VOLUMETRIC SURVEY REPORT

OF

LAKE GRANBURY

JULY 2003 SURVEY

Prepared by the:

TEXAS WATER DEVELOPMENT BOARD

September 2005

Prepared for:

Brazos River Authority

Staff of the Surface Water Resources Division prepared this report:

Barney Austin, Ph.D.

Duane Thomas
Randall Burns
Marc Sansom
Heidi Moltz

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

EXECUTIVE OVERVIEW

The Texas Water Development Board entered into a contract with the Brazos River Authority to perform a volumetric survey of Lake Granbury. The goal of the study was to produce updated elevation-area and elevation-volume tables using current GPS, acoustical depth sounder and GIS technology.

Records indicate the top of the conservation (TOC) pool for Lake Granbury is at elevation 693.0 feet above mean sea level. A lake boundary was digitized from digital orthophoto quadrangle images (DOQs). Depth and positional data were collected along a layout of transects or pre-plotted navigation lines spaced approximately 500 feet apart using commercially available software.

Data were collected at Lake Granbury during the period of July 15 to July 22, 2003. During that period, the water levels at the reservoir gage varied between 692.40 ft and 692.65 ft. Approximately 125,000 data points were collected over 205 miles of pre-planned transects.

The result of the current survey indicates the lake encompasses 7,945 surface acres and contains 129,011 ac-ft at the TOC pool elevation 693.0 ft. The TWDB 1994 survey report (1993 field survey) found 8,310 surface acres and a total volume of 136,823 ac-ft. The 1994 boundary was digitized from USGS 1:24,000 scale Topographic Maps and so to provide a more direct comparison for studying loss of capacity the 1994 area and volume were recalculated (revised) utilizing the more recent boundary, digitized from the 1995-96 DOQs. The results of the 1994 report revisions indicate the lake's surface area was 7,949 ac and the total volume was 131,593 ac-ft. Comparison of the revised 1993 survey to the current 2003 survey of Lake Granbury show little or no change in surface area and a 2% reduction in total volume at TOC pool. Most of this reduction appears to be in the area of continued deltaic accretion in the upper reaches of Lake Granbury where the Brazos River enters the main body of the reservoir.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

VOLUMETRIC SURVEY REPORT
ON LAKE GRANBURY
SURVEY OF JULY 2003

INTRODUCTION

Staff of the Surface Water Availability Section of the Texas Water Development Board (TWDB) conducted a volumetric survey of Lake Granbury during the period of July 15 through July 22, 2003. The purpose of the survey was to determine the current volume of the lake at conservation pool elevation (CPE) 693.0 feet above mean sea level[1] (msl). For the purpose of this report, the term "top of conservation (TOC) pool" will be used to mean the conservation pool elevation (693.0 feet) for Lake Granbury. The equipment and methodology used in the current survey was similar to that used in the January 1994 TWDB volumetric survey report[1]. Survey results are presented in the following pages in both graphical and tabular form.

The vertical datum used during this survey is that used by the United States Geological Survey (USGS) for the lake elevation gage at Lake Granbury. The datum for this gage is reported as mean sea level (msl) National Geodetic Vertical Datum of 1929 (NGVD 1929)[2]. Thus, elevations are reported here in feet (ft) above mean sea level (msl) NGVD 29. Volume and area calculations in this report are referenced to water levels provided by the USGS gage: USGS 08090900 Lk Grandbury nr Granbury, TX[3].

The following table summarizes information and pertinent data for De Cordova Bend Dam and Lake Granbury and is based on information furnished by the Brazos River

Authority[4]. Reservoir data is based on the results of the revised 1994 survey and the 2003 current survey.

PERTINENT DATA

Table 1. De Cordova Bend Dam and Lake Granbury Pertinent Data

Owner of Dam and Facilities:

Brazos River Authority

Operator of Dam and Facilities:

Brazos River Authority

Engineer and General Contractor

Ambursen Engineering Corporation (Design)

H.B. Zachry Company (General Contractor)

Location:

On the Brazos River in Hood County, 8 miles southeast of the City of Granbury (Figure 1).

Purpose:

Multi-purpose reservoir for flood control, water supply, industrial purposes, and recreation

Authorization:

State[5]: Water Rights Permit No. 2111 issued, July 24, 1964 authorized the Brazos River Authority (BRA) to construct and maintain a dam and reservoir (Lake

Granbury) on the Brazos River, to impound and not exceed 155,000 ac-ft of water at TOC pool elevation 693.0 ft. The BRA was authorized a priority right to divert and use not to exceed 10,000 ac-ft of water per annum for municipal, 70,000 ac-ft per annum for industrial, 20,000 ac-ft per annum for irrigation, 500 ac-ft of the 20,000 ac-ft for irrigation for mining, and 350,000 ac-ft per annum for hydroelectric power generation purposes. The priority rights of Lake Granbury also fall under the order of Certificate of Adjudication 5167 for the purpose of system operation as authorized by the Commission Order of July 23, 1964. For detailed information about the water rights permits and the System Operation Order, refer to Volumetric Survey of Lake Granbury (TWDB, 1994) or the Records Division of Texas Commission on Environmental Quality (TCEQ).

Drainage area:

25,679 square miles, contributing drainage area 16,113 square miles

Dam:

Type	Ambursen-type concrete and earthfill
Length	2,200 ft
Maximum height	84 ft (above natural streambed)
Top width	17 ft

Spillway:

Type	Gated control ogee weir
Control	16 tainter gates, each 36 by 35 ft
Length	576 ft (net at crest)
Crest elevation	658.0 ft above msl

Outlet works:

Type	concrete sluiceway
Invert elevation (lowest gate)	640.0 ft and 652.0 ft above msl
Control	sluice gates

Reservoir Data:

The following information was obtained from revisions to the TWDB 1994 Volumetric Survey of Lake Granbury[1]:

FEATURE	ELEVATION (Feet)	CAPACITY (Acre-feet)	AREA (Acres)
Top of Conservation Storage Space	693.0	131,593	7,949
Lowest gated outlet (invert)	640.0	1,125	230

The following information was obtained from the TWDB 2004 Volumetric Survey of Lake Granbury:

FEATURE	ELEVATION (Feet)	CAPACITY (Acre-feet)	AREA (Acres)
Top of Conservation Storage Space	693.0	129,011	7,945
Lowest gated outlet (invert)	640.0	965	208

VOLUMETRIC SURVEYING TECHNOLOGY

Prior methodologies for calculating volumes and areas from bathymetric data included the range survey and contour survey methods[6,7]. Comparisons between those methods and the current method described below are not recommended[7].

The equipment used to perform the latest volumetric survey consisted of a 23-foot aluminum tri-hull SeaArk craft with cabin, equipped with twin 90-Horsepower Honda outboard motors. Installed within the enclosed cabin are a Coastal Oceanographics' Helmsman Display (for navigation), an Innerspace Technology Model 449 Depth Sounder and Model 443 Velocity Profiler, Trimble Navigation, Inc. AG132 GPS receiver with Omnistar differential GPS correction signal and PC. A water-cooled 4.5 kW generator provides electrical power through an in-line uninterruptible power supply.

In shallow areas and where navigational hazards such as stumps were present, a 20-foot aluminum shallow-draft flat bottom SeaArk craft with cabin, equipped with one 100-horsepower Yamaha outboard motor was used. The on-board portable data collection system included a Knudsen 320 B/P Echosounder (depth sounder), a Trimble Navigation, Inc. AG132 GPS receiver with Omnistar differential GPS correction signal and a laptop computer. The GPS equipment, survey vessels, and depth sounders in combination provide efficient hydrographic survey systems. Reference to brand names throughout this report does not imply endorsement by TWDB.

Using the advances in survey technology, accurate estimates of the lake volume can then be determined by building a 3-D TIN[8] model of the lake from the collected data.

PRESURVEY PROCEDURES

The lake's boundary was digitized using Environmental Systems Research Institute's (ESRI)[9] ArcGIS 8.3 from digital orthophoto quadrangles (DOQs). VARGIS of Texas LLC produced the DOQs for the Texas Orthoimagery Program (TOP). The DOQs produced for the Department of Information Resources and the GIS Planning Council under the TOP reside in the public domain. More information can be obtained on the Internet at http://www.tnris.state.tx.us/DigitalData/doqs.htm.

The lake elevations, at the time the DOQs were photographed (January 19, 1995, February 02, 1995, and January 9, 1996) were 692.3 ft, 692.65 ft, and 692.43 ft respectively. The lake shoreline is predominately steep banks and bulkheads. Therefore, the lake and island boundaries were given an elevation of 693.0 ft (TOC) and TWDB Staff utilized these updated boundary conditions in modeling Lake Granbury. The water surface elevations on Lake Granbury varied between elevation 692.40 ft and 692.65 ft during the survey.

The survey layout was designed by placing survey track lines at 500-foot intervals (Figure 2) within the digitized lake boundary using the HYPACK[10] software.

The survey design required the use of approximately 360 survey track lines placed generally perpendicular to the original river channel and tributaries along the length of the lake. The survey track lines (transects/range lines) were designed in a pattern similar to those transects designed for the 1993 TWDB survey (1994 TWDB report).

SURVEY PROCEDURES

The following procedures were followed during the TWDB volumetric survey of Lake Granbury. Information regarding equipment calibration and operation, the field survey, and data processing is also presented.

Equipment Calibration and Operation

Prior to collecting data onboard the Hydro-survey boat, the depth sounder was calibrated with the Innerspace 443 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 acclimate it. The probe was next raised to the water surface where the depth was considered zero. The probe was then gradually lowered on a cable to a depth just above the lake bottom, and then raised again 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 weighted measuring tape to ensure that the depth sounder was properly calibrated and operating correctly.

While collecting data onboard the River Runner (shallow draft) boat, the Knudsen depth sounder was calibrated using the DIGIBAR-Pro Profiling Sound Velocimeter from Odom Hydrographic Systems[11]. The steps to determine the speed of sound are similar to those used for the Innerspace 443 Velocity Profiler. The probe was first placed in the water to acclimate it, raised to the water surface where the depth was considered zero. The probe was then gradually lowered on a cable to a depth just above the lake bottom, and then raised again 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 velocimeter. The speed of sound was then entered into the bar check feature in the Knudsen software program[12]. The depth was then checked manually with a stadia (survey) rod or weighted measuring tape to ensure that the depth sounder was properly calibrated and operating correctly.

The speed of sound in the water column varied from 4,944 feet per second to 4,954 feet per second during the Lake Granbury survey. 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 $\pm$0.2 ft. An additional estimated error of $\pm$0.3 ft arises from variation in boat inclination. These two factors combine to give an overall accuracy of $\pm$0.5 ft for any instantaneous reading. These errors tend to be fairly minimal over the entire survey, since some errors are positive and some are negative, canceling each other out.

During the survey, the horizontal mask setting on the onboard GPS receiver was set to 10 degrees and the PDOP (Position Dilution of Precision) limit was set to seven to maximize the accuracy of the horizontal positioning. 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. Further positional accuracy is obtained through differential corrections from the Omnistar receiver. The lake project initialization file used by the HYPACK data collection program was set up to convert the collected Differential GPS positions to NAD 83, State Plane, Texas North Central Zone coordinates on the fly.

Data Collection

TWDB staff collected data at Lake Granbury for six days during the period of July 15 to July 22, 2003. Lake levels remained near TOC during the survey varying between elevations 692.4 ft and 692.65 ft, thus allowing the survey crew to collect data in most areas of the lake that would be inundated at TOC.

The design layout for collecting data at Lake Granbury required pre-plotting transects (range lines) that were perpendicular to the old river channel and tributaries. These transects had an average spacing of 500 ft. While collecting data, the boat operator would steer the boat on course (with GPS navigation) starting from one shore and heading to the opposite shore. The data collector would monitor the data display and depth sounder to make sure the latitude, longitude, and depth (x, y, z) values were being logged. As the boat travels across the pre-plotted transect lines, the depth sounder takes approximately ten readings of the lake bottom each second. The depth readings are stored on the computer along with the positional data generated by the boat's GPS receiver. The data files collected are downloaded and transferred to the office for editing after the survey is completed. These points are then averaged to one data point per second for generating the TIN model. The distance between data points depends on the speed of the boat. The maximum distance between data points during the 2003 survey of Lake Granbury was approximately 20 ft.

Over 125,000 data points were collected over the 205 miles traveled during the data collection phase of Lake Granbury. These points were stored digitally on the boat's computer in 512 data files. Ancillary data were collected in those areas where the crew was not able to stay on course due to obstructions. Data were not collected in areas with significant obstructions or where the water was too shallow. Figure 2 shows the actual location of all data points collected.

Data Processing

The collected data were downloaded from diskettes onto TWDB's network computers and backups were made for future reference. Each raw data file was run through the EDIT routine in the HYPACK Program. Anomalies such as depth spikes or data with missing depth or positional information were deleted from the files. A correction for the lake elevation at the time of data collection was also applied to each file during the EDIT routine. After all adjustments had been made to the raw data files, the edited files were saved. The edited files were then combined into a single X, Y, Z data file, to be used with the GIS software to develop a model of the lake bottom elevation.

The resulting data file was imported into ESRI's Arc/Info Workstation GIS 8.3 software. This 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[8]. Where by 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 used in this method. The generated network of three-dimensional triangular planes represents the 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 can be determined from the triangulated irregular network created using this method of interpolation. The computed lake volume and area tables are presented in Appendix A and Appendix D, respectively for the 2003 Lake Granbury Survey.

The 1993 survey data was rerun with the boundary used in calculating the 2004 volume and area tables. These revised volume and area tables for the 1994 report (1993 survey) are presented in Appendix B and E with the original 1994 report volume and area

tables presented in Appendix C and F. An elevation-volume graph and an elevation-area graph including both surveys and the revisions to the 1994 report are presented in Appendix F and Appendix H, respectively. Small adjustments to the 2003 survey and 1994 revised survey areas are incorporated in the tables. The areas were linearly interpolated from elevations 690.0 ft to 693.0 ft to smooth artifacts introduced by, ESRI's method for extrapolating to the boundary[8].

Other products developed from the model include, Figures 3 a, b and c, which are shaded relief maps, and Figures 4 a, b and c, which are shaded depth range maps. Figures 3 and 4 were developed directly from the TIN model by assigning different colors to specified ranges correlating to elevations in Figure 3 and depths in Figure 4. Figure 5 illustrates four regions that were developed to investigate the differences between the 1993 and 2003 data sets in four distinct areas of the reservoir. Boundaries were developed around areas where the 1993 and 2003 data sets were most consistent, eliminating coves, side channels, and the riverine portion of Lake Granbury. Digitizing a smooth boundary between the DOQ boundary and the 1993 and 2003 data sets created these four regions. TOP elevation 693.0 ft was given to these boundaries and the volume calculated for each region with each data set. While these volumes have little relevance to the overall reservoir volume they do help identify where sedimentation is occurring. TIN models for each region where developed using both data sets and the total volume calculated for each TIN. The most noteworthy observation from this exercise was areas 1, 2, and 3 exhibited little or no change in volume while area 4 exhibited a significant difference in volume between the two data sets. This would indicate the predominant loss of reservoir capacity due to sediment is caused by deltaic accretion in area 4.

A contour map of Lake Granbury was developed by converting the TIN 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 5-ft intervals is presented in Figure 6. Finally, endpoint coordinates for 16 range lines can be found in Appendix I. These range lines were used in comparing the current TWDB 2003 TIN model and the 1993 revised TIN model. Differences between cross-

sections are partially due to the fact that the 2003 range lines do not exactly match the range lines driven in the 1993 survey. The range line plots are presented in Appendix J.

RESULTS

Results from the 2003 TWDB resurvey indicate Lake Granbury encompasses 7,945 surface acres and contains a total volume of 129,011 ac-ft at top of conservation pool elevation (693.0 ft). The length of the shoreline at the digitized elevation of 693.0 ft was calculated to be approximately 159 miles. The deepest point physically measured during the survey was at elevation 625.9 ft corresponding to a depth of 67.1 ft from TOC pool. This point was located approximately 1,500 ft upstream of De Cordova Bend Dam.

SUMMARY AND COMPARISONS

Water Rights Permit No. 2111 authorized the construction of De Cordova Bend Dam and creation of Lake Granbury. Construction commenced in December 15, 1966. Deliberate impoundment began September 15, 1969. Original design[4] information estimated the volume of the lake at the top of conservation pool elevation of 693.0 to be 153,500 ac-ft with surface area of 8,700 acres. Prior to this report, the most recent volumetric survey report on Lake Granbury was published by the TWDB in January 1994.

At TOC pool, the 2003 TWDB survey calculated 7,945 surface acres and reports a volume of 129,011 ac-ft. The capacity of the active pool (conservation storage) between elevations 693.0 ft and 206.0 ft is 128,803 ac-ft. The dead pool storage or that capacity of water below the invert of the lowest outlet (elevation 640.0 ft) was 965 ac-ft. The 1994 (report date) elevation-area-capacity table indicates that Lake Granbury had a volume of 136,823 ac-ft and a surface area of 8,310 acres at the TOC pool. Using a more recent and accurate boundary, the revised 1994 elevation-area-capacity table indicates

that Lake Granbury had a volume of 131,593 ac-ft and a surface area of 7,949 acres at the TOC pool.

The 2003 survey indicates the lake has experienced little or no reduction in surface area and a 2% reduction in total volume at the TOC pool when compared to the 1994 revised tables. A significant portion of this reduction appears to be at the entrance of the Brazos River into the main body of the lake where a delta continues to grow.

A comparative summary of the historical data and the results of the TWDB 2003 resurvey are presented in Table 2. Comparisons between initial volume calculations and the TWDB volumetric surveys are difficult and some apparent changes might simply be due to methodological differences[7]. It is recommended that a similar survey be performed in five to ten years or after major flood events to monitor changes to the lake's capacity.

