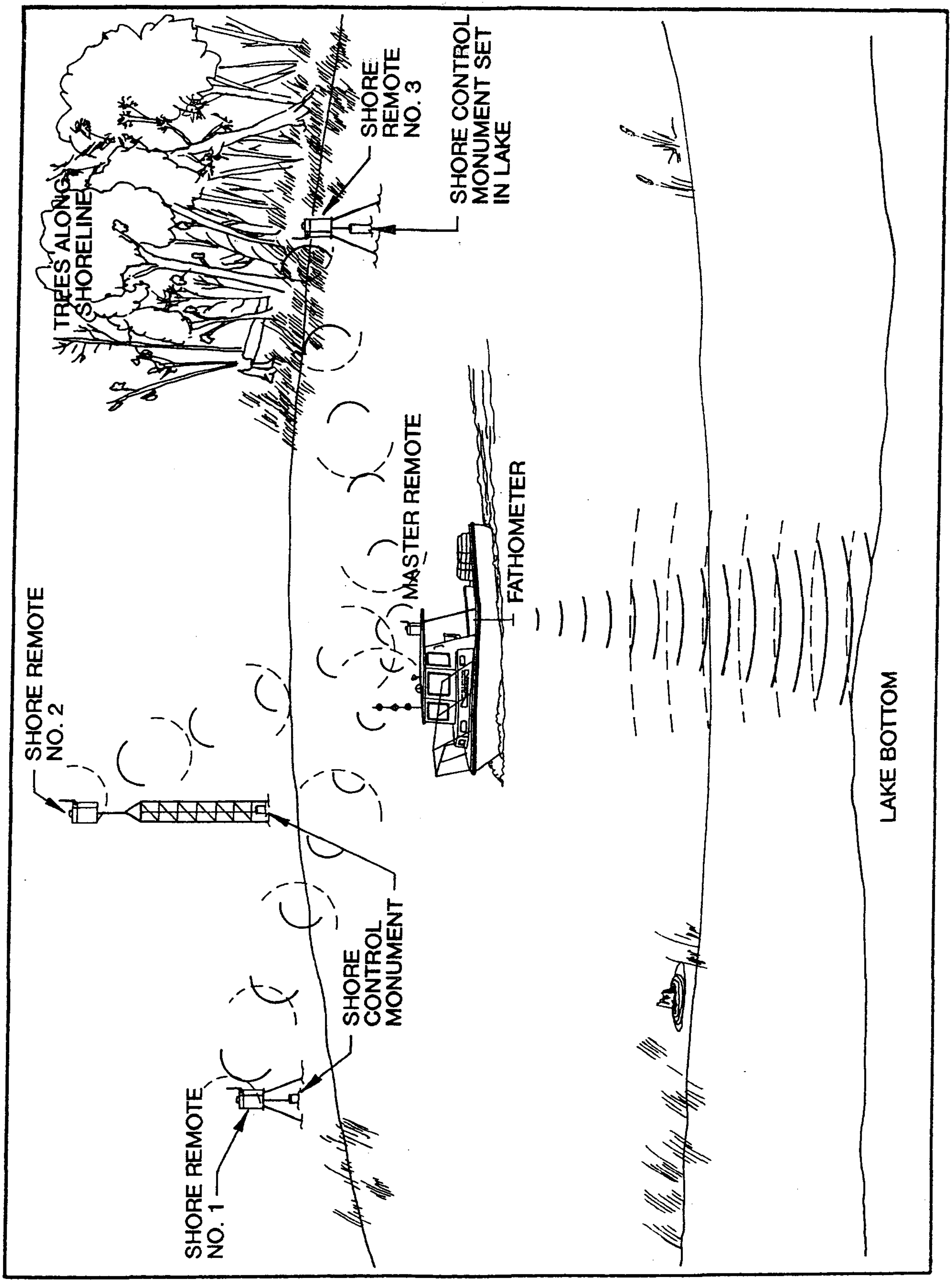

FIGURE 4

BLUE CYPRESS & LAKE POINSETT
HYDROGRAPHIC POSITIONS AND SOUNDING SYSTEM

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software supports both range-range and range-azimuth positioning systems, as well as interfaces to digital fathometer, plotters, printers and remote graphic displays. On-line screen graphic displays include the pre-plotted survey lines, the updated boat track across the survey area, adjustable left/right indicator, as well as other positioning information such as boat speed, quality of fix and line bearing. All data obtained were recorded on the hard disk which can be quickly and easily transferred to a 3.5 floppy disc to provide back-up storage of data as they were obtained.

The Hypack program provides guidance information to direct the helmsman along pre-determined tracklines across the study area. The location of the shore remotes coordinates of the tracklines and other navigational information is entered into the Hypack program. The system updates every second and records location and depth data. Fixes were obtained and marked on the analog record every 100 feet along the tracklines. For these surveys, all positions were converted to State plane coordinates for the east zone of Florida (NAD 27).

2.1.4 Bathymetric Survey

The open water bathymetric surveys of both lakes were conducted from CPE II, a 24 foot semi-enclosed Privateer outfitted with two 120 horsepower outboard motors.

The Innerspace Model 448 Fathometer was used for the open water portion of the survey. The fathometer operates at 209 kilohertz and is a survey-grade fathometer, accurate to $\pm$ 0.1 feet and capable of operating in depths of 1.5 to 500 feet. To ensure this accuracy, the fathometer was calibrated at the start of each survey day, periodically throughout the survey, at the end of each paper roll, and the end of each day. This calibration was accomplished at two depths with a graduated sounding line equipped with an acoustic target suspended below the transducer.

The fathometer transducer attached to a boat generally displaces vertically when a vessel is underway, relative to its position at rest. The factors accountable for this vertical displacement are termed "settlement" and "squat".

The combined effects of settlement and squat at various sounding speeds (2 to 5 knots) were determined prior to the commencement of each survey project.

Measurements were made for the survey vessel carrying a normal load of personnel and equipment with care being taken to insure an average trim to the vessel. The squat test was accomplished by setting a standard leveling instrument on shore and a survey level rod secured to the fathometer transducer. An elevation is recorded from shore with the boat at rest. The vessel is then motored past the instrument man at normal survey speeds. The level rod is held over the same location, and the elevation is again read from the survey level ashore. The difference between the two readings is the result of the combined effect of settlement and squat at the location of the transducer. Several measurements of reasonable agreement are averaged for the final value.

The squat of the survey vessel used for the fathometer surveys was 0.1 feet at normal survey speed. This value was applied to the survey data during the reduction phase.

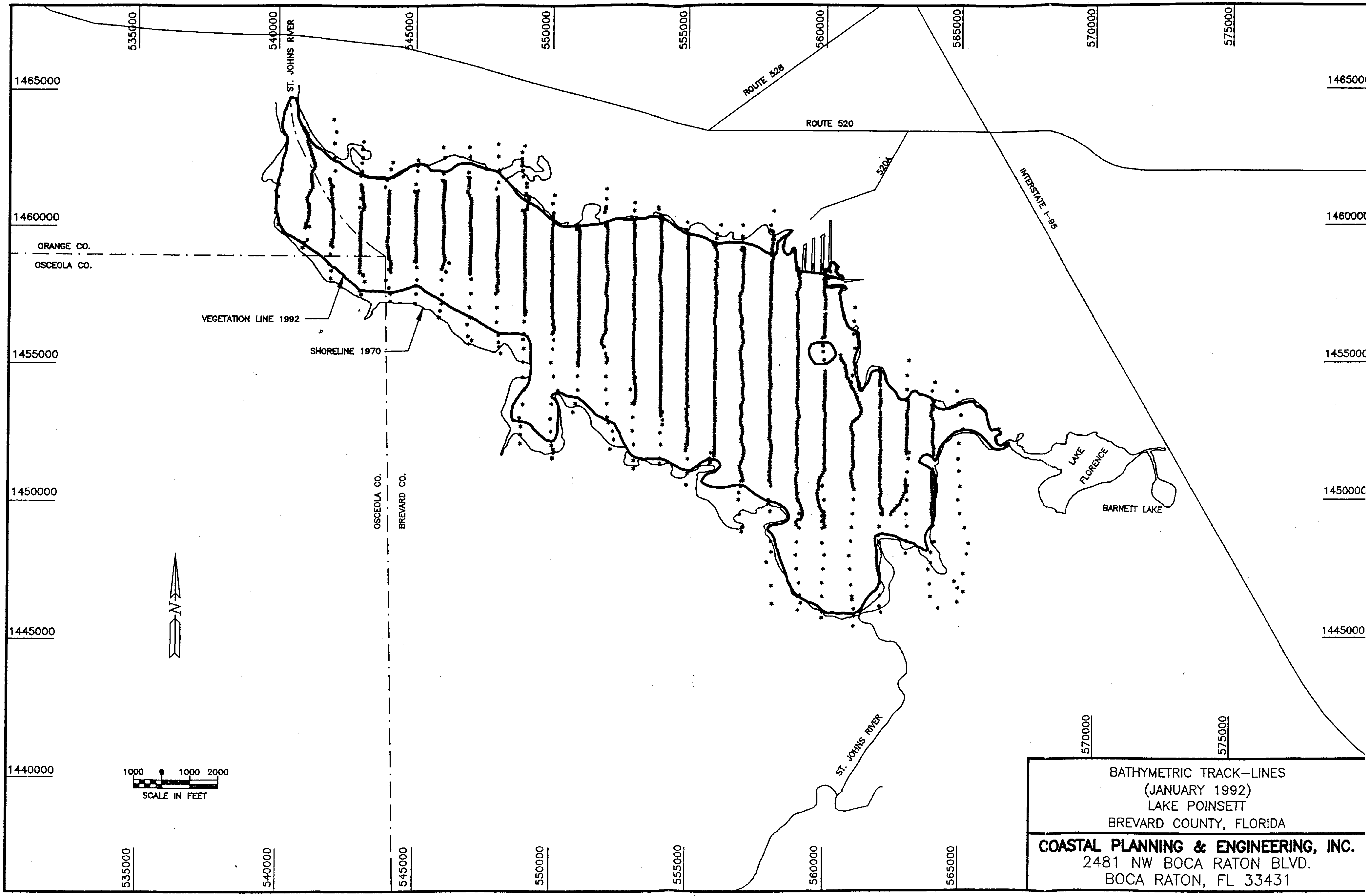
The second phase of the bathymetric survey encompassed the areas of submerged vegetation within the lake and the emergent vegetation along the shoreline. An airboat was used as the survey vessel to provide access across the marsh and shallow depth of the lake. Soundings were obtained using a graduated survey rod with a six inch diameter plate attached to the pole to provide resistance to sediment penetration.

<u>Poinsett Lake</u>

The bathymetric survey of Lake Poinsett was started on December 16, 1991, with the installation of three electronic stage gauge recorders. The open water bathymetric survey began on the 18th, but was shut down midday on the 19th, due to high winds. The open water survey restarted on January 5, 1992, and was completed January 6, 1991. The shoreline, manual rod surveys of Lake Poinsett were completed between January 7 and 9, 1992. Figure 5 shows the tracklines run across Lake Poinsett in a north/south direction.

<u>Blue Cypress Lake</u>

Blue Cypress Lake was surveyed using the Innerspace 448 Fathometer between January 22 and 28, 1992. Cypress trees and reeds (bulrush) fringe the shoreline of the lake and extend 200 to 500 feet from the shore into the open water. The fathometer survey was not extended into this region, due to the submerged logs, stumps and reeds. The nearshore area was mapped on the 28th and 29th, using the manual survey method. A 14 foot Boston Whaler was used to maneuver between the cypress trees and stumps up to the dry shoreline. In areas where the trees and stumps would not allow boat access to the edge of the lake, the distance to the shoreline was estimated. This distance was generally less than 50 feet. Manual soundings were obtained with the graduated rod, fitted with a six inch bottom disk. Figure 6 shows the tracklines run across Blue Cypress Lake in an east/west direction.



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520A
INTERSTATE I-95
ORANGE CO.
OSCEOLA CO.
VEGETATION LINE 1992
SHORELINE 1970
OSCEOLA CO.
BREVARD CO.
LAKE FLORENCE
BARNETT LAKE
N
1000
1000 2000
SCALE IN FEET
ST. JOHNS RIVER
BATHYMETRIC TRACK-LINES
(JANUARY 1992)
LAKE POINSETT
BREVARD COUNTY, FLORIDA
COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
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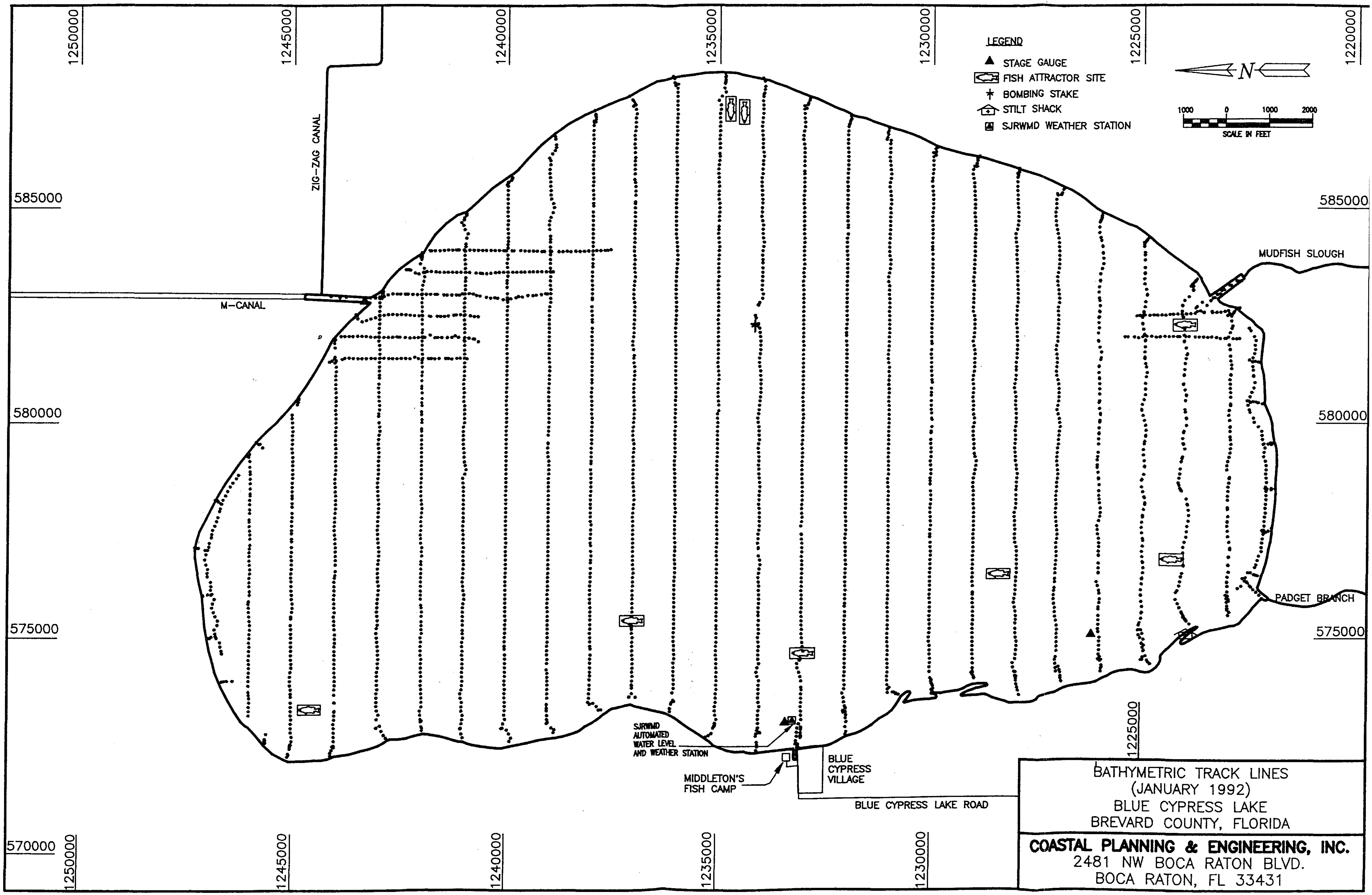
FIGURE 5



BATHYMETRIC TRACK LINES
(JANUARY 1992)
BLUE CYPRESS LAKE
BREVARD COUNTY, FLORIDA

COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 6

Photoelectric Device

Fathometer soundings were checked using a photoelectric device provided by the SJRWMD, to determine the water/flocculent layer interface. Redundant survey lines were sampled on each lake for the fathometer error analysis. Photoelectric device soundings were obtained from each of these lines at 2000 foot intervals. The photoelectric device was mounted on a rigid graduated pole and consists of a light source focused on a photoelectric cell. A voltmeter was wired to the photoelectric cell which registered the presence of the light beam. When the head of the photoelectric device was lowered into the flocculent sediment layer, the light beam was broken, resulting in a drop in the voltage. The depth was read from the graduated pole when this drop was noted. This depth was then compared to the fathometer reading at the same location.

