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HOUSTON COUNTY LAKE
HYDROGRAPHIC SURVEY REPORT

INTRODUCTION

Staff of the Hydrographic Survey Unit of the Texas Water Development Board (TWDB) conducted a hydrographic survey of Houston County Lake during the period of January 18 and 19, 1999. The purpose of the survey was to determine the capacity of the lake at the conservation pool elevation. From this information, future surveys will be able to determine the location and rates of sediment deposition in the conservation pool 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 the elevation is noted otherwise. The conservation pool elevation for Houston County Lake is 260.0 feet. The original design information estimates the original surface area at this elevation to be 1,282 acres and the storage volume to be 19,500 acre-feet of water.

LAKE HISTORY AND GENERAL INFORMATION

Information in this section was obtained from Texas Water Development Board Report 126 (1974) and from results of the current, 1999, volumetric survey. Houston County Water Control and Improvement District No. 1 (Houston County WCID No. 1) owns the water rights to Houston County Lake and operates and maintains associated Houston County Dam. The lake is located on Little Elkhart Creek in Houston County, 10 miles northwest of Crockett, Texas (see Figure 1). Records indicate the drainage area is approximately 44 square miles. At the conservation pool elevation, the lake has approximately 17 miles of shoreline and is 3.6 miles long. The widest point of the reservoir is approximately 1.2 miles (located 2.0 miles upstream of the dam).

Water Rights Permit No. 2160 (Application No. 2380) was issued to Houston County Fresh WCID No. 1 on May 10, 1965 and authorized the construction of a dam to impound 19,500 acre-feet of water. The owner was granted the right to divert and use not to exceed 3,500 acre-feet of water for municipal purposes and 3,500 acre-feet of water for industrial purposes. The Texas Water Commission issued Certificate of Adjudication No. 08-5097 on May 5, 1987. The certificate authorizes Houston County WCID No. 1 to maintain an existing dam and reservoir on Little Elkhart Creek (Houston County Lake) and to impound not to exceed 19,500 acre-feet of water. The owner was authorized to divert and use not to exceed 3,500 acre-feet of water per year for municipal purposes.

Records indicate the construction for Houston County Lake started April 14, 1966. Deliberate impoundment began November 4, 1966 and the project was officially completed in December 1966. The design engineer for the facility was Lloyd Engineers and Freese, Nichols and Endress. The general contractor was Spencer Construction Company. The estimated cost of the dam was $500,000.00.

Houston County Lake Dam and appurtenant structures consist of a rolled-earth embankment 1,250 feet in length, with a maximum height of 63 feet and a crest elevation of 277.0 feet. The service spillway is a concrete morning glory type drop inlet with a seven feet by seven feet conduit. The crest elevation is 260.0 feet. There is a valve-controlled one and one-half feet diameter low-flow outlet with an invert elevation of 234.0 feet. The emergency spillway is an uncontrolled excavated channel located at the right (north) end of the embankment. The 500 feet wide crest is at elevation 265.0 feet.

HYDROGRAPHIC SURVEYING TECHNOLOGY

The equipment used in the performance of the hydrographic survey consists 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 OmniSTAR receiver, and an on-board 486 computer. A water-cooled generator provides electrical power 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 takes 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 data files are downloaded daily 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 lake elevation recorded on the day the survey was performed. Accurate estimates of the lake volume and surface area can be quickly determined by creating a 3-D digital 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 in Appendix F.

PRE-SURVEY PROCEDURES

The reservoir's surface area was determined prior to the survey by digitizing with AutoCad software the lake's pool boundary (elevation 260.0). The boundary file was created from the 7.5-minute USGS quadrangle map, Hays Spring, TX. (1964). The graphic boundary file created was then transformed into the proper datum, from NAD '27 datum to NAD '83, using Environmental Systems Research Institute's (ESRI) Arc/Info project command with the NADCOM (standard conversion method within the United States) 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 with Coastal Oceangraphics, Inc. Hypack software by placing survey track lines at 500-foot intervals across the lake. The survey design for this lake required approximately 79 survey lines to be placed along the length of the lake. The survey layout files were copied onto diskettes for use during the field survey.

SURVEY PROCEDURES

Equipment Calibration and Operation

At the beginning of each surveying day, the depth sounder was calibrated with the Innerspace Velocity Profiler, an instrument used to measure the variation in the speed of sound at different depths in the water column. The average speed of sound through the entire water column below the boat was determined by averaging local speed-of-sound measurements collected through the water column. The velocity profiler probe was first placed in the water to moisten and acclimate the probe. The probe was next raised to the water surface where the depth was zeroed. The probe was then gradually lowered on a cable to a depth just above the lake bottom, and then raised to the surface. During this lowering and raising procedure, local speed-of-sound measurements were collected., from which the average speed was computed by the velocity profiler. This average speed of sound was entered into the ITI449 depth sounder, which then provided the depth of the lake bottom. The depth was then checked manually with a measuring tape to ensure that the depth sounder was properly calibrated and operating correctly. During the survey of Houston County Lake, the speed of sound in the water column varied from 4,764 to 4,773 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 readings are positive and some are negative. Further information on these calculations is presented in Appendix F.

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 the measured horizontal position. 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. The lake's initialization file used by the Hypack data collection program was set up to convert the collected DGPS positions on the fly to state plane coordinates. Both sets of coordinates were then stored in the survey data file.

Field Survey

Data were collected at Houston County Lake on January 18 and 19, 1999. During data collection, the crew had excellent weather with moderate temperatures and mild winds. Approximately 22,419 data points were collected over the 31 miles traveled. These points were stored digitally on the boat's computer in 72 data files. Data were not collected in areas of shallow water (depths less than 3.0 feet) or with significant obstructions unless these areas represented a large amount of water. Figure 2 shows the actual location of all data collection points.

TWDB staff observed the land surrounding the lake to be generally flat to rolling hills. Along the south shoreline of the lake, the crew observed residential development with bulkheads, piers and boat slips. There were fewer residential sites on the north shore.

While performing the survey on the lake, the field crew noted on the depth sounder chart that the bathymetry or contour of the lake bottom reflected the characteristics of the terrain surrounding the lake. A gradual slope was notice as the boat traveled from the shoreline to the center of the lake. The old channel of Little Elkhart Creek was easily distinguished during the data collection in the main body of the lake.

As the field crew collected data upstream of the intake facility for the treatment plant, navigational hazards such as submerged trees and stumps became apparent. In addition, sediment deposits and standing vegetation were observed in the upper reaches of Little Elkhart Creek. The crew was able to collect data in these areas, but at a much slower pace. Data collection in the headwaters was limited when the boat could no longer cross the lake due to shallow water and extensive vegetation.

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 downloaded 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. A correction for the lake elevation at the time of data collection was also applied to each file during the EDIT routine. During the survey, the water surface varied between 260.10 and 260.15 feet. After all changes had been made to the raw data files, the edited files were saved with a different extension. The edited files were combined into a single X,Y,Z data file, to be used with the GIS software to develop a model of the lake's bottom surface.

