U.S. Department of the Interior
U.S. Geological Survey

In cooperation with
Federal Emergency Management Agency,
City of Boise, City of Garden City,
City of Eagle, and Ada County

Stream Channel Cross Sections for a Reach of the Boise River in Ada County, Idaho

Open-File Report 99–211

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By Jon E. Hortness *and* Douglas C. Werner

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Boise, Idaho
1999

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

Additional information can be obtained from:

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http://idaho.usgs.gov

Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Federal Center
Denver, CO 80225
e-mail: infoservices@usgs.gov

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CONVERSION FACTORS

Multiply	By	To obtain
acre-foot (acre-ft)	1,233	cubic meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
inch (in.)	2.54	centimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

Stream Channel Cross Sections for a Reach of the Boise River in Ada County, Idaho

By Jon E. Hortness *and* Douglas C. Werner

Abstract

The Federal Emergency Management Agency produces maps of areas that are likely to be inundated during major floods, usually the 100-year, or 1-percent probability, flood. The maps, called Flood Insurance Rate Maps, are used to determine flood insurance rates for homes, businesses, or other structures located in flood-prone areas. State and local governments also use these maps for help with, among other things, development planning and disaster mitigation.

During the period October 1997 through December 1998, the initial phase of a hydraulic analysis project of the Boise River from Barber Dam to the Ada/Canyon County boundary, the U.S. Geological Survey collected stream channel cross-section data at 238 locations along the river and documented 108 elevation reference marks established for horizontal and vertical control. In the final phase of the project, the Survey will use these data to determine water-surface elevations for the 10-, 50-, 100-, and 500-year floods and to define floodway limits. The Federal Emergency Management Agency will use the results of this hydraulic analysis to update the 100- and 500-year flood boundaries and the floodway limits on their Flood Insurance Rate Maps.

INTRODUCTION

The Federal Emergency Management Agency (FEMA) produces maps of areas that are likely to be inundated during major floods, usually the 100-year, or 1-percent probability, flood. The chance of a given flow being exceeded once in any given year is expressed as an annual probability. Thus, a 1-percent probability flood has a 1-in-100 chance of occurring in any given year. Similarly, a 50-year flood has a 1-in-50 chance of occurring in any given year. The return period of a flow is defined as the average elapsed time between events that equal or exceed that flow. An annual probability of 1 percent results in a return period of 100 years, which is why the flood is sometimes referred to as the 100-year flood.

FEMA uses these maps, called Flood Insurance Rate Maps (FIRMs), to determine flood insurance rates for homes, businesses, or other structures located in flood-prone areas. State and local governments also use these maps for help with, among other things, development planning and disaster mitigation. The current FIRMs were produced in 1979 and since have not been updated.

About 30 percent of Idaho's population resides in the lower Boise River Basin (Idaho Department of Commerce, written commun., 1999) between Lucky Peak Lake and the Snake River, the fastest growing area in Idaho (fig.1). The population of Ada County, alone, increased nearly 30 percent between 1990 and 1997, to approximately 267,000. The increase in population, the resulting development along the Boise River, and the time elapsed since the FIRMs were produced were factors that led FEMA to a decision to update the FIRMs. In 1997, the U.S. Geological Survey (USGS), in cooperation with FEMA; the cities of Boise, Garden City, and Eagle; and Ada County, began the initial phase of a hydraulic analysis project on the Boise River between Barber Dam, about 5 mi downstream from Lucky Peak Lake, and the Ada/Canyon County boundary.

During the initial phase of the project (October 1997 through December 1998), the USGS collected cross-section data at 238 locations along the river channel and documented 108 elevation reference marks established for horizontal and vertical control. The USGS will use these data in the final phase of the

