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U.S. Department of the Interior
U.S. Geological Survey

Prepared in cooperation with the Rockdale County Department of Water Resources

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Abstract

The U.S. Geological Survey, in cooperation with the Rockdale County Department of Water Resources, conducted a bathymetric and topographic survey of Randy Poynter Lake in northern Georgia in 2012. The Randy Poynter Lake watershed drains surface area from Rockdale, Gwinnett, and Walton Counties. The reservoir serves as the water supply for the Conyers-Rockdale Big Haynes Impoundment Authority.

The Randy Poynter reservoir was surveyed to prepare a current bathymetric map and determine storage capacities at specified water-surface elevations. Topographic and bathymetric data were collected using a marine-based mobile mapping unit to estimate storage capacity. The marine-based mobile mapping unit operates with several components: multibeam echosounder, singlebeam echosounder, light detection and ranging system, navigation and motion-sensing system, and data acquisition computer. All data were processed and combined to develop a triangulated irregular network, a reservoir capacity table, and a bathymetric contour map.

Introduction

Randy Poynter Lake is an approximately 640-acre reservoir that was constructed to store water to meet the drinking water needs of Rockdale County, Georgia. The lake was formed following the impoundment of Big Haynes Creek with the construction of Jack Turner Dam. Randy Poynter Lake is located in Black Shoals Park, which is about 6 miles north of Conyers, Georgia. The lake is also used for recreational activities in northwestern Georgia. Protection and monitoring of this water supply is a concern to the Rockdale County Department of Water Resources. Changes in land use, such as timber clear-cutting and residential development in basins that drain into the lake, have raised concern about possible changes in the rate of sedimentation in the reservoir. Sedimentation impacts a reservoir if the decreased storage capacity prevents supplying the full service for which the reservoir was designed. Sufficient capacity must be maintained in domestic water-supply reservoirs to assure continuity of supply during periods of prolonged drought and to meet expected increases in water demand.

The U.S. Geological Survey (USGS), in cooperation with the Rockdale County Department of Water Resources, collected bathymetric and topographic data at Randy Poynter Lake using a marine-based mobile mapping unit. The results of the survey of Randy Poynter Lake will be used to help understand the ecosystem and develop a component that is essential to a water census for the Rockdale County water supply. The results can also be used as a baseline survey to document temporal changes in lakebed elevation and storage capacities.

Description of the Study Area

Randy Poynter Lake is located in north Rockdale County, Georgia (fig. 1). The reservoir was created by the impoundment of Big Haynes Creek approximately 6.5 miles upstream from its confluence with the Yellow River. Following the construction of Jack Turner Dam, the lake was dedicated in April 1998 and opened to the public in April 2000. The reservoir extends from Jack Turner Dam on the south (fig. 2) to the Haralson Mill covered bridge on the north (fig. 3). The Randy Poynter Lake watershed drains surface area from Rockdale, Gwinnett, and Walton Counties. The reservoir serves as the water supply for the Conyers-Rockdale Big Haynes Impoundment Authority. Due to rapid population growth beginning in the 1960s, and associated water demands, water resources are limited. The 2010 census reported a 22-percent increase in the population of Rockdale County from 2000 to 2010 (Census Viewer, 2013). The Randy Poynter reservoir is designed to meet Rockdale County's estimated water-supply needs through 2030 (Rockdale County, 2013). The reservoir and nearby Black Shoals Park also serve as a recreational attraction.

The area of study has a subtropical climate characterized by warm, humid weather. According to long-term climatological records compiled by the Parameter-Elevation Regressions on Independent Slopes Model (PRISM) Climate Group, the mean annual air temperature is 62.7 °F (degrees Fahrenheit). Generally, July is the hottest month with a mean temperature of 90.3 °F, and January is the coldest with a mean temperature of 32.7 °F (PRISM Climate Group, 2012). Average annual precipitation, based on records for the 1971–2000 period at precipitation stations, is approximately 51 inches (in.) (PRISM Climate Group, 2012). The drainage basin is located in the Piedmont Plateau province. The Piedmont Plateau province encompasses nearly one-third of the State and lies between the Blue Ridge Mountains and the Upper Coastal Plain. The soil in the study area, as described by a countywide soil survey, is predominately Pacolet-Wedowee-Ashlar (Lathem, 2000). This soil type is typically well drained to excessively drained and has a loamy surface layer and a loamy or clayey subsoil. This area is characterized by steep hillslopes, which increases susceptibility to erosion and thus sedimentation.