Water Level Measurements

Water level measurements were made using electronic stage recorders. These gauges average over 100 readings per cycle to eliminate wave induced changes. Three (3) gauges were set in each lake relative to the vertical datum of NGVD. Surface water level fluctuations were recorded continuously during the bathymetric surveys.

The water level on Lake Poinsett fluctuated 0.7 feet between December 7, 1991 and January 10, 1992, during the survey period (Table 3). Blue Cypress Lake fluctuated only 0.02 feet between January 22 and 28, 1992. These water level variations were used to correct the hydrographic survey data. There was no indication, based on gauge data, of a slope on the surface of either lake during the surveys. This may be due to the fact that surveys were performed in calm weather and no wind set-up was experienced.

A reference elevation was determined for each lake, at the request of the SJRWMD, using the approximate elevation of the lake at the time of the survey.

TABLE 3

LAKE REFERENCE WATER LEVEL (NGVD)
AND MEASURED WATER LEVELS

Lake	Reference Level (Ft)	Maximum (Ft)	Minimum (Ft)	Range (Ft)
Poinsett	13	13.52	12.85	0.67
Blue Cypress	23	23.28	23.26	0.02

2.1.5 Sediment Thickness Measurements

Prior to conducting the jet probe survey on Blue Cypress Lake, a low frequency model 449 Innerspace Fathometer was tested. The use of this fathometer could, if successful, reduce the time required to complete the sediment thickness survey and provide a continual cross-section of the lake bottom sediments. The fathometer was equipped with a 41 kHz transducer which can penetrate suspended sediments and light silt. The analog records of the low frequency fathometer were "washed out" by the high organic content of the lake sediments. Therefore it was determined that manual methods of sediment determination would be required.

Two methods were utilized to manually measure sediment thickness: a 3/4-inch PVC graduated rod and a low pressure jet probe. The 3/4-inch PVC rod was used only in the area of submerged aquatic vegetation which was surveyed from the air boat. This probe method was necessary because the water intake for the jet probe pump would become blocked by the submerged vegetation. Approximately 20% of the probes on Lake Poinsett were taken by this method. The remaining sediment thickness was determined with the use of the low pressure water jet probe. The apparatus consisted of 5-foot sections of 1-inch diameter PVC pipe connected by flexible hose to a 3 hp gasoline driven water pump. Water force was manually controlled by adjusting a relief valve included in the hose system (Figure 7).

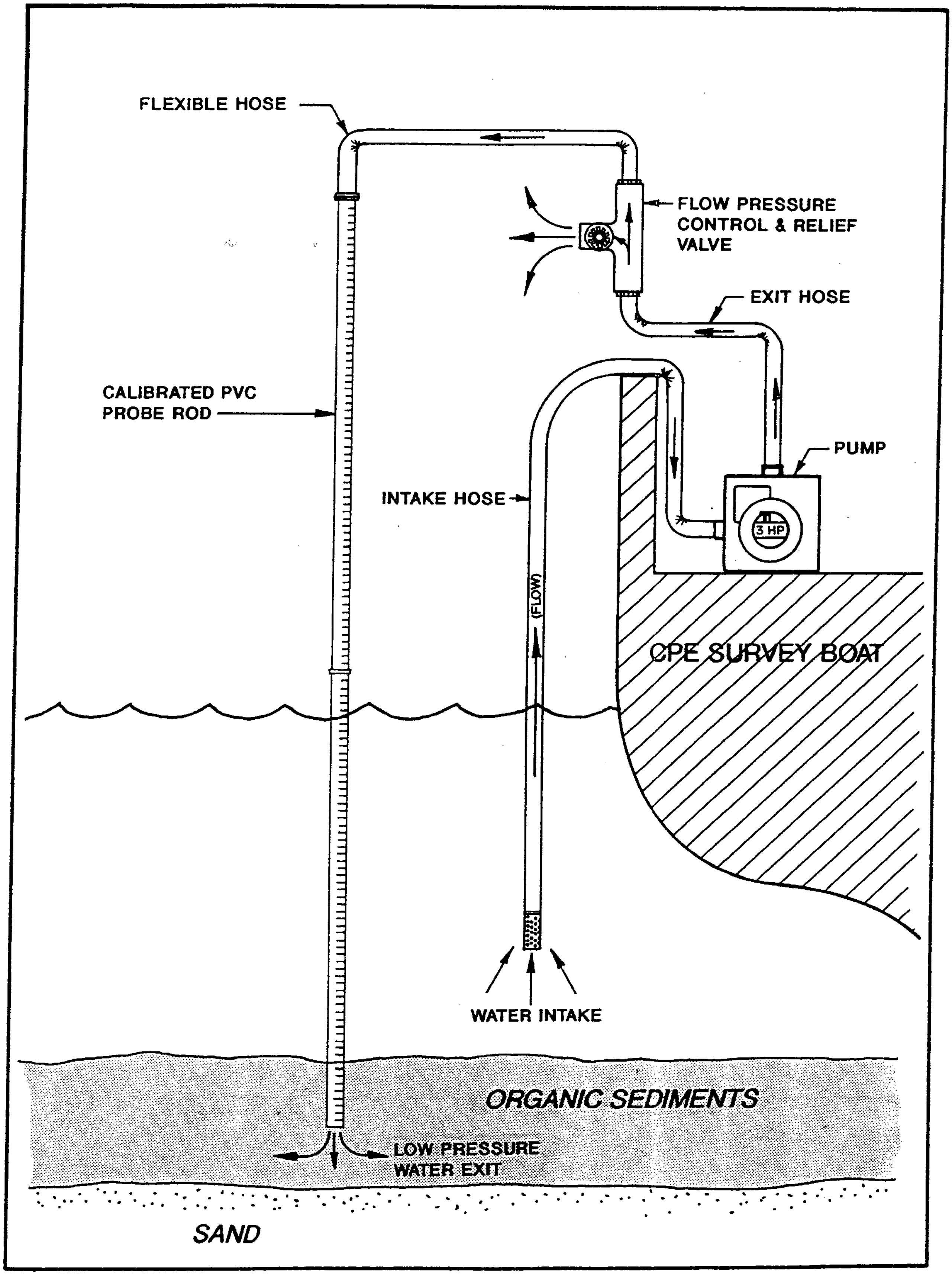


FIGURE 7

FINE SEDIMENT JET PROBE SYSTEM

Pressurized water forced out the end of the probe disturbed the fine sediment directly under the pipe enabling the operator to push the pipe down through the soft sediment layer and determine by feel where the harder sandy bottom started. The operator then determined where the waterline intersected the graduated lines marked on the PVC pipe and recorded the depth of penetration.

Sediment thickness on Lake Poinsett was measured between the 7th and 10th of January, 1992. Figure 8 shows the grid pattern used within Lake Poinsett. Both methods of measurement were used in Lake Poinsett. Blue Cypress Lake was investigated with the low pressure jet probe device and was completed between January 27 and 31, 1992. Figure 9 shows the grid pattern surveyed on Blue Cypress Lake. The western third of Blue Cypress Lake was determined to be exposed sand from interpolation of the fathometer records. Hard bottoms, such as sand, return a sharp signal which traces as a thin line. In soft sediment, the signal is reflected off the flocculent layer water interface but also penetrates below this surface resulting in a wide trace on the analog record. The jet probe was used across the area of flocculent organic sediment. The hard sand bottom area was confirmed using the graduated sounding rod with a six inch plate, at each pre-determined jet probe site.

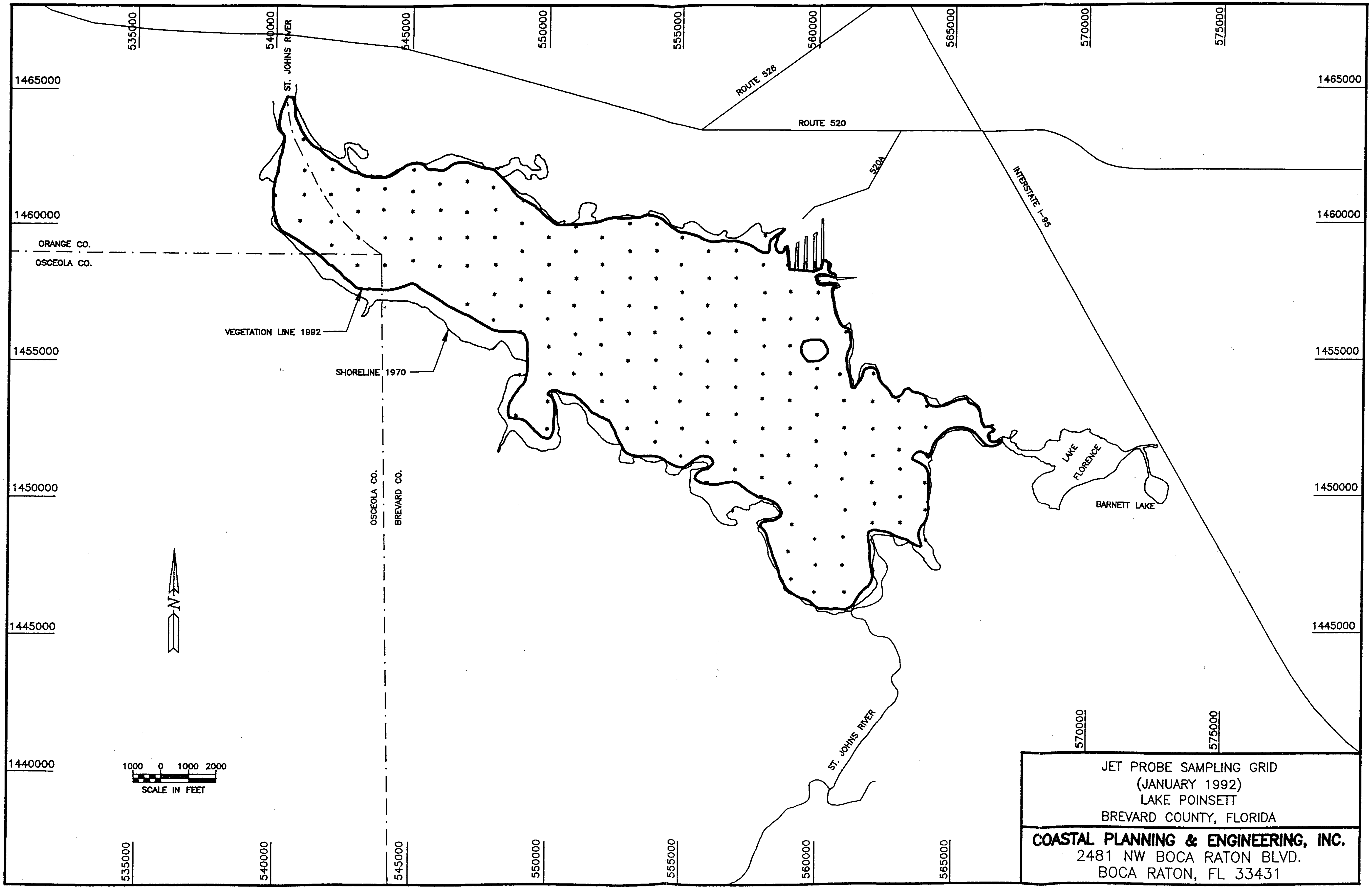
2.2 Data Reduction

Hydrographic data obtained included: digital data stored on magnetic disk; analog records of fathometer charts; field book annotation of manual depths; jet probes; squat tests; tide readings; and surveyor observations and remarks. These data were reduced to develop the final databases and charts used for volume computations and analyses.

2.2.1. Data Editing

Bathymetric data were edited using Coastal Oceanographic Data Editing software. Analog fathometer records were reviewed against the digital data display graphics on a color monitor screen. Anomalous data were corrected to the analog chart depths. Manual depth data recorded in the field book were applied to the digital coordinate data. Depth data were corrected for errors due to vessel squat and converted to elevations, feet NGVD. The resulting data were combined to provide a tabulation for each line to be provided to the District in a Lotus 123 spreadsheet format. These data were also imported into SURFER for contour plotting and volume computations.

The shoreline of each lake was digitized from USGS 1:24000 topographic quad sheets using AutoCad software on a Calcomp digitizing tablet with a physical resolution of 0.001 inches, thus providing a scaling accuracy of 2 feet at 1:24000. Recorded field observations on the location of emergent vegetation were compared with the digitized charts and differences were also plotted.



