VOLUMETRIC SURVEY
OF
LAKE MEXIA

Prepared for:

BISTONE MUNICIPAL WATER SUPPLY DISTRICT

Prepared by:

Texas Water Development Board

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Texas Water Development Board

Craig D. Pedersen, Executive Administrator

This report was prepared by the Hydrographic Survey group:

Scot Sullivan, P.E.
Duane Thomas
Steve Hutton
Marc Robichaud

For more information, please call (512) 936-0848

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INTRODUCTION

Staff of the Hydrographic Survey Unit of the Texas Water Development Board (TWDB) conducted a hydrographic survey of Lake Mexia on May 7 and 8, 1996. The purpose of the survey was to determine the capacity of the lake at the conservation pool elevation and to establish baseline information for future surveys. From this information, future surveys will be able to determine sediment deposition locations and rates over time. Survey results are presented in the following pages in both graphical and tabular form. All elevations presented in this report will be reported in feet above mean sea level based on the National Geodetic Vertical Datum of 1929 (NGVD '29) unless otherwise noted. The original design data supplied by Bistone Municipal Water Supply District indicated the surface area of Lake Mexia, at the conservation pool elevation of 448.3 feet, was 1,200 acres with a corresponding capacity of 10,000 acre-feet.

HISTORY AND GENERAL INFORMATION OF THE RESERVOIR

Lake Mexia and Bistone Dam are located on the Navasota River in Limestone County, approximately seven miles southwest of Mexia, Tx. The lake and dam facility are owned by the Bistone Municipal Water Supply District. Inflows to the lake originate over a 198 square mile drainage area. At the conservation capacity pool elevation of 443.8 feet, the lake is approximately two miles long and six-tenths of a mile wide at it's widest point.

The project was designed by Koch & Fowler and Grafe, Inc. The general contractor was P. P. Prescott & Sons, Inc. Construction of Bistone Dam began on July 26, 1960 and was completed on June 5, 1961. Estimated cost of the dam was $312,000. Deliberate impoundment of the reservoir began on the completed date of the dam. The reservoir reached the conservation pool elevation and the spillway was engaged on June 18, 1961 due to heavy rains in the area. Bistone Dam is an earthfill embankment, 1,645 feet in length. The crest of the dam rises 50 feet above the original riverbed to an elevation of 462.3 feet. The spillway is a concrete ogee type located at the east end of the dam. The spillway's crest length is 520 feet at elevation 443.8 feet. The outlet works consist of a 24 inch diameter steel pipe low-flow outlet with an invert elevation of 422.1 feet. A sluice gate, located on the downstream side of the embankment serves as control. The raw-water intake for the filter plant is a 36 inch diameter pipe with an invert elevation 425.3 feet.

Water rights Permit Number 1955 was issued May 4, 1960 by the State Board of Water Engineers to the Bistone Municipal Water Supply District. The permit allowed the storage of 10,000 acre-feet of water and use annually, not to exceed, 5,000 acre-feet of water for municipal purposes and 4,000 acre-feet of water for industrial purposes. Certificate of Adjudication Number 12-5287 was issued January 14, 1988 to the Bistone Municipal Water Supply District. The Certificate authorized the owner to maintain an existing reservoir known as Lake Mexia and impound, not to exceed 9,600 acre-feet of water. The owner was authorized to divert and use, not to exceed 2,887 acre-feet of water per annum for municipal purposes within the City of Mexia and the Mexia State School. The owner was also authorized to use, 65 acre-feet of water per annum for industrial purposes.

HYDROGRAPHIC SURVEYING TECHNOLOGY

The following sections will describe the equipment and methodology used to conduct this hydrographic survey. Some of the theory behind Global Positioning System (GPS) technology and its accuracy are also addressed.

GPS Information

The following is a brief and simple description of Global Positioning System (GPS) technology. GPS is a new technology that uses a network of satellites, maintained in precise orbits around the earth, to determine locations on the surface of the earth. GPS receivers continuously monitor the broadcasts from the satellites to determine the position of the receiver.

With only one satellite being monitored, the point in question could be located anywhere on a sphere surrounding the satellite with a radius of the distance measured. The observation of two satellites decreases the possible location to a finite number of points on a circle where the two spheres intersect. With a third satellite observation, the unknown location is reduced to two points where all three spheres intersect. One of these points is obviously in error because its location is in space, and it is ignored. Although three satellite measurements can fairly accurately locate a point on the earth, the minimum number of satellites required to determine a three dimensional position within the required accuracy is four. The fourth measurement compensates for any time discrepancies between the clock on board the satellites and the clock within the GPS receiver.

GPS technology was developed in the 1960s by the United States Air Force and the defense establishment. After program funding in the early 1970s, the initial satellite was launched on February 22, 1978. A four year delay in the launching program occurred after the Challenger space shuttle disaster. In 1989, the launch schedule was resumed. Full operational capability will be reached when the NAVSTAR (NAVigation System with Time And Ranging) satellite constellation is composed of 24 Block II satellites. At the time of the survey, the system had achieved initial operational capability. A full constellation of 24 satellites, in a combination of Block I (prototype) and Block II satellites, was fully functional. The NAVSTAR satellites provide data based on the World Geodetic System (WGS '84) spherical datum. WGS '84 is essentially identical to NAD '83.

The United States Department of Defense (DOD) is currently responsible for implementing and maintaining the satellite constellation. In an attempt to discourage the use of these survey units as a guidance tool by hostile forces, the DOD has implemented means of false signal projection called Selective Availability (S/A). Positions determined by a single receiver when S/A is active result in errors to the actual position of up to 100 meters. These errors can be reduced to centimeters by performing a static survey with two GPS receivers, one of which is set over a point with known coordinates. The errors induced by S/A are time-constant. By monitoring the movements of the satellites over time (one to three hours), the errors can be

minimized during post processing of the collected data and the unknown position computed accurately.

Differential GPS (DGPS) can determine positions of moving objects in real-time or "on-the-fly." In the early stages of this program, one GPS receiver was set up over a benchmark with known latitude and longitude coordinates established by the hydrographic survey crew. This receiver remained stationary at this shore station during the survey and monitored the movements of the satellites overhead. Position corrections were determined and transmitted via a radio link once per second to a second GPS receiver located on the moving boat. The boat receiver used these corrections, or differences, in combination with the satellite information it received to determine its differential location. The large positional errors experienced by a single receiver when S/A is active are greatly reduced by utilizing DGPS. The reference receiver calculates satellite corrections based on its known fixed position, which results in positional accuracies within three meters for the moving receiver. DGPS was used to determine horizontal position only. Vertical information was supplied by the depth sounder.

The need for setting up a shore station receiver for current surveys has been eliminated with the development of fee-based reference position networks. These networks use a small number of GPS receivers to create differential corrections for a large number of transmitting stations. This type of system is known as, Wide Area Differential GPS (WADGPS). The TWDB contracts this service from ACCQPOINT, a WADGPS correction network that broadcasts over FM radio. A small radio receiver, on-board the boat, collects positional correction information from the closest broadcast station and provides the data to the GPS receiver on board the boat to allow the position to be differentially corrected.

Equipment and Methodology

The equipment used in the performance of the hydrographic survey consisted of a 23-foot aluminum tri-hull SeaArk craft with cabin, equipped with twin 90-Horsepower Johnson outboard motors. Installed within the enclosed cabin are an Innerspace Helmsman Display (for

navigation), an Innerspace Technology Model 449 Depth Sounder and Model 443 Velocity Profiler, a Trimble Navigation, Inc. 4000SE GPS receiver, an ACCQPOINT FM receiver, and an on-board computer. Power was provided by a water-cooled generator through an in-line uninterruptible power supply. Reference to brand names does not imply endorsement by the TWDB.

The GPS equipment, survey vessel, and depth sounder combine together to provide an efficient hydrographic survey system. As the boat travels across the lake surface, the depth sounder gathers approximately ten readings of the lake bottom each second. The depth readings are stored on the survey vessel's on-board computer along with the corrected positional data generated by the boat's GPS receiver. The daily data files collected are downloaded from the computer and brought to the office for editing after the survey is completed. During editing, bad data is removed or corrected, multiple data points are averaged to get one data point per second, and average depths are converted to elevation readings based on the daily recorded lake elevation on the day the survey was performed. Accurate estimates of the lake volume can be quickly determined by building a 3-D model of the reservoir from the collected data. The level of accuracy is equivalent to or better than previous methods used to determine lake volumes, some of which are discussed below.

