Volumetric and Sedimentation Survey of SOMERVILLE LAKE

April 2012 Survey

Texas Water Development Board

June 2014

Texas Water Development Board

Prepared for:

Brazos River Authority

With Support Provided by:

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

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Executive summary

In October, 2011, the Texas Water Development Board (TWDB) entered into agreement with the U.S. Army Corps of Engineers, Fort Worth District, and in November, 2011, entered into agreement with the Brazos River Authority to perform a volumetric and sedimentation survey of Somerville Lake. The Brazos River Authority provided 50% of the funding for this survey, while the U.S. Army Corps of Engineers, Fort Worth District, provided the remaining 50% of the funding through their Texas Water Allocation Assessment Program. Surveying was performed using a multi-frequency (200 kHz, 50 kHz, and 24 kHz), sub-bottom profiling depth sounder. In addition, sediment core samples were collected in select locations and correlated with the multi-frequency depth sounder signal returns to estimate sediment accumulation thicknesses and sedimentation rates.

Somerville Dam and Somerville Lake are located on Yegua Creek in Burleson, Lee, and Washington Counties, approximately 15 miles northwest of Brenham, Texas. The conservation pool elevation of Somerville Lake is 238.0 feet above mean sea level (NGVD29). TWDB collected bathymetric data for Somerville Lake between April 17, 2012, and April 26, 2012. The daily average water surface elevation during the survey ranged between 239.13 and 240.65 feet above mean sea level.

The 2012 TWDB volumetric and sedimentation survey indicates that Somerville Lake has a total reservoir capacity of 150,293 acre-feet and encompasses 11,395 acres at conservation pool elevation (238.0 feet above mean sea level, NGVD29). Previous capacity estimates include the original design estimate by the U.S. Army Corps of Engineers of 164,974 acre-feet, a U.S. Army Corps of Engineers resurvey in 1992, of 159,682 acre-feet, and two TWDB surveys in 1995 and 2003. The TWDB volumetric surveys conducted in 1995 and 2003 were re-evaluated using current processing procedures resulting in updated capacity estimates of 156,184 acre-feet and 149,072 acre-feet, respectively.

Based on two methods for estimating sedimentation rates, the 2012 TWDB sedimentation survey estimates Somerville Lake loses between 326 and 469 acre-feet of capacity per year due to sedimentation below conservation pool elevation (238.0 feet above mean sea level, NGVD29). The sedimentation survey indicates sediment accumulation varies throughout the reservoir. The heaviest accumulations measured are between 0.25 and 1.63 miles west of the dam and on the south shore of the reservoir opposite Birch Creek State Park. TWDB recommends that a similar methodology be used to resurvey Somerville Lake in 10 years or after a major flood event.

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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 72nd 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 October 2011, the Texas Water Development Board entered into agreement with the U.S. Army Corps of Engineers, Fort Worth District, and in November 2011, entered into agreement with the Brazos River Authority to perform a volumetric and sedimentation survey of Somerville Lake (TWDB, 2011a, TWDB, 2011b). This report describes the methods used to conduct the volumetric and sedimentation survey, including data collection and processing techniques. This report serves as the final contract deliverable from TWDB to the Brazos River Authority and the U.S. Army Corps of Engineers, Fort Worth District, and contains as deliverables: (1) an elevation-area-capacity table of the reservoir acceptable to the Texas Commission on Environmental Quality [Appendix A, B], (2) a bottom contour map [Figure 6], (3) a shaded relief plot of the reservoir bottom [Figure 4], and (4) an estimate of sediment accumulation and location [Figure 10].

Somerville Lake general information

The Somerville Dam and Somerville Lake are located on Yegua Creek in Burleson, Lee, and Washington Counties, approximately 15 miles northwest of Brenham, Texas (Figure 1). Somerville Dam and Somerville Lake are owned by the U.S. Government and operated by the U.S. Army Corps of Engineers, Fort Worth District (TWDB, 1973). The U.S. Congress authorized the construction of Somerville Lake for flood control, water conservation, and other multipurpose uses with the passage of the Flood Control Act of September 3, 1954 (USACE, 2007a). The construction of Somerville Dam began on June 4, 1962. The deliberate impoundment of water began on January 3, 1967, and the dam was completed on October 27, 1967 (TWDB, 1973). Additional pertinent data about Somerville Dam and Somerville Lake can be found in Table 1.

Water rights for Somerville Lake have been appropriated to the Brazos River Authority through Certificate of Adjudication Nos. 12-5164 and 12-5167. The complete certificates are on file in the Information Resources Division of the Texas Commission on Environmental Quality.

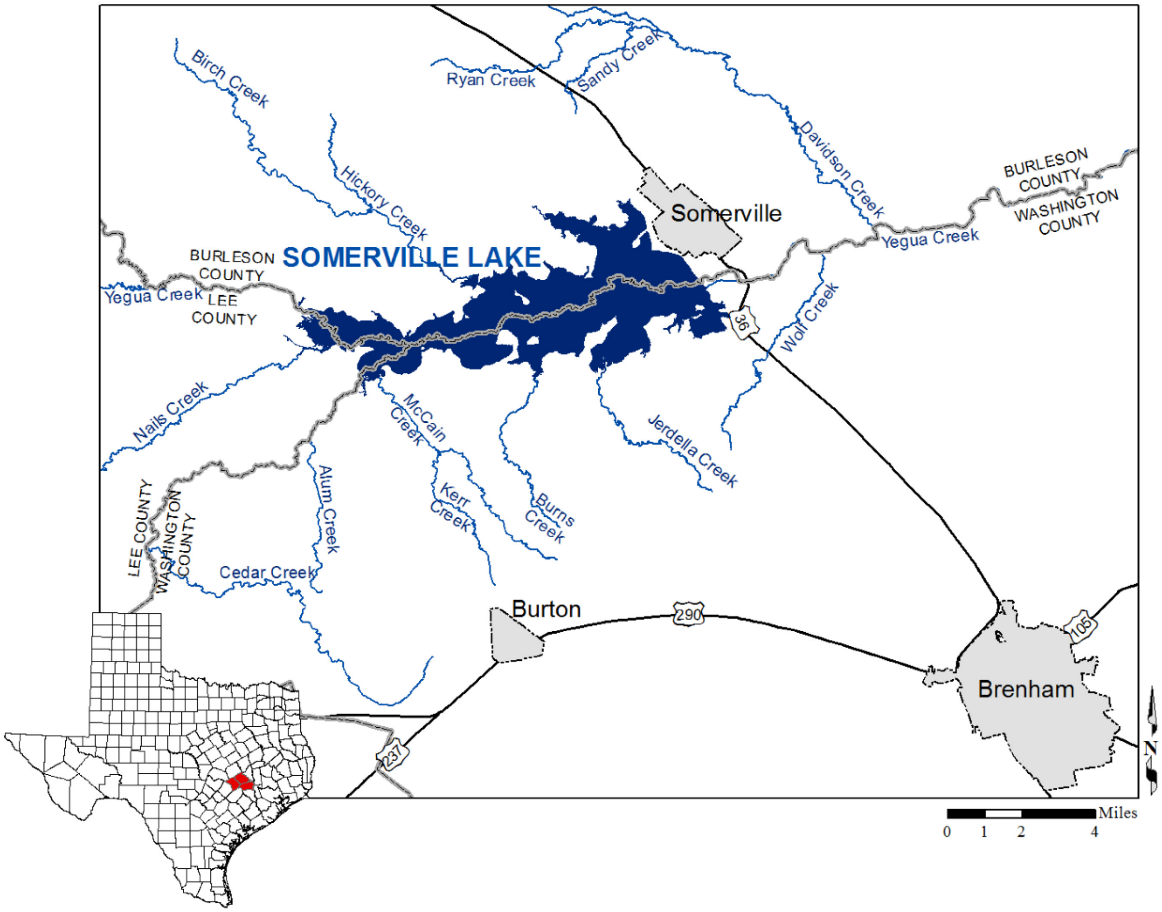

Figure 1. **Location of Somerville Lake**

Table 1. Pertinent data for Somerville Dam and Somerville Lake

Owner
The U.S. Government
Operated by the U.S. Army Corps of Engineers, Fort Worth District

Engineer
U.S. Army Corps of Engineers

General contractor
Clement Brothers Company, Inc., Hickory, North Carolina

Location of dam
20.0 river miles upstream from confluence of Yegua Creek with the Brazos River, in Burleson and Washington Counties, 2 miles south of Somerville, Texas and approximately 15 miles northwest of Brenham, Texas.