JET PROBE SAMPLING GRID
(JANUARY 1992)
LAKE POINSETT
BREVARD COUNTY, FLORIDA

COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 8

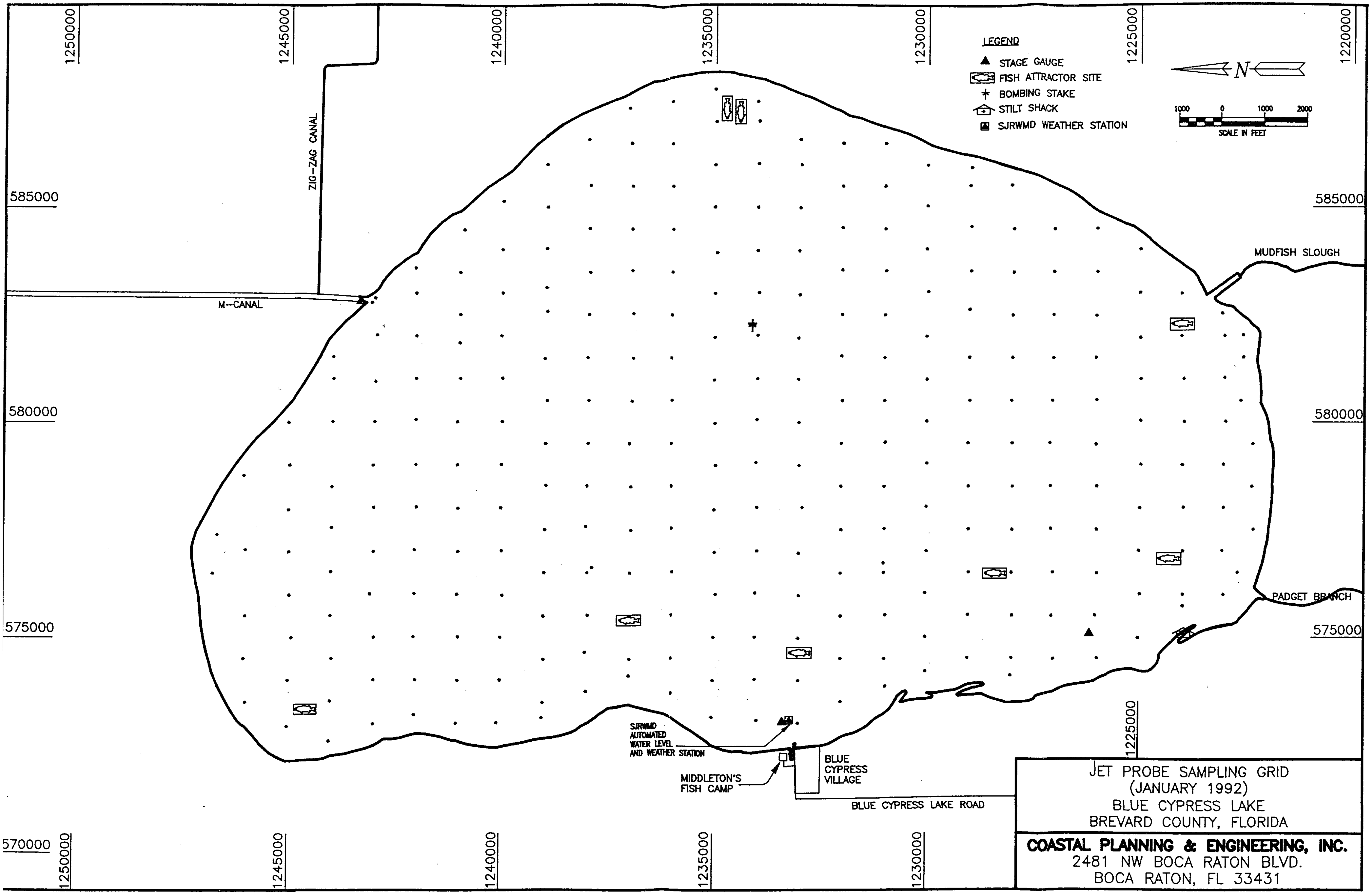

LEGEND
STAGE GAUGE
FISH ATTRACTOR SITE
BOMBING STAKE
STILT SHACK
SJRWMD WEATHER STATION
N
1000 0 1000 2000
SCALE IN FEET
1250000
1245000
1240000
1235000
1230000
1225000
1220000
585000
580000
575000
570000
ZIG-ZAG CANAL
M-CANAL
MUDFISH SLOUGH
PADGET BRANCH
SJRWMD AUTOMATED WATER LEVEL AND WEATHER STATION
MIDDLETON'S FISH CAMP
BLUE CYPRESS VILLAGE
BLUE CYPRESS LAKE ROAD
JET PROBE SAMPLING GRID
(JANUARY 1992)
BLUE CYPRESS LAKE
BREVARD COUNTY, FLORIDA
COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 9

Sediment data editing was similar to the manual depth readings. The depth of the hard layer below the fine organic layer was stored with the coordinate data for each sampling site.

2.2.2 Contour and Plotting

Edited data from the Coastal Oceanographic software was transferred into SURFER, a topographic contouring package developed by Golden Software. Contours were generated in SURFER by the program module GRID utilizing a Kriging algorithm with an octant search method taking the nearest 4 points within 1000 feet of the grid cell. Grid cell size for each lake was done at 150 feet.

Grid files created in SURFER were next transferred into the TOPO module to produce preliminary contour plots and create DXF files of the contour files. Volume computation and final contour plots were developed by transferring the DXF files into the AutoCad design package installed on an IBM compatible 80486 computer.

For Lake Poinsett, the 15 foot (NGVD) contour was digitized on approximately 1000 foot centers from USGS 1:24000 Topographic Quad Sheets. The 15 foot contour generally defines the limits of the wetlands around Lake Poinsett. The digitized shoreline of Lake Poinsett from the USGS Topographic Quad Sheets represents the lake's edge based on aerial photographs taken in 1970. The position of the lakeward edge of the reeds (bulrush) and cattails were determined on each survey trackline run across the shoreline and marsh by the airboat. These data were plotted to develop a vegetation/open water interface line which is plotted on the bathymetric and sediment depth contours maps. These two lines do not match indicating a change in the size of the open water area of the lake.

At the time of the Blue Cypress Lake survey, the level of the lake was measured to be 23.3 feet NGVD. A "dry" shoreline was reached or estimated on each survey line. For the majority of the lake this "dry" shoreline appeared to be little more than a levee of organic debris piled up around the trees and vegetation surrounding the lake. The limiting elevation of the marsh to the west of Blue Cypress Lake is shown as the 25 foot contour of the USGS Topographic Quad Sheets. To the east is a wide expanse of marshes generally limited by the 20 foot contour or dikes. The west to east sloping topography in which the lake is located does not lend itself to expanding the extent of the contours above the reference level of the lake. Therefore, the 23 foot contour was assumed as the reference elevation and the limits of the lake for plotting and volume computations. The digitized shoreline of Blue Cypress Lake taken from USGS quad sheets and developed from 1972 aerial photographs matches closely with the 23 foot contour. SURFER data files for Blue Cypress Lake were transferred into AutoCad for contour editing around the edges of the lake to connect open contours which result at the boundary of grid data.

Charts and maps of each set of bathymetric and sediment thickness data were plotted at 1 foot contour intervals on 11 by 17 inch sheets. Bathymetric plots were also provided in 24 x 36 inch format.

2.2.3 Area and Volume Calculations

Once all editing was completed, the surface area between contour lines was determined using the AutoCad area command, which calculates the area of closed polylines. The surface area result was entered into Lotus 123 to calculate cumulative surface areas and volumes for each contour level.

Lake volumes were calculated at 1-foot contour intervals from each contour surface area. The volumes of the lake and sediment thickness contained within each 1-foot contour was calculated using the truncated cone method (Wetzel, 1983) given as:

$$V=h\times[A1+A2+\sqrt{(A1xA2)}]/3$$

where:
- V = volume of the layer
- h = thickness of the layer
- A1 = area of the upper surface
- A2 = area of the lower surface

Volumes for each layer were totalled for the complete depth and sediment thickness for both lakes to compute the total volumes. Hypsographic curves were developed from this data for the total water volume and organic sediment thickness from each lake.

3.0 RESULTS

Results obtained from these studies included a description of each lake based on the bathymetric and sediment thickness surveys, as well as the stage volume and stage area curves. This information can be used in the District's water resource management programs.

3.1 Bathymetry

Two bathymetric contour plots were made for each lake. The first plot shows contours referenced to NGVD (Figures 10 and 11). These provide actual elevations of the bottom of the lake. These plots were used for all volume and surface area computations. The second plots use the elevation of the lake surface at the time of the survey as the

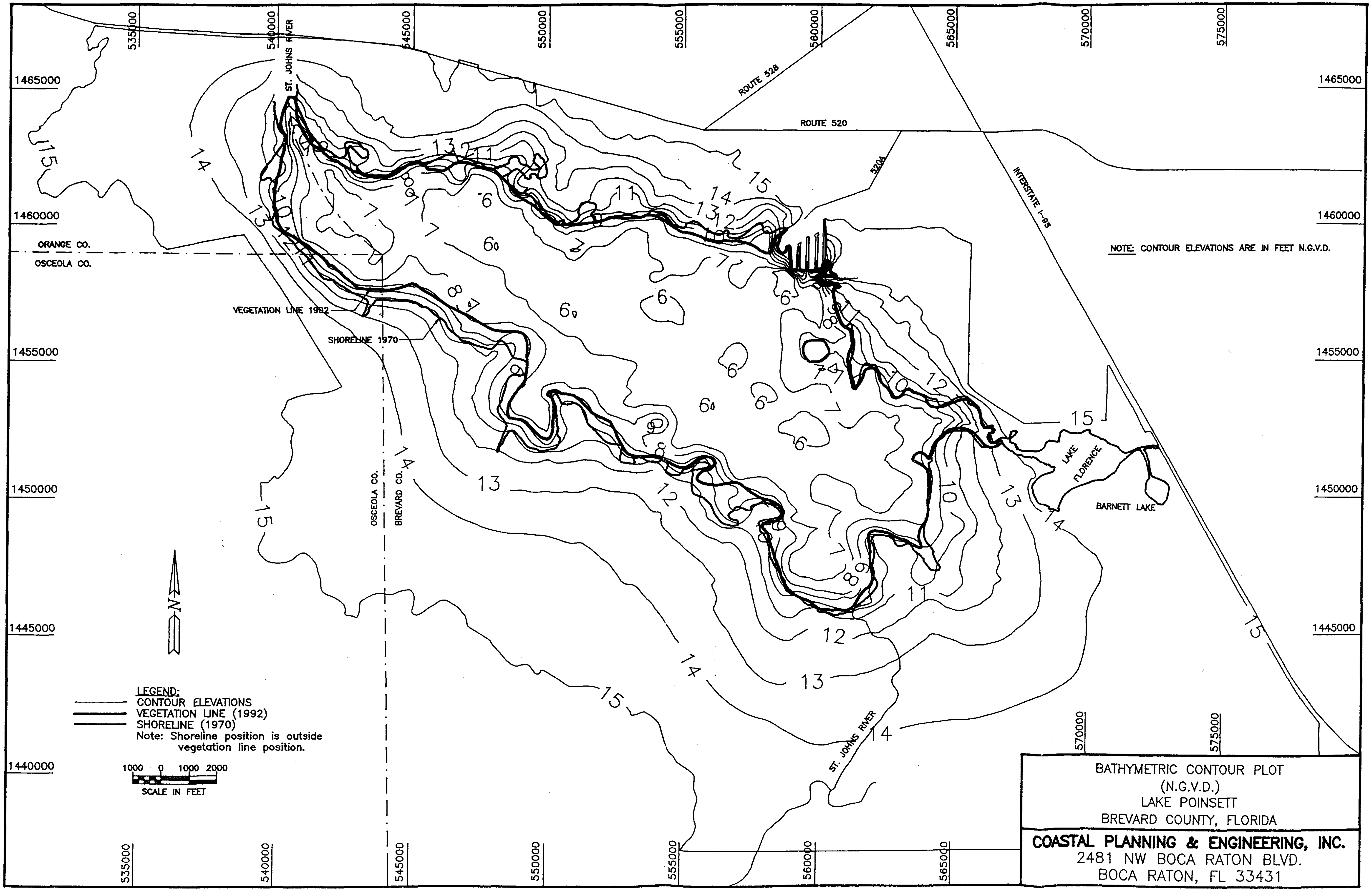

ST. JOHNS RIVER
ROUTE 528
ROUTE 520
520A
INTERSTATE I-95
NOTE: CONTOUR ELEVATIONS ARE IN FEET N.G.V.D.
ORANGE CO.
OSCEOLA CO.
VEGETATION LINE 1992
SHORELINE 1970
OSCEOLA CO.
BREVARD CO.
LAKE FLORENCE
BARNETT LAKE
LEGEND:
CONTOUR ELEVATIONS
VEGETATION LINE (1992)
SHORELINE (1970)
Note: Shoreline position is outside vegetation line position.
1000 0 1000 2000
SCALE IN FEET
BATHYMETRIC CONTOUR PLOT
(N.G.V.D.)
LAKE POINSETT
BREVARD COUNTY, FLORIDA
COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 10

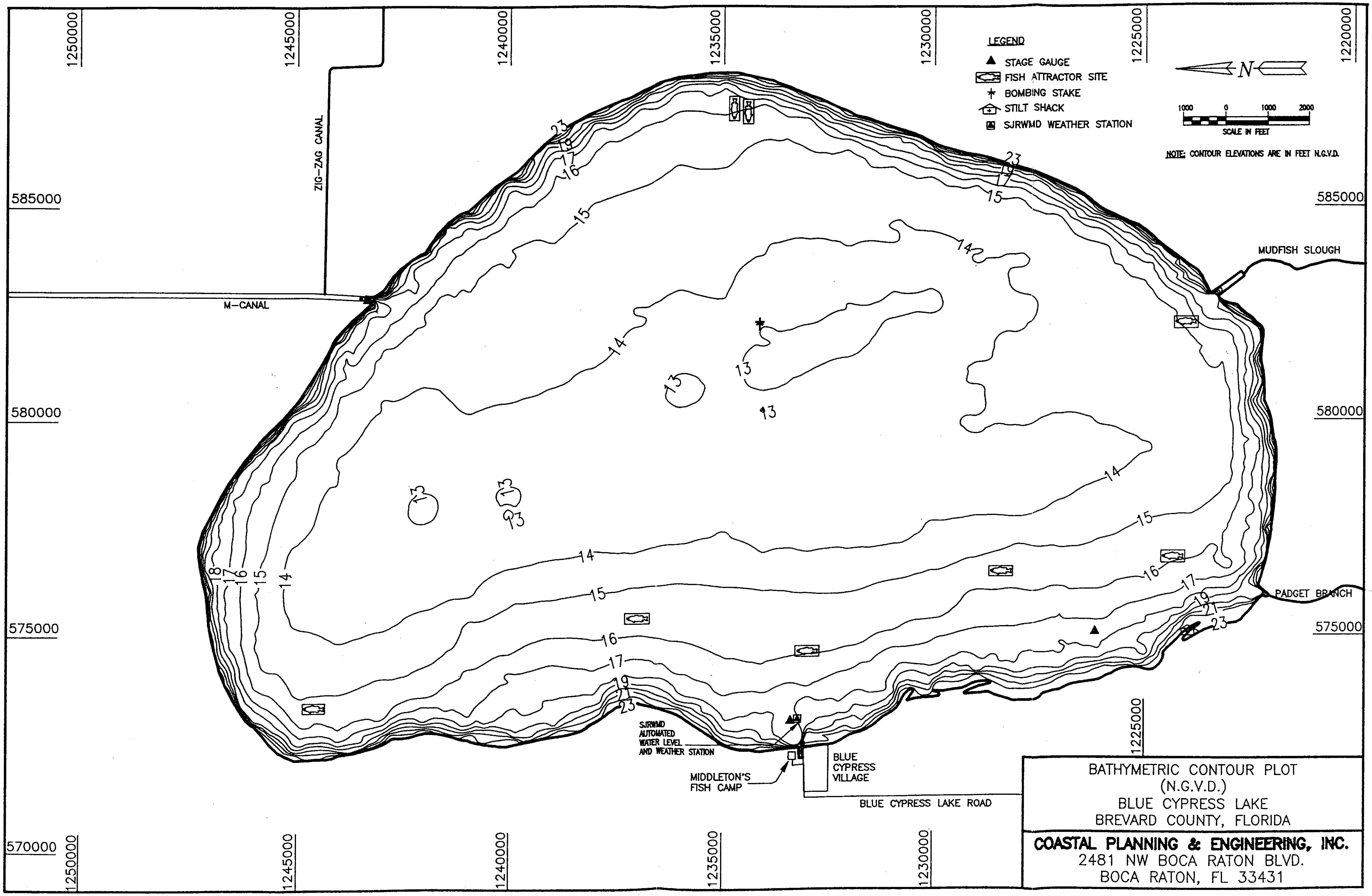

LEGEND
STAGE GAUGE
FISH ATTRACTOR SITE
BOMBING STAKE
STILT SHACK
SJRWMD WEATHER STATION
N
1000 0 1000 2000
SCALE IN FEET
NOTE: CONTOUR ELEVATIONS ARE IN FEET N.G.V.D.
ZIG-ZAG CANAL
M-CANAL
MUDFISH SLOUGH
PADGET BRANCH
SJRWMD AUTOMATED WATER LEVEL AND WEATHER STATION
MIDDLETON'S FISH CAMP
BLUE CYPRESS VILLAGE
BLUE CYPRESS LAKE ROAD
1250000
1245000
1240000
1235000
1230000
1225000
1220000
585000
580000
575000
570000
BATHYMETRIC CONTOUR PLOT
(N.G.V.D.)
BLUE CYPRESS LAKE
BREVARD COUNTY, FLORIDA
COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 11

reference elevation of "0" foot contour (Figures 12 and 13). These charts provide easily understood maps of the water depths that can be given to local interest groups and individuals that may request results of this survey.

