Volumetric and Sedimentation Survey of LAVON LAKE

May – July 2021

Texas Water Development Board

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Texas Water Development Board

Prepared for:

North Texas Municipal Water District

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Executive summary

In March 2021, the Texas Water Development Board (TWDB) entered into an agreement with the North Texas Municipal Water District (NTMWD) to perform a volumetric and sedimentation survey of Lavon Lake (Collin 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.

Lavon Dam, impounding Lavon Lake, is located on the East Fork of the Trinity River in Collin County, approximately three miles east of Wylie, and 22 miles northeast of Dallas, Texas. The conservation pool elevation of Lavon Lake is 492.0 feet above mean sea level (NGVD29). The TWDB collected bathymetric data for Lavon Lake between May 3 and July 7, 2021, while daily average water surface elevations ranged between 492.65 and 501.93 feet NGVD29.

The 2021 TWDB volumetric survey indicates Lavon Lake has a total reservoir capacity of 412,498 acre-feet and encompasses 20,595 acres at conservation pool elevation (492.0 feet NGVD29). Previous capacity estimates at elevation 492.0 feet include a U.S. Army Corps of Engineers estimate of 456,527 acre-feet in 1970, and a 2011 TWDB re-calculated capacity estimate of 411,745 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. Information from past surveys is presented here for informational purposes only.

The 2021 TWDB sedimentation survey measured 39,851 acre-feet of sediment. The sedimentation survey indicates sediment deposition is occurring throughout the reservoir with heavy accumulation near the dam, on the west side of the reservoir north of the Clear Lake Campground, and north of the U.S. Highway 380 bridge. The TWDB recommends that a similar methodology be used to resurvey Lavon Lake 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 March 2021, the TWDB entered into an agreement with the North Texas Municipal Water District (NTMWD), to perform a volumetric and sedimentation survey of Lavon Lake (Collin County, Texas) (Texas Water Development Board, 2021). 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).

Lavon Lake general information

Lavon Dam, impounding Lavon Lake, is located on the East Fork of the Trinity River in Collin County, approximately three miles east of Wylie, and 22 miles northeast of Dallas, Texas (Figure 1). Lavon Lake is owned by the U.S. Government and operated by the U.S. Army Corps of Engineers (USACE), Fort Worth District. Lavon Lake is primarily a water supply reservoir, storing water for the member cities of the North Texas Municipal Water District, and provides flood control to parts of Collin, Dallas, and Rockwall Counties (U.S. Army Corps of Engineers, 2022a).

The North Texas Municipal Water District, created in 1951, provides drinking water, wastewater treatment, and solid waste disposal to its member cities and customers, encompassing approximately 2.0 million people across 10 counties (North Texas Municipal Water District, 2022a, North Texas Municipal Water District, 2022b).

Construction on Lavon dam began in January 1948, and the dam was completed in September 1953. Deliberate impoundment began on September 14, 1953 (U.S. Army Corps of Engineers, 2022b). On May 15, 1970, construction began on a modification of Lavon Dam that increased the conservation storage pool from elevation 472.0 feet to the current

elevation of 492.0 feet by raising the top of the dam 12 feet. The modification was completed, and deliberate impoundment began December 1, 1975 (U.S. Army Corps of Engineers, 2022b). Additional pertinent data about Lavon Dam and Lavon Lake can be found in Table 1.

Water rights for Lavon Lake have been appropriated to the NTMWD through Certificate of Adjudication Nos. 08-2410 and Amendments to Certificate of Adjudication Nos. 08-2410A, 08-2410B, 08-2410C, 08-2410D, 08-2410E, 08-2410F, 08-2410G, 08-2410H, 08-2410I, and 08-2410J (Texas Commission on Environmental Quality, 2022). The complete certificates are on file at the Texas Commission on Environmental Quality (TCEQ).

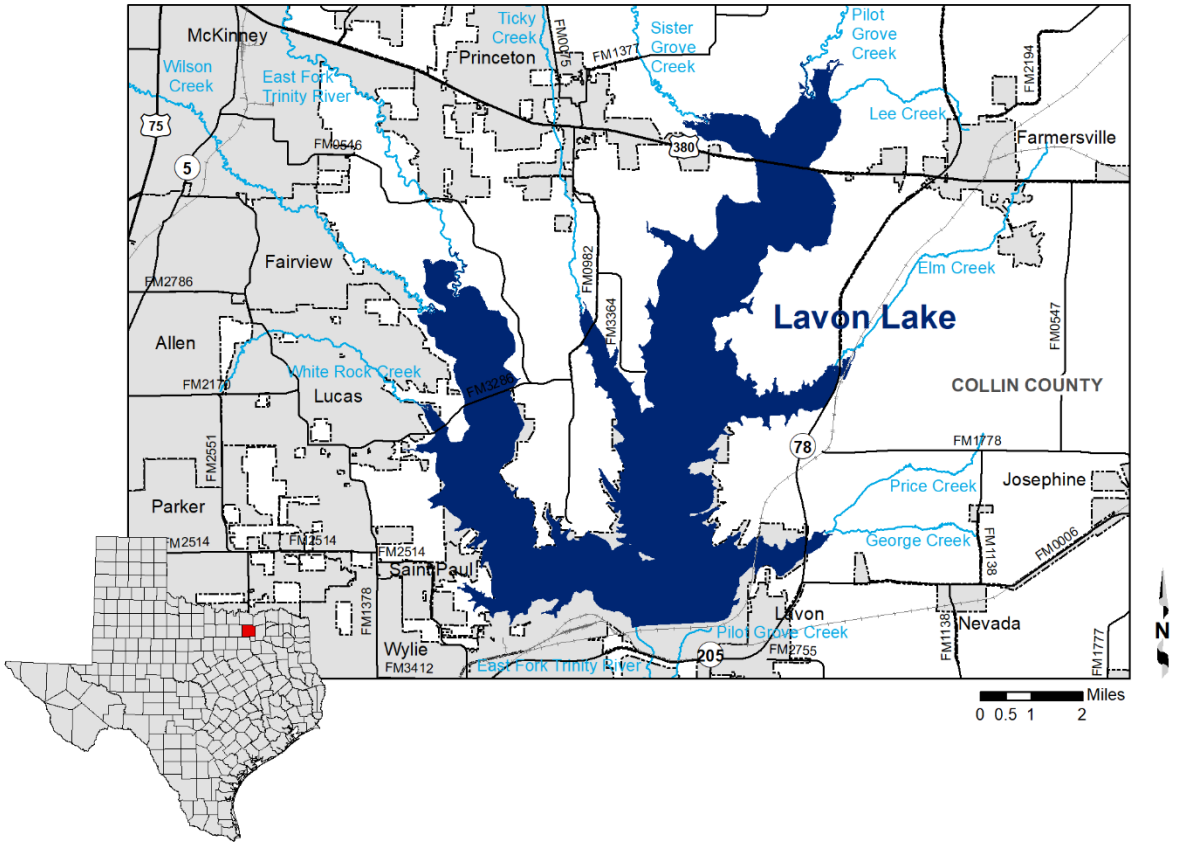

Figure 1. Location map.

Table 1. Pertinent Data for Lavon Dam and Lavon Lake

Owner(s)	
United States (U.S.) Government	
Operator(s)	
U.S. Army Corps of Engineers (USACE), Fort Worth District	
Engineer (Design)	
U.S. Army Corps of Engineers (USACE)	
Drainage Area	
Total Drainage Area	770 square miles
Dam	
Type	Rolled earth fill
Length	19,493 feet, including the spillway
Maximum Height	81 feet
Top Width	30 feet
Spillway	
Type	Concrete Ogee Weir
Total Length	480.0 feet
Control	12 tainter gates, each gate is 40 by 28 feet
Crest Elevation	475.5 feet above mean sea level
Top of gate elevation	503.5 feet above mean sea level
Outlet Works	
Type	Five 36-inch diameter sluices through spillway piers controlled by slide gate action
Control	Five manually operated slide gates with 3 by 4 feet emergency slide gates
Invert elevation	Three – 453.0 feet NGVD29 One – 473.0 feet NGVD29 One – 482.0 feet NGVD29

Reservoir Data (Based on 2021 TWDB survey)

Feature	Elevation (feet above MSL[a])	Capacity (acre-feet)	Area (acres)
Top of dam	514.0	1,046,246	37,327
Maximum design water surface elevation	509.0	869,420	33,358
Top of flood control pool elevation	503.5	697,702	29,082
Top of conservation pool elevation	492.0	412,498	20,595
Spillway crest elevation	475.5	144,827	11,422
Invert of lowest intake	453.0	2,841	1,562
Streambed	433.0	0	0
Conservation storage capacity[b]	—	409,657	—

Sources: Texas Water Development Board, 2013; U.S. Army Corps of Engineers, 2022b.

[a.] Mean Sea Level indicates a reference to USGS National Geodetic Vertical Datum 1929 (NGVD29).

[b.] 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 the dam outlet works.

Volumetric and sedimentation survey of Lavon Lake

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 08060500 Lavon Lk nr Lavon, TX* (U.S. Geological Survey, 2021). 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. 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 Lavon Lake between May 3 and July 7, 2021, while daily average water surface elevations ranged between 492.65 and 501.93 feet 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 channels and spaced approximately 500 feet apart. Many of the same survey lines also were used by the TWDB for the *Volumetric and Sedimentation Survey of Lavon Lake, June - July 2011 Survey* (Texas Water Development Board, 2013). 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 2021 TWDB survey.

The TWDB partnered with the USACE Engineer Research and Development Center (ERDC) to collect high-resolution multibeam bathymetry data adjacent to three raw water intake structures owned by NTMWD at Lavon Lake on August 13, 2021, while the daily water surface elevation averaged 491.01 feet NGVD29. The raw water intake structures are located on the south shoreline in the East Fork of the Trinity River of Lavon Lake (Figure 2). For data collection, the TWDB used a Teledyne Odom Hydrographic MB1 Multibeam Echosounder System with a maximum ping frequency of 60 hertz (Hz), an adjustable

operating frequency ranging from 170 to 220 kilohertz (kHz), adjustable swath coverage up to 120 degrees, and an integrated real-time sound velocity probe. Data were collected in a manner to provide full coverage bathymetry plots of the raw water intake structure channels and the reservoir bottom near these structures. A patch test was performed to quantify any residual biases in the initial alignment measurements of the multibeam echosounder, the motion reference unit (MRU), and the heading sensor. A patch test is a series of reciprocal transects where data are collected at varying speeds, depths, and bottom terrain in a test area. These data are used to determine angular offsets and time delays to calibrate the sensor orientation system between each component and the vessel. The patch test determines the vessel orientation alignment corrections for latency, pitch, roll, and yaw (U.S. Army Corps of Engineers, 2013). The collected data was post processed by USACE ERDC and provided to TWDB as a one foot by one foot spaced grid of data points. All data anomalies were removed during the post processing routine.

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 18 locations to collect sediment core samples (Figure 2). Sediment cores were collected on June 9-10, 2022, with a custom-coring boat and an SDI VibeCore system. Two cores were not recoverable, therefore a Ponar grab sampler was used.

Sediment cores are collected in 3-inch diameter aluminum tubes. 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.

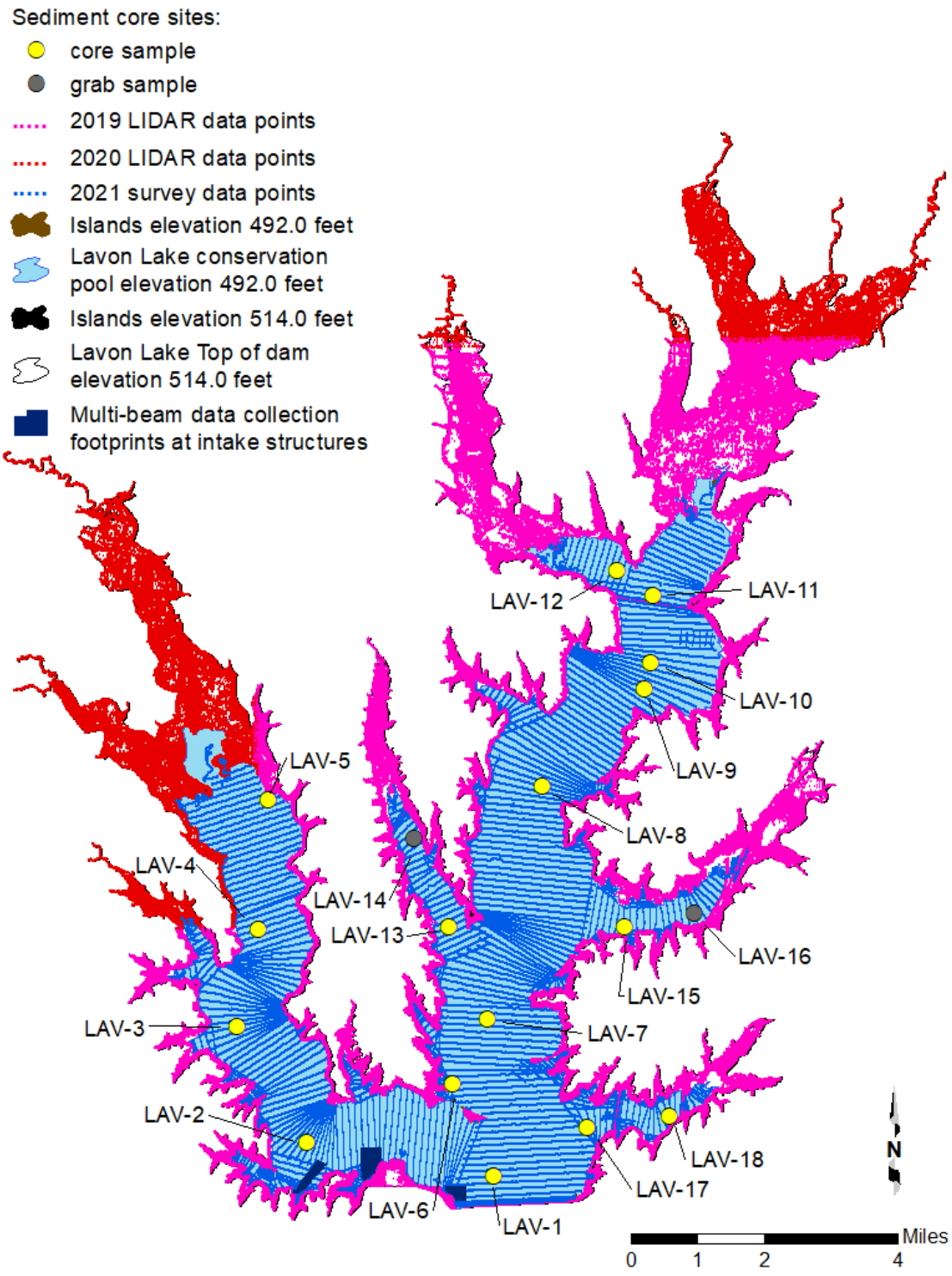

Figure 2. **2021 TWDB sounding data (*blue dots*), sediment coring locations (*yellow circles*), grab sample locations (*gray circles*), 2019 LIDAR data for topographic model (*pink dots*), and 2020 LIDAR data for topographic model (*red dots*).**

Data processing

Model boundary

The topographic model boundary of the reservoir was generated with Light Detection and Ranging (LIDAR) data available from the Texas Natural Resource Information System (TNRIS). Multiple LIDAR datasets were needed for complete coverage of Lavon Lake acquired at different times. These data were collected on April 20, 2019, while the daily average water surface elevation of the reservoir measured 497.67 feet; on February 27, 2020, while the daily average water surface elevation of the reservoir measured 492.28 feet; and on February 7-8, 2020, and March 1, 2020, while the daily average water surface elevation of the reservoir measured 490.46, 490.49, and 492.08 feet, respectively. The LIDAR data files (.las) 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. The horizontal datum of the LIDAR data is North American Datum 1983 (NAD83; meters) and the projection is Universal Transverse Mercator (UTM) Zone 14. The vertical datum is North American Vertical Datum 1988 (NAVD88; meters). Contours representing the top of the dam elevation of 156.6552 meters NAVD88, equivalent to 514.0 feet NGVD29, was extracted from the raster. The vertical datum transformation offset of 0.012 meters, was used to convert from meters NAVD88 to meters NGVD29 before converting to feet NGVD29. 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, 2022a) and VERTCON software (National Geodetic Survey, 2022b) to a single reference point in the vicinity of the survey, the reservoir elevation gage *USGS 08060500 Lavon Lk nr Lavon, TX Latitude 33º01'54"N, Longitude 96º28'56"W NAD27.* The topographic model contour was edited to close the contour across the dam and remove other artifacts. Horizontal coordinate transformations to NAD83 State Plane Texas North Central Zone (feet) coordinates were applied using the ArcGIS Project tool.

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, 2022). The boundary was digitized at the land-water interface from images photographed on September 6, 2017, while the daily average water surface elevation measured 492.22 feet NGVD29. For modeling purposes, the boundary was assigned an elevation of 492.2 feet.

LIDAR data points

To utilize the LIDAR data in the reservoir topographic model, the LIDAR data files (.las) 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. Points were extracted from the terrain at the z-tolerance level of 0.25 meters. New attribute fields were added to convert the elevations from meters NAVD88 to meters NGVD29, then feet NGVD29 for compatibility with the bathymetric survey data. LIDAR data outside of the 514.00-foot contour were deleted and the feature class projected to NAD83 State Plane Texas North Central Zone (feet). LIDAR data inside the bathymetric model boundary did not agree with survey data where the data overlapped, therefore, all LIDAR data was removed from the bathymetric model.

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 is 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 used by the 3D Analyst extension of ArcGIS 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).

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). Although LIDAR was utilized for the topographic TIN model, linear interpolation was necessary to accurately model features in the areas between survey data and LIDAR data and in some cases between the bathymetric model boundary and the LIDAR data points. Linear interpolation results in improved elevation-capacity and elevation-area calculations.

Figure 3 illustrates typical results from application of the anisotropic interpolation as applied to Lavon Lake. 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 I) and elevation-area (Appendix F and J) tables.