In general, land use within the Randy Poynter drainage basin, as defined by the National Land Cover Database (NLCD) 2006 (Fry and others, 2011), can be classified as urban. Low-, medium-, and high-intensity residential and developed open-space land coverages were combined to compute total urban land use. Urban land use was the predominant basinwide land use in 2006 at 42 percent. Inspection of aerial photography indicates further urban development since the completion of the 2006 NLCD. Forested land (cumulative total of mixed, deciduous, and evergreen) in 2006 accounted for 35 percent of the basin. Inspection of land use trends indicates that the primary change in the Randy Poynter drainage basin has been a decrease in forested areas and an increase in urbanization. Three datasets were used for comparison: NLCD 1992–2001 Retrofit Change Product (Fry and others, 2009), NLCD 2001 (Homer and others, 2004), and NLCD 2006 (Fry and others, 2011). The results indicated an 11-percent reduction in forested land and a 5-percent increase in urbanization from 1992 to 2001. Similarly, comparison of the 2001 and 2006 NLCD showed a 4-percent decrease in forested land and an 11-percent increase in urbanization.

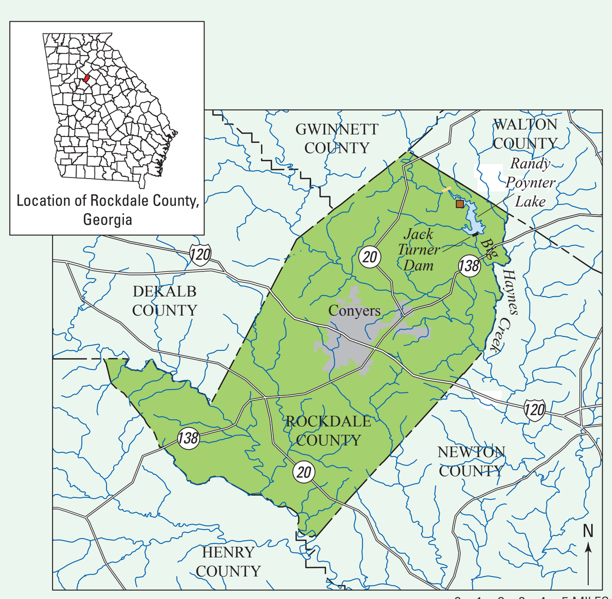

Figure 1. Location of Randy Poynter Lake, Rockdale County, Georgia.

Figure 2. Randy Poynter Lake looking upstream from Jack Turner Dam, July 2012.

Figure 3. The upstream extent of Randy Poynter Lake showing the Haralson Mill covered bridge, July 2012.

Methods and Data Collection

In 2012, the USGS, in cooperation with the Rockdale County Department of Water Resources, collected bathymetric and topographic data at Randy Poynter Lake using a marine-based mobile mapping unit (fig. 4) to estimate storage capacity. The marine-based mobile mapping unit operates with several components: multibeam echosounder (MBES), singlebeam echosounder (SBES), light detection and ranging (lidar) system, navigation and motion-sensing system, and data acquisition computer. The marine-based mobile mapping unit was deployed July 16–21, 2012, and August 13–16, 2012.

Bathymetric data were collected using the multibeam and singlebeam echosounders. The MBES used in this study was an R2Sonic Sonic 2024 multibeam echosounder (*http://r2sonic.com*). The Sonic 2024 collects a wide swath of high-resolution bathymetric data by recording the intensity of sound reflected off the lake bottom (acoustic backscatter). The Sonic 2024 was operated at a frequency of 300 kilohertz (kHz), and data were collected at a 120-degree swath sector with a 50-percent overlap between swaths. The water-surface elevation at the time of data collections was 727 feet (ft) above North American Vertical Datum of 1988 (NAVD 88). The MBES was used to provide full coverage of the lakebed at elevations below 725 ft NAVD 88. Additional data were collected in shallow areas using an Odom Hydrotrac SBES (*http://www.odomhydrographic.com*). The data collected with the SBES were used to fill data gaps and validate the data collected with the MBES. The MBES data were collected in longitudinal transects to provide a complete swath of the reservoir. The SBES data were collected by driving along the shoreline and surveying cross sections in desired locations. The resulting bathymetric datasets were processed using filters in the HYPACK/HYSWEEP software (*http://www.hypack.com*) to remove data spikes or erroneous points. The data collected by the MBES and the SBES were compared in areas of overlap data collection. The average difference in lakebed elevation was 3 centimeters (cm) (1.2 in.).