3.1.1 Lake Poinsett

The average water depth of Lake Poinsett is approximately 3.8 feet at its reference elevation of 13 feet NGVD. The surface area at the reference elevation of 13 ft NGVD is 11.5 square miles. The total area of open water, as defined during the survey by the beginning of the emergent vegetation line (bulrush) was 6.1 square miles. Therefore, at the reference elevation of 13 foot NGVD, the surface area of the lake contains approximately 5.4 square miles of marsh vegetation. The total marsh area around Lake Poinsett is limited on the USGS topographic map by the 15 foot NGVD contour, Interstate 95 to the east and State Road 520 to the north. This boundary was digitized and entered into the bathymetric database as the upper limits of stage storage area of Lake Poinsett. This results in a total coverage of the lake and associated marsh of 27.6 square miles. This area includes Lake Florence, which was not surveyed.

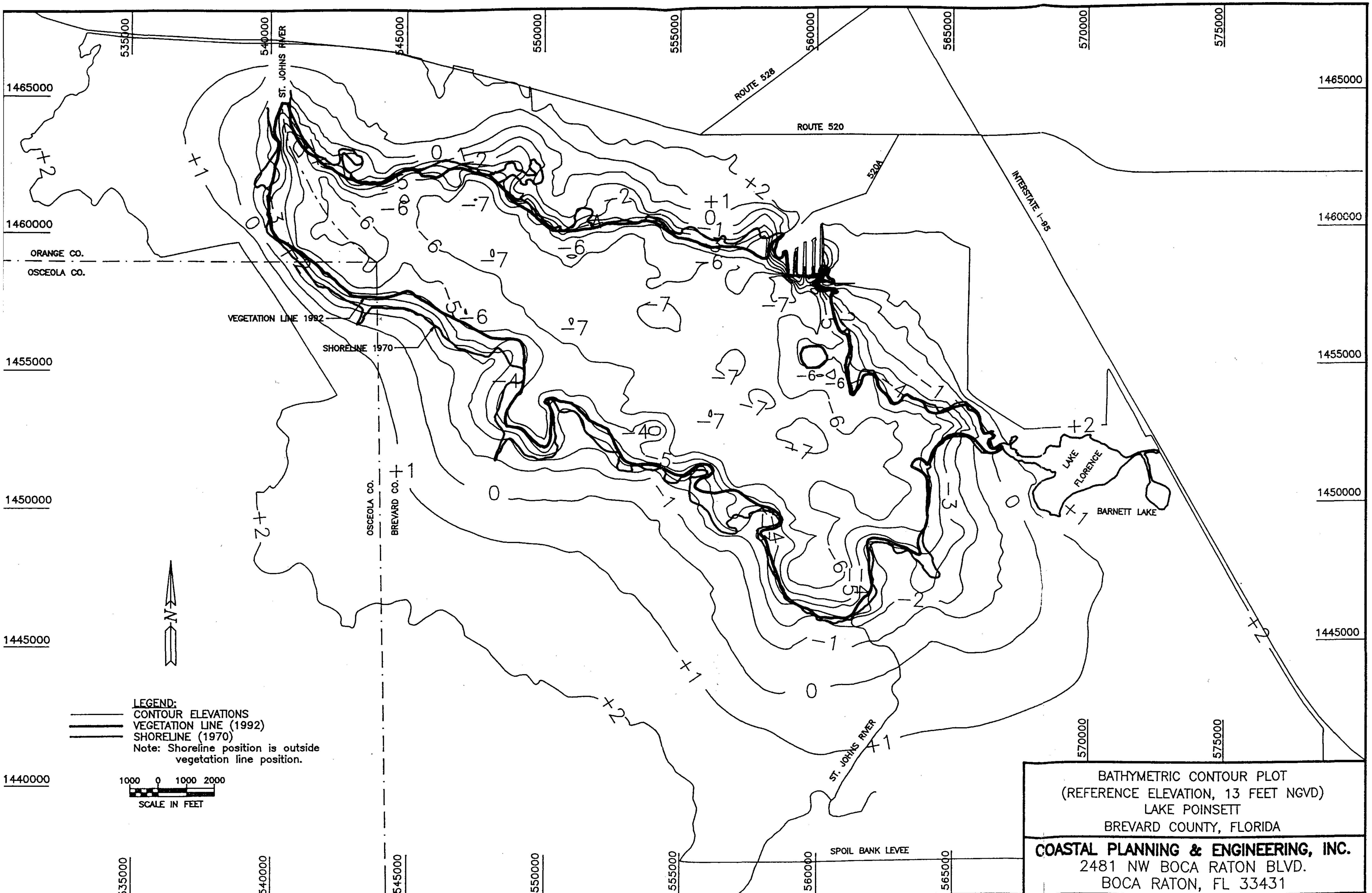
The -2 foot contour closely follows (relative to the 13 foot reference elevation) the shoreline digitized from the USGS quad sheet (Figure 12). Lakeward, the contours drop off rapidly to the -5 foot contour then remain relatively flat across the lake. The deepest depth within the lake is -7 feet. However, along the finger canals of the subdivision adjacent to Poinsett Lodge, a depth of -13 feet was measured.

The contours across the marsh from the -2 foot contour to the +2 foot contour are widely spaced. The +2 foot contour relates to the 15 foot NGVD contour and was interpolated from USGS Topographic Quad Sheets (Figure 12).

3.1.2 Blue Cypress Lake

The lake surface area covers approximately 10.6 square miles. The lake shoreline consists of a low organic debris levee. In most locations during the survey, the levee was exposed less than a foot above the water level. A review of the USGS Quad Sheets around the lakes indicates that to the west the marsh is limited by the 25 foot contour. To the east of the lake, the limiting elevation slopes down to the 20 foot contour. Therefore, it was impractical to incorporate the marsh area outside of the surveyed area based on the elevation of the Topographic Quad Sheets, as was done for Lake Poinsett.

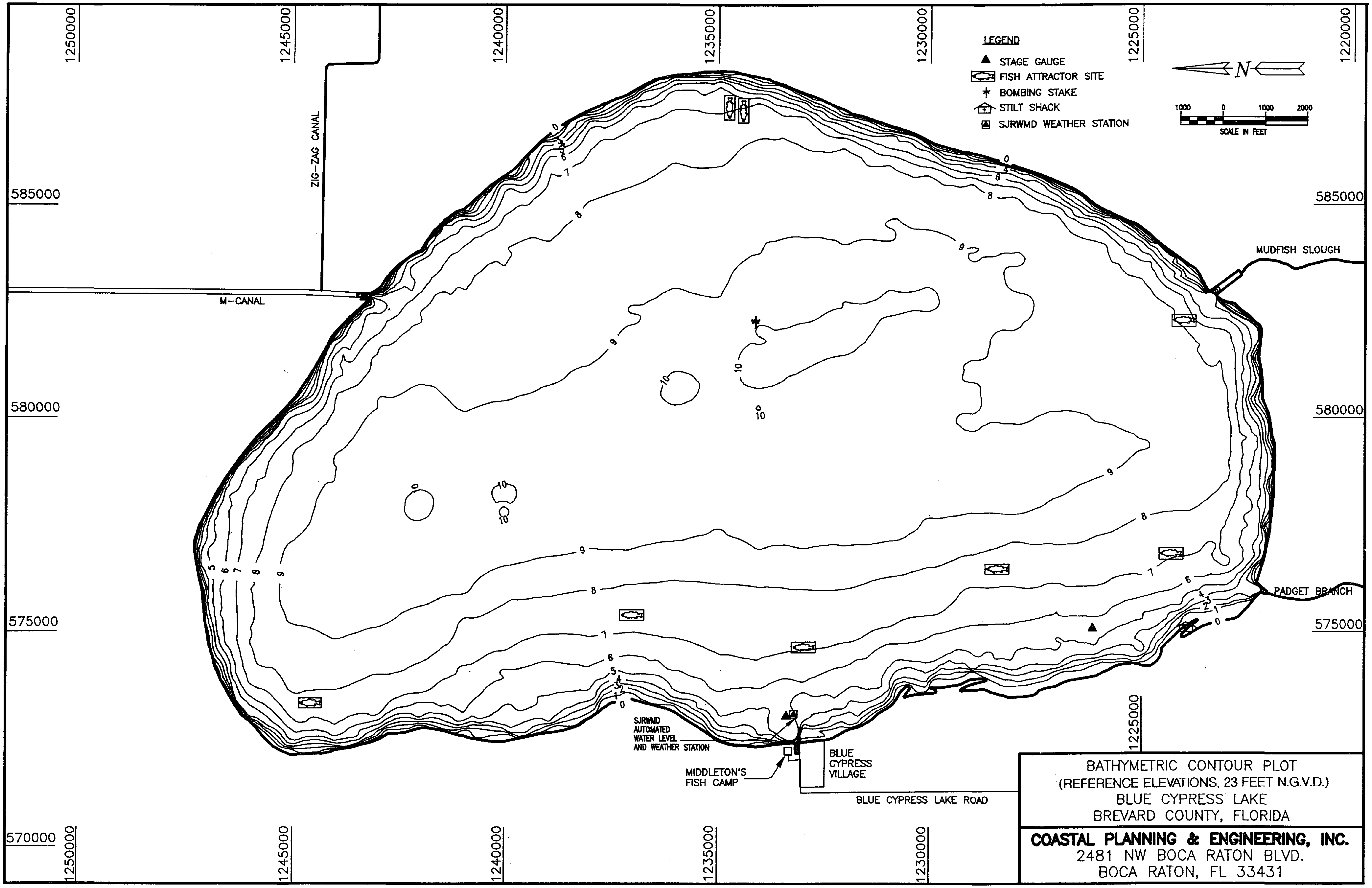
The average depth in Blue Cypress Lake is 7.8 feet relative to its reference elevation of 23 feet NGVD. The water depth increases rapidly from the shoreline to the -7 foot contour along the north, east and south shore. The western shore-



BATHYMETRIC CONTOUR PLOT
(REFERENCE ELEVATION, 13 FEET NGVD)
LAKE POINSETT
BREVARD COUNTY, FLORIDA

COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 12



BATHYMETRIC CONTOUR PLOT
(REFERENCE ELEVATIONS, 23 FEET N.G.V.D.)
BLUE CYPRESS LAKE
BREVARD COUNTY, FLORIDA

COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 13

line depth increases rapidly to only the -5 foot contour (Figure 13). The center of the lake is relatively flat at a depth of 9 feet with several areas to 10 feet, which are the deepest depths found in the lake.

The southeastern central portion of the lake appears to be developing a low shoal. This area is represented by the broadening of the -8 foot contour toward the center of the lake. This may be resulting from runoff into the lake from Mudfish Slough. Along the northeastern central portion of the lake, the -8 foot contour also is shifted more toward the center of the basin. This may be the result of water flowing out of the M-canal in the northeast corner of the lake.

3.2 Surface Area and Volume

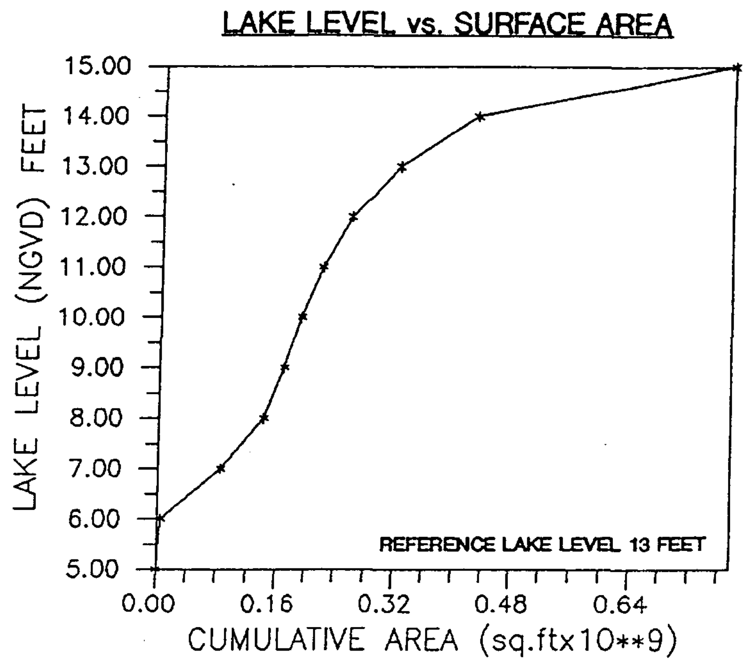
Hypsographic curves relating water levels to lake surface area and volume were developed from bathymetric contours of both lakes. Figures 14 and 15 present the hypsographic curves for each lake. Data used to develop these curves are located in Appendix I.

3.2.1 Lake Poinsett

Lake Poinsett covers 32.1 x 10^7 square feet (ft^2) and contains 1.2125 x 10^9 cubic feet (ft^3) of water at its reference level of 13 feet NGVD. Increasing the lake level 1 foot above the reference level would increase the surface area of the water in the basin by 32.7% and would increase the lake volume 30.7%. An increase of 2 feet would increase the surface area by 140% inundating the total marsh area around the lake. This would result in a 79.3% increase in water volume above the reference level. This volume does not include the water volume of Lake Florence, which lies to the east of Lake Poinsett and is included within the marsh area.

To decrease the lake volume by 50 percent would require lowering the lake level by 2.4 feet to 10.6 feet NGVD. To expose 50 percent of the bottom sediments would require lowering the lake level to 8.7 feet NGVD, which would require removing .95419 x 10^9 cu. ft. or 78.7 percent of the lake water. However, this would be difficult to accomplish since it would require the diverting of the St. Johns River which runs through Lake Poinsett.