Table 2. Area and Volume Comparisons of Lake Granbury

FEATURE	Original Design	TWDB Volumetric Survey	**TWDB Revised Survey**	TWDB Current Survey
Year	1969	1994	**1994**	2003
Area (acres)	8,700	8,310	**7,949**	7,945
Volume (ac-ft)	153,500	136,823	**131,593**	129,011

Notes:

1. Original design data was furnished by the Brazos River Authority
2. All results from top of conservation pool elevation 693.0 ft

REFERENCES

1. Texas Water Development Board, 1996, “Volumetric Survey of Lake Granbury”

2. United States Geological Survey, 2002, Water Data Report TX-02-3. “Water Resources Data Texas Water Year 2002”

3. United States Geological Survey. Surface Water for Texas. 2004. <http://waterdata.usgs.gov/tx/nwis/sw>.

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

5. Texas Water Commission, 1987, Certificate of Adjudication 12-5164

6. United States Department of Agriculture. 1983. Soil Conservation Service. National Engineering Handbook. Section 3, “Sedimentation”, Chapter 7, “Field Investigations and Surveys”

7. Blanton III, James O. Bureau of Reclamation. 1982. “Procedures for Monitoring Reservoir Sedimentation”

8. ESRI, Environmental Systems Research Institute, 1995. “ARC/INFO Surface Modeling and Display, TIN Users Guide.”

9. ESRI, Environmental Systems Research Institute, 2002. “What is ArcGIS”

10. Coastal Oceanographics, Inc. 2003. “HYPACK MAX Gold, v2.12A” <http://www.coastalo.com>.

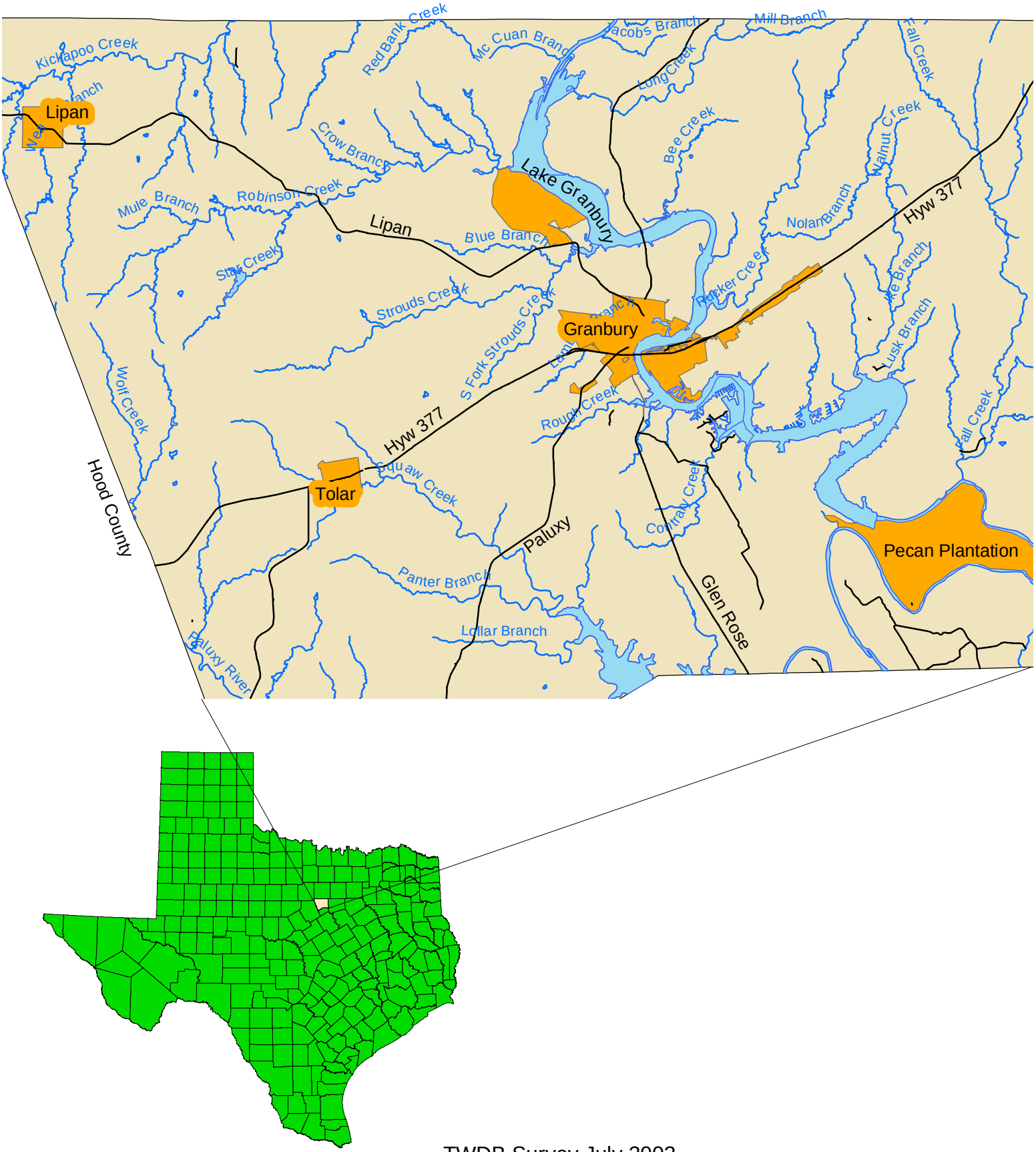
11. Odom Hydrographic Systems, Inc., 1999. “Digibar-Pro Profiling Sound Velocimeter Operation Manual”

