VOLUMETRIC SURVEY OF LAKE WAXAHACHIE

Prepared for:

Ellis County Water Control and Improvement District No. 1

In Participation with the

U. S. Army Corps of Engineers, Fort Worth District

Prepared by
Texas Water Development Board

November 6, 2000

Texas Water Development Board

This report was prepared by staff of the Surface Water Section:

Ruben S. Solis, Ph.D., P.E.
Duane Thomas
Randall Burns
Marc Sansom

Published and Distributed
by the
Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LAKE WAXAHACHIE
VOLUMETRIC SURVEY REPORT

INTRODUCTION

Staff of the Surface Water Section of the Texas Water Development Board (TWDB) conducted a volumetric survey of Lake Waxahachie on July 27 and 28, 2000. The primary purpose of this survey was to determine the current volume of the lake at conservation pool elevation. Results from this survey will serve as a base line for future surveys to allow the location and rates of sediment deposition to be determined. Survey results are presented in the following pages in both graphical and tabular form. Elevations presented in this report are referenced to the datum used in TWDB (1973) in engineering drawings of Lake Waxahachie. Elevations there are given as "elevation above msl", where msl is defined in the publication as the mean sea level of 1929 measured at Galveston. The conservation pool elevation for Lake Waxahachie is given as 531.5 feet, corresponding to the elevation of the service spillway. The surface area at this elevation was given as 690 acres and the storage volume was reported as 13,500 acre-feet. This report compares the current survey results with the original design plans.

The City of Waxahachie operates a reservoir elevation gage and reports daily elevation readings. The gage is checked when the lake's surface water elevation is at the spillway crest elevation to ensure that it reads at 531.5 feet, corresponding to the elevation shown in TWDB (1973), at that time. A second reservoir elevation gage was recently installed by the United States Geological Survey (USGS) at Lake Waxahachie (08063600 Lake Waxahachie near Waxahachie, TX). At the time of the current survey the USGS gage reported lake level elevations approximately one-half of a foot higher than reported by the City of Waxahachie gage. As stated above, data collected during this survey, and volume and area calculations resulting from these measurements, were referenced to water levels provided by the City of Waxahachie gage rather than the USGS gage. As a footnote, at some point following the completion of this report, the USGS plans to re-establish the gage datum. Finally, the USGS 7.5-minute quadrangle map (Forreston, Tex., 1961) (based on the 1929 National Geodetic Vertical Datum) shows the elevation of the service spillway to be 531.0 feet. It is assumed that the msl elevation of 531.5 feet was simply rounded to 531.0 feet on the USGS quadrangle map.

LAKE HISTORY AND GENERAL INFORMATION

Historical information on Lake Waxahachie was obtained from TWDB (1966) and TWDB (1973). The Ellis County Water Control and Improvement District # 1(Ellis County WCID#1) owns the water rights to Lake Waxahachie. The City of Waxahachie operates and maintains the lake facility and associated South Prong Dam. The lake is located on South Prong Creek (Trinity River Basin) in Ellis County, four miles southeast of Waxahachie, Texas (Figure 1). Records indicate that the drainage area is approximately 30 square miles. At conservation pool elevation, the lake has approximately 13 miles of shoreline and is 3 miles long.

The Board of Water Engineers issued Water Rights Permit No. 1742 (Application No. 1874) to the Ellis County WCID#1 on March 14, 1955. The permit authorized the District to construct a dam on South Prong Creek in Ellis County and to impound 13,500 acre-feet of water. Permission was granted to use 2,810 acre-feet of water annually for municipal purposes and 760 acre-feet for industrial purposes. The Texas Water Commission issued Certificate of Adjudication No. 08-5018 on May 5, 1987. The certificate basically re-authorizes the impoundment and uses as stated in Permit No. 1742. It authorizes the Ellis County Water Control and Improvement District # 1 to maintain an existing dam and lake on South Prong Creek known as South Prong Dam and Lake Waxahachie and to impound up to 13,500 acre-feet of water.

Construction for Lake Waxahachie and South Prong Dam started on March 26, 1956. The dam was completed and impoundment began in November 1956. The design engineer for the project was Forrest and Cotton, Inc. The general contractor was J. W. Moorman and Son.

Engineering designs (TWDB, 1973) show South Prong Dam and appurtenant structures to consist of a rolled-earth embankment approximately 3,800 feet in length, with a maximum height of 66 feet and a crest elevation of 541.5 feet msl. Highway 877 runs parallel to the dam on a berm located on the downstream slope of the embankment. Improvements were made to the downstream slope of the embankment by covering the surface area with soil cement in a stair-step pattern. The service spillway is an uncontrolled concrete weir with a crest length of 300 feet at elevation 531.5 feet msl and is located immediately to the south (right) of the embankment. The bridge for Highway 877 spans the service spillway channel. The original outlet works consist of a concrete vertical intake structure. The structure has three gated openings, each 2.5 feet by 2.5 feet, at centerline elevation 526.0 feet msl, 513.0 feet msl and 500.0 feet msl. The invert elevation for the lowest gated outlet is 498.75 feet msl. Control valves for the gates are located at the top of the structure. Discharges flow into a 24-inch diameter pipe that passes through the embankment to a pump well in the raw water pump station downstream of the dam. Water can be pumped to the city's filtration and treatment plant or can be released downstream as required. A second pump station was added in the early 1990's. The concrete pier (or platform) that the two pumps rest on is located immediately upstream of the dam between the north (left) abutment and the original intake structure. The invert elevation for the well casings is 512.0 feet.

SURVEY EQUIPMENT

The equipment used to perform the volumetric survey consists of a 20-foot aluminum flat bottom SeaArk craft with cabin equipped with one 115-Horsepower Evinrude outboard motor. The surveying equipment included a Knudsen 320 B/P Echosounder (depth sounder), a Trimble Navigation, Inc. 4000SE GPS receiver, an OmniSTAR receiver, and a 486 laptop computer. (Reference to brand names throughout this report does not imply endorsement by TWDB).

The GPS equipment, survey vessel, and depth sounder in combination provide an efficient hydrographic survey system. During the data collection phase, the depth sounder takes approximately ten bottom readings each second. The depth readings are stored on the laptop computer along with the corrected positional data generated by the boat's GPS receiver. The data files are downloaded from the computer each day and returned to the office for editing after the survey is completed. During editing, poor-quality 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 can be quickly determined by building a 3-dimensional numerical model of the lake from the collected data.

PRE-SURVEY PROCEDURES

The reservoir's boundary was digitized from digital orthophoto quadrangle images (DOQ's) using Environmental Systems Research Institute's (ESRI) Arcview. The DOQ's were produced by VARGIS of Texas LLC for the TEXAS Orthoimagery Program (TOP). The DOQ products produced for the Department of Information Resources and the GIS Planning Council under the Texas Orthoimagery Program reside in the public domain. More information can be obtained on the Internet at http://www.tnris.state.tx.us/DigitalData/doqs.htm. The map work was created from the Forreston, Texas DOQ. The graphic boundary file was transformed from UTM Zone 15 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.

Although the lake elevation at the time the DOQ was photographed is unknown (Feb. 19, 1995), it was overlaid on the boundary shown in the USGS 7.5-minute quadrangle map, Forreston, TX (1961). The two boundaries closely coincided. As stated earlier, the elevation of the service spillway, which defines the conservation pool elevation, shown on the USGS quad map as 531.0 feet is assumed to coincide with the elevation shown on engineering designs in TWDB, 1973 (531.5 feet msl).

The survey layout was designed by placing survey track lines at 500-foot intervals within the digitized lake boundary using HyPack software. The survey design required the use of approximately 36 survey lines perpendicular to the length of the lake.

SURVEY PROCEDURES

Equipment Calibration and Operation

At the beginning of the survey, the depth sounder was calibrated using the bar check feature in the Knudsen software program. This was accomplished by positioning the transducer over a known (measured) depth. The speed of sound was then adjusted (either higher or lower) until the depths displayed matched the known depth. The depth was then checked manually with a stadia (survey) rod to ensure that the depth sounder was properly calibrated and operating correctly. During the survey of Lake Waxahachie, the speed of sound in the water column varied from 4,844 to 4,846 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. An additional estimated error of ±0.3 feet arises from variation in boat inclination. These two factors combine to give an overall 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 I.

During the survey, the horizontal mask setting on the on-board GPS receiver was set to 10°, and the PDOP (Position Dilution of Precision) limit was set to 7 to maximize the accuracy of the horizontal positioning. An internal alarm sounds if 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.

Field Survey

TWDB staff collected data at Lake Waxahachie on July 27 and 28, 2000. The lake was approximately 0.7 feet below the service spillway crest during the survey as observed by TWDB staff. The City of Waxahachie reservoir gage reading at the time was 530.83 feet, or within 0.7 feet of the elevation given by TWDB (1973) for the service spillway. Weather conditions during the survey at Lake Waxahachie consisted of warm temperatures with mild winds. The survey crew was able to collect data on 32 of the 36 pre-plotted survey transects in the lake. Random data was collected along the shoreline and in those areas that were too restricted to drive the pre-plotted lines. Approximately 14,000 data points were collected over the 22.7 miles traveled. These points, shown in Figure 2, were stored digitally on the boat's computer in 61 data files. Data were not collected in areas with significant obstructions unless these areas represented a large amount of water.

South Prong Creek flows in a west to east direction with South Prong Dam being located at the east end of the lake basin. TWDB staff observed that the terrain surrounding the lake basin was characteristic of North Texas prairie land. The relief was flat to moderate with some rolling hills. Generally, the south shoreline had more relief than the north side in the lake basin. Topsoil mixed with shale and limestone was noted along the shoreline. No major bank erosion was observed. Residential development was scattered around the perimeter of the lake with more homes concentrated along the north side. The city of Waxahachie maintains several parks and public access areas to the lake along the north shore. During the survey the crew noted a large residential development going in on the south side of the lake. A large area of exposed soil with a lack of ground cover was observed in this construction area.

While performing the survey the field crew noted on the depth sounder chart that the contour of the lake bottom was fairly regular (meaning no major drops or rises in the bathymetry) in the main basin of the lake. The bathymetry of the lake bottom was similar to the topography surrounding the lake.

Navigational hazards such as submerged stumps and large areas of aquatic vegetation were encountered in the upper reaches of Lake Waxahachie. Data were collected in this area but at a much slower rate. Data collection was halted when depths in the upper reaches of the lake became less than one and one-half feet or accessibility was prevented due to the vegetation. Several elevated structures cross the upper reaches of Lake Waxahachie. The survey crew had vertical clearance and was able to gather data upstream of a petroleum pipeline, railroad trestle, and the bridges of Interstate Highway 35 East.

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 the day.

Data Processing

The collected data were downloaded from diskettes onto 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. Offsets to account for the lake elevation during the data collection were also applied to each file with the EDIT routine. During the survey, the water surface varied between elevation 530.83 and 530.84 feet msl according to elevation data provided by the City of Waxahachie elevation gage. After all corrections were applied to the raw data file, the edited file was 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 Ultra 10 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 lake's bottom surface using Arc/Info's TIN software module. The module generates a triangulated irregular network (TIN) from the data points and the boundary file using a method known as Delauney's criteria for triangulation. 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 lake area and volume is determined from the triangulated irregular network created using this method of interpolation.

Volumes below elevation 531.5 feet msl presented in Appendices A and C were calculated from the TIN using Arc/Info software. Surface areas presented in Appendices B and D were also computed with the same software. Changes in volume and area as a function of elevation are presented in Appendices E and F, respectively.

Other products developed from the model include a shaded elevation range 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 elevation contour map of the bottom surface at two-foot intervals is presented in Figure 5. Finally, cross-sections, shown on the map in Figure 5, are presented in the plots in Appendix G and the corresponding endpoints are shown in Appendix H.

RESULTS

Results from the 2000 TWDB survey indicate that Lake Waxahachie encompasses 656 surface acres and contains a total volume of 11,386 acre-feet at the conservation pool elevation of 531.5 feet msl (gage datum). Dead pool storage, the volume below the invert elevation of the lowest gated outlet at 498.75 feet msl, is 607 acre-feet. Thus, the conservation storage (total volume - dead storage) for Lake Waxahachie is 10,779 acre-feet. The shoreline at conservation pool elevation was calculated to be approximately 13 miles. The deepest point of the lake, at elevation 481.2 feet msl and corresponding to a depth of 50.3 feet, was located approximately 480 feet upstream from the center of South Prong Dam.

