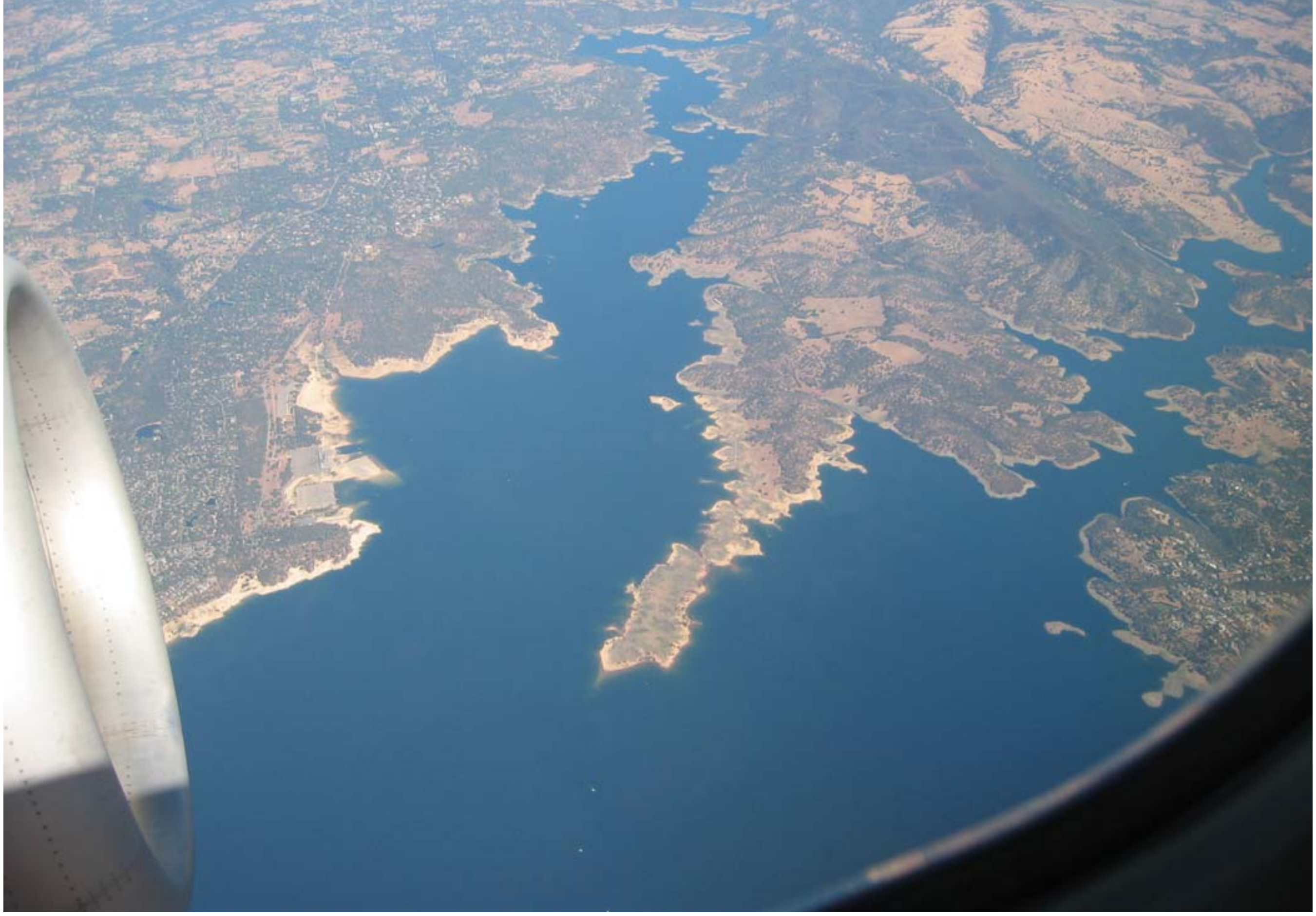
RECLAMATION
Managing Water in the West

Folsom Lake
2005 Sedimentation Survey



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14. ABSTRACT

The Bureau of Reclamation (Reclamation) surveyed Folsom Lake in the fall of 2005 via an interagency agreement with the U.S. Army Corps of Engineers (Corps of Engineers). The extensive surveys developed topographic imagery to study Folsom Dam, the wing and auxiliary dams, and the eight dikes that form Folsom Lake. This report presents the computed present storage-elevation relationship (area-capacity tables) developed from the 2005 surveys. Unless noted, all elevations in this report are tied to the project vertical datum in feet that was determined to be 2.34 feet less than the North American Vertical Datum of 1988 (NAVD88-05).

The underwater survey was conducted from September 9 through 22, 2005 between lake elevations 437 and 441 feet (project datum). The underwater survey used sonic depth recording equipment interfaced with a global positioning system (GPS) that gave continuous sounding positions throughout the underwater portions of the reservoir covered by the survey vessel. The above-water topography was developed by aerial photography under contract with Reclamation. The main body of the reservoir was flown on October 20, 2005 near reservoir elevation 430.2 (NAVD88-05) and high accuracy data was flown on 10/31/2005 near reservoir elevation 427.1 (NAVD88-05). The 2005 topographic maps were developed from the combined data sets. All digital topographic images for these studies were tied to vertical datum NAVD88-05. For purpose of computing updated area and capacity tables, the topographic elevations were shifted 2.34 feet to match the project vertical elevations. The bathymetric survey measured a minimum elevation of 190. Lake contour surface areas were developed from elevation 490.0 and below.

As of September 2005, at water surface elevation 466.0, the surface area was 11,140 acres with a total capacity of 966,823 acre-feet. Since initial closure in 1955, about 43,407 acre-feet of volume loss was measured by the 2005 survey.

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Folsom Lake
2005 Sedimentation Survey

prepared by

Ronald L. Ferrari

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Sedimentation and River Hydraulics Group
Denver, Colorado

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Mission Statements

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.

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

Acknowledgments

Reclamation's Sedimentation and River Hydraulics Group (Sedimentation Group) of the Technical Service Center (TSC) prepared and published this report. Corps of Engineers provided funding for conducting the detailed surveys of the Folsom Lake study area and for the analysis presented in this report. Terri Reaves, Chief of Reclamation's Mid-Pacific Region Surveys and Mapping Branch coordinated the collection and analysis of these extensive data sets. Ronald Ferrari of the Sedimentation Group, with assistance from staff of the Surveys and Mapping Branch, conducted the underwater data collection. The Surveys and Mapping Branch completed the topographic mapping of the merged data for these surveys. Ron Ferrari completed this report and the data processing needed to generate the reservoir only topography and area-capacity tables. Stacey Smith of the Mid-Pacific Region assisted in the computation of the operational values. This report includes comments, from December 2006 review, from the Corps of Engineers and Mid-Pacific Region. Kent Collins of the Sedimentation Group performed the technical peer review of this documentation.

Reclamation Report

This report was produced by the Bureau of Reclamation's Sedimentation and River Hydraulics Group (Mail Code 86-68540), PO Box 25007, Denver, Colorado 80225-0007. **http://www.usbr.gov/pmts/sediment/**

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Folsom Lake 2005 Sedimentation Survey

Introduction

Folsom Dam and reservoir are located on the American River approximately two miles upstream from the city of Folsom and 20 miles northeast of the city of Sacramento, California, figure 1. The dam is located in Sacramento County with portions of the lake also in El Dorado and Placer Counties. The reservoir provides a water supply for irrigation, domestic, municipal, industrial, and power production purposes. The reservoir also provides flood protection and recreation. Releases provide water quality control in the Sacramento-San Joaquin delta, maintain fish runs in the American River below the dam, and help maintain navigation along the lower reaches of the Sacramento River. Folsom Dam was constructed by the Corps of Engineers in the late 1940's and transferred to Reclamation upon completion in a 1956 Memorandum of Understanding. A 1981 Memorandum of Understanding made the Corps of Engineers responsible for any studies necessary to determine the structural adequacy of the dam.

Figure 1 - Folsom Lake location map.

Folsom Lake was created by the closure of Folsom Dam on February 25, 1955. Folsom Dam is a concrete structure flanked by two earth wing dams, Mormon Island Auxiliary Dam, and eight dikes with combined crest lengths of around 5 miles. The concrete portion is a 1,400 foot straight gravity structure with a maximum structural height[1] of 340.0 feet, a crest elevation of 480.5[2], and parapet wall elevation of 484.0 feet. The left wing dam is a zoned earthen embankment with a crest length of 2,100 feet and maximum height of 145 feet at crest elevation 480.5. The right wing dam is a zoned earthen embankment with a crest length of 6,700 feet and maximum height of 145 feet at crest elevation 480.5. Mormon Island Auxiliary Dam is located east of the main dam and is a zoned earthen embankment with a crest length of 4,820 feet and maximum height of 110 feet at crest elevation 480.5. There are eight dikes located around the reservoir rim with crest elevations of 480.5 and ranging in maximum height from 15 to 105 feet and length from 740 to 2,060 feet.

The spillway is a gate-controlled overflow spillway divided by piers into eight equal sections and is located in the center gravity section of the dam at crest elevation 418.0. Flow is controlled by 42-foot wide radial gates that are 50-foot high in the service spillway area and 53-foot high in the emergency spillway area. The service spillway consists of the western-most five gates that discharge into a stilling basin in the original river channel below. The eastern most three gates make up the emergency spillway and discharge into a flip bucket that projects the discharge. The discharge capacity is 567,000 cubic feet per second (cfs); however, the levee system that protects the city of Sacramento downstream only allows a safe channel capacity of 115,000 cfs.

The outlet works consists of eight 5-foot wide by 9-foot high gated sluice outlets located in the overflow spillway section of the dam. Four river outlet conduits are at invert elevation 280.0 and four are at invert elevation 210.0. The maximum discharge capacity, into the spillway stilling basin, is 27,800 cfs at reservoir elevation 466.0.

Three 15.5-foot-diameter penstocks are located in the right non-overflow section of the concrete dam that carry water approximately 500 feet downstream to three generating units at the Folsom Power plant. The powerplant is the primary source of normal releases into the American River.

The drainage area above Folsom Dam is approximately 1,861 square miles and 1,020 square miles are considered sediment contributing. The total drainage area

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[1]The definition of such terms as “crest length,” “structural height,” etc. may be found in manuals such as Reclamation’s *Design of Small Dams and* ASCE’s *Nomenclature for Hydraulics.*

[2]Elevations in feet. All elevations based on the original project datum established during construction that was found to be 2.34 feet lower than NAVD88-2005 (NAVD88-05). Unless noted, all listed elevations in feet and in project vertical datum.

value is from the USGS water resource data (USGS, 1990). The non-sediment contributing area includes the normal surface area of Folsom Lake and drainage areas above the numerous dams located within the drainage basin above Folsom Dam. The drainage basin elevations range from approximately 10,400 feet at the headwaters to normal reservoir surface elevation 466.0. The reservoir is around 28.0 miles in length and around 0.6 miles in width.