Previous Survey Procedures

Originally, reservoir surveys were conducted with a rope stretched across the reservoir along pre-determined range lines. A small boat would manually pole the depth at selected intervals along the rope. Over time, aircraft cable replaced the rope and electronic depth sounders replaced the pole. The boat was hooked to the cable, and depths were again recorded at selected intervals. This method, used mainly by the Soil Conservation Service, worked well for small reservoirs.

Larger bodies of water required more involved means to accomplish the survey, mainly due to increased size. Cables could not be stretched across the body of water, so surveying instruments were utilized to determine the path of the boat. Monuments were set for the end points of each line so the same lines could be used on subsequent surveys. Prior to a survey, each end point had to be located (and sometimes reestablished) in the field and vegetation cleared so that line of sight could be maintained. One surveyor monitored the path of the boat and issued commands via radio to insure that it remained on line while a second surveyor determined depth measurement locations by turning angles. Since it took a major effort to determine each of the points along the line, the depth readings were spaced quite a distance apart. Another major cost was the land surveying required prior to the reservoir survey to locate the range line monuments and clear vegetation.

Electronic positioning systems were the next improvement. If triangulation could determine the boat location by electronic means, then the boat could take continuous depth soundings. A set of microwave transmitters positioned around the lake at known coordinates would allow the boat to receive data and calculate its position. Line of site was required, and the configuration of the transmitters had to be such that the boat remained within the angles of 30 and 150 degrees in respect to the shore stations. The maximum range of most of these systems was about 20 miles. Each shore station had to be accurately located by survey, and the location monumented for future use. Any errors in the land surveying resulted in significant errors that were difficult to detect. Large reservoirs required multiple shore stations and a crew to move the shore stations to the next location as the survey progressed. Land surveying was still a major cost.

Another method used mainly prior to construction utilized aerial photography to generate elevation contours which could then be used to calculate the volume of the reservoir. Fairly accurate results could be obtained, although the vertical accuracy of the aerial topography was generally one-half of the contour interval or $\pm$ five feet for a ten-foot contour interval. This method could be quite costly and was only applicable in areas that were not inundated.

PRE-SURVEY PROCEDURES

The reservoir's surface area was determined prior to the survey by digitizing with AutoCad software the lake's conservation pool boundary from a USGS quad sheet named TEHUACANA, TX. 1960 (Photo revised 1978). The graphical boundary file created was then transformed into the proper datum, from NAD '27 datum to NAD '83, using Environmental Systems Research Institutes's (ESRI) Arc/Info project command with the NADCOM parameters. The area of the lake boundary was checked to verify that the area was the same in both datums.

The survey layout was designed by placing survey track lines at 500 foot intervals across the lake, perpendicular to the creeks, streams and or river channels. The survey design for this lake required approximately 63 survey lines to be placed along the length of the lake. Survey setup files were created using Coastal Oceangraphics, Inc. “Hypack” software for each group of track lines that represent a specific section of the lake. The setup files were copied onto diskettes for use during the field survey.

SURVEY PROCEDURES

The following procedures were followed during the hydrographic survey of Lake Mexia performed by the TWDB. Information regarding equipment calibration and operation, the field survey, and data processing is presented.

Equipment Calibration and Operation

During the survey, the onboard GPS receiver was set to a horizontal mask of 10° and a PDOP (Position Dilution of Precision) limit of 7 to maximize the accuracy of horizontal positions. An internal alarm sounds if the PDOP rises above seven to advise the field crew that the horizontal position has degraded to an unacceptable level.

At the beginning of each surveying day, the depth sounder was calibrated with the

Innerspace Velocity Profiler. The Velocity Profiler calculates an average speed of sound through the water column of interest for a designated draft value of the boat (draft is the vertical distance that the boat penetrates the water surface). The draft of the boat was previously determined to average 1.2 ft. The velocity profiler probe is placed in the water to moisten and acclimate the probe. The probe is then raised to the water surface where the depth is zeroed. The probe is lowered on a cable to just below the maximum depth set for the water column, and then raised to the surface. The unit displays an average speed of sound for a given water depth and draft, which is entered into the depth sounder. The depth value on the depth sounder was then checked manually with a measuring tape to ensure that the depth sounder was properly calibrated and operating correctly. During the survey of Lake Mexia, the speed of sound in the water column varied daily between 4890 and 4900 feet per second. Based on the measured speed of sound for various depths, and the average speed of sound calculated for the entire water column, the depth sounder is accurate to within ±0.2 feet, plus an estimated error of ±0.3 feet due to the plane of the boat for a total accuracy of ±0.5 feet for any instantaneous reading. These errors tend to be minimized over the entire survey, since some are plus readings and some are minus readings. Further information on these calculations is presented in Appendix A.

Field Survey

Data was collected on Lake Mexia, May 7 and 8, 1996. Approximately 18,750 data points were collected over the 13 miles traveled along the pre-planned survey lines and the random data-collection lines. These points were stored digitally on the boat's computer in 54 data files. Data were not collected in areas of shallow water (depths less than 3.0 ft.) or with significant obstructions unless these areas represented a large amount of water. Figure 2 shows the actual location of the data collection points. It should be noted the field crew attempted to collect data in the upper reaches of Lake Mexia (specifically the Navasota River arm) but shallow water prohibited any further data collection beyond that shown on Figure 2.

While collecting data, TWDB staff observed the lake bottom to be fairly uniform. A

gradual declination from the shoreline to the old river channel was noted. No specific river channels could be detected in the reservoir on the depth sounder's analog chart. Lake Mexia was fairly clear of navigational hazards such as stumps in the main body of the lake. The crew did encounter some stumps and shallows in the upper reaches of Cedar Creek. Shallow water was also found in the upper reaches of Sandy Creek, north of Hwy. 84 and in the upper arm where the Navasota River feeds into the lake. The vertical clearance of the abandoned Comanche Crossing Bridge over Lake Mexia temporarily restricted the boat from reaching the upper end of the lake. A temporary boat ramp was constructed by the Bistone Municipal Water Supply District to facilitate access to the upper end of the lake. Without the efforts and assistance of employees of the Bistone Municipal Water Supply District, collecting data in the area upstream of the bridge would not have been possible.

The collected data were stored in individual data files for each pre-plotted range line or random data collection event. These files were downloaded to diskettes at the end of each day for future processing.

Data Processing

The collected data were down-loaded from diskettes onto the TWDB's computer network. Tape backups were made for future reference as needed. To process the data, the EDIT routine in the Hypack Program was run on each raw data file. Data points such as depth spikes or data with missing depth or positional information were deleted from the file. The depth information collected every 0.1 seconds was averaged to get one reading for each second of data collection. A correction for the lake elevation at the time of data collection was applied to each file during the EDIT routine. The water surface varied slightly, between 446.75 and 446.76 feet, during the two data collection days. The data file, after editing was completed, was saved with a different extension to distinguish it from the raw data file. After all the files were edited, the edited files were combined into a single data file, of latitude, longitude and elevation.

The resulting DOS data file was imported into the UNIX operating system used to run Environmental System Research Institutes's (ESRI) Arc/Info GIS software. The latitude and longitude coordinates of each point were converted to decimal degrees by a UNIX awk command. The awk command manipulates the data file format into a MASS points format for use by the GIS software. The graphic boundary file previously digitized was also imported.

The boundary and MASS points files were graphically edited using the Arc/Edit module. The MASS points file was converted into a point coverage and plotted along with the boundary file. If data points were collected outside the boundary file, the boundary was modified to include the data points. Also, the boundary near the edges of the lake in areas of significant sedimentation was down-sized to reflect the observations of the field crew. The resulting boundary shape was considered to be the acreage at the conservation pool elevation of the lake. This was calculated as 1,047 acres for Lake Mexia. The Board does not represent the boundary, as depicted in this report, to be a detailed actual boundary. Instead, it is a graphical approximation of the actual boundary used solely to compute the volume and area of the lake. The boundary does not represent the true land versus water boundary of the lake. An aerial topographic map of the upper four feet of the lake or an aerial photo taken when the lake is at the conservation pool elevation would more closely define the present boundary. However, the minimal increase in accuracy does not appear to offset the cost of those services at this time.

