Volumetric Survey of LAKE AUSTIN

December 2008 Survey

Prepared by:

Texas Water Development Board

June 2010

Texas Water Development Board

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Prepared for:

City of Austin

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Executive Summary

In September of 2008, the Texas Water Development Board (TWDB) entered into agreement with the City of Austin, to perform a volumetric survey of Lake Austin. Lake Austin is located on the Colorado River in Travis County, inside the western city limits of Austin, Texas.

This survey was performed using a single-frequency (200 kHz) depth sounder and differential global positioning system navigation equipment. Data was collected along pre-planned survey lines spaced at approximately 500 foot intervals perpendicular to the submerged river channel. In areas of interest to the City of Austin, data points were also collected at 100 foot intervals for detailed analysis. Bathymetric data collection occurred December 12-19, 2008 during which the daily average water surface elevation of the lake ranged between 491.82 and 492.92 feet above mean sea level (NGVD 29). The conservation pool elevation for the lake is 492.8 feet above mean sea level, although the normal operating level of the lake is between 491.8 and 492.8 feet above mean sea level (NGVD 29).

Results of the TWDB 2008 volumetric survey indicate Lake Austin has a total reservoir capacity of 24,644 acre-feet and encompasses 1,589 acres at conservation pool elevation (492.8 feet above mean sea level, NGVD 29). TWDB previously surveyed Lake Austin in March of 1999. Comparisons of capacities at conservation pool elevation derived from current and previous surveys suggest Lake Austin gains approximately 44 acre-feet per year. To improve estimates of sediment accumulation or scouring rates, TWDB recommends resurveying Lake Austin in approximately 10 years or after a major flood event, and that the next lake survey is a sedimentation survey. In sedimentation surveys, TWDB collects sediment core samples and employs a multi-frequency depth sounder to measure both the water depth and the sediment thickness throughout the lake. Results from sedimentation surveys include computed sediment volumes, computed sediment accumulation rates, core sample analysis, and maps identifying the spatial distribution of accumulated sediment throughout the lake.

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Note: *References to brand names throughout this report do not imply endorsement by the Texas Water Development Board*

Introduction

The Hydrographic Survey Program of the Texas Water Development Board (TWDB) was authorized by the 72^{nd} Texas State Legislature in 1991. The Texas Water Code authorizes TWDB to perform surveys to determine reservoir storage capacity, sedimentation levels, rates of sedimentation, and projected water supply availability.

In September 2008, the Texas Water Development Board (TWDB) entered into agreement with the City of Austin, Texas, for the purpose of performing a volumetric survey of Lake Austin (TWDB, 2008). This report describes the methods used in conducting the volumetric survey, including data collection methods and data processing techniques. This report serves as the final contract deliverable from TWDB to the City of Austin, and contains as deliverables: (1) an elevation-area-capacity table of the lake acceptable to the Texas Commission on Environmental Quality [Appendix A, B], (2) a bottom contour map [Figure 5], and (3) a shaded relief plot of the lake bottom [Figure 3].

Lake Austin general information

The LCRA Act passed by the Texas Legislature in 1934 established the Lower Colorado River Authority (LCRA) as a "conservation and reclamation district" responsible for harnessing the Colorado River and its tributaries and making them productive for the people within its water service area. By 1951, LCRA had constructed six dams on the Colorado River. The string of lakes created by these dams is known as the Highland Lakes, and includes (from upstream to downstream) Lake Buchanan, Inks Lake, Lake Lyndon Baines Johnson (LBJ), Lake Marble Falls, Lake Travis, and Lake Austin. All of these lakes are owned and operated by the LCRA with the exception of Lake Austin, which is owned by the City of Austin but operated by LCRA (Lower Colorado Regional Water Planning Group, 2006a).

LCRA uses its Water Management Plan (LCRA, 2003) as a blueprint for operating the Highland Lakes as a system. Lakes Buchanan and Travis are operated primarily for water supply and flood control, while Inks Lake, Lake LBJ, Lake Marble Falls, and Lake Austin are pass-through reservoirs.

Tom Miller Dam and Lake Austin are located on the Colorado River (Colorado River Basin) in Travis County, inside the western city limits of Austin, Texas as shown on Figure 2. Tom Miller Dam is built atop the remains of two former dams that were destroyed in massive floods (LCRA, 2009d). Both these dams were known as Austin Dam and had created the lake known as Lake McDonald. The first dam was built from 1890 to 1893, and the second was built from 1909 to 1912 (LCRA, 2009d). Construction on the present day Tom Miller Dam, named for an Austin mayor, began on July 5, 1938, with deliberate impoundment beginning in 1939 (LCRA, 1971, 2009d). On March 31, 1940 the hydroelectric plant at Tom Miller Dam came on line (LCRA, 1971), fulfilling the original purpose for building Tom Miller Dam to provide hydroelectric power as well as water storage (LCRA, 2009d). Additional pertinent data about Tom Miller Dam can be found in Table 1.

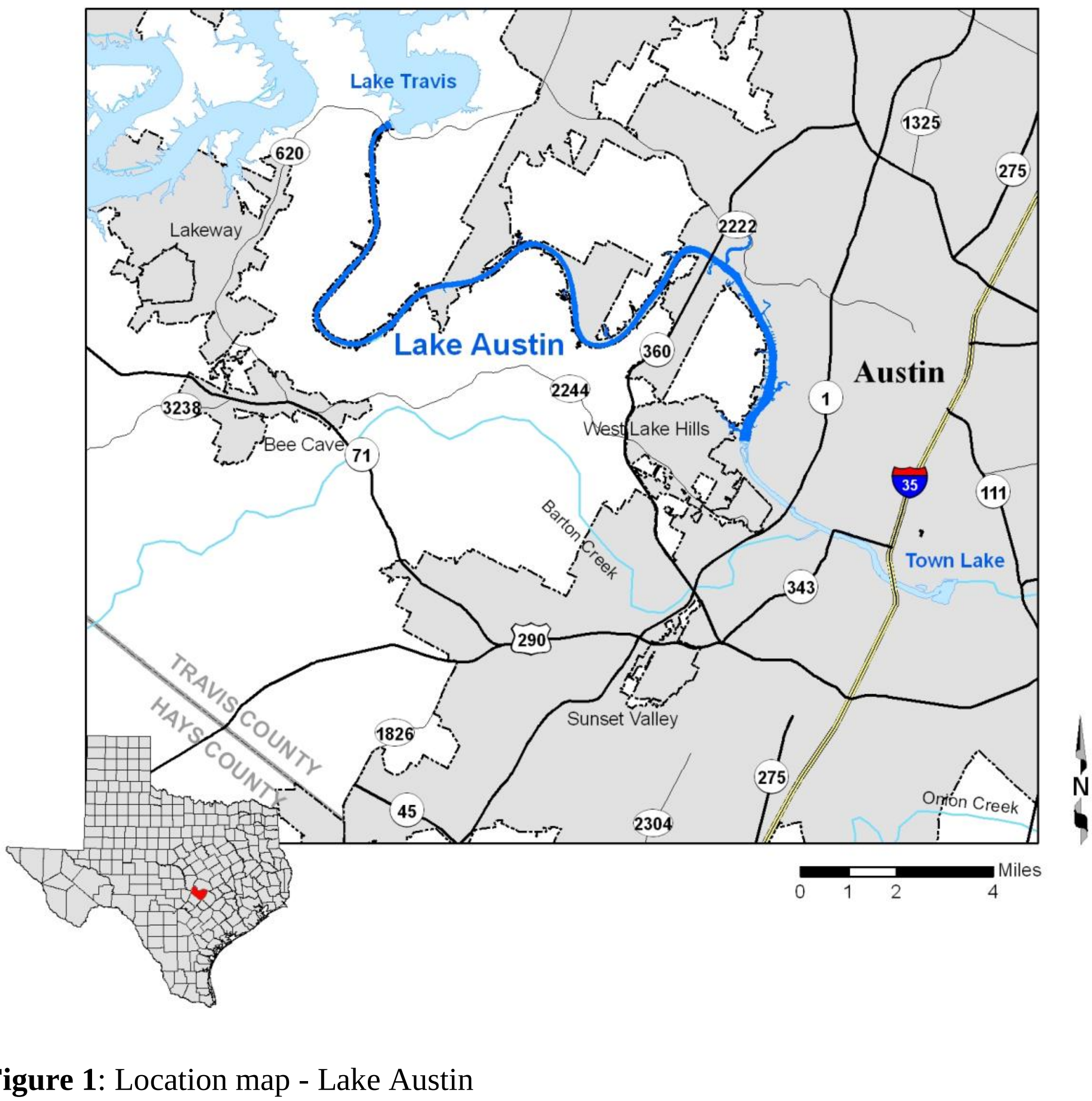

Figure 1: Location map - Lake Austin

Table 1. Pertinent data for Tom Miller Dam and Lake Austin (LCRA, 1971, 2009d)

Owner

The City of Austin. Built and operated by the Lower Colorado River Authority.