12. Knudsen Engineering Limited, 2002. “320B Series Echosounder Hardware Manual”

Figure 1

LAKE GRANBURY

Location Map

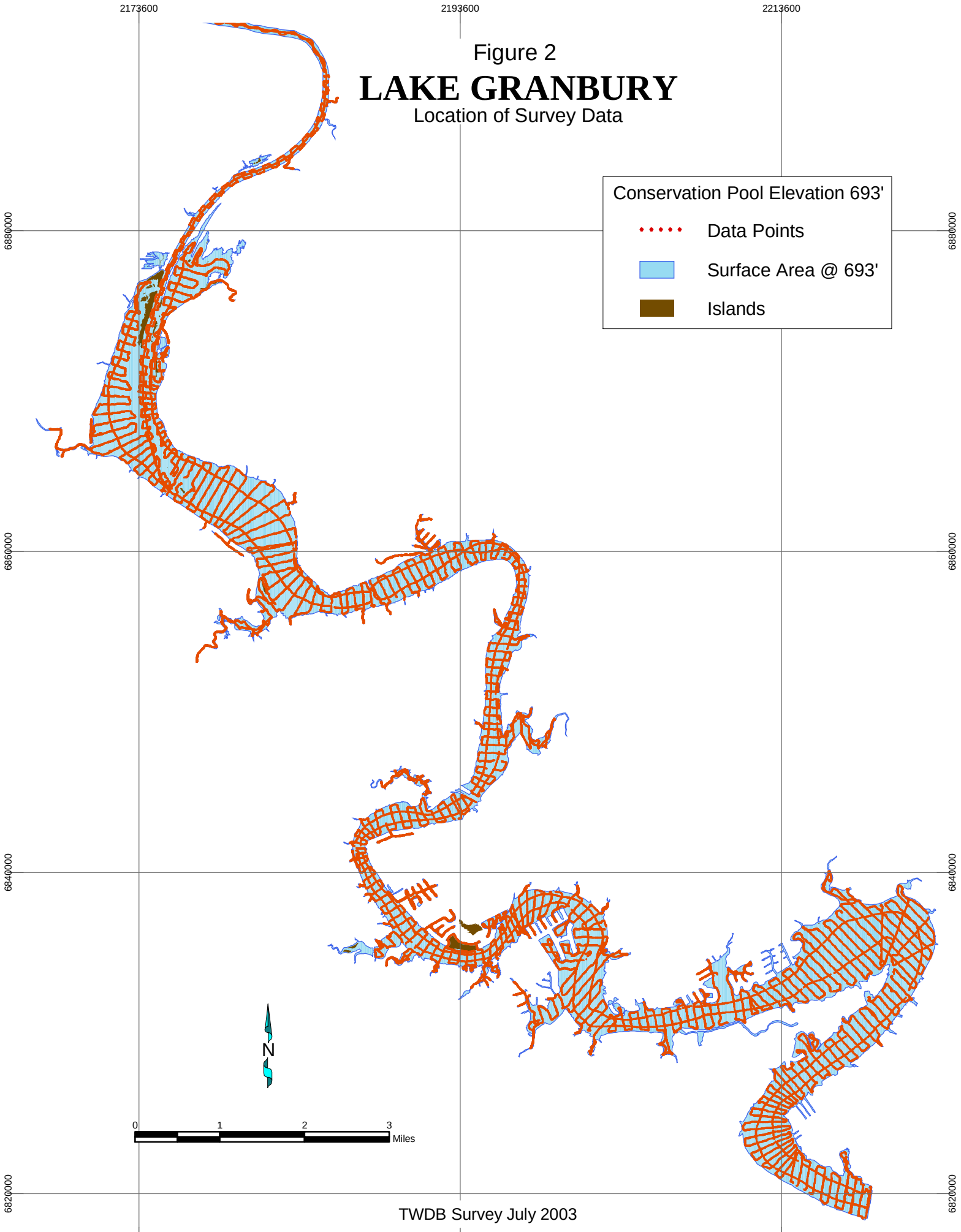


TWDB Survey July 2003

Figure 2

LAKE GRANBURY

Location of Survey Data

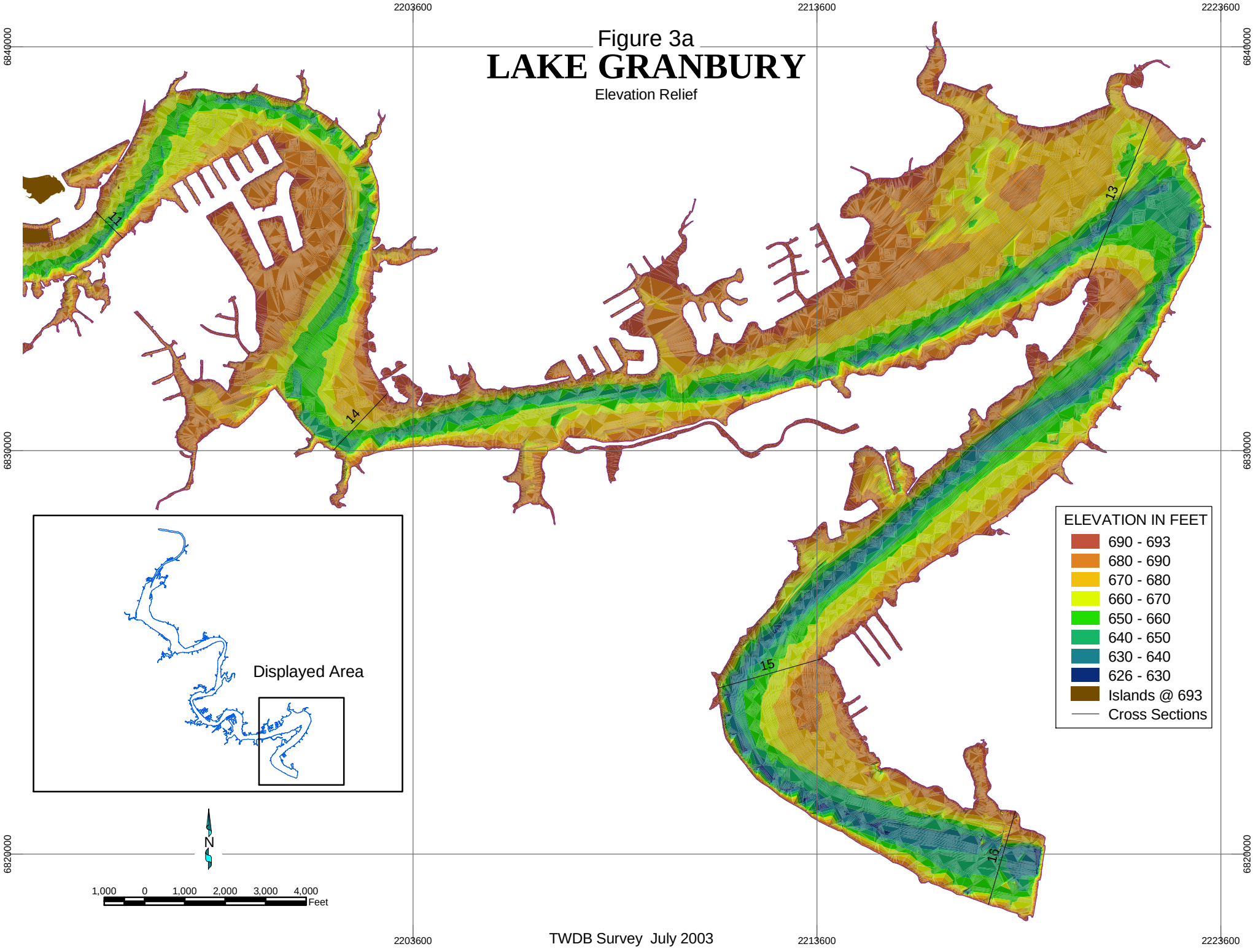


TWDB Survey July 2003

Figure 3a

LAKE GRANBURY

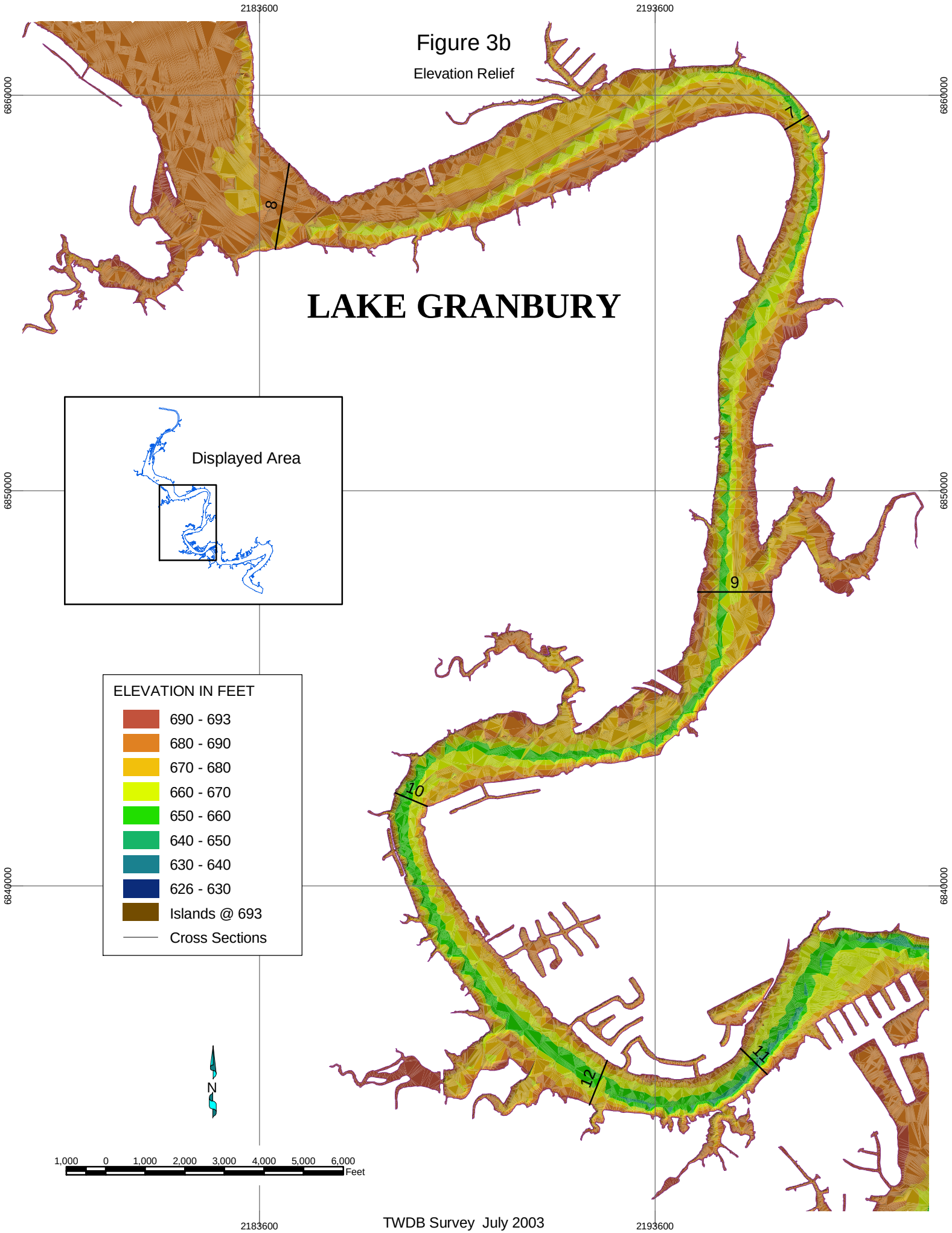
Elevation Relief



TWDB Survey July 2003

Figure 3b

Elevation Relief



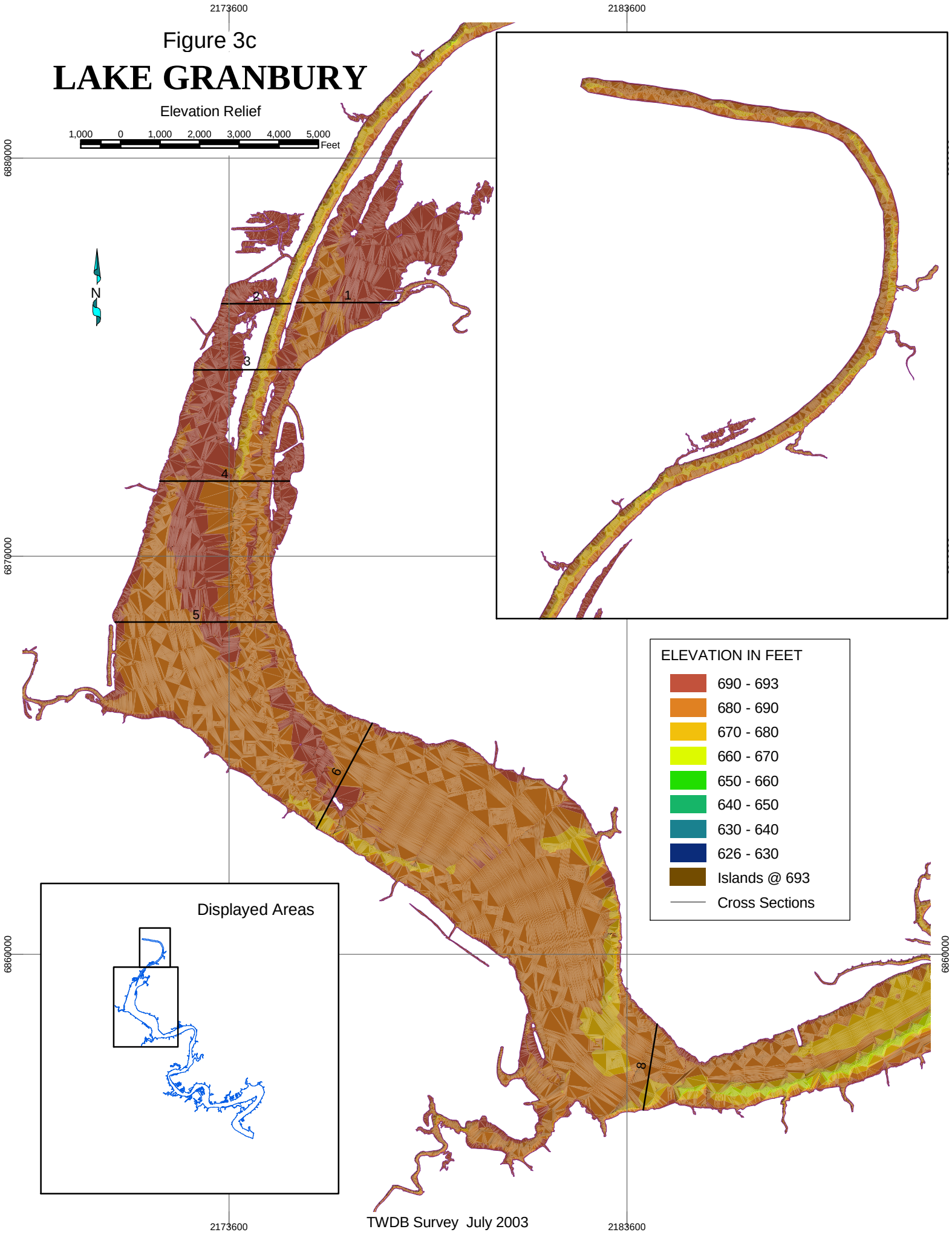
TWDB Survey July 2003

Figure 3c

LAKE GRANBURY

Elevation Relief

1,000 0 1,000 2,000 3,000 4,000 5,000 Feet

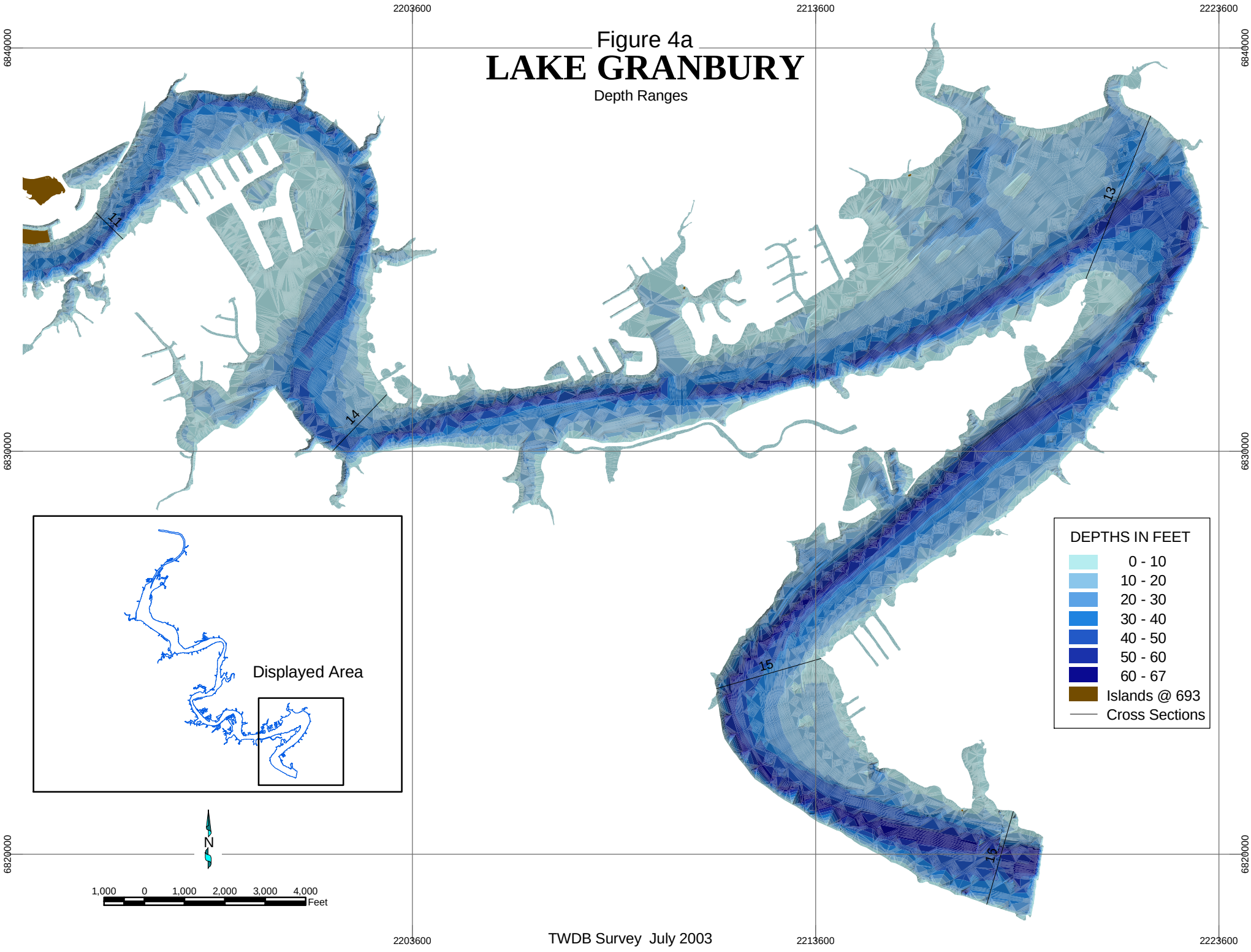


TWDB Survey July 2003

Figure 4a

LAKE GRANBURY

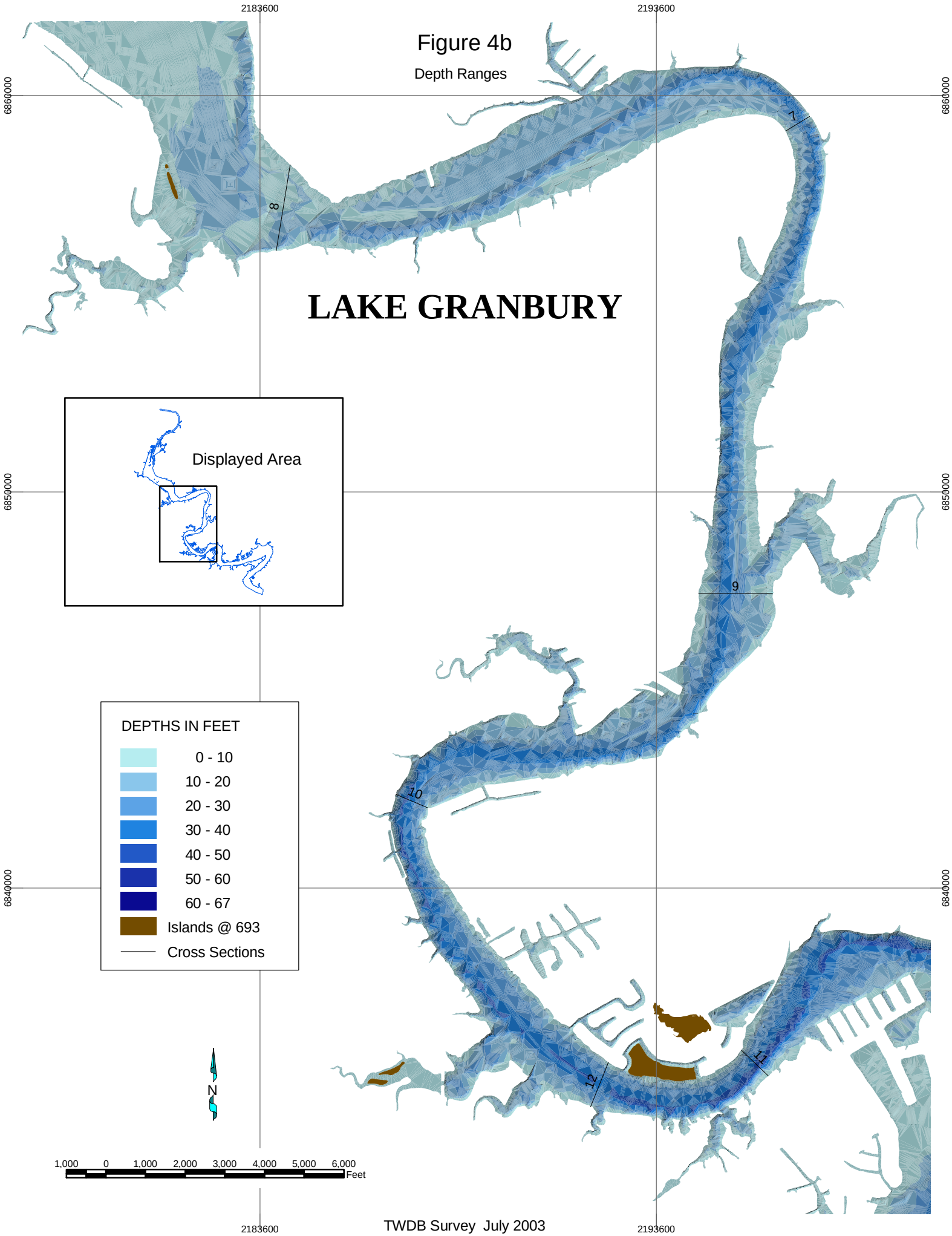
Depth Ranges



TWDB Survey July 2003

Figure 4b

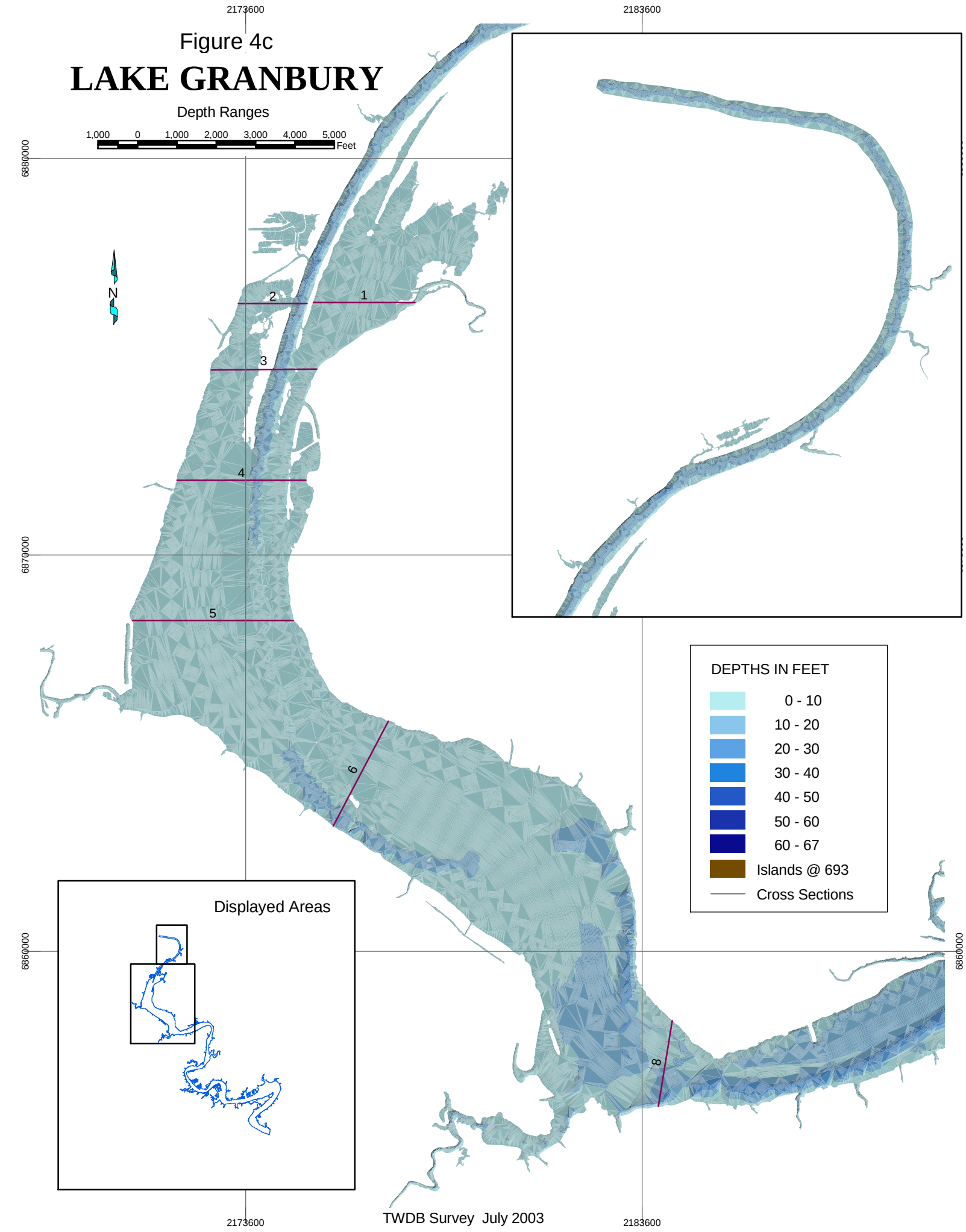
Depth Ranges



TWDB Survey July 2003

Figure 4c

LAKE GRANBURY

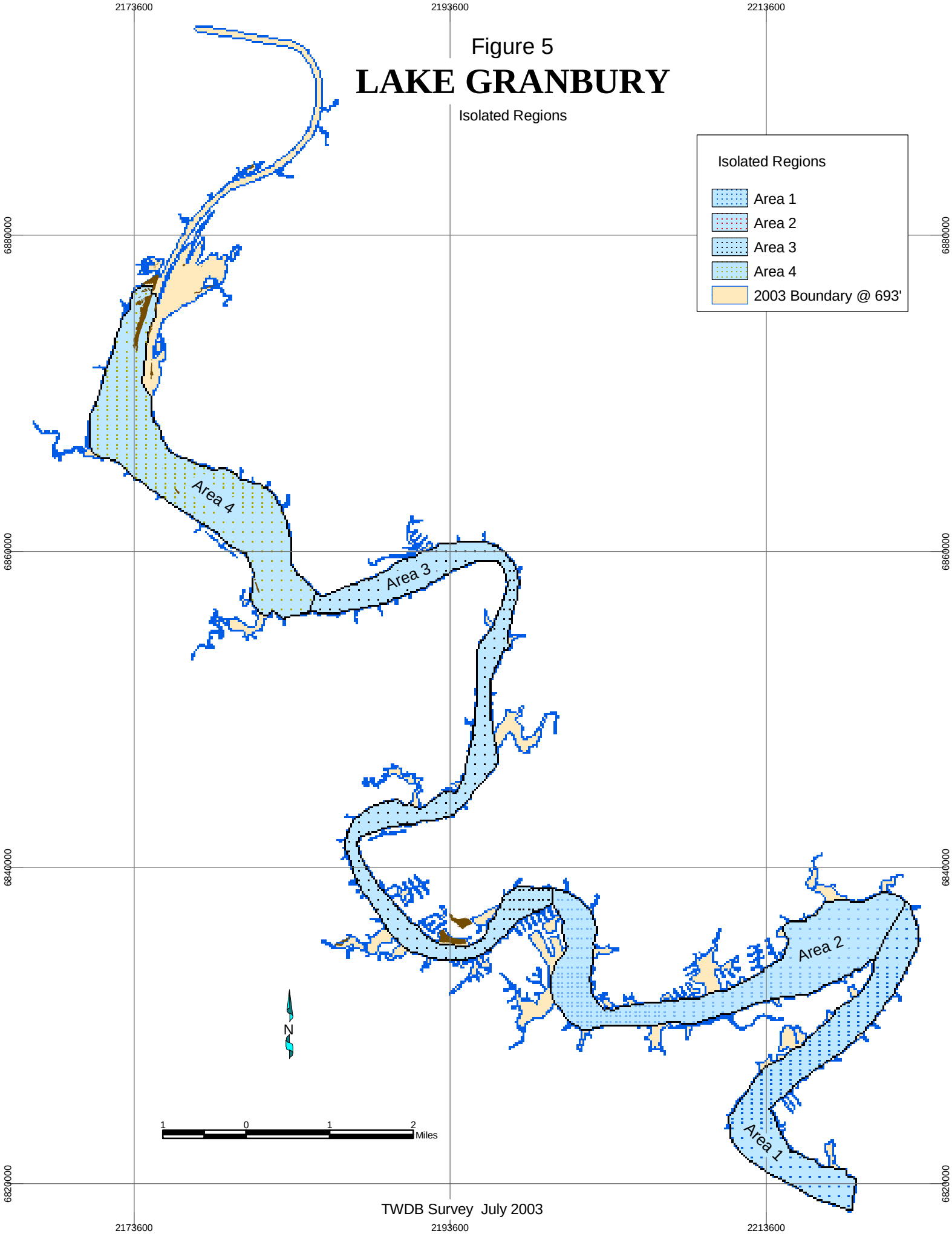


TWDB Survey July 2003

Figure 5

LAKE GRANBURY

Isolated Regions



TWDB Survey July 2003

Appendix A

Lake Granbury

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD — JULY 2003 SURVEY

Conservation Pool Elevation 693.0

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
625										0
626	0	0	0	0	0	0	0	0	0	0
627	0	0	0	0	0	0	0	0	0	0
628	0	0	0	0	1	1	1	1	1	1
629	2	2	2	2	3	3	4	4	4	5
630	6	6	7	8	9	10	11	13	15	17
631	19	22	25	27	30	33	37	40	43	47
632	50	54	58	62	66	70	75	79	84	89
633	94	99	104	110	116	122	128	134	140	147
634	154	161	169	176	184	192	200	208	217	225
635	234	243	253	262	272	282	292	303	313	324
636	335	346	358	369	381	393	405	417	430	443
637	456	469	482	496	510	524	538	553	568	583
638	599	615	631	647	664	681	698	715	733	751
639	769	788	807	826	845	864	884	904	924	945
640	965	986	1,007	1,029	1,051	1,073	1,095	1,118	1,141	1,164
641	1,187	1,211	1,235	1,259	1,284	1,309	1,334	1,359	1,385	1,411
642	1,437	1,464	1,490	1,517	1,545	1,572	1,600	1,628	1,656	1,685
643	1,714	1,743	1,772	1,802	1,831	1,862	1,892	1,923	1,954	1,985
644	2,017	2,049	2,081	2,114	2,147	2,180	2,214	2,248	2,282	2,317
645	2,352	2,387	2,423	2,459	2,496	2,533	2,571	2,609	2,647	2,686
646	2,725	2,765	2,805	2,846	2,887	2,928	2,970	3,013	3,056	3,099
647	3,143	3,188	3,233	3,278	3,324	3,371	3,417	3,465	3,512	3,560
648	3,609	3,658	3,707	3,757	3,807	3,858	3,909	3,960	4,012	4,065
649	4,117	4,171	4,224	4,278	4,333	4,388	4,443	4,499	4,555	4,612
650	4,669	4,726	4,785	4,843	4,902	4,962	5,022	5,082	5,144	5,205
651	5,268	5,330	5,394	5,458	5,522	5,587	5,653	5,719	5,785	5,852
652	5,920	5,988	6,057	6,127	6,197	6,267	6,339	6,411	6,483	6,557
653	6,631	6,705	6,781	6,857	6,933	7,010	7,088	7,167	7,246	7,326
654	7,406	7,488	7,569	7,652	7,735	7,819	7,903	7,988	8,073	8,159
655	8,246	8,334	8,422	8,510	8,599	8,689	8,779	8,870	8,962	9,054
656	9,147	9,240	9,334	9,428	9,524	9,619	9,716	9,813	9,911	10,009
657	10,108	10,208	10,308	10,409	10,511	10,613	10,717	10,820	10,925	11,030
658	11,136	11,243	11,351	11,459	11,568	11,677	11,788	11,899	12,011	12,124
659	12,237	12,352	12,467	12,583	12,699	12,817	12,935	13,055	13,175	13,296
660	13,417	13,540	13,663	13,787	13,912	14,038	14,165	14,293	14,421	14,551
661	14,681	14,812	14,944	15,077	15,211	15,345	15,480	15,617	15,754	15,892
662	16,030	16,170	16,310	16,452	16,594	16,737	16,881	17,025	17,171	17,317
663	17,464	17,613	17,762	17,911	18,062	18,213	18,366	18,519	18,673	18,828
664	18,984	19,140	19,298	19,456	19,616	19,776	19,937	20,100	20,263	20,427
665	20,592	20,757	20,924	21,092	21,260	21,430	21,600	21,772	21,944	22,117
666	22,291	22,467	22,643	22,820	22,998	23,177	23,356	23,537	23,719	23,901
667	24,085	24,269	24,454	24,641	24,828	25,016	25,205	25,395	25,585	25,777
668	25,970	26,163	26,358	26,553	26,749	26,947	27,145	27,344	27,544	27,745
669	27,947	28,150	28,354	28,559	28,765	28,972	29,180	29,389	29,599	29,810
670	30,022	30,235	30,449	30,664	30,880	31,098	31,316	31,536	31,756	31,978
671	32,201	32,425	32,650	32,876	33,103	33,332	33,561	33,792	34,024	34,257
672	34,491	34,726	34,962	35,200	35,439	35,679	35,920	36,163	36,406	36,651
673	36,898	37,146	37,395	37,645	37,897	38,150	38,405	38,661	38,918	39,176
674	39,436	39,698	39,961	40,225	40,491	40,758	41,026	41,297	41,568	41,841
675	42,115	42,391	42,668	42,947	43,227	43,508	43,791	44,075	44,361	44,648
676	44,936	45,226	45,518	45,810	46,105	46,401	46,699	46,999	47,300	47,603
677	47,908	48,214	48,523	48,833	49,144	49,458	49,773	50,090	50,409	50,730
678	51,053	51,378	51,706	52,035	52,368	52,702	53,039	53,377	53,718	54,062
679	54,407	54,755	55,105	55,457	55,811	56,167	56,526	56,887	57,249	57,614
680	57,981	58,350	58,721	59,094	59,469	59,846	60,226	60,607	60,990	61,376
681	61,763	62,152	62,543	62,936	63,331	63,728	64,127	64,528	64,930	65,335

Appendix A (continued)

Lake Granbury

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD — JULY 2003 SURVEY

Conservation Pool Elevation 693.0

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
682	65,741	66,150	66,560	66,973	67,388	67,805	68,224	68,646	69,070	69,496
683	69,925	70,355	70,788	71,223	71,660	72,100	72,541	72,985	73,431	73,880
684	74,331	74,784	75,239	75,697	76,157	76,619	77,083	77,550	78,020	78,492
685	78,967	79,444	79,925	80,408	80,895	81,384	81,877	82,374	82,873	83,377
686	83,883	84,393	84,906	85,422	85,942	86,464	86,990	87,519	88,051	88,586
687	89,125	89,668	90,216	90,767	91,324	91,884	92,449	93,019	93,592	94,170
688	94,752	95,338	95,928	96,521	97,118	97,719	98,322	98,930	99,540	100,155
689	100,773	101,395	102,022	102,652	103,288	103,928	104,573	105,222	105,875	106,532
690	107,195	107,863	108,536	109,214	109,900	110,595	111,299	112,008	112,720	113,435
691	114,151	114,871	115,593	116,318	117,045	117,775	118,507	119,242	119,978	120,718
692	121,460	122,204	122,951	123,700	124,452	125,206	125,962	126,721	127,482	128,246
693	129,011									

Appendix B

Lake Granbury

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD — OCTOBER 1993 SURVEY

REVISED

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
625										0
626	0	0	0	0	0	0	0	0	0	0
627	0	0	0	0	0	0	0	0	0	1
628	1	1	1	1	1	2	2	2	3	3
629	3	4	4	5	6	6	7	8	9	10
630	12	13	15	18	20	22	25	28	32	35
631	39	42	46	50	54	58	63	67	72	76
632	81	86	90	95	101	106	111	117	123	129
633	136	142	149	156	164	171	179	187	195	203
634	211	220	229	238	247	256	266	276	286	296
635	306	316	327	338	349	360	371	383	395	407
636	419	432	444	457	470	484	497	511	525	539
637	554	569	584	600	616	632	648	665	682	699
638	717	734	753	771	790	809	828	848	867	887
639	908	928	949	970	991	1,013	1,035	1,057	1,079	1,102
640	1,125	1,148	1,171	1,195	1,219	1,243	1,268	1,293	1,318	1,344
641	1,370	1,396	1,423	1,449	1,476	1,504	1,531	1,559	1,587	1,615
642	1,644	1,673	1,702	1,731	1,761	1,791	1,821	1,851	1,882	1,913
643	1,944	1,975	2,007	2,039	2,071	2,103	2,136	2,169	2,202	2,235
644	2,269	2,303	2,338	2,372	2,407	2,443	2,478	2,514	2,550	2,587
645	2,624	2,661	2,699	2,737	2,776	2,815	2,854	2,894	2,935	2,976
646	3,017	3,059	3,101	3,144	3,188	3,232	3,276	3,321	3,367	3,413
647	3,460	3,507	3,554	3,603	3,651	3,700	3,750	3,800	3,850	3,901
648	3,952	4,004	4,056	4,109	4,162	4,216	4,270	4,324	4,379	4,435
649	4,491	4,547	4,604	4,661	4,719	4,777	4,836	4,895	4,955	5,015
650	5,075	5,136	5,198	5,260	5,323	5,386	5,449	5,513	5,578	5,643
651	5,709	5,775	5,842	5,909	5,977	6,046	6,115	6,184	6,255	6,325
652	6,397	6,469	6,541	6,615	6,689	6,763	6,838	6,914	6,991	7,068
653	7,146	7,224	7,304	7,383	7,464	7,545	7,626	7,709	7,791	7,875
654	7,959	8,044	8,129	8,215	8,301	8,389	8,477	8,565	8,654	8,744
655	8,835	8,926	9,018	9,110	9,203	9,297	9,392	9,487	9,583	9,679
656	9,776	9,874	9,973	10,072	10,172	10,273	10,374	10,476	10,579	10,683