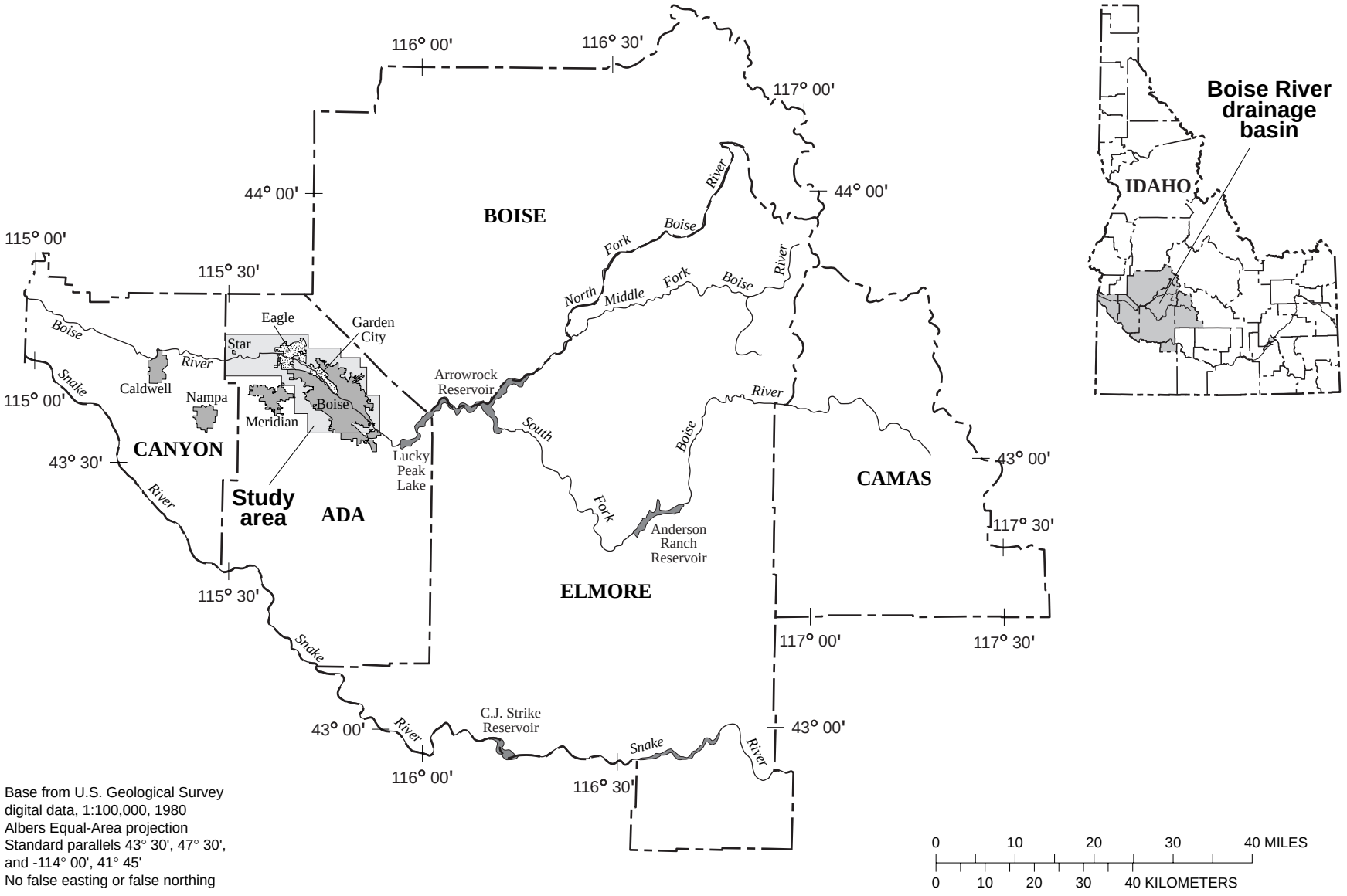

Figure 1. Location of the Boise River drainage basin, Idaho.

project to perform a one-dimensional step-backwater analysis to determine water-surface elevations for the 10-, 50-, 100-, and 500-year floods and to define the floodway limits. FEMA will use the results of the 100- and 500-year analyses to update the current FIRMs.

Purpose and Scope

The purposes of this report are to (1) present stream channel cross-section data that were collected for use in defining the 100- and 500-year flood plain of the Boise River in Ada County, and (2) document elevation reference mark data established for horizontal and vertical control for the entire study area from Barber Dam to the Ada/Canyon County boundary.

General locations and land-surface elevation profiles are presented for each cross section. The profile data are available in tabular ASCII format from the USGS, Idaho District, Website. Horizontal and vertical control data are presented for all elevation reference marks used in this project. These data are also available from the USGS, Idaho District, Website.

Additional cross-section data were obtained at bridges and diversion structures located throughout the study area. Only structures that control flow in the Boise River were surveyed for this study. Those data are not published in this report but can be obtained by contacting the USGS office listed on the back of the inside cover page.

Description of Study Area

The Boise River originates in the Sawtooth Mountains in central Idaho as three separate forks—North Fork, Middle Fork, and South Fork—that flow in a southwesterly direction. All three forks eventually flow into Lucky Peak Lake in eastern Ada County, Idaho. From Lucky Peak Lake, the Boise River flows in a single channel in a northwesterly direction until it joins the Snake River near the Idaho/Oregon border (fig. 1).

The study area is the 26-mi reach of the lower Boise River that extends from Barber Dam downstream through the cities of Boise, Garden City, and Eagle to the Ada/Canyon County boundary (fig. 2). This reach also includes an approximately 6.5-mi-long channel around the south side of Eagle Island, just west of Garden City. The total river length in the study area is about 32.5 mi.

Several diversion structures in the study area are used to divert flow for irrigation purposes. A detailed description of these structures and their locations is available in the Task 1 Report for the Boise and Payette Rivers diversion upgrade project (Quadrant Consulting, Inc., and others, 1997).