Engineer (Design)

Lower Colorado River Authority.
Moran, Proctor and Freeman were consultants.

Location of Dam

On the Colorado River in Travis County, inside the western city limits of Austin.

Drainage Area

38,240 square miles, of which 11,900 is probably noncontributing. Runoff is largely regulated by upstream storage and power plant operation.

Dam

Type	Concrete gravity overflow, pier and slab with gated spillway, and rock fill sections.
Length	1,590 feet
Height (top non-overflow section)	85 feet
Height (top of bridge)	100 feet

Spillway (uncontrolled)

Type	Concrete ogee
Length	458 feet
Crest elevation	492.8 feet above mean sea level

Spillway (gated)

Type	Concrete ogee
Length (net)	459 feet
Crest elevation	480.8 feet above mean sea level for the 12 foot gates
Control	5 tainter gates, each 51 by 12 feet 4 tainter gates, each 51 by 18 feet Actual vertical dimension of gates are 14.7 and 19.85 feet

Outlet Works

None. Water releases made through turbine operation.

Power Features

Two generating units each, 7,500 kw capacity
The turbines are automatic adjustable blade propeller-type.

Reservoir Data (Based on 2008 Texas Water Development Board survey)

Feature	Elevation (feet above mean sea level)	Capacity (Acre-feet)	Area (Acres)
Top of dam	519.0	N/A	N/A
Uncontrolled spillway crest\ Top of conservation pool	492.8	24,644[b]	1,589
Gated spillway crest	480.8	9,387	966
Davis Water Treatment Plant intake	475.0[a]	4,822	626
Ullrich Water Treatment Plant intake	466.0[a]	1,180	201
Sediment pool	462.0	613[c]	93
Usable storage		24,031[d]	
Streambed	441.0	N/A	N/A

[a] *Source:* Austin et al, 2001
[b] Total reservoir capacity
[c] The sediment pool or dead pool storage is that capacity of water below the invert of the lowest outlet
[d] Conservation Storage Capacity (Total Reservoir Capacity minus Sediment Pool Storage)

Water rights

The water rights for Lake Austin were appropriated to the City of Austin through Certificate of Adjudication No. 14-5471 and its amendments. The City supplies water to many customers, including customers within and outside the corporate city limits of Austin, as well as the communities of Rollingwood, Sunset Valley, Pflugerville, and Round Rock, one water control and improvement district, five water supply corporations, seven municipal utility districts, and three private utilities (City of Austin, 2009). A brief summary of the certificate and amendments follows. The complete certificates are on file in the Records Division of the Texas Commission on Environmental Quality.

Certificate of Adjudication No. 14-5471

Priority Date: June 30, 1913

This certificate authorizes the City of Austin to maintain an existing dam and reservoir on the Colorado River (Tom Miller Dam and Lake Austin), and to impound therein up to 21,000 acre-feet of water. The City of Austin is authorized to divert and use a maximum of 250,000 acre-feet of water per year from Lake Austin for municipal purposes and 150 acre-feet of water per year for irrigation purposes. The City of Austin is authorized to use the water impounded for recreation purposes. The City of Austin is further authorized to divert and use water through Tom Miller Dam for the generation of hydroelectric power, though subject to several conditions.

Amendment to Certificate of Adjudication No. 14-5471A

Granted: March 20, 1991

This amendment combines the City of Austin's water rights authorized under Certificate Numbers 14-5471, 14-5472, and 14-5490, authorizing the City to maintain the existing dams and reservoirs as follows: Tom Miller and Lake Austin, Longhorn Dam and Town Lake, and Barton Springs Pool. Under this combined certificate, the City of Austin is authorized to divert and use a maximum of 271,403 acre-feet of water per year from Lake Austin and Town Lake for municipal purposes; to temporarily change the purpose of use of 1000 acre-feet of the above municipal authorization to irrigation purposes and to divert said water from Lake Austin, Town Lake, and Barton Springs Pool for a period of time ending December 31, 2011, at which time the 1000 acre-feet of water will revert to municipal use; and to divert and use a maximum of 150 acre-feet of water per year from

Lake Austin, Town Lake, and Barton Springs Pool for irrigation purposes. The City of Austin also retains its rights to release water for hydroelectric power generation and interbasin transfers, subject to several conditions.

Amendment to Certificate of Adjudication No. 14-5471B
Granted: July 30, 1999

In addition to the current authorization to divert and use water from Town Lake (now Ladybird Lake) for industrial (cooling purposes), the City of Austin is authorized to divert water from a point on the Colorado River in Fayette County and from Cedar Creek Reservoir on Cedar Creek for industrial (cooling purposes) at the Fayette Power Project. The total amount of water diverted at the Fayette Power Project and the amount of water consumed from Town Lake shall not exceed 24,000 acre-feet per year.

Amendment to Certificate of Adjudication No. 14-5471C

Granted: January 31, 2005

In addition to the current diversion points in certificate 14-5471B, the City of Austin is authorized to divert, circulate and recirculate the maximum combined amount of 24,000 acre-feet of water per year from an additional diversion point, at a maximum diversion rate of 13.93 cfs (6,250 gpm), located near the confluence of the Colorado River and Onion Creek for industrial (cooling) purposes at the Sand Hill Energy Center.

Volumetric survey of Lake Austin

Datum

The vertical datum used during this survey is that used by the United States Geological Survey (USGS) for the reservoir elevation gage USGS 08154900 LCRA Lk Austin at Austin, TX (USGS, 2009). The datum for this gage is reported as National Geodetic Vertical Datum 1929 (NGVD 29). Elevations reported here are in feet above mean sea level, NGVD29. Volume and area calculations in this report are referenced to water levels provided by the USGS gage. The horizontal datum used for this report is North American Datum of 1983 (NAD83), and the horizontal coordinate system is State Plane Texas Central Zone (feet).

TWDB bathymetric data collection

Bathymetric data collection occurred December 12-19, 2008, during which the daily average water surface elevation of the lake ranged between 491.82 and 492.92 feet above mean sea level (NGVD 29). Bathymetric data was collected with a Knudsen Engineering Ltd. single-frequency (200 kHz) depth sounder integrated with differential global positioning system (DGPS) equipment. The DGPS unit, used at the request of the City of Austin, has a better than 10 centimeter horizontal accuracy. Data collection occurred while navigating along pre-planned range lines oriented perpendicular to the location of the original river channels and spaced approximately 500 feet apart. In areas of interest specified by the City of Austin, data was collected at approximately 100 feet intervals. Many of the survey lines were those originally surveyed by TWDB during the 1999 Lake Austin volumetric survey.

Each day prior to beginning the survey, TWDB used a weighted tape and stadia rod to physically verify the depth readings recorded by the depth sounder. During the 2008 survey, team members collected approximately 550,673 data points over cross-sections totaling 58.55 miles in length. Figure 2 shows where data points were collected during the TWDB 2008 survey.