SUMMARY AND COMPARISONS

Lake Waxahachie was initially impounded in 1956. Storage calculations in 1945 (TWDB, 1973) reported the volume at conservation pool elevation 531.5 feet msl to be 13,500 acre-feet with a surface area of 690 acres. The dead pool below elevation 498.75 feet msl was reported as 1,500 acre-feet, and thus the conservation storage was 12,000 acre-feet.

On July 27 and 28, 2000, TWDB staff completed a volumetric survey of Lake Waxahachie. The 2000 survey utilized differential global positioning system and geographical information system technology to create a digital model of the lake's bathymetry. Results indicate that the lake's volume at the conservation pool elevation of 531.5 feet msl is 11,386 acre-feet, with a corresponding area of 656 acres. The dead pool below 498.75 feet was found to be 607 acre-feet, and thus the conservation storage found in this survey is 10,779 acre-feet.

Comparing the findings from the original design and the current survey, the surface area at conservation pool elevation 531.5 feet msl decreased by 34 surface acres. The reduction in volume at conservation pool elevation is 2,114 acre-feet (-15.7%) or 48.0 acre-feet/year (since 1956). The greatest loss in volume appears to occur between elevations 510 feet and 527 feet msl based on plots shown in Appendices F and G. The average annual deposition rate of sediment in the lake can be estimated at 1.6 acre-feet/square mile of drainage area. It is recommended that the same methodology be used in five to ten years or after major flood events to monitor changes to the lake's storage volume.

REFERENCES

1. Texas Water Development Board. 1966. Dams and Lakes in Texas, Historical and Descriptive Information. Report 48.

2. Texas Water Development Board. 1973. Engineering Data on Dams and Lakes in Texas. Part II. Report 126.

Appendix A

Lake Waxahachie

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD JULY 2000 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
481						0	0	0	0	0
482	0	0	0	0	0	0	1	1	1	1
483	1	2	2	2	2	3	3	3	4	4
484	5	5	6	6	7	8	9	9	10	11
485	12	13	15	16	17	18	20	21	23	25
486	26	28	30	32	34	36	38	40	43	45
487	47	50	52	54	57	59	62	64	67	69
488	72	75	77	80	83	86	88	91	94	97
489	100	103	106	109	112	115	118	121	124	127
490	131	134	137	140	144	147	150	154	157	161
491	164	168	171	175	179	182	186	190	193	197
492	201	205	209	213	216	220	225	229	233	237
493	241	245	249	254	258	262	267	271	276	280
494	285	290	294	299	304	309	314	319	324	330
495	335	340	346	352	357	363	369	375	381	387
496	393	400	406	413	419	426	433	440	447	454
497	461	469	476	484	492	500	508	516	524	532
498	540	549	557	566	575	584	593	602	611	620
499	630	639	649	658	668	678	688	698	708	719
500	729	740	750	761	772	783	794	806	817	829
501	840	852	864	876	889	901	914	926	939	952
502	965	978	992	1005	1019	1033	1046	1060	1074	1089
503	1103	1117	1132	1147	1162	1177	1192	1207	1222	1238
504	1253	1269	1285	1301	1317	1334	1350	1366	1383	1400
505	1416	1433	1450	1467	1485	1502	1520	1537	1555	1573
506	1591	1609	1627	1646	1664	1683	1702	1720	1739	1759
507	1778	1797	1817	1836	1856	1876	1896	1916	1936	1957
508	1977	1998	2019	2040	2061	2082	2104	2126	2147	2169
509	2191	2214	2236	2258	2281	2304	2327	2350	2373	2396
510	2419	2443	2467	2490	2514	2538	2562	2587	2611	2636
511	2660	2685	2710	2735	2760	2785	2811	2836	2862	2887
512	2913	2939	2966	2992	3018	3045	3072	3099	3126	3154
513	3181	3209	3237	3265	3293	3321	3349	3378	3407	3435
514	3464	3493	3523	3552	3582	3611	3641	3671	3701	3732
515	3762	3793	3823	3854	3885	3916	3948	3979	4011	4042
516	4074	4106	4138	4170	4203	4235	4268	4301	4334	4367
517	4400	4434	4467	4501	4535	4569	4603	4637	4672	4706
518	4741	4776	4811	4847	4882	4918	4953	4989	5026	5062
519	5098	5135	5172	5209	5246	5284	5321	5359	5397	5435
520	5474	5512	5551	5590	5630	5669	5709	5749	5789	5829
521	5870	5911	5952	5993	6034	6075	6117	6159	6200	6243
522	6285	6327	6370	6413	6456	6499	6543	6587	6631	6675
523	6719	6763	6808	6853	6898	6943	6989	7035	7080	7126
524	7173	7219	7266	7313	7360	7407	7455	7502	7551	7599
525	7648	7697	7747	7797	7847	7897	7948	7999	8050	8102
526	8154	8206	8258	8311	8363	8417	8470	8524	8578	8632
527	8687	8742	8798	8853	8909	8966	9022	9079	9137	9194
528	9251	9309	9367	9425	9484	9542	9601	9660	9719	9778
529	9838	9897	9957	10017	10078	10138	10199	10259	10320	10382
530	10443	10505	10566	10628	10690	10753	10815	10878	10941	11004
531	11067	11130	11194	11258	11322	11386				

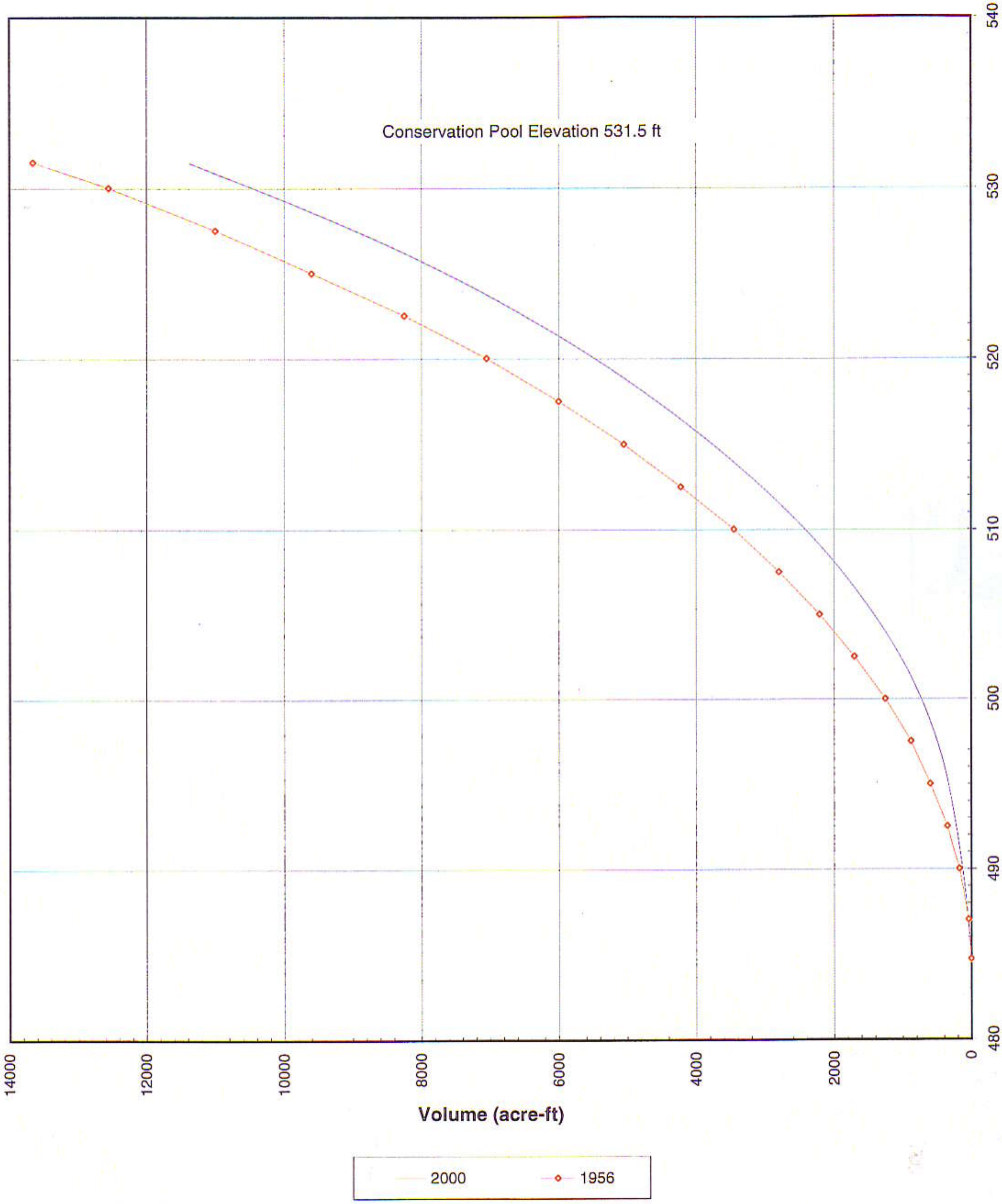
Lake Waxahachie

RESERVOIR AREA TABLE

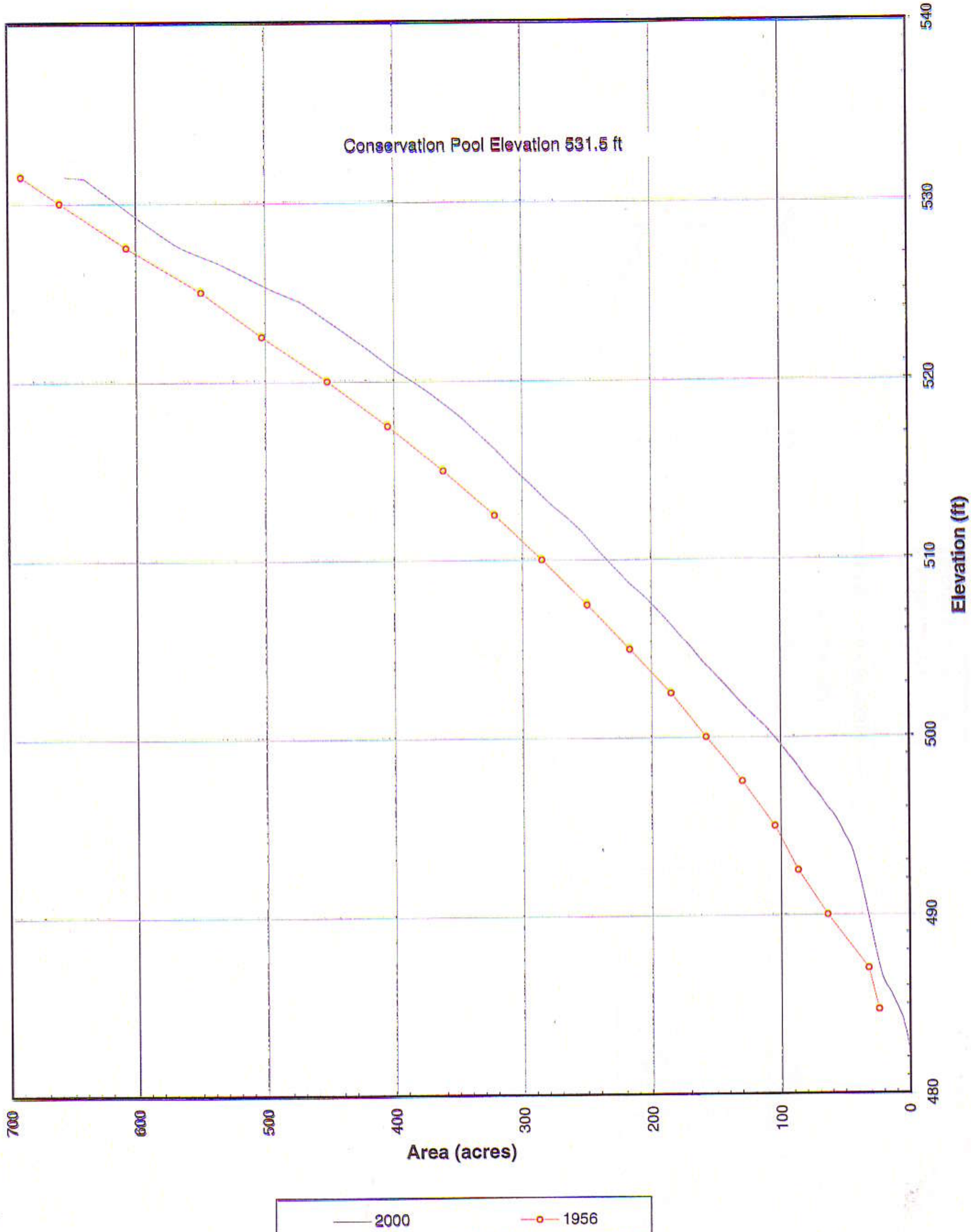
TEXAS WATER DEVELOPMENT BOARD — JULY 2000 SURVEY