A review of the surface area hypsographic curves for Lake Poinsett shows that an inflection point occurs at the 8 foot NGVD level. This change in the curve reflects that the basin of the lake has been filled and that additional increases in water levels will result in larger surface area being flooded as the water moves across the shore terrace. The water surface area up to the bulrush line is 0.1705 x 10^9 ft^2. This surface area closely relates to the area of the inflection point indicating the beginning of the marsh. As the marsh is filled, the surface area



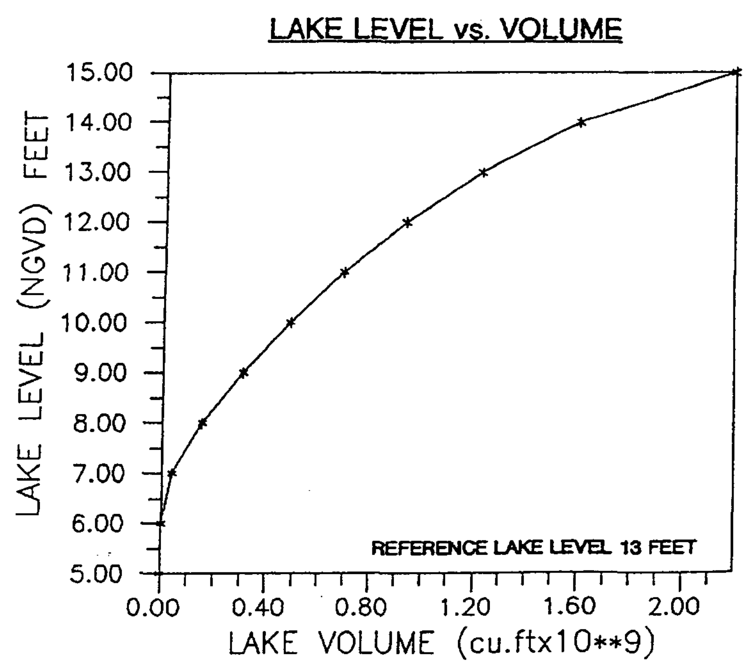


FIGURE 14

HYPSOGRAPHIC CURVES FOR LAKE POINSETT

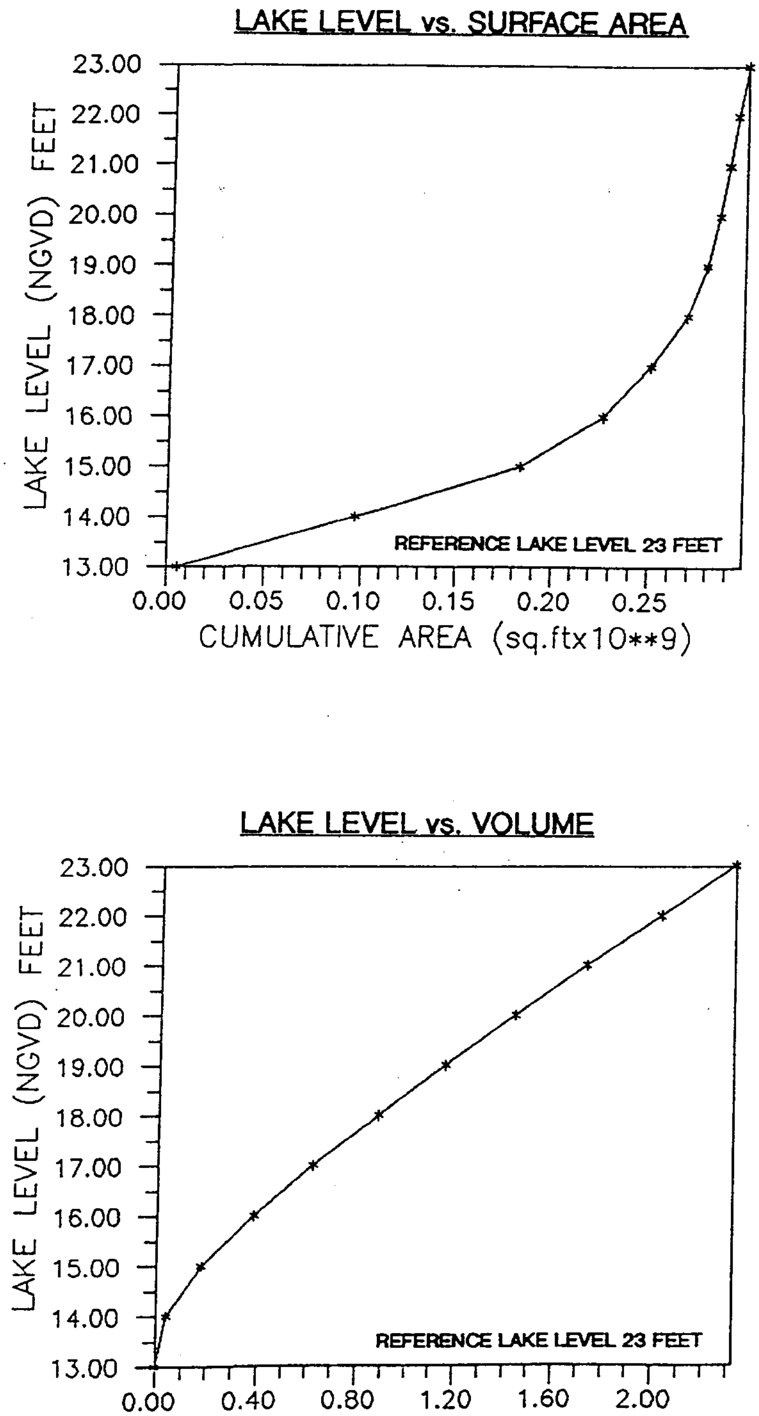


FIGURE 15

HYPSOGRAPHIC CURVES FOR BLUE CYPRESS LAKE

increases rapidly, while the volume increases more slowly. The lake volume hypsographic curves shows that as the lake basin fills, the volume rises rapidly until the marsh is reached. As the wetlands are flooded, the rate of volume increase lessens.

3.2.2 Blue Cypress Lake

Blue Cypress Lake contains 2.3048 x 10^9 cubic feet of water and has a surface area of 0.2965 x 10^9 square feet at its reference level of 23 feet NGVD. As previously discussed, the topography surrounding the lake and the low organic debris levee along the majority of the shoreline precluded the expansion of the contours above the reference elevation. Also, the vast marsh to the north, south and east of Blue Cypress Lake covers too large an area to be incorporated into this study. Hypsographic curves were limited to the boundary of the lake as defined by the survey.

To reduce the volume of water in the lake by 50 percent would require lowering the lake level by 4.0 feet to 19.0 NGVD. To expose 50 percent of the bottom sediments would require lowering the lake level to 14.6 feet NGVD, which would require removing 2.18034 x 10^9 cubic feet or 94.6 percent of the lake water. This would leave the remaining half of the lake with a maximum depth of less than two feet of water.

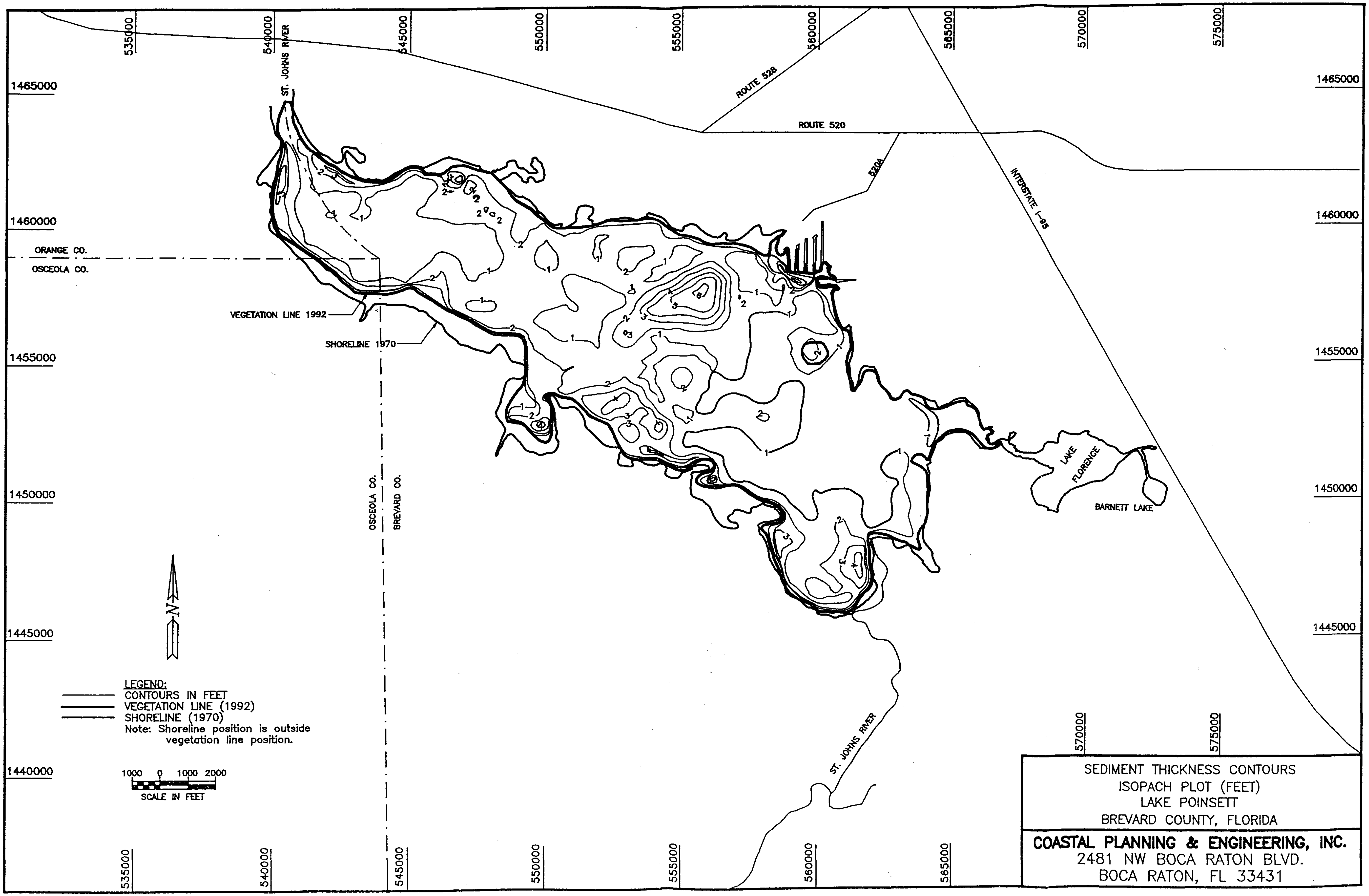
A review of Blue Cypress Lake hypsographic curves show that as water fills the central portion of the lake, the surface area increases rapidly as does the volume. As the water level reaches the base of the shore terrace slope, the surface area rate lessens and the rise of the lake volume becomes almost linear as would be expected.

3.3 Sediment Thickness

Sediment thicknesses in both lakes were plotted as organic sediment thickness charts; the results are shown in Figures 16 and 17. Hypsographic curves were completed for sediment depth versus both surface area and volume (Figures 18 and 19). The data used to plot the curves are presented in Appendix I.

3.3.1 Lake Poinsett

Fine organic sediments covered the total open water extent of Lake Poinsett. The organic sediments in the lake consist of easily probed flocculent material. The average sediment thickness is 1.3 feet. A deep pocket is located in the center of the lake where the fine sediment is over 6 feet deep. Another area of deep sediment is located in the dredged canal adjacent to Poinsett Lodge with a thickness of over 5 feet. These pockets and other smaller pockets of sediment are



SEDIMENT THICKNESS CONTOURS
ISOPACH PLOT (FEET)
LAKE POINSETT
BREVARD COUNTY, FLORIDA

COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 16

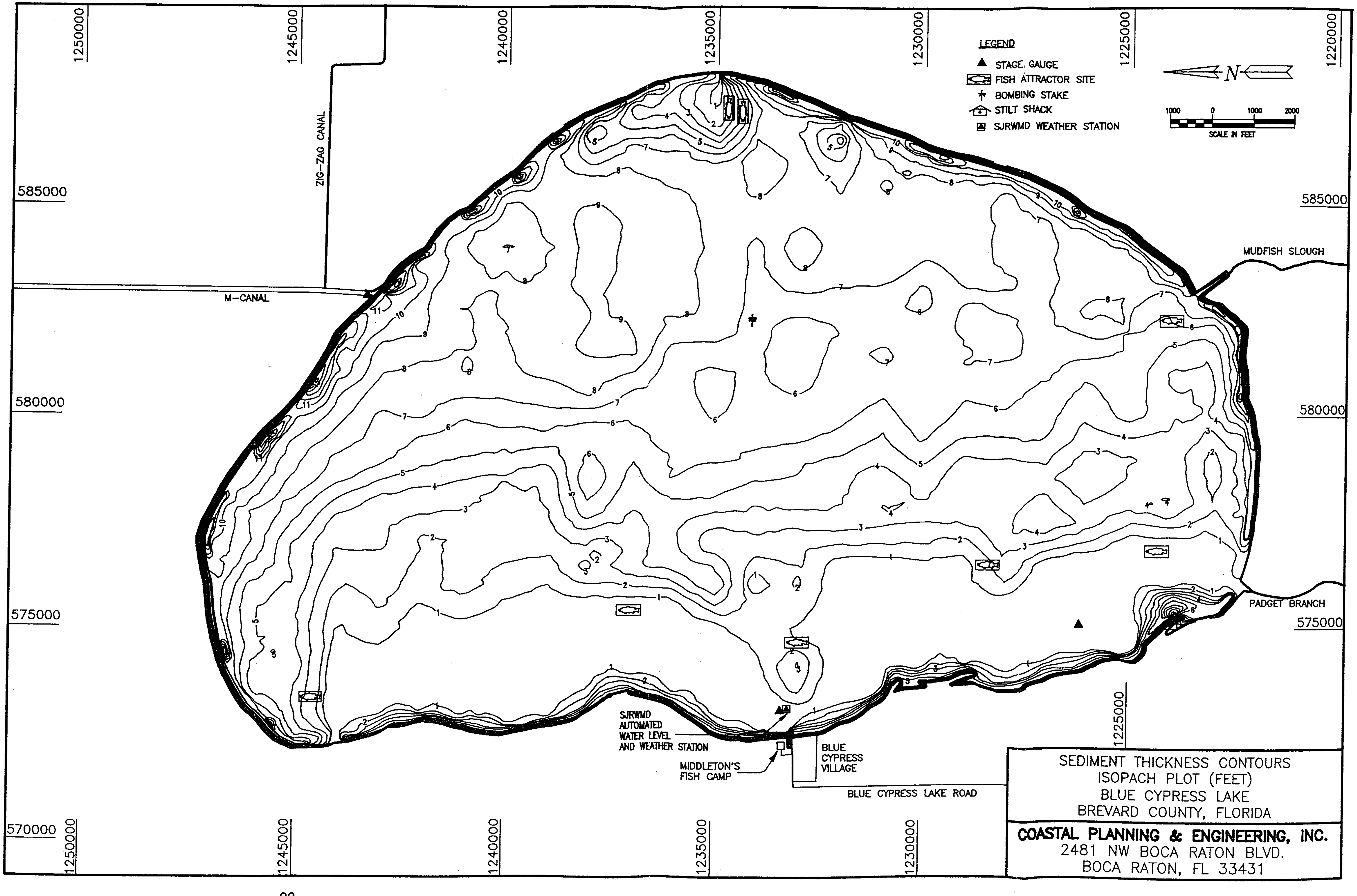
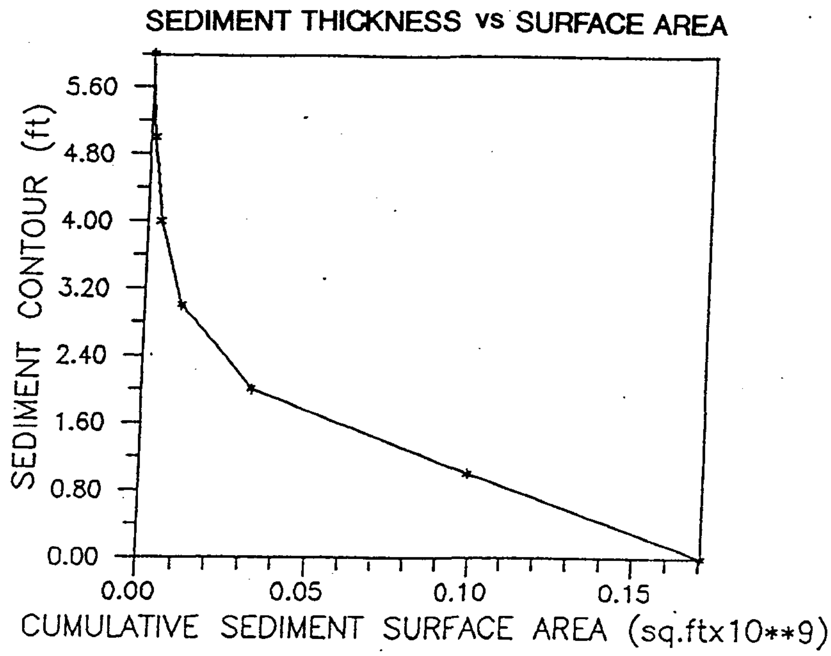