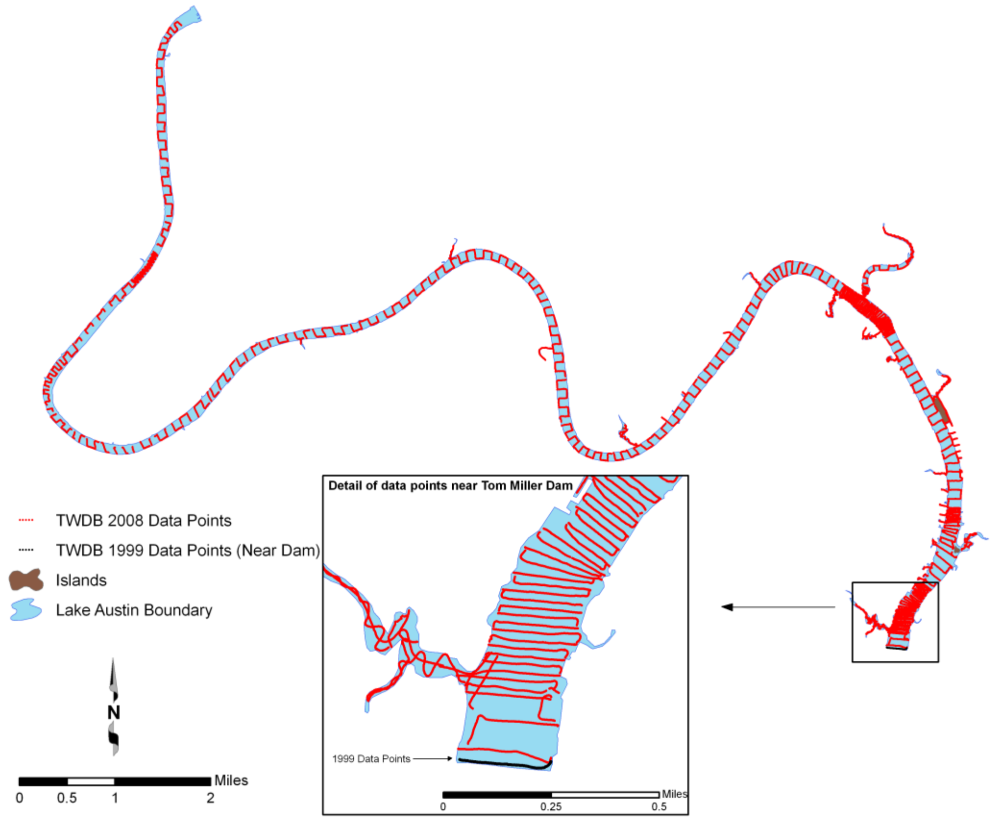

Figure 2: Map of data collected during TWDB Survey (including data extracted from the 1999 survey data set)

Data processing

Model boundary

The reservoir boundary was digitized from digital ortho quarter-quadrangle photographs (DOQQs) obtained from the Texas Natural Resources Information System (TNRIS), using Environmental Systems Research Institute's (ESRI) ArcGIS 9.2 software (NAIP, 2006, TNRIS, 2009). The DOQQs that cover Lake Austin include Austin West NW, Austin West NE, Austin West SE, Bee Cave NE, and Mansfield Dam SE. These DOQQs were photographed on June 1, 2007 and July 27, 2007, during which the water surface elevation was 492.1 and 492.2 feet above mean sea level, respectively. The 2007 DOQQs are of 1-meter resolution. For this analysis, it was determined that the boundary digitized at the land water interface in the photographs is a reasonable approximation of the lake boundary at conservation pool elevation. Therefore, the delineated boundary was given an elevation of 492.8 feet to facilitate calculating the area-capacity tables up to the conservation pool elevation.

Triangulated irregular network (TIN) model

Upon completion of the data collection effort, the raw data files collected by TWDB were edited using customized MATLAB processing scripts and the HydroEdit software package. Specifically, HydroEdit applies a median filter to the raw survey data and removes individual data anomalies or points with incorrect GPS coordinates. HydroEdit also uses the water surface elevation at the time of each sounding to convert sounding depths to corresponding bathymetric elevations. The MATLAB processing scripts are then used to visually inspect each of the filtered cross-sections to identify and rectify any series of data anomalies that were not edited using the HydroEdit filters. In the upper reaches of the lake hydrilla and other plant growth were prominent. Therefore, the data was further edited manually using the survey software Hypack Max. To allow processing outside of MATLAB, HydroEdit, and Hypack Max, the sounding coordinates (X,Y,Z) are exported as a “mass points” file. Additionally, a line of data directly adjacent to Tom Miller Dam was extracted from the TWDB 1999 survey data set and used to supplement the 2008 survey data set and TIN model (Figure 2). Using the self-similar interpolation technique (described below), TWDB interpolated bathymetric elevation data located in-between surveyed cross sections. To better represent reservoir bathymetry in shallow regions, TWDB used the line extrapolation technique (described below) (Furnans, 2006).

To create a surface representation of the Lake Austin bathymetry, the 3D Analyst Extension of ArcGIS (ESRI, Inc.) is used. This extension allows for the creation of a triangulated irregular network (TIN) model of the bathymetry, where each data point and boundary node becomes the vertex of a triangular portion of the reservoir bottom surface (ESRI, 1995). From the TIN model, reservoir capacities and areas are calculated at one-tenth of a foot (0.1 foot) intervals, from elevation 441.0 feet to elevation 492.8 feet.

The elevation-capacity and elevation-area tables, updated for 2008, are presented in Appendices A and B, respectively. The area-capacity curves are presented in Appendix C. Elevations in the tables and area-capacity curves are referenced to the NGVD 29 datum.

The Lake Austin TIN model was interpolated and averaged using a cell size of 1 foot by 1 foot and converted to a raster representation. The raster representation was used to produce an elevation relief map representing the topography of the reservoir bottom (Figure 3), a map showing shaded depth ranges for Lake Austin (Figure 4), and a 5-foot contour map (Figure 5 - attached). The reservoir extent depicted in these figures is that corresponding to elevation 492.8 feet.

Self-similar interpolation

The 3D Analyst extension utilizes the Delaunay method for triangulation. A limitation of the Delaunay method for triangulation when creating TIN models results in unnatural contour lines extending into the reservoir where the reservoir walls are steep and the reservoir is relatively narrow. These contours are likely a poor representation of the true reservoir bathymetry in these areas. Also, if the surveyed cross sections are not perpendicular to the centerline of the submerged river channel (the location of which is often unknown until after the survey), then the TIN model is not likely to well-represent the true channel bathymetry.

To ameliorate these problems, a self-similar interpolation routine (developed by TWDB) was used to interpolate the bathymetry between the 500 and 100 foot-spaced survey lines. The interpolation effectively increases the density of points input into the TIN model, and precisely directs the TIN interpolation of the reservoir topography (Furnans, 2006). In the case of Lake Austin, the interpolation helped represent the lake morphology near the banks and the submerged river channel (Figure 6). In areas where obvious geomorphic features indicate a high-probability of cross-section shape changes (e.g. incoming tributaries, significant widening/narrowing of channel, etc.), the assumptions used in applying the interpolation are not likely to be valid; therefore, self-similar interpolation was not used in areas of Lake Austin where a high probability of change between cross-sections exists. Figure 6 illustrates typical results of the application of the interpolation of Lake Austin. The bathymetry shown in Figure 6C, in which self-similar interpolation was applied, was used in computing reservoir capacity and area tables (Appendix A, B).

