UNITED STATES
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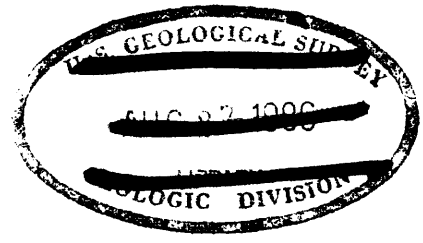
CHANNEL GEOMETRY AND HYDROLOGIC DATA FOR SIX ERUPTION-AFFECTED TRIBUTARIES OF THE LEWIS RIVER, MOUNT ST. HELENS, WASHINGTON, WATER YEARS 1983-84

By Holly A. Martinson, Hazel E. Hammond, William W. Mast, and Patrice D. Mango

Open-File Report 85-631



Portland, Oregon
1986

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

For readers who prefer to use inch-pound units, conversion factors for terms used in this report are listed below.

Multiply SI	By	To obtain inch-pound
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
square kilometer (km^2)	0.3861	square mile (mi^2)
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)

CHANNEL GEOMETRY AND HYDROLOGIC DATA FOR SIX ERUPTION-AFFECTED TRIBUTARIES OF THE LEWIS RIVER, MOUNT ST. HELENS, WASHINGTON, WATER YEARS 1983-84

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ABSTRACT

The May 18, 1980, eruption of Mount St. Helens generated a lateral blast, lahars, and tephra deposits that altered tributary channels in the Lewis River drainage basin. In order to assess potential flood hazards, study channel adjustments, and construct a sediment budget for the perturbed drainages on the northeast, east, and southeast flanks of the volcano, channel cross sections were monumented and surveyed on Pine Creek, Muddy River, and Smith Creek during September and October of 1980. Additional cross sections were monumented on Swift Creek, Bean Creek, and Clearwater Creek during the summer of 1981. This network of about 80 channel cross sections has been resurveyed annually during lower flows. Selected cross sections have been surveyed more frequently, after periods of higher flow. The repetitive cross-section surveys provide measurements of bank erosion or accretion and of channel erosion or aggradation. Longitudinal stream profiles were surveyed periodically for selected short reaches of channel. Corresponding map views constructed from aerial photographs together with the longitudinal profiles provide a means for assessing channel profile and planform stability and for applying changes measured at channel cross sections to longer reaches of channel for sediment-budget computations. This report presents plots of channel cross-section profiles, longitudinal stream profiles, and channel planform maps constructed from the survey data collected during water years 1983-84.

INTRODUCTION

Purpose and Scope

The May 18th and subsequent 1980 eruptions of Mount St. Helens drastically altered an area of about 550 km^2, largely north of the volcano, and affected all channels draining the volcano. Tributary channels of the Lewis River system draining the south and east flanks of the volcano were changed primarily by lahars (mudflows or debris flows of volcanic origin) that flowed down major streams originating on Mount St. Helens (Janda and others, 1981, fig. 1; Cummans, 1981). Lahars flowed the entire length of Smith Creek, Muddy River, Pine Creek, and Swift Creek, forming deltas upon entering the eastern and western ends of Swift Reservoir (fig. 1).

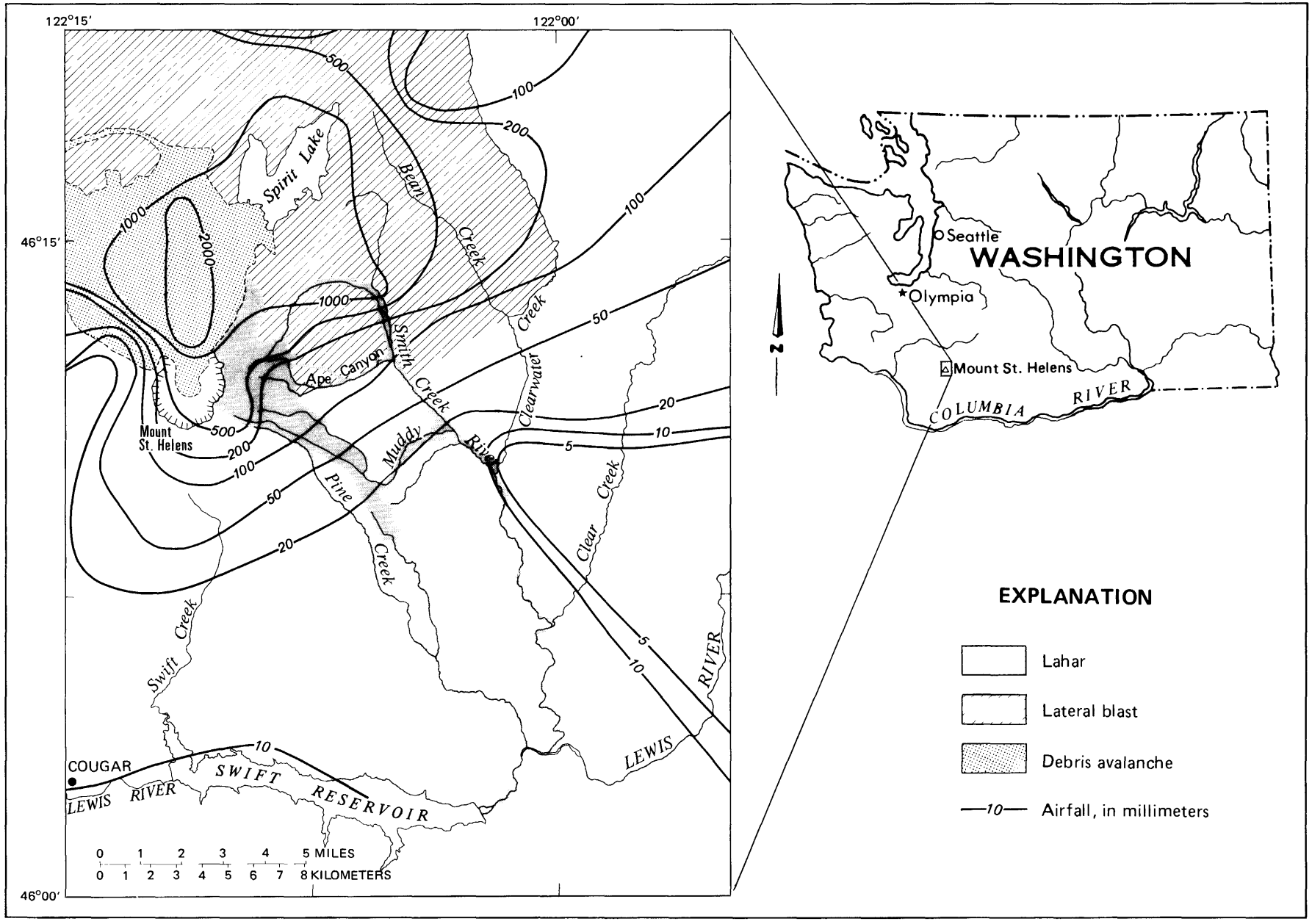


FIGURE 1. – Location of Mount St. Helens, Washington and study channels of the Lewis River system that were altered by the lateral blast, lahars, and airfall from the May 18th and subsequent 1980 eruptions.

Lewis River tributary basins also were modified to varying degrees by the lateral blast (directed blast of Hoblitt and others, 1981; pyroclastic density flow of Waitt, 1981; and pyroclastic surge of Moore and Sisson, 1981), pyroclastic flows (Rowley and others, 1981), and tephra deposition (Waitt and Dzurisin, 1981; Waitt and others, 1981). Dynamic effects and deposits from these events altered rainfall-runoff relationships (Swanson and others, 1983), channel geometry (Janda and others, 1981; Lisle and others, 1983), and the amount of sediment readily available to stream channels (Janda and others, 1981; Martinson and others, 1982). The blast and airfall deposits destroyed and damaged vegetation, eliminating or reducing evapotranspiration over much of the affected area. Glaciers in the headwaters of streams originating on the flanks of the volcano were affected by removal of mass, surface erosion, and (or) mantling with debris (Brugman and Post, 1981; Brugman and Meier, 1981).

In order to assess potential flood hazards, document storm-induced changes in the morphology of the eruption-altered stream channels, and assist in the development of sediment budgets, 88 monumented channel cross sections (figs. 2 and 3) were established on six tributaries of the Lewis River during 1980-81. Annual or more frequent cross-section surveys provide measurements of bank erosion or accretion and of channel erosion or aggradation.

In addition, longitudinal stream profiles of the low-water thalweg and (or) water surface have been surveyed periodically for selected short reaches of channel. Corresponding map views were constructed for these reaches of channel by supplementing survey data with data from aerial photographs. The longitudinal profiles and map views provide a means for assessing channel profile and planform stability and for applying changes measured at channel cross sections to longer reaches of channel.

Cross-section survey data from WY (water years) 1980-82 have been summarized previously (Martinson and others, 1984). This report presents the cross-section data collected during WY 1983-84 (October 1982 through September 1984). Previously published low-flow survey data from 1982 are also included as a basis for assessing changes in cross-section profiles resulting from storm runoff during WY 1983-84. Longitudinal stream profiles and reach maps constructed from survey data collected during WY 1983-84 are also presented.

Acknowledgments

We thank the following for helping to survey channel cross sections and longitudinal profiles during the 1983-84 field seasons and (or) for their assistance in data reduction and report preparation: Tamra Noyes-Hill, Adam W. Burnett, Kenneth A. Cameron, Jeanette E. Dodge, Steven D. Finneran, Kris K. Gould, Kevin C. Hadley, Jon J. Major, Donald J. Mosier, Patrick T. Pringle, Donald S. Ropiequet, Kurt R. Spicer, and Michael G. Tunnicliff. Review comments and helpful suggestions for content and organization of the report were provided by Deigh T. Bates, John G. Elliott, Steve E. Hammond, and Kevin M. Scott.

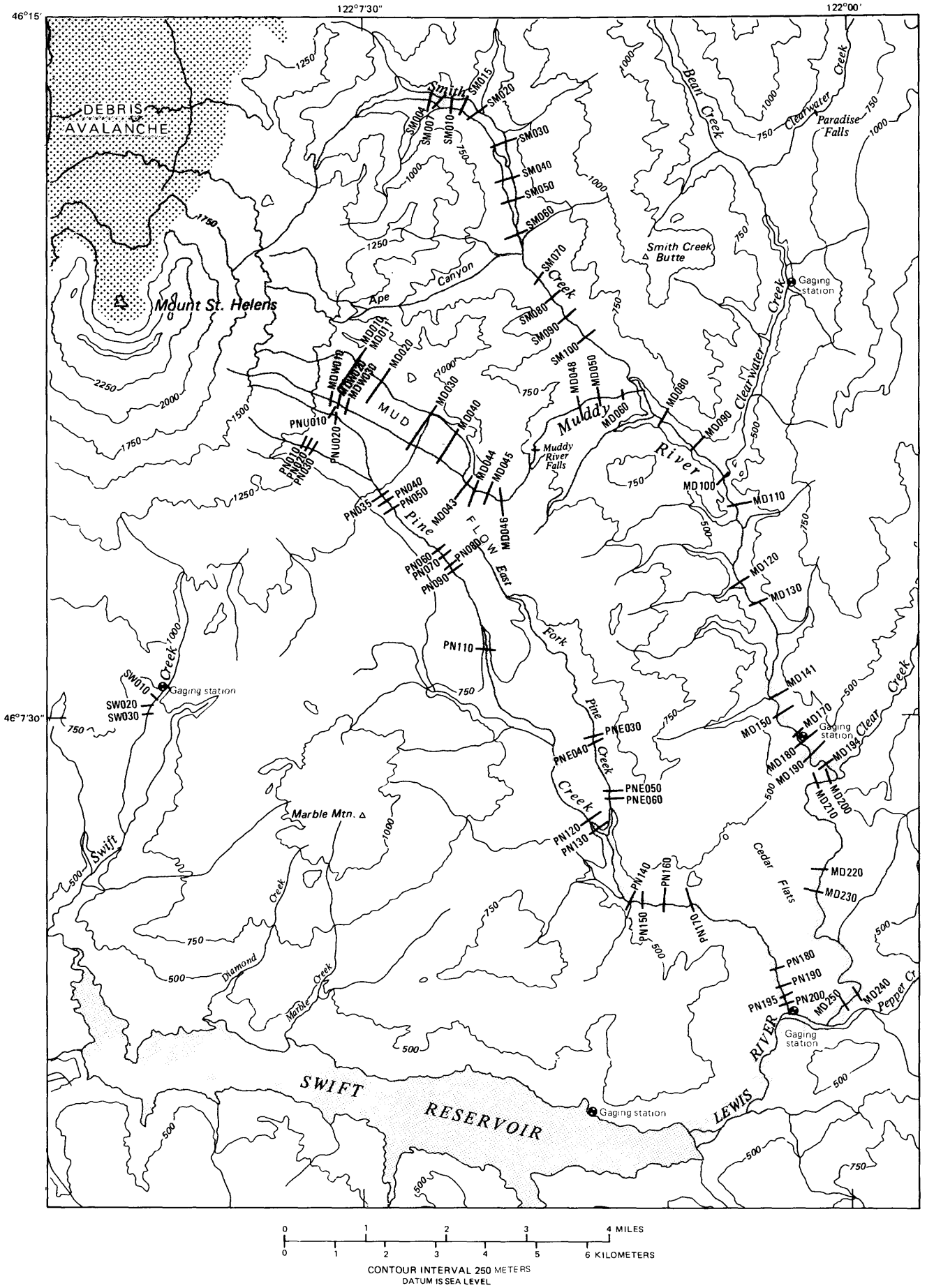


FIGURE 2. – Location of channel cross sections and stream gaging stations on Pine Creek, Muddy River, Smith Creek, and Swift Creek.

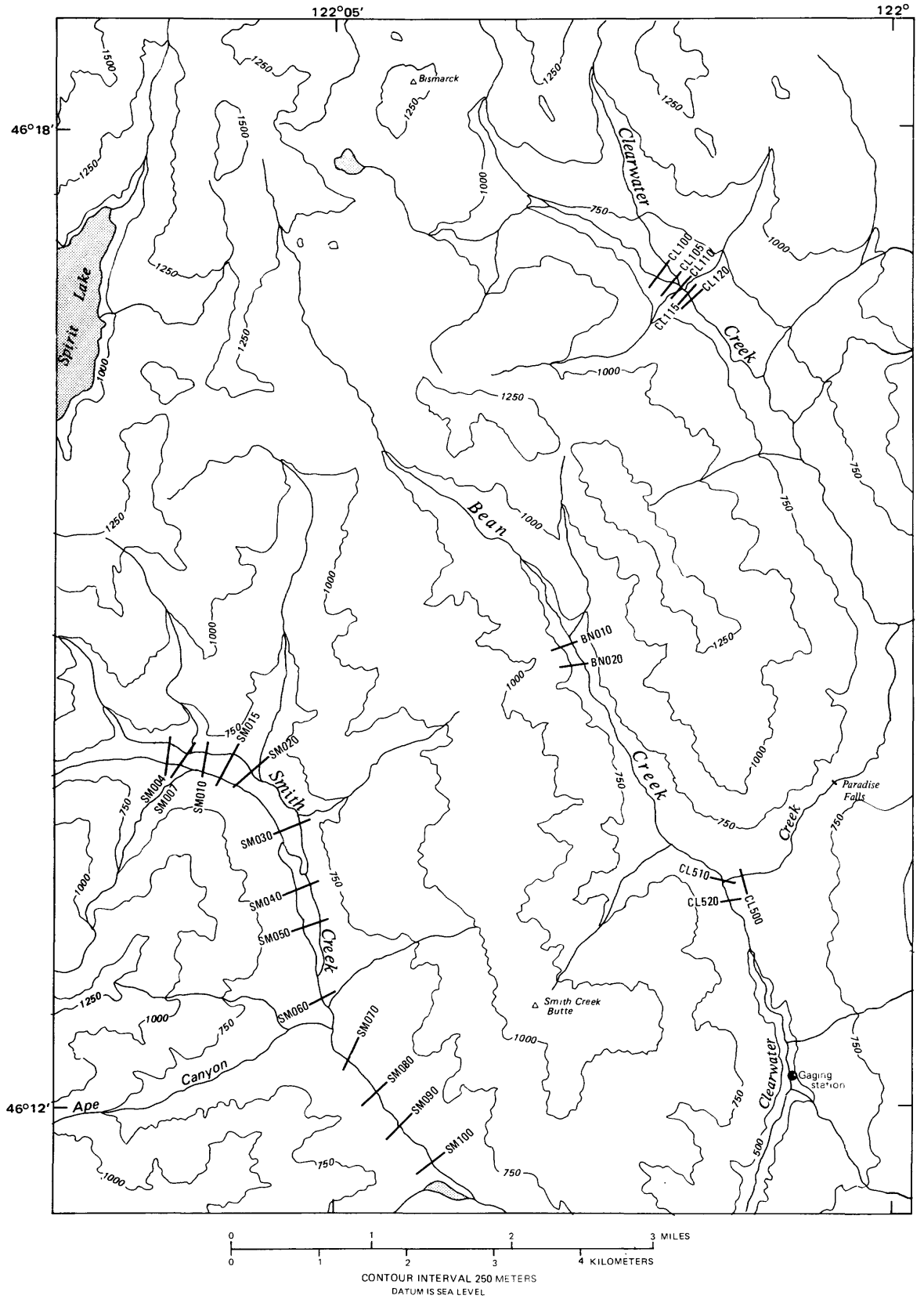


FIGURE 3. – Locations of channel cross sections and stream gaging stations on Smith Creek, Bean Creek, and Clearwater Creek.

DESCRIPTION OF STUDY AREA

Physical Setting

Study sites in the Lewis River system (fig. 1) were selected to monitor channel response to the different types and magnitudes of volcanic impacts. The study streams are within a 20-km radius, 150° sector northeast, east, and south of Mount St. Helens. The affected channels vary in drainage area, length, and gradient (table 1).

Table 1.--Summary of drainage basin and channel characteristics for study basins, Lewis River system, Mount St. Helens, Washington

Stream	Drainage area at mouth (km^2)	Channel length (km)	Mean gradient	Elevation at mouth (m)	Relief (m)	Valley trend
Muddy River	[1]351	29.8	0.024	315	2178	NW-SE
Smith Creek	60	11.9	0.020	497	1996	NW-SE
Clearwater Creek	[2]102	21.7	0.018	445	1180	NW-SE
Bean Creek	21	11.3	0.027	523	1063	NW-SE
Pine Creek	62	22.0	0.045	310	2219	NW-SE
Swift Creek	60	13.0	0.133	186	2343	N-S

[1] Including Smith Creek, Clearwater Creek, Bean Creek, and Clear Creek.
[2] Including Bean Creek.

The 473-km^2 drainage area includes streams originating on the flanks of the volcano that were affected by lahars, as well as streams farther to the east that were affected by only the lateral blast and tephra (airborne material) deposition (fig. 1). The relative severity and extent of lahars that entered tributaries of the Lewis River on May 18, 1980, generally decreases in a clockwise direction from northeast to south (Janda and others, 1981). Damage from the lateral blast in the study area is limited to portions of the basins northeast to east-northeast of the volcano, and it decreases with distance from the volcano. Tephra from the May 18th and subsequent 1980 eruptions was carried primarily to the northeast by the prevailing winds. The axis of maximum tephra deposition crosses upper portions of the Smith Creek, Bean Creek, and Clearwater Creek basins, where thickness of deposits decreases with distance from the volcano (Waitt and others, 1981). Volcanic effects on study basins within the Lewis River system are summarized in table 2.

Table 2.--Summary of eruptive effects on study basins, Lewis River system, Mount St. Helens, Washington

Drainage basin, sub-basin	Channel length affected by lahars[1] (percent)	Drainage area affected by blast[2] (percent)	Thickness of tephra deposits[3] (mm)
Muddy River Basin[4]	--	30	2-1500
Muddy River[5]	100	1	10-200
Smith Creek	100	81	20-1500
Clearwater Creek[6]	0	44	70-400
Bean Creek	0	98	70-800
Clear Creek	0	0	2-150
Pine Creek Basin	--	1	10-200
East Fork Pine Creek	100	1	10-20
Main Fork Pine Creek	80	1	10-200
Pine Creek[7]	100	1	10-15
Swift Creek	100	1	10-200

1 Extent of lahars determined from maps prepared by Janda and others, 1981; Pierson, 1983.

2 Boundary of the blast-affected area taken from U.S. Geological Survey 1:100,000 scale series map of Mount St. Helens and Vicinity, 1981.

3 Thickness of tephra deposits determined from isopach maps of Waitt and others, 1981. Total thickness of deposits is dominated by the May 18, 1980, directed blast (pyroclastic-density flow) and air-fall deposits.

4 At the mouth of Muddy River, including Smith Creek, Clearwater Creek, Bean Creek, and Clear Creek.

5 At the mouth of Muddy River, excluding Smith Creek, Clearwater Creek, Bean Creek, and Clear Creek

6 Excluding Bean Creek.

7 Downstream from confluence of East Fork and Main Fork Pine Creek.

Hydrologic Setting

Climate

Mount St. Helens is located on the western side of the Cascade Range in southwestern Washington. Mean annual precipitation is 3.3 m or more near the volcanic summit, and decreases to 2.2 to 3.0 m away from the mountain to the east and south (Gullidge, 1970). Most precipitation occurs during the winter rainy season, which begins about October, peaks in December or January, and declines into the spring. Seventy-five percent of the annual precipitation occurs during October through March.

Most rainfall occurs as showers of light to moderate intensity rather than as heavy rains. The freezing elevation varies widely throughout the winter. The midwinter snowline is typically between about 800 and 1000 m above sea level. Average annual snow accumulation varies from zero at lower altitudes to more than 8 m above 1,500 m; density of the snowpack increases from about 25 to 45 percent water equivalent between early winter and April (Gullidge, 1970).

No long-term precipitation stations are located within the study area. Long-term records of rainfall and (or) temperature have been collected near Cougar, Washington, since about 1927, although location of the measurement site(s) has varied during the period of record. The currently-operating Cougar 6E station is at an elevation of 201 m, about 17 km south-southwest of Mount St. Helens (fig. 1). Mean annual precipitation measured at Cougar 6E for the 25-yr period of WY 1958-82 was 2.94 m. Total annual precipitation of 3.53 m and 3.14 m were measured during WY 1983 and WY 1984, respectively (table 3). During WY 1983, all fall and winter months except November were wetter than average; during WY 1984, the fall and winter months except November were drier than average (table 3).

Table 3.-- Summary of monthly precipitation data, Cougar 6E, Washington, water years 1958-82, 1983, and 1984

	Monthly Precipitation				
	Water Years 1958-82			Water Year 1983	Water Year 1984
Month	Maximum (mm)	Minimum (mm)	Mean (mm)	Total (mm)	Total (mm)
October	488	37	236	286	109
November	816	117	422	396	826
December	792	151	521	559	364
January	815	73	453	624	329
February	782	132	369	527	314
March	508	36	312	405	364
April	300	65	199	129	272
May	283	41	121	94	288
June	270	11	88	163	146
July	150	0	33	173	0
August	239	0	64	58	1
September	313	0.8	119	119	132
Total			2937	3533	3145

Although WY 1983-84 precipitation amounts were above average, exceptionally large storms did not occur during the two-yr period. Total daily precipitation at Cougar 6E did not equal or exceed the 2-yr, 24-hour maximum daily value of 127 mm (U.S. Weather Service, oral commun.) Daily values for rainfall measured at the Cougar 6E station during WY 1983-84 are plotted in figure 4. The largest values for daily rainfall during WY 1983 and WY 1984, respectively, were 107 mm, measured on January 5, 1983, and 92 mm measured on November 3, 1983.

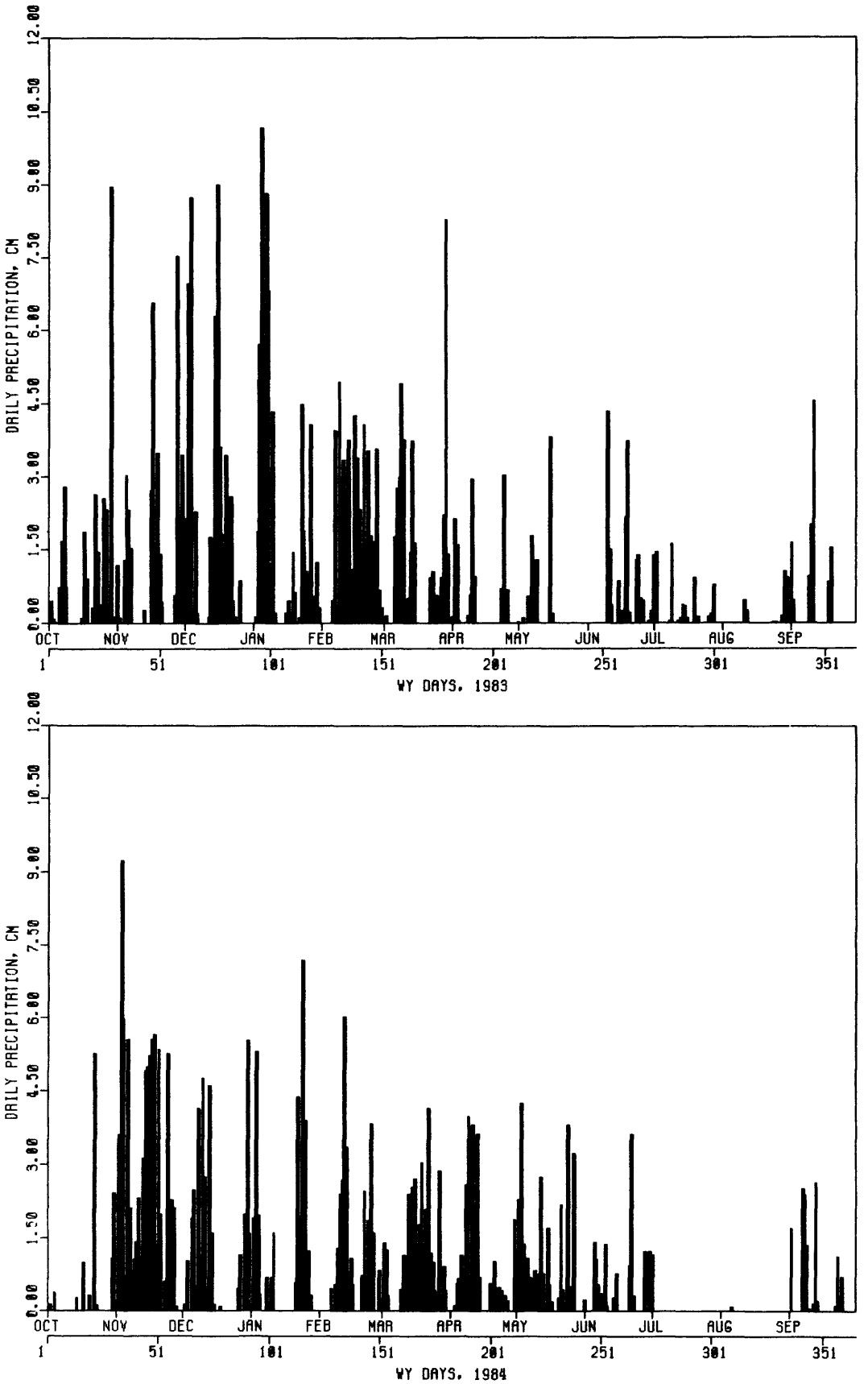


FIGURE 4. – Daily precipitation, Cougar 6E, Washington, water years 1983-84.

