Volumetric and Sedimentation Survey of LAKE WAXAHACHIE

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Texas Water Development Board

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Prepared for:

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Executive summary

In September 2020, the Texas Water Development Board (TWDB) entered into an agreement with the City of Waxahachie, Texas, to perform a volumetric and sedimentation survey of Lake Waxahachie (Ellis County, Texas). Surveying was performed using a multi-frequency (208 kHz, 50 kHz, and 12 kHz), sub-bottom profiling depth sounder. Sediment core samples were collected and correlated with sub-bottom acoustic profiles to estimate sediment accumulation thicknesses and sedimentation rates.

South Prong Dam and Lake Waxahachie are located on South Prong Creek in Ellis County, approximately 4 miles southeast of Waxahachie, Texas. The conservation pool elevation of Lake Waxahachie is 531.50 feet above mean sea level (NGVD29). The TWDB collected bathymetric data for Lake Waxahachie on July 22, 2020, while the daily average water surface elevation measured 530.26 feet above mean sea level (NGVD29).

The 2020 TWDB volumetric survey indicates Lake Waxahachie has a total reservoir capacity of 11,642 acre-feet and encompasses 657 acres at conservation pool elevation (531.50 feet above mean sea level, NGVD29).

Previous capacity estimates at conservation pool elevation (531.50 feet above mean sea level, NGVD29) include an original design estimate of 13,500 acre-feet and a 2000 TWDB volumetric survey estimate re-calculated using current processing procedures, of 11,572 acre-feet. Because of differences in past and present survey methodologies, direct comparison of volumetric surveys to others to estimate loss of area and capacity can be unreliable. The 2020 TWDB survey results do not mean the reservoir has gained capacity since 2000. Rather it is a result of data collected over a larger area and improved methods.

The 2020 TWDB sedimentation survey measured 1,874 acre-feet of sediment. The sedimentation survey indicates sediment is accumulating throughout the main body of the lake and gets progressively thicker from upstream to downstream. The TWDB recommends that a similar methodology be used to resurvey Lake Waxahachie in 10 years or after a major high flow 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. Texas Water Code Section 15.804 authorizes the TWDB to perform surveys to determine reservoir storage capacity, sedimentation levels, rates of sedimentation, and projected water supply availability.

In September 2020, the TWDB entered into an agreement with the City of Waxahachie to perform a volumetric and sedimentation survey of Lake Waxahachie (Texas Water Development Board, 2020). This report provides an overview of the survey methods, analysis techniques, and associated results. Also included are the following contract deliverables: (1) an elevation-area-capacity table of the reservoir acceptable to the Texas Commission on Environmental Quality (Appendices E and F); (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 9).

Lake Waxahachie general information

South Prong Dam and Lake Waxahachie are located on South Prong Creek in Ellis County, approximately 4 miles southeast of Waxahachie, Texas (Figure 1). Lake Waxahachie is owned and operated by the Ellis County Water Control and Improvement District No. 1 (Ellis County WCID#1). Construction of the dam began on March 26, 1956, and the dam was completed in November 1956. Deliberate impoundment of water also began in November 1956 (Texas Water Development Board, 1973). The reservoir was built solely for water supply purposes for the city of Waxahachie (Texas Water Commission, 1964). Additional pertinent data about South Prong Dam and Lake Waxahachie can be found in Table 1.

Water rights for Lake Waxahachie are appropriated to Ellis County Water Control and Improvement District No. 1 through Certificate of Adjudication 08-5018 and Amendment to Certificate of Adjudication No. 08-5018A (Texas Commission on Environmental Quality, 2020). The complete permits are on file with the Texas Commission on Environmental Quality.

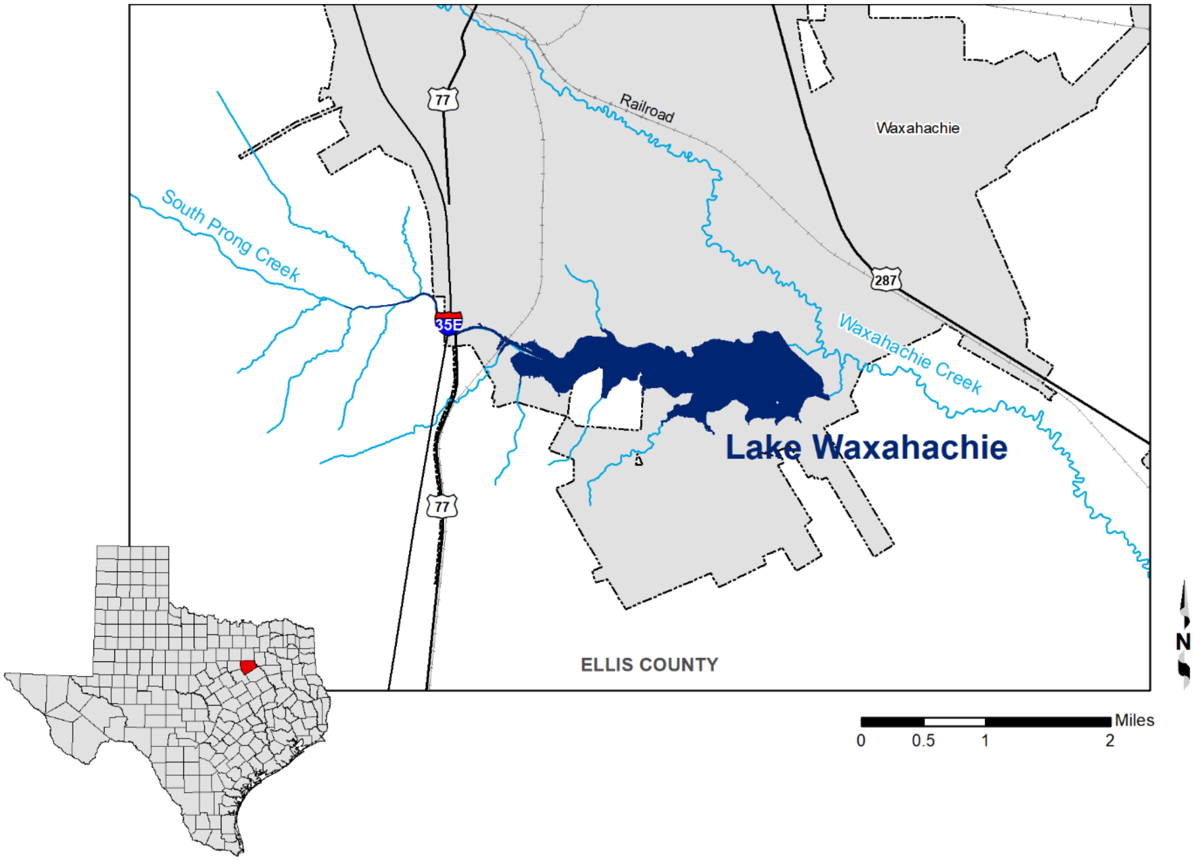


Figure 1. Location map.

Table 1. Pertinent Data for South Prong Dam and Lake Waxahachie			
Owner(s)			
Ellis County Water Control and Improvement District No. 1 (Ellis County WCID#1)			
Engineer (Design)			
Forrest and Cotton, Inc.			
General Contractor			
J.W. Moorman and Son			
Purpose			
Water Supply			
Drainage area			
30 square miles			
Dam			
Type	Earth fill		
Length	4,100 feet (includes spillway)		
Maximum Height	66 feet		
Top Width	18 feet		
Spillway			
Location	At the right abutment		
Type	Concrete weir (uncontrolled)		
Crest Length	300 feet		
Crest Elevation	531.50 feet above mean sea level		
Outlet Works			
Type	Concrete vertical intake structure		
Number	3 gated openings (2.5 feet by 2.5 feet)		
Pipe Size	24 inches		
Discharge Control			
Treating plant	Valve		
Downstream releases	Valve		
Reservoir Data (Based on 2020 TWDB survey)			
Feature	**Elevation (feet above MSL)**	**Capacity (acre-feet)**	**Area (acres)**
Top of dam	541.50	19,712	935
Conservation pool elevation/ Spillway crest	531.50	11,642	657
Invert/dead pool elevation	498.75	582	91
Conservation storage capacity[a]	—	11,060	—

Source(s): Texas Water Development Board, 1973.

[a] Usable conservation storage 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 Lake Waxahachie

Datum

The vertical datum used during this survey is the National Geodetic Vertical Datum 1929 (NGVD29). This datum is utilized by the United States Geological Survey (USGS) for the reservoir elevation gage *USGS 08063600 Lk Waxahachie nr Waxahachie, TX* (U.S. Geological Survey, 2020). Elevations herein are reported in feet relative to the NGVD29 datum. Volume and area calculations in this report are referenced to water levels reported by the USGS gage *USGS 08063600 Lk Waxahachie nr Waxahachie, TX.* The horizontal datum used for this report is North American Datum 1983 (NAD83), and the horizontal coordinate system is State Plane Texas North Central Zone (feet).

TWDB bathymetric and sedimentation data collection

The TWDB collected bathymetric data for Lake Waxahachie on July 22, 2020, while the daily average water surface elevation measured 530.26 feet above mean sea level (NGVD29). For data collection, the TWDB used a Specialty Devices, Inc. (SDI), single-beam, multi-frequency (208 kHz, 50 kHz, and 12 kHz) sub-bottom profiling depth sounder integrated with differential global positioning system (DGPS) equipment. Data were collected along pre-planned survey lines oriented perpendicular to the assumed location of the original river channel(s) and spaced approximately 500 feet apart or less depending on expected variations in topography. Many of the same survey lines also were used by the TWDB for the *Volumetric Survey of Lake Waxahachie, July 2000 Survey* (Texas Water Development Board, 2000). 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. Each speed of sound profile, or velocity cast, is saved for further data processing. Figure 2 shows the data collection locations for the 2020 TWDB survey.

All sounding data were collected and reviewed before sediment core sampling sites were selected. Sediment core samples are collected throughout the reservoir to assist with interpretation of the sub-bottom acoustic profiles. After analyzing the sounding data, the TWDB selected 8 locations to collect sediment core samples, though sediment core 8 could not be recovered due to reservoir conditions (Figure 2). Sediment cores were collected on September 16, 2020, with a custom-coring boat and an 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 of penetration the tube must be driven during sediment sampling. A sediment core extends from the current reservoir-bottom surface, through the accumulated sediment, and into the pre-impoundment surface. After the sample is retrieved, the core tube is cut to the level of the sediment core. The tube is capped, labeled, and transported to TWDB headquarters for further analysis.

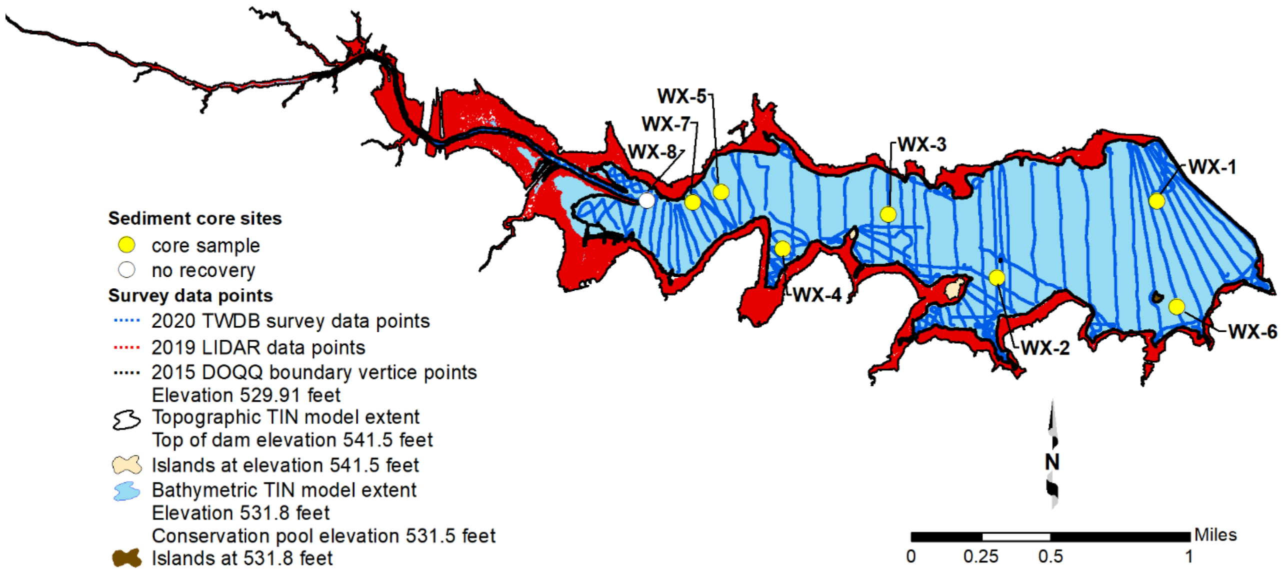


Figure 2. 2020 TWDB sounding data (*blue dots*), 2019 LIDAR data (*red dots),* and sediment coring locations (*yellow circles)*.