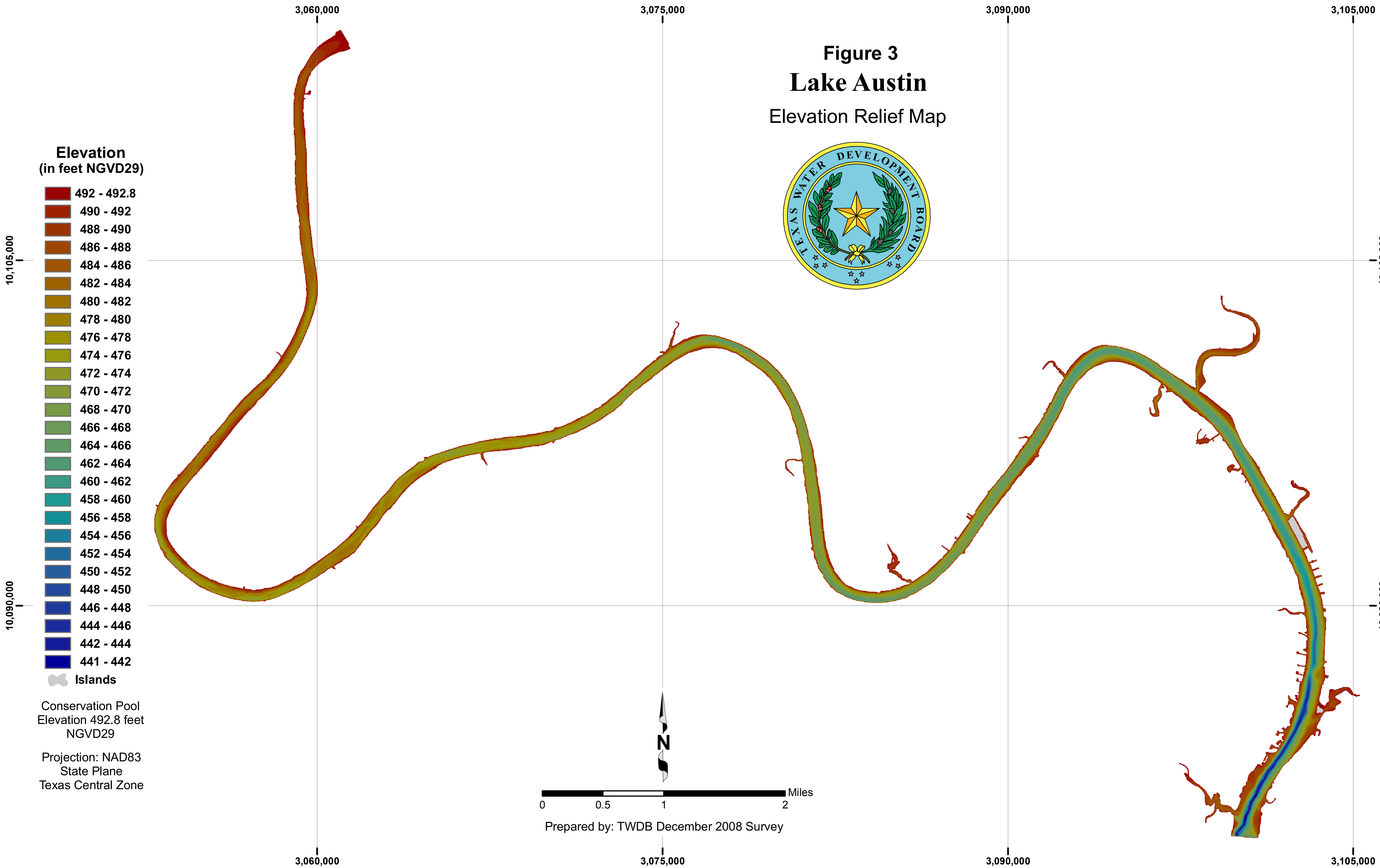

Figure 3
Lake Austin
Elevation Relief Map
TEXAS WATER DEVELOPMENT BOARD
Elevation
(in feet NGVD29)
492 - 492.8
490 - 492
488 - 490
486 - 488
484 - 486
482 - 484
480 - 482
478 - 480
476 - 478
474 - 476
472 - 474
470 - 472
468 - 470
466 - 468
464 - 466
462 - 464
460 - 462
458 - 460
456 - 458
454 - 456
452 - 454
450 - 452
448 - 450
446 - 448
444 - 446
442 - 444
441 - 442
Islands
Conservation Pool
Elevation 492.8 feet
NGVD29
Projection: NAD83
State Plane
Texas Central Zone
3,060,000
3,075,000
3,090,000
3,105,000
10,105,000
10,090,000
N
0
0.5
1
2
Miles
Prepared by: TWDB December 2008 Survey

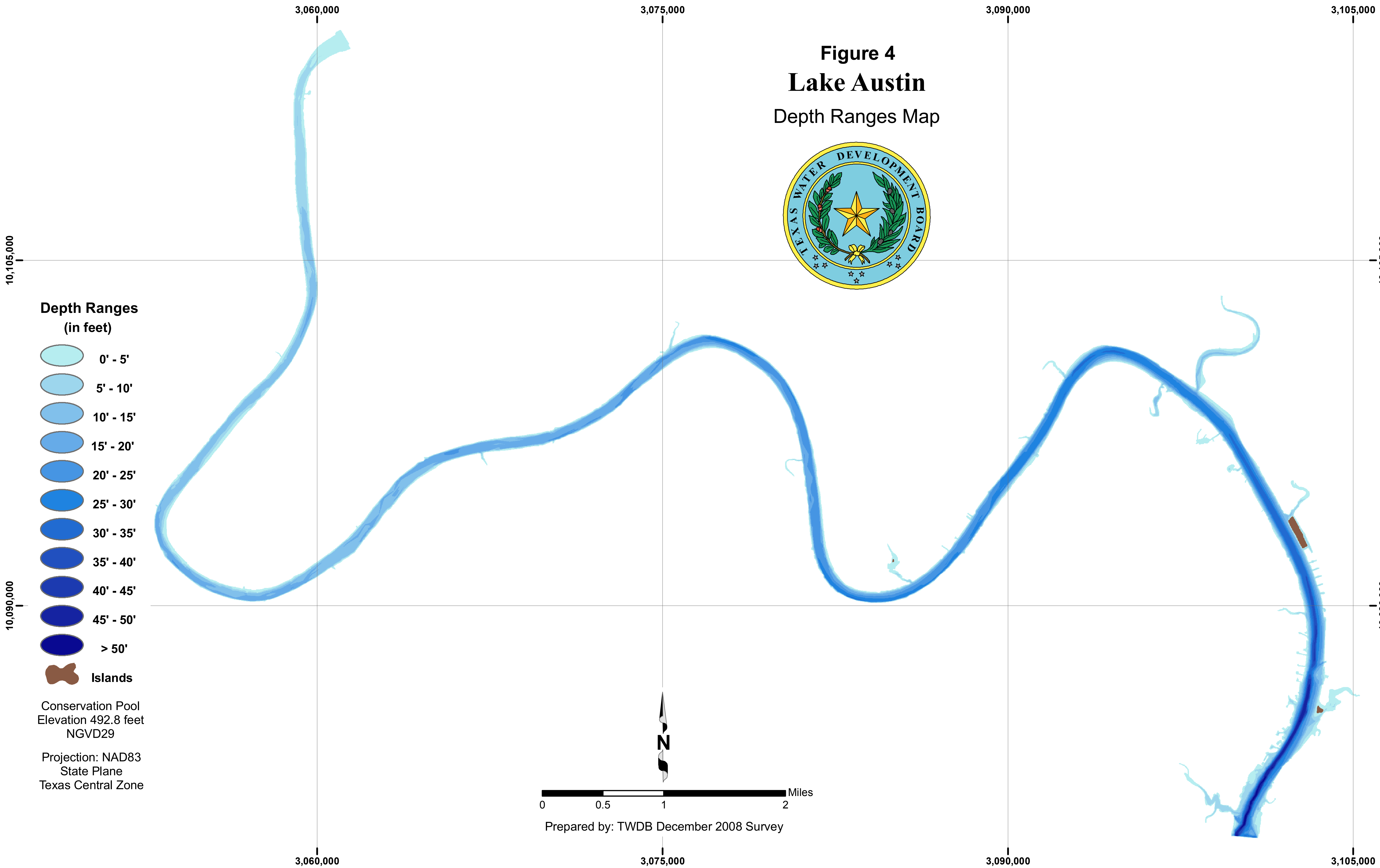

Figure 4
Lake Austin
Depth Ranges Map
TEXAS WATER DEVELOPMENT BOARD
3,060,000
3,075,000
3,090,000
3,105,000
10,105,000
10,090,000
Depth Ranges
(in feet)
0' - 5'
5' - 10'
10' - 15'
15' - 20'
20' - 25'
25' - 30'
30' - 35'
35' - 40'
40' - 45'
45' - 50'
> 50'
Islands
Conservation Pool
Elevation 492.8 feet
NGVD29
Projection: NAD83
State Plane
Texas Central Zone
N
0
0.5
1
2
Miles
Prepared by: TWDB December 2008 Survey