Water-discharge and Suspended-sediment Measurements

Gaging stations were installed during the summer of 1981 on Pine Creek, Muddy River, and Clearwater Creek for measurement of post-eruption water and suspended-sediment discharge (figs. 2 and 3). During WY 1983, a gaging station was established on Clear Creek, and the Muddy River gage was relocated to a site downstream from the mouth of Clear Creek. Locations and drainage areas for the gaging stations are summarized in table 4. Peak flows and peak suspended-sediment concentrations measured during WY 1983-84 on Muddy River, Clearwater Creek, Clear Creek, and Pine Creek also are summmarized in table 4.

Table 4.-- Summary of peak water-discharge and peak suspended-sediment concentration measurements at gaging stations on Muddy River, Clearwater Creek, Clear Creek, and Pine Creek, Mount St. Helens, Washington, water years 1983-84

Stream: Station number	Peak water discharge: Date	Peak water discharge: Instantaneous discharge (m^3/s)	Peak sediment concentration: Date	Peak sediment concentration: Instantaneous discharge (m^3/s)	Peak sediment concentration: Concentration (mg/L)
Muddy River:[1]	12/03/82	257.7	12/13/82	179.6	49,800
14216350	11/17/83	144.6	--	--	--
Muddy River:[2]	11/17/83	228.1	11/03/83	103.1	41,900
14216500[3]					
Clearwater Creek:[4]	03/10/83	118.9	12/27/82	5.7	982
14216300	11/17/83	61.1	11/17/85	95.7	79,100
Clear Creek:[5]	03/10/83	56.6	--	--	--
142164506	11/17/83	64.9	--	--	--
Pine Creek:[7]	12/03/82	90.1	12/03/82	48.1	24,400
14216900	11/17/83	84.9	[8]11/03/83	19.8	37,800

[1] Stream gaging station is located 7.9 km upstream from the mouth. Drainage area above the gaging station is 212 km^2.
[2] Stream gaging station is located 0.8 km upstream from the mouth. Drainage area above the gaging station is 349.6 km^2.
[3] Established 06/24/83.
[4] Stream gaging station is located 4.4 km upstream from the mouth. Drainage area above the gaging station is 85.4 km^2.
[5] Stream gaging station is located 1.6 km upstream from the mouth. Drainage area above the gaging station is 121.5 km^2.
[6] Established 12/14/82.
[7] Stream gaging station is located 0.2 km upstream from the mouth. Drainage area above the gaging station is 58.8 km^2.
[8] Concentration and discharge values for WY 1984 are daily means.

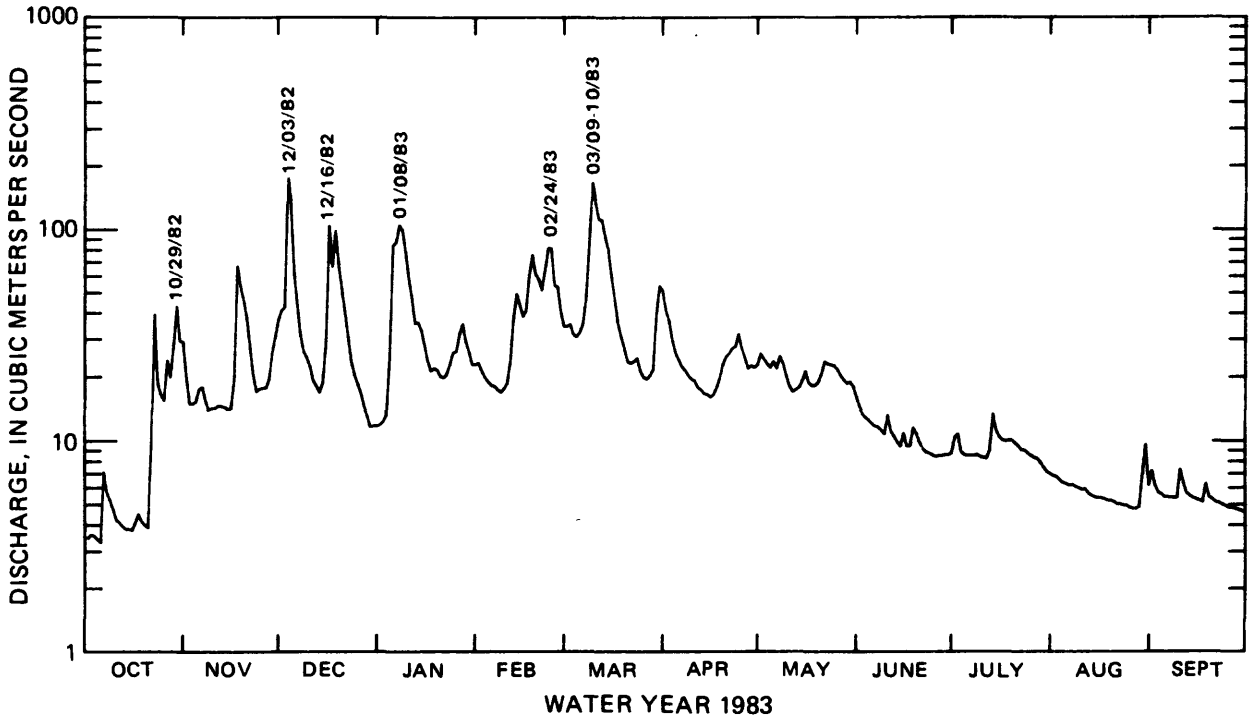
The annual hydrographs of daily mean discharge at the Muddy River, Clearwater Creek, Clear Creek, and Pine Creek gages (figs. 5-7) show that high volumes of storm runoff occurred from three to five times during WY 1983, and from one to five times during WY 1984. Peak and daily mean discharges measured at the stations for periods of highest storm runoff are summarized in table 5.

Table 5.-- Peak discharge and corresponding daily mean discharge for periods of storm runoff, Muddy River, Clearwater Creek, Clear Creek, and Pine Creek, Mount St. Helens, Washington, water years 1983-84

[values are in cubic meters per second]

Date	Muddy River		Muddy River[1]		Clearwater Creek		Clear Creek		Pine Creek	
	Peak	Daily mean	Peak	Daily mean	Peak	Daily mean	Peak	Daily mean	Peak	Daily mean
10/29/82	111.0	43.0	--	--	17.8	15.3	--	--	21.2	11.5
12/03/82	257.7	175.6	--	--	96.9	44.7	--	--	90.1	33.7
12/16/82	151.8	103.9	--	--	49.3	41.3	36.8	35.4	--	24.6
01/08/83	123.5	99.4	--	--	62.3	53.2	56.6	51.8	54.9	36.2
02/24/83	98.6	81.6	--	--	36.2	34.0	33.1	32.6	13.0	13.0
03/09-10/83	250.6	166.8	--	--	118.9	68.8	56.6	48.1	28.3	23.4
11/03/83	102.4	--	136.7	82.5	[2]24.0	[2]13.1	--	--	35.6	19.8
11/17/83	144.6	--	228.1	197.5	61.1	59.4	64.9	--	84.9	47.5
01/03/84	--	--	93.2	73.9	[2]17.9	[2]14.3	--	--	22.0	17.5
01/25/84	--	--	130.2	102.4	[2]21.6	[2]19.9	--	--	38.2	28.1
02/12/84	--	--	93.7	64.6	[2]13.1	[2]10.4	--	--	22.6	14.1

[1] New Muddy River gaging station established below Clear Creek during water year 1984.
[2] Provisional data



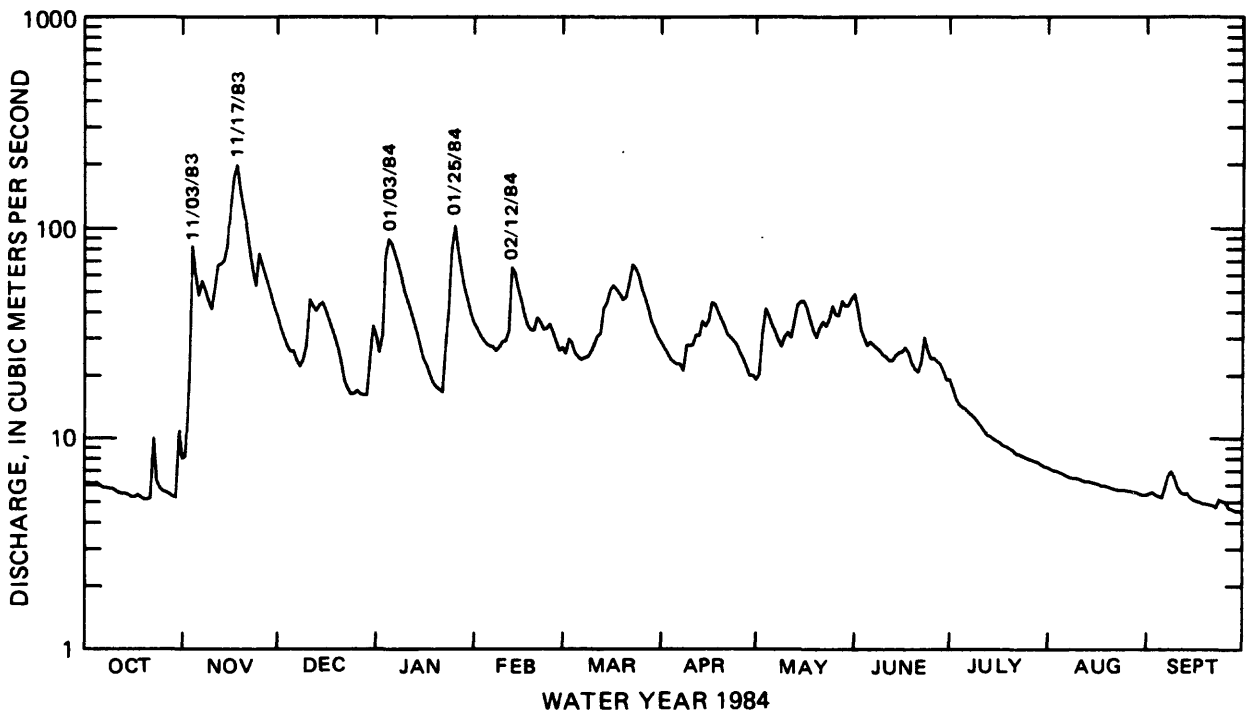
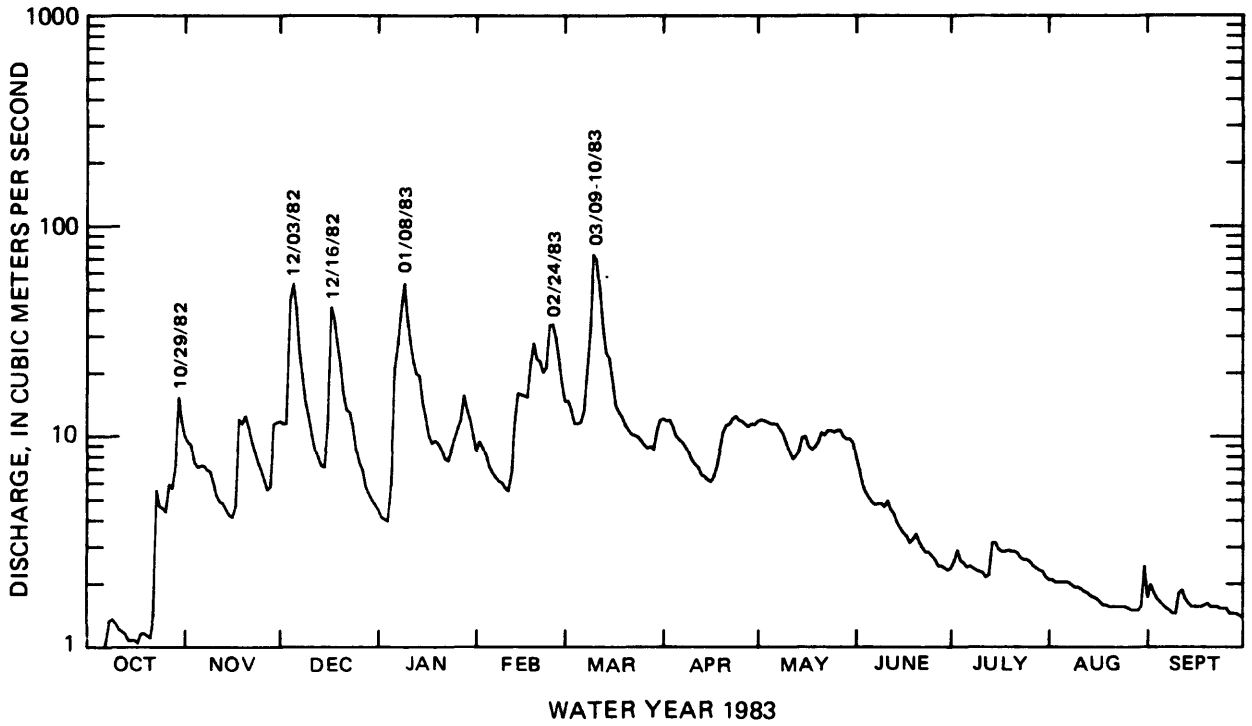


FIGURE 5. – Annual hydrographs of daily mean discharge for Muddy River near Cougar, Washington, water years 1983-84. Data for water year 1983 are from the stream gaging station above Clear Creek; data for water year 1984 are from the gaging station below Clear Creek.



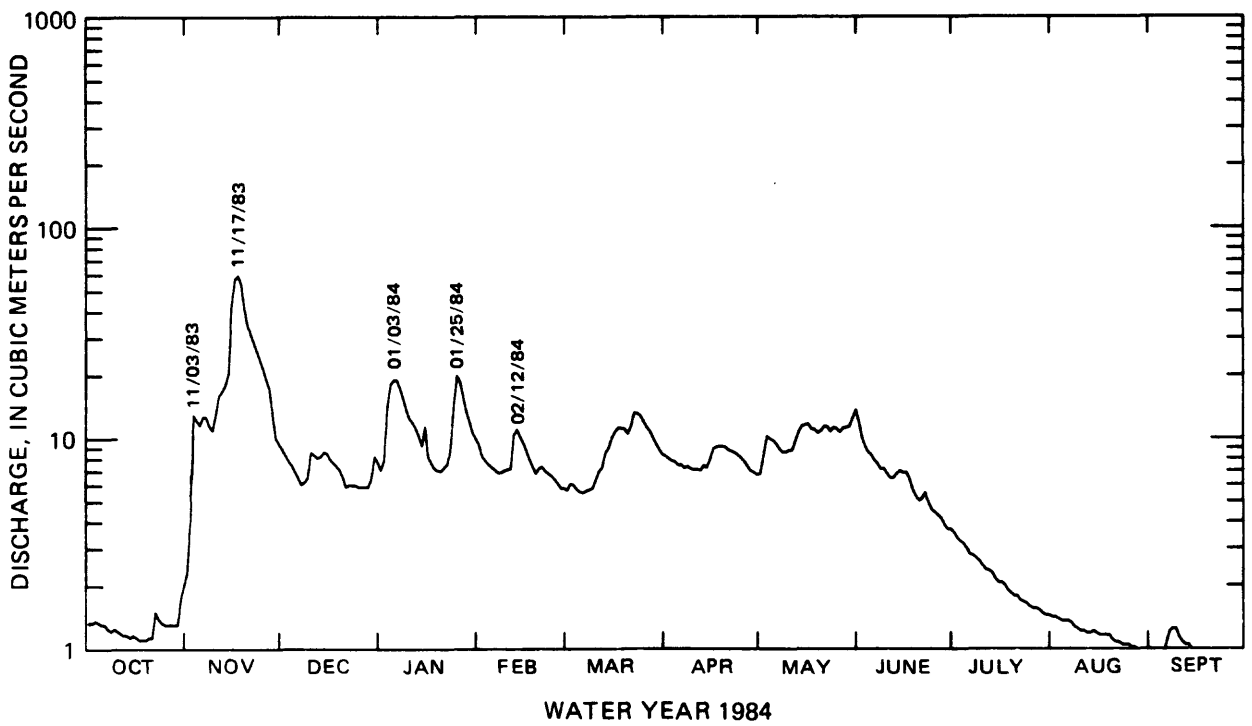
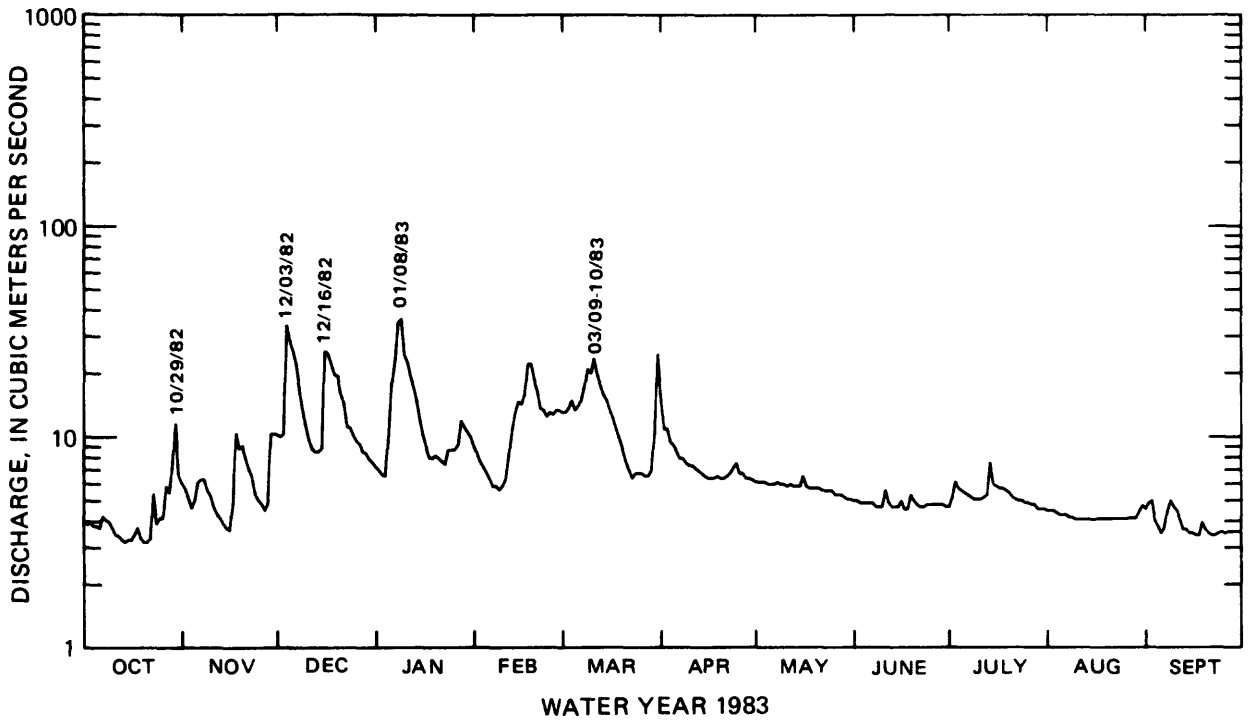


FIGURE 6. – Annual hydrographs of daily mean disharge for Clearwater Creek near mouth, Cougar, Washington, water years 1983-84.



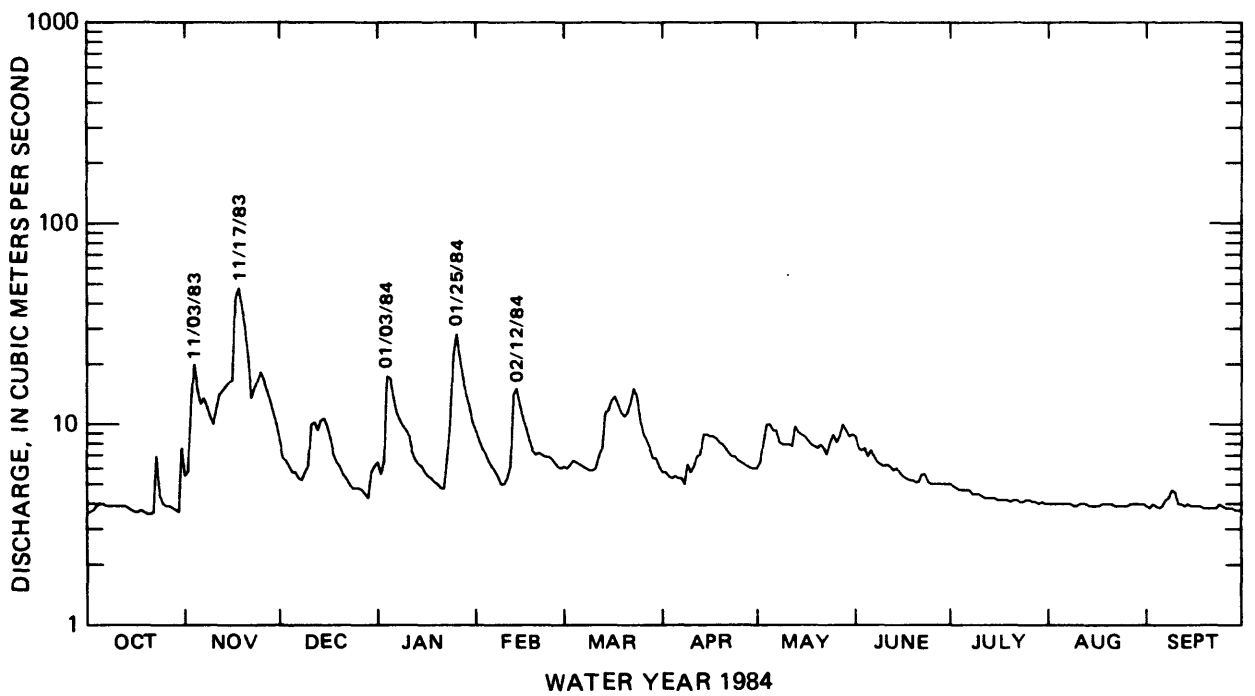


FIGURE 7. – Annual hydrograph of daily mean discharge for Pine Creek near Cougar, Washington, water years 1983-84.

METHODS OF DATA COLLECTION

Selection of Cross-section Locations

A total of 88 cross sections was established during the summers of 1980-81 in clusters of two or more per stream reach on Muddy River, Smith Creek, Bean Creek, Clearwater Creek, Pine Creek, and Swift Creek. Clusters of two to six cross sections were established in a stream reach to provide data on a range of channel environments, such as river bends, straight reaches, pools, and riffles (figs. 2 and 3). Cross sections were established in clusters, rather than in a random distribution. The clusters define study reaches where adjustments in riparian conditions, channel slope, channel pattern, and streambed material could be studied in conjunction with changes in cross-section geometry. The clusters also define reaches for sediment budget computations. Cross sections also were located above and below the confluence of major tributaries. Usually, one or more cross sections were located at or near pre-eruption stream gaging stations and at bridge sites, where pre-eruption survey data are available. Some cross sections on Smith and Clearwater Creeks were located to coincide with cross sections measured photogrammetrically from imagery taken during June and July, 1980. The spacing of these cross sections is about four cross sections per kilometer of channel length. For other clusters of cross sections, spacing between cross sections generally ranges from 3 to 16 cross sections per kilometer of channel, depending on width of the channel.

The network of cross-section measurement sites established during the summer and fall of 1980 on Lewis River tributaries has been modified slightly. A few cross sections were added to the initial network to increase areal coverage of channel adjustments or to obtain additional measurements in critical areas. Occasionally, natural processes such as local bank erosion, channel avulsion, deposition during floods, gullying, and shallow-seated landsliding have destroyed one or both cross-section endpoint monuments. In addition, salvage logging on the floodplain and on near-channel terraces along the mainstem of the Muddy River destroyed some of the cross-section monuments during the summer of 1982. Where a single monument was destroyed, the cross section was re-established using the remaining monument and a compass bearing. Where all monuments for a cross section were destroyed, new cross sections were established close to the same location, and, where possible, monuments of new surveys were tied to landmarks or reference marks from previous surveys. In some cases this was not possible, and cross-section relocation was only approximate.