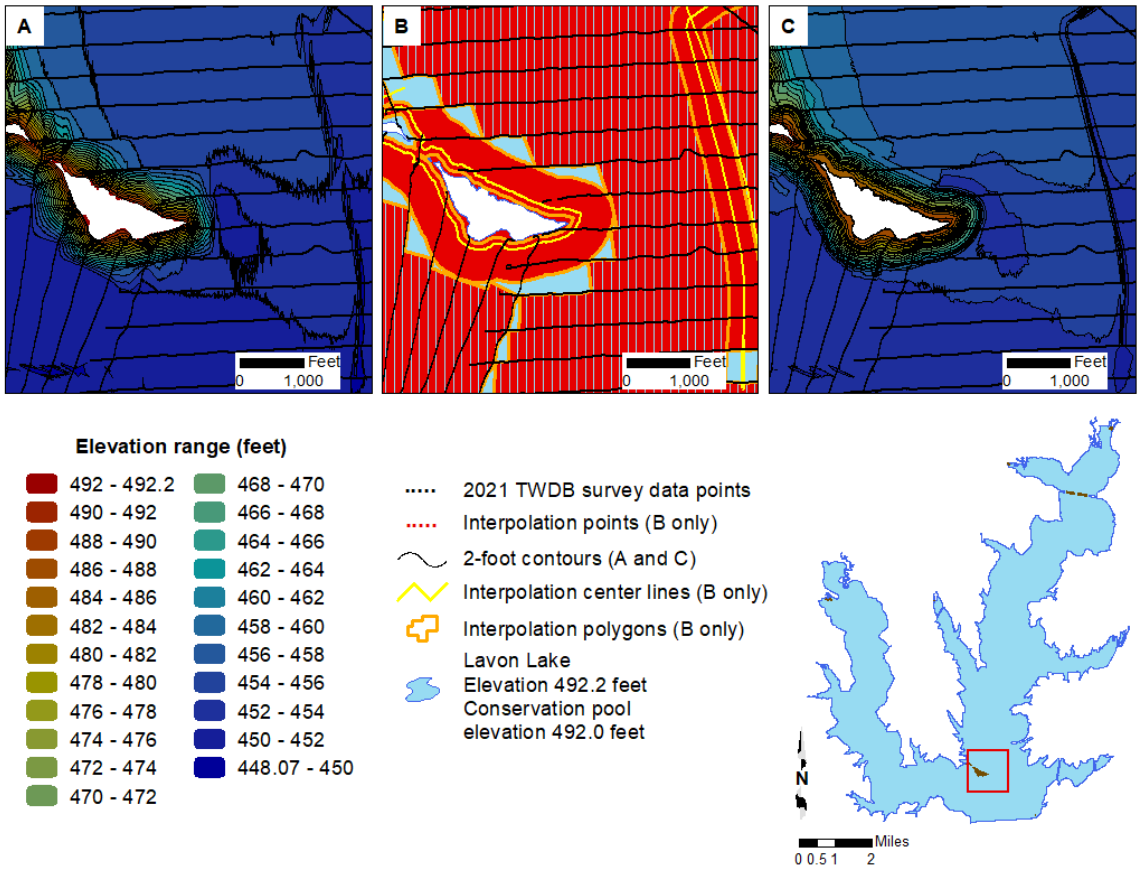

Figure 3. **Anisotropic spatial interpolation as applied to Lavon Lake sounding data; A) bathymetric contours without interpolated points, B) sounding points (*black*) and interpolated points (*red*), C) bathymetric contours with interpolated points.**

Although anisotropic spatial interpolation and linear interpolation were originally applied to the 2011 TWDB survey, in 2017, the 2011 TWDB survey of Lavon Lake was updated to account for flat triangles. Computed areas between 484.0 feet and 493.0 feet were linearly interpolated between the computed values, and volumes above 484.0 feet were calculated based on the corrected areas (Texas Water Development Board, 2016). The 2011 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

Volumes and areas were computed for the entire reservoir at 0.1-foot intervals, from 447.2 to 492.2 feet for the bathymetric TIN model, and from 447.2 to 514.0 feet for the bathymetric and topographic TIN model. The bathymetric elevation-capacity table and

bathymetric elevation-area table, based on the 2021 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. The topographic elevation-capacity table and topographic elevation-area table developed from the 2021 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 bathymetric volumetric TIN model was converted to a raster representation using a cell size of 2 feet by 2 feet. The raster data then 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 Lavon Lake (Figure 5); and (3) a 2-foot contour map (Figure 6).

Figure 4

Lavon Lake

Elevation relief map

Elevations

(feet NGVD29)

512 - 514	490 - 492	460 - 462
510 - 512	488 - 490	458 - 460
508 - 510	486 - 488	456 - 458
506 - 508	484 - 486	454 - 456
504 - 506	482 - 484	452 - 454
502 - 504	480 - 482	450 - 452
500 - 502	478 - 480	448 - 450
498 - 500	476 - 478	447.4 - 448
496 - 498	474 - 476	
494 - 496	472 - 474	
492 - 494	470 - 472	
	468 - 470	
	466 - 468	
	464 - 466	
	462 - 464	

2,560,000 2,580,000 2,600,000 2,620,000

7,160,000 7,140,000 7,120,000 7,100,000 7,080,000 7,060,000

N

0 1 2 4 Miles

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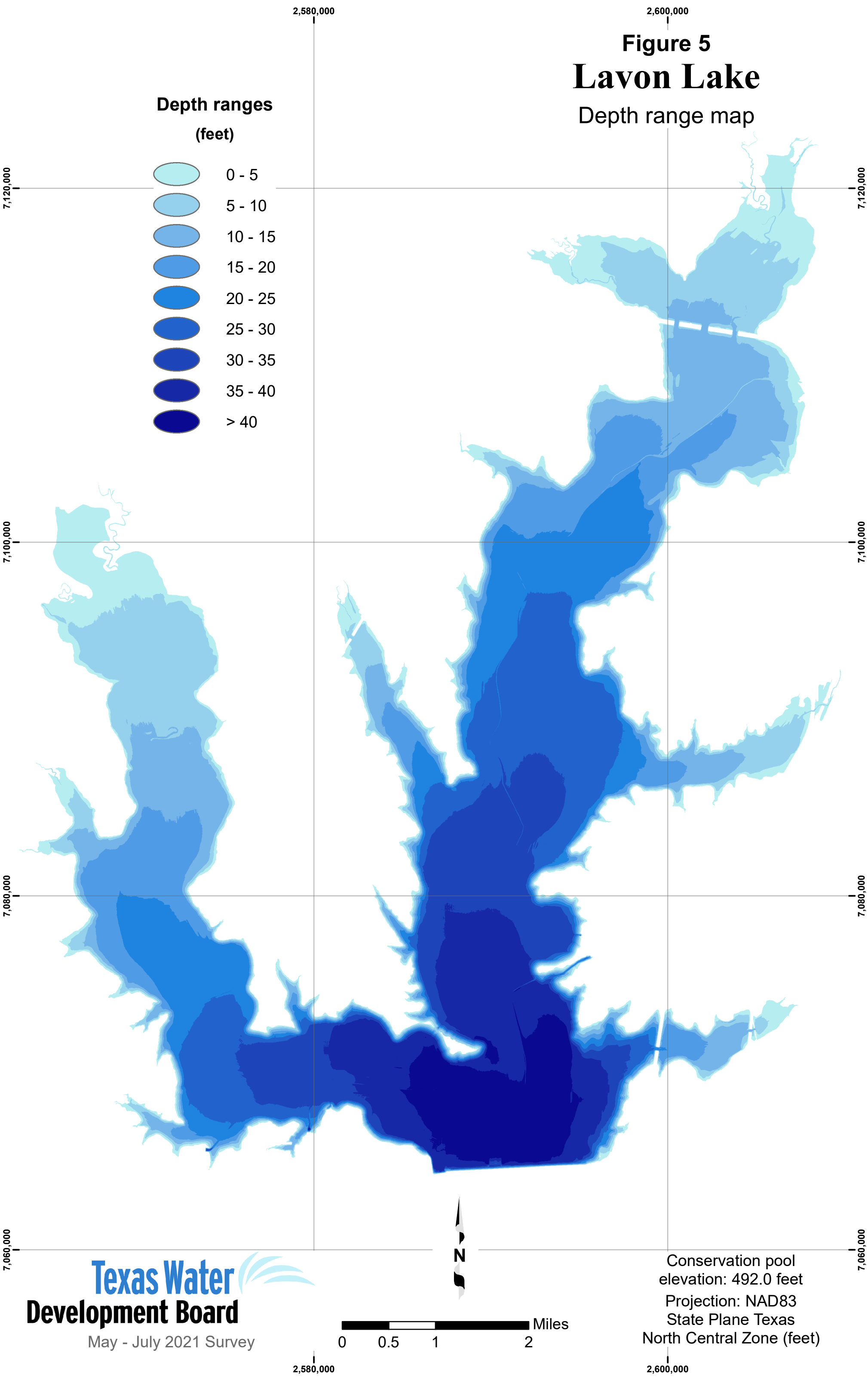
Conservation pool elevation: 492.0 feet

Projection: NAD83
State Plane Texas
North Central Zone (feet)

Figure 5

Lavon Lake

Depth range map



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May - July 2021 Survey

Conservation pool elevation: 492.0 feet

Projection: NAD83
State Plane Texas
North Central Zone (feet)

Analysis of sediment data from Lavon Lake

Sedimentation in Lavon Lake 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 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 are presented in 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
LAV-1	2589651.7	7066769.1	68.0 / 61.0	post-impoundment	0.0–5.0” high water content, silty clay with fine silt on top, soupy, smooth	2.5Y 4/2 dark grayish brown
					5.0–57.0” high to moderate water content, water content decreases with depth, silty clay, peanut butter like, density increases with depth, uniform consistency and texture throughout	2.5Y 2.5/1 black
					57.0−61.0” moderate water content, silty clay, sticky, smooth, uniform consistency and texture throughout	5Y 4/1 dark gray
				pre-impoundment	61.0–68.0” moderate to low water content, water content decreases with depth, silty clay, density increases with depth, loosely packed at top, malleable, organic material present throughout (fibrous roots, vegetation, leaf litter)	2.5Y 3/1 very dark gray
LAV-2	2574924.55	7069466.4	43.0 / 31.0	post-impoundment	0.0–3.0” very high water content, silt, soupy, smooth	5Y 4/1 dark gray
					3.0–9.0” high water content, silt, pudding like, uniform consistency and texture throughout	5Y 4/1 dark gray
					9.0−31.0” moderate water content, silty clay, peanut butter like, sticky, more dense than previous layer, uniform consistency and texture throughout	2.5Y 2.5/ black
				pre-impoundment	31.0–43.0” moderate to low water content, water content decreases with depth, silty clay, loosely packed at top, density increases with depth, malleable, organic material present throughout (fibrous roots)	5Y 3/1 very dark gray
LAV-3	2569451.34	7078618.99	42.0 / 29.0	post-impoundment	0.0–5.0” high water content, silty clay with fine silt on top of layer, soupy, smooth	5Y 3/2 dark olive gray
					5.0−29.0” moderate water content, silty clay with small bits of clay throughout, peanut butter like, sticky, organic material present (pecan shell at 11 inches)	2.5Y 3/1 very dark gray

[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 (continued). 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
LAV-3 (continued)	2569451.34	7078618.99	42.0 / 29.0	pre-impoundment	29.0–42.0" low water content, silty clay, loosely packed at top of layer, bits of clay throughout, not very compact, dense but easily fractured by hand, uniform texture throughout, organic material present throughout (fibrous roots, vegetation)	2.5Y 2.5/1 black
LAV-4	2571104.28	7086271.09	18.0 / N/A	post-impoundment	0.0–12.0" high to moderate water content, water content decreases with depth, silty clay, soupy at top and pudding like consistency with depth, density increases with depth, sticky, mottled coloration	5Y 4/1 dark gray 2.5Y 4/2 dark grayish brown
					12.0–18.0" moderate water content, silty clay, increased density, peanut butter consistency	2.5Y 3/1 very dark gray
LAV-5	2571882.75	7096456.55	26.0 / 18.0	post-impoundment	0.0–3.0" high water content, silt, soupy, smooth	2.5Y 4/1 dark gray
					3.0–18.0" high to moderate water content, water content decreases with depth, silty clay, smooth, peanut butter like consistency, sticky, uniform consistency and texture throughout, small bits of clay at bottom of layer	5Y 3/1 very dark gray
				pre-impoundment	18.0−26.0" low water content, silty clay, malleable, loosely packed at top of layer, density increases with depth, organic material present throughout (fibrous roots, woody debris)	2.5Y 3/1 very dark gray
LAV-6	2586460.83	7074063.87	3.0 / 1.0	post-impoundment	0.0–1.0" high water content, thin layer of fine silt on top, soupy, smooth	5Y 4/1 dark gray
				pre-impoundment	1.0–3.0" low water content, silty clay, not very dense, malleable, mottled coloration, organic material present (charred wood)	2.5Y 2.5/1 black
LAV-7	2589204.41	7079180.42	45.0 / 39.0	post-impoundment	0.0–2.0" very high water content, silt, soupy, smooth	2.5Y 3/1 very dark gray
					2.0–39.0" high to moderate water content, water content decreases with depth, silty clay, pudding like, uniform consistency and texture throughout	2.5Y 3/1 very dark gray

[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 (continued). 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
LAV-7 (continued)	2589204.41	7079180.42	45.0 / 39.0	pre-impoundment	39.0–45.0" low water content, silty clay, not very dense, malleable, uniform consistency and texture throughout, organic material present throughout (fibrous/small roots)	2.5Y 3/1 very dark gray
LAV-8	2593491.62	7097574.04	38.0 / 30.0	post-impoundment	0.0–2.0" high water content, silt, soupy, smooth	2.5Y 4/2 dark grayish brown
					2.0–12.0" high water content, silty clay, smooth, pudding like, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
					12.0–30.0" high to moderate water content, water content decreases with depth, silty clay, smooth, peanut butter like, more dense than previous layer, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
				pre-impoundment	30.0–38.0" low water content, silty clay, loosely packed at top, density increases with depth, malleable, organic material present throughout (fibrous roots)	2.5Y 2.5/1 black
LAV-9	2601554.15	7105229.52	34.0 / 26.0	post-impoundment	0.0–2.0" high water content, silt, soupy, smooth	2.5Y 4/2 dark grayish brown
					2.0−26.0" high to moderate water content, water content decreases with depth, silty clay, smooth, pudding like to peanut butter consistency with increases in depth, density increases with depth, uniform texture, mottled coloration	2.5Y 4/1 dark gray 2.5Y 2.5/1 black
				pre-impoundment	26.0–34.0" low water content, silty clay, malleable, dense, uniform consistency and texture throughout, organic material present throughout (fibrous roots, vegetation)	2.5Y 2.5/1 black
LAV-10	2602108.93	7107356.92	29.0 / 15.0	post-impoundment	0.0-4.0" high water content, silt soupy smooth	5Y 4/1 dark gray
					4.0-9.0" moderate water content, silty clay, pudding like consistency, smooth, uniform consistency and texture throughout	5Y 4/1 dark gray
					9.0-15.0" moderate water content, silty clay, pudding like consistency, large bits of clay throughout	GLEY 2.5/N 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 (continued). 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
LAV-10 (continued)	2602108.93	7107356.92	29.0 / 15.0	pre-impoundment	15.0-29.0" low water content, silty clay, loosely packed with bits of clay, density increases with depth, malleable, organic material present (fibrous roots)	2.5Y 3/1 very dark gray
LAV-11	2602296.82	7112650.67	100.0 / 98.0	post-impoundment	0.0–3.0" high water content, silt, soupy, smooth	2.5 Y 4/1 dark gray
					3.0–10.0" high water content, silty clay, smooth, pudding like, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
					10.0–38.0" moderate water content, silty clay, smooth, sticky, density increases with depth, uniform consistency and texture throughout	2.5Y 2.5/1 black
					38.0–98.0" moderate water content, water content decreases with depth, silty clay, sticky, peanut butter like, density increases with depth	2.5Y 4/1 dark gray
				pre-impoundment	98.0–100.0" low water content, silty clay, very dense and compact, malleable, crumbly when broken apart organic material present throughout (fibrous roots)	2.5Y 2.5/1 black
LAV-12	2599449.82	7114624.42	12.0 / 6.0	post-impoundment	0.0–6.0" high water content, silty clay with small bits of clay throughout but increasing amounts near the following layer, pudding like	2.5Y 3/1 very dark gray
				pre-impoundment	6.0–12.0" low water content, silty clay, malleable, loosely packed, organic material present throughout (fibrous roots, vegetation)	2.5Y 3/1 very dark gray
LAV-13	2586193.76	7086476.86	52.0 / 43.0	post-impoundment	0.0–11.0" high water content, silty clay with a thin layer of silt on top, smooth, pudding like, uniform consistency and texture throughout, mottled coloration	2.5Y 3/1 very dark gray 2.5Y 4/2 dark grayish brown
					11.0–22.0" moderate water content, silty clay, peanut butter like, sticky, more dense than previous layer, uniform consistency and texture throughout	GLEY1 2.5/N black
					22.0–43.0" moderate water content, silty clay, peanut butter like, sticky, smooth, more dense than previous layer, organic material present (sparce, 2 pieces of woody debris)	2.5Y 3/1 very dark gray

[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 (continued). 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
LAV-13 (continued)	2586193.76	7086476.86	52.0 / 43.0	pre-impoundment	43.0 – 52.0" low water content, silty clay, dense but crumbly, malleable, uniform texture, organic material present throughout (fibrous/dendritic roots, woody debris)	2.5Y 3/1 very dark gray
LAV-14	2583419.39	7093417.86	Grab[c]	post-impoundment	high to moderate water content, silty clay with a layer of fine silt on top, small bits of clay throughout, organic matter present (leaf litter, woody debris)	5Y 3/2 dark olive gray
LAV-15	2600051.78	7086421.63	10.0 / 2.0	post-impoundment	0.0–2.0" high water content, silt with small grain size bits of clay and coarse grain sand present, soupy	5Y 4/2 olive gray
				pre-impoundment	2.0–10.0" low water content, clay, malleable, uniform consistency and texture throughout	2.5Y 3/1 very dark gray
LAV-16	2605580.39	7087547.06	Grab[c]	post-impoundment	high water content, silty clay with a thin layer of silt on top, sand to pea-sized bits of clay throughout, organic material present (woody debris)	5Y 3/2 dark olive gray
LAV-17	2597057.56	7070658.88	26.0 / 24.0	post-impoundment	0.0–11.0" high to moderate water content, water content decreases with depth, silty clay with a fine layer of silt on top, smooth, pudding like, uniform consistency and texture throughout	5Y 4/1 dark gray
					11.0–24.0" high to moderate water content, water content decreases with depth, silty clay, smooth, pudding like, uniform consistency and texture throughout	2.5Y 2.5/1 black
				pre-impoundment	24.0−26.0" low water content, silty clay, moderately packed, uniform consistency and texture throughout, organic material present throughout (fibrous roots)	2.5Y 2.5/1 black
LAV-18	2603584.42	7071532.82	13.0 / 9.0	post-impoundment	0.0−3.0" high water content, silt, soupy, smooth	2.5Y 3/1 very dark gray
					3.0−9.0" moderate water content, silty clay with small bits of clay throughout, smooth, pudding like, smooth, uniform consistency and texture throughout, mottled coloration	2.5Y 3/1 very dark gray 10YR 2/1 black
				pre-impoundment	9.0−13.0" low water content, clay, malleable, dense but easily fractured by hand, organic material present (seed pod)	2.5Y 4/1 dark gray

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

[b.] Sediment core samples are measured in inches with zero representing the current bottom surface.