The edited MASS points and modified boundary file were used to create a Digital Terrain Model (DTM) of the reservoir's bottom surface using Arc/Info's TIN module. The module builds an irregular triangulated network from the data points and the boundary file. The software uses a method known as Delauney's criteria for triangulation. A triangle is formed between three non-uniformly spaced points, including all points along the boundary. If there is another point within the triangle, additional triangles are created until all points lie on the vertex of a triangle. All of the data points are preserved for use in determining the solution of the model by using this method. The generated network of three-dimensional triangular planes represents the actual bottom surface. Once the triangulated irregular network (TIN) is formed, the software then calculates elevations along the triangle’s surface plane by solving the equations for elevation

along each leg of the triangle. Information for the entire reservoir area can be determined from the triangulated irregular network created using this method of interpolation.

There were some areas where values could not be calculated by interpolation because of a lack of information. "Flat triangles" were drawn at these locations. Arc/Info does not use flat triangle areas in the volume or contouring features of the model. Approximately 413 additional points were required for interpolation and contouring of the entire lake surface. The TIN product calculated the surface area and volume of the entire reservoir at one-tenth of a foot intervals from the three-dimensional triangular plane surface representation. The computed reservoir volume table is presented in Appendix B and the area table in Appendix C. An elevation-area-volume graph is presented in Appendix D.

Other presentations developed from the model include a shaded relief map and a shaded depth range map. To develop the shaded relief map, the three-dimensional triangular surface was modified by a GRIDSHADE command. Colors were assigned to different elevation values of the grid. Using the command COLORRAMP, a set of colors that varied from navy to yellow was created. The lower elevation was assigned the color of navy, and the lake conservation pool elevation was assigned the color of yellow. Different color shades were assigned to the different depths in between. Figure 3 presents the resulting depth shaded representation of the lake. Figure 4 presents a similar version of the same map, using bands of color for selected depth intervals. The color increases in intensity from the shallow contour bands to the deep water bands.

The DTM was then smoothed and linear smoothing algorithms were applied to the smoothed model to produce smoother contours. The resulting contour map of the bottom surface at two and five-foot intervals is presented in Figure 5.

RESULTS

Results from the 1996 survey indicate Lake Mexia now encompasses 1,048 surface acres and contains a volume of 4,806 acre-feet at the conservation pool elevation of 448.3 feet. The shoreline at this elevation was calculated to be 21.55 miles. The lowest elevation encountered was around elevation 424.7 feet, or 23.6 feet of depth and was found just downstream of Comanche Crossing.

The storage volume calculated by the 1996 survey is approximately 52 percent less than the previous record information for the lake. The lowest gated outlet invert elevation is at elevation 422.1 feet. This outlet has not been operated in a long time, and may be covered by silt now. The raw water intake is therefore assumed to be the lowest outlet for the lake. The area directly around the intakes is clean, but there is no water storage below the intakes. Therefore, the conservation storage capacity for the lake is the same as the capacity of the lake, or 4,806 acre-feet.

SUMMARY

Lake Mexia and Bistone Dam were authorized to be constructed under Permit Number 1955 issued on May 4, 1960. Construction of the dam commenced in July of 1960 and deliberate impoundment of water began in June of 1961. Initial storage calculations estimated the volume of the lake at the conservation pool elevation of 448.3 feet to be 10,000 acre-feet with surface area of 1,200 acres.

During the period of May 7 and 8, 1996, a hydrographic survey of Lake Mexia was performed by the Texas Water Development Board's Hydrographic Survey Program. The 1996 survey used technological advances such as differential global positioning system and geographical information system technology to build a model of the reservoir's bathemetry. These advances allowed a survey to be performed quickly and to collect significantly more data of the bathemetry of Lake Mexia than previous survey methods. Results from the survey indicate that the lake's capacity at the conservation pool elevation of 448.3 feet was 4,806 acre-feet. The estimated reduction in storage capacity, if compared to the original volume was 5,194

acre-feet, or 51.9 percent. This equates to an estimated loss of 148.4 acre-feet per year during the 35 years between the TWDB's survey and the initial date impoundment began. The annual deposition rate of sediment in the conservation pool can be estimated at 0.749 acre-ft per square mile of drainage area.

It is difficult to compare the original design information and the survey performed by the TWDB because little is know about the procedures and data used in calculating the original storage information. However, the TWDB considers the 1996 survey to be a significant improvement over previous survey procedures and recommends that the same methodology be used in five to ten years or after major flood events to monitor changes to the lake's storage capacity. The second survey will remove any noticeable errors between the original design data and the 1996 survey and will facilitate accurate calculations of sedimentation rates and storage losses presently occurring in Lake Mexia.

CALCULATION OF DEPTH SOUNDER ACCURACY

This methodology was extracted from the Innerspace Technology, Inc. Operation Manual for the Model 443 Velocity Profiler.

For the following examples, $t = (D - d)/V$

where: t_D **= travel time of the sound pulse, in seconds (at depth = D)**
D = depth, in feet
d = draft = 1.2 feet
V = speed of sound, in feet per second

To calculate the error of a measurement based on differences in the actual versus average speed of sound, the same equation is used, in this format:

$$D = [t(V)]+d$$

For the water column from 2 to 30 feet: $V = 4832$ **fps**

$$t_{30} = (30-1.2)/4832$$
$$= 0.00596 \text{ sec.}$$

For the water column from 2 to 45 feet: $V = 4808$ **fps**

$$t_{45} = (45-1.2)/4808$$
$$= 0.00911 \text{ sec.}$$

For a measurement at 20 feet (within the 2 to 30 foot column with V = 4832 fps):

$$D_{20} = [((20-1.2)/4832)(4808)]+1.2$$
$$= 19.9' \quad (-0.1')$$

For a measurement at 30 feet (within the 2 to 30 foot column with V = 4832 fps):

$$D_{30} = [((30-1.2)/4832)(4808)]+1.2$$
$$= 29.9' \quad (-0.1')$$

For a measurement at 50 feet (within the 2 to 60 foot column with V = 4799 fps):

$$D_{50} = [((50-1.2)/4799)(4808)]+1.2$$

$= 50.1'$ (+0.1')

For the water column from 2 to 60 feet: V = 4799 fps Assumed V_{80} = 4785 fps

$t_{60} = (60-1.2)/4799$
$= 0.01225$ sec.

For a measurement at 10 feet (within the 2 to 30 foot column with V = 4832 fps):

$D_{10} = [((10-1.2)/4832)(4799)]+1.2$
$= 9.9'$ (-0.1')

For a measurement at 30 feet (within the 2 to 30 foot column with V = 4832 fps):

$D_{30} = [((30-1.2)/4832)(4799)]+1.2$
$= 29.8'$ (-0.2')

For a measurement at 45 feet (within the 2 to 45 foot column with V = 4808 fps):

$D_{45} = [((45-1.2)/4808)(4799)]+1.2$
$= 44.9'$ (-0.1')

For a measurement at 80 feet (outside the 2 to 60 foot column, assumed V = 4785 fps):

$D_{80} = [((80-1.2)/4785)(4799)]+1.2$
$= 80.2'$ (+0.2')

TEXAS WATER DEVELOPMENT BOARD

RESERVOIR VOLUME TABLE

Aug 15 1996

LAKE MEXIA MAY 1996 SURVEY

VOLUME IN ACRE-FEET ELEVATION INCREMENT IS ONE TENTH FOOT

ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
431										
432									1	1
433	1	1	2	2	3	3	4	5	5	6
434	7	9	10	11	13	15	16	18	20	22
435	25	27	29	32	35	38	41	44	47	51
436	54	58	62	67	71	76	81	86	91	97
437	103	109	115	122	129	137	145	153	162	171
438	181	191	201	212	223	235	247	259	272	285
439	299	313	327	341	356	372	388	404	421	438
440	456	474	493	512	531	552	572	593	615	637
441	659	682	705	728	752	777	802	827	853	879
442	905	933	961	990	1019	1049	1080	1111	1144	1177
443	1210	1245	1281	1318	1357	1399	1443	1488	1534	1581
444	1629	1678	1728	1779	1831	1883	1936	1990	2044	2099
445	2155	2212	2270	2329	2389	2450	2512	2576	2641	2707
446	2774	2845	2918	2992	3068	3146	3226	3307	3391	3477
447	3565	3655	3746	3838	3930	4024	4119	4214	4310	4408
448	4506	4605	4705	4806						