Each cross section in the Lewis River basin was assigned a unique 5- or 6-character alphanumeric identifier. The first two or three characters of the identifier are letters that indicate the specific tributary drainage basin in which the cross section is located, such as "MD" for Muddy River or "PN" for Pine Creek. The last three digits are the cross-section number in the study basin. Cross-section numbers increase in a downstream direction.

Location of channel cross sections and descriptions of endpoint monuments are on file at the Mount St. Helens National Volcanic Monument Headquarters (U.S. Forest Service) in Amboy, Washington, and at the Cascades Volcano Observatory (U.S. Geological Survey) in Vancouver, Washington.

Surveying Methods

Cross sections usually spanned the valley floor and were located by establishing a line of sight perpendicular to the channel or parallel to the valley strike. The endpoints of the cross sections were monumented with metal fenceposts or sections of steel reinforcing bar. The direction of each cross section with respect to magnetic north was measured. Channel cross sections were surveyed using electronic distance measuring equipment and a theodolite. The instruments were set up on line with the monuments, which served as reference marks for horizontal and vertical control. Where deep gullies or vertical banks occasionally precluded precise surveying, a few points on the cross section were measured with hand level and tape. Maximum depth of the channel was estimated where channels were too deep to be waded.

The theodolites used are accurate to about 6 seconds of angular measurement. The precision of electronic distance measurements is generally about 0.05 m per kilometer and is affected by factors such as atmospheric conditions, ground moisture and stability at the instrument station, rod placement, length of shots, and steepness of terrain.

Frequency of Surveys

Each cross section was surveyed annually during the spring or summer of 1983 and 1984 following the peak of rainfall and snowmelt runoff. Of these, 15 cross sections were surveyed after significant winter storms. The cross-section network including numbering scheme, number of cross sections, number of reaches of clustered cross sections, and number of times additional cross sections were surveyed following storms is summarized for each stream in table 6.

CROSS-SECTION DATA

An arbitrary elevation and station distance were assigned to a reference monument at each cross section. Field measurements, consisting of slope distance and corresponding vertical angle readings, were converted to horizontal distance and relative elevation and referenced to these monuments with fixed station distance and elevation. Cross-section survey data were stored and manipulated electronically. Cross sections from recent surveys were plotted and superimposed on cross sections from earlier surveys to show channel changes.

TABLE 6.--Description of cross-section network on Lewis River system, Mount St. Helens, Washington, water years 1983-84

Drainage basin, sub-basin	Number of cross-section clusters	Total number of cross sections[1]	Number of cross sections surveyed after storms	Numbering scheme
Muddy River				
Muddy River	11	28	4-8	MD010-MD250
West Muddy Channel	1	3	0	MDW010-MDW030
Smith Creek	3	13	3	SM004-SM100
Clearwater Creek	2	6	0	CL100-CL520
Bean Creek	1	2	0	BN010-BN100
Clear Creek	0	0	0	--
(TOTAL)	(18)	(52)	(7-11)	--
Pine Creek				
Main Fork Pine	7	21	0-3	PN010-PN200
East Fork Pine	2	4	0-1	PNE030-PNE060
Upper East Pine	1	2	0	PNU010-PNU020
(TOTAL)	(10)	(27)	(0-4)	--
Swift Creek	1	3	0	SW010-SW030

[1] Surveyed annually during low flow.

Surveyed channel cross sections and longitudinal profiles showing the locations of these cross sections are presented in graphical form at the end of the report (figs. 8, 9, 12, 13, 16, 17, 20, 21, 24, 25, 28, and 29). An index of cross-section survey sites precedes the survey data for each tributary drainage. Cross sections in each tributary drainage are presented in upstream to downstream order. Plots are viewed looking downstream. All cross sections in a stream reach or cluster are plotted with the same scale and vertical exaggeration, but scale and (or) vertical exaggeration may vary from reach to reach. For some cross sections, a portion of the profile is also plotted at an enlarged scale and (or) different vertical exaggeration to show detailed changes in and near the channel. For some cross sections, scale or vertical exaggeration has been changed from those used in previously published profile data (Martinson and others, 1984) to show detailed changes in and near the channel.

LONGITUDINAL PROFILE DATA AND PLANFORM MAPS

Longitudinal profiles of the low-water channel thalweg and (or) water surface were surveyed for some of the study reaches of clustered cross sections during 1982, 1983, and (or) 1984. Map views corresponding to the longitudinal profiles were constructed using a stereo transfer scope

and aerial photographs taken about the same time of the longitudinal surveys. Longitudinal profiles and channel maps for selected reaches constructed from survey data collected during WY 1982-84 are presented at the end of the report, preceded by index maps showing locations of the selected reaches (figs. 10, 11, 14, 15, 18, 19, 22, 23, 26, and 27).

The longitudinal profiles and channel maps are useful for assessing channel-bed and channel-planform stability and for assessing whether rates of erosion or deposition measured at cross sections can be extended over a longer reach of channel for sediment budget computations.

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CROSS SECTIONS, LONGITUDINAL PROFILES, AND MAP VIEWS

INDEX TO MUDDY RIVER CROSS-SECTION SITES

As an aid to the reader, listed below are the individual cross-section site numbers and corresponding page number of the plot.

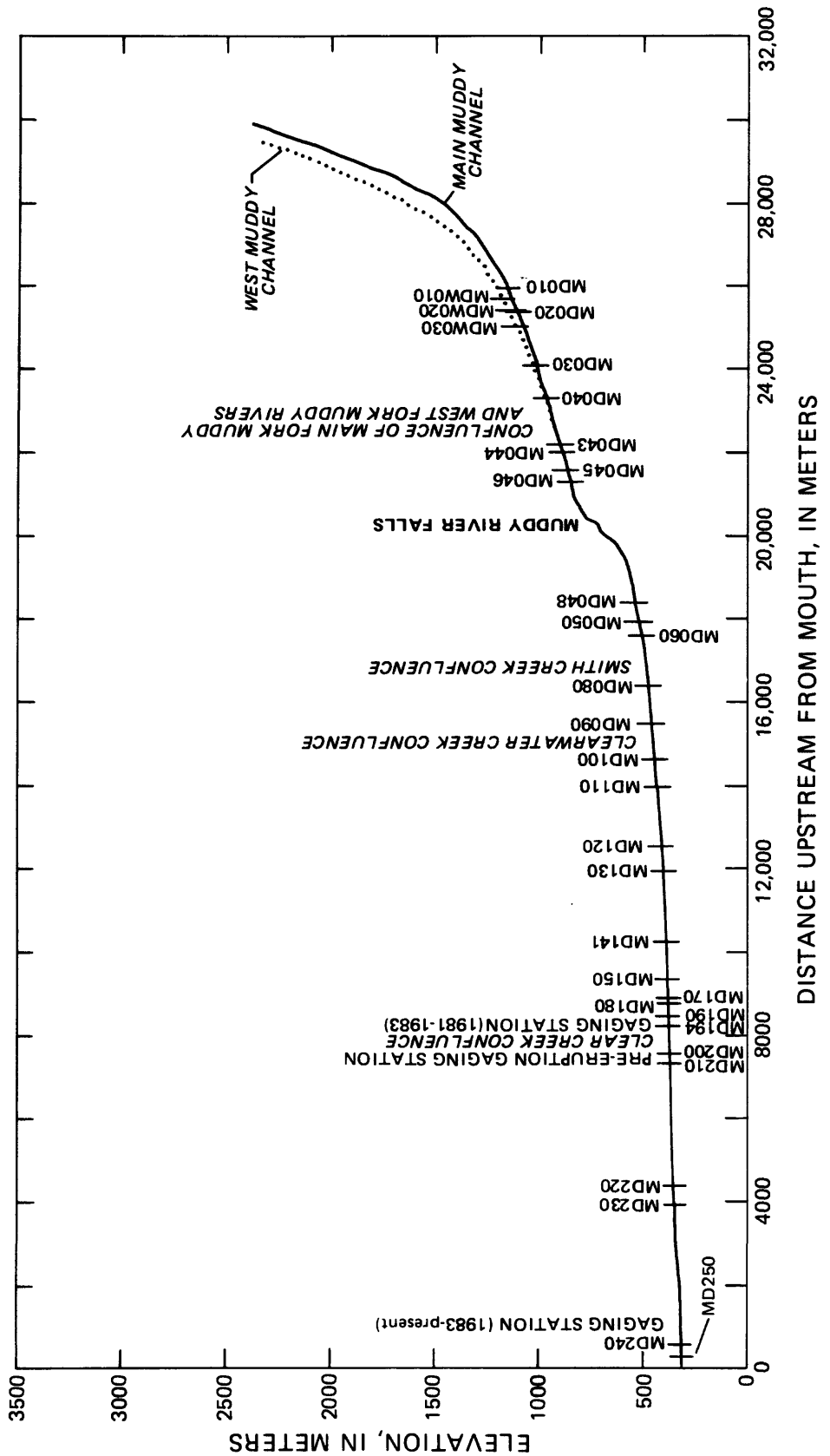
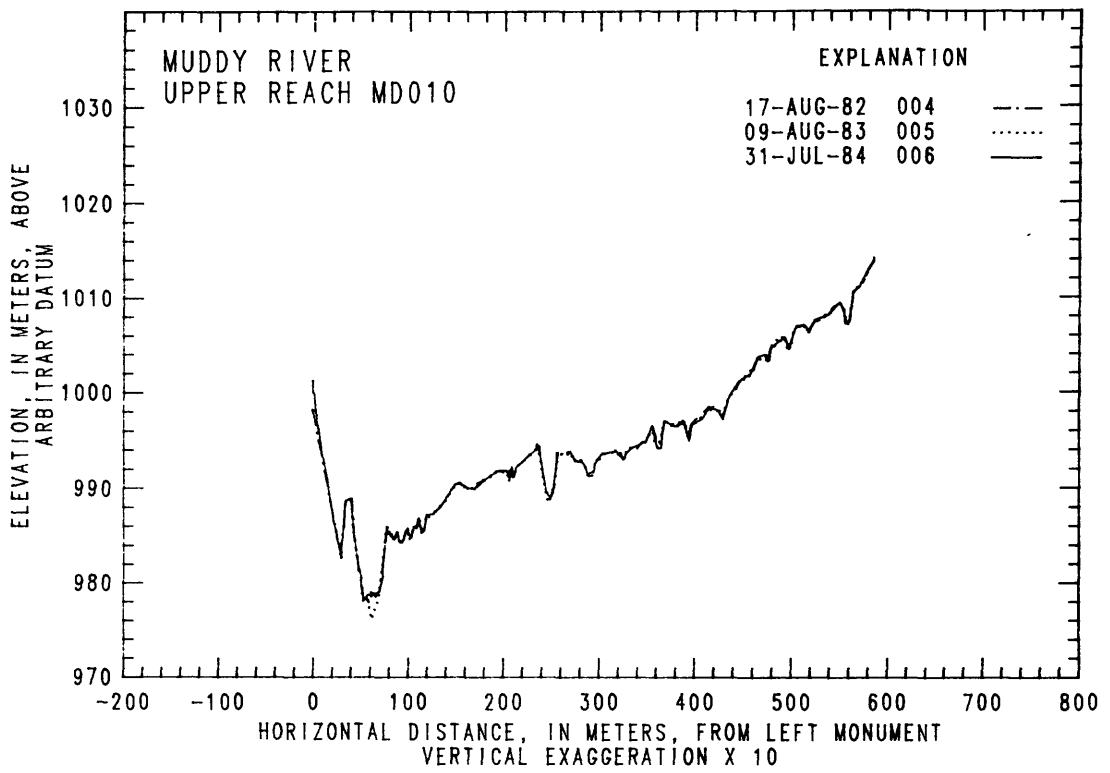


FIGURE 8. – Longitudinal profile of Muddy River, showing locations of cross-section survey sites. Channel distance upstream from mouth and elevation above sea level are determined from U.S. Geological Survey topographic maps, 7.5-minute series, Mount St. Helens SE and Mount St. Helens NE quadrangles.



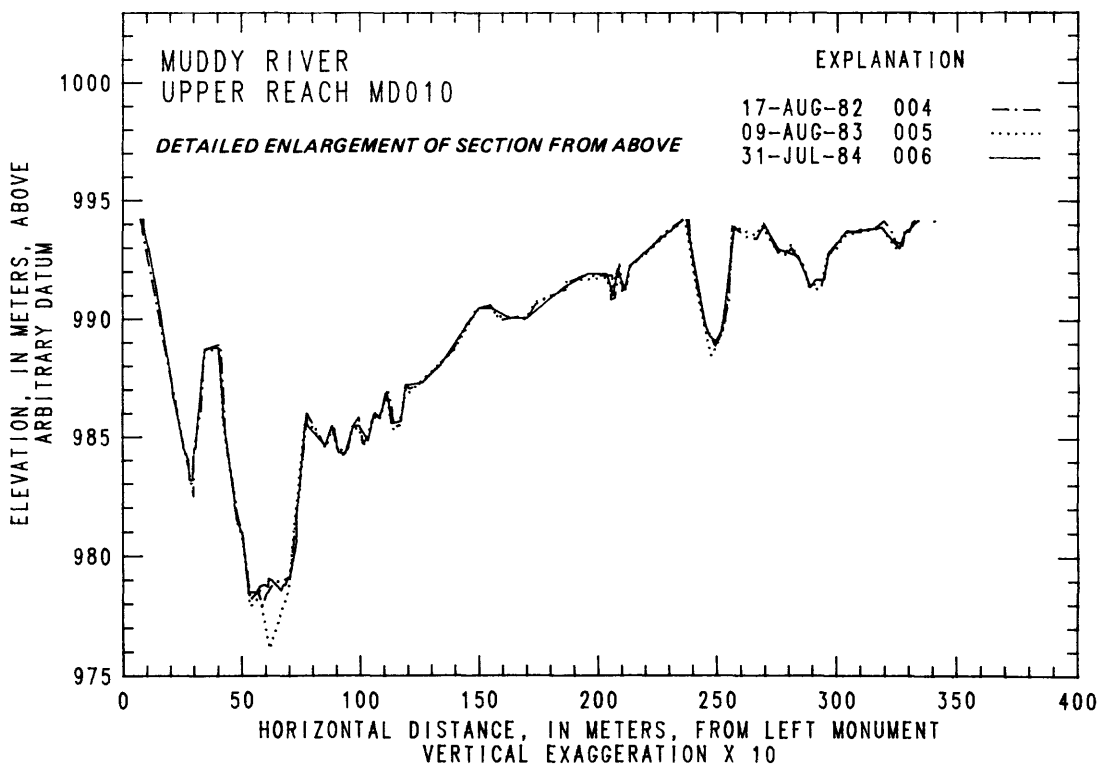
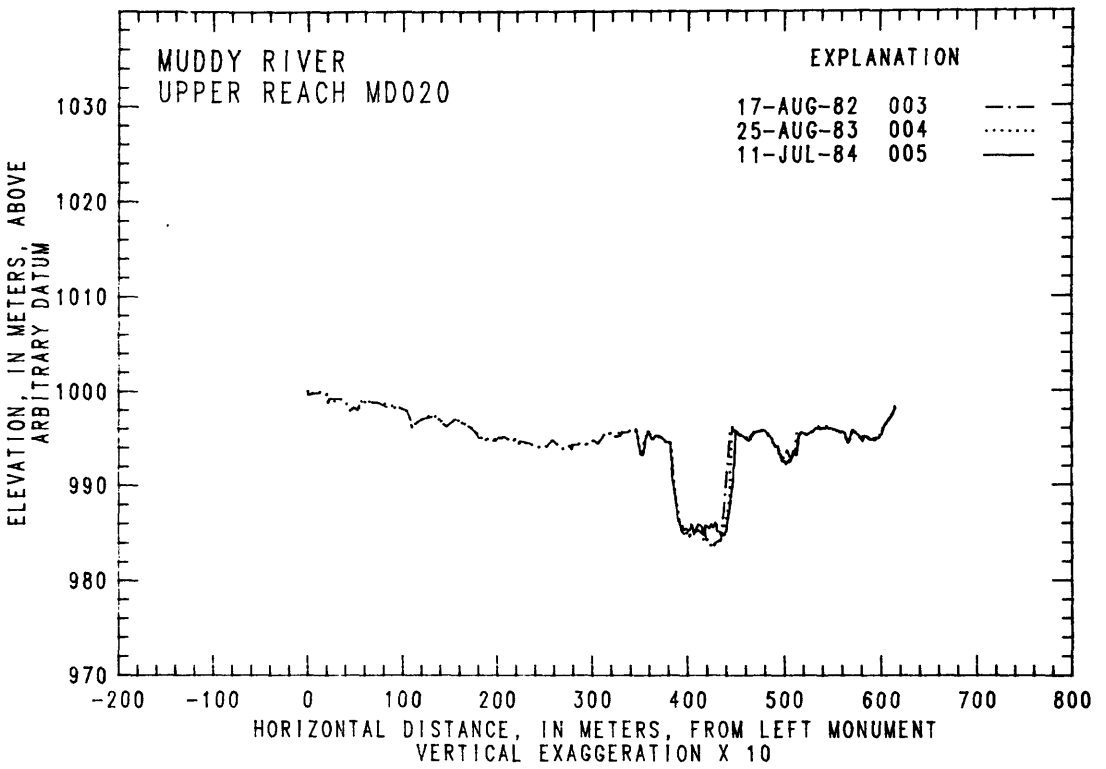


FIGURE 9. – Cross-section profiles for selected sites, Muddy River.



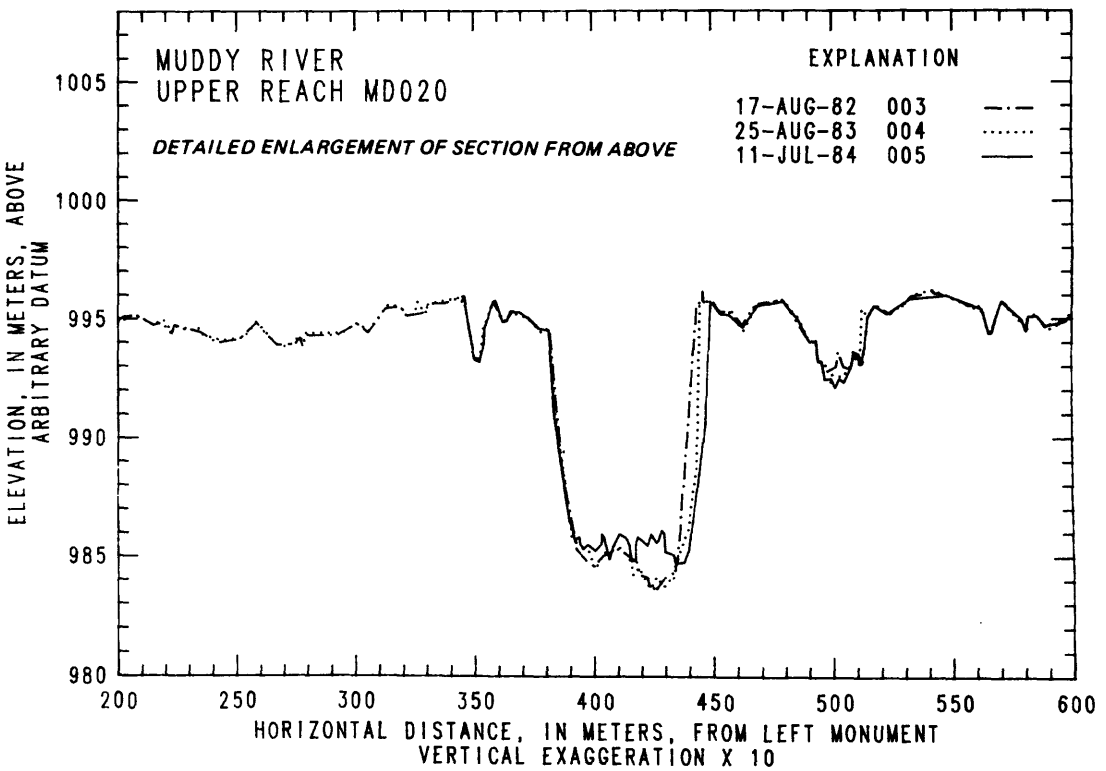


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

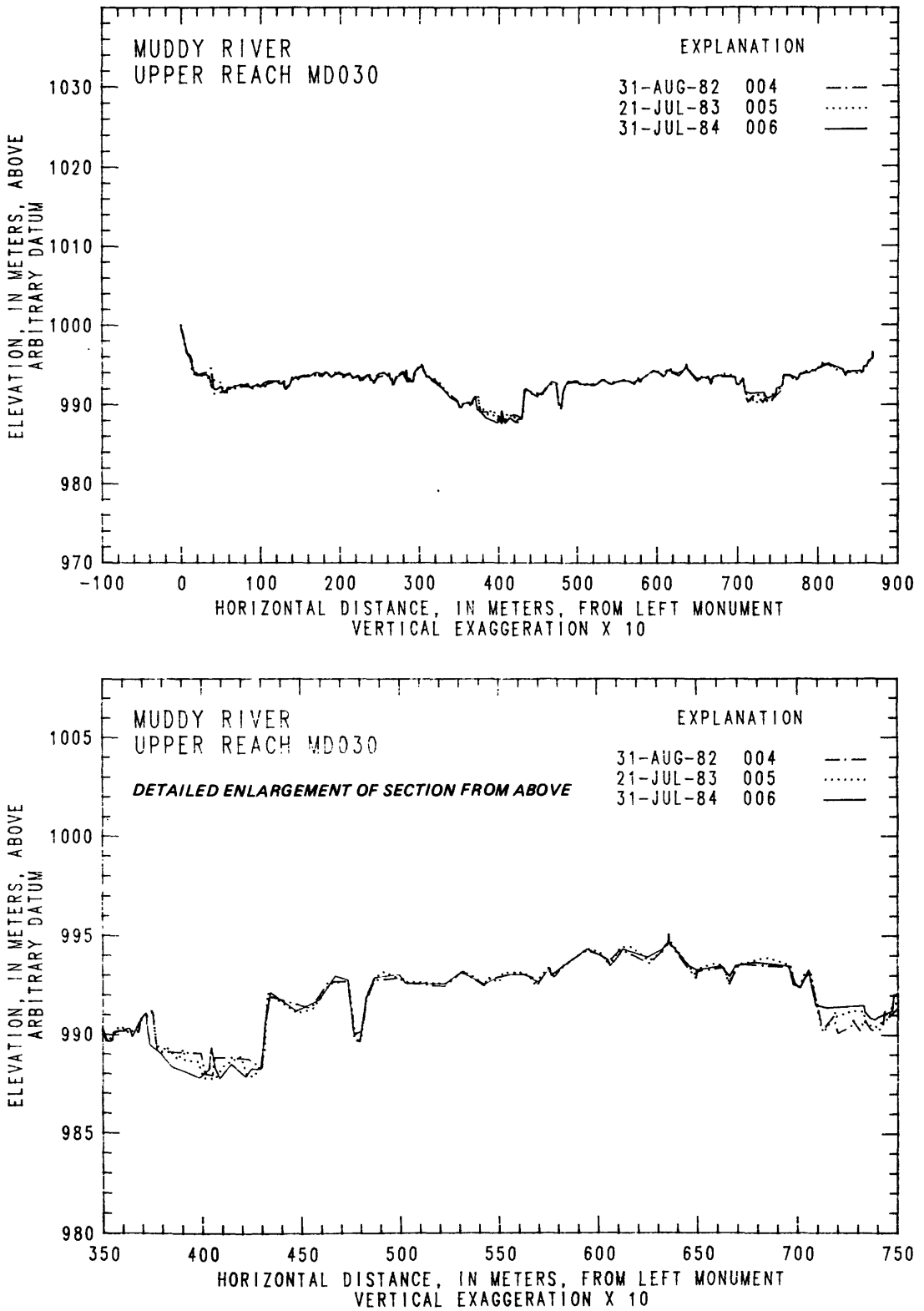
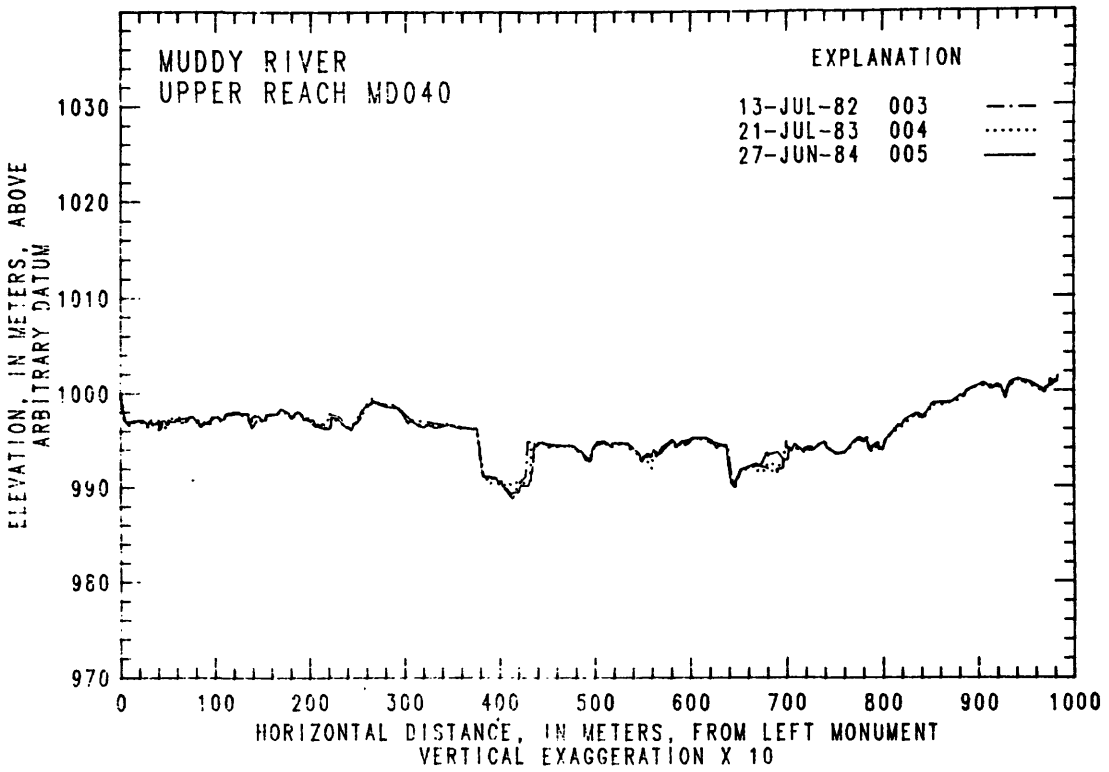