Thirteen miles of topographic data were collected along the shoreline using lidar. The lidar system used was an Optech ILRIS-HD-ER-MC laser scanner (*http://www.optech.ca*). The laser scanner has an 80-percent reflectivity range of 1,700 meters (m) (5,577 ft), a laser repetition rate of 10 kHz, an average raw-range accuracy of 3 to 4 millimeters (mm) (0.1 to 0.16 in.) at 100 m (328 ft), and a maximum sample density (point-to-point spacing) of 1.3 mm at 100 m (0.05 in. at 328 ft). The lidar data were collected at an equal distance from the shoreline to reduce error resulting from reference frame misalignments. Additional topographic data points were collected during June 18–20, July 16–21, and August 13–16, 2012, to evaluate lidar data, fill data gaps, and define the full pool elevation of the reservoir. These points were collected using a Real-Time Network Global Navigation Satellite System (RTN-GNSS) established and maintained by eGPS Solutions (*http://egps.net*). RTN-GNSS elevation data were collected at 70 points within the georeferenced lidar point cloud. The average vertical difference and standard deviation of these points were 7 mm and 7 cm (0.28 to 2.8 in.), respectively.

The data collected with the MBES, SBES and lidar are accurately represented in three-dimensional space by use of the navigation and motion-sensing system. The Applanix (*http://www.applanix.com*) Position Orientation System for Marine Vessels (POS MV) was used to measure the pitch, roll, and heading of the boat, accurate within ±0.02 degree, and heave within 5 percent of the heave amplitude, or 5 cm (2 in.), whichever is greater (Applanix Corporation, 2006). The POS MV utilizes an inertial measurement unit (IMU) coupled with Global Positioning System (GPS) antennas to produce highly detailed and accurate georeferenced point clouds. A temporary benchmark was established and a GPS base station was used to aid in the accuracy of the survey. The navigation information from the survey was post-processed using the POS-Pac Mobile Mapping Suite (MMS) software (Applanix Corporation, 2010). This was done by combining the POS MV-recorded real-time data and GPS base station data to generate a blended navigation solution (standard best-estimate of travel or SBET file). The post-processed navigation data (SBET file) was applied to the MBES, SBES, and lidar data. In addition to the SBET file, POS-Pac MMS generates a file describing the accuracy of the post-processed solution. The horizontal accuracy of the post-processed file has a minimum and maximum root mean square (RMS) error of 0.4 and 2 cm (0.2 and 0.8 in.), respectively. The RMS error of the vertical accuracy ranged from 0.7 to 2.9 cm (0.3 to 1.1 in.). Stated accuracies are based on peak-to-peak errors, and the majority of the points have higher accuracies and lower associated errors.

The errors associated with the collection of bathymetric data can be classified as systematic or random. Systematic errors are those that can be measured or modeled through calibration (Byrnes and others, 2002). Random errors are a result of the limitations of the measuring device and an inability to perfectly model the systematic errors. Errors associated with the SBET file would be applicable to the positional accuracy of the bathymetric data. The bathymetric point accuracy is represented by an error ellipsoid of which one of the vertical components is the depth measurement error. Because the lake floor is not visible, random errors associated with the limitations of the MBES are more difficult to quantify. To minimize these errors, quality assurance assessments were performed in real time during the survey. Additional field data were also collected to accurately calibrate the MBES. A sound velocity cast was taken for each day of data collection to account for variations of sound in the water column. Patch tests were performed to check for variations in the orientation of the sonar head and timing. The latency test was performed to measure the timing offset between the MBES and GPS component of the POS MV. The angular offsets of the transducer head were measured for their respective axes—longitudinal axis (roll test), lateral axis (pitch test), and rotation about vertical axis (yaw test). All timing (latency) and angular offsets (roll, pitch, and yaw) were accounted for in the HYPACK/HYSWEEP software.

