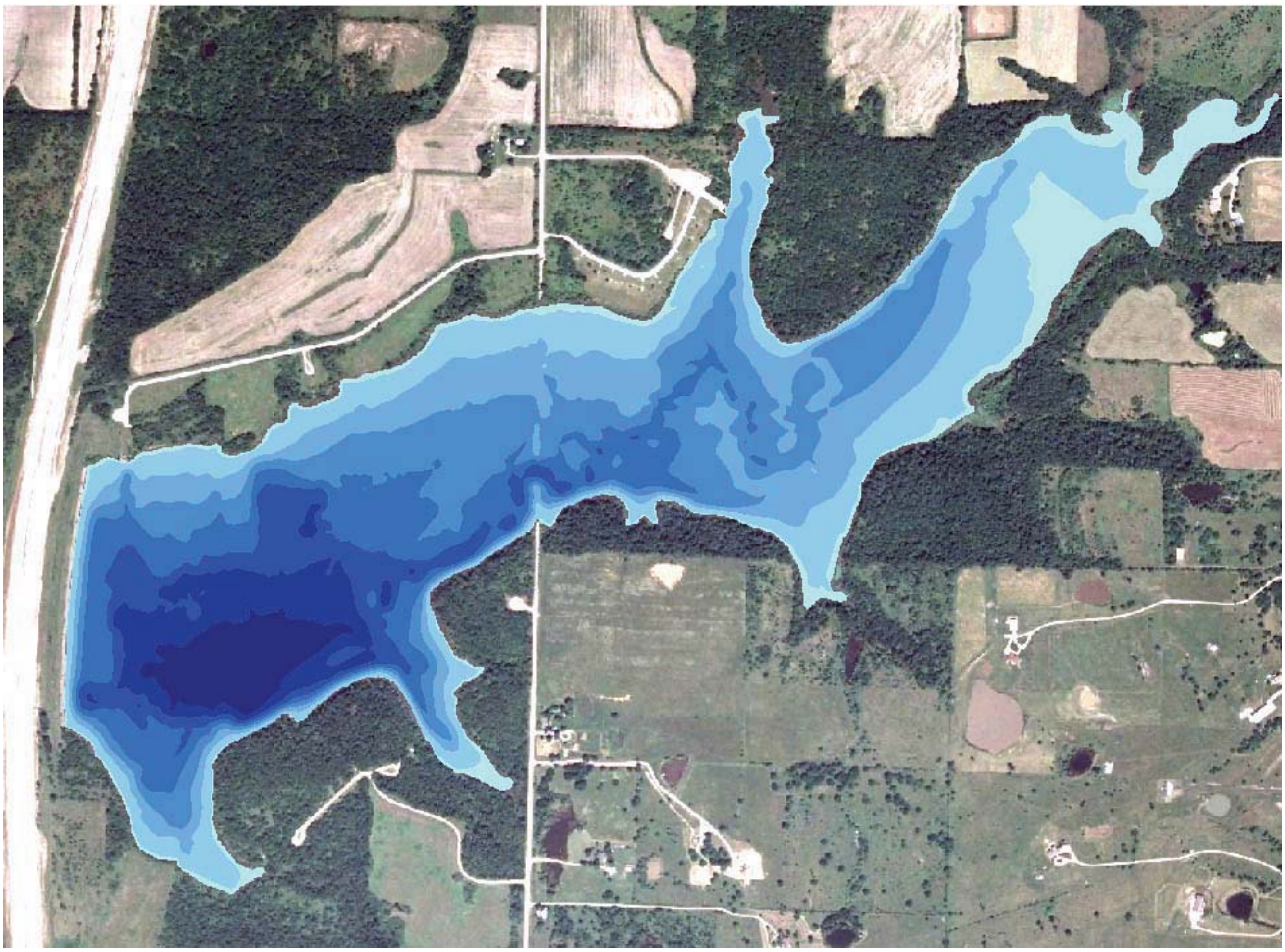
Bathymetric and Sediment Survey of Louisburg-Middle Creek Lake, Miami County, Kansas



Kansas Biological Survey

Applied Science and Technology for Reservoir Assessment (ASTRA) Program

Report 2009-002 (February 2010)

This work was funded by the Kansas Water Office through the State Water Plan Fund in support of the Reservoir Sustainability Initiative.

SUMMARY

On June 25, 2008, the Kansas Biological Survey (KBS) performed a bathymetric survey of Louisburg-Middle Creek Lake in Miami County, Kansas. The survey was carried out using acoustic echosounding apparatus linked to a global positioning system. The bathymetric survey was georeferenced to both horizontal and vertical reference datums.

Sediment samples were collected from three sites within the reservoir: One sample was taken near the dam; a second at mid-lake; and a third in the upper end. Sampling was performed on the same day as the bathymetric survey, following completion of the survey. Sediment samples were analyzed for particle size distributions.

Summary Data:

Bathymetric Survey:		
	Date of survey:	September 17, 2008
Reservoir Statistics:		
	Elevation on survey date	985.65 ft
	Area on survey date:	251 acres
	Volume on survey date:	3087 acre-feet
	Maximum depth:	34 ft.
Elevation Benchmark (if applicable)		
	UTM location of elevation benchmark:	354158.13, 4263842.46
	UTM Zone:	15N
	UTM datum:	NAD83
	Elevation of benchmark, from GPS:	987.06 ft.
	Vertical datum, all data:	NAVD88
Sediment Survey:		
	Date of sediment survey:	September 17, 2008

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LAKE HISTORY AND PERTINENT INFORMATION