TEXAS WATER DEVELOPMENT BOARD

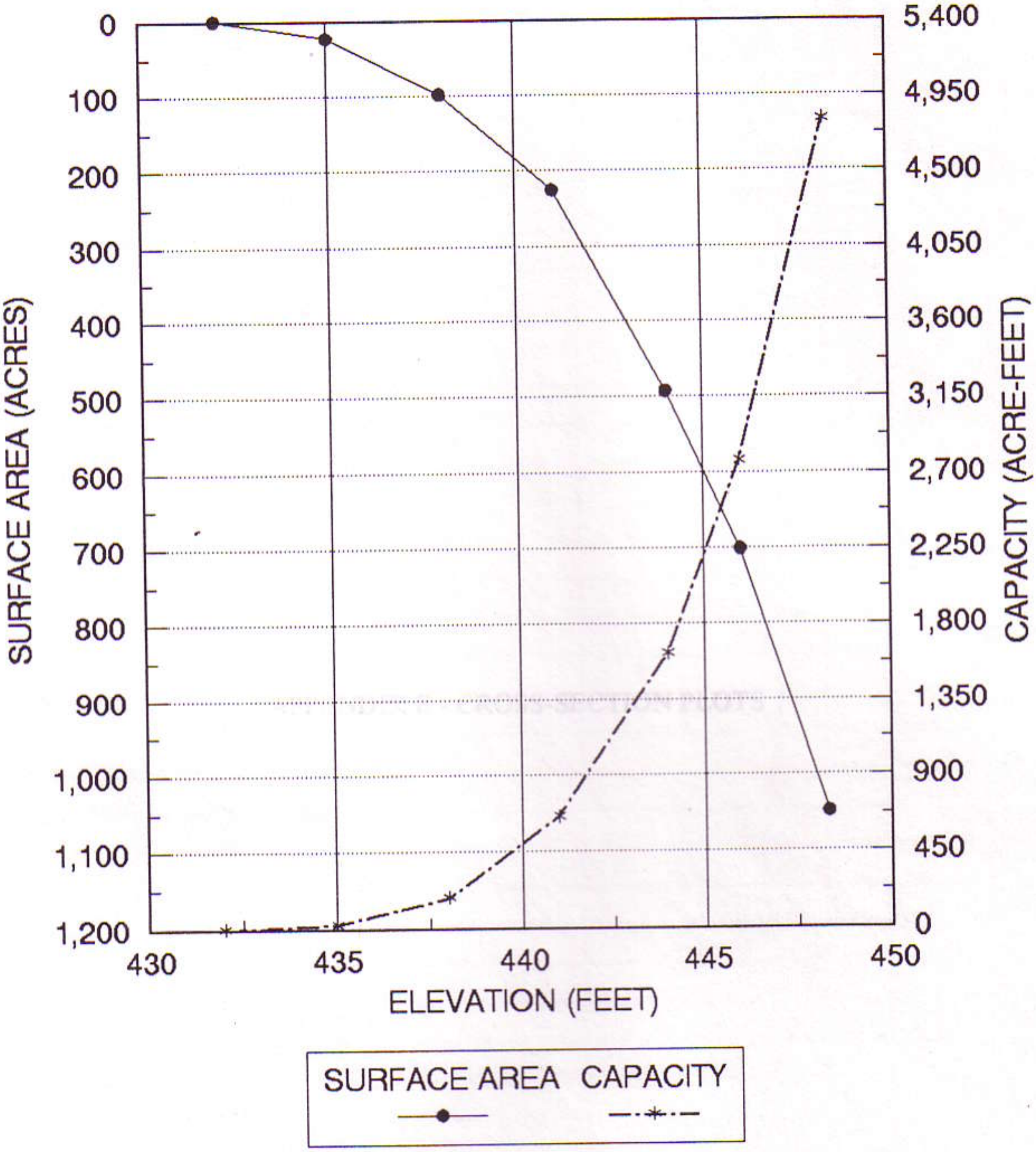
Aug 15 1996

RESERVOIR AREA TABLE

LAKE MEXIA MAY 1996 SURVEY

AREA IN ACRES — ELEVATION INCREMENT IS ONE TENTH FOOT

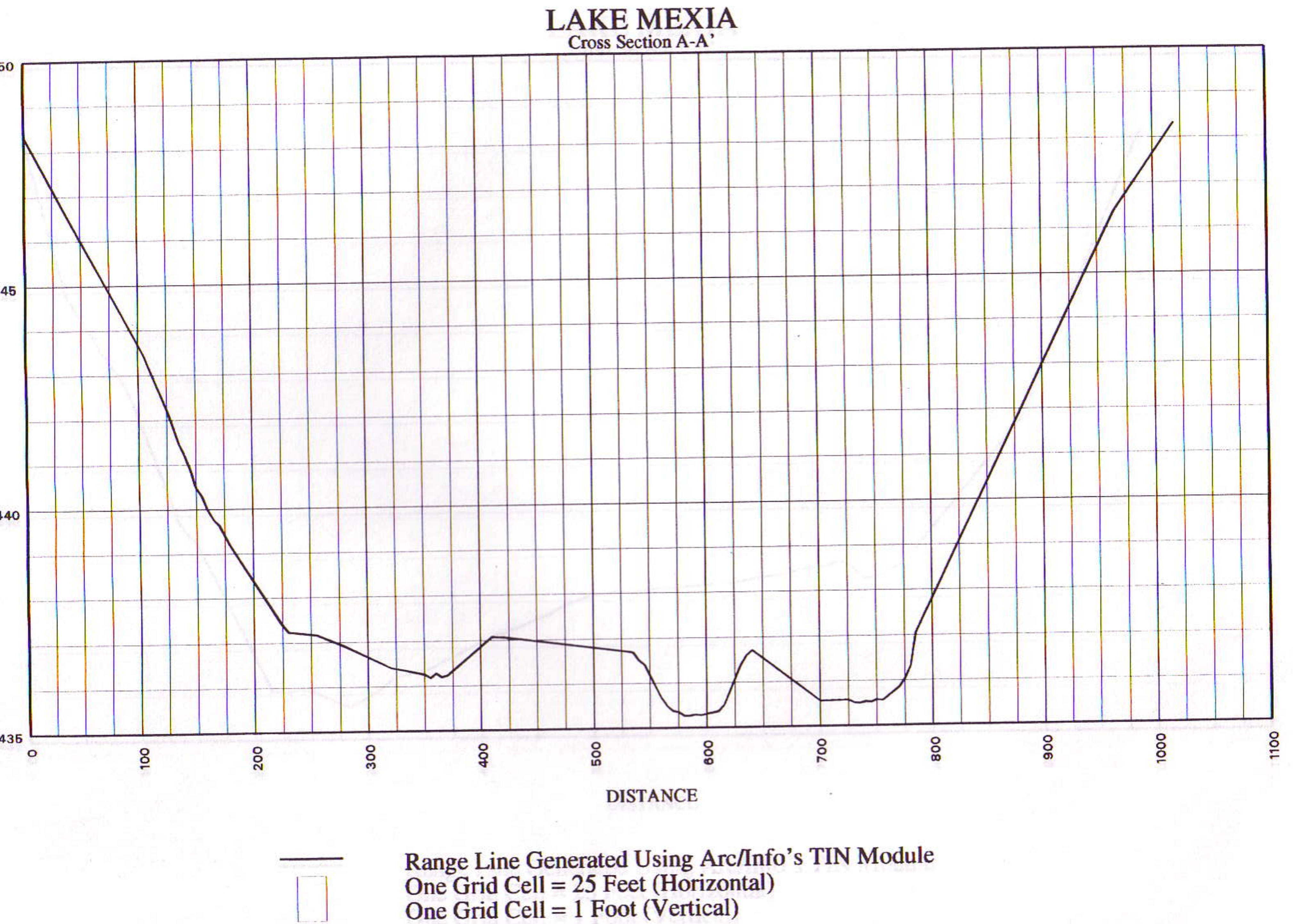
ELEV. FEET	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
431										
432						1	1	1	2	2
433	3	3	4	4	5	6	7	8	9	10
434	12	13	14	15	16	17	18	20	21	22
435	23	24	25	27	28	30	31	33	34	36
436	38	39	42	44	46	48	50	52	55	57
437	60	64	67	70	74	78	81	86	90	94
438	98	102	106	110	114	118	122	126	130	133
439	137	141	145	148	152	156	160	165	170	175
440	180	185	189	194	199	203	208	213	217	221
441	225	230	234	238	242	246	250	255	260	265
442	270	277	284	291	298	304	311	318	326	334
443	342	353	366	381	399	435	446	455	462	475
444	492	498	505	512	519	526	533	540	547	554
445	566	575	585	596	606	618	629	642	654	667
446	701	717	734	752	770	788	807	827	847	867
447	897	906	915	923	932	941	950	959	968	977
448	987	996	1005	1048						