Data processing

Model boundary

The bathymetric model boundary of the reservoir was digitized from aerial photographs, also known as digital orthophoto quarter-quadrangle images (DOQQs), obtained through the Texas Imagery Service. The Texas Natural Resources Information System (TNRIS) manages the Texas Imagery Service, allowing public organizations in the State of Texas to access Google Imagery as a service using Environmental Systems Research Institute's ArcGIS software (Texas Natural Resources Information System, 2020a). The photographs have a resolution of 6 inches (Texas Natural Resources Information System, 2020b). The boundary was digitized at the land-water interface from images photographed on March 21, 2018, while the daily average water surface elevation measured 531.81 feet NGVD29 and assigned an elevation value of 531.8 feet for modeling purposes. To better define the upper elevations, a contour was digitized at the land-water interface from images photographed on August 7, 2015, while the daily average water surface elevation measured 529.91 feet NGVD29.

To calculate the area and capacity at the top of the dam, elevation 541.5 feet, a topographic model boundary was developed from Light Detection and Ranging (LIDAR) Data available from the Texas Natural Resource Information System. The LIDAR data were collected between January 26 and July 12, 2019 (Texas Water Development Board, 2021), while the daily average water surface elevation of the reservoir measured between 531.68 and 532.77 feet. The LIDAR data .las files were imported into an LAS Dataset and the dataset was converted to a raster using a cell size of 1.0 meters by 1.0 meters. A contour at 165.057 meters equivalent to 541.526 feet NAVD88, was extracted as the upper extent of the model. The elevation of the top of the dam is 541.5 feet above mean sea level. The horizontal datum of the LIDAR data is Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83; meters) Zone 14, and the vertical datum is North American Vertical Datum 1988 (NAVD88; meters). The vertical datum transformation offset of 0.026 feet was used to convert from feet NAVD88 to feet above mean sea level. The vertical datum transformation offset for the conversion from NAVD88 to NGVD29 was determined by applying the National Oceanic and Atmospheric Administration National Geodetic Survey's NADCON software (National Geodetic Survey, 2017a) and VERTCON software (National Geodetic Survey, 2017b) to a single reference point in the vicinity of the survey, the reservoir elevation gage *USGS 08063600 Lk Waxahachie nr*

Waxahachie, TX Latitude 32º20'30"N, Longitude 96º48'18"W NAD27. The contour was edited to close the contour across the top of the dam. Horizontal coordinate transformations to NAD83 State Plane Texas North Central Zone (feet) coordinates were done using the ArcGIS Project tool.

LIDAR data points

To utilize the LIDAR data in the reservoir topographic model, the LIDAR data .las files were converted to a multipoint feature class in an Environmental Systems Research Institute's ArcGIS file geodatabase filtered to include only data classified as ground points. A topographical model of the data was generated. The ArcGIS tool Terrain to Points was used to extract points from the Terrain, or topographical model of the reservoir. The Terrain was created using the z-tolerance Pyramid Type. All points were extracted from the terrain, i.e., no thinning of the LIDAR data points was performed. New attribute fields were added to convert the elevations from meters to feet NAVD88 and then to feet above mean sea level for compatibility with the bathymetric survey data. LIDAR data outside of the 541.5-foot contour and inside the 531.8-foot contour were deleted and the feature class projected to NAD83 State Plane Texas North Central Zone (feet). No further interpolation of the data in the areas with only LIDAR coverage was necessary.

Triangulated Irregular Network model

Following completion of data collection, the raw data files collected by the TWDB were edited to remove data anomalies. The current bottom surface of the reservoir is automatically determined by the data acquisition software. Hydropick software, developed by TWDB staff, was used to display, interpret, and edit the multi-frequency data by manually removing data anomalies in the current bottom surface and to manually edit the pre-impoundment surfaces. The speed of sound profiles, also known as velocity casts, were used to further refine the measured depths. For each location velocity casts are collected, the harmonic mean sound speed of all the casts are calculated. From this, depths collected using one average speed of sound are corrected with an overall optimum speed of sound for each specific depth (Specialty Devices, Inc., 2018).

All data were exported into a single file, including the current reservoir bottom surface, pre-impoundment surface, and sediment thickness at each sounding location. 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 was then preconditioned by inserting a uniform grid of artificial survey points between the actual survey lines. Bathymetric elevations at these artificial points were determined using an anisotropic spatial interpolation algorithm described in the next section. This technique creates a high resolution, uniform grid of interpolated bathymetric elevation points throughout a majority of the reservoir (McEwen *et al.* 2011a). The resulting point file was 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 (Environmental Systems Research Institute, 1995).

Spatial interpolation of reservoir bathymetry

Isotropic spatial interpolation techniques such as the Delaunay triangulation are, in many instances, unable to suitably interpolate bathymetry 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 artifacts may 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, the 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 by directly examining the survey data, or more robustly by examining scanned USGS 7.5-minute quadrangle maps (DRGs), hypsography files (the vector format of USGS 7.5-minute quadrangle map contours), and historical aerial photographs, when available. Using the survey data, polygons are created to partition the reservoir into segments with centerlines defining the directionality of interpolation within each segment. 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 reservoir bathymetry and sediment accumulation throughout the reservoir. Specific details of this interpolation technique can be found in the HydroTools manual (McEwen and others, 2011a) and in McEwen and others (2011b). No additional interpolation was necessary in the areas where LIDAR data was used for the topographic TIN model.

In areas inaccessible to survey data collection, such as small coves and shallow, upstream areas of the reservoir, linear interpolation is used for volumetric and sediment accumulation estimations (McEwen and others, 2011a). Linear interpolation is required due to artifacts created at the reservoir boundary elevation during the TIN model generation process, and results in improved elevation-capacity and elevation-area calculations.

Figure 3 illustrates typical results from application of the anisotropic interpolation and linear interpolation as applied to Lake Waxahachie. In Figure 3A, deeper channels and steep slopes 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 in creation of the volumetric TIN model, represented in Figure 3B, directs Delaunay triangulation to better represent the reservoir bathymetry between survey cross-sections. The bathymetry shown in Figure 3C was used in computing reservoir elevation-capacity (Appendix E) and elevation-area (Appendix F) tables.

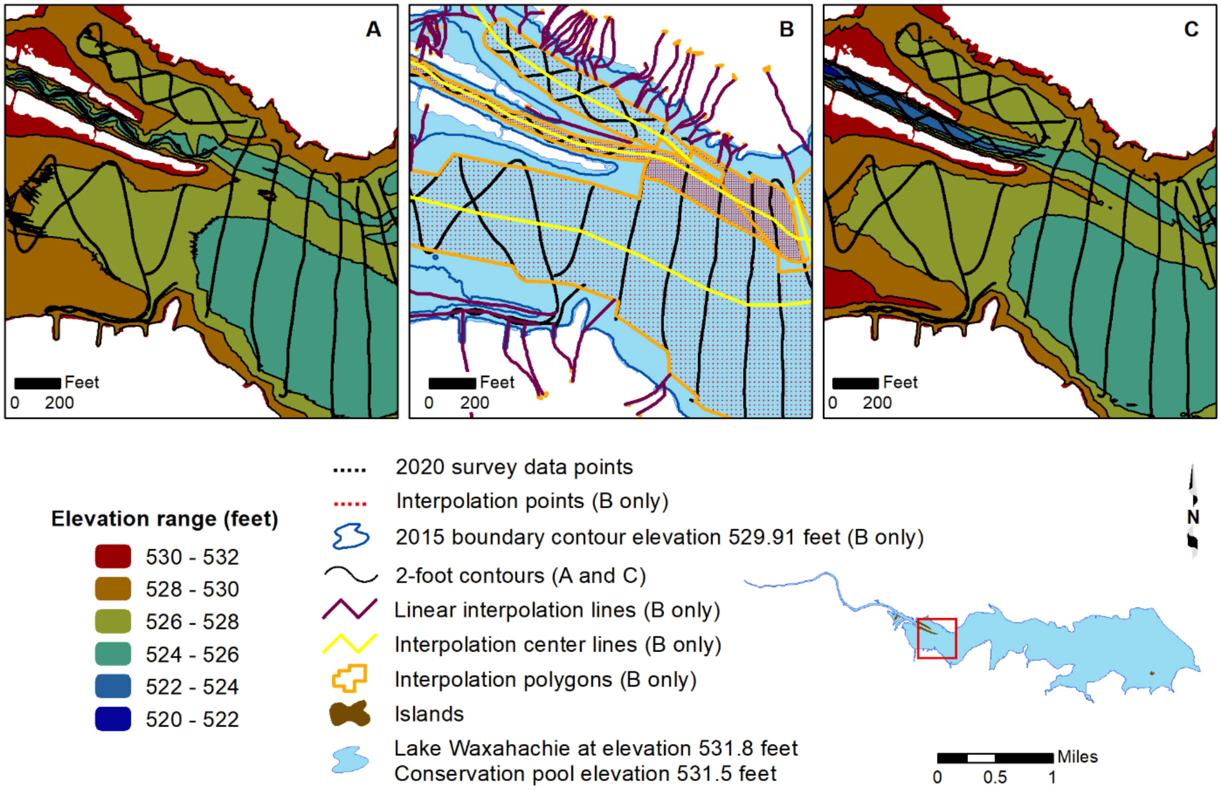


Figure 3. **Anisotropic spatial interpolation and linear interpolation as applied to Lake Waxahachie sounding data; A) bathymetric contours without interpolated points, B) sounding points (*black*) and interpolated points (*red*), C) bathymetric contours with interpolated points.**

To properly compare results from the 2000 TWDB survey of Lake Waxahachie, the TWDB applied anisotropic spatial interpolation to the survey data collected in 2000. The 2000 survey boundary was digitized from aerial photographs taken on February 19, 1995. According to the associated metadata, the 1995-1996 aerial photographs 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. The water surface elevation of the reservoir at the time of the photograph is unknown, however, the boundary was assigned the elevation of 531.50 feet (Texas Water Development Board, 2000). While linear interpolation was used to estimate the topography in areas without data, flat triangles led to anomalous area and volume calculations at the boundary elevation of 531.5 feet. Therefore, areas between 528.5 feet and 531.5 feet were linearly interpolated between the computed values, and volumes above 528.5 feet were calculated based on the corrected areas (Texas Water Development Board, 2016). The 2000 re-calculated elevation-capacity table and elevation-area table are presented in Appendices A and B, respectively. The re-calculated capacity curve is presented in Appendix C, and the re-calculated area curve is presented in Appendix D.

Area, volume, and contour calculation

For the bathymetric TIN model, volumes and areas were computed for the entire reservoir at 0.1-foot intervals, from 482.5 to 531.5 feet above mean sea level. The bathymetric elevation-capacity table and bathymetric elevation-area table developed from the 2020 survey and analysis are presented in Appendices E and F, respectively. The bathymetric capacity curve is presented in Appendix G, and the bathymetric area curve is presented in Appendix H. For the topographic TIN model, volumes and areas were computed for the entire reservoir at 0.1-foot intervals, from 482.5 to 541.5 feet above mean sea level. The topographic elevation-capacity table and topographic elevation-area table developed from the 2020 survey and analysis are presented in Appendices I and J, respectively. The topographic capacity curve is presented in Appendix K, and the topographic area curve is presented in Appendix L.

The volumetric bathymetric TIN model was converted to a raster representation using a cell size of 1 foot by 1 foot. The resulting raster data were used to produce three figures: (1) an elevation relief map representing the topography of the reservoir bottom (Figure 4); (2) a depth range map showing depth ranges for Lake Waxahachie (Figure 5); and (3) a 2-foot contour map (Figure 6).

