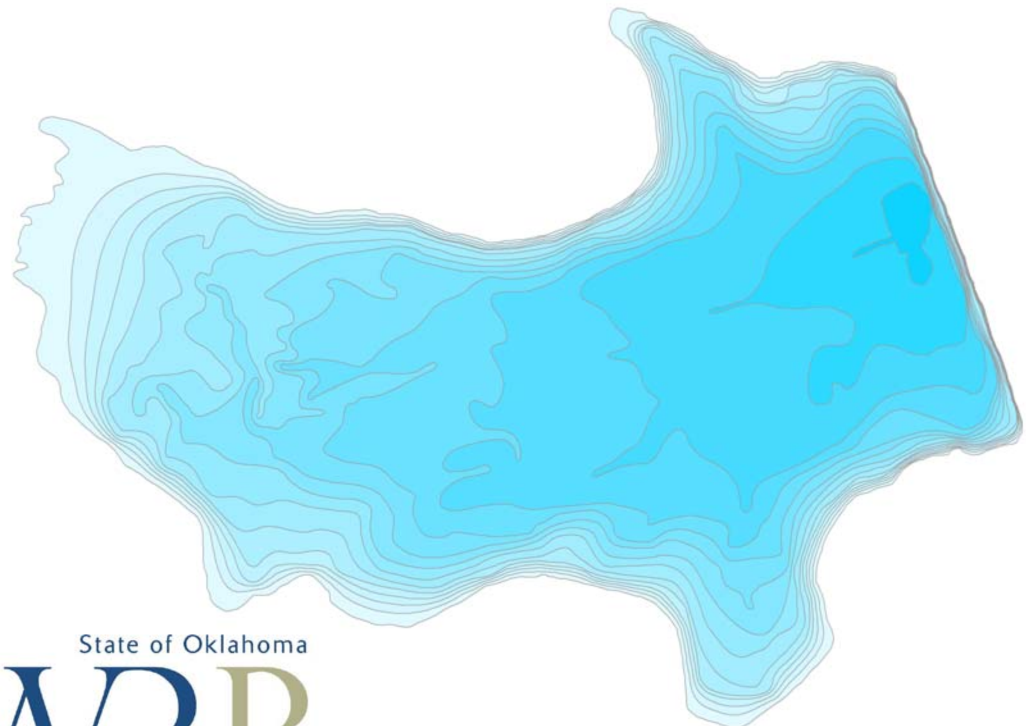
HYDROGRAPHIC SURVEY OF DAVE BOYER (WALTERS) LAKE



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DAVE BOYER (WALTERS) LAKE HYDROGRAPHIC SURVEY REPORT

INTRODUCTION

The Oklahoma Water Resources Board (OWRB) conducted a hydrographic survey of Dave Boyer (Walters) Lake in September of 2005. The purpose of the study was to collect hydrographic data of Dave Boyer (Walters) Lake and convert this information into an area-elevation-volume table at the conservation pool elevation The information produced will serve as a base to establish the location and rate of sedimentation in the conservation pool for future surveys.

Dave Boyer (Walters) Lake is located in Cotton County on an unnamed tributary of East Cache Creek, approximately 1 mile northwest of the City of Walters, Oklahoma. A general location map of Dave Boyer (Walters) Lake is shown on the following page (**Figure 1**).

Dave Boyer (Walters) Lake is a multipurpose waterbody with the designated beneficial uses of public and private water supply, warm water aquatic community, and primary body contact recreation. These beneficial uses are promulgated through Oklahoma's Water Quality Standards and limit how much of specific contaminants can be in the water and the water still support these designated uses. Dave Boyer (Walters) Lake has the additional limitation of a Sensitive Water Supply. Due to this additional limitation, no new loads or increased loads from existing point sources shall be allowed unless those new or increased loads can be shown to maintain or improve existing water quality.
The City of Walters owns and operates the lake as its primary water supply.

LAKE HISTORY AND PERTINENT INFORMATION

Background

Dave Boyer (Walters) Lake is a water supply for the City of Walters. The dam was constructed in 1936; the name of the contractor is unknown. The Works Progress Administration (WPA) was involved in some of the work, probably the erosion control weirs in the spillway (M-J, 1978).

The dam is considered a high hazard structure according to the rules and regulations of the OWRB and the screening criteria contained in the “Recommended Guidelines for Safety Inspection of Dam” (OWRB, 1983).

Dave Boyer (Walters) Lake is located in the Central Great Plains ecoregion, which features mixed grass prairie. The lake provides many attractive areas for water-oriented activities such as picnicking, golfing, fishing, and boating. Facilities include

Figure 1: Location map for Dave Boyer (Walters) Lake.

surfaced and impervious roads, a boat ramp, and a golf course, which is operated and maintained by the City of Walters.

A majority of the land cover in the drainage basin of Dave Boyer (Walters) Lake is grasslands, small grains, pasture/hay, row crops, and very little deciduous forest areas. The tribal lands located within the watershed are Kiowa, Comanche, Apache, and Fort Sill Apache tribal jurisdiction statistical area (TJSA).

Water Rights

The OWRB currently adjudicates the water rights for Dave Boyer (Walters) lake and its tributaries. A vested right based on application #1936-79 was filed on 01/01/1936 and amended on 06/09/1964 to appropriate 268 acre-feet/year (ac-ft/yr) for municipal use by the City of Walters.

Outlet Works

Dave Boyer (Walters) lake dam is an earth fill structure. **Table 1** lists some of the relevant details of the dam and outlet works. The embankment is approximately 1,760 feet (ft) long with a maximum height of 30 ft. The embankment has a crest width of 13 ft at approximately elevation 1,020 ft with an elevation of 1,017.2 ft at the low end of dam (OWRB, 1983). The upstream slope is protected by hard, coarse-grained sandstone, which extends to the crest of the dam. Dam specifications are referenced to National Geodetic Vertical Datum 29 (NGVD 29).

The spillway is uncontrolled; the excavated trapezoidal section is located near the left abutment. The crest is a 25 ft wide concrete slab at control elevation 1,013.2 ft with a length of 150 ft and serves as a roadway. The concrete extends 50 ft on either side of the control section with end elevations of 1,015 ft on the right and 1,017.4 ft on the left (M-J, 1978). A fish screen upstream of the concrete base extends across the approach channel. Downstream of the concrete structure at 200-300 ft intervals are 4 WPA erosion control structures built from concrete and native stone (M-J, 1978). The first erosion control structure is at elevation 1,012.3 ft with an approximately 3 to 4 ft drop in elevation to each thereafter.

The outlet works consists of a round intake tower with four gates and four valves all open. A 24 inch cast iron pipe bulkhead downstream is the only outlet. An 8-inch gravity flow valved line branches off the 24 inch outlet for municipal water supply.