LAKE MEXIA

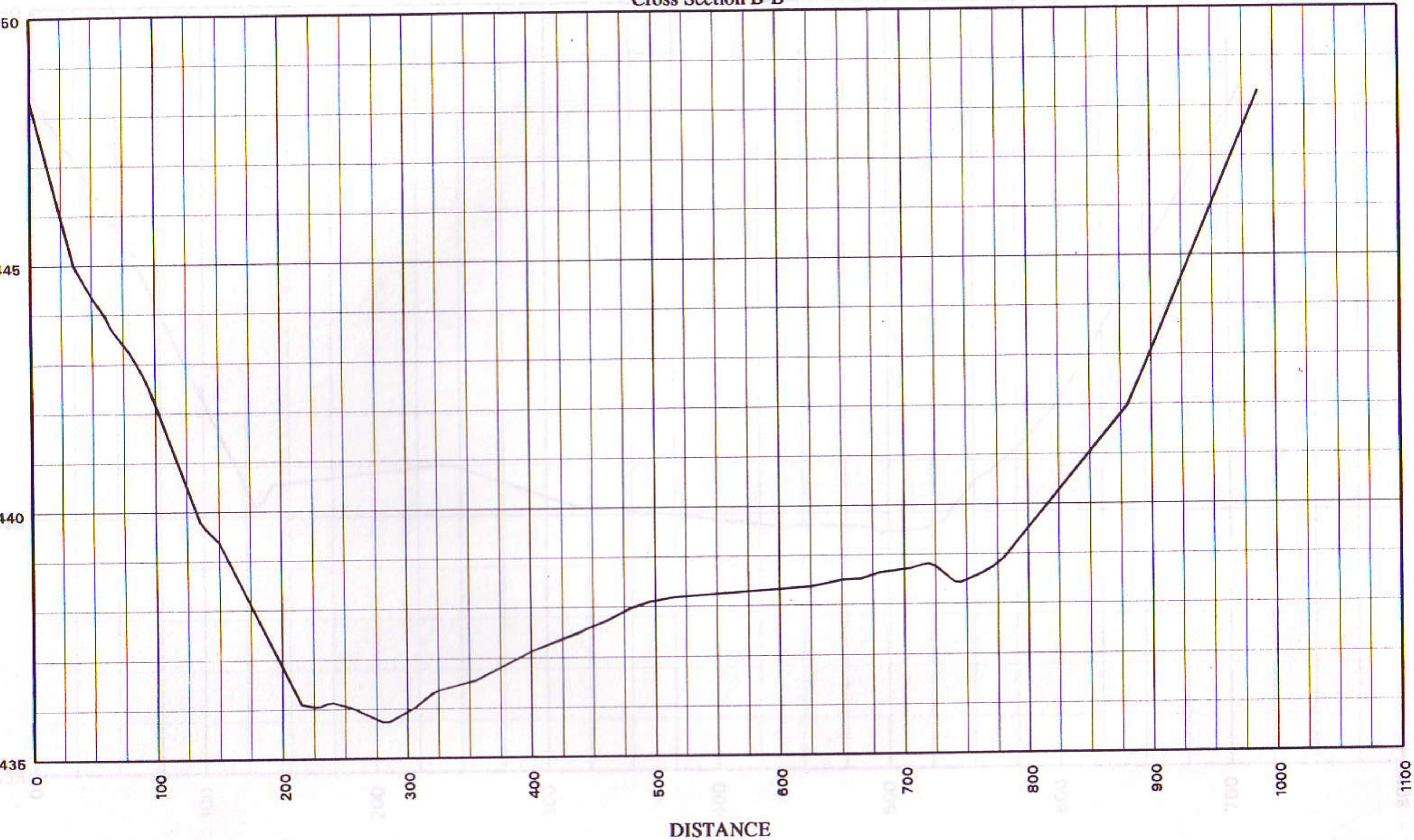
May 1996 Survey

Prepared by: TWDB August 1996

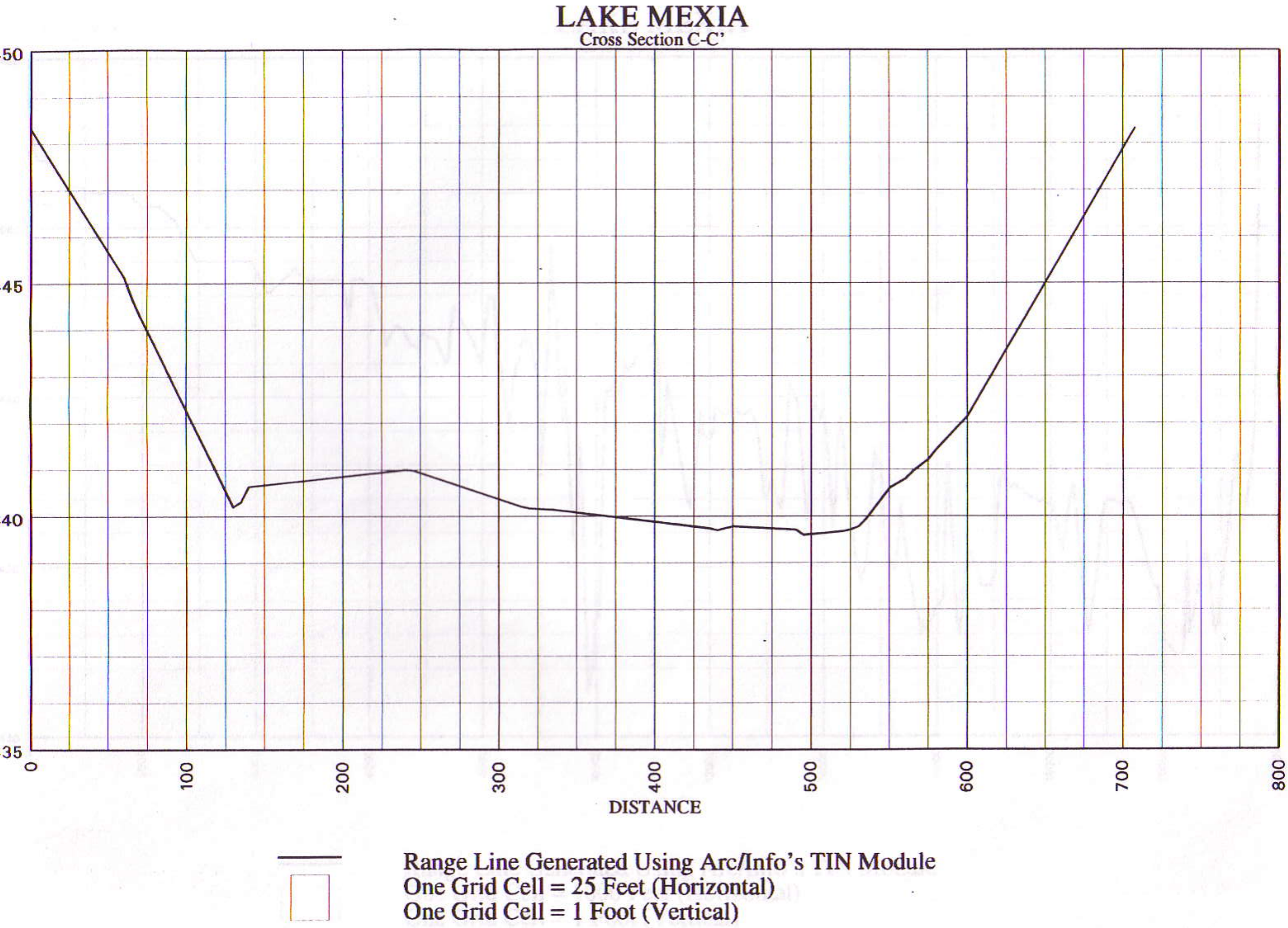

LAKE MEXIA
Cross Section A-A'
450
445
440
435
0
100
200
300
400
500
600
700
800
900
1000
1100
DISTANCE
Range Line Generated Using Arc/Info's TIN Module
One Grid Cell = 25 Feet (Horizontal)
One Grid Cell = 1 Foot (Vertical)

LAKE MEXIA

Cross Section B-B'