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



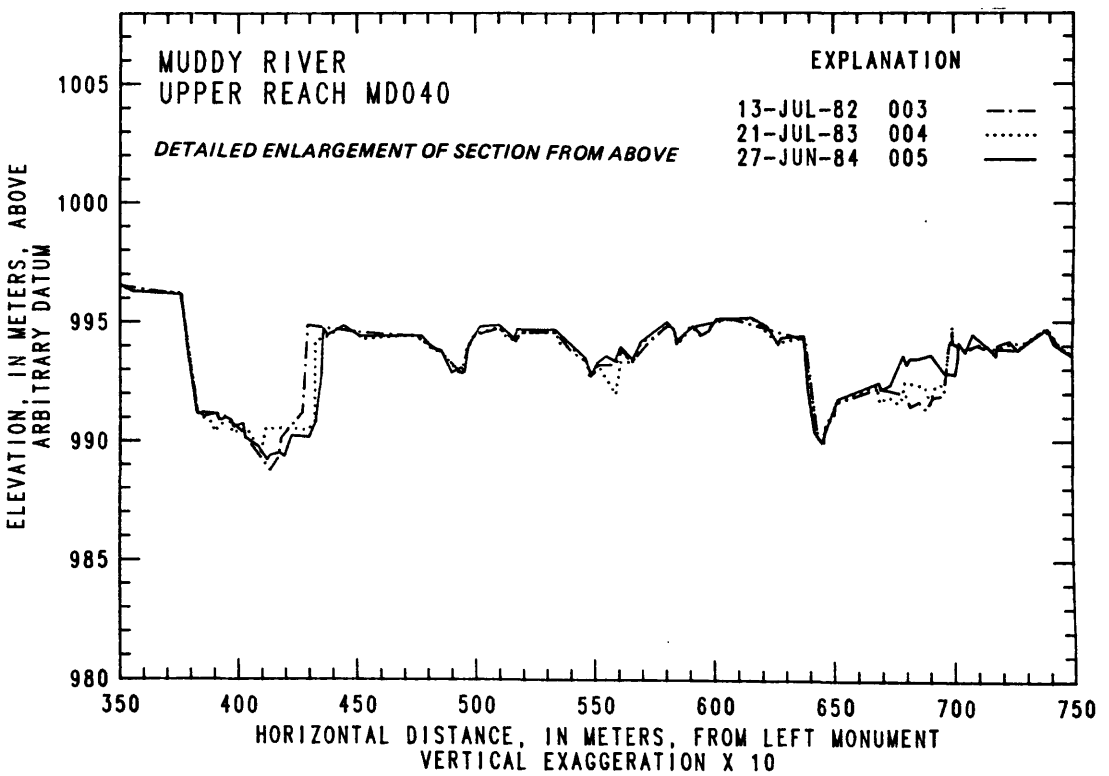


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

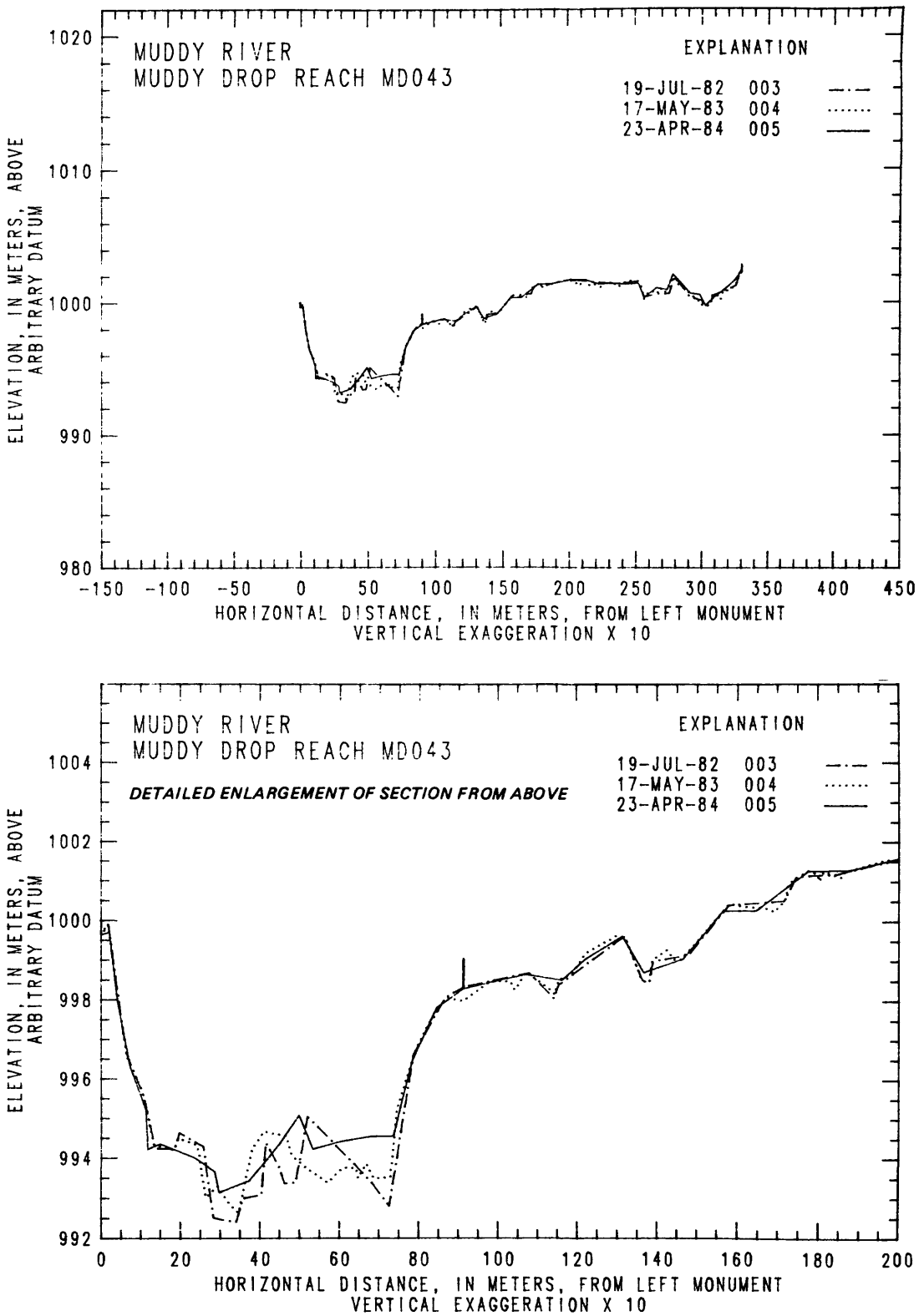
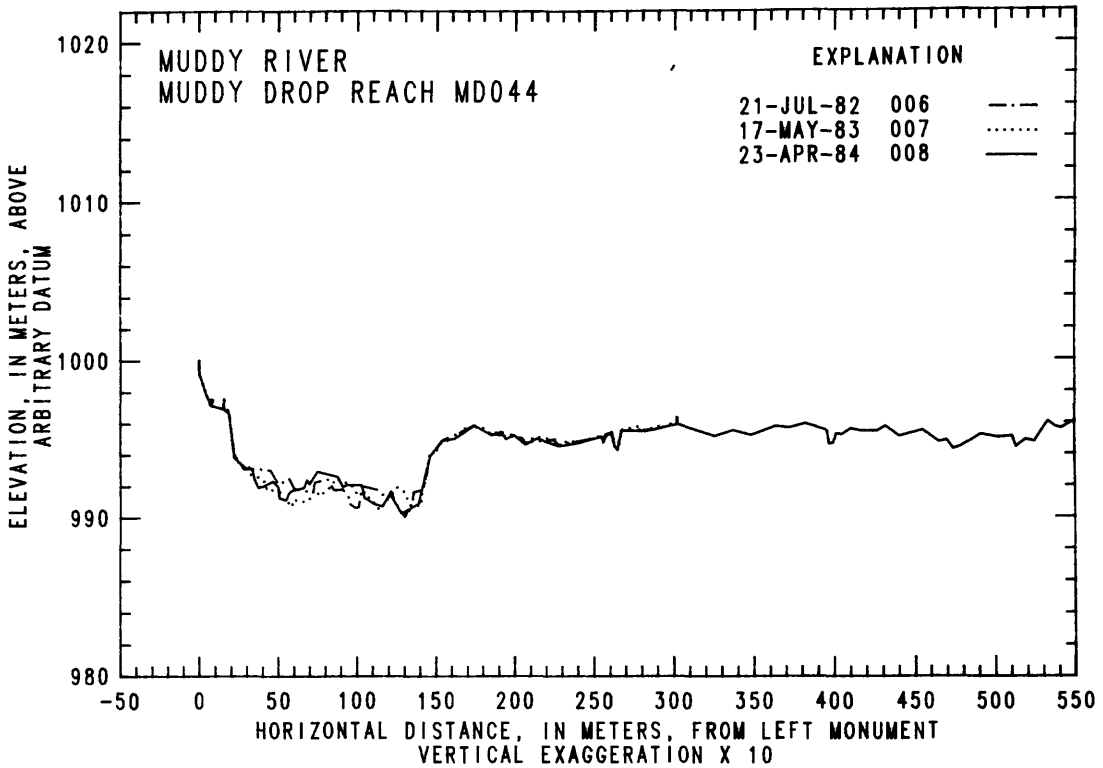


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



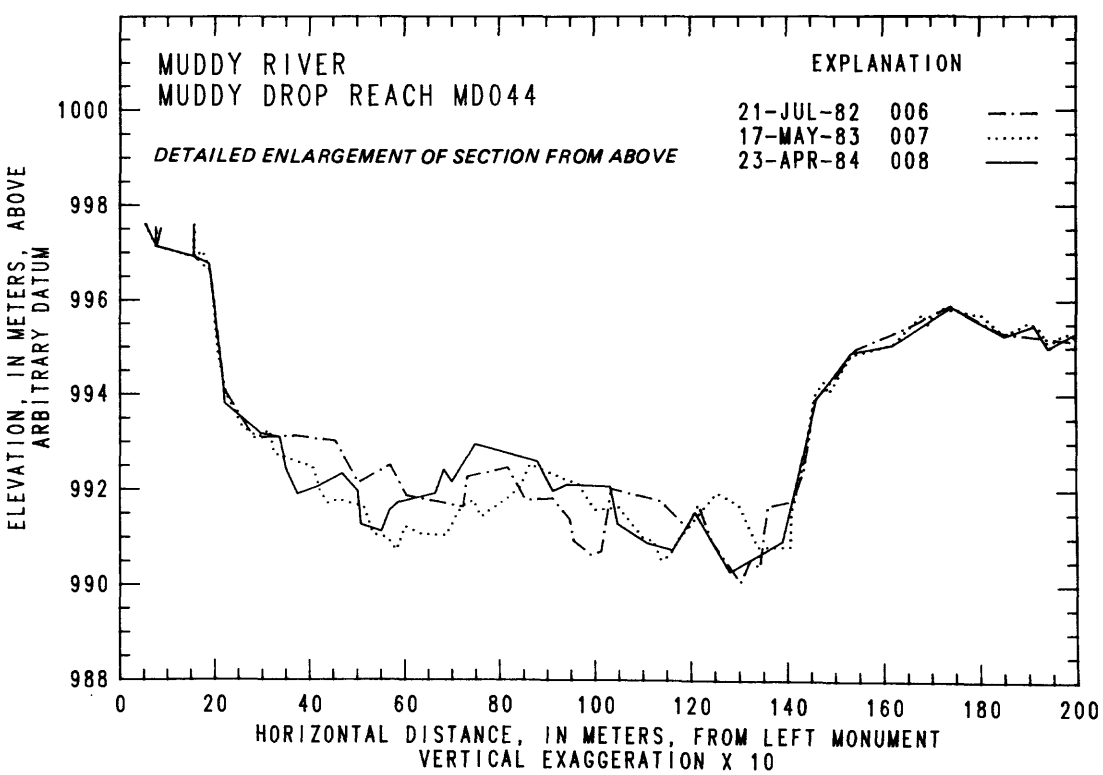
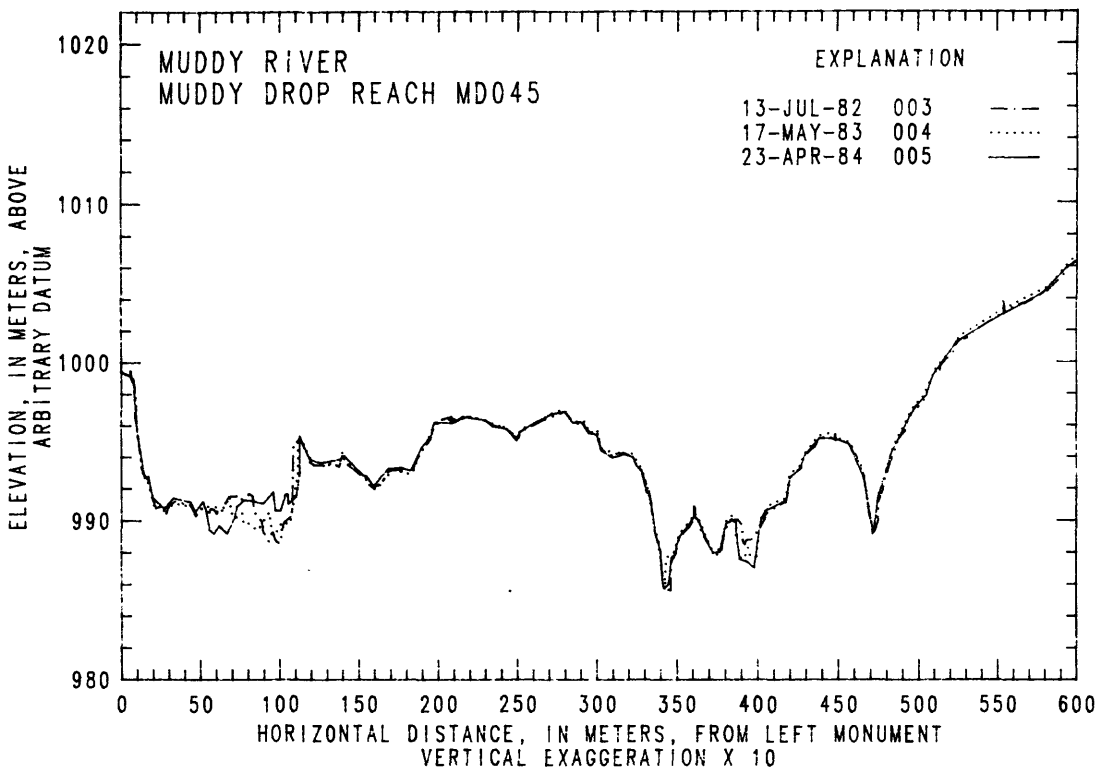


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



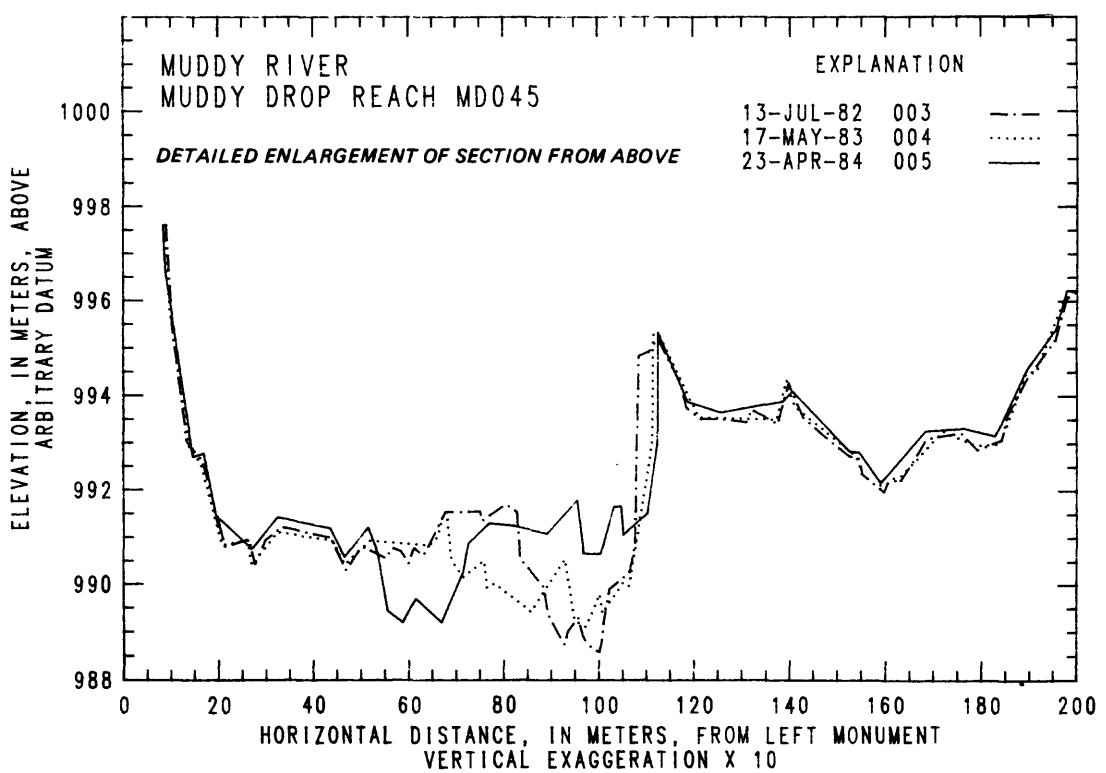
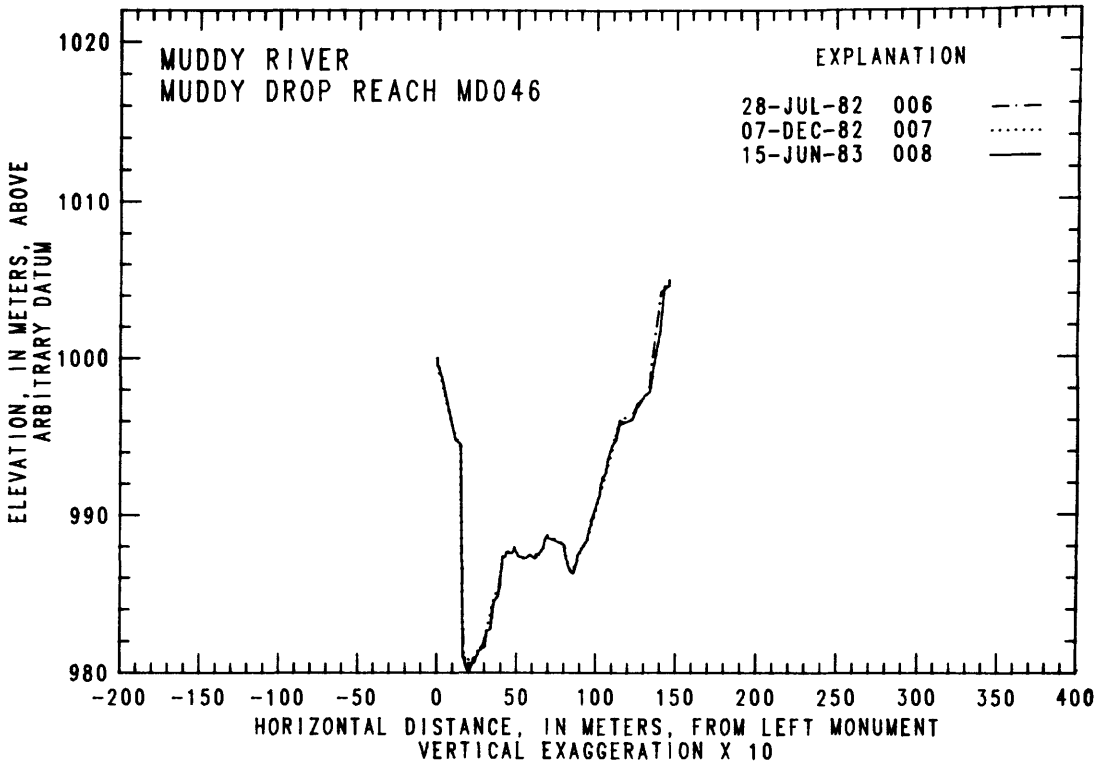


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



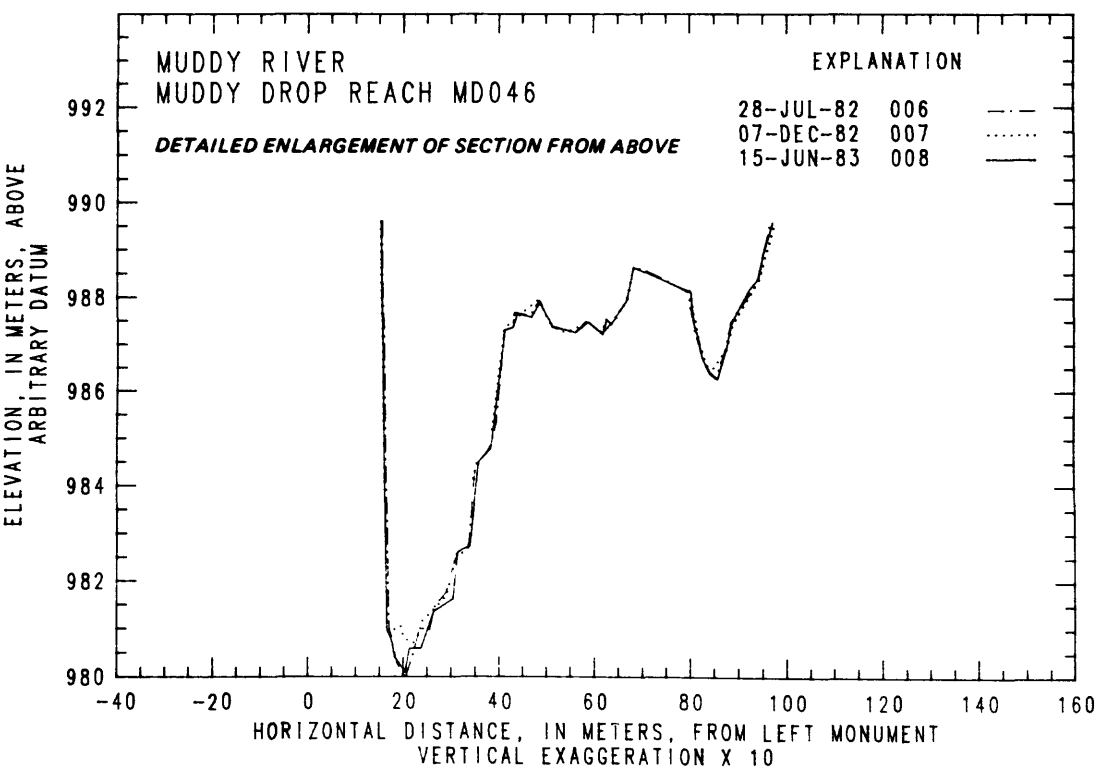
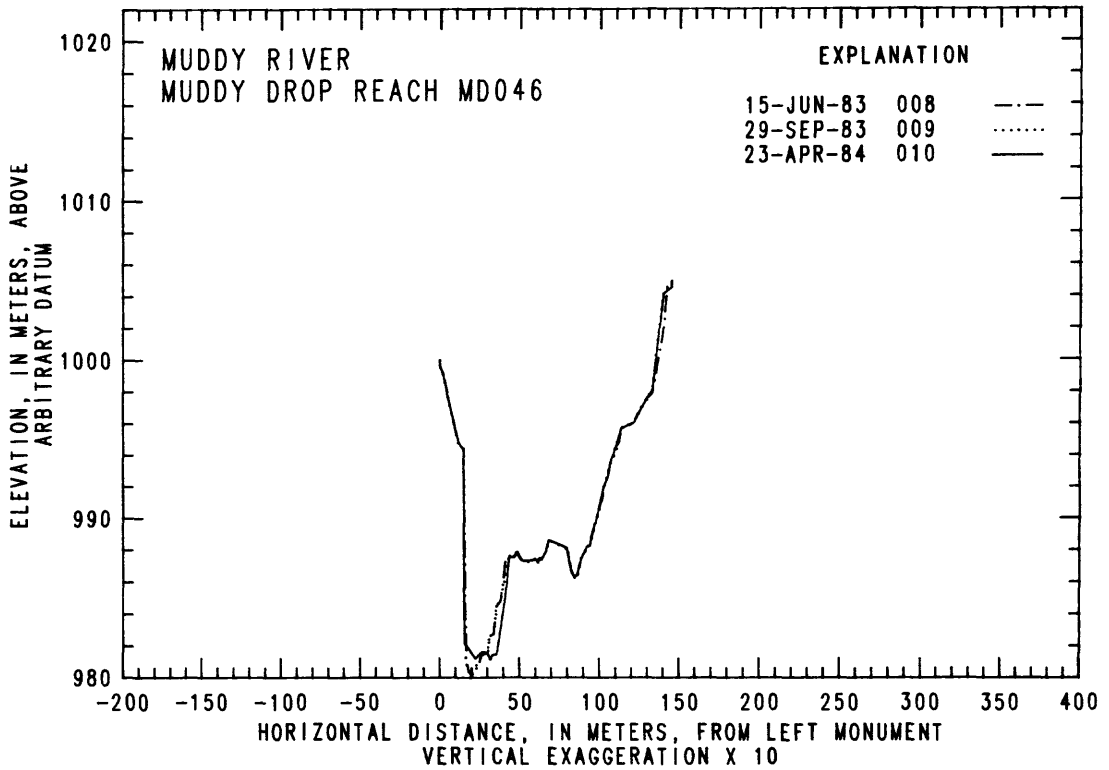