Figure 4

Lake Waxahachie

Elevation relief map

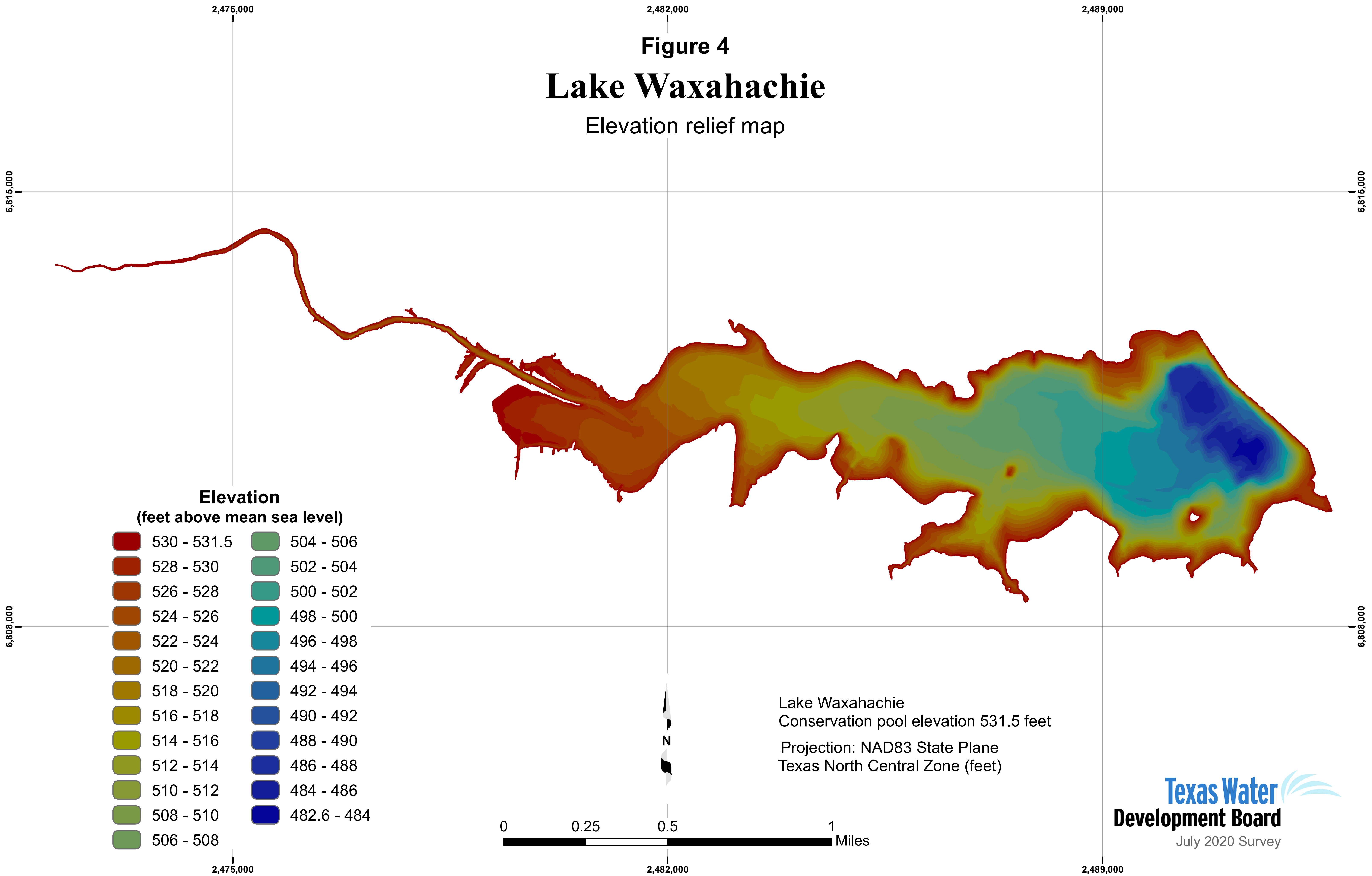
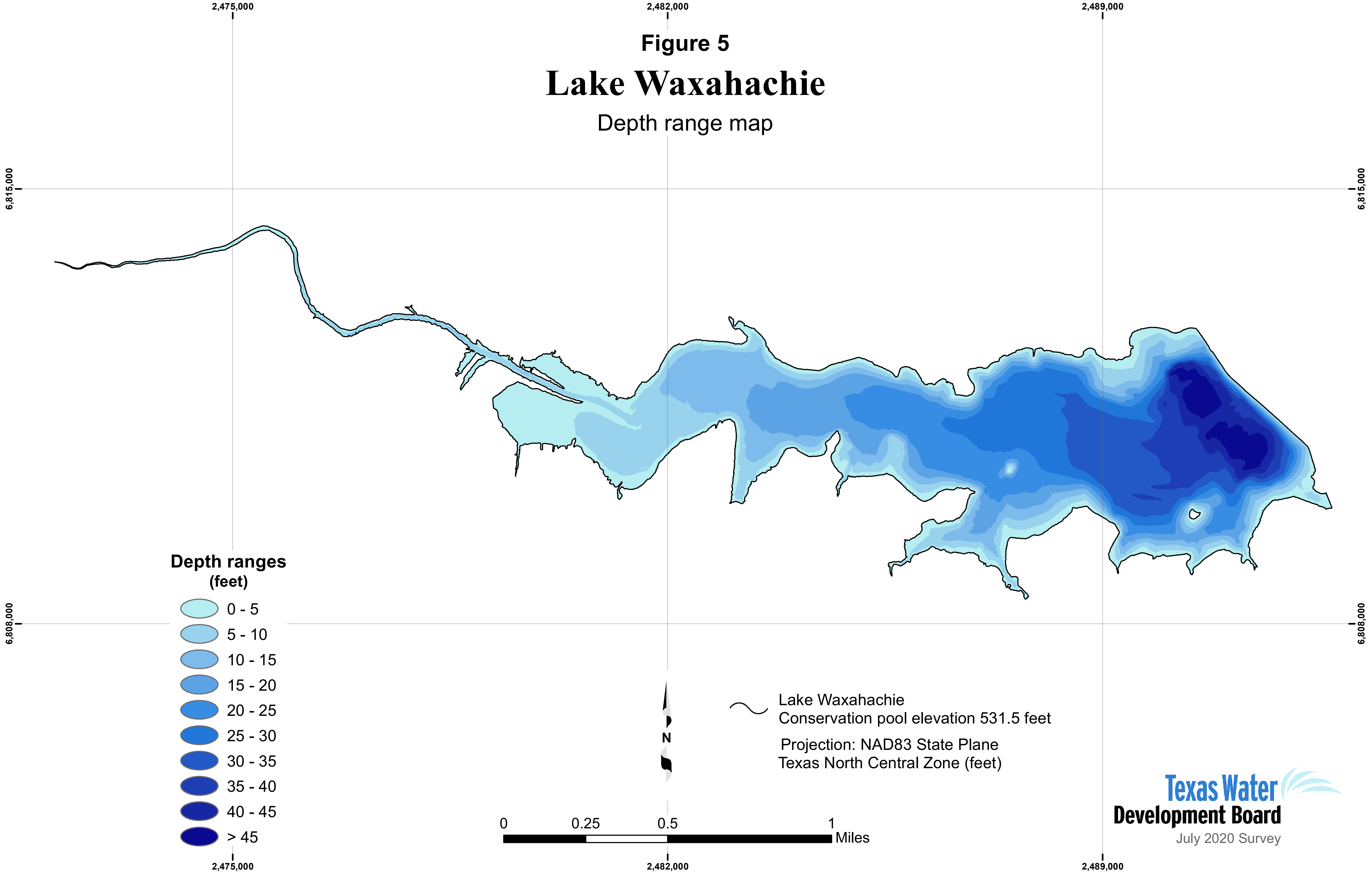


Figure 5

Lake Waxahachie

Depth range map



Analysis of sediment data from Lake Waxahachie

Sedimentation in Lake Waxahachie was determined by analyzing the acoustic signal returns of all three depth sounder frequencies using customized software called Hydropick. While the 208 kHz signal is used to determine the current bathymetric surface, the 208 kHz, 50 kHz, and 12 kHz are 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 are correlated with the acoustic signals in each frequency to assist in identifying the pre-impoundment surface. The difference between the current surface bathymetry and the pre-impoundment surface bathymetry yields a sediment thickness value at each sounding location.

Sediment cores were analyzed at TWDB headquarters in Austin. Each core was split longitudinally and analyzed to identify the location of the pre-impoundment surface. The pre-impoundment surface was identified within the sediment core using the following methods: (1) a visual examination of the sediment core for terrestrial and organic 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) recording changes in texture from well sorted, relatively fine-grained sediment to poorly sorted mixtures of coarse and fine-grained materials; and, (3) identifying variations in the physical properties of the sediment, particularly sediment water content and penetration resistance with depth (Van Metre and others, 2004). Total sediment core length, post impoundment sediment thickness, and pre-impoundment thickness were recorded. Physical characteristics of the sediment core, such as Munsell soil color, texture, relative water content, and presence of organic materials were recorded (Table 2).

Table 2. Sediment core sample analysis data.

Sediment core sample	Easting[a] (feet)	Northing[a] (feet)	Total core sample / post-impoundment sediment length (inches)	Sediment core description[b]		Munsell soil color
WX-1	2490476.56	6811594.86	104.0 / 103.0	post-impoundment	0.0–103.0” very high to moderate water content, water content decreases with depth, silty clay, dense and smooth, pudding like, mottled coloration	10YR 2/1 black, 10YR 3/2 very dark grayish brown
				Pre-impoundment	103.0–104.0” low water content, water content decreases with depth, silty clay, dense and smooth, mottled coloration	10YR 2/1 black, 10YR 3/2 very dark grayish brown
WX-2	2487440.20	6810141.62	11.0 / 2.0	post-impoundment	0.0–2.0” high water content, silt, soupy, smooth	10YR 2/1 black
				pre-impoundment	2.0–11.0” moderate to low water content, water content decrease with depth, silty clay, malleable, bits of clay, dense, very tiny gravel throughout	10YR 2/1 black
WX-3	2485370.69	6811345.55	120.0 / N/A	post-impoundment	0.0–120.0” high to low water content, water content decreases with depth, silty clay, dense, peanut butter consistency, smooth, mottled, pre-impoundment not reached	10YR 2/1 black, 10YR 3/2 very dark grayish brown
WX-4	2483371.71	6810690.48	10.0 / 0.0	pre-impoundment	0.0–10.0” low to very low water content, water content decreases with depth, silty clay with very thin layer of silt on top, dense, bits of clay and shell	10YR 2/1 black
WX-5	2482195.12	6811761.65	45.0 / 36.0	post-impoundment	0.0–1.0” very high water content, silt, soupy, smooth	10YR 3/2 very dark grayish brown
					1.0–36.0” moderate to low water content, silty clay smooth, sticky, peanut butter consistency, density increases with depth, mottled coloration to 21 inches	10YR 3/2 very dark grayish brown and 10YR 2/1 black, 10YR 3/2 very dark grayish brown
				pre-impoundment	36.0–45.0” very low water content, silty clay, very dense, root throughout layer, organic material present	10YR 2/1 black

[a] Coordinates are based on NAD83 State Plane Texas North Central System (feet).
[b] Sediment core samples are measured in inches with zero representing the current bottom surface.

Table 2. Sediment core sample analysis data (continued).

Sediment core sample	Easting[a] (feet)	Northing[a] (feet)	Total core sample / post-impoundment sediment length (inches)	Sediment core description[b]		Munsell soil color
WX-6	2490853.67	6809589.29	53.0 / 47.0	post-impoundment	0.0–1.0” very high water content, silt, soupy, smooth	10YR 3/2 very dark grayish brown
					1.0–47.0” high to low water content, water content decreases with depth, silty clay, sticky, peanut butter consistency, density increases with depth	10YR 3/2 very dark grayish brown
				pre-impoundment	47.0–53.0” very low water content, sandy clay, very dense, fibrous roots and twigs throughout, organic material present	10YR 5/1 gray
WX-7	2481663.68	6811568.81	33.0 / 25.0	post-impoundment	0.0–3.0” high water content, silt, smooth, pudding like	10YR 3/2 very dark grayish brown
					3.0–20.0” moderate to low water content, water content decreases with depth, silty clay, sticky, peanut butter consistency, malleable, organic matter littered throughout layer, large chunk of leaves and roots at 16 inches, organic matter present	10YR 3/2 very dark grayish brown transitioning to 10YR 2/1 black with depth
					20.0–25.0” low water content, silty clay, very dense, bits of shell and sand	10YR 2/1 black
				pre-impoundment	25.0–33.0” very low water content, clay, fibrous roots and sand mixed throughout layer, organic material present	10YR 2/1 black
WX-8	2480792.00	6811612.4	N/A	N/A	No recovery. Non navigable (water level to low)	N/A

[a] Coordinates are based on NAD83 State Plane Texas North Central System (feet).
[b] Sediment core samples are measured in inches with zero representing the current bottom surface.

A photograph of sediment core WX-7 (for location, refer to Figure 2) is shown in Figure 7. The base, or deepest part of the sample is denoted by the blue line. The pre-impoundment boundary (yellow line closest to the base) was evident within sediment core sample WX-7 at 25 inches. Pre-impoundment boundaries are identified by the change in color, texture, moisture, porosity, and structure. Identification of the pre-impoundment surface for each sediment core followed a similar procedure.

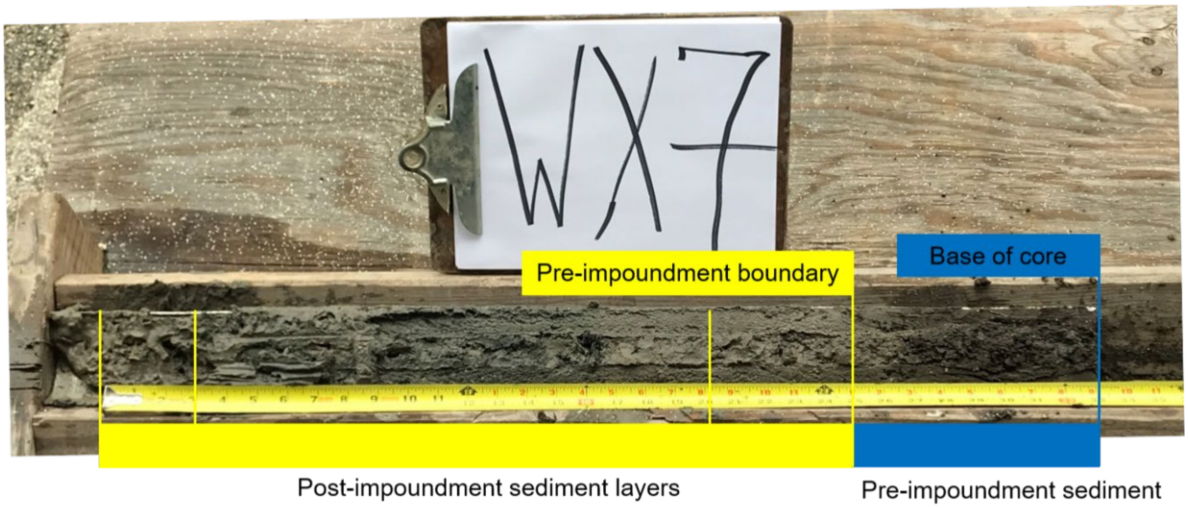


Figure 7. Sediment cores WX-7. Post-impoundment sediment layers are identified by yellow boxes. Pre-impoundment sediment layers are identified by blue boxes.

