VOLUMETRIC SURVEY OF LAKE BONHAM

Prepared for:

City of Bonham

Prepared by:
Texas Water Development Board

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EXECUTIVE OVERVIEW

The Texas Water Development Board (TWDB) and the City of Bonham entered into contract TWDB R04-4801-060 in December 2003 to survey the capacity of the lake at the conservation pool elevation. Staff of the Hydrographic Survey Team of the TWDB conducted a volumetric survey of Lake Bonham, in two field trips, during the period of February 23 through March 9, 2004. During the February 23rd and 24th, 2004, survey dates, the water levels varied between elevations 564.85 ft and 565.04 ft. Staff returned on March 9, 2004, to collect data in upper reaches of the lake where FM 898 crosses the West Oakland Branch, Wolf Creek, and Timber Creek arms of the reservoir. During the March trip, the lake was at elevation 564.91 ft. Conservation pool elevation (CPE) for Lake Bonham is 565.0 ft.

For this survey, staff delineated the lake boundary (shoreline) using digital orthophoto quadrangle images (DOQs) photographed in January 1996 and the 570-ft contour from the 1976 USGS topographic sheet. The survey team collected depth and positional data along a layout of range lines (pre-plotted navigation lines), spaced approximately 500 feet apart, using the Global Positioning System (GPS) and commercially available guidance software. Acoustic bottom profiles were taken with a single-frequency depth sounding system operating at 200 kilohertz (kHz).

The survey team collected approximately 19,000 data points over 30 miles of range lines. The results of the current survey indicate the lake encompasses 1,012 surface acres and has a capacity of 11,038 acre-feet (ac-ft) at cpe 565.0 ft. Original design information (1969), indicated Lake Bonham had approximately 1,020 surface acres and a volume of 11,976 ac-ft. at CPE. In 1984, the sedimentation rate in the Lake Bonham watershed was estimated to be 2.8 ac-ft/mi^2/yr. Comparing current survey results to original design information, indicates approximately 995 ac-ft have been lost since impoundment, corresponding to a sedimentation rate of approximately 0.9 ac-ft/mi^2/yr or 27 ac-ft/yr.

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INTRODUCTION

Staff of the Surface Water Availability Section of the Texas Water Development Board (TWDB) conducted a volumetric survey of Lake Bonham on February 23, and 24, 2004 and then returned on March 9, 2004 to access areas upstream of the FM 898 bridges crossing West Oakland Branch, Wolf Creek, and theTimber Creek arms of the reservoir. The purpose of the survey was to determine the current volume of the lake at the conservation pool elevation (cpe) 565.0 feet. 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 City of Bonham and the United States Geological Survey (USGS) for the reservoir elevation gauge at Lake Bonham. The datum for this gauge is reported as mean sea level (msl). Thus, elevations are reported here in feet (ft) above msl. Volume and area calculations in this report are referenced to water levels provided by the USACE gauge: USGS 07332610 Lk. Bonham nr Bonham, TX.[1, 2] During the February dates, the USGS gauge was reporting erroneous elevations; therefore, the survey crew recorded daily reading as observed on the staff gauge located on the City of Bonham's intake structure. The gauge was repaired and reading correctly during the March trip.

Lake Bonham is located on Timber Creek (Red River Basin) in Fannin County, 5 miles northeast of Bonham, TX (Figure 6). Lake Bonham impounds Timber, Little Timber, Sand, and Wolf Creeks generally from the west, with West Oakland and East Oakland Branches entering the lake from the north. At the top of cpe 565.0 ft above msl, the lake has approximately 22 miles of shoreline and records[3] indicate the drainage area is approximately 29 square miles.

LAKE HISTORY AND GENERAL INFORMATION

The State Board of Water Engineers authorized Lake Bonham and Timber Creek Dam under Permit No. 2195 (Application No. 2421) to the Bonham Municipal Water Authority on February 15, 1966. Currently, the City of Bonham operates Lake Bonham under the authority granted to them in

Certificate[4] of Adjudication No. 02-4925. Permission was given to operate a dam and existing reservoir known as Lake Bonham and to impound therein not to exceed 13,000 ac-ft of water. The water rights owner may divert and use not exceed a total 5,340 ac-ft per annum. The impoundment can also be used for recreational purposes. For more information about the uses, diversion locations, priorities and special conditions, please refer to the Certificate of Adjudication 02-4925 that is on record with the Texas Commission on Environmental Quality.

Construction for Timber Creek Dam started in December 1967 and was completed in November 1969.

The following table for Timber Creek Dam and Lake Bonham is based on information furnished by the Bonham Municipal Water Authority[3] (City of Bonham) and results of the TWDB 2004 survey.

Table 1. Timber Creek Dam and Lake Bonham Pertinent Data

Owner

City of Bonham

Operator

City of Bonham

Design Engineer

Wisenbaker, Fix and Associates

General Contractor

Vilbig Construction Company

Location

On Timber Creek (Red River Basin) in Fannin County, 5 miles northeast of Bonham, TX

Purpose

Municipal and recreation use

Drainage Area

29 square miles

Dam

Type:	Earthfill
Length:	4,860 ft
Maximum Height:	70 ft
Crest Elevation:	584.0± ft

Spillway (Emergency)

Location:	Right abutment
Type:	Cut in bank
Length:	400 ft
Crest elevation:	571.0 ft
Control:	None

Spillway (Service)

Location:	Near the center of the dam
Type:	Drop inlet 20 ft x 20 ft
Discharge:	Conduit 7 ft x 7 ft
Crest Elevation:	565.0 ft
Control:	Two 5 by 7 ft gates

Low-Flow Outlet

Type:	18-in. pre-stressed concrete cylinder
Control:	Two 18-in. flange gate valves
Discharge:	To outlet conduit
Invert elevation:	538.0 ft

The following information was obtained from the TWDB 2004 volumetric survey.

Feature	Elevation (feet Above msl)	Capacity (Acre-feet)	Area (Acres)
Top of Conservation Pool	565.0	11,038	1,012
Conservation Pool (Between elev. 565.0 ft – 538.0 ft)	N/A	11,026	N/A
Inactive Pool, below low-flow invert	538.0	12	18

RESULTS AND COMPARISONS

Results from the 2004 TWDB survey indicate that Lake Bonham is encircled by a shoreline approximately 22 miles in length at gauge elevation 565.0 ft. The deepest point measured during the survey was 29.9 ft, corresponding to gauge elevation 535.2 ft, and was located approximately 600 ft upstream of Timber Creek Dam. Encompassing 1,012 surface acres, the lake contains a total volume of 11,038 ac-ft at CPE 565.0 ft. The inactive pool or dead pool storage, below elevation 538.0 ft, contains 12 ac-ft; thus, the conservation storage capacity found in this survey is 11,026 ac-ft.

The original estimates[5] in 1970 (Wisenbaker, Fix and Associates) indicate Lake Bonham contained 11,976 ac-ft and had a surface area of 1,020 acres after initial impoundment. Comparing current survey results (2004) to original design information (1970), indicates approximately 8% loss in total volume. These results are smaller than previous estimates. In 1984, the rate of sedimentation[5] for Lake Bonham was estimated to be 2.8 ac-ft/yr/mi^2 or approximately 81 ac-ft/yr. When compared to the 1970 volume estimates, results of the current survey indicate Lake Bonham has lost 938 ac-ft in total volume. Using this comparison, the survey team estimated the average annual sedimentation rate for Lake Bonham to be 0.9 ac-ft/yr/mi^2, or approximately 27 ac-ft/yr.

Prior methodologies for calculating volumes, areas, and sedimentation from bathymetric data included the range survey and contour survey methods[6, 7, 8]. Due to the different computational methods, comparisons between those methods and the method used for the 2004

survey are not recommended[8]. However, these comparisons are presented here to illustrate the variability and range for calculated sedimentation rates. A summary between the 1970 and the 2004 TWDB volumetric survey are presented in Table 2. A complete discussion of equipment, procedures, and methods, are included in Appendix A. In addition, Appendix A describes other appendices and figures produced for this report.

Table 2. Area and Capacity Comparisons for Lake Bonham

FEATURE	Original Design	TWDB Current Survey
Year	1969	2004
Area (acres)	1,020	1,012
Volume (ac-ft)	11,976	11,038

The use of modern equipment and modeling techniques provides a valuable tool in establishing the rate of sedimentation in reservoirs. The survey team's use of current positioning technologies (GPS), navigation software, and modeling techniques have provided us with the best possible estimates of sedimentation rate and volumes available at this time. As illustrated in the figures on the following page, variations in the rate of sedimentation between decades occur because of changes in the watershed, such as land use and new flood control structures. The technologies and methodologies used also affect estimates of sedimentation rates. It is recommended that another survey utilizing similar methods be performed in five to ten years or after major flood events to monitor changes to the lake's capacity.

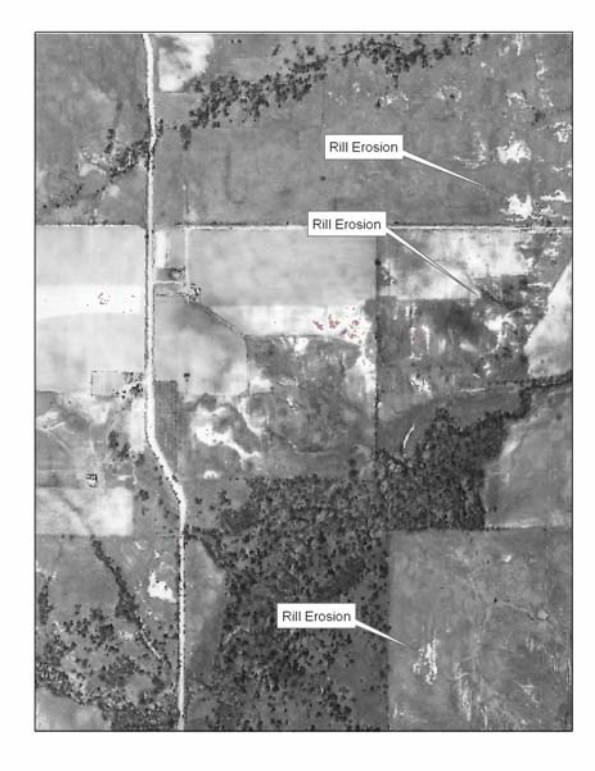

Figure 1. Areas of rill erosion are evident in the 1950 photograph directly above.

Figure 2. Changes in land use and installation of stock ponds appear to have slowed the erosion in the 1996 photograph of the same area above right. Markers indicate identical positions in both photographs.