LEGEND
STAGE GAUGE
FISH ATTRACTOR SITE
BOMBING STAKE
STILT SHACK
SJRWMD WEATHER STATION
N
SCALE IN FEET
ZIG-ZAG CANAL
M-CANAL
MUDFISH SLOUGH
PADGET BRANCH
SJRWMD AUTOMATED WATER LEVEL AND WEATHER STATION
MIDDLETON'S FISH CAMP
BLUE CYPRESS VILLAGE
BLUE CYPRESS LAKE ROAD
SEDIMENT THICKNESS CONTOURS
ISOPACH PLOT (FEET)
BLUE CYPRESS LAKE
BREVARD COUNTY, FLORIDA
COASTAL PLANNING & ENGINEERING, INC.
2481 NW BOCA RATON BLVD.
BOCA RATON, FL 33431

FIGURE 17



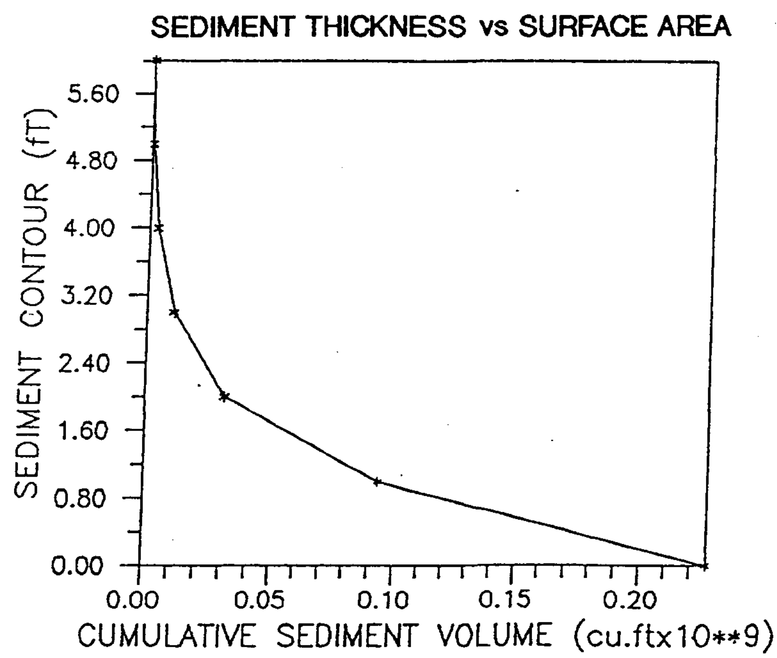
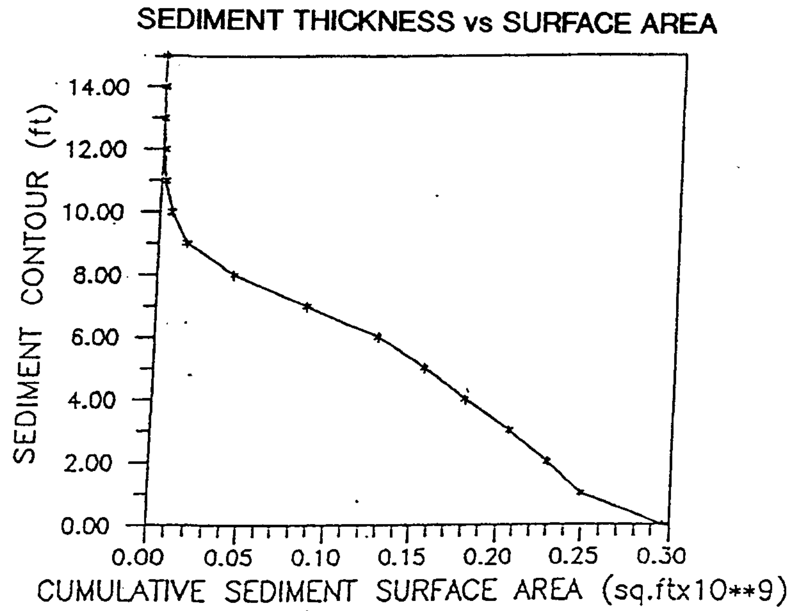


FIGURE 18

SEDIMENT THICKNESS vs. SURFACE AREA FOR LAKE POINSETT



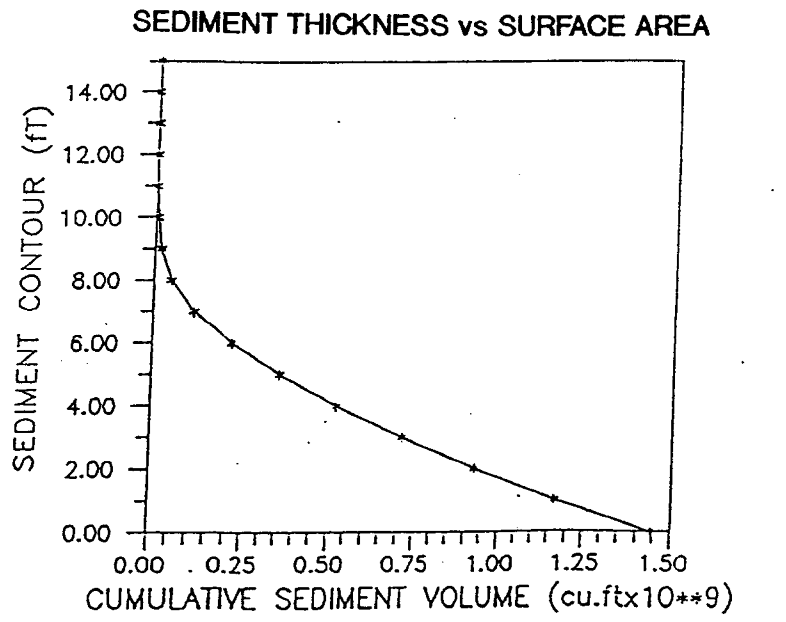


FIGURE 19

SEDIMENT THICKNESS vs. SURFACE AREA FOR BLUE CYPRESS LAKE

below the average natural sand lake bottom. Around much of the shoreline and within embayments the organic sediments are, on average, thicker than the open water section of the lake. Organic sediment tend to accumulate around the fringes of the lake where aquatic plants reduce wave turbulence (Henderson-Sellers, 1978). The sediment in these areas consisted of a more tightly compacted silty material. This depositional terrace can be seen as the thickening of sediments along the shoreline from two to four feet in thickness.

Expansion of the emergent vegetation across the shore terrace is evident by the reduction of the open water area between the USGS Quad Maps (1970) and the mapping of the edge of the vegetation in this survey. This has resulted in a reduction of open water area by 654.5 acres or approximately 1.0 square miles.

The total volume of soft sediment calculated for Poinsett Lake is 0.2266×10^9 ft^3 or approximately 8.4 million cubic yards.

3.3.2 Blue Cypress Lake

Fine sediments in Blue Cypress cover 2488×10^9 ft^2 or about 81 percent of the lake bottom. The soft sediments were located on the eastern portion of the lake. In the western portion of the lake, exposed sand bottom was found (Figure 17). The sediment thickness averages 4.9 feet. Within the lake basin, an area of thick sediment (9 feet) is located in the northeast corner. In this area, the sediment consisted of fibrous organic material which was extremely easy to probe. The sediments within the southeastern portion of the lake consisted of a dark, firm clay type material which was somewhat resistant to probing, but was underlain by hard, dense material which was easily distinguished from the upper sediments. The thickest sediments (15 feet) are located along the shore terrace where cypress trees extend out into the lake two to five hundred feet from the shoreline. The sediment of the shore terrace was a more compacted material, but was easily probed.

The total volume of soft sediments computed for Blue Cypress Lake is 1.4430×10^9 ft^3 or approximately 53.4 million cubic yards.

3.4 Error Analysis

Electronic positioning and depth measurement equipment was utilized to survey Lake Poinsett and Blue Cypress Lake. Error in conducting bathymetric surveys as a result of the electronic equipment can be introduced by such factors as: fathometer calibration, digitization, navigation and lake surface slope.

All bathymetric survey work was performed on calm days. Water level readings, taken during the survey, recorded no detectable slope. Therefore, potential error caused by lake surface slope was not analyzed.

The accuracy of the navigation equipment is estimated to be $\pm$ 3 feet. To analyze the potential navigation error, several independent lake surveys would need to be completed and statistically analyzed. This is not practical. However, due to the very flat bottom slopes of the two lakes, the impact of navigation error on depth measurements is believed to be minor.

3.4.1 Bathymetric Measurements

The error analysis for the hydrographic survey data was determined using the U.S. Army Corps of Engineers method for bathymetric survey systems (Clausner, et al. 1986).

An estimate of potential fathometer depth sounding repeatability was accomplished by surveying replicate transects. Line 21 at Lake Poinsett was surveyed 4 times and line 8 at Blue Cypress Lake was surveyed 3 times. A mean profile was calculated for each lake by averaging the measured elevations at specific distances. The average difference between the actual survey points and the mean points were then computed at each distance. An overall average of the individual averages was then calculated over the entire transect length to identify the "average difference from mean".

The average difference from the mean profile ranged from 0.02 to -0.07 feet for the Poinsett Lake replicates with an overall average difference of -0.006 feet (Table 4).

The Blue Cypress Lake replicates had an average difference from the mean ranging from 0.01 to -0.02 feet with an overall average difference of -0.001 feet (Table 5). The standard deviation for the Lake Poinsett samples is 0.071 feet and 0.065 feet for Blue Cypress Lake. This indicates that the vertical repeatability of the fathometer soundings is very good.

Another indicator of vertical repeatability is the "average width of vertical envelope". This is the difference between the highest and lowest measurement at a given distance averaged over the transect length. This value measures the average maximum vertical variation for each transect. The average width of the vertical envelope ranged from 0.20 to 0.30 feet for all seven replicate lines.

A visual comparison of the four Lake Poinsett replicate transects and the mean profile is plotted in Figures 20 and 21. The three Blue Cypress Lake transects are compared to each other in Figure 22.

Table 4

Lake Poinsett - Mean vs. Replicate Depths

STATION	MEAN DEPTH (FT.)	DIFFERENCE FROM MEAN AT REPLICATE: LINE 21A	LINE 21B	LINE 21C	LINE 21D
450	-5.4	0.0	0.0	0.0	0.0
500	-5.4	0.0	-0.1	0.0	0.0
550	-5.4	0.1	-0.1	0.1	0.0
600	-5.5	0.0	-0.1	0.0	-0.1
650	-5.5	0.1	0.0	0.1	-0.1
700	-5.5	0.1	0.1	0.1	-0.1
750	-5.6	0.0	0.0	0.0	-0.2
800	-5.6	0.0	0.0	0.0	-0.1
850	-5.6	0.0	0.0	0.0	-0.1
900	-5.6	0.0	-0.1	0.0	-0.1
950	-5.6	0.0	-0.1	0.0	-0.1
1000	-5.6	0.0	-0.1	0.0	-0.1
1050	-5.6	0.1	0.0	0.1	-0.1
1100	-5.7	0.0	0.0	0.0	-0.1
1150	-5.7	0.1	0.0	0.1	-0.1
1200	-5.8	0.0	-0.1	0.0	-0.1
1250	-5.8	0.0	0.0	0.0	-0.1
1300	-5.8	0.0	0.0	0.0	-0.1
1350	-5.8	0.1	0.0	0.1	0.0
1400	-5.9	0.0	-0.1	0.0	-0.1
1450	-5.9	0.0	-0.1	0.1	-0.1
1500	-5.9	0.0	0.1	0.1	0.0
1550	-6.0	0.0	0.0	0.0	-0.1
1600	-6.0	0.0	0.0	0.0	-0.1
1650	-6.1	0.0	0.0	0.0	-0.1
1700	-6.2	0.0	0.0	0.0	-0.1
1750	-6.2	0.1	0.0	0.0	-0.1
1800	-6.2	0.1	0.0	0.1	-0.1
1850	-6.2	0.2	0.0	0.1	-0.1
1900	-6.3	0.1	-0.1	0.0	-0.1
1950	-6.3	0.0	-0.1	0.0	-0.1
2000	-6.3	0.0	-0.1	0.0	-0.1
2050	-6.3	0.0	-0.1	0.0	-0.1
2100	-6.3	0.0	-0.1	0.0	-0.1
2150	-6.3	0.1	-0.1	0.1	0.0
2200	-6.4	0.0	-0.1	0.0	-0.1
2250	-6.4	0.0	0.0	0.1	0.0
2300	-6.5	0.0	0.0	0.1	0.0
2350	-6.6	0.0	0.0	0.1	0.0
2400	-6.7	0.1	0.0	0.1	0.0
2450	-6.6	0.0	0.0	0.0	0.0
2500	-6.5	0.0	-0.1	0.0	0.0
2550	-6.4	0.0	-0.1	0.0	0.0
2600	-6.3	0.0	-0.1	0.0	0.0
2650	-6.2	0.1	0.0	0.1	0.0
2700	-6.2	0.0	-0.1	0.0	-0.1
2750	-6.1	0.0	0.0	0.1	-0.1
2800	-6.0	0.0	0.1	0.1	-0.1
2850	-6.0	0.0	0.1	0.1	-0.1
2900	-6.0	0.0	0.0	0.0	-0.1
2950	-6.0	0.0	0.0	0.0	-0.1
3000	-5.9	0.0	0.0	0.2	0.0
3050	-6.0	0.0	-0.1	0.1	-0.1
3100	-6.0	0.0	0.0	0.1	-0.1
3150	-5.9	0.0	0.1	0.1	0.0
3200	-5.9	0.0	0.1	0.0	-0.1
3250	-5.9	0.0	0.1	0.1	-0.1
3300	-5.9	0.0	0.1	0.1	-0.1
3350	-5.9	0.0	0.1	0.1	-0.1
3400	-5.9	0.1	0.0	0.1	-0.1
3450	-5.9	0.0	0.0	0.0	-0.1
3500	-5.8	0.0	0.0	0.1	0.0
3550	-5.8	0.0	-0.1	0.0	0.0
3600	-5.8	0.0	-0.2	0.0	0.0
AVERAGE DIFFERENCE FROM MEAN		0.02	-0.02	0.05	-0.07
STANDARD DEVIATION		0.046	0.070	0.053	0.049
VERTICAL ENVELOPE		0.20	0.30	0.20	0.20

