

Prepared in cooperation with the  
Nebraska Department of Environmental Quality

# Hydrographic Surveys for Six Water Bodies in Eastern Nebraska, 2005–07

Scientific Investigations Report 2008–5048



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By Michaela R. Johnson, Michael J. Andersen, and Sonja K. Sebree

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## Conversion Factors and Datums

<b>Multiply</b>	<b>By</b>	<b>To obtain</b>
Length		
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
Area		
acre	4,047	square meter (m <sup>2</sup> )
Volume		
acre-foot (acre-ft)	1,233	cubic meter (m <sup>3</sup> )

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).





# Hydrographic Surveys for Six Water Bodies in Eastern Nebraska, 2005–07

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## Abstract

The U.S. Geological Survey, in cooperation with the Nebraska Department of Environmental Quality, completed hydrographic surveys for six water bodies in eastern Nebraska: Maskenthine Wetland, Olive Creek Lake, Standing Bear Lake, Wagon Train Lake and Wetland, Wildwood Lake, and Yankee Hill Lake and sediment basin. The bathymetric data were collected using a boat-mounted survey-grade fathometer that operated at 200 kHz, and a differentially corrected Global Positioning System with antenna mounted directly above the echo-sounder transducer. Shallow-water and terrestrial areas were surveyed using a Real-Time Kinematic Global Positioning System. The bathymetric, shallow-water, and terrestrial data were processed in a geographic information system to generate a triangulated irregular network representation of the bottom of the water body. Bathymetric contours were interpolated from the triangulated irregular network data using a 2-foot contour interval. Bathymetric contours at the conservation pool elevation for Maskenthine Wetland, Yankee Hill Lake, and Yankee Hill sediment pond also were interpolated in addition to the 2-foot contours. The surface area and storage capacity of each lake or wetland were calculated for 1-foot intervals of water surface elevation and are tabulated in the Appendix for all water bodies.

## Introduction

Lakes experience physical changes with time as a result of sediment deposition and bank erosion. Understanding the hydrologic and bathymetric characteristics of Nebraska's lakes, and how those characteristics have changed with time, is essential for the effective management of these valuable resources. The U.S. Geological Survey (USGS), in cooperation with Nebraska Department of Environmental Quality, conducted hydrographic surveys to determine the storage capacity of six water bodies in eastern Nebraska (fig. 1). The purpose of this report is to document the methods used and present the results of the hydrographic surveys conducted 2005 through 2007.

## Maskenthine Wetland

The Maskenthine Wetland is located near Stanton, Nebraska (fig. 1). A small dam was constructed in 1989 to create the 7.6-acre wetland that also serves as a sediment basin (Lower Elkhorn Natural Resources District, 2008). The wetland filters out sediment from surface water flowing into Maskenthine Lake. Maskenthine Wetland was dry at the time of the survey.

## Olive Creek Lake

The Olive Creek Lake near Kramer, Nebraska, was formed when a dam was built on the south tributary of Olive Branch in 1964 (fig. 1). The 174-acre lake was primarily used for flood control and recreation (U.S. Army Corps of Engineers, 2006a). It was modified in 2002–03 to renovate the fishery by constructing jetty and island habitat structures. Two small dams also were constructed to form sediment basins on two tributaries at the upper end of the lake (G. Michl, Nebraska Department of Environmental Quality, written commun., 2007). The scope of the hydrographic survey for this lake was limited to the area downstream from these dams.

## Standing Bear Lake

The Standing Bear Lake was formed when a dam was built on a tributary of Papillion Creek in Omaha, Nebraska, in 1977 (fig. 1). The 137-acre lake as built was constructed to provide flood control and recreation (U.S. Army Corps of Engineers, 2006b). The lake was surveyed in 1998 by the Nebraska Department of Environmental Quality with a surface area of 104 acres (Nebraska Department of Environmental Quality, 2003).

## Wagon Train Lake and Wetland

The Wagon Train Lake near Hickman, Nebraska, was formed when a dam was built on the north tributary of Hickman Branch in 1963 (fig. 1). The 260-acre lake was constructed to provide flood control and recreation. The 30-acre

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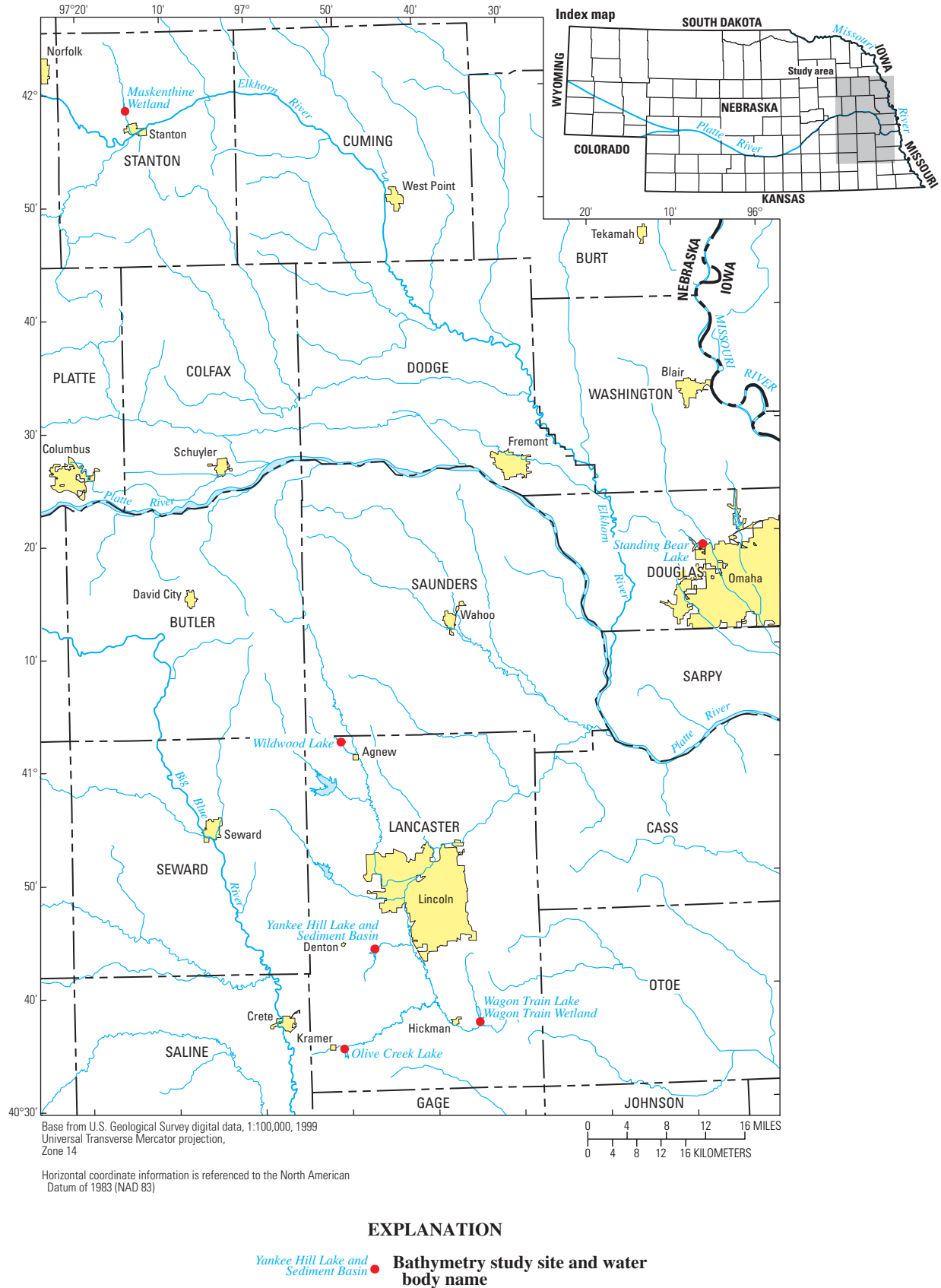


Figure 1. Locations of hydrographic surveys in eastern Nebraska 2005–07.

wetland was created in 2002 when the lake was renovated to provide shoreline stabilization and reduce sediment inflow to the lake by creating a sediment basin and wetland areas (Nebraska Department of Environmental Quality, 2002a).