Drainage area
1,006 square miles

Dam

Type	Earthfill
Length	20,210 feet plus 4,715 feet of dike at right of spillway
Maximum height	80 feet
Top width (spillway section)	20 feet
Top width (embankment section)	34 feet

Spillway

Type	Ogee
Length	1,250 feet
Crest elevation	258.0 feet above mean sea level
Control	None

Outlet works

Type	1 gate controlled conduit
Dimension	10 feet diameter
Invert elevation	206.0 feet above mean sea level
Control	2 tractor type gates, each 5 by 10 feet

Reservoir data (Based on 2012 TWDB survey)

Feature	**Elevation (feet** NGVD29[a]**)**	**Capacity (acre-feet)**	**Area (acres)**
Top of dam	280.0	N/A	N/A
Maximum design water surface	274.5	N/A	N/A
Spillway crest	258.0	N/A	N/A
Top of conservation storage space	238.0	150,293	11,395
Outlet works invert elevation	206.0	0	0
Usable conservation storage space[b]	-	150,293	-

Source: (TWDB1973, TWDB 2005, USACE 2007b, USACE, 2013)
[a] NGVD29 = National Geodetic Vertical Datum 1929
[b] Usable conservation storage space equals total capacity at conservation pool elevation minus dead pool capacity. Dead pool refers to water that cannot be drained by gravity through a dam's outlet works.

Volumetric and sedimentation survey of Somerville Lake

Datum

The vertical datum used during this survey is the National Geodetic Vertical Datum 1929 (NGVD29). This datum is also utilized by the United States Geological Survey (USGS) for the reservoir elevation gage *USGS 08109900 Somerville Lk nr Somerville, TX* (USGS, 2013). Elevations herein are reported in feet relative to the NGVD29 datum. 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 1983 (NAD83), and the horizontal coordinate system is State Plane Texas Central Zone (feet).

TWDB bathymetric and sedimentation data collection

TWDB collected bathymetric data for Somerville Lake between April 17, 2012, and April 26, 2012. The daily average water surface elevations during the survey ranged between 239.13 and 240.65 feet above mean sea level (NGVD29). For data collection, TWDB used a Specialty Devices, Inc. (SDI), single-beam, multi-frequency (200 kHz, 50 kHz, and 24 kHz) sub-bottom profiling depth sounder integrated with differential global positioning system (DGPS) equipment. Data collection occurred while navigating along pre-planned survey lines oriented perpendicular to the assumed location of the original river channels and spaced approximately 500 feet apart. Many of the survey lines were also surveyed by TWDB during the 1995 and 2003 surveys. The depth sounder was calibrated daily using a velocity profiler to measure the speed of sound in the water column and a weighted tape or stadia rod for depth reading verification. Figure 2 shows where data collection occurred during the 2012 TWDB survey.

All sounding data was collected and reviewed before sediment core sampling sites were selected. Sediment core samples are collected at regularly spaced intervals within the reservoir, or at locations where interpretation of the acoustic display would be difficult without site-specific sediment core data. Following the analysis of the sounding data, TWDB selected six locations to collect sediment core samples (Figure 2). The sediment core samples were collected on January 7, 2013, and January 15, 2013, with a custom-coring boat and SDI VibeCore system.

Sediment cores are collected in 3-inch diameter aluminum tubes. Analysis of the acoustic data collected during the bathymetric survey assists in determining the depth to which the tube must be driven during sediment sampling. The goal is to collect a sediment core sample extending from the current reservoir-bottom, through the accumulated sediment, and to the pre-impoundment surface. After retrieving the sample, a stadia rod is inserted into the top of the tube to assist in locating the top of the sediment in the tube. This identifies the location of the layer corresponding to the current reservoir surface. The aluminum tube is cut to this level, capped, and transported back to TWDB headquarters for further analysis. During this time, some settling of the upper layer can occur.

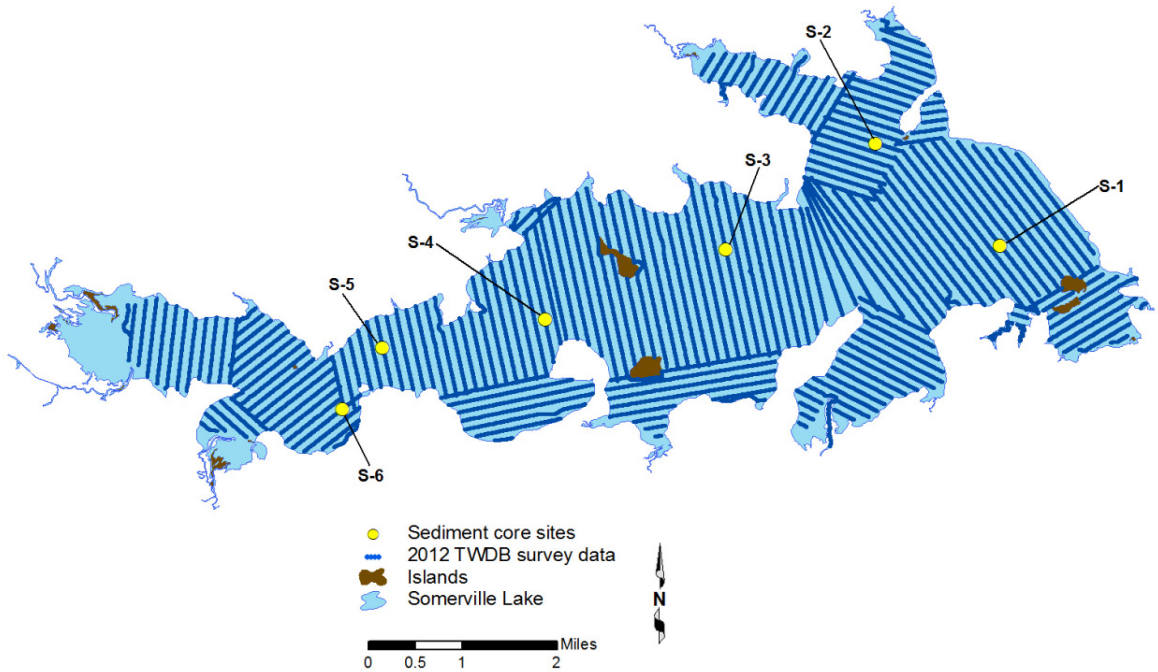

Figure 2. Data collection during 2012 TWDB Somerville Lake survey

Data processing

Model boundaries

The reservoir boundary was digitized from aerial photographs, also known as digital orthophoto quarter-quadrangle images (DOQQs), obtained from the Texas Natural Resources Information System (TNRIS, 2009) using Environmental Systems Research Institute's ArcGIS 9.3.1 software. The quarter-quadrangles that cover Somerville Lake are Flag Pond (NE, SW, SE), and Somerville (NE, NW, SE, SW). The DOQQs were photographed on May 4, 2010, while the daily average water surface elevation measured 237.99 feet (NGVD29). According to metadata associated with the 2010 DOQQs, the photographs have a resolution or ground sample distance of 1.0-meters and a horizontal accuracy within + / - 6 meters to true ground (USDA, 2011, TNRIS, 2010). For this analysis, the boundary was digitized at the land-water interface in the 2010 photographs and given an elevation of 238.0 feet to facilitate calculating the area-capacity tables up to the conservation pool elevation.