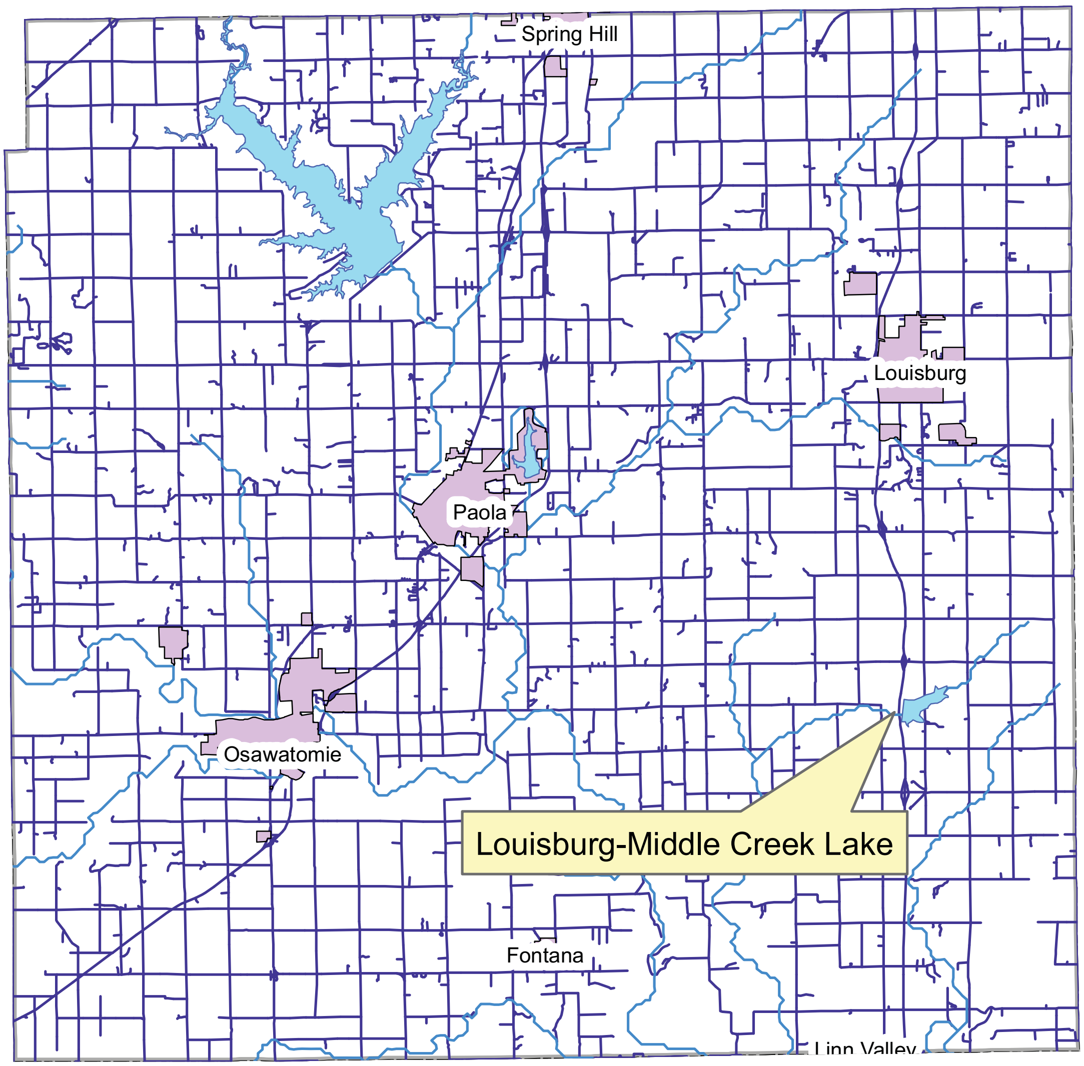
Lake history summarized from Kansas Department of Wildlife and Parks website for Louisburg-Middle Creek Lake (http://www.kdwp.state.ks.us/news/KDWP-Info/Locations/State-Fishing-Lakes/Region-2/Louisburg-Middle-Creek)

Figure 1. Louisburg-Middle Creek Lake, Miami County, Kansas.

History: The Louisburg-Middle Creek State Fishing Lake was built as a water supply source for the City of Louisburg through a cooperative agreement between the City, the Natural Resources Conservation Service, and the Kansas Department of Wildlife and Parks. Construction and final agreements for the operation and maintenance of the lake were completed and signed in 1986.

Purpose: Water supply, recreation. The lake and surrounding lands are managed by the Kansas Department of Wildlife and Parks for fishing and hunting purposes.

Miami County, Kansas



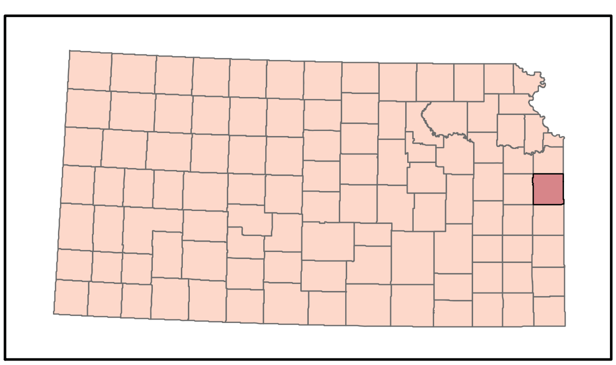


Figure 2. Location of Louisburg-Middle Creek Lake in Miami County, Kansas

Reservoir Bathymetric (Depth) Surveying Procedures

KBS operates a Biosonics DT-X echosounding system (www.biosonicsinc.com) with a 200 kHz split-beam transducer and a 38-kHz single-beam transducer. Latitude-longitude information is provided by a global positioning system (GPS) that interfaces with the Biosonics system. ESRI's ArcGIS is used for on-lake navigation and positioning, with GPS data feeds provided by the Biosonics unit through a serial cable. Power is provided to the echosounding unit, command/navigation computer, and auxiliary monitor by means of a inverter and battery backup device that in turn draw power from the 12-volt boat battery.

Pre-survey preparation:

Geospatial reference data: Prior to conducting the survey, geospatial data of the target lake is acquired, including georeferenced National Agricultural Imagery Project (NAIP) photography. The lake boundary is digitized as a polygon shapefile from the FSA NAIP georeferenced aerial photography obtained online from the Data Access and Service Center (DASC). Prior to the lake survey, a series of transect lines are created as a shapefile in ArcGIS for guiding the boat during the survey.

Survey procedures:

Calibration (Temperature and ball check): After boat launch and initialization of the Biosonics system and command computer, system parameters are set in the Biosonics Visual Acquisition software. The temperature of the lake at 1-2 meters is taken with a research-grade metric electronic thermometer. This temperature, in degrees Celsius, is input to the Biosonics Visual Acquisition software to calculate the speed of sound in water at the given temperature at the given depth. Start range, end range, ping duration, and ping interval are also set at this time. A ball check is performed using a tungsten-carbide sphere supplied by Biosonics for this purpose. The ball is lowered to a known distance (1.0 meter) below the transducer faces. The position of the ball in the water column (distance from the transducer face to the ball) is clearly visible on the echogram. The echogram distance is compared to the known distance to assure that parameters are properly set and the system is operating correctly.

On-lake survey procedures: Using the GPS Extension of ArcGIS, the GPS data feed from the GPS receiver via the Biosonics echosounder, and the pre-planned transect pattern, the location of the boat on the lake in real-time is shown on the command/navigation computer screen. The transect pattern is maintained except when modified by obstructions in the lake (e.g., partially submerged trees) or shallow water and mudflats. Data are automatically logged in new files every half-hour (approximately 9000-ping files) by the Biosonics system.