Storage Capacities

The four datasets (MBES, SBES, lidar, and RTN-GNSS) were processed and combined to provide a three-dimensional model of the Randy Poynter reservoir. The three-dimensional model was used to calculate reservoir storage volumes using HYPACK bathymetric software. This software produces volume data by performing computations between two specified surfaces (for example, a lakebed and a water-surface elevation). Erroneous soundings that resulted from instrument error during data collection in the field were removed by using a 0.5-ft grid overlay and averaging all points that fall within each square. A sensitivity analysis was performed to determine the optimal grid size used to estimate capacity. A triangulated irregular network (TIN) model of the bathymetric surface was then created in HYPACK from the subset data. The TIN model was used as the lower bounding surface for computation of storage capacity, and specified water-surface elevations were input as upper surface boundaries. Volumes were then computed at various water-surface elevations (table 1; fig. 5). The relation of water-surface elevation to storage capacity is rated to an elevation of 735 ft (NAVD 88), which is approximately the crest of the Jack Turner Dam spillway.

Bathymetric Contours

Bathymetric contours were created using HYPACK bathymetric software in conjunction with ArcGIS (Environmental Systems Research Institute, 2010) geographic information system (GIS) software. The field bathymetric sounding data were reduced in HYPACK by overlaying a 5-ft grid and averaging all the data points that fall within each square. Subsetting the original sounding data with the 5-ft grid removes unnecessary spikes that may result from instrument error in the data-collection process. A coarser grid was used for the generation of the contours as opposed to the estimation of capacity. The generation of contours does not require that all minor features on the lakebed be defined. The subset data were then imported into ArcGIS, and a TIN model of the bathymetric surface was numerically rendered (fig. 6). Elevation contours of the bathymetric surface were created from the TIN surface model in ArcGIS. Because contours generated from a TIN surface model are produced from triangles, their jagged edges do not fully represent the smooth curvatures of the true bathymetric surface of Randy Poynter Lake (Wilson and Richards, 2006). Thus, the elevation contours generated by the software were subsequently edited and smoothed using the Polynomial Approximation with Exponential Kernel (PAEK) algorithm within ArcGIS. The PAEK algorithm removes vertices along the contour lines based on a tolerance specified by the user. The tolerance is the length of a "moving" path used in calculating the new vertices (Environmental Systems Research Institute, 2010). The smoothed contours were compared with the original edited elevation data to ensure that the true topography of the lakebed was represented. Contours are labeled at 5-ft elevation intervals (fig. 7).

The Randy Poynter reservoir is relatively young and few spatial datasets exist. Pre-impoundment contours created through photogrammetry were available and compared to the 2012 dataset. A TIN surface model was created from the pre-impoundment contours and directly compared to the TIN created from the 2012 dataset. A grid was generated showing the difference between the two datasets. This gave a general overview of the scour and deposition that has occurred over the life of the reservoir. The grid indicated that the greatest area of deposition is the upstream inflow point of Big Haynes Creek (fig. 8). This could be attributed to sediment inflows, difference in accuracy of the two surveys, or a combination of both.

Figure 4. A U.S. Geological Survey boat equipped with a marine-based mobile mapping unit.