Summary and Conclusions

This Reclamation report presents the 2005 results of the survey of Folsom Lake. The primary objectives of the surveys were to gather data needed to:

- develop lake topography
- develop detailed topography of the entrapment structures
- compute area-capacity relationships
- estimate storage depletion, by sediment deposition, since dam closure

Reclamation was directed to survey Folsom Lake in the fall of 2005 by an interagency agreement with the Corps of Engineers. The extensive surveys developed detailed topography to be used for studies of Folsom Dam, Mormon Island Auxiliary Dam, the wing dams, and the eight dikes that form Folsom Lake. Aerial surveys covered upstream and downstream of the entrapment structures and extended up the north and south arms of the American River. Combined aerial and bathymetric survey data were used to develop the 2005 area and capacity tables of Folsom Lake formed by these entrapment structures.

The underwater (bathymetric) survey was conducted from September 9 through 22, 2005 between lake elevations 437 and 441 feet (project datum). The bathymetric survey used sonic depth recording equipment interfaced with a real-time kinematic (RTK) global positioning system (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 Folsom Lake. The positioning system provided information to allow the boat operator to maintain a course along these grid lines. The reservoir's water surface elevations (project datum), recorded by the Reclamation reservoir gauge during the time of collection, were used to convert the sonic depth measurements to reservoir bottom elevations. These gauge elevations are tied to the project vertical datum that was found to be 2.34 feet lower than NAVD88-05. All area and capacity computations within this report are tied to the project vertical datum.

The above-water topography was developed by aerial photography under contract with Reclamation. The main body of the reservoir was flown on October 20, 2005 near reservoir elevation 430.2 (NAVD88-05) and high accuracy data was flown on October 31, 2005 near reservoir elevation 427.1 (NAVD88-05). All digital topographic images for these surveys were tied to vertical datum NAVD88-05.

The 2005 Folsom Lake topography for this report is a combination of the 2005 aerial and the shifted underwater data sets with elevations tied to NAVD88-05. For purpose of computing updated area and capacity tables, these topographic elevations were reduced 2.34 feet for the measured surface areas to match the project datum elevations. Since all past and present reservoir operations are tied to the project vertical datum, all elevations and resulting values were shifted to match the project datum elevations. Unless noted, all elevations in this report are tied to the project vertical datum in feet.

In September 2005, Reclamation and Corps of Engineers, under the direction of the National Geodetic Survey, established an extensive geodetic control network for the entire project area in North American Datum of 1983 (NAD83) and NAVD88-05. This control network was established prior to all the photogrammetric work with the horizontal control in California state plane, zone 2, in NAD83. This control network was established after the bathymetric survey was conducted and was used to adjust the processed bathymetric data to match the aerial survey's horizontal and vertical datums.

A computer graphics program generated the 2005 reservoir surface areas at predetermined contour intervals from these combined data sets. The 2005 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 project datum elevation increments (Bureau of Reclamation, 1985).

Tables 1 and 2 contain summaries of the Folsom Lake and watershed characteristics for the 2005 survey. The 2005 survey determined that the reservoir has a total storage capacity of 966,823 acre-feet and a surface area of 11,140 acres at joint use reservoir water surface elevation 466.0. Since initial closure in 1955, about 43,407 acre-feet of volume loss was measured by the 2005 survey.

Control Survey Data Information

Reclamation's Mid-Pacific Regional Surveys and Mapping Branch provided the control network information used by the bathymetric survey crew. The base station was set over marker "WD48," located on the east wing dam, and was used throughout the duration of the survey, figure 2. The data collection was in California state plane coordinates, zone 2, NAD83 and the vertical was tied to National Geodetic Vertical Datum of 1929 (NGVD29).

Figure 2- RTK GPS base station, WD48.

In September of 2005, Reclamation and Corps of Engineers, under the direction of the National Geodetic Survey, surveyed an extensive geodetic control network for the entire project area in NAD83 and NAVD88-05. This control network was used for all of the photogrammetric work that followed, but was established after the bathymetric survey was conducted. The results of the 2005 geodetic control survey required a shift of the bathymetric data in the vertical and a slight shift in the horizontal coordinates to match the aerial survey data's horizontal (NAV83) and vertical datums (NAVD88-05). The bathymetric data was tied to base station "WD48" and the following shifts were applied.

NAD83/NGVD29 (project elevation)		NAD83/NAVD88-05	Difference
North	2,019,300.82	2,019,301.29	(+) 0.47
West	6,804,655.01	6,804,654.40	(-) 0.61
Elevation:	481.04	483.38	(+) 2.34

Reservoir Operations

Folsom Dam operates to provide regulated diversion and downstream flows from the American River. The September 2005 capacity table shows 1,074,207 acre-feet of total storage below the maximum water surface elevation 475.4 feet. The 2005 survey measured a minimum lake bottom near elevation 190. Since all past and present operations are tied to the project vertical datum, all elevations and resulting values in NAVD88-05 were shifted to match. The following values are from the September 2005 capacity table:

- 107,384 acre-feet of surcharge between elevation 466.0 and 475.4 feet.
- 398,724 acre-feet of joint use between elevation 425.8 and 466.0 feet.
- 484,706 acre-foot of active storage between elevation 327.0 and 425.8 feet.
- 83,387 acre-foot of inactive storage between elevation 205.5 and 327.0 feet.
- 6 acre-foot of dead storage below 205.5 feet.

Folsom Lake computed annual inflow and reservoir stage available records are listed by water year on table 1 for the operation period 1955 through 2005. The inflow values were computed by the Mid-Pacific Regional office and show annual fluctuation with a computed average inflow of 2,787,400 acre-feet per year. The maximum reservoir elevation was 467.2 recorded during water year 1963 with a minimum elevation of 347.6 recorded during water year 1978.

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 3. 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.

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 on 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 California’s state plane, zone 2, coordinates in NAD83. The RTK GPS system

Figure 3 - Survey vessel with mounted instrumentation on Jackson Lake in Wyoming.

employs two receivers that track the same satellites simultaneously just like with differential GPS.

In 2001, the Sedimentation and River Hydraulics Group began utilizing an integrated multibeam hydrographic survey system. The system consists of a single transducer mounted on the center bow or forward portion of the boat. From the single transducer a fan array of narrow beams generate a detailed cross section of bottom geometry as the survey vessel passes over the areas to be mapped. The system transmits 80 separate 1-1/2 degree slant beams resulting in a 120-degree swath from the transducer. The 200 kHz high-resolution multibeam echosounder system measured the relative water depth across the wide swath perpendicular to the vessel's track. Figure 4 illuminates the swath of the sea floor that is about 3.5 times as wide as the water depth below the transducer.

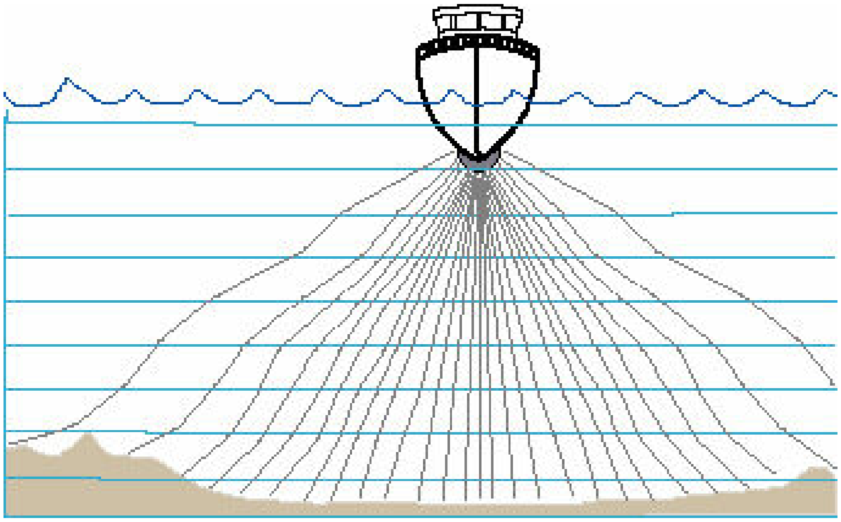

Figure 4 - Multibeam collection system.

The multibeam system is composed of several instruments that are all in constant communication with a central on-board notebook computer. The components include the RTK GPS for positioning; a motion reference unit to measure the heave, pitch, and roll of the survey vessel; a gyro to measure the yaw or vessel attitude; and a velocity meter to measure the speed of sound of the reservoir water column. With the proper calibration, the data processing software utilizes all the incoming information to provide an accurate detailed x, y, z data set of the lake bottom.

The Folsom Lake bathymetric survey collection was conducted from September 9 through September 22 of 2005 between water surface elevation 437 and 441 (project datum). The survey was run using the multibeam instrumentation described above. The survey system software continuously recorded reservoir depths and horizontal coordinates as the survey vessel moved across close-spaced grid lines covering the reservoir area. Most of the transects (grid lines) were run along the original river alignment of the reservoir where the multibeam swaths overlapped each other. In the shallower depths, around thirty feet and less, the swaths did not overlap. The multibeam system could have provided full bottom coverage not covered by these swaths, but time, budget, and access prevented this in the shallow water portions of the reservoir. Due to the cost and sensitivity of the multibeam transducer, the collection crew generally avoids collection in depths shallower than 10 feet. The loss of these additional data points did not have a significant impact on the area computations since they occurred in shallower areas of the reservoir where the bottom topography was generally flatter in nature.

The 2005 collection of bathymetric data did not include single beam data in the shallow, less than 10 foot, areas of the reservoir. It was anticipated that the lake would be low enough during aerial collection to obtain enough overlap between the aerial and multibeam data sets, but this did not occur throughout the reservoir. Besides the shallow flat areas of the reservoirs some of the additional areas not covered included the upstream arms and coves of the reservoir. For these missed areas the contours between the surveyed data were interpolated using contouring software. These contours should not be considered reliable and would not meet most accuracy standards. To preserve the integrity of the data sets, interpolated points were not added to the shallow water areas. Also, these areas were small relative to the total reservoir area and would not have had a significant effect on the overall surface area computations.

The first part of the analysis started with the processing of all the collected raw profile data files of the bottom. This included application of all necessary correction information that was collected, such as vessel location and the roll, pitch, and yaw effects on the survey vessel. Other corrections included application of the field measured sound velocity of the reservoir water column and then conversion of all corrected depth data to elevations. All elevations in the final processing were tied to the Reclamation measured water surface gauge elevations at the time of collection. During map processing, these bottom elevations were converted to NAVD88-05 datum by adding 2.34 feet. The geodetic survey also measured a slight shift in the horizontal coordinates (+) 0.47 feet north and (-) 0.61 feet west that was also applied.