Figure 8 illustrates the relationships between acoustic signal returns and the layering seen in sediment cores. In this example, sediment core WX-7 are shown correlated with each frequency: 208 kHz, 50 kHz, and 12 kHz. The current bathymetric surface is determined by signal returns from the 208 kHz transducer as represented by the top red line in Figure 8. The pre-impoundment surface is identified by comparing boundaries observed in the 208 kHz, 50 kHz, and 12 kHz signals to the location of the pre-impoundment surface of the sediment core sample. Many layers of sediment were identified during analysis based on changes in observed characteristics such as water content, organic matter content, and sediment particle size, and each layer is classified as either post-impoundment or pre-impoundment. Yellow boxes represent post-impoundment sediments identified in the sediment core. Blue boxes indicate pre-impoundment sediments.

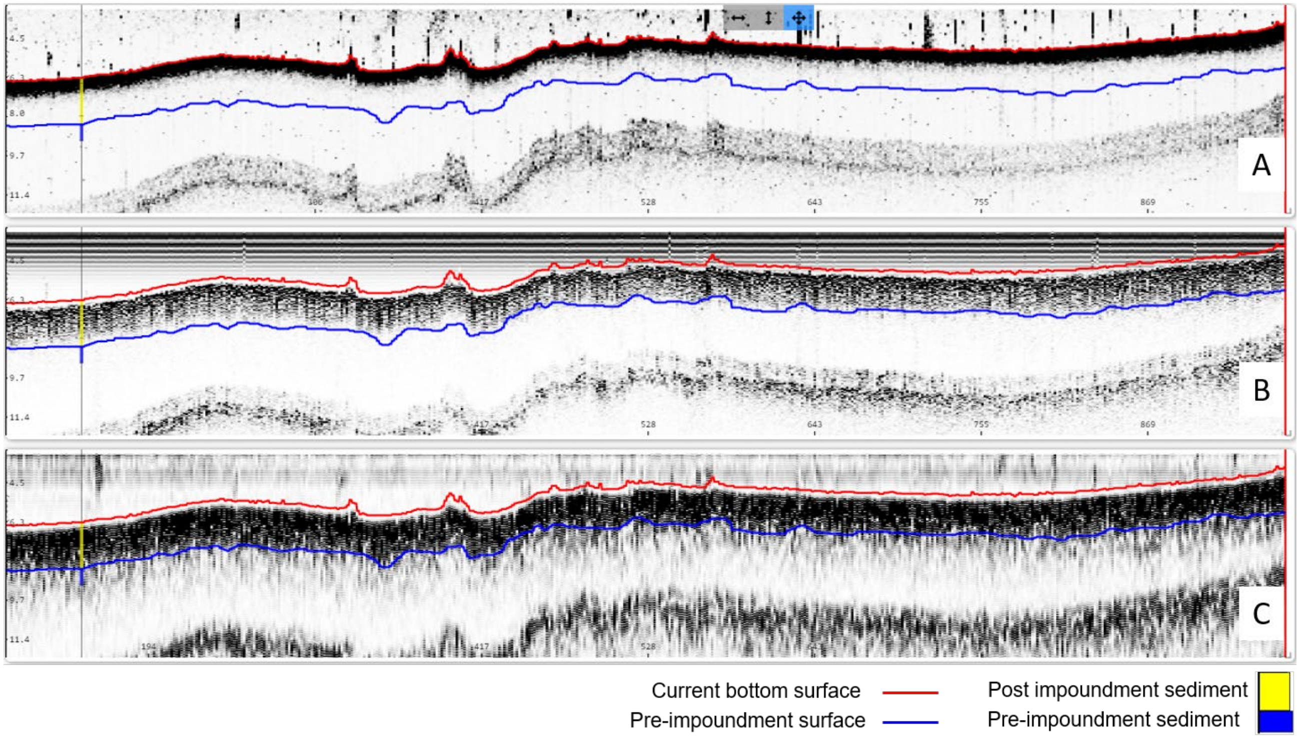


Figure 8. Sediment core sample WX-7 compared with acoustic signal returns. A) 208 kHz frequency, B) 50 kHz frequency, and C) 12 kHz frequency.

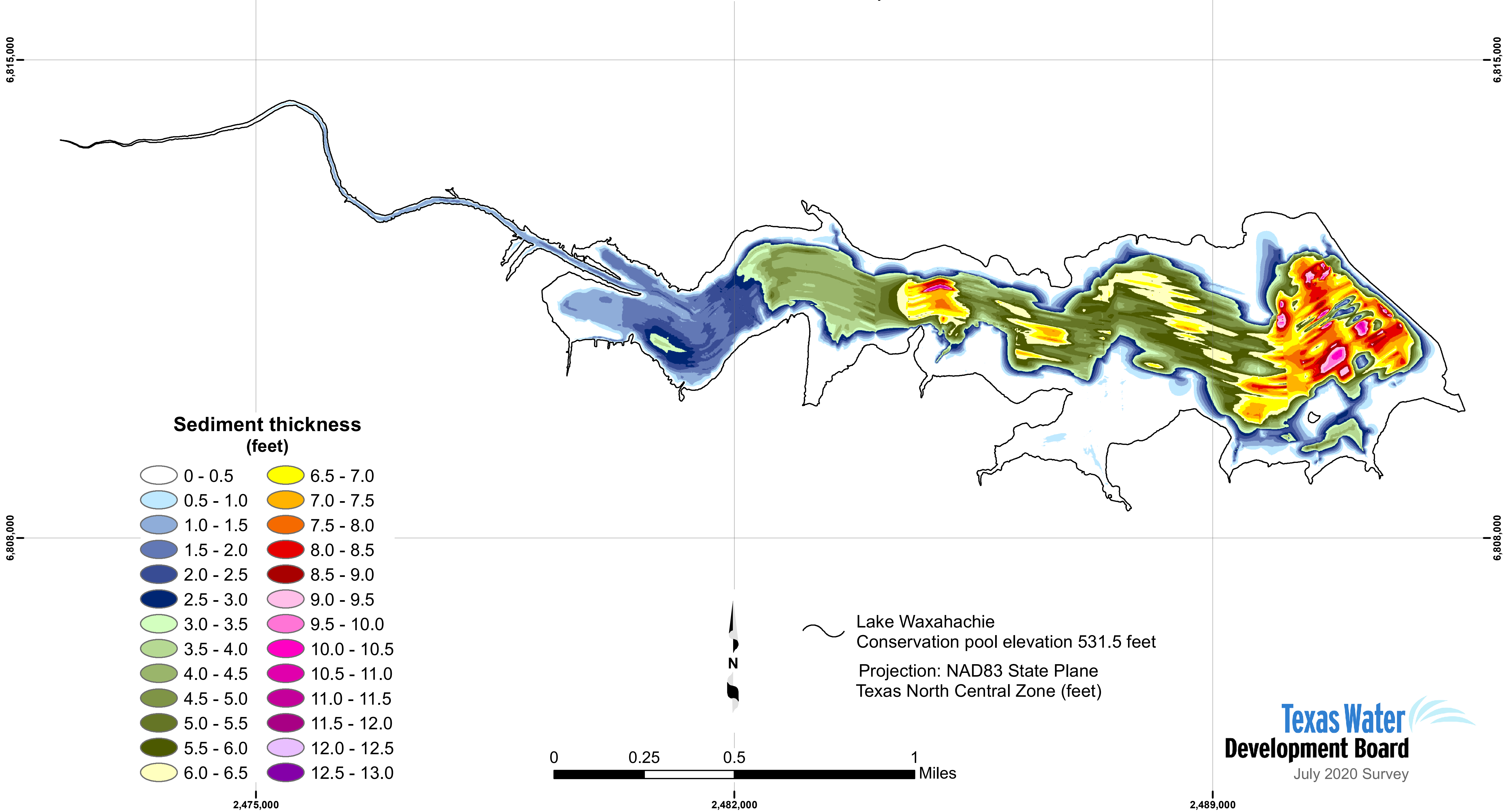
The pre-impoundment boundary in sediment core WX-7 most closely aligned with the different layers picked up by the 50 kHz; therefore, the 50 kHz signal was used to locate the pre-impoundment surface (Figure 8). The pre-impoundment surface is first identified along cross-sections where sediment core samples were collected. This information is used as a guide for identifying the pre-impoundment surface along cross-sections where sediment core samples were not collected.

After the pre-impoundment surface for all cross-sections is identified, a pre-impoundment TIN model and a sediment thickness TIN model are created. Pre-impoundment elevations and sediment thicknesses are interpolated between surveyed cross-sections using HydroTools with the same interpolation definition file used for bathymetric interpolation. For the purposes of TIN model creation, the TWDB assumed the sediment thickness at the reservoir boundary and contour was 0 feet (defined as the 531.8-foot, and 529.91-foot elevation contours). The sediment thickness TIN model was converted to a raster representation using a cell size of 2 feet by 2 feet and was used to produce a sediment thickness map (Figure 9). Elevation-capacity and elevation-area tables were computed from the pre-impoundment TIN model for the purpose of calculating the total volume of accumulated sediment.

Figure 9

Lake Waxahachie

Sediment thickness map



Survey results

Volumetric survey

The 2020 TWDB volumetric survey indicates that Lake Waxahachie has a total reservoir capacity of 11,642 acre-feet and encompasses 657 acres at conservation pool elevation (531.50 feet NGVD29). Current area and capacity estimates are compared to previous area and capacity estimates in Table 3. Because of differences in past and present survey methodologies, direct comparison of volumetric surveys to others to estimate loss of area and capacity can be unreliable. The 2020 TWDB survey results do not mean the reservoir has gained capacity since 2000. Rather it is a result of data collected over a larger area and improved methods.

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

Survey	Surface area (acres)	Total capacity (acre-feet)	Source
Top of conservation pool elevation (531.50 feet above mean sea level[a])			
Original design	690	13,500	Texas Water Development Board, 1973
TWDB 2000	656	11,386	Texas Water Development Board, 2000
TWDB 2000 re-calculated	656	11,572	Texas Water Development Board, 2016
TWDB 2020	657	11,642	

[a] Feet NGVD29 – National Geodetic Vertical Datum 1929

Sedimentation survey

The 2020 TWDB sedimentation survey measured 1,874 acre-feet of sediment. The sedimentation survey indicates sediment accumulation is greatest in the main body of the reservoir and increases in thickness from upstream to downstream. Comparison of capacity estimates of Lake Waxahachie derived using differing methodologies are provided in Table 4 for sedimentation rate calculation. The 2020 TWDB sedimentation survey indicates Lake Waxahachie has lost capacity at an average of 29 acre-feet per year since impoundment due to sedimentation below conservation pool elevation (531.50 feet NGVD29). Long-term trends indicate Lake Waxahachie loses capacity at an average of 33 acre-feet per year since impoundment due to sedimentation below conservation pool elevation (531.50 feet NGVD29) (Figure 10). Differences in methodology may also contribute to differences between these surveys.