## Wildwood Lake

The Wildwood Lake near Agnew, Nebraska, was formed when a dam was constructed on a tributary to North Oak Creek in 1980 (fig. 1). The 110-acre flood-control and recreational lake was renovated to reduce sediment inflow to the reservoir and add habitat structures in 2001. During the renovation parts of the lake were deepened, islands were created and shoreline scallops were created to create a varying depth shoreline (Lower Platte South Natural Resources District, 2008).

## Yankee Hill Lake and Sediment Basin

The Yankee Hill Lake near Denton, Nebraska, was formed when a dam was constructed on Cardwell Branch in 1965 (fig. 1). The 211-acre flood-control and recreational lake was renovated in 2004 (Nebraska Department of Environmental Quality, 2002b). Habitat structures were added to the lake and sediment basins were constructed on the two major tributaries to the lake (Nebraska Department of Environmental Quality, 2007). Yankee Hill Lake was dry at the time of the survey. The scope of the hydrographic survey for this lake was limited to the sediment basin on the west tributary and the lake downstream from these sediment basins.

## Methods

Mapping the entire conservation pool of each water body was completed by hydrographic surveys, a combination of bathymetric, shallow-water, and terrestrial surveying. Bathymetry was surveyed using a differential Global Positioning System (DGPS) receiver together with a digital survey fathometer. Water-surface elevations were recorded during bathymetric surveying to allow later calculation of bottom elevations by subtracting water depth. Water-surface elevations were determined from the vertical distance measured from a fixed reference mark location down to the water surface.

The shallow-water and terrestrial surveys were conducted where additional data were needed, that is, in shallow water where water depths were less than 3 feet and for terrestrial areas up to the conservation pool elevation. These data were collected using Real-Time Kinematic (RTK) Global Positioning System (GPS).

The bathymetric, shallow-water, and terrestrial data were combined using geographic information systems (GIS) to map the bathymetry of the conservation pool, and to determine the surface area and storage capacity (volume) of each water body.

Contour lines of equal elevation were plotted, reviewed, and edited for accuracy and consistency. Bathymetric maps were constructed to present these contours.

## Bathymetric and GPS Data Collection

All bathymetric data were collected on a series of cross-section lines oriented perpendicularly to the longitudinal axis of the lake. These cross-sections were spaced 10 to 15 feet apart. The bathymetric surveys were conducted by boat from June 8, 2005, through June 24, 2005 (table 1). These surveys were conducted independently from the shallow-water and terrestrial surveys that were necessary to characterize impoundment structures, the areas of the lake too shallow to survey by boat, or areas that were dry at the time of surveying. Shallow-water and terrestrial surveys occurred primarily from June 28, 2005, through November 8, 2006. Additional terrestrial surveying occurred on July 15, 2007. Maskenthine Wetland and Yankee Hill Lake and sediment basin were surveyed solely with terrestrial methods because they were dry at the time they were surveyed (fig. 2). The remaining water bodies were surveyed using a combination of bathymetric, shallow-water, and terrestrial methods (fig. 2).

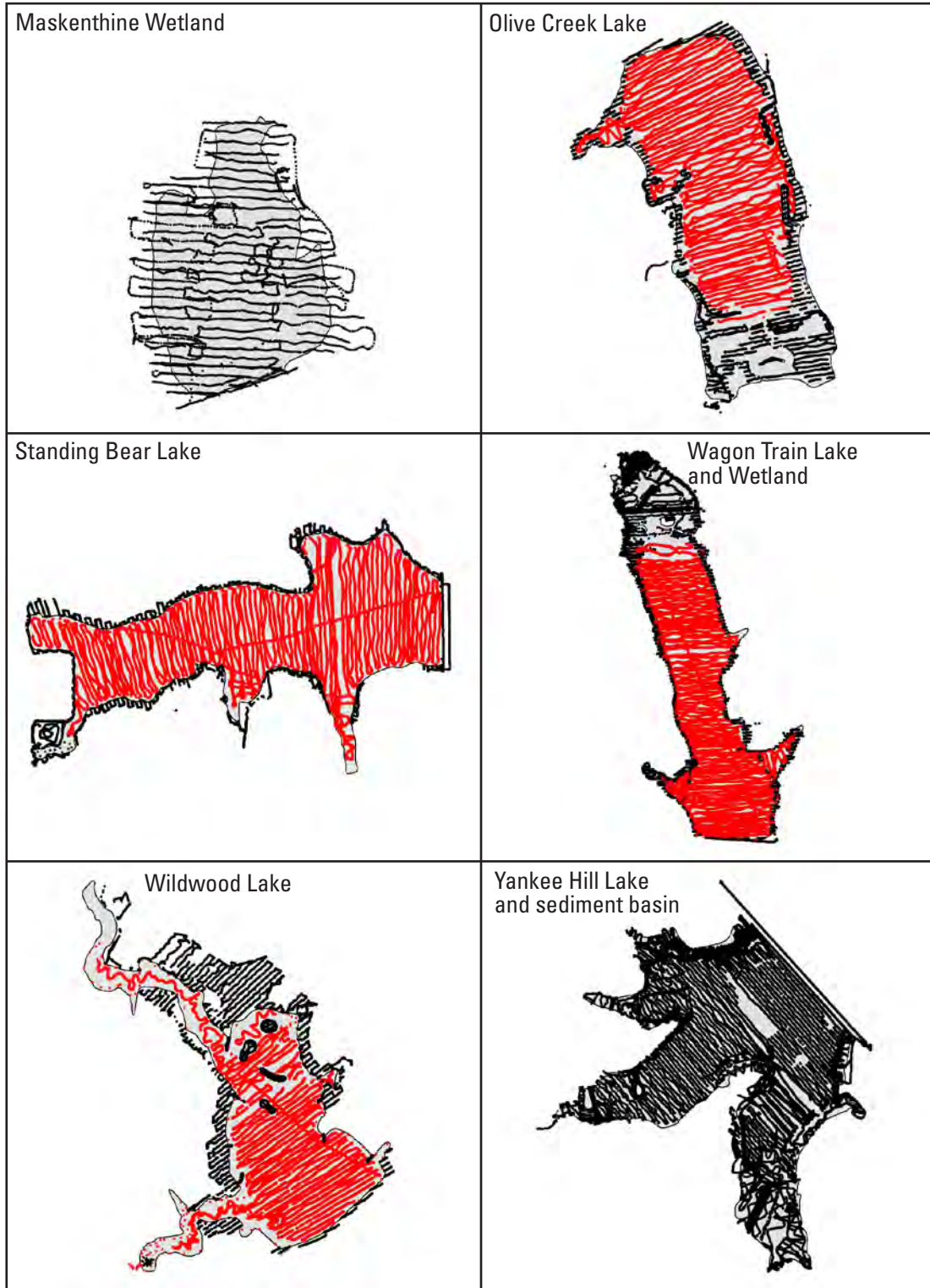
The bathymetric data were collected using a survey-grade fathometer operating at 200 kHz (Innerspace Technology, 2001) and DGPS mounted on a boat. The fathometer was used to collect water-depth data at discrete points approximately 0.1 foot apart depending on water depth, boat speed, and other operational parameters. The nominal accuracy of the bathymetric data was plus or minus 0.5 foot.