AREA IN ACRES — ELEVATION INCREMENT IS ONE TENTH FOOT

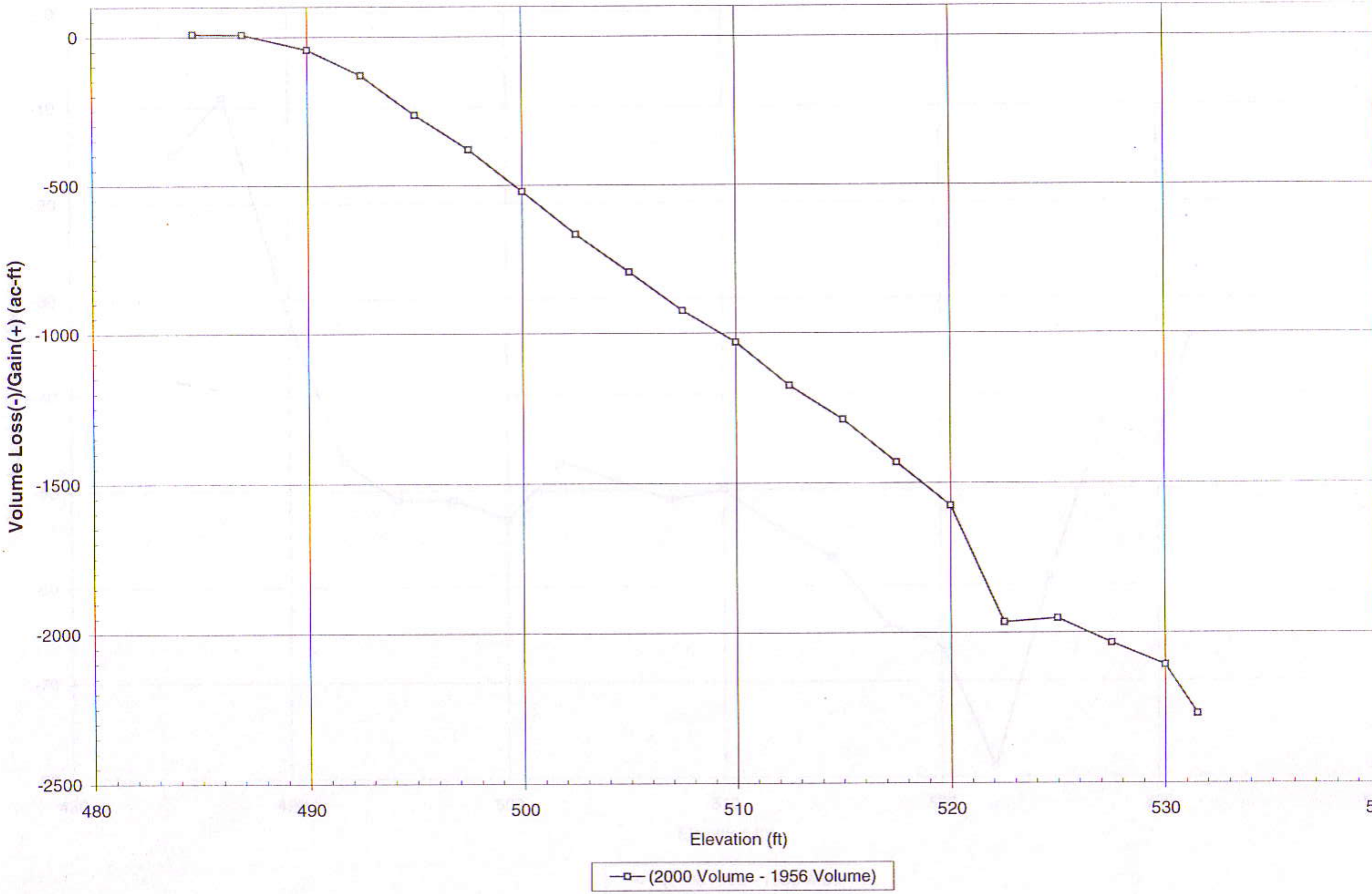
ELEVATION IN FEET	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
481						0	0	0	0	0
482	0	1	1	1	1	1	1	2	2	2
483	2	2	3	3	3	3	4	4	4	5
484	5	5	6	6	7	7	8	9	9	10
485	10	11	12	13	13	14	14	15	16	17
486	18	19	19	20	21	21	22	22	22	23
487	23	23	24	24	25	25	25	25	26	26
488	26	27	27	27	28	28	28	28	29	29
489	29	30	30	30	30	31	31	31	32	32
490	32	32	33	33	33	34	34	34	35	35
491	35	35	36	36	36	37	37	37	38	38
492	38	39	39	39	40	40	40	41	41	41
493	42	42	43	43	43	44	44	45	45	46
494	47	47	48	49	49	50	51	52	52	53
495	54	54	55	56	57	58	59	60	61	62
496	63	64	65	66	67	68	69	70	71	72
497	74	75	76	77	78	79	80	81	82	83
498	84	85	86	87	88	89	90	91	92	93
499	95	95	96	97	98	100	101	102	103	104
500	105	106	108	109	110	111	112	114	115	117
501	118	119	121	122	124	125	126	128	129	130
502	132	133	134	135	136	138	139	140	141	143
503	144	145	147	148	149	150	152	153	154	155
504	157	158	160	161	162	163	164	165	166	167
505	168	170	171	172	173	175	176	177	178	180
506	181	182	183	184	186	187	188	189	191	192
507	193	194	196	197	198	199	201	202	203	205
508	206	208	209	211	213	214	216	217	219	220
509	221	223	224	225	227	228	229	231	232	233
510	235	236	237	238	240	241	242	243	245	246
511	247	248	249	250	252	253	254	256	257	258
512	260	261	263	264	266	268	269	271	273	274
513	276	278	279	281	282	283	285	286	288	289
514	290	292	293	295	296	298	299	301	302	304
515	305	307	308	309	311	312	313	315	316	317
516	319	320	322	323	324	326	328	329	331	332
517	334	335	337	338	339	341	342	344	345	347
518	349	350	352	354	355	357	359	361	362	364
519	366	368	370	371	373	375	377	379	381	383
520	386	388	390	392	394	396	398	400	402	404
521	406	408	410	411	413	415	417	419	420	422
522	424	426	428	430	432	434	436	438	440	442
523	444	446	448	450	452	454	456	458	460	462
524	463	465	467	469	472	474	478	481	484	487
525	491	494	497	500	503	506	508	511	514	516
526	519	522	525	527	530	533	536	539	542	546
527	549	553	556	559	563	565	568	570	573	575
528	577	579	581	582	584	586	588	590	592	594
529	596	598	600	602	603	605	607	609	611	613
530	615	616	618	620	622	624	626	628	629	631
531	633	635	637	639	641	656				