Table 1: Dave Boyer (Walters) Dam and Lake Pertinent Data.

Owner of Dave Boyer (Walters) Dam and Facilities
City of Walters
Operator of Dave Boyer (Walters) Dam and Facilities
City of Walters

Engineer

Unknown

Location

On a tributary of East Cache Creek, in Cotton County, approximately one mile northwest of Walters, Oklahoma.

Drainage Area

3.75 square miles (Above Dave Boyer (Walters) dam site)

Embankment

Location	On an unnamed tributary of East Cache Creek
Type	Earth fill
Length	1,760 ft
Top Width	13 ft
Elevation	1,020 ft (1,017.2 at low end of dam) NGVD
Maximum Height	30 ft
Elevation of streambed	990 ft ±

Spillway

Location	Left abutment
Type	Uncontrolled, concrete roadway for crest
Length	150 ft bottom, 250 ft total
Width	25 ft
Crest Elevation	1,013.2 ft NGVD

Outlet Works

Type	Round intake tower with 4 gates, all open
Invert Elevation	Unknown
Type	24-inch pipe
Control	Bulkhead downstream with 8-inch branch for city water supply, which is valved downstream

Lake Design Specifications

Dave Boyer (Walters) Dam was constructed in 1936 with an area of 125 acres (ac) and a cumulative volume of 861 acre-feet (ac-ft) of water at the normal pool elevation of 1,012 ft (M-J, 1978). The current gage is referenced to National American Vertical Datum 1988 (NAVD 88).

HYDROGRAPHIC SURVEYING PROCEDURES

Surveying Technology

The Hydro-survey vessel was an 18-ft aluminum Silverstreak hull with cabin, powered by a single 115-Horsepower Mercury outboard motor. Equipment used to conduct the survey included: a ruggedized notebook computer; Ocean Data Equipment Corporation (ODEC) Bathy 1500 Echo Sounder; Trimble Navigation, Inc. Real time kinematic (RTK) global positioning system (GPS) consisting of a 4800 base and a 4700 rover with differential GPS (DGPS) correction; and an Odom Hydrographics, Inc, DIGIBAR-Pro Profiling Sound Velocimeter. A 12V battery and inverter provided the power supply to the equipment.

The echo sounder, GPS, and survey vessel were integrated to provide an efficient hydrographic surveying system. The hydrographic survey consisted of four successive procedures. These include setup, field surveying, post-processing of the collected data, and GIS application. As the boat travels across the lake surface on pre-plotted transect lines, the echo sounder gathers approximately 13 to15 readings per second along the lake bottom. The depth readings are stored on the survey vessel's on-board computer along with the positional and elevation data generated from the boat's GPS receiver. The daily data files collected are downloaded from the computer and brought to the office for editing after the survey is completed. During editing, data "noise" is removed or corrected, sound velocity corrections are applied, offsets are applied, and depths are converted to elevation readings. Accurate estimates of area-capacity are determined for the lake by building a 3-D triangulated irregular network (TIN) model of the reservoir from the collected data. The application of this new technology allows for accurate determinations of lake volume.

Pre-survey Technology

Boundary File

The digitized boundary of Dave Boyer (Walters) Lake was produced from the one-meter 2003 color digital ortho quarter quads (DOQQs) of Cotton County, Oklahoma at a scale of 1:1,500. The reservoir boundary was digitized in NAD 1983 State Plane Coordinates (Oklahoma South-3502). The 2003 United States Department of Agriculture-Farm Service Agency-Aerial Photography Field Office (USDA-FSA-APFO) color DOQQs photo dates were 20030616. One-meter black and white U.S. Geological Survey (USGS) DOQQs of Cotton County were used as a reference and were taken on 19950205. The normal pool elevation for Dave Boyer (Walters) Lake is 1,012 ft NAVD. The lake level elevations for each photo were unknown because there is no gauging station on the lake to reference the dates to. When visually comparing the 2003 and 1995 photos it was determined that the 2003 photos were taken when the lake was at a higher elevation than when the 1995 photos were taken. Based on the location and depth data collected during the survey it was possible to approximate that the lake was at elevation 1,007 ft NAVD when the 1995 photos were taken.

Table 2: Digital Ortho Quarter-Quadrangles Used for Creating Lake Boundary File.

DOQQs	Date	Elevation (ft NAVD)
USDA-FSA-APFO – Walter NW, NE, and SW	20030616	Undetermined
USGS – Walters NW, NE, and SW	19950205	~1,007.6

Setup

HYPACK software from Hypack Inc. was used to assign geodetic parameters, import background files, and create virtual track lines (transects). The geodetic parameters assigned were State Plane NAD 83 Zone OK-3502 Oklahoma South and distance units and depth as US Survey Feet. The survey transects were spaced according to the accuracy required for the project. The survey transects within the digitized reservoir boundary were at 200-ft increments that ran perpendicular to the shoreline. Approximately 17 virtual transects were created for the Dave Boyer (Walters) project not including the track lines that ran parallel to the shoreline, which were created after the initial surveying of the lake transects.

Surveying Methods

The procedures followed by the OWRB during the hydrographic survey adhere to U.S. Army Corps of Engineers (USACE) standards (USACE, 2002). The quality control and quality assurance procedures for equipment calibration and operation, field survey, data processing, and accuracy standards are presented in the following sections.

Equipment Calibration and Operation

While on board the Hydro-survey vessel, the ODEC Bathy 1500 Echo Sounder with a depth resolution of 0.1 ft was calibrated using A DIGIBAR-Pro Profiling Sound Velocimeter, by Odom Hydrographics. The unit measures the variation in the speed of sound at different depths throughout the water column. The factors that influence the speed of sound—depth, temperature, and salinity—are all taken into account.

The method involved lowering the probe in the water to the calibration depth mark to allow for acclimation and calibration of the depth sensor. The unit was then raised to as close to the water's surface as possible, gradually lowered at a controlled speed to a depth just above the lake bottom, and finally was raised again to the surface. The unit collected sound velocity measurements in feet/seconds (ft/sec) at 1 ft increments on both the deployment and retrieval phases. The data was then reviewed for any erroneous readings; which if any occurred they were then edited out of the sample. This data was used in the EDIT process to correct the soundings for the variations of the speed of sound with depth. A known speed of sound was entered into the echo sounder. The sound velocity corrections were applied to the raw data in the HYPACK EDIT program. Based on the sound velocity profile data and the designated speed of sound entered into the echo sounder, HYPACK will perform the depth adjustments to the raw data.