Data for shallow-water and terrestrial areas were collected with RTK GPS receivers. At each lake, the GPS base station was positioned at a benchmark having an established location, and the collected data were processed through the National Geodetic Survey Online Positioning User Service (OPUS). The accuracy of these benchmark locations were reported to be within 2 inches horizontally and vertically. The base station transmitted radio signals to roving GPS units to maintain the vertical and horizontal control during data collection. The scope of the terrestrial surveys included areas between the shallow-water bottom elevations (areas with less than 3-foot water depth at the time of bathymetric surveying) and the conservation pool elevation, islands, impoundment structures, jetties, and the fixed reference mark locations used during the bathymetric surveys.

## Data Processing

The data from the bathymetric, shallow-water, and terrestrial surveys were formatted as text files of northing and easting coordinates in meters and elevation in feet. All data were converted to a common map projection [Universal Transverse Mercator, zone 14, horizontal North American Datum of 1983 and North American Vertical Datum of 1988 for use in GIS processing (Snyder, 1987)]. The text file from

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**EXPLANATION**

- Bathymetry point—Elevation point collected by boat-mounted fathometer for bathymetric surveys
- RTK GPS point—Elevation point collected by a surveying person using a Real Time Kinematic (RTK) Global Navigation Satellite System (GPS) for shallow-water or terrestrial surveys

Figure 2. Data collection method for each water body.

**Table 1.** Dates of surveys for each water body by bathymetric, shallow-water, and terrestrial survey type.

[DGPS, differential Global Positioning System; RTK GPS, Real-Time Kinematic Global Positioning System; --, bathymetric data not required because lake was dry]

Water body	Bathymetric survey dates (DGPS)	Shallow-water and terrestrial survey dates (RTK GPS)
Maskenthine Wetland	--	May 10, 2006 and July 11–12, 2006
Olive Creek Lake	June 8–9, 2005	July 14, 2006 and July 18–20, 2006
Standing Bear Lake	June 10–11, 2005	October 24–25, 2006
Wagon Train Lake and Wetland	June 12, 2005 June 14, 2005 June 20–22, 2005	July 15, 2005, July 19, 2005, August 1, 2006, and July 15, 2007
Wildwood Lake	June 22–24, 2005	October 31, 2006, November 1, 2006, and November 8, 2006
Yankee Hill Lake and sediment basin	--	June 28–30, July 12, 2005, and July 5–6, 2006

each lake or wetland was used to generate point features as a shapefile (Environmental Systems Research Institute, 1998). Each point shapefile was plotted and compared to a digital orthophotographic quarter quadrangle (DOQQ) of the area surrounding the water body using ArcMap to ensure accurate georeferencing and to inspect for data errors (U.S. Geological Survey, 1998). All GIS processing used the Environmental Systems Research Institute, Inc. (ESRI), Redlands, Calif., GIS software, ArcGIS, an integrated collection of GIS software products including ArcMap, ArcEdit, and the 3-D Analyst extension.

## Bathymetric Surface Generation

A triangulated irregular network (TIN) surface was used to represent the bottom of the water body. The initial TIN surface was generated from the combined bathymetric, shallow-water, and terrestrial point data. Based on the TIN surface, contours were interpolated using a 2-foot contour interval. Bathymetric contours at the conservation pool elevation for Maskenthine Wetland, Yankee Hill Lake, and Yankee Hill sediment pond also were interpolated in addition to the 2-foot contours. The contour lines were plotted over the DOQQ and a Digital Raster Graphic (DRG) topographic map to assess any errors or anomalies in either the TIN or point data. After several iterations, the final contour lines interpolated from the TIN surface were smoothed within ArcEdit using spline functions and grain tolerance settings. Additional editing and smoothing of the final contour lines was done within ArcMap to ensure consistency with land features in the DOQQ and the surveyed data.

The final TIN was generated from the combined bathymetric, shallow-water, and terrestrial point data; final contours; and a polygon defining the water body. The contour line at the conservation pool elevation or, if greater, the maximum elevation contour line, was converted to a single polygon

defining the extent of the water body. The extent polygon was the boundary used to confine the final TIN to the area of each water body. The final TIN was used to produce surface area and storage capacity (volume) tables detailing the size in acres and storage capacity in acre-feet for each 1-foot unit change in water-surface elevation.

## Hydrographic Surveys

The results of the bathymetric surveys are presented in this section. The bathymetric contours are first presented as a series of six maps. Summary statistics for the surface area and storage capacity (volumes) calculated for each water body are tabulated in a second section, and the individual 1-foot interval surface-area and storage-capacity tables are presented in the appendix of this report. Additionally, the Final Bathymetric Contours and Point Data section describes where contour shapefiles and shapefiles of surveyed points are available electronically for download from a Web link listed in the section.

### Bathymetric Contours

The combined bathymetric, shallow-water, and terrestrial data were used to generate a TIN surface representing the bottom of each water body. Bathymetric contours interpolated from the TIN surface were smoothed and matched against the land features in the DOQQ and the bathymetric data. A map showing the final bathymetric contours for each lake or wetland was produced (plates 1–6).

### Area and Volume Calculation

Each water body's surface area and storage capacity table was calculated from the final TIN and is listed in tables