Triangulated Irregular Network model

Following completion of data collection, the raw data files collected by TWDB were edited to remove data anomalies. DepthPic©, software developed by SDI, Inc., is used to display, interpret, and edit the multi-frequency data by manually removing data anomalies in the current bottom surface and manually digitizing the reservoir-bottom surface at the time of initial impoundment (i.e. pre-impoundment surface). For processing outside of DepthPic©, an in-house software package, HydroTools, is used to identify the current reservoir-bottom surface, pre-impoundment surface, sediment thickness at each sounding location, and output the data into a single file. The water surface elevation at the time of each sounding was used to convert each sounding depth to a corresponding reservoir-bottom elevation. This survey point dataset is then preconditioned by inserting a uniform grid of artificial survey points between the actual survey lines. Bathymetric elevations at these artificial points are determined using an anisotropic spatial interpolation algorithm described in the spatial interpolation of reservoir bathymetry section below. This technique creates a high resolution, uniform grid of interpolated bathymetric elevation points throughout a majority of the reservoir (McEwen et al., 2011). Finally, the point file resulting from spatial interpolation is used in conjunction with sounding and boundary data to create volumetric and sediment Triangulated Irregular Network (TIN) models utilizing the 3D Analyst Extension of ArcGIS. The 3D Analyst algorithm uses Delaunay's criteria for triangulation to create a grid composed of triangles from non-uniformly spaced points, including the boundary vertices (ESRI, 1995).

Spatial interpolation of reservoir bathymetry

Isotropic spatial interpolation techniques such as the Delaunay triangulation used by the 3D Analyst extension of ArcGIS are, in many instances, unable to suitably interpolate bathymetries between survey lines common to reservoir surveys. Reservoirs and stream channels are anisotropic morphological features where bathymetry at any particular location is more similar to upstream and downstream locations than to transverse locations. Interpolation schemes that do not consider this anisotropy lead to the creation of several types of artifacts in the final representation of the reservoir bottom surface and hence to errors in volume. These include: artificially-curved contour lines extending into the reservoir where the reservoir walls are steep or the reservoir is relatively narrow; intermittent representation of submerged stream channel connectivity; and oscillations of contour lines in between survey lines. These artifacts reduce the accuracy of the resulting volumetric and sediment TIN models in areas between actual survey data.

To improve the accuracy of bathymetric representation between survey lines, TWDB developed various anisotropic spatial interpolation techniques. Generally, the directionality of interpolation at different locations of a reservoir can be determined from external data sources. A basic assumption is that the reservoir profile in the vicinity of a particular location has upstream and downstream similarity. In addition, the sinuosity and directionality of submerged stream channels can be determined from direct examination of survey data or more robustly by examining scanned USGS 7.5 minute quadrangle maps (known as digital raster graphics) and hypsography files (the vector format of USGS 7.5 minute quadrangle map contours), when available. Using the survey data, polygons are created to partition the reservoir into segments with centerlines defining directionality of interpolation within each segment. For surveys with similar spatial coverage, these interpolation definition files are in principle independent of the survey data and could be applied to past and future survey data of the same reservoir. In practice, however, minor revisions of the interpolation definition files may be needed to account for differences in spatial coverage and boundary conditions between surveys. Using the interpolation definition files and survey data, the current reservoir-bottom elevation, pre-impoundment elevation, and sediment thickness are calculated for each point in the high resolution uniform grid of artificial survey points. The reservoir boundary, artificial survey points grid, and survey data points are used to create volumetric and sediment TIN models representing the reservoir bathymetry and sediment accumulation throughout the reservoir. Specific details of this interpolation technique can be found in the HydroTools manual (McEwen et al., 2011a) and in McEwen et al., 2011b.

In areas inaccessible to survey data collection such as small coves and shallow upstream areas of the reservoir, linear extrapolation is used for volumetric and sediment accumulation estimations. The linear extrapolation follows a linear definition file linking the survey points file to the lake boundary file (McEwen et al., 2011a). Without extrapolated data, the TIN Model builds flat triangles. A flat triangle is defined as a triangle where all three vertices are equal in elevation, generally the elevation of the reservoir boundary. Reducing flat triangles by applying linear extrapolation improves the elevation-capacity and elevation-area calculations. It is not possible to remove all flat triangles, and linear extrapolation is only applied where adding bathymetry is deemed reasonable. For example, linear extrapolation was deemed reasonable and applied to Somerville Lake in the following situations: in small coves of the main body of the lake and in obvious channel features visible in aerial photographs taken on July 26, 2008, while the daily average water surface elevation measured 236.8 feet, and on June 6, 2006, and June 14, 2006, while the daily average water surface elevation measured 235.7 feet and 235.52 feet, respectively.

Figure 3 illustrates typical results from application of the anisotropic interpolation and linear extrapolation techniques to Somerville Lake. The bathymetry shown in Figure 3C was used in computing reservoir capacity and area tables (Appendix A, B). In Figure 3A, deeper channels indicated by surveyed cross sections are not continuously represented in areas between survey cross sections. This is an artifact of the TIN generation routine rather than an accurate representation of the physical bathymetric surface. Inclusion of interpolation points, represented in Figure 3C, in creation of the volumetric TIN model directs Delaunay triangulation to better represent the lake bathymetry between survey cross-sections.

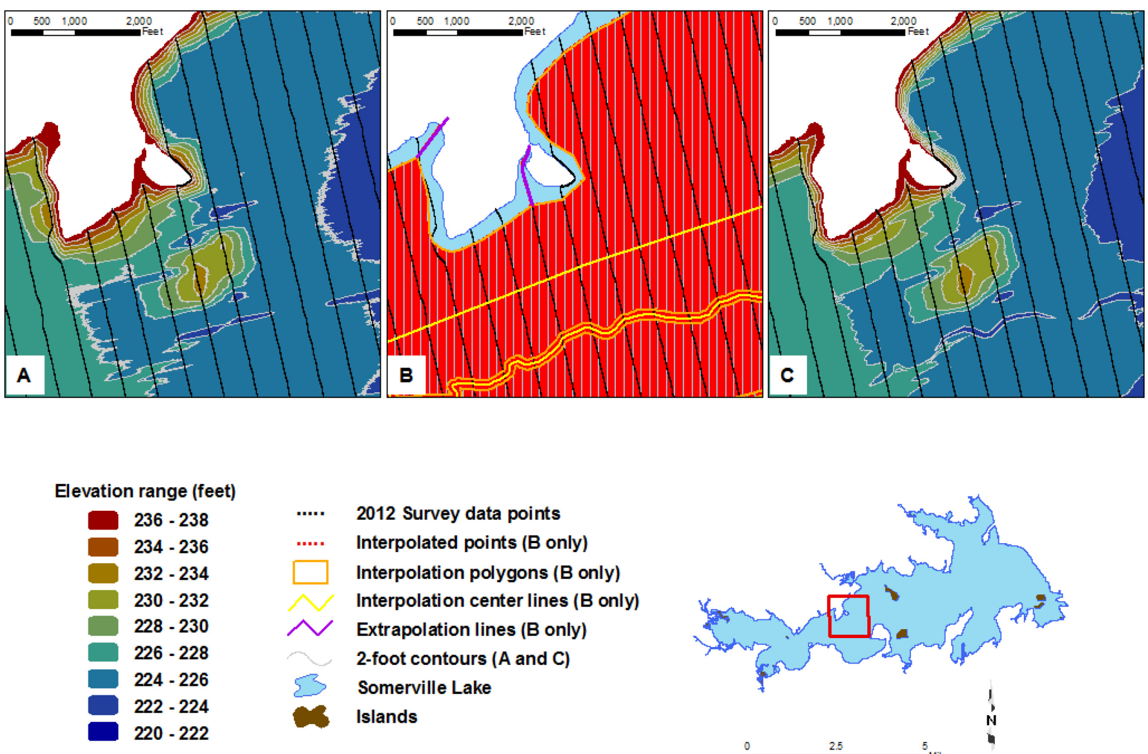

Figure 3. Anisotropic spatial interpolation and linear extrapolation of Somerville Lake sounding data - A) bathymetric contours without interpolated points, B) sounding points (black) and interpolated points (red), C) bathymetric contours with the interpolated points

Area, volume, and contour calculation

Using ArcInfo software and the volumetric TIN model, volumes and areas were calculated for the entire reservoir at 0.1 feet intervals, from 209.0 to 238.0 feet. The elevation-capacity table and elevation-area table, updated for 2012, are presented in Appendices A and B, respectively. The area-capacity curves are presented in Appendix C.

The volumetric TIN model was converted to a raster representation using a cell size of 2 feet by 2 feet. The raster data was then used to produce an elevation relief map (Figure 4), representing the topography of the reservoir bottom; a depth range map (Figure 5), showing shaded depth ranges for Somerville Lake; and a 2-foot contour map (Figure 6 - attached).