The average speed of sound in the water column was 4,926.20 ft/sec during the Dave Boyer (Walters) Lake survey. The sound velocity profile readings are shown in **Appendix A**.

A quality assurance cross-line check was undertaken on intersecting (cross-section/parallel) lake transect lines to verify compliance with the resultant depth accuracy (95%) of ±2.0 ft. HYPACK Cross Statistics program was used to assess vertical accuracy and confidence measures of acoustically recorded depths. The program reads the cross-section profile data and longitudinal profile data, computes the intersection, and interpolates a depth from each input file (USACE, 2002). For each cross-section, the output file will list the horizontal intersection, the interpolated depths, absolute difference in depth reading, mean difference, and standard deviation. A total of 14 cross-sections were used for statistical analysis to compute error estimates.

The maximum allowable bias for general surveys and studies is ± 0.5 ft. Biases are often referred to as systematic or external errors and may contain observational errors (USACE, 2002). Examples of bias include a bar check calibration error, tidal errors, or erroneous squat corrections. Random errors are the errors that are present in the measurement system that cannot be easily minimized by further calibration. Examples of random error include uneven bottom topography, bottom vegetation, positioning error, and speed of sound variation in the water column. The depth accuracy estimate is determined from actual depth comparisons taken over the same terrain and computing the mean difference (MD) which are considered bias errors and the standard deviation (SD) which are considered random errors between single-beam cross-line check comparisons. The two estimates are then combined to compute the Root Mean Square (RMS) error. The RMS error estimate is used to compare relative accuracies of estimates that differ substantially in bias and precision (USACE, 2002).

A mean difference of 0.02 ft and a standard deviation of 0.25 ft were computed from a number of 77 data points. Using the following formulas, a 95% depth accuracy of ±0.07 ft was calculated.

$$SE = SD / \sqrt{n}$$

$$RMS = \sqrt{MD^2 + SE^2}$$

$$RMS\ (95\%)\ depth\ accuracy = 1.96 \times RMS$$

where:

SE = standard error
SD = standard deviation
n = number of data points
RMS = root mean square error
MD = mean difference

The data plotted in **Figure 2** illustrates that the measurements have high precision, high repeatability, and high absolute accuracy. It must be noted that high precision or repeatability does not necessarily indicate high accuracy. Tightly scattered data may be highly accurate, whereas highly repeatable data could have large undetected biases (USACE, 2002). These error estimates likely represent the inner limits of the survey error. There was no wind present the day the survey took place; wind has a tendency to bias the data set. Were there a higher percentage of data collected from cross-sections near creek channels (if they existed) the error estimate would likely be more than reported due to creek channels being where the sharpest changes in depth occurs.

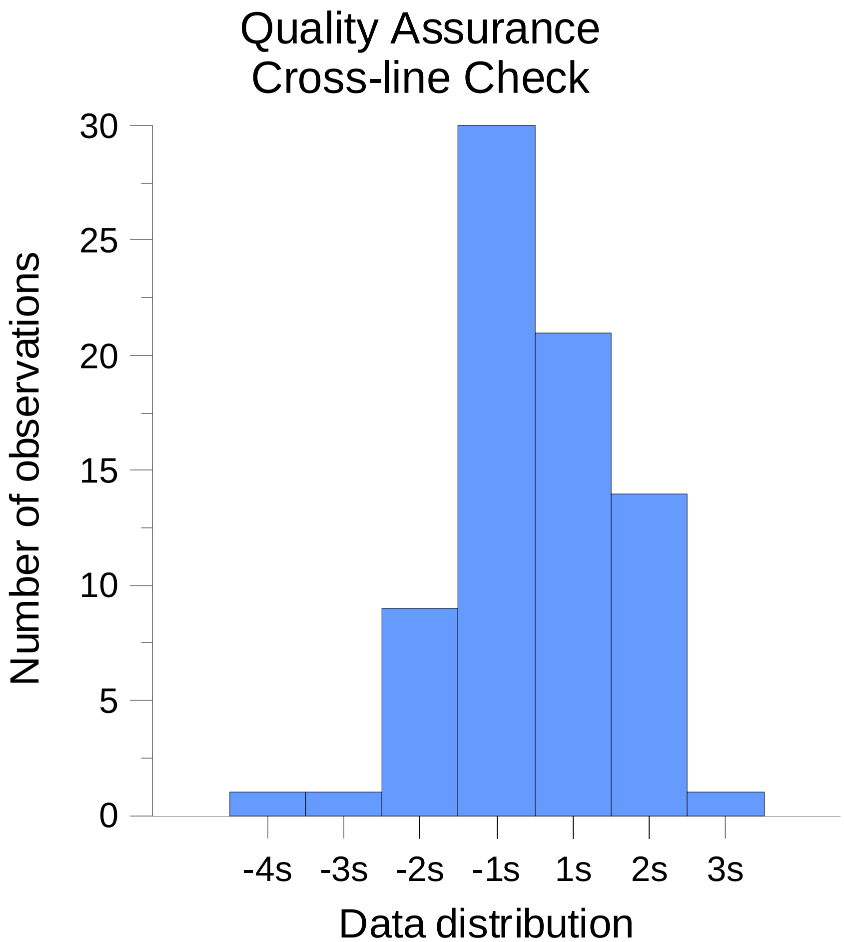

Figure 2: Histogram of relative depth distribution, in standard deviations, at cross-line intersections.

In addition to depth accuracy estimate, error was also estimated for squat. Squat is defined as the change in vessel trim as it moves through the water. Squat corrections are considered positive due to the transducer depressing into the water at acceleration. The estimated error for squat was +0.25 ft. When combined, the two factors give a total estimated error range of +0.18 to +0.32 ft.

The GPS system is an advanced high performance geographic data-acquisition tool that uses DGPS to provide sub-centimeter positional accuracy on a second-by-second basis. Potential errors are reduced with DGPS RTK system due to the initial integer ambiguity between satellites and receiver being resolved. Before the survey, Trimble's GPS Configurator software was used to configure the GPS receiver. To maximize the accuracy of the horizontal positioning, the horizontal mask setting was set to 15 degrees and the Position Dilution of Precision (PDOP) limit was set to 6. The position interval was set to 2 seconds because a 1 pulse per second box (PPS) was not available and the Signal to Noise Ratio (SNR) mask was set to 4. The collected DGPS positions were converted to state-plane coordinate system using the HYPACK program.

A latency test was performed to determine the fixed delay time between the GPS and single beam echo sounder. The timing delay was determined by running reciprocal survey lines over a channel bank. The raw data files were downloaded into HYPACK, LATENCY TEST program. The program varies the time delay to determine the "best fit" setting. A position latency of –1.00 seconds was produced and adjustments were applied to the raw data in the EDIT program.