A USGS streamflow-gaging station, Boise River at Glenwood Bridge (13206000), is located at Glenwood Street in Garden City (fig. 2). Much of the 2,800 mi^2 of drainage area upstream from the gaging station is mountainous. Discharge at the gage is regulated by flows out of Lucky Peak Lake. Arrowrock and Anderson Ranch Reservoirs (fig. 1) regulate discharges farther upstream. The total combined storage available in Lucky Peak Lake and Arrowrock and Anderson Ranch Reservoirs is about 974,200 acre-ft. For the period of record October 1981 through September 1998 (water years 1982 through 1998), the annual mean discharge at the Glenwood gage was about 1,367 ft^3/s; the maximum discharge was 9,840 ft^3/s and the minimum was 42 ft^3/s (Brennan and others, 1999). During this period, three separate flow events exceeded the 10-year flood flow of 7,200 ft^3/s.

COLLECTION OF CROSS-SECTION DATA

Cross-section data were collected at 238 locations spaced approximately 700 ft apart along the entire study reach. Cross-section locations were placed closer together in areas near bridges or diversion structures. Each cross section was given a station number that corresponded to its location on the river, in river miles. A river mile is the actual river channel distance, measured along the thalweg (centerline), that covers one linear mile. River miles are calculated in an upstream direction beginning with zero at the river mouth. River miles are designated by the USGS National Mapping Division on 7.5-minute (1:24,000-scale) maps. With regard to river miles, the north channel around Eagle Island is designated as the main channel and, thus, was numbered in an upstream progression. The south channel around Eagle Island is designated as a side channel

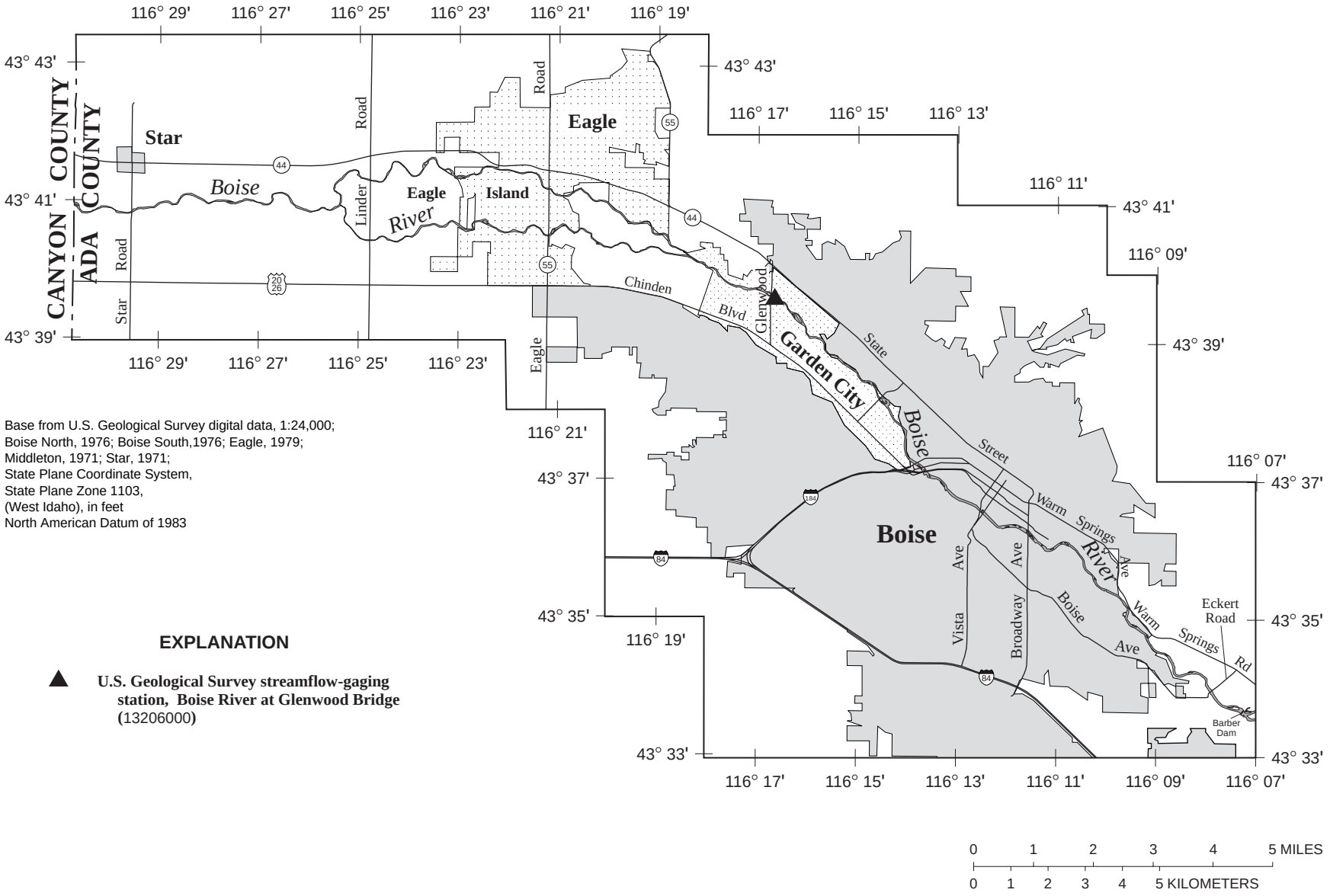

Figure 2. Location of the study area in Ada County, Idaho.

and, thus, was numbered beginning with zero at the downstream end. River mile locations are shown in figure 3.