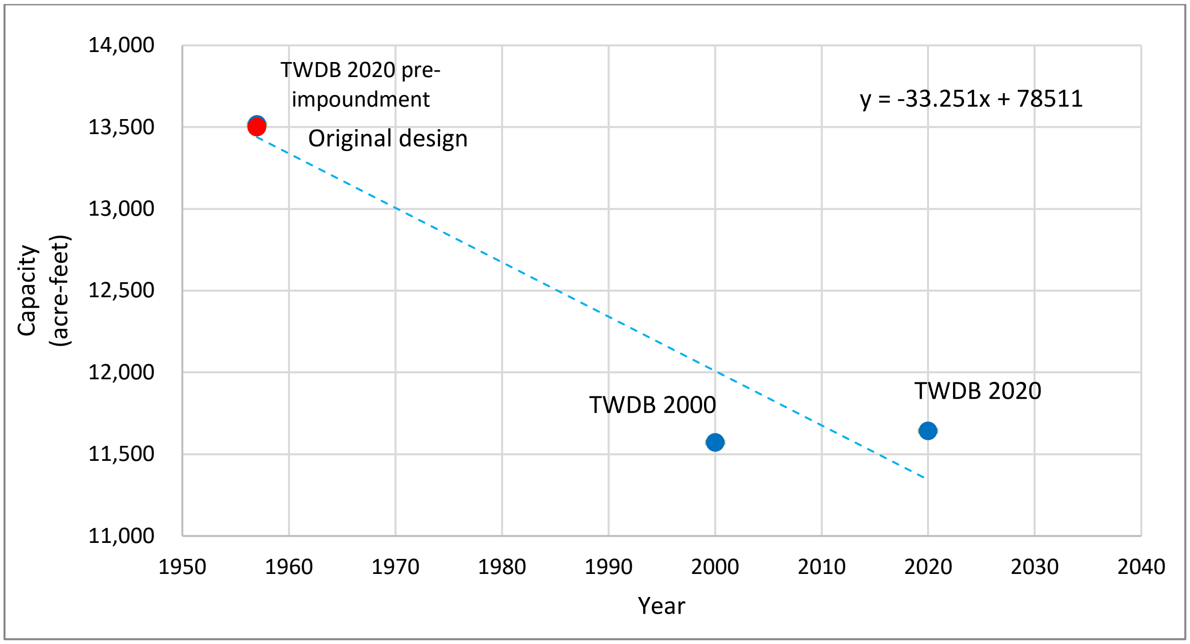


Figure 10. Plot of current and previous capacity estimates (acre-feet) at elevation 531.50 feet. Capacity estimates for TWDB surveys plotted with blue dots and other surveys with a red dot. The blue trend line illustrates the total average loss of capacity through 2020.

Table 4. Average annual capacity loss comparisons.

Survey	Top of conservation pool elevation (531.50 feet NGVD29)		
Original design[a]	13,500	<>	<>
TWDB 2000 re-calculated[b]	<>	11,572	<>
TWDB pre-impoundment estimate based on 2020 survey	<>	<>	13,516
TWDB 2020 volumetric survey	11,642	11,642	11,642
Volume difference (acre-feet) Percent change	1,858 13.8	-70 -0.6	1,874 13.9
Number of years	64	20	64
Capacity loss rate (acre-feet/year)	29	-3.5	29
Capacity loss rate (acre-feet/square mile of drainage area of 30 square miles /year)	0.97	-0.12	0.98

[a] Source: Texas Water Development Board, 1973, South Prong Dam was completed, and deliberate impoundment began in November 1956.
[b] Source: Texas Water Development Board, 2016

Recommendations

The TWDB recommends a volumetric and sedimentation survey of Lake Waxahachie within a 10-year timeframe or after a major high flow event to assess changes in reservoir capacity and to further improve estimates of sediment accumulation rates.

TWDB contact information

For more information about the TWDB Hydrographic Survey Program, visit www.twdb.texas.gov/surfacewater/surveys. Any questions regarding the TWDB Hydrographic Survey Program or this report may be addressed to: Hydrosurvey@twdb.texas.gov.

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Appendix A

Lake Waxahachie

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD — July 2000 Survey re-calculated October 2016

CAPACITY IN ACRE-FEET — Conservation Pool Elevation 531.5 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
481	0	0	0	0	0	0	0	0	0	0
482	0	0	0	0	0	0	0	0	1	1
483	1	1	1	1	2	2	2	2	3	3
484	3	4	4	5	5	6	6	7	7	8
485	9	10	11	12	13	14	15	17	18	19
486	21	22	24	25	27	29	31	33	35	37
487	39	41	43	45	47	49	52	54	56	59
488	61	64	66	69	71	74	77	79	82	85
489	88	90	93	96	99	102	105	108	111	114
490	117	121	124	127	130	134	137	140	144	147
491	151	154	158	161	165	168	172	176	179	183
492	187	191	195	199	203	207	211	215	219	223
493	227	232	236	240	245	249	254	258	263	267
494	272	277	282	286	291	296	302	307	312	317
495	322	328	333	339	345	350	356	362	368	374
496	381	387	393	400	407	413	420	427	434	441
497	449	456	464	471	479	487	495	503	511	519
498	528	536	545	554	562	571	580	589	599	608
499	617	627	637	646	656	667	677	687	697	708
500	719	729	740	751	762	774	785	797	809	820
501	832	845	857	869	882	895	907	920	933	947
502	960	973	987	1,000	1,014	1,028	1,042	1,056	1,070	1,085
503	1,099	1,114	1,128	1,143	1,158	1,173	1,188	1,204	1,219	1,235
504	1,250	1,266	1,282	1,298	1,315	1,331	1,347	1,364	1,380	1,397
505	1,414	1,431	1,448	1,465	1,482	1,500	1,517	1,535	1,553	1,571
506	1,589	1,607	1,625	1,643	1,662	1,681	1,699	1,718	1,737	1,757
507	1,776	1,796	1,815	1,835	1,855	1,875	1,895	1,915	1,935	1,956
508	1,977	1,998	2,019	2,040	2,062	2,083	2,105	2,127	2,149	2,172
509	2,194	2,217	2,239	2,262	2,285	2,308	2,331	2,355	2,378	2,402
510	2,426	2,449	2,474	2,498	2,522	2,546	2,571	2,596	2,621	2,646
511	2,671	2,696	2,721	2,747	2,772	2,798	2,824	2,850	2,877	2,903
512	2,930	2,956	2,983	3,010	3,037	3,065	3,092	3,120	3,148	3,176
513	3,204	3,232	3,261	3,289	3,318	3,347	3,376	3,405	3,434	3,464
514	3,493	3,523	3,553	3,583	3,613	3,643	3,674	3,704	3,735	3,766
515	3,797	3,828	3,859	3,891	3,923	3,955	3,987	4,019	4,052	4,084
516	4,117	4,150	4,183	4,216	4,249	4,282	4,316	4,350	4,384	4,418
517	4,452	4,486	4,521	4,555	4,590	4,625	4,660	4,695	4,731	4,766
518	4,802	4,838	4,874	4,910	4,946	4,983	5,020	5,057	5,094	5,131
519	5,169	5,207	5,244	5,282	5,320	5,359	5,397	5,436	5,475	5,514
520	5,554	5,593	5,633	5,673	5,713	5,754	5,794	5,835	5,876	5,918
521	5,959	6,001	6,043	6,085	6,127	6,170	6,212	6,255	6,298	6,342
522	6,385	6,429	6,473	6,517	6,561	6,605	6,650	6,695	6,740	6,785
523	6,830	6,876	6,922	6,968	7,014	7,060	7,107	7,154	7,201	7,248
524	7,295	7,343	7,390	7,438	7,486	7,535	7,583	7,632	7,682	7,731
525	7,781	7,831	7,882	7,933	7,984	8,035	8,087	8,139	8,191	8,243
526	8,295	8,348	8,401	8,454	8,508	8,562	8,616	8,670	8,724	8,779
527	8,835	8,890	8,946	9,002	9,059	9,115	9,172	9,230	9,288	9,346
528	9,404	9,462	9,521	9,580	9,639	9,698	9,757	9,817	9,877	9,937
529	9,997	10,057	10,118	10,179	10,240	10,301	10,363	10,425	10,486	10,549
530	10,611	10,674	10,736	10,799	10,863	10,926	10,990	11,053	11,117	11,182
531	11,246	11,311	11,376	11,441	11,506	11,572				

Note: Capacities above elevation 528.5 feet calculated from interpolated areas

Appendix B

Lake Waxahachie

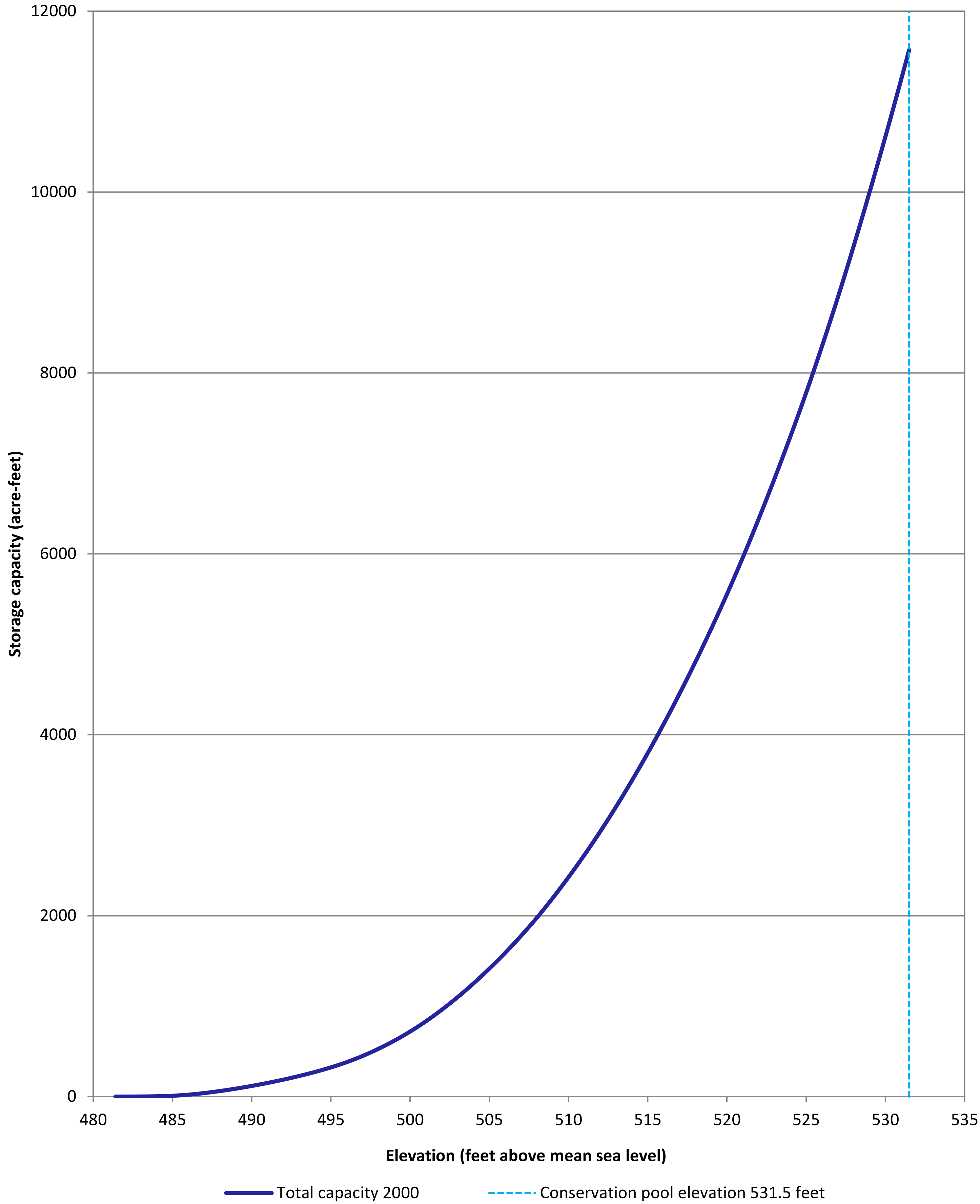
RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD
AREA IN ACRES
ELEVATION INCREMENT IS ONE TENTH FOOT

July 2000 Survey re-calculated October 2016
Conservation Pool Elevation 531.5 feet NGVD29