[c.] Grab Samples were collected using a petite Ponar dredge sampler.

A photograph of sediment core LAV-1 (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 this sediment core sample at 61 inches and 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.

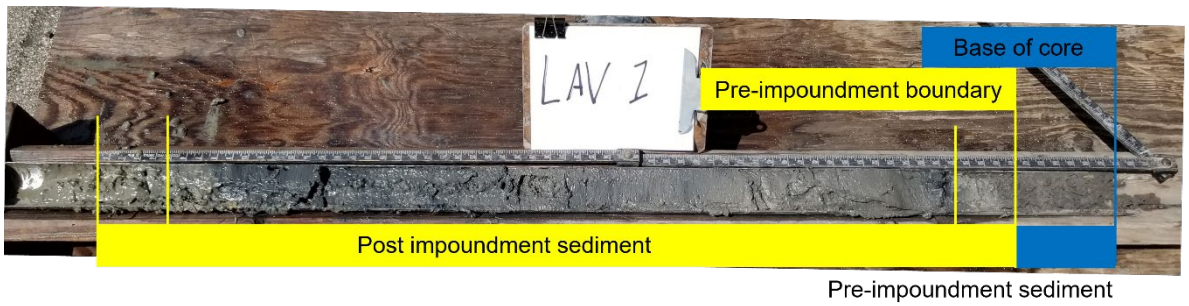


Figure 7. **Sediment core LAV-1. Post-impoundment sediment layers occur in the top 61 inches of this sediment core (identified by the yellow box). Pre-impoundment sediment layers were identified and are defined by the blue box.**

Figure 8 illustrates the relationships between acoustic signal returns and the depositional layering seen in sediment cores. In this example, sediment core LAV-1 is shown correlated with each frequency: 208 kHz, 50 kHz, and 12 kHz. The current bathymetric surface is determined based on 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 may be 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.

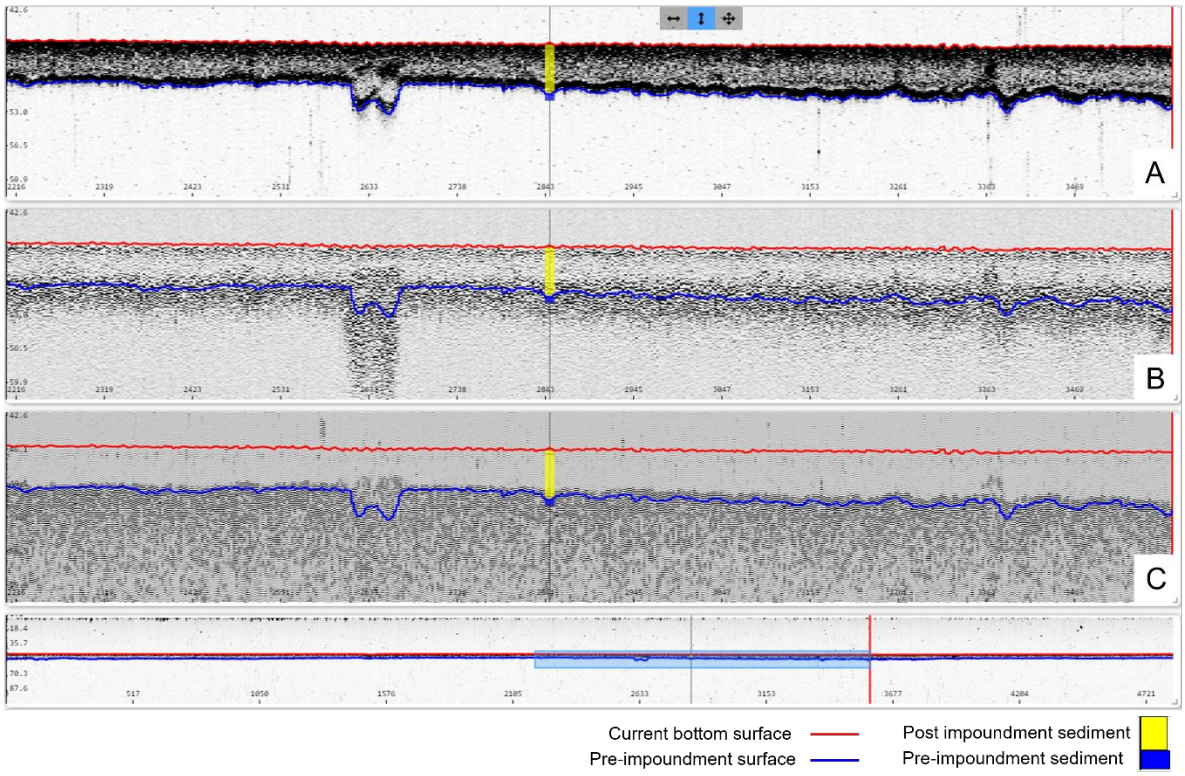


Figure 8. **Sediment core sample LAV-1 compared with acoustic signal returns. A) 208 kHz frequency, B) 50 kHz frequency, and C) 12 kHz frequency.**

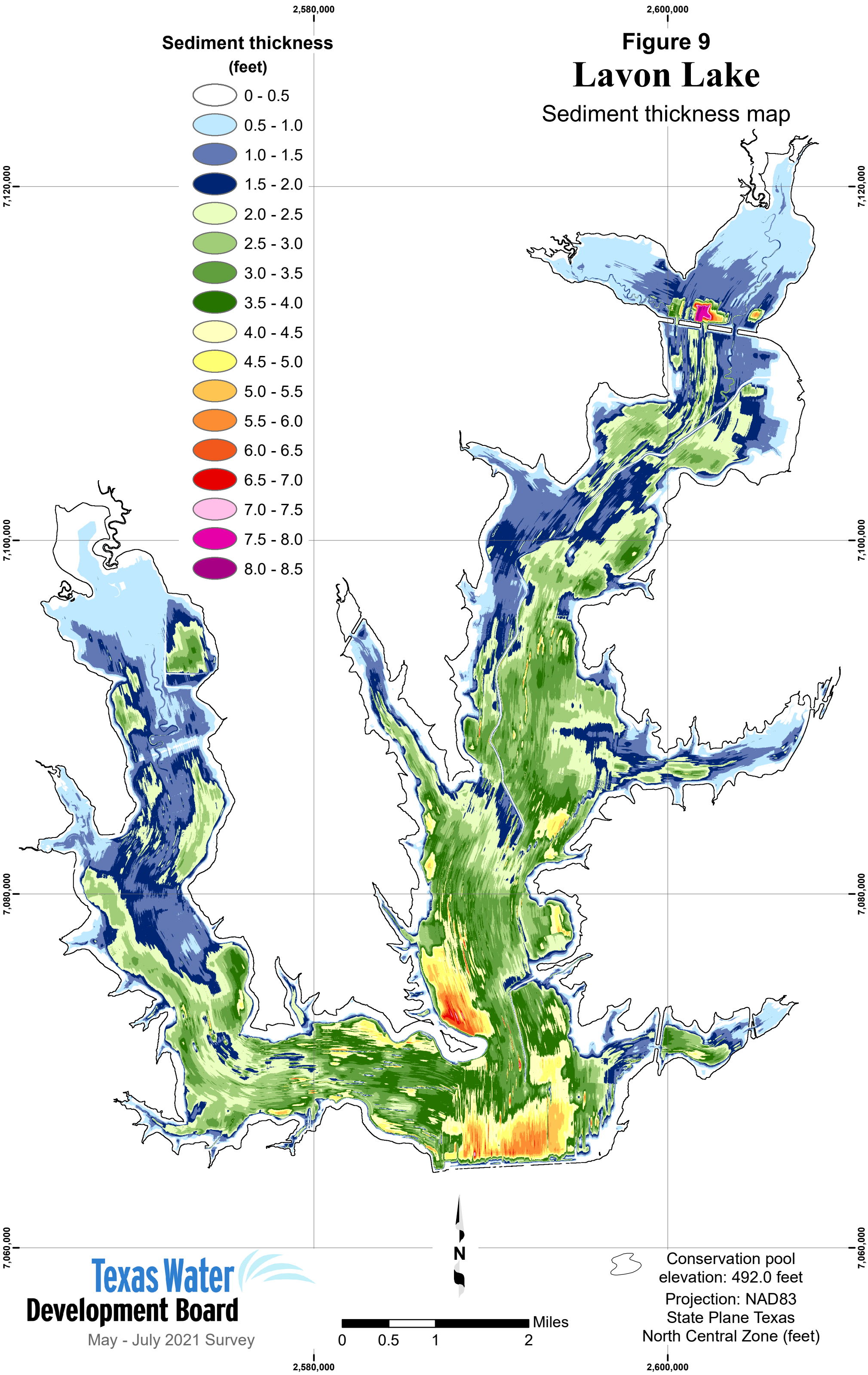
The pre-impoundment boundary in sediment core LAV-1 most closely aligned with the different layers picked up by the 208 kHz acoustic returns (Figure 8). The pre-impoundment surface is first identified along cross-sections for which sediment core samples were collected. This information then is used as 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 was zero (0.0) feet (defined as the 492.2-foot elevation contour). The sediment thickness TIN model was converted to a raster representation using a cell size of 5 feet by 5 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

Lavon Lake

Sediment thickness map



Texas Water Development Board

May - July 2021 Survey

Survey results

Volumetric survey

The 2021 TWDB volumetric survey indicates Lavon Lake has a total reservoir capacity of 412,498 acre-feet and encompasses 20,595 acres at conservation pool elevation (492.0 feet NGVD29). Current area and capacity estimates are compared to previous area and capacity estimates at conservation pool elevation, 492.0 feet, in Table 3. Current area and capacity estimates are compared to previous area and capacity estimates at the original conservation pool elevation, 472.0 feet, in Table 4. 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. However, the similarity in methodology and technology between the 2011 and 2021 surveys provides substantial opportunity for insight into how the reservoir has changed in the last decade. The apparent increase in capacity over the 2011 TWDB survey is largely due to better survey data coverage of the lake in 2021, especially in areas upstream of roadways U.S. Highway 380 and FM 3286 and in general around the lake above elevation 487.0 feet, because of higher water surface elevations during data collection. Figure 10 illustrates how capacity has changed throughout the reservoir since 2011, with capacity losses occurring between elevations 449.8 and 485.3 feet due to sedimentation.

Table 3. Surface area and total capacity at conservation pool elevation 492.0 feet.

Survey	Surface area (acres)	Total capacity (acre-feet)	Conservation pool elevation[a]	Source
USACE 1970	21,357	456,527	492.0	U.S. Army Corps of Engineers, 1974
TWDB 2011	20,559	409,360	492.0	Texas Water Development Board, 2013
TWDB 2011 re-calculated	21,004	411,745	492.0	Texas Water Development Board, 2016
TWDB 2021	20,595	412,498	492.0	

[a] National Geodetic Vertical Datum 1929 (NGVD29).

Table 4. Surface area and total capacity at conservation pool elevation 472.0 feet.

Survey	Surface area (acres)	Total capacity (acre-feet)	Conservation pool elevation[a]	Source
1946 Original	11,080	143,600	472.0	U.S. Army Corps of Engineers, 1975
1951 Revised	11,085	150,324	472.0	U.S. Army Corps of Engineers, 1975
USACE 1959	10,987	143,297	472.0	U.S. Army Corps of Engineers, 1975
USACE 1965	10,857	133,776	472.0	U.S. Army Corps of Engineers, 1975
USACE 1970	10,947	136,847	472.0	U.S. Army Corps of Engineers, 1974
TWDB 2011 re-calculated	10,053	107,962	472.0	Texas Water Development Board, 2016
TWDB 2021	10,055	107,247	472.0	

[b.] National Geodetic Vertical Datum 1929 (NGVD29).

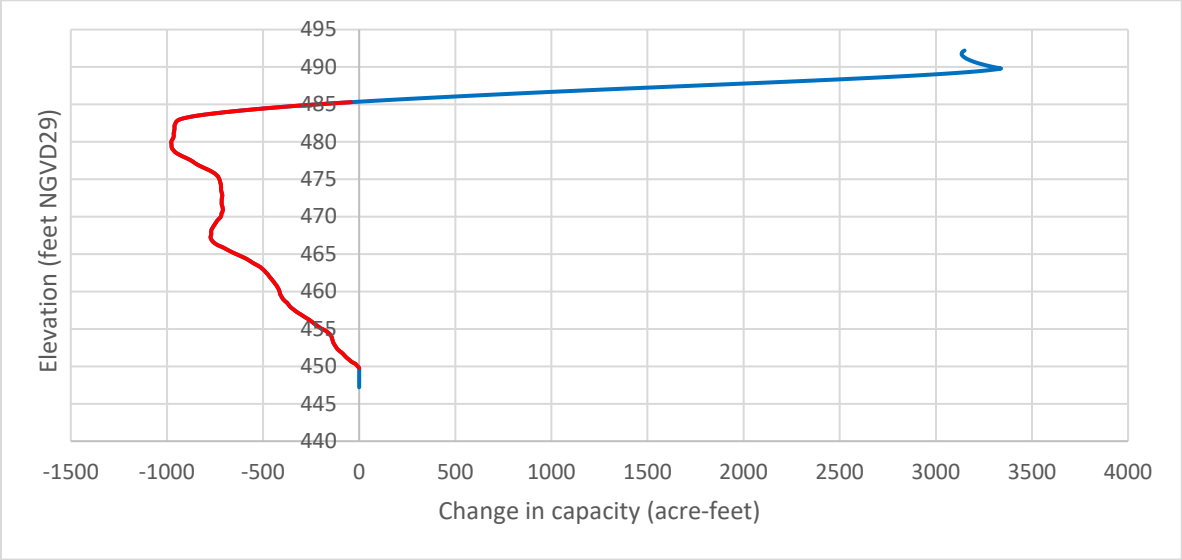


Figure 10. **Change in capacity of Lavon Lake between TWDB 2021 and 2011 surveys. The red segments show elevations where capacity decreased since 2011. The blue segments show elevations where capacity increased since 2011. Capacity loss due to sedimentation is occurring between elevations 449.8 and 485.3 feet. Capacity gain above elevation 485.3 feet is largely a result of increased data coverage in the 2021 survey.**

Sedimentation survey

The 2021 TWDB sedimentation survey measured 39,851 acre-feet of sediment.

The 2021 TWDB sedimentation survey indicates Lavon Lake has lost capacity at an average of 586 acre-feet per year since impoundment due to sedimentation below conservation pool elevation (492.0 feet above mean sea level) The sedimentation survey indicates post-impoundment sediment deposition is occurring throughout the reservoir with

heavy accumulation near the dam, on the west side of the reservoir north of the Clear Lake Campground, and north of the U.S. Highway 380 bridge (Figure 9). Comparison of capacity estimates of Lavon Lake derived using differing methodologies are provided in Table 5 for sedimentation rate calculation. Identification of the pre-impoundment surface can be made more challenging by fluctuating water levels. Lavon Lake has periodically experienced low water levels leading to the desiccation of any exposed sediment, for example, between August 21, 2013, and March 3, 2015, the water surface elevation of the reservoir measured below 482.0 feet NGVD29, reaching as low as 479.0 feet on December 14, 2014. Upon inundation and re-saturation, exposed sediment will not return to its original high level of water content (Dunbar and Allen, 2003). Drying of sediment in exposed areas create hard surfaces that cannot be penetrated with gravity coring techniques, and compressive stresses on the sediments may also increase sediment density, inhibiting the measurement of the original, pre-impoundment surface. Density stratification in the sediment layers can also impair acoustic return signals of the multi-frequency depth sounder (U.S. Army Corps of Engineers, 2013).

Table 5. Average annual capacity loss comparisons at elevation 492.0 feet.

Survey	Top of conservation pool elevation 492.0 feet NGVD29 (acre-feet)		
USACE 1970	456,527	<>	<>
TWDB 2011 re-calculated	<>	411,745	<>
TWDB pre-impoundment estimate based on 2021 survey	<>	<>	452,349
2020 volumetric survey	412,498	412,498	412,498
Volume difference (acre-feet) Percent change	44,029 9.6	-753 -0.2	39,851 8.8
Number of years[a]	46[b]	10	68[c]
Capacity loss rate (acre-feet/year)	957	-75	586
Capacity loss rate (acre-feet/square mile of drainage area of 770 square miles /year)	1.24	-0.10	0.76

[a.] Note: Lavon Dam was completed in September 1953, and deliberate impoundment began on September 14, 1953. Modification to raise the dam 12 feet and conservation pool elevation 20 feet started on May 15, 1970, and deliberate impoundment on the modified dam began on December 1, 1975.

[b.] Number of years based on difference between 2021 survey date and impoundment date of 1975

[c.] Number of years based on difference between 2021 survey date and impoundment date of 1953.

Sediment range lines

Sixty-three sediment range lines for Lavon Lake were established to measure sediment accumulation over time by the U.S. Army Corps Engineers (U.S. Army Corps of Engineers, 1975). In the resurvey of 1965 survey report, nine sediment range lines are plotted showing comparison of the 1951, 1959, and 1965 surveys (U.S. Army Corps of Engineers, 1975). The TWDB digitized the U.S. Army Corps of Engineers maps and the historical cross-sections for comparison with the TWDB 2011 and 2021 surveys. A map depicting these range lines can be found in Appendix M along with Table M1 listing the endpoint coordinates for each range line. Some differences in the cross-sections may be a result of difficulties interpreting the quadrangle map contours and inaccuracies in the quadrangle maps due to scale (U.S. Army Corps of Engineers, 1975) and distortions caused by digitizing the cross-sections from the U.S. Army Corps of Engineers report. Additionally, some differences between the TWDB cross-sections may be a result of spatial interpolation and the interpolation routine of the TIN Model.