Lake Waxahachie
July 2000

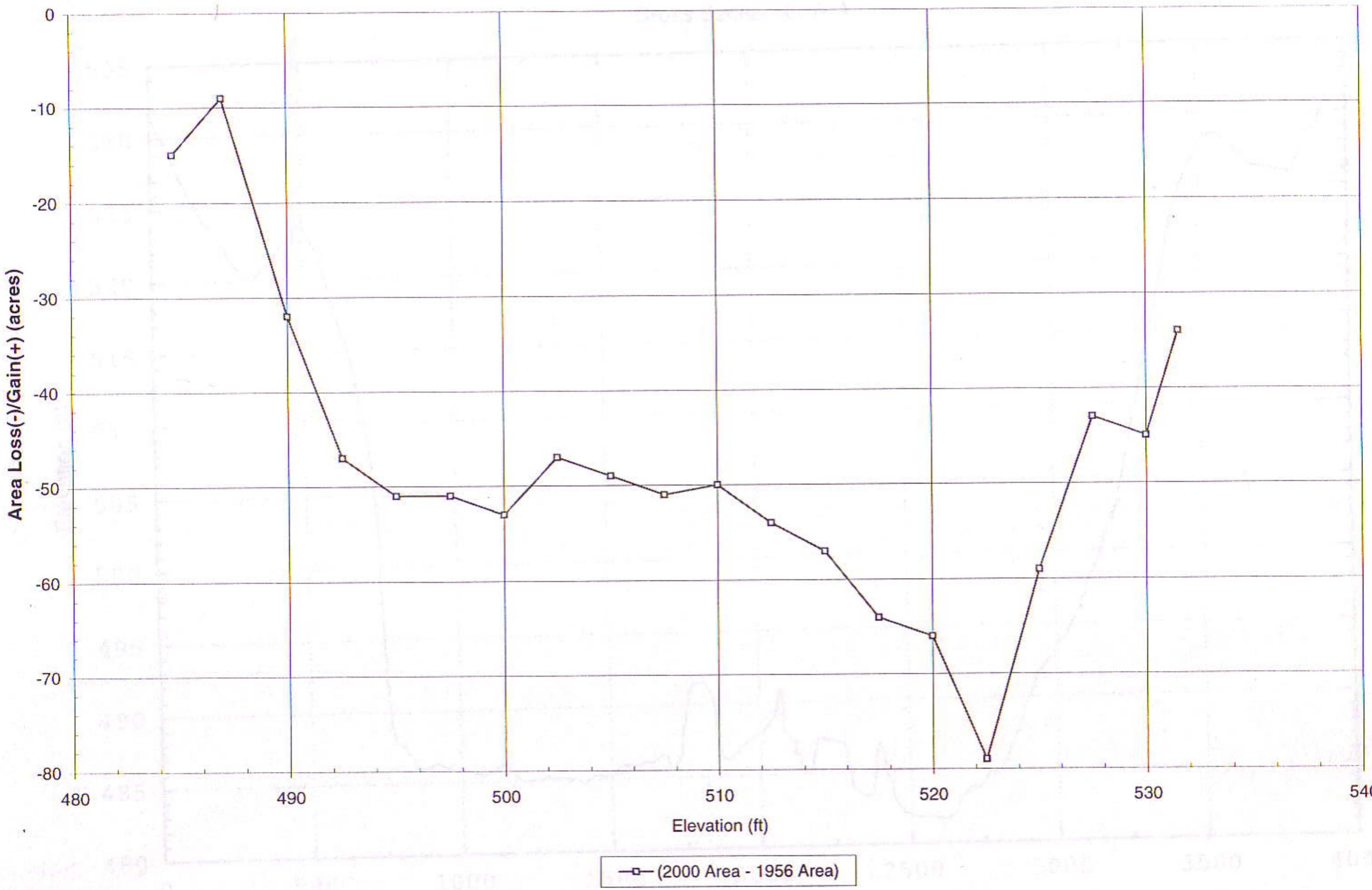


Lake Waxahachie
July 2000



Lake Waxahachie Changes in Volume

Appendix E

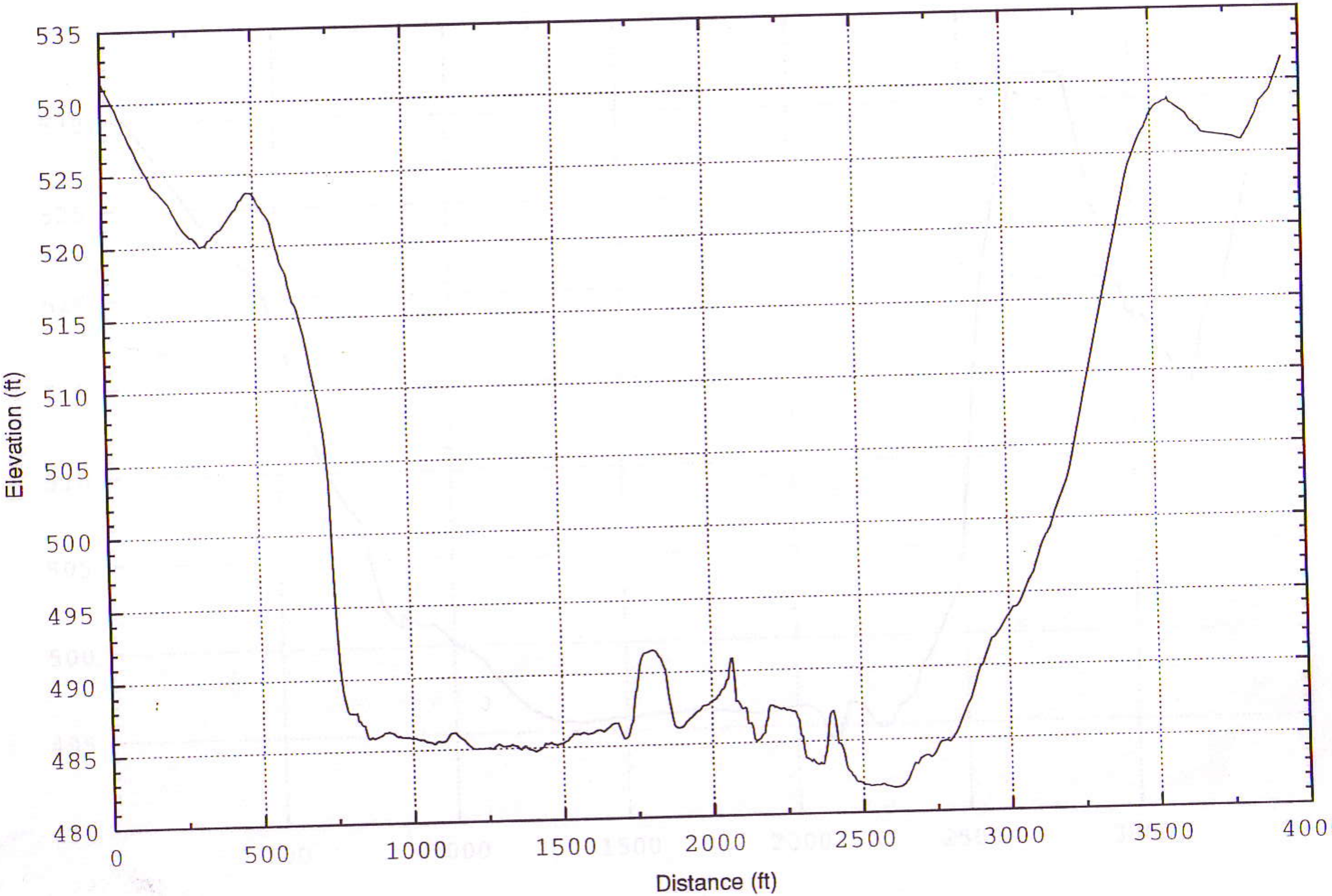


Lake Waxahachie Changes in Area

Appendix F

Lake Waxahachie

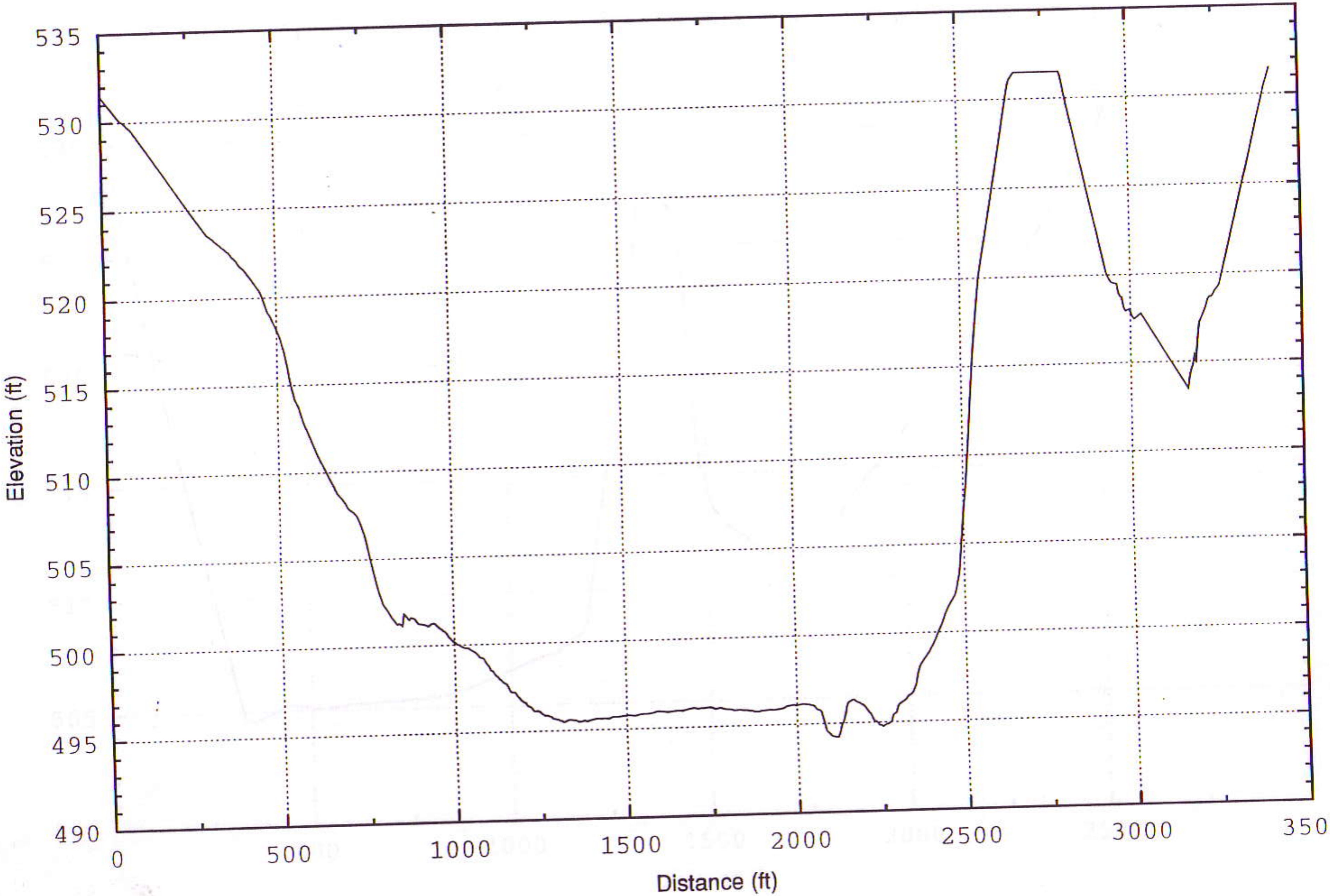
Cross Section #1 A-A'



Appendix G

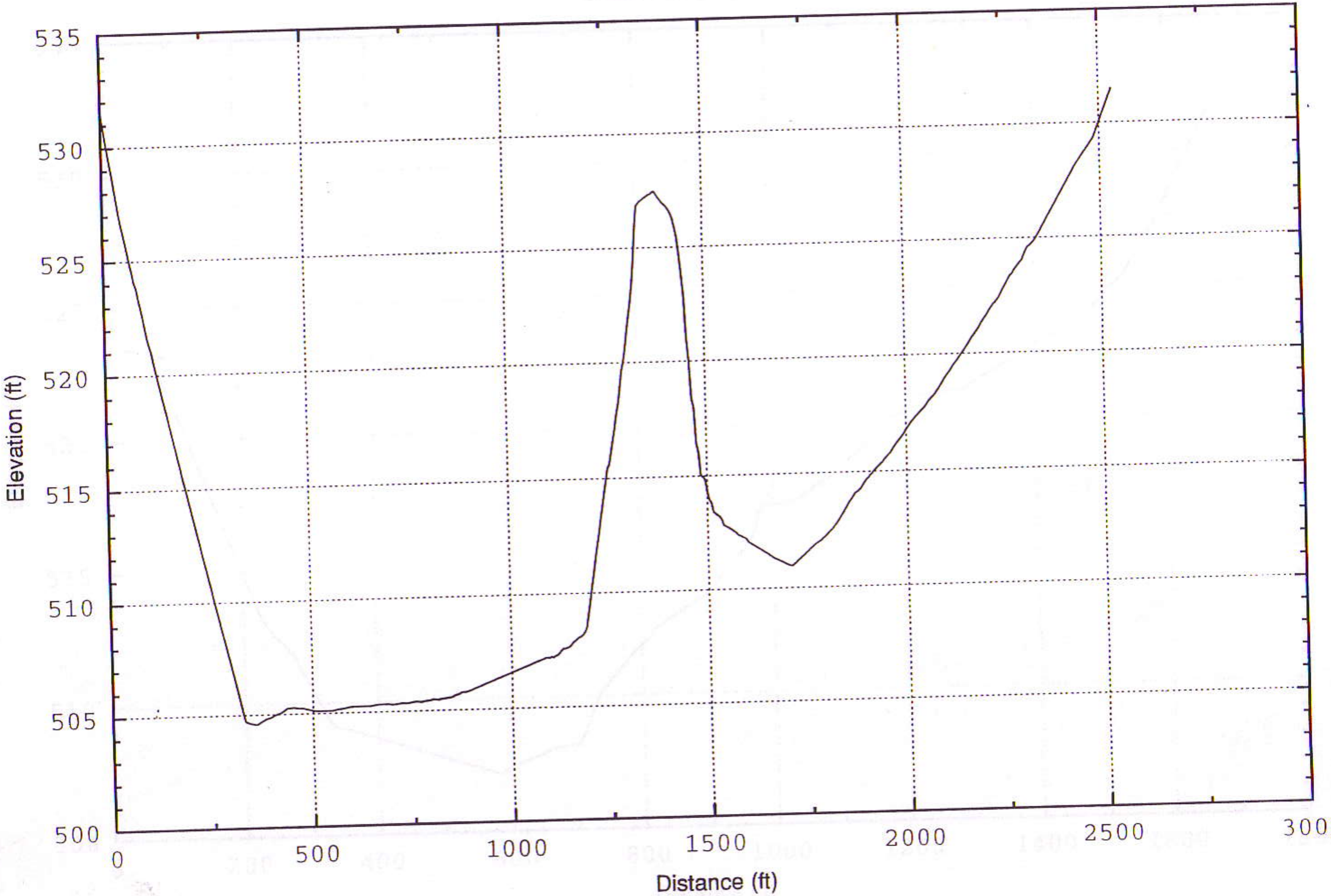
Lake Waxahachie

Cross Section #2 B-B'



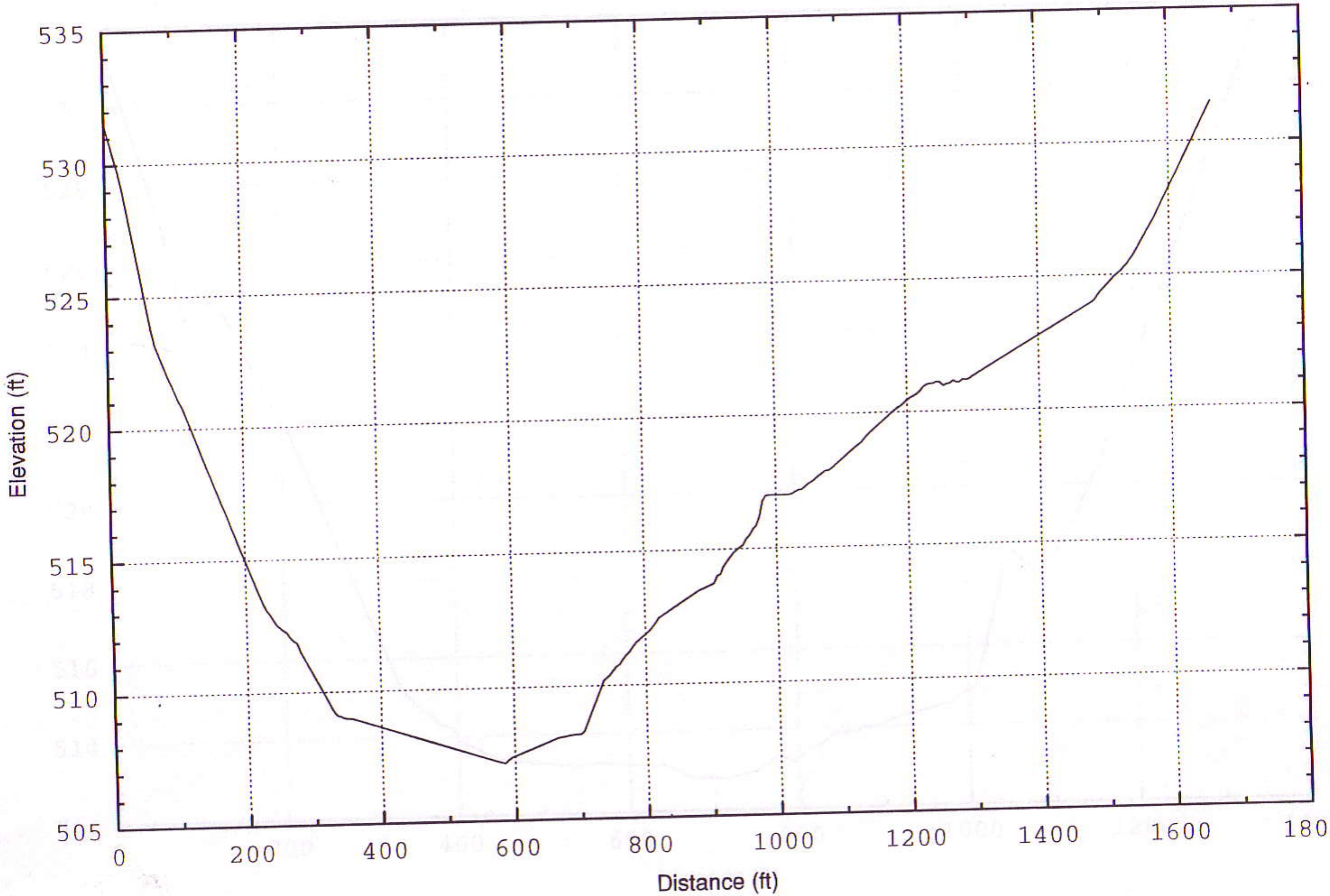
Lake Waxahachie

Cross Section #3 C-C'