A minimum of two control points (hubs) were established at each cross-section location. These control points were placed to allow for the cross sections to be oriented perpendicular to the direction of flow at each location. At least one of the control points at each cross section was marked with both a wooden stake and metal rebar, and the rest were marked with either a stake or rebar.

Cross-section data were collected using an electronic total station. The total station was set up over one of the control points, then horizontal and vertical coordinates were obtained at several points across the river channel. In some locations, the water level was too high to allow the survey crews to wade across safely. In these instances, points in the river channel were surveyed using a boat. The channel depth was obtained at several locations across the river and referenced to one of the control points by using the water-surface elevation. The number of depths obtained at each location depended on the width of the channel but was sufficient to obtain a good representation of the channel bottom. The cross sections also were referenced to horizontal and vertical datums, which will be discussed in subsequent sections.

Figure 3 presents an index of enlarged figures (5, 7, 10, 13, 15, and 17) that show the locations of cross sections in greater detail. Included on each enlarged map is the station number for each cross section. The cross-section profiles (figs. 6, 8, 9, 11, 12, 14, 16, and 18) show distance across the channel, in feet, from the left-most surveyed point, and land-surface elevation, in feet, above the North American Vertical Datum of 1988 (NAVD 88). For consistency, a maximum of 500 horizontal feet at each cross section is presented. If a particular cross section is longer than 500 ft, only the 500 ft near the river channel is presented. Complete information for each cross section also is available in tabular ASCII format from the USGS, Idaho District, Website located at http://idaho.usgs.gov/projects/boiseriver/boiseriver.htm

Horizontal Referencing

Horizontal control was based on the North American Datum of 1983 (NAD 83), State Plane Coordinates, Idaho West Zone, in feet. Horizontal referencing of the cross sections was accomplished using a differential Global Positioning System (GPS). A GPS receiver (base station) was located within several miles of the cross sections on a known, geographically referenced point. A second GPS receiver was used to obtain coordinates at a minimum of one control point (hub) at each cross section. The horizontal accuracy for this process was determined to be 3 ft.

Each cross section was surveyed in a local coordinate system by using conventional surveying techniques. The cross-section data then were transformed to NAD 83 by using the GPS control data and a geographic information system (GIS).

Vertical Referencing

The vertical control was based on the North American Vertical Datum of 1988. The vertical control for this project was established as part of a subcontract for contour mapping of the area. Elevation reference marks (ERMs) were set by the contractor for use in the development of 2-ft contour maps. The general location and identification number of each ERM are shown in figure 4. Latitude, longitude, elevation, and a short description of each ERM are presented in table 1. In addition, this information, as well as detailed site descriptions, can be downloaded from the USGS, Idaho District, Website.

Differential, dual frequency GPS units were used to determine the vertical and horizontal locations of each ERM. The minimum setup session at each point lasted about 15 minutes, but most sessions were 20 minutes or longer. Satellite data were logged by the receiver at 10-second intervals. The GPS network consisted of several loops with a maximum of 10 ERMs per loop. Each loop was closed separately by using GPS software. The final vertical adjustment was based on holding 10 local surveyed bench marks constant.