Field Survey

Data collection for Dave Boyer (Walters) Lake occurred September 8, 2005. The water level elevation during the data collection process was approximately 4 to 5 ft below normal pool elevation 1,012 ft NAVD.

Data collection began at the dam area and extended to the upper end of the lake. Data were collected on parallel transect lines at a 200 ft intervals that ran perpendicular to the shoreline. Where applicable shoreline data was collected in the two to three ft water depth (or as close as the boat draft allows). Areas with depths less than the minimum depth limit of the boat were avoided.

Once the entire lake had been surveyed on transects that ran perpendicular to the shoreline, Hypack software was used to create 14 transects that ran parallel to the shoreline. This formed a grid of survey lines on the lake. It would not be feasible to conduct this method on a reservoir of 1,000 acres or more because it would be too time-intensive. The addition of this method allowed for the best delineation of the lake contours. If data were collected on 200 ft increment perpendicular transects alone, this critical detail would be missing. Data was collected in the upper end of Dave Boyer (Walters) Lake until the boat could no longer navigate in the shallow waters **Appendix C.**

The crew was able to collect data on 16 of the 17 pre-plotted perpendicular transect lines. Data was collected on all but one of the 14 parallel transect lines created. For all the transects, approximately 4,313 data points were collected while traversing a total of 9.8 US nautical miles. The data points were stored on the boat's computer in 38 data files.

Data Processing

The collected data was downloaded from the field computer onto the OWRB computer network and data burned to a CD as a permanent record. After downloading the data, each raw data file was reviewed for accuracy and completeness using the EDIT program within HYPACK. The EDIT program allows the user to assign transducer offsets, GPS offsets, and latency corrections, display the raw data profile, and review/edit all raw X, Y, and Z information. Collected data points that have inaccurate or absent depth or positional information are interpolated to be congruent with adjacent accurate points or deleted completely.

Offset correction values of 8.3 ft for height of the GPS and a -1.1 ft vertical for the transducer were applied to all raw data along with a latency correction factor of –1.00 seconds. The speed of sound readings, are documented in **Appendix A** from the Profiling Sound Velocimeter.

Within the EDIT program, the corrected depth mentioned earlier that is recorded by the echo sounder is subtracted from the elevation reading recorded by the GPS to convert the depth in feet to an elevation.

After editing the data for errors and correcting the spatial attributes (offsets), a data reduction scheme is needed. To accomplish this the data is resampled spatially at a 10 ft interval using the Sounding Selection program in HYPACK. The resultant data was saved and exported out as a xyz.txt file. The HYPACK data file for Dave Boyer (Walters) Lake is located at the end of the document on the CD entitled *Dave Boyer (Walters) HYPACK/GIS Metadata.*

Geographic Information System (GIS) software was used to process the edited XYZ data collected from the survey. The GIS software used was ArcGIS Desktop and ArcInfo Workstation, version 8.3, from Environmental System Research Institute (ESRI). All of the GIS datasets created are in Oklahoma State Plane South Coordinate System referenced to the North American Datum 1983. Horizontal and vertical units are in feet. The edited data points in XYZ text file format were converted into ArcInfo point coverage format. The point coverage contains the X and Y horizontal coordinates and the elevation and depth values associated with each collected point.

Volumetric and area calculations were derived using a TIN surface model. The TIN model was created in ArcInfo, using the collected survey data points and the lake boundary inputs. The TIN consists of connected data points that form a network of triangles representing the bottom surface of the lake. Approximately 4,313 data points were used to create the TIN model. The lake volume was calculated by slicing the TIN horizontally into planes 0.1 ft thick. The volume and area of each slice are shown in **Appendix B**.

Contours, depth ranges, and the shaded relief map were derived from a digital elevation model grid. This grid was created using the ArcInfo TOPOGRIDTOOL command and had a spatial resolution of 10 ft. A low pass 3x3 filter was run to lightly smooth the grid to improve contour generation. The contours were created at a 1-ft interval using the ArcInfo LATTICECONTOUR command. Some contour lines required editing to allow for polygon topology and to improve general smoothness of the lines. The contours were then converted to a polygon coverage and attributed to show 1-ft depth ranges across the lake. The bathymetric map of the lake is shown with 1-ft contour intervals in **Appendix C**.

All geographic datasets derived from the survey contain Federal Geographic Data Committee (FGDC) compliant metadata documentation. The metadata describes the procedures and commands used to create the datasets. The GIS metadata file for Dave Boyer (Walters) Lake is located at the end of the document on the CD entitled *Dave Boyer (Walters) HYPACK/GIS Metadata.*

RESULTS

Results from the 2005 OWRB survey indicate Dave Boyer (Walters) Lake encompasses 121 ac and contains a cumulative capacity of 636 ac-ft at normal pool elevation 1,012 ft NAVD 88. The shoreline calculated from the digitized reservoir boundary was 2.3 miles. The average depth for Dave Boyer (Walters) Lake was 7.6 1ft with a maximum depth of 14.0 ft.

SUMMARY AND COMPARISONS

Dave Boyer (Walters) Dam was constructed in 1936 with an area of 125 ac and a cumulative volume of 861 ac-ft of water at the normal pool elevation to 1,012 ft (M-J, 1978).

OWRB performed a hydrographic survey of Dave Boyer (Walters) Lake in September. For the production of the DEM of Dave Boyer (Walters) Lake's bathymetry, a DGPS, echo sounder, and GIS were utilized. The OWRB survey delineated 121 surface ac and a cumulative capacity of 636 ac-ft at normal pool elevation 1,012 ft NAVD (**Table 3**).

Table 3: Reservoir data from OWRB 2005 Survey at the top of conservation pool 1,012 ft.

Feature	Result
Elevation (NAVD)	1,012
Area (acres)	121
Capacity (ac-ft)	636

Area and capacity figures from original design was compared to the 2005 data set for the purpose of area-capacity evaluation.

Table 4 summarizes historical area/capacity readings.

Table 4: Area and Capacity Comparisons of Dave Boyer (Walters) Lake at Normal Pool Elevation (1,012 ft NAVD).

Feature	Survey Year	
	1978*	2005
Area (acres)	125	121
Cumulative Volume (acre-feet)	861	636

* (M-J, 1978)

The OWRB considers the 2005 survey to be a significant improvement over previous survey endeavors and recommends that the same methodology be used in five years or after major flood events to monitor changes to the lake's storage capacity. The survey and computation methods utilized in the OWRB survey differ from those employed in the historical surveys. When comparing area-capacity between the historical original design and the OWRB hydrographic survey, the new capacity calculation of 636 ac-ft will serve as a more accurate number for future comparisons.