The resulting data file was downloaded to a Sun Sparc 20 workstation running the UNIX operating system. Environmental System Research Institute's (ESRI) Arc/Info GIS software was used to convert the data to a MASS points file. The MASS points and the boundary file were then used to create a Digital Terrain Model (DTM) of the reservoir's bottom surface using Arc/Info's TIN (triangular irregular network) software module. The module generates a TIN from the data points and the boundary file using a method known as Delauney's criteria for triangulation. In this method, 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. The generated network of three-dimensional triangular planes represents the actual bottom surface. With this representation of the bottom, the software then calculates elevations along the triangle surface plane by determining the elevation along each leg of the triangle. The reservoir area and volume can be determined from the triangulated irregular network created using this method of interpolation.

Volumes and areas were calculated from the TIN for the entire reservoir at one-tenth of a foot intervals. From elevation 221.40 to elevation 260.0, the surface areas and volumes of the lake were mathematically estimated using Arc/Info software. The computed water surface area of the lake at elevation 260.0 was 1,330 surface acres, and the computed area of islands in the lake was 44 acres, giving a total enclosed area of 1,374 acres. The computed area was 92 surface acres more than originally calculated in 1966 (Texas Water Development Board, 1967). The computed reservoir volume table is presented in Appendix A and the area table in Appendix B. An elevation-area-volume graph is presented in Appendix C.

Other products developed from the model include a shaded relief map (Figure 3) and a shaded depth range map (Figure 4). To develop these maps, the TIN was converted to a lattice using the TINLATTICE command and then to a polygon coverage using the LATTICEPOLY command. Linear filtration algorithms were applied to the DTM to produce smooth cartographic contours. The resulting contour map of the bottom surface at two-foot intervals is presented in Figure 5. Finally, range-lines obtained from the current survey are shown in Figure 5 and in Appendix D.

RESULTS

Results from the 1999 TWDB survey indicate Houston County Lake encompasses 1,374 surface acres and contains a volume of 17,665 acre-feet at the conservation pool elevation of 260.0 feet. The shoreline at this elevation was calculated to be approximately 17 miles. The deepest point of the lake, elevation 221.45 feet or 38.55 feet of depth, was located approximately 512 feet upstream from Houston County Dam near the outlet structure. The dead storage volume, or the amount of water below the lowest outlet invert elevation in the dam (at 234.0 feet), was calculated to be 552 acre-feet. The conservation storage capacity, or the amount of water between the spillway and the lowest outlet, is therefore 17,113 acre-feet.

SUMMARY

Houston County Lake was formed in 1966. Initial storage calculations estimated the volume at the conservation pool elevation of 260.0 feet to be 19,500 acre-feet with a surface area of 1,282 acres, and a conservation pool capacity of 19,500 acre-feet.

During January 18-19, 1999, staff from the Texas Water Development Board's Hydrographic Survey Program completed a hydrographic survey of Houston County Lake. The 1999 survey took advantage of technological advances such as differential global positioning system and geographical information system technology to create a digital model of the reservoir's bathymetry. With these advances, the survey was completed more quickly and significantly more bathymetric data were collected than in previous surveys. Results indicate that the lake's capacity (volume - dead storage) at the conservation pool elevation of 260.0 feet is 17,113 acre-feet and the area is 1,330 acres.

The estimated reduction in storage capacity at the conservation pool elevation of 260.0 feet since 1966 is 2,387 acre-feet or 72 acre-feet per year. The average annual deposition rate of sediment in the conservation pool of the reservoir can be estimated at 1.8 acre-feet per square mile of drainage area. *(Please note that this is just a mathematical estimate based on the difference between the original design and the current survey. Limited knowledge on actual sedimentation can be determined from one field survey.)*

It is difficult to compare the original design information and the TWDB performed survey because little is know about the original design method, the amount of data collected, and the method used to process the collected data. However, the TWDB considers the 1999 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.

REFERENCES

Texas Water Development Board. 1967. Dams and reservoirs in Texas, historical and descriptive information, Report 48, June 1967.

Texas Water Development Board. 1974. Engineering data on dams and reservoirs in Texas. Part I. Report 126. October 1974.

Appendix A

Houston County Lake

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD

JANUARY 1999 SURVEY

VOLUME IN ACRE-FEET

ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
221					0	0	0	0	0	0
222	0	0	0	0	0	0	0	0	0	1
223	1	1	1	1	1	2	2	2	3	3
224	3	4	4	5	6	6	7	8	8	9
225	10	11	12	13	14	16	17	18	20	21
226	23	24	26	28	30	32	34	36	38	41
227	43	46	49	52	55	58	61	64	67	71
228	74	78	82	86	90	94	98	102	107	111
229	116	121	126	132	137	143	148	154	160	166
230	173	179	186	192	199	206	213	221	228	236
231	244	252	260	268	276	285	293	302	311	320
232	330	339	349	358	368	378	388	399	409	420
233	431	442	453	465	477	489	501	513	526	539
234	552	565	579	592	606	620	634	649	663	678
235	693	708	724	739	755	771	787	803	820	837
236	854	871	888	906	924	942	960	979	998	1017
237	1036	1056	1076	1096	1116	1137	1157	1178	1200	1221
238	1243	1265	1287	1309	1332	1355	1378	1401	1425	1449
239	1473	1498	1523	1548	1574	1600	1626	1653	1680	1708
240	1736	1764	1792	1821	1851	1880	1911	1941	1973	2004
241	2036	2069	2102	2135	2169	2203	2238	2274	2310	2346
242	2383	2420	2458	2496	2534	2574	2613	2654	2694	2736
243	2778	2820	2863	2907	2951	2995	3041	3087	3133	3181
244	3229	3278	3327	3378	3428	3480	3532	3585	3638	3692
245	3747	3802	3859	3915	3972	4030	4089	4148	4207	4267
246	4328	4389	4451	4513	4576	4640	4703	4768	4833	4898
247	4964	5031	5098	5165	5233	5302	5371	5441	5511	5582
248	5653	5725	5798	5870	5943	6017	6091	6166	6241	6316
249	6392	6469	6545	6623	6700	6778	6857	6936	7016	7096
250	7176	7257	7338	7420	7502	7585	7668	7751	7835	7919
251	8004	8089	8174	8260	8346	8433	8520	8607	8695	8783
252	8872	8961	9051	9141	9231	9322	9414	9506	9598	9691
253	9784	9878	9973	10068	10164	10260	10357	10455	10553	10652
254	10751	10851	10952	11053	11155	11257	11360	11464	11568	11672
255	11778	11883	11990	12096	12204	12311	12420	12528	12638	12747
256	12858	12968	13080	13191	13304	13416	13530	13643	13757	13872
257	13987	14103	14220	14337	14454	14572	14691	14810	14929	15049
258	15169	15289	15411	15532	15654	15776	15899	16022	16146	16270
259	16395	16520	16645	16771	16898	17024	17152	17279	17407	17536
260	17665									