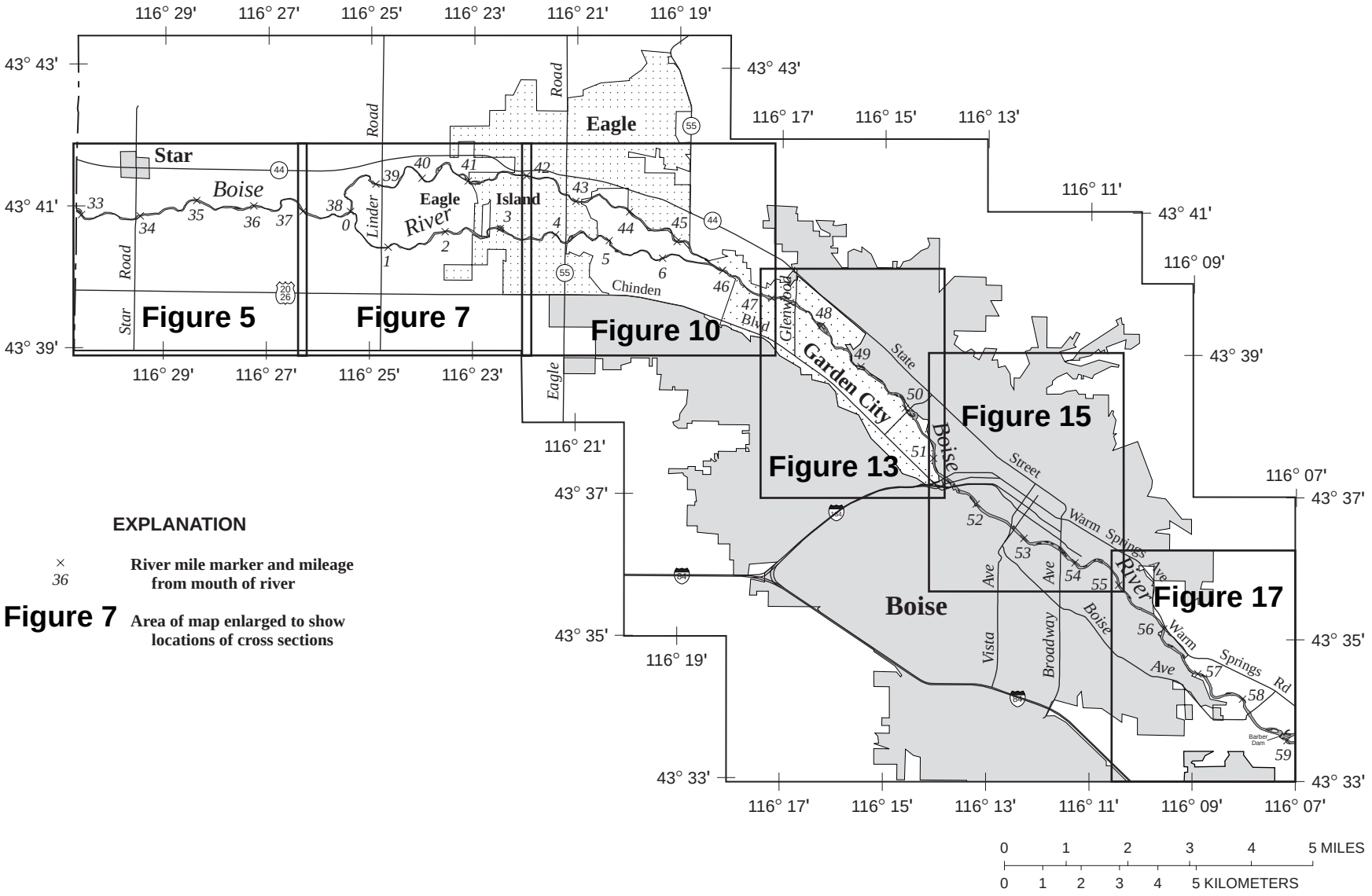

Figure 3. River mile locations and index of enlarged figures showing cross-section locations on the Boise River in Ada County, Idaho.