Recommendations

The TWDB recommends a detailed analysis of sediment deposits in the areas where exposure of the lake bottom may have led to identification of a false pre-impoundment using augured-coring techniques, as well as a volumetric and sedimentation survey in 10 years or after a major high flow event 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

LAVON LAKE

RESERVOIR CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD
CAPACITY IN ACRE-FEET
ELEVATION INCREMENT IS ONE TENTH FOOT

June - July 2011 Survey re-calculated May 2017
Conservation Pool Elevation 492.0 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
448	0	0	0	0	0	0	0	0	0	0
449	0	0	0	0	0	0	1	1	3	8
450	16	29	48	75	109	152	203	262	329	404
451	485	572	663	759	859	963	1,071	1,183	1,299	1,418
452	1,542	1,670	1,802	1,937	2,075	2,217	2,362	2,510	2,661	2,815
453	2,972	3,132	3,295	3,461	3,629	3,800	3,974	4,151	4,329	4,510
454	4,693	4,878	5,067	5,257	5,451	5,647	5,847	6,049	6,256	6,467
455	6,686	6,910	7,139	7,373	7,611	7,853	8,099	8,349	8,604	8,862
456	9,125	9,392	9,663	9,938	10,217	10,501	10,789	11,082	11,378	11,678
457	11,982	12,291	12,604	12,920	13,240	13,562	13,889	14,219	14,553	14,889
458	15,228	15,570	15,916	16,264	16,617	16,973	17,333	17,697	18,065	18,437
459	18,812	19,191	19,574	19,962	20,354	20,751	21,151	21,556	21,963	22,374
460	22,790	23,209	23,632	24,059	24,489	24,923	25,360	25,801	26,246	26,696
461	27,151	27,611	28,076	28,546	29,022	29,503	29,989	30,480	30,976	31,478
462	31,986	32,498	33,015	33,538	34,066	34,599	35,137	35,681	36,229	36,783
463	37,344	37,909	38,480	39,058	39,644	40,237	40,836	41,441	42,051	42,667
464	43,287	43,913	44,544	45,180	45,821	46,468	47,119	47,776	48,437	49,104
465	49,775	50,451	51,132	51,816	52,504	53,197	53,894	54,596	55,301	56,012
466	56,729	57,450	58,176	58,907	59,641	60,379	61,122	61,868	62,618	63,372
467	64,129	64,889	65,653	66,421	67,192	67,968	68,749	69,535	70,326	71,122
468	71,922	72,726	73,535	74,347	75,164	75,986	76,812	77,644	78,479	79,319
469	80,164	81,013	81,867	82,726	83,590	84,459	85,332	86,211	87,094	87,983
470	88,878	89,778	90,685	91,597	92,515	93,437	94,365	95,299	96,240	97,187
471	98,140	99,099	100,063	101,033	102,009	102,990	103,975	104,965	105,960	106,959
472	107,962	108,970	109,981	110,996	112,015	113,037	114,063	115,093	116,127	117,166
473	118,209	119,257	120,309	121,364	122,423	123,487	124,554	125,625	126,699	127,778
474	128,861	129,947	131,037	132,131	133,230	134,332	135,437	136,547	137,659	138,776
475	139,897	141,022	142,152	143,285	144,423	145,566	146,715	147,869	149,029	150,195
476	151,367	152,545	153,730	154,923	156,122	157,328	158,540	159,758	160,983	162,213
477	163,449	164,691	165,939	167,195	168,457	169,726	171,003	172,287	173,578	174,875
478	176,177	177,484	178,797	180,114	181,436	182,763	184,094	185,430	186,770	188,115
479	189,466	190,820	192,180	193,543	194,912	196,286	197,664	199,048	200,437	201,831
480	203,230	204,633	206,041	207,454	208,873	210,297	211,726	213,161	214,600	216,045
481	217,495	218,949	220,409	221,874	223,345	224,820	226,301	227,787	229,278	230,775
482	232,277	233,785	235,297	236,813	238,334	239,861	241,393	242,930	244,473	246,023
483	247,578	249,138	250,704	252,274	253,851	255,433	257,020	258,612	260,208	261,809
484	263,415	265,025	266,643	268,266	269,895	271,531	273,172	274,820	276,474	278,134
485	279,801	281,473	283,152	284,836	286,527	288,225	289,928	291,637	293,353	295,075
486	296,802	298,536	300,277	302,023	303,776	305,534	307,299	309,070	310,847	312,631
487	314,420	316,216	318,017	319,825	321,639	323,460	325,286	327,119	328,957	330,802
488	332,653	334,511	336,374	338,244	340,119	342,001	343,889	345,783	347,684	349,590
489	351,503	353,421	355,346	357,277	359,215	361,158	363,108	365,063	367,025	368,993
490	370,968	372,948	374,934	376,927	378,926	380,931	382,942	384,959	386,983	389,013
491	391,048	393,090	395,138	397,193	399,253	401,320	403,392	405,471	407,556	409,648
492	411,745	413,848	415,958	418,074	420,196	422,324	424,458	426,599	428,746	430,898
493	433,057									

Note: Capacities above elevaiton 484.0 feet calculated from interpolated areas

Appendix B

LAVON LAKE

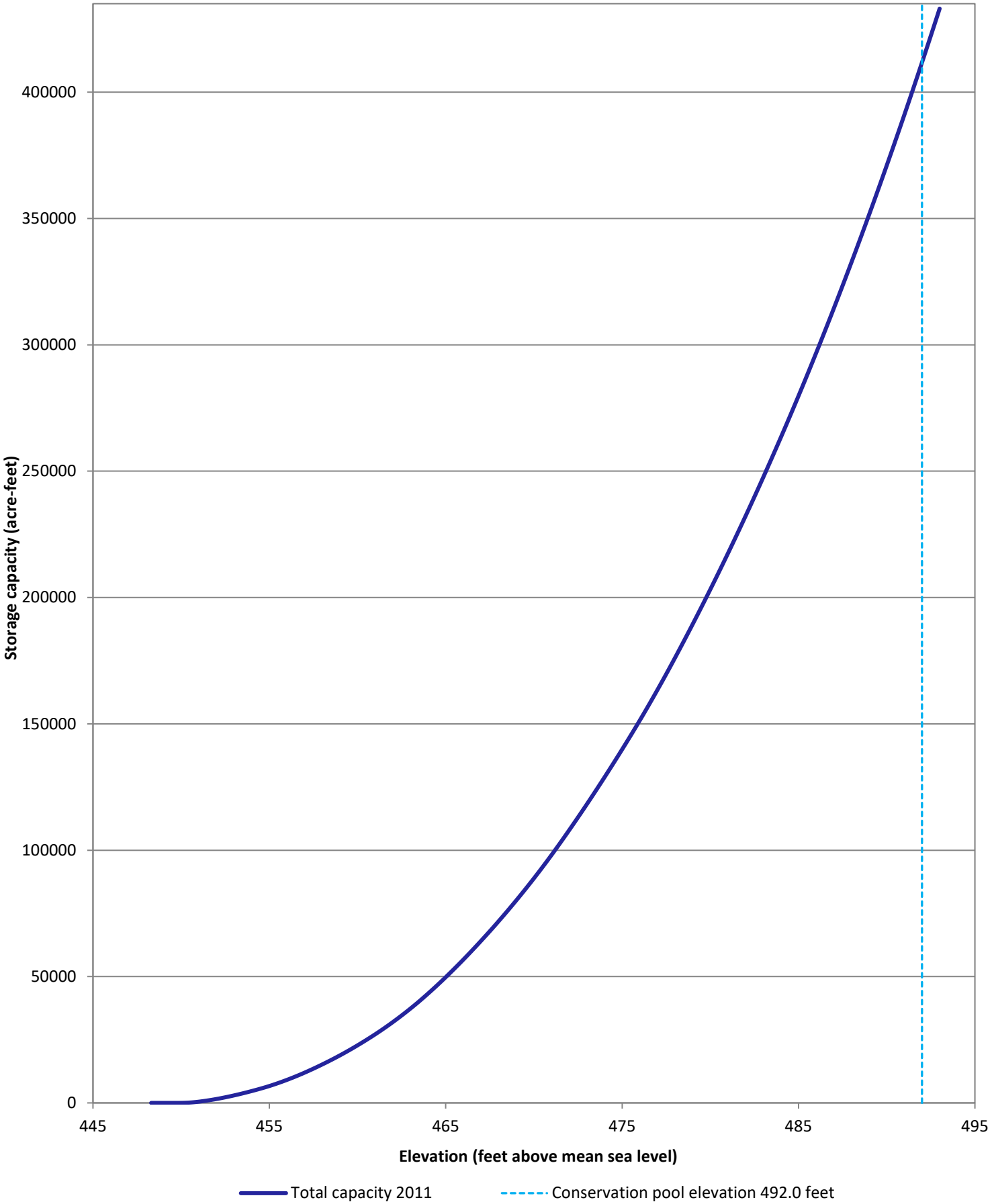
RESERVOIR AREA TABLE

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

June - July 2011 Survey re-calculated May 2017
Conservation Pool Elevation 492.0 feet NGVD29

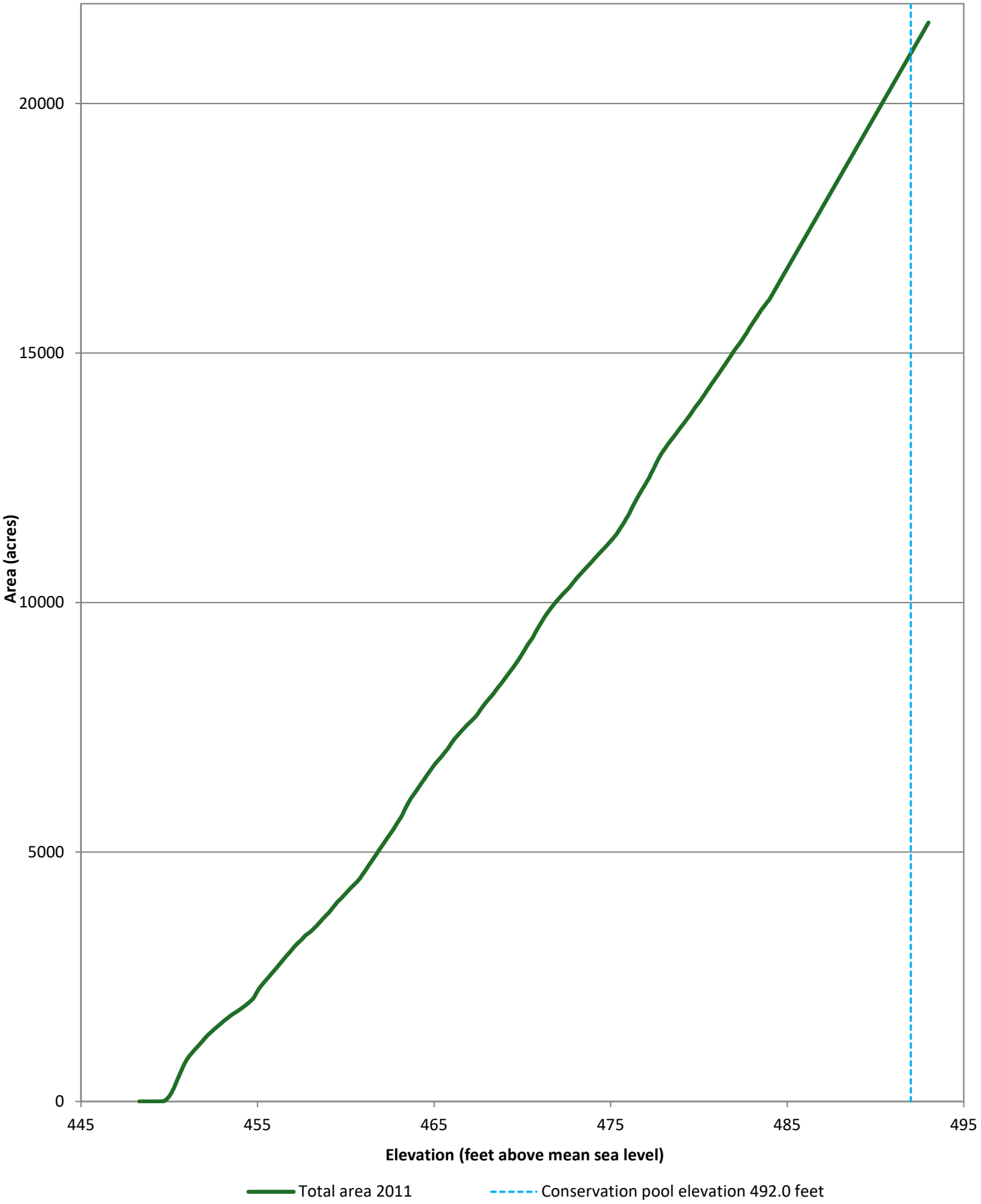
ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
448	0	0	0	0	0	0	0	0	0	0
449	0	0	0	1	1	2	3	7	32	64
450	104	161	225	301	387	471	550	631	709	782
451	841	894	939	979	1,022	1,060	1,097	1,137	1,177	1,218
452	1,259	1,299	1,335	1,368	1,400	1,433	1,464	1,495	1,525	1,554
453	1,585	1,616	1,644	1,671	1,698	1,726	1,751	1,773	1,796	1,819
454	1,843	1,869	1,895	1,921	1,949	1,979	2,010	2,044	2,086	2,151
455	2,214	2,271	2,315	2,358	2,401	2,442	2,481	2,523	2,565	2,605
456	2,647	2,688	2,731	2,773	2,817	2,861	2,903	2,942	2,982	3,021
457	3,067	3,107	3,145	3,179	3,212	3,245	3,285	3,324	3,351	3,376
458	3,403	3,434	3,470	3,505	3,541	3,583	3,622	3,661	3,699	3,735
459	3,771	3,810	3,854	3,900	3,943	3,988	4,025	4,057	4,094	4,134
460	4,172	4,212	4,250	4,287	4,322	4,355	4,390	4,429	4,469	4,524
461	4,574	4,624	4,678	4,732	4,783	4,834	4,886	4,938	4,992	5,047
462	5,097	5,148	5,201	5,254	5,306	5,356	5,405	5,458	5,514	5,573
463	5,628	5,682	5,744	5,821	5,891	5,959	6,022	6,081	6,131	6,180
464	6,231	6,283	6,336	6,387	6,436	6,487	6,540	6,592	6,641	6,690
465	6,738	6,783	6,825	6,864	6,904	6,948	6,994	7,035	7,082	7,137
466	7,190	7,239	7,284	7,324	7,363	7,404	7,443	7,480	7,518	7,555
467	7,589	7,622	7,658	7,693	7,734	7,781	7,836	7,886	7,935	7,980
468	8,023	8,065	8,106	8,147	8,190	8,241	8,289	8,334	8,377	8,422
469	8,472	8,518	8,567	8,615	8,662	8,709	8,758	8,809	8,862	8,919
470	8,976	9,032	9,094	9,153	9,204	9,252	9,306	9,375	9,440	9,500
471	9,558	9,615	9,676	9,731	9,781	9,830	9,878	9,924	9,969	10,012
472	10,053	10,092	10,132	10,171	10,207	10,243	10,280	10,319	10,365	10,411
473	10,454	10,497	10,536	10,575	10,614	10,652	10,691	10,728	10,765	10,804
474	10,844	10,884	10,923	10,962	11,000	11,038	11,074	11,112	11,149	11,191
475	11,230	11,271	11,312	11,354	11,406	11,461	11,515	11,569	11,628	11,691
476	11,748	11,815	11,891	11,959	12,026	12,089	12,153	12,215	12,272	12,331
477	12,392	12,452	12,514	12,592	12,657	12,731	12,805	12,874	12,937	12,996
478	13,048	13,097	13,149	13,198	13,246	13,291	13,336	13,380	13,429	13,478
479	13,523	13,569	13,617	13,665	13,712	13,758	13,811	13,865	13,916	13,962
480	14,008	14,056	14,108	14,159	14,213	14,267	14,317	14,372	14,423	14,472
481	14,521	14,572	14,626	14,678	14,729	14,780	14,834	14,887	14,940	14,995
482	15,048	15,097	15,143	15,189	15,239	15,293	15,347	15,400	15,462	15,522
483	15,575	15,631	15,682	15,737	15,790	15,847	15,894	15,940	15,987	16,033
484	16,078	16,140	16,201	16,263	16,324	16,386	16,448	16,509	16,571	16,632
485	16,694	16,756	16,817	16,879	16,940	17,002	17,063	17,125	17,187	17,248
486	17,310	17,371	17,433	17,494	17,556	17,618	17,679	17,741	17,802	17,864
487	17,926	17,987	18,049	18,110	18,172	18,233	18,295	18,357	18,418	18,480
488	18,541	18,603	18,664	18,726	18,788	18,849	18,911	18,972	19,034	19,096
489	19,157	19,219	19,280	19,342	19,403	19,465	19,527	19,588	19,650	19,711
490	19,773	19,834	19,896	19,958	20,019	20,081	20,142	20,204	20,266	20,327
491	20,389	20,450	20,512	20,573	20,635	20,697	20,758	20,820	20,881	20,943
492	21,004	21,066	21,128	21,189	21,251	21,312	21,374	21,436	21,497	21,559
493	21,620									

Note: Areas between elevations 484.0 and 493.0 feet linearly interpolated



Lavon Lake
June - July 2011 Survey
re-calculated May 2017
Prepared by: TWDB

Appendix C: 2011 re-calculated capacity curve



Lavon Lake
June - July 2011 Survey
re-calculated May 2017
Prepared by: TWDB

Appendix D: 2011 re-calculated area curve

Appendix E

LAVON LAKE

RESERVOIR BATHYMETRIC CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD — May - July 2021 Survey