Appendix B

Houston County Lake

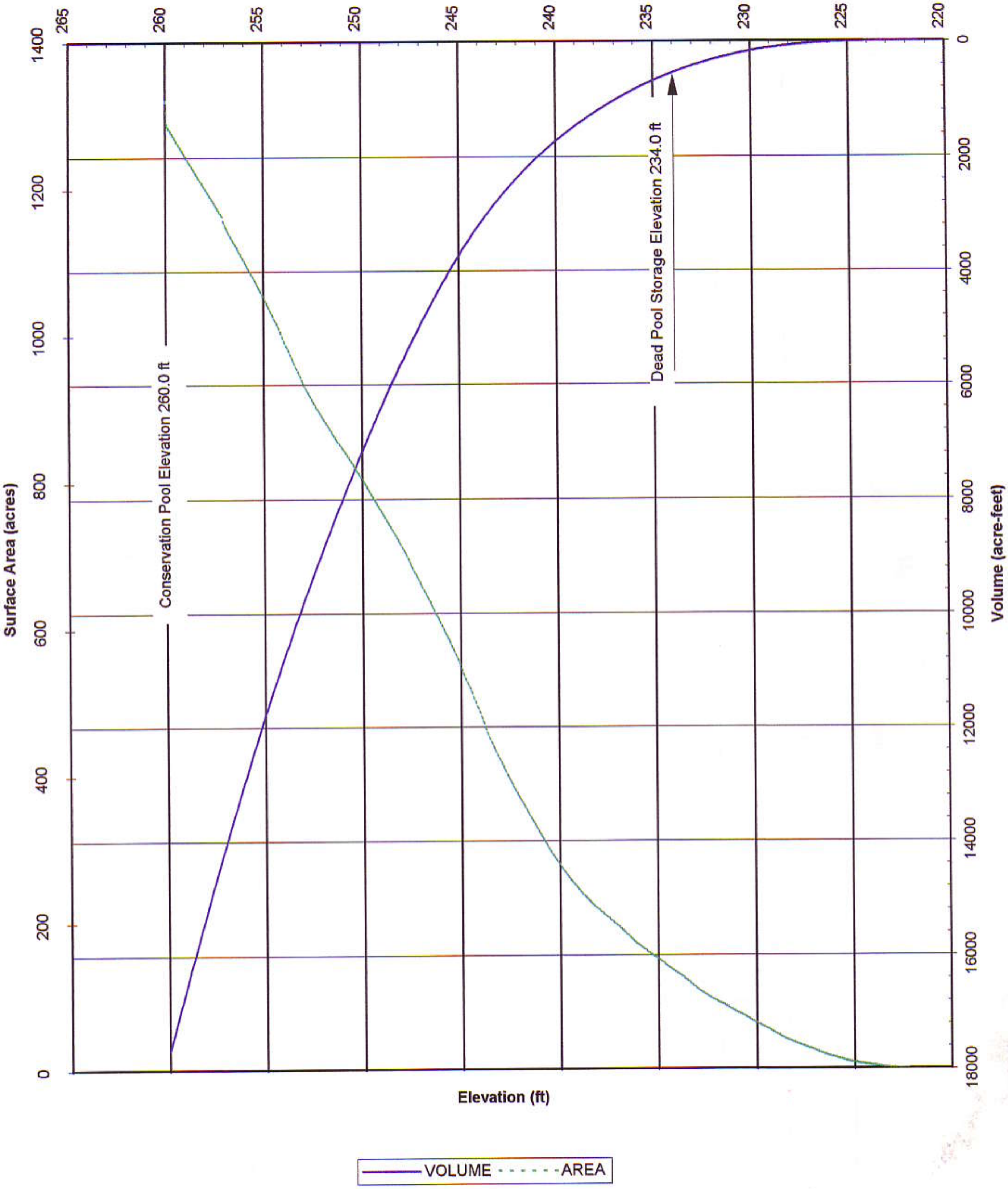
RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — January 1999 SURVEY

AREA IN ACRES — ELEVATION INCREMENT IS ONE TENTH FOOT

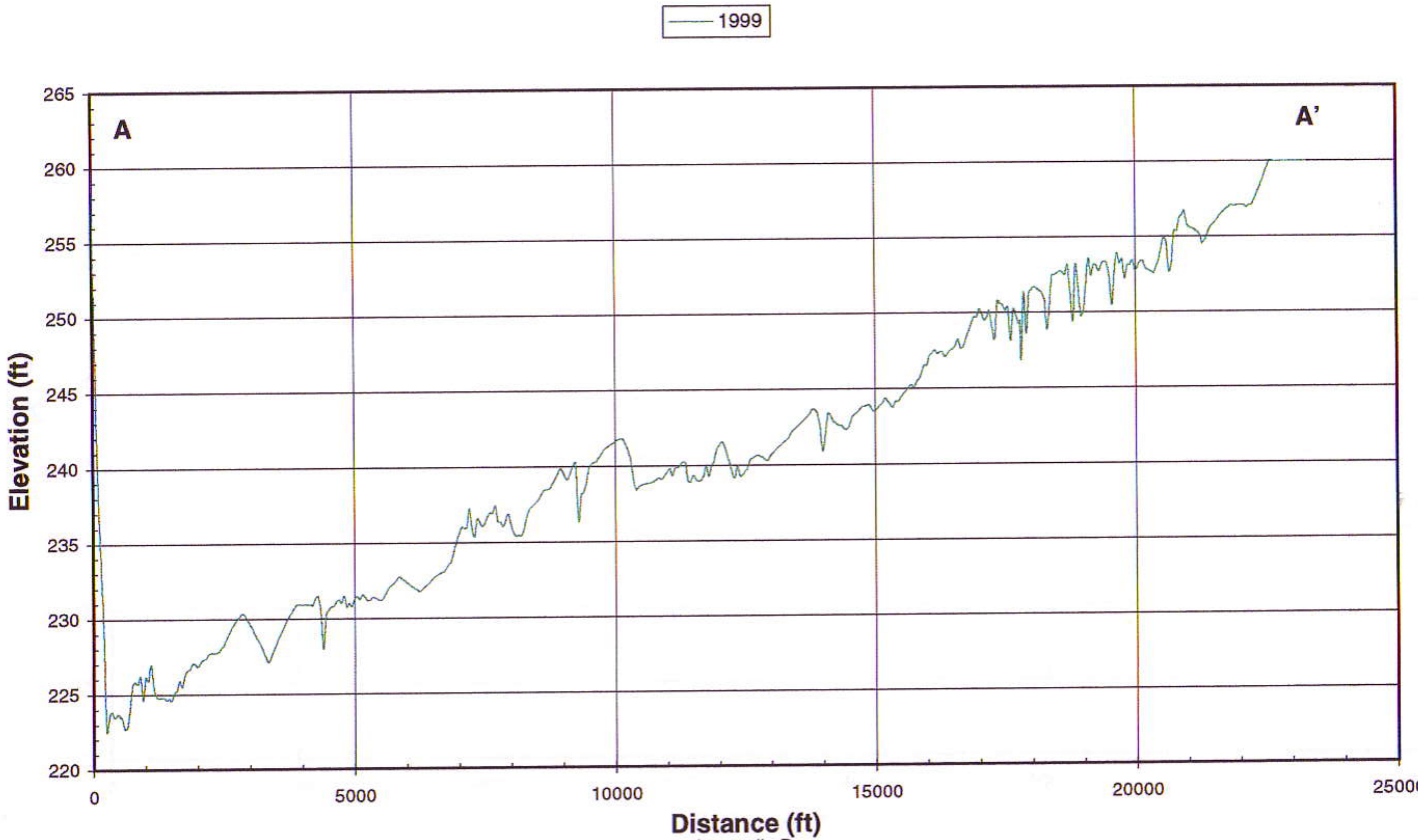
ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
221					0	0	0	0	0	0
222	0	0	0	0	1	1	1	1	1	1
223	1	1	2	2	2	3	3	3	4	4
224	5	5	5	6	6	7	7	8	8	9
225	9	10	10	11	12	12	13	14	15	16
226	16	17	18	19	19	20	21	22	23	25
227	26	27	28	29	30	31	32	33	34	35
228	36	37	38	39	40	42	43	44	46	48
229	49	51	52	54	55	56	58	59	60	62
230	63	65	66	68	70	71	73	74	76	77
231	78	80	81	83	84	86	88	89	90	92
232	93	95	96	98	99	101	103	104	106	108
233	110	112	115	117	119	122	124	126	128	129
234	131	133	135	137	139	141	143	146	148	149
235	151	153	155	157	158	160	162	164	166	168
236	170	172	175	177	180	183	185	188	190	193
237	195	198	200	202	204	206	209	211	213	216
238	218	220	223	225	227	230	233	236	239	242
239	245	248	252	255	258	262	265	269	273	276
240	280	284	288	292	296	300	305	309	314	318
241	323	327	332	337	342	347	351	356	361	365
242	370	375	379	385	390	395	400	405	411	416
243	422	427	433	438	444	450	456	463	471	478
244	485	492	499	505	512	518	525	531	537	544
245	551	557	564	570	576	582	587	593	598	604
246	609	615	620	626	631	636	642	647	652	657
247	662	668	673	678	683	689	695	700	706	711
248	716	721	725	730	734	739	743	748	752	757
249	761	766	770	774	779	784	789	793	797	802
250	806	811	815	819	824	828	832	836	840	844
251	848	852	856	860	864	868	872	876	881	885
252	889	894	898	903	907	912	917	921	926	932
253	937	943	949	954	961	967	973	979	985	991
254	997	1004	1010	1016	1022	1027	1033	1038	1044	1049
255	1055	1060	1065	1070	1075	1080	1085	1090	1095	1100
256	1105	1110	1115	1120	1124	1129	1134	1139	1144	1149
257	1155	1165	1169	1173	1178	1182	1186	1191	1195	1200
258	1204	1208	1213	1217	1222	1226	1230	1235	1239	1244
259	1248	1252	1257	1261	1266	1270	1275	1279	1284	1288
260	1330									