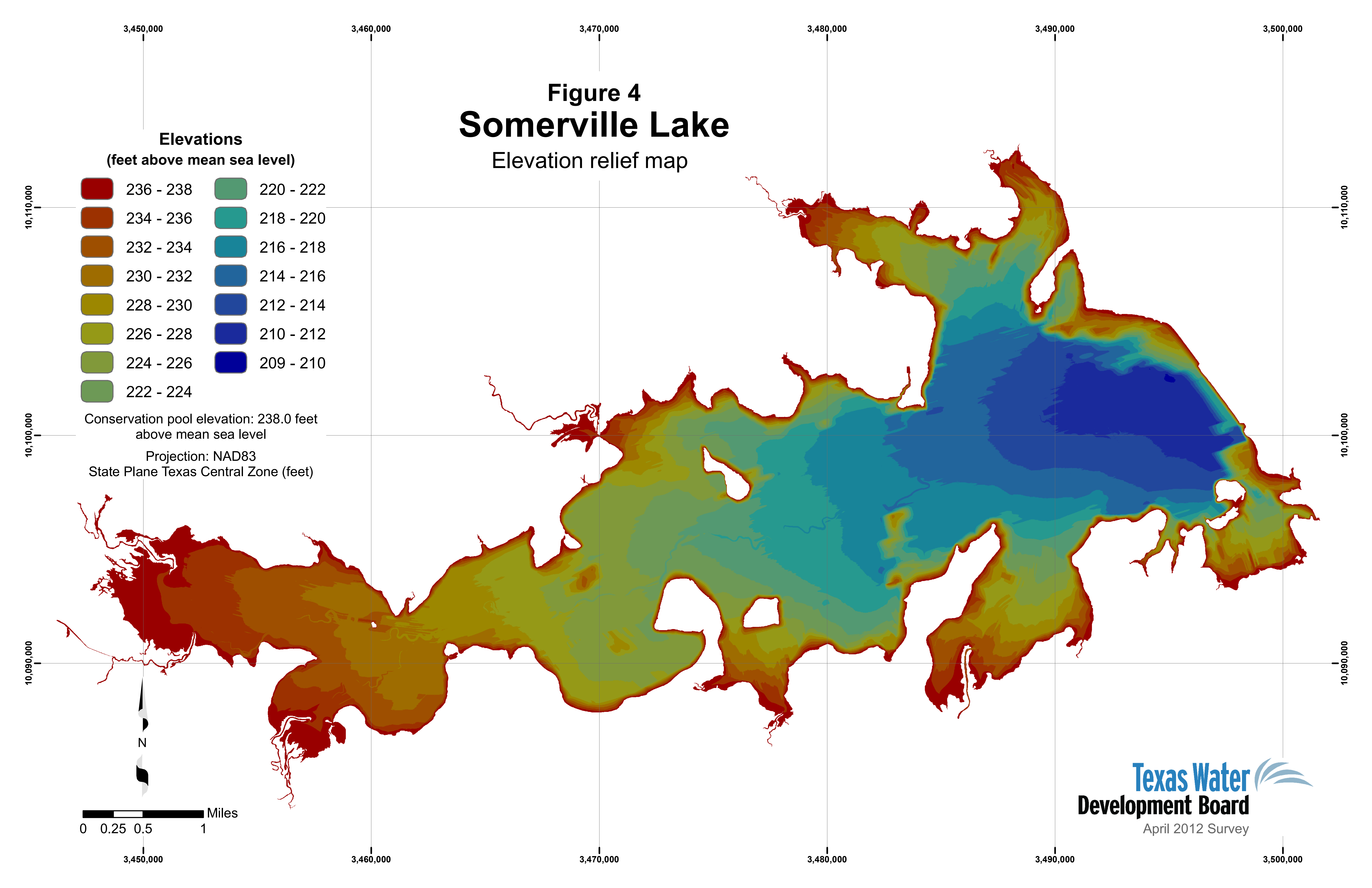

Figure 4
Somerville Lake
Elevation relief map

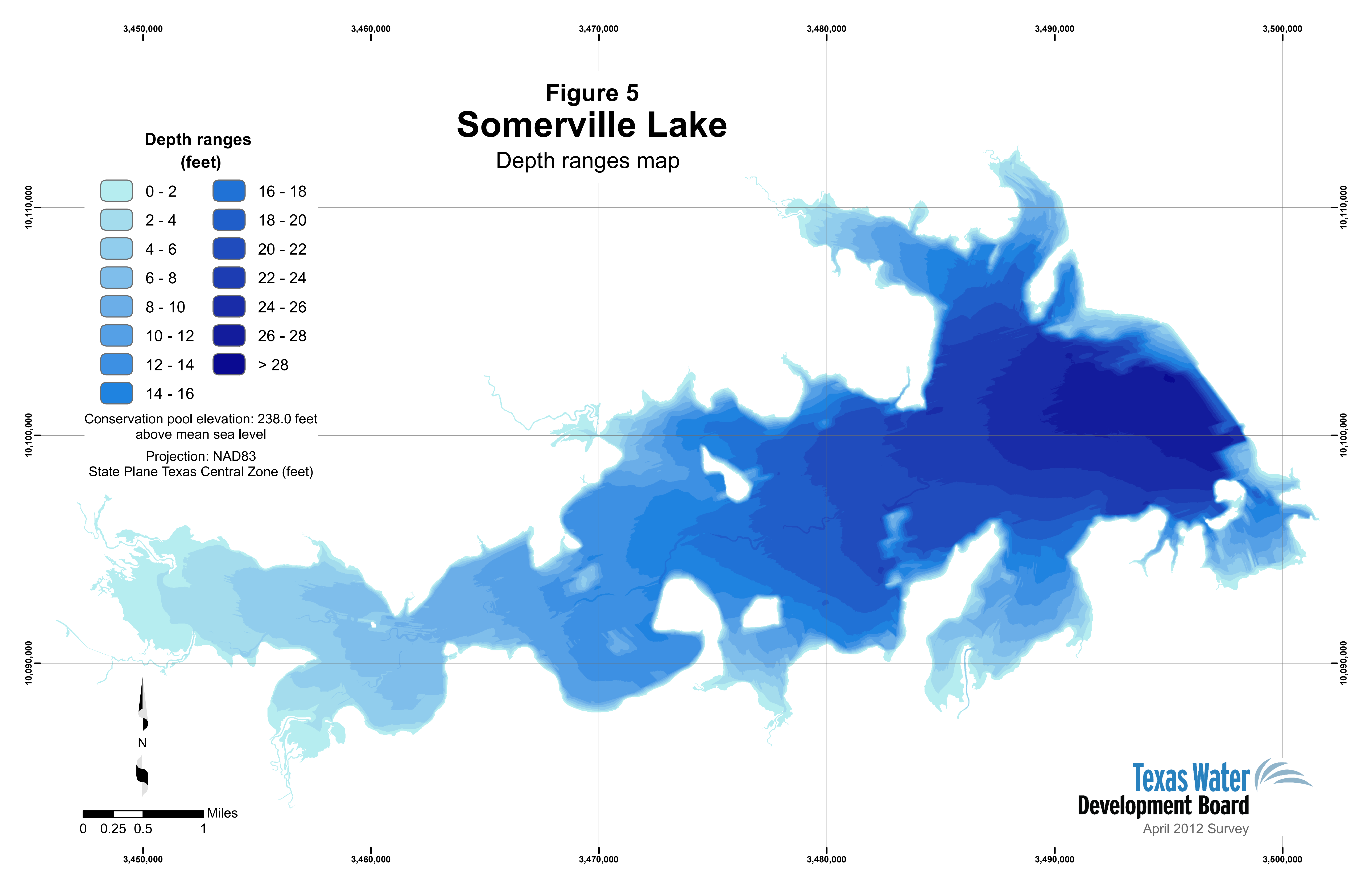

Figure 5
Somerville Lake
Depth ranges map
Depth ranges (feet)
0 - 2
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
16 - 18
18 - 20
20 - 22
22 - 24
24 - 26
26 - 28
> 28
Conservation pool elevation: 238.0 feet above mean sea level
Projection: NAD83
State Plane Texas Central Zone (feet)
3,450,000
3,460,000
3,470,000
3,480,000
3,490,000
3,500,000
10,110,000
10,100,000
10,090,000
N
Miles
0
0.25
0.5
1
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Analysis of sediment data from Somerville Lake

Sedimentation in Somerville Lake was determined by analyzing the acoustic signal returns of all three depth sounder frequencies in the DepthPic© software. The 200 kHz signal was analyzed to determine the current bathymetric surface of the reservoir, while all three frequencies, 200 kHz, 50 kHz, and 24 kHz, were analyzed to determine the reservoir bathymetric surface at the time of initial impoundment (i.e. pre-impoundment surface). Sediment core samples collected in the reservoir were used to assist in identifying the location of the pre-impoundment surface in the acoustic signals. The difference between the current surface and the pre-impoundment surface yields a sediment thickness value at each sounding location.