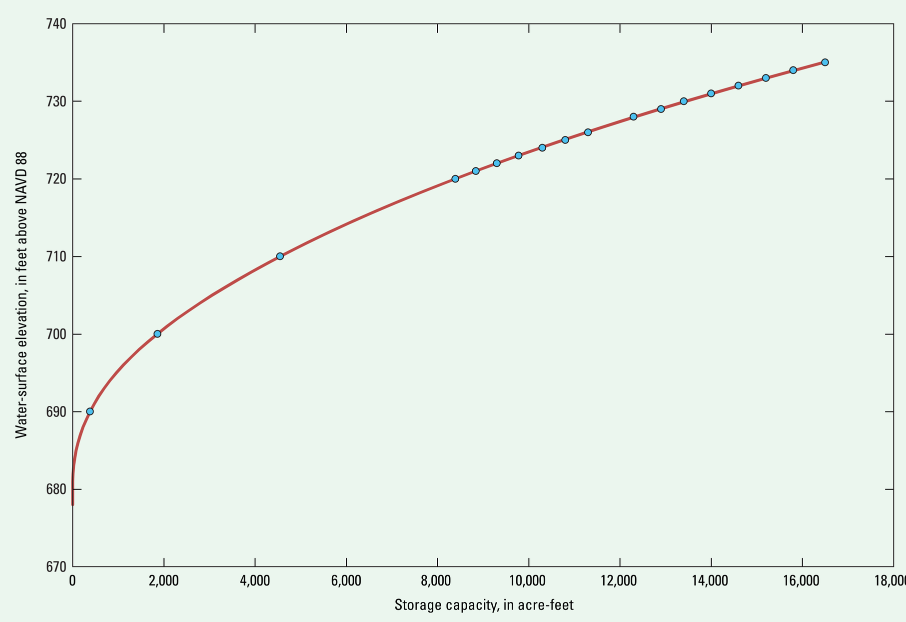

Figure 5. The relation between water-surface elevation and storage capacity for Randy Poynter Lake, Georgia, 2012.

References Cited

Applanix Corporation, 2006, POS-MV™ V4 user guide, Rev. 0: Richmond Hill, Ontario, Canada, PUBS–MAN–000513, 369 p.

Applanix Corporation, 2010, POS-Pac™ MMS™ GNSS-inertial tools user manual, Rev. 5: Richmond Hill, Ontario, Canada, PUBS-MAN-001768, 248 p.

Byrnes, M.R., Baker, J.L., and Li, Feng, 2002, Quantifying potential measurement errors associated with bathymetric change analysis, ERDC/CHL CHETN-IV-50; U.S. Army Engineer Research and Development Center, Vicksburg, Miss., *http://chl.erdc.usace.army.mil/library/publications/chetn/pdf/chetn-iv-50.pdf*.

Census Viewer, 2013, Population of Rockdale County, Georgia: Census 2010 and 2000 interactive map, demographics, statistics, graphs, quick facts, accessed March 2013 at *http://censusviewer.com/county/GA/Rockdale*.

Environmental Systems Research Institute, 2010, ArcGIS–A complete integrated system, accessed February 2011 at *http://www.esri.com/software/arcgis/*.

Fry, J.A., Coan, M.J., Homer, C.G., Meyer, D.K., and Wickham, J.D., 2009, Completion of the National Land Cover Database (NLCD) 1992–2001 Land Cover Change Retrofit product: U.S. Geological Survey Open-File Report 2008–1379, 18 p., *http://pubs.usgs.gov/of/2008/1379/*.

Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011, Completion of the 2006 National Land Cover Database for the conterminous United States: Photogrammetric Engineering and Remote Sensing, v. 77, no. 9, p. 858–864.

Homer, Collin, Huang, Chengquan, Yang, Limin, Wylie, Bruce, and Coan, Michael, 2004, Development of a 2001 National Landcover Database for the United States: Photogrammetric Engineering and Remote Sensing, v. 70, no. 7, p. 829–840.

Lathem, J.R., 2000, Soil survey of Newton and Rockdale Counties, Georgia: United States Department of Agriculture, Natural Resources Conservation Service, accessed February 2003 at *http://soildatamart.nrcs.usda.gov/Manuscripts/GA649/0/newton_rockdale.pdf*.

PRISM Climate Group, 2012, Oregon State University, accessed February 2012 at *http://prism.oregonstate.edu*.

Rockdale County, 2013, Randy Poynter Lake and Jack Turner Dam, accessed May 2012 at *http://www.rockdalecounty.org/main.cfm?id=2761*.

Wilson, G.L., and Richards, J.M., 2006, Procedural documentation and accuracy assessment of bathymetric maps and area/capacity tables for small reservoirs: U.S. Geological Survey Scientific Investigations Report 2006–5208, 24 p. plus oversize figs., *http://pubs.usgs.gov/sir/2006/5208/*.