Due to the massive amount of multibeam data collected, procedures within the collection and analysis software logically filtered data points without adversely affecting the results were utilized. Filtering mainly occurred in the flatter areas of the reservoir where the additional survey points were not necessary to map the bottom details of the reservoir. Quality control and assurance of the data sets were accomplished by conducting field calibration as required by the multibeam system and by collecting velocity profile data for the areas being surveyed. The processing of the multibeam data was conducted by Reclamation's Sedimentation Group. The processed data in an x,y,z format was forwarded to the Surveys and Mapping Branch for topographic development.

Reservoir Area and Capacity

Topography Development

Survey and Mapping Branch Processing

The entire topography of 2005 Folsom Lake and the surrounding area were developed by the Reclamation's Mid-Pacific Region Surveys and Mapping Branch. This included overseeing the contracting of the aerial collection and quality control. The aerial mapping included the upstream arms of the north and south forks of the American River and the high accuracy mapping of the dams and dikes that enclose the reservoir. Using standard photogrammetric processes the film diapositives were used for aerial triangulation and subsequent 3D data collection. Using AutoCAD, breaklines along with random and regularly gridded points were also compiled to create surface models for contour generation. For the bathymetric data, the processed x,y,z data points were shifted to match the aerial horizontal and vertical control datums which were in NAD83 and NAVD88-05 respectively. The bathymetry contours were developed using a hardclip boundary around the underwater data that was developed from the aerial data, contour elevation 430.0 (NAVD88-05). Due to the large data sets, the final contours were broken up into seven blocks or drawing files. The area blocks also included digital terrain model (DTM) files that contained the surface data in the form of breaklines along with the random and regular gridded points. These data files were forwarded to the Sedimentation Group for area and capacity computations and sediment inflow calculations. All data was tied to California state plane, zone 2, in NAD83 and the elevations tied to NAVD88-05. Additional files included the full orthorectified photos of the project area. Additional information on these coverage files and methods of processing are listed in the metadata file located in the appendix.

Sedimentation Group Processing

The Sedimentation Group uses ARCGIS (ESRI, 2006) to process data for developing reservoir topography and computing the resulting surface areas and volumes. To accomplish this, the 2005 Folsom Lake study area's processed x,y,z data points were combined into one data set. This included the nearly nine million bathymetric data points that were shifted to match the aerial data datums. These bathymetric points were combined with the aerial data points, located within the DTM files, for developing the study area contours.

The first step was to enclose all the combined data points within a hardclip polygon so that during contour development all interpretations would remain within the study area. The contours within this hardclip were developed from the combined aerial and underwater data sets using the triangular irregular network (TIN) surface-modeling package within ARCGIS. 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 were interpolated along the triangle elements using the surface contouring option within ARCGIS.

The aerial data of the dam and dikes is a very detailed set of points of the entire structures that are located beyond or downstream of the actual reservoir area. For the purpose of computing the surface area and capacity of the reservoir area only, a hardclip was developed to enclose the data points within the reservoir area only. This was accomplished by using the elevation 500.0 (NAVD88-05) contour developed from the entire study area survey points as described above. This contour is above the top of the dam, but was chosen for developing the updated reservoir surface areas since there have been discussions of possibly raising the existing structures and resulting reservoir levels. Using ARCGIS edit tools, the elevation 500.0 (NAVD88-05) contour was enclosed along the existing dike and dams by overlaying this contour onto the orthorectified photos. Once this polygon was developed and enclosed, elevation 500.0 (NAVD88-05) was assigned for the purpose of developing the reservoir TIN and resulting contours.

Within this reservoir area elevation 500.0 (NAVD88-05) hardclip, a TIN was developed for the Folsom Lake reservoir area. From this TIN, the 2005 surface areas and volumes were computed at one-foot increments from elevation 500.0 (NAVD88-05) and below. The contour data presented on these maps are tied to the vertical datum of NAVD88-05. All surface area and volume computations within this report were tied to the Folsom Lake project datum by shifting the elevations 2.34 feet lower than NAVD88-05. The vertical shift is necessary since past and present reservoir operations are tied to the project vertical datum.

Development of the 2005 Contours

Reclamation's Survey and Mapping Branch in Sacramento developed the 2005 contours of the Folsom Lake study area by combining the 2005 aerial and underwater data sets. These contours are presented on 204 detailed maps as illustrated on the index map, figure 5. The contours presented on these maps are tied to NAVD88-05 and are 2.34 feet higher than the project vertical datum and the horizontal coordinates are on the California State Plane, zone 2, in NAD83. Examples of maps are illustrated on figures 6 through 11. These maps are of the whole study area that extends upstream and downstream of the entrapment structures forming Folsom Lake. The metadata file in the appendix provides additional information on the creation of these maps.

Development of the 2005 Folsom Lake Surface Areas

The 2005 surface areas for Folsom Lake were computed at 1-foot increments from the TIN that covered the Folsom Lake area only. This TIN was developed within a hardclip area that included the existing elevation 500.0 (NAVD88-05) contour that was modified to run along the present alignment of the entrapment structures. These calculations were performed using the ARCGIS surface area and volume command that computes areas at user-specified elevations directly from the TIN and takes into consideration all regions of equal elevation. For the purpose of computing the 2005 area and capacity tables for this report, the measured surface area elevations in NAVD88-05 where shifted down by 2.34 feet to match the project elevations.

2005 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). For the purpose of this study, the measured 2005 survey areas at 3-foot increments from elevation 190.0.0 through 490.0 were used to compute the new area and capacity tables and were used as the control parameters for computing the 2005 Folsom Lake capacity. The ACAP program can compute the 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 Folsom Lake. The capacity equation is then used over the full range of

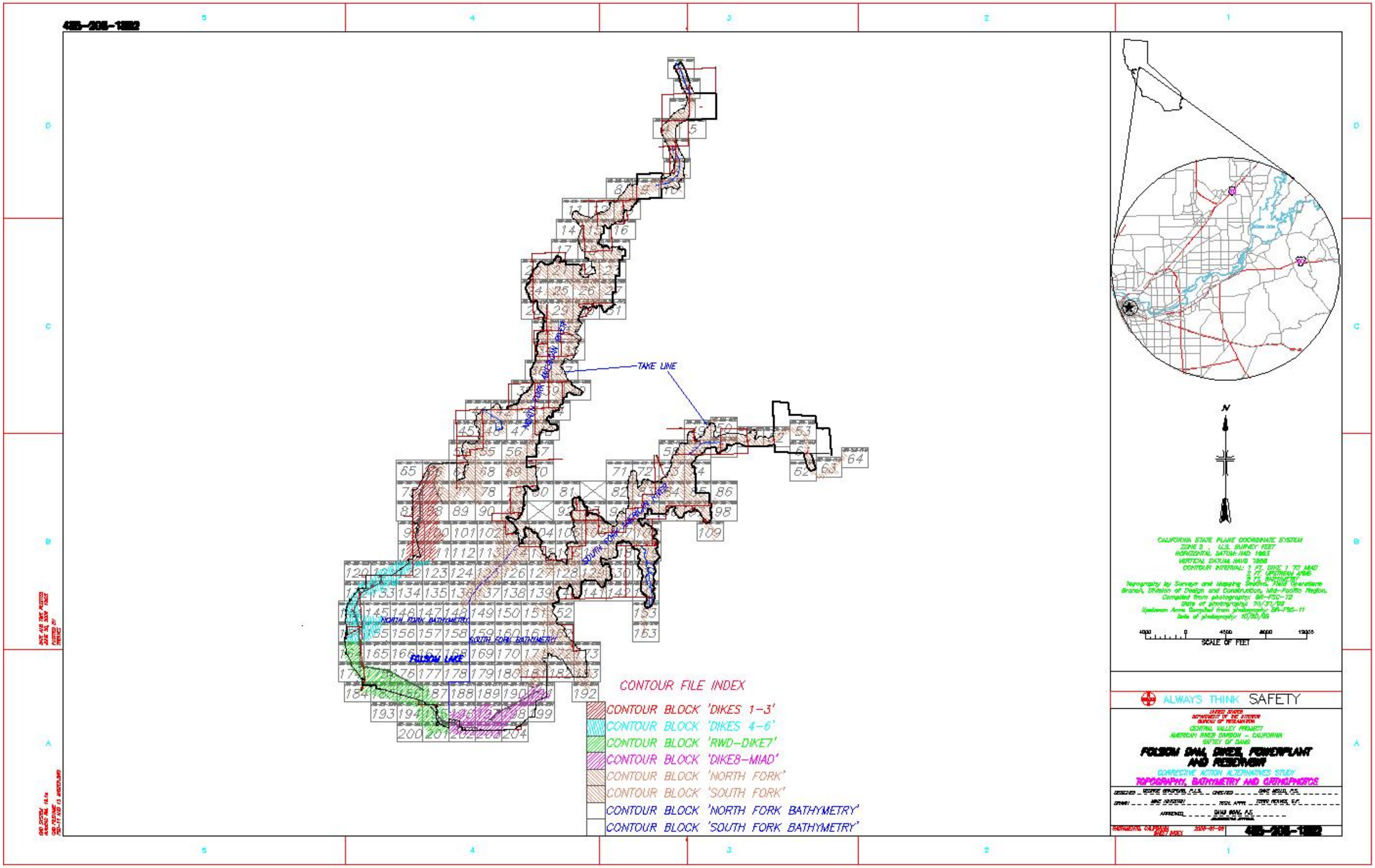

Figure 5 - Map index for the 2005 Folsom Lake survey.