Establishment Of Lake Level On Survey Dates:

State and Local Reservoirs:

Most state and local lakes in Kansas do not have water surface elevation gauges. Therefore, a local benchmark at the edge of a lake is established, typically a concrete pad or wall adjacent to the water. The location of the benchmark is photographed and a description noted. On the day of the survey, the vertical distance between the water surface and the surface of the benchmark is measured. In cases where the benchmark must be established a distance away from the lake, a survey-grade laser level is used to establish the vertical distance between benchmark and water surface.

A TopCon HiPerLite+ survey-grade static global positioning system is used to establish the height of the benchmark. The unit is set at a fixed distance above the benchmark, and the vertical distance between the benchmark and the Antenna Reference Point recorded. The unit is allowed to record data points for a minimum of two hours at a rate of one point every 10 seconds.

Following GPS data acquisition, the data are downloaded at the office from the GPS unit, converted from TopCon proprietary format to RINEX format, and uploaded to the National Geodetic Survey (NGS) On-line Positioning User Service (OPUS). Raw data are processed by OPUS with respect to three NGS CORS (Continuously Operating Reference Stations) locations and results returned to the user.

The elevation of the benchmark is provided in meters as the orthometric height (NAVD88, computed using GEOID03). The vertical difference between the lake surface on the survey day is subtracted from the OPUS-computer orthometric height to produce the lake elevation value, in meters. This lake elevation value is entered as an attribute of the lake perimeter polygon shapefile in postprocessing.

The ASTRA elevation benchmark for Louisburg-Middle Creek Lake (Figure 3a, Figure 3b).

The water surface elevation of Louisburg-Middle Creek Lake on September 17, 2008 was 985.65 feet AMSL, NAVD88.

Location of Lake Elevation Benchmark:

Louisburg-Middle Creek Lake**:** .

UTM (NAD83, Zone 15): Easting (X) [meters] 354158.134, Northing (Y) [meters] 4263842.463

Figure 3a. View west from boat ramp.

Figure 3b. Close-up view. Lake level was measured from the water surface to the top of the concrete dock anchor pad. (Arrow indicates specific location on pad).

```
FILE: log0197t.08O (Louisburg-Middle Creek Lake)

 2005   NOTE:  The IGS precise and IGS rapid orbits were not available
 2005   at processing time.  The IGS ultra-rapid orbit was/will be used to
 2005   process the data.
 2005
                              NGS OPUS SOLUTION REPORT
                              ========================

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: www.ngs.noaa.gov/OPUS/Using_OPUS.html#accuracy

      USER: mjakub@ku.edu                          DATE: July 16, 2008
RINEX FILE: log0197t.08o                           TIME: 16:41:25 UTC

  SOFTWARE: page5  0612.06 master23.pl            START: 2008/07/15  19:21:00
 EPHEMERIS: igu14882.eph [ultra-rapid]             STOP: 2008/07/15  21:28:00
  NAV FILE: brdc1970.08n                       OBS USED:  5158 /  6121   :
84%
  ANT NAME: TPSHIPER_PLUS   NONE             # FIXED AMB:    46 /    55   :
84%
ARP HEIGHT: 1.01                             OVERALL RMS: 0.024(m)

 REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)           ITRF00
(EPOCH:2008.5379)

         X:      -407119.430(m)   0.073(m)          -407120.143(m)   0.073(m)
         Y:     -4980907.367(m)   0.077(m)         -4980905.994(m)   0.077(m)
         Z:      3950154.405(m)   0.046(m)          3950154.279(m)   0.046(m)

       LAT:   38 30 39.68587      0.023(m)       38 30 39.70913      0.023(m)
     E LON:  265 19 38.13492      0.067(m)      265 19 38.10097      0.067(m)
     W LON:   94 40 21.86508      0.067(m)       94 40 21.89903      0.067(m)
    EL HGT:          268.836(m)   0.092(m)             267.733(m)   0.092(m)
 ORTHO HGT:          300.857(m)   0.111(m) [NAVD88 (Computed using GEOID03)]

                        UTM COORDINATES    STATE PLANE COORDINATES
                         UTM (Zone 15)         SPC (1502 KS S)
Northing (Y) [meters]     4263842.463          611552.220
Easting (X)  [meters]      354158.134          733714.304
Convergence  [degrees]    -1.04174064          2.35195868
Point Scale                0.99986194          0.99998947
Combined Factor            0.99981976          0.99994729

US NATIONAL GRID DESIGNATOR: 15SUC5415863842(NAD 83)

                              BASE STATIONS USED
PID       DESIGNATION                        LATITUDE    LONGITUDE DISTANCE(m)
DJ3671 KST5 TOPEKA 5 CORS ARP              N390240.554 W0960220.776  132688.8
DF9221 ZKC1 KANSAS CTY WAAS 1 CORS ARP     N385248.550 W0944726.964   42246.8
AH9088 LTHM LATHROP CORS ARP               N393433.425 W0941012.528  125979.6

                 NEAREST NGS PUBLISHED CONTROL POINT
JE1919      MIDDLE                         N382916.883 W0944038.029    2590.1

This position and the above vector components were computed without any
knowledge by the National Geodetic Survey regarding the equipment or
field operating procedures used.
```