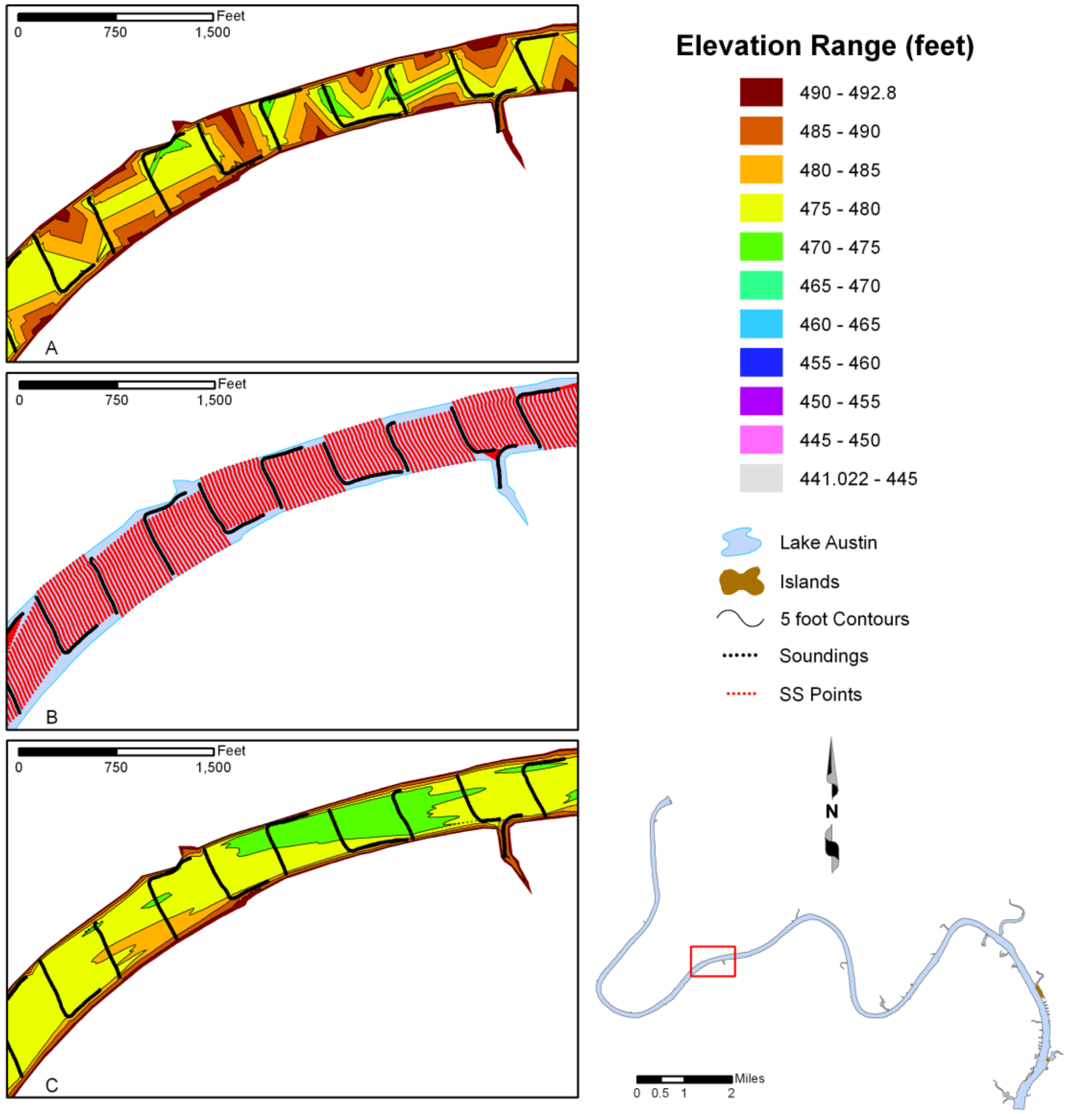

Figure 6: Application of the self-similar interpolation technique – A) bathymetric contours without interpolated points, B) Sounding points (black) and interpolated points (red) with reservoir boundary shown at elevation 492.8 feet above mean sea level, C) bathymetric contours with the interpolated points. Note: In 7A the deeper channels indicated by the surveyed cross sections are not continuously represented in the areas in-between the cross sections. This is an artifact of the TIN generation routine, rather than an accurate representation of the physical bathymetric surface. Inclusion of the interpolated points (6C) corrects this and smoothes the bathymetric contours.

Line extrapolation

In order to estimate the bathymetry within the small coves and other un-surveyed portions of Lake Austin, TWDB applied line extrapolation, which is similar to self-similar interpolation discussed above. TWDB uses line extrapolation to extrapolate bathymetries in small coves where water depths are too shallow to allow boat passage. Line extrapolation requires the user to define (1) a longitudinal axis approximately bisecting the small cove, (2) the elevation at the beginning of the longitudinal axis, (3) the number of cross sections along the longitudinal axis, and (4) the number of points between the longitudinal axis and the cove boundary. The starting elevation of the longitudinal axis is typically assumed equivalent to the elevation of the TIN model near the beginning of the longitudinal line or estimated based on the nearest surveyed depth.

Line extrapolation assumes a V-shaped profile for cross-sections within the extrapolation area, with the deepest section of the profile located along the longitudinal axis. Elevations along the longitudinal axis are interpolated linearly based on the distance along the axis from the start (nearest the reservoir interior) to the end (where the axis crosses the reservoir boundary). The elevations at points along each extrapolated cross-section are linearly interpolated from an elevation on the longitudinal axis (at the intersection with the cross-section) and the elevation at the extrapolation area boundary. Figure 7 illustrates line extrapolation as applied to Lake Austin.

The inherent assumption of line extrapolation is that a V-shaped cross-section is a reasonable approximation of the actual unknown cross-section within the extrapolated area. As of yet, TWDB has been unable to test this assumption, and therefore can only assume that the results of the usage of line extrapolation are more accurate than those derived without line extrapolation. The use of a V-shaped extrapolated cross-section likely provides a conservative estimate of the water volume in un-surveyed areas, as most surveyed cross-sections within Lake Austin had shapes more similar to U-profiles than to V-profiles. The V-profiles are thus conservative in that a greater volume of water is implied by a U-profile than a V-profile. Further information on line extrapolation is provided in the HydroEdit User's Manual (Furnans, 2006).

