Lahontan Reservoir
2004 Survey

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13. ABSTRACT *(Maximum 200 words)*

The Bureau of Reclamation surveyed Lahontan Reservoir in June 2004 to develop new reservoir topography and compute a present storage-elevation relationship (area-capacity tables). The underwater survey, conducted between reservoir elevation 4,153.2 (feet) and 4,156.0 (project datum), used sonic depth recording equipment interfaced with a real-time kinematic (RTK) global positioning system (GPS) that gave continuous sounding positions throughout the underwater portion of the reservoir covered by the survey vessel. The above-water topography was obtained from aerial photography flown on November 4 of 1988. This study assumed no change since the 1988 aerial survey from elevation 4,155 and above.

As of June 2004, at spillway crest elevation 4,162.0, the surface area was 13,159 acres with a total capacity of 289,721 acre-feet. At maximum reservoir elevation 4,169.0, the surface area was 17,764 acres with a total capacity of 400,734 acre-feet.

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Lahontan Reservoir 2004 Survey

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March 2005

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UNITED STATES DEPARTMENT OF THE INTERIOR

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

BUREAU OF RECLAMATION

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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INTRODUCTION

Lahontan Dam and Reservoir, about 17 miles west of Fallon and 45 miles northeast of Carson City, Nevada, is located in Churchill County on the Carson River (fig. 1). The dam, reservoir, and facilities are part of the Newlands Project that supplies irrigation water to the Truckee-Carson Irrigation District. The reservoir captures water from the Carson River along with Truckee River diversions through the Truckee Canal.

Figure 1 – Lahontan Reservoir Location Map.

The reservoir, formed by a rolled earth and gravel zoned dam was completed in 1915. The dam consists of two zones with earth and gravel on the upstream zone and gravel fill on the downstream zone. The dam dimensions are:

Hydraulic height[1]	120	feet	Structural height	162	feet
Top width	20	feet	Crest length	1,325	feet
Crest elevation	4,174.0	feet[2]			

[1]The definition of such terms as "hydraulic height," "structural height," etc. may be found in manuals such as Reclamation's *Design of Small Dams* and *Guide for Preparation of Standing Operating Procedures for Dams and Reservoirs*, or ASCE's *Nomenclature for Hydraulics.*

[2]Elevations in feet. All elevations based on the original project datum established by U.S. Bureau of Reclamation that was reported to be 3.75 feet higher than the National Geodetic Vertical Datum of 1929 (NGVD29) and 0.3 feet higher than the North American Vertical Datum of 1988 (NAVD88).

There are two ungated fixed crest overflow spillways located on each abutment of the dam. Each spillway is 250-foot-long with a crest elevation of 4,162.0. Twenty-inch-high wooden flashboards are on top of each crest and are removable for projected spillway use. Modifications in 1985 increased the combined discharge capacity of the spillways to 30,000 cubic feet per second (cfs) at dam crest elevation 4,174.0.

An outlet works is located through the left central section of the dam embankment and consists of a gated 114-foot-high concrete intake tower that controls the flow to two 9-foot horseshoe conduits. The lowest inlet gate is at elevation 4,070.0. The total discharge capacity of the combined outlets is 2,000 cfs at reservoir elevation 4,162.0. There are two powerplants with a maximum rated discharge capacity of 1,000 cfs.

The drainage area above Lahontan Dam is approximately 1,799 square miles and all is considered sediment contributing. The reservoir, at elevation 4,162 is about 18 miles in length with an average width of 0.9 miles.

SUMMARY AND CONCLUSIONS

This Reclamation report presents the 2004 results of the survey of Lahontan Reservoir. The primary objective of the survey was to gather data to:

- develop reservoir topography
- compute area-capacity relationships

The hydrographic survey crew utilized horizontal and vertical control that was previously established as part of the Lahontan Reservoir network. The global positioning system (GPS) base was set over monument "Dam 2" that was located near the dam. The horizontal control was in the Nevada state plane west coordinate zone in the North American Datum of 1983 (NAD83) and the vertical control was tied to the National American Vertical Datum of 1988 (NAVD88). All elevations in this report are in feet and referenced to the Reclamation project vertical datum that is reported to be 3.75 feet higher than National Geodetic Vertical Datum of 1929 (NGVD29) and 0.3 feet higher than NAVD88.

The underwater survey was conducted in June 2004 between reservoir elevation 4,154 and 4,156. The bathymetric survey used sonic depth recording equipment interfaced with a real-time kinematic (RTK) GPS capable of determining sounding locations within the reservoir. The system continuously recorded depth and horizontal coordinates of the survey boat as it navigated along grid lines covering Lahontan Reservoir. The positioning system provided information to allow the boat operator to maintain a course along these grid lines. The reservoir's water surface elevations recorded by the USGS reservoir gauge during the time of collection were used to convert the sonic depth measurements to reservoir bottom elevations.

The 2004 above-water area of Lahontan Reservoir was developed from aerial photography obtained on November 4, 1988 near reservoir elevation 4,091.3. The 1988 survey developed 5-foot reservoir contours from elevation 4,095 and above. The 1988 data was on the Lahontan

Dam local vertical datum that was (+) 3.75 feet above NGVD29 and the horizontal coordinates were Nevada's state plane, west zone, on the North American Datum of 1927.

For this study, mapping tools were utilized to convert the digital aerial information to match the 2004 underwater data in Nevada's state plane coordinates, west zone, NAD83. With the 2004 underwater data as a background, the 1988 aerial contour 4,150 was adjusted in the upper end of the reservoir to reflect changes that had occurred since 1988. This adjusted contour was assigned elevation 4,150 and was used as a clip to enclose the 2004 underwater data during contour development. The final 2004 Lahontan Reservoir topography is a combination of the 1988 aerial contours from elevation 4,155 and above, the adjusted 4,150 aerial contour, and the 2004 underwater collected data. A computer graphics program generated the 2004 reservoir surface areas at predetermined contour intervals from these combined data sets. The 2004 area and capacity tables were generated by a computer program that used the measured contour surface areas and a curve-fitting technique to compute area and capacity at prescribed elevation increments (Bureau of Reclamation, 1985).

Tables 2 and 3 contain summaries of the Lahontan Reservoir and watershed characteristics for the 2004 survey. The 2004 survey determined that the reservoir has a storage capacity of 289,721 acre-feet and a surface area of 13,159 acres at spillway crest elevation 4,162.0.

RESERVOIR OPERATIONS

Lahontan Reservoir is part of the Newlands Project that provides a water supply to the Truckee-Carson Irrigation District. The June 2004 capacity table shows 400,734 acre-feet of total storage below the maximum water surface elevation 4,169.0. The 2004 survey measured a minimum lake bottom elevation of 4,073.6. The following values are from the June 2004 capacity table:

- 87,750 acre-feet of surcharge elevation 4,163.67 and 4,169.0.
- 23,263 acre-feet of joint use between elevation 4,162.0 and 4,163.67.
- 289,721 acre-foot of active storage between elevation 4,070.0 and 4,162.0.
- 0 acre-foot of dead storage below 4,070.0.

Lahontan Reservoir available inflow and end-of-month stage records are listed by water year on table 2 for operation period 1965 through 2003. The inflow values are from the USGS gauging station "Carson River near Fort Churchill, Nevada." This station is located upstream of the reservoir and measured only 1,302 square miles of the total 1,799 square miles of drainage area above the dam. The listed values do not reflect the diverted Truckee River inflows through the Truckee Canal to the reservoir. These gauge records were the only information available during preparation of this report. The average computed runoff at this gauge, for water years 1911 through 2003, was 271,700 acre-feet per year. The table also lists the maximum and minimum reservoir elevations by water year. The extremes for the period of record were maximum elevation 4,164.43 in 1942 and minimum elevation 4,070.0 in 1929 (Geological Survey, 2003).

HYDROGRAPHIC SURVEY EQUIPMENT AND METHOD

The hydrographic survey equipment was mounted in the cabin of a 24-foot trihull aluminum vessel equipped with twin in-board motors (figure 2). The hydrographic system included a GPS receiver with a built-in radio, a depth sounder, a helmsman display for navigation, a computer, and hydrographic system software for collecting the underwater data. An on-board generator supplied power to all the equipment. The shore equipment included a second GPS receiver with an external radio. The GPS receiver and antenna were mounted on a survey tripod over a known datum point and a 12-volt battery provided the power for the shore unit.

Figure 2 - Survey vessel with mounted hydrographic equipment on Jackson Lake in Wyoming

The Sedimentation and River Hydraulics Group uses RTK GPS with the major benefit being precise heights measured in real time to monitor water surface elevation changes. The basic output from a RTK receiver are precise 3D coordinates in latitude, longitude, and height with accuracies in the order of 2 centimeters horizontally and 3 centimeters vertically. The output is on the GPS datum of WGS-84 that the hydrographic collection software converted into Nevada's NAD83 state plane west zone coordinate system. The RTK GPS system employs two receivers that track the same satellites simultaneously just like with differential GPS.

Lahontan Reservoir hydrographic survey was conducted in June of 2004 between reservoir elevation 4,153.2 and 4,156.0 (Reclamation project datum). The bathymetric survey was run using sonic depth recording equipment, interfaced with a RTK GPS, capable of determining sounding locations within the reservoir. The survey system software continuously recorded reservoir depths and horizontal coordinates as the survey boat moved across closely spaced grid lines covering the reservoir area. Most of the transects (grid lines) were run somewhat perpendicular to the downstream alignment of the reservoir at around a 300-foot spacing. Data was also collected along the shore as the boat traversed between transects. The survey vessel's

guidance system gave directions to the boat operator to assist in maintaining the course along these predetermined lines. During each run, the depth and position data were recorded on the notebook computer hard drive for subsequent processing. Additional shoreline and shallow water data was obtained by mounting the collection equipment in a smaller shallow draft boat. The underwater data set includes about 3,470,000 data points.

The 2004 underwater data were collected by a depth sounder that was calibrated by lowering a weighted cable below the boat with beads marking known depths. The depth sounder was calibrated by adjusting the speed of sound, which can vary with density, salinity, temperature, turbidity, and other conditions. The collected data were digitally transmitted to the computer collection system via a RS-232 port. The depth sounder also produced an analog hard-copy chart of the measured depths. The analog charts were printed for all survey lines as the data were collected and recorded by the computer. The charts were analyzed during post-processing, and when the analog charted depths indicated a difference from the recorded computer bottom depths, the computer data files were modified. The water surface elevations at the dam, recorded by the USGS gauge, were used to convert the sonic depth measurements to true lake-bottom elevations.