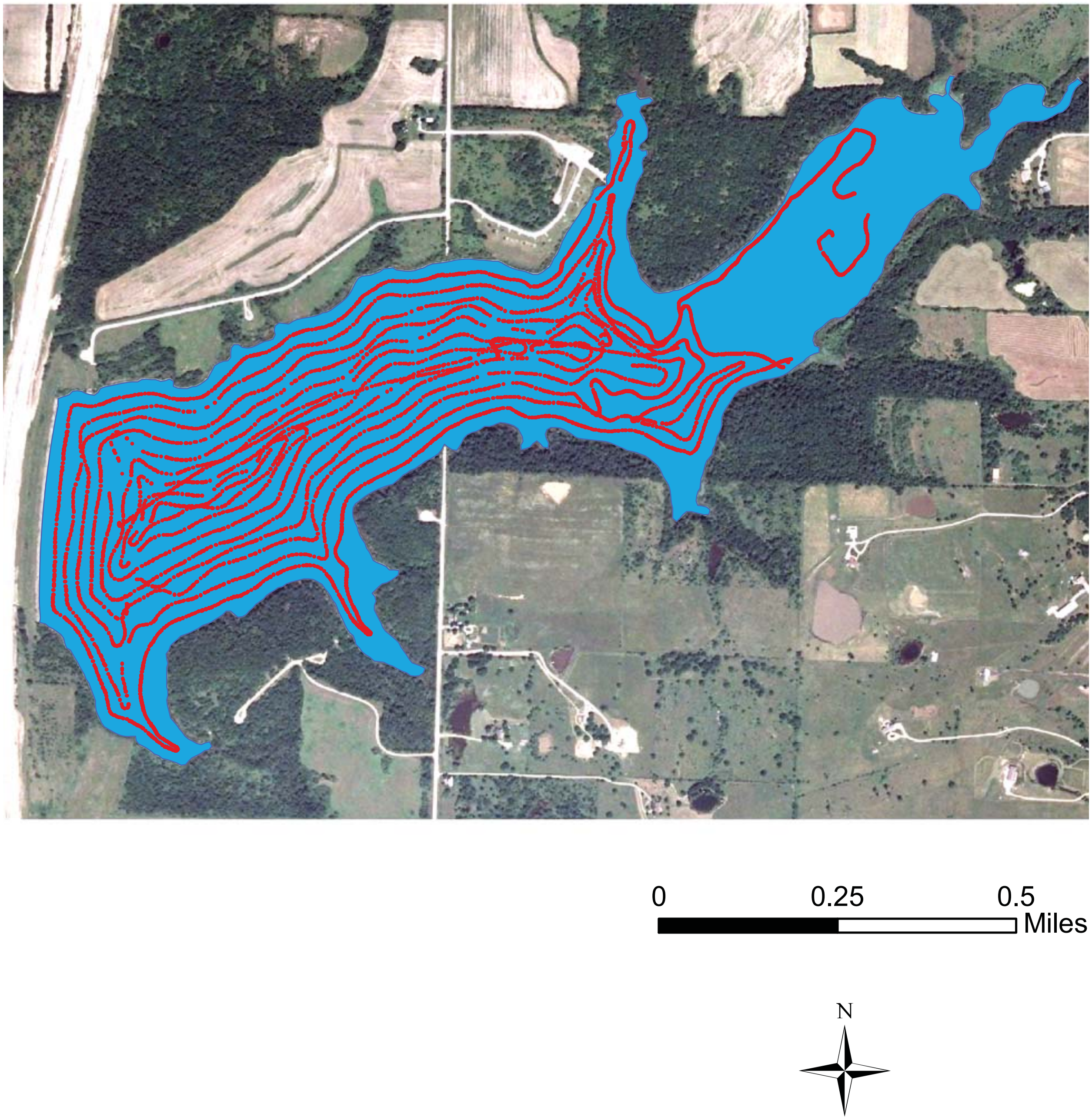


Figure 4. Bathymetric survey transects for Louisburg-Middle Creek Lake.
Dense submerged tree cover prevented bathymetric mapping in much of the upper end.

Post-processing *(Visual Bottom Typer)*

The Biosonics DT-X system produces data files in a proprietary DT4 file format containing acoustic and GPS data. To extract the bottom position from the acoustic data, each DT4 file is processed through the Biosonics Visual Bottom Typer (VBT) software. The processing algorithm is described as follows:

> *"The BioSonics, Inc. bottom tracker is an "end_up" algorithm, in that it begins searching for the bottom echo portion of a ping from the last sample toward the first sample. The bottom tracker tracks the bottom echo by isolating the region(s) where the data exceeds a peak threshold for N consecutive samples, then drops below a surface threshold for M samples. Once a bottom echo has been identified , a bottom sampling window is used to find the next echo. The bottom echo is first isolated by user_defined threshold values that indicate (1) the lowest energy to include in the bottom echo (bottom detection threshold) and (2) the lowest energy to start looking for a bottom peak (peak threshold). The bottom detection threshold allows the user to filter out noise caused by a low data acquisition threshold. The peak threshold prevents the algorithm from identifying the small energy echoes (due to fish, sediment or plant life) as a bottom echo."* (Biosonics Visual Bottom Typer User's Manual, Version 1.10, p. 70).

Data is output as a comma-delimited (*.csv) text file. A set number of qualifying pings are averaged to produce a single report (for example, the output for ping 31 {when pings per report is 20} is the average of all values for pings 12-31). Standard analysis procedure for all 2008 and later data is to use the average of 5 pings to produce one output value. All raw *.csv files are merged into one master *.csv file using the shareware program File Append and Split Tool (FAST) by Boxer Software (Ver. 1.0, 2006).

Post-processing **(*Excel*)**

The master *.csv file created by the FAST utility is imported into Microsoft Excel. Excess header lines are deleted (each input CSV file has its own header), and the header file is edited to change the column headers "#Ping" to "Ping" and "E1' " to "E11", characters that are not ingestable by ArcGIS. Entries with depth values of zero (0) are deleted, as are any entries with depth values less than the start range of the data acquisition parameter (0.49 meters or less) (indicating areas where the water was too shallow to record a depth reading).

In Excel, depth adjustments are made. A new field – Adj_Depth – is created. The value for AdjDepth is calculated as AdjDepth = Depth + (Transducer Face Depth), where the Transducer Face Depth represents the depth of the transducer face below water level in meters (Typically, this value is 0.2 meters; however, if changes were made in the field, the correct level is taken from field notes and applied to the data). Depth in feet is also calculated as DepthFt = Adj_Depth * 3.28084.

These water depths are RELATIVE water depths that can vary from day-to-day based on the elevation of the water surface. In order to normalize all depth measurements to an absolute reference, water depths must be subtracted from an established value for the elevation of the water surface at the time of the bathymetric survey. Determination of water surface elevation has been described in an earlier section on establishment of lake levels.

To set depths relative to lake elevation, two additional fields are added to the attribute table of the point shapefile: LakeElevM, the reference surface elevation (the elevation of the water surface on the day that the aerial photography from which the lake perimeter polygon was digitized)and Elev_Ft, the elevation of the water surface in feet above sea level (Elev_ft), computed by converting ElevM to elevation in feet (ElevM * 3.28084).

Particularly for multi-day surveys, Adj_Depth and Depth_Ft should **NOT** be used for further analysis or interpolation. If water depth is desired, it should be produced by subtracting Elev_M or Elev_Ft from the reference elevation used for interpolation purposes (for federal reservoirs, the elevation of the water surface on the day that the aerial photography from which the lake perimeter polygon was digitized).