CAPACITY IN ACRE-FEET — Conservation Pool Elevation 492.0 feet NGVD29

ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION (feet NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
447	0	0	0	0	0	0	0	0	0	0
448	0	0	0	0	0	0	0	0	0	0
449	0	0	0	0	0	1	1	1	2	4
450	9	18	34	56	85	120	164	218	281	351
451	427	509	597	688	785	885	990	1,098	1,209	1,324
452	1,443	1,566	1,693	1,825	1,960	2,099	2,241	2,386	2,535	2,686
453	2,841	2,999	3,160	3,324	3,492	3,662	3,835	4,010	4,187	4,367
454	4,548	4,732	4,917	5,105	5,294	5,486	5,681	5,878	6,079	6,283
455	6,492	6,709	6,933	7,162	7,394	7,631	7,871	8,116	8,366	8,619
456	8,877	9,138	9,404	9,673	9,947	10,224	10,506	10,792	11,082	11,377
457	11,675	11,977	12,283	12,594	12,908	13,226	13,548	13,873	14,202	14,533
458	14,868	15,207	15,550	15,895	16,245	16,597	16,953	17,312	17,676	18,044
459	18,416	18,792	19,173	19,558	19,949	20,343	20,741	21,144	21,551	21,961
460	22,376	22,793	23,215	23,640	24,068	24,500	24,935	25,374	25,816	26,263
461	26,714	27,172	27,634	28,102	28,574	29,052	29,535	30,023	30,516	31,015
462	31,519	32,028	32,543	33,063	33,587	34,116	34,651	35,191	35,735	36,286
463	36,841	37,402	37,969	38,542	39,121	39,707	40,299	40,897	41,500	42,109
464	42,724	43,344	43,969	44,598	45,232	45,871	46,514	47,162	47,815	48,473
465	49,135	49,803	50,475	51,151	51,832	52,517	53,207	53,901	54,600	55,303
466	56,011	56,723	57,440	58,164	58,893	59,626	60,364	61,106	61,853	62,604
467	63,359	64,118	64,881	65,648	66,420	67,197	67,979	68,765	69,556	70,352
468	71,152	71,957	72,766	73,580	74,399	75,223	76,052	76,885	77,723	78,566
469	79,413	80,265	81,122	81,984	82,850	83,722	84,598	85,481	86,368	87,260
470	88,158	89,060	89,968	90,880	91,798	92,723	93,653	94,588	95,530	96,478
471	97,431	98,389	99,353	100,322	101,297	102,276	103,261	104,250	105,244	106,244
472	107,247	108,254	109,266	110,281	111,300	112,323	113,350	114,381	115,415	116,454
473	117,497	118,543	119,594	120,648	121,707	122,769	123,836	124,906	125,981	127,060
474	128,142	129,228	130,318	131,412	132,509	133,610	134,714	135,823	136,935	138,050
475	139,170	140,293	141,421	142,552	143,687	144,827	145,972	147,121	148,276	149,436
476	150,601	151,773	152,950	154,135	155,325	156,522	157,726	158,937	160,153	161,375
477	162,605	163,840	165,083	166,333	167,589	168,853	170,123	171,399	172,681	173,970
478	175,263	176,562	177,867	179,177	180,492	181,812	183,138	184,470	185,807	187,149
479	188,496	189,848	191,205	192,568	193,936	195,310	196,688	198,072	199,460	200,854
480	202,253	203,657	205,067	206,482	207,903	209,329	210,760	212,196	213,636	215,080
481	216,530	217,984	219,445	220,911	222,382	223,858	225,340	226,826	228,318	229,814
482	231,316	232,824	234,337	235,855	237,377	238,905	240,439	241,979	243,526	245,081
483	246,645	248,217	249,799	251,388	252,985	254,591	256,205	257,826	259,454	261,089
484	262,731	264,379	266,033	267,693	269,359	271,030	272,708	274,391	276,080	277,775
485	279,476	281,182	282,895	284,613	286,338	288,068	289,805	291,548	293,297	295,052
486	296,813	298,580	300,352	302,131	303,915	305,705	307,502	309,305	311,115	312,931
487	314,755	316,585	318,423	320,267	322,118	323,975	325,839	327,709	329,585	331,467
488	333,356	335,249	337,149	339,053	340,963	342,877	344,797	346,721	348,650	350,583
489	352,521	354,464	356,410	358,361	360,315	362,273	364,235	366,201	368,171	370,146
490	372,124	374,106	376,093	378,082	380,076	382,074	384,075	386,080	388,089	390,102
491	392,118	394,138	396,162	398,190	400,221	402,257	404,296	406,340	408,388	410,440
492	412,498	414,560	416,627							

Appendix F

LAVON LAKE

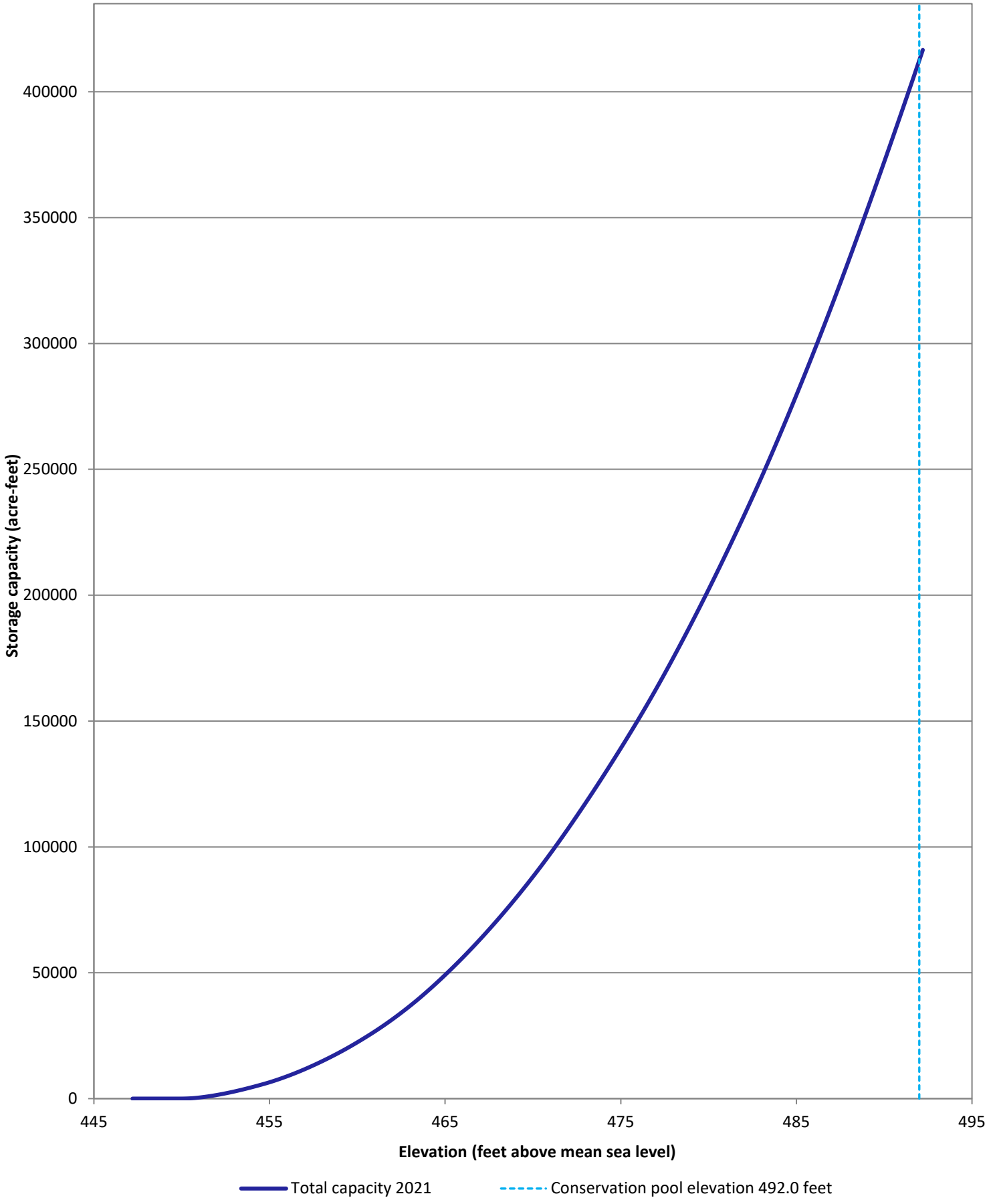
RESERVOIR BATHYMETRIC AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — May - July 2021 Survey

AREA IN ACRES — Conservation Pool Elevation 492.0 feet NGVD29

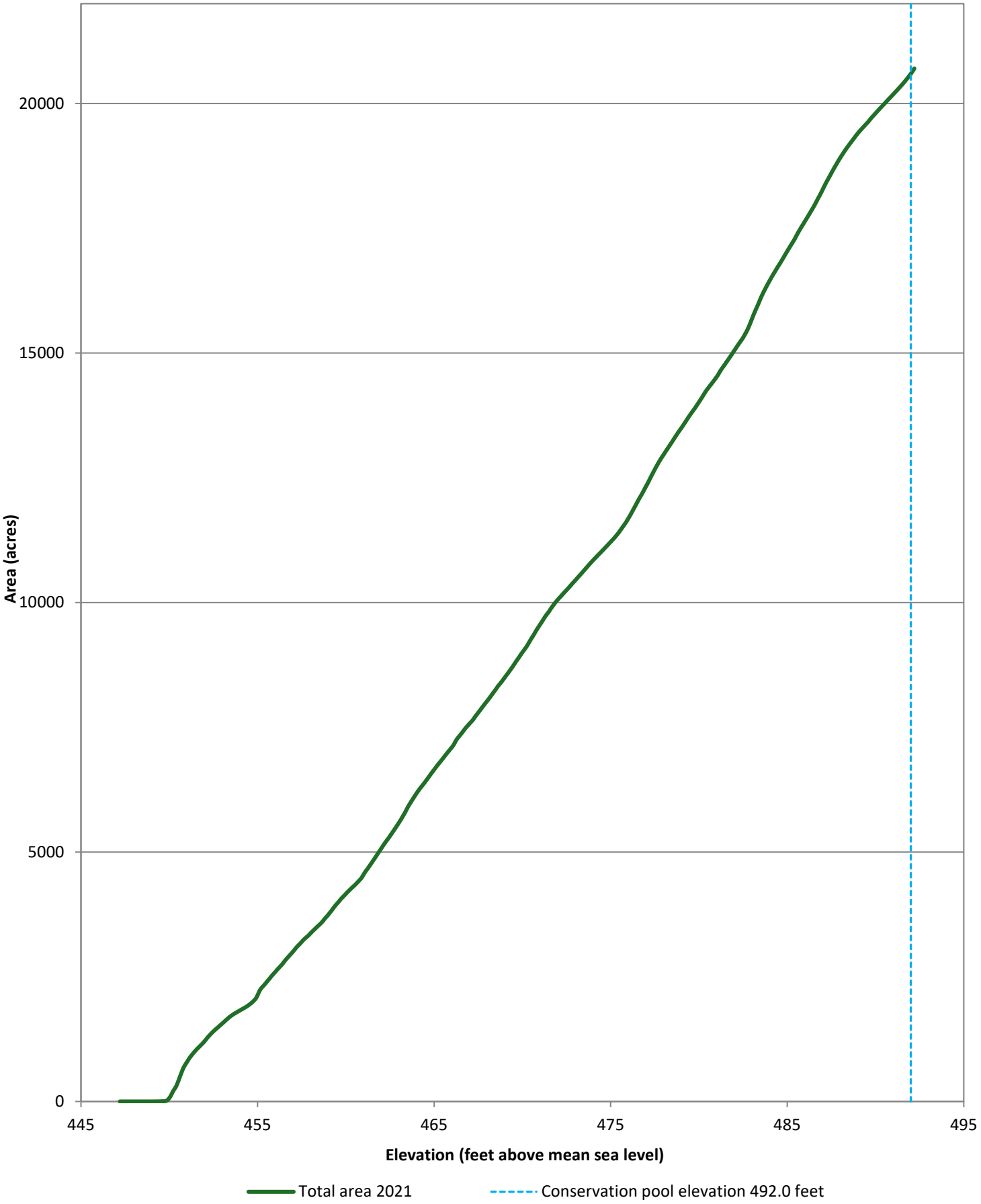
ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION (feet NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
447	0	0	0	0	0	0	0	0	0	0
448	0	0	0	0	0	0	0	0	0	0
449	0	0	1	1	2	3	4	6	9	29
450	68	123	195	252	311	397	492	584	671	734
451	790	847	898	942	985	1,025	1,062	1,097	1,132	1,169
452	1,208	1,251	1,295	1,334	1,371	1,406	1,438	1,469	1,499	1,532
453	1,562	1,594	1,627	1,659	1,689	1,716	1,741	1,763	1,783	1,804
454	1,825	1,845	1,865	1,886	1,907	1,932	1,960	1,989	2,024	2,063
455	2,128	2,207	2,264	2,304	2,344	2,387	2,429	2,472	2,515	2,556
456	2,594	2,636	2,675	2,712	2,752	2,797	2,842	2,882	2,922	2,960
457	3,000	3,043	3,087	3,124	3,159	3,198	3,238	3,270	3,301	3,333
458	3,370	3,406	3,440	3,474	3,509	3,542	3,576	3,614	3,660	3,700
459	3,740	3,785	3,830	3,877	3,924	3,964	4,004	4,049	4,087	4,123
460	4,160	4,198	4,233	4,268	4,301	4,333	4,368	4,407	4,444	4,487
461	4,545	4,602	4,650	4,699	4,751	4,802	4,855	4,906	4,961	5,013
462	5,066	5,121	5,173	5,222	5,268	5,319	5,371	5,423	5,475	5,529
463	5,583	5,638	5,698	5,759	5,822	5,891	5,951	6,008	6,064	6,119
464	6,173	6,224	6,272	6,318	6,362	6,408	6,457	6,505	6,554	6,602
465	6,649	6,696	6,742	6,787	6,830	6,875	6,920	6,966	7,010	7,053
466	7,096	7,143	7,208	7,266	7,310	7,354	7,398	7,446	7,491	7,531
467	7,570	7,609	7,648	7,700	7,747	7,793	7,839	7,887	7,934	7,979
468	8,024	8,070	8,117	8,166	8,214	8,262	8,315	8,358	8,401	8,448
469	8,496	8,545	8,591	8,641	8,690	8,742	8,795	8,848	8,897	8,951
470	9,001	9,048	9,097	9,153	9,213	9,273	9,328	9,388	9,448	9,503
471	9,557	9,610	9,667	9,722	9,770	9,816	9,871	9,920	9,969	10,012
472	10,055	10,094	10,132	10,172	10,211	10,248	10,287	10,327	10,368	10,406
473	10,445	10,486	10,525	10,564	10,604	10,646	10,686	10,727	10,766	10,805
474	10,844	10,881	10,918	10,955	10,990	11,027	11,064	11,101	11,139	11,177
475	11,215	11,253	11,291	11,332	11,375	11,422	11,473	11,522	11,572	11,625
476	11,684	11,743	11,809	11,874	11,938	12,005	12,072	12,132	12,193	12,259
477	12,326	12,390	12,462	12,532	12,600	12,668	12,732	12,795	12,854	12,910
478	12,963	13,019	13,072	13,125	13,178	13,232	13,286	13,341	13,395	13,445
479	13,496	13,547	13,601	13,655	13,709	13,760	13,811	13,860	13,909	13,962
480	14,016	14,071	14,126	14,183	14,238	14,285	14,333	14,377	14,423	14,470
481	14,519	14,572	14,635	14,687	14,737	14,788	14,839	14,889	14,942	14,994
482	15,047	15,100	15,154	15,205	15,254	15,308	15,369	15,433	15,508	15,591
483	15,681	15,770	15,853	15,932	16,014	16,100	16,177	16,249	16,316	16,383
484	16,446	16,510	16,572	16,629	16,688	16,746	16,801	16,860	16,919	16,980
485	17,039	17,098	17,156	17,212	17,270	17,336	17,402	17,463	17,523	17,580
486	17,638	17,696	17,753	17,813	17,872	17,933	17,998	18,066	18,132	18,197
487	18,269	18,342	18,412	18,476	18,540	18,604	18,670	18,731	18,792	18,853
488	18,910	18,965	19,020	19,072	19,122	19,170	19,218	19,265	19,312	19,358
489	19,403	19,445	19,485	19,523	19,562	19,600	19,637	19,683	19,725	19,763
490	19,803	19,842	19,881	19,918	19,956	19,994	20,032	20,070	20,107	20,144
491	20,182	20,220	20,258	20,296	20,335	20,375	20,416	20,459	20,502	20,548
492	20,595	20,645	20,701							



Lavon Lake
May - July 2021 Survey
Prepared by: TWDB

Appendix G: 2021 Bathymetric capacity curve



Lavon Lake
May - July 2021 Survey
Prepared by: TWDB

Appendix H: 2021 Bathymetric area curve

Appendix I

LAVON LAKE

RESERVOIR BATHYMETRIC AND TOPOGRAPHIC CAPACITY TABLE

TEXAS WATER DEVELOPMENT BOARD
CAPACITY IN ACRE-FEET
ELEVATION INCREMENT IS ONE TENTH FOOT

May - July 2021 Survey
Conservation pool elevation 492.0 feet NGVD29
Top of dam elevation 514.0 feet NGVD29

ELEVATION (feet NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
447	0	0	0	0	0	0	0	0	0	0
448	0	0	0	0	0	0	0	0	0	0
449	0	0	0	0	0	1	1	1	2	4
450	9	18	34	56	85	120	164	218	281	351
451	427	509	597	688	785	885	990	1,098	1,209	1,324
452	1,443	1,566	1,693	1,825	1,960	2,099	2,241	2,386	2,535	2,686
453	2,841	2,999	3,160	3,324	3,492	3,662	3,835	4,010	4,187	4,367
454	4,548	4,732	4,917	5,105	5,294	5,486	5,681	5,878	6,079	6,283
455	6,492	6,709	6,933	7,162	7,394	7,631	7,872	8,117	8,366	8,619
456	8,877	9,139	9,404	9,673	9,947	10,224	10,506	10,792	11,083	11,377
457	11,675	11,977	12,283	12,594	12,908	13,226	13,548	13,873	14,202	14,533
458	14,869	15,208	15,550	15,896	16,245	16,597	16,953	17,313	17,676	18,044
459	18,416	18,793	19,173	19,559	19,949	20,343	20,742	21,144	21,551	21,962
460	22,376	22,794	23,215	23,640	24,069	24,501	24,936	25,374	25,817	26,263
461	26,715	27,172	27,635	28,102	28,575	29,052	29,535	30,023	30,517	31,015
462	31,519	32,029	32,543	33,063	33,588	34,117	34,652	35,191	35,736	36,286
463	36,842	37,403	37,970	38,543	39,122	39,707	40,299	40,897	41,501	42,110
464	42,725	43,345	43,970	44,599	45,233	45,872	46,515	47,163	47,816	48,474
465	49,136	49,804	50,476	51,152	51,833	52,518	53,208	53,902	54,601	55,304
466	56,012	56,724	57,441	58,165	58,894	59,627	60,365	61,107	61,854	62,605
467	63,360	64,119	64,882	65,649	66,421	67,198	67,980	68,766	69,557	70,353
468	71,153	71,958	72,767	73,581	74,400	75,224	76,053	76,887	77,725	78,567
469	79,414	80,266	81,123	81,985	82,851	83,723	84,600	85,482	86,369	87,262
470	88,159	89,062	89,969	90,882	91,800	92,724	93,654	94,590	95,532	96,479
471	97,432	98,391	99,355	100,324	101,299	102,278	103,262	104,252	105,246	106,245
472	107,249	108,256	109,268	110,283	111,302	112,325	113,352	114,382	115,417	116,456
473	117,498	118,545	119,596	120,650	121,709	122,771	123,838	124,908	125,983	127,062
474	128,144	129,230	130,320	131,414	132,511	133,612	134,717	135,825	136,937	138,053
475	139,172	140,296	141,423	142,554	143,690	144,829	145,974	147,124	148,279	149,439
476	150,604	151,775	152,953	154,137	155,328	156,525	157,729	158,939	160,155	161,378
477	162,607	163,843	165,086	166,335	167,592	168,855	170,125	171,402	172,684	173,973
478	175,266	176,565	177,870	179,180	180,495	181,816	183,142	184,473	185,810	187,152
479	188,499	189,851	191,208	192,571	193,940	195,313	196,692	198,075	199,464	200,857
480	202,256	203,661	205,070	206,486	207,907	209,333	210,764	212,200	213,640	215,085
481	216,534	217,989	219,449	220,915	222,387	223,863	225,344	226,831	228,322	229,819
482	231,321	232,829	234,342	235,860	237,383	238,911	240,445	241,985	243,532	245,087
483	246,650	248,223	249,804	251,394	252,991	254,597	256,211	257,832	259,461	261,096
484	262,737	264,385	266,039	267,700	269,366	271,037	272,715	274,398	276,087	277,782
485	279,483	281,190	282,903	284,622	286,346	288,076	289,813	291,557	293,306	295,062
486	296,823	298,590	300,362	302,141	303,925	305,716	307,512	309,316	311,126	312,943
487	314,766	316,597	318,435	320,280	322,131	323,988	325,852	327,722	329,599	331,483
488	333,373	335,268	337,169	339,075	340,987	342,903	344,825	346,751	348,682	350,617
489	352,557	354,502	356,450	358,402	360,359	362,319	364,283	366,251	368,223	370,200
490	372,180	374,164	376,152	378,145	380,140	382,140	384,143	386,151	388,162	390,176
491	392,195	394,217	396,243	398,273	400,307	402,344	404,386	406,433	408,483	410,538
492	412,598	414,663	416,733	418,815	420,901	422,992	425,087	427,186	429,290	431,398
493	433,511	435,630	437,753	439,882	442,016	444,155	446,300	448,451	450,607	452,768
494	454,936	457,109	459,288	461,477	463,682	465,903	468,140	470,391	472,654	474,930
495	477,218	479,517	481,827	484,146	486,475	488,812	491,156	493,508	495,867	498,233
496	500,605	502,985	505,371	507,764	510,163	512,570	514,983	517,402	519,828	522,261
497	524,700	527,146	529,599	532,058	534,524	536,996	539,474	541,959	544,450	546,947
498	549,450	551,960	554,476	556,998	559,526	562,060	564,601	567,148	569,701	572,260
499	574,825	577,396	579,972	582,555	585,144	587,738	590,338	592,945	595,558	598,177
500	600,804	603,437	606,077	608,725	611,379	614,041	616,712	619,391	622,077	624,773