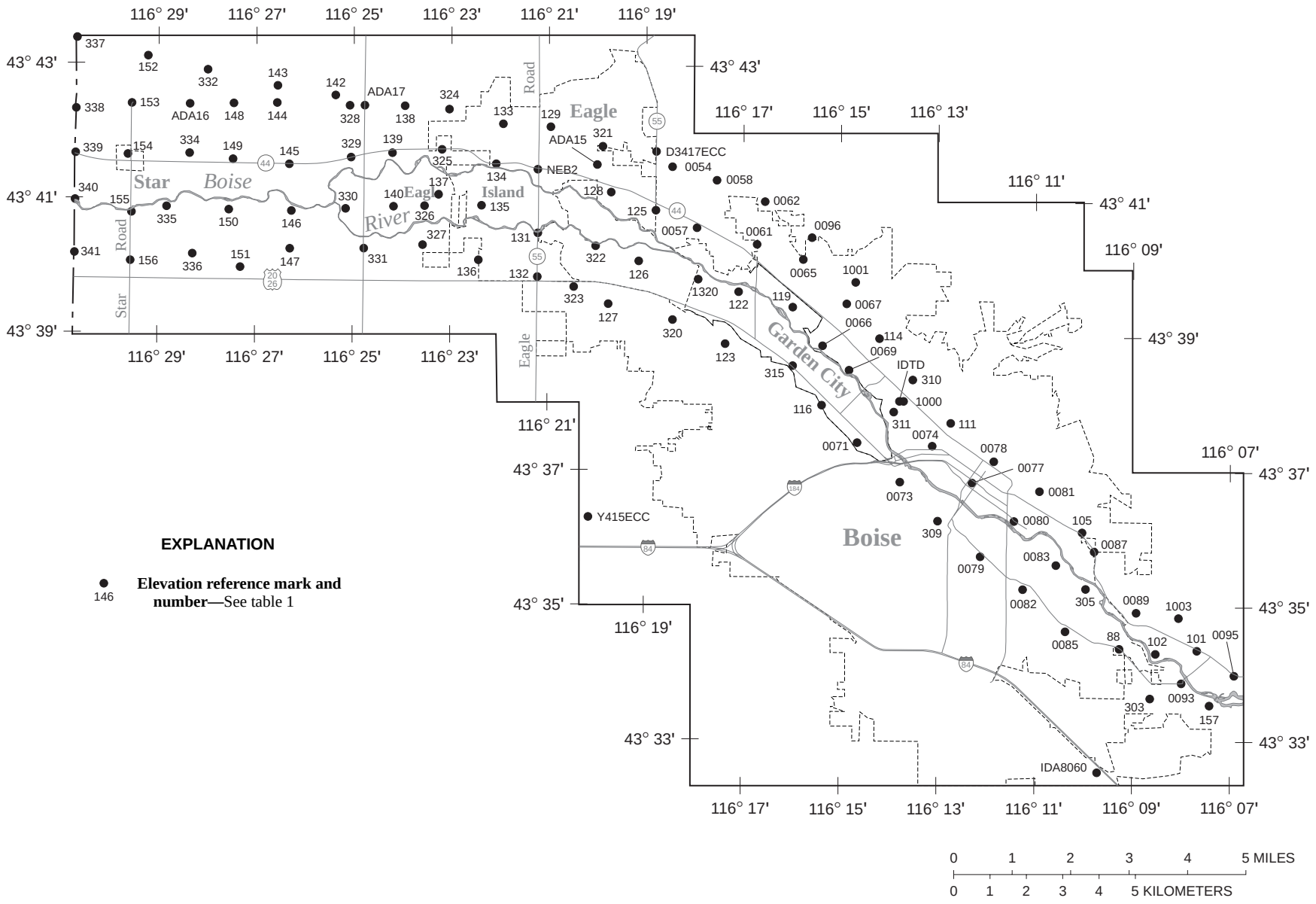

Figure 4. Location of elevation reference marks used for the study of the Boise River flood plain in Ada County, Idaho.

Table 1. Site information for elevation reference marks established for horizontal and vertical control for the study of the Boise River flood plain in Ada County, Idaho

[Locations of reference marks are shown in figure 4; latitude and longitude are based on the North American Datum of 1983 and shown in degrees, minutes, and seconds; reference mark elevations are based on the North American Vertical Datum of 1988; in., inch]

Reference mark number	Location		Elevation, in feet	Descriptions
	Latitude	Longitude		
88	43° 34' 21.577193"	116° 09' 17.512178"	2758.08	Towill, Inc., rebar and cap
101	43° 34' 20.147949"	116° 07' 42.355435"	2770.04	Towill, Inc., rebar and cap
102	43° 34' 17.177148"	116° 08' 33.231115"	2747.38	Towill, Inc., rebar and cap
105	43° 36' 05.270297"	116° 10' 03.785220"	2734.91	Towill, Inc., rebar and cap
111	43° 37' 42.299474"	116° 12' 45.893360"	2693.55	Towill, Inc., rebar and cap
114	43° 38' 57.523940"	116° 14' 13.852333"	2666.83	Towill, Inc., rebar and cap
116	43° 37' 57.875275"	116° 15' 24.668973"	2699.45	Towill, Inc., rebar and cap
119	43° 39' 25.220324"	116° 16' 00.849641"	2624.69	Towill, Inc., rebar and cap
122	43° 39' 38.638294"	116° 17' 07.386349"	2612.26	Towill, Inc., rebar and cap
123	43° 38' 52.414167"	116° 17' 23.868224"	2670.21	Towill, Inc., rebar and cap
125	43° 40' 50.787069"	116° 18' 49.768673"	2584.01	Towill, Inc., rebar and cap
126	43° 40' 05.558918"	116° 19' 10.769139"	2587.51	Towill, Inc., rebar and cap
127	43° 39' 27.127530"	116° 19' 47.642266"	2640.42	Towill, Inc., 1-1/8 in. brass disk
128	43° 41' 06.643208"	116° 19' 44.929204"	2574.67	Towill, Inc., 1-1/8 in. brass disk
129	43° 42' 04.736837"	116° 20' 59.719397"	2615.79	Towill, Inc., rebar and cap
131	43° 40' 29.874323"	116° 21' 14.648493"	2565.79	Towill, Inc., 1-1/8 in. brass disk
132	43° 39' 50.871972"	116° 21' 15.344728"	2618.98	Towill, Inc., 1-1/8 in. brass disk
133	43° 42' 06.853523"	116° 21' 58.400610"	2590.37	Towill, Inc., rebar and cap
134	43° 41' 31.444666"	116° 22' 06.651284"	2554.78	Towill, Inc., rebar and cap
135	43° 40' 54.150137"	116° 22' 24.359001"	2544.75	Towill, Inc., rebar and cap
136	43° 40' 05.686137"	116° 22' 27.999731"	2601.60	Towill, Inc., rebar and cap
137	43° 41' 03.681838"	116° 23' 17.283672"	2533.83	Towill, Inc., rebar and cap
138	43° 42' 22.442082"	116° 23' 59.052413"	2553.63	Towill, Inc., rebar and cap