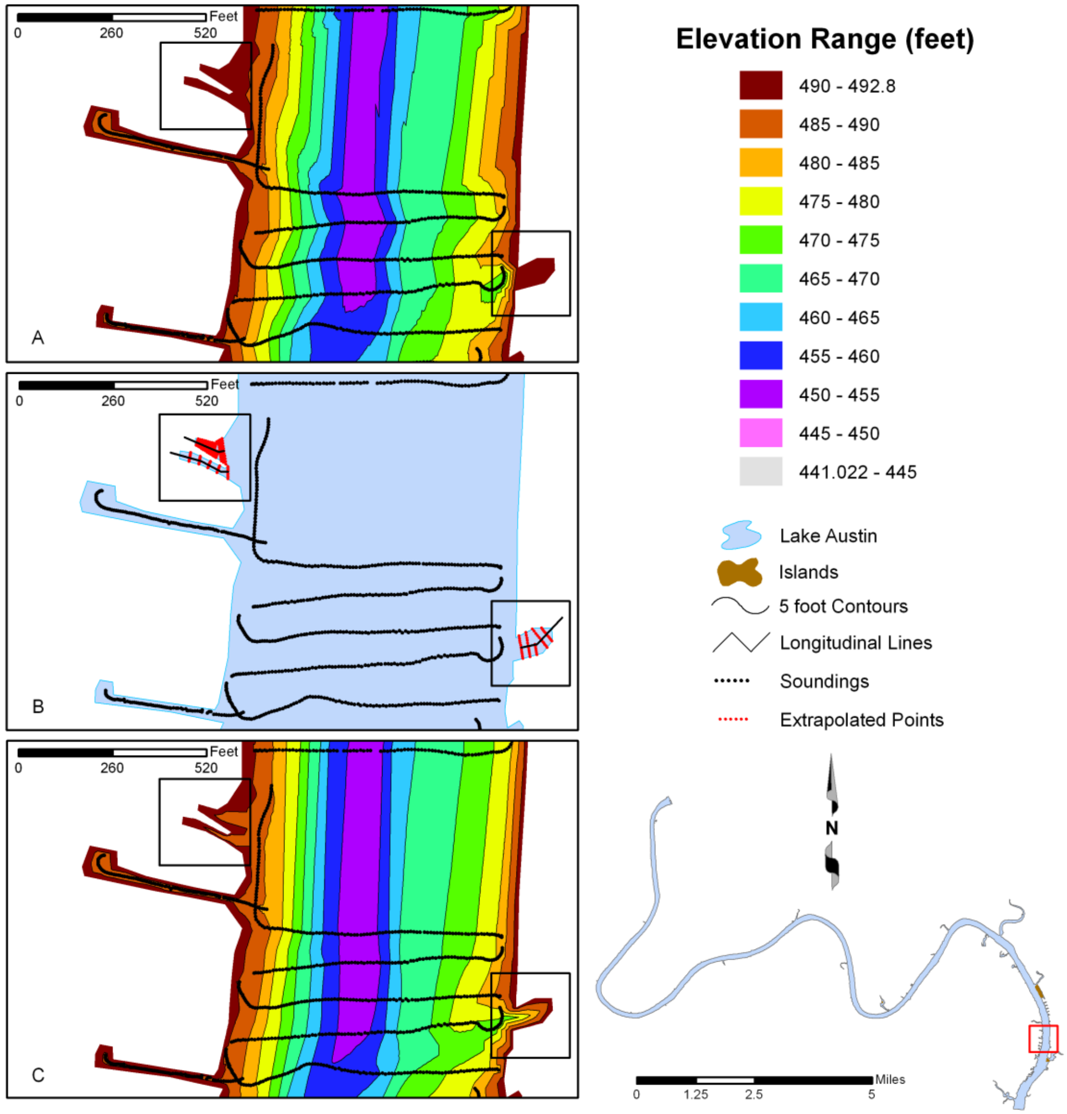

Figure 7: Application of the line extrapolation technique to Lake Austin sounding data – A) bathymetric contours without extrapolated points, B) Sounding points (black) and extrapolated points (red) with reservoir boundary shown at elevation 492.8 feet above mean sea level, and C) bathymetric contours with the extrapolated points. Note: In 7A the bathymetric contours do not extend into the un-surveyed area and "flat" triangles are formed connecting the nodes of the reservoir boundary. This is an artifact of the TIN generation routine when data points are too far apart or are absent from portions of the reservoir. Inclusion of the extrapolated points (7C) corrects this and smoothes the bathymetric contours.

Volumetric survey results

The results of the TWDB 2008 volumetric survey indicate Lake Austin has a total reservoir capacity of 24,644 acre-feet and encompasses 1,589 acres at conservation pool elevation (492.8 feet above mean sea level, NGVD 29).

The original capacity of Lake Austin at conservation pool elevation was calculated by the Lower Colorado River Authority in 1939 to be 21,000 acre-feet (LCRA, 1971). TWDB previously surveyed Lake Austin in March of 1999. Differences in past, present, and future methodologies makes direct comparison of volumetric surveys potentially unreliable. TWDB also does not recommend directly comparing results from one TWDB survey to the next unless the data from each survey was collected and processed using similar techniques.

To properly compare results from TWDB surveys of Lake Austin, TWDB applied the 2008 data processing techniques to the survey data collected in 1999. Specifically, TWDB applied the self-similar interpolation and line extrapolation techniques to the 1999 survey dataset (Furnans, 2006). A revised TIN model was created using the boundary from the original 1999 survey. The 1999 survey boundary was created from 7.5 minute USGS quadrangle maps, with a stated accuracy of ± ½ the contour interval (City of Austin, 1984). As presented in Table 2, revision of the 1999 survey using current TWDB data processing methods resulted in a 2,442 acre-feet (11.2 %) increase in reservoir capacity. Such an increase is typical for lakes of similar size and shape as Lake Austin, and is due to the improved representation of the lake bathymetry between adjacent cross sections obtained with interpolation (see Figure 6, Figure 7, and sections entitled Self-similar interpolation and Line extrapolation).

Table 2 – Current and previous survey capacity and surface area data*

Survey	Area (Surface acres)	Capacity (Acre-feet)
LCRA 1939	1,830	21,000
TWDB 1999	1,599	21,804
TWDB 1999 (Revised)	1,599	24,246
TWDB 2008	1,589	24,644

*Since completion of current Tom Miller Dam

Theoretically, comparing lake volumes from multiple lake surveys allows for calculation of capacity loss rates, and if all lost capacity is due to sediment accumulation, then comparisons of lake volumetric surveys would yield sediment accumulation rates. In practice, however, the differences in methodologies used in each lake survey may yield greater differences in computed lake volumes than physical volume differences due to sediment accumulation over time. In addition, because volumetric surveys are not exact, small losses or gains in sediment may be masked by the imprecision of the computed volumes. For this reason, TWDB prefers to estimate sediment accumulation rates through sedimentation surveys, which directly measure the sediment layer thicknesses throughout the reservoir. The sediment accumulation rates derived from such surveys reflect the average rate of sediment accrual since the time of impoundment. However, the values shown in Table 3 suggest a general trend of increasing lake capacity.

Table 3 – Volume comparisons for Lake Austin

	Volume Comparisons @ CPE (acre-feet)		
Survey	Comparison #1	Comparison #2	Comparison #3
1939	21,000	21,000	
1999 Revised	24,246	<>	24,246
2008	<>	24,644	24,644
ΔV	3,246 (15.5%)	3,644 (17.4%)	398 (1.6%)
# of Years	60	69	15
Capacity Change Rate	+54 Acre-ft/Year	+53 acre-ft/year	+44 acre-ft/year

The TWDB did not investigate the validity of the results of the 1939 capacity estimates for Lake Austin. Comparisons between the most recent TWDB surveys of Lake Austin suggest that Lake Austin gained 398 acre-feet of capacity, an average of approximately 44 acre-feet per year, between 1999 and 2008. TWDB did not attempt to determine a potential cause for the increase in capacity between surveys. Such differences could indicate sediment removal from the lake, or might be attributed to differences in the extent of data collection efforts within each survey. Spatial comparisons of the bathymetry from the 1999 and 2008 survey may indicate whether the reported volume increase is due to sediment scour or due to simple differences in data collection locations between surveys.

Recommendations

TWDB recommends resurveying Lake Austin in 10 years or after a major flood event to improve estimated capacity changes occurring in the reservoir. In an attempt to improve Lake Austin capacity estimates, TWDB recommends conducting a combined volumetric and sedimentation survey. For sedimentation surveys, TWDB employs a multi-frequency depth sounder to measure both the water depth and the sediment thickness throughout the lake. TWDB also collects sediment core samples as direct spot-measurements of accumulated sediment. These measurements are used in assessing the multi-frequency sounding data and deriving lake-wide sediment thickness datasets. Results from sedimentation surveys include current reservoir capacities, computed sediment volumes, and maps identifying the spatial distribution of sediment throughout the lake.