Appendix C



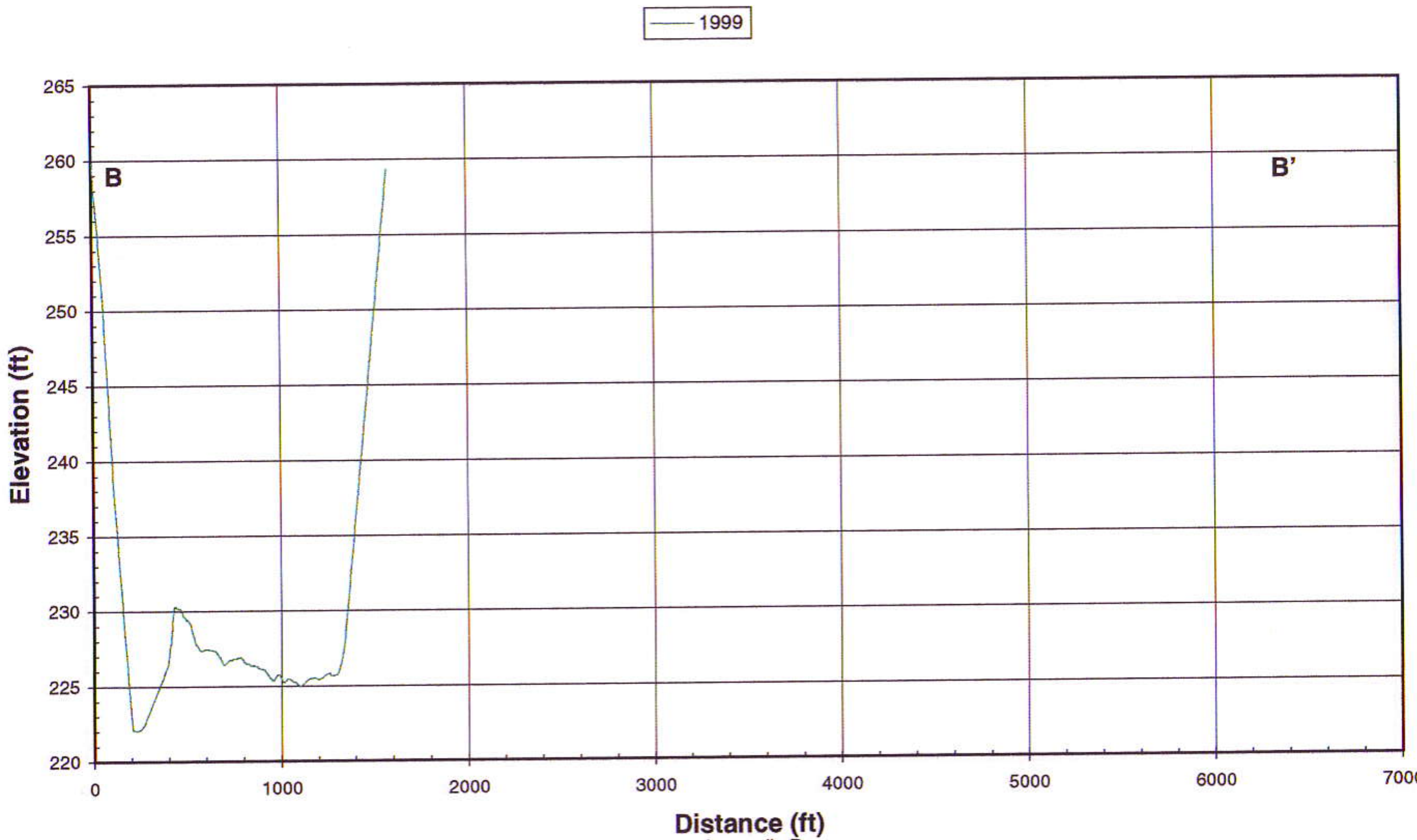
Houston County Lake
January 1999
Prepared by: TWDB June 1999