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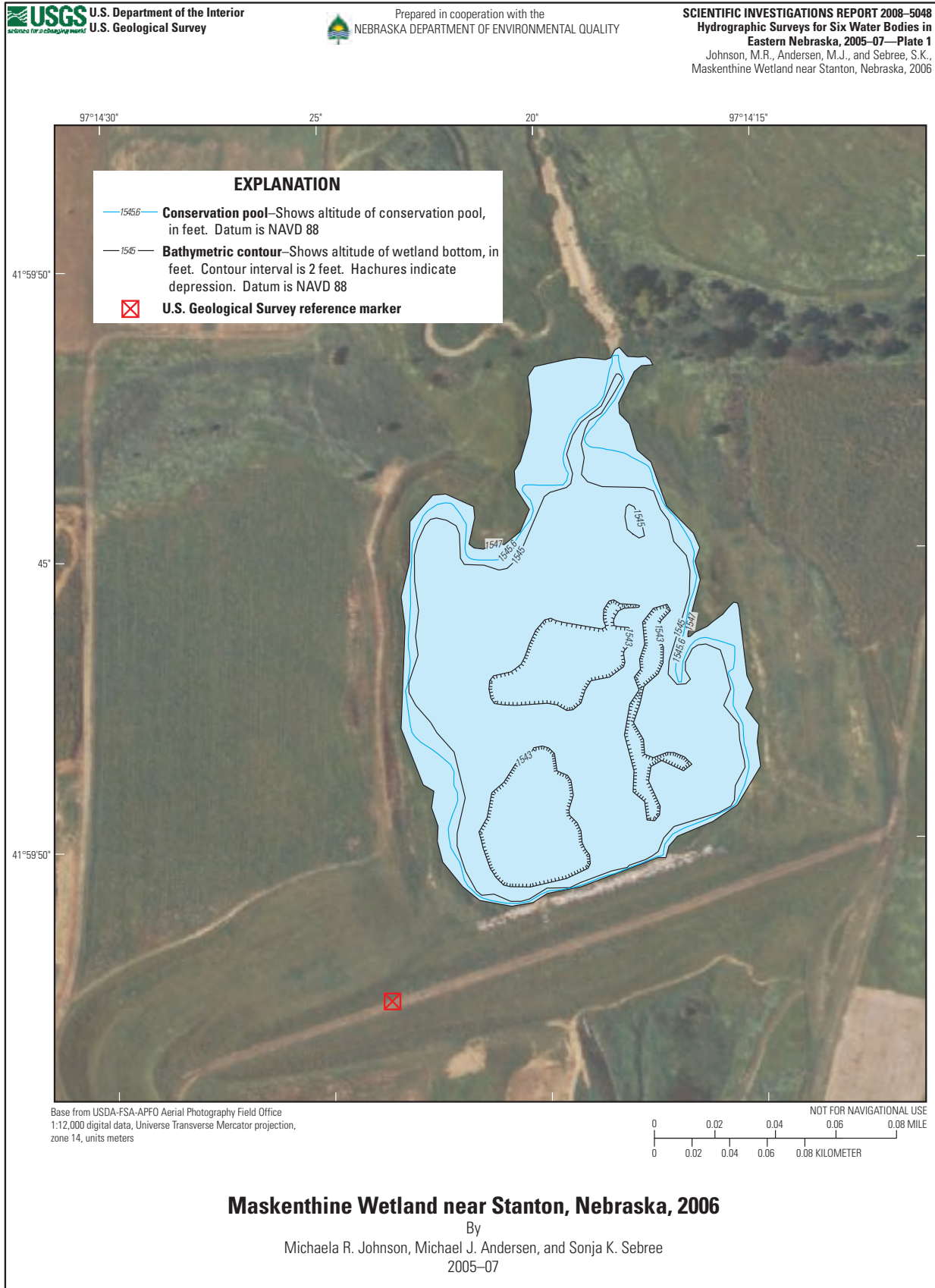
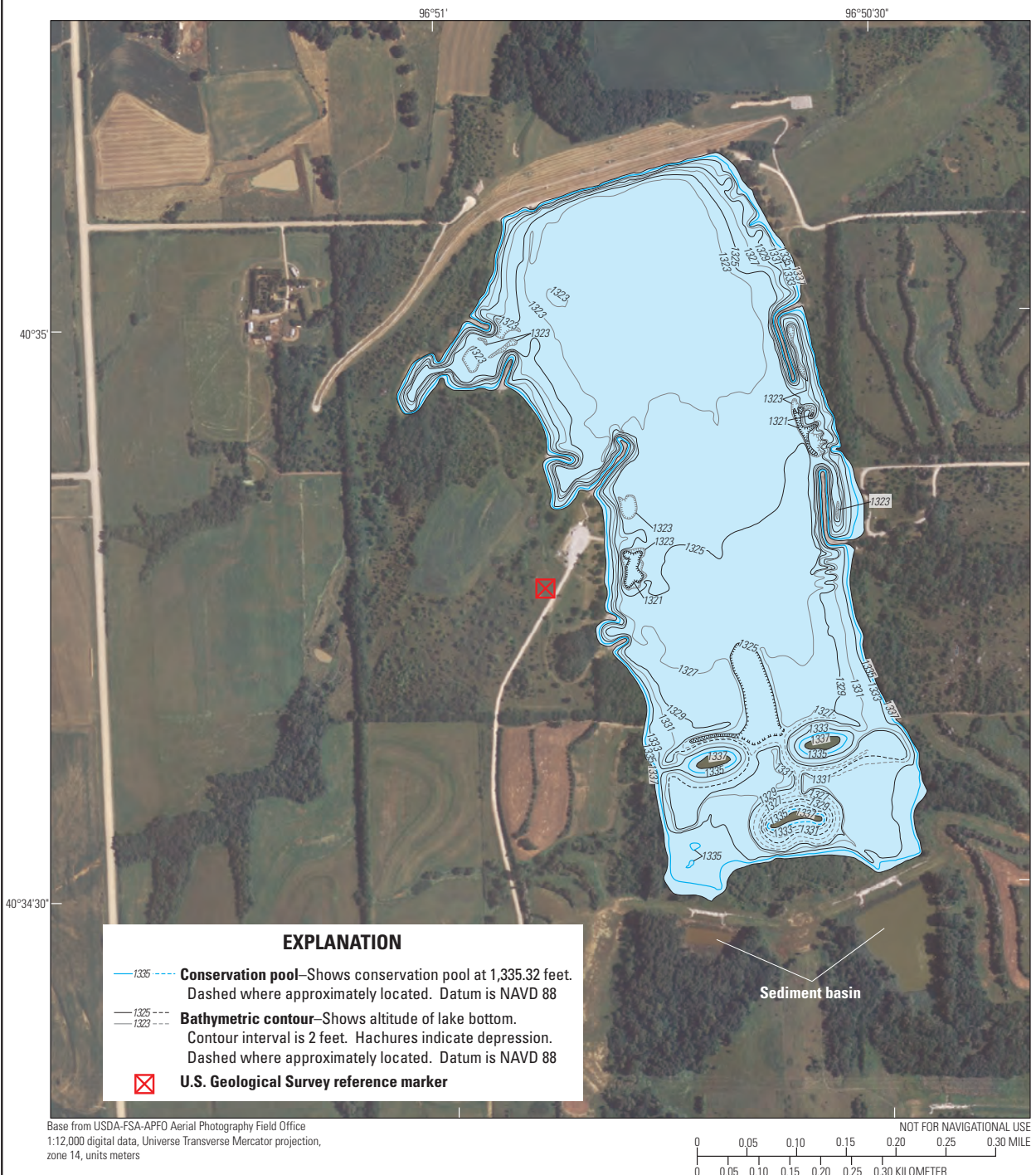


Plate 1. Bathymetric contours of Maskenthine Wetland near Stanton, Nebraska, 2006.



**Olive Creek Lake near Kramer, Nebraska, 2005-06**

By  
Michaela R. Johnson, Michael J. Andersen, and Sonja K. Sebree  
2005-07

Plate 2. Bathymetric contours of Olive Creek near Kramer, Nebraska, 2005-06.