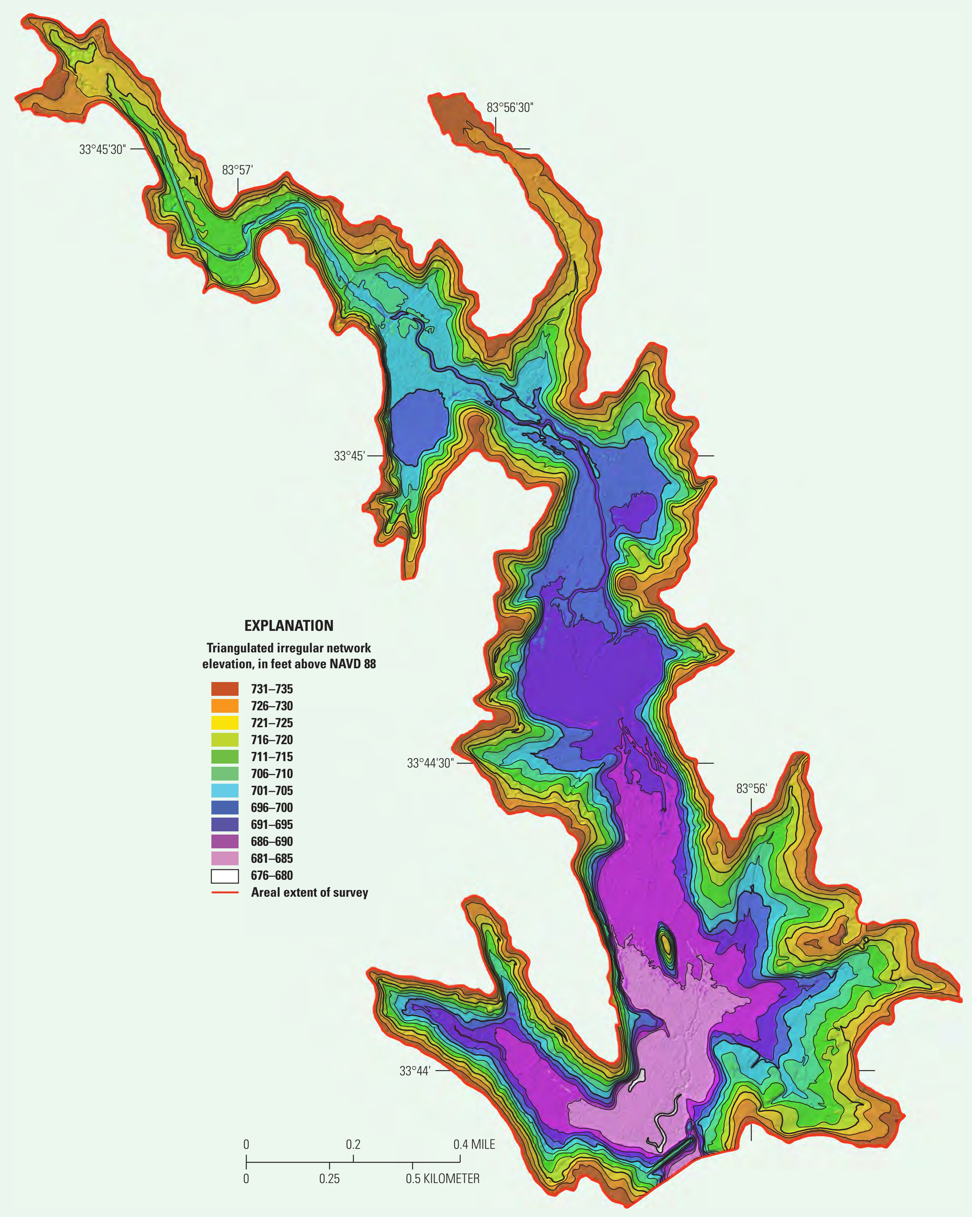

Figure 6. Bathymetric surface of Randy Poynter Lake, Rockdale County, Georgia, 2012.