Post-processing *(ArcGIS):*

Ingest to ArcGIS is accomplished by using the Tools – Add XY Data option. The projection information is specified at this time (WGS84). Point files are displayed as Event files, and are then exported as a shapefile (filename convention: ALLPOINTS_WGS84.shp). The pointfile is then reprojected to the UTM coordinate system of the appropriate zone (14 or 15) (filename convention ALLPOINTS_UTM.shp).

Raster interpolation of the point data is performed using the same input data and the Topo to Raster option within the 3D Extension of ArcGIS. The elevation of the reservoir on the date of aerial photography used to create the perimeter/shoreline shapefile was used as the water surface elevation in all interpolations from point data to raster data.

Contour line files are derived from the raster interpolation files using the ArcGIS command under 3D Analyst – Raster Surface – Contour.

Area-elevation-volume tables are derived using an ArcGIS extension custom written for and available from the ASTRA Program. Summarized, the extension calculates the area and volume of the reservoir at 1/10-foot elevation increments from the raster data for a series of water surfaces beginning at the lowest elevation recorded and progressing upward in 1/10-foot elevation increments to the reference water surface. Cumulative volume is also computed in acre-feet.

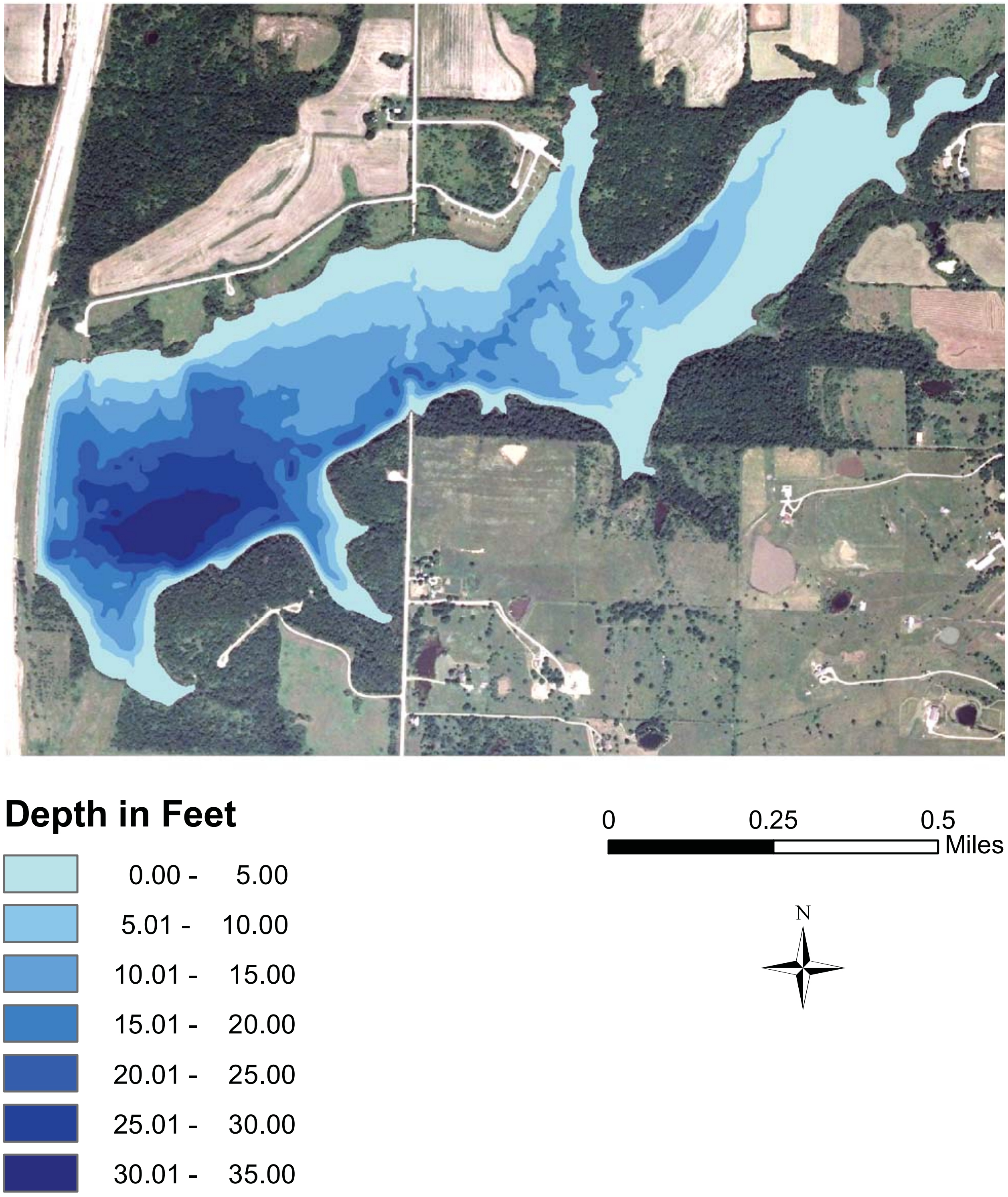


Figure 5. Water depth based on September 17, 2008 bathymetric survey.for Louisburg-Middle Creek Lake. Depths are based on a pool elevation of 985.65 feet.

Table 1

Cumulative area in acres by tenth foot elevation increments

Elevation (ft NAVD88)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
951	0	0	0	0	0	1	1	1	2	2
952	2	3	3	3	3	4	4	4	5	5
953	6	6	7	7	7	8	8	8	8	9
954	9	9	9	9	10	10	10	10	10	11
955	11	11	11	11	12	12	12	12	12	13
956	13	13	13	13	14	14	14	15	15	15
957	16	16	17	17	18	18	18	19	19	19
958	20	20	20	21	21	21	21	22	22	23
959	23	23	24	24	25	25	25	26	26	26
960	27	27	28	28	28	29	29	30	30	31
961	31	32	32	33	33	33	34	34	34	35
962	35	35	36	36	36	37	37	37	38	38
963	39	39	39	40	40	41	41	41	42	42
964	43	43	43	44	44	45	45	46	46	46
965	47	47	48	48	49	49	50	50	51	51
966	52	52	53	53	54	54	55	56	56	57
967	57	58	58	59	60	60	61	61	62	63
968	63	64	65	65	66	67	68	69	70	71
969	72	73	74	75	76	77	78	78	79	80
970	81	82	83	84	85	86	87	88	89	89
971	90	91	92	93	94	95	96	97	98	99
972	100	101	102	103	104	105	106	107	108	109
973	111	112	113	114	115	116	117	118	119	120
974	121	122	123	124	126	127	128	129	130	131
975	133	134	135	136	137	139	140	141	142	143
976	144	145	146	147	148	149	150	151	151	152
977	153	154	155	156	156	157	158	159	160	160
978	161	162	163	164	164	165	166	167	168	169
979	170	170	171	172	173	175	176	177	178	179
980	180	181	182	183	183	184	185	186	187	188
981	189	190	191	192	193	193	194	195	196	197
982	198	199	200	201	202	203	204	205	206	207
983	208	209	210	211	212	213	215	216	217	218
984	220	221	223	224	226	228	229	231	233	235
985	237	239	241	243	245	248	251			