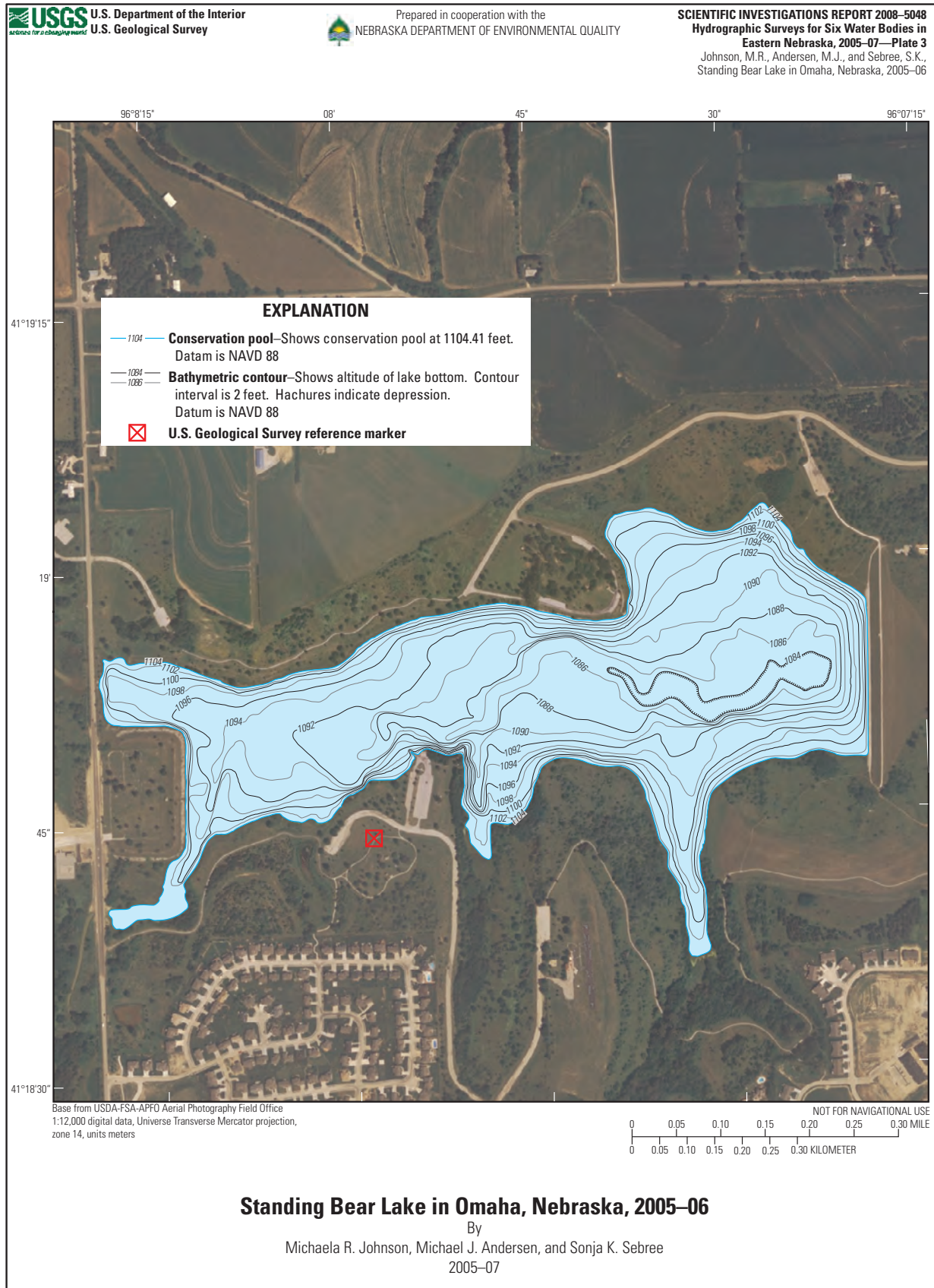


Plate 3. Bathymetric contours of Standing Bear Lake in Omaha, Nebraska, 2005–06.