TWDB Contact Information

More information about the TWDB Hydrographic Survey Program can be found at: http://www.twdb.state.tx.us/assistance/lakesurveys/volumetricindex.asp

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Appendix A

Lake Austin

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD — DECEMBER 2008 SURVEY

CAPACITY IN ACRE-FEET — Conservation Pool Elevation 492.8 Feet NGVD 29

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
441	0	0	0	0	0	0	0	0	0	0
442	0	1	1	1	1	1	2	2	2	3
443	3	3	4	4	5	5	6	6	7	8
444	8	9	10	11	12	13	14	14	16	17
445	18	19	20	21	22	24	25	26	28	29
446	30	32	33	35	36	38	39	41	42	44
447	45	47	49	50	52	54	55	57	59	61
448	62	64	66	68	70	72	73	75	77	79
449	81	83	85	87	89	91	93	95	97	99
450	101	104	106	108	110	112	114	117	119	121
451	123	126	128	130	132	135	137	139	142	144
452	147	149	152	154	157	159	162	165	167	170
453	173	175	178	181	184	187	190	193	196	199
454	202	205	208	211	214	217	221	224	227	231
455	234	237	241	244	248	251	255	259	262	266
456	270	273	277	281	285	289	293	297	301	305
457	309	313	318	322	326	330	335	339	344	348
458	353	358	362	367	372	377	382	387	392	397
459	402	408	413	418	424	430	436	441	447	454
460	460	466	472	479	485	492	499	506	513	520
461	528	535	543	551	559	568	576	585	594	603
462	613	622	632	641	651	661	671	681	692	703
463	714	725	736	748	760	772	784	797	810	824
464	838	852	866	881	896	911	927	943	959	976
465	993	1,010	1,028	1,046	1,064	1,083	1,101	1,121	1,140	1,160
466	1,180	1,200	1,220	1,241	1,262	1,284	1,306	1,328	1,351	1,374
467	1,398	1,422	1,447	1,472	1,498	1,524	1,551	1,578	1,606	1,635
468	1,663	1,693	1,722	1,753	1,783	1,814	1,846	1,878	1,910	1,943
469	1,976	2,010	2,044	2,078	2,113	2,149	2,185	2,221	2,258	2,295
470	2,332	2,370	2,409	2,447	2,487	2,526	2,567	2,607	2,648	2,689
471	2,731	2,774	2,817	2,860	2,904	2,949	2,994	3,039	3,085	3,132
472	3,179	3,226	3,274	3,322	3,370	3,419	3,469	3,518	3,569	3,620
473	3,671	3,724	3,776	3,830	3,884	3,938	3,993	4,049	4,105	4,162
474	4,220	4,278	4,336	4,395	4,455	4,515	4,575	4,636	4,697	4,759
475	4,822	4,885	4,948	5,012	5,076	5,141	5,207	5,273	5,339	5,407
476	5,474	5,542	5,611	5,680	5,749	5,819	5,890	5,960	6,032	6,104
477	6,176	6,249	6,323	6,397	6,472	6,547	6,623	6,699	6,776	6,853
478	6,931	7,010	7,089	7,169	7,250	7,331	7,413	7,496	7,579	7,663
479	7,748	7,834	7,920	8,007	8,094	8,183	8,271	8,361	8,451	8,542
480	8,634	8,726	8,818	8,912	9,005	9,100	9,195	9,291	9,387	9,484
481	9,581	9,679	9,778	9,877	9,977	10,077	10,178	10,279	10,381	10,483
482	10,586	10,690	10,793	10,897	11,002	11,107	11,213	11,319	11,425	11,532
483	11,640	11,747	11,856	11,964	12,074	12,183	12,293	12,404	12,515	12,626
484	12,738	12,851	12,963	13,077	13,191	13,305	13,420	13,536	13,652	13,769
485	13,886	14,004	14,123	14,242	14,361	14,481	14,602	14,723	14,844	14,966
486	15,089	15,212	15,335	15,459	15,583	15,708	15,833	15,959	16,085	16,212
487	16,339	16,467	16,595	16,724	16,854	16,984	17,114	17,245	17,377	17,509
488	17,642	17,776	17,910	18,045	18,180	18,316	18,453	18,590	18,728	18,866
489	19,005	19,144	19,285	19,425	19,566	19,708	19,850	19,992	20,135	20,279
490	20,422	20,567	20,712	20,857	21,002	21,148	21,295	21,442	21,589	21,737
491	21,886	22,035	22,184	22,334	22,484	22,635	22,786	22,938	23,090	23,243
492	23,397	23,551	23,705	23,860	24,016	24,172	24,329	24,486	24,644	

Appendix B

Lake Austin

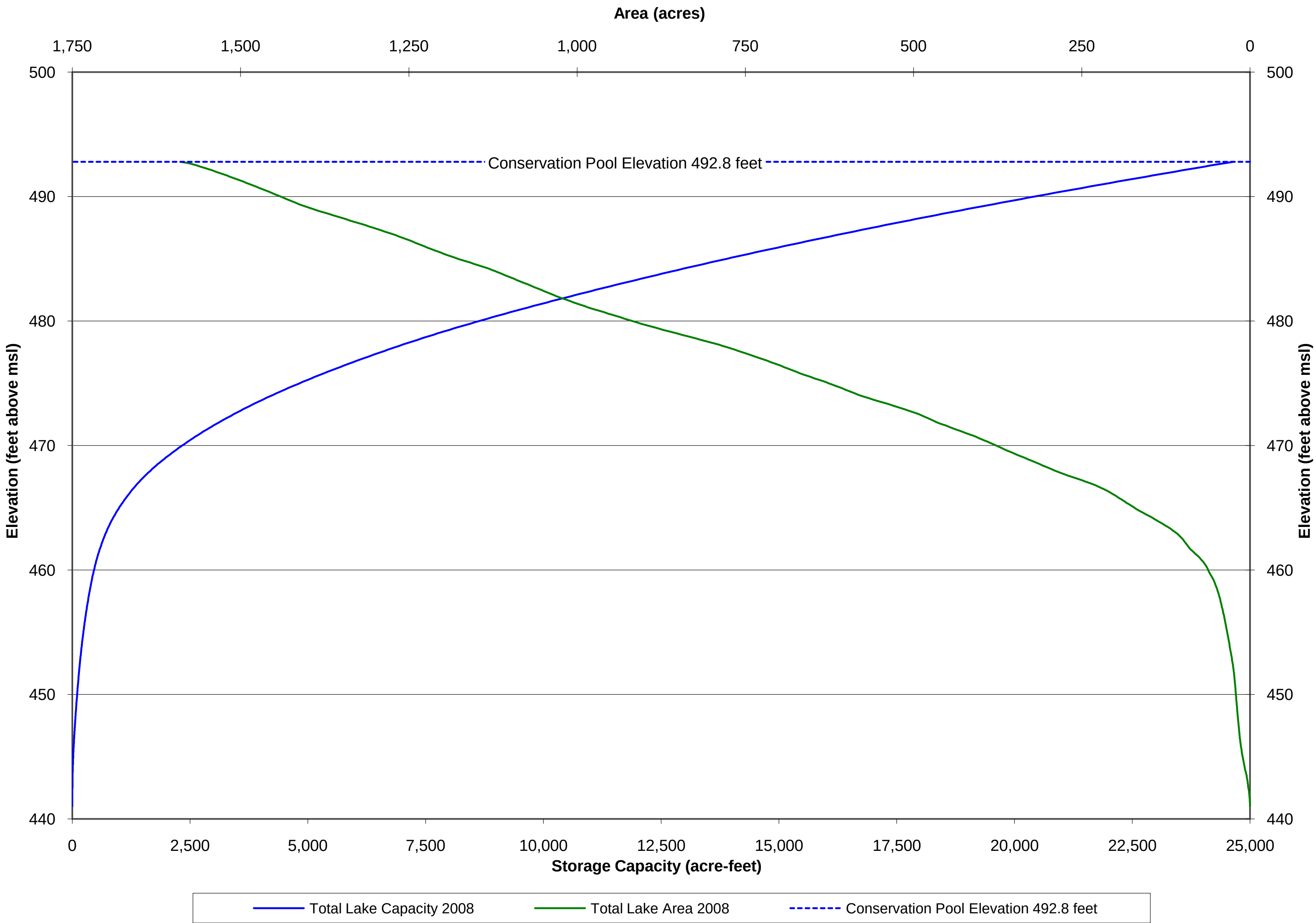
RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — DECEMBER 2008 SURVEY