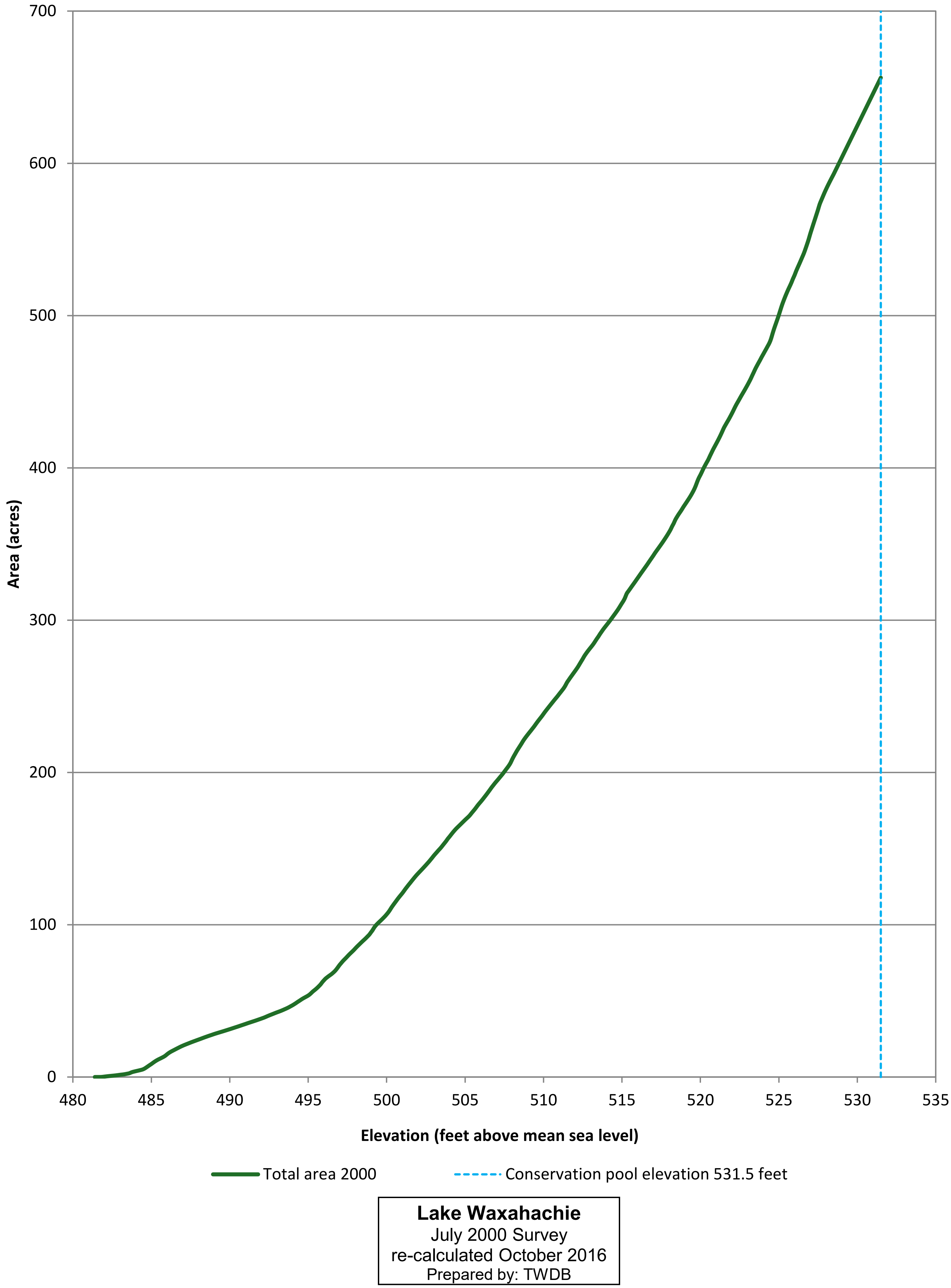
ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
481	0	0	0	0	0	0	0	0	0	0
482	0	0	1	1	1	1	1	1	1	1
483	1	2	2	2	2	2	2	3	3	4
484	4	4	4	5	5	5	6	6	7	8
485	9	9	10	11	11	12	12	13	13	14
486	15	16	16	17	17	18	19	19	20	20
487	21	21	21	22	22	23	23	23	24	24
488	25	25	25	26	26	26	27	27	28	28
489	28	29	29	29	29	30	30	30	31	31
490	31	32	32	32	33	33	33	34	34	34
491	35	35	36	36	36	37	37	37	38	38
492	38	39	39	40	40	40	41	41	42	42
493	42	43	43	44	44	45	45	45	46	47
494	47	48	48	49	50	50	51	52	52	53
495	54	54	55	56	57	58	59	60	61	62
496	63	65	65	66	67	68	69	70	71	72
497	74	75	76	77	78	79	80	81	82	83
498	84	86	87	88	89	89	90	91	92	94
499	95	96	98	99	101	102	103	104	105	106
500	107	108	110	111	113	114	115	117	118	119
501	121	122	124	125	126	127	129	130	131	133
502	134	135	136	137	138	139	140	141	143	144
503	145	146	148	149	150	151	152	154	155	156
504	158	159	160	162	163	164	165	166	167	168
505	169	170	171	172	173	174	176	177	178	180
506	181	182	183	185	186	187	189	190	192	193
507	194	195	197	198	199	200	202	203	205	206
508	209	211	212	214	216	217	219	221	222	224
509	225	226	228	229	230	232	233	234	236	237
510	238	240	241	243	244	245	246	248	249	250
511	252	253	254	256	257	259	261	262	264	265
512	266	268	269	271	273	275	276	278	279	281
513	282	283	285	286	288	289	291	292	294	295
514	297	298	299	301	302	303	305	306	308	310
515	311	313	315	317	319	320	322	323	325	326
516	328	329	331	332	334	335	336	338	339	341
517	342	344	345	347	348	350	351	353	354	356
518	358	360	362	364	366	368	369	371	372	374
519	376	377	379	380	382	384	386	388	391	393
520	395	398	400	402	404	405	408	410	412	414
521	416	418	420	422	424	426	428	430	432	434
522	436	438	440	442	444	445	447	449	451	453
523	454	456	458	461	463	465	467	469	471	473
524	475	476	478	480	482	485	488	491	494	497
525	500	504	507	510	512	515	517	519	522	524
526	526	529	532	534	536	539	541	544	547	550
527	554	557	560	563	566	570	573	576	578	580
528	583	585	587	589	591	593	595	597	599	601
529	604	606	608	610	612	614	616	618	620	623
530	625	627	629	631	633	635	637	639	641	644
531	646	648	650	652	654	656				

Note: Areas between elevations 528.5 and 531.5 feet linearly interpolated



Lake Waxahachie
July 2000 Survey
re-calculated October 2016
Prepared by: TWDB

Appendix C: 2000 re-calculated capacity curve



Appendix D: 2000 re-calculated area curve

Appendix E

Lake Waxahachie

RESERVOIR BATHYMETRIC CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD — July 2020 Survey

CAPACITY IN ACRE-FEET — Conservation pool elevation 531.5 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
482	0	0	0	0	0	0	0	0	0	0
483	0	0	0	0	0	0	1	1	1	1
484	1	2	2	2	3	3	4	4	5	5
485	6	6	7	8	8	9	10	11	12	13
486	14	16	17	19	20	22	24	25	27	29
487	31	34	36	38	40	42	45	47	49	52
488	54	57	59	62	64	67	70	72	75	78
489	81	84	86	89	92	95	98	101	104	108
490	111	114	117	120	124	127	130	134	137	140
491	144	147	151	154	158	162	165	169	173	177
492	180	184	188	192	196	200	204	208	212	216
493	220	225	229	233	238	242	246	251	255	260
494	264	269	274	278	283	288	293	298	303	308
495	313	318	324	329	335	340	346	352	358	364
496	370	376	382	389	395	402	409	416	423	430
497	437	444	452	460	467	475	483	491	500	508
498	516	525	533	542	551	560	569	578	587	596
499	605	615	624	634	644	653	663	674	684	694
500	704	715	726	736	747	758	769	781	792	804
501	815	827	839	852	864	876	889	901	914	927
502	940	953	967	980	994	1,008	1,021	1,036	1,050	1,064
503	1,079	1,093	1,108	1,123	1,138	1,154	1,169	1,184	1,200	1,215
504	1,231	1,247	1,263	1,279	1,296	1,312	1,329	1,345	1,362	1,379
505	1,397	1,414	1,431	1,449	1,467	1,485	1,503	1,521	1,539	1,557
506	1,576	1,594	1,613	1,632	1,651	1,670	1,689	1,708	1,728	1,747
507	1,767	1,786	1,806	1,826	1,846	1,866	1,886	1,907	1,927	1,948
508	1,969	1,990	2,011	2,033	2,054	2,076	2,098	2,120	2,143	2,165
509	2,188	2,211	2,234	2,257	2,280	2,304	2,327	2,351	2,375	2,399
510	2,423	2,448	2,472	2,497	2,522	2,547	2,572	2,597	2,622	2,648
511	2,674	2,699	2,725	2,752	2,778	2,805	2,831	2,858	2,885	2,912
512	2,939	2,966	2,994	3,021	3,049	3,077	3,105	3,133	3,161	3,190
513	3,219	3,247	3,276	3,306	3,335	3,364	3,394	3,424	3,454	3,484
514	3,514	3,544	3,575	3,605	3,636	3,667	3,698	3,729	3,761	3,792
515	3,824	3,855	3,887	3,919	3,951	3,984	4,016	4,049	4,082	4,115
516	4,148	4,181	4,215	4,248	4,282	4,316	4,351	4,385	4,420	4,454
517	4,489	4,524	4,559	4,595	4,630	4,666	4,701	4,737	4,773	4,809
518	4,846	4,882	4,919	4,956	4,993	5,030	5,068	5,105	5,143	5,181
519	5,219	5,258	5,296	5,335	5,374	5,413	5,452	5,492	5,532	5,571
520	5,612	5,652	5,692	5,733	5,774	5,814	5,856	5,897	5,939	5,980
521	6,022	6,064	6,107	6,149	6,192	6,234	6,277	6,321	6,364	6,407
522	6,451	6,495	6,539	6,583	6,628	6,672	6,717	6,762	6,807	6,852
523	6,898	6,944	6,990	7,036	7,082	7,128	7,175	7,221	7,268	7,315
524	7,363	7,410	7,457	7,505	7,553	7,601	7,649	7,698	7,747	7,795
525	7,845	7,894	7,944	7,995	8,046	8,097	8,148	8,200	8,252	8,305
526	8,357	8,410	8,464	8,517	8,571	8,625	8,679	8,733	8,788	8,843
527	8,898	8,954	9,010	9,066	9,122	9,178	9,235	9,292	9,350	9,407
528	9,465	9,523	9,582	9,640	9,699	9,759	9,818	9,878	9,938	9,998
529	10,058	10,119	10,180	10,241	10,302	10,364	10,426	10,488	10,550	10,613
530	10,676	10,739	10,803	10,866	10,930	10,994	11,058	11,122	11,187	11,251
531	11,316	11,381	11,446	11,511	11,577	11,642	11,708	11,774	11,841	

Appendix F

Lake Waxahachie

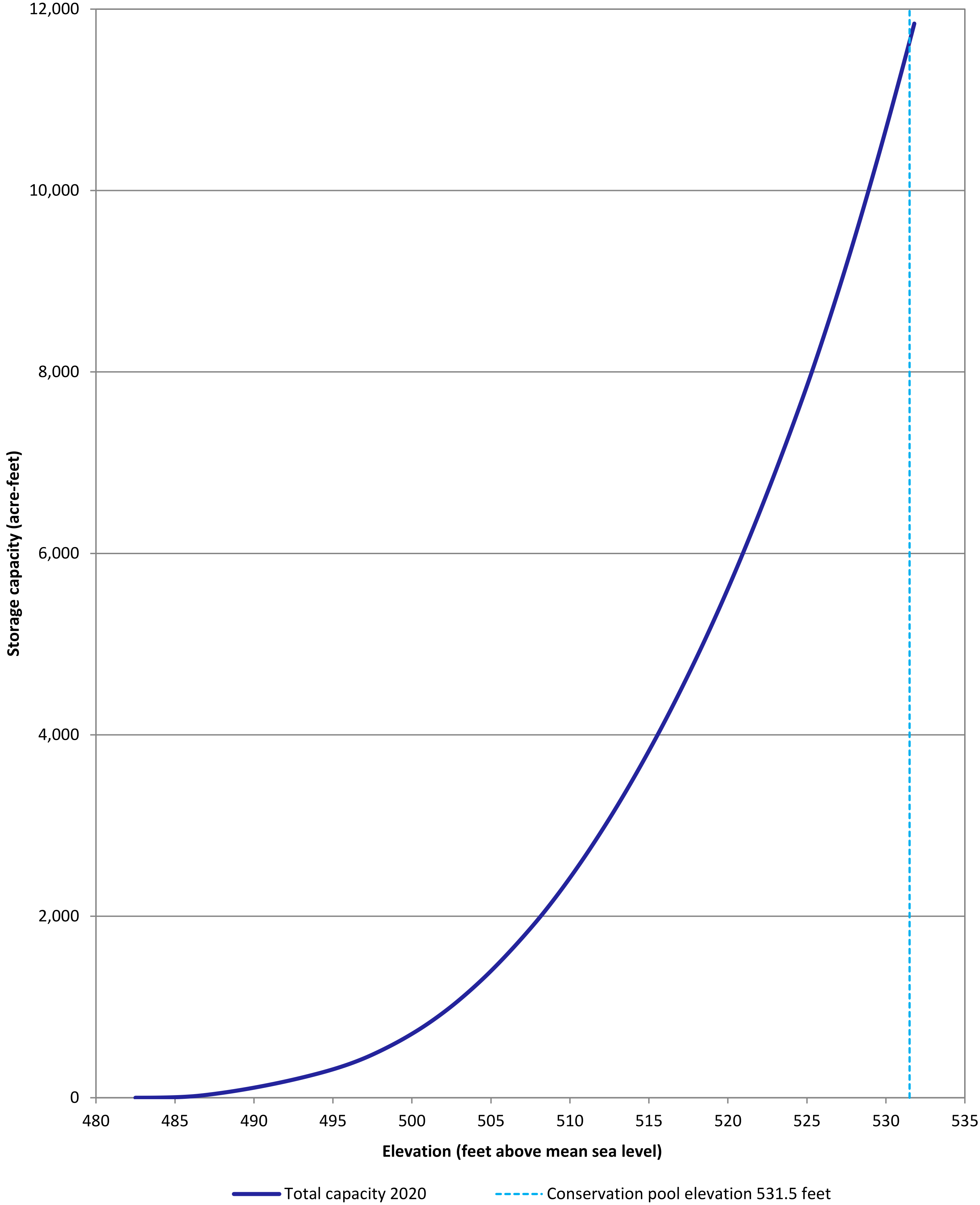
RESERVOIR BATHYMETRIC AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — July 2020 Survey