Lake Waxahachie

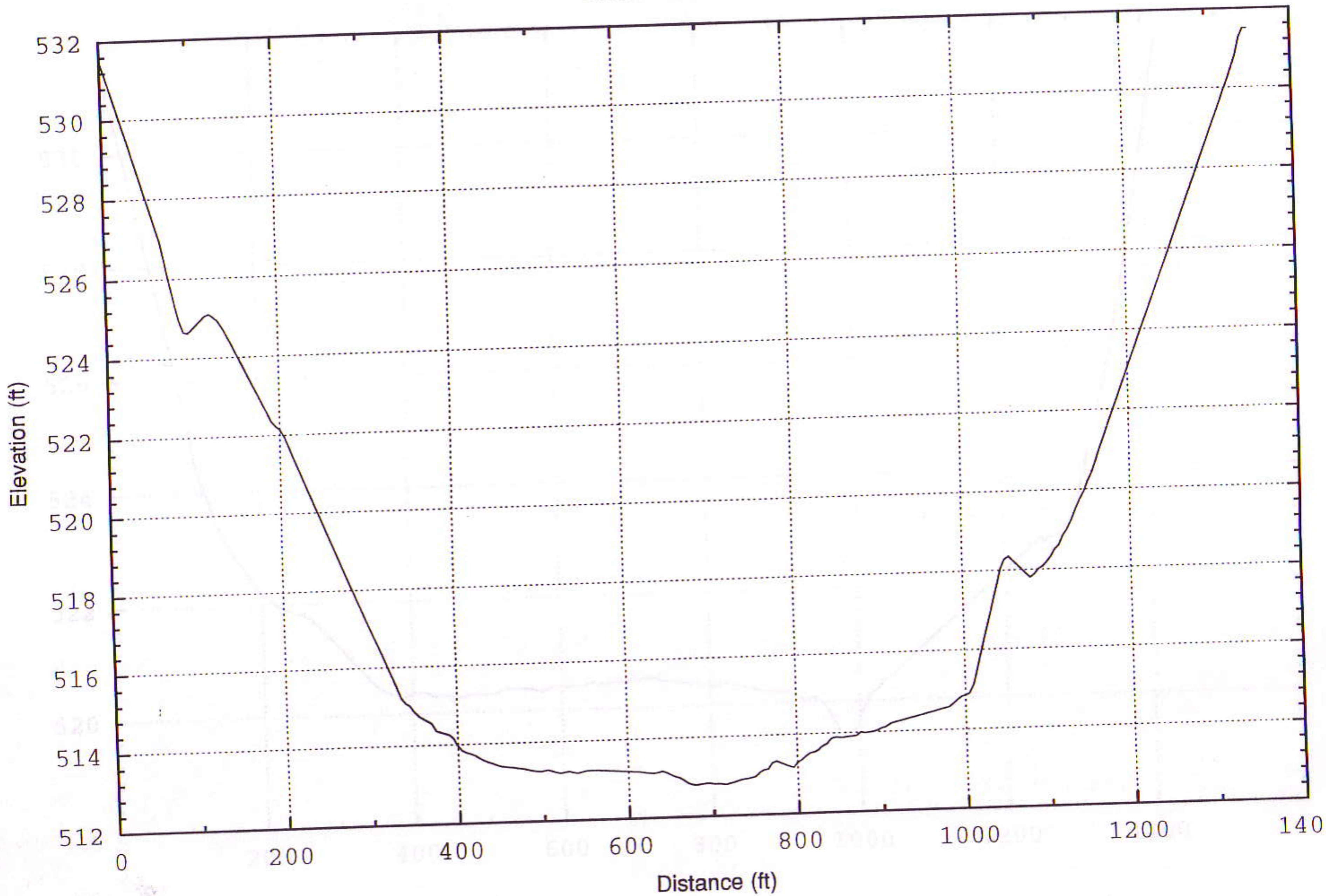
Cross Section #4 D-D'



Appendix G

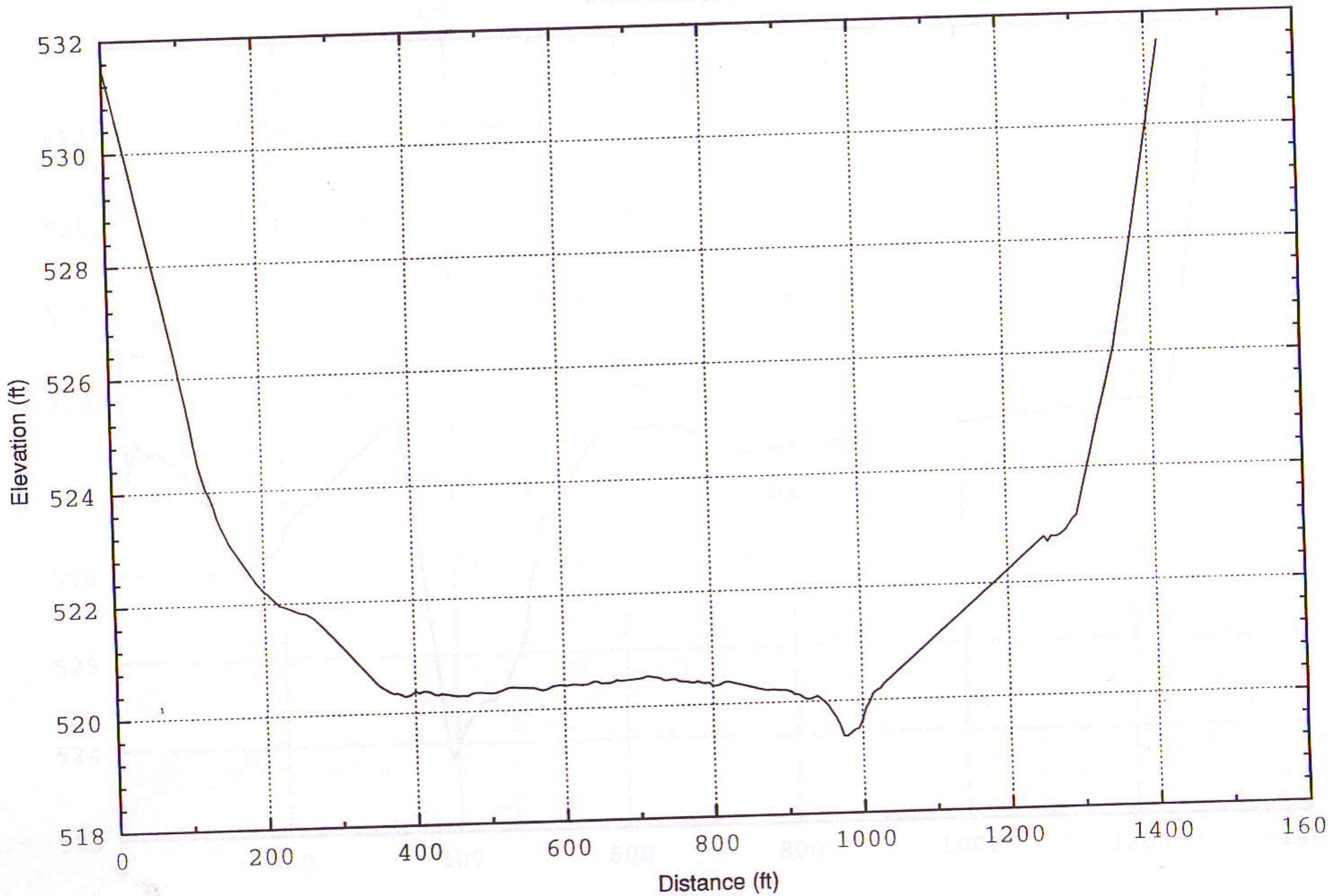
Lake Waxahachie

Cross Section #5 E-E'



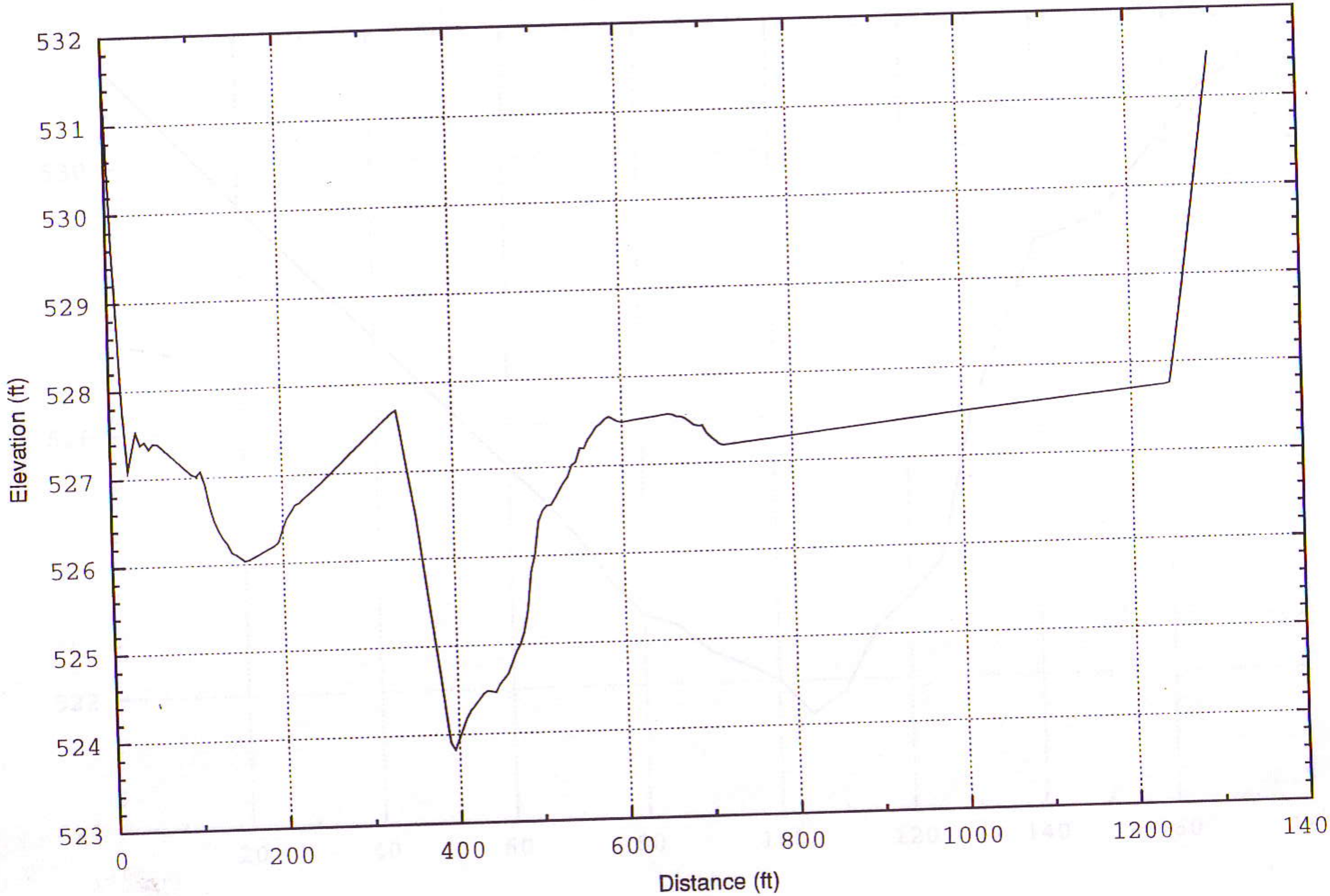
Lake Waxahachie

Cross Section #6 F-F'