Sedimentation Range A - A' 1999 Survey
Houston County Lake

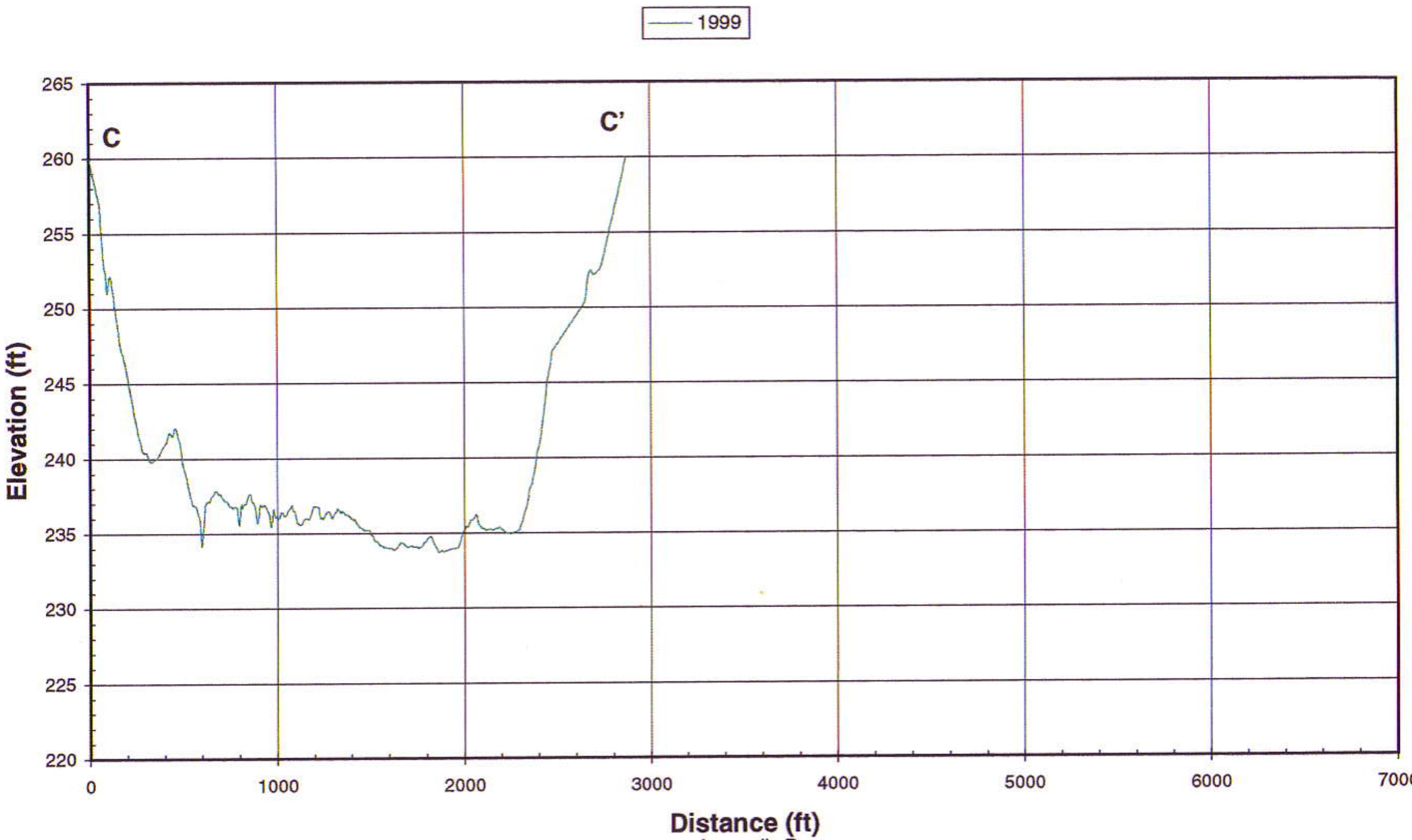


Appendix D

Sedimentation Range B- B' 1999 Survey
Houston County Lake

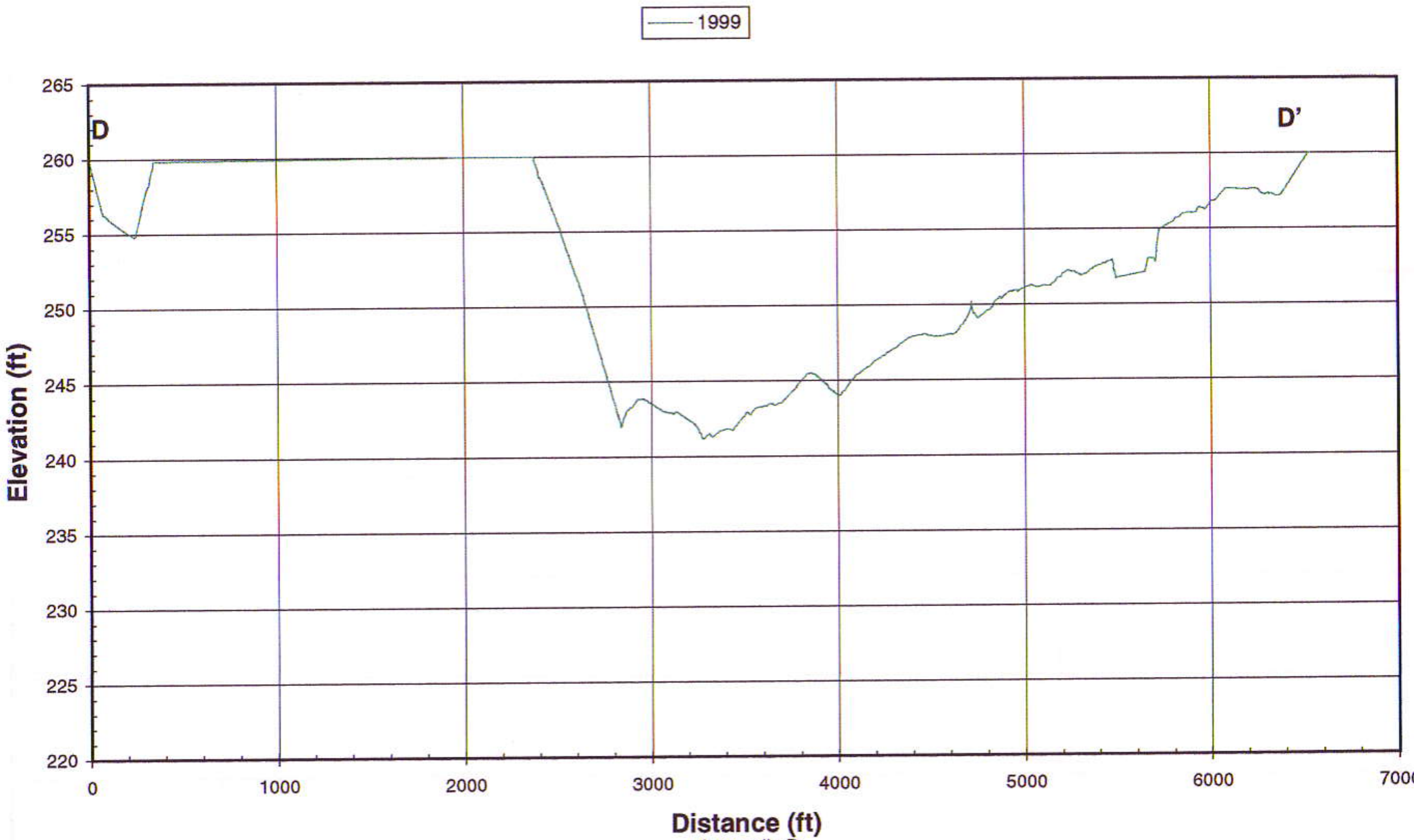


Sedimentation Range C - C' 1999 Survey
Houston County Lake

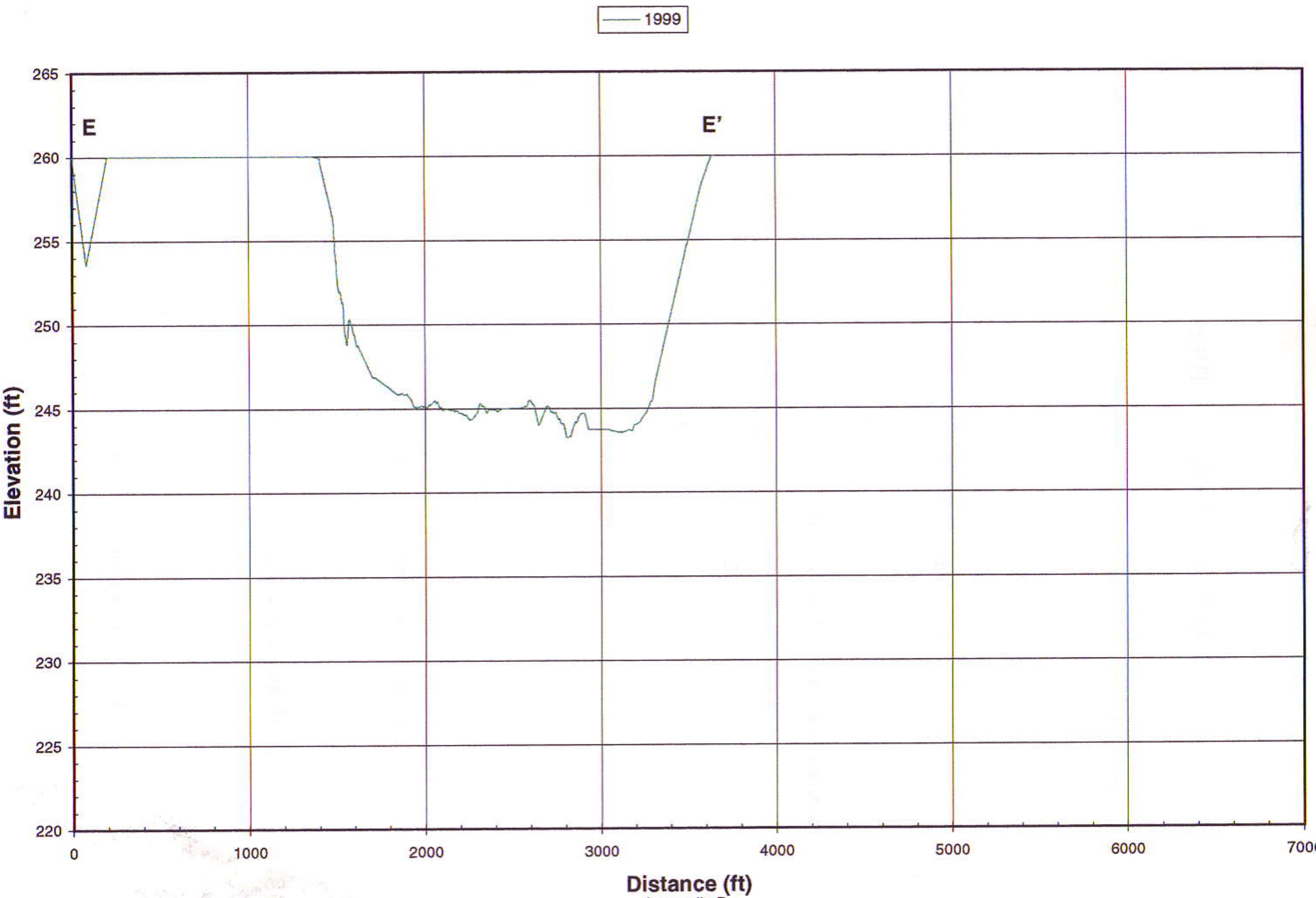


Appendix D

Sedimentation Range D - D' 1999 Survey
Houston County Lake



Sedimentation Range E - E' 1999 Survey
Houston County Lake



Appendix D

APPENDIX E - DEPTH SOUNDER ACCURACY

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

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

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

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

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

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

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

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

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

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

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

APPENDIX F - GPS BACKGROUND

GPS Information

The following is a brief and simple description of Global Positioning System (GPS) technology. GPS is a relatively 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 satellite broadcasts 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 located in space, and is ignored, while the second is the point of interest located on earth. 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.

The United States Air Force and the defense establishment developed GPS technology in the 1960's. After program funding in the early 1970's, 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 was reached on April 27, 1995 when the NAVSTAR (NAVigation System with Time And Ranging) satellite constellation was composed of 24 Block II satellites. Initial operational capability, a full constellation of 24 satellites, in a combination of Block I (prototype) and Block II satellites, was achieved December 8, 1993. The NAVSTAR satellites provide data based on the World Geodetic System (WGS '84) spherical datum. WGS '84 is essentially identical to the 1983 North American Datum (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, DOD 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) is an advance mode of satellite surveying in which positions of moving objects can be determine in real-time or "on-the-fly." This technological breakthrough was the backbone of the development of the TWDB's Hydrographic Survey Program. In the early stages of the program, one GPS receiver was set up over a benchmark with known coordinates established by the hydrographic survey crew. This receiver remained stationary 