657	10,787	10,892	10,998	11,105	11,212	11,320	11,429	11,539	11,649	11,760
658	11,872	11,984	12,097	12,211	12,325	12,440	12,556	12,672	12,789	12,907
659	13,025	13,144	13,264	13,385	13,506	13,628	13,751	13,874	13,998	14,123
660	14,249	14,376	14,503	14,631	14,760	14,890	15,020	15,151	15,283	15,416
661	15,549	15,683	15,818	15,954	16,090	16,228	16,365	16,504	16,644	16,784
662	16,925	17,067	17,209	17,353	17,497	17,642	17,788	17,934	18,082	18,230
663	18,379	18,529	18,680	18,831	18,984	19,137	19,291	19,445	19,601	19,757
664	19,914	20,072	20,231	20,390	20,551	20,712	20,874	21,036	21,200	21,364
665	21,530	21,696	21,863	22,030	22,199	22,369	22,539	22,711	22,883	23,056
666	23,230	23,405	23,581	23,758	23,936	24,115	24,294	24,475	24,656	24,838
667	25,022	25,206	25,391	25,577	25,764	25,952	26,141	26,332	26,522	26,714
668	26,907	27,101	27,296	27,492	27,689	27,886	28,085	28,285	28,486	28,687
669	28,890	29,094	29,299	29,504	29,711	29,919	30,128	30,338	30,549	30,761
670	30,974	31,188	31,403	31,619	31,837	32,055	32,275	32,495	32,717	32,940
671	33,164	33,389	33,615	33,842	34,071	34,300	34,530	34,762	34,995	35,229
672	35,464	35,701	35,938	36,177	36,417	36,659	36,901	37,145	37,391	37,638
673	37,886	38,136	38,387	38,640	38,894	39,150	39,407	39,666	39,927	40,188
674	40,452	40,716	40,983	41,250	41,519	41,790	42,062	42,336	42,611	42,889
675	43,167	43,447	43,729	44,012	44,297	44,583	44,871	45,160	45,451	45,744
676	46,038	46,334	46,631	46,930	47,231	47,533	47,836	48,142	48,449	48,758
677	49,068	49,380	49,694	50,009	50,327	50,646	50,967	51,290	51,615	51,942
678	52,271	52,602	52,935	53,270	53,607	53,946	54,287	54,631	54,977	55,325
679	55,675	56,028	56,382	56,739	57,098	57,458	57,821	58,185	58,551	58,920
680	59,290	59,662	60,036	60,412	60,790	61,170	61,552	61,936	62,322	62,710
681	63,100	63,492	63,886	64,283	64,682	65,084	65,487	65,893	66,301	66,711

Appendix B (continued)

Lake Granbury

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD — OCTOBER 1993 SURVEY

REVISED

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
682	67,124	67,539	67,956	68,376	68,798	69,223	69,650	70,080	70,513	70,947
683	71,384	71,823	72,265	72,709	73,156	73,606	74,058	74,513	74,970	75,431
684	75,895	76,362	76,833	77,308	77,786	78,268	78,753	79,242	79,734	80,230
685	80,728	81,230	81,735	82,243	82,755	83,270	83,789	84,312	84,839	85,370
686	85,905	86,445	86,988	87,536	88,089	88,645	89,206	89,772	90,341	90,914
687	91,491	92,072	92,656	93,243	93,833	94,426	95,022	95,621	96,223	96,828
688	97,435	98,046	98,660	99,276	99,896	100,519	101,145	101,775	102,409	103,046
689	103,686	104,330	104,978	105,628	106,282	106,938	107,597	108,260	108,924	109,593
690	110,263	110,936	111,613	112,291	112,973	113,658	114,345	115,036	115,730	116,427
691	117,127	117,830	118,535	119,243	119,953	120,665	121,379	122,096	122,814	123,535
692	124,258	124,982	125,709	126,437	127,168	127,901	128,635	129,372	130,110	130,851
693	131,593									

Appendix C

Lake Granbury

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD — OCTOBER 1993 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
627	0	0	0	0	1					
628	1	1	1	1	1	2	2	2	3	3
629	3	4	4	5	6	6	7	8	9	10
630	12	14	16	18	20	23	26	29	32	35
631	39	43	47	51	55	59	63	68	72	77
632	82	87	92	97	102	107	113	119	125	131
633	138	144	151	159	166	174	181	189	197	206
634	214	223	232	241	251	260	270	280	290	300
635	310	321	332	343	354	365	377	389	401	413
636	425	438	451	464	477	491	505	519	533	547
637	562	577	593	609	625	641	657	674	692	709
638	727	745	763	782	801	820	840	860	880	900
639	920	941	962	984	1,005	1,027	1,049	1,071	1,094	1,117
640	1,140	1,163	1,187	1,211	1,235	1,260	1,285	1,310	1,336	1,362
641	1,388	1,414	1,441	1,468	1,495	1,523	1,551	1,579	1,607	1,636
642	1,665	1,694	1,723	1,753	1,783	1,813	1,844	1,874	1,905	1,936
643	1,968	2,000	2,032	2,064	2,096	2,129	2,162	2,195	2,229	2,263
644	2,296	2,342	2,365	2,410	2,433	2,479	2,502	2,548	2,571	2,617
645	2,663	2,686	2,732	2,778	2,801	2,847	2,893	2,938	2,961	3,007
646	3,053	3,099	3,145	3,191	3,214	3,260	3,306	3,352	3,398	3,444
647	3,489	3,535	3,604	3,650	3,696	3,742	3,788	3,834	3,903	3,949
648	3,994	4,040	4,109	4,155	4,201	4,270	4,316	4,362	4,431	4,477
649	4,545	4,591	4,660	4,706	4,775	4,821	4,890	4,936	5,005	5,073
650	5,119	5,188	5,257	5,303	5,372	5,441	5,510	5,556	5,624	5,693
651	5,762	5,831	5,900	5,969	6,038	6,107	6,175	6,244	6,313	6,382
652	6,451	6,520	6,612	6,680	6,749	6,818	6,910	6,979	7,048	7,140
653	7,208	7,300	7,369	7,461	7,530	7,622	7,691	7,782	7,851	7,943
654	8,035	8,104	8,196	8,287	8,379	8,471	8,540	8,632	8,724	8,815
655	8,907	8,999	9,091	9,183	9,275	9,366	9,481	9,573	9,665	9,757
656	9,848	10,055	10,078	10,147	10,262	10,354	10,468	10,560	10,675	10,767
657	10,882	10,973	11,088	11,203	11,318	11,410	11,524	11,639	11,754	11,869
658	11,983	12,098	12,190	12,305	12,443	12,557	12,672	12,787	12,902	13,017
659	13,131	13,269	13,384	13,499	13,636	13,751	13,866	14,004	14,118	14,256
660	14,371	14,509	14,646	14,761	14,899	15,037	15,152	15,289	15,427	15,565
661	15,702	15,840	15,978	16,116	16,253	16,391	16,529	16,667	16,804	16,942
662	17,103	17,241	17,378	17,516	17,677	17,815	17,975	18,113	18,274	18,411
663	18,572	18,710	18,871	19,031	19,192	19,330	19,490	19,651	19,812	19,972
664	20,133	20,294	20,455	20,615	20,776	20,937	21,097	21,258	21,442	21,602
665	21,763	21,924	22,107	22,268	22,452	22,612	22,796	22,957	23,186	23,416
666	23,416	23,646	23,875	24,105	24,105	24,334	24,564	24,793	25,023	25,023
667	25,253	25,482	25,712	25,941	26,171	26,171	26,400	26,630	26,860	27,089
668	27,319	27,319	27,548	27,778	28,007	28,237	28,466	28,696	28,926	28,926
669	29,155	29,385	29,614	29,844	30,073	30,303	30,533	30,762	30,992	31,221
670	31,451	31,680	31,910	32,140	32,140	32,369	32,599	32,828	33,058	33,287
671	33,517	33,747	33,976	34,206	34,435	34,665	34,894	35,124	35,583	35,813
672	36,042	36,272	36,501	36,731	36,961	37,190	37,420	37,649	37,879	38,108
673	38,338	38,797	39,027	39,256	39,486	39,715	39,945	40,174	40,634	40,863
674	41,093	41,322	41,552	41,781	42,241	42,470	42,700	42,929	43,388	43,618
675	43,848	44,077	44,536	44,766	44,995	45,225	45,684	45,914	46,143	46,602
676	46,832	47,062	47,521	47,750	47,980	48,439	48,669	48,898	49,357	49,587
677	50,046	50,275	50,505	50,964	51,194	51,653	51,882	52,342	52,571	53,030
678	53,260	53,719	53,949	54,408	54,637	55,096	55,326	55,785	56,015	56,474
679	56,933	57,163	57,622	57,851	58,310	58,770	58,999	59,458	59,917	60,147
680	60,606	61,065	61,524	61,754	62,213	62,672	62,902	63,361	63,820	64,279
681	64,738	64,968	65,427	65,886	66,345	66,804	67,034	67,493	67,952	68,411
682	68,871	69,330	69,789	70,248	70,707	71,166	71,625	72,084	72,314	72,773
683	73,232	73,691	74,151	74,839	75,298	75,758	76,217	76,676	77,135	77,594

Appendix C (continued)

Lake Granbury

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD OCTOBER 1993 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
684	78,053	78,512	78,972	79,660	80,119	80,579	81,038	81,497	82,185	82,645
685	83,104	83,563	84,252	84,711	85,170	85,859	86,318	87,006	87,466	87,925
686	88,613	89,073	89,761	90,220	90,909	91,368	92,057	92,746	93,205	93,893
687	94,353	95,041	95,730	96,189	96,878	97,567	98,026	98,714	99,403	100,092
688	100,781	101,240	101,928	102,617	103,306	103,994	104,454	105,142	105,831	106,520
689	107,208	107,897	108,586	109,275	109,963	110,652	111,341	112,029	112,718	113,407
690	114,096	114,784	115,473	116,391	117,080	117,769	118,457	119,146	119,835	120,753
691	121,442	122,130	122,819	123,508	124,426	125,115	125,803	126,722	127,410	128,099
692	129,017	129,706	130,624	131,313	132,002	132,920	133,609	134,527	135,216	136,134
693	136,823									