Table 2

Cumulative volume in acre-feet by tenth foot elevation increments

Elevation (ft NAVD88)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
951	0	0	0	0	0	0	0	0	0	1
952	1	1	1	2	2	2	3	3	4	4
953	5	5	6	7	7	8	9	10	10	11
954	12	13	14	15	16	17	18	19	20	21
955	22	23	24	25	26	28	29	30	31	32
956	34	35	36	38	39	40	42	43	45	46
957	48	49	51	53	54	56	58	60	62	64
958	65	67	69	71	74	76	78	80	82	84
959	87	89	91	94	96	99	101	104	106	109
960	112	114	117	120	123	126	128	131	134	137
961	141	144	147	150	153	157	160	163	167	170
962	174	177	181	184	188	192	195	199	203	207
963	211	214	218	222	226	230	235	239	243	247
964	251	256	260	264	269	273	278	282	287	291
965	296	301	306	310	315	320	325	330	335	340
966	345	351	356	361	367	372	378	383	389	394
967	400	406	412	418	423	429	435	442	448	454
968	460	467	473	480	486	493	500	506	513	520
969	527	535	542	549	557	565	572	580	588	596
970	604	612	621	629	637	646	654	663	672	681
971	690	699	708	717	727	736	746	755	765	775
972	785	795	805	815	826	836	847	857	868	879
973	890	901	912	924	935	947	958	970	982	994
974	1006	1018	1030	1043	1055	1068	1080	1093	1106	1119
975	1133	1146	1159	1173	1187	1200	1214	1228	1242	1257
976	1271	1286	1300	1315	1330	1344	1359	1374	1389	1405
977	1420	1435	1451	1466	1482	1498	1513	1529	1545	1561
978	1577	1593	1610	1626	1642	1659	1675	1692	1709	1726
979	1743	1760	1777	1794	1811	1829	1846	1864	1882	1899
980	1917	1935	1954	1972	1990	2008	2027	2046	2064	2083
981	2102	2121	2140	2159	2178	2197	2217	2236	2256	2276
982	2295	2315	2335	2355	2376	2396	2416	2437	2457	2478
983	2499	2520	2540	2562	2583	2604	2625	2647	2669	2690
984	2712	2735	2757	2779	2802	2824	2847	2870	2893	2917
985	2940	2964	2988	3012	3037	3062	3087			