139	43° 41' 40.392844"	116° 24' 14.423115"	2528.99	Towill, Inc., 1-1/8 in. brass disk
140	43° 40' 52.711432"	116° 24' 12.573232"	2525.09	Towill, Inc., rebar and cap
142	43° 42' 31.539992"	116° 25' 24.737501"	2527.91	Towill, Inc., rebar and cap
143	43° 42' 39.677461"	116° 26' 36.007580"	2525.33	Towill, Inc., rebar and cap
144	43° 42' 24.321955"	116° 26' 36.620748"	2502.97	Towill, Inc., rebar and cap
145	43° 41' 29.751665"	116° 26' 21.199269"	2506.25	Towill, Inc., rebar and cap
146	43° 40' 48.311002"	116° 26' 18.139612"	2499.90	Towill, Inc., rebar and cap
147	43° 40' 14.566707"	116° 26' 19.802089"	2517.41	Towill, Inc., rebar and cap
148	43° 42' 23.740882"	116° 27' 29.886349"	2502.84	Towill, Inc., rebar and cap
149	43° 41' 33.913900"	116° 27' 30.353108"	2493.01	Towill, Inc., rebar and cap
150	43° 40' 48.857680"	116° 27' 35.189944"	2488.61	Towill, Inc., rebar and cap
151	43° 39' 57.835181"	116° 27' 20.680106"	2544.07	Towill, Inc., rebar and cap
152	43° 42' 55.233573"	116° 29' 17.439938"	2520.66	Towill, Inc., rebar and cap
153	43° 42' 23.334493"	116° 29' 35.561515"	2468.18	Towill, Inc., rebar and cap
154	43° 41' 37.761844"	116° 29' 39.825473"	2470.02	Towill, Inc., rebar and cap
155	43° 40' 46.111224"	116° 29' 35.014166"	2481.84	Towill, Inc., rebar and cap
156	43° 40' 03.079664"	116° 29' 35.831860"	2504.77	Towill, Inc., rebar and cap
157	43° 33' 31.308285"	116° 07' 26.884005"	2802.14	Towill, Inc., rebar and cap
303	43° 33' 37.459483"	116° 08' 39.779794"	2841.68	Towill, Inc., rebar and cap
305	43° 35' 14.817366"	116° 09' 59.076299"	2727.57	Towill, Inc., rebar and cap
309	43° 36' 15.087363"	116° 13' 01.239630"	2747.31	Towill, Inc., 1-1/8 in. brass disk
310	43° 38' 20.775957"	116° 13' 32.716111"	2673.48	3 in. brass disk
311	43° 37' 52.120804"	116° 13' 56.015897"	2662.68	Towill, Inc., rebar and cap
315	43° 38' 33.161712"	116° 16' 00.578514"	2638.87	Towill, Inc., rebar and cap
320	43° 39' 13.431315"	116° 18' 28.535558"	2660.74	Towill, Inc., rebar and cap
321	43° 41' 47.645719"	116° 19' 55.717961"	2587.34	Towill, Inc., 1-1/8 in. brass disk
322	43° 40' 18.752895"	116° 20' 03.553330"	2578.03	Towill, Inc., rebar and cap
323	43° 39' 42.251733"	116° 20' 30.401965"	2626.82	Towill, Inc., rebar and cap
324	43° 42' 19.774362"	116° 23' 04.549530"	2570.86	Towill, Inc., rebar and cap
325	43° 41' 43.680128"	116° 23' 13.367703"	2548.87	Towill, Inc., rebar and cap
326	43° 40' 53.591881"	116° 23' 34.435735"	2529.28	Towill, Inc., rebar and cap
327	43° 40' 18.774000"	116° 23' 36.623777"	2587.64	Towill, Inc., rebar and cap