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 another 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. This type of operation can provide horizontal positional accuracy within one meter. In addition, the large positional errors experienced by a single receiver when S/A is active are negated. The lake surface during the survey serves as the vertical datum for the bathymetric readings from a depth sounder. The sounder determines the lake's depth below a given horizontal location at the surface.

The need for setting up a stationary shore receiver for current surveys has been eliminated by registration with a fee-based satellite reference position network (OmniSTAR). This service works on a worldwide basis in a differential mode basically the same way as the shore station. For a given area in the world, a network of several monitoring sites (with known positions) collect GPS signals from the NAVSTAR network. GPS corrections are computed at each of these sites to correct the GPS signal received to the known coordinates of the site. The correction corresponding to each site are automatically sent to a "Network Control Center" where they are checked and repackaged for up-link to a "Geostationary" L-band satellite. The "real-time" corrections are then broadcast by the satellite to users of the system in the area covered by that satellite. The OmniSTAR receiver translates the information and supplies it to the on-board Trimble receiver for correction of the boat's

GPS positions. The accuracy of this system in a real-time mode is normally 1 meter or less.

Previous Survey Procedures

Originally, reservoir surveys were conducted by stretching a rope across the reservoir along pre-determined range lines and, from a small boat, poling 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 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 at 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 the horizontal location 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. Continuous horizontal positioning by electronic means allowed for the continuous collection of depth soundings by boat. A set of microwave transmitters positioned around the lake at known coordinates allowed 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 with 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 remained a major cost with this method.

More recently, aerial photography has been used prior to construction to generate elevation contours from which to calculate the volume of the reservoir. Fairly accurate results could be obtained, although the vertical accuracy of the aerial topography is generally one-half of the contour interval or $\pm$ five feet for a ten-foot contour interval. This method can be quite costly and is applicable only in areas that are not inundated.