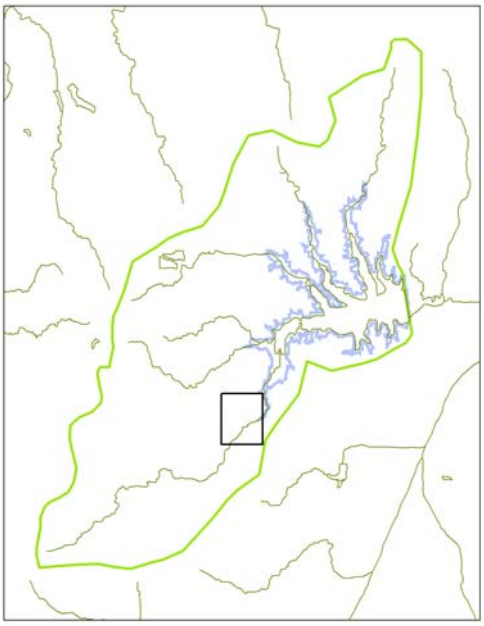

Figure 3. The boxed area in the figure to the immediate right represents the position of the photographs in Figures 1 and 2. Continued changes in land use from the 1950s are a contributing factor leading to a decrease in the sedimentation rates in the Lake Bonham watershed.

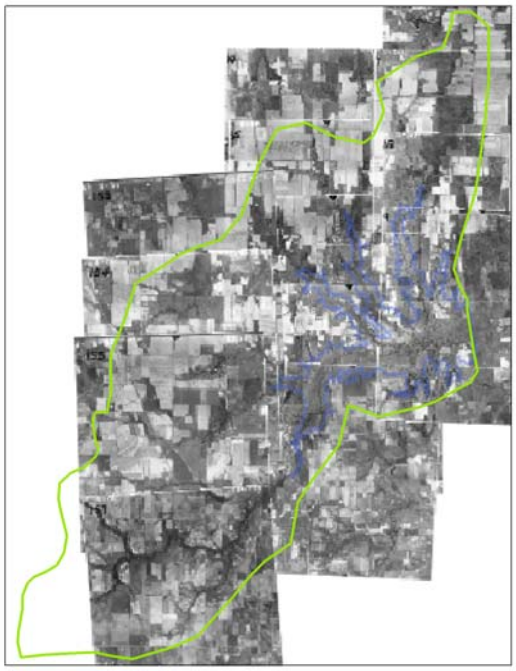

Figure 4. For this project, a series of 1950 aerial photos where scanned and coarsely geo referenced to observe changes in land use and conservation practices. The green boundary is the 29 mi^2 watershed interpreted from a combination of the U.S.Census Bureau 100,000 scale line files, 1996 aerial photography, and 1976 U.S.Geological Survey topographic sheets.

There are about 550 acres of ponds in the 1950 photography, whereas by 1996 the acreage had increased to around 2,500 acres. Yearly average rainfall was not considered and the above acreages are from visual inspection only. The photography also indicates a decrease in cropland during the 46-year period.

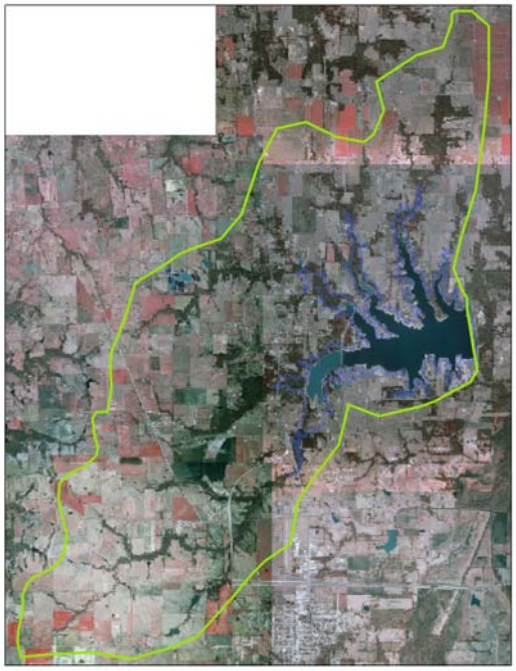

Figure 5. This figure shows Lake Bonham and the 29 mi^2 watershed in 1996. The 570-ft contour in light blue, from the 1979 topographic map, was use in the modeling to compensate for the low (562.0 ft) water levels in the 1996 photographs. Survey team members, with assistance from the City of Bonham, established the water surface elevation in the January 27, 1996 photographs to be 562.0 ft.

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APPENDIX A – EQUIPMENT, PROCEDURES, AND METHODS

VOLUMETRIC SURVEYING TECHNOLOGY

Equipment

The equipment used to perform the TWDB 2004 volumetric survey consisted of a 20-foot aluminum, flat bottom SeaArk craft (River-runner) with cabin and equipped with a 100-horsepower Yamaha outboard motor. To collect data on board, we used a Knudsen 320 B/P Echosounder[9] (depth sounder), a Trimble Navigation, Inc. AG132 GPS receiver with Omnistar[10] differential GPS correction signal, and a laptop computer. During the March 9, 2004 trip the hydro survey team installed this equipment on a 17-foot Jon boat, powered by a 9.9 Horsepower Evinrude outboard motor. The 17-foot Jon boat allowed the team to gain access to areas of the reservoir that were upstream of the FM 898 bridges crossing the West Oakland Branch, Wolf Creek, and Timber Creek arms of the reservoir. The combination of survey vessels, GPS equipment, and depth sounders provide efficient hydrographic survey systems.

PRE-SURVEY PROCEDURES

The lake's boundary was digitized using Environmental Systems Research Institute's (ESRI) [11] ArcGIS 8.3 from digital orthophoto quadrangle images (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 elevation at the time the DOQs were photographed on January 27, 1996 was 562.0 ft. The lake and island boundaries were given an elevation of 562.0 ft and TWDB Staff used this updated boundary as input to the model of Lake Bonham for this report.

Since the digitized boundary for the DOQs was below cpe of 565.0 ft, the 570-ft contour from the 1976 USGS topographic map was used as an upper bound in the model. The model tended to overestimate or "jump" the area at elevation 562 ft due to the insertion of a very

detailed boundary at that elevation. This "jump" in surface area was linearly interpolated in the Area Table by calculating an incremental value from elevation 560.6 ft to 570.0 ft and uniformly distributing that increment in the table from 560.6 ft to 566.0 ft.

The survey layout was designed by placing survey track lines at 500-foot intervals (Figure 7) within the digitized lake boundary using HYPACK MAX[12] software. The survey design required the use of approximately 90 survey lines placed perpendicular to the original creek channel and tributaries.

SURVEY PROCEDURES

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

Equipment Calibration and Operation

On board the River-runner boat, the survey team calibrated the Knudsen depth sounder, using the DIGIBAR-Pro Profiling Sound Velocimeter from Odom Hydrographic Systems[13]. To determine the speed-of-sound, the probe was first placed in the water to acclimate it, then 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, 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 SDI data collection system. The depth was then checked manually with a surveying stadia 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 remained constant at 4,742 feet per second throughout the Lake Bonham 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[14].

During the survey, the horizontal mask setting on the on-board 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. If the PDOP rises above seven, an internal alarm sounds to advise the field crew that the horizontal position has degraded to an unacceptable level. Further positional accuracy is obtained through differential corrections using the internal Omnistar receiver[10]. The HYPACK initialization file for Lake Bonham was set up to perform an "on-the-fly" conversion from the collected Differential GPS positions to state-plane coordinates.

Field Survey

Upon arriving at Lake Bonham, TWDB staff met with personnel from the City of Bonham. After discussing the logistics for the survey, the crew began data collection that day. The water levels remained below cpe during the survey, ranging from 563.95 ft to 564.91 ft. Overall, the survey crew experienced winter conditions with cold wind blowing (from the north) and occasional showers during the February dates and mild sunny conditions on March 9th.

Approximately 19,000 data points were collected over the 30 miles traveled during the data collection phase of Lake Bonham with an approximate maximum distance of 30 ft between data points on each range line (see Figure7). Random data were collected in those areas where the crew could not stay on course because of navigational obstructions. As the channels became too narrow for perpendicular transects, data were collected in a zigzag pattern. The boat's computer stored all data points in 110 data files.

Data Processing

The collected data were transferred from the survey computers onto TWDB's network computers and backups were made for future reference as needed. Each raw data file was processed using the HYPACK Program's EDIT routine. Data points such as depth spikes, erroneous depths caused by vegetation interference 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 changes are made to the data files, they were saved and combined into a single X, Y, Z data file.

The resulting data file was imported into ESRI's Arc/Info Workstation GIS 8.3 software[15]. This software was used to convert each data set 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 pre- and post-impoundment surfaces 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[15]. Using this method, a triangle is formed between three non-uniformly spaced points, including all points along the boundary. If there is another point within the triangle, additional triangles are created until all points lie on the vertex of a triangle. 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 triangular surface plane by determining the elevation along each leg of the triangle.

Volumes and areas were calculated from the TIN for the entire lake at one-tenth of a foot interval from the lowest elevation to the contour used for the lake boundary during the 2004 survey. From elevation 535.2 ft to 570.0 ft, the surface areas and volumes of the lake were computed using Arc/Info software. The computed lake volume table is presented in Appendix B and the area table in Appendix C. An elevation-volume graph and an elevation-area graph are presented in Appendix D and Appendix E respectively.

Other products developed from the model include a shaded relief map (Figure 8) and a shaded depth range map (Figure 9). To develop these maps, the TIN was converted to a lattice using the TINLATTICE command and then to a polygon coverage using the LATTICEPOLY command. Linear filtration algorithms were applied to the DTM to produce smooth cartographic contours. The resulting contour map of the bottom surface at 2-ft intervals is presented in Figure 10. Finally, the cross-section endpoints are in Appendix F and the corresponding cross-section plots are in Appendix G.