Table 1. Site information for elevation reference marks established for horizontal and vertical control for the study of the Boise River flood plain in Ada County, Idaho—Continued

Reference mark number	Location		Elevation, in feet	Descriptions
	Latitude	Longitude		
328	43° 42' 22.509411"	116° 25' 07.160758"	2528.47	Towill, Inc., rebar and cap
329	43° 41' 36.183628"	116° 25' 05.349470"	2520.82	Towill, Inc., rebar and cap
330	43° 40' 50.331838"	116° 25' 11.480220"	2511.64	Towill, Inc., rebar and cap
331	43° 40' 15.159427"	116° 24' 48.909956"	2568.83	Towill, Inc., rebar and cap
332	43° 42' 47.083332"	116° 28' 05.777778"	2521.16	Towill, Inc., rebar and cap
334	43° 41' 39.006632"	116° 28' 23.895954"	2483.18	Towill, Inc., rebar and cap
335	43° 40' 51.338679"	116° 28' 51.650279"	2475.68	Towill, Inc., rebar and cap
336	43° 40' 09.432830"	116° 28' 19.476125"	2515.92	Towill, Inc., rebar and cap
337	43° 43' 03.759108"	116° 30' 45.388276"	2493.59	Towill, Inc., rebar and cap
338	43° 42' 18.600536"	116° 30' 45.354820"	2459.58	Towill, Inc., rebar and cap
339	43° 41' 39.004453"	116° 30' 45.570426"	2459.57	Towill, Inc., rebar and cap
340	43° 40' 57.092778"	116° 30' 45.796627"	2459.06	Towill, Inc., rebar and cap
341	43° 40' 10.005013"	116° 30' 46.032136"	2497.75	Towill, Inc., rebar and cap
1000	43° 38' 01.878959"	116° 13' 43.892313"	2667.88	Survey spike
1001	43° 39' 47.602157"	116° 14' 43.588286"	2677.62	Towill, Inc., rebar and cap
1003	43° 34' 49.289124"	116° 08' 05.064577"	2794.36	Towill, Inc., rebar and cap
1320	43° 39' 49.579858"	116° 17' 57.394603"	2601.81	Towill, Inc., rebar and cap
0054	43° 41' 29.743950"	116° 18' 29.746747"	2593.59	City of Boise 3-1/2 in. brass disk
0057	43° 40' 35.534012"	116° 17' 59.096446"	2594.49	City of Boise 3-1/2 in. brass disk
0058	43° 41' 17.968065"	116° 17' 35.181041"	2627.99	City of Boise 3-1/2 in. brass disk
0061	43° 40' 21.092060"	116° 16' 45.139090"	2613.50	City of Boise 3-1/2 in. brass disk
0062	43° 40' 59.141179"	116° 16' 35.368934"	2647.24	City of Boise 3-1/2 in. brass disk
0065	43° 40' 07.764874"	116° 15' 48.158583"	2623.52	City of Boise 3-1/2 in. brass disk
0066	43° 38' 51.089084"	116° 15' 23.800597"	2636.64	City of Boise 3-1/2 in. brass disk
0067	43° 39' 28.391900"	116° 14' 54.313479"	2653.02	City of Boise 3-1/2 in. brass disk
0069	43° 38' 29.219768"	116° 14' 51.240587"	2646.39	City of Boise 3-1/2 in. brass disk
0071	43° 37' 24.651125"	116° 14' 40.826475"	2660.28	City of Boise 3-1/2 in. brass disk
0073	43° 36' 49.706135"	116° 13' 48.065500"	2730.60	City of Boise 3-1/2 in. brass disk
0074	43° 37' 21.848898"	116° 13' 08.500872"	2679.30	City of Boise 3-1/2 in. brass disk
0077	43° 36' 49.214741"	116° 12' 19.309962"	2697.61	City of Boise 3-1/2 in. brass disk
0078	43° 37' 08.344759"	116° 11' 52.592248"	2713.75	City of Boise 3-1/2 in. brass disk
0079	43° 35' 43.446757"	116° 12' 08.597256"	2714.17	City of Boise 3-1/2 in. brass disk
0080	43° 36' 15.195497"	116° 11' 27.532879"	2703.36	City of Boise 3-1/2 in. brass disk
0081	43° 36' 41.762798"	116° 10' 56.335451"	2720.12	City of Boise 3-1/2 in. brass disk
0082	43° 35' 14.322297"	116° 11' 16.466805"	2725.62	City of Boise 3-1/2 in. brass disk
0083	43° 35' 35.925948"	116° 10' 35.729307"	2717.91	City of Boise 3-1/2 in. brass disk
0085	43° 34' 36.996713"	116° 10' 24.121308"	2747.67	City of Boise 3-1/2 in. brass disk
0087	43° 35' 48.203490"	116° 09' 48.783348"	2746.45	City of Boise 3-1/2 in. brass disk
0089	43° 34' 53.750875"	116° 08' 57.156839"	3010.49	City of Boise 3-1/2 in. brass disk
0093	43° 33' 50.909839"	116° 08' 01.099429"	2788.72	City of Boise 3-1/2 in. brass disk
0095	43° 33' 58.056905"	116° 06' 56.494525"	2796.71	City of Boise 3-1/2 in. brass disk
0096	43° 40' 27.284289"	116° 15' 37.489770"	2688.30	City of Boise 3-1/2 in. brass disk
ADA15	43° 41' 31.342325"	116° 20' 02.467871"	2570.11	3 in. brass disk
ADA16	43° 42' 22.988882"	116° 28' 23.876911"	2487.48	3 in. brass disk
ADA17	43° 42' 22.651553"	116° 24' 48.872507"	2538.78	3 in. brass disk
D3417ECC	43° 41' 43.316446"	116° 18' 49.570241"	2645.79	PK nail
[1]F141	43° 36' 34.989986"	116° 28' 25.475245"	2527.38	Brass disk
IDA8060	43° 32' 31.195960"	116° 09' 44.588449"	3012.20	Brass disk
IDTD	43° 38' 01.848780"	116° 13' 49.074870"	2666.17	Brass disk
[1]K 143	43° 42' 57.847043"	116° 37' 20.062419"	2419.77	Brass disk
NEB 2	43° 41' 26.637781"	116° 21' 15.207965"	2559.06	Aluminum disk
[1]P84RES	43° 25' 33.433520"	116° 02' 55.651840"	3401.29	Brass disk
Y415ECC	43° 36' 17.272400"	116° 20' 11.002853"	2648.51	Survey spike

[1]Elevation reference marks not shown in figure 4 (outside of map limits).

Geoid96 was used as the geoid model for the adjustment. The accuracy for these points was determined to be about 2 cm (0.787 in.) vertical and 1 cm (0.394in.) horizontal.

Prior to placement of the ERMs, all cross sections were connected vertically by running level lines between the hubs located at each cross section. Each level loop was closed separately and then connected by a level line to at least one ERM before the elevation was transformed to NAVD 88. Finally, all loops were connected and closed according to FEMA guidelines (1995).

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To view Figures 5 through 18 follow this link - FIGURES.