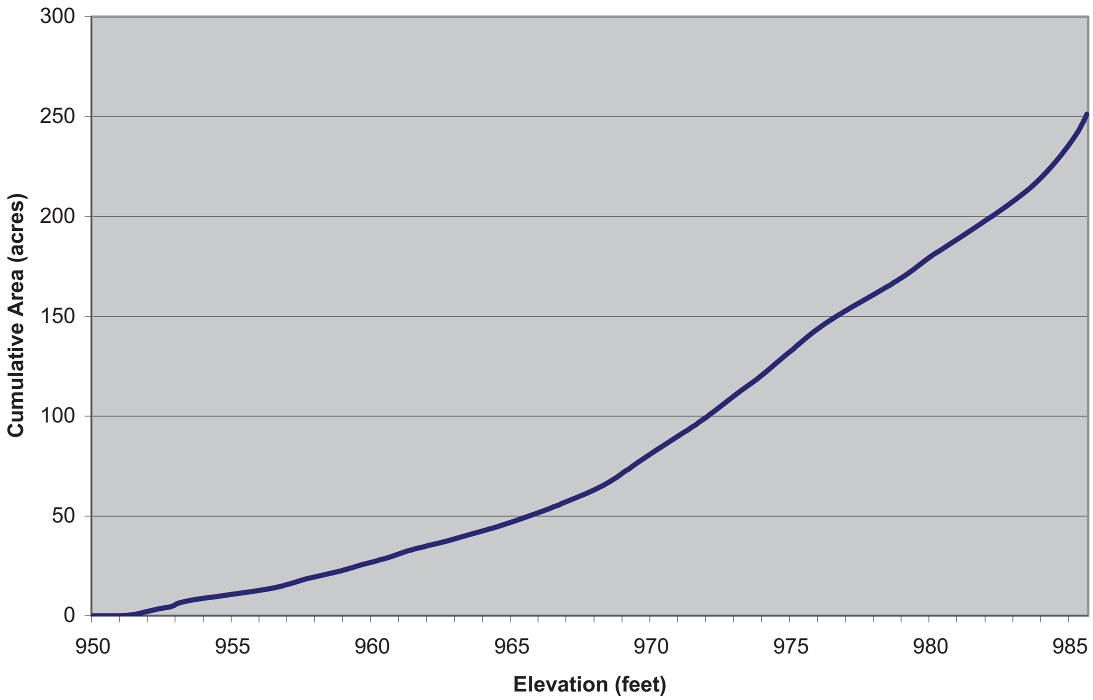


Figure 6. Cumulative area-elevation curve

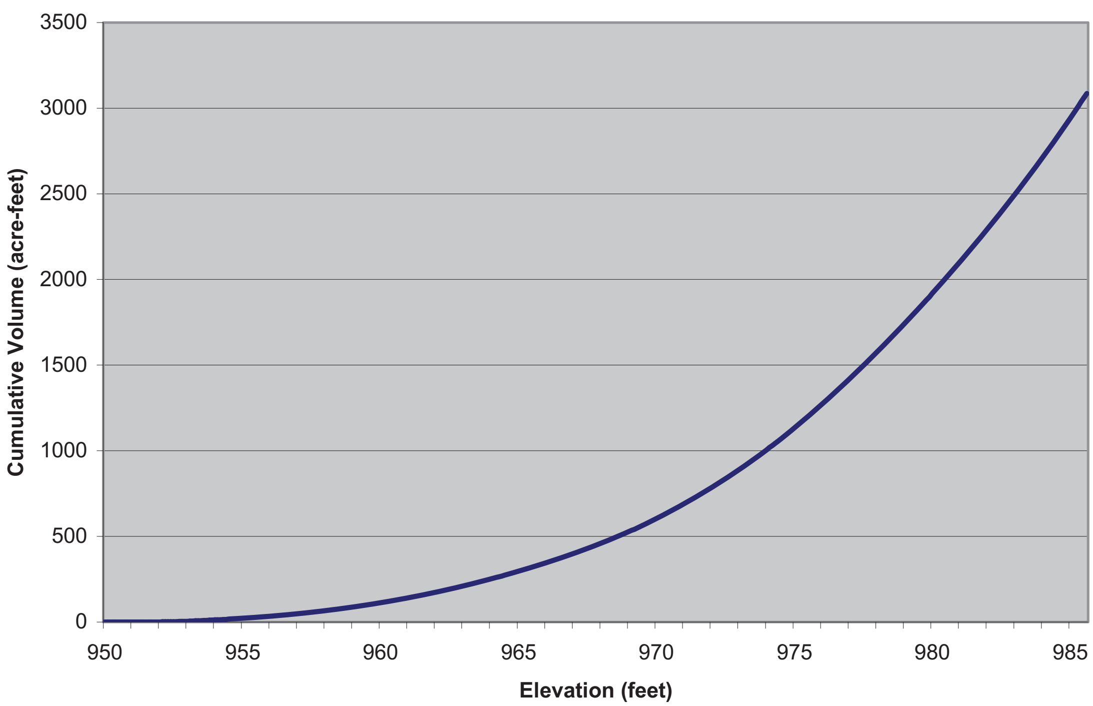


Figure 7. Cumulative volume-elevation curve

SEDIMENT SAMPLING PROCEDURES

Sediment samples were collected from three sites within the reservoir using a Wildco drop-corer (Wildlife Supply Company, Buffalo, NY). One sample is taken near the dam; a second at mid-lake; and a third in the upper end/transitional area. Sampling was performed on the same day as the bathymetric survey, following completion of the survey. As the drop-corer samples only the upper sediment, the entire sample in each case was collected and sealed in a sampling container. The samples were then shipped to the Kansas State University Soil Testing Laboratory (Manhattan, KS), for texture analysis. No bulk density sampling or analysis were performed for Louisburg-Middle Creek Lake.

SEDIMENT SAMPLING RESULTS:

Sampling sites were distributed across the length of the reservoir (Figure 8). Silt percentages decreased from 72% at the inflow end (LMC-3) to 34% near the dam (LMC-1). Conversely, the clay fraction increased from the inflow end to the dam, while sand constituted a minor or non-existent fraction in all three samples (Table 3; Figure 9; Figure 10).

Table 3
Louisburg-Middle Creek Lake Sediment Sampling Site Data

CODE	UTMX	UTMY	%Sand	% Silt	% Clay
LMC-1	353086.1	4263064.0	4	34	62
LMC-2	353907.5	4263467.5	0	58	42
LMC-3	354673.6	4263715.7	3	72	25

Coordinates are Universal Transverse Mercator (UTM), NAD83, Zone 15 North

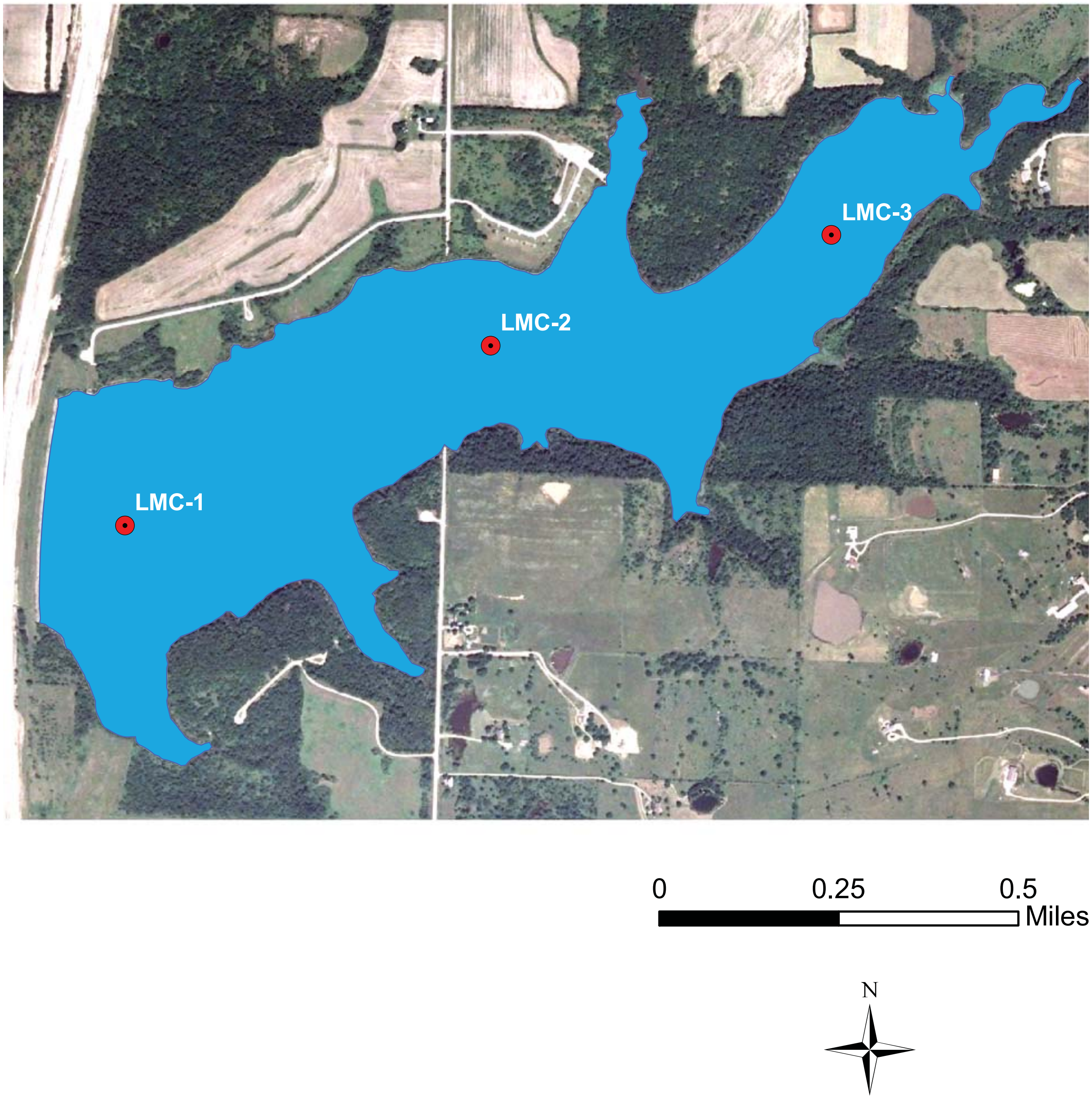


Figure 8. Location of sediment samples in Louisburg-Middle Creek Lake.