Appendix I

LAVON LAKE

RESERVOIR BATHYMETRIC AND TOPOGRAPHIC CAPACITY TABLE (continued)

TEXAS WATER DEVELOPMENT BOARD
CAPACITY IN ACRE-FEET
ELEVATION INCREMENT IS ONE TENTH FOOT

May - July 2021 Survey
Conservation pool elevation 492.0 feet NGVD29
Top of dam elevation 514.0 feet NGVD29

ELEVATION (feet NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
501	627,476	630,188	632,908	635,636	638,372	641,116	643,868	646,628	649,396	652,172
502	654,957	657,750	660,552	663,363	666,182	669,008	671,843	674,685	677,535	680,392
503	683,258	686,131	689,012	691,901	694,798	697,702	700,614	703,534	706,461	709,397
504	712,339	715,290	718,248	721,214	724,187	727,168	730,157	733,153	736,157	739,168
505	742,186	745,212	748,246	751,288	754,338	757,395	760,461	763,534	766,616	769,706
506	772,804	775,910	779,024	782,146	785,276	788,414	791,560	794,714	797,875	801,045
507	804,222	807,408	810,601	813,803	817,012	820,230	823,455	826,688	829,929	833,178
508	836,434	839,699	842,971	846,251	849,539	852,834	856,136	859,446	862,763	866,088
509	869,420	872,760	876,107	879,461	882,823	886,193	889,571	892,957	896,352	899,755
510	903,166	906,585	910,012	913,447	916,890	920,341	923,801	927,269	930,746	934,231
511	937,724	941,226	944,735	948,252	951,778	955,311	958,853	962,403	965,961	969,528
512	973,103	976,687	980,278	983,878	987,486	991,102	994,725	998,357	1,001,996	1,005,643
513	1,009,297	1,012,959	1,016,628	1,020,305	1,023,989	1,027,680	1,031,378	1,035,084	1,038,797	1,042,517
514	1,046,246									

Appendix J

LAVON LAKE

RESERVOIR BATHYMETRIC AND TOPOGRAPHIC AREA TABLE

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

May - July 2021 Survey
Conservation pool elevation 492.0 feet NGVD29
Top of dam elevation 514.0 feet NGVD29

ELEVATION (feet NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
447	0	0	0	0	0	0	0	0	0	0
448	0	0	0	0	0	0	0	0	0	0
449	0	0	1	1	2	3	4	6	9	29
450	68	123	195	252	311	397	492	584	671	734
451	790	847	898	942	985	1,025	1,062	1,097	1,132	1,169
452	1,208	1,251	1,295	1,334	1,371	1,406	1,438	1,469	1,499	1,532
453	1,562	1,594	1,627	1,659	1,689	1,716	1,741	1,763	1,783	1,804
454	1,825	1,845	1,865	1,886	1,907	1,932	1,960	1,989	2,024	2,063
455	2,128	2,207	2,265	2,304	2,344	2,387	2,429	2,472	2,515	2,556
456	2,594	2,636	2,675	2,713	2,752	2,797	2,842	2,882	2,922	2,960
457	3,000	3,043	3,087	3,124	3,160	3,198	3,238	3,270	3,301	3,333
458	3,370	3,406	3,440	3,475	3,509	3,542	3,576	3,614	3,660	3,700
459	3,740	3,785	3,830	3,878	3,924	3,964	4,004	4,049	4,087	4,124
460	4,160	4,198	4,233	4,268	4,301	4,333	4,368	4,407	4,444	4,487
461	4,545	4,602	4,650	4,699	4,751	4,802	4,855	4,907	4,961	5,013
462	5,066	5,121	5,173	5,222	5,269	5,319	5,371	5,423	5,475	5,529
463	5,583	5,638	5,699	5,759	5,822	5,891	5,951	6,008	6,064	6,119
464	6,173	6,224	6,272	6,318	6,362	6,408	6,457	6,505	6,555	6,602
465	6,649	6,696	6,742	6,787	6,830	6,875	6,921	6,966	7,010	7,053
466	7,096	7,143	7,208	7,266	7,310	7,354	7,398	7,446	7,491	7,531
467	7,570	7,609	7,648	7,700	7,747	7,794	7,839	7,887	7,934	7,979
468	8,025	8,070	8,117	8,166	8,214	8,262	8,315	8,358	8,402	8,449
469	8,496	8,545	8,591	8,641	8,690	8,742	8,795	8,848	8,897	8,951
470	9,001	9,049	9,098	9,153	9,213	9,273	9,328	9,388	9,448	9,503
471	9,557	9,610	9,667	9,722	9,770	9,816	9,871	9,920	9,969	10,012
472	10,055	10,094	10,133	10,172	10,211	10,248	10,287	10,327	10,368	10,406
473	10,445	10,486	10,525	10,565	10,605	10,646	10,687	10,727	10,767	10,805
474	10,844	10,881	10,918	10,955	10,990	11,027	11,064	11,101	11,139	11,177
475	11,215	11,253	11,292	11,333	11,376	11,422	11,473	11,523	11,572	11,625
476	11,684	11,744	11,809	11,875	11,939	12,006	12,072	12,132	12,193	12,260
477	12,326	12,391	12,462	12,533	12,600	12,668	12,732	12,795	12,854	12,911
478	12,963	13,019	13,072	13,125	13,179	13,232	13,287	13,341	13,395	13,446
479	13,496	13,547	13,601	13,655	13,710	13,761	13,811	13,860	13,909	13,963
480	14,016	14,071	14,126	14,183	14,239	14,285	14,333	14,378	14,424	14,471
481	14,520	14,573	14,636	14,688	14,738	14,788	14,840	14,889	14,942	14,995
482	15,047	15,100	15,155	15,205	15,255	15,309	15,370	15,434	15,508	15,592
483	15,682	15,771	15,854	15,933	16,015	16,101	16,178	16,250	16,317	16,384
484	16,447	16,511	16,573	16,630	16,690	16,747	16,802	16,861	16,920	16,982
485	17,040	17,100	17,157	17,214	17,272	17,338	17,404	17,465	17,524	17,582
486	17,640	17,698	17,755	17,815	17,874	17,936	18,000	18,068	18,135	18,200
487	18,272	18,344	18,414	18,478	18,542	18,607	18,673	18,736	18,802	18,867
488	18,925	18,981	19,039	19,091	19,141	19,189	19,237	19,284	19,331	19,378
489	19,423	19,465	19,505	19,543	19,582	19,620	19,658	19,704	19,745	19,784
490	19,823	19,863	19,901	19,939	19,977	20,015	20,053	20,091	20,128	20,166
491	20,203	20,241	20,280	20,318	20,358	20,398	20,440	20,483	20,527	20,573
492	20,622	20,674	20,734	20,843	20,883	20,926	20,969	21,014	21,061	21,108
493	21,157	21,208	21,260	21,313	21,367	21,422	21,477	21,533	21,589	21,645
494	21,701	21,760	21,834	21,960	22,136	22,293	22,438	22,572	22,698	22,819
495	22,935	23,047	23,148	23,241	23,326	23,407	23,482	23,553	23,624	23,693
496	23,760	23,828	23,896	23,963	24,030	24,096	24,162	24,228	24,294	24,361
497	24,427	24,494	24,559	24,625	24,689	24,752	24,815	24,878	24,940	25,002
498	25,064	25,126	25,189	25,251	25,314	25,375	25,437	25,499	25,560	25,621
499	25,680	25,738	25,797	25,855	25,914	25,974	26,035	26,096	26,161	26,231
500	26,299	26,367	26,437	26,509	26,583	26,663	26,746	26,829	26,910	26,993

Appendix J

LAVON LAKE

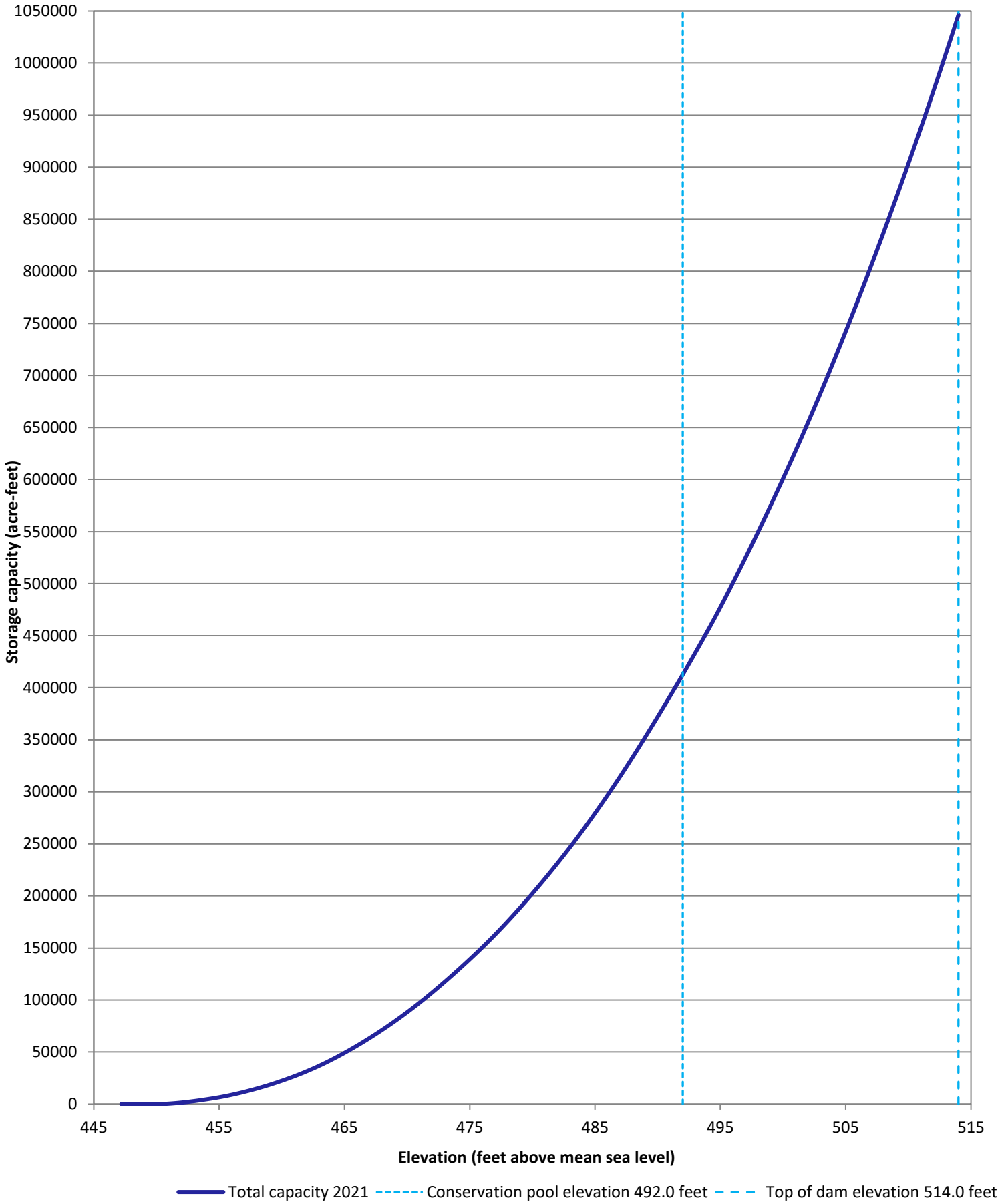
RESERVOIR BATHYMETRIC AND TOPOGRAPHIC AREA TABLE (continued)

TEXAS WATER DEVELOPMENT BOARD — May - July 2021 Survey

AREA IN ACRES — Conservation pool elevation 492.0 feet NGVD29

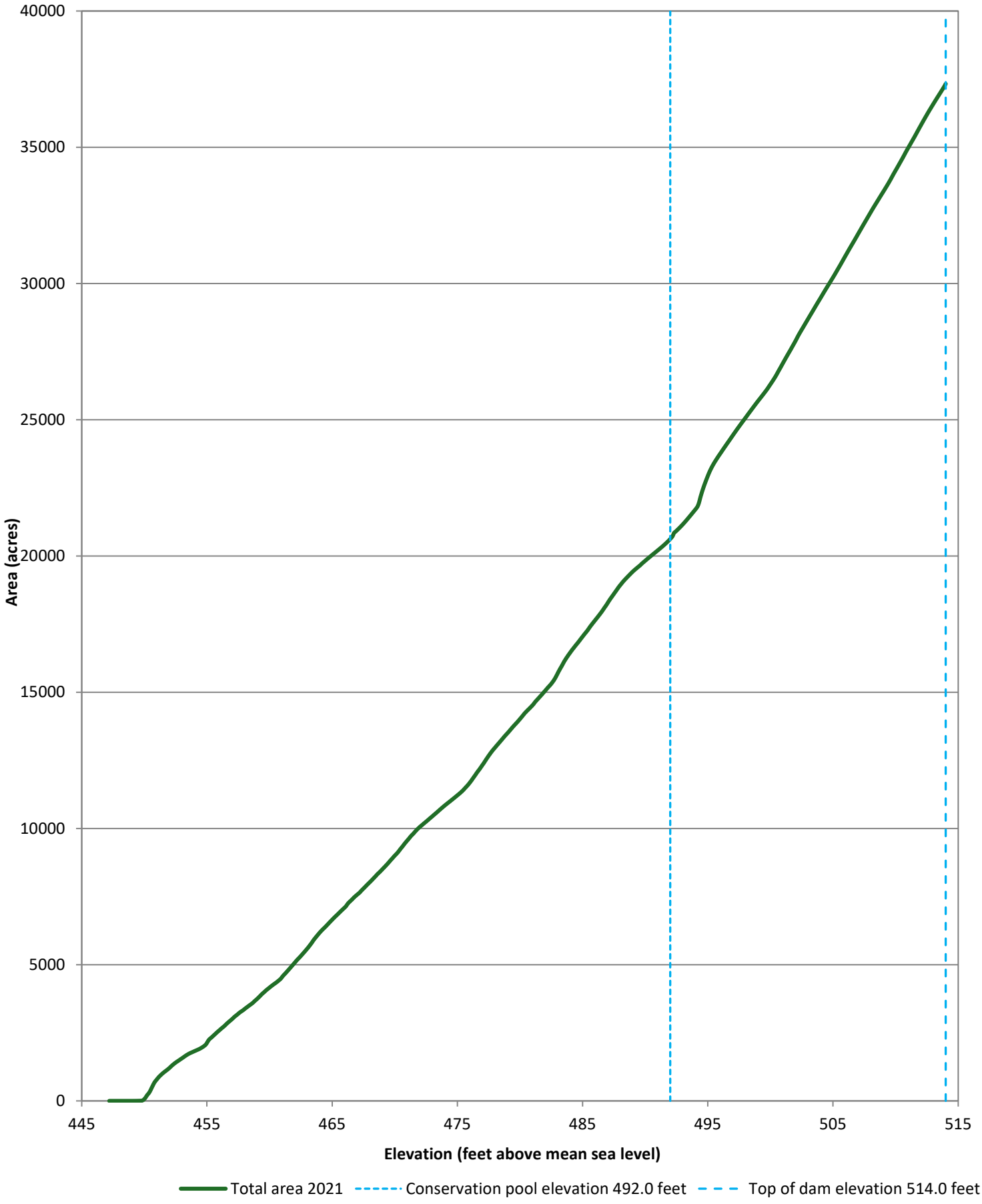
ELEVATION INCREMENT IS ONE TENTH FOOT — Top of dam elevation 514.0 feet NGVD29

ELEVATION (feet NGVD29)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
501	27,076	27,158	27,240	27,321	27,401	27,480	27,559	27,641	27,723	27,805
502	27,888	27,976	28,065	28,148	28,227	28,305	28,382	28,460	28,538	28,616
503	28,694	28,772	28,850	28,926	29,004	29,082	29,160	29,237	29,314	29,389
504	29,465	29,543	29,620	29,698	29,773	29,849	29,924	29,998	30,073	30,148
505	30,223	30,300	30,378	30,458	30,537	30,615	30,695	30,776	30,858	30,939
506	31,020	31,101	31,181	31,261	31,340	31,419	31,497	31,575	31,655	31,735
507	31,816	31,895	31,975	32,055	32,134	32,213	32,292	32,370	32,449	32,528
508	32,607	32,685	32,762	32,838	32,912	32,986	33,061	33,136	33,210	33,284
509	33,358	33,432	33,507	33,583	33,659	33,738	33,819	33,904	33,989	34,071
510	34,150	34,230	34,311	34,392	34,474	34,555	34,638	34,723	34,809	34,893
511	34,973	35,053	35,134	35,215	35,295	35,376	35,458	35,542	35,627	35,710
512	35,792	35,875	35,957	36,038	36,118	36,197	36,277	36,354	36,430	36,505
513	36,581	36,655	36,729	36,803	36,876	36,948	37,020	37,093	37,167	37,243
514	37,327									