Analysis of the sediment core samples was conducted at TWDB headquarters in Austin. Each sample was split longitudinally and analyzed to identify the location of the pre-impoundment surface. The pre-impoundment surface is identified within the sediment core sample by one or a combination of the following methods: (1) a visual examination of the sediment core for terrestrial materials, such as leaf litter, tree bark, twigs, intact roots, etc., concentrations of which tend to occur on or just below the pre-impoundment surface; (2) changes in texture from well sorted, relatively fine-grained sediment to poorly sorted mixtures of coarse and fine-grained materials; and (3) variations in the physical properties of the sediment, particularly sediment water content and penetration resistance with depth (Van Metre et al., 2004). The total sample length, sediment thickness, and the pre-impoundment thickness were recorded. Physical characteristics of the sediment core, including color, texture, relative water content, and presence of organic materials, were also recorded (Table 2).

Table 2. **Sediment core sampling analysis data - Somerville Lake**

Core	Easting[a] (ft)	Northing[a] (ft)	Total core sample/ post-impoundment sediment	Sediment core description	Munsell soil color
S-1	3494032.4	10099602.62	25.75"/22.5"	0-22.5" very loose clay sediment, high water content	GLEY1 3/10Y
				22.5"-27.75" dense sediment, clay soil with peds and organics present	GLEY1 2.5/10GY
S-2	3487827.55	10105100.8	23"/20"	0-10" very aqueous sediment	-
				10-16" very loose sediment	GLEY2 2.5/10G
				16-20" loose sediment	GLEY2 2.5/10G
				20-23" dense sediment	GLEY2 2.5/10G
S-3	3480762.14	10098925.89	-	No core recovered	-
S-4	3472151.6	10094738.84	56.5"/not reached	0-6.5" very loose clay sediment	GLEY2 2.5/10G
				6.5-20" very loose clay sediment	GLEY2 3/10G
S-5	3464303.66	10092878.7	72.5"/31"	0-3" very loose sediment, high water content	GLEY2 2.5/10G
				3-31" loose sediment, medium water content	GLEY2 2.5/10G
				31-33.5" very dense soil with peds present, organics present	GLEY2 3/5BG
S-6	3462492.31	10089366.65	48"/15.5"	0-4" very loose sediment, high water content	GLEY2 2.5/10G
				4-15.5" dense sediment	GLEY2 2.5/10G
				15.5-20" very dense soil with peds and organics present	GLEY2 2.5/5BG

[a] Coordinates are based on NAD83 State Plane Texas Central System (feet)

A photograph of sediment core S-2 is shown in Figure 7 and is representative of the sediment cores sampled from Somerville Lake. The 200 kHz frequency measures the top layer as the current bottom surface of the reservoir.

Figure 7. **Sediment core S-2 from Somerville Lake**

Sediment core sample S-2 consisted of 23 inches of total sediment corresponding to the length of the aluminum sampling tube. The upper sediment layer (horizon), 0–10.0 inches, consisted of very aqueous sediment. The second horizon, beginning at 10.0 inches and extending to 16.0 inches below the surface, consisted of very loose sediment with high water content, and measured GLEY2 2.5/10G on the Munsell soil color chart. The third horizon, beginning at 16.0 inches and extending to 20.0 inches below the surface, consisted of loose sediment with a GLEY2 2.5/10G Munsell soil color. The forth horizon, from 20.0 inches to 23.0 inches consisted of dense sediment with a GLEY2 2.5/10G Munsell soil color. The base of the sample is denoted by the blue line in Figure 7.

The pre-impoundment boundary (red line in Figure 7) was evident within this sediment core sample at 20.0 inches and identified by the change in texture, moisture, porosity, and structure. Identification of the pre-impoundment surface for the remaining sediment cores followed a similar procedure.

Figures 8 and 9 illustrate how measurements from sediment core samples are used with sonar data to help identify the interface between the post- and pre-impoundment layers in the acoustic signal. Within DepthPic©, the current surface is automatically determined based on signal returns from the 200 kHz transducer and verified by TWDB staff, while the pre-impoundment surface must be determined visually. The pre-impoundment surface is first identified along cross-sections for which sediment core samples have been collected.

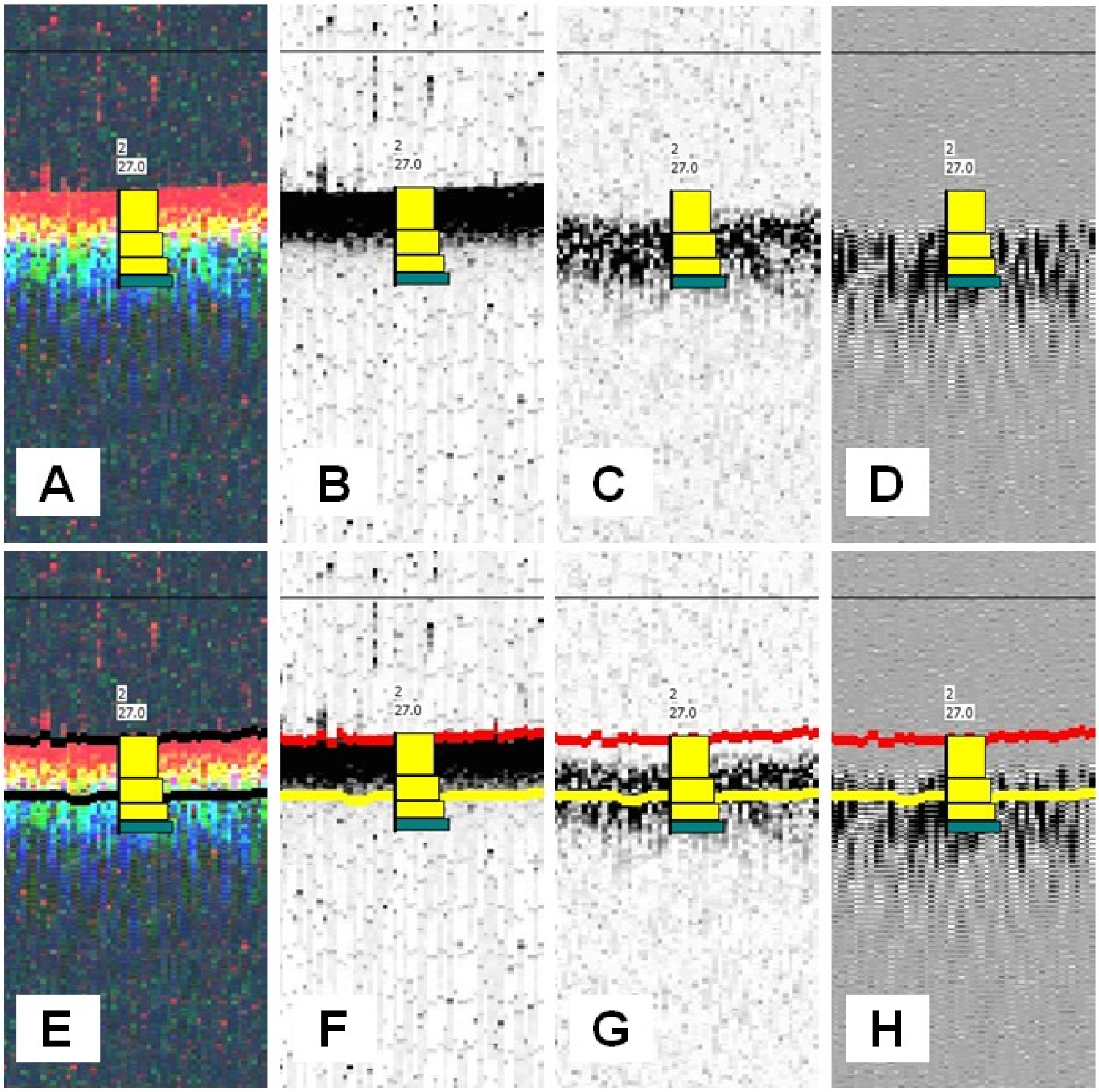

Figure 8. **Comparison of sediment core S-2 with acoustic signal returns A,E) combined acoustic signal returns, B,F) 200 kHz frequency, C,G) 50 kHz frequency, D,H) 24 kHz frequency**