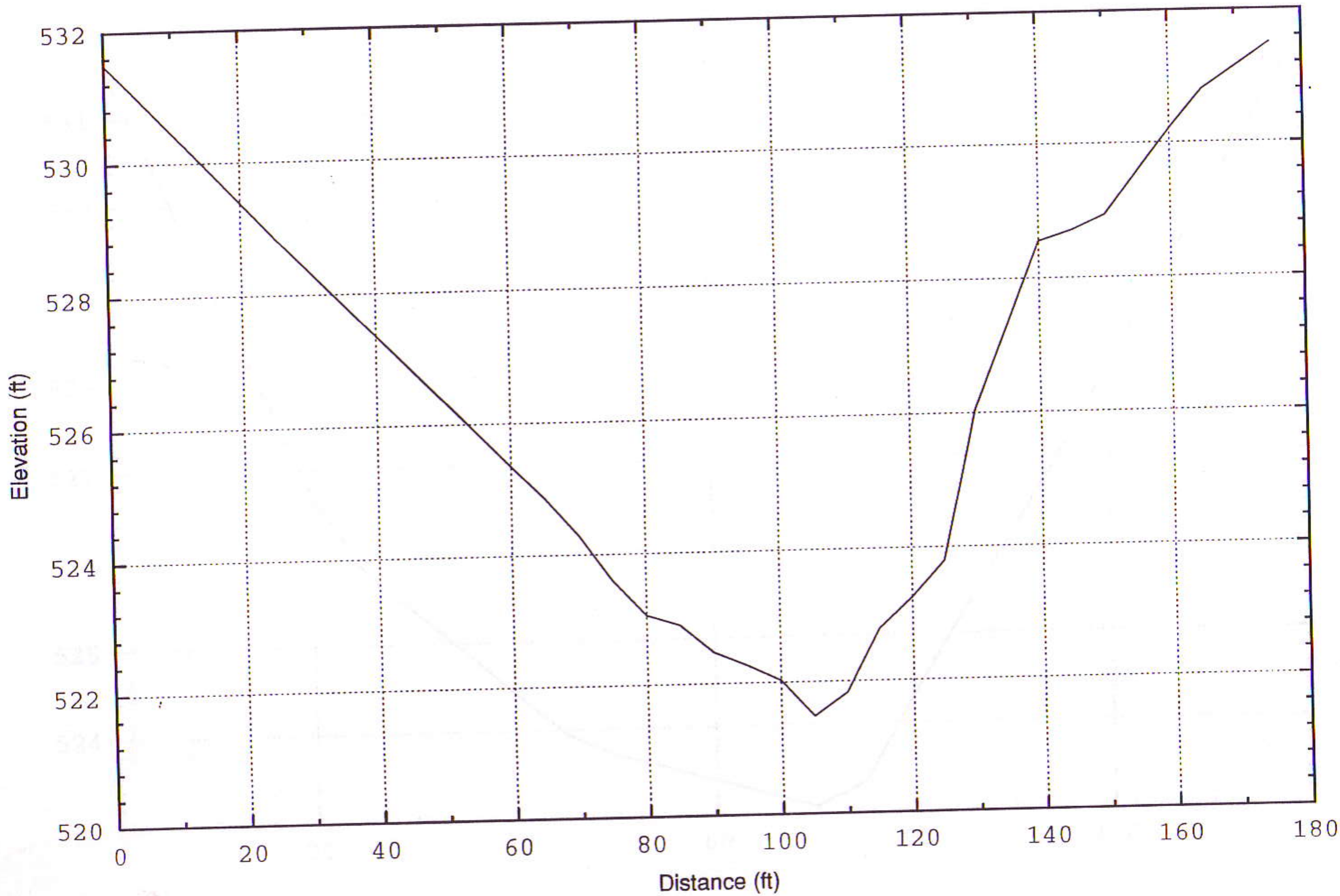
Lake Waxahachie

Cross Section #7 G-G'



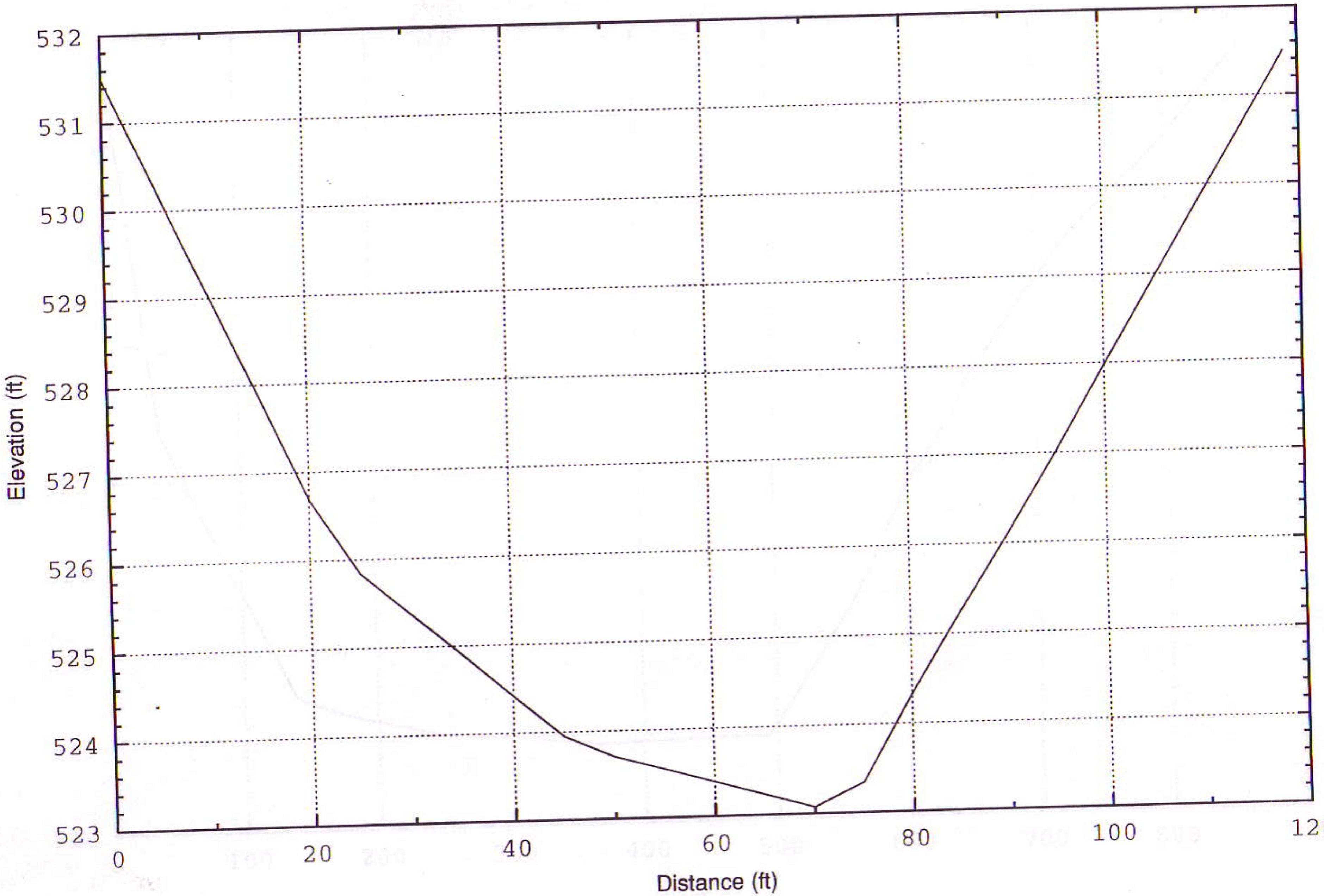
Lake Waxahachie

Cross Section #8 H-H'



Lake Waxahachie

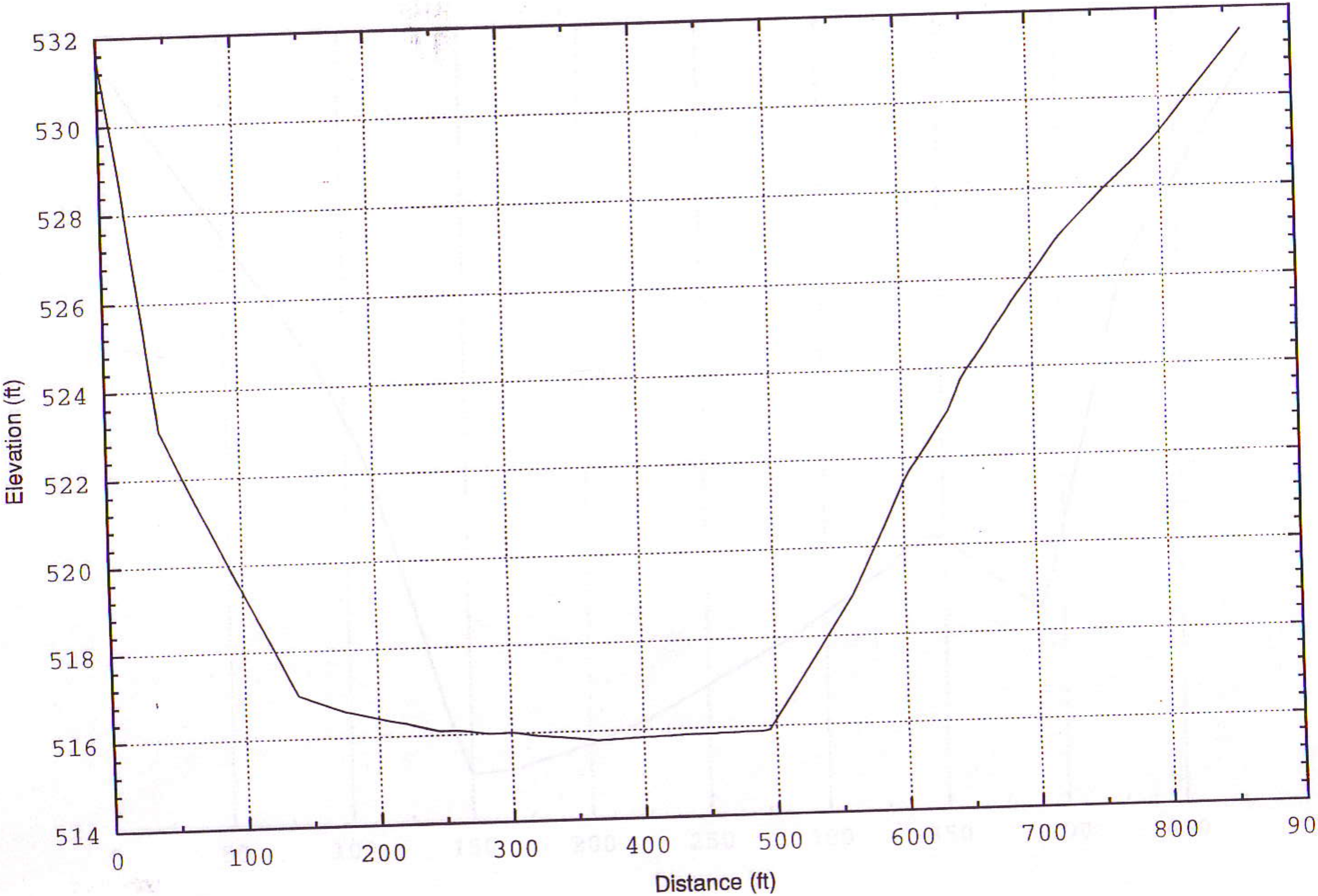
Cross Section #9 I-I'