Lahontan Reservoir Datum

Prior to the reservoir underwater survey, the hydrographic survey crew conducted a RTK GPS survey to confirm the horizontal and vertical control of existing datums. RTK GPS was also used to establish a temporary point in the upper portion of the reservoir and monitor the reservoir surface elevation. The base was set on the NGS control point "Dam 2" that was listed as a third order horizontal control point by the NGS. The regional office provided updated coordinate information for the points listed below with Dam 2 labeled as "Dam 2 – A." All vertical information for this study is referenced to the Lahontan Reservoir water surface gauge measurements that were found to be 3.75 feet higher than NGVD29 and 0.3 feet higher than NAVD88. The horizontal control was in the Nevada state plane west coordinate zone in NAD83. Following are coordinates for points used during the 2004 reservoir survey:

	Dam 2 – A	Aluminum Cap C/L Bridge + Dam
East	2,486,473.8491	2,488,140.46
North	14,840,611.35492	14,839,308.70
Elevation	4,224.91 (NAVD88)	4,173.35 (NAVD88)
Elevation	4,221.46 (NGVD29)	4,169.90 (NGVD29)

RESERVOIR AREA AND CAPACITY

Topography Development

The topography of Lahontan Reservoir was developed from the 2004 collected underwater and the 1988 aerial contours. The 1988 aerial contours included 5-foot increments from elevation 4,095 to elevation 4,170. ARC/INFO geographic information system (GIS) software was used to transform the digital aerial contours to Nevada's NAD 1983 state plane coordinates, west zone.

The aerial contour of elevation 4,150 performed a hardclip around the 2004 underwater data of Lahontan Reservoir. This hardclip was used during the triangular irregular network (TIN) development so interpolation did not occur outside the enclosed polygon. This contour was selected since it was the closest available data to represent the upper elevations of the 2004 surveyed reservoir bottom elevations. Using ARCEDIT, the 2004 underwater data and the 1988 aerial contour at elevation 4,150 were plotted. The plot illustrated that in the upper end of the reservoir the 2004 underwater data near elevation 4,150 was located downstream of the 4,150 aerial contour. This 2004 measured change since the 1988 survey was assumed to be due to sediment deposition. For the 2004 analysis, the 1988 aerial developed 4,150 contour was adjusted in the upper end of the reservoir to reflect the 2004 measured changes. Using select and move commands within ARCEDIT, the vertices of the clip were shifted to fit the upper contour around the 2004 underwater data at elevation 4,150. This clip was assigned an elevation of 4,150.0 to reflect the 2004 surface area.

Contours for the reservoir below elevation 4,150.0 were computed from the underwater data set using the triangular irregular network (TIN) surface-modeling package within ARC/INFO. A TIN is a set of adjacent non-overlapping triangles computed from irregularly spaced points with x,y coordinates and z values. TIN was designed to deal with continuous data such as elevations. The TIN software uses a method known as Delaunay's criteria for triangulation where triangles are formed among all data points within the polygon clip. The method requires that a circle drawn through the three nodes of a triangle will contain no other point, meaning that sample points are connected to their nearest neighbors to form triangles using all collected data. This method preserves all collected survey points. Elevation contours are then interpolated along the triangle elements. The TIN method is discussed in detail in the ARC/INFO V7.0.2 *Users Documentation,* (ESRI, 1992).

The linear interpolation option of the ARC/INFO TINCONTOUR command was used to interpolate contours from the Lahontan Reservoir TIN. In addition, the contours were generalized by filtering out vertices along the contours. This generalization process improved the presentability of the resulting contours by removing very small variations in the contour lines. This generalization had no bearing on the computation of surface areas and volumes for Lahontan Reservoir since the areas were calculated from the developed TIN. The areas of the enclosed contour polygons at one-foot increments were developed from the survey data for elevations 4,074.0 through elevation 4,150.0. The 2004 study assumed no change in area, since the 1988 survey, for elevation 4,155.0 and above. The 2004 contour topography is presented on figures 3 through 18.

1988 Contour Data

The 1988 contours of Lahontan Reservoir were developed by Reclamation's Mid-Pacific Region from aerial photography obtained on November 4 of 1988. The reservoir level was very low during the 1988 collection allowing an updated area and capacity table to be developed from reservoir elevation 4091.3 to elevation 4,174.0 (dated 03/09/89). For the 2004 analysis, the 1988 digital contours were obtained from the regional office. These reservoir contours were at 5-foot increments from elevation 4,095.0 and above. The 1988 aerial data was processed on Lahontan

Dam local vertical datum that is (+) 3.75 feet above the NGVD29. The coordinates were on the Nevada State Plane, west zone, on the 1927 North American Datum.

As part of the 2004 analysis, the 1988 digital aerial contours were processed using the ARC/INFO editing tools. This included converting the positioning data to Nevada State Plane, west zone, in NAD83 and computing the surface area of the different contours. Obtaining the surface areas required minor editing to close the contour polygons. This mainly occurred at breaks in the contour lines where the mapping labels indicated the contour elevations. This was completed for contour elevations 4095 through 4160. There was not enough digital information to complete this process for contours 4165 and 4170.

The following table compares the surface areas in acres by reservoir elevation for the different methods of development. The 1988 values are from the published Lahontan area and capacity tables dated March 9, 1989. The 1988 GIS surface areas are from the 2004 ARC/INFO analysis of the 1988 developed contours. As described previously, the 1988 digital contours required minor editing to develop closed polygons for the 2004 study. The fourth column lists the surface area differences between the methods of column 2 and 3. The fifth column lists the percent of change between the two methods. The sixth column list the surface areas used to compute the 2004 area and capacity for Lahontan Reservoir. These 2004 surface areas, for elevations 4,095 through 4,145, were computed from the 2004 underwater collected data. Surface areas for elevation 4,155 and above are from the 1988 survey area table, column 2, that assumed no change since 1988. The surface area at elevation 4,150 is the adjusted surface area of the GIS generated 1988 aerial contour as described above. The last column shows the percent of difference between the 2004 surface area values and the 1988 table surface area values. The table shows that the differences between the 1988 and 2004 survey results were not significant.

Elev. (feet)	**1988 Table Surface Areas** (acres)	**1988 GIS Surface Areas** (acres)	**1988 GIS - Table Difference** (acres)	**1988 GIS - Table Percent Diff.**	**2004 Surface Areas** (acres)	**2004 Areas - 1988 Table Percent Diff.**
4095	838.4	872.0	33.6	4.0	809.0	3.5
4100	1,094.8	1,101.5	6.7	0.6	1,042.1	4.8
4105	1,337.0	1,341.8	4.8	3.6	1,265.3	5.4
4110	1,584.2	1,571.7	(-) 12.5	0.8	1,498.3	5.4
4115	2,008.4	2,015.0	6.6	0.3	1,926.6	4.1
4120	2,458.8	2,531.2	72.4	2.9	2,376.8	3.3
4125	2,995.1	3,026.5	31.4	1.0	2,930.9	2.1
4130	3,825.4	3,827.2	1.8	0.0	3,736.3	2.3
4135	4,639.1	4,635.2	(-) 3.9	0.1	4,574.9	1.4
4140	5,287.9	5,263.0	(-) 24.9	0.5	5,136.9	2.8
4145	5,895.8	5,922.0	26.2	0.4	5,779.5	2.0
4150	7,203.7	7,138.5	(-) 65.2	0.9	6,955.9	3.4
4155	8,495.5	8,538.0	42.5	0.5	8,495.5	0.0
4160	11,313.8	11,694.9	381.1	3.4	11,313.8	0.0

Table 1 – Reservoir surface area comparisons.

Development of 2004 Contour Areas

The 2004 contour surface areas for Lahontan Reservoir were computed at 1-foot increments from elevation 4,074.0 to 4,150.0. The 2004 underwater survey measured a minimum reservoir bottom elevation of 4,073.6. These calculations were performed using the ARC/INFO VOLUME command. This command computes areas at user-specified elevations directly from the TIN and takes into consideration all regions of equal elevation. For the purpose of this study, the measured 2004 survey areas at 2-foot increments from elevation 4,074.0 through 4,150.0 were used to compute the new area and capacity tables. This study assumed no change in surface area, since the 1988 aerial data, from elevation 4,155.0 and above. As noted previously the surface area at elevation 4,150 was generated from the adjusted 1988 aerial developed contour. Using ARC/INFO edit tools the 4,150 contour was adjusted in the upper end using the 2004 underwater elevations as a guide. The resulting surface area was 6,955.9 acres compared to the 1988 GIS surface area of 7,138.5 acres (table 1, column 3).

2004 Storage Capacity

The storage-elevation relationships based on the measured surface areas were developed using the area-capacity computer program ACAP (Bureau of Reclamation, 1985). The 2004 surveyed surface areas at 2- and 5-foot contour intervals from reservoir elevation 4,074.0 to elevation 4,150.0 were used as the control parameters for computing the 2004 Lahontan Reservoir capacity. Since this study did not collect above water data, the 1988 surface areas at 5-foot increments for elevation 4,155.0 through 4170.0 and the surface area for elevation 4,174.0 were used to complete the area and capacity table. The program can compute an area and capacity at elevation increments 0.01- to 1.0-foot by linear interpolation between the given contour surface areas. The program begins by testing the initial capacity equation over successive intervals to ensure that the equation fits within an allowable error limit. The error limit was set at 0.000001 for Lahontan Reservoir. The capacity equation is then used over the full range of intervals fitting within this allowable error limit. For the first interval at which the initial allowable error limit is exceeded, a new capacity equation (integrated from basic area curve over that interval) is utilized until it exceeds the error limit. Thus, the capacity curve is defined by a series of curves, each fitting a certain region of data. Differentiating the capacity equations, which are of second order polynomial form, derives final area equations:

$$y = a_1 + a_2x + a_3x^2$$

where:
- y = capacity
- x = elevation above a reference base
- a_1 = intercept
- a_2 and a_3 = coefficients

Results of the Lahontan Reservoir area and capacity computations are listed in table 2 and columns 8 and 9 of table 3. On table 3, columns 3 list the 1969 capacity values found on a table that was revised February 1972. Columns 4 through 6 list the 1988 surface areas and capacity values. Column 6 is the recomputed 1988 capacities using ACAP. Columns 8 and 9 list the 2004 area and capacity values. A separate set of 2004 area and capacity tables has been

published for the 0.01, 0.1 and 1-foot elevation increments (Bureau of Reclamation 2003). A description of the computations and coefficients output from the ACAP program is included with these tables. The 1969, 1988, and 2004 area-capacity curves are plotted on figure 19. As of June 2004, at spillway crest elevation 4,162.0, the surface area was 13,159 acres with a total capacity of 289,721 acre-feet.