Figure 8 compares sediment core sample S-2 with the acoustic signals for all frequencies combined (A, E), 200 kHz (B, F), 50 kHz (C, G), and 24 kHz (D, H). The sediment core sample is represented in each figure as colored boxes. The yellow boxes represent post-impoundment sediment, and the blue box represents the pre-impoundment sediment. In Figure 8A-D, the bathymetric surfaces are not shown. In Figure 8E, the current bathymetric surface is represented as the top black line and in Figures 8 F-H as the top red line. The pre-impoundment surface is identified by comparing boundaries observed in the 200 kHz, 50 kHz and 24 kHz signals to the location of the pre-impoundment surface of the sediment core sample. Each sediment core sample was compared to all three frequencies and the boundary in the 200 kHz signal most closely matched the pre-impoundment interface of the sediment core samples; therefore, the 200 kHz signal was used to locate the pre-impoundment layer. The pre-impoundment surface was manually drawn and is represented by the bottom black line in Figure 8E, and by the yellow line in Figures 8F-H. Figure 9 shows sediment core sample S-2 correlated with the 200 kHz frequency of the nearest surveyed cross-section. The pre-impoundment surface identified along cross-sections where sediment core samples were collected is used as a guide for identifying the pre-impoundment surface along cross-sections where sediment core samples were not collected.

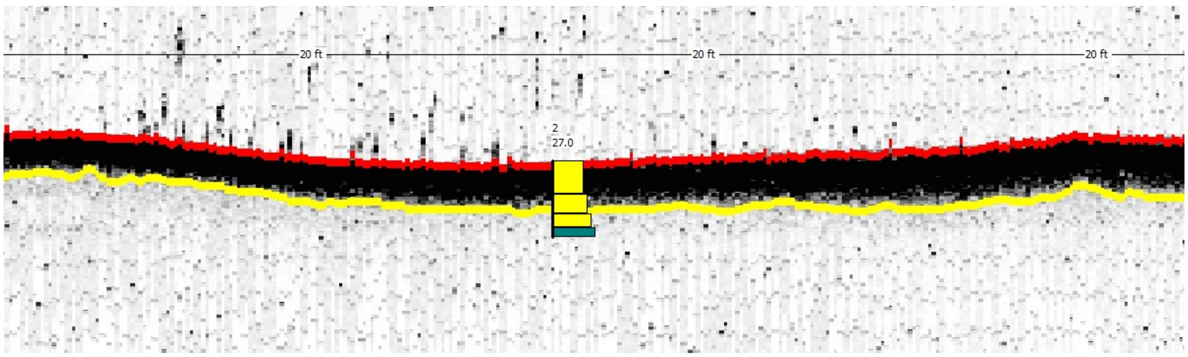

Figure 9. Cross-section of data collected during 2012 survey, displayed in DepthPic© (200 kHz frequency), correlated with sediment core sample S-2 and showing the current surface in red and pre-impoundment surface in yellow

After the pre-impoundment surface from all cross-sections was identified, a sediment thickness TIN model is created following standard GIS techniques (Furnans, 2007). Sediment thicknesses were interpolated between surveyed cross-sections using HydroTools with the same interpolation definition file used for bathymetric interpolation. For the purposes of the TIN model creation, TWDB assumed sediment thickness at the reservoir boundary was zero feet (defined as the 238.0 foot NGVD29 elevation contour). The sediment thickness TIN model was converted to a raster representation using a cell size of 5 feet by 5 feet and used to produce a sediment thickness map of Somerville Lake (Figure 10).

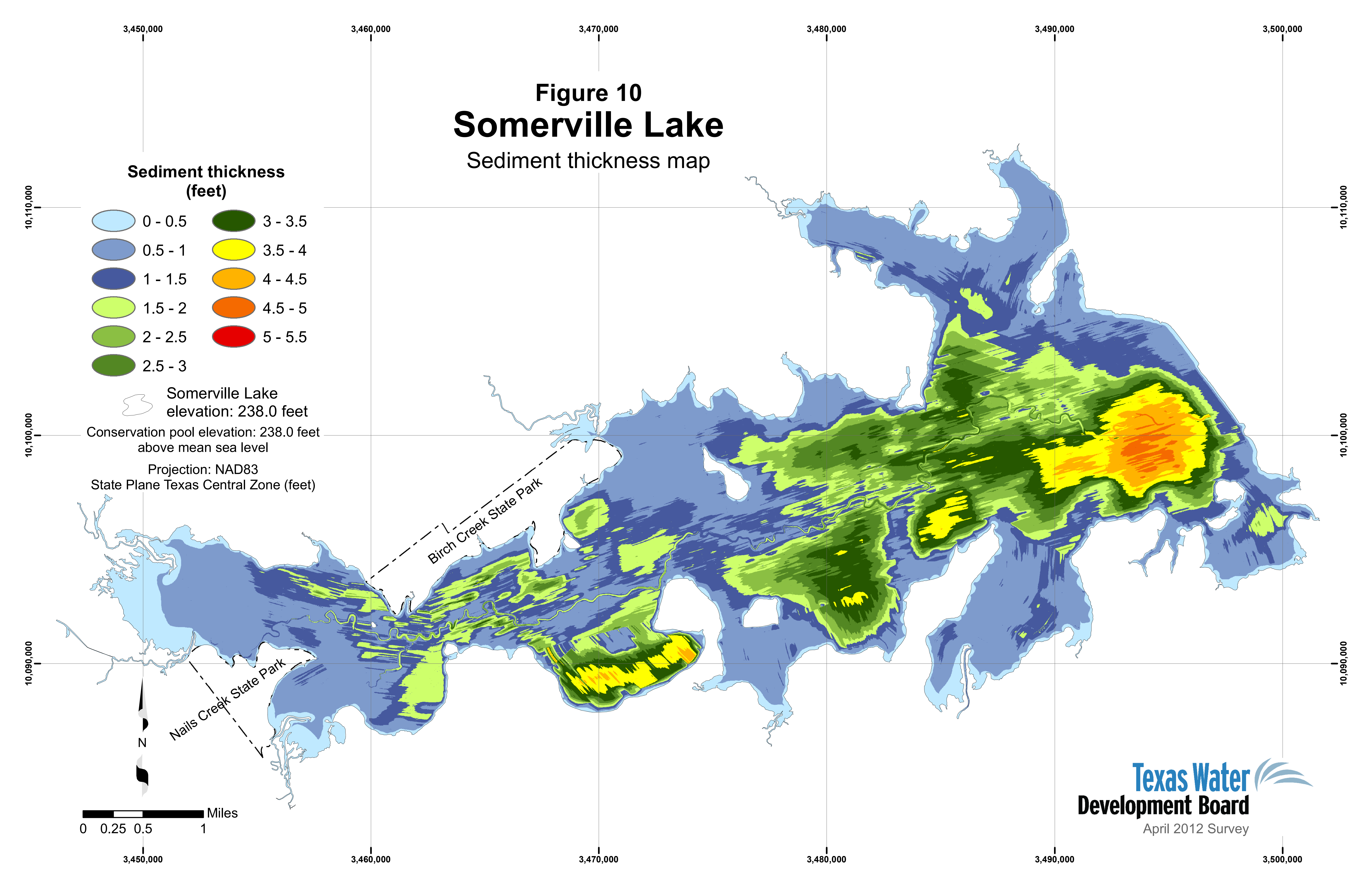
Figure 10
Somerville Lake
Sediment thickness map
Sediment thickness (feet)
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 3.5
3.5 - 4
4 - 4.5
4.5 - 5
5 - 5.5
Somerville Lake elevation: 238.0 feet
Conservation pool elevation: 238.0 feet above mean sea level
Projection: NAD83
State Plane Texas Central Zone (feet)
Birch Creek State Park
Nails Creek State Park
N
Miles
0 0.25 0.5 1
3,450,000
3,460,000
3,470,000
3,480,000
3,490,000
3,500,000
10,110,000
10,100,000
10,090,000
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Survey results

Volumetric survey

The results of the 2012 TWDB volumetric survey indicate Somerville Lake has a total reservoir capacity of 150,307 acre-feet and encompasses 11,395 acres at conservation pool elevation (238.0 feet above mean sea level, NGVD29). The original design estimate by the U.S. Army Corps of Engineers indicates Somerville Lake encompassed 11,656 acres with a total reservoir capacity of 164,974 acre-feet. In 1992, the U.S. Army Corps of Engineers conducted a resurvey of Somerville Lake indicating the lake encompassed 11,591 acres with a total reservoir capacity of 159,682 acre-feet. Because of differences in past and present survey methodologies, direct comparison of volumetric surveys to estimate loss of capacity is difficult and can be unreliable.