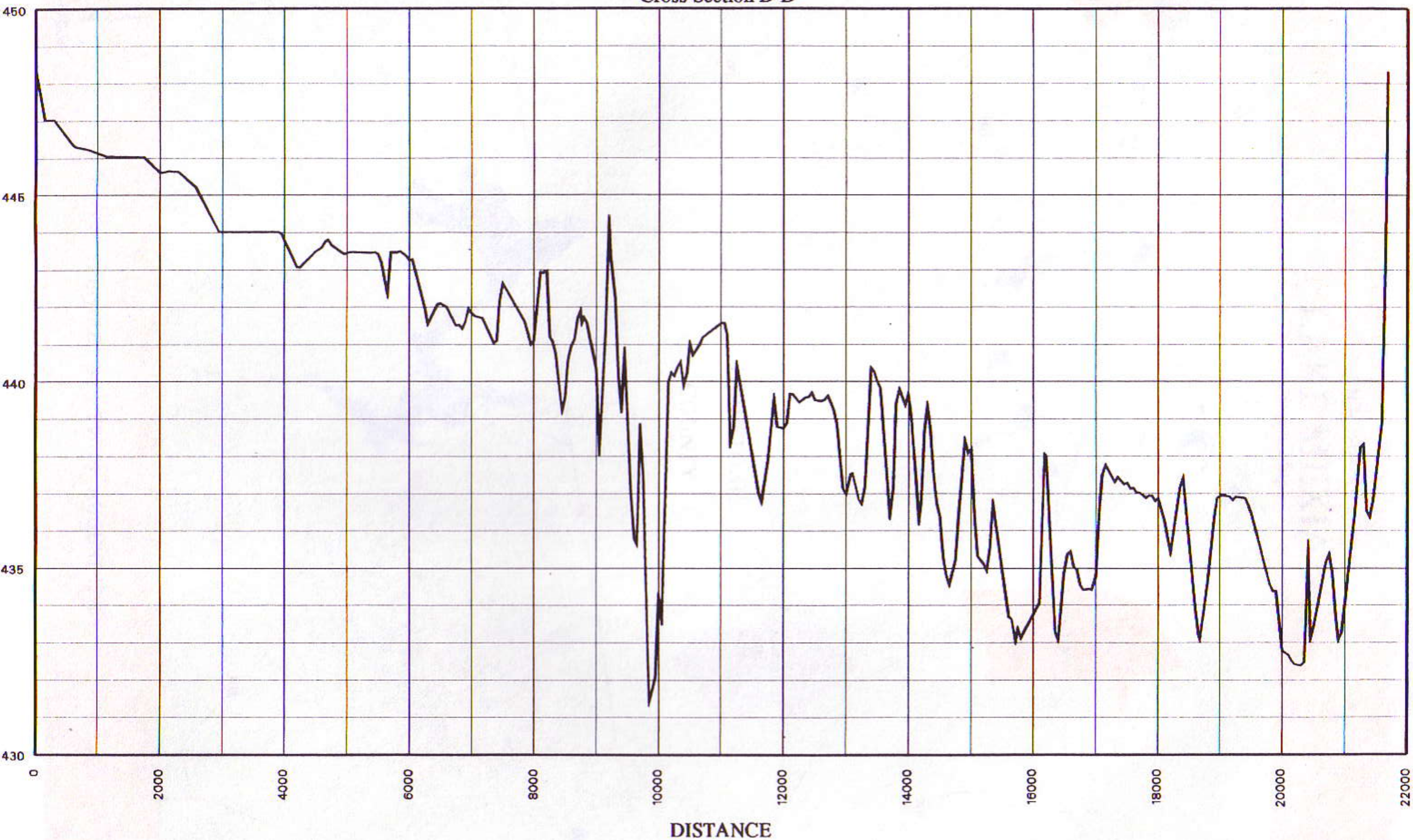
Range Line Generated Using Arc/Info's TIN Module
One Grid Cell = 25 Feet (Horizontal)
One Grid Cell = 1 Foot (Vertical)



LAKE MEXIA
Cross Section C-C'
450
445
440
435
0
100
200
300
400
500
600
700
800
DISTANCE
Range Line Generated Using Arc/Info's TIN Module
One Grid Cell = 25 Feet (Horizontal)
One Grid Cell = 1 Foot (Vertical)

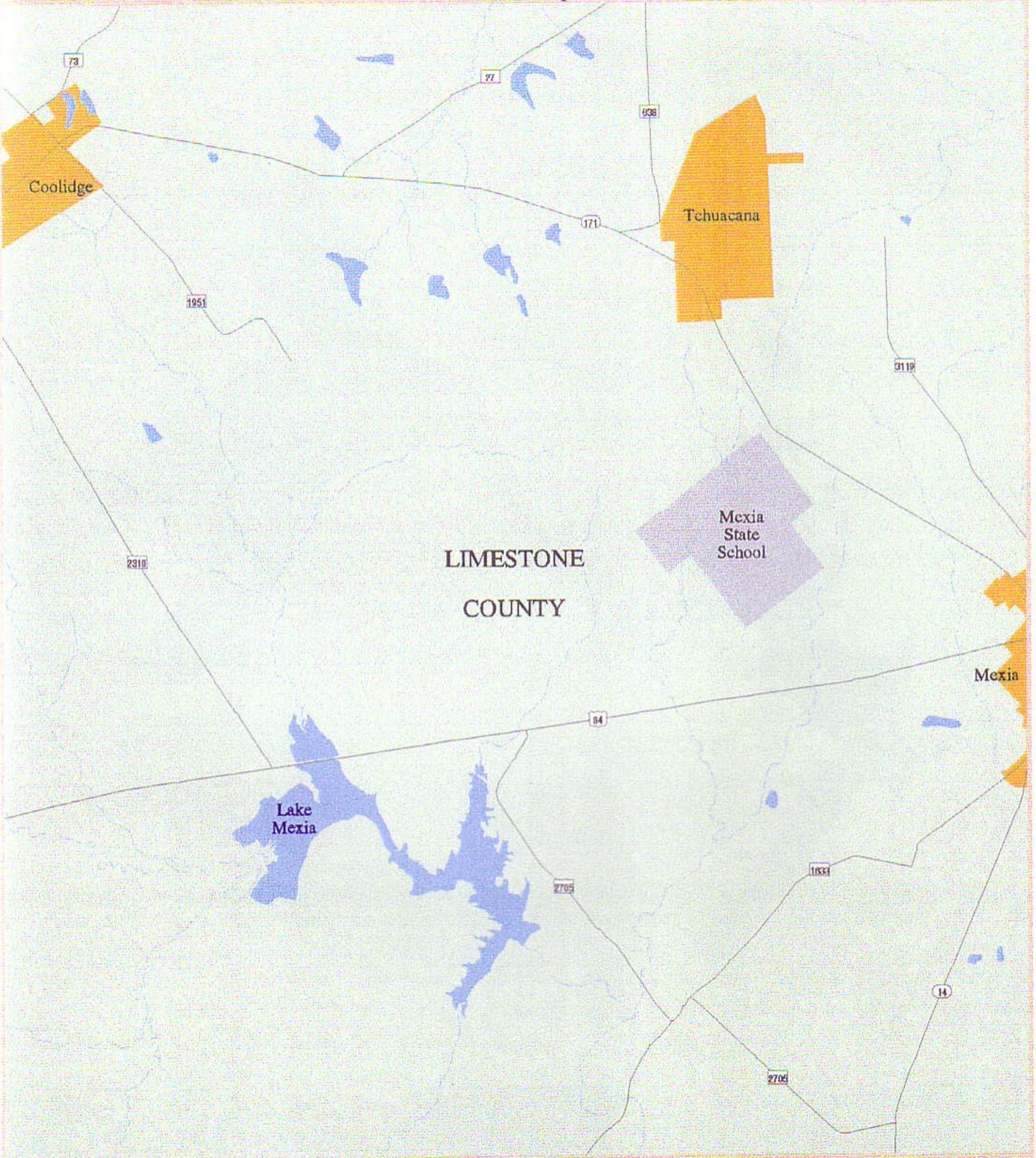
LAKE MEXIA

Cross Section D-D'



Range Line Generated Using Arc/Info's TIN Module
One Grid Cell = 1000 Feet (Horizontal)
One Grid Cell = 1 Foot (Vertical)