Lavon Lake
May - July 2021 Survey
Prepared by: TWDB

Appendix K: 2021 Bathymetric and topographic capacity curve



Lavon Lake
May - July 2021 Survey
Prepared by: TWDB

Appendix L: 2021 Bathymetric and topographic area curve

Appendix M

Lavon Lake

Sediment range lines

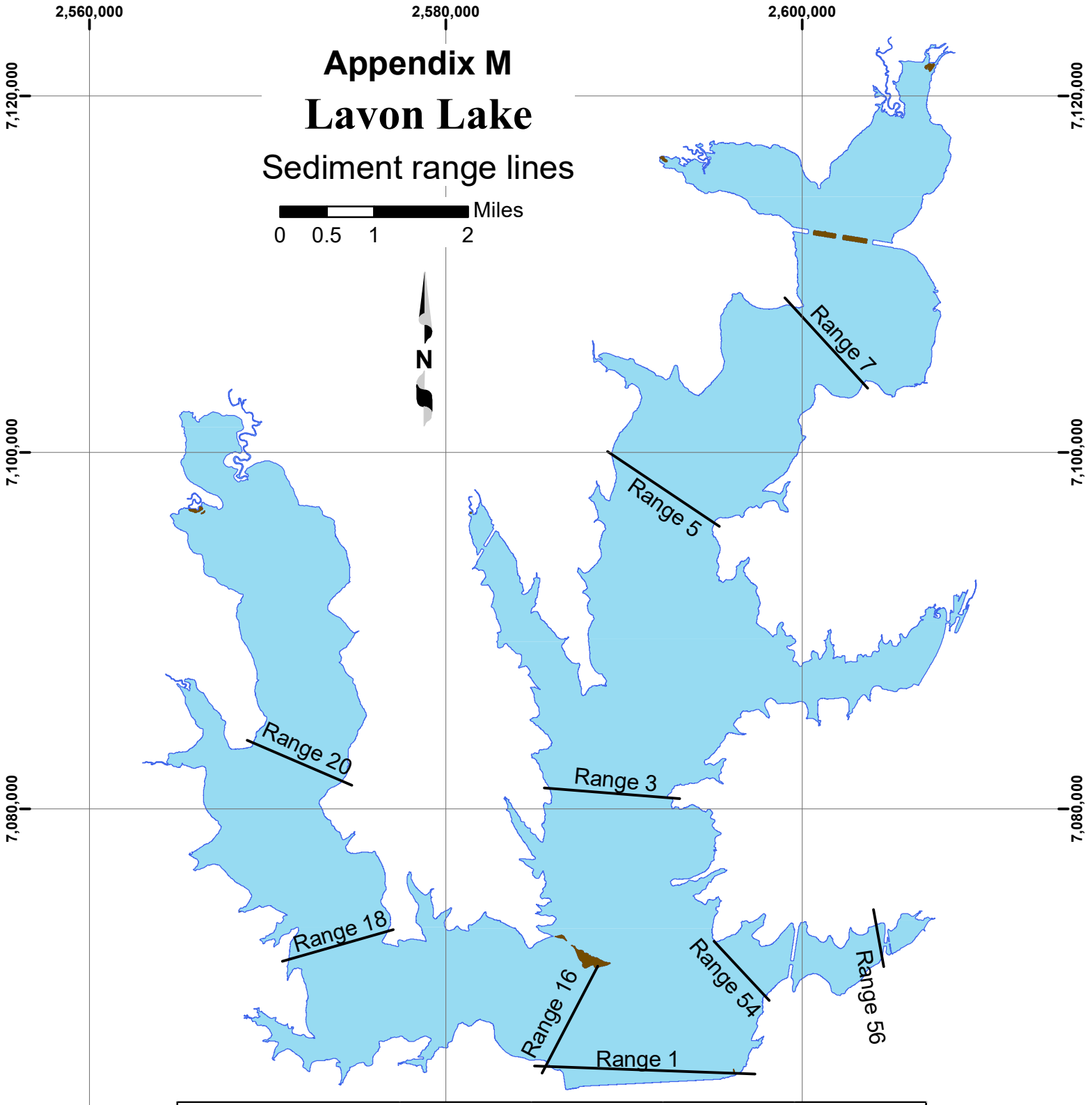
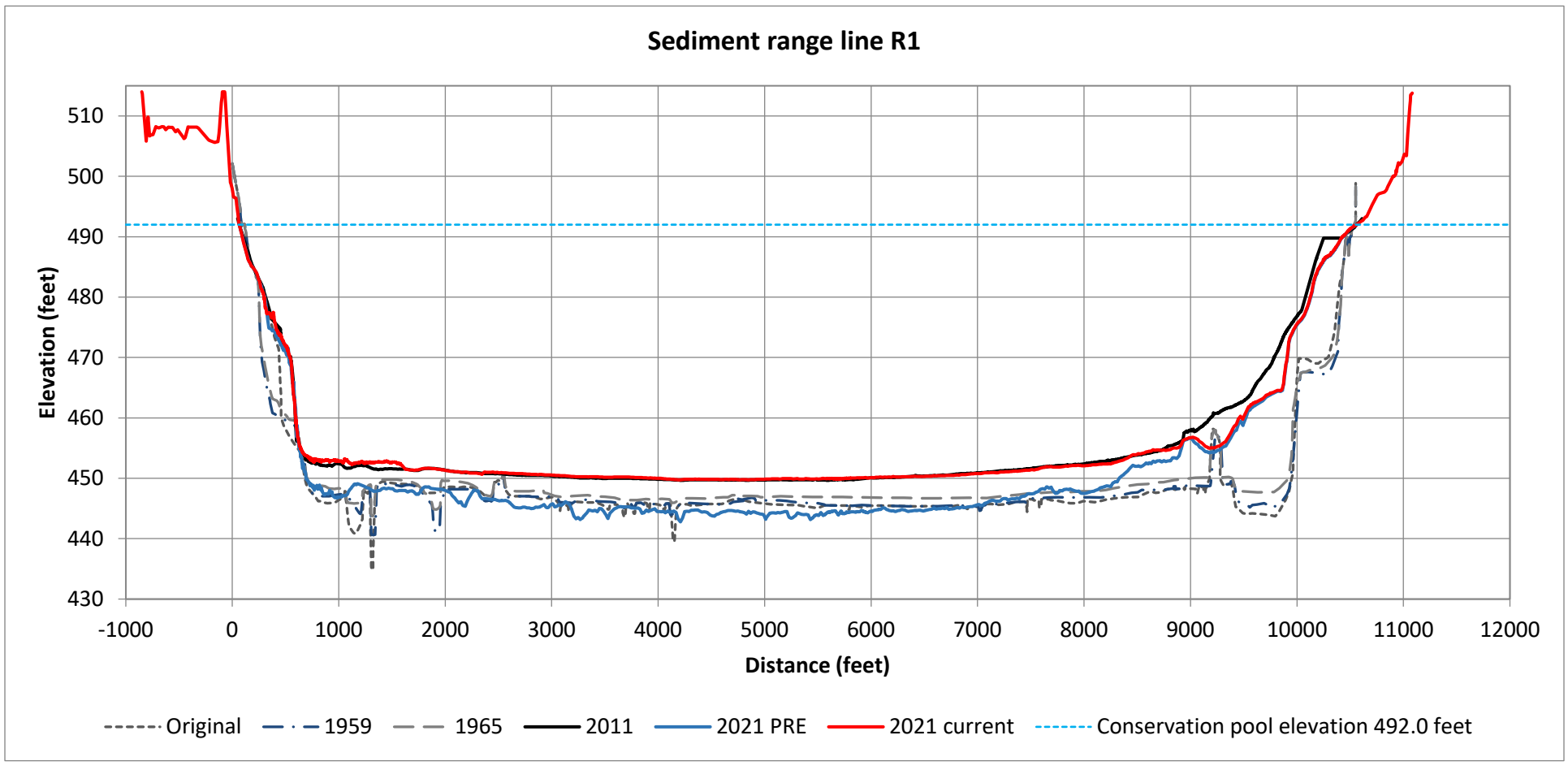
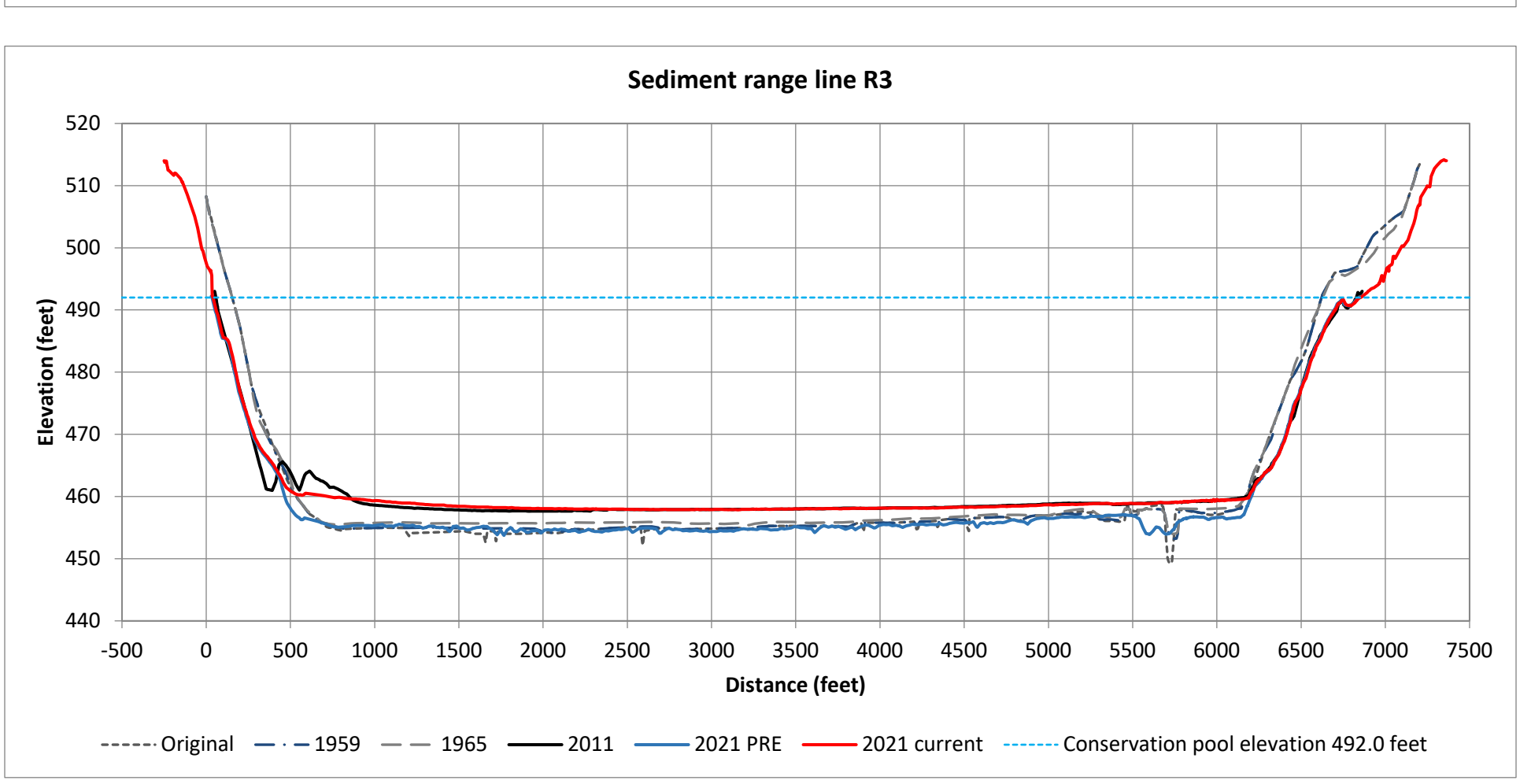
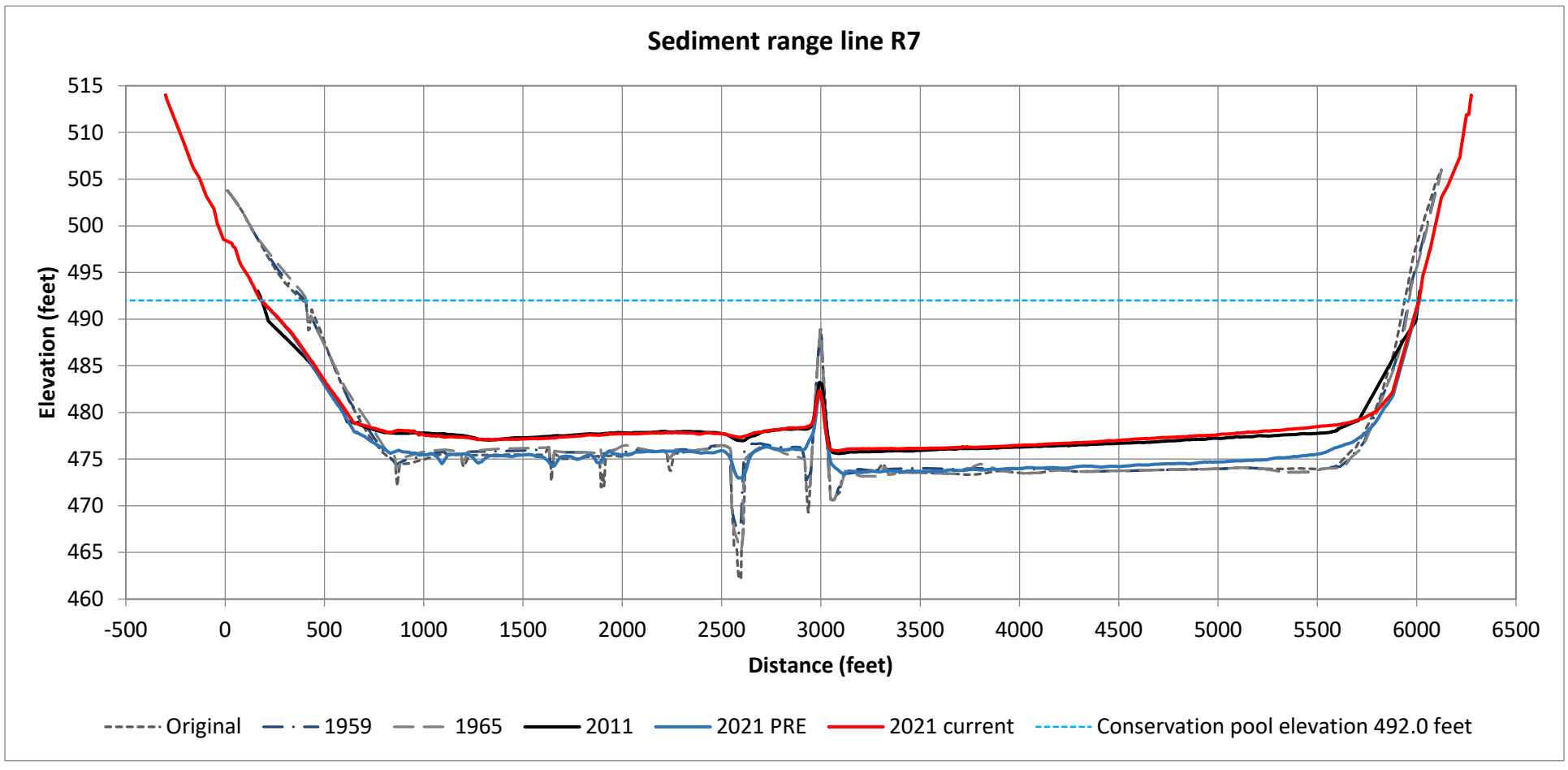


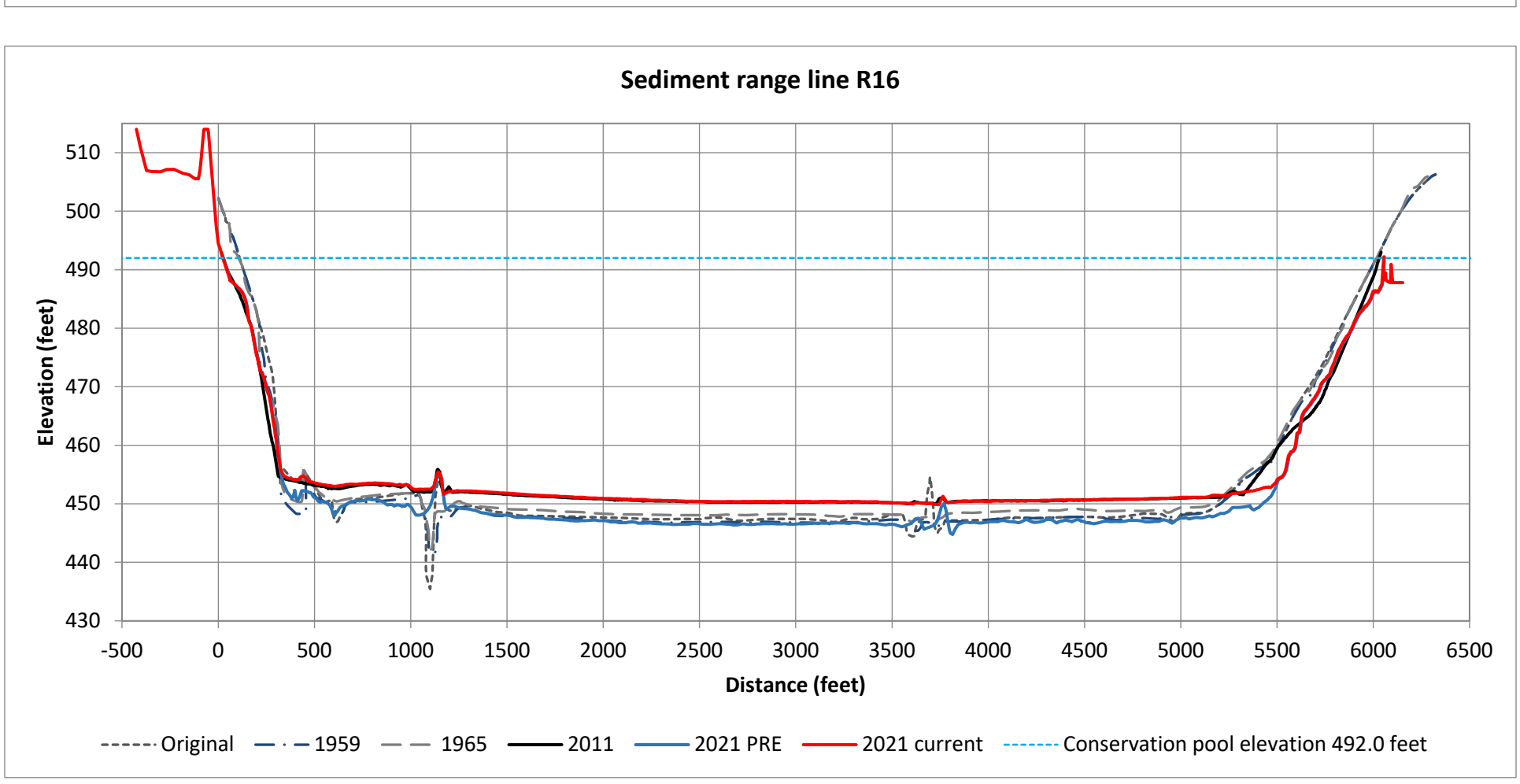
Table M1: Lavon Lake sedimentation range line endpoint coordinates				
Sediment Range Line	**X_R**	**Y_R**	**X_L**	**Y_L**
Range 1	2584978.79305	7065561.87067	2597338.62130	7065128.26273
Range 3	2585513.04286	7081163.68584	2593109.07897	7080567.65418
Range 5	2589074.11567	7100048.99444	2595348.40799	7095852.22693
Range 7	2599022.38078	7108673.90861	2603675.12597	7103581.12370
Range 16	2585390.40224	7065177.27919	2588519.42913	7071162.80882
Range 18	2570826.93275	7071449.77381	2577051.16933	7073216.29953
Range 20	2568852.69084	7083844.44803	2574709.52932	7081313.46258
Range 54	2595042.41949	7072568.29264	2598155.32765	7069243.57508
Range 56	2603997.72530	7074350.05862	2604571.41996	7071146.90806
XY: NAD83 State Plane Texas North Central Zone (feet)			L= Left End Point R= Right End Point	