REFERENCES

Mason-Johnston and Associates Inc. (M-J) 1978. “Tributary of East Cache Creek, Phase I Inspection Report Nation Dam Safety Program, Walters City Lake- Dam and Spillway, Cotton County, OK, Inventory No. OK 00560”.

Oklahoma Water Resources Board (OWRB) 1983. “Examination Report, Walters Lake Dam, Oklahoma Safety of Dams Program”.

U.S. Army Corps of Engineers (USACE). 2002. Engineering and Design - Hydrographic Surveying, Publication EM 1110-2-1003, 3rd version.

Appendix A: Sound Velocity Profile

Table A. 1: Sound Velocity Profile Data for September 8, 2005.

Depth (ft)	9/8/05
2	4932.81
3	4929.40
4	4925.79
5	4925.20
6	4924.90
7	4924.61
8	4924.51
9	4924.31
10	4924.31

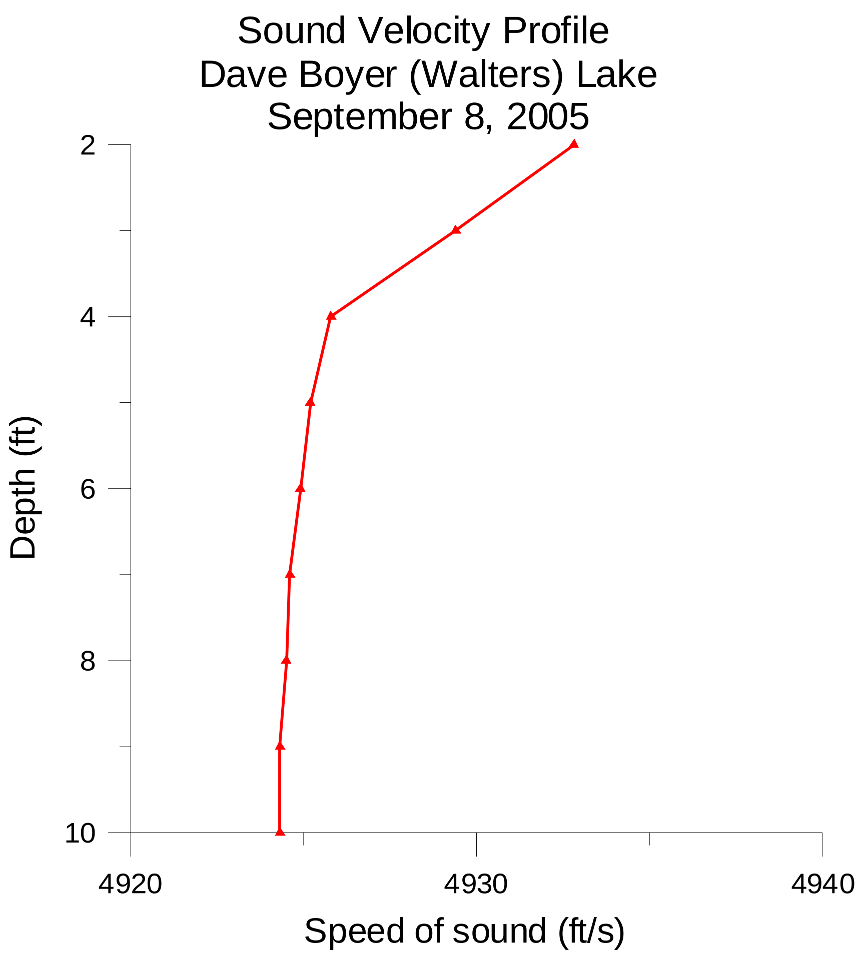

Figure A. 1: Sound Velocity Profiles for September 8, 2005.

Appendix B: Area-Capacity Data

Table B. 1: Dave Boyer (Walters) Lake Cumulative Area by 0.1-foot Increments.

DAVE BOYER (WALTERS) LAKE AREA TABLE										
Area in acres by tenth foot elevation increments										
2005 SURVEY										
OKLAHOMA WATER RESOURCES BOARD										
ELEVATION										
(ft NAVD)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
998	0	0.0007	0.0041	0.0101	0.0187	0.031	0.0488	0.0692	0.1095	0.3672
999	1.150	1.7273	2.2253	2.72	3.21	3.79	4.52	5.27	6.22	7.33
1000	9.2	11.0	13.0	15.0	17.1	18.9	20.7	22.3	23.6	25.0
1001	26.8	28.5	29.8	31.0	32.3	33.4	34.6	36.0	37.4	39.3
1002	42.8	44.1	45.1	46.2	47.2	48.1	49.2	50.4	51.5	52.9
1003	55.2	56.2	57.0	57.8	58.5	59.3	60.2	61.1	62.2	63.3
1004	65	66	67	68	69	70	71	71	72	73
1005	75	76	77	78	79	80	81	82	83	83
1006	85	86	87	87	88	89	90	91	92	93
1007	94	95	95	96	97	97	98	98	99	100
1008	100	101	101	102	102	102	103	103	104	104
1009	104	105	105	105	106	106	107	107	107	108
1010	108	109	109	110	110	111	111	112	112	112
1011	113	114	114	115	116	117	117	118	119	120
1012	121.44									

Table B. 2: Dave Boyer (Walters) Lake Cumulative Volume by 0.1-foot Increments.

DAVE BOYER (WALTERS) LAKE CAPACITY TABLE										
Volume in acre-feet by tenth foot elevation increments										
2005 SURVEY										
OKLAHOMA WATER RESOURCES BOARD										
ELEVATION										
(ft NAVD)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
998	0	0	0.0002	0.0009	0.002	0.005	0.009	0.015	0.023	0.044
999	0.1	0.2	0.4	0.7	1.0	1.3	1.8	2.2	2.8	3.5
1000	4.3	5.3	6.5	7.9	9.5	11.3	13.3	15.5	17.8	20.2
1001	22.7	25.5	28.4	31.5	34.6	37.9	41.3	44.9	48.5	52.4
1002	56.4	60.8	65.2	69.8	74.5	79.2	84.1	89.1	94.2	99.4
1003	104.8	110.4	116.0	121.8	127.6	133.5	139.4	145.5	151.7	157.9
1004	164.3	170.9	177.6	184.4	191.2	198.1	205.2	212.3	219.4	226.7
1005	234.1	241.6	249.3	257.0	264.8	272.8	280.8	288.9	297.1	305
1006	314	322	331	340	348	357	366	375	384	394
1007	403	412	422	432	441	451	461	470	480	490
1008	500	510	520	531	541	551	561	572	582	592
1009	603	613	624	634	645	655	666	677	687	698
1010	709	720	731	742	753	764	775	786	797	808
1011	820	831	842	854	865	877	889	900	912	924
1012	936.25									