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



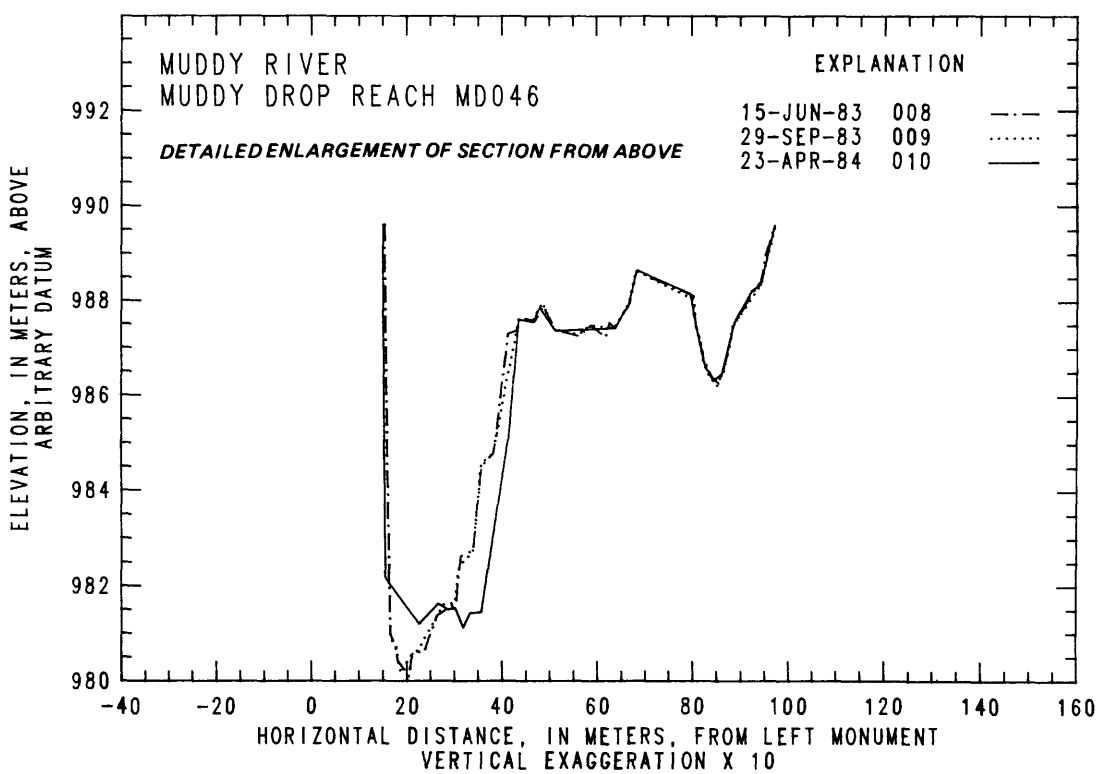


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

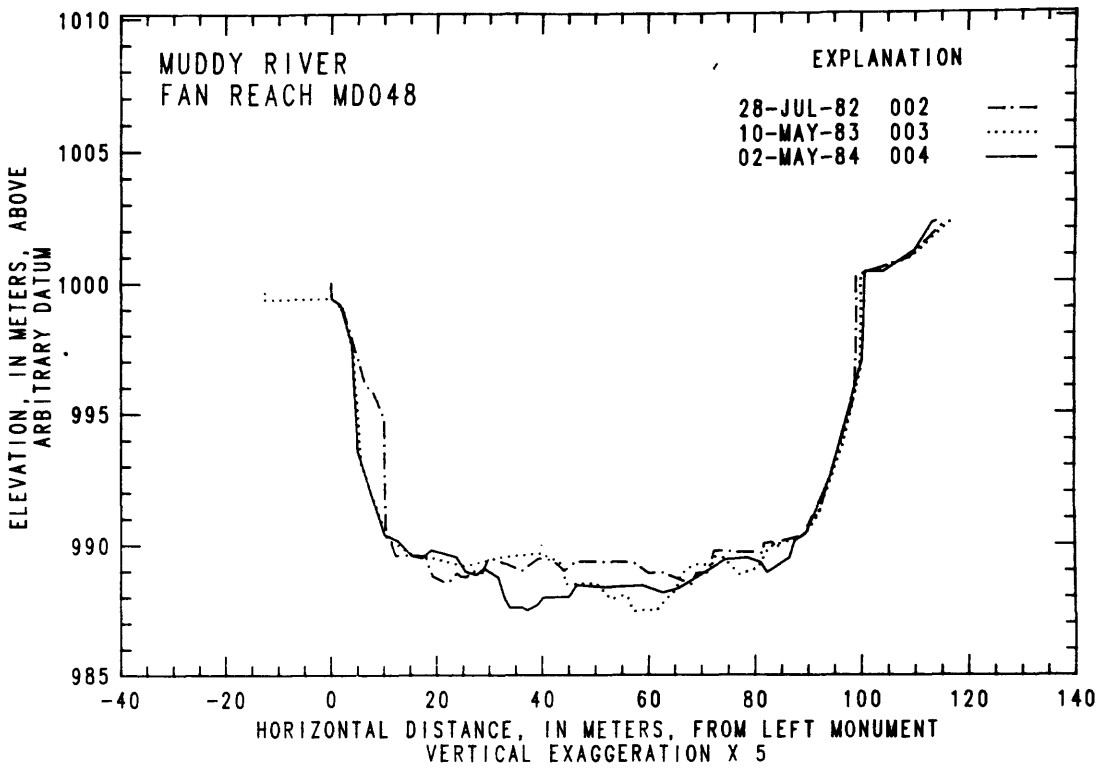


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

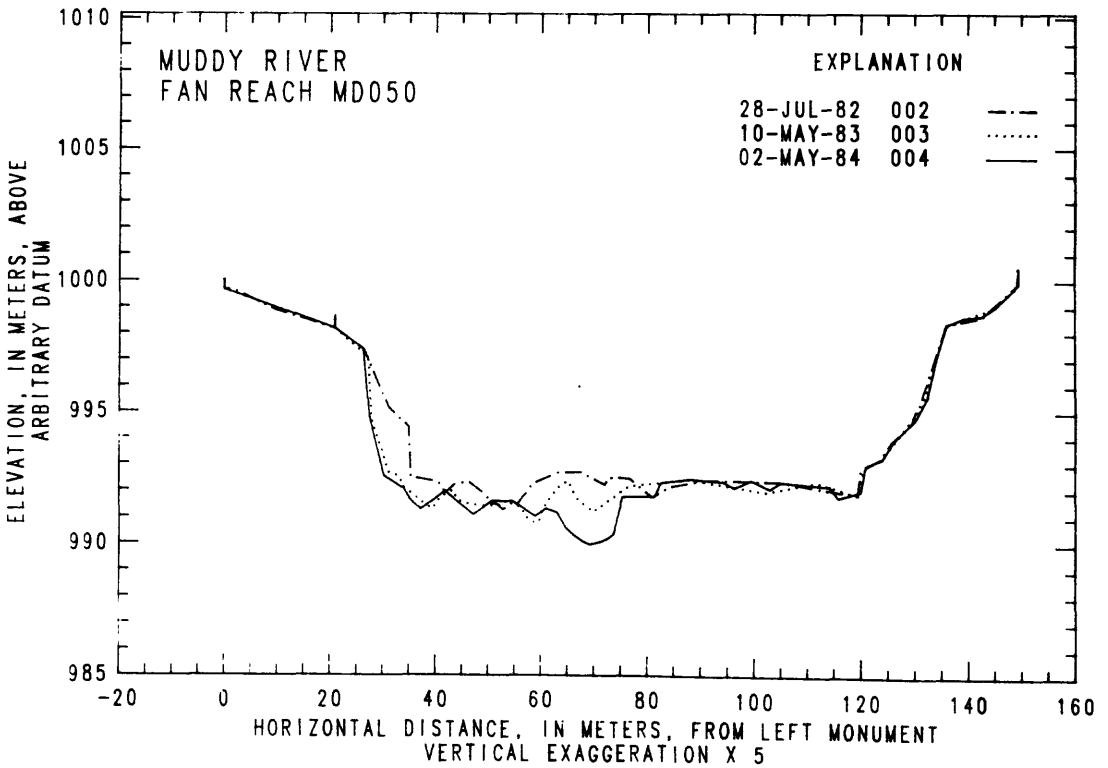


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

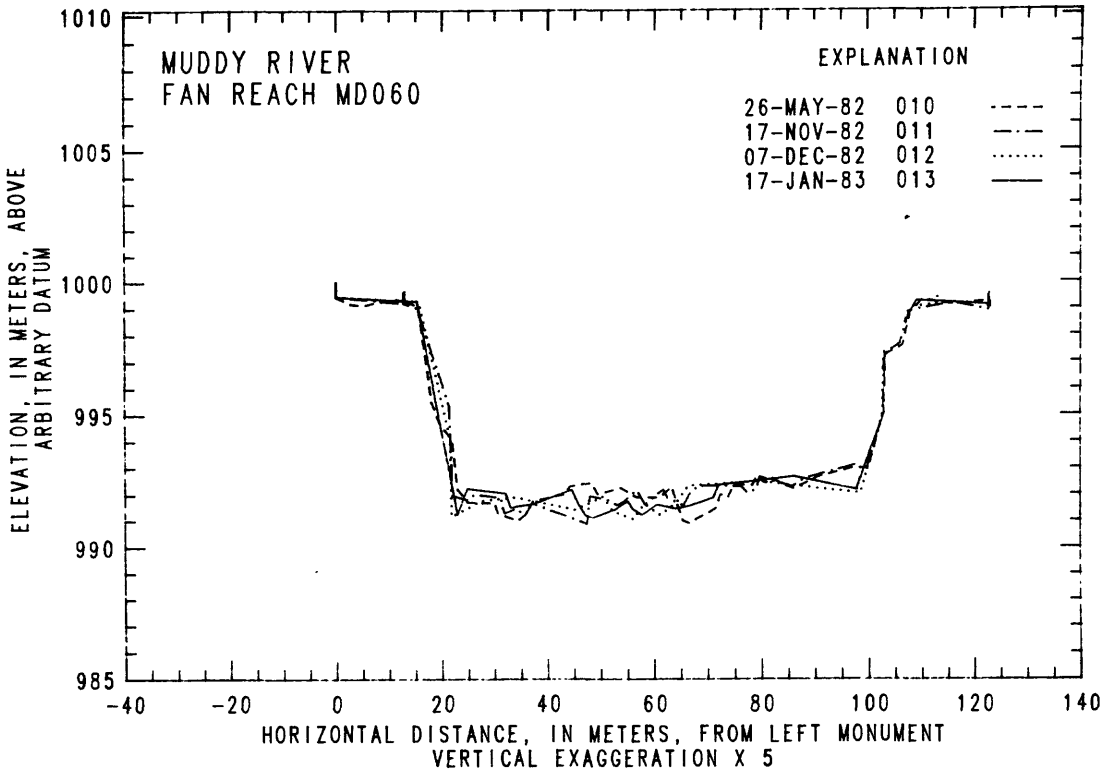


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

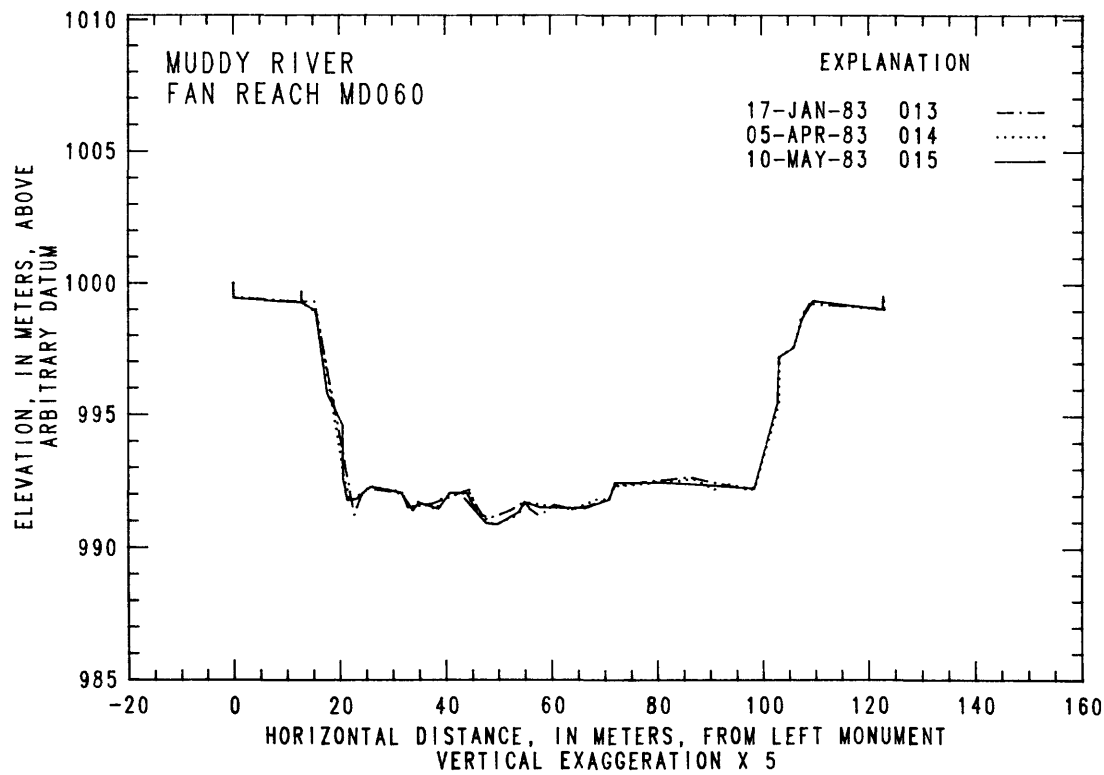


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

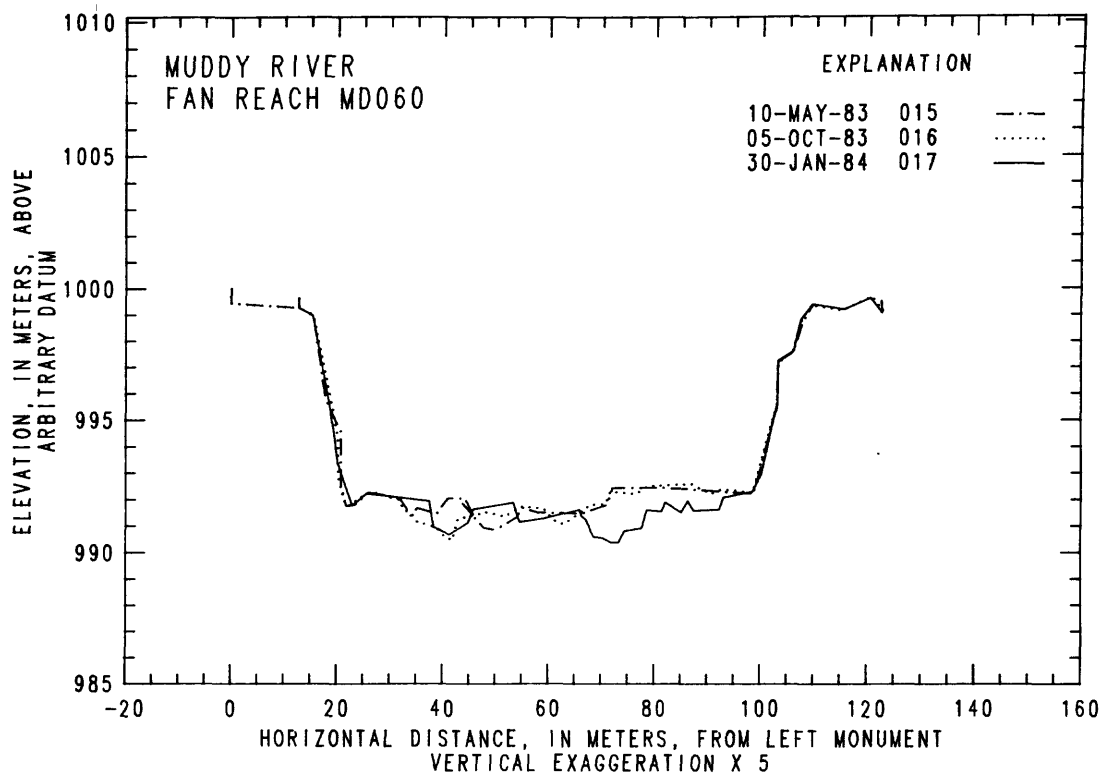


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

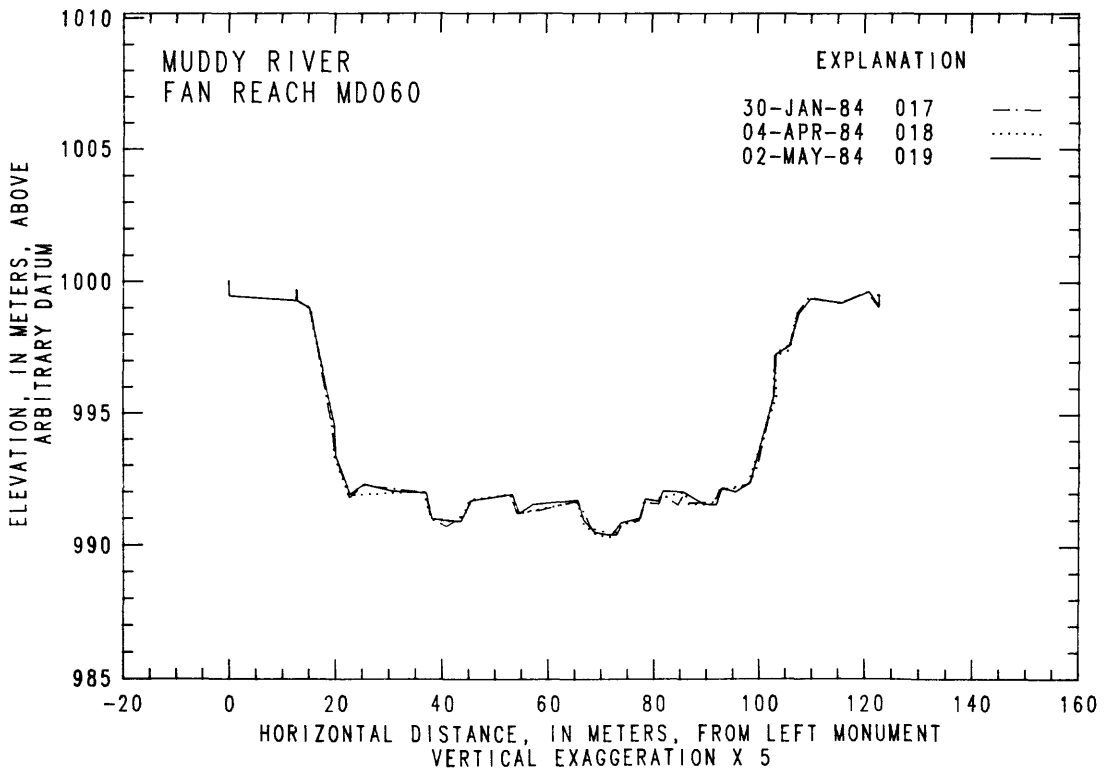


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

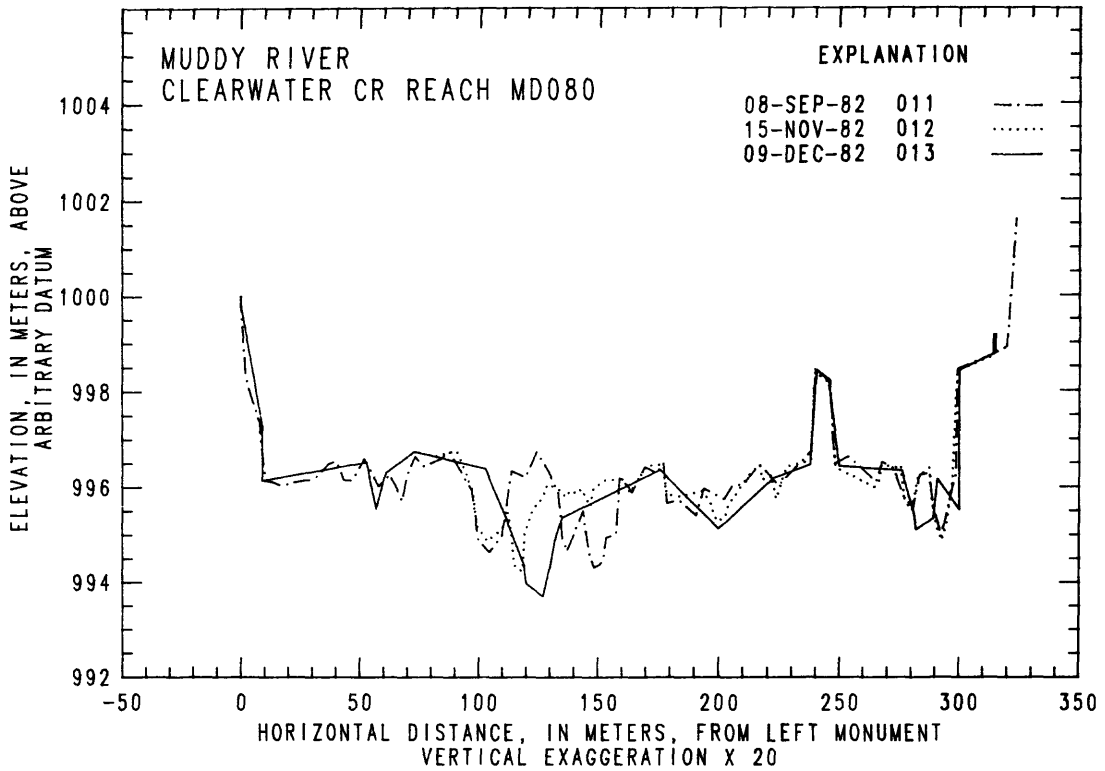


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

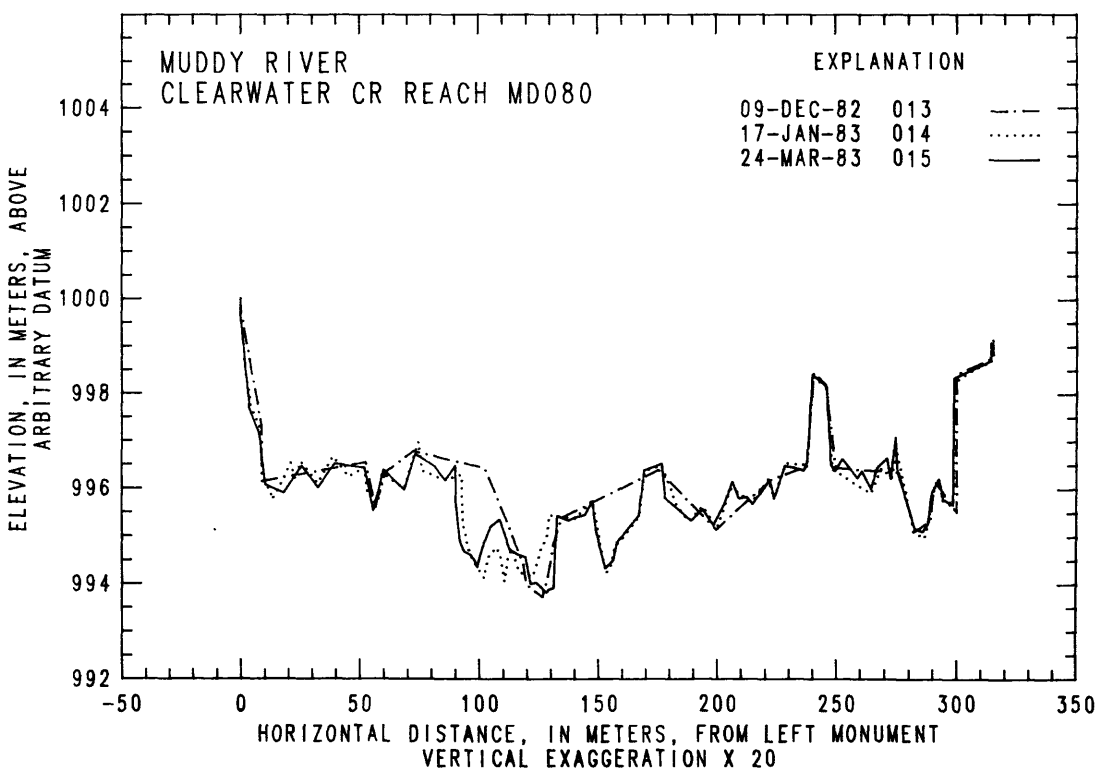


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

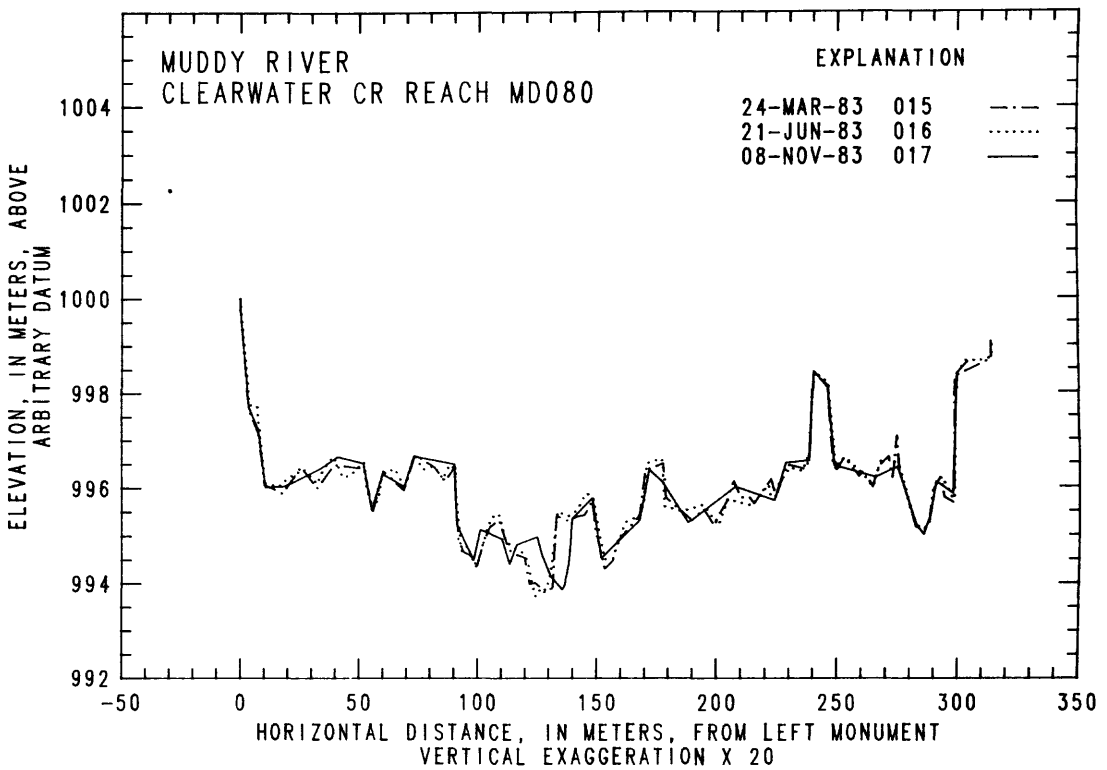
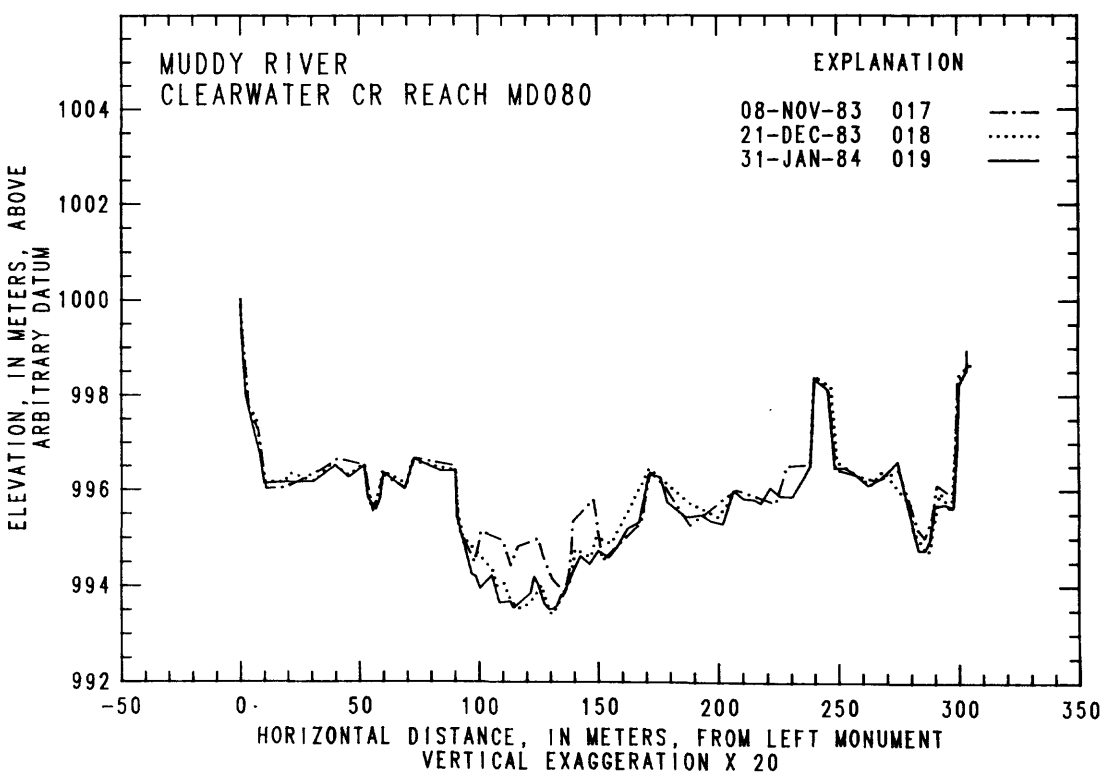


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



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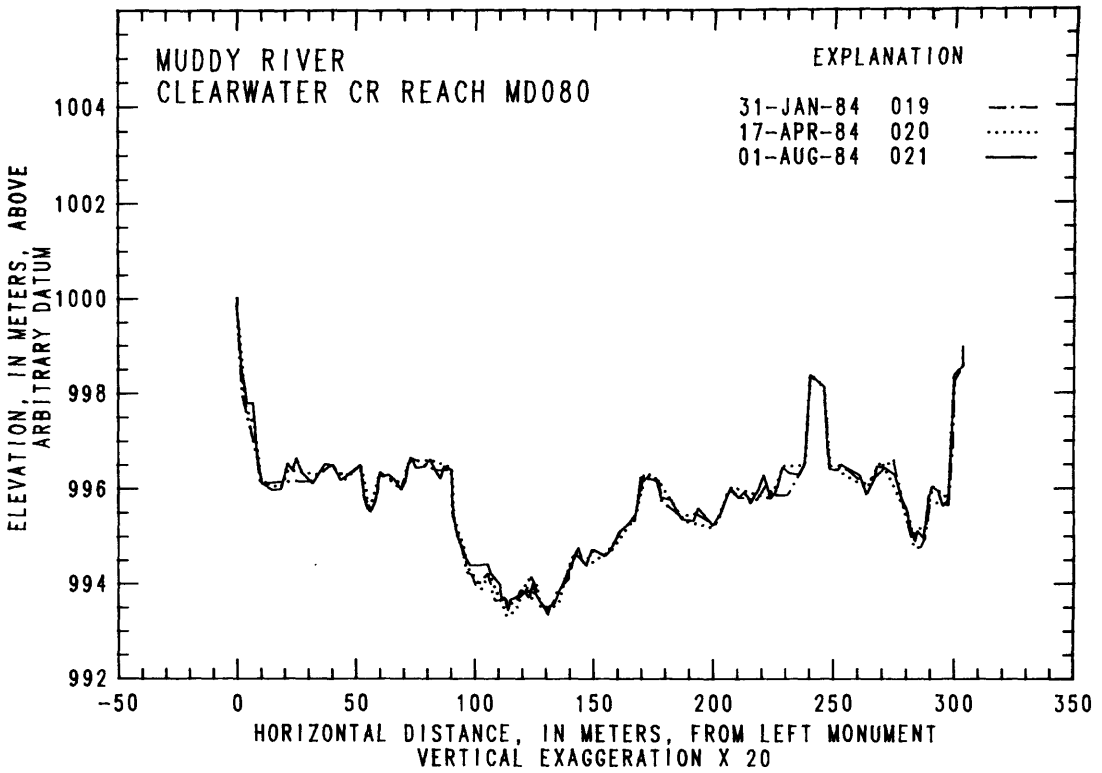