2004 RESERVOIR ANALYSES

Figure 19 is a plot of available Lahontan Reservoir surface area and capacity values for the years 1969, 1988, and 2004. The surface area and capacity plots illustrate the differences between all the report values for these survey years. Since there were no reliable original surface area and capacity values for Lahontan Reservoir there was no means of computing sediment deposition since dam closure in June of 1915. Column 10 of table 3 shows the capacity difference between the recomputed 1988 capacity and the 2004 capacity. At elevation 4,150.0, the computed difference is 5,259 acre-feet between the two surveys. A portion of this difference is due to sediment inflow, but it is assumed a portion of this computed loss is also due to the differences between methods of collection and analysis by the studies. Due to these unknowns, a reliable sediment deposition and projection cannot be computed by comparing the 2004 survey results with previous surveys of 1969 and 1988. During the original planning of Lahontan Reservoir, the estimated loss of total capacity of the reservoir over the first 100 years of operation was 5.3 percent. Even with all the unknowns the comparison of the three surveys, figure 19 does illustrate that overall changes have been minimal. The original design of the reservoir had a dead pool elevation of 4,070.0 with only 100 acre-feet of capacity. The 2004 survey measured a minimal elevation of 4,073.6 with a 46 acre-feet of capacity at reservoir elevation 4,080.0. The 2004 study results show that all of the original dead pool capacity is filled with sediment deposition, but the total amount of deposition at the dam for the first 89 years of operation, 1915 through 2004, is minimal. Due to all of these conditions, a future survey of Lahontan should not be needed for many years unless major sediment inflow events are observed.

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RESERVOIR SEDIMENT
DATA SUMMARY

Lahontan Reservoir
NAME OF RESERVOIR

1
DATA SHEET NO.

DAM	1. OWNER Bureau of Reclamation	2. STREAM Carson River	3. STATE Nevada
	4. SEC. 33 TWP. 19 N RANGE 26 E	5. NEAREST P.O. Fallon	6. COUNTY Churchill
	7. LAT 39° 27' 45" LONG 119° 04' 00"	8. TOP OF DAM ELEVATION 4174.0[1]	9. SPILLWAY CREST EL 4162.0[2]

RESERVOIR	10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE ACRE-FEET	15. DATE STORAGE BEGAN
	a. SURCHARGE	4,169.0[3]		108,500	425,800	
	b. FLOOD CONTROL					6/1915
	c. POWER					
	d. Joint	4,163.67		22,200	317,300	16. DATE NORMAL OPERATION BEGAN
	e. CONSERVATION	4,162.0		295,000	295,100	
	f. INACTIVE					
	g. DEAD	4,070.0		100	100	6/1915

17. LENGTH OF RESERVOIR	18[4] MILES	AVG. WIDTH OF RESERVOIR	0.9	MILES
18. TOTAL DRAINAGE AREA	1,799[5] SQUARE MILES	22. MEAN ANNUAL PRECIPITATION	4.2[6]	INCHES
19. NET SEDIMENT CONTRIBUTING AREA	1,799[5] SQUARE MILES	23. MEAN ANNUAL RUNOFF	3.9[7]	INCHES
20. LENGTH MILES	AV. WIDTH MILES	24. MEAN ANNUAL RUNOFF	271,700[7]	ACRE-FEET
21. MAX. ELEVATION	MIN. ELEVATION	25. ANNUAL TEMP. MEAN 54°F	RANGE -17°F to 110°F[6]	

BASIN

SURVEY DATA

26. DATE OF SURVEY	27. PER.	28. ACCL	29. TYPE OF SURVEY	30. NO. OF RANGES OR	31. SURFACE AREA, AC.	32. CAPACITY ACRE-FEET	33. C/I RATIO
1988			Contour (D)	5-ft	13,159[8]	296,893[8]	
6/04			Contour (D)	2-ft	13,159[9]	289,721[9]	

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIP.	35. PERIOD WATER INFLOW, ACRE FEET			WATER INFLOW TO DATE, AF	
		a. MEAN ANN.	b. MAX. ANN.	c. TOTAL	a. MEAN ANN.	b. TOTAL
6/04		271,700[7]				

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SEDIMENT DEPOSITS TO DATE, AF		
	a. TOTAL	b. AV. ANN.	c. /MI.²-YR.	a. TOTAL	b. AV. ANNUAL	c. /MI.²-YR.
6/04	[10]					

26. DATE OF SURVEY	39. AV. DRY WT. (#/FT³)	40. SED. DEP. TONS/MI.²-YR.		41. STORAGE LOSS, PCT.		42.	
		a. PERIOD	b. TOTAL TO	a. AV.	b. TOTAL TO	a.	b.
6/04				[10]	[10]		

26. DATE SURVEY	43. DEPTH DESIGNATION RANGE FEET BELOW, AND ABOVE, CREST ELEVATION											
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											
2004												

26. DATE Survey	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR														
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-105	105-110	110-115	115-120	120-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

Table 2. - Reservoir sediment data summary (page 1 of 2).

45. RANGE IN RESERVOIR OPERATION [7]

YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF	YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF
				1965	4164.0	4131.4	382,300
1966	4158.2	4124.2	171,040	1967			448,700
1968	4160.8	4133.4	162,500	1969	4163.5	4131.0	560,800
1970	4163.4	4144.9	322,400	1971	4163.7	4142.4	295,200
1972	4163.2	4141.1	187,700	1973	4162.4	4139.8	276,200
1974	4162.3	4139.1	354,100	1975	4163.4	4141.0	321,400
1976	4154.8	4127.1	80,600	1977	4151.3	4102.6	26,260
1978	4160.6	4104.8	257,600	1979	4163.0	4142.5	235,200
1980	4160.5	4139.7	431,700	1981	4157.0	4117.4	121,300
1982	4162.4	4116.4	551,700	1983	4163.0	4147.2	804,600
1984	4159.3	4139.9	482,900	1985	4160.4	4135.2	197,500
1986	4163.2	4133.9	537,500	1987	4161.5	4124.5	110,900
1988	4148.7	4094.0	43,230	1989	4154.0	4091.0	166,400
1990	4153.3	4109.1	71,520	1991	4137.1	4100.7	72,980
1992	4133.2	4089.4	52,130	1993	4157.8	4091.8	340,000
1994	4147.4	4090.7	382,230	1995	4163.5	4091.9	633,400
1996	4164.2	4148.0	467,800	1997	4163.9	4144.5	604,200
1998	4163.4	4144.3	449,800	1999	4163.6	4149.2	425,300
2000	4157.4	4134.4	110,100	2001	4154.1	4129.0	53,500
2002	4155.3	4125.6	64,900	2003	4157.6	4128.7	198,100

46. ELEVATION - AREA - CAPACITY DATA FOR **2004 CAPACITY**[9]

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
2004	**SURVEY**		4,073.6	0	0	4,075	0.1	0
4,078	3.5	4	4,080	48.4	46	4,082	128.5	223
4,084	197.0	548	4,085	256.8	775	4,086	360.4	1,084
4,088	498.0	1,942	4,090	602.9	3,043	4,092	693.5	4,339
4,094	771.8	5,805	4,095	809.0	6,595	4,096	851.6	7,425
4,098	944.9	9,222	4,100	1,042.1	11,209	4,102	1,127.2	13,378
4,104	1,219.5	15,725	4,105	1,265.3	16,967	4,106	1,314.6	18,257
4,108	1,404.7	20,976	4,110	1,498.3	23,879	4,112	1,630.1	27,008
4,114	1,818.3	30,456	4,115	1,926.6	32,329	4,116	1,996.5	34,290
4,118	2,166.1	38,453	4,120	2,376.8	42,996	4,122	2,611.2	47,984
4,124	2,849.9	53,445	4,125	2,930.9	56,335	4,126	3,019.0	59,310
4,128	3,376.6	65,706	4,130	3,736.3	72,819	4,132	4,132.6	80,688
4,134	4,422.9	89,243	4,135	4,547.9	93,728	4,136	4,679.1	98,342
4,138	4,914.0	107,935	4,140	5,136.9	117,986	4,142	5,379.2	128,502
4,144	5,657.6	139,539	4,145	5,779.5	145,257	4,150	6,955.9	177,096
4,155	8,495.5	215,724	4,160	11,313.8	265,248	4,162	13,159	289,721
4,163.67	14,700	312,984	4,165	15,927.6	333,351	4,169	17,764	400,734
4,170	18,222.8	418,727	4,174	20,041.0	495,255			

47. REMARKS AND REFERENCES

[1] All elevations are in feet based on the original project datum that is 3.75 feet higher then NGVD29 and 0.3 feet higher than NAVD88.

[2] Uncontrolled spillway. Top of 20-inch flashboards are at elevation 4,163.67 feet.

[3] Values from Reservoir Capacity Allocation table dated 11/83. No reliable original values.

[4] Length at elevation 4,162.

[5] From USGS water year records, 2003.

[6] Bureau of Reclamation Project Data Book, 1981. Values for Newlands Project.

[7] Mean annual runoff of 271,700 AF, item 24, from 1911 through 2003 from USGS gage "Carson River near Fort Churchill, Nevada." Drainage area of gage is 1,302 square miles compared to reservoir drainage of 1,799. Value does not account for additional inflow from the Truckee Canal diversion flows. Maximum and minium elevations from USGS annual report for listed water years. Values from available records.