Appendix D

Lake Granbury

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — JULY 2003 SURVEY

Conservation Pool Elevation 693.0

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
625										0
626	0	0	0	0	0	0	0	0	0	0
627	0	0	0	0	0	0	0	0	0	0
628	1	1	1	1	1	1	2	2	2	2
629	2	3	3	3	4	4	4	5	5	6
630	6	7	8	9	10	12	15	17	20	23
631	25	26	28	29	30	31	32	33	34	36
632	37	38	39	40	42	43	45	46	48	50
633	52	53	55	57	58	60	62	64	66	68
634	70	72	74	76	78	80	82	84	86	88
635	90	92	94	96	99	101	103	105	107	109
636	111	113	115	117	119	121	123	125	127	129
637	131	133	135	138	140	143	146	148	151	154
638	157	160	162	165	168	171	173	176	178	181
639	184	186	188	191	193	196	198	201	203	205
640	208	211	213	216	219	222	225	228	231	234
641	236	239	242	245	247	250	253	255	258	261
642	263	266	268	271	274	276	279	281	284	287
643	289	292	295	297	300	303	306	309	312	315
644	318	321	324	328	331	334	338	341	345	349
645	353	357	361	365	369	374	378	382	386	391
646	395	399	404	408	413	418	423	428	433	438
647	443	448	452	457	461	466	470	474	479	483
648	487	491	496	500	504	509	513	517	521	526
649	530	534	538	543	547	551	556	560	564	569
650	574	578	583	588	593	598	604	609	615	620
651	625	631	636	641	647	652	658	663	669	674
652	680	686	692	698	704	710	717	724	730	736
653	743	750	756	763	769	776	782	789	795	802
654	808	815	821	827	834	840	846	852	859	865
655	871	877	883	888	894	900	906	912	918	924
656	930	936	943	949	955	962	968	975	981	987
657	994	1,000	1,007	1,014	1,021	1,028	1,035	1,042	1,049	1,057
658	1,064	1,071	1,078	1,086	1,093	1,101	1,108	1,116	1,124	1,131
659	1,139	1,147	1,155	1,163	1,172	1,180	1,188	1,196	1,204	1,213
660	1,221	1,230	1,238	1,247	1,256	1,264	1,273	1,281	1,290	1,298
661	1,307	1,315	1,324	1,332	1,340	1,349	1,358	1,366	1,375	1,384
662	1,392	1,400	1,409	1,417	1,425	1,434	1,443	1,451	1,460	1,468
663	1,477	1,485	1,494	1,502	1,510	1,519	1,527	1,536	1,545	1,553
664	1,563	1,572	1,581	1,590	1,599	1,608	1,617	1,626	1,635	1,644
665	1,654	1,662	1,671	1,680	1,690	1,699	1,709	1,719	1,728	1,738
666	1,747	1,757	1,766	1,775	1,784	1,793	1,803	1,812	1,821	1,830
667	1,839	1,848	1,858	1,867	1,876	1,885	1,894	1,903	1,912	1,922
668	1,931	1,940	1,949	1,958	1,968	1,977	1,987	1,996	2,006	2,016
669	2,025	2,035	2,045	2,054	2,064	2,074	2,084	2,094	2,105	2,115
670	2,125	2,136	2,147	2,157	2,168	2,179	2,190	2,201	2,212	2,223
671	2,234	2,245	2,256	2,267	2,278	2,290	2,301	2,312	2,323	2,335
672	2,346	2,358	2,370	2,382	2,394	2,407	2,419	2,432	2,445	2,458
673	2,471	2,484	2,498	2,511	2,525	2,538	2,552	2,566	2,580	2,594
674	2,608	2,622	2,636	2,650	2,664	2,679	2,693	2,708	2,722	2,737
675	2,751	2,765	2,779	2,793	2,806	2,820	2,834	2,848	2,863	2,877
676	2,892	2,907	2,922	2,937	2,953	2,970	2,988	3,005	3,022	3,039
677	3,057	3,074	3,091	3,109	3,126	3,144	3,161	3,180	3,199	3,219
678	3,241	3,264	3,286	3,309	3,333	3,355	3,377	3,399	3,422	3,444
679	3,466	3,487	3,509	3,531	3,554	3,575	3,597	3,617	3,638	3,659
680	3,679	3,699	3,720	3,741	3,762	3,782	3,803	3,823	3,843	3,862
681	3,882	3,902	3,921	3,941	3,960	3,979	3,998	4,017	4,036	4,055

Appendix D (continued)

Lake Granbury

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — JULY 2003 SURVEY

Conservation Pool Elevation 693.0

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
682	4,074	4,094	4,114	4,136	4,161	4,185	4,207	4,228	4,249	4,272
683	4,296	4,318	4,340	4,361	4,382	4,404	4,427	4,449	4,474	4,498
684	4,520	4,542	4,565	4,587	4,610	4,633	4,658	4,684	4,710	4,735
685	4,761	4,789	4,818	4,849	4,880	4,913	4,946	4,981	5,016	5,050
686	5,082	5,114	5,147	5,179	5,210	5,241	5,272	5,303	5,336	5,372
687	5,411	5,450	5,493	5,541	5,586	5,629	5,672	5,715	5,757	5,799
688	5,840	5,881	5,917	5,951	5,986	6,020	6,055	6,091	6,128	6,164
689	6,201	6,241	6,283	6,328	6,379	6,430	6,470	6,508	6,551	6,600
690	6,656	6,699	6,742	6,785	6,828	6,871	6,914	6,957	7,000	7,043
691	7,086	7,129	7,171	7,214	7,257	7,300	7,343	7,386	7,429	7,472
692	7,515	7,558	7,601	7,644	7,687	7,730	7,773	7,816	7,859	7,902
693	7,945									

Appendix E

Lake Granbury

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — OCTOBER 1993 SURVEY

REVISED

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
625										0
626	0	0	0	0	0	0	0	0	0	0
627	0	0	0	0	0	1	1	1	1	1
628	1	1	2	2	2	3	3	3	4	4
629	5	5	6	6	7	8	9	10	11	13
630	16	18	20	22	25	27	29	31	33	35
631	37	38	39	40	41	42	43	44	45	46
632	47	48	50	51	52	54	56	58	61	63
633	65	68	70	72	73	75	77	80	82	83
634	85	87	89	91	93	95	96	98	100	102
635	104	105	107	109	111	113	115	117	119	122
636	124	126	128	130	132	135	137	140	142	145
637	148	151	153	156	159	162	166	169	171	174
638	177	180	183	186	189	191	194	197	199	202
639	204	207	209	212	214	217	219	222	225	227
640	230	233	236	239	242	245	249	252	255	258
641	260	263	266	269	271	274	277	279	282	284
642	287	290	292	295	297	300	302	305	307	310
643	312	315	318	320	323	325	328	331	333	336
644	339	342	345	348	352	355	358	361	364	368
645	372	375	379	383	388	392	397	402	407	412
646	417	422	427	432	437	443	448	453	459	464
647	469	474	479	484	488	493	497	502	506	511
648	516	520	525	529	534	538	543	548	552	557
649	561	566	571	575	580	585	589	594	599	603
650	608	613	618	623	628	633	638	644	649	655
651	660	666	671	677	682	688	693	699	705	711
652	717	724	730	736	743	749	756	762	769	775
653	781	788	794	801	807	813	819	826	832	838
654	844	850	856	863	869	875	882	888	895	902
655	909	915	922	929	935	942	948	955	962	968
656	975	982	989	995	1,003	1,010	1,017	1,025	1,032	1,040
657	1,048	1,056	1,063	1,071	1,078	1,086	1,092	1,099	1,106	1,113
658	1,119	1,126	1,133	1,140	1,146	1,153	1,160	1,167	1,174	1,181
659	1,188	1,195	1,202	1,209	1,216	1,224	1,231	1,239	1,246	1,254
660	1,262	1,269	1,277	1,285	1,293	1,300	1,308	1,315	1,323	1,330
661	1,338	1,345	1,353	1,360	1,368	1,375	1,383	1,391	1,398	1,406
662	1,414	1,422	1,430	1,438	1,446	1,454	1,463	1,471	1,479	1,487
663	1,495	1,503	1,511	1,519	1,527	1,535	1,543	1,551	1,559	1,567
664	1,575	1,583	1,591	1,599	1,607	1,615	1,623	1,631	1,640	1,648
665	1,657	1,665	1,674	1,683	1,691	1,701	1,710	1,719	1,728	1,737
666	1,746	1,755	1,764	1,773	1,782	1,791	1,800	1,809	1,819	1,828
667	1,838	1,848	1,857	1,866	1,876	1,885	1,895	1,905	1,914	1,924
668	1,934	1,944	1,953	1,963	1,973	1,983	1,993	2,002	2,012	2,022
669	2,032	2,042	2,052	2,063	2,073	2,083	2,093	2,104	2,114	2,125
670	2,136	2,147	2,157	2,168	2,179	2,190	2,201	2,212	2,223	2,234
671	2,245	2,256	2,267	2,278	2,289	2,300	2,312	2,323	2,335	2,346
672	2,358	2,370	2,382	2,394	2,407	2,420	2,434	2,448	2,462	2,476
673	2,490	2,505	2,521	2,536	2,551	2,566	2,581	2,596	2,610	2,625
674	2,640	2,655	2,669	2,684	2,699	2,714	2,730	2,746	2,762	2,778
675	2,794	2,809	2,825	2,840	2,855	2,871	2,886	2,902	2,917	2,934
676	2,950	2,966	2,982	2,997	3,013	3,029	3,045	3,062	3,078	3,095
677	3,112	3,130	3,147	3,165	3,184	3,202	3,221	3,240	3,260	3,279
678	3,299	3,319	3,339	3,359	3,380	3,401	3,424	3,447	3,470	3,493
679	3,515	3,536	3,556	3,576	3,596	3,615	3,635	3,654	3,673	3,693
680	3,712	3,731	3,750	3,769	3,789	3,808	3,828	3,849	3,869	3,890
681	3,912	3,934	3,957	3,980	4,002	4,025	4,047	4,069	4,091	4,114

Appendix E (continued)

Lake Granbury

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — OCTOBER 1993 SURVEY

REVISED

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
682	4,137	4,161	4,186	4,211	4,236	4,262	4,287	4,311	4,335	4,357
683	4,380	4,404	4,431	4,456	4,481	4,507	4,534	4,562	4,591	4,622
684	4,656	4,692	4,728	4,763	4,800	4,836	4,871	4,906	4,939	4,971
685	5,002	5,034	5,067	5,100	5,134	5,171	5,209	5,249	5,289	5,332
686	5,375	5,416	5,457	5,500	5,546	5,590	5,632	5,672	5,712	5,754
687	5,791	5,824	5,855	5,886	5,916	5,945	5,974	6,003	6,033	6,063
688	6,091	6,121	6,150	6,181	6,213	6,247	6,282	6,317	6,352	6,389
689	6,426	6,456	6,488	6,519	6,550	6,579	6,608	6,636	6,665	6,692
690	6,720	6,761	6,802	6,843	6,884	6,925	6,966	7,007	7,048	7,089
691	7,130	7,171	7,212	7,253	7,294	7,335	7,376	7,416	7,457	7,498
692	7,539	7,580	7,621	7,662	7,703	7,744	7,785	7,826	7,867	7,908
693	7,949									

Appendix F

Lake Granbury

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — OCTOBER 1993 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
627	1	1	1	1	1					
628	1	1	2	2	2	3	3	3	4	4
629	5	5	6	6	7	8	9	10	11	14
630	16	18	20	23	25	27	30	32	34	36
631	37	38	40	41	42	43	44	45	46	47
632	48	49	50	52	53	55	57	59	62	64
633	67	69	71	73	75	77	79	81	83	85
634	87	89	91	93	94	96	98	100	101	103
635	105	107	109	111	113	115	116	119	121	123
636	126	128	130	132	134	136	139	142	144	147
637	150	153	156	158	161	165	168	171	174	177
638	179	182	185	188	191	194	196	199	202	204
639	207	209	212	214	217	219	222	224	227	230
640	233	235	239	242	245	248	251	255	257	260
641	263	266	269	272	274	277	280	282	285	288
642	290	293	295	298	300	303	306	308	311	313
643	316	318	321	323	326	329	331	334	337	340
644	343	346	349	352	355	358	361	365	368	371
645	375	379	383	387	391	396	400	405	410	415
646	420	425	430	436	441	446	452	457	462	468
647	473	478	483	487	492	497	501	506	510	515
648	520	524	529	533	538	543	547	552	556	561
649	565	570	575	580	584	589	594	598	603	608
650	612	617	622	627	632	637	643	648	654	659
651	665	670	676	681	687	693	698	704	710	716
652	722	728	735	741	748	754	761	767	774	780
653	786	793	799	806	812	819	825	831	837	843
654	849	856	862	868	875	881	888	894	901	908
655	915	922	928	935	942	948	955	962	969	975
656	982	989	996	1,003	1,011	1,018	1,026	1,034	1,041	1,049
657	1,058	1,066	1,074	1,082	1,089	1,097	1,104	1,111	1,118	1,125
658	1,132	1,139	1,146	1,153	1,160	1,167	1,174	1,181	1,188	1,195
659	1,202	1,209	1,217	1,224	1,232	1,239	1,247	1,255	1,262	1,270
660	1,278	1,286	1,294	1,302	1,310	1,318	1,326	1,333	1,341	1,349
661	1,356	1,364	1,372	1,379	1,387	1,395	1,403	1,411	1,418	1,426
662	1,434	1,443	1,451	1,459	1,467	1,475	1,484	1,492	1,500	1,509
663	1,517	1,525	1,533	1,542	1,550	1,558	1,566	1,574	1,582	1,591
664	1,599	1,607	1,615	1,623	1,632	1,640	1,648	1,657	1,665	1,674
665	1,683	1,691	1,700	1,709	1,718	1,728	1,737	1,746	1,755	1,764
666	1,774	1,783	1,792	1,801	1,810	1,820	1,829	1,839	1,849	1,858
667	1,868	1,878	1,888	1,897	1,907	1,916	1,926	1,936	1,946	1,956
668	1,966	1,976	1,986	1,996	2,006	2,016	2,026	2,036	2,046	2,057
669	2,067	2,077	2,088	2,099	2,109	2,120	2,131	2,142	2,154	2,165
670	2,176	2,188	2,199	2,211	2,222	2,234	2,246	2,258	2,270	2,281
671	2,293	2,296	2,319	2,319	2,342	2,342	2,365	2,388	2,388	2,410
672	2,410	2,433	2,433	2,456	2,456	2,479	2,502	2,502	2,525	2,548
673	2,548	2,571	2,594	2,594	2,617	2,640	2,640	2,663	2,686	2,686
674	2,709	2,732	2,755	2,755	2,778	2,801	2,801	2,824	2,847	2,870
675	2,870	2,893	2,916	2,938	2,938	2,961	2,984	2,984	3,007	3,030
676	3,053	3,076	3,076	3,099	3,122	3,145	3,145	3,168	3,191	3,214
677	3,237	3,260	3,260	3,283	3,306	3,329	3,352	3,375	3,398	3,421
678	3,444	3,466	3,489	3,512	3,535	3,558	3,581	3,604	3,627	3,650
679	3,673	3,696	3,719	3,742	3,765	3,788	3,811	3,834	3,857	3,880
680	3,903	3,926	3,926	3,949	3,972	3,994	4,017	4,040	4,063	4,086
681	4,109	4,132	4,155	4,178	4,201	4,224	4,247	4,270	4,293	4,316
682	4,339	4,362	4,385	4,431	4,454	4,477	4,500	4,523	4,545	4,568
683	4,591	4,614	4,660	4,683	4,706	4,729	4,752	4,798	4,821	4,844

Appendix F (continued)