AREA IN ACRES — Conservation pool elevation 531.5 feet NGVD29

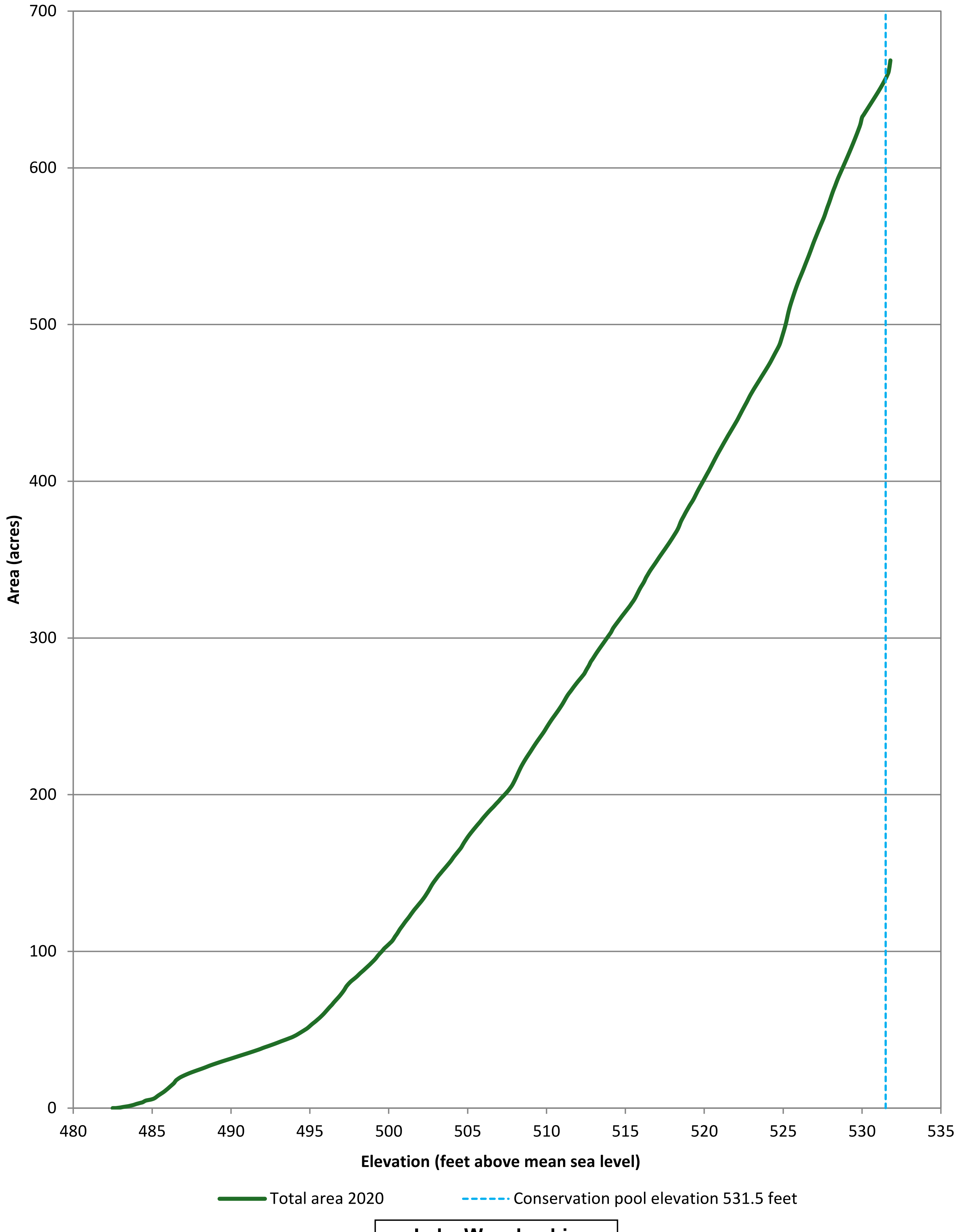
ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
482	0	0	0	0	0	0	0	0	0	0
483	0	1	1	1	1	1	1	2	2	2
484	3	3	3	3	4	4	5	5	5	5
485	6	6	7	7	8	9	9	10	11	12
486	12	13	14	15	16	18	18	19	20	20
487	21	21	22	22	22	23	23	24	24	24
488	25	25	25	26	26	26	27	27	28	28
489	28	29	29	29	30	30	30	31	31	31
490	32	32	32	33	33	33	34	34	34	34
491	35	35	35	36	36	36	37	37	37	38
492	38	39	39	39	40	40	40	41	41	42
493	42	42	43	43	43	44	44	45	45	45
494	46	46	47	48	48	49	49	50	51	51
495	52	53	54	55	56	57	57	58	59	60
496	62	63	64	65	66	67	68	69	71	72
497	73	74	76	77	79	80	81	82	82	83
498	84	85	86	87	88	89	90	91	92	93
499	94	95	96	97	98	99	100	102	103	104
500	105	105	106	108	109	111	112	114	115	117
501	118	120	121	122	124	125	126	128	129	130
502	131	132	134	135	137	138	140	142	143	145
503	146	148	149	150	151	152	154	155	156	157
504	159	160	161	163	164	165	166	168	170	171
505	173	174	176	177	178	179	180	182	183	184
506	185	186	188	189	190	191	192	193	194	195
507	196	197	198	200	201	202	203	204	206	207
508	209	212	214	216	218	220	222	223	225	226
509	228	229	231	232	234	235	237	238	240	241
510	243	244	246	247	249	250	252	253	255	256
511	258	259	261	263	264	266	267	268	270	271
512	272	274	275	276	277	279	281	283	285	286
513	288	289	291	292	294	295	297	298	299	301
514	302	304	306	307	309	310	311	313	314	315
515	317	318	319	321	322	324	325	327	329	331
516	333	334	336	338	340	342	343	345	346	348
517	349	351	352	354	355	357	358	360	361	363
518	364	366	367	369	371	374	376	378	380	381
519	383	385	386	388	390	392	394	396	398	400
520	401	403	405	407	409	411	413	415	416	418
521	420	422	424	425	427	429	431	432	434	436
522	437	439	441	443	445	447	449	451	453	455
523	456	458	460	461	463	465	466	468	469	471
524	473	474	476	478	480	482	484	486	488	491
525	494	498	502	506	510	514	517	520	523	526
526	528	531	533	536	538	541	543	546	549	551
527	554	557	559	561	564	566	569	572	575	577
528	580	583	586	589	591	594	596	598	601	603
529	605	608	610	612	615	617	620	622	625	628
530	632	634	635	637	639	640	642	643	645	646
531	648	650	651	653	655	657	659	662	669	



Lake Waxahachie
July 2020 Survey
Prepared by: TWDB

Appendix G: Bathymetric capacity curve



Lake Waxahachie
July 2020 Survey
Prepared by: TWDB

Appendix H: Bathymetric area curve

Appendix I

Lake Waxahachie

RESERVOIR BATHYMERTIC AND TOPOGRPAHIC CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD | July 2020 Survey

CAPACITY IN ACRE-FEET | Conservation pool elevation 531.5 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT | Top of dam elevation 541.5 feet NGVD29

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
482	0	0	0	0	0	0	0	0	0	0
483	0	0	0	0	0	0	1	1	1	1
484	1	2	2	2	3	3	4	4	5	5
485	6	6	7	8	8	9	10	11	12	13
486	14	16	17	19	20	22	24	25	27	29
487	31	34	36	38	40	42	45	47	49	52
488	54	57	59	62	64	67	70	72	75	78
489	81	84	86	89	92	95	98	101	104	108
490	111	114	117	120	124	127	130	134	137	140
491	144	147	151	154	158	162	165	169	173	177
492	180	184	188	192	196	200	204	208	212	216
493	220	225	229	233	238	242	246	251	255	260
494	264	269	274	278	283	288	293	298	303	308
495	313	318	324	329	335	340	346	352	358	364
496	370	376	382	389	395	402	409	416	423	430
497	437	444	452	460	467	475	483	491	500	508
498	516	525	533	542	551	560	569	578	587	596
499	605	615	624	634	644	653	663	674	684	694
500	704	715	726	736	747	758	769	781	792	804
501	815	827	839	852	864	876	889	901	914	927
502	940	953	967	980	994	1,008	1,021	1,036	1,050	1,064
503	1,079	1,093	1,108	1,123	1,138	1,154	1,169	1,184	1,200	1,215
504	1,231	1,247	1,263	1,279	1,296	1,312	1,329	1,345	1,362	1,379
505	1,397	1,414	1,431	1,449	1,467	1,485	1,503	1,521	1,539	1,557
506	1,576	1,594	1,613	1,632	1,651	1,670	1,689	1,708	1,728	1,747
507	1,767	1,786	1,806	1,826	1,846	1,866	1,886	1,907	1,927	1,948
508	1,969	1,990	2,011	2,033	2,054	2,076	2,098	2,120	2,143	2,165
509	2,188	2,211	2,234	2,257	2,280	2,304	2,327	2,351	2,375	2,399
510	2,423	2,448	2,472	2,497	2,522	2,547	2,572	2,597	2,622	2,648
511	2,674	2,699	2,725	2,752	2,778	2,805	2,831	2,858	2,885	2,912
512	2,939	2,966	2,994	3,021	3,049	3,077	3,105	3,133	3,161	3,190
513	3,219	3,247	3,276	3,306	3,335	3,364	3,394	3,424	3,454	3,484
514	3,514	3,544	3,575	3,605	3,636	3,667	3,698	3,729	3,761	3,792
515	3,824	3,855	3,887	3,919	3,951	3,984	4,016	4,049	4,082	4,115
516	4,148	4,181	4,215	4,248	4,282	4,316	4,351	4,385	4,420	4,454
517	4,489	4,524	4,559	4,595	4,630	4,666	4,701	4,737	4,773	4,809
518	4,846	4,882	4,919	4,956	4,993	5,030	5,068	5,105	5,143	5,181
519	5,219	5,258	5,296	5,335	5,374	5,413	5,452	5,492	5,532	5,571
520	5,612	5,652	5,692	5,733	5,774	5,814	5,856	5,897	5,939	5,980
521	6,022	6,064	6,107	6,149	6,192	6,234	6,277	6,321	6,364	6,407
522	6,451	6,495	6,539	6,583	6,628	6,672	6,717	6,762	6,807	6,852
523	6,898	6,944	6,990	7,036	7,082	7,128	7,175	7,221	7,268	7,315
524	7,363	7,410	7,457	7,505	7,553	7,601	7,649	7,698	7,747	7,795
525	7,845	7,894	7,944	7,995	8,046	8,097	8,148	8,200	8,252	8,305
526	8,357	8,410	8,464	8,517	8,571	8,625	8,679	8,733	8,788	8,843
527	8,898	8,954	9,010	9,066	9,122	9,178	9,235	9,292	9,350	9,407
528	9,465	9,523	9,582	9,640	9,699	9,759	9,818	9,878	9,938	9,998
529	10,058	10,119	10,180	10,241	10,302	10,364	10,426	10,488	10,550	10,613
530	10,676	10,739	10,803	10,866	10,930	10,994	11,058	11,122	11,187	11,251
531	11,316	11,381	11,446	11,511	11,577	11,643	11,709	11,775	11,842	11,910
532	11,979	12,047	12,116	12,186	12,255	12,325	12,396	12,467	12,538	12,609
533	12,681	12,753	12,825	12,897	12,970	13,043	13,117	13,190	13,264	13,338
534	13,413	13,488	13,563	13,638	13,713	13,789	13,865	13,941	14,018	14,095
535	14,172	14,249	14,327	14,404	14,482	14,561	14,639	14,718	14,797	14,876
536	14,956	15,036	15,116	15,196	15,277	15,357	15,438	15,520	15,601	15,683
537	15,765	15,847	15,930	16,013	16,096	16,179	16,263	16,346	16,430	16,514
538	16,599	16,684	16,768	16,854	16,939	17,025	17,111	17,197	17,283	17,370
539	17,457	17,544	17,631	17,719	17,807	17,895	17,983	18,072	18,161	18,250
540	18,339	18,429	18,519	18,609	18,699	18,790	18,881	18,972	19,064	19,156
541	19,248	19,340	19,432	19,525	19,618	19,712				