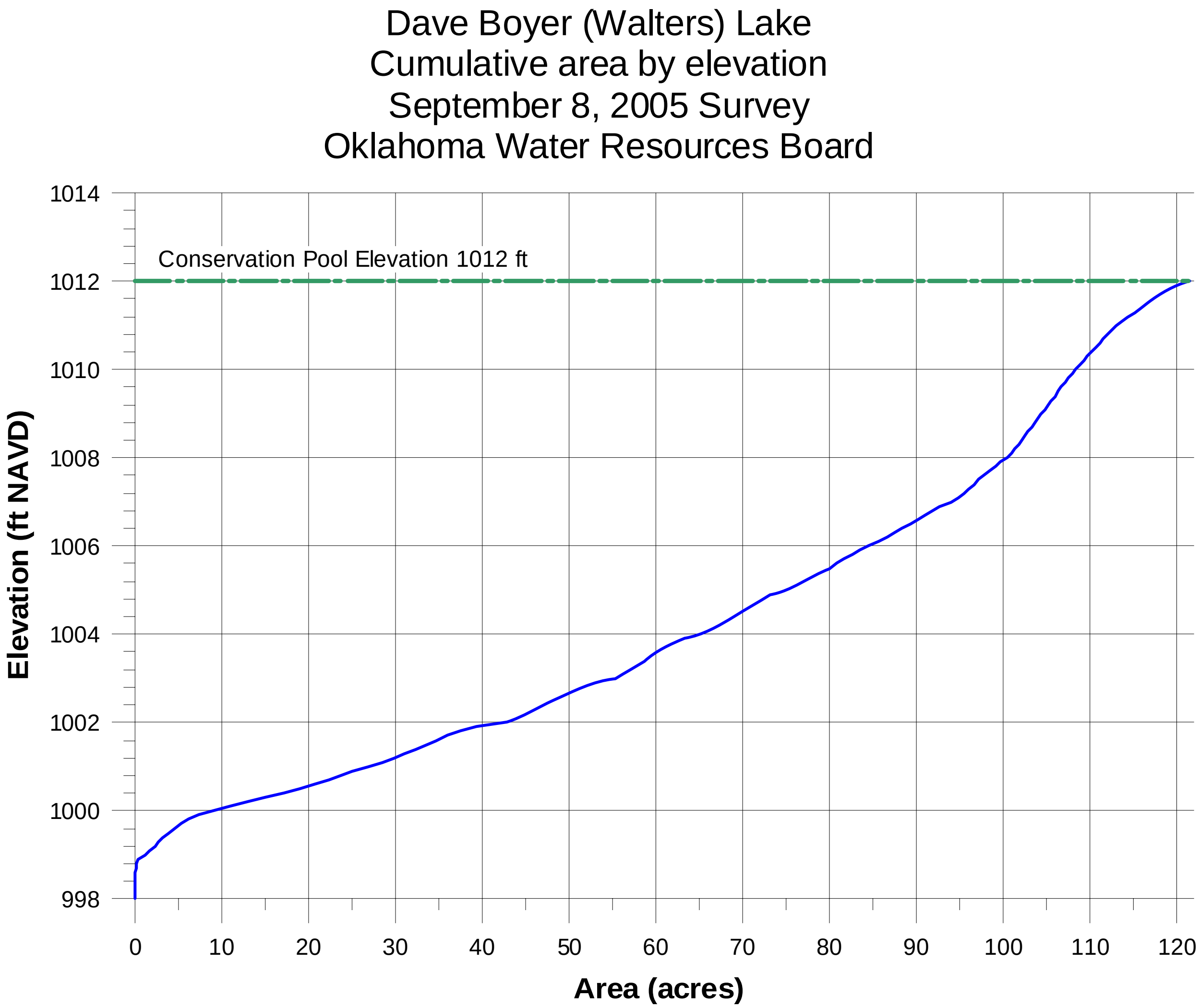

Figure B. 1: Dave Boyer (Walters) Lake Area-Elevation Curve.