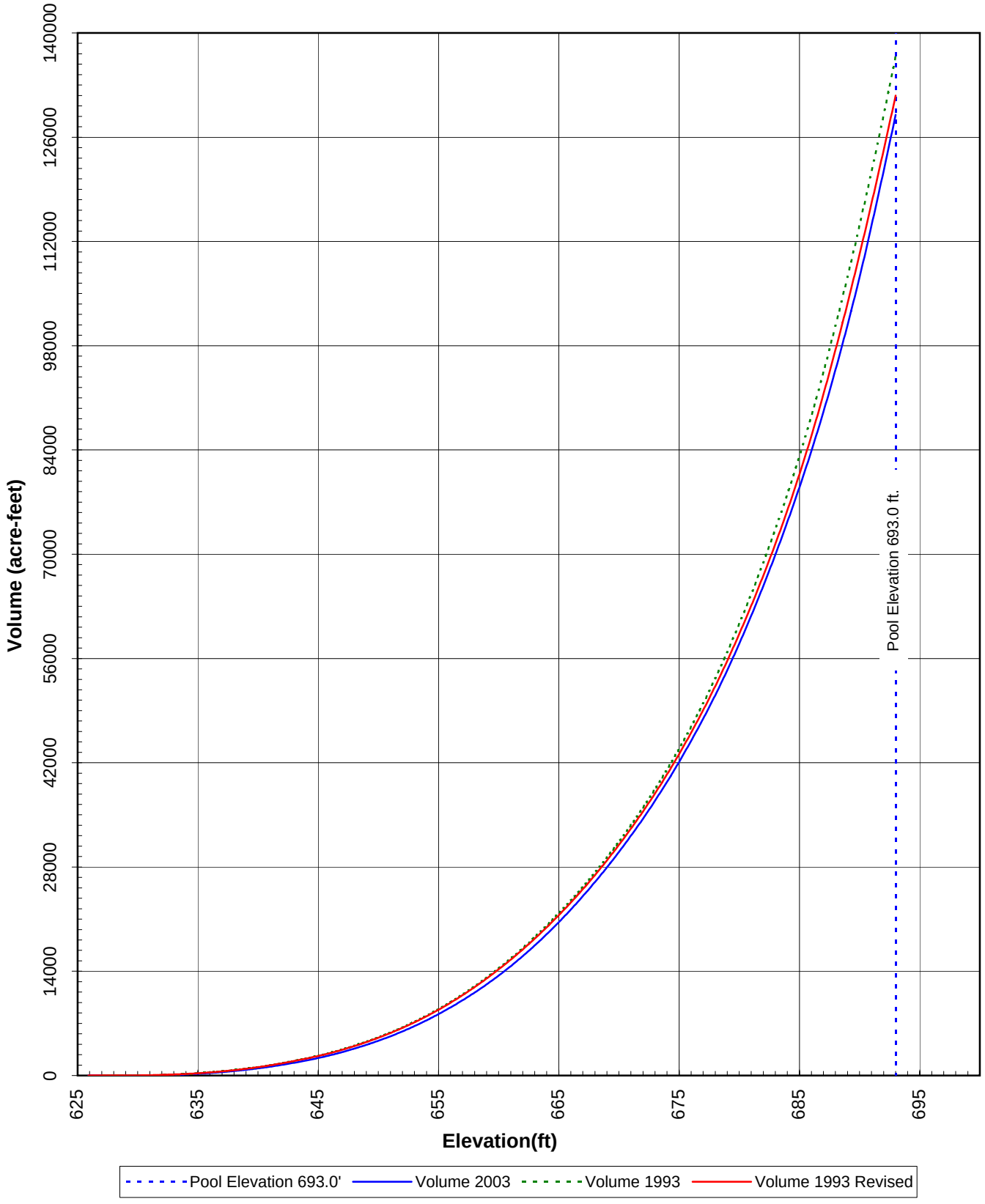
Lake Granbury

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — OCTOBER 1993 SURVEY

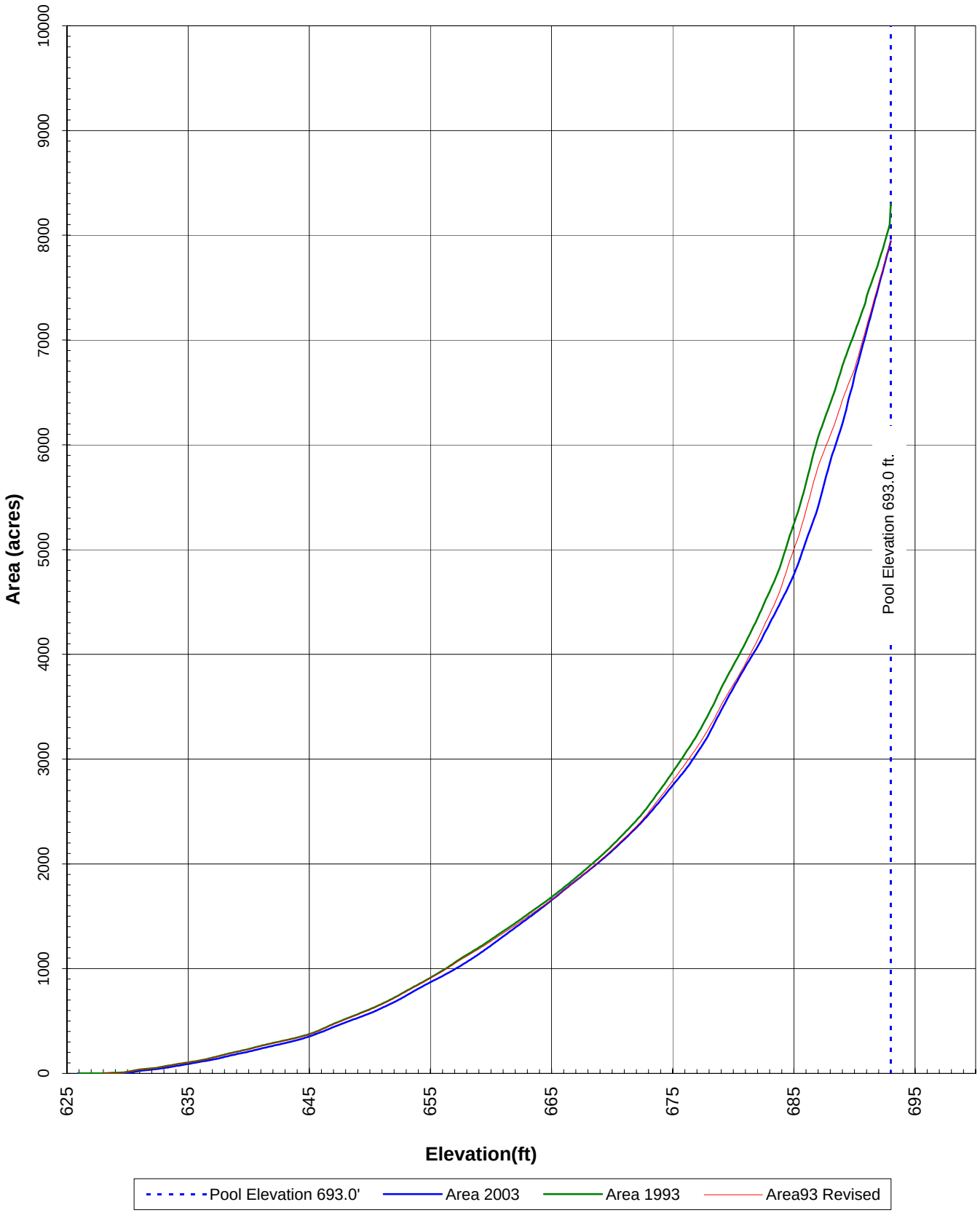
AREA IN ACRES — ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION IN FEET	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
684	4,890	4,936	4,959	5,005	5,028	5,073	5,119	5,142	5,188	5,211
685	5,257	5,280	5,303	5,349	5,395	5,418	5,464	5,510	5,556	5,601
686	5,647	5,670	5,716	5,762	5,808	5,854	5,900	5,946	5,992	6,038
687	6,061	6,107	6,129	6,175	6,198	6,244	6,267	6,290	6,336	6,359
688	6,405	6,428	6,451	6,497	6,520	6,566	6,612	6,635	6,680	6,703
689	6,749	6,795	6,818	6,841	6,887	6,910	6,956	6,979	7,002	7,025
690	7,071	7,094	7,140	7,163	7,185	7,231	7,254	7,300	7,323	7,369
691	7,415	7,438	7,484	7,507	7,553	7,576	7,622	7,645	7,668	7,714
692	7,736	7,782	7,828	7,851	7,897	7,943	7,966	8,012	8,058	8,104
693	8,310									



Lake Granbury
July 2003
Prepared by: TWDB

Appendix G Elevation vs. Volume



Lake Granbury
July 2003
Prepared by: TWDB

Appendix I

Lake Granbury

TEXAS WATER DEVELOPMENT BOARD JULY 2003 SURVEY

Range Line Endpoints

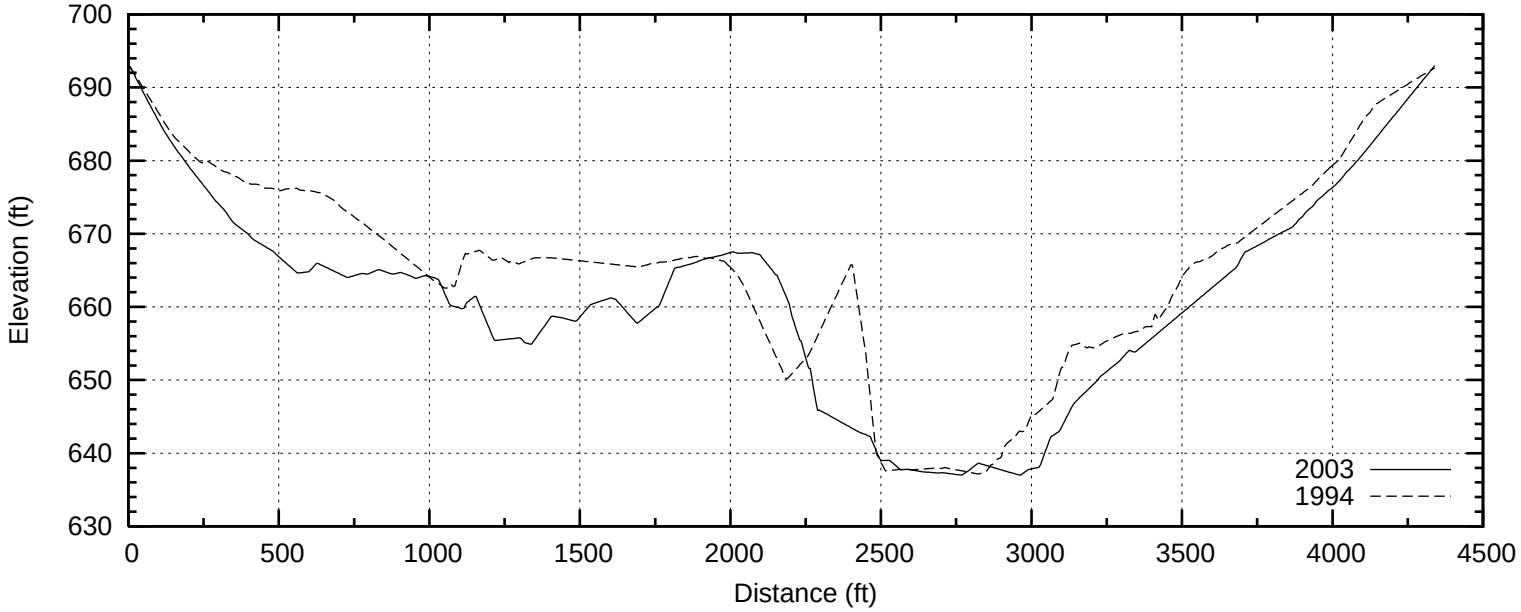
State Plane NAD83 Units-feet

L-Left endpoint
R-right endpoint

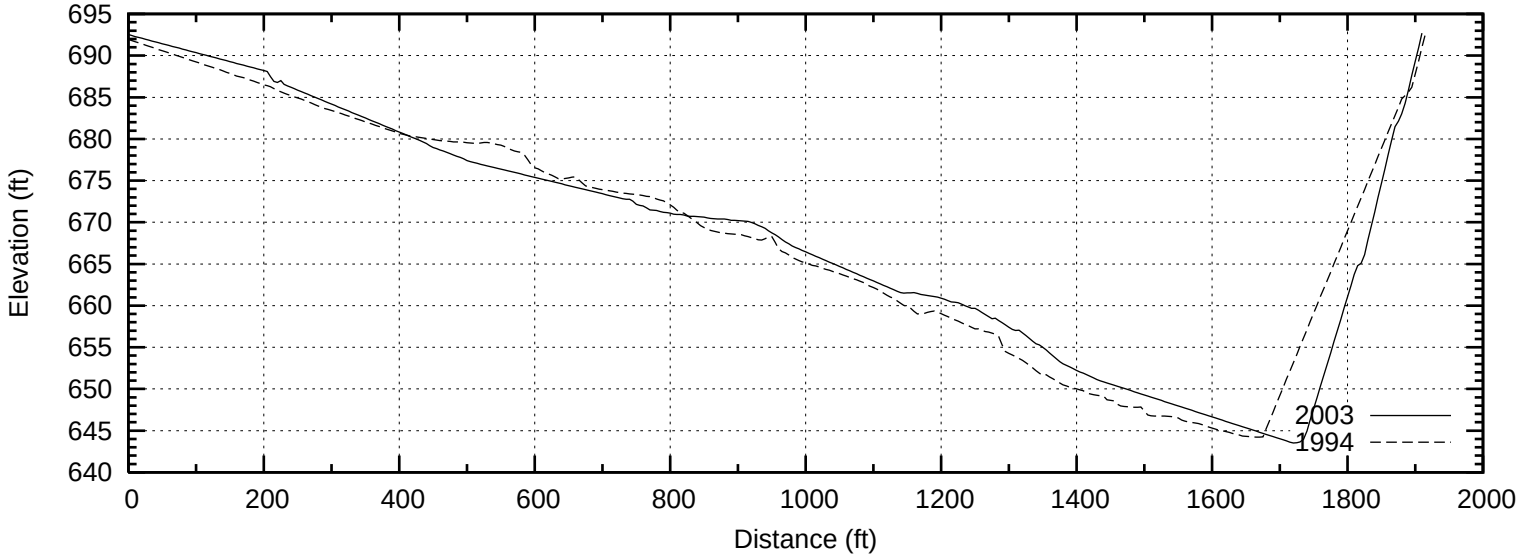
Range Line	X	Y
RL1-L	2177869.3	6876368.5
RL1-R	2175308.3	6876368.5
RL2-L	2175148.3	6876336.5
RL2-R	2173419.5	6876336.5
RL3-L	2175388.3	6874688.0
RL3-R	2172731.3	6874672.0
RL4-L	2175116.3	6871887.0
RL4-R	2171866.8	6871887.0
RL5-L	2174812.0	6868349.5
RL5-R	2170746.3	6868349.5
RL6-L	2177197.0	6865804.0
RL6-R	2175804.5	6863163.0
RL7-L	2197469.8	6859473.5
RL7-R	2196869.5	6859105.5
RL8-L	2184360.0	6858249.0
RL8-R	2184008.0	6856088.0
RL9-L	2196533.3	6847432.5
RL9-R	2194668.5	6847432.5
RL10-L	2187837.5	6842022.0
RL10-R	2187033.3	6842362.5
RL11-L	2195753.0	6835907.5
RL11-R	2196425.3	6835259.5
RL12-L	2192388.8	6835606.0
RL12-R	2191939.3	6834487.0
RL13-L	2221908.0	6838308.5
RL13-R	2220307.3	6834275.0
RL14-L	2202956.0	6831393.5
RL14-R	2201611.5	6829985.0
RL15-L	2213736.5	6824855.0
RL15-R	2211143.5	6824110.5
RL16-L	2218506.5	6821069.0
RL16-R	2217842.3	6818756.5