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

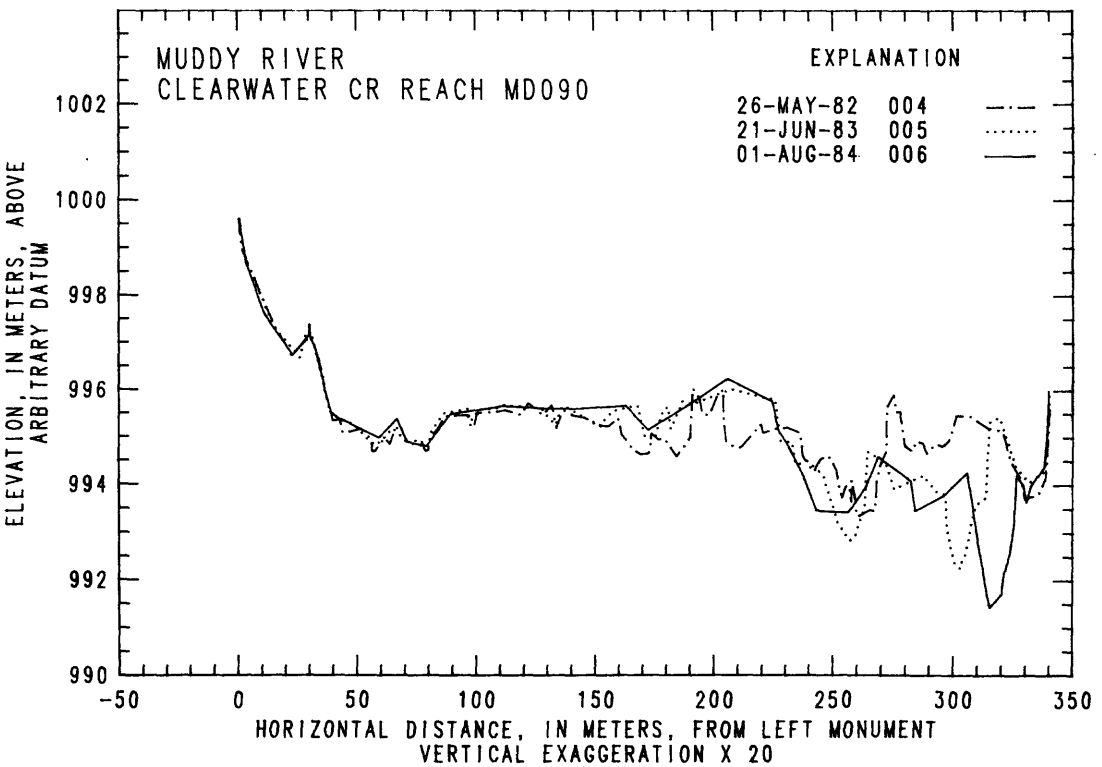


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

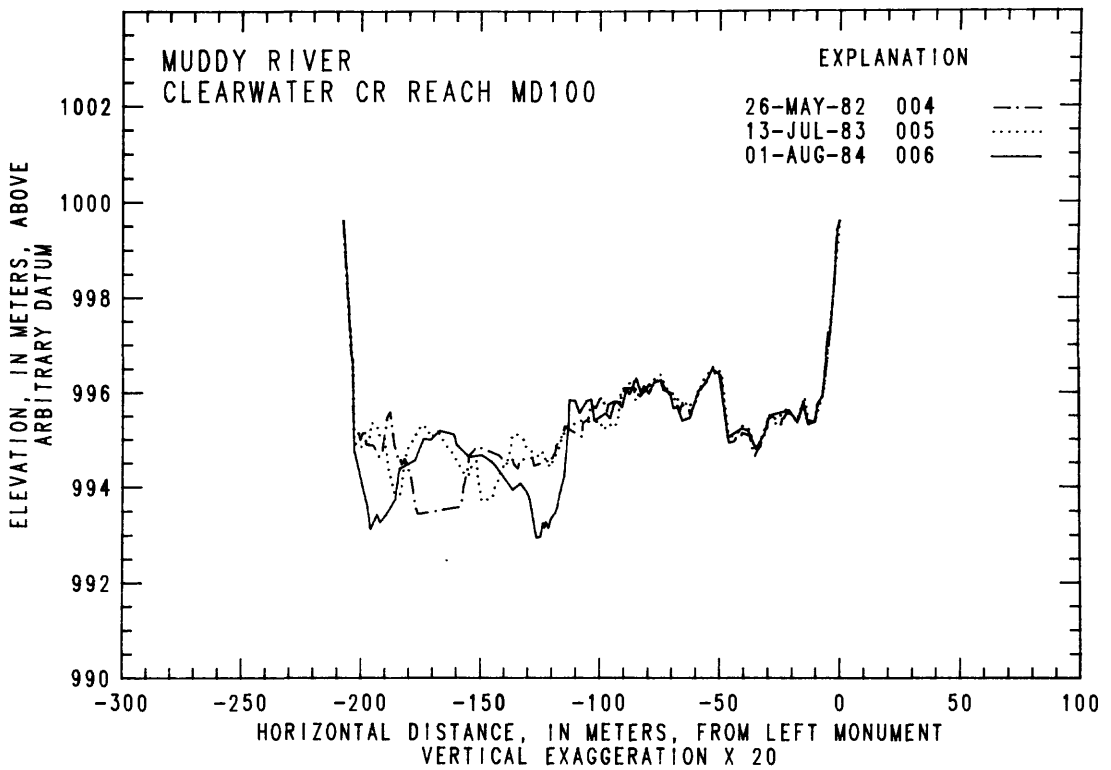


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

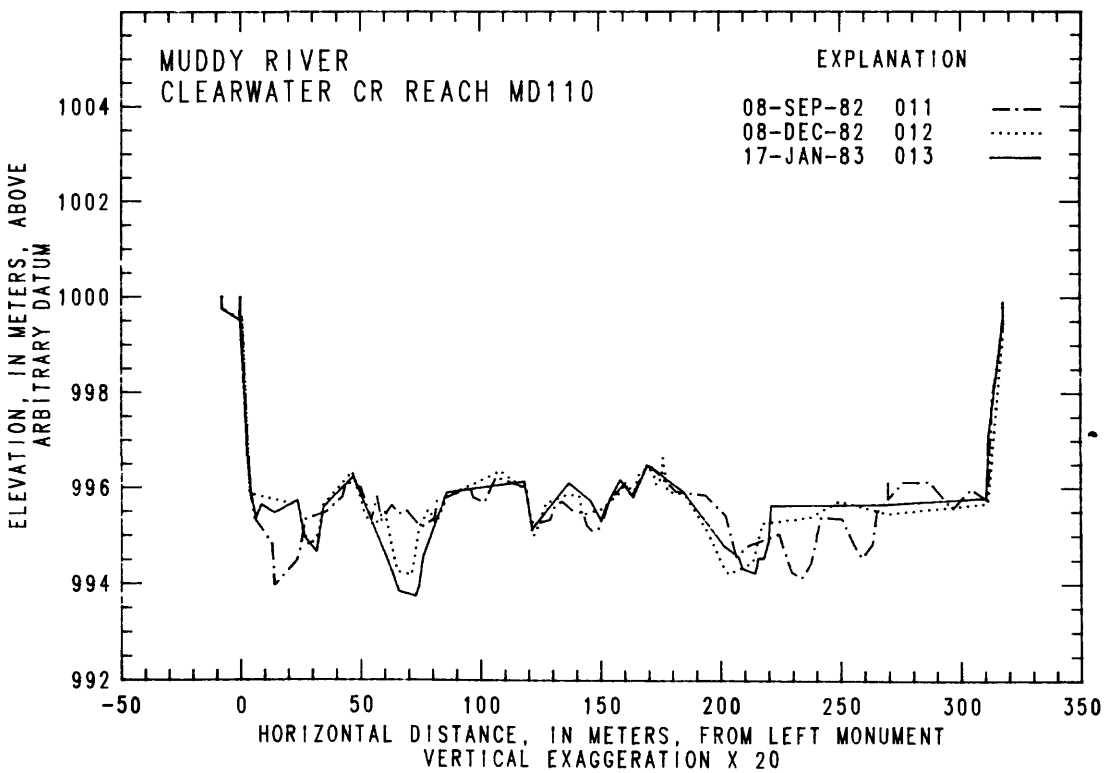


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

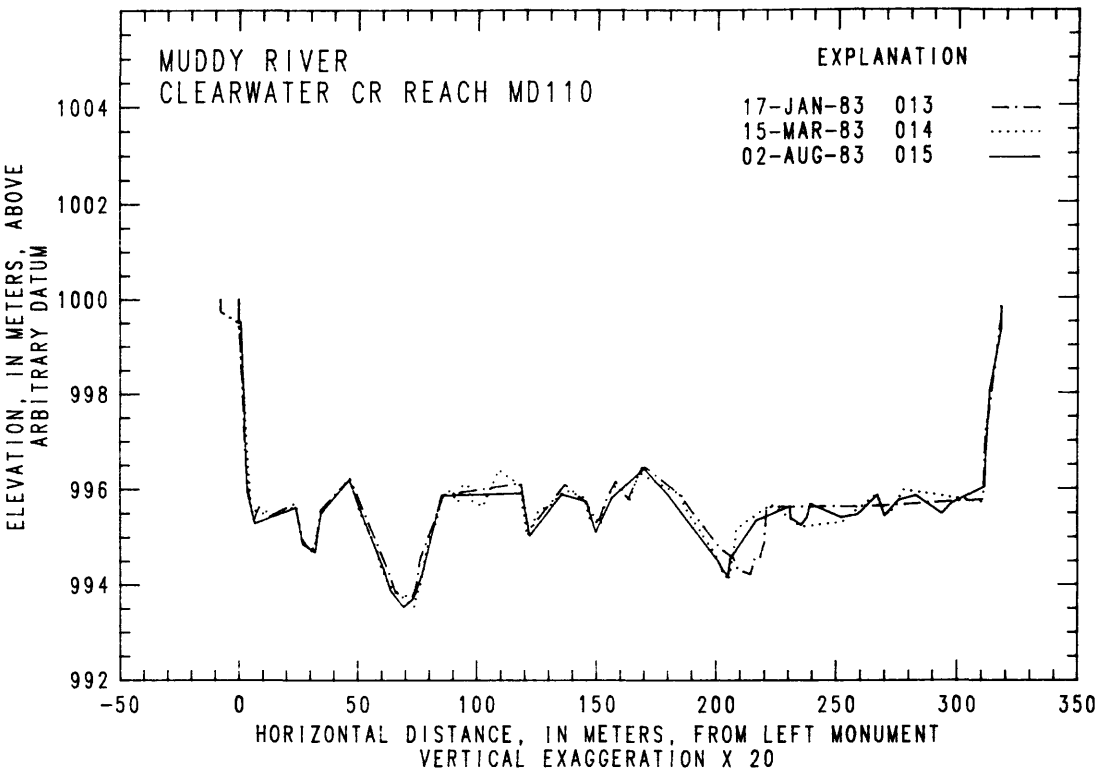


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

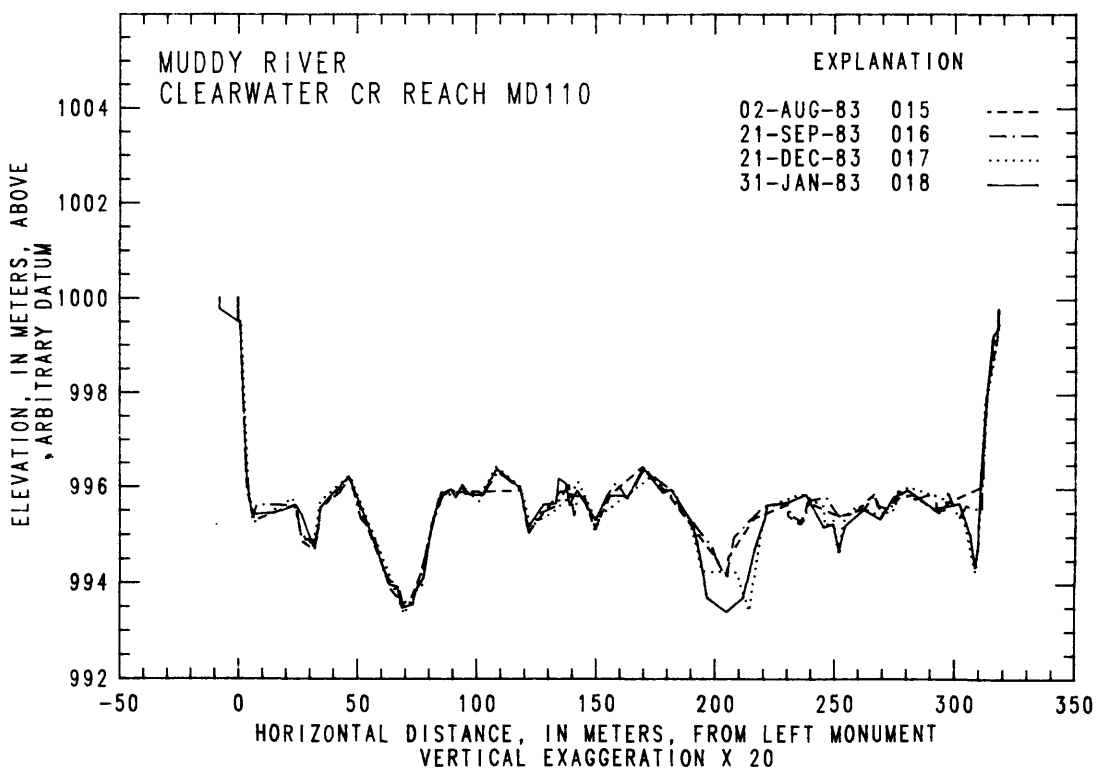


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

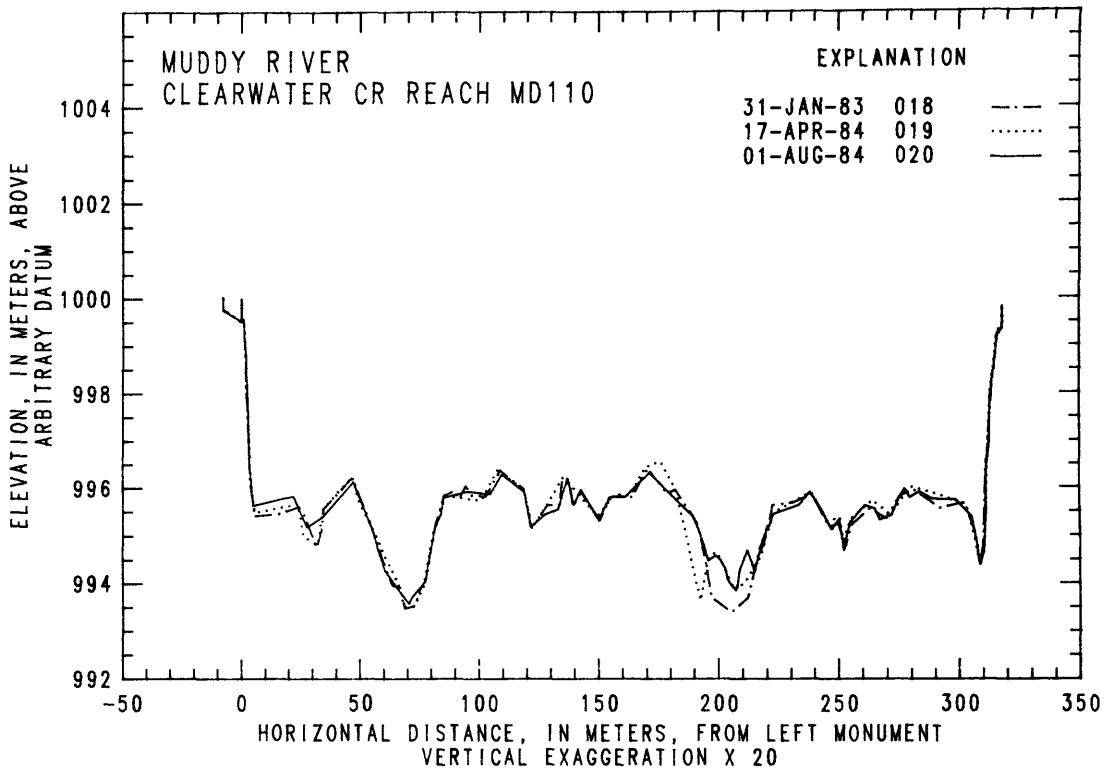


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

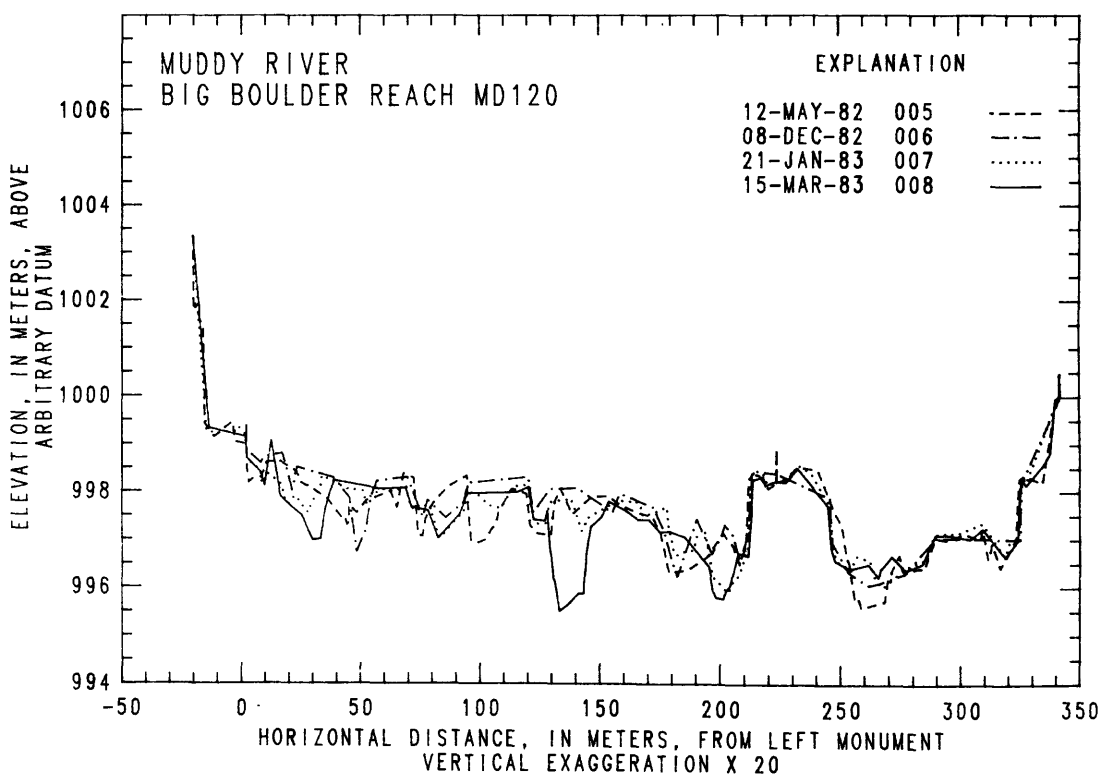


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

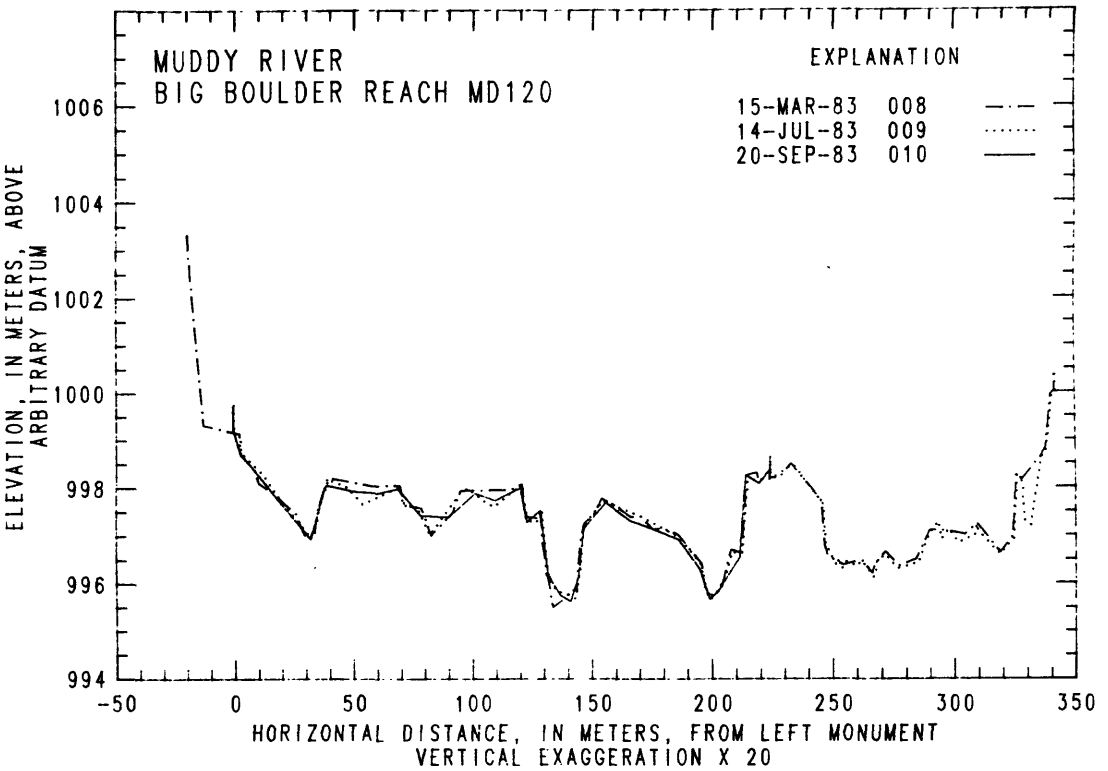


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