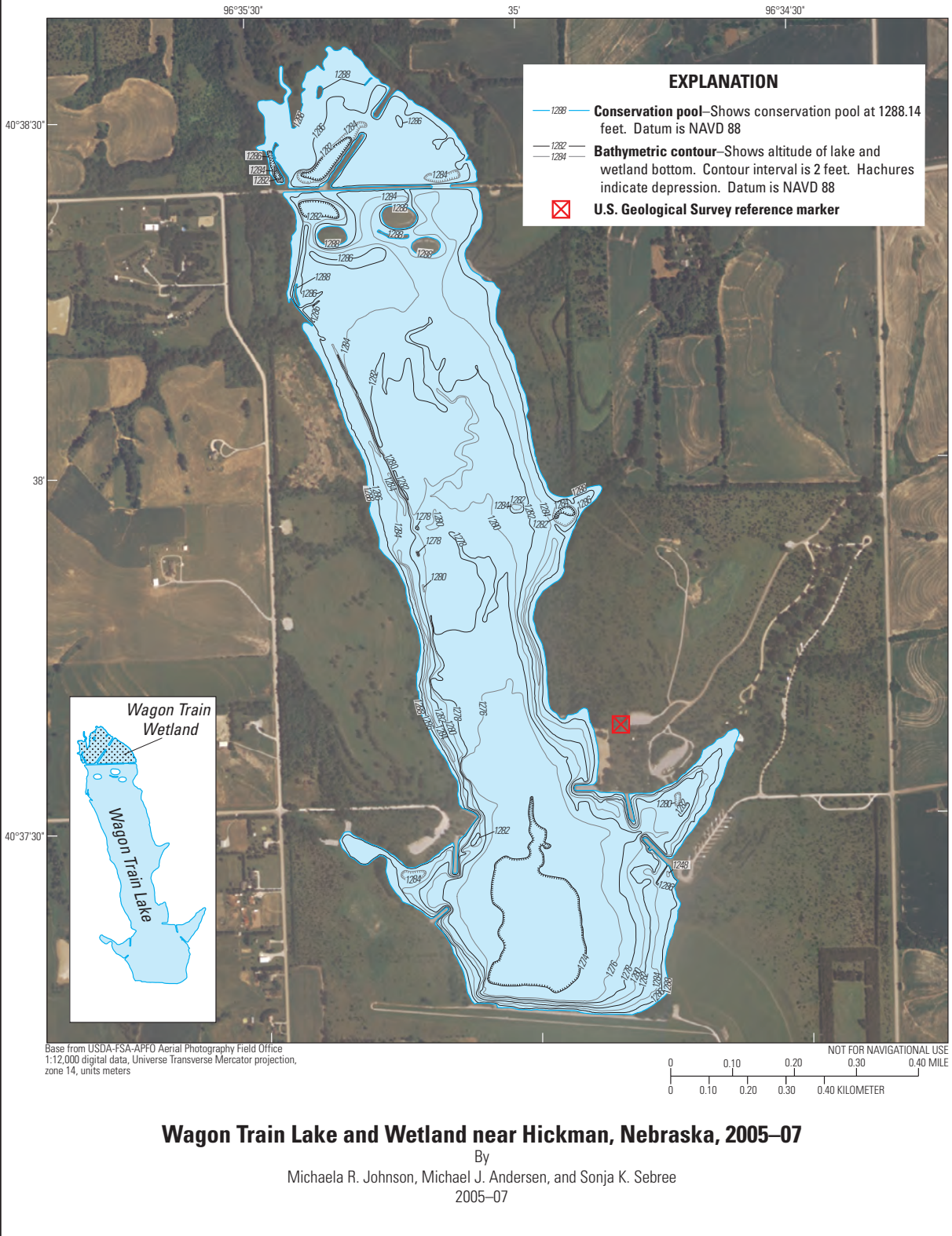
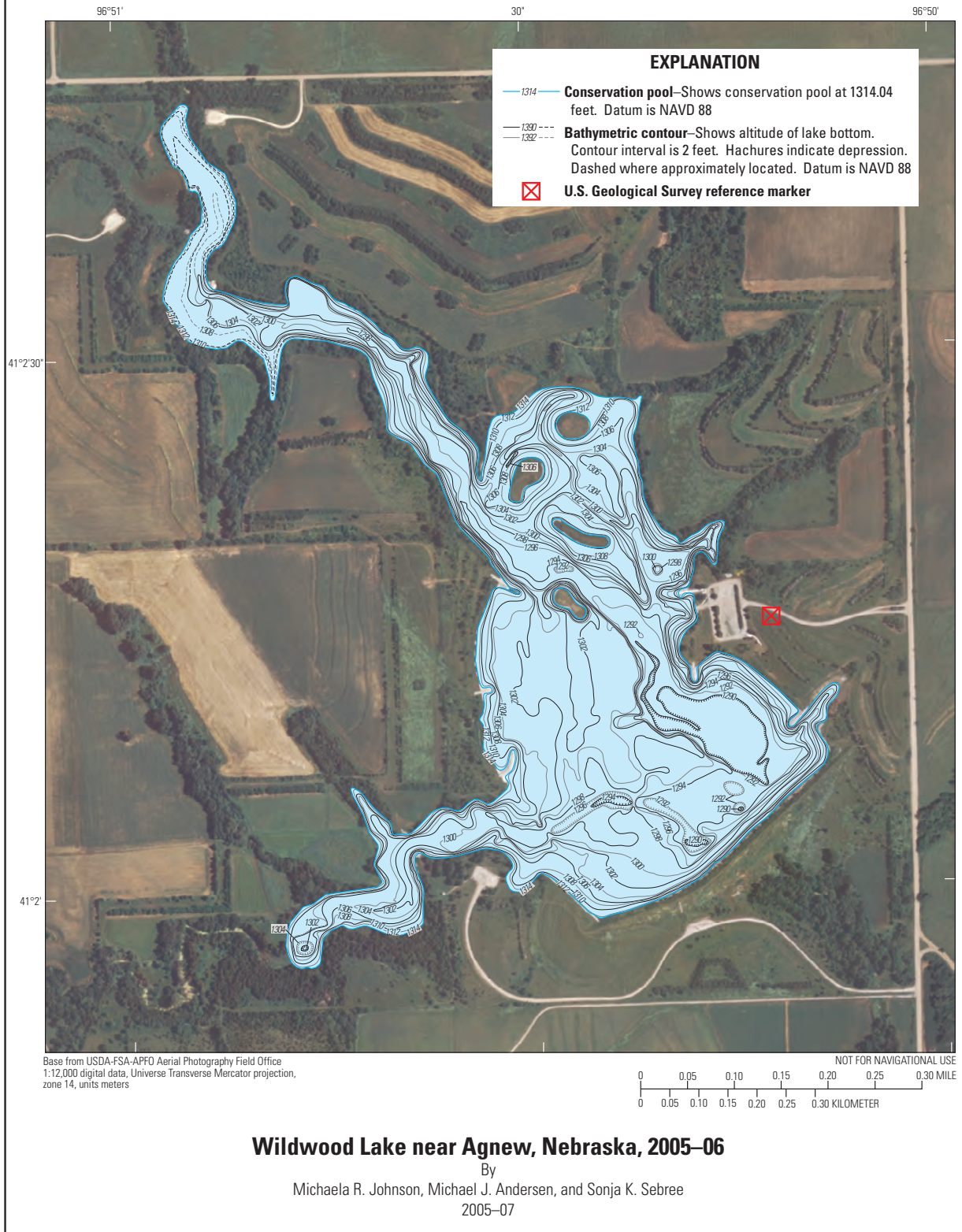
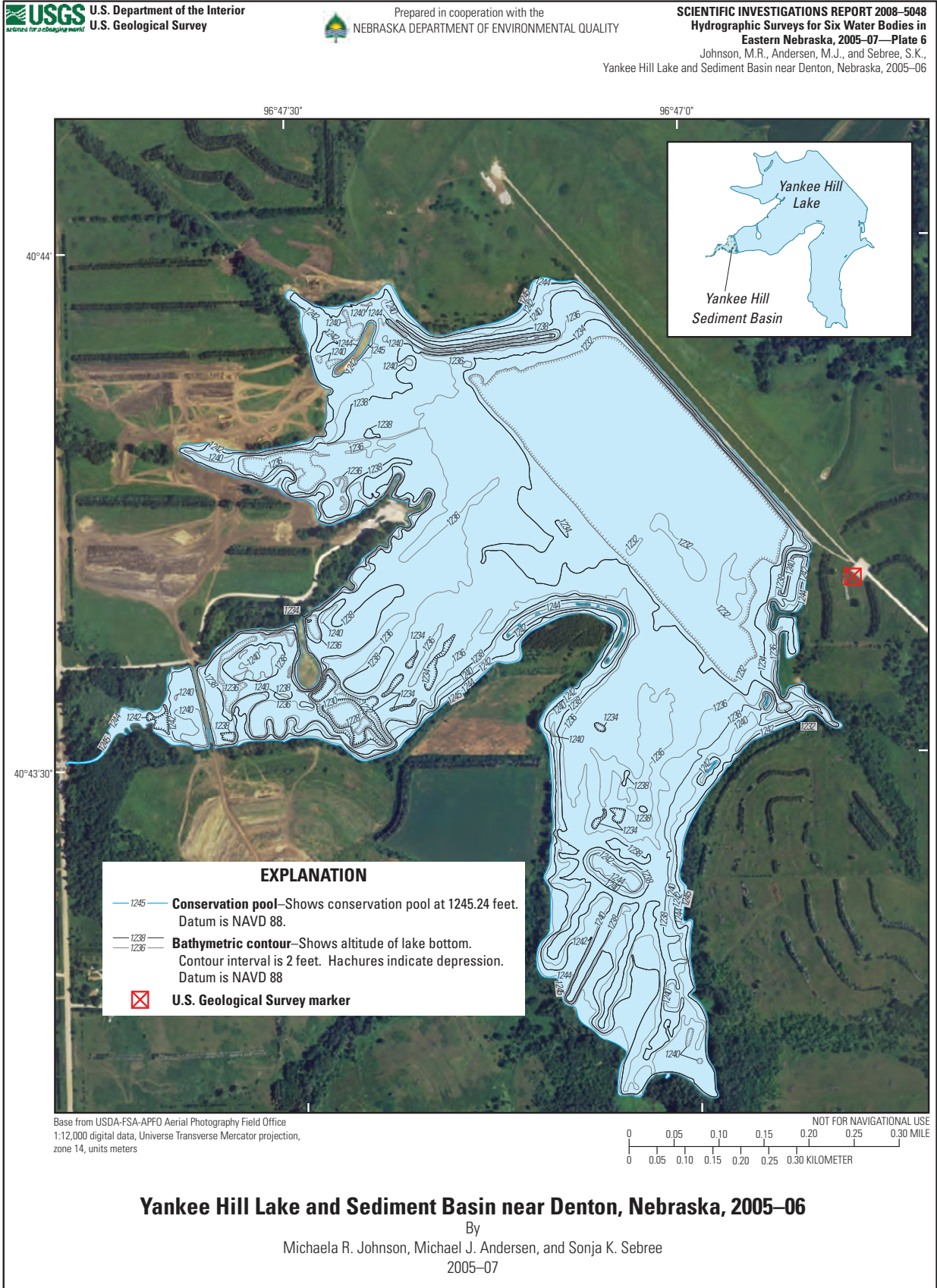


Plate 4. Bathymetric contours of Wagon Train Lake and Wetland near Hickman, Nebraska, 2005-07.