Appendix G

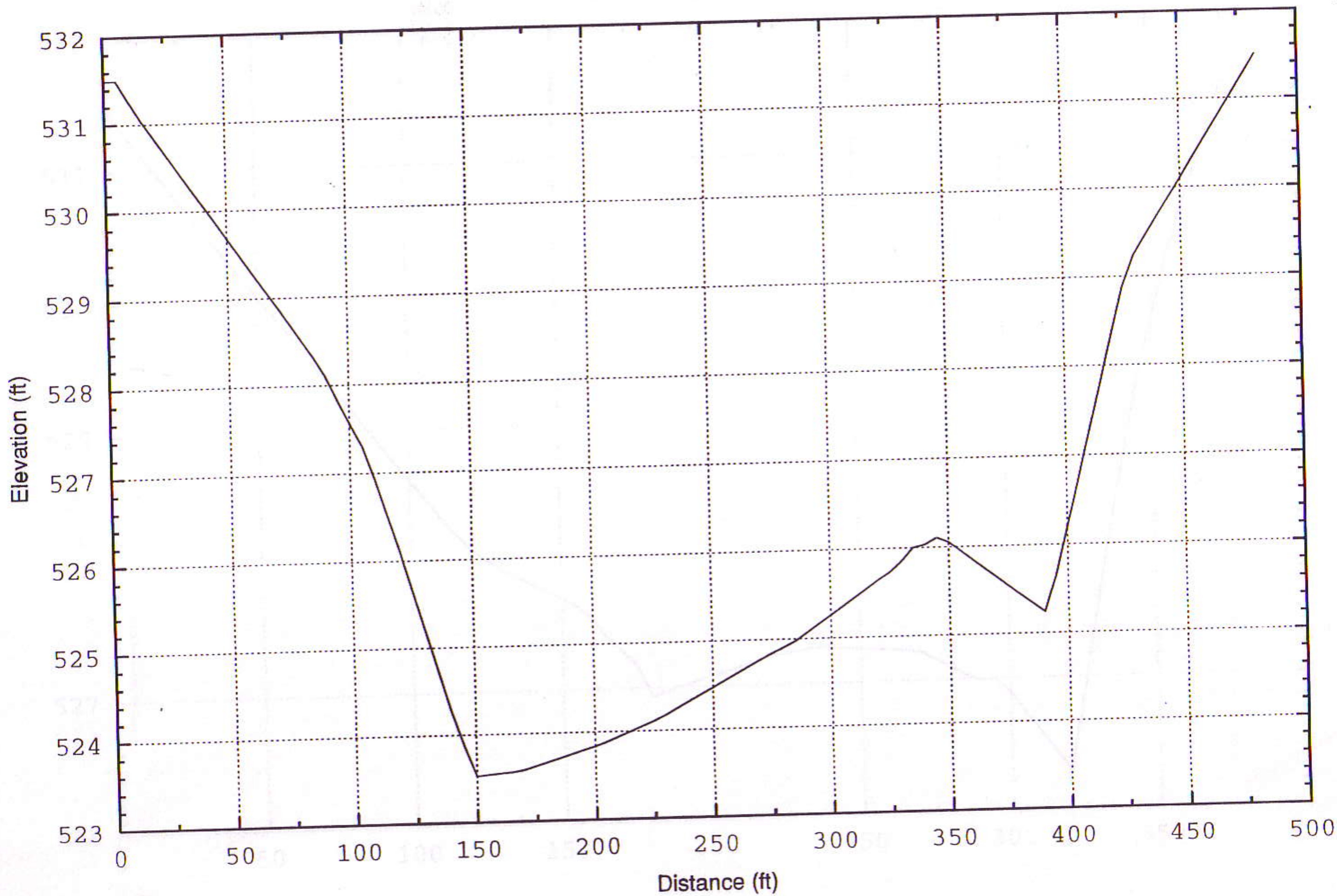
Lake Waxahachie

Cross Section #10 J-J'



Lake Waxahachie

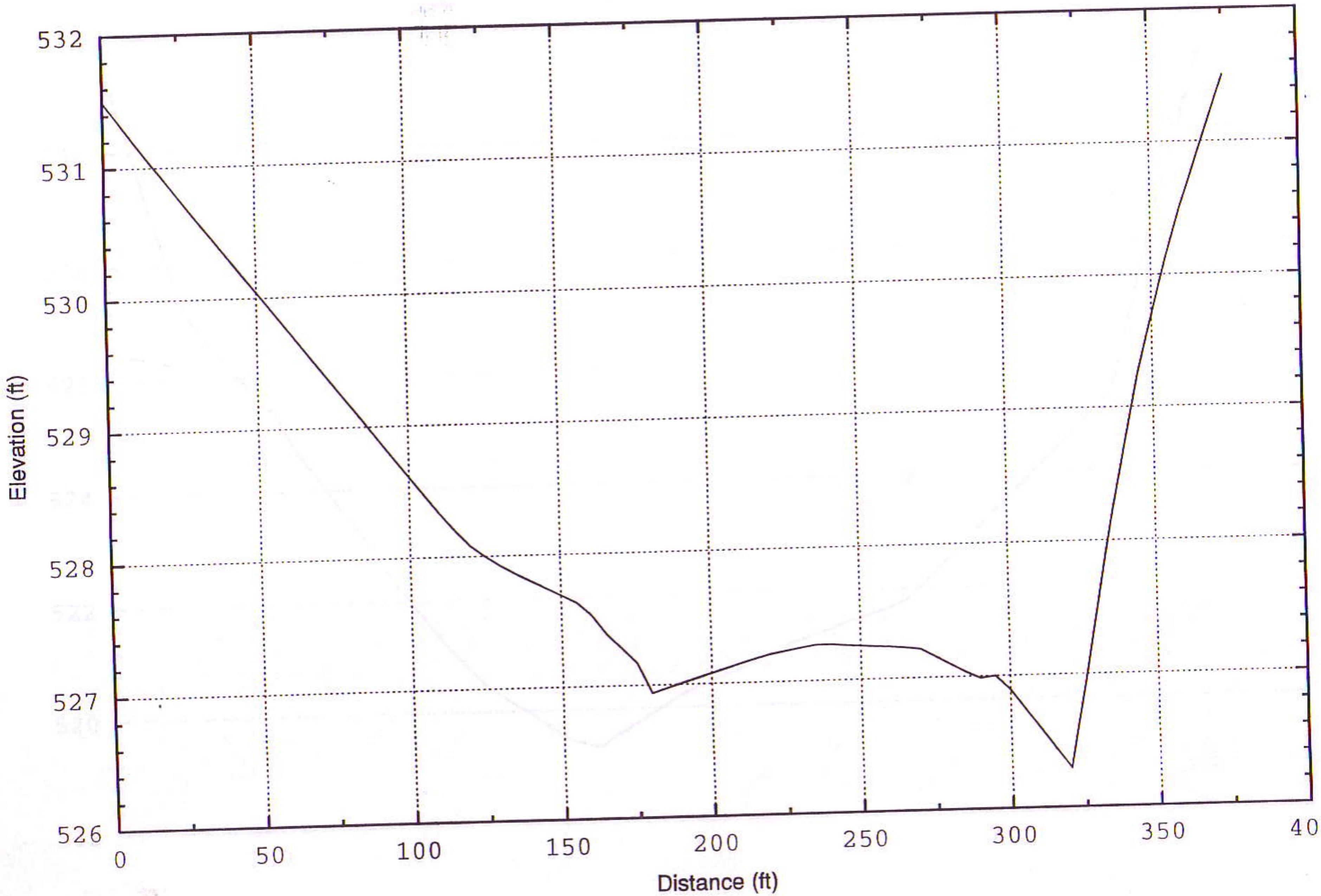
Cross Section #11 K-K'



Appendix G

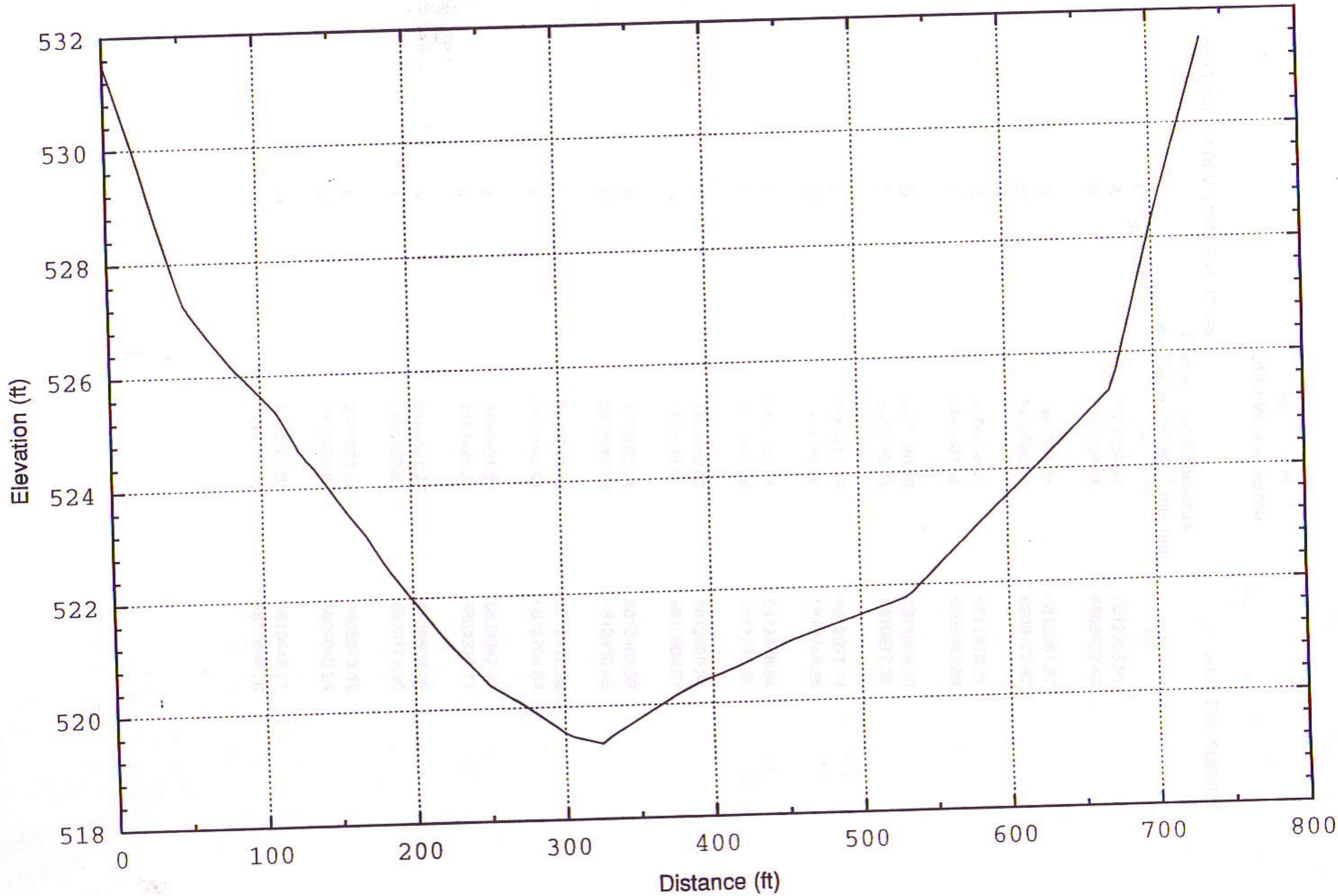
Lake Waxahachie

Cross Section #12 L-L'



Lake Waxahachie

Cross Section #13 M-M'



Appendix H

Lake Waxahachie

TEXAS WATER DEVELOPMENT BOARD

JULY 2000 SURVEY

Range Line Endpoints

State Plane NAD83 Units-feet

Range Line	X	Y
A	2489726.54	6812765.31
A'	2492458.24	6809922.43
B	2489331.24	6812261.87
B'	2490795.30	6809172.87
C	2486814.47	6811679.39
C'	2488081.82	6809485.89
D	2486230.49	6811863.00
D'	2485723.74	6810277.38
E	2484215.73	6812097.79
E'	2484199.06	6810748.26
F	2482006.01	6812378.54
F'	2482526.96	6811059.89
G	2480580.67	6812029.36
G'	2479924.79	6810909.57
H	2479065.21	6812462.39
H'	2478949.79	6812330.49
I	2477042.78	6812812.88
I'	2477095.81	6812706.83
J	2486801.29	6809847.47
J'	2487495.39	6809335.17
K	2486421.76	6809660.09
K'	2486453.85	6809178.80
L	2487073.01	6808973.33
L'	2487438.01	6809060.24
M	2483104.35	6810946.71
M'	2483784.33	6810664.76