Table 5

Blue Cypress Lake - Mean vs. Replicate Depth

STATION	MEAN DEPTH (FT.)	DIFFERENCE FROM MEAN AT REPLICATE: LINE 8A	LINE 8B	LINE 8C
0	-6.2	0.0	0.0	0.0
100	-6.1	0.0	0.0	0.0
200	-6.3	0.0	-0.1	0.0
300	-6.9	0.0	0.0	0.0
400	-7.2	0.0	0.0	0.0
500	-7.1	0.0	0.0	0.1
600	-7.1	-0.1	0.0	-0.1
700	-7.0	-0.1	0.0	-0.1
800	-7.3	0.0	0.0	0.1
900	-7.6	0.0	-0.1	0.0
1000	-7.6	0.0	0.0	0.1
1100	-7.6	0.0	0.0	0.0
1200	-7.7	0.0	0.0	0.0
1300	-7.8	0.1	0.0	0.0
1400	-7.9	0.1	0.0	0.0
1500	-8.0	0.0	0.1	0.1
1600	-8.2	0.0	0.0	0.0
1700	-8.2	0.0	0.1	0.0
1800	-8.3	-0.1	0.0	0.0
1900	-8.5	0.0	0.0	0.0
2000	-8.8	0.0	0.0	0.0
2100	-8.9	0.2	0.0	0.0
2200	-9.0	0.0	0.0	0.0
2300	-9.1	0.0	0.1	0.1
2400	-9.1	0.0	0.0	0.0
2500	-9.1	0.0	0.0	0.0
2600	-9.1	0.0	0.0	0.1
2700	-9.1	0.0	0.0	0.0
2800	-9.2	0.1	0.0	0.0
2900	-9.3	0.0	0.0	0.0
3000	-9.4	0.0	0.0	0.0
3100	-9.4	0.0	0.0	0.0
3200	-9.5	-0.1	0.0	0.0
3300	-9.5	-0.1	0.1	-0.1
3400	-9.4	0.0	0.1	0.0
3500	-9.4	0.0	0.0	0.1
3600	-9.5	-0.1	-0.1	0.1
3700	-9.5	0.0	0.0	0.1
3800	-9.6	-0.1	0.0	0.0
3900	-9.6	0.0	0.0	0.1
4000	-9.6	0.0	-0.1	0.0
4100	-9.6	0.0	0.0	0.0
4200	-9.5	-0.1	-0.1	0.0
4300	-9.4	0.0	-0.1	-0.1
4400	-9.3	0.0	0.0	-0.1
4500	-9.2	0.1	0.0	0.0
4600	-9.3	0.1	-0.2	0.0
4700	-9.2	0.1	-0.1	0.0
4800	-9.1	0.0	0.0	0.1
4900	-9.1	0.1	0.0	0.0
5000	-9.1	0.0	-0.1	0.0
5100	-9.0	0.0	0.0	0.1
5200	-9.1	0.0	-0.1	0.0
5300	-9.1	0.0	0.0	0.0
5400	-9.1	0.0	0.0	0.1
5500	-9.0	-0.1	0.1	0.0
5600	-9.0	0.0	0.0	0.1
5700	-9.0	-0.1	-0.1	0.0
5800	-8.9	0.0	0.0	0.0
5900	-8.9	0.0	0.0	0.0
6000	-9.0	0.0	-0.1	0.0
6100	-9.0	0.0	0.0	0.0
6200	-9.0	0.0	0.1	0.0
6300	-9.0	0.0	0.1	0.0
6400	-9.1	0.0	0.0	-0.1
6500	-9.0	0.1	0.0	0.0

Table 5 (cont.)

Blue Cypress Lake - Mean vs. Replicate Depth

STATION	MEAN DEPTH (FT.)	DIFFERENCE FROM MEAN AT REPLICATE: LINE 8A	LINE 8B	LINE 8C
6600	-9.0	-0.1	0.0	0.0
6700	-8.9	0.0	0.0	0.1
6800	-8.9	0.0	0.0	0.1
6900	-9.0	-0.1	-0.1	0.1
7000	-9.0	0.1	-0.1	0.0
7100	-9.0	0.1	-0.1	-0.1
7200	-8.9	0.0	0.0	0.0
7300	-8.9	0.0	0.0	0.0
7400	-8.9	0.0	0.1	-0.1
7500	-8.9	0.0	0.0	0.1
7600	-9.0	0.1	-0.1	-0.1
7700	-8.9	0.1	0.0	0.0
7800	-8.9	0.0	0.0	0.1
7900	-8.9	0.1	-0.1	0.1
8000	-9.0	0.1	-0.1	-0.1
8100	-8.9	0.0	0.0	-0.1
8200	-8.9	0.0	-0.1	0.0
8300	-8.9	-0.1	0.0	0.0
8400	-8.8	-0.1	0.1	-0.1
8500	-8.8	0.1	0.0	-0.1
8600	-8.7	0.0	0.0	0.0
8700	-8.7	0.0	0.1	-0.1
8800	-8.7	-0.1	0.0	-0.1
8900	-8.7	0.0	0.0	0.1
9000	-8.6	0.0	0.0	0.0
9100	-8.6	0.0	0.0	0.1
9200	-8.6	0.0	0.0	0.0
9300	-8.5	0.0	0.0	-0.1
9400	-8.2	0.1	-0.1	0.0
9500	-7.9	0.2	-0.2	-0.1
9600	-7.2	0.1	-0.2	0.0
9700	-6.2	0.2	-0.1	-0.1
9800	-5.4	0.1	-0.1	0.0
9900	-5.0	0.1	0.0	0.0
AVERAGE DIFFERENCE FROM MEAN		0.01	-0.02	0.00
STANDARD DEVIATION		0.065	0.063	0.062
VERTICAL ENVELOPE		0.30	0.30	0.20