**Plate 5.** Bathymetric contours of Wildwood Lake near Agnew, Nebraska, 2005–06.



**Plate 6.** Bathymetric contours of Yankee Hill Lake and sediment basin near Denton, Nebraska, 2005-06.

3 through 10 in the appendix, at the back of this report. The surface area and storage capacity tables were calculated for each 1-foot change in elevation within the 3-D Analyst extension in ArcMap and written to a user-assigned output text file. Statistics for each water body obtained from the surface area and volume tables are listed in table 2. Separate area and capacity tables were generated for Wagon Train Lake, Wagon Train Wetland, Yankee Hill Lake, and Yankee Hill sediment basin.

## Timing of Bathymetric, Shallow-Water, and Terrestrial Surveys

Bathymetric, shallow-water, and terrestrial surveys were conducted 1 year apart. The shallow-water and terrestrial surveys began at the elevation where it became too shallow (less than 3 feet deep) for the bathymetric survey method. The impoundment structures and jetties were static between years, being composed of concrete rip-rap. Shallow water features and other terrestrial features may have undergone erosion or siltation in the interim between these surveys. These processes could have had some impact on the surface area and storage capacity; however, the difference in elevations of points replicated between years of survey did not exceed 0.5 foot, which also is the accuracy range associated with the bathymetric survey methods. Shallow-water and terrestrial data points collected in 2007 at Wagon Train Wetland also were within 0.5 foot of the data collected at replicate locations in 2006.

## Estimation of Bathymetric Contours

Bathymetric contours were estimated for some areas where bathymetric, shallow-water, and terrestrial data were not collected. Existing ancillary data were used to help locate

these contours. DOQQ imagery aided in reshaping contours to follow the features of the water body, such as islands and jetties. Bathymetric contours were estimated using this method near the three islands in the southern part of Olive Creek Lake. The channels connecting the open lake with shoals and pools behind these islands were not accessible by boat and RTK GPS data were not collected. The northern arm of Wildwood Lake also contains bathymetric contours that were estimated using a combination of RTK GPS data, DOQQ, and topographic maps (DRG).

## Final Bathymetric Contours and Point Data

The final contours and the combined bathymetric, shallow-water, and terrestrial point data for each water body are available for electronic download from this [Web link](#).

Data available on the Web are compressed in .zip format. WinZip® is a Windows-based file compression utility. A program similar to this is needed to extract the data files. A downloadable trial copy of WinZip software is available on the Web at: <http://www.winzip.com/downwz.htm> (accessed February 21, 2008).

The compressed data files, one per water body, contain geospatial data sets in shapefile format (Environmental Systems Research Institute, Inc., 1998). A shapefile consists of a main coordinates file, an index file, and a dBASE® format attribute table. Each record in the main file describes a spatial object with a list of its vertices and their coordinates. In the index file, each record contains the offset of the corresponding main file record from the beginning of the main file. The dBASE table contains feature–attribute records, one per feature, that tabulate additional information describing the features.

The 12 shapefiles that compose the downloadable sets of geospatial data are listed and described as follows:

**Table 2.** Summary statistics for each water body listing conservation-pool (CP) elevation, water-surface elevation when surveyed, surface area and volume at the CP elevation, and minimum and maximum contour elevations.

[All elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88); --, water body was dry at the time of survey]

Water body	Conservation-pool elevation (feet)	Water-surface elevation during bathymetry survey (feet)	Surface area at conservation pool elevation (acres)	Storage capacity at conservation pool elevation (acre-feet)	Minimum contour elevation, (feet)	Maximum contour elevation, (feet)
Maskenthine Wetland	1,545.60	--	7.6	13.9	1,543	1,547
Olive Creek Lake	1,335.32	1,331	120.2	1,060.0	1,321	1,337
Standing Bear Lake	1,104.41	1,104	116.3	1,278.0	1,084	1,104
Wagon Train Lake	1,288.14	1,288	260.8	1,942.4	1,274	1,288
Wagon Train Wetland	1,288.14	1,288	32.0	70.4	1,282	1,288
Wildwood Lake	1,314.04	1,310	111.0	1,347.1	1,290	1,314
Yankee Hill Lake	1,245.24	--	188.4	1,668.8	1,228	1,245
Yankee Hill sediment basin	1,245.24	--	3.5	11.3	1,240	1,245

1. SIR08\_5048\_mkvwcontour—bathymetric contours for Maskenthine Wetland (arc);
2. SIR08\_5048\_mkwpcontour—bathymetric point data for Maskenthine Wetland (point);
3. SIR08\_5048\_olvcontour—bathymetric contours for Olive Creek Lake (arc);
4. SIR08\_5048\_olvpoints—bathymetric point data for Olive Creek Lake (point);
5. SIR08\_5048\_stbcontour—bathymetric contours for Standing Bear Lake (arc);
6. SIR08\_5048\_stbpoints—bathymetric point data for Standing Bear Lake (point);
7. SIR08\_5048\_wtcontour—bathymetric contours for Wagon Train Lake and Wetland (arc);
8. SIR08\_5048\_wtpoints—bathymetric point data for Wagon Train Lake and Wetland (point);
9. SIR08\_5048\_wwrcontour—bathymetric contours for Wildwood Lake (arc);
10. SIR08\_5048\_wwrpoints—bathymetric point data for Wildwood Lake (point);
11. SIR08\_5048\_ynkcontour—bathymetric contours for Yankee Hill Lake and sediment basin (arc); and
12. SIR08\_5048\_ynkpoints—bathymetric point data for Yankee Hill Lake and sediment basin (point).

A compressed file containing metadata documentation is also available from the Web link.

## Summary

Hydrographic surveys were completed for six water bodies in eastern Nebraska: Maskenthine Wetland, Olive Creek Lake, Standing Bear Lake, Wagon Train Lake and Wetland, Wildwood Lake, and Yankee Hill Lake and sediment basin. Bathymetric, shallow-water, and terrestrial data were collected on a series of cross-sections spaced 10 to 15 feet apart across each water body and aligned perpendicularly to the longitudinal axis of the water body. The bathymetric data were collected using a boat-mounted survey-grade fathometer that operated at 200 kHz and a Differential Global Positioning System (DGPS) receiver. Data for shallow-water and terrestrial areas were collected using Real-Time Kinematic (RTK) global positioning system units. The bathymetric, shallow-water, and terrestrial data were combined and formatted as text files of northing and easting coordinates and elevations. For each water body, a triangulated irregular network (TIN) surface was generated from the bathymetric data to represent the bottom of the lake or wetland. Contours of the triangulated irregular network surface were interpolated using a 2-foot contour interval and subsequently were smoothed to create the final map. Bathymetric contours at the conservation pool elevation for Maskenthine Wetland, Yankee Hill Lake, and Yankee Hill sediment pond also were interpolated in addition to the 2-foot contours. The surface area and storage-capacity were calculated for 1-foot intervals of water-surface elevation. Tables of

the surface area and storage capacity for each water body are included in the appendix.