Appendix B

Lake Bonham

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD MARCH 2004 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
535		0	0	0	0	0	0	0	0	0
536	0	0	0	0	0	1	1	1	1	2
537	2	2	3	4	4	5	6	7	8	10
538	12	14	16	18	20	23	25	28	31	34
539	38	41	45	49	52	57	61	65	70	75
540	80	85	91	96	102	108	114	120	126	133
541	140	147	154	161	168	176	183	191	200	208
542	217	226	235	244	253	263	273	283	294	304
543	315	326	337	349	361	372	385	397	410	423
544	436	449	463	477	491	505	520	535	551	566
545	582	599	615	632	649	666	683	701	720	738
546	757	776	796	816	836	856	877	898	920	942
547	964	986	1009	1032	1056	1079	1103	1128	1153	1178
548	1203	1229	1255	1281	1308	1335	1362	1390	1418	1446
549	1474	1503	1532	1561	1591	1621	1651	1681	1712	1743
550	1775	1806	1838	1870	1903	1936	1969	2003	2037	2071
551	2105	2140	2175	2210	2246	2282	2318	2354	2391	2428
552	2465	2503	2541	2579	2618	2656	2695	2735	2774	2814
553	2854	2895	2935	2976	3017	3059	3101	3143	3185	3228
554	3271	3314	3357	3401	3445	3490	3535	3580	3626	3672
555	3718	3765	3812	3859	3907	3955	4004	4052	4102	4151
556	4201	4251	4302	4353	4405	4456	4509	4561	4615	4668
557	4722	4777	4832	4887	4944	5000	5057	5115	5173	5231
558	5290	5350	5410	5470	5531	5592	5654	5716	5779	5842
559	5906	5970	6035	6100	6166	6232	6299	6366	6434	6502
560	6571	6640	6710	6781	6852	6923	6996	7069	7143	7217
561	7292	7368	7445	7523	7601	7680	7761	7842	7924	8007
562	8092	8183	8274	8366	8458	8552	8645	8740	8835	8930
563	9026	9122	9219	9316	9414	9512	9611	9710	9809	9909
564	10010	10110	10212	10313	10416	10518	10621	10725	10829	10933
565	11038	11146	11253	11362	11471	11580	11690	11800	11911	12022
566	12134									

Volume estimated from the 570 contour

Appendix C

Lake Bonham

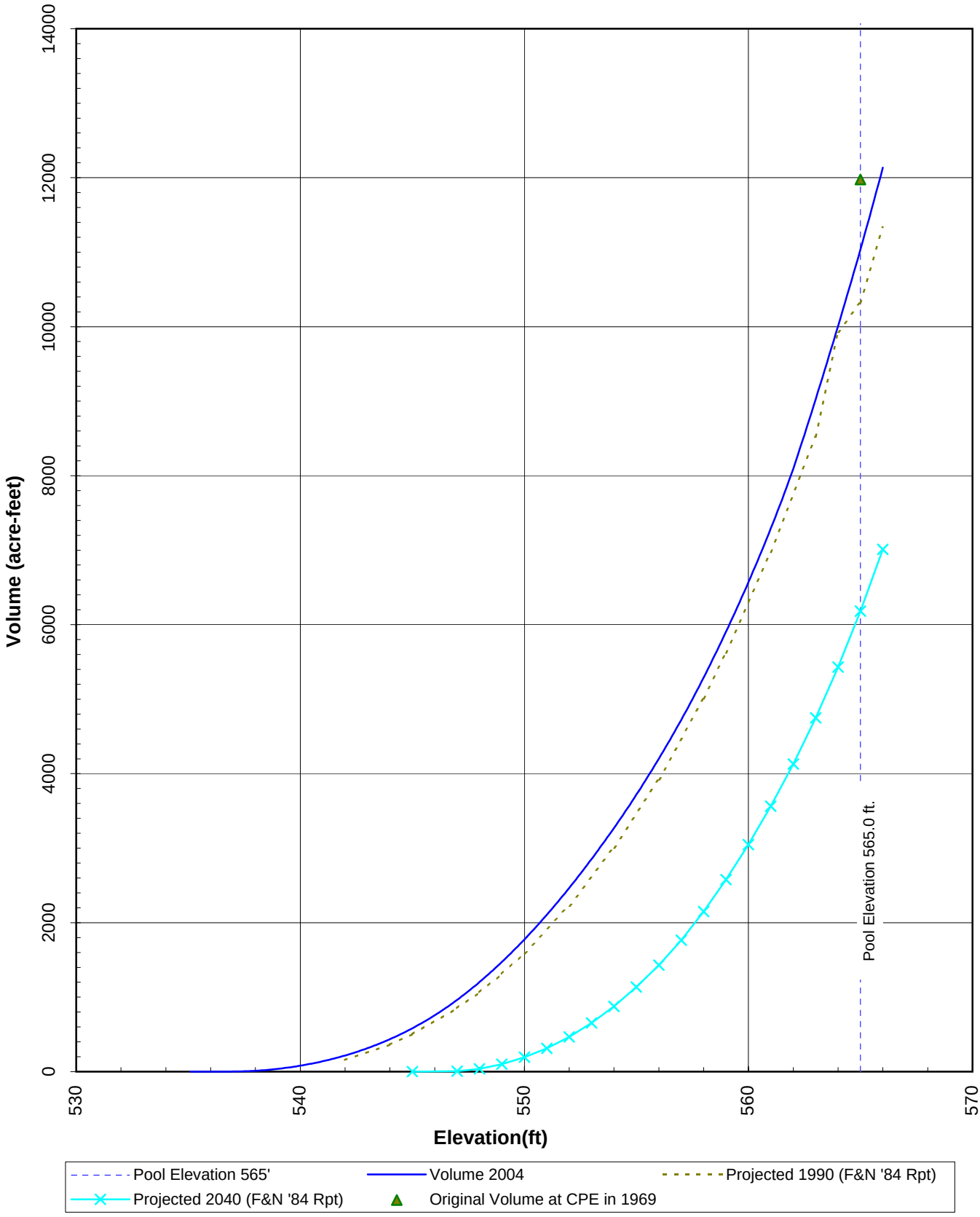
RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — MARCH 2004 SURVEY

AREA IN ACRES — ELEVATION INCREMENT IS ONE TENTH FOOT

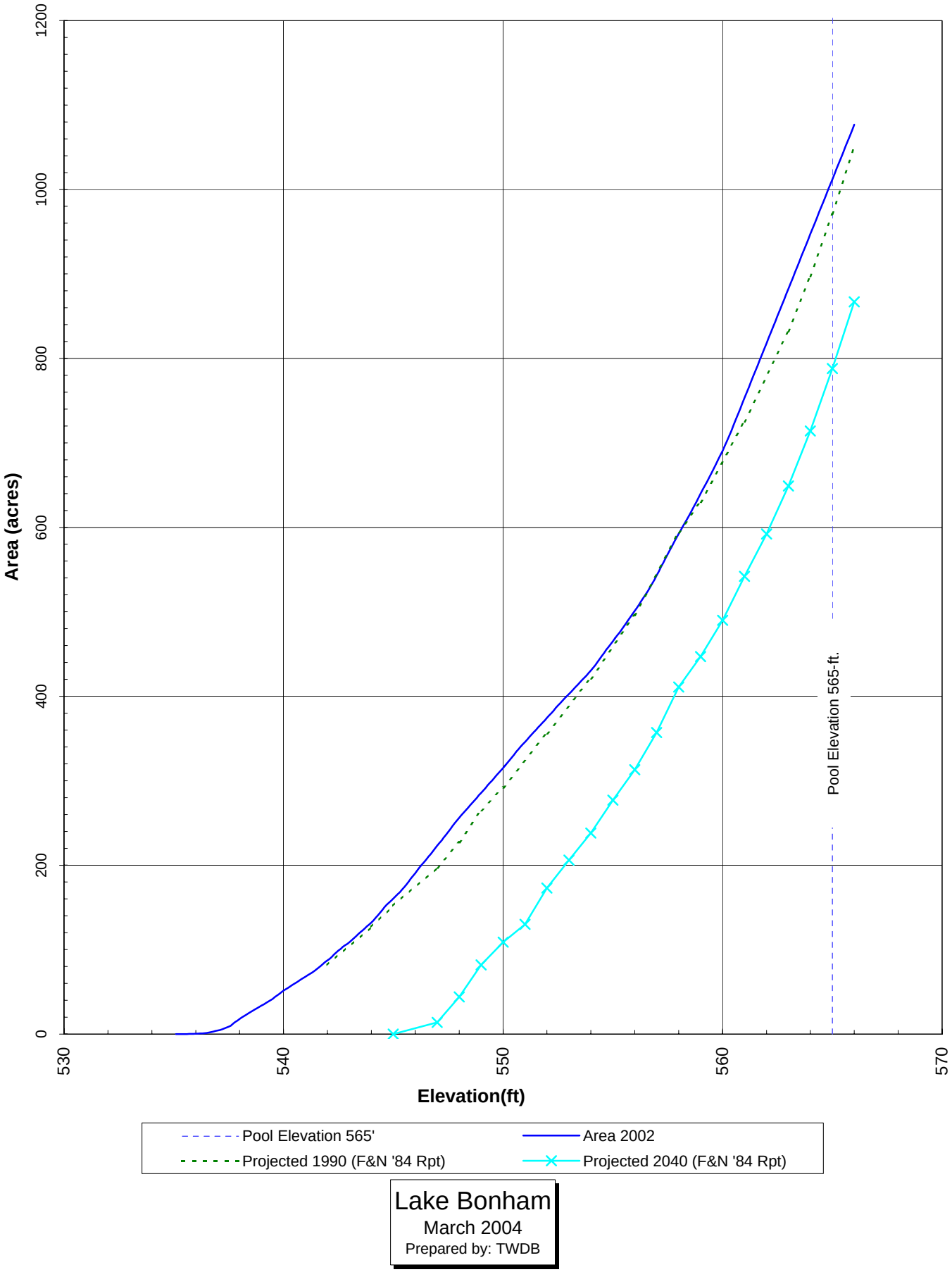
ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
535		0	0	0	0	0	0	0	0	0
536	0	1	1	1	1	1	2	2	3	4
537	4	5	6	7	8	9	10	12	14	16
538	18	20	21	23	25	26	28	29	31	32
539	34	35	37	38	40	42	44	46	48	50
540	51	53	55	56	58	60	61	63	65	66
541	68	70	71	73	75	77	79	81	83	85
542	87	89	92	94	97	99	101	103	105	107
543	109	111	113	116	118	121	123	125	127	130
544	132	135	138	141	144	147	150	153	156	158
545	160	163	166	168	171	174	177	181	184	187
546	191	194	197	201	204	207	210	213	216	220
547	223	226	229	233	236	239	243	246	250	253
548	256	259	262	265	268	271	274	277	280	283
549	286	289	291	294	297	300	303	306	309	312
550	315	318	321	324	327	330	334	337	340	343
551	346	349	352	355	357	360	363	366	369	372
552	374	377	380	383	386	389	392	395	397	400
553	403	405	408	411	414	416	419	422	425	428
554	430	434	437	440	444	448	451	455	458	462
555	465	469	472	475	479	483	486	490	494	497
556	501	505	509	513	517	521	525	529	534	538
557	543	548	553	558	563	568	573	578	583	588
558	592	597	601	606	611	615	620	625	630	635
559	640	645	650	655	659	664	670	675	680	685
560	691	696	702	708	714	721	727	734	740	747
561	753	760	766	773	779	786	792	798	805	811
562	818	824	831	837	844	850	857	863	870	876
563	883	889	896	902	908	915	921	928	934	941
564	947	954	960	967	973	980	986	993	999	1006
565	1012	1018	1025	1031	1038	1044	1051	1057	1064	1070
566	1077									