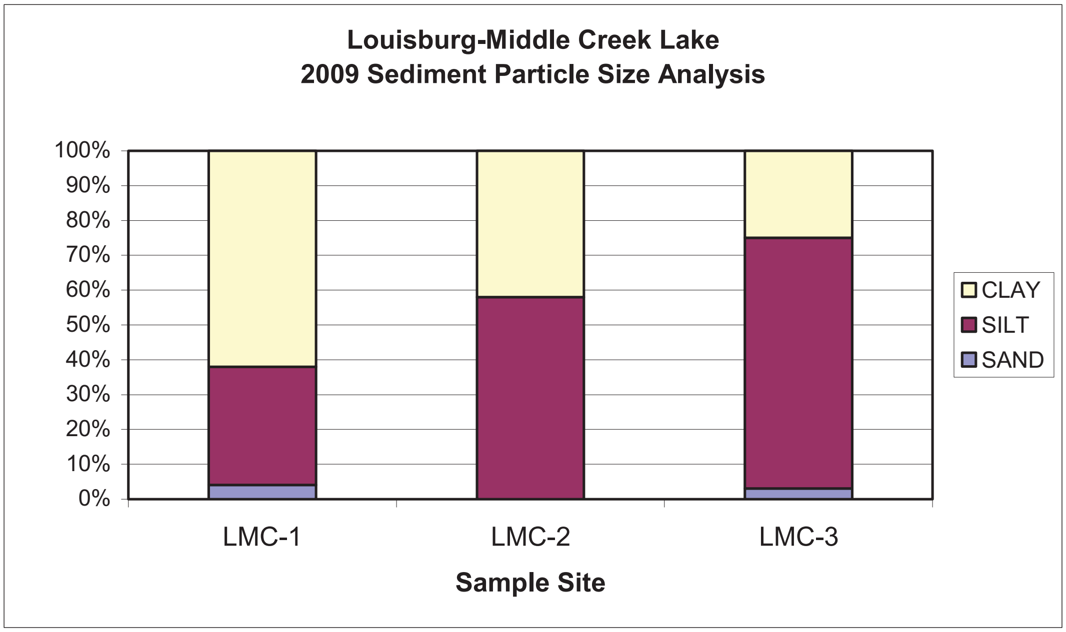


Figure 9. Sediment particle size analysis.

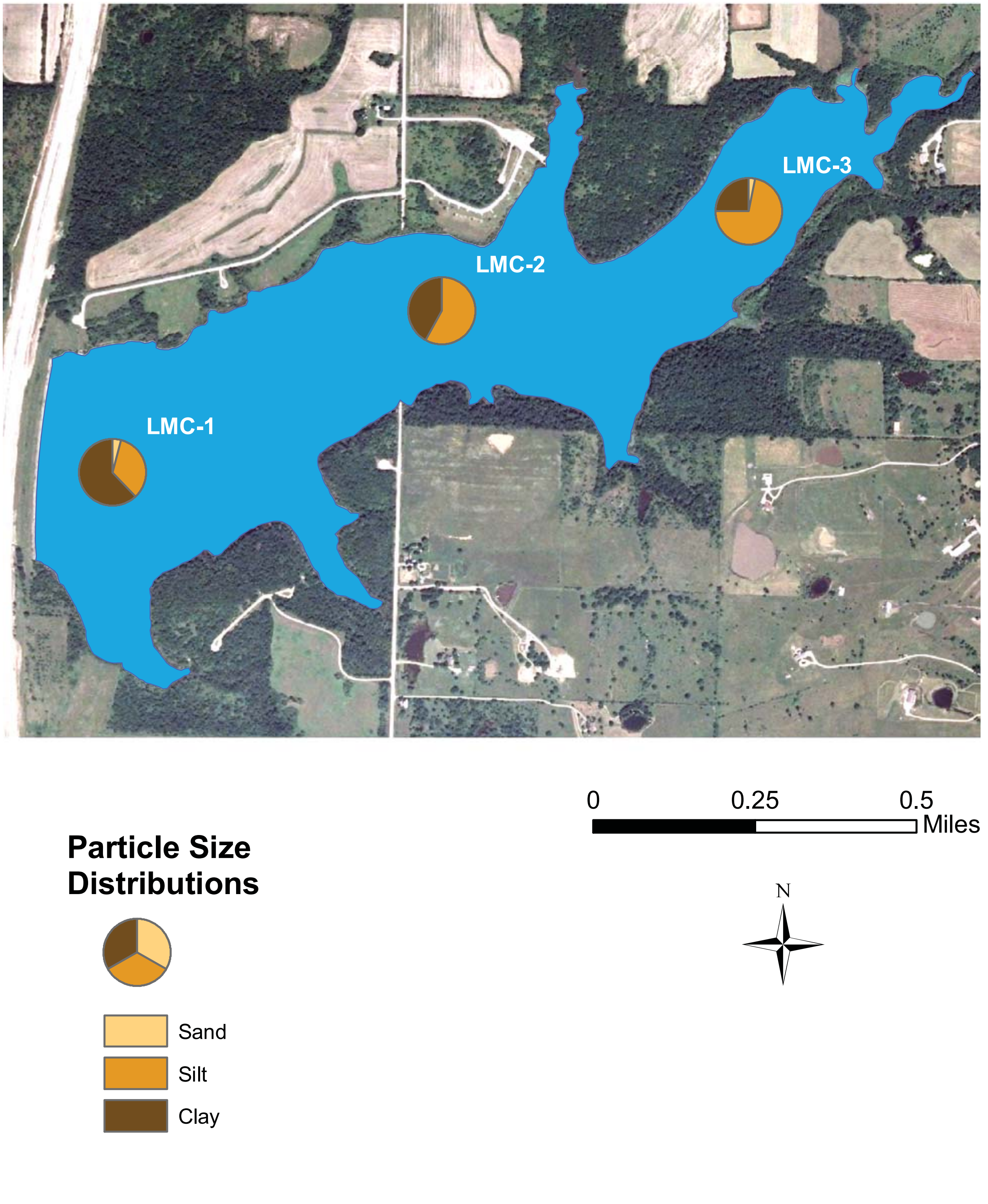


Figure 10. Particle size distribution of sediment samples in Louisburg-Middle Creek Lake.