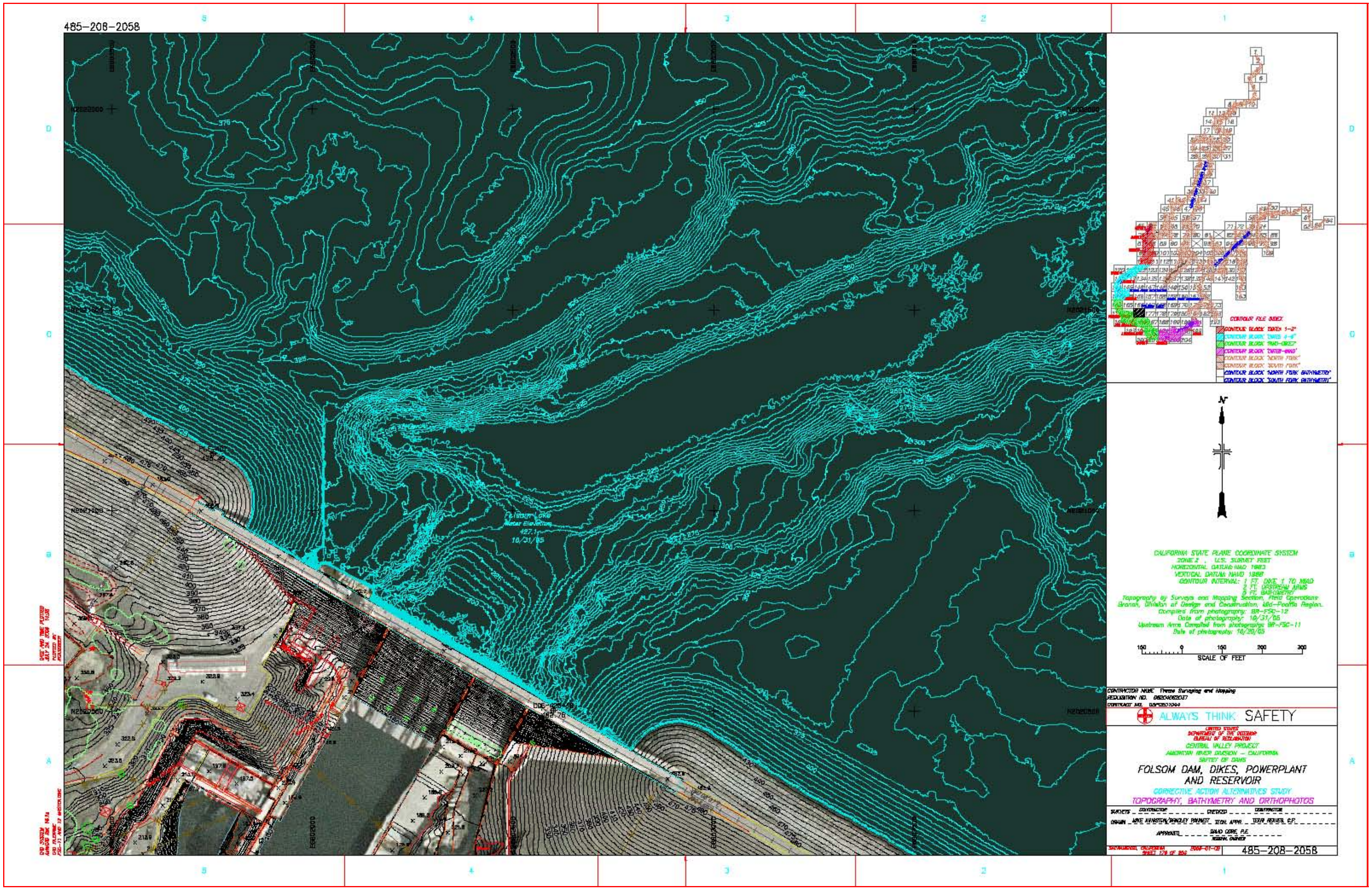

Figure 6 - Folsom Dam and lake topography, drawing 485-208-2058.

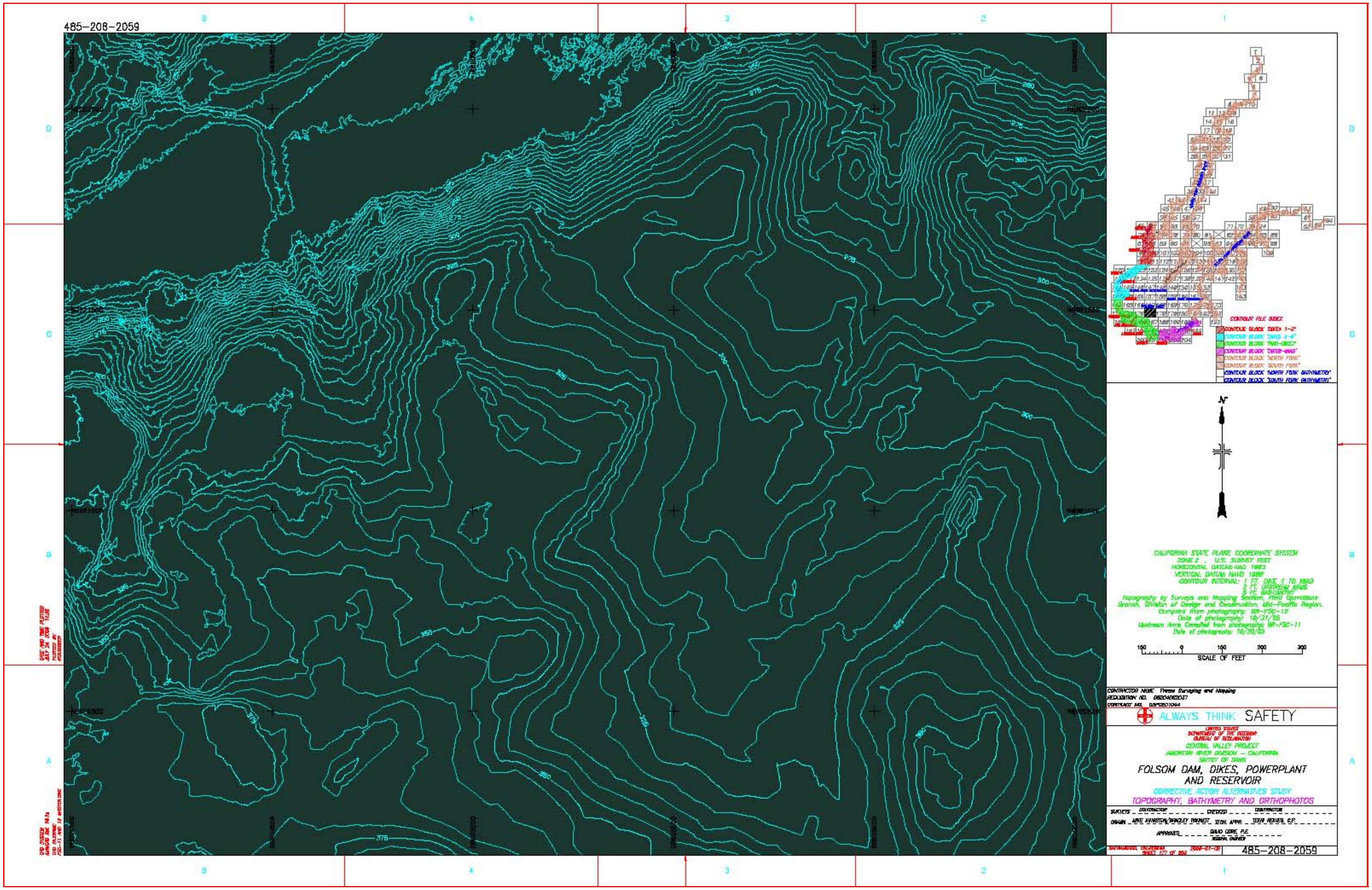

Figure 7 - Folsom Lake topography, drawing 485-208-2059.

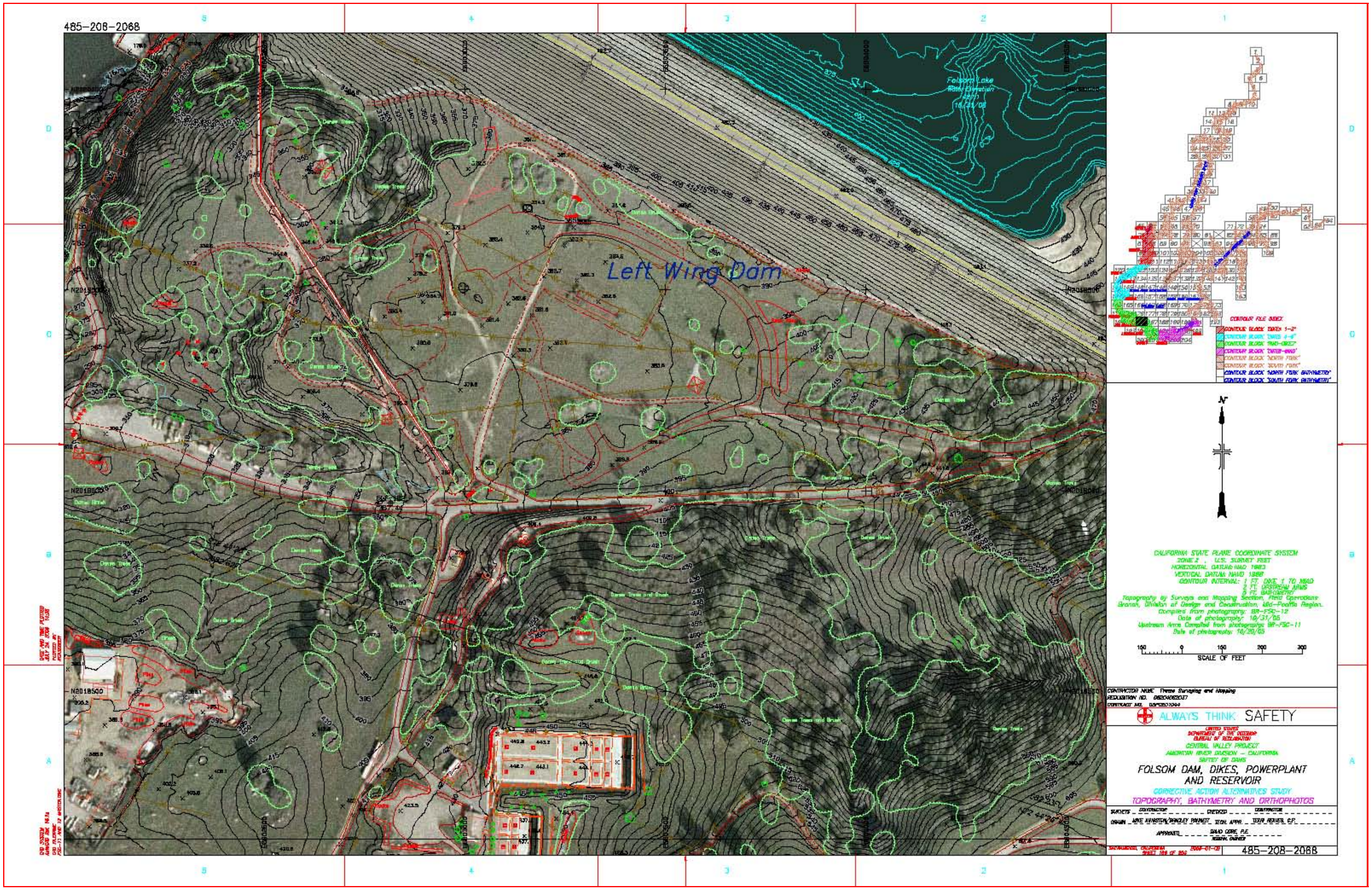

Figure 8 - Folsom Lake left wing dam and topography, drawing 485-208-2088.