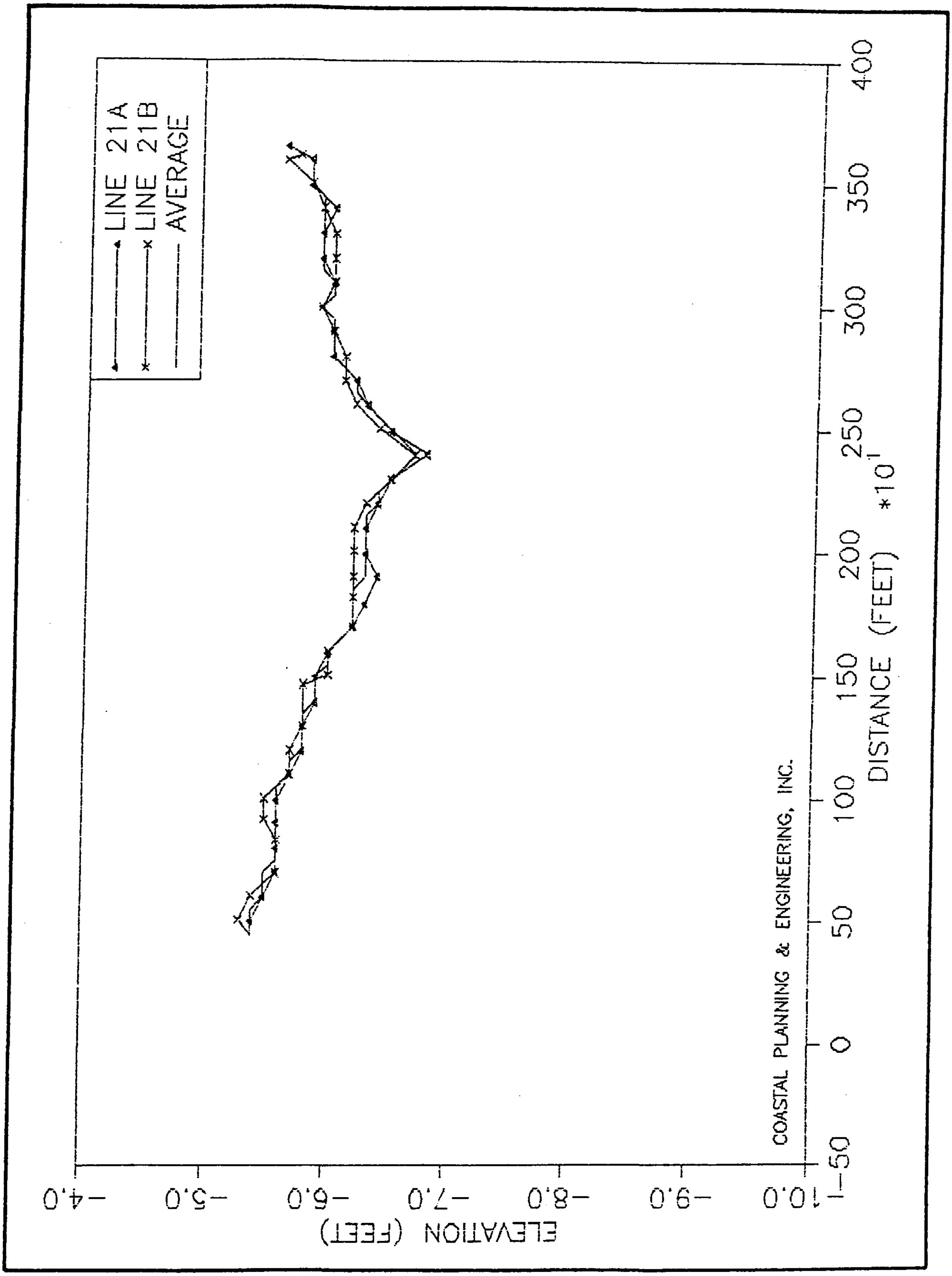


FIGURE 20

ERROR ANALYSIS TRANSECT LINES
LAKE POINSETT

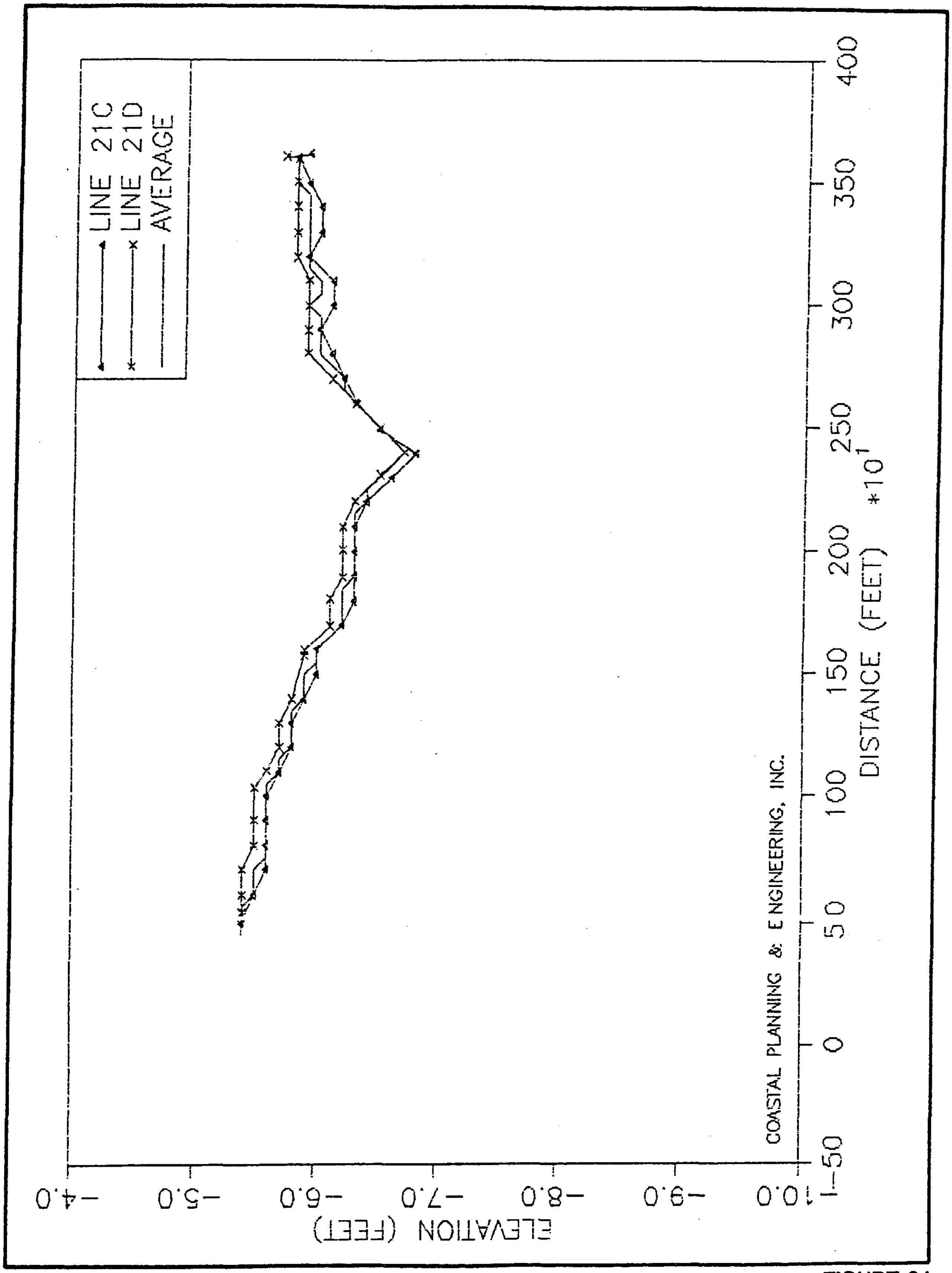


FIGURE 21

ERROR ANALYSIS TRANSECT LINES
LAKE POINSETT

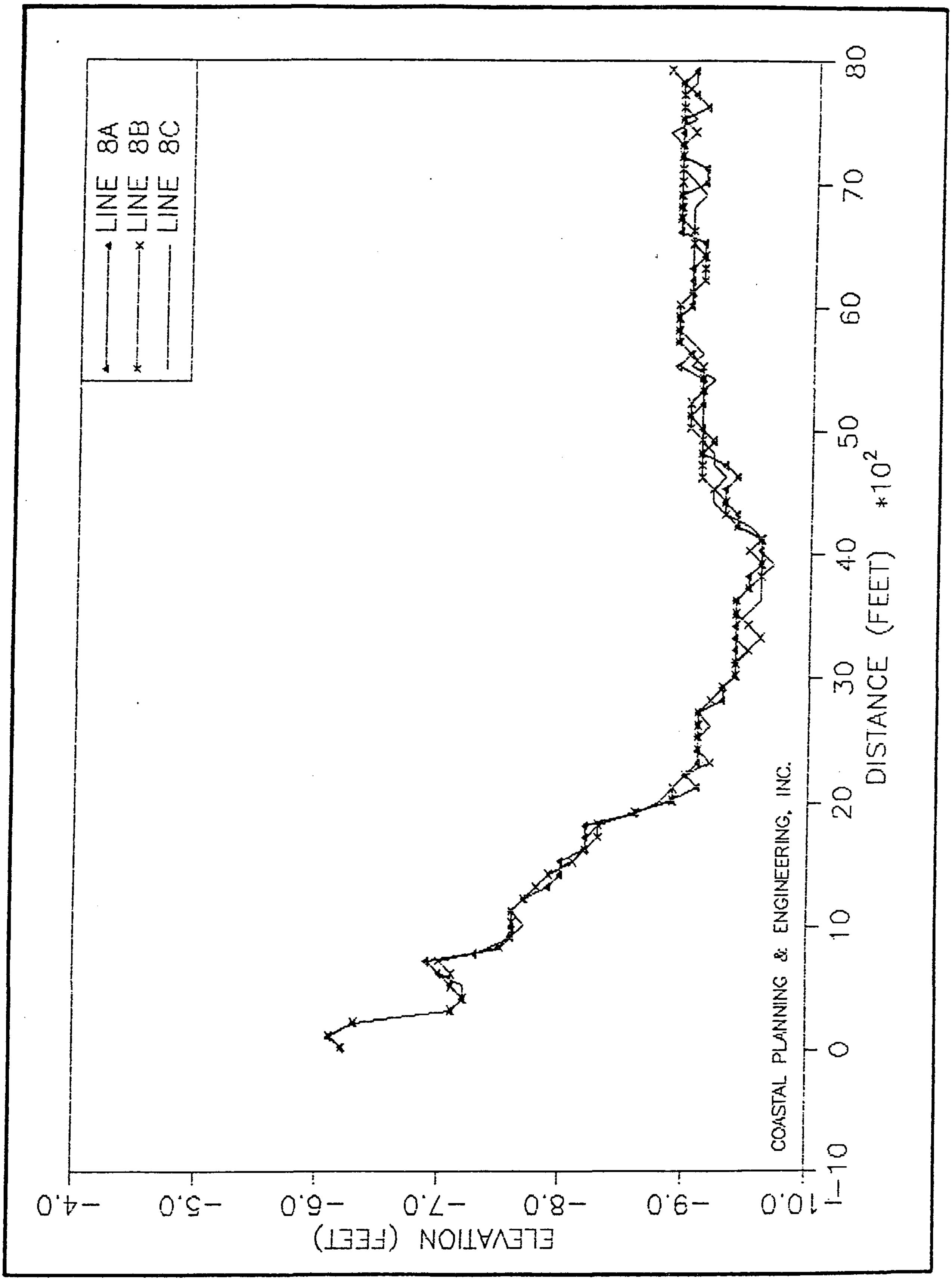


FIGURE 22

ERROR ANALYSIS TRANSECT LINES
BLUE CYPRESS LAKE

3.4.2 Photoelectric Device

To evaluate potential fathometer depth sounding error, the results of the survey were compared with replicate water depth measurements made with a photoelectric device (PD). The device consists of a photoelectric beam and receptor mounted on a rod. The photoelectric sensor is connected to a voltmeter. When the sensor is lowered below the top of the flocculent layer, the light beam is broken causing a meter deflection. At that instant the operator reads the water depth from the rod. The device is only useful on soft bottoms with suspended flocculent layers into which the sensor can be penetrated. The photoelectric device will not work on sand bottoms.

Four photoelectric device water depths were taken simultaneously with fathometer soundings at Lake Poinsett (Table 6). Seven photoelectric device and fathometer depth readings were collected at Blue Cypress Lake. The results of the duplicate measurements are plotted in Figure 23. The clustering of all data points along the diagonal line of this figure indicates a very close agreement of the two depth measuring methods. The average difference between the PD readings and fathometer readings was +0.04 feet. The standard deviation of the depth difference was only 0.09 feet. This comparison demonstrates the fathometer's depth measurements accurately define the top of the flocculent layer as the lake bottom. Estimates of water volume would therefore not include interstitial water in the flocculent layer.

A comparison of the photoelectric device and fathometer data indicates that there is no significant error in depth measurements. Therefore, the survey depths do not require adjustment for measurement error.

Table 6

FATHOMETER VS. PD DEPTHS

LAKE-PD SAMPLE NO.	FATHOMETER DEPTH (FT.)	PD DEPTH (FT.)	DEPTH DIFFERENCE (FT.)
PSL-PD1	6.1	6.1	0.0
PSL-PD2	6.7	6.7	0.0
PSL-PD3	6.1	6.0	-0.1
PSL-PD4	6.6	6.6	0.0
BCL-PD1	10.1	10.2	0.1
BCL-PD2	5.2	5.2	0.0
BCL-PD3	7.7	7.7	0.0
BCL-PD4	9.5	9.5	0.0
BCL-PD5	9.0	9.2	0.2
BCL-PD6	9.0	9.2	0.2
BCL-PD7	8.9	8.9	0.0
AVERAGE			0.04
STANDARD DEVIATION			0.09

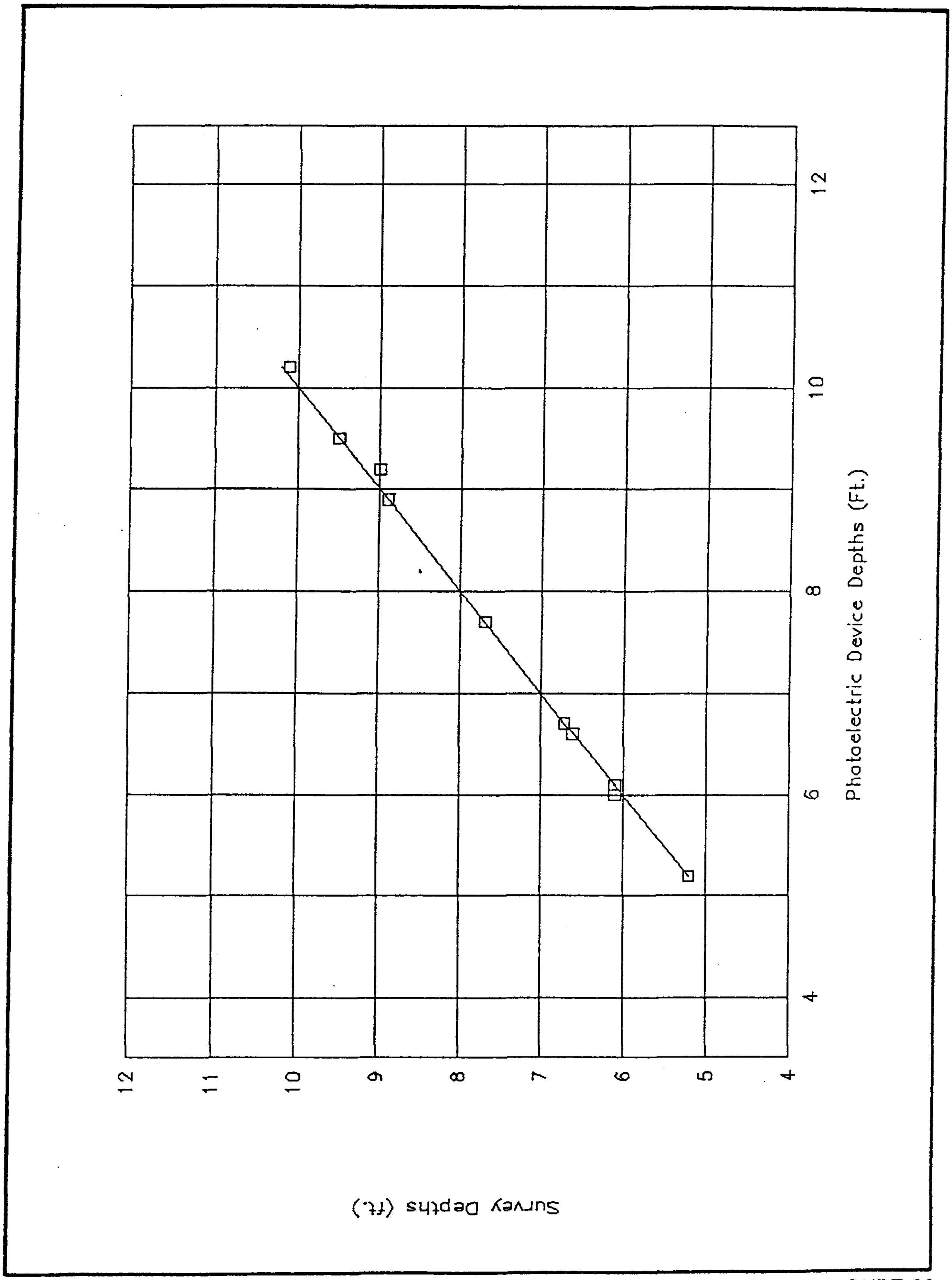


FIGURE 23

FATHOMETER vs. PD DEPTH MEASUREMENTS

4.0 CONCLUSIONS

In December 1991 and January 1992, bathymetric and sediment depth surveys of Lake Poinsett and Blue Cypress Lake found the following:

- Lake Poinsett covers 0.3208 x 10^9 square feet and contains 1.2125 x 10^9 cubic feet of water at the reference elevation of 13 feet NGVD.
- Lake Poinsett's bottom is covered by fine flocculent sediment with an average thickness of 1.3 feet.
- The total volume of soft sediments covering the bottom of Lake Poinsett is 2.266 x 10^9 ft^3 or approximately 8.4 million cubic yards.
- Blue Cypress Lake covers approximately .2965 x 10^9 ft^2 and contains 2.3048 x 10^9 cubic feet of water at its reference elevation of 23 feet NGVD.
- The average thickness of the sediments covering the bottom of Blue Cypress Lake is 4.9 ft. The total volume of soft sediment covering the bottom of Blue Cypress Lake is 1.443 x 10^9 ft^3 or approximately 53.4 million cubic yards.
- Lake Poinsett's volume analysis included the surrounding marsh area by addition of the 15 foot contour outside the limit of the lake survey site. However, it did not include Lake Florence, which will increase the volumes.
- Blue Cypress Lake did not include the marsh area due to the large expanse of marsh and lack of the topographic data on the quad sheets adjacent to the lake.
- Hypsographic curves for lake level versus cumulative area for the lakes differ due to the decrease in the rate of rise which occurs as the marsh area of Lake Poinsett is filled. The marsh area of Blue Cypress was not analyzed but should be investigated in the future to determine the total stage area relationship for this lake.
- Lake Poinsett's open water area has apparently been reduced by approximately 654.5 acres since 1970, as shown by the expansion of the emergent vegetation as mapped in this study compared to the USGS Topographic Quad Sheets, which are based on 1970 aerials.
- Within Blue Cypress Lake, the beginning of shoals appear to be developing lakeward of Mudfish Slough and the M-canal both located on the eastern side of the lake.

- No apparent shoals were noted within Lake Poinsett.
- Error analysis of the fathometer data indicates no significant error in depth measurements.

5.0 RECOMMENDATIONS

- Future surveys of these lakes should reproduce the same trackline to insure accurate contour comparisons.
- Future surveys should use similar accurate navigation and bathymetric equipment to insure repeatable results.
- Lake Florence, which lies within the marsh area to the east of Lake Poinsett, should be surveyed. The results should be incorporated with these results, to include the volume of water in its basin with the total stage volume analysis of Lake Poinsett.
- Blue Cypress Lake marsh border should be surveyed to define the limiting elevations of the surrounding wetlands, so that total stage area computation can be computed.

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APPENDIX I

HYPSOGRAPHIC CURVE DATA

TABLE 1. HYPSOGRAPHIC DATA FOR LAKE POINSETT

DEPTH CONTOUR (FT)	LAKE LEVEL (NGVD)	CUMULATIVE AREA (SQ.FTx10**9)	LAYER VOLUME (CU.FTx10**9)	LAKE VOLUME (CU.FTx10**9)	LAKE VOLUME (%)
2	15	0.7697	0.5893	2.1738	179.28
1	14	0.4256	0.3720	1.5845	130.68
0	13	0.3208	0.2881	1.2125	100.00
-1	12	0.2566	0.2372	0.9244	76.24
-2	11	0.2182	0.2039	0.6873	56.68
-3	10	0.1900	0.1787	0.4833	39.86
-4	9	0.1677	0.1543	0.3046	25.12
-5	8	0.1412	0.1115	0.1503	12.40
-6	7	0.0843	0.0367	0.0388	3.20
-7	6	0.0051	0.0020	0.0021	0.18
-8	5	0.0001	0.0001	0.0001	0.01
-9	4	<0.0001	----	----	----

TABLE 2 . HYPSOGRAPHIC DATA FOR BLUE CYPRESS LAKE

DEPTH CONTOUR (FT)	LAKE LEVEL (NGVD)	CUMULATIVE AREA (SQ.FTx10^9)	LAYER VOLUME (CU.FTx10^9)	LAKE VOLUME (CU.FTx10^9)	LAKE VOLUME (%)
0	23	0.2965	0.2943	2.3048	100.00
-1	22	0.2920	0.2902	2.0105	87.23
-2	21	0.2883	0.2862	1.7204	74.64
-3	20	0.2840	0.2810	1.4342	62.23
-4	19	0.2780	0.2730	1.1532	50.03
-5	18	0.2680	0.2589	0.8802	38.19
-6	17	0.2499	0.2378	0.6213	26.96
-7	16	0.2259	0.2041	0.3835	16.64
-8	15	0.1830	0.1376	0.1795	7.79
-9	14	0.0968	0.0418	0.0419	1.82
-10	13	0.0055	0.0018	0.0001	0.00
-11	12	<0.0001	----	----	----

TABLE 3. SEDIMENT DATA FOR LAKE POINSETT

SEDIMENT CONTOUR (FT)	CUMULATIVE AREA (SQ.FTx10^9)	LAYER VOLUME (CU.FTx10^9)	SEDIMENT VOLUME (CU.FTx10^9)	SEDIMENT VOLUME (%)
0	0.1705	0.1332	0.2266	100.00
1	0.0991	0.0627	0.0934	41.23
2	0.0324	0.0205	0.0307	13.57
3	0.0105	0.0070	0.0103	4.54
4	0.0039	0.0026	0.0033	1.47
5	0.0014	0.0007	0.0008	0.34
6	0.0002	0.0001	0.0001	0.05
7	<0.0001	----	----	----

NOTE: SEDIMENT VOLUME CALCULATED ACCORDING TO THE FOLLOWING FORMULA:

(A1+A2+(A1*A2)^0.5)/3.

TABLE 4. SEDIMENT DATA FOR BLUE CYPRESS LAKE

SEDIMENT CONTOUR (FT)	CUMULATIVE AREA (SQ.FTx10^9)	LAYER VOLUME (CU.FTx10^9)	SEDIMENT VOLUME (CU.FTx10^9)	SEDIMENT VOLUME (%)
0	0.2965	0.2723	1.4430	100.00
1	0.2488	0.2390	1.1707	81.13
2	0.2293	0.2176	0.9318	64.57
3	0.2060	0.1925	0.7142	49.49
4	0.1794	0.1669	0.5217	36.15
5	0.1548	0.1406	0.3548	24.58
6	0.1269	0.1054	0.2142	14.84
7	0.0853	0.0626	0.1088	7.54
8	0.0424	0.0278	0.0461	3.20
9	0.0155	0.0108	0.0183	1.27
10	0.0067	0.0045	0.0075	0.52
11	0.0025	0.0019	0.0030	0.21
12	0.0013	0.0008	0.0012	0.08
13	0.0005	0.0003	0.0003	0.02
14	0.0001	0.0000	0.0000	0.00
15	<0.0001	------	------	------

NOTE:
SEDIMENT VOLUME CALCULATED ACCORDING TO THE FOLLOWING FORMULA:

(A1+A2+(A1*A2)^0.5)/3.