Area estimated from the 570' contour



Lake Bonham
March 2004
Prepared by: TWDB

Appendix D Elevation vs. Volume



Lake Bonham
March 2004
Prepared by: TWDB

Appendix E Elevation vs. Area

Appendix F

Lake Bonham

TEXAS WATER DEVELOPMENT BOARD March 2003 SURVEY

Range Line Endpoints

State Plane NAD83 Units-feet

L-Left endpoint
R-right endpoint

Range Line	X	Y
Line 01-L	2,687,139.3	7,293,515.5
Line 01-R	2,687,577.3	7,289,904.0
Line 02-L	2,685,572.5	7,292,671.0
Line 02-R	2,685,861.5	7,290,015.5
Line 03-L	2,683,982.3	7,292,403.0
Line 03-R	2,684,710.8	7,290,098.5
Line 04-L	2,682,054.8	7,291,477.5
Line 04-R	2,682,343.3	7,289,084.5
Line 05-L	2,680,559.0	7,290,899.0
Line 05-R	2,680,702.0	7,289,197.5
Line 06-L	2,677,832.5	7,290,480.0
Line 06-R	2,678,577.3	7,289,337.5
Line 07-L	2,676,577.3	7,289,014.0
Line 07-R	2,677,563.5	7,288,478.0
Line 08-L	2,686,246.5	7,293,967.0
Line 08-R	2,685,645.0	7,293,249.5
Line 09-L	2,685,162.8	7,293,780.0
Line 09-R	2,684,406.5	7,293,228.5
Line 10-L	2,684,002.3	7,296,220.5
Line 10-R	2,683,185.3	7,296,057.0
Line 11-L	2,682,670.5	7,292,819.5
Line 11-R	2,681,885.3	7,292,189.5
Line 12-L	2,681,353.3	7,293,635.5
Line 12-R	2,680,749.8	7,293,315.0
Line 13-L	2,681,077.3	7,292,324.0
Line 13-R	2,680,246.5	7,291,702.5
Line 14-L	2,680,192.3	7,293,186.5
Line 14-R	2,679,626.0	7,292,613.5

Figure 6

Lake Bonham

Location Map

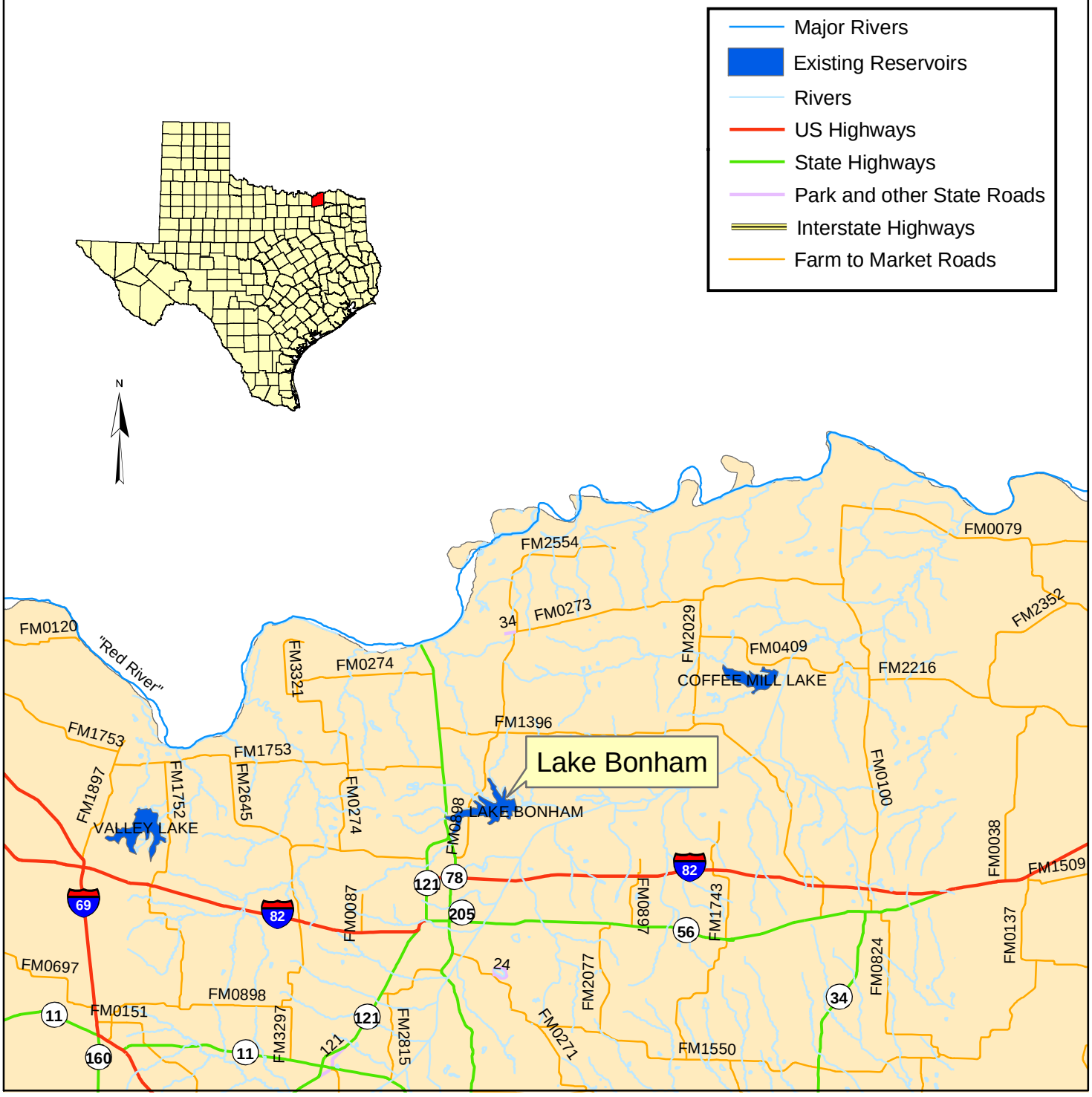
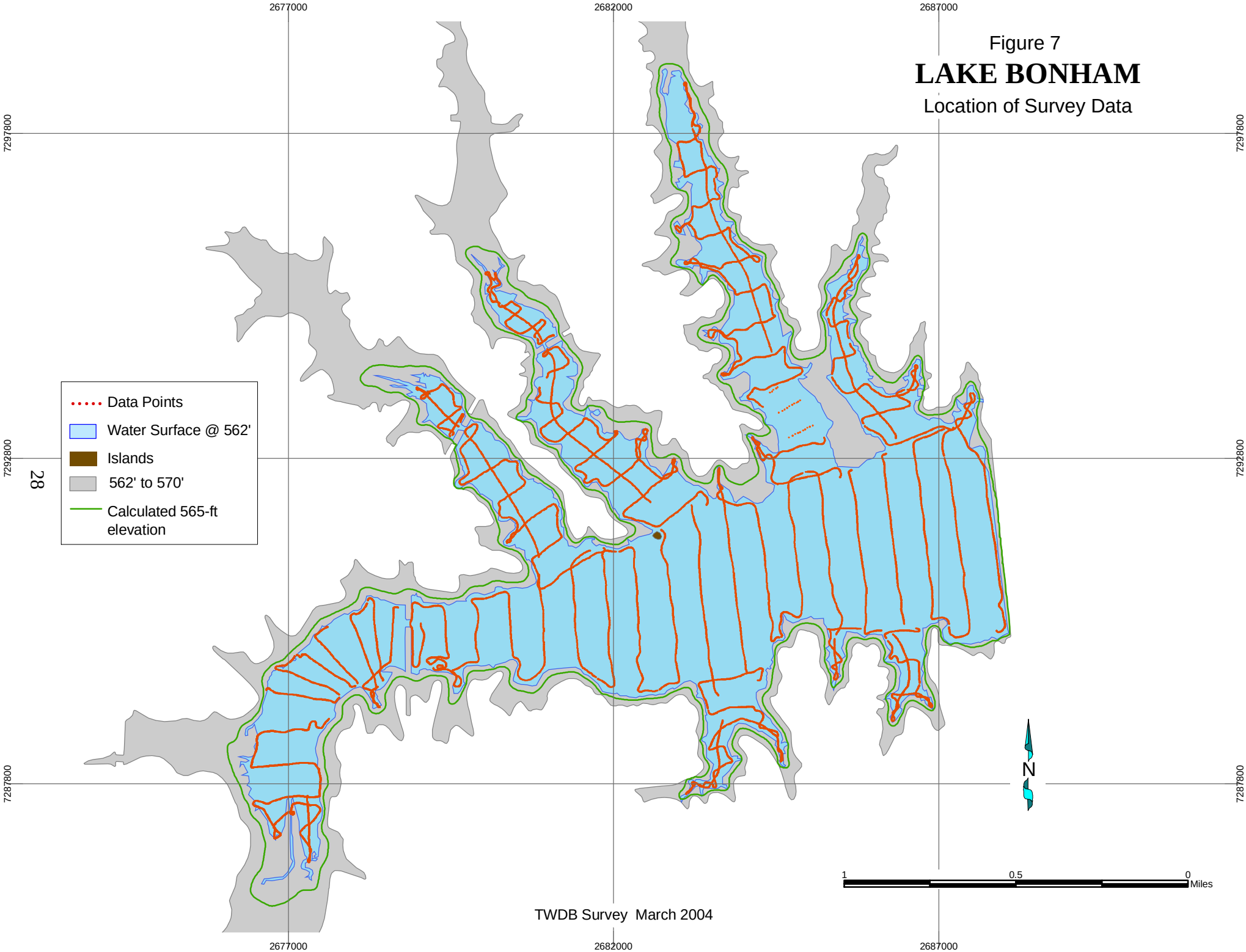