FIGURE 1
LAKE MEXIA
Location Map



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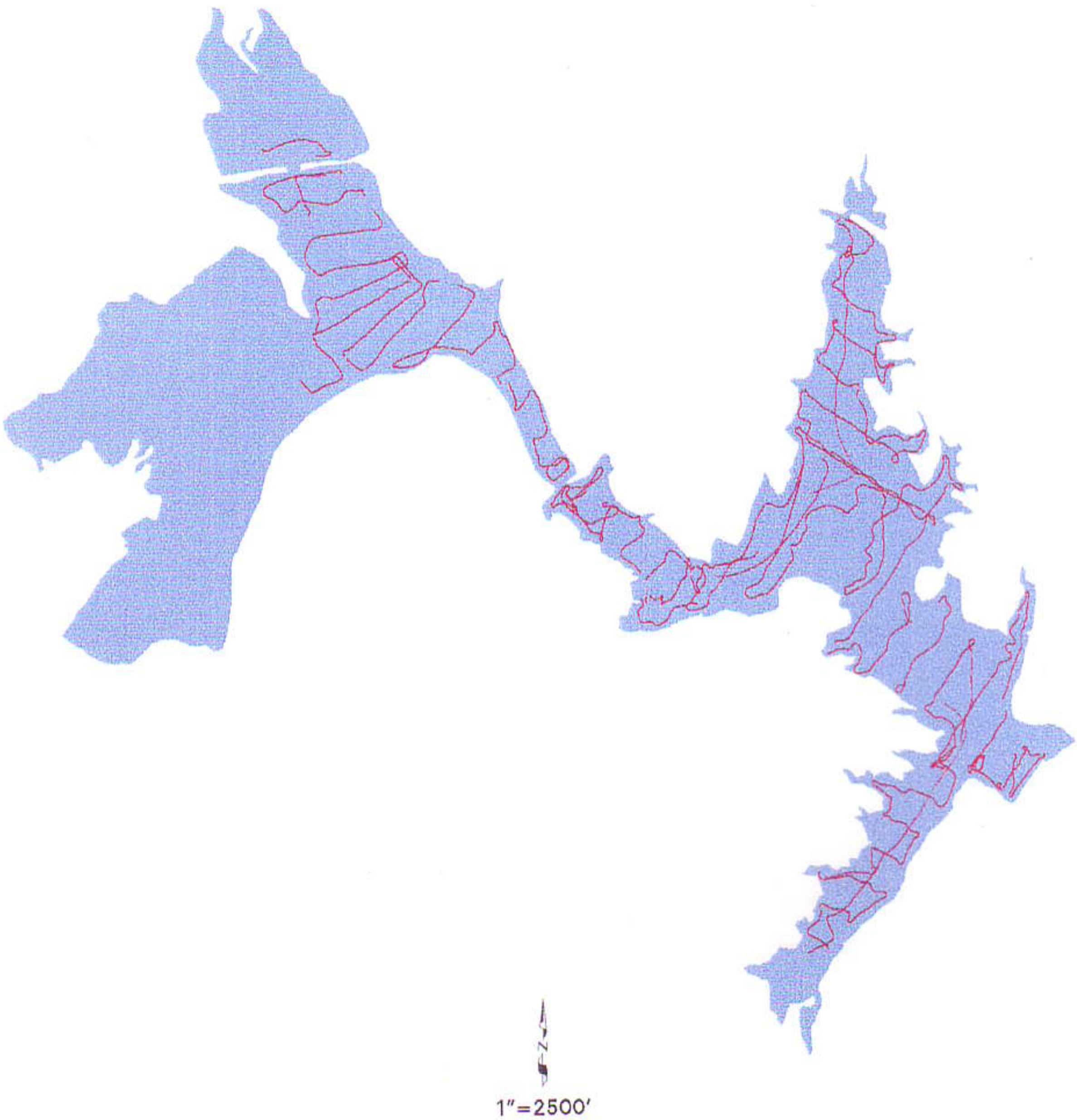
1"=7000'