[8] Surface area & capacity at elevation 4,162.0, spillway crest elevation. 1988 capacity recomputed by Reclamation's ACAP computer program.

[9] All capacities computed by Reclamation's ACAP computer program. The 2004 survey assumed no change from elevation 4,155 and above since 1988 survey.

[10] Due to no original capacity values there are no capacity loss computations.

48. AGENCY MAKING SURVEY Bureau of Reclamation

49. AGENCY SUPPLYING DATA Bureau of Reclamation | DATE March 2005

Table 2. - Reservoir sediment data summary (page 2 of 2).

1	2	3	4	5	6	7	8	9	10	11
Elev		1969	1988	1988	1988	1969-88	2004	2004	1988-04	
		Survey	Survey	Survey	Survey	Change	Survey	Survey	Change	Percent
Feet		Ac-Ft	Acres	Ac-Ft	Ac-Ft	Ac-Ft	Acres	Ac-Ft	Ac-Ft	Depth
4,174.0			20,041	502,203	501,133		20,041.0	495,255	5,878	100.0
4,170.0			18,223	425,432	424,605		18,222.8	418,727	5,878	96.5
4,169.0			17,764	407,459	406,612		17,764.0	400,734	5,878	95.6
4,165.0			15,928	339,894	339,230		15,927.6	333,351	5,879	92.1
4,163.67		317,280	14,728	319,861	318,862	-1,582	14,700.0	312,984	5,878	90.9
4,162.0		295,149	13,159	295,542	295,599	-450	13,159.0	289,721	5,878	89.5
4,160.0		272,552	11,314	270,671	271,126	1,426	11,313.8	265,248	5,878	87.7
4,155.0		225,609	8,495	222,763	221,603	4,006	8,495.5	215,724	5,879	83.3
4,150.0		187,155	7,204	183,623	182,355	4,800	6,956.0	177,096	5,259	78.9
4,145.0		153,440	5,896	150,814	149,606	3,834	5,779.8	145,257	4,349	74.6
4,140.0		127,781	5,288	122,795	121,647	6,134	5,136.9	117,986	3,661	70.2
4,135.0		103,519	4,639	97,991	96,829	6,690	4,547.9	93,728	3,101	65.8
4,130.0		82,701	3,825	76,647	75,668	7,033	3,736.3	72,819	2,849	61.4
4,125.0		65,297	2,995	59,780	58,617	6,680	2,930.9	56,335	2,282	57.0
4,120.0		50,891	2,459	46,148	44,982	5,909	2,376.8	42,996	1,986	52.6
4,115.0		39,076	2,008	34,993	33,814	5,262	1,926.6	32,329	1,485	48.2
4,110.0		29,463	1,584	26,118	24,833	4,630	1,498.3	23,879	954	43.9
4,105.0		21,845	1,337	18,842	17,530	4,315	1,265.3	16,967	563	39.5
4,100.0		15,682	1,095	12,758	11,450	4,232	1,042.1	11,209	241	35.1
4,095.0		10,472	838	7,959	6,617	3,855	809.0	6,595	22	30.7
4,091.3		7,217	538	5,159	3,865	3,352	662.0	3,865	0	27.5
4,090.0		6,212	0	0		6,212	602.9	3,043		26.3
4,085.0		3,080	0	0		3,080	256.8	775		21.9
4,080.0		1,172	0	0		1,172	48.4	46		17.5
4,075.0		368	0	0		368	0.1	0		13.2
4,073.6		254	0	0		254	0.0	0		11.9
4,070.0		91	0	0		91	0.0	0		8.8
4,065.0		17	0	0		17	0.0	0		4.4
4,060.0		0	0	0		0	0.0	0		0.0

1	Elevation of reservoir water surface.
2	1969 reservoir surface areas not located.
3	1969 reservoir capacity values from revised table Feb. 1972.
4	1988 measured reservoir surface areas from table 03/09/89.
5	1988 reservoir capacity from table 03/09/89. 1989 table assumed 5,159 AF at elevation 4,091.3.
6	1988 reservoir capacity recomputed using ACAP. Assumed 3,865 AF at at elevation 4,091.3. Computed capacity from 2004 survey.
7	1969 and 1988 computed difference, colunm (3) - column (6).
8	2004 measured reservoir surface area. Areas for elevation 4,155 and above from 1989 survey
9	2004 reservoir capacity computed using ACAP.
10	1988 and 2004 computed volume difference, column (3) - column (9).
11	Depth of reservoir expressed in percentage of total depth (114).

Table 3. - Summary of 2004 survey results

N
W
E
S

Feet
0 400 800 1200

Scale 1:4800

Carson Lahontan River

LAHONTAN DAM

Blackbird Point

Location

Vertical datum Based on Lahontan Dam Local datum which is 3.75 feet above the National Geodetic Datum of 1929

Horizontal datum based on Nevada's State Plane Coordinate System, West Zone (NAD83)

Contours for elevations 4150 and above developed from 1988 aerial photography at 5 foot intervals. The upper end of contour 4150 adjusted for 2004 underwater data

UNITED STATES
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LAHONTAN RESERVOIR
NEVADA

LAHONTAN RESERVOIR
TOPOLOGY

DRAWN BY: _____ TECHNICAL APPROVAL: _____
CHECKED BY: _____ APPROVED: _____
Dam Manager

Denver, Colorado SEP 16, 2004 | 1

Figure 3. – Lahontan Reservoir topographic map, No 1.

N

W E

S

Feet

0 400 800 1200

Scale: 1:4800

Location

Vertical datum based on Lahonton Dam Local datum which is 3.75 feet above the National Geodetic Datum of 1929.

Horizontal datum based on Nevada's State Plane Coordinate System, West Zone (NAD83)

Contours for elevations 4150 and above developed from 1988 aerial photography at 5 foot intervals. The upper end of contour 4150 adjusted for 2004 underwater data

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CHECKED BY _____ APPROVED _____
Dam Manager

Denver, Colorado SEP 16, 2004 | 2

Figure 4. – Lahontan Reservoir topographic map, No. 2

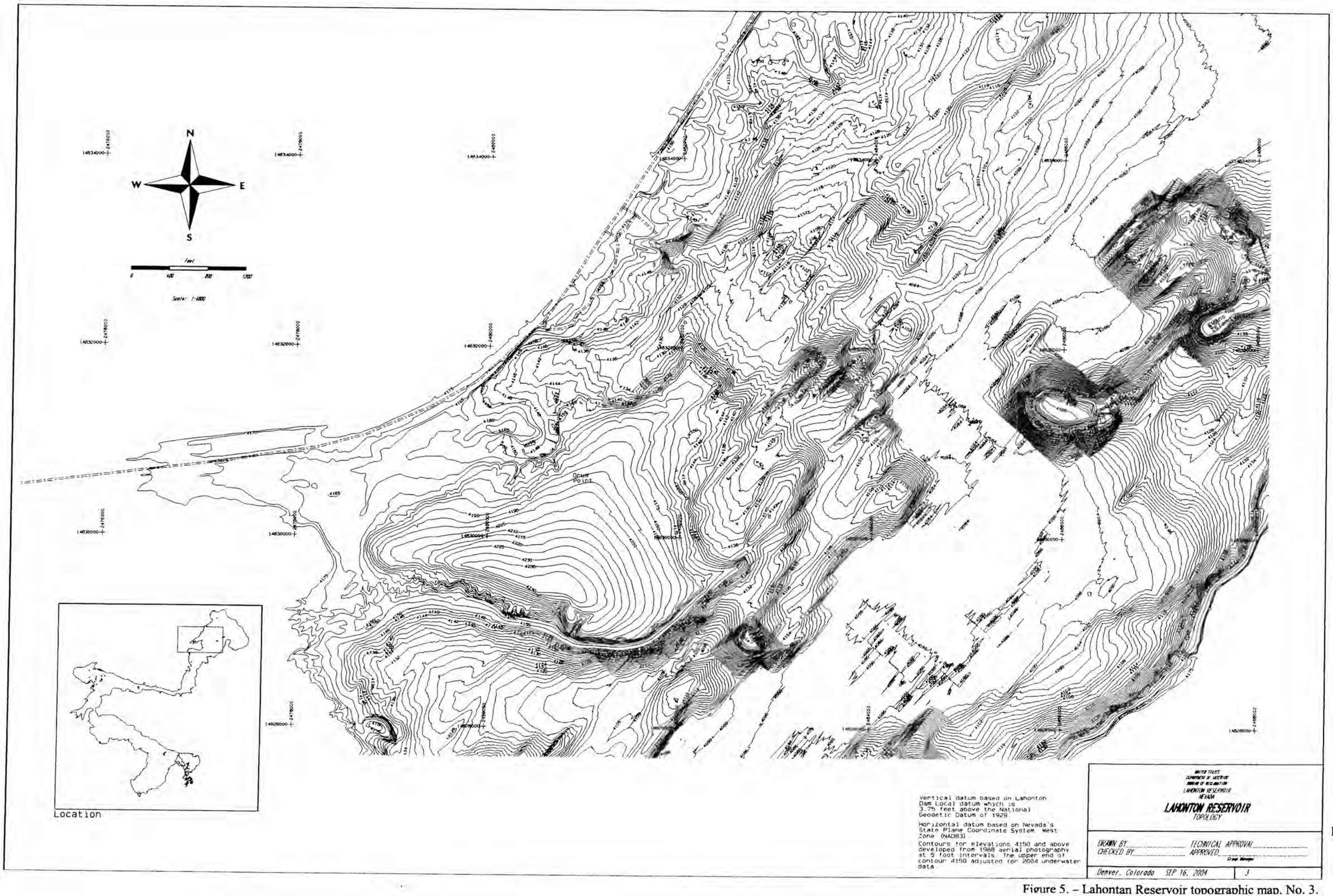

Figure 5. – Lahontan Reservoir topographic map, No. 3.