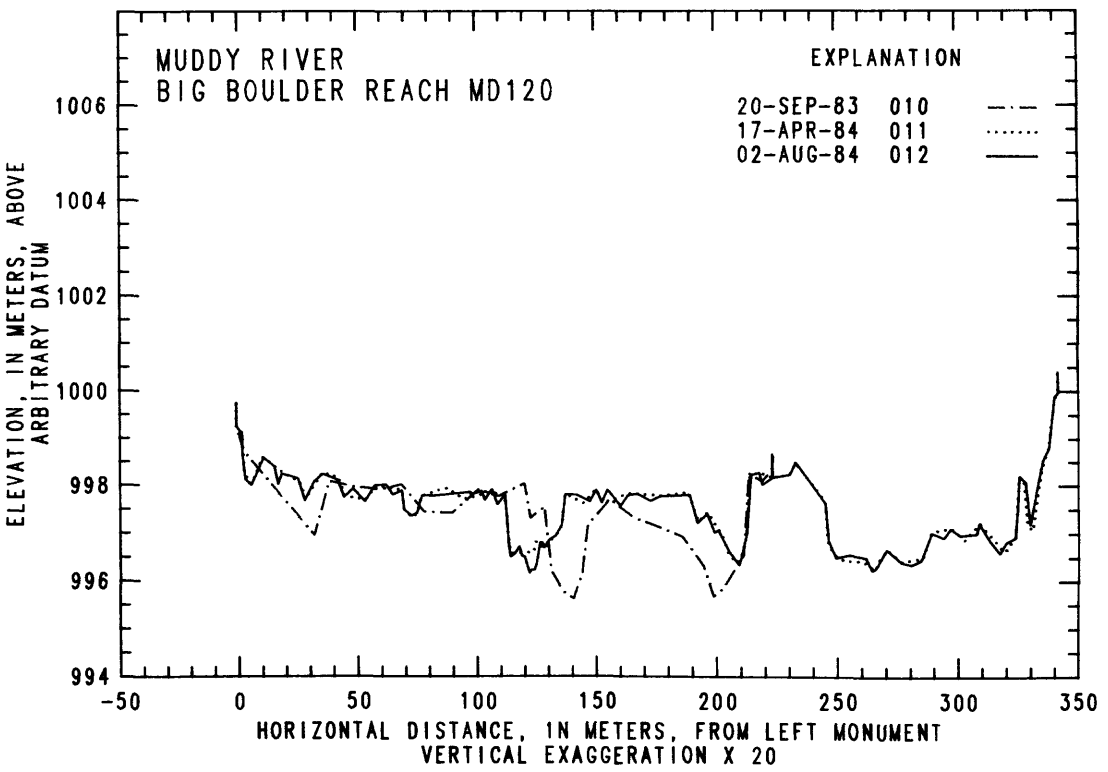


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

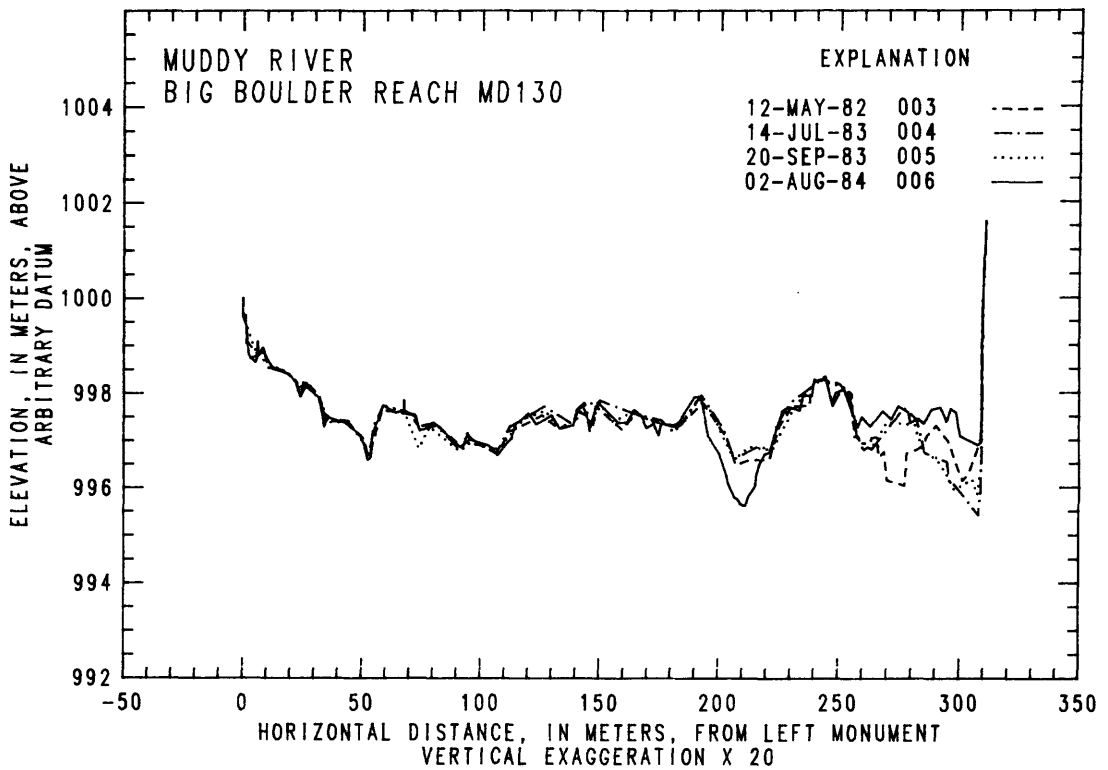


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

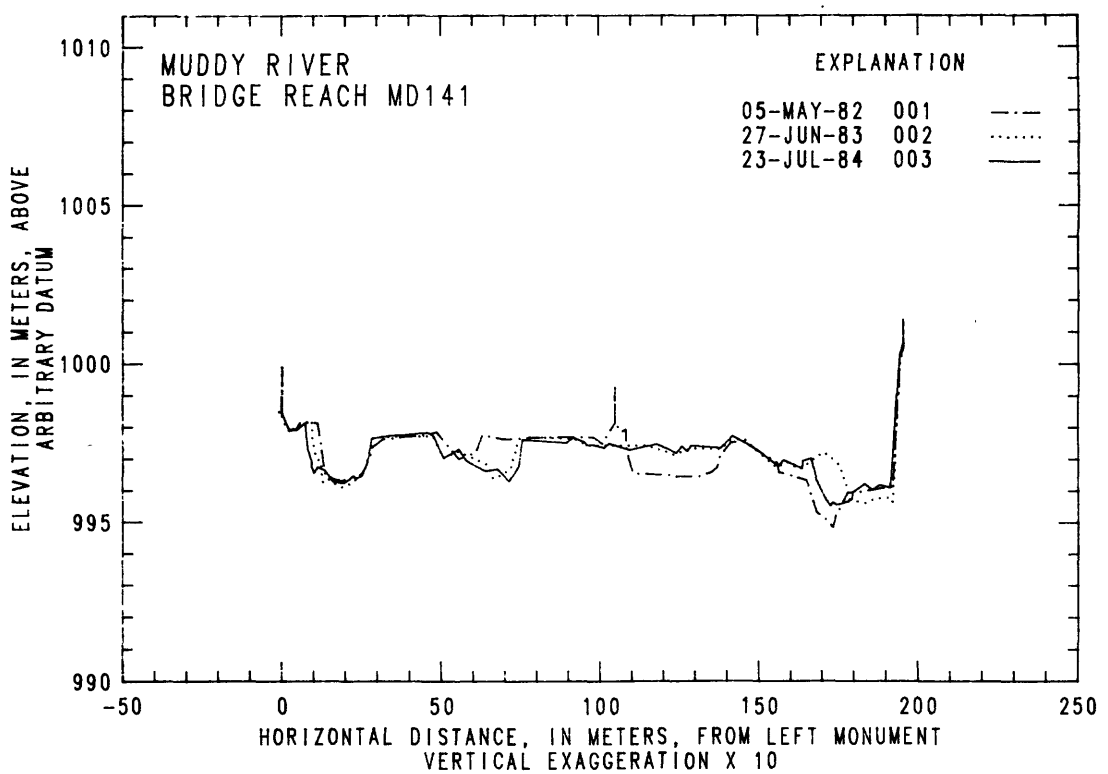


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

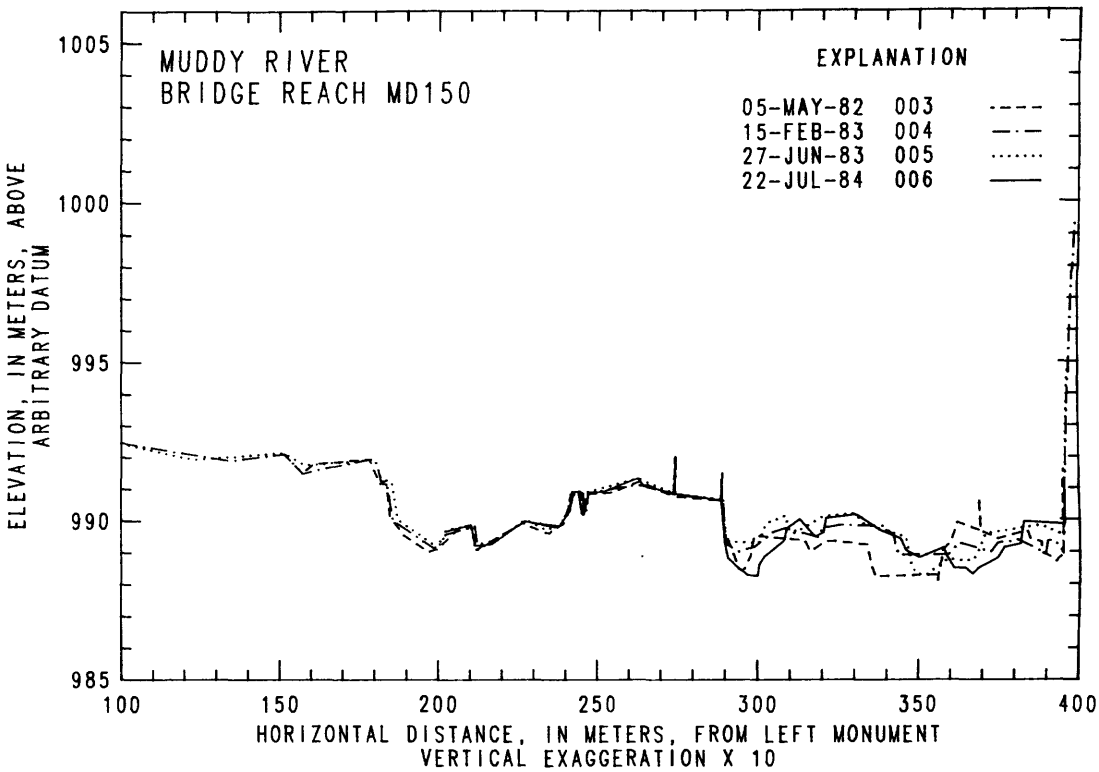


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

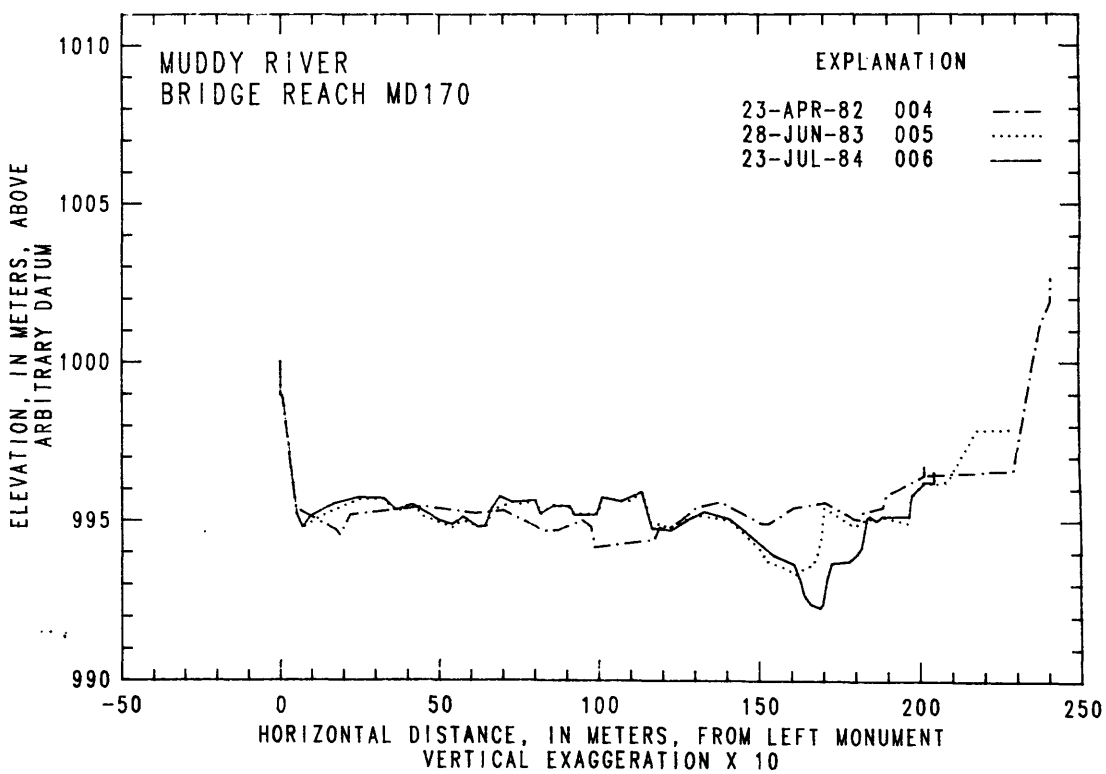


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

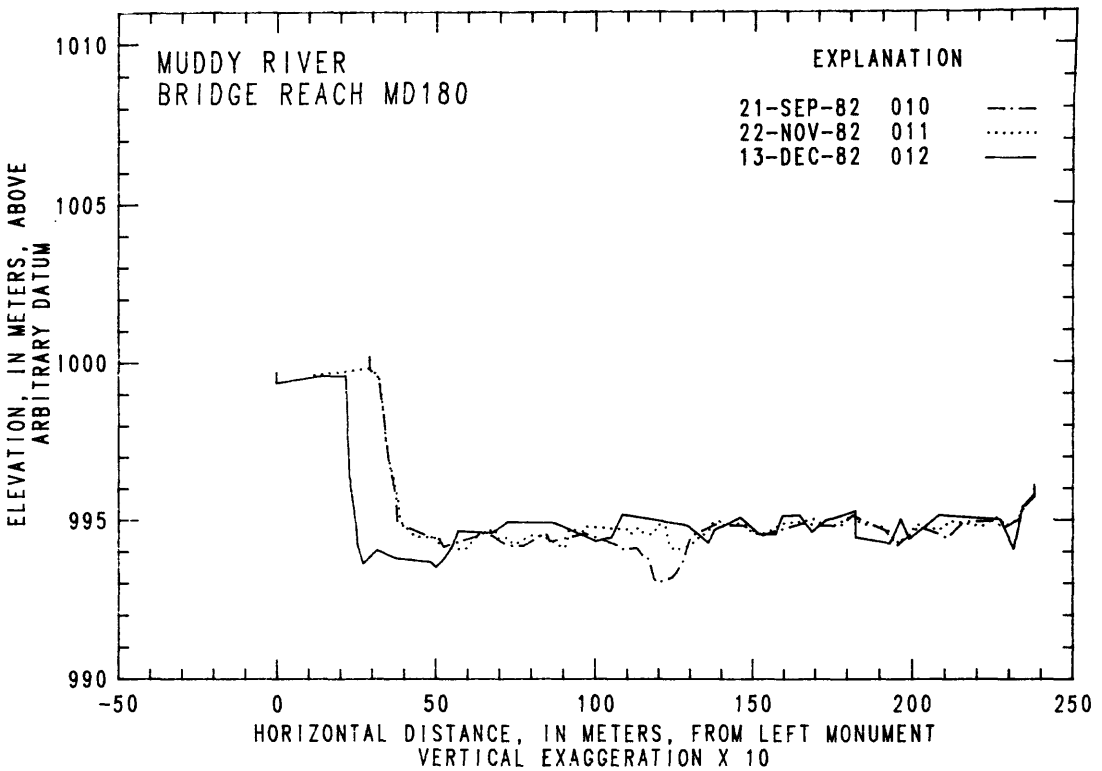


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

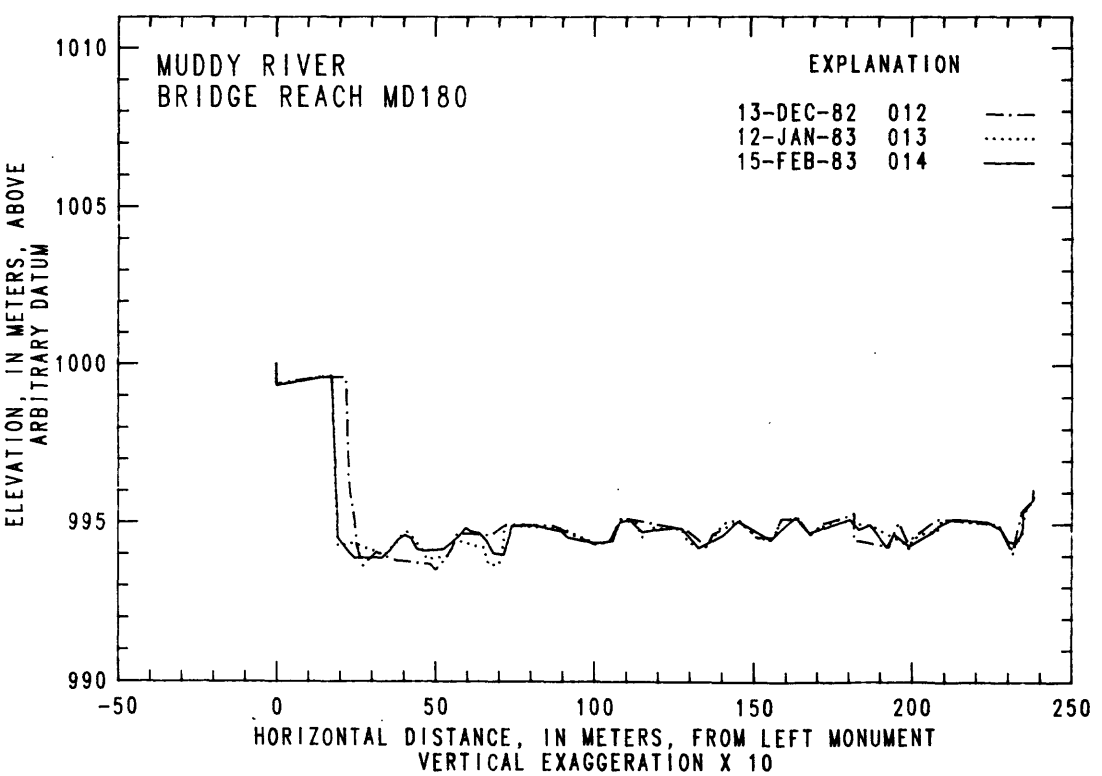


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

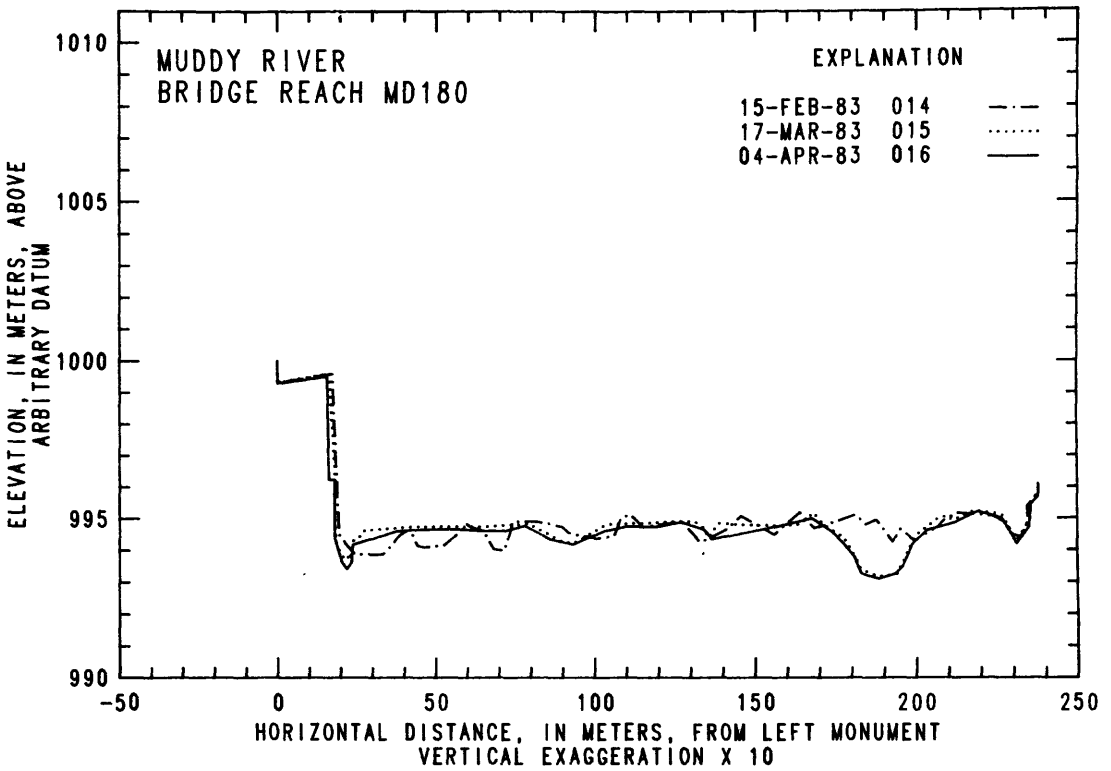


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

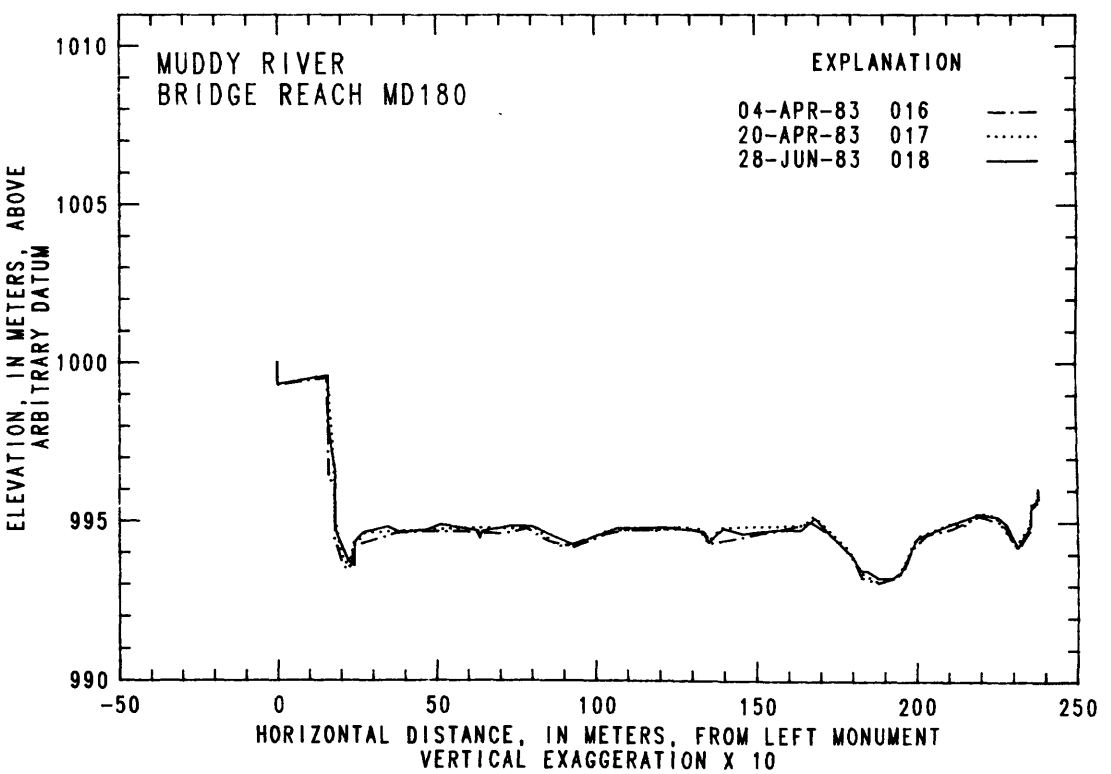