APPENDIX I - 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')

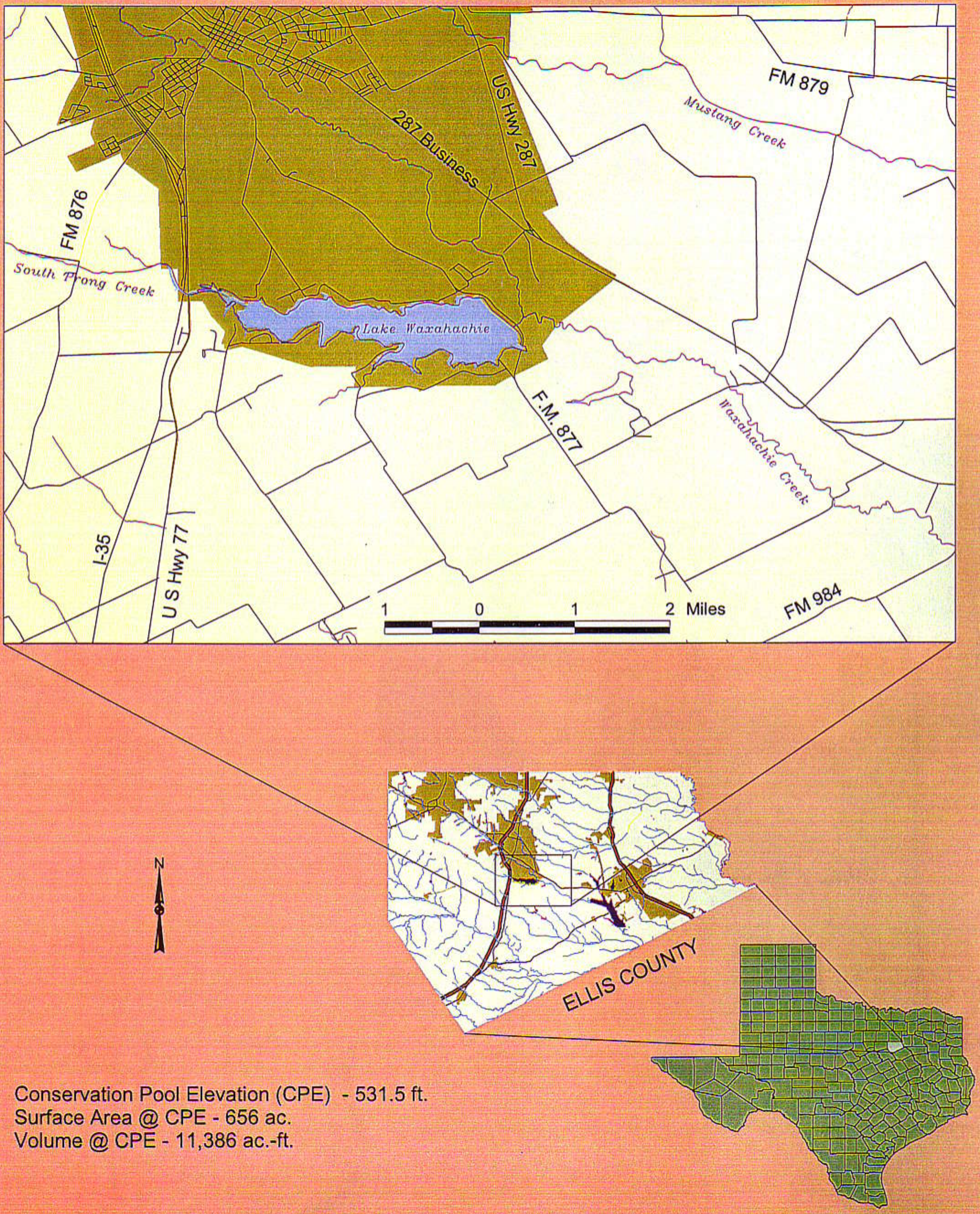
For a measurement at 80 feet (outside the 2 to 60 foot column, assumed V = 4785 fps):

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

FIGURE 1

LAKE WAXAHACHIE

Location Map



Conservation Pool Elevation (CPE) - 531.5 ft.
Surface Area @ CPE - 656 ac.
Volume @ CPE - 11,386 ac.-ft.

TWDB Survey July 2000

Figure 2

LAKE WAXAHACHIE

Location of Survey Data

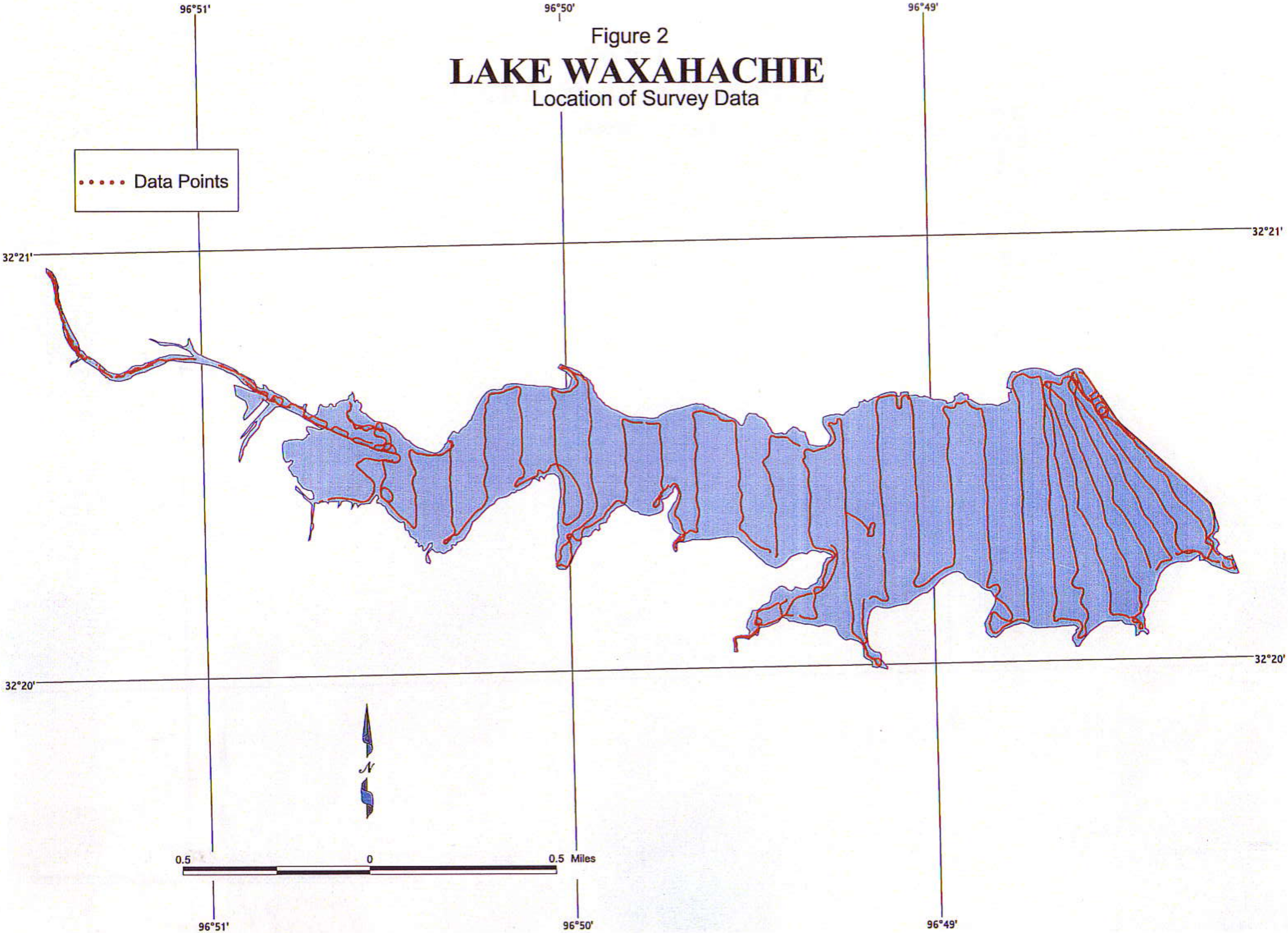


Figure 3

LAKE WAXAHACHIE

Elevation Ranges

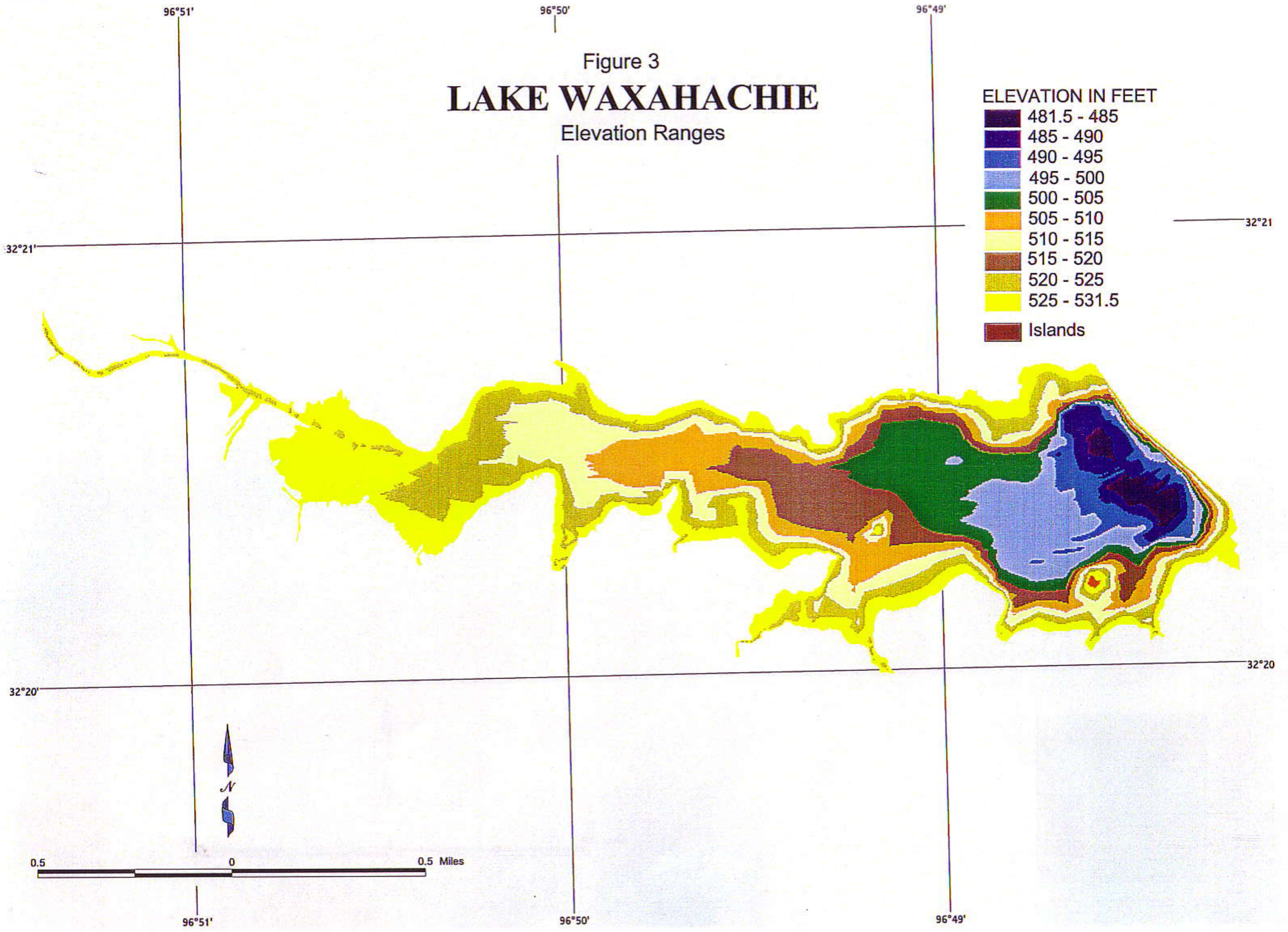


Figure 4

LAKE WAXAHACHIE

Depth Ranges