Figure 7

LAKE BONHAM

Location of Survey Data

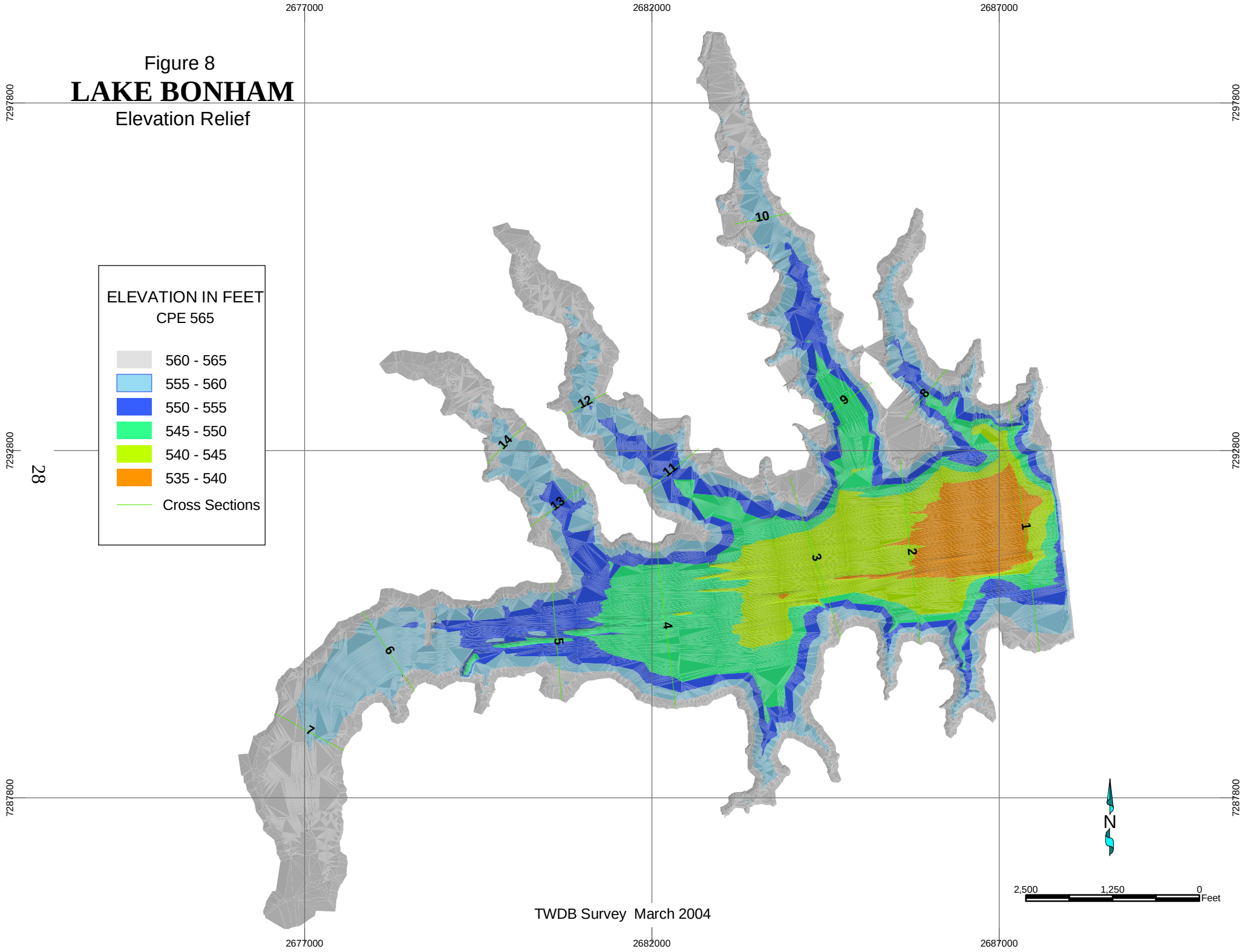


TWDB Survey March 2004

Figure 8

LAKE BONHAM

Elevation Relief



TWDB Survey March 2004

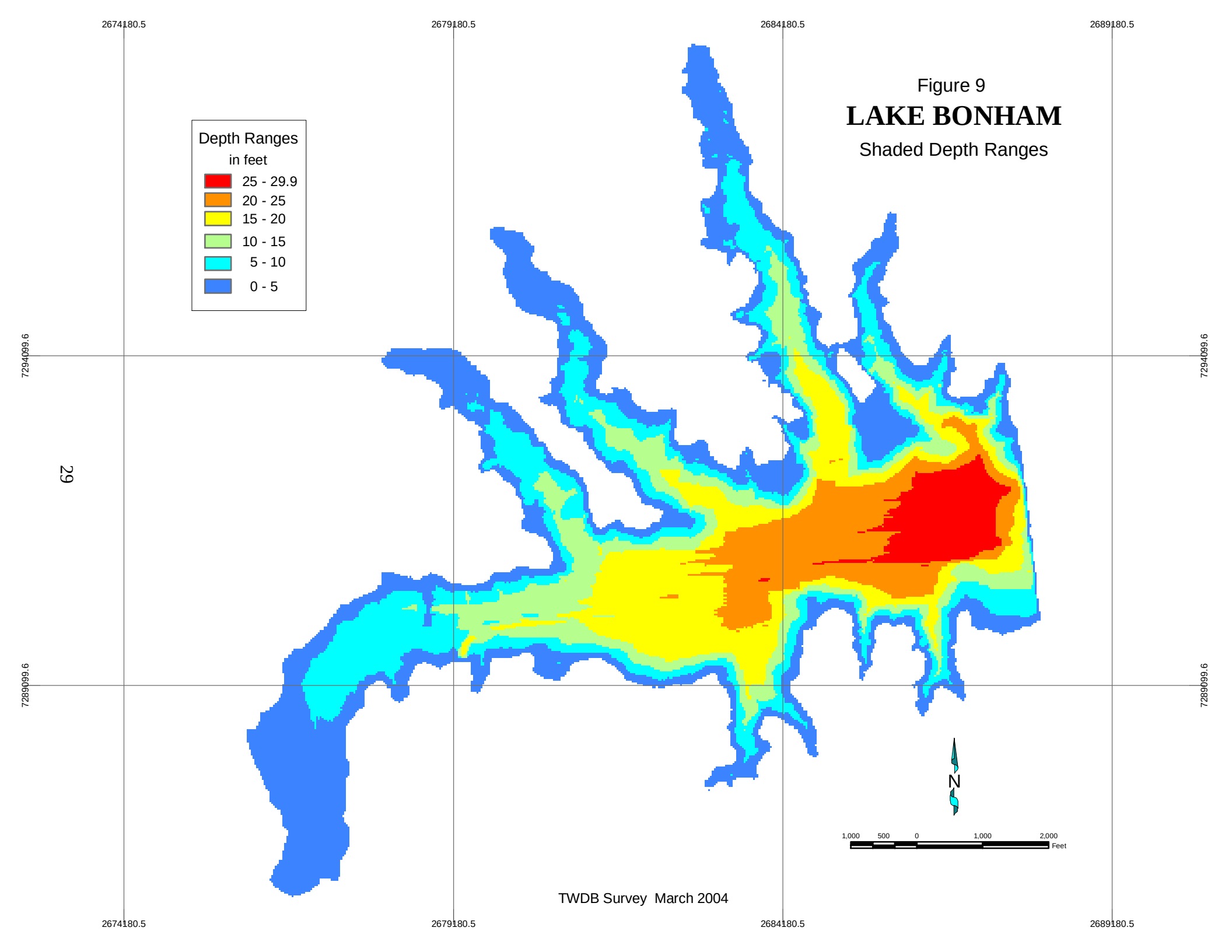

2674180.5
2679180.5
2684180.5
2689180.5
7294099.6
7289099.6
Depth Ranges
in feet
25 - 29.9
20 - 25
15 - 20
10 - 15
5 - 10
0 - 5
Figure 9
LAKE BONHAM
Shaded Depth Ranges
N
1,000 500 0 1,000 2,000
Feet
TWDB Survey March 2004

Figure 10

LAKE BONHAM

2' - Contour Map

Water Surface @ 565' (calculated contour)

Islands

Conservation Pool 565' (calculated)

Digitized 562' waters edge

Cross Sections

Contours

538
540
542
544
546
548
550
552
554
556
558
560
562
564
565
566
568

TEXAS WATER DEVELOPMENT BOARD

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 Bonham. The Texas Water Development Board makes no representations or assumes any liability.

N

2,000 1,000 0 2,000 Feet

Prepared by : TEXAS WATER DEVELOPMENT BOARD MARCH 2004

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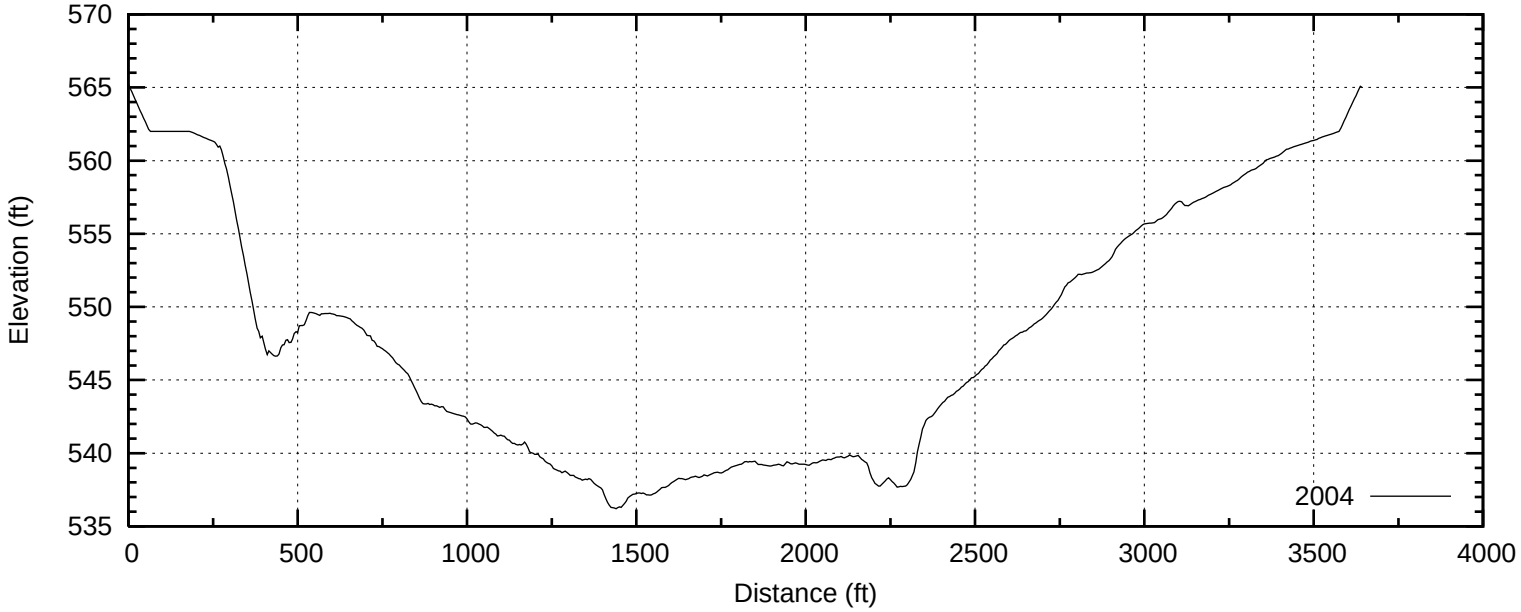
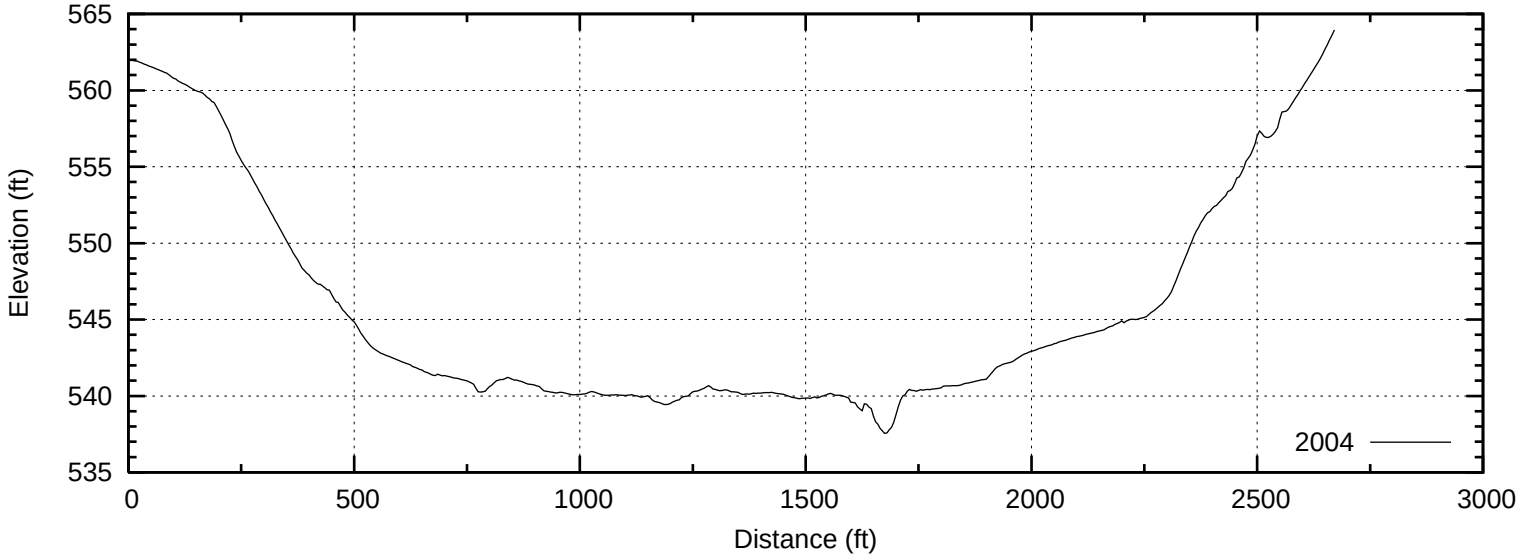
Range Line SR01