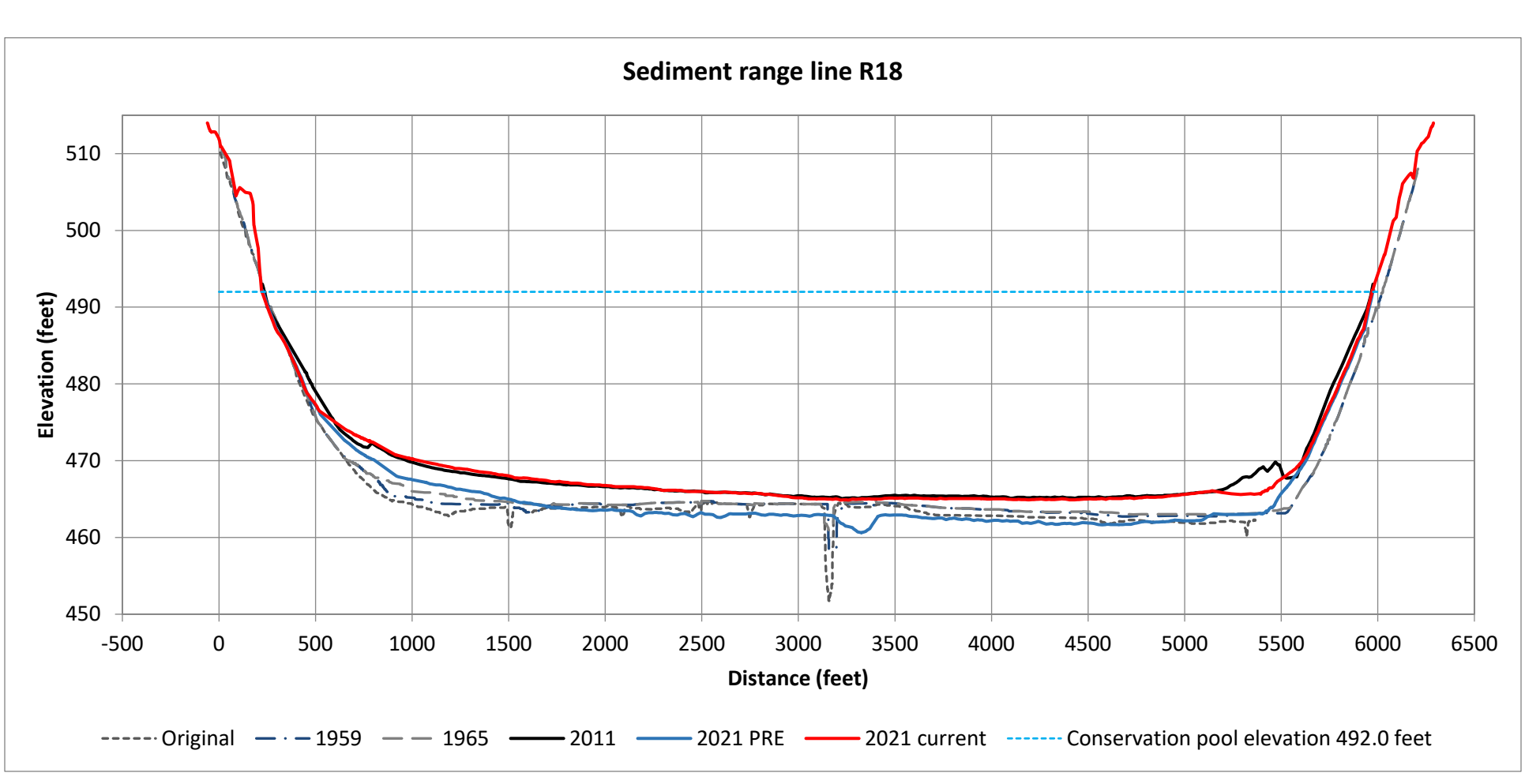

Sediment range line R1
Elevation (feet)
510
500
490
480
470
460
450
440
430
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet

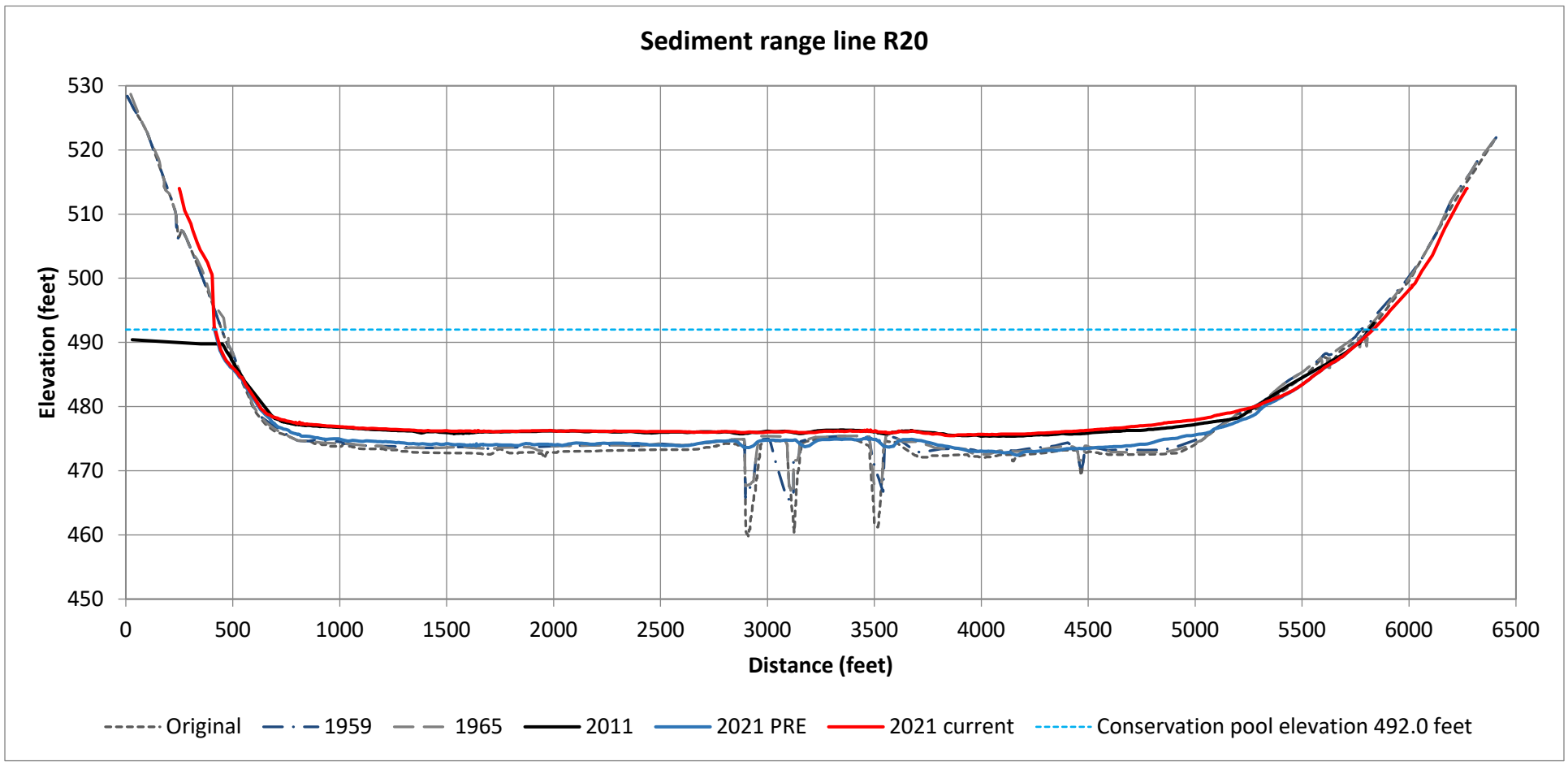

Sediment range line R3
Elevation (feet)
520
510
500
490
480
470
460
450
440
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet

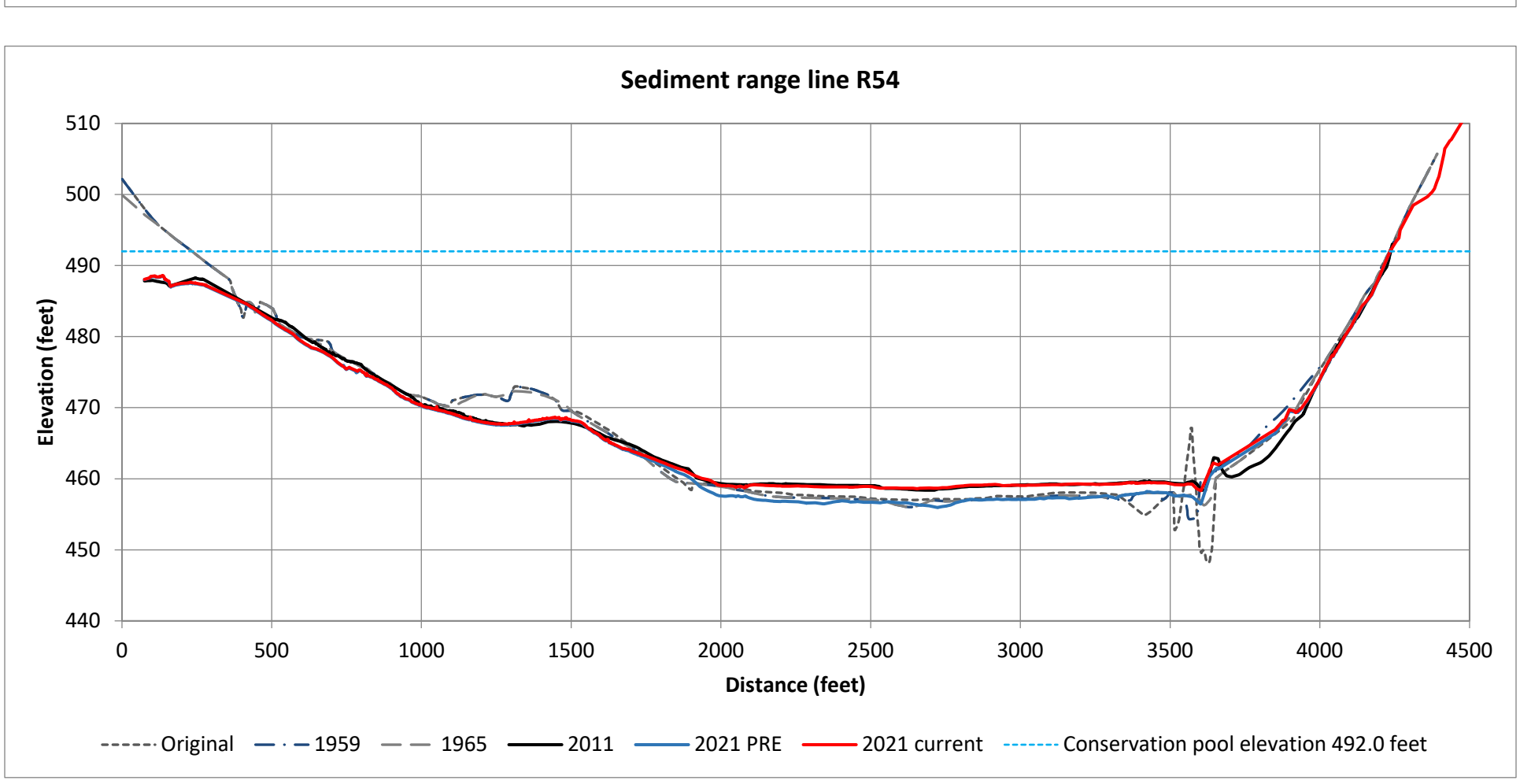
Sediment range line R5
Elevation (feet)
520
510
500
490
480
470
460
450
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet


Sediment range line R7
Elevation (feet)
515
510
505
500
495
490
485
480
475
470
465
460
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet


Sediment range line R16
Elevation (feet)
510
500
490
480
470
460
450
440
430
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet


Sediment range line R18
Elevation (feet)
510
500
490
480
470
460
450
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet


Sediment range line R20
Elevation (feet)
530
520
510
500
490
480
470
460
450
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet


Sediment range line R54
Elevation (feet)
510
500
490
480
470
460
450
440
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet

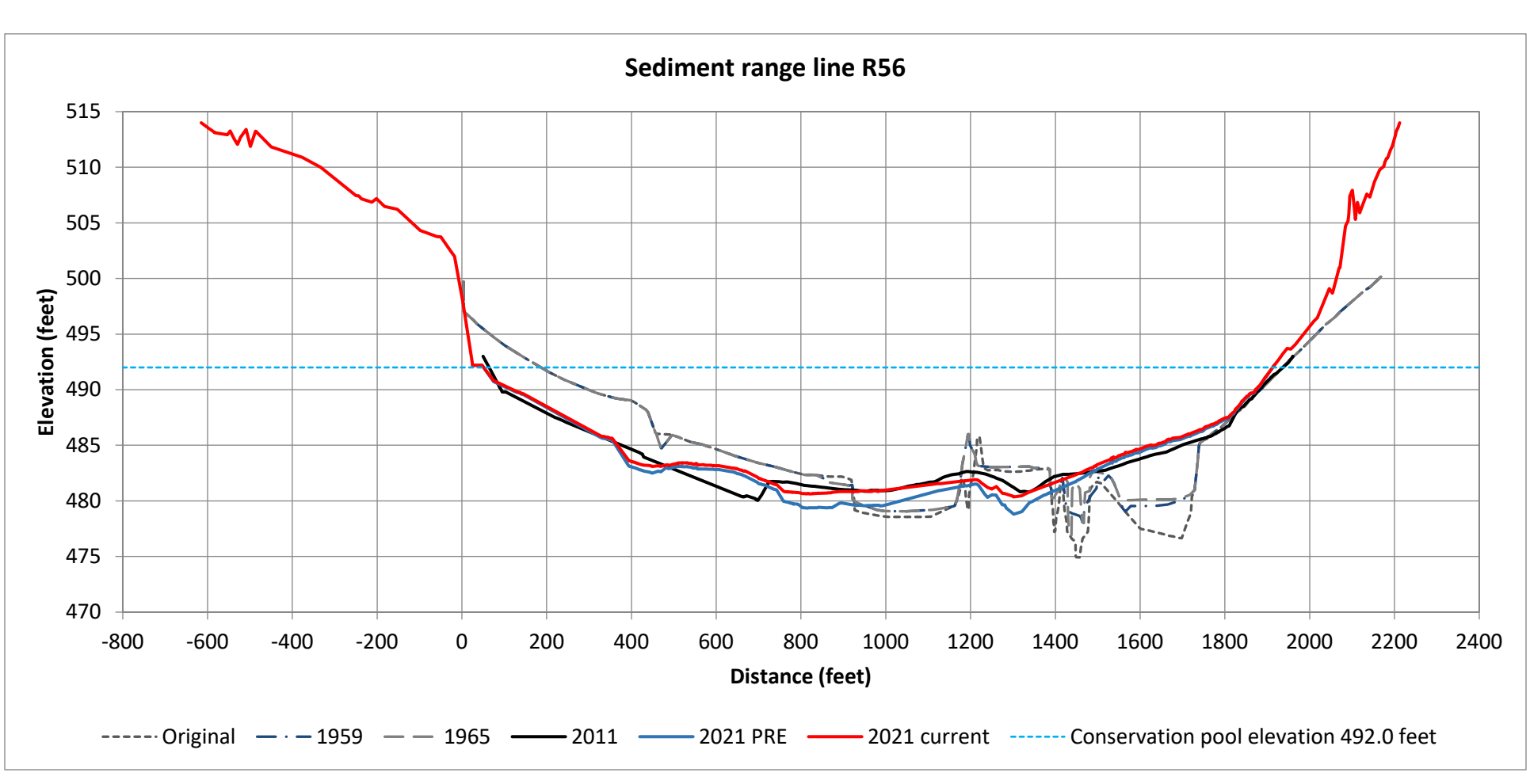

Sediment range line R56
Elevation (feet)
515
510
505
500
495
490
485
480
475
470
-800
-600
-400
-200
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Distance (feet)
Original
1959
1965
2011
2021 PRE
2021 current
Conservation pool elevation 492.0 feet

Figure 6

Lavon Lake

2' - contour map

Contours

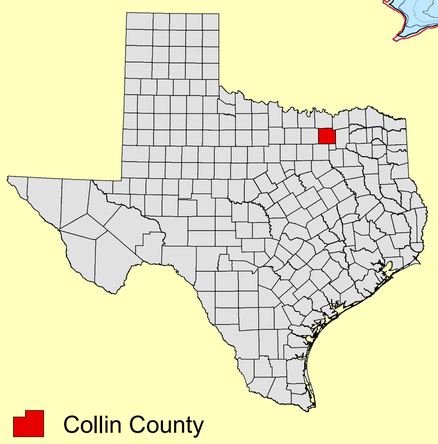
feet NGVD29

- 492
- 490
- 488
- 486
- 484
- 482
- 480
- 478
- 476
- 474
- 472
- 470
- 468
- 466
- 464
- 462
- 460
- 458
- 456
- 454
- 452
- 450

Lavon Lake
Elevation 492.2 feet
Conservation pool
elevation 492.0 feet
NGVD29

Islands

Projection: NAD83
State Plane Texas
North Central Zone (feet)



Collin County

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

2,580,000

2,600,000

7,120,000

7,080,000

N

0 0.5 1 2 Miles

Texas Water Development Board

May - July 2021 Survey