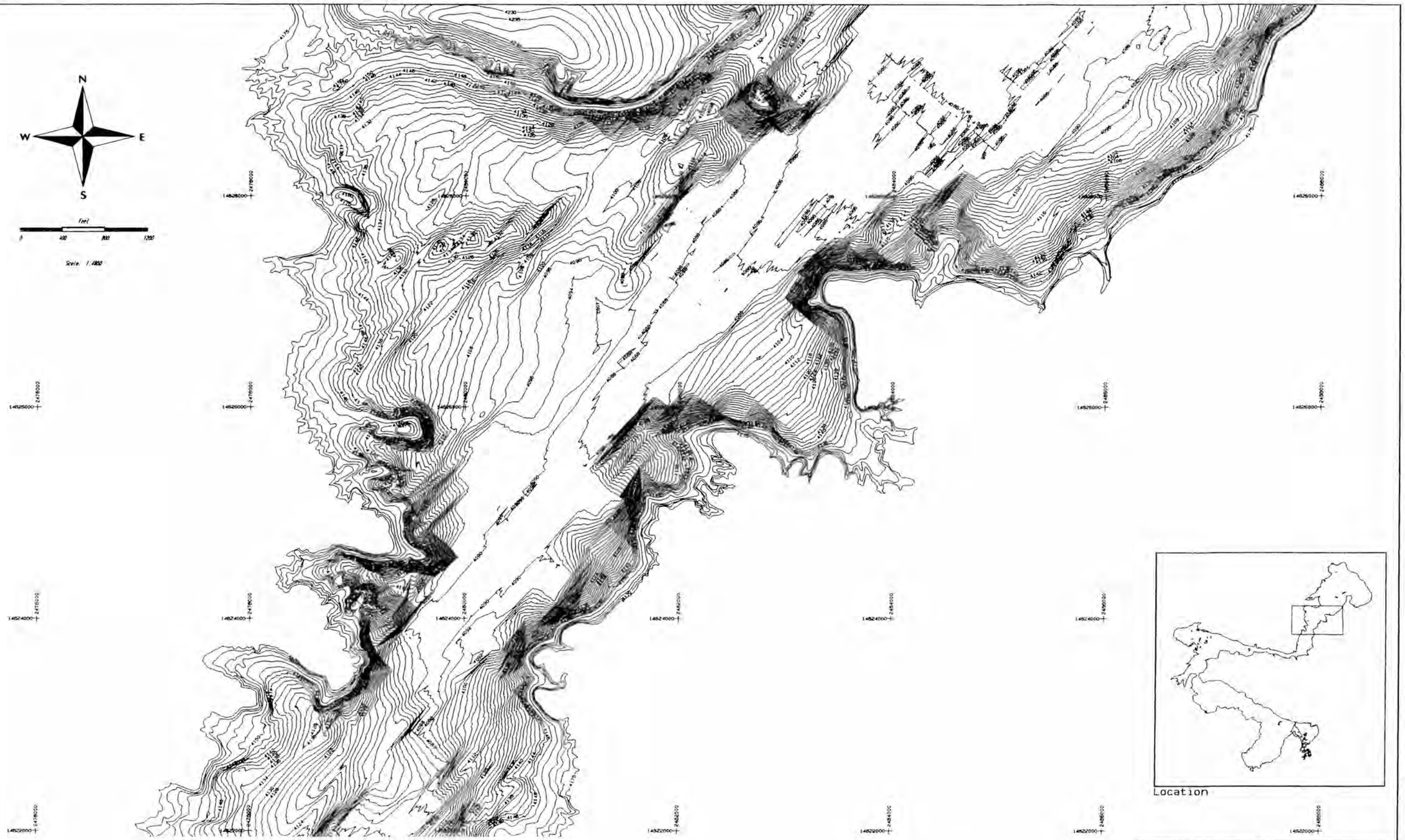

Figure 6. – Lahontan Reservoir topographic map, No. 4.

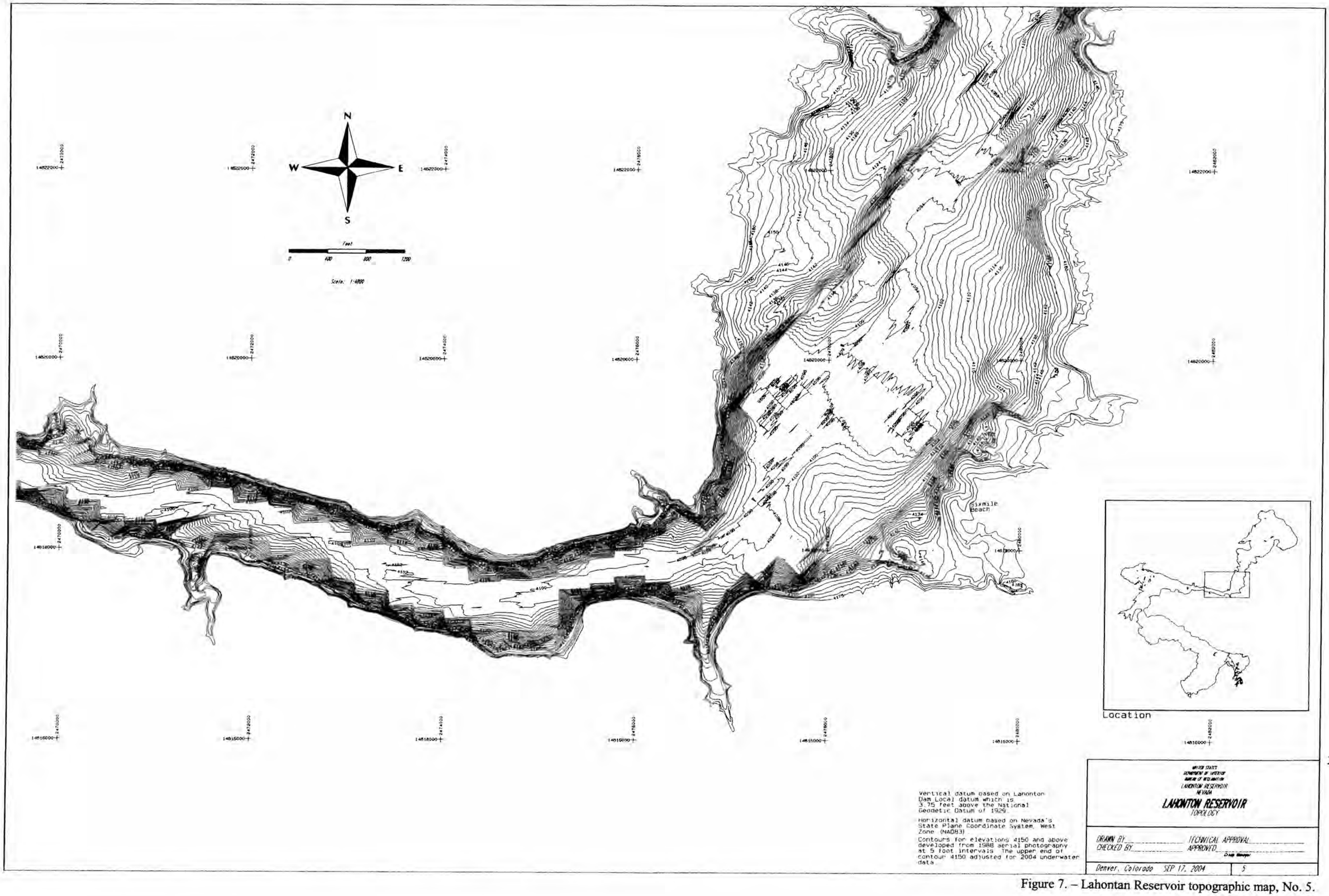

Figure 7. – Lahontan Reservoir topographic map, No. 5.

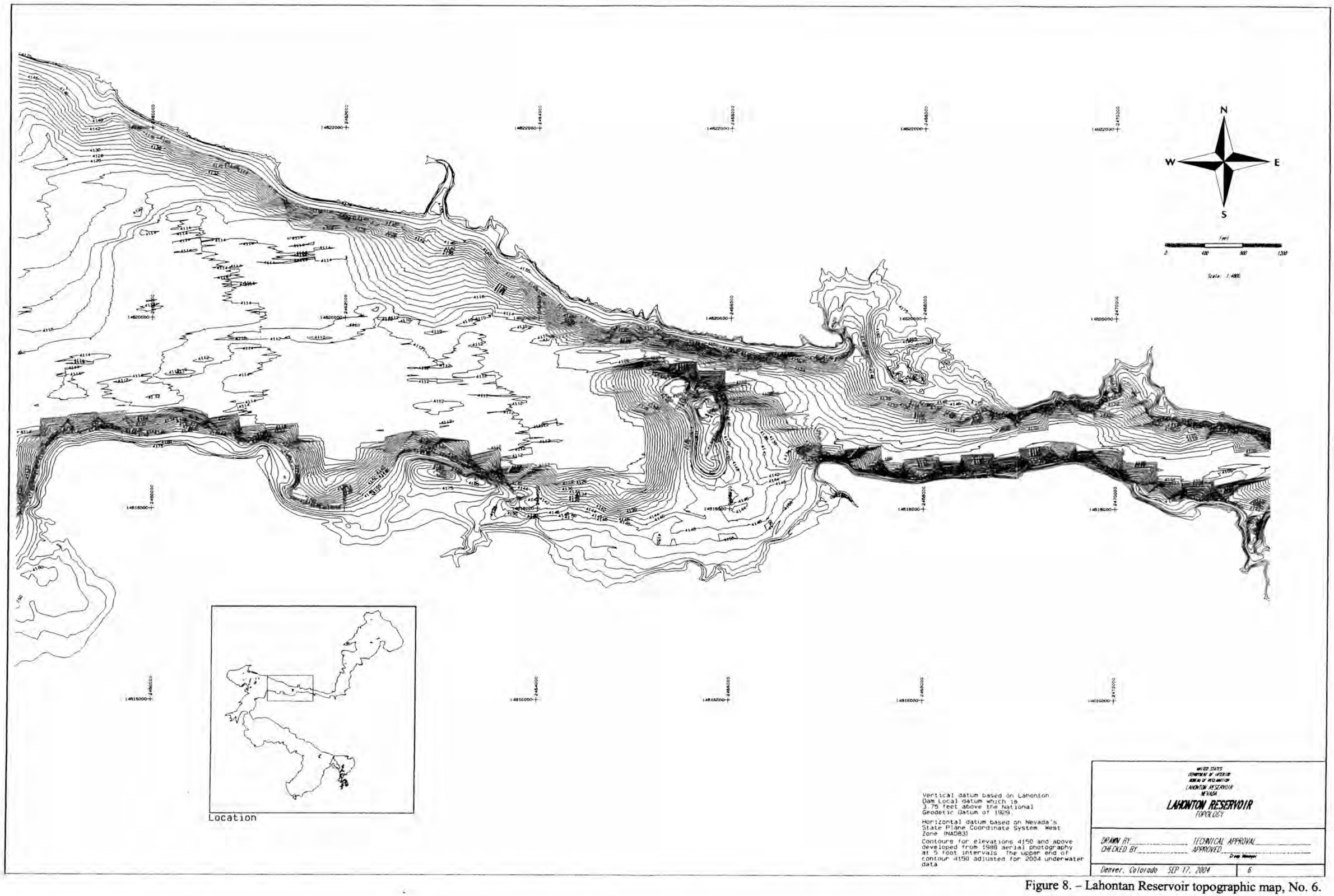

Figure 8. – Lahontan Reservoir topographic map, No. 6.