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

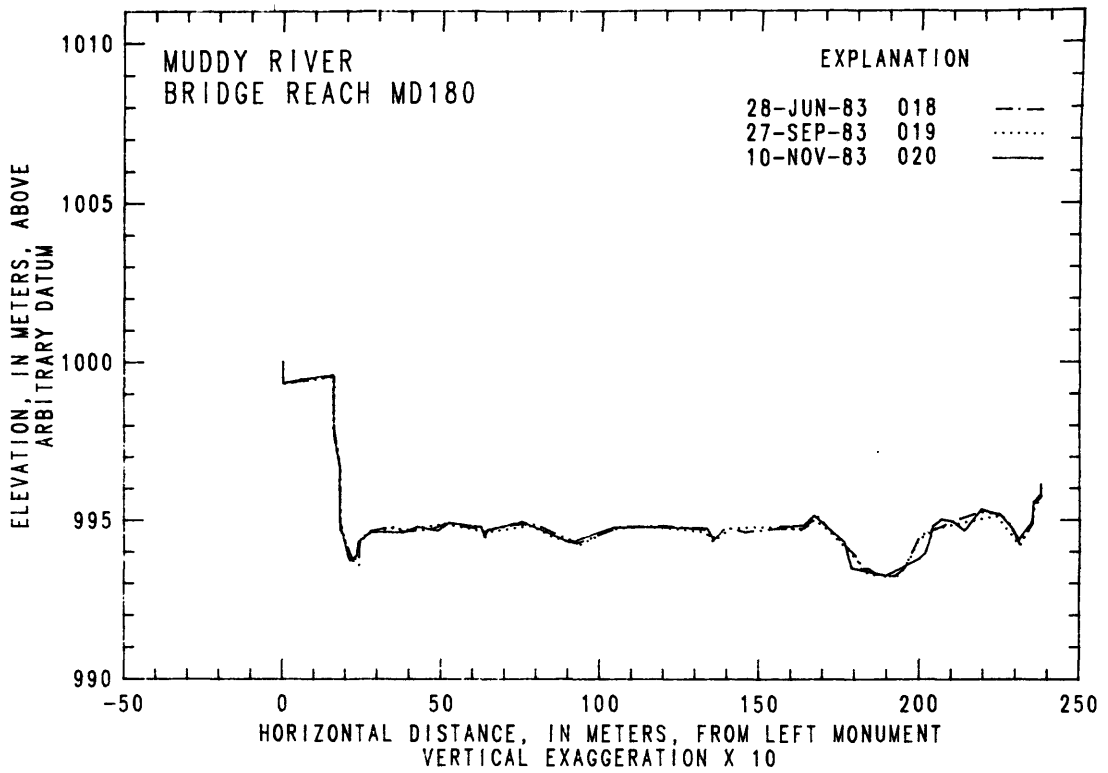


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

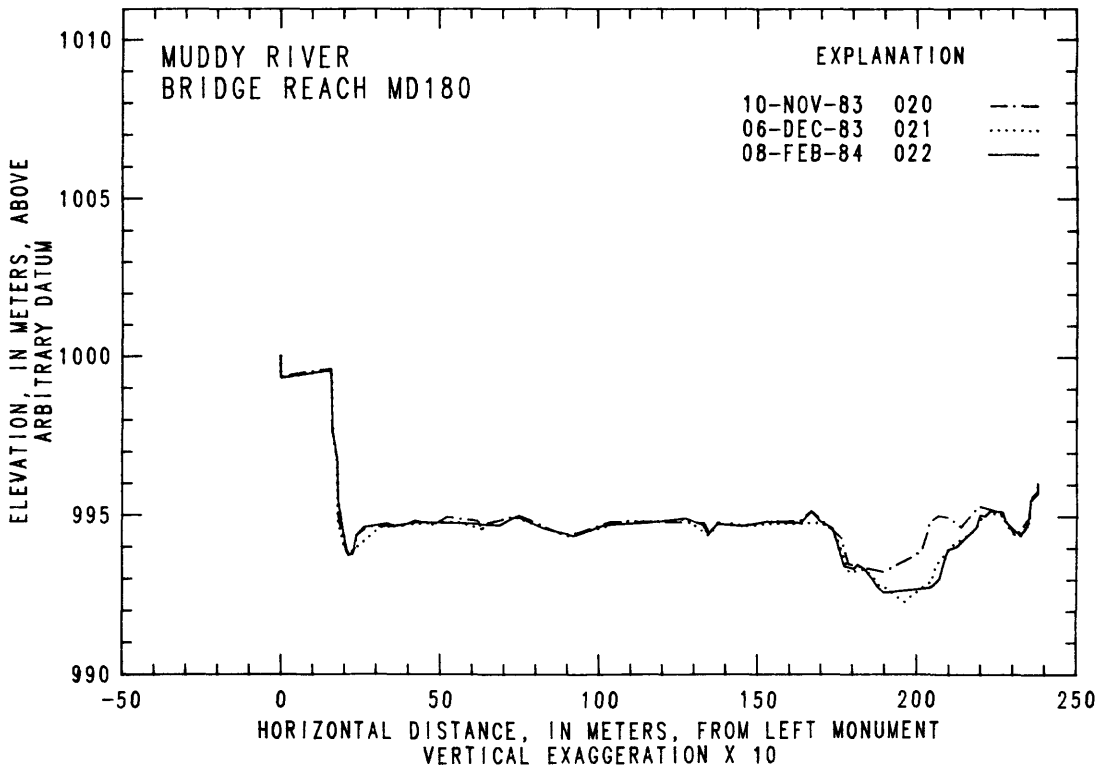


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

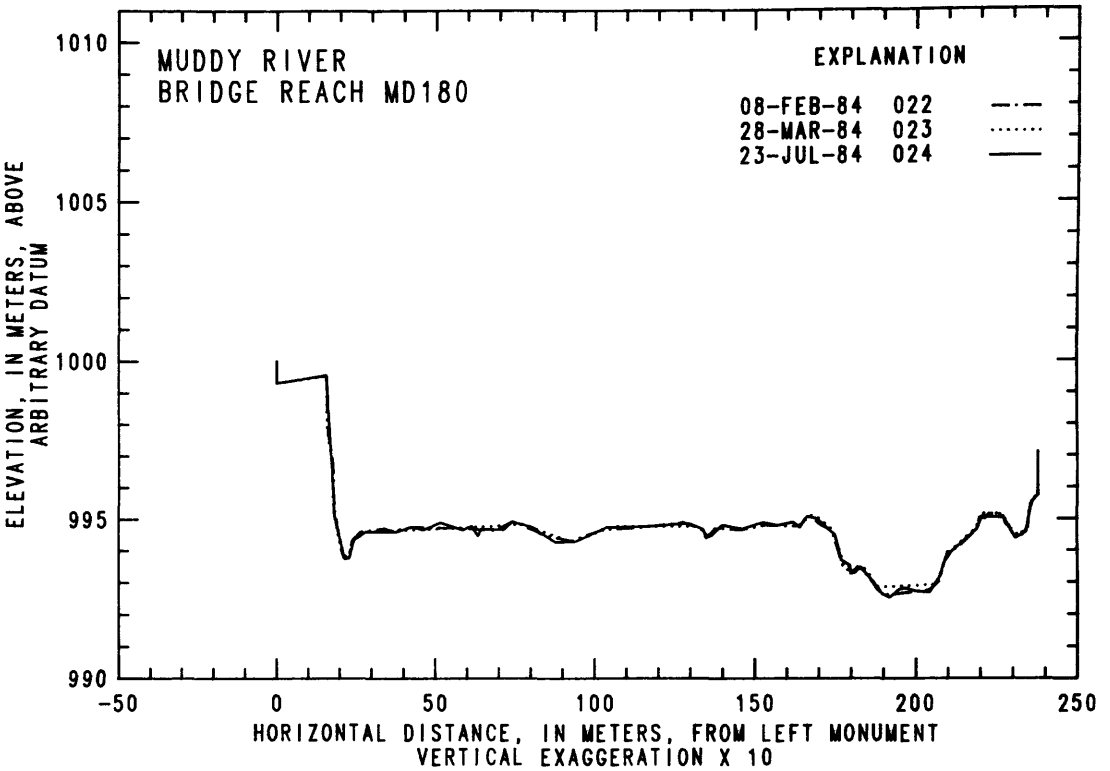


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

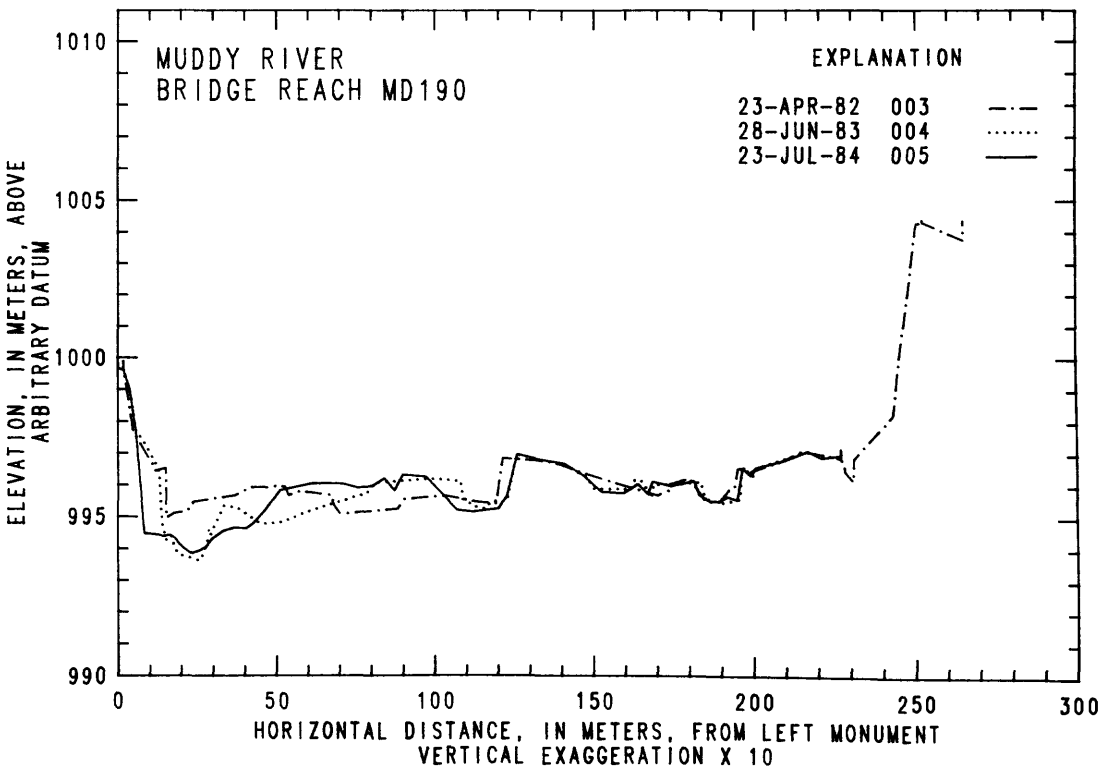


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

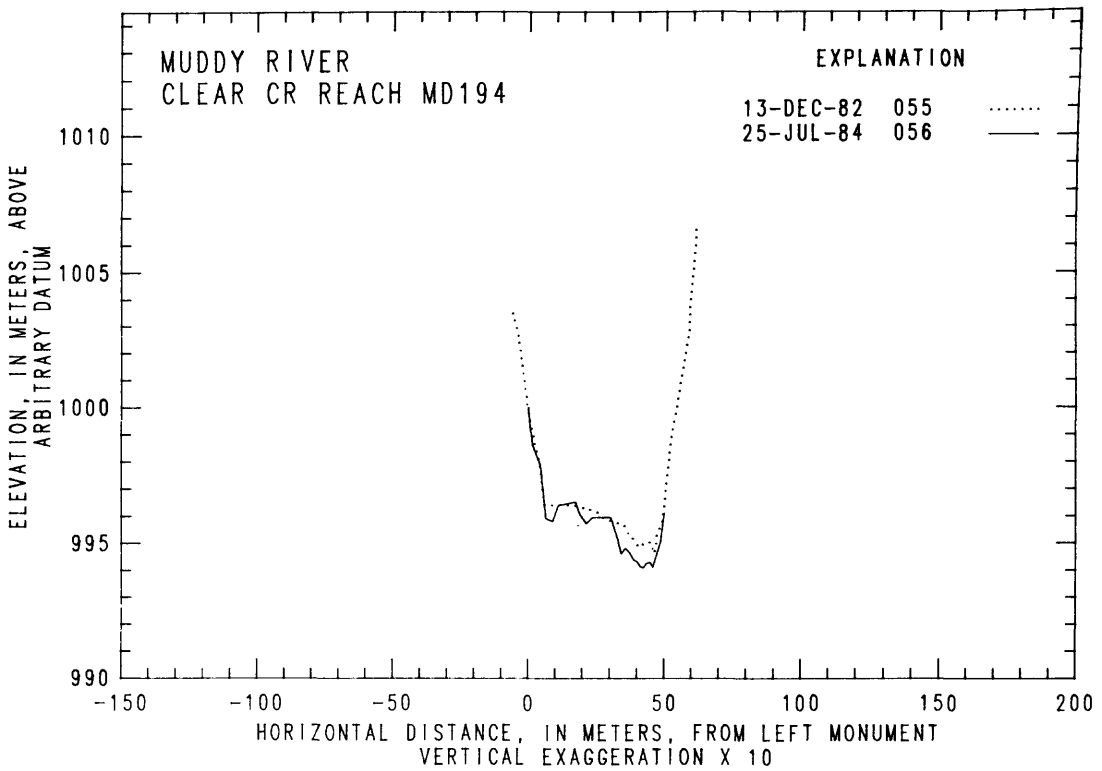


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

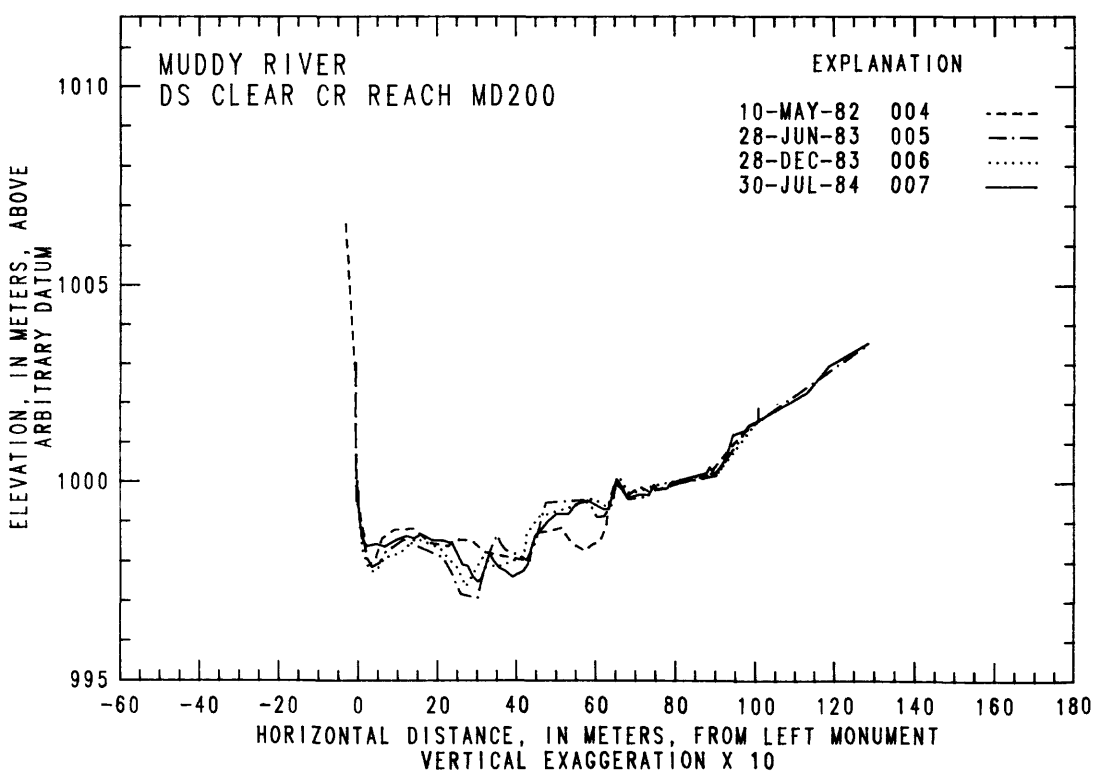


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

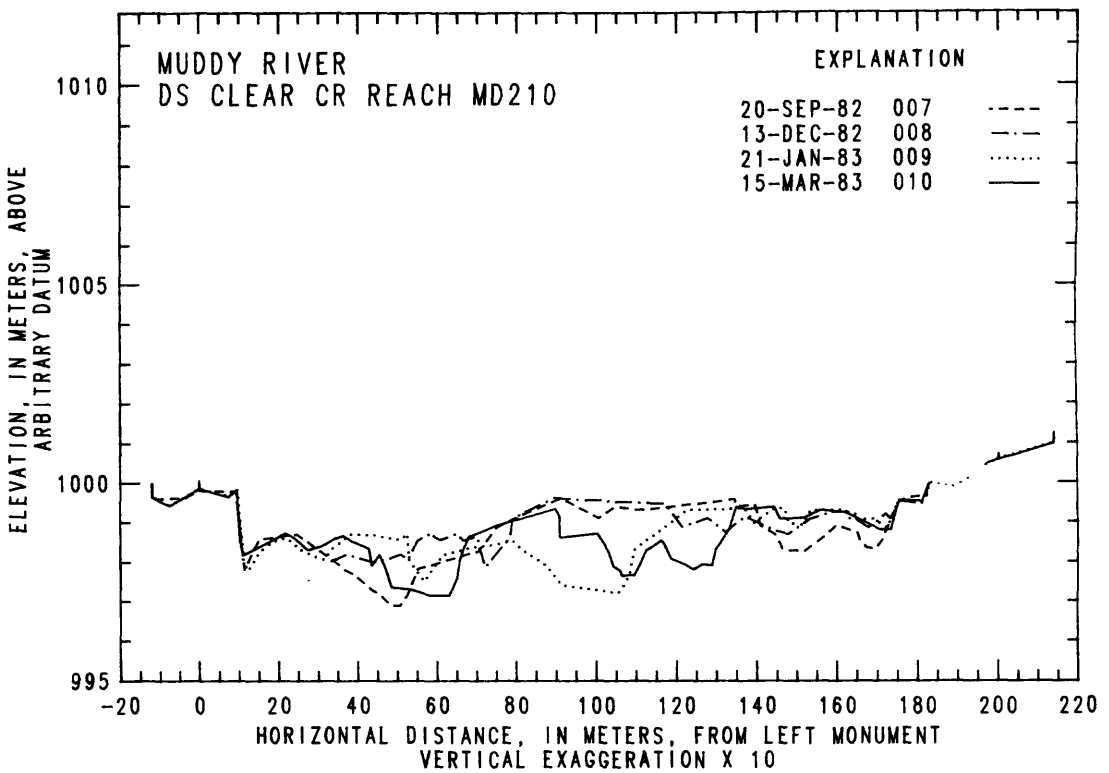


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

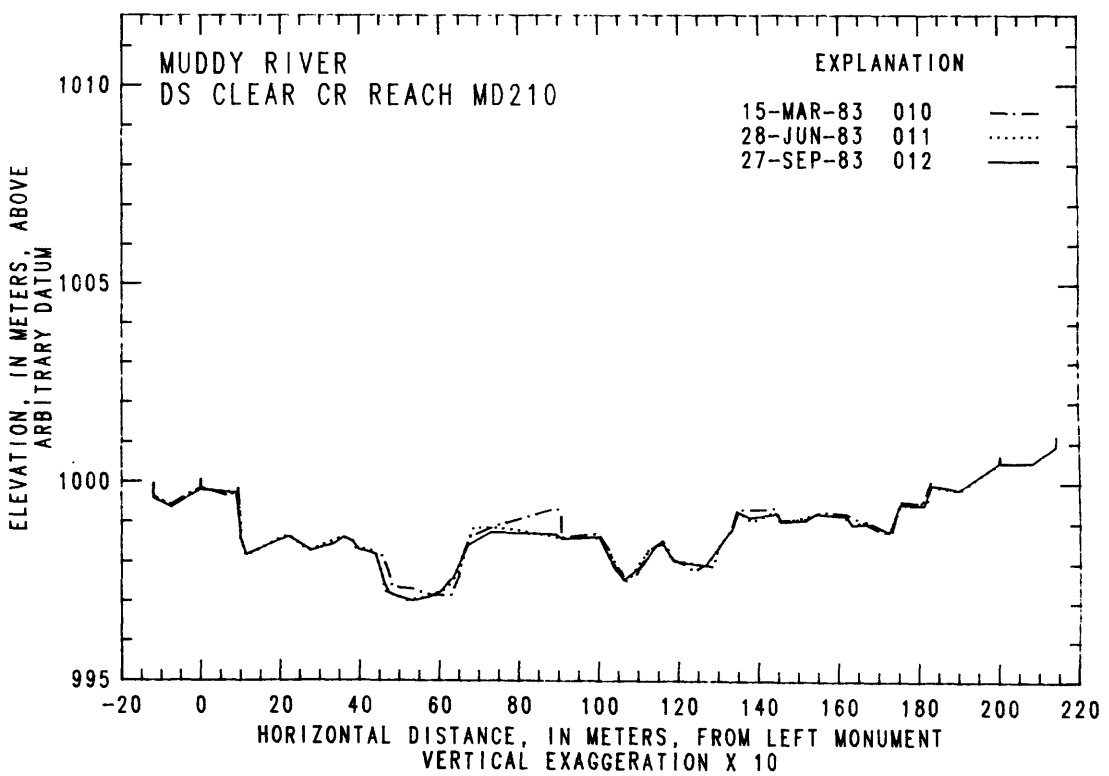


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