Range Line SR02



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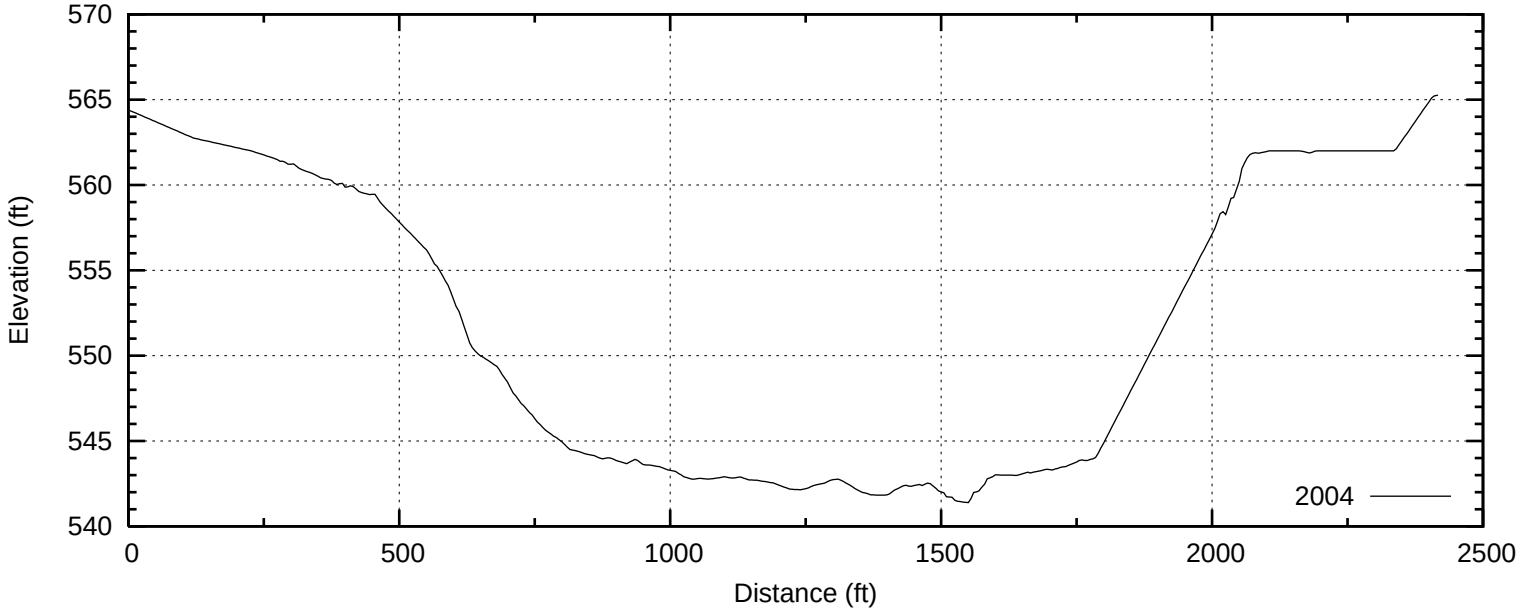
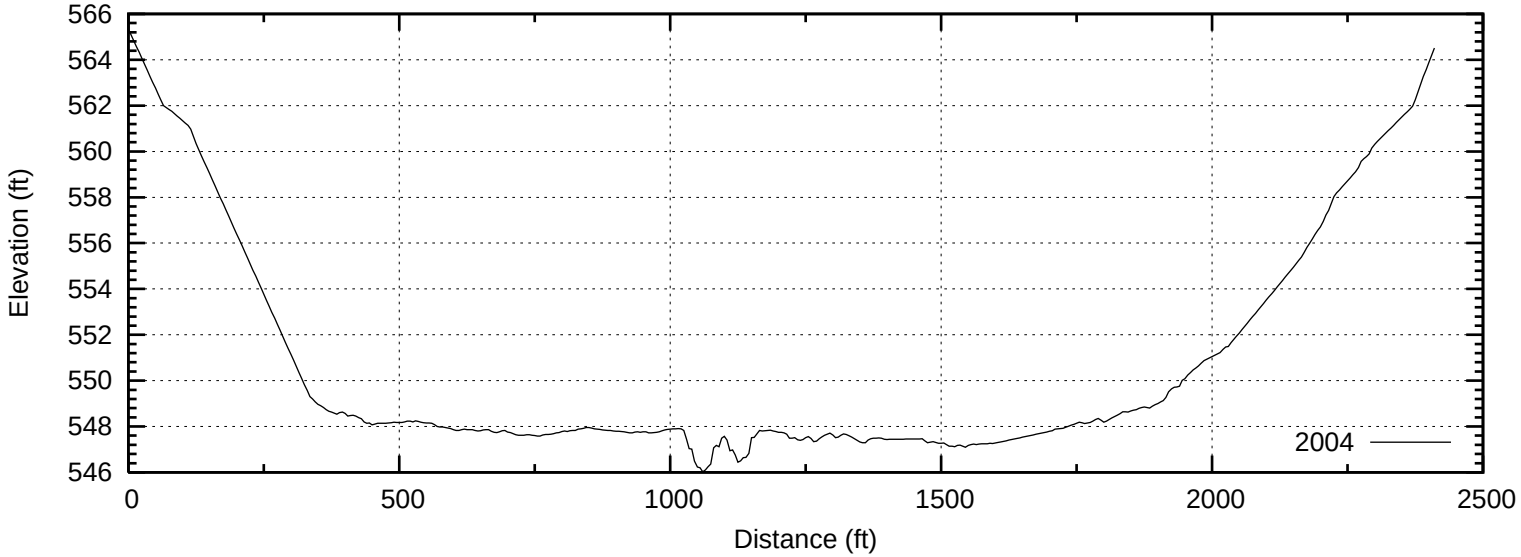
Range Line SR03



Range Line SR04



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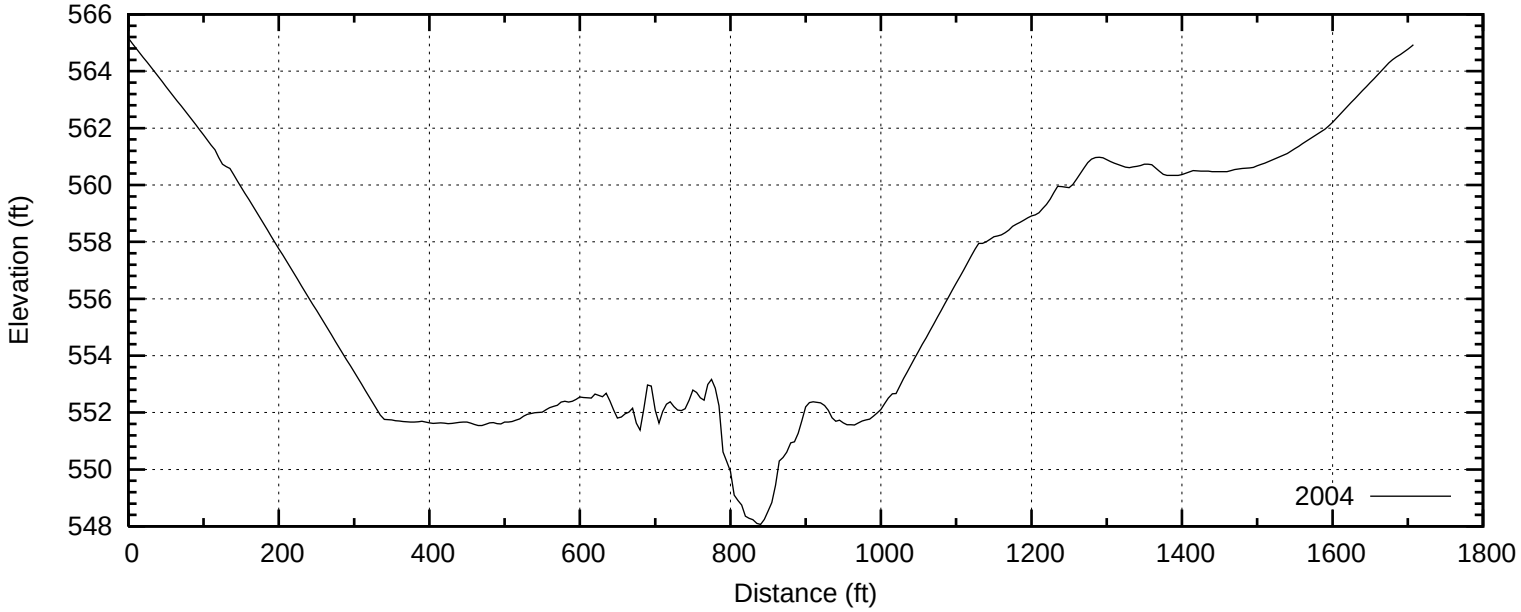
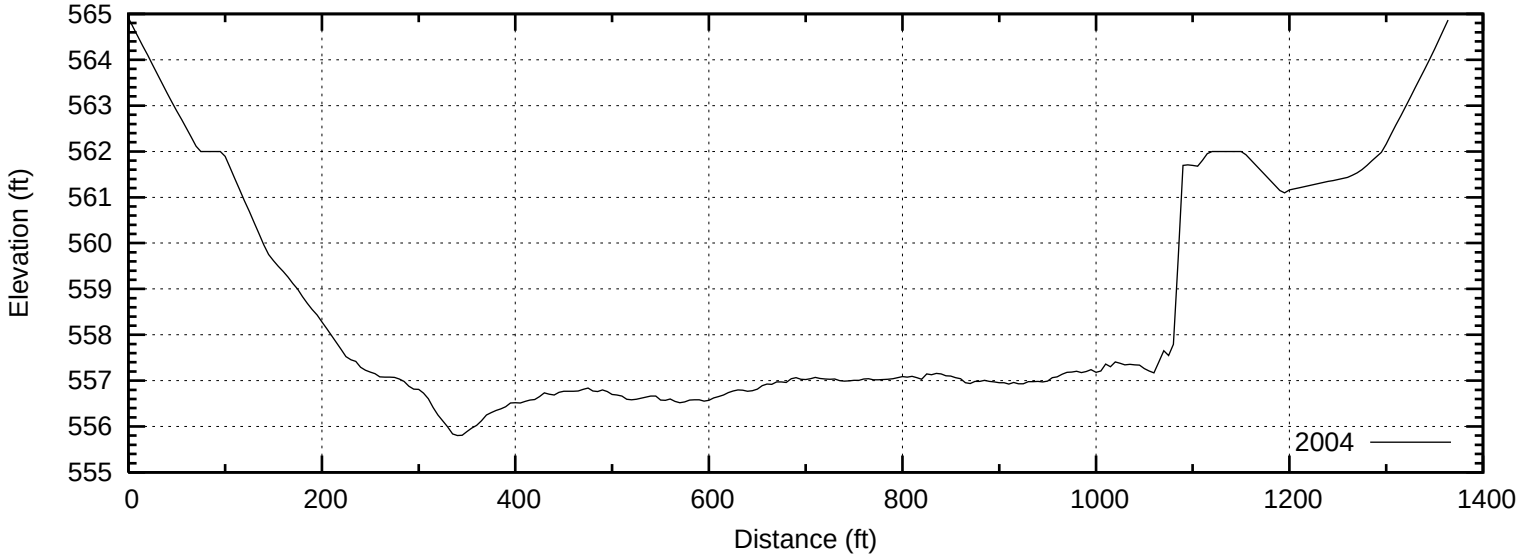
Range Line SR05