Lake Granbury

Range Line SR13

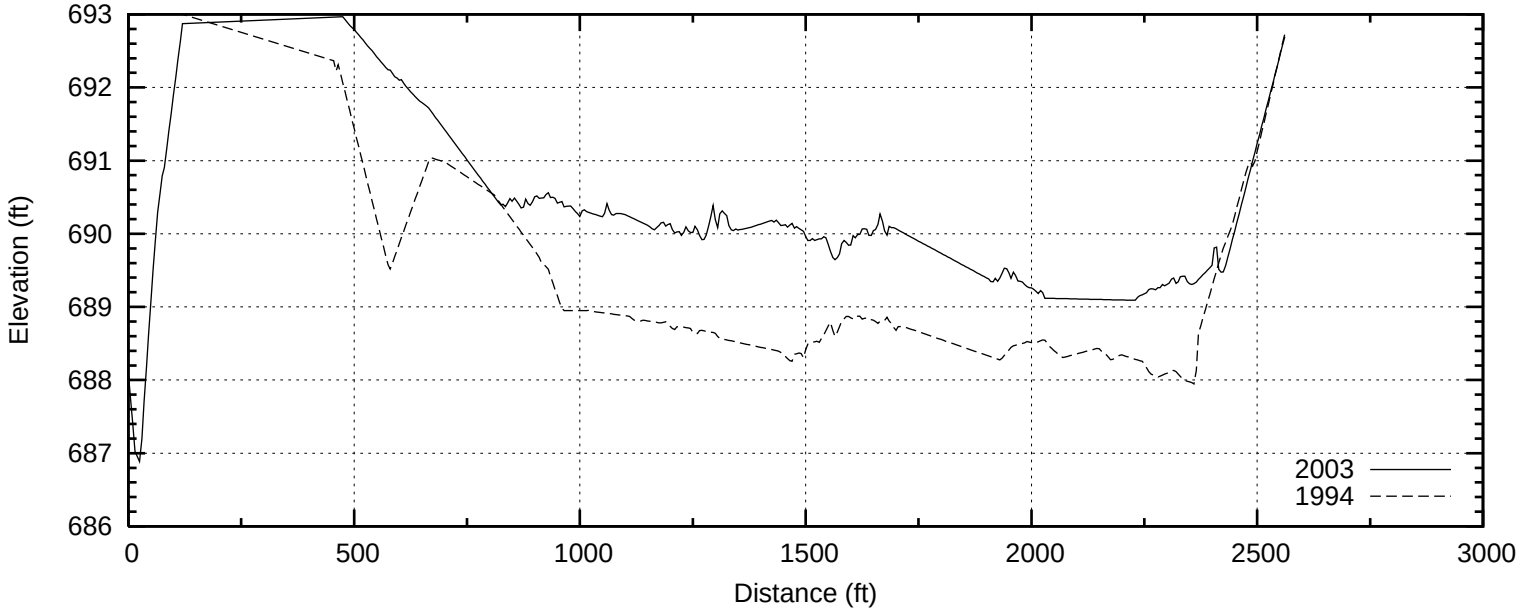


Range Line SR14

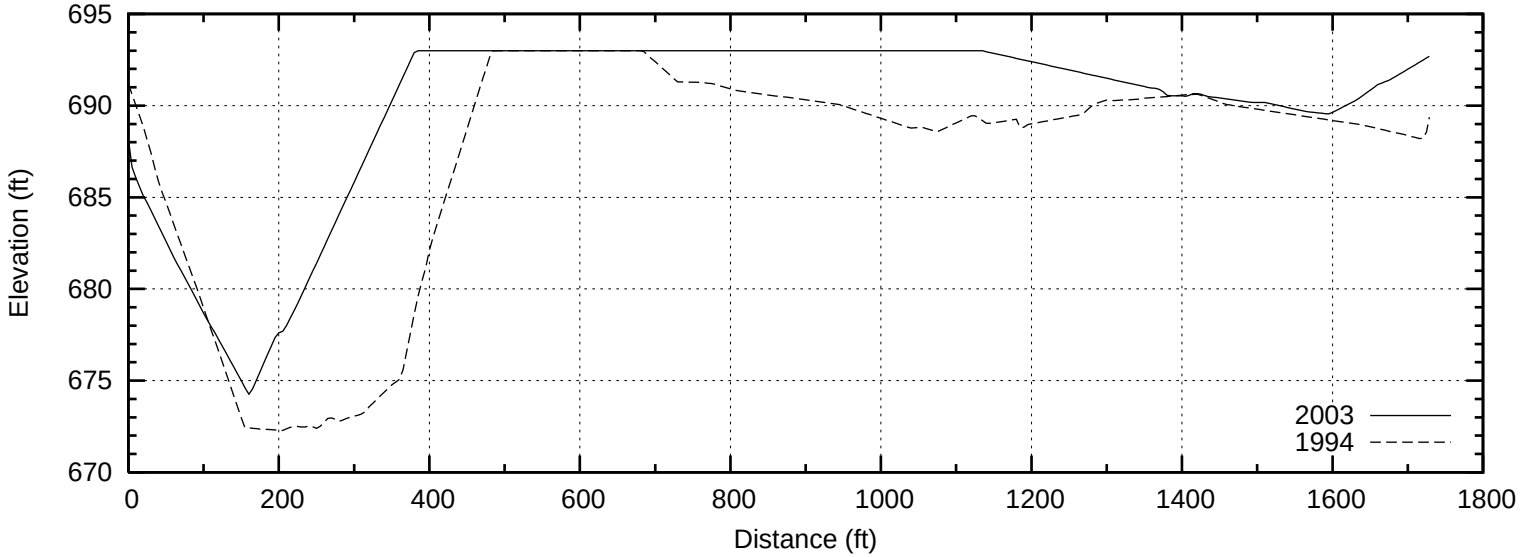


Lake Granbury

Range Line SR01

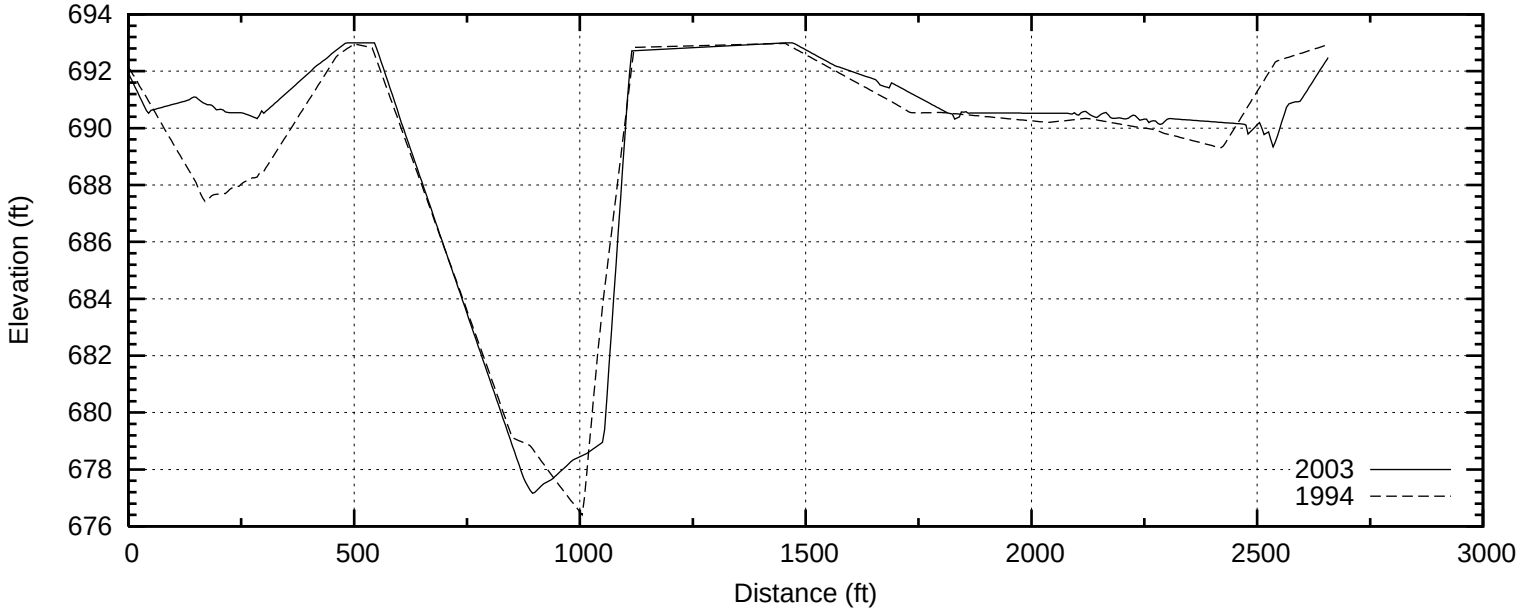


Range Line SR02

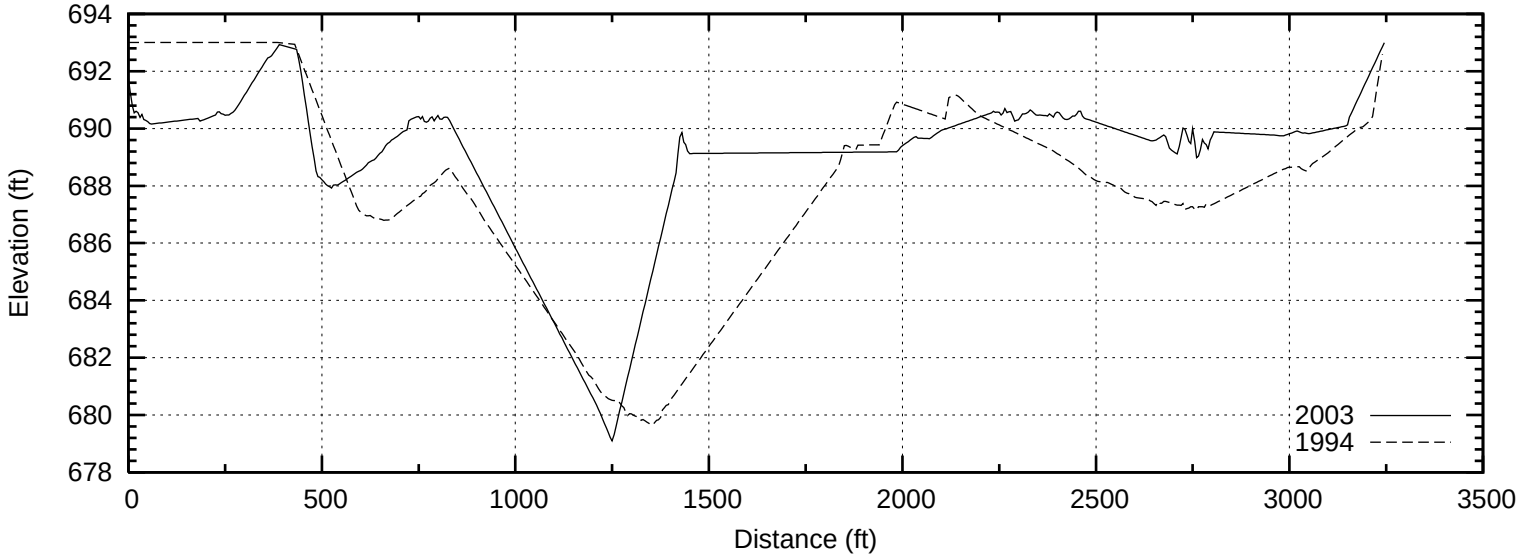


Lake Granbury

Range Line SR03

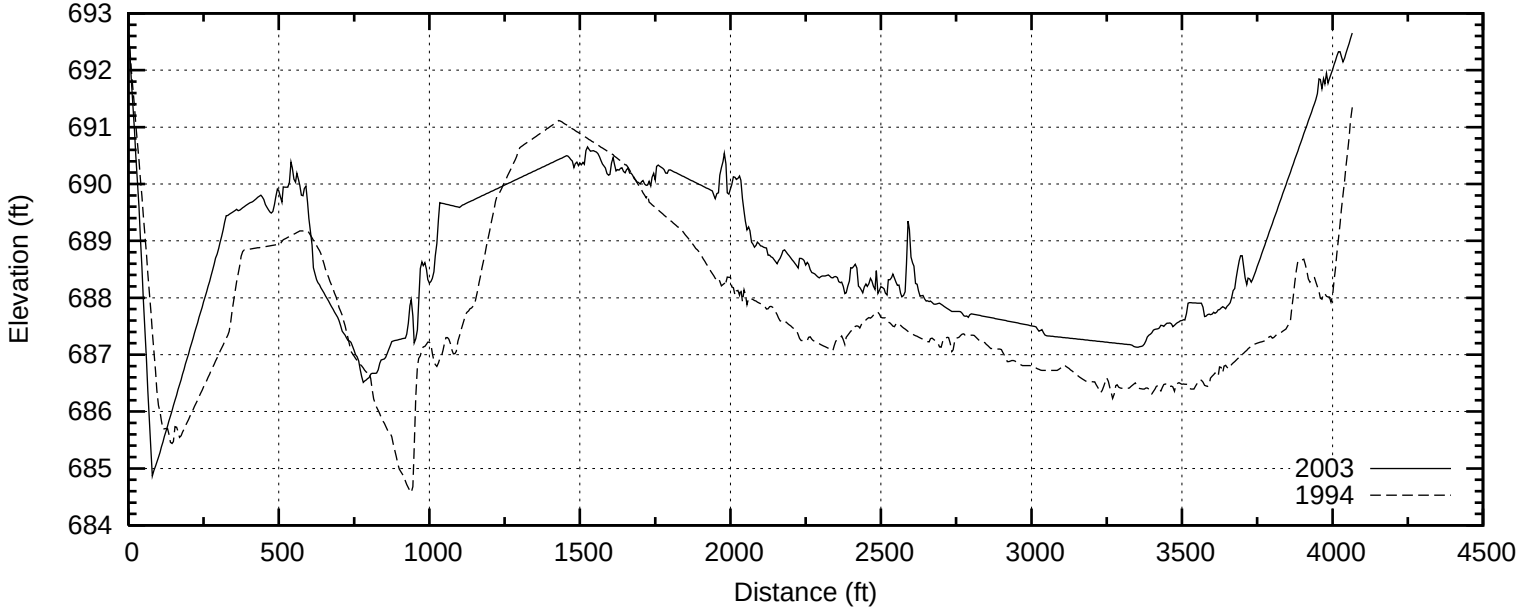


Range Line SR04

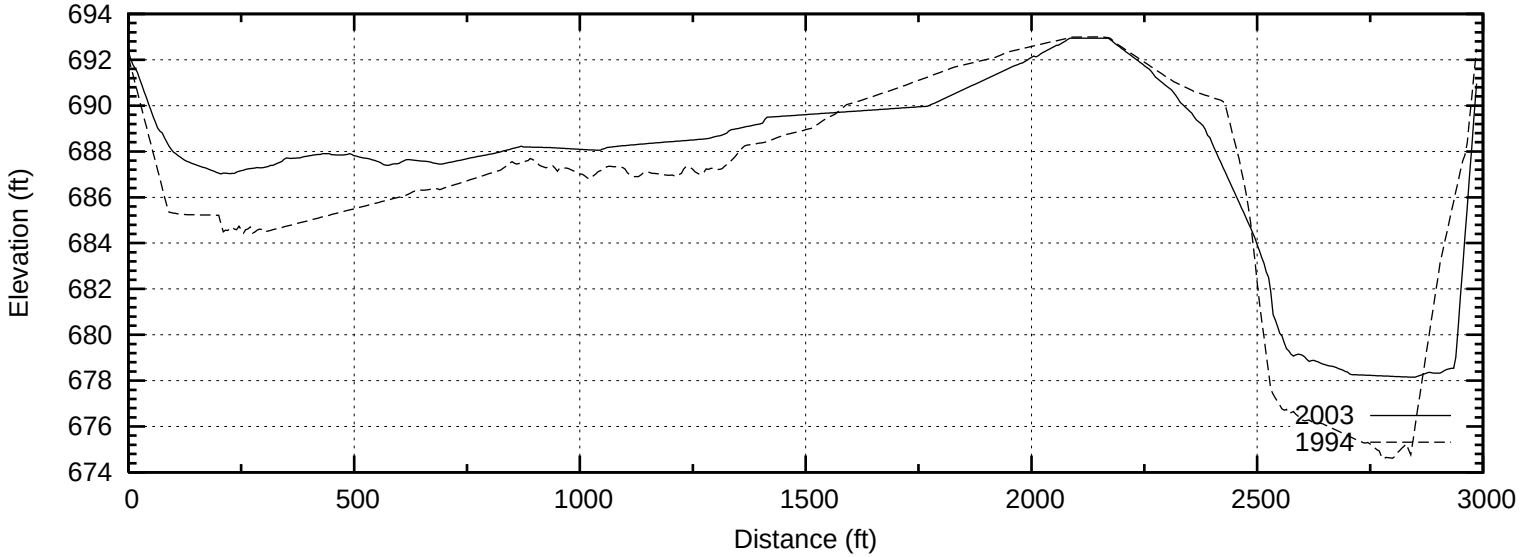


Lake Granbury

Range Line SR05

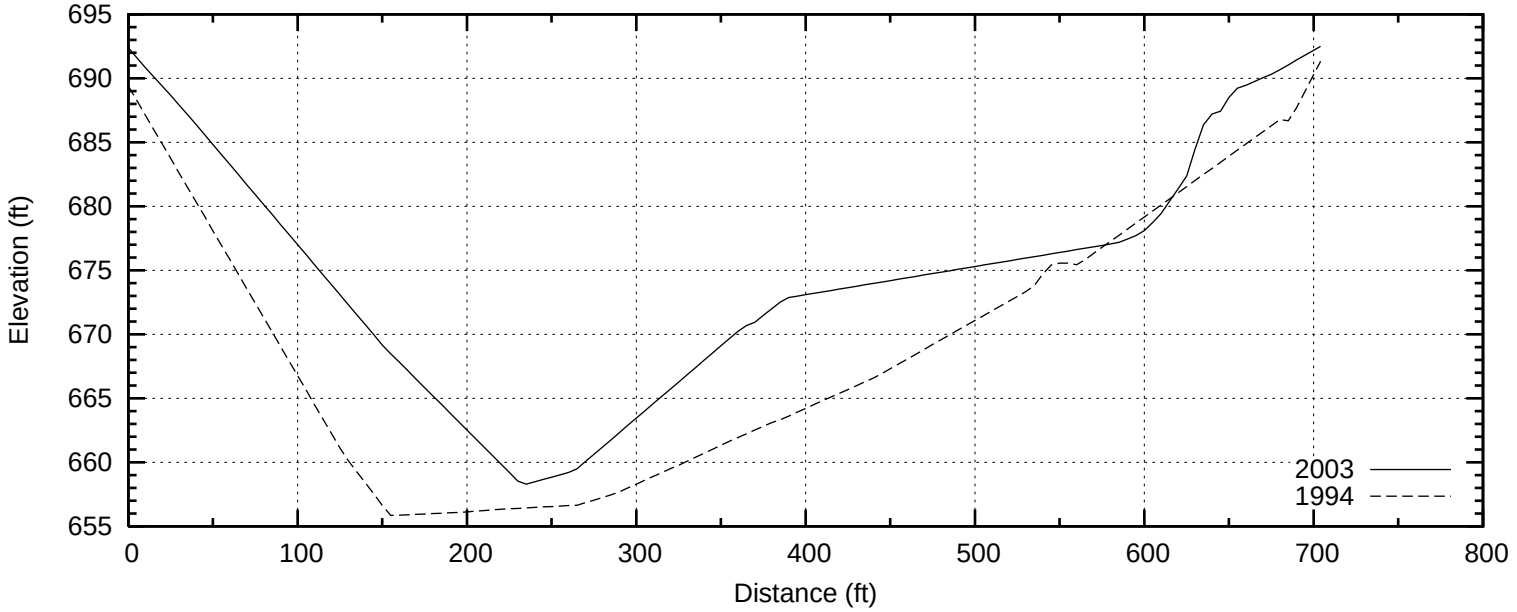


Range Line SR06

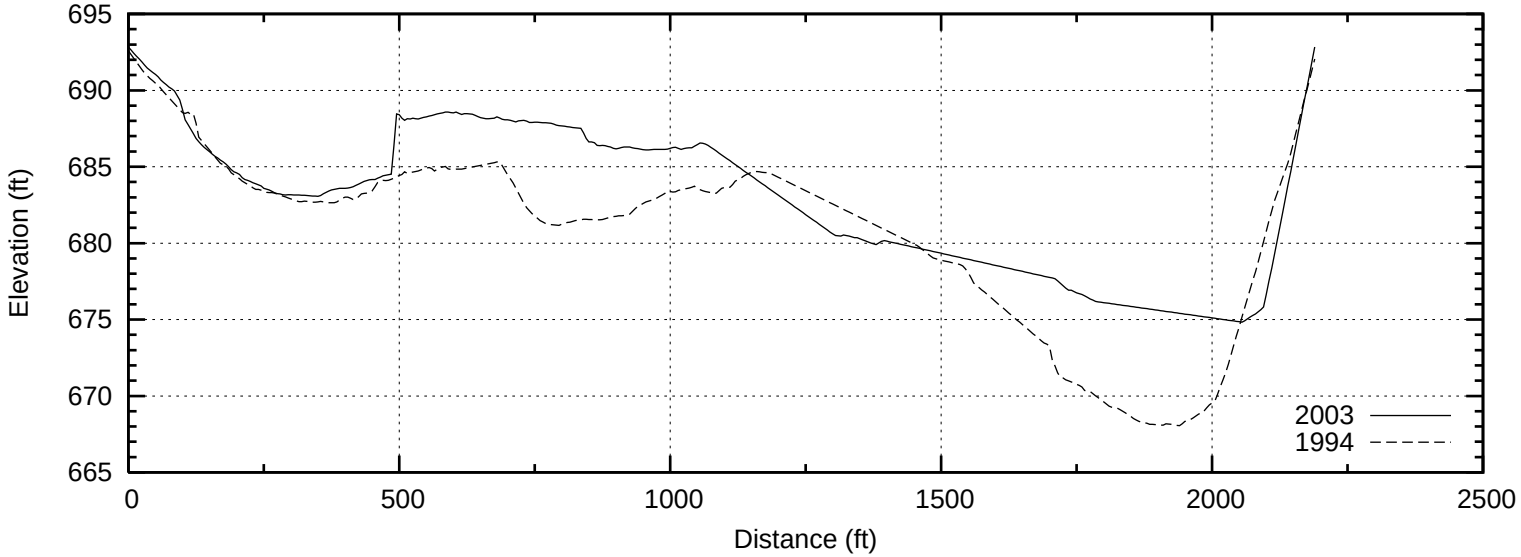


Lake Granbury

Range Line SR07

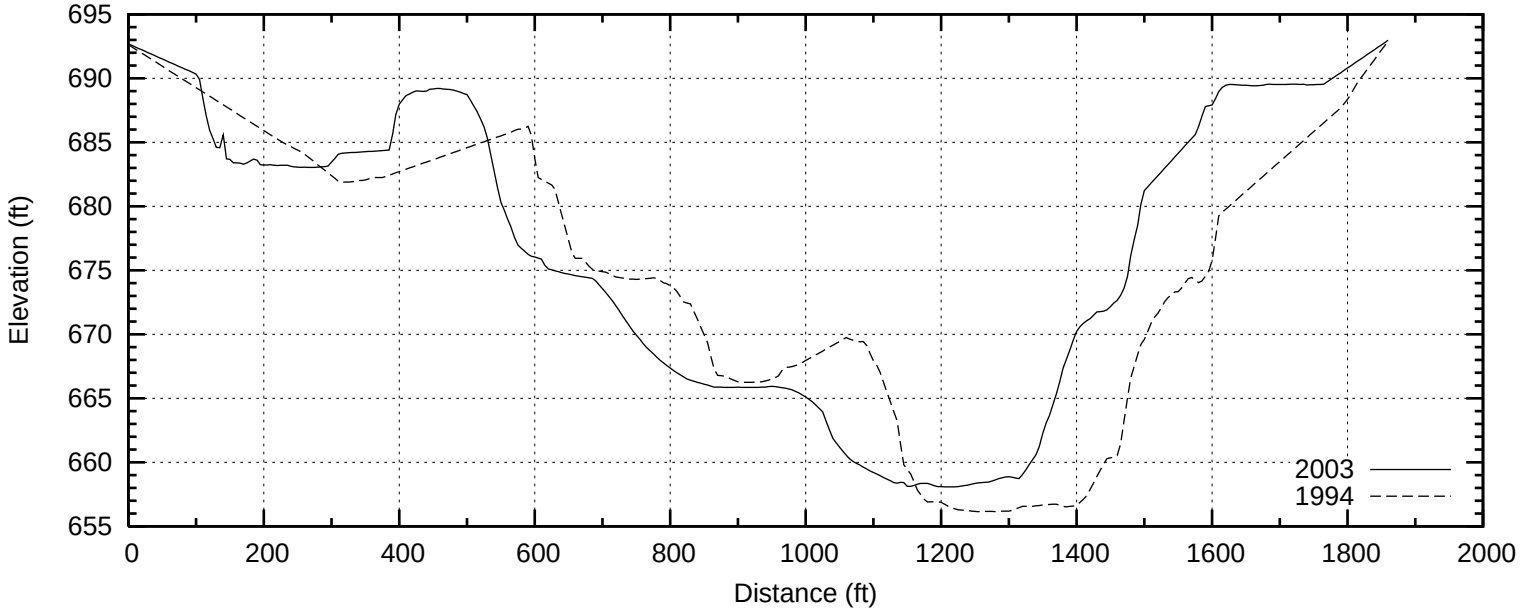


Range Line SR08

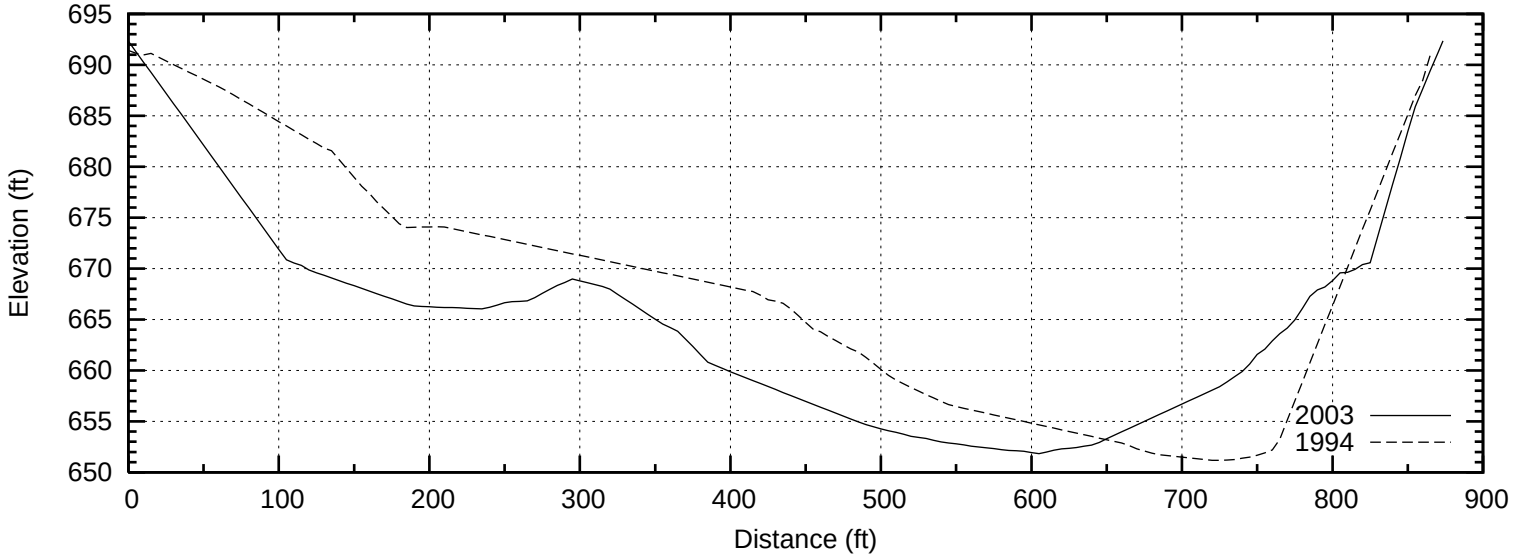


Lake Granbury

Range Line SR09

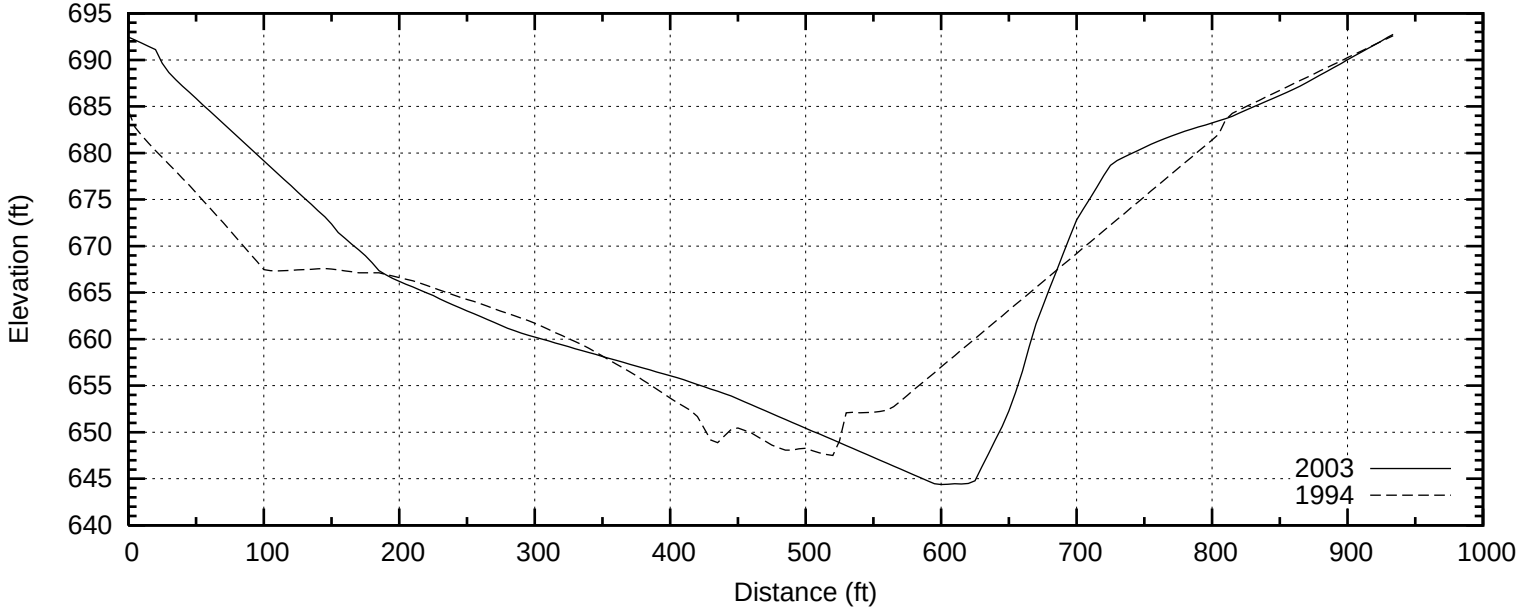


Range Line SR10

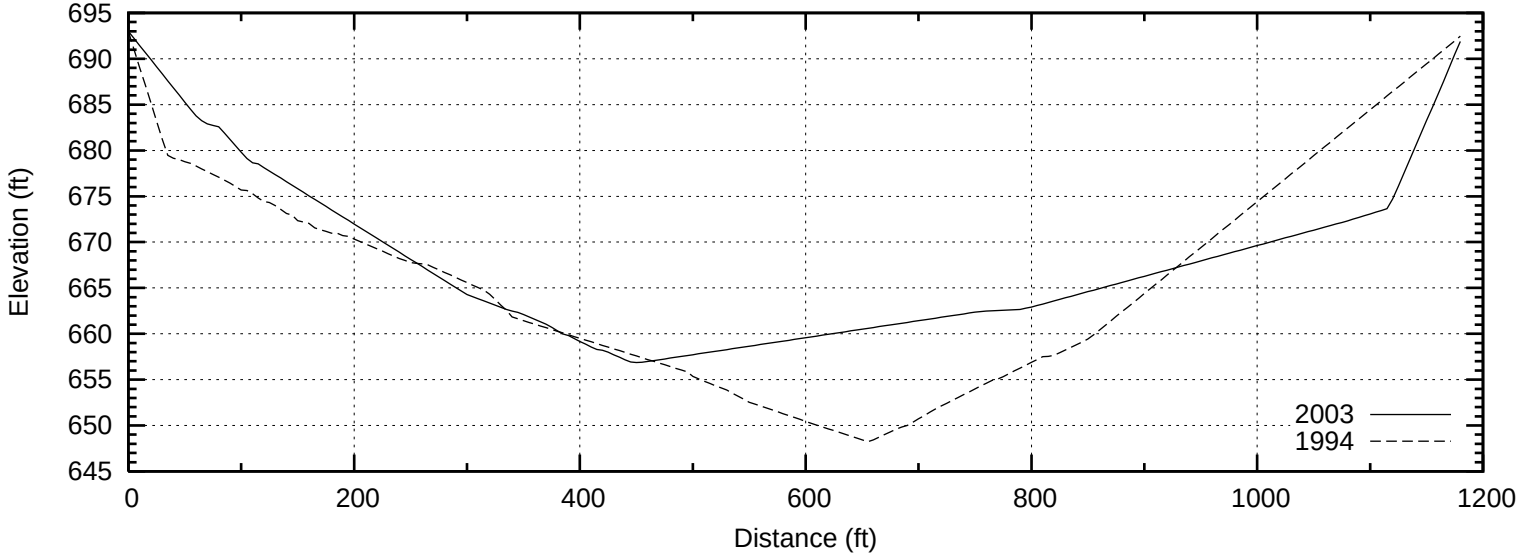