Previous surveys of Somerville Lake by TWDB were conducted in 1995 and 2003. To properly compare results of TWDB surveys, TWDB applied the 2013 data processing techniques to the data collected in 1995 and 2003. Specifically, TWDB applied anisotropic spatial interpolation to the survey data collected in 1995 and 2003 using the same interpolation definition file as was used for the 2012 survey with minor edits to account for differences in data coverage and boundary conditions. Additionally, data points from the 1995 survey that did not adhere to the pre-planned survey design were deleted. New TIN models were created using the original boundaries. The 1995 survey boundary was digitized from the 238.0-feet contour from 7.5 minute USGS quadrangle maps, with a stated accuracy of ± ½ the contour interval (USBB, 1947). The 2003 survey boundary was digitized from aerial photographs taken on February 20, 1995, while the water surface elevation of the reservoir measured 239.82 feet above mean sea level. The boundary was defined as 239.8 feet for modeling purposes. According to the associated metadata, the 1995-1996 DOQQs have a resolution of 1-meter, with a horizontal positional accuracy that meets the National Map Accuracy Standards (NMAS) for 1:12,000-scale products. Re-evaluation of the 1995 and 2003 surveys resulted in a 0.7 percent and 1.3 percent increase, respectively, in total capacity estimates (Table 3).

Table 3. Current and previous survey capacity and surface area data

Survey	Surface area (acres)	Total capacity (acre-feet)
Original[a]	11,656	164,974
USACE 1992 Resurvey	11,591	159,682
TWDB 1995[b]	11,456	155,062
TWDB 1995 (re-calculated)	11,456	156,184
TWDB 2003[c]	11,555	147,104
TWDB 2003 (re-calculated)	11,127	149,072
TWDB 2012	11,395	150,293

[a] Source: (USACE, 1995) Note: In previous TWDB survey reports (TWDB, 2003, TWDB, 2005), TWDB Report 126 (TWDB, 1973), and the USACE pertinent data sheet for Somerville Lake (USACE, 2013), the original area and capacity estimates are reported as 11,460 acres and 160,110 acre-feet. This capacity is not the original surveyed capacity, but rather the amount of water the Brazos River Authority is authorized to impound in Somerville Lake per Certificate of Adjudication No. 12-5164 issued by the Texas Water Commission, now the Texas Commission on Environmental Quality, on December 14, 1987.
[b] Source: (TWDB, 2003)
[c] Source: (TWDB, 2005)

Sedimentation survey

Based on two methods for estimating sedimentation rates presented in Table 4, the 2012 TWDB sedimentation survey estimates Somerville Lake loses between 326 and 469 acre-feet per year of capacity due to sedimentation below conservation pool elevation (238.0 feet NGVD29). The sedimentation survey indicates sediment accumulation varies throughout the reservoir. The heaviest accumulations measured are between 0.25 and 1.63 miles west of the dam and on the south shore of the reservoir opposite Birch Creek State Park.

Comparison of capacity estimates of Somerville Lake derived using differing methodologies are provided in Table 4 for sedimentation rate calculation. The sediment accumulation rates derived from these survey comparisons reflect the average rate of sediment accrual during the time between each previous survey and the current survey. Based on the 2012 estimated sediment volume, Somerville Lake lost an average of approximately 379 acre-feet of capacity per year from 1967 to 2012.

Table 4. Capacity loss comparisons for Somerville Lake

Survey	Volume comparisons at conservation pool elevation (acre-feet)				Pre-impoundment (acre-feet)
Original	164,974	<>	<>	<>	<>
USACE 1992 Resurvey		159,682	<>	<>	<>
TWDB 1995 (re-calculated)	<>	<>	156,184	<>	<>
TWDB 2003 (re-calculated)	<>	<>	<>	149,072	<>
TWDB pre-impoundment estimate based on 2012 survey	<>	<>	<>	<>	167,353[b]
2012 volumetric survey	150,293	150,293	150,293	150,293	150,293
Volume difference (acre-feet)	14,681 (8.9%)	9,389 (5.9%)	5,891 (3.8%)	-1,221 (-0.8%)	17,060 (10.2%)
Number of years	45[a]	20	17	9	45[a]
Capacity loss rate (acre-feet/year)	326	469	347	-136	379

Note: Somerville Dam was completed on October 27, 1967 and deliberate impoundment began on January 3, 1967

[a] Number of years based on difference between 2012 survey date and deliberate impoundment date of 1967

[b] 2012 TWDB surveyed capacity of 150,293 acre-feet plus 2012 TWDB surveyed sediment volume of 17,060 acre-feet

Recommendations

To improve estimates of sediment accumulation rates, TWDB recommends resurveying Somerville Lake in approximately 10 years or after a major flood event. To further improve estimates of sediment accumulation, TWDB recommends another sedimentation survey. A re-survey would allow a more accurate quantification of the average sediment accumulation rate for Somerville Lake.

TWDB contact information

More information about the Hydrographic Survey Program can be found at: http://www.twdb.texas.gov/surfacewater/surveys/index.asp

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Appendix A

Somerville Lake

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD | April 2012 Survey
CAPACITY IN ACRE-FEET | Conservation Pool Elevation 238.0 feet NGVD29
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
209	0	0	0	0	0	0	0	0	0	0
210	1	1	1	2	3	5	8	12	17	24
211	33	43	57	74	96	122	152	187	226	269
212	318	370	426	486	549	616	685	758	833	912
213	994	1,079	1,167	1,259	1,353	1,451	1,553	1,657	1,765	1,876
214	1,990	2,108	2,229	2,354	2,483	2,616	2,754	2,896	3,043	3,195
215	3,350	3,510	3,673	3,840	4,011	4,186	4,365	4,547	4,733	4,924
216	5,119	5,319	5,525	5,735	5,951	6,172	6,396	6,626	6,860	7,098
217	7,341	7,588	7,840	8,099	8,362	8,630	8,902	9,179	9,460	9,745
218	10,034	10,327	10,624	10,926	11,232	11,543	11,857	12,176	12,500	12,828
219	13,159	13,495	13,835	14,178	14,526	14,877	15,232	15,590	15,952	16,317
220	16,686	17,057	17,431	17,808	18,188	18,572	18,958	19,348	19,741	20,138
221	20,537	20,940	21,346	21,756	22,169	22,587	23,008	23,433	23,862	24,295
222	24,731	25,171	25,615	26,062	26,513	26,968	27,427	27,889	28,356	28,826
223	29,300	29,777	30,259	30,744	31,233	31,726	32,222	32,723	33,227	33,735
224	34,248	34,765	35,286	35,814	36,348	36,888	37,434	37,986	38,542	39,103
225	39,669	40,240	40,818	41,400	41,989	42,582	43,182	43,787	44,397	45,012
226	45,633	46,258	46,888	47,521	48,158	48,799	49,444	50,093	50,746	51,403
227	52,064	52,729	53,398	54,071	54,749	55,431	56,117	56,807	57,503	58,203
228	58,909	59,620	60,336	61,056	61,781	62,511	63,244	63,981	64,723	65,468
229	66,216	66,969	67,725	68,484	69,246	70,012	70,781	71,553	72,329	73,107
230	73,888	74,672	75,459	76,249	77,042	77,839	78,639	79,442	80,250	81,062
231	81,878	82,698	83,523	84,354	85,189	86,029	86,875	87,725	88,581	89,441
232	90,306	91,176	92,050	92,929	93,812	94,700	95,593	96,490	97,392	98,300
233	99,212	100,130	101,052	101,979	102,910	103,846	104,786	105,732	106,681	107,635
234	108,593	109,556	110,523	111,495	112,471	113,452	114,437	115,427	116,422	117,421
235	118,424	119,431	120,442	121,457	122,476	123,499	124,525	125,556	126,590	127,628
236	128,670	129,716	130,764	131,816	132,871	133,929	134,991	136,056	137,125	138,198
237	139,275	140,356	141,441	142,531	143,625	144,723	145,827	146,935	148,048	149,167
238	150,293									