Figure 9 - Folsom Lake topography, drawing 485-208-2089.

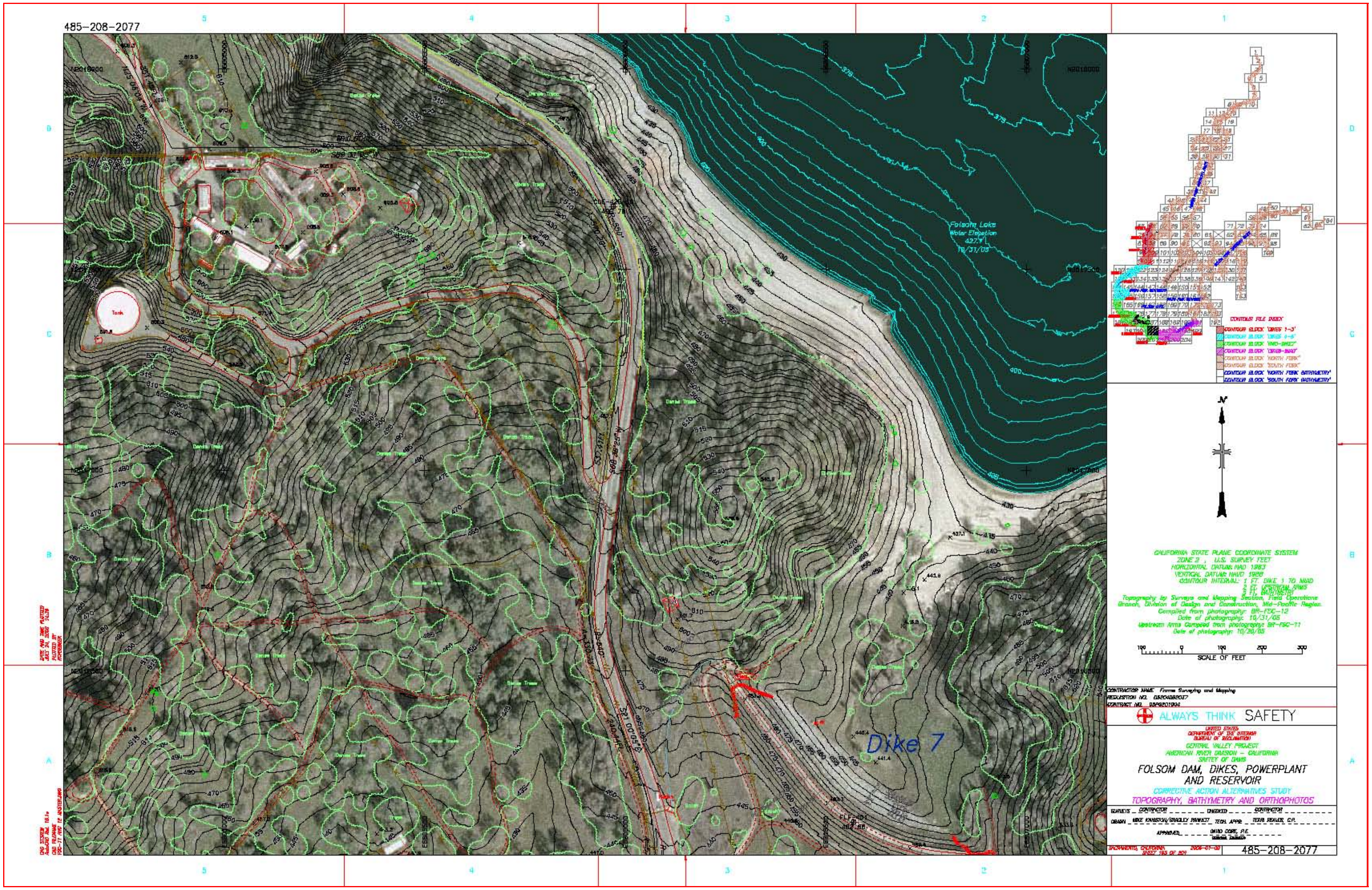

Figure 10 - Folsom Lake and Dike 7 topography, drawing 485-208-2077.

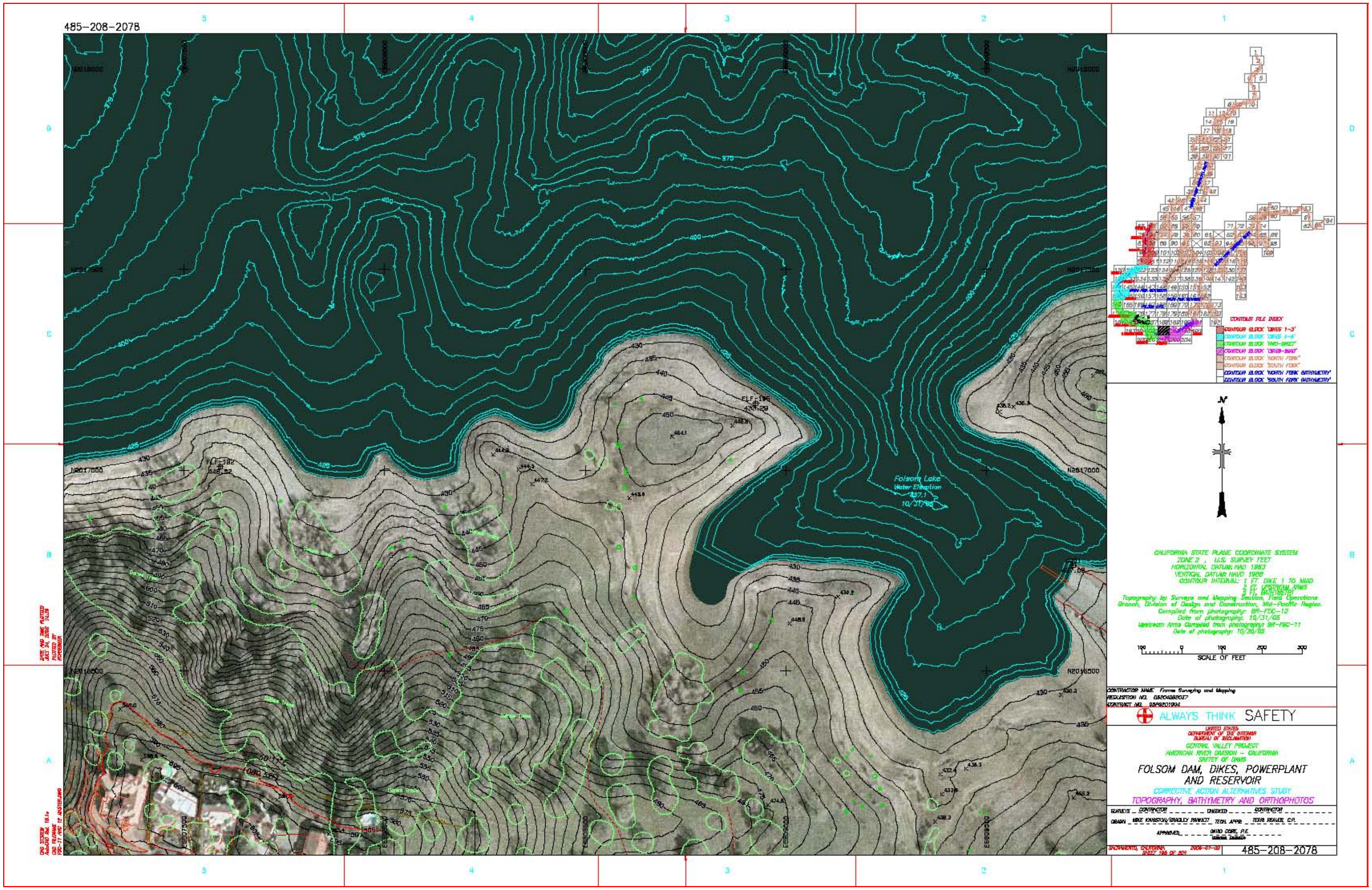

Figure 11 - Folsom Lake topography, drawing 485-208-2078.

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 Folsom Lake area and capacity computations are listed in a separate set of 2005 area and capacity tables and have been published for the 0.01, 0.1 and 1-foot elevation increments (Bureau of Reclamation 2006). A description of the computations and coefficients output from the ACAP program is included with these tables. The 1955, 1991, and 2005 area-capacity curves are listed on table 2 and plotted on figure 12. As of September 2005, at top of joint use elevation 466.0, the surface area was 11,140 acres with a total capacity of 966,823 acre-feet.

2005 Reservoir Analyses

Results of the 2005 Folsom Lake area and capacity computations are listed in table 1 and columns 8 and 9 of table 2. Columns 2 and 3 of table 2 list the 1955 or original area and capacity values and column 4 and 5 list the 1991 surface and area and capacity results for Folsom Lake. Column 6 and 10 of table 2 list the capacity differences between the original and 1991 and 2005 survey results. Figure 12 is a plot of the Folsom Lake surface area and capacity values for the three surveys and illustrates the differences between the surveys. The comparisons show that the total reservoir capacity in 2005 is 45,871 acre-feet less in volume from the original volume at maximum reservoir elevation 475.4.

Research into the original area and capacity data found 20-foot contour surface areas were used to compute the original volumes. For elevations 400 and below, the 20-foot contours were developed from U.S. Geologic Survey (USGS) river survey data collected in 1935-36. The 20-foot contours above elevation 400 came from 1940’s USGS quadrangle maps of the reservoir area. During the original planning of Folsom Lake, the 100 year estimated loss of total capacity of the reservoir below elevation 466.0 was 5.7 percent, a total of 58,000 acre-feet, or an annual average loss of 580 acre-feet. There was not any information on factors used to compute this sediment inflow value. The 2005 investigation found that the total drainage area into Folsom Lake is around 1,861 square miles and with several of the upstream reservoirs capturing sediment, it was computed that 1,020 square miles of the drainage area contributes sediment inflow into Folsom Lake. There are several reservoirs operating as diversion structures that were assumed had no effect on sediment retention. It is assumed the original 100 year estimate took into account the upper reservoir effects, but to what degree is not known.

The 2005 survey computed a loss of 43,407 acre-feet of storage during the first 50.5 years of operation below joint use reservoir elevation 466.0. It is unknown how much of this loss is due to differences in the detail of the surveys. The 1991 survey was a combination of an aerial survey conducted during low reservoir content (elevation 366), and a single beam bathymetric survey conducted at reservoir elevation 418. Parallel cross sections were run 200-feet apart to fill in the deeper reservoir area not covered by the aerial survey. The survey computed an average annual loss of 921.7 acre-feet, below elevation 466.0, over the first 36.1 years of operation by comparing the original recomputed volume with the 1991 computed volume. The 2005 survey computed an average annual loss of 703.6 acre-feet, below elevation 466.0, for the 14.4 years of operation since the 1991 survey. Even though the period is small between these surveys, the average annual loss of 703.6 acre-feet is a better representation for computing future losses since both surveys were of better detail than the original. There are many factors in the drainage basins that affect the annual sediment inflows, but it is recommended that the 703.6 acre-feet value be used as a basis for future prediction of reservoir losses.