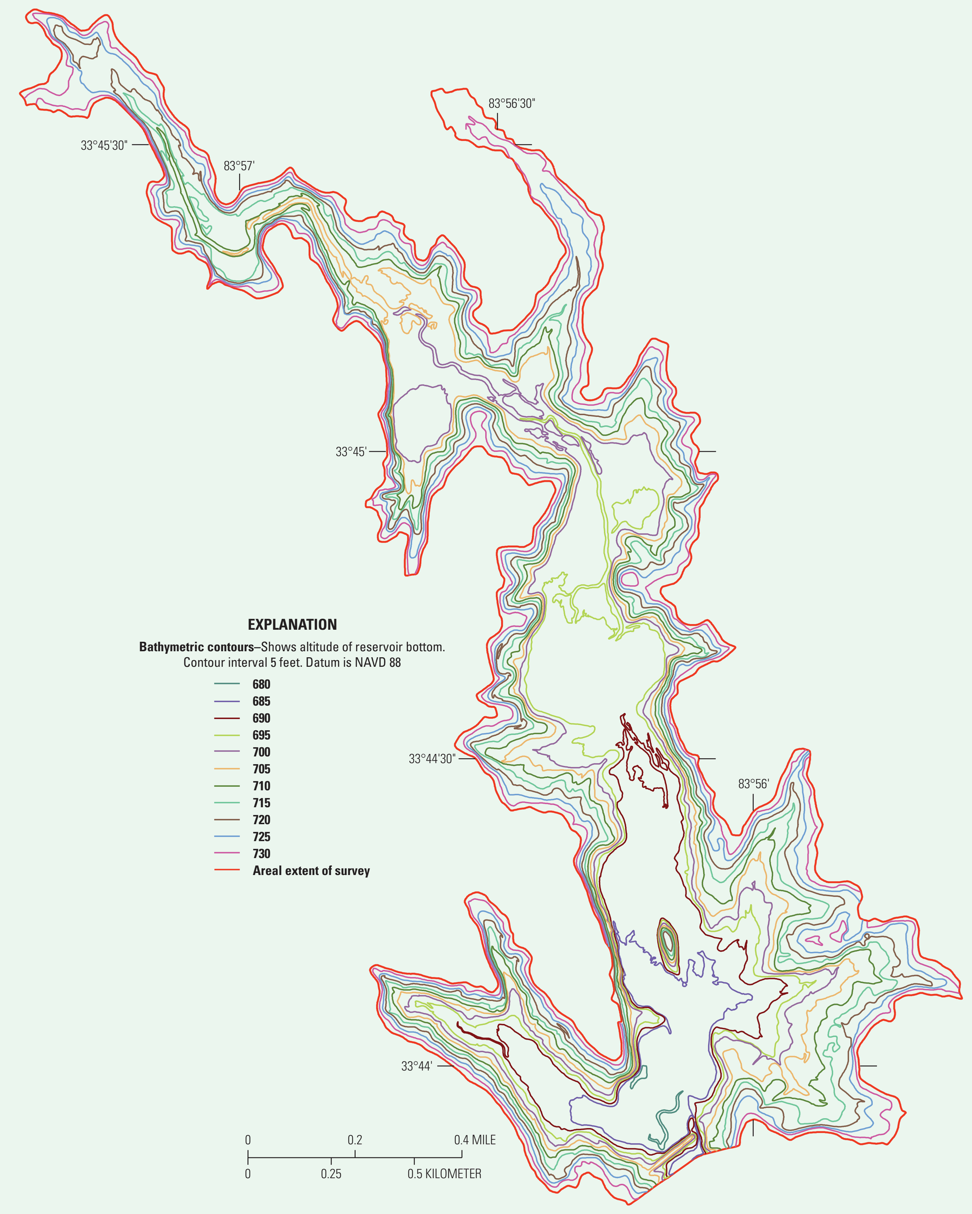

Figure 7. Bathymetric contours of Randy Poynter Lake, Rockdale County, Georgia, 2012.