Lake Granbury

Range Line SR11

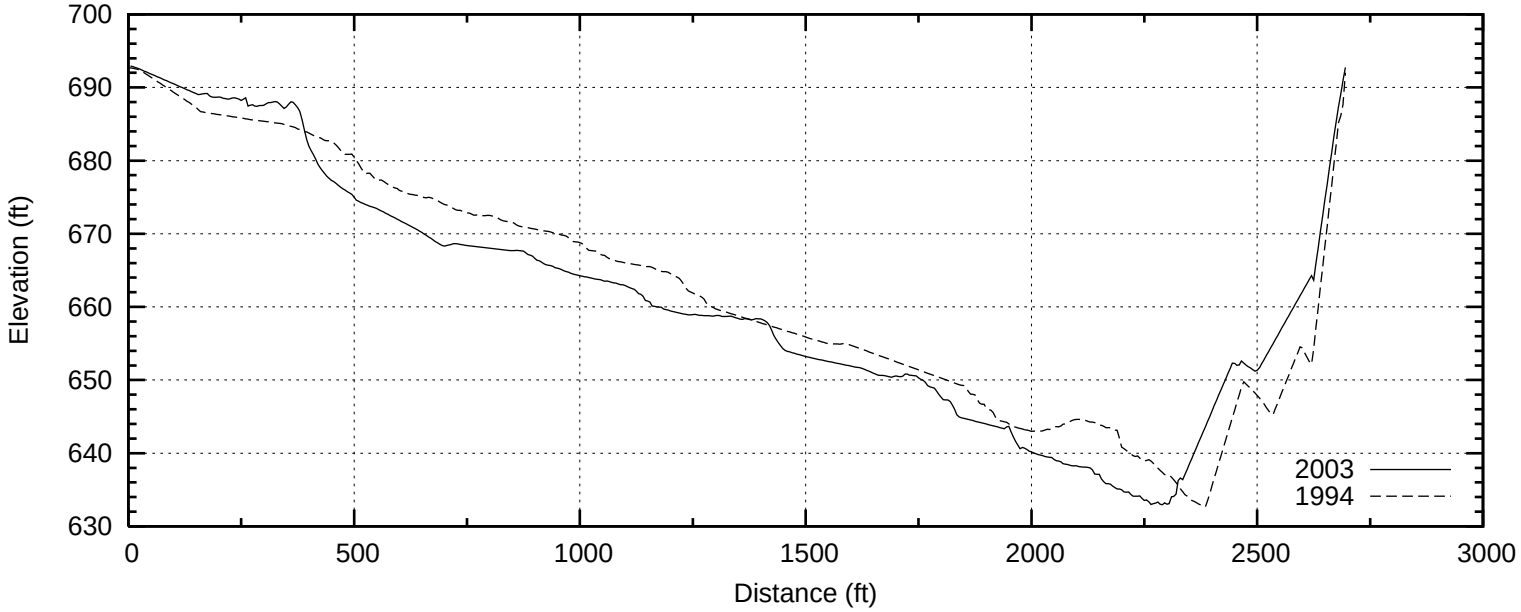


Range Line SR12



Lake Granbury

Range Line SR15



Range Line SR16

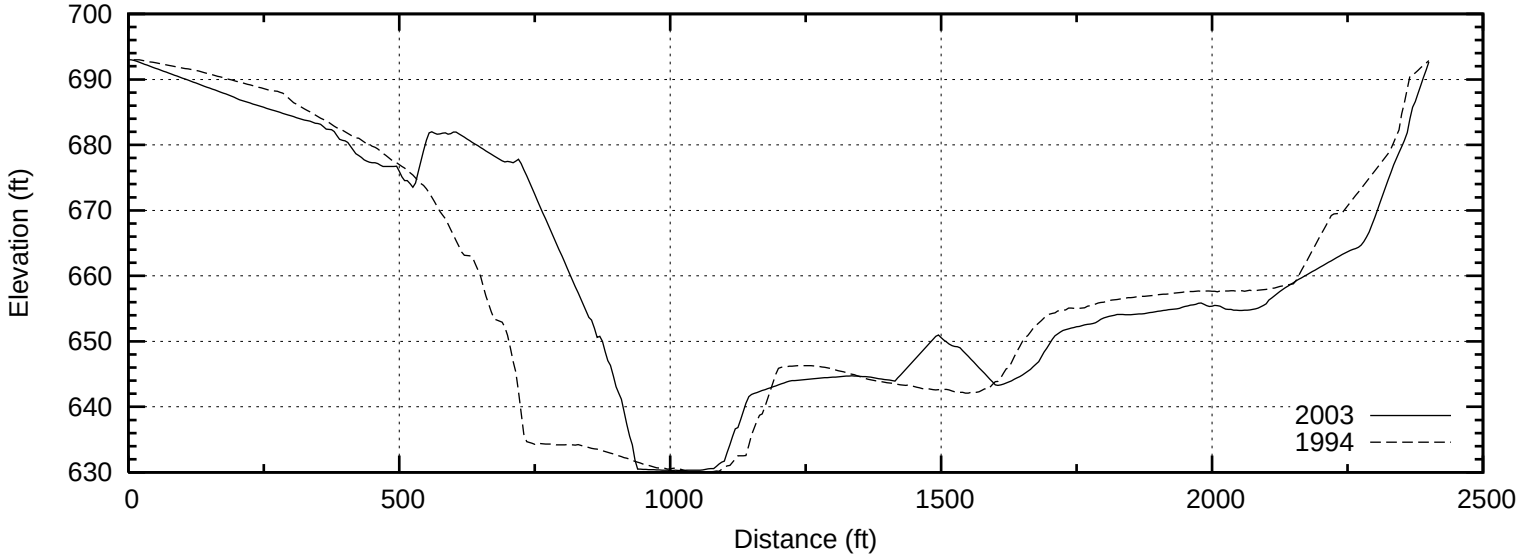


Figure 6

LAKE GRANBURY

2' Contours

N

1 0.5 0 1 Miles

Top of Conservation Pool Elevation 693'

- **Water Surface @ 693'**
- **Islands @ 693'**
- **Range Lines**

Contours

630
632
634
636
638
640
642
644
646
648
650
652
654
656
658
660
662
664
666
668
670
672
674
676
678
680
682
684
686
688
690
692

2160000 2180000 2200000 2220000

6900000 6880000 6860000 6840000 6820000

2180000 2200000 2220000

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 Granbury. The Texas Water Development Board makes no representations nor assumes any liability.

TEXAS WATER DEVELOPMENT BOARD JULY 2003 SURVEY