It is the general conclusion that the difference between the original and 2005 surveys is due partially to sediment inflow, but the differences in the detail between the two surveys is also a factor. The 2005 survey is of greater detail and provides an accurate representation of the present reservoir volume as of September 2005.

RESERVOIR SEDIMENT
DATA SUMMARY

Folsom Lake
NAME OF RESERVOIR

1
DATA SHEET NO.

DAM	1. OWNER: Bureau of Reclamation [1]	2. STREAM: American River	3. STATE: California
	4. SEC 24 TWP. 10 N RANGE 7 E	5. NEAREST P.O. Folsom	6. COUNTY: Sacramento
	7. LAT 38 ° 42 ' 29 " LONG 121 ° 09 ' 22 "	8. TOP OF DAM ELEVATION: 480.5 [2]	9. SPILLWAY CREST EL. 418.0 [3]

RESERVOIR	10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, AC-FT	13. ORIGINAL CAPACITY, AC-FT	14. GROSS STORAGE ACRE-FEET	15 DATE STORAGE BEGAN
	a. SURCHARGE	475.4 [4]	11,931	109,848	1,120,078	2/25/55
	b. FLOOD CONTROL					
	c. POWER					
	d. JOINT USE	466.0	11,440	411,211	1,010,230	16 DATE NORMAL OPERATIONS BEGAN
	e. CONSERVATION	425.8	8,946	508,972	599,019	12/6/1955[5]
	f. INACTIVE	327.0	2,035	89,933	90,047	
	g. DEAD	205.5	20	114	114	
	17. LENGTH OF RESERVOIR 28 [6] MILES		AVG. WIDTH OF RESERVOIR 0.64 MILES			

BASIN	18. TOTAL DRAINAGE AREA 1,861 SQUARE MILES	22. MEAN ANNUAL PRECIPITATION 22.4 [7] INCHES	
	19. NET SEDIMENT CONTRIBUTING AREA 1,020 [8] SQUARE MILES	23. MEAN ANNUAL RUNOFF 28.2 INCHES	
	20. LENGTH MILES	AVG. WIDTH MILES	24. MEAN ANNUAL RUNOFF 2,787,400 [9] ACRE-FEET
	21. MAX. ELEVATION	MIN. ELEVATION	25. ANNUAL TEMP, MEAN 61 °F RANGE 17 °F to 112 °F [7]

SURVEY DATA

26. DATE OF SURVEY	27. PER. YRS	28. PER. YRS	29. TYPE OF SURVEY	30. NO. OF RANGES OR INTERVALS	31. SURFACE AREA, AC.	32. CAPACITY ACRE - FEET	33. C/ RATIO AF/AF
2/25/55			Contour (D)	20-ft	11,440 [4]	1,010,230 [4]	0.36
4/15/91 [10]	36.1	36.1	Contour (D)	5-ft	11,183 [11]	976,955 [11]	0.35
9/21/05	14.4	50.5	Contour (D)	3-ft	11,140 [11]	966,823 [11]	0.35

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET			36 WATER INFLOW TO DATE, AF	
		a. MEAN ANN.	b. MAX. ANN.	c. TOTAL	a. MEAN ANN.	b. TOTAL
4/15/91	22.7 [7]	2,795,100 [9]	6,541,200	101,568,200	2,745,100	101,568,200
9/21/05		2,899,400	5,414,300	40,591,900	2,787,400	142,160,100

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SEDIMENT DEPOSITS TO DATE, AF		
	a. TOTAL	b. AVG. ANN.	c. /MI.^{2}-YR.	a. TOTAL	b. AVG. ANN.	c. /MI.^{2}-YR.
4/15/91	33,275 [12]	921.7 [12]	0.90 [12]	33,275 [12]	921.7 [12]	0.90 [12]
09/21/05	10,132 [12]	703.6 [12]	0.69 [12]	43,407 [12]	859.5 [12]	0.84 [12]

26. DATE OF SURVEY	39. AVG. DRY WT. (#/FT^3)	40. SED. DEP. TONS/MI.^{2}-YR		41. STORAGE LOSS, PCT.		42 SEDIMENT INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AVG. ANNUAL	b. TOTAL TO DATE	a. PER.	b. TOT.
4/15/91				0.091	3.29		
9/21/05				0.085	4.30		

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE BY RESERVOIR ELEVATION									
		190.0-300.0	300.0-327.0	327.0-350.0	350.0-370.0	370.0-390.0	390.0-410.0	410.0-430.0	430.0-450.0	450.0-466.0
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION									
9/21/05		14.6	6.4	5.9	2.5	6.1	15.4	19.9	16.6	12.6

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR													
	0-10	10-20	20-30	30-40	50-60	60-70	70-80	80-90	90-100	100-105	105-111	110-115	115-120	120-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION													

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

45. RANGE IN RESERVOIR OPERATION [13]

YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF	YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF
				1955	408.0	244.5	1,204,600
1956	466.9	353.2	4,781,300	1957	466.6	400.0	2,296,600
1958	466.6	398.7	4,205,400	1959	456.2	387.3	1,315,400
1960	466.9	378.2	1,760,700	1961	458.9	391.6	1,180,500
1962	460.7	394.5	2,171,000	1963	467.2	406.0	3,386,600
1964	464.6	403.0	1,914,300	1965	466.3	410.2	4,421,200
1966	457.7	416.3	1,516,500	1967	465.3	419.6	3,987,000
1968	446.2	418.8	1,844,600	1969	455.7	406.5	4,548,800
1970	457.1	420.1	3,380,000	1971	463.9	416.3	3,040,400
1972	464.4	421.8	2,067,900	1973	464.6	424.0	3,093,100
1974	462.8	424.4	4,407,800	1975	461.3	425.2	2,785,700
1976	443.7	403.1	1,142,300	1977	404.1	349.6	356,000
1978	460.0	347.6	2,963,100	1979	464.5	428.3	2,276,600
1980	454.8	424.7	3,971,800	1981	461.3	425.9	1,411,800
1982	465.0	419.1	6,112,800	1983	465.1	427.7	6,541,200
1984	464.5	426.8	4,159,100	1985	455.5	424.5	1,796,700
1986	465.7	413.1	4,573,400	1987	440.9	405.1	1,102,900
1988	415.0	369.1	962,400	1989	463.3	358.9	2,167,000
1990	425.8	359.0	1,345,000	1991	443.8	352.0	1,376,700
1992	440.0	360.3	1,086,500	1993	465.5	355.6	3,259,600
1994	424.0	370.9	1,041,500	1995	465.5	364.3	5,414,300
1996	464.4	393.7	3,799,600	1997	455.6	394.4	4,886,800
1998	463.6	405.4	4,437,400	1999	463.6	416.0	3,431,000
2000	448.9	416.3	2,722,500	2001	440.3	398.2	1,244,200
2002	452.8	378.9	1,865,200	2003	465.1	407.6	2,404,600
2004	440.7	399.6	1,794,700	2005	465.4	391.4	3,204,000

46. ELEVATION - AREA - CAPACITY - DATA FOR **2005 CAPACITY**

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
<u>2005</u>	**<u>SURVEY</u>**		190.0	0	0	195.0	0	1
200.0	0	3	205.0	1	6	210.0	2	11
215.0	13	55	220.0	45	180	225.0	97	543
230.0	136	1,128	235.0	190	1,931	240.0	249	3,037
245.0	300	4,410	250.0	354	6,049	255.0	420	7,976
260.0	489	10,253	265.0	560	12,869	270.0	630	15,844
275.0	710	19,191	280.0	785	22,932	285.0	864	27,051
290.0	952	30,585	295.0	1,062	36,611	300.0	1,184	42,226
305.0	1,304	48,449	310.0	1,426	55,271	315.0	1,554	62,715
320.0	1,691	70,823	325.0	1,841	79,646	327.0	1,907	83,393
330.0	2,015	89,273	335.0	2,216	99,838	340.0	2,428	111,443
345.0	2,646	124,123	350.0	2,886	137,943	355.0	3,168	153,060
360.0	3,519	169,747	365.0	3,914	188,313	370.0	4,346	208,980
375.0	4,726	231,679	380.0	5,104	256,241	385.0	5,466	282,681
390.0	5,835	310,921	395.0	6,202	341,024	400.0	6,576	372,964
405.0	6,979	406,833	410.0	7,381	442,754	415.0	7,743	480,578
420.0	8,078	520,142	425.0	8,407	561,341	427.0	8,612	578,359
430.0	8,874	604,610	435.0	9,239	649,918	440.0	9,574	696,955
445.0	9,894	745,632	450.0	10,208	795,889	455.0	10,515	847,700
460.0	10,801	900,996	465.0	11,084	955,710	466.0	11,140	966,823
470.0	11,380	1,011,844	475.0	11,687	1,069,528	475.4	11,710	1,074,207
480.0	11,973	1,128,679	485.0	12,233	1,189,200	490.0	12,484	1,250,992

47. REMARKS AND REFERENCES

[1] Constructed by the Corps of Engineers. Upon completion transferred to Reclamation to operate as part of the Central Valley Project.

[2] Top of parapet wall at elevation 484.0. All elevations in feet based on original project datum that is 2.34 feet lower than NAVD88 (2005).

[3] Spillway crest elevation 418.0. Elevation top of drum gates: five at 468.0 and three at 471.0 feet.

[4] Area and capacity calculated by BOR program ACAP for sediment computation purposes. Areas below elevation 400.0 based on 1935-36 USGS survey resulting in 20-foot contour map. Areas above elevation 400.0 based on USGS quadrangle maps dated 1940's.

[5] Full power production with all generators began on December 6, 1955.

[6] Total length includes North Fork American River (16.3 miles) and South Fork American River (11.7 miles) at elevation 466.

[7] Climate records, Bureau of Reclamation Project Data Book, 1981. Values for Central Valley Project.

[8] Total drainage area from USGS water year records. Loss of contributing areas due to closing of North Fork in 1941 (343 mi^2), French Meadows in 1964 (34.2 mi^2), Hell Hole in 1965 (79.8 mi^2), Loon Lake in 1963 (6.0 mi^2), Caples Lake in 1924 (13.5 mi^2), Silver Lake in in 1876 (15.2 mi^2), Union Valley in 1962 (66.9 mi^2), Ice House in 1959 (23.6 mi^2), Slab Creek in 1967 (229.4 mi^2), Lake Edison in in 1961 (13.0 mi^2), and Folsom Lake surface area (17.9 mi^2).