Appendix J

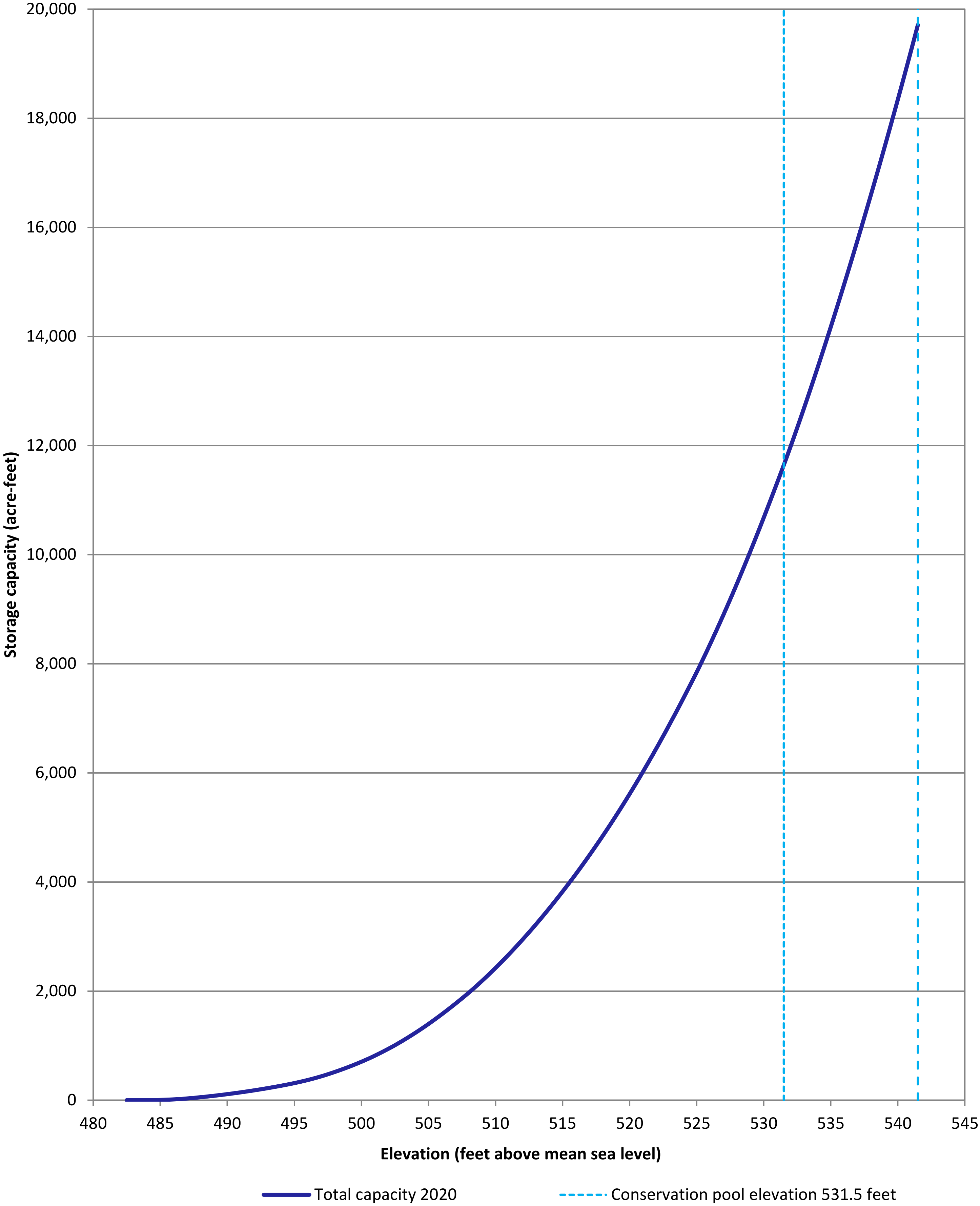
Lake Waxahachie

RESERVOIR BATHYMETRIC AND TOPOGRPAHIC AREA TABLE

TEXAS WATER DEVELOPMENT BOARD
AREA IN ACRES
ELEVATION INCREMENT IS ONE TENTH FOOT

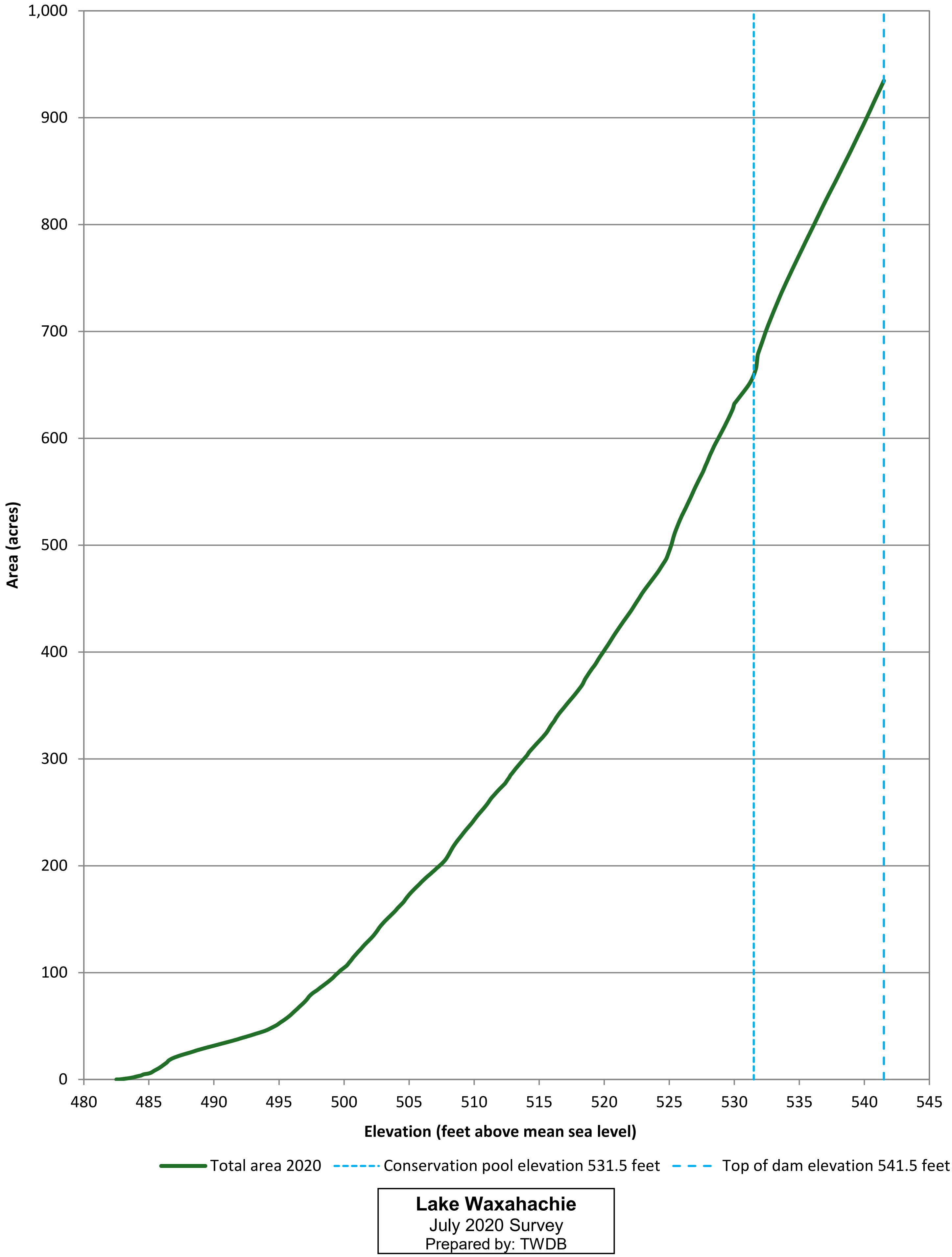
July 2020 Survey
Conservation pool elevation 531.5 feet NGVD29
Top of dam elevation 541.5 feet NGVD29

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
482	0	0	0	0	0	0	0	0	0	0
483	0	1	1	1	1	1	1	2	2	2
484	3	3	3	3	4	4	5	5	5	5
485	6	6	7	7	8	9	9	10	11	12
486	12	13	14	15	16	18	18	19	20	20
487	21	21	22	22	22	23	23	24	24	24
488	25	25	25	26	26	26	27	27	28	28
489	28	29	29	29	30	30	30	31	31	31
490	32	32	32	33	33	33	34	34	34	34
491	35	35	35	36	36	36	37	37	37	38
492	38	39	39	39	40	40	40	41	41	42
493	42	42	43	43	43	44	44	45	45	45
494	46	46	47	48	48	49	49	50	51	51
495	52	53	54	55	56	57	57	58	59	60
496	62	63	64	65	66	67	68	69	71	72
497	73	74	76	77	79	80	81	82	82	83
498	84	85	86	87	88	89	90	91	92	93
499	94	95	96	97	98	99	100	102	103	104
500	105	105	106	108	109	111	112	114	115	117
501	118	120	121	122	124	125	126	128	129	130
502	131	132	134	135	137	138	140	142	143	145
503	146	148	149	150	151	152	154	155	156	157
504	159	160	161	163	164	165	166	168	170	171
505	173	174	176	177	178	179	180	182	183	184
506	185	186	188	189	190	191	192	193	194	195
507	196	197	198	200	201	202	203	204	206	207
508	209	212	214	216	218	220	222	223	225	226
509	228	229	231	232	234	235	237	238	240	241
510	243	244	246	247	249	250	252	253	255	256
511	258	259	261	263	264	266	267	268	270	271
512	272	274	275	276	277	279	281	283	285	286
513	288	289	291	292	294	295	297	298	299	301
514	302	304	306	307	309	310	311	313	314	315
515	317	318	319	321	322	324	325	327	329	331
516	333	334	336	338	340	342	343	345	346	348
517	349	351	352	354	355	357	358	360	361	363
518	364	366	367	369	371	374	376	378	380	381
519	383	385	386	388	390	392	394	396	398	400
520	401	403	405	407	409	411	413	415	416	418
521	420	422	424	425	427	429	431	432	434	436
522	437	439	441	443	445	447	449	451	453	455
523	456	458	460	461	463	465	466	468	469	471
524	473	474	476	478	480	482	484	486	488	491
525	494	498	502	506	510	514	517	520	523	526
526	528	531	533	536	538	541	543	546	549	551
527	554	557	559	561	564	566	569	572	575	577
528	580	583	586	589	591	594	596	598	601	603
529	605	608	610	612	615	617	620	622	625	628
530	632	634	635	637	639	640	642	643	645	646
531	648	650	652	654	656	659	663	667	678	682
532	685	689	692	696	699	702	706	709	712	715
533	718	721	724	727	730	732	735	738	741	743
534	746	749	751	754	756	759	762	764	767	769
535	772	774	777	779	782	784	787	789	792	794
536	797	799	802	804	807	809	812	814	817	819
537	822	824	827	829	831	834	836	838	841	843
538	846	848	850	853	855	858	860	863	865	868
539	870	873	875	878	880	883	885	888	890	893
540	895	898	900	903	906	908	911	914	916	919
541	921	924	927	929	932	935				



Lake Waxahachie
July 2020 Survey
Prepared by: TWDB

Appendix K: Bathymetric and topographic capacity curve



Appendix L: Bathymetric and topographic area curve

Figure 6

CONTOURS
(feet above mean sea level)

- 530
- 528
- 526
- 524
- 522
- 520
- 518
- 516
- 514
- 512
- 510
- 508
- 506
- 504
- 502
- 500
- 498
- 496
- 494
- 492
- 490
- 488
- 486
- 484

Islands

Lake Waxahachie
Conservation pool elevation
531.5 feet

Projection: NAD83 State Plane
Texas North 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 Lake Waxahachie. The Texas Water Development Board makes no representations nor assumes any liability.

Lake Waxahachie

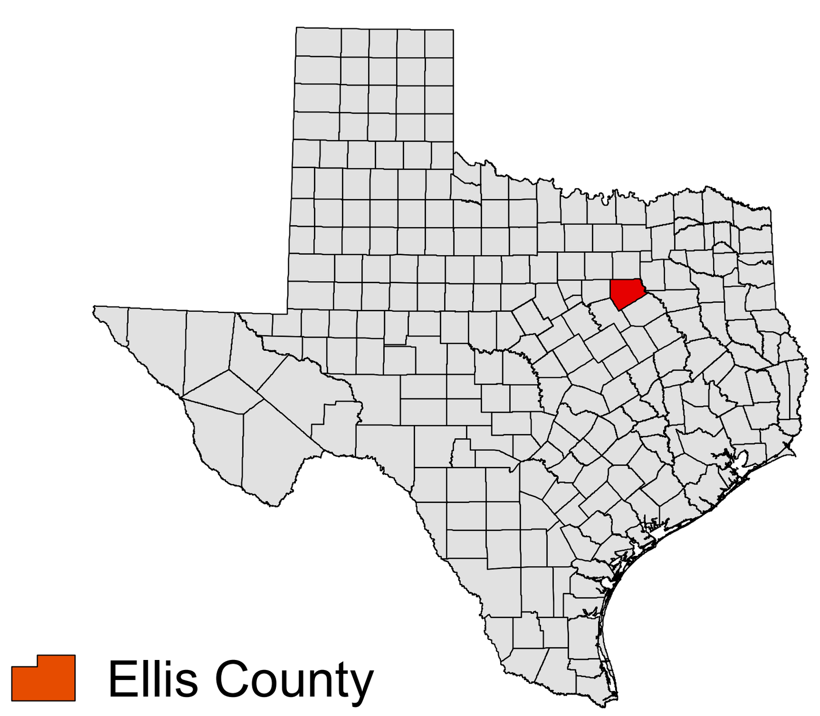
2' - contour map

Texas Water Development Board

July 2020 Survey

N

0 0.25 0.5 1 Miles



Ellis County