AREA IN ACRES — Conservation Pool Elevation 492.8 Feet NGVD 29

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
441	0	0	0	0	0	0	1	1	1	1
442	1	1	2	2	2	3	3	3	3	4
443	4	4	4	5	5	5	6	6	7	7
444	7	8	8	9	9	9	10	10	10	11
445	11	11	12	12	12	13	13	13	13	14
446	14	14	14	15	15	15	15	16	16	16
447	16	16	17	17	17	17	17	17	18	18
448	18	18	18	18	19	19	19	19	19	19
449	20	20	20	20	20	20	20	21	21	21
450	21	21	21	22	22	22	22	22	22	22
451	23	23	23	23	23	23	24	24	24	24
452	25	25	25	25	26	26	26	27	27	27
453	27	28	28	28	29	29	29	30	30	30
454	31	31	31	32	32	32	33	33	33	34
455	34	34	35	35	35	36	36	36	37	37
456	37	38	38	39	39	40	40	40	41	41
457	42	42	43	43	43	44	44	45	45	46
458	46	47	47	48	49	49	50	51	51	52
459	53	53	54	55	56	57	58	60	60	61
460	62	63	64	65	66	68	69	70	72	74
461	75	77	79	81	83	85	87	89	91	92
462	93	95	96	98	99	100	102	104	106	108
463	110	113	115	118	121	123	127	130	133	136
464	139	142	145	149	152	156	159	163	166	169
465	172	175	178	181	183	186	189	192	195	198
466	201	204	207	210	214	218	221	225	230	234
467	239	245	250	255	260	266	271	277	282	286
468	291	295	299	304	308	313	317	321	325	330
469	334	339	344	348	352	357	361	365	369	373
470	377	381	386	390	395	399	403	407	412	417
471	422	427	433	438	442	447	452	458	462	467
472	471	475	479	483	487	491	496	502	507	513
473	519	524	530	536	542	548	554	561	567	572
474	578	583	588	593	597	602	607	611	616	621
475	626	631	636	642	647	653	658	664	669	673
476	678	683	687	692	697	702	707	712	717	722
477	728	733	738	744	749	755	760	766	772	777
478	783	789	796	803	810	816	823	830	837	844
479	851	858	866	873	879	886	892	899	906	912
480	918	924	930	936	942	948	954	960	966	972
481	978	984	989	994	1,000	1,005	1,011	1,016	1,021	1,026
482	1,030	1,035	1,040	1,044	1,049	1,053	1,058	1,062	1,067	1,071
483	1,076	1,081	1,085	1,090	1,094	1,099	1,103	1,108	1,112	1,117
484	1,121	1,126	1,131	1,136	1,142	1,148	1,153	1,159	1,165	1,171
485	1,177	1,182	1,188	1,193	1,198	1,203	1,208	1,213	1,217	1,222
486	1,227	1,232	1,236	1,241	1,245	1,250	1,255	1,260	1,265	1,270
487	1,275	1,280	1,286	1,292	1,297	1,303	1,309	1,315	1,320	1,327
488	1,333	1,338	1,344	1,350	1,356	1,362	1,369	1,375	1,381	1,387
489	1,393	1,398	1,403	1,409	1,413	1,418	1,423	1,427	1,432	1,436
490	1,441	1,445	1,450	1,454	1,459	1,463	1,468	1,472	1,477	1,482
491	1,486	1,491	1,496	1,501	1,506	1,511	1,516	1,521	1,526	1,531
492	1,536	1,542	1,547	1,553	1,559	1,565	1,572	1,578	1,589	



Lake Austin
December 2008 Survey
Prepared by: TWDB

Appendix C: Area and Capacity Curves

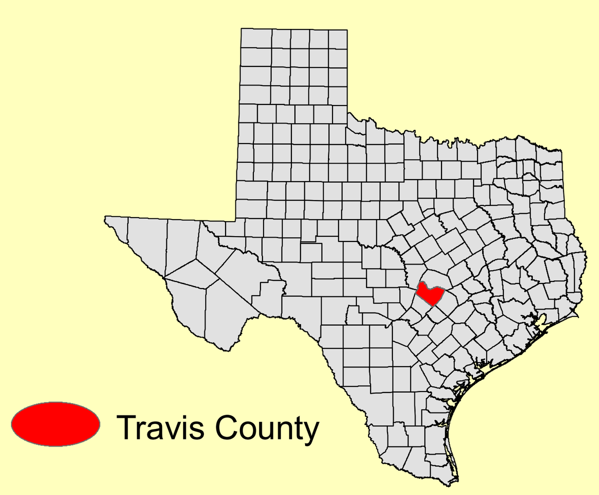
Figure 5

CONTOURS
(in feet NGVD29)

445
450
455
460
465
470
475
480
485
490
Islands
Lake Austin

Conservation Pool Elevation:
492.8 feet NGVD29

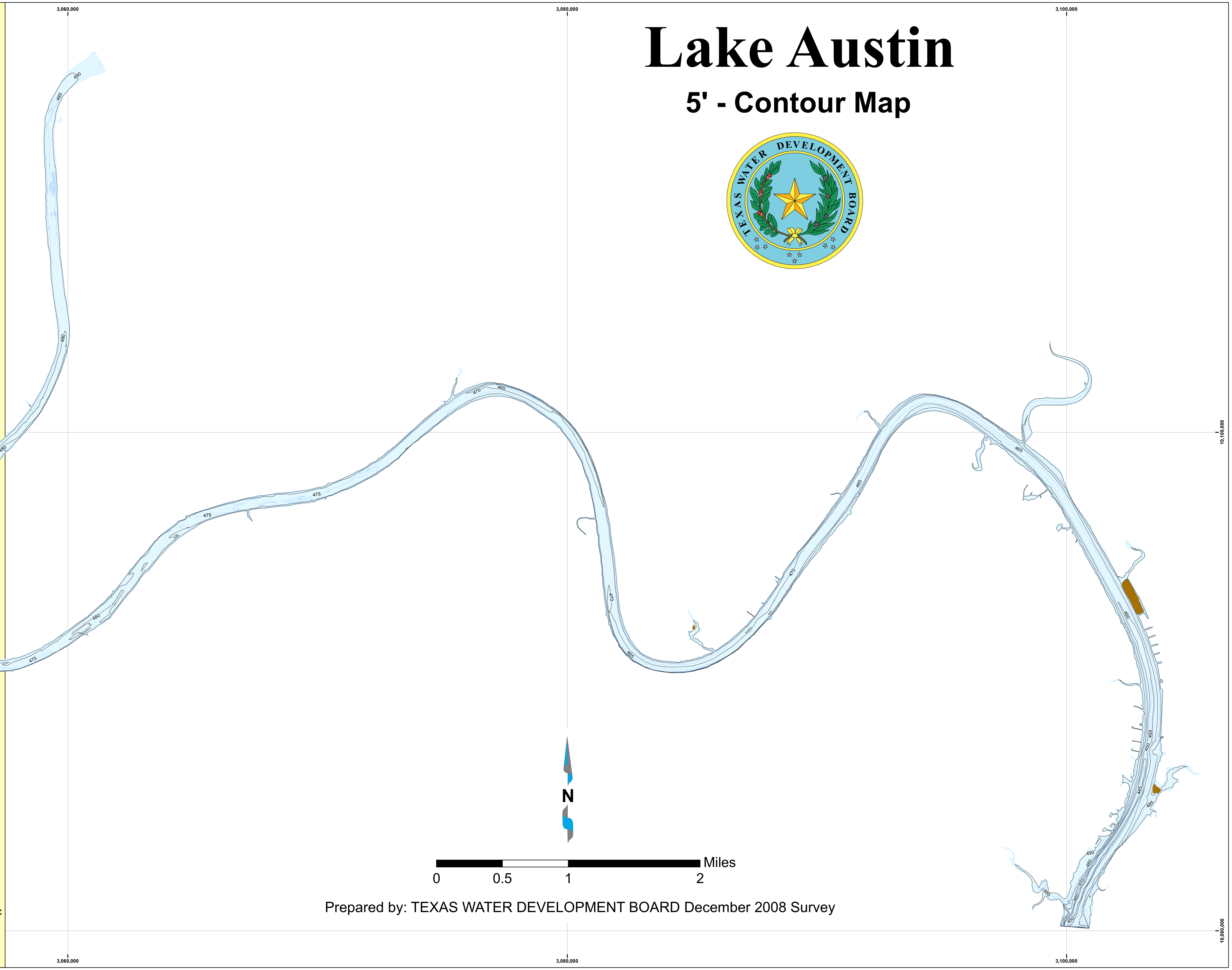
Projection: NAD83
State Plane Texas Central Zone



This map is a product of a survey conducted by the Texas Water Development Board's Hydrographic Survey Program to determine the capacity of Lake Austin. The Texas Water Development Board makes no representations nor assumes any liability.

Lake Austin

5' - Contour Map



Prepared by: TEXAS WATER DEVELOPMENT BOARD December 2008 Survey