[9] Computed inflows for water years 1955 through 2005. For water year 1955, inflow values for March through September 1955.

[10] 1991 bathymetric survey performed by Reclamation, 4/15/91 through 4/21/91 at elevation 418. Aerial on 10/10/90 at elevation 366.0

[11] Surface area and capacity at joint use elevation 466.0.

[12] Computed capacity loss, by comparing differences of surveys, is affected by the detail and methods of surveys. Original data from 20-foot contour intervals. 1991 and 2005 data from more detailed aerial and underwater data.

[13] Water year data provided by Reclamation's Mid Pacific Regional Office.

48. AGENCY MAKING SURVEY Bureau of Reclamation
49. AGENCY SUPPLYING DATA Bureau of Reclamation DATE September 2006

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

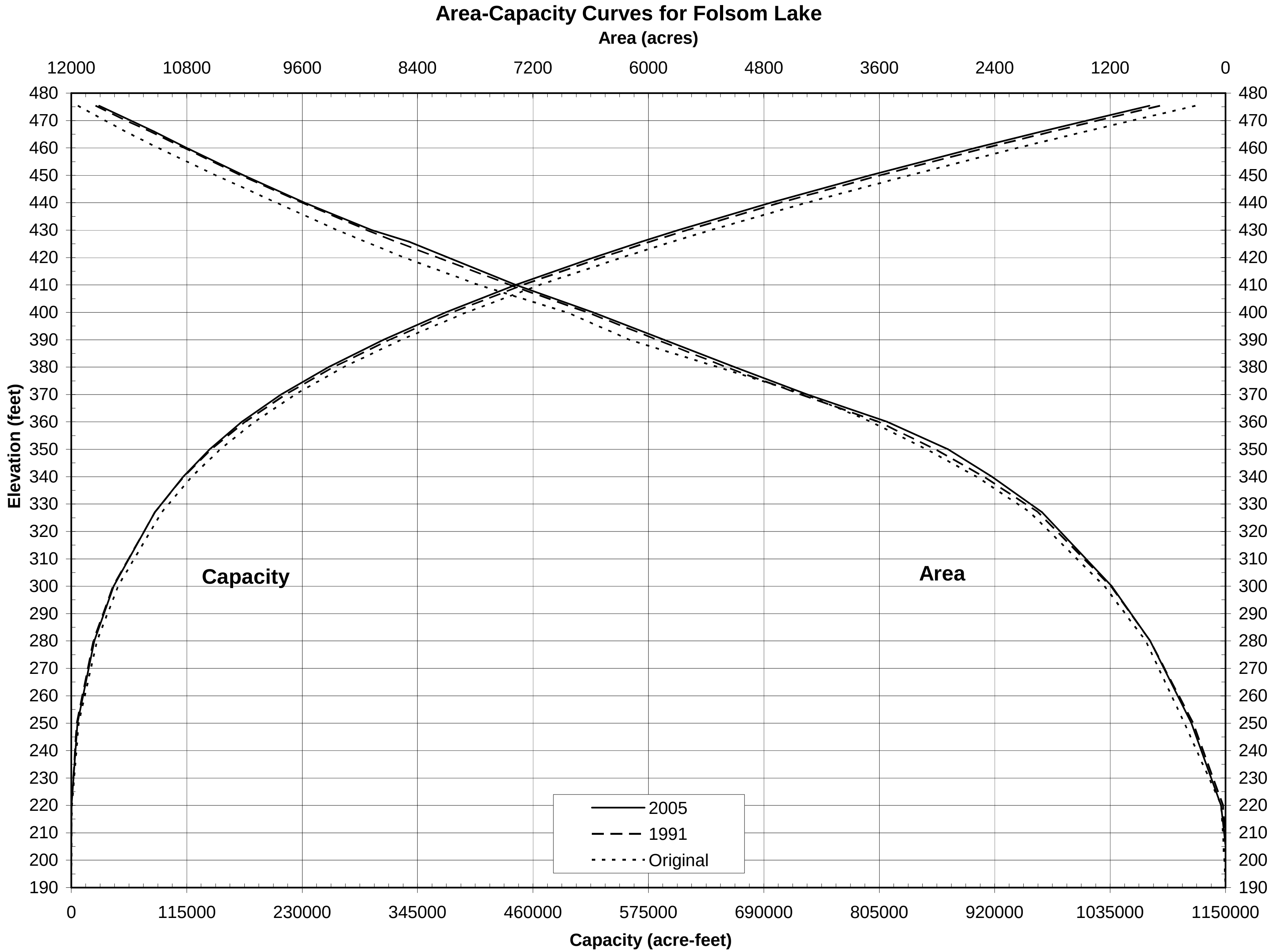

Figure 12 - Folsom Lake area and capacity plots.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Elevation <u>Feet</u>	Original Survey <u>Acres</u>	Original Capacity <u>Ac-Ft</u>	1991 Survey <u>Acres</u>	1991 Survey <u>Ac-Ft</u>	1991 Computed Sediment Volume <u>Ac-Ft</u>	1991 Percent Computed <u>Sediment</u>	2005 Survey <u>Acres</u>	2005 Survey <u>Ac-Ft</u>	2005 Total Sediment Volume <u>Ac-Ft</u>	2005 Percent Computed <u>Sediment</u>	Sediment Volume 1991-2005 <u>Ac-Ft</u>	Percent Computed Sediment <u>1991-2005</u>	Percent Reservoir <u>Depth</u>
475.4	11931	1120078	11749	1084778	35300		11710	1074207	45871		10571		100.0
470	11650	1056410	11432	1022185	34225		11380	1011844	44566		10341		98.1
466	11440	1010230	11183	976955	33275	100.0	11140	966823	43407	100.0	10132	100.0	96.7
460	11100	942610	10829	910928	31682	95.2	10801	900966	41644	95.9	9962	98.3	94.6
450	10500	834610	10240	805535	29075	87.4	10208	795889	38721	89.2	9646	95.2	91.1
440	9870	732760	9604	706360	26400	79.3	9574	696955	35805	82.5	9405	92.8	87.6
430	9240	637210	8932	613650	23560	70.8	8874	604610	32600	75.1	9040	89.2	84.1
425.8	8946	599019	8629	576772	22247	66.9	8489	568099	30920	71.2	8673	85.6	82.6
420	8540	548310	8191	527987	20323	61.1	8078	520142	28168	64.9	7845	77.4	80.6
410	7770	466760	7444	449815	16945	50.9	7381	442754	24006	55.3	7061	69.7	77.1
400	6850	393660	6638	379410	14250	42.8	6576	372964	20696	47.7	6446	63.6	73.6
390	6200	328410	5915	316613	11797	35.5	5835	310921	17489	40.3	5692	56.2	70.1
380	5280	271010	5196	261095	9915	29.8	5104	256241	14769	34.0	4854	47.9	66.6
370	4370	222760	4413	212978	9782	29.4	4346	208980	13780	31.7	3998	39.5	63.1
360	3690	182460	3609	173043	9417	28.3	3519	169747	12713	29.3	3296	32.5	59.6
350	3110	148460	3019	139493	8967	26.9	2886	137943	10517	24.2	1550	15.3	56.1
340	2590	119960	2514	111945	8015	24.1	2428	111443	8517	19.6	502	5.0	52.6
327	2035	90047	1950	83071	6976	21.0	1907	83393	6654	15.3	-322	-3.2	48.0
300	1260	46310	1192	41465	4845	14.6	1184	42226	4084	9.4	-761	-7.5	38.5
280	830	25560	784	22040	3520	10.6	785	22932	2628	6.1	-892	-8.8	31.5
250	430	7260	338	5450	1810	5.4	354	6049	1211	2.8	-599	-5.9	21.0
220	45	585	26	130	455	1.4	45	180	405	0.9	-50	-0.5	10.5
205.5	20	114	1	3	111	0.3	1	6	108	0.2	-3	0.0	5.4
190	0	0	0	0	0	0.0	0	0	0	0.0	0	0.0	0.0

1 Elevation of reservoir water surface.
2 Original reservoir surface areas.
3 Original reservoir capacity computed using ACAP.
4 1991 measured reservoir surface area.
5 1991 reservoir capacity computed using ACAP.
6 1991 computed sediment volume, column (3) - column (5).
7 1991 measured sediment in percentage of total sediment, 33,275 acre-feet, by elevation.
8 2005 measured reservoir surface area.
9 2005 reservoir capacity computed using ACAP.
10 2005 measured sediment volume = column (3) - column (9).
11 2005 measured sediment in percentage of total sediment, 43,407 acre-feet, by elevation.
12 Measured sediment volume from 1991 to 2005, column (5) - column (9).
13 Measured sediment in percentage my elevation from 1991 to 2005. Total sediment volume of 10,132 acre-feet.
14 Depth of reservoir expressed in percentage of total depth (285.4), from maximum water surface.

Table 2 - Summary of 2005 survey results.

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Appendix

February 21, 2007
Folsom Dam Raise
Topography and Imagery

Identification_Information:
Citation:
Citation_Information:
Originator:
U.S. Bureau of Reclamation.
Publication_Date:
May 2006
Title:

Folsom Dam Raise - Topography and Imagery

Master Data files:

BR FSC 11 and 12 Master Topo Folsom Dam.dwg

Geospatial_Data_Presentation_Form:
Raster and Vector Data
Online_Linkage:
AM Teamworks and/or REDS
Overview:

Topography, Bathymetry and Imagery was developed to study the Dikes, the Wing Dams, Folsom Dam, and Mormon Island Auxiliary Dam along with the up-stream arms of the American River.

The project consists of 1 Sheet Index @ 1:48000 on drawing number 485-208-1882 and 204 mapping sheets @ 1:1200 on drawing numbers 485-208-1883 through 485-208-2086.

Orthophotos for above water sheets in related sheet tiles are in .sid format with .sdw files for geo-referencing.

Project Datum:
California Coordinate System, CCS, Zone 2, U.S. Survey Feet
Horizontal Datum:
NAD 83
Vertical Datum:
NAVD 88 (2005)

Process and Methodology Description:

Ground Control:
The Bureau of Reclamation and the Army Corps of Engineers, under the direction of the National Geodetic Survey, performed an extensive geodetic control network in NAD83/NAVD88 encompassing the project. Aerial control was then established for the photogrammetric work.