Table 1. Reservoir storage volumes for Randy Poynter Lake at specified water-surface elevations in 2012

[Capacity at specified water-surface elevations were calculated from the bathymetric TIN model created in HYPACK and not from smoothed bathymetric contours. Elevation, as used in this report, refers to distance above the North American Vertical Datum of 1988 (NAVD 88)]

Water-surface elevation, in feet above NAVD 88	Storage capacity, in acre-feet	Storage capacity, in billion gallons	Storage capacity, in cubic kilometers
690	380	0.12	7.7
691	480	0.16	9.8
692	580	0.19	12
693	690	0.22	14
694	820	0.27	17
695	960	0.31	20
696	1,110	0.36	23
697	1,280	0.42	26
698	1,460	0.48	30
699	1,650	0.54	34
700	1,860	0.61	38
701	2,070	0.68	42
702	2,300	0.75	47
703	2,540	0.83	52
704	2,800	0.91	57
705	3,060	1.0	62
706	3,340	1.1	68
707	3,630	1.2	74
708	3,920	1.3	80
709	4,230	1.4	86
710	4,550	1.5	93
711	4,880	1.6	99
712	5,220	1.7	106
713	5,580	1.8	114
714	5,940	1.9	121
715	6,320	2.1	129
716	6,710	2.2	137
717	7,120	2.3	145
718	7,530	2.4	153
719	7,960	2.6	162
720	8,390	2.7	171
721	8,840	2.9	180
722	9,300	3.0	189
723	9,780	3.2	199
724	10,300	3.4	210
725	10,800	3.5	220
726	11,300	3.7	230
727	11,800	3.8	240
728	12,300	4.0	250
729	12,900	4.2	263
730	13,400	4.4	273
731	14,000	4.6	285
732	14,600	4.8	297
733	15,200	5.0	309
734	15,800	5.1	322
735	16,500	5.4	336

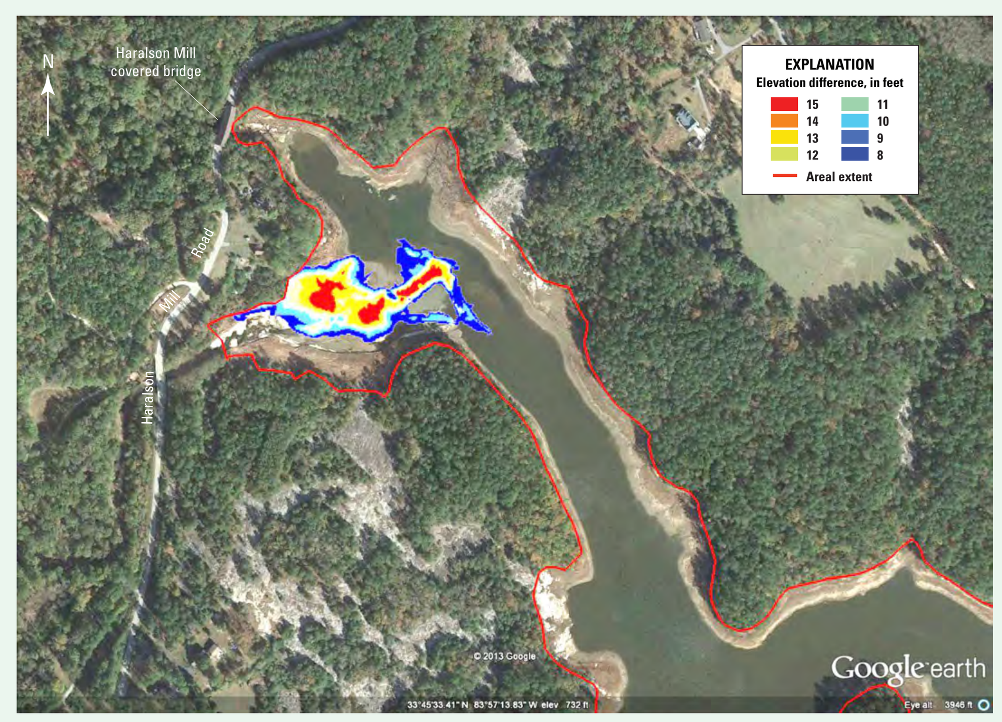

Figure 8. Increase in elevation of Randy Poynter Lake as indicated by the comparison of pre-impoundment contours and the current (2012) bathymetric survey.

Estimation of Reservoir Storage Capacity Using Multibeam Sonar and Terrestrial Lidar, Randy Poynter Lake, Rockdale County, Georgia, 2012

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