Appendix B

Somerville Lake

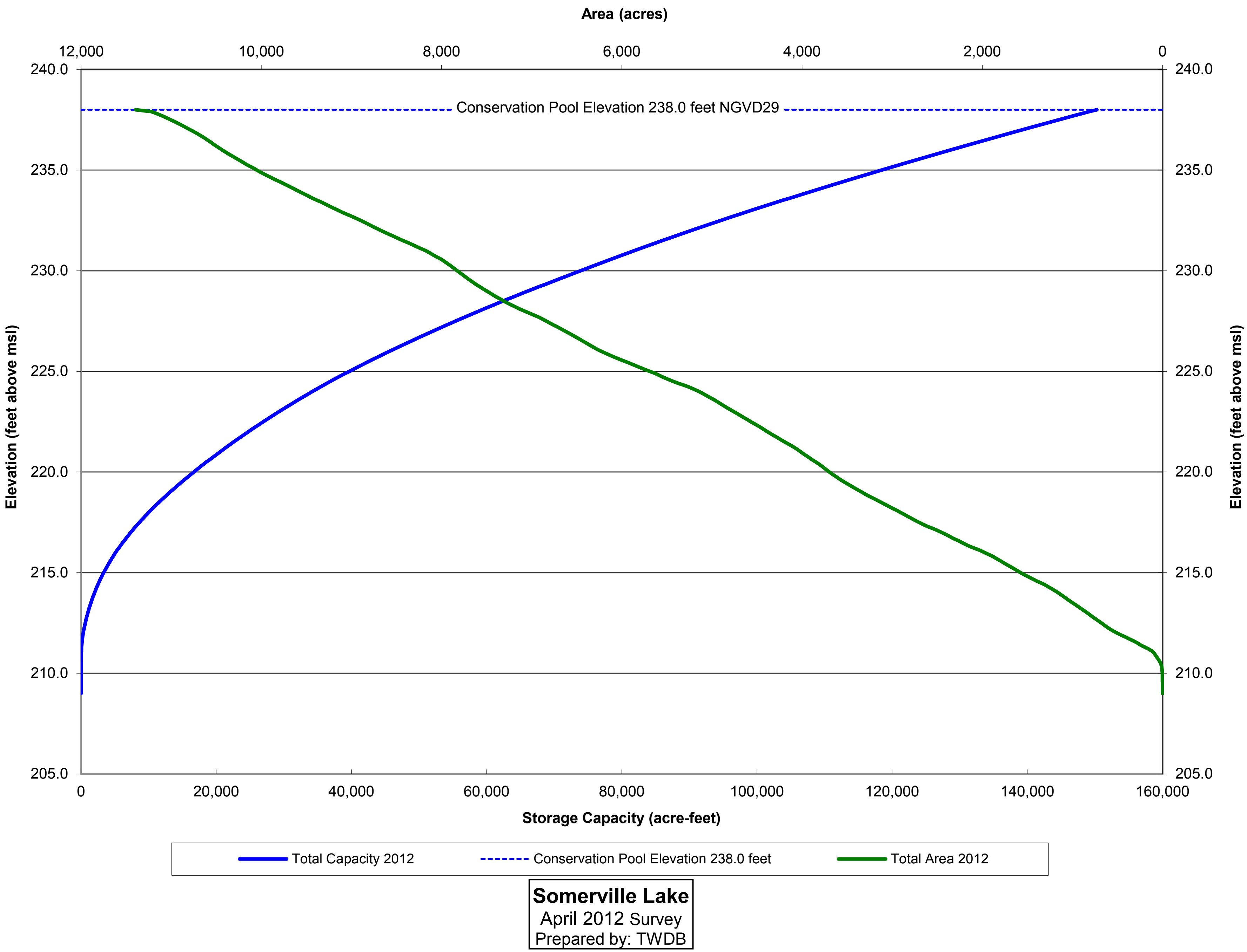
RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — April 2012 Survey

AREA IN ACRES — Conservation Pool Elevation 238.0 feet NGVD29

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
209	0	0	0	0	0	0	0	1	1	2
210	3	4	5	8	13	21	35	47	64	78
211	94	117	154	197	244	277	321	368	413	461
212	503	545	582	616	647	678	708	741	773	804
213	835	866	898	930	962	997	1,031	1,062	1,094	1,126
214	1,158	1,192	1,230	1,269	1,307	1,355	1,404	1,448	1,490	1,537
215	1,576	1,613	1,651	1,690	1,730	1,767	1,806	1,845	1,882	1,929
216	1,977	2,025	2,081	2,134	2,181	2,225	2,269	2,319	2,361	2,403
217	2,450	2,497	2,550	2,610	2,657	2,701	2,747	2,787	2,828	2,869
218	2,911	2,951	2,997	3,040	3,084	3,126	3,169	3,214	3,257	3,298
219	3,338	3,376	3,416	3,454	3,494	3,531	3,568	3,601	3,634	3,669
220	3,699	3,728	3,756	3,785	3,816	3,849	3,883	3,915	3,948	3,981
221	4,012	4,044	4,077	4,114	4,154	4,193	4,233	4,270	4,308	4,346
222	4,383	4,418	4,453	4,491	4,530	4,570	4,606	4,644	4,681	4,720
223	4,758	4,797	4,836	4,872	4,908	4,944	4,982	5,023	5,064	5,104
224	5,146	5,194	5,244	5,306	5,373	5,433	5,487	5,539	5,586	5,634
225	5,686	5,745	5,802	5,855	5,908	5,966	6,023	6,077	6,129	6,180
226	6,230	6,273	6,313	6,353	6,391	6,431	6,469	6,508	6,547	6,589
227	6,629	6,671	6,712	6,756	6,799	6,840	6,881	6,927	6,978	7,032
228	7,084	7,135	7,181	7,228	7,273	7,314	7,353	7,395	7,431	7,468
229	7,504	7,541	7,577	7,610	7,642	7,674	7,707	7,737	7,767	7,796
230	7,827	7,856	7,885	7,915	7,949	7,980	8,015	8,059	8,100	8,136
231	8,178	8,229	8,280	8,327	8,377	8,430	8,480	8,529	8,578	8,628
232	8,675	8,721	8,766	8,811	8,854	8,899	8,949	8,998	9,050	9,103
233	9,149	9,198	9,244	9,288	9,334	9,384	9,430	9,472	9,516	9,562
234	9,606	9,650	9,693	9,738	9,783	9,833	9,879	9,924	9,967	10,010
235	10,050	10,088	10,131	10,171	10,209	10,247	10,286	10,325	10,363	10,400
236	10,436	10,470	10,503	10,535	10,567	10,600	10,634	10,670	10,709	10,748
237	10,790	10,832	10,874	10,918	10,962	11,009	11,057	11,107	11,161	11,220
238	11,395									



Appendix C: Area and Capacity Curves


Figure 6
Contours
(feet above mean sea level)
236
234
232
230
228
226
224
222
220
218
216
214
212
210
Islands
Somerville Lake Conservation pool elevation 238.0 feet above mean sea level
Projection: NAD83
State Plane
Texas Central Zone (feet)
This map is the product of a survey conducted by the Texas Water Development Board's Hydrographic Survey Program to determine the capacity of Somerville Lake. The Texas Water Development Board makes no representations nor assumes any liability.
Somerville Lake
2' - contour map
Burleson
Lee
Washington
N
0
0.5
1
2
Miles
Texas Water Development Board
April 2012 Survey