Figure 1

HOUSTON COUNTY LAKE

Location Map

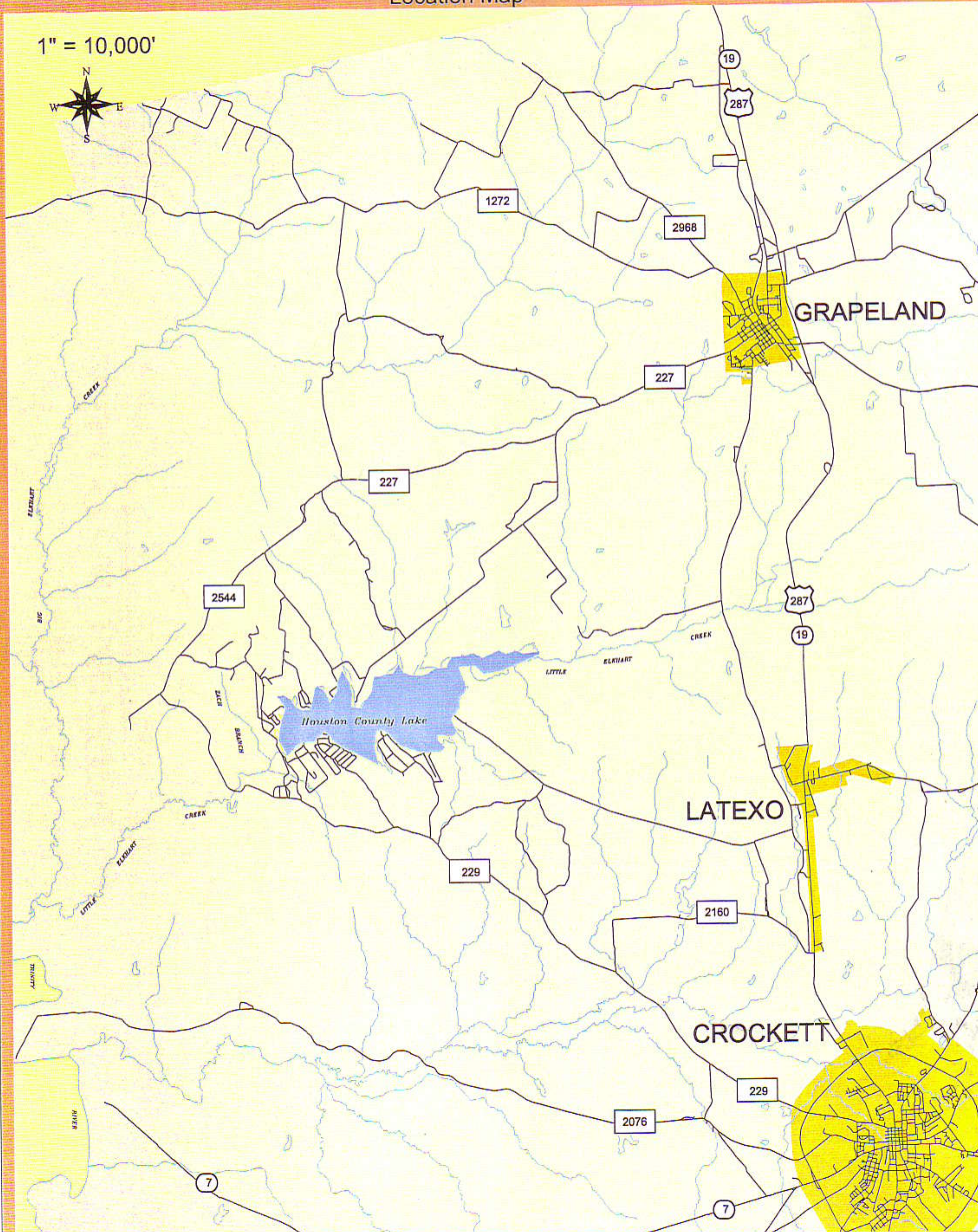


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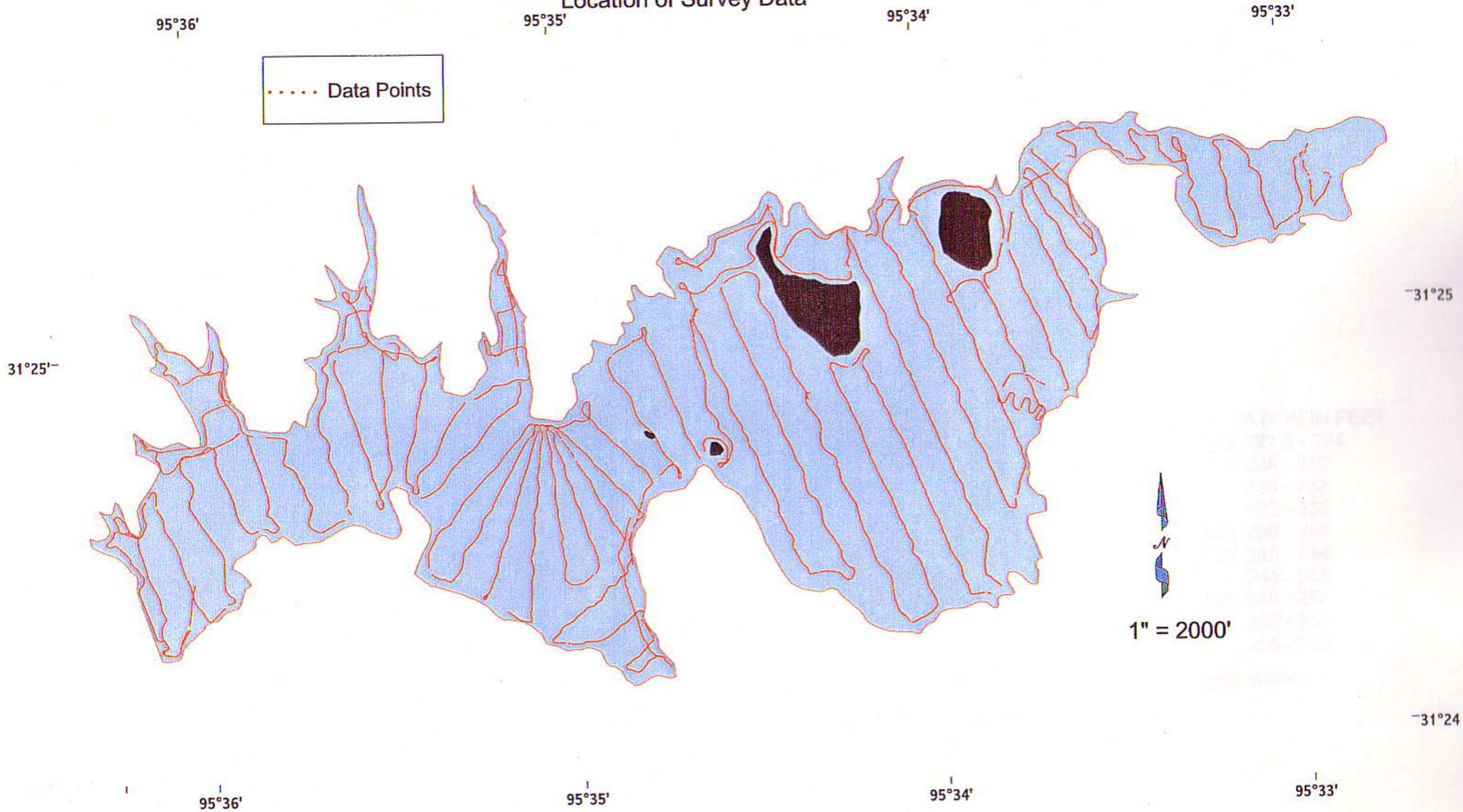
Figure 2