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## 14 Hydrographic Surveys for Six Water Bodies in Eastern Nebraska, 2005–07

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# Appendix

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**16 Hydrographic Surveys for Six Water Bodies in Eastern Nebraska, 2005–07**

**Table 3.** Surface area and storage capacity for Maskenthine Wetland (surface area 7.6 acres and storage capacity 13.9 acre-feet at conservation-pool elevation of 1,545.6 feet).

<b>Elevation, in feet</b>	<b>Surface area, in acres</b>	<b>Storage capacity, in acre-feet</b>
1,543.0	1.6	0.5
1,544.0	4.7	3.9
1,545.0	6.7	9.6
1,546.0	8.1	17.1
1,547.0	9.1	25.7



**Table 4.** Surface area and storage capacity for Olive Creek Lake (surface area 120.2 acres and storage capacity 1,060.0 acre-feet at conservation-pool elevation of 1,335.32 feet).

<b>Elevation, in feet</b>	<b>Surface area, in acres</b>	<b>Storage capacity, in acre-feet</b>
1,320.0	0.1	0.1
1,321.0	.5	.4
1,322.0	1.0	1.2
1,323.0	27.3	12.6
1,324.0	43.1	48.4
1,325.0	54.4	97.3
1,326.0	64.5	157.1
1,327.0	74.2	226.4
1,328.0	84.0	306.5
1,329.0	88.5	392.5
1,330.0	94.7	485.2
1,331.0	99.0	582.0
1,332.0	104.8	684.0
1,333.0	110.7	791.8
1,334.0	115.0	904.7
1,335.0	119.0	1,021.7
1,336.0	122.2	1,142.4
1,337.0	125.1	1,266.0

**18 Hydrographic Surveys for Six Water Bodies in Eastern Nebraska, 2005–07****Table 5.** Surface area and storage capacity for Standing Bear Lake (surface area 116.3 acres and storage capacity 1,278.0 acre-feet at conservation-pool elevation of 1,104.41 feet).

<b>Elevation, in feet</b>	<b>Surface area, in acres</b>	<b>Storage capacity, in acre-feet</b>
1,083.0	1.4	0.4
1,084.0	4.0	3.0
1,085.0	7.3	8.7
1,086.0	12.3	18.3
1,087.0	17.6	33.0
1,088.0	23.0	53.4
1,089.0	28.9	79.4
1,090.0	34.9	111.3
1,091.0	41.2	149.3
1,092.0	49.3	194.4
1,093.0	56.6	247.5
1,094.0	63.9	307.7
1,095.0	70.8	375.2
1,096.0	77.6	449.4
1,097.0	83.5	530.1
1,098.0	88.9	616.3
1,099.0	94.0	707.9
1,100.0	99.0	804.2
1,101.0	103.4	905.4
1,102.0	107.0	1,010.7
1,103.0	110.0	1,119.3
1,104.0	114.2	1,231.5

**Table 6.** Surface area and storage capacity for Wagon Train Lake (surface area 260.8 acres and storage capacity 1,942.4 acre-feet at full conservation pool elevation of 1,288.14 feet).

<b>Elevation, in feet</b>	<b>Surface area, in acres</b>	<b>Storage capacity, in acre-feet</b>
1,273.0	1.4	0.3
1,274.0	15.9	7.5
1,275.0	35.6	33.6
1,276.0	52.7	78.4
1,277.0	64.0	137.0
1,278.0	78.2	207.9
1,279.0	92.5	293.8
1,280.0	104.9	392.1
1,281.0	124.3	507.0
1,282.0	147.2	642.6
1,283.0	167.8	801.6
1,284.0	187.2	978.1
1,285.0	216.5	1,182.6
1,286.0	234.9	1,408.6
1,287.0	249.0	1,651.7
1,288.0	259.3	1,905.9

**Table 7.** Surface area and storage capacity for Wagon Train Wetland (surface area 32.0 acres and storage capacity 70.4 acre-feet at conservation pool elevation of 1,288.14 feet).

<b>Elevation, in feet</b>	<b>Surface area, in acres</b>	<b>Storage capacity, in acre-feet</b>
1,282.0	1.2	0.4
1,283.0	1.7	1.9
1,284.0	2.7	4.0
1,285.0	6.2	8.4
1,286.0	14.6	18.2
1,287.0	23.9	38.8
1,288.0	31.1	66.0

**Table 8.** Surface area and storage capacity for Wildwood Lake (surface area 111.0 acres and storage capacity 1,347.1 acre-feet at conservation pool elevation of 1,314.04 feet).

<b>Elevation, in feet</b>	<b>Surface area, in acres</b>	<b>Storage capacity, in acre-feet</b>
1,289.0	0.1	0.0
1,290.0	4.2	1.5
1,291.0	6.5	7.1
1,292.0	8.7	14.4
1,293.0	11.1	24.5
1,294.0	14.4	37.1
1,295.0	17.2	53.2
1,296.0	20.8	72.0
1,297.0	24.3	94.5
1,298.0	28.8	120.8
1,299.0	33.8	152.5
1,300.0	38.0	188.2
1,301.0	44.0	229.3
1,302.0	53.0	277.5
1,303.0	62.4	336.0
1,304.0	69.3	401.6
1,305.0	75.5	474.5
1,306.0	80.7	552.5
1,307.0	87.2	637.2
1,308.0	91.7	726.7
1,309.0	96.5	820.9
1,310.0	101.1	919.7
1,311.0	103.6	1,022.2
1,312.0	105.7	1,126.9
1,313.0	107.9	1,233.7
1,314.0	109.9	1,342.6

**Table 9.** Surface area and storage capacity for Yankee Hill Lake (surface area 188.4 acres and storage capacity 1,668.8 acre-feet at conservation pool elevation of 1,245.24 feet).

<b>Elevation, in feet</b>	<b>Surface area, in acres</b>	<b>Storage capacity, in acre-feet</b>
1,228.0	0.5	0.2
1,229.0	.9	1.0
1,230.0	1.4	2.1
1,231.0	19.0	11.3
1,232.0	37.3	40.6
1,233.0	42.2	80.7
1,234.0	50.2	126.1
1,235.0	67.7	184.4
1,236.0	91.1	263.3
1,237.0	112.4	366.4
1,238.0	127.7	486.6
1,239.0	139.6	621.0
1,240.0	148.8	764.9
1,241.0	161.2	920.9
1,242.0	169.4	1,086.1
1,243.0	176.3	1,259.2
1,244.0	182.0	1,438.5
1,245.0	186.6	1,622.9

**Table 10.** Surface area and storage capacity for Yankee Hill sediment basin (surface area 3.5 acres and storage capacity 11.3 acre-feet at conservation pool elevation of 1,245.24 feet).

<b>Elevation, in feet</b>	<b>Surface area, in acres</b>	<b>Storage capacity, in acre-feet</b>
1,240.0	0.4	0.2
1,241.0	1.3	1.1
1,242.0	1.9	2.7
1,243.0	2.4	4.8
1,244.0	2.8	7.5
1,245.0	3.2	10.5

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