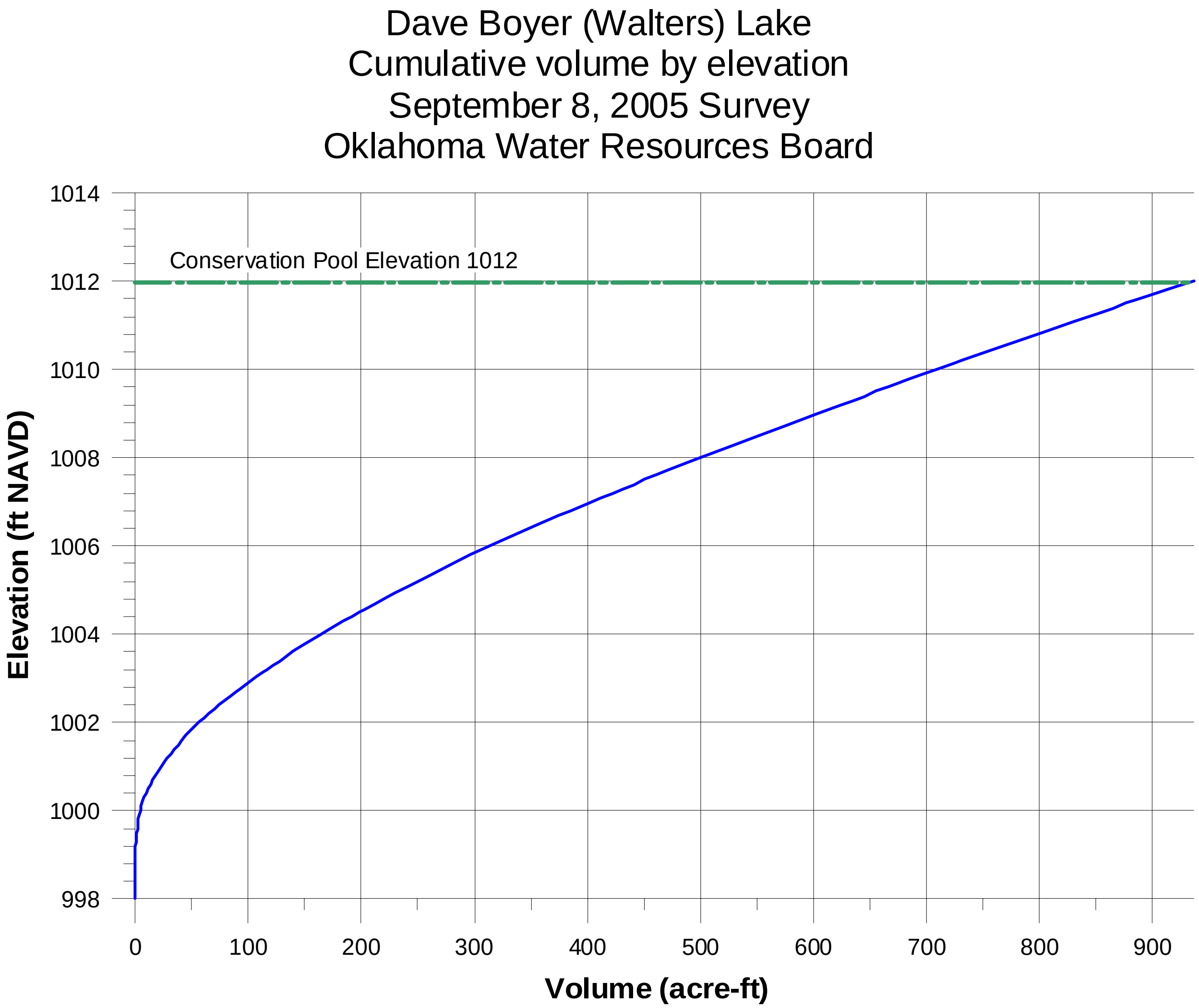

Figure B. 2: Dave Boyer (Walters) Lake Volume-Elevation Curve.

Appendix C: Dave Boyer (Walters) Lake Bathymetric Maps

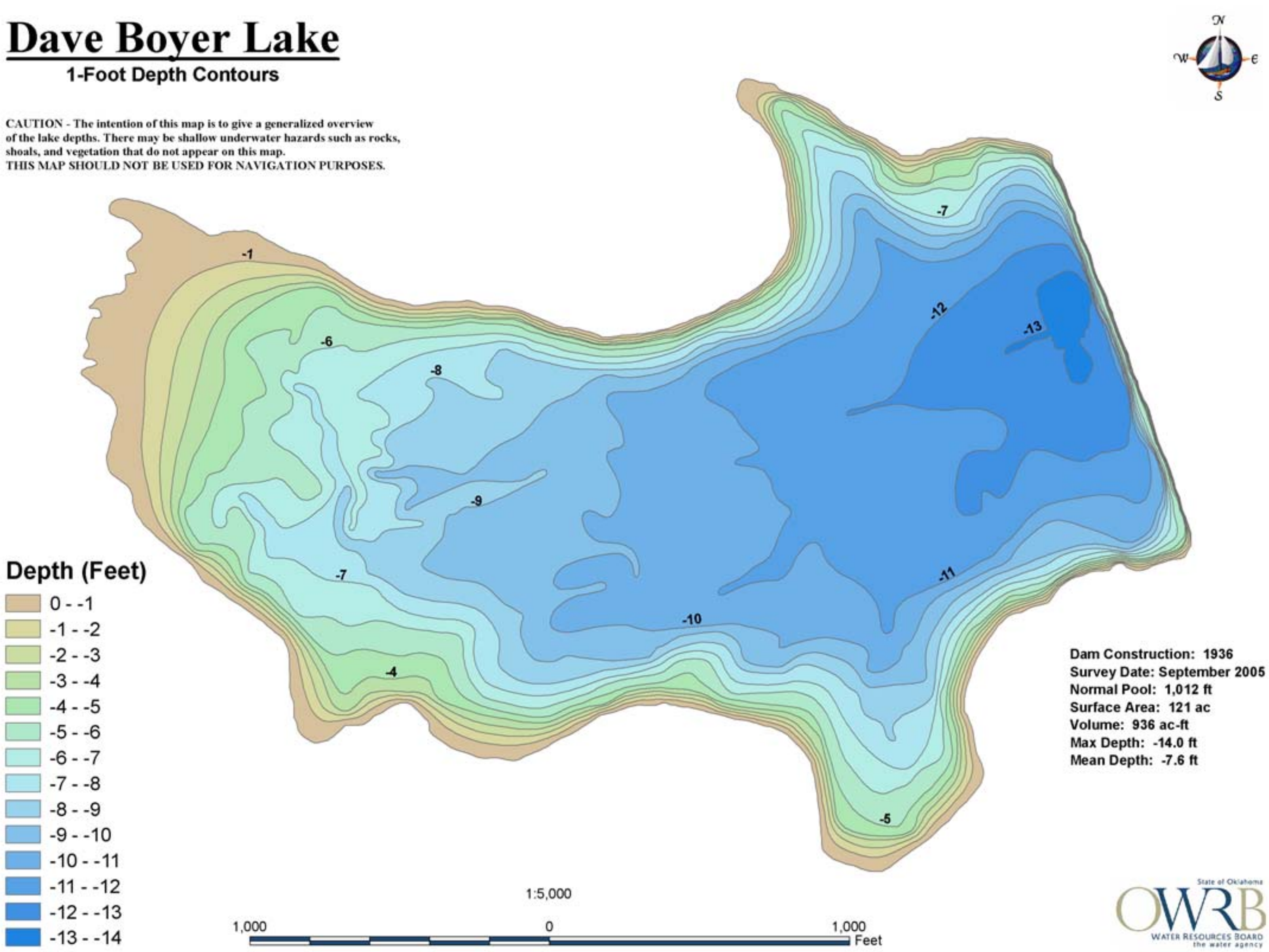

Figure C. 1: Dave Boyer (Walters) Lake Bathymetric Map with 1-foot Contour Intervals.