Range Line SR06



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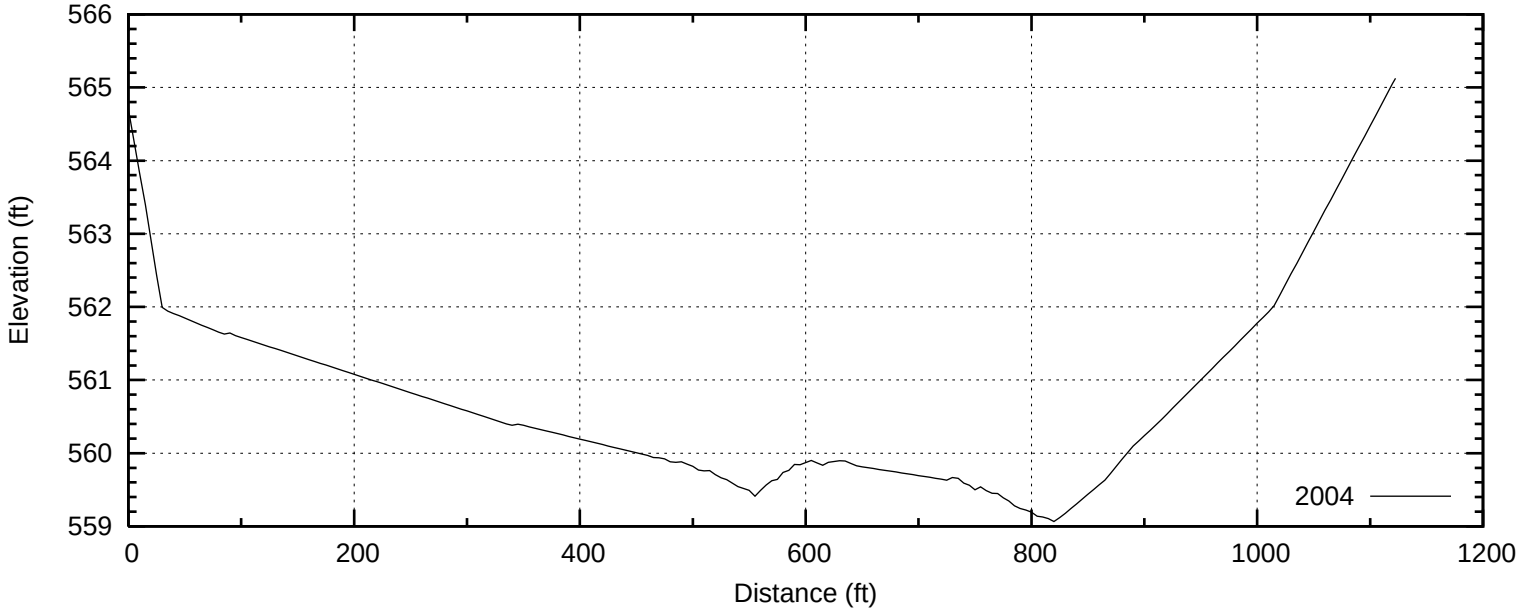
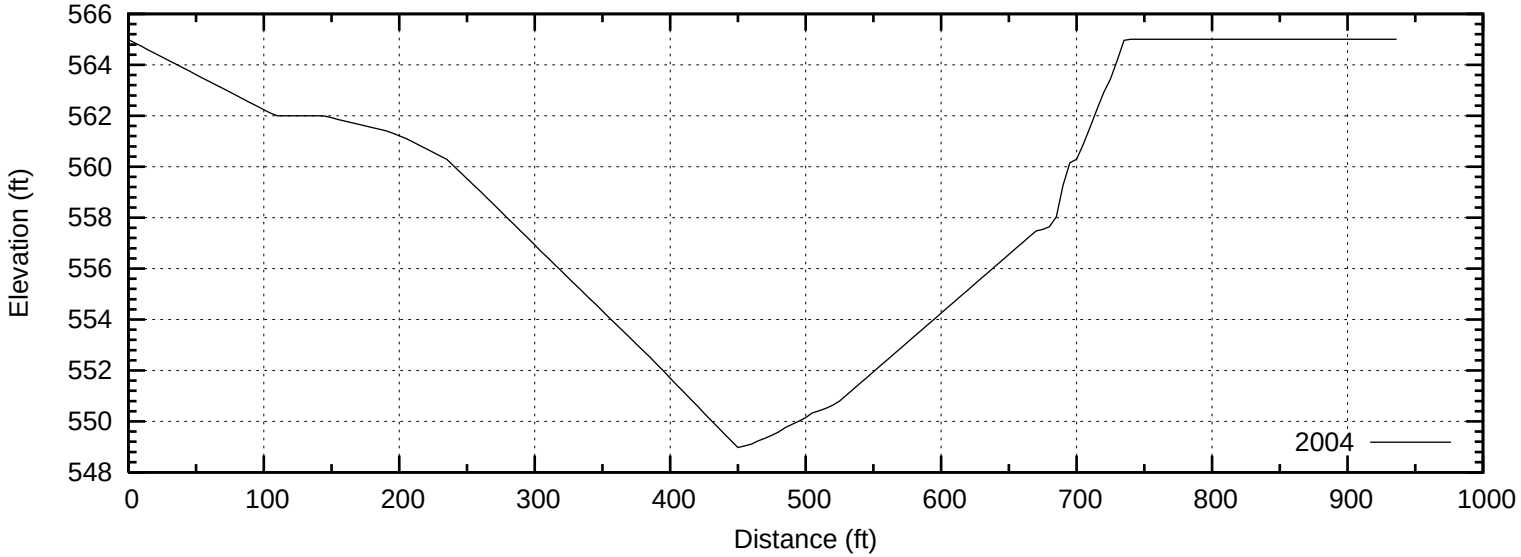
Range Line SR07



Range Line SR08



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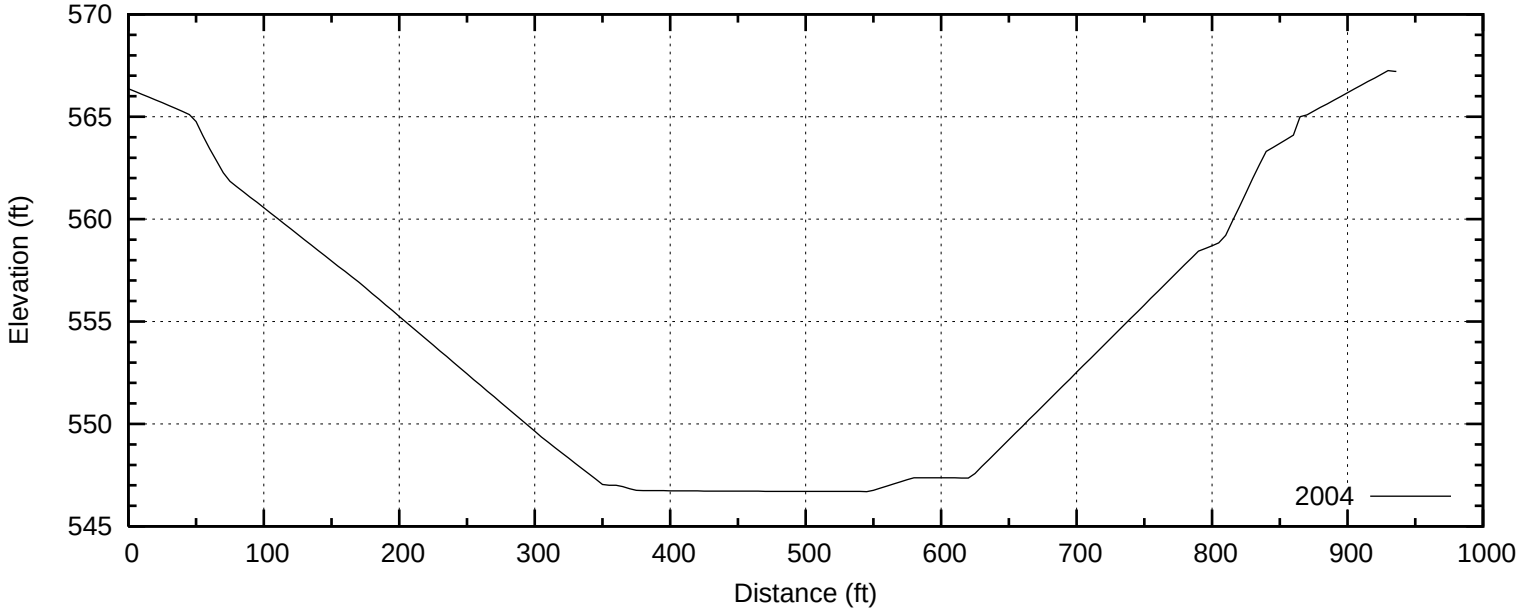
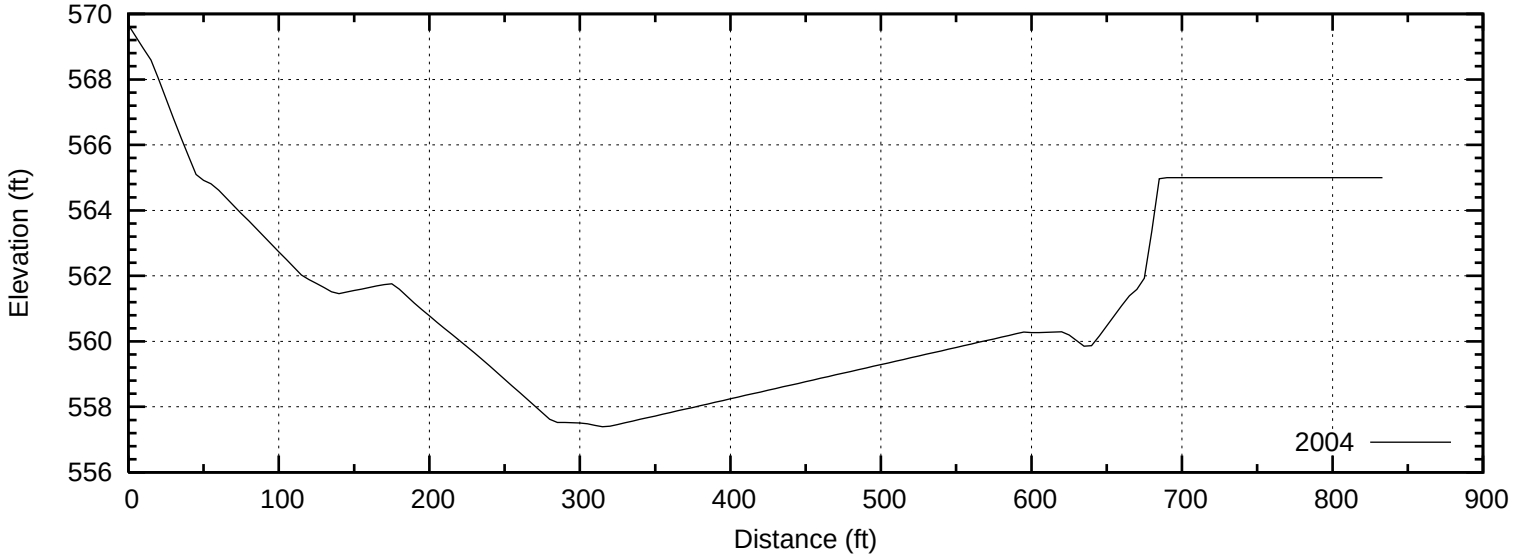
Range Line SR09