FIGURE 2

LAKE MEXIA

Location of Survey Data



EXPLANATION

Data Points

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FIGURE 3

LAKE MEXIA

Shaded Relief

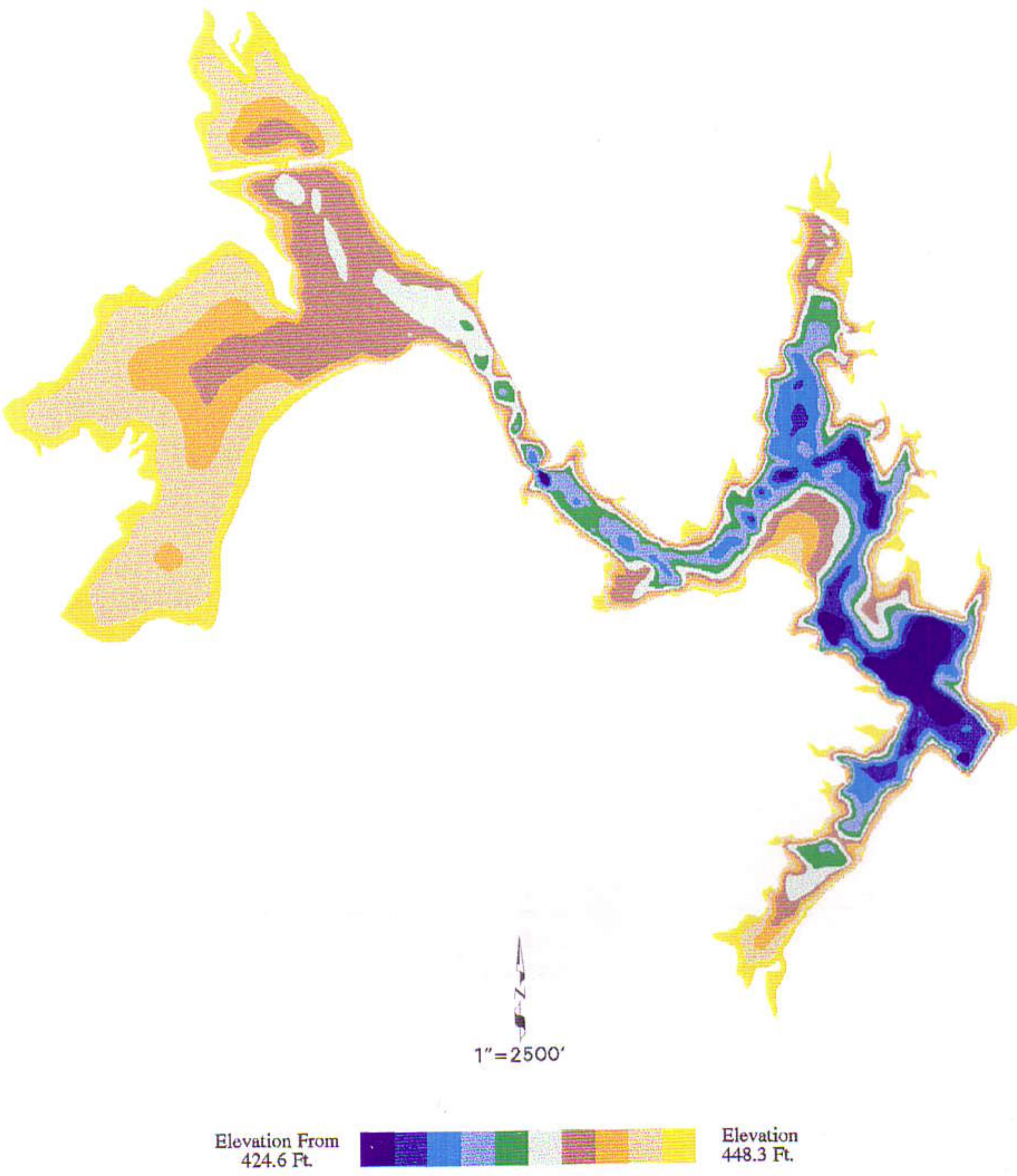

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FIGURE 4

LAKE MEXIA

Depth Ranges

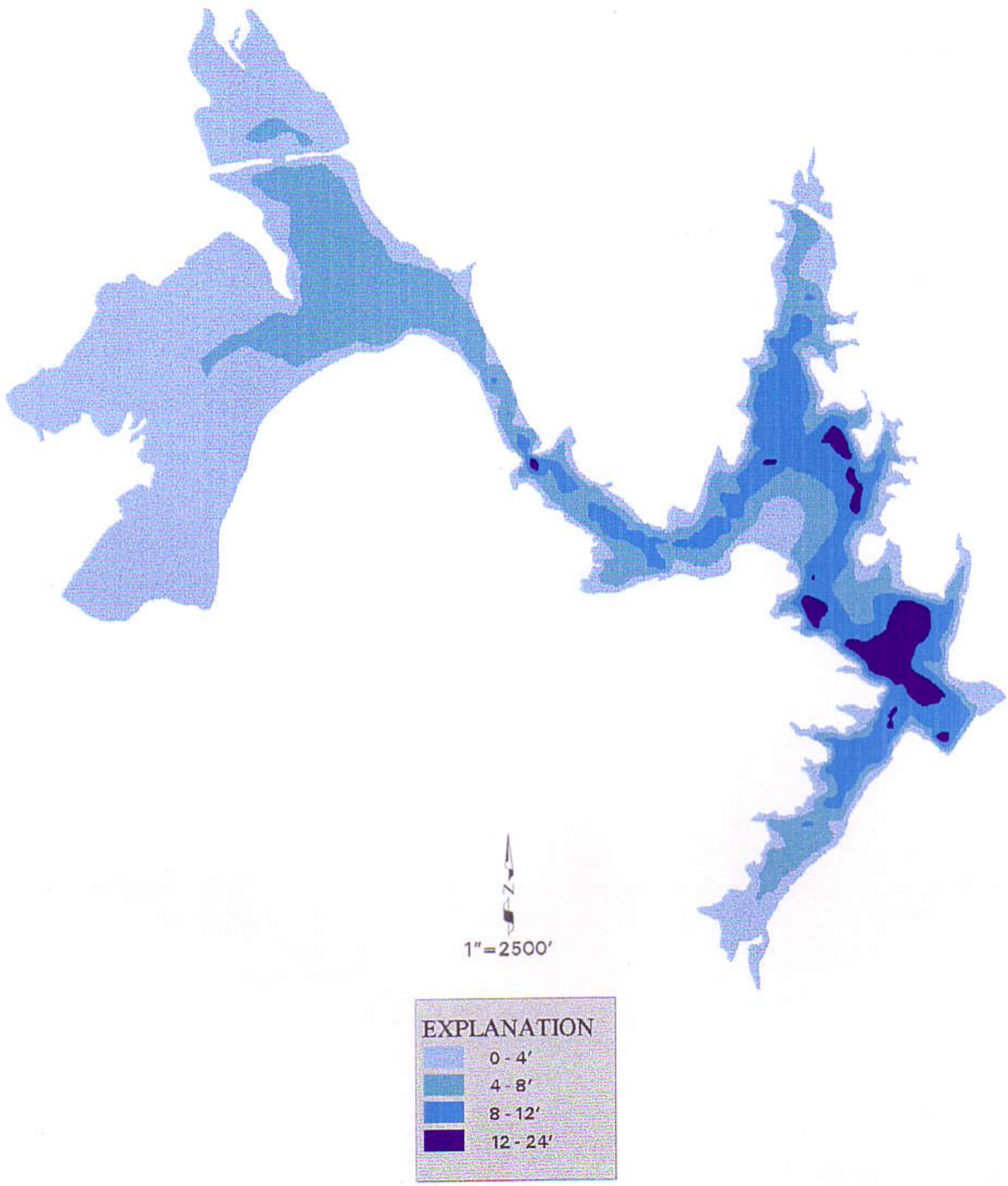

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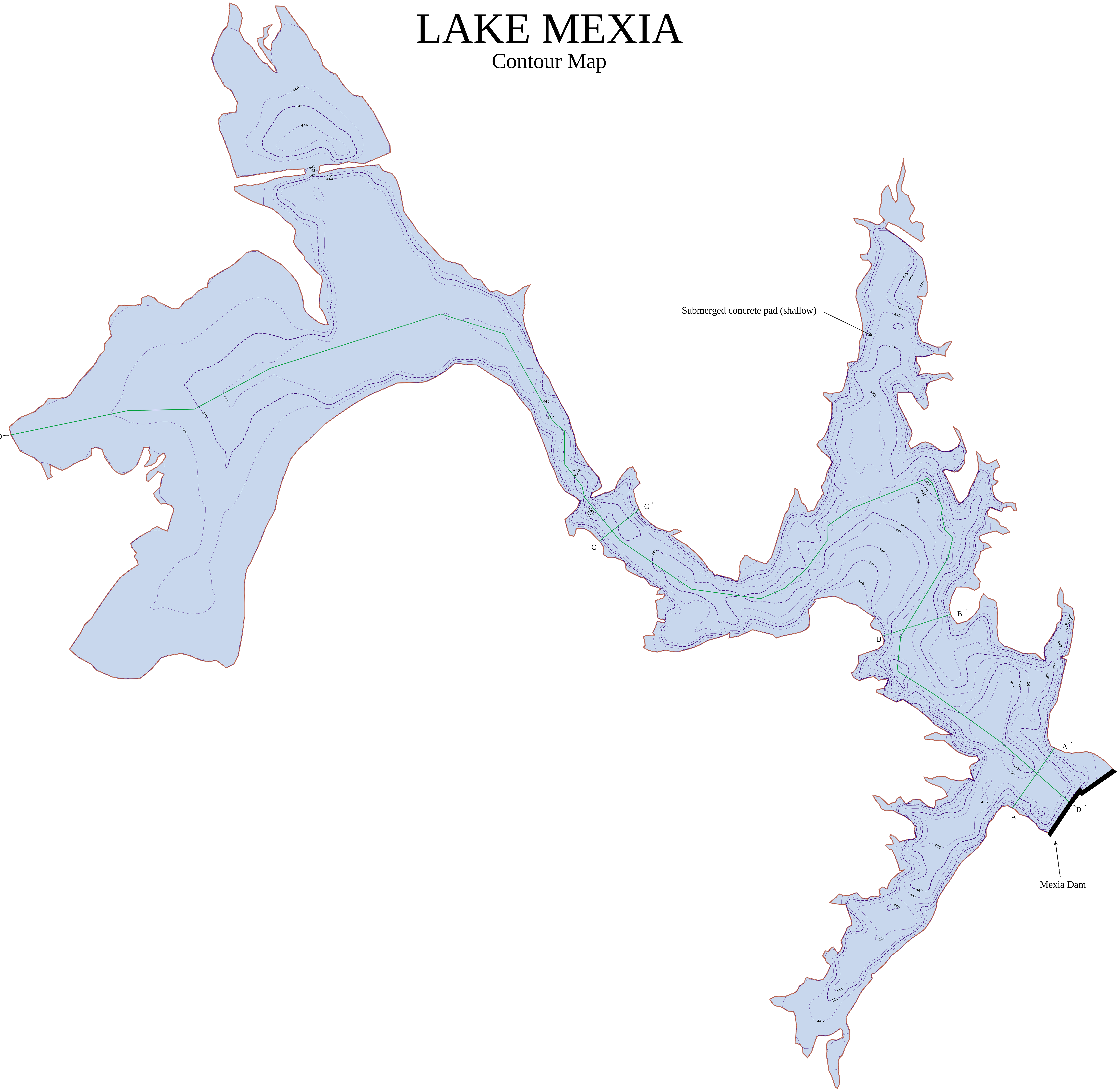
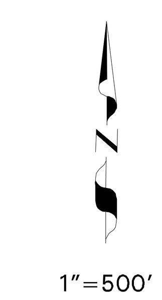
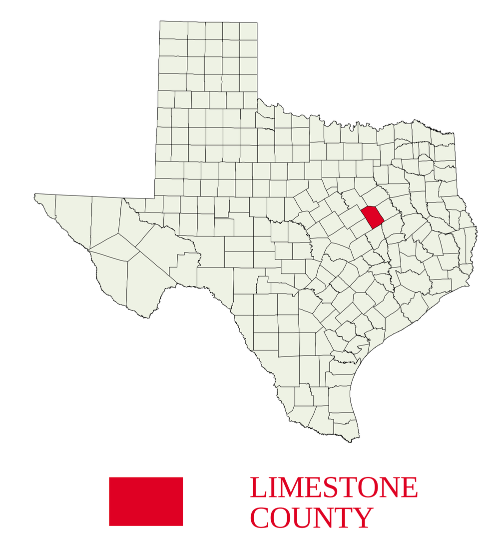
FIGURE 5

LAKE MEXIA

Contour Map







EXPLANATION

- 5 Ft. Contour Lines
- 2 Ft. Contour Lines
- Normal Pool Elevation 448.3 Ft.
- Cross Section Line

This map is the product of a survey conducted by the Texas Water Development Board's Hydrographic Survey Program to determine the capacity of Lake Mexia. The Texas Water Development Board makes no representations or assumes any liability if this information is used for other purposes such as boating maps.

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