HOUSTON COUNTY LAKE

Location of Survey Data



Prepared by : TWDB June 1999

Figure3

HOUSTON COUNTY LAKE

Shaded Relief

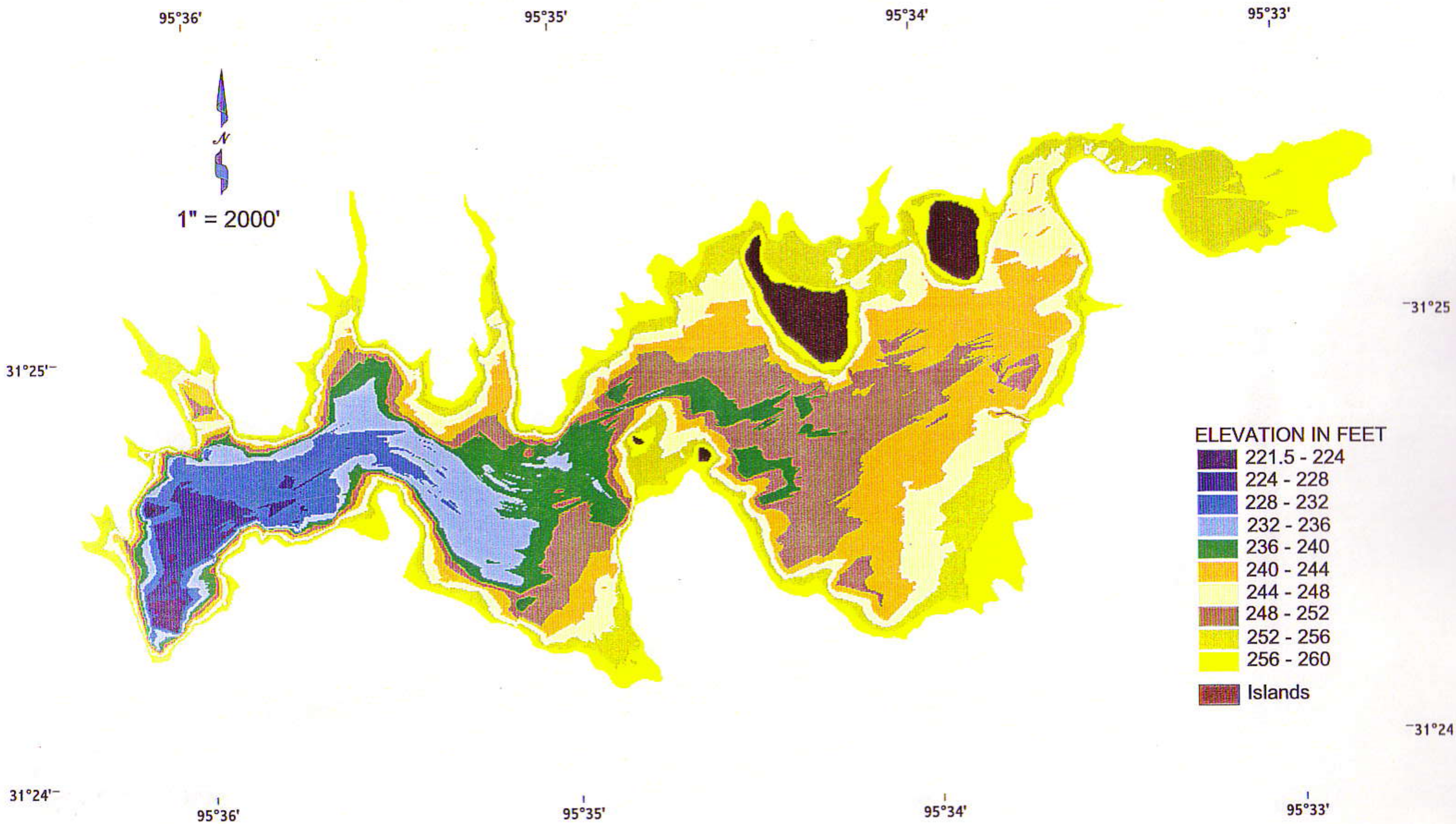


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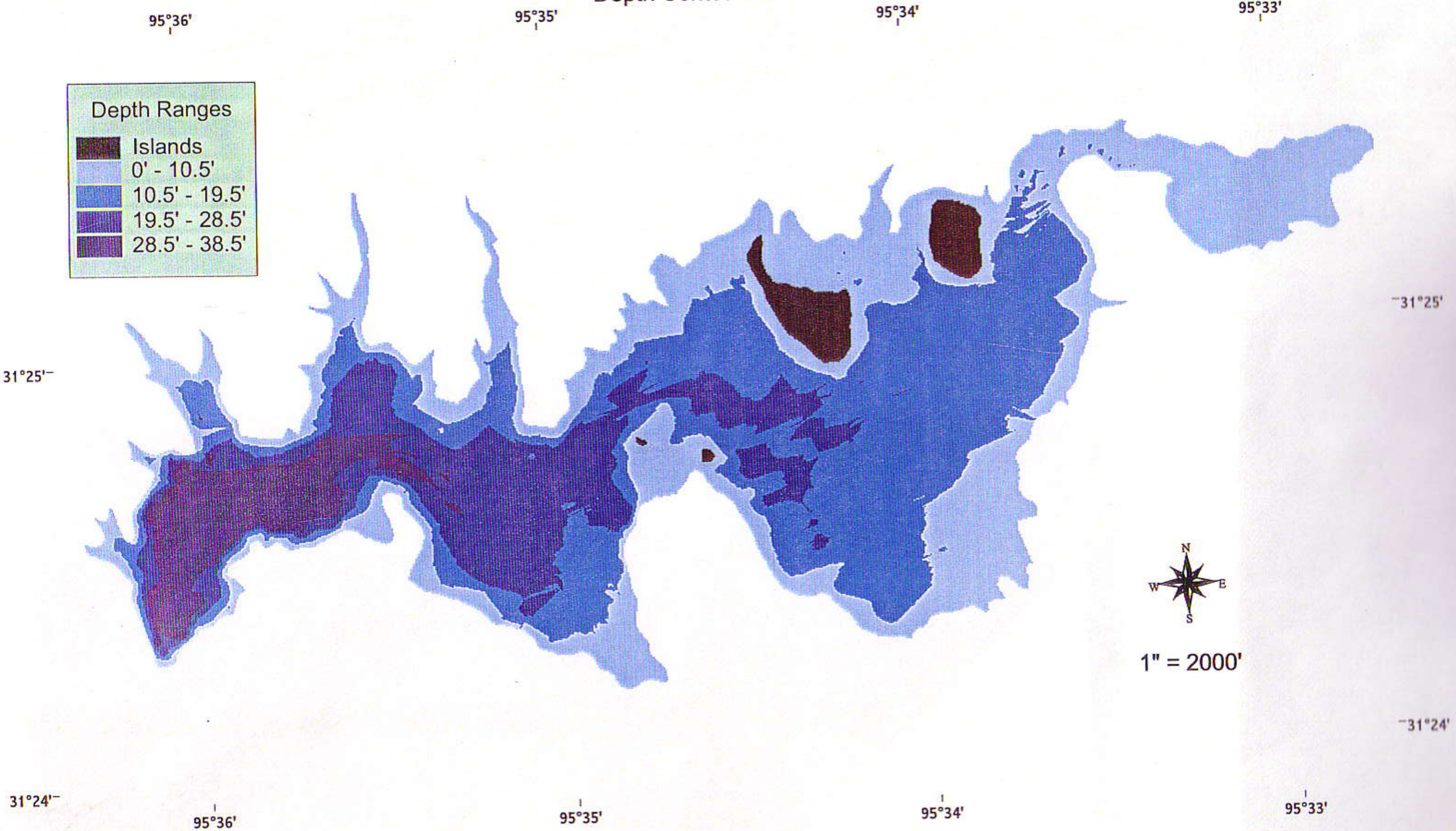
Figure 4

HOUSTON COUNTY LAKE

Depth Contours



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