Range Line SR10



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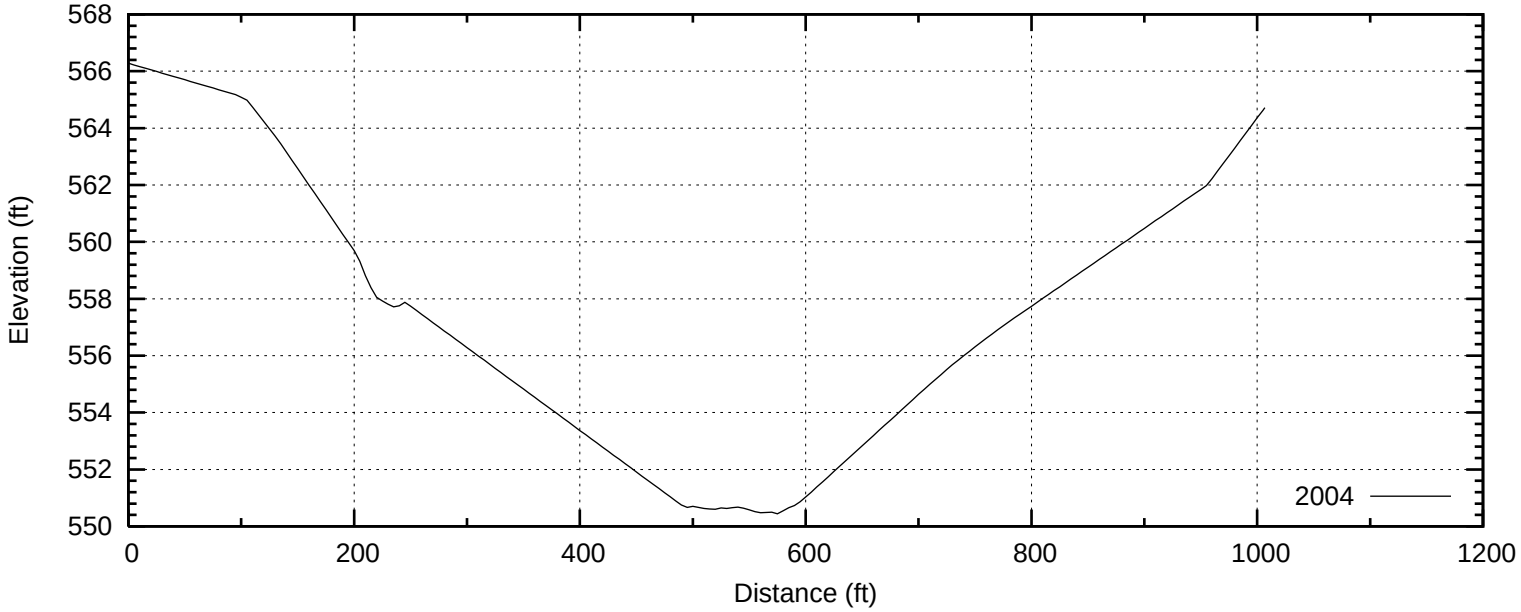
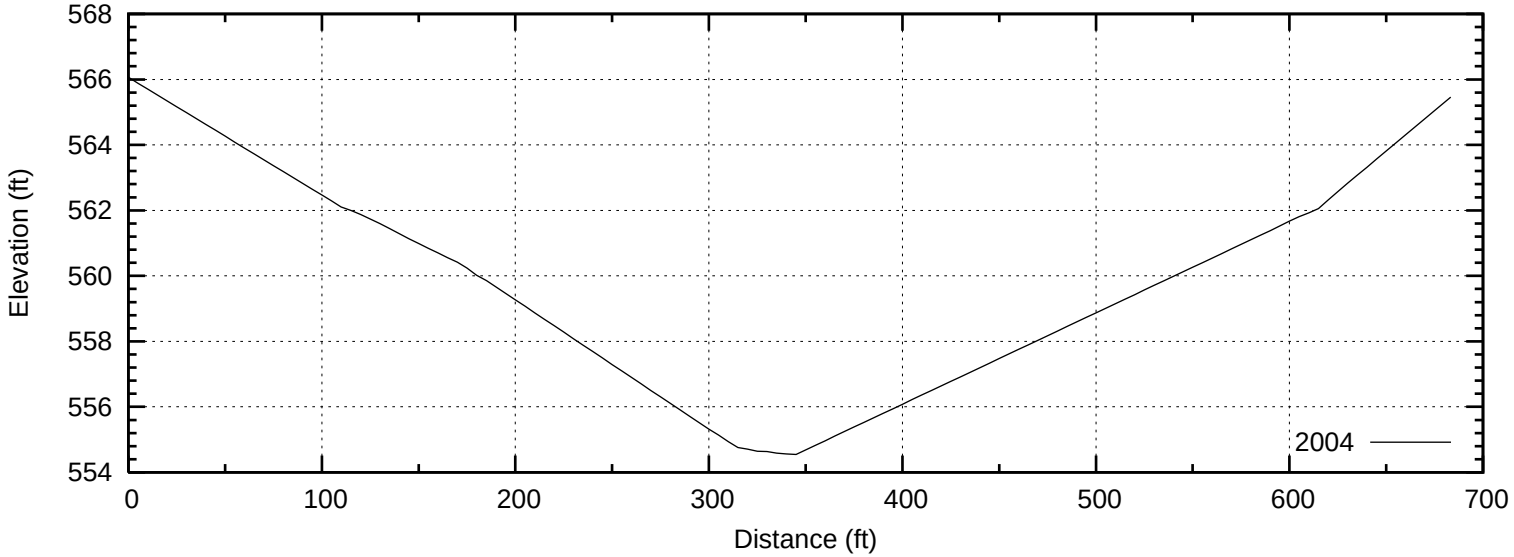
Range Line SR11

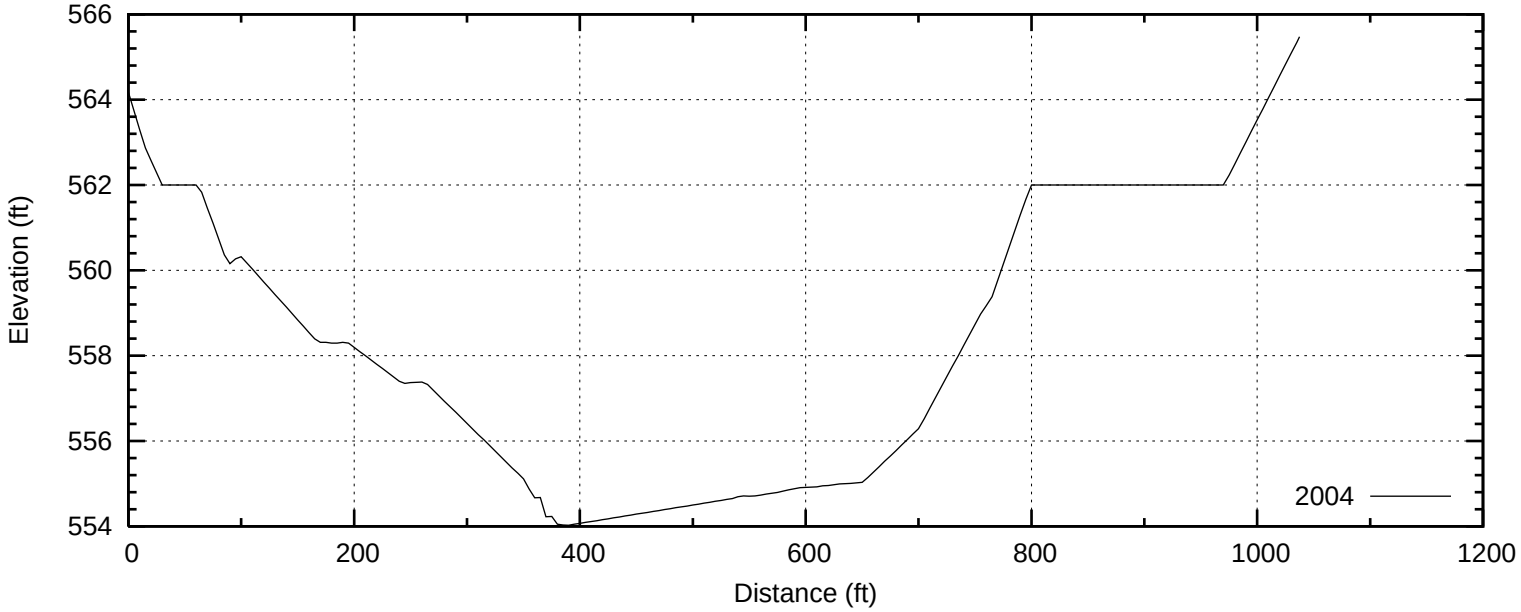


Range Line SR12



Lake Bonham

Range Line SR13



Range Line SR14