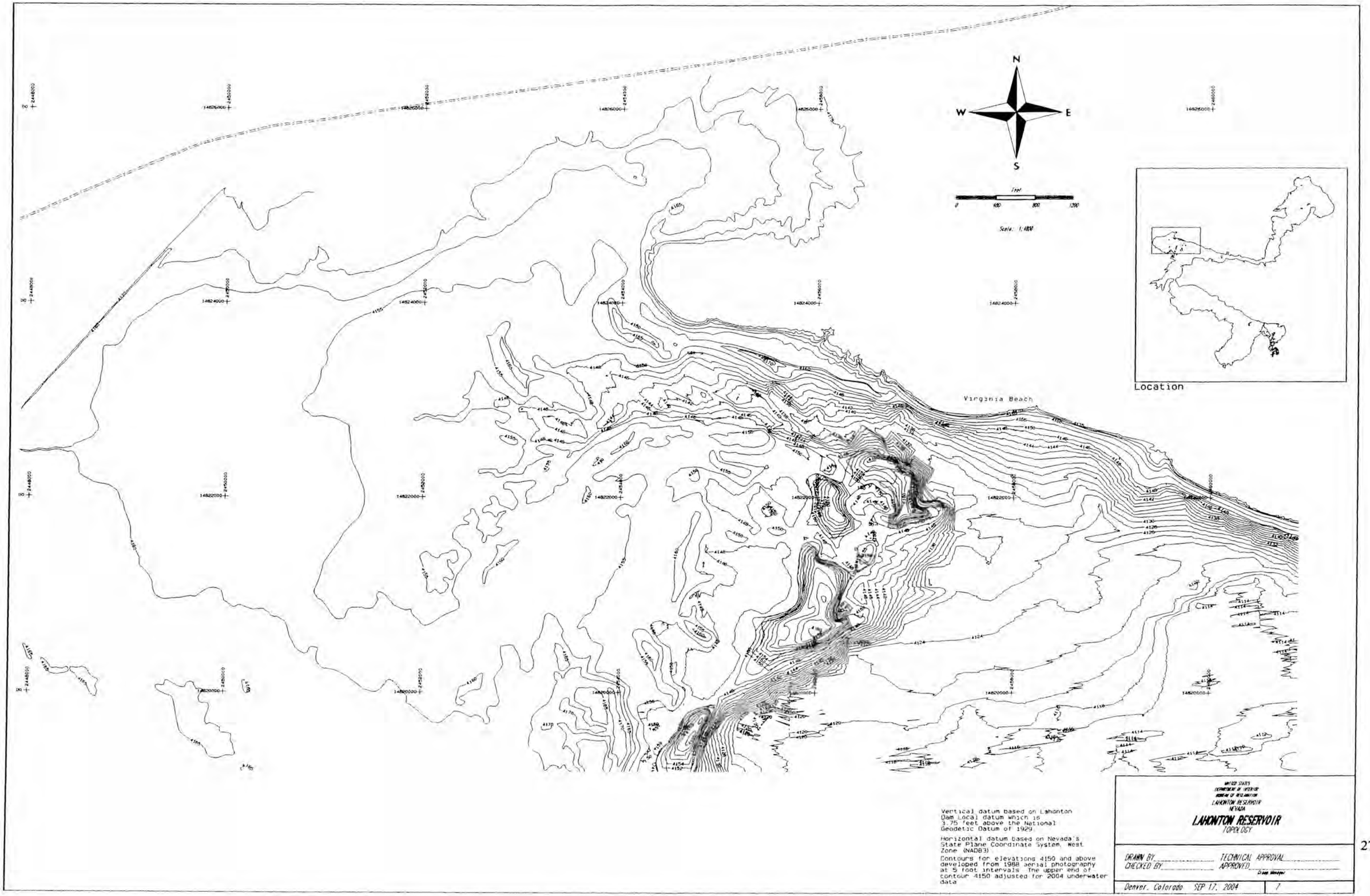

Figure 9. – Lahontan Reservoir topographic map, No. 7.

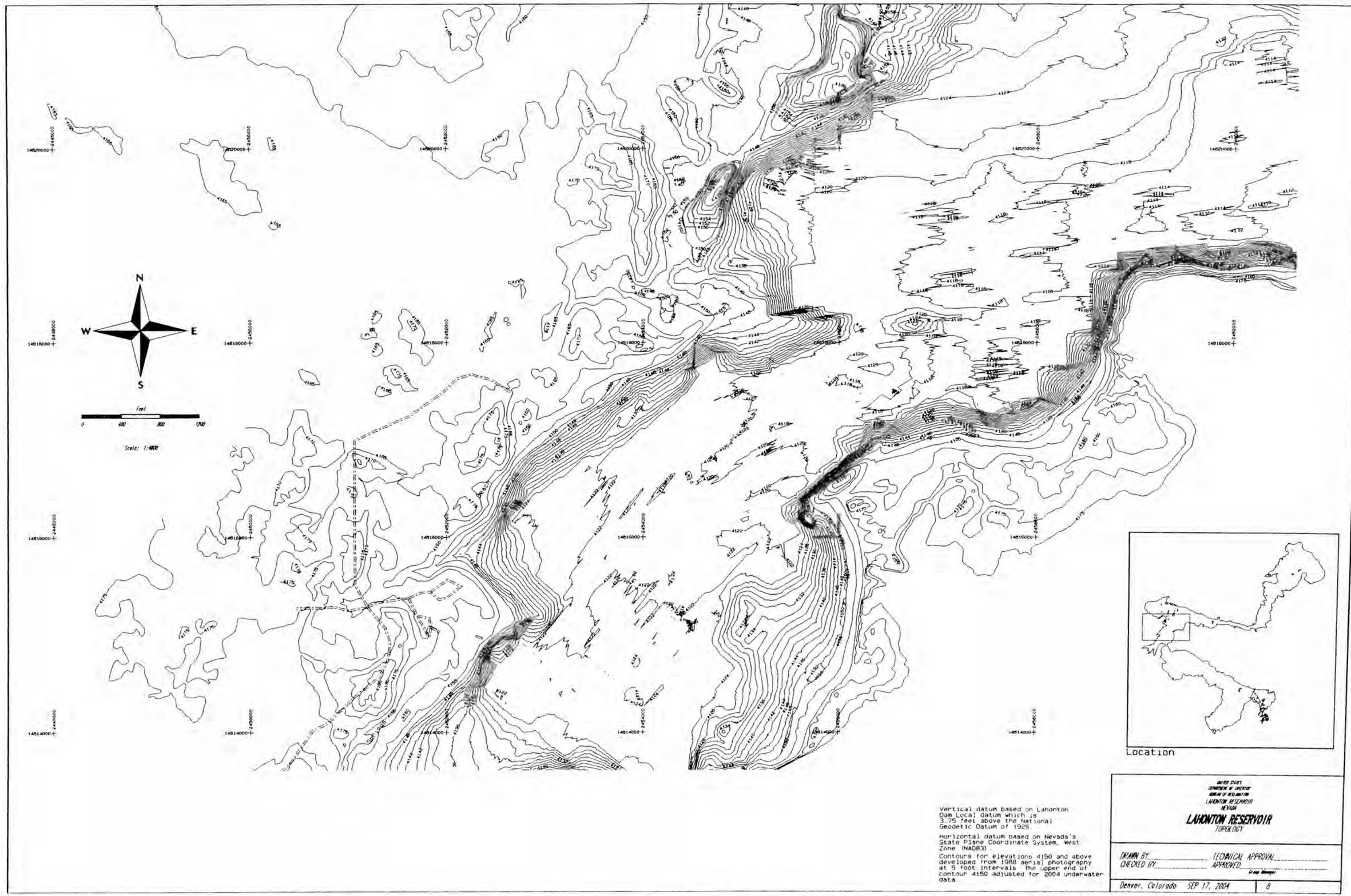

Figure 10. – Lahontan Reservoir topographic map, No. 8.

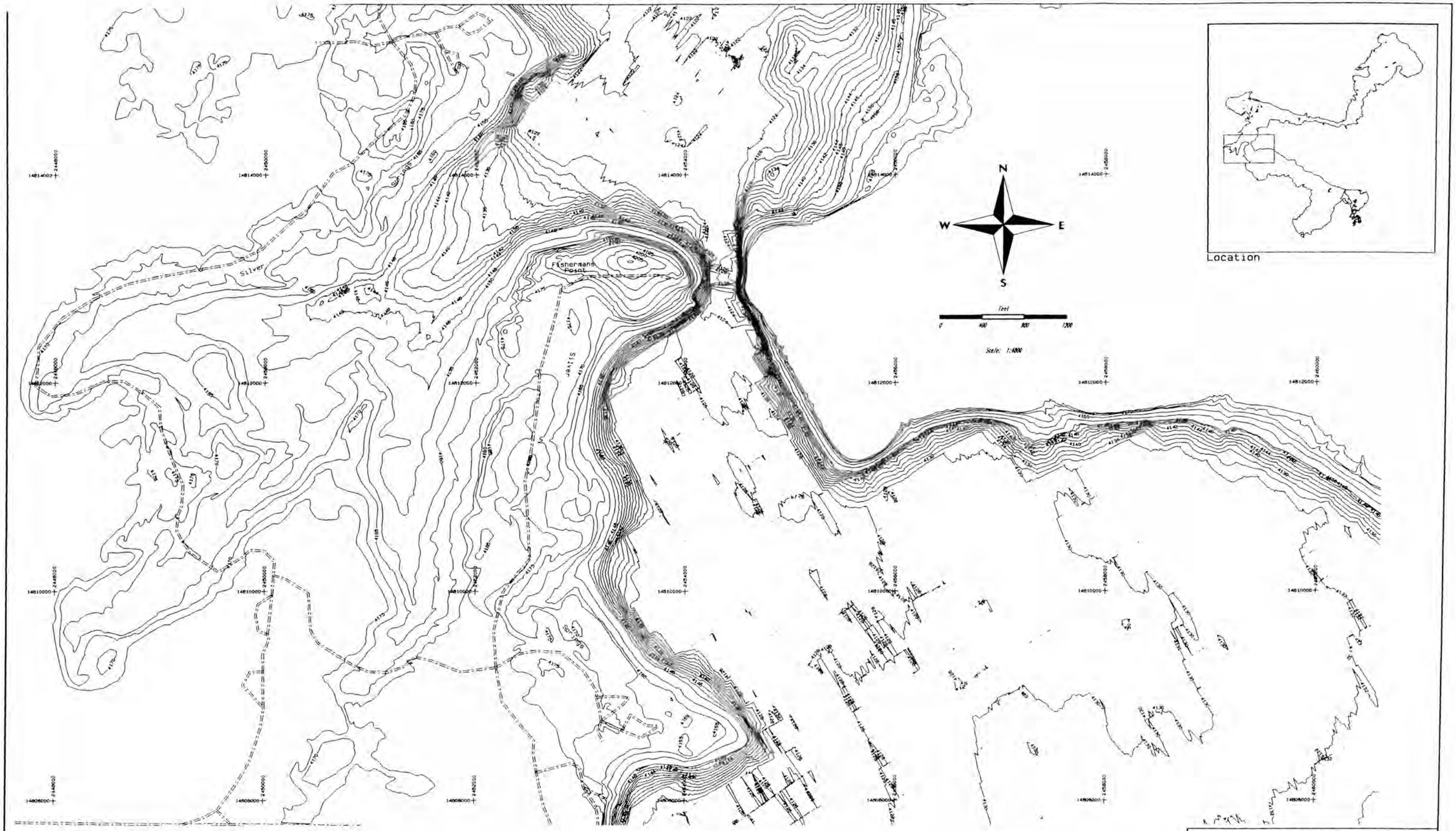

Figure 11. – Lahontan Reservoir topographic map, No. 9.

N

W E

S

Feet

0 400 800 1200

Scale: 1:4800

Location

Vertical datum based on Lahonton Dam Local datum which is 3.75 feet above the National Geodetic Datum of 1929.

Horizontal datum based on Nevada's State Plane Coordinate System, West Zone (NAD83).

Contours for elevations 4150 and above developed from 1988 aerial photography at 5 foot intervals. The upper end of contour 4150 adjusted for 2004 underwater data

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Figure 12. – Lahontan Reservoir topographic map, No. 10.

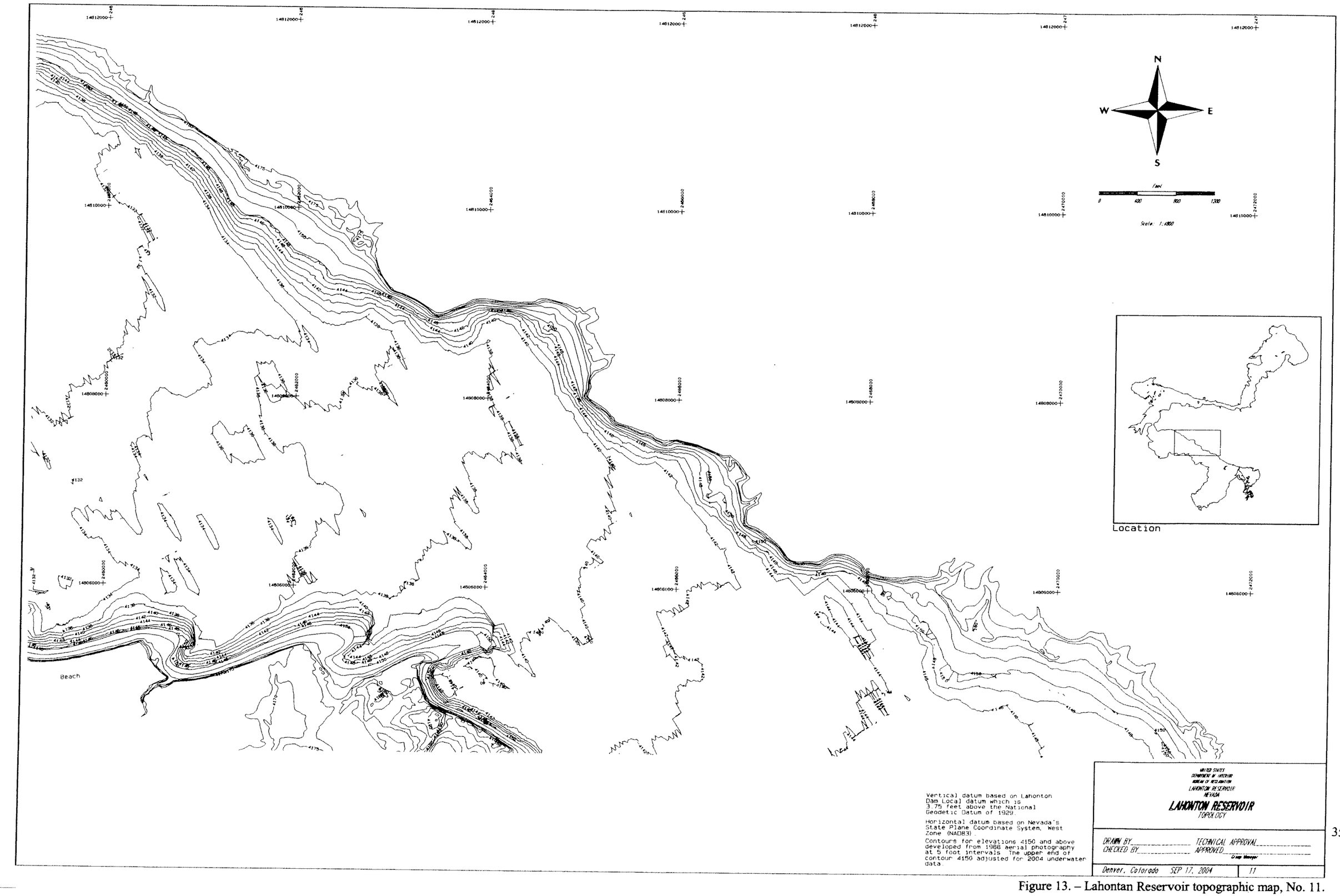

Figure 13. – Lahontan Reservoir topographic map, No. 11.

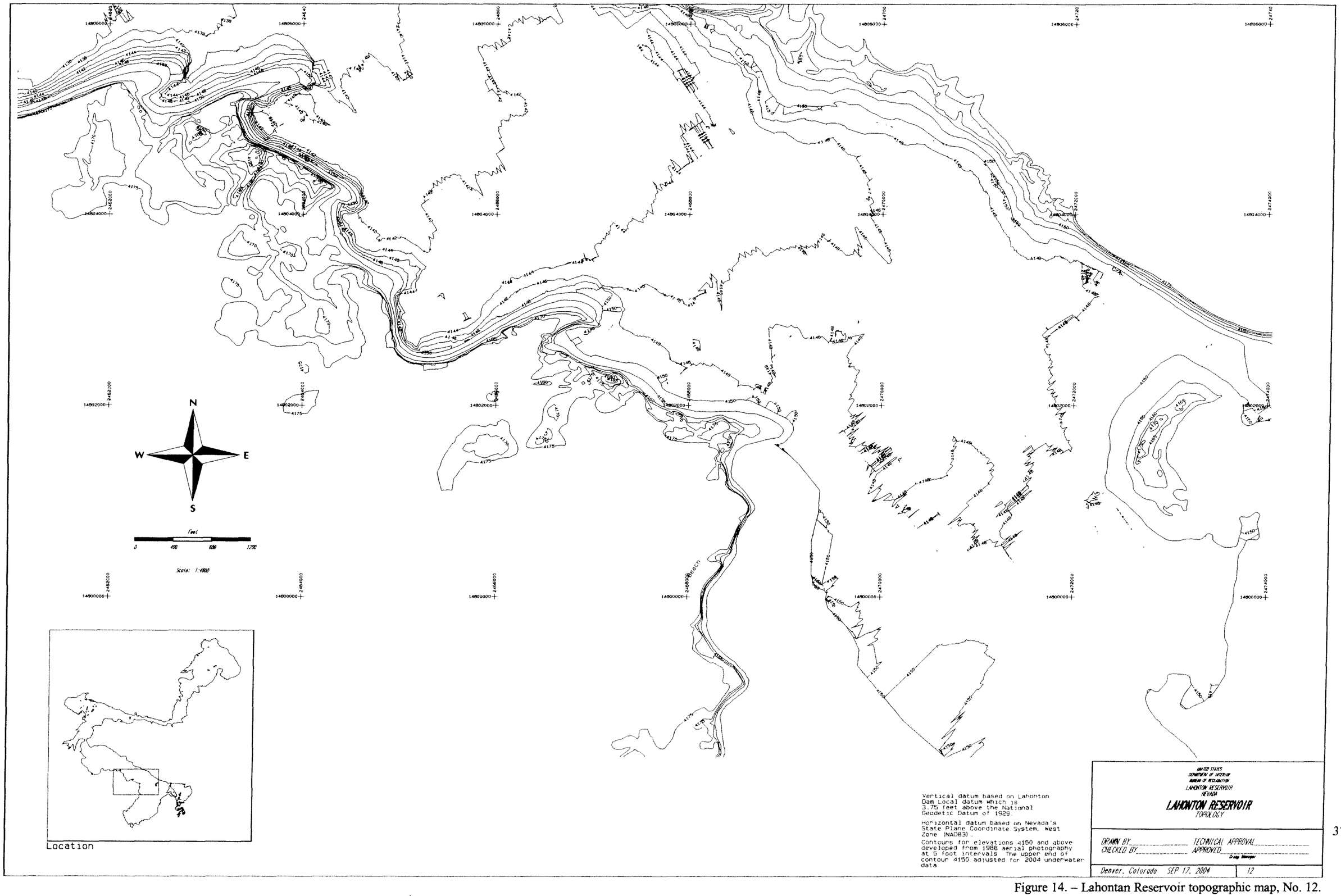

Figure 14. – Lahontan Reservoir topographic map, No. 12.

Cargo Dam

Location

N
W E
S

feet
0 400 800 1200

Scale: 1:4800

Vertical datum based on Lahonton Dam Local datum which is 3.75 feet above the National Geodetic Datum of 1929.

Horizontal datum based on Nevada's State Plane Coordinate System, West Zone (NAD83).

Contours for elevations 4150 and above developed from 1988 aerial photography at 5 foot intervals. The upper end of contour 4150 adjusted for 2004 underwater data

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TOPOLOGY

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CHECKED BY
TECHNICAL APPROVAL
APPROVED
Chief, Technical Services Division

Denver, Colorado SEP 19, 2004 | 13

Figure 15. – Lahontan Reservoir topographic map, No. 13.

N

W E

S

Feet

0 400 800 1200

Scale: 1:4800

Location

Vertical datum based on Lahonton Dam local datum which is 3.75 feet above the National Geodetic Datum of 1929

Horizontal datum based on Nevada's State Plane Coordinate System, West Zone (NAD83).

Contours for elevations 4150 and above developed from 1988 aerial photography at 5 foot intervals. The upper end of contour 4150 adjusted for 2004 underwater data

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TOPOLOGY

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CHECKED BY _____ APPROVED _____
Area Manager

Denver, Colorado MAR 11, 2005 | 14

Figure 16. – Lahontan Reservoir topographic map, No. 14.

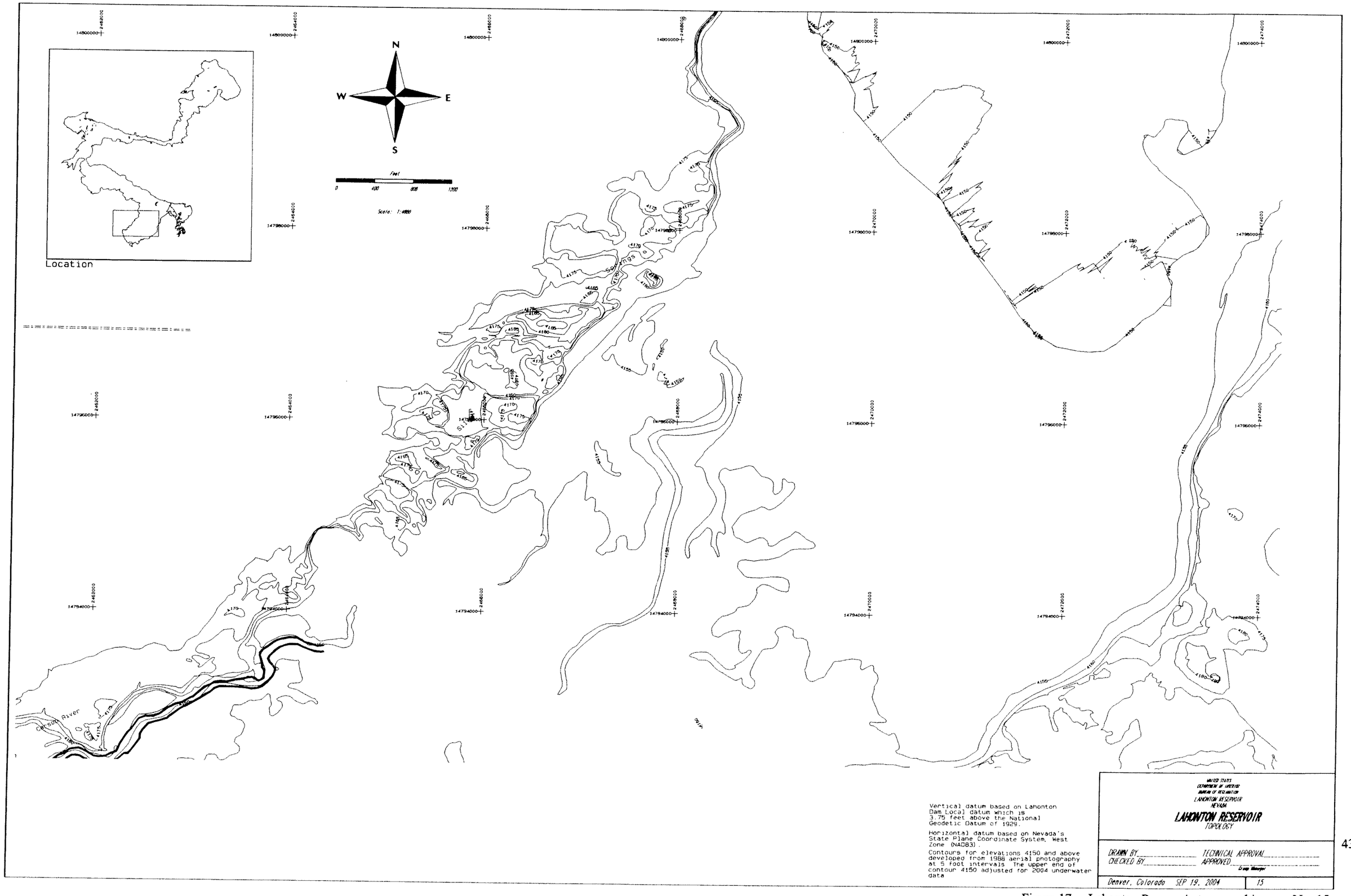

Figure 17. – Lahontan Reservoir topographic map, No. 15.

Carson River

N
W
E
S

Feet
0 400 800 1200

Scale: 1:4800

Location

Vertical datum based on Lahonton Dam Local datum which is 3.75 feet above the National Geodetic Datum of 1929.

Horizontal datum based on Nevada's State Plane Coordinate System, West Zone (NAD83).

Contours for elevations 4150 and above developed from 1988 aerial photography at 5 foot intervals. The upper end of contour 4150 adjusted for 2004 underwater data.

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Dsgn Manager

Denver, Colorado SEP 19, 2004 | 16

Figure 18. – Lahontan Reservoir topographic map, No. 16.

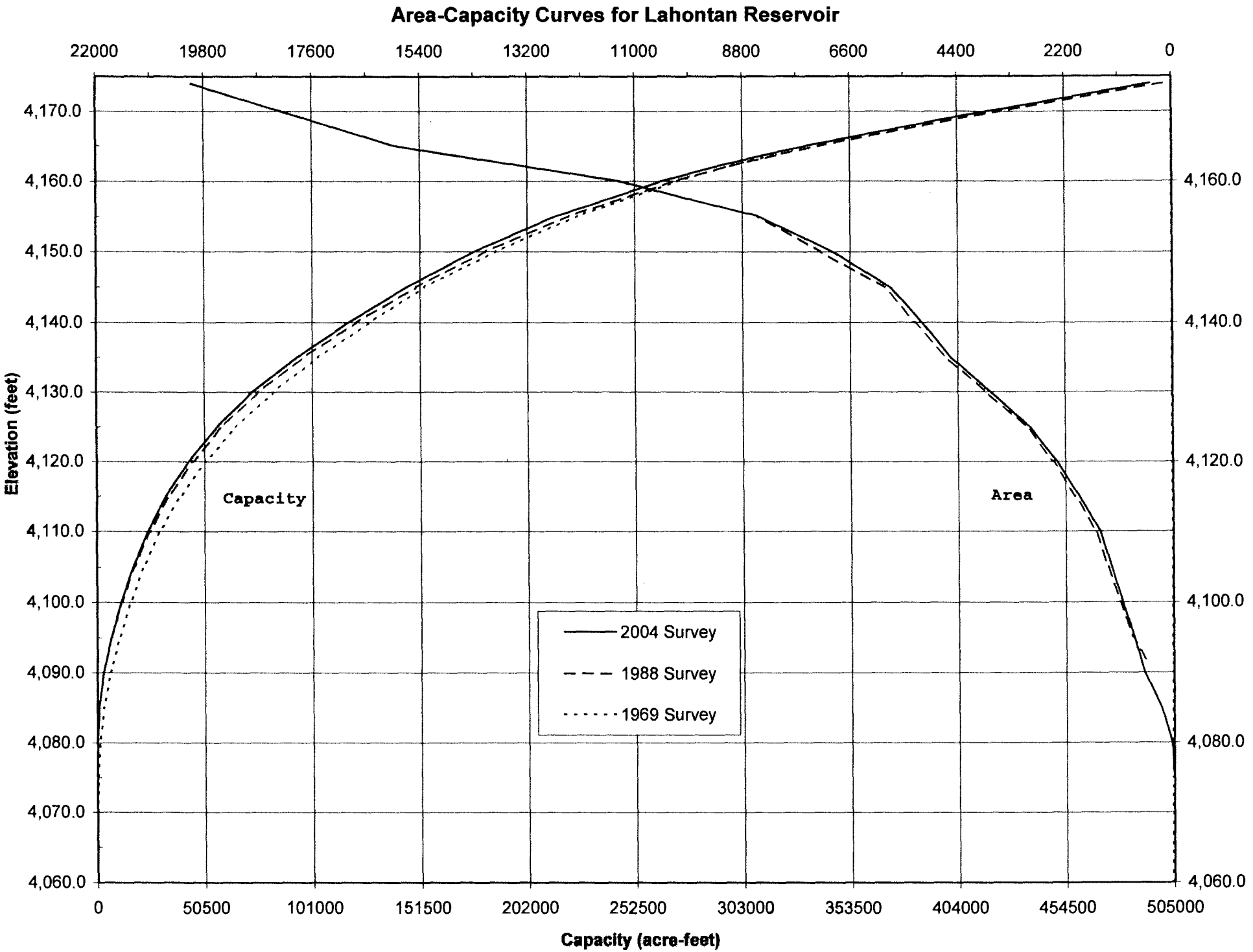

Figure 19. - 2004 area and capacity curves.