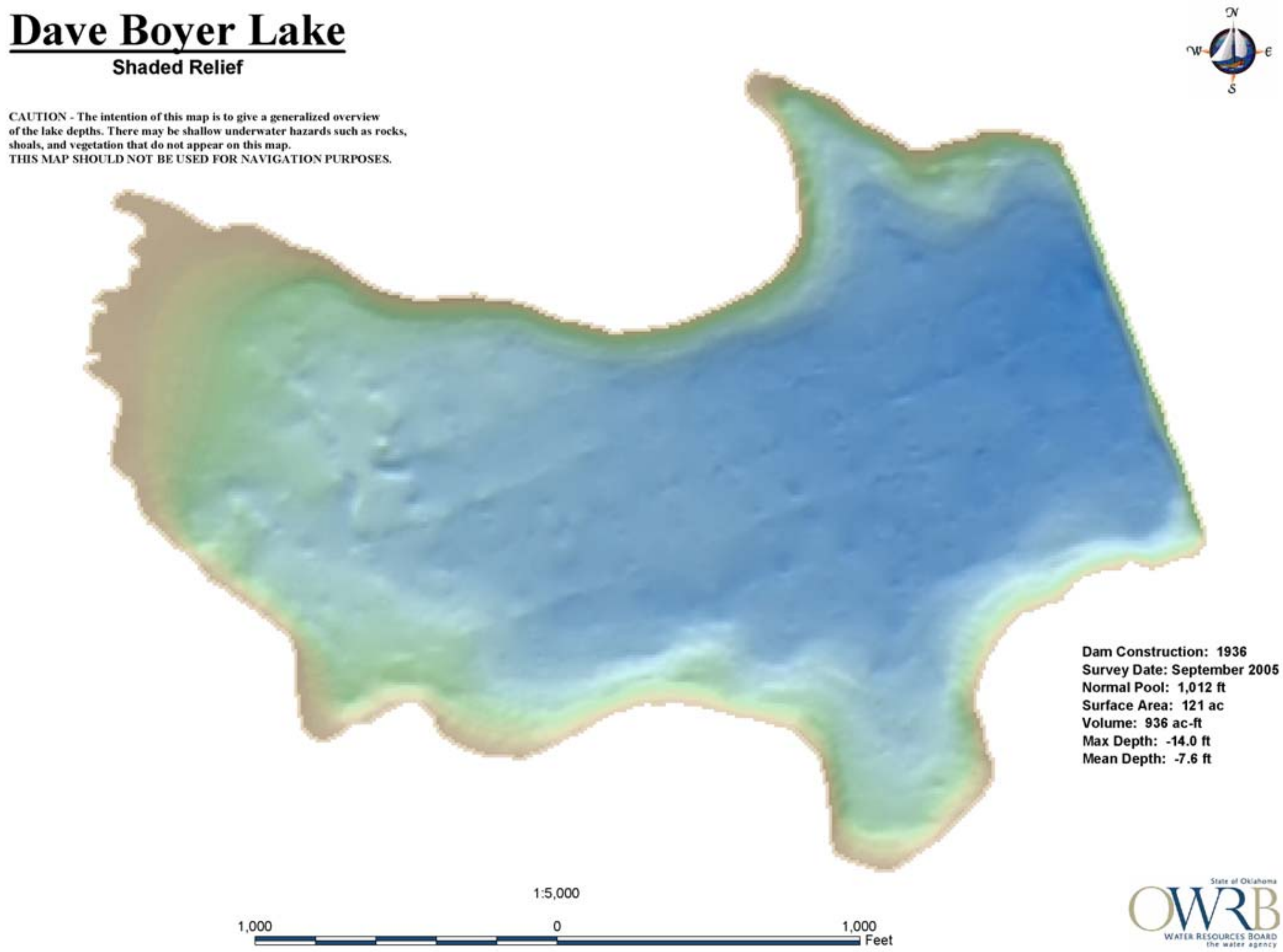

Figure C. 2: Dave Boyer (Walters) Lake Shaded Relief Bathymetric Map.

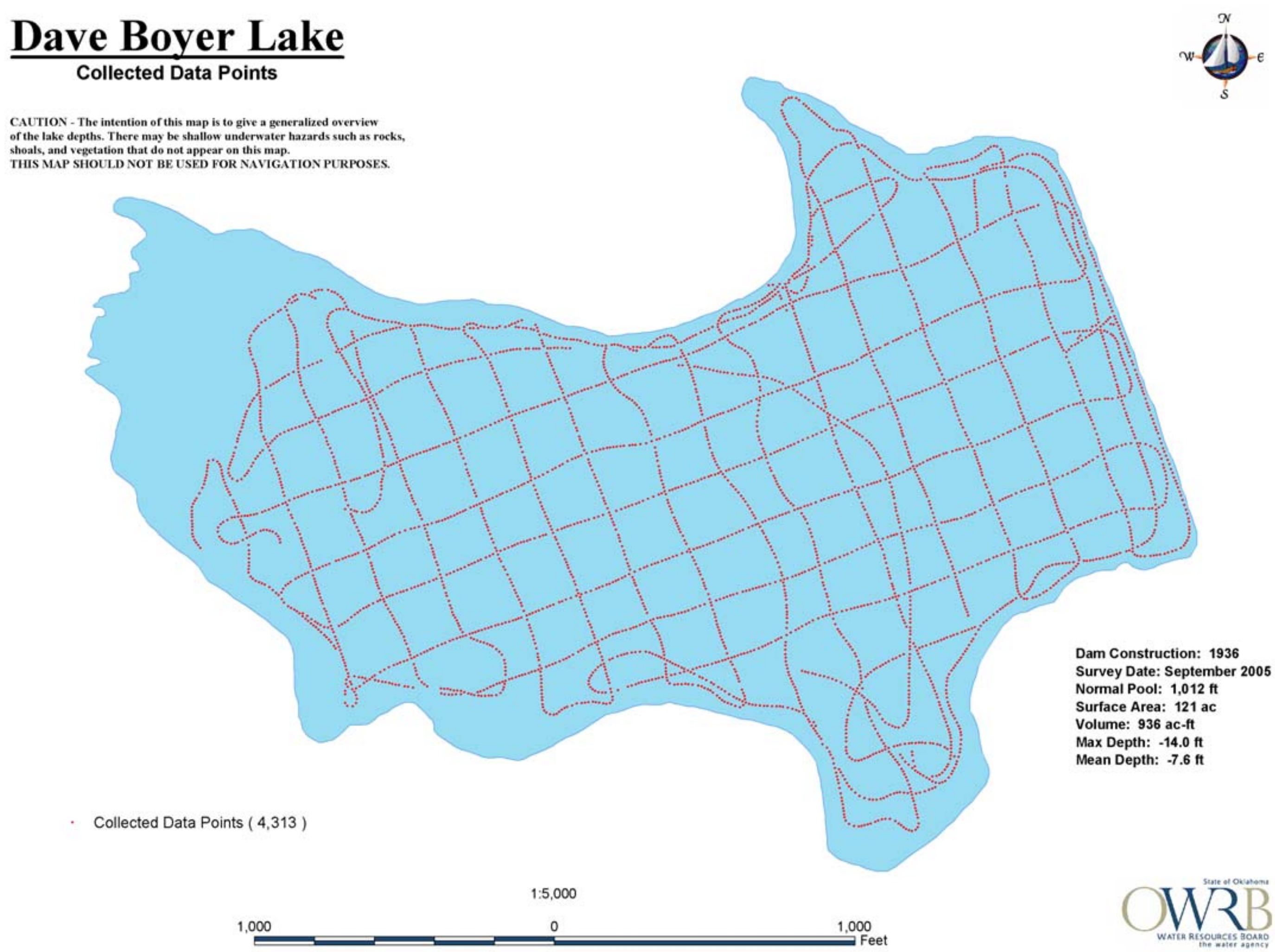

Figure C. 3: Collected Data Points.