Aerial Photography:
Under contract with BOR, American Aerial Surveys, Ione, CA provided color vertical aerial photography as follows; BR-FSC-11@ 1:6000 flown for the Upstream Arms of the American River on 10-20-05 with a reservoir elevation of 430.2'. BR-FSC-12 @ 1:3600 flown for high accuracy mapping from Dike 1 to MIAD on 10-31-05 with a reservoir elevation of 427.1'. Aerial obliques of all structures were taken 12-05-05.
Bathymetry:
Bathymetric Data was collected in October 2005 using Real Time Kinetic Global Positioning System with a Multiple Beam Sonar Collection System by the Bureau of Reclamation Sedimentation and River Hydraulics Group from Denver, CO. The average reservoir elevation during data collection was 440' giving reliable readings below approximately 425'.

The bathymetric data was collected prior to the completion of the Geodetic Network and was post processed to the final survey adjustment. To allow efficient contour generation, the data files were filtered. A Triangulated Irregular Network (TIN) was computed with the insertion of the photogrammetric water surfaces as a breakline around the perimeter.

Because the sensor could not collect data in shallow water, some of the upstream arm data was interpolated between the photogrammetric water surface information and the bathymetric data points which created anomalous contour data and should be considered unreliable. These areas will not meet any accuracy standards. This data was not edited or clipped out to keep vector work concatenated for area capacity and surface area calculations.

Photogrammetry:

Using standard photogrammetric processes, film diapositives were used for aerial triangulation and subsequent 3D data collection. Breaklines and random and regularly gridded points were compiled to create surface models for subsequent contour generation.

1 foot contours were produced from Dike 1 to Morman Island Auxiliary Dam, 2 foot contours cover the upstream arms and 5 foot contours reflect the bathymetry, all at a horizontal scale of 1:1200/1"=100'.

Field surveys were performed to check final data and the results meet or exceed standards on above water data.

Orthophotos:

Full orthorectification was performed using the photogrammetric surface information. Tif images were compressed to create .sid files with associated world files corresponding to the sheet layout and index. Any surface information outside of the contoured corridors were only collected for gross rectification for surrounding areas and said data and imagery will not meet mapping standards.

Satellite Imagery:
p0576North.sid and .sdw
p0576South.sid and .sdw

Date Flown: January 2004

Pixel Size: 2 feet

Prepared By: IntraSearch Inc.
MapMart
12424 East Weaver Place
Suite 100
Centennial, Colorado 80111
303-759-5050
303-759-0400 - fax
www.intrasearch.com
www.mapmart.com
info@intrasearch.com
Map Mart Project Number: 2004-p-0576
Digital Take Line Information:

Information for a digital take line (NAD27) was extracted from (22) USACE drawings AM-1-13-490 dated January 1952 and (6) BOR drawings 485-208-254 through 485-208-259 dated October 1958. A simple transformation was performed to move this data into the current horizontal datum of NAD83.

This boundary data is limited by the condition of the records and was oftentimes not clearly visible, had obvious errors and omissions and was produced using survey and drafting methods suitable only for that particular timeframe. Some data manipulation was necessary to resolve minor issues of precision and newer technology. Major issues with no obvious resolution are noted.

Some field work was performed to check this data and without significant field verification we believe the take line data is now within a +/-10' error ellipse but have no solutions for major discrepancies. The take line data should be considered informational only until a full boundary survey is performed.

Horizontal Alignment Information:

Information for the construction of a digital horizontal alignment was taken from BOR's Spec 896 book. The horizontal alignment data is limited by the condition of the records and was oftentimes not clearly visible, had obvious errors and omissions and was produced using survey and drafting methods suitable only for that particular timeframe. Some data manipulation was necessary to resolve minor issues of precision and newer technology.

Data Management:

Appropriate data files are referenced into the master AutoCAD file:

BR FSC 11 and 12 Master Topo Folsom Dam.dwg

Mapping Features_2d.dwg

Contour Data referenced into master AutoCAD file per contour blocks:

Contour Blk Dikes 1-3.dwg
Contour Blk Dikes 4-6.dwg
Contour Blk RWD-Dike7.dwg
Contour Blk Dikes8-MIAD.dwg
Contour Blk North and South Forks.dwg
Contour Blk North Fork Bathymetry.dwg
Contour Blk South Fork Bathymetry.dwg

Surface Data in the form of DTM breaklines and random and regularly gridded points are available:

DTM Dikes 1-3.dwg
DTM Dikes 4-6.dwg
DTM RWD-Dike7.dwg
DTM Dikes8-MIAD.dwg
DTM North and South Forks.dwg
DTM North Fork Bathymetry.dwg
DTM South Fork Bathymetry.dwg

Additional Data Available:

Mapping Features_3d.dwg
Folsom Take Line 83.dwg
Waterlines (2d and 3d).dwg

Data Limitations:

Terrain information outside the main contour corridors will not meet standards for vertical accuracy and is intended only to support gross orthorectification of surrounding areas.

Data Duplication:

USBR Surveys and Photogrammetry; Art Aguirre 978-5333 or AM Teamworks and/or REDS.

Time_Period_Information:
Calendar_Date: Date of Aerial Photography October 20 and 31, 2005
Date of Bathymetry August 2005
Currentness_Reference:
Current to the listed Calendar Date provided. See Data Quality for process steps.
Status:
Progress: Only current to the date specified.
Maintenance_and_Update_Frequency: Updated as determined by USBR.
Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -121.10.00
East_Bounding_Coordinate: -121.00.00
North_Bounding_Coordinate: 38.46.00
South_Bounding_Coordinate: 38.37.30
Access_Constraints: None.
Use_Constraints:
If used, please indicate that the database source was the U.S. Bureau of Reclamation.
Point_of_Contact:

Contact_Information:
Contact_Person_Primary:
Contact_Person: Terri Reaves
Contact_Organization: U.S. Bureau of Reclamation, Design and Construction
Contact_Position: Regional Chief of Surveys and Mapping
Contact_Voice_Telephone: (916) 978-5306
Contact_Facsimile_Telephone: (916) 978-5345
Contact_Electronic_Mail_Address: treaves@mp.usbr.gov
Hours_of_Service: 7:00 AM - 4:00 PM M-F
Contact_Instructions: Email your request to the above email address
Data_Set_Credit: Bureau of Reclamation
Division of Design and Construction, Surveys and Mapping Branch
2800 Cottage Way
Sacramento, CA 95825
916-978-5306
POC Terri Reaves

Geodetic Survey and Ground Control

Frame Surveys and Mapping
17029 Lambert Rd.
Ione, CA 95640
209-274-6500
POC Curtis Holmes

Aerial Photography

American Aerial Surveys
17029 Lambert Rd.
Ione, CA 95640
209-274-6500
POC Curtis Holmes

Bathymetry

USBR - Reservoir Area and Upstream Arms - 5 foot contours
Sedimentation and River Hydraulics Group
Denver, Co
POC Ronald Ferrari
303-445-2551

Photogrammetry

USBR - Dike 1 through MIAD - 1 foot contours
Surveys and Mapping Branch
Sacramento, CA
POC Terri Reaves
916-978-5306

American Aerial Surveys /Spectrum Mapping - North and South Forks - 2 foot contours
17029 Lambert Rd.
Ione, CA 95640
209-274-6500
POC Curtis Holmes

Orthophotos

Tri-State Surveying, Ltd., Inc.
1925 East Prater Way
Sparks, NV 89434-8938
775-358-9491

POC Mitch Bartorelli

Security_Information:
Security_Classification_System: None
Security_Classification: None
Security_Handling_Description: None
Native_Data_Set_Environment:
AutoCAD 2005
Cross_Reference:
Citation_Information:
Title: None

Data_Quality_Information:
Digital databases created within the USBR were reviewed using existing quality standards.
Logical_Consistency_Report:
Data meets accuracy and quality standards within USBR, the National Standard for Spatial Data Accuracy (NSSDA) and the National Map Accuracy Standards (NMAS) for 1:1200 with 1, 2 and 5 foot contours.
Completeness_Report:
This database represents the most current and up to date mapping for the Folsom Project up to the date of photography, October 2005.
Horizontal_Positional_Accuracy:
All horizontal positions meet or exceed NSSDA.
Vertical_Positional_Accuracy:
All vertical positions meet or exceed NSSDA.
Lineage:
Source_Information:
Source_Scale_Denominator: 1:3600 photography and 1:6000 photography.
Type_of_Source_Media:

Aerial Photography:
American Aerial Surveys, Inc - Ione, California
Zeiss RMK Top 15
Zeiss Pleogon a3/4
Camera Serial No. :141307
Lens Serial No. : 141329
Calibrated Focal Length 154.060

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition: NAD83
Grid_Coordinate_System: California Coordinate System - Zone 2
Lambert:
Scale_Factor_at_Central_Meridian: .999914672977
Longitude_of_Central_Meridian: -122.00.00
Latitude_of_Projection_Origin: 37.40.00
False_Easting: 6561666.667'
False_Northing: 1640416.667'
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 1980
Semi-major_Axis: 20925604.4742'
Denominator_of_Flattening_Ratio: 298.2572221008827

Distribution_Information:
Distributor:

Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
U.S. Bureau of Reclamation, Mid-Pacific Region, Design and Construction
Contact_Person: Terri Reaves
Contact_Position: Regional Chief of Surveys and Mapping
Contact_Voice_Telephone: 916-978-5306
Contact_Facsimile_Telephone: 916-978-5345
Contact_Electronic_Mail_Address: treaves@mp.usbr.gov
Hours_of_Service: 7:00 AM - 4:00 PM
Contact_Instructions: Call or email for method of data transfer
Distribution_Liability:
This data set was designed for 1:1200 mapping with 1 foot contour coverage on Dike1 to Mormon Island Auxiliary Dam, 2 foot contour coverage on up-stream arms inside of USBR take line and 5 foot bathymetric contour coverage. Mapping was developed from the source documents following standard procedures of compilation, draft editing, map and orthophoto generation. Use of this data at scales and contour intervals which are more detailed than the source is not recommended.

Metadata_Reference_Information:
Metadata_Date: May 2006
Metadata_Review_Date: May 2006
Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Terri Reaves
Contact_Organization: U.S. Bureau of Reclamation, Mid-Pacific Region
Contact_Position: Chief of Surveys and Mapping
Contact_Address:
Address_Type: mailing address
Address:
US Bureau of Reclamation
Terri Reaves - MP222
2800 Cottage Way W2916
City: Sacramento
State_or_Province: CA
Postal_Code: 95825
Country: USA
Contact_Voice_Telephone: 916-978-5306
Contact_Facsimile_Telephone: 926-978-5345
Contact_Electronic_Mail_Address: treaves@mp.usbr.gov
Hours_of_Service: 7:00 AM - 4:00 PM
Contact_Instructions: Call or email
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Access_Constraints: None
Metadata_Use_Constraints:
If used, please indicate that the data source was the U.S. Bureau of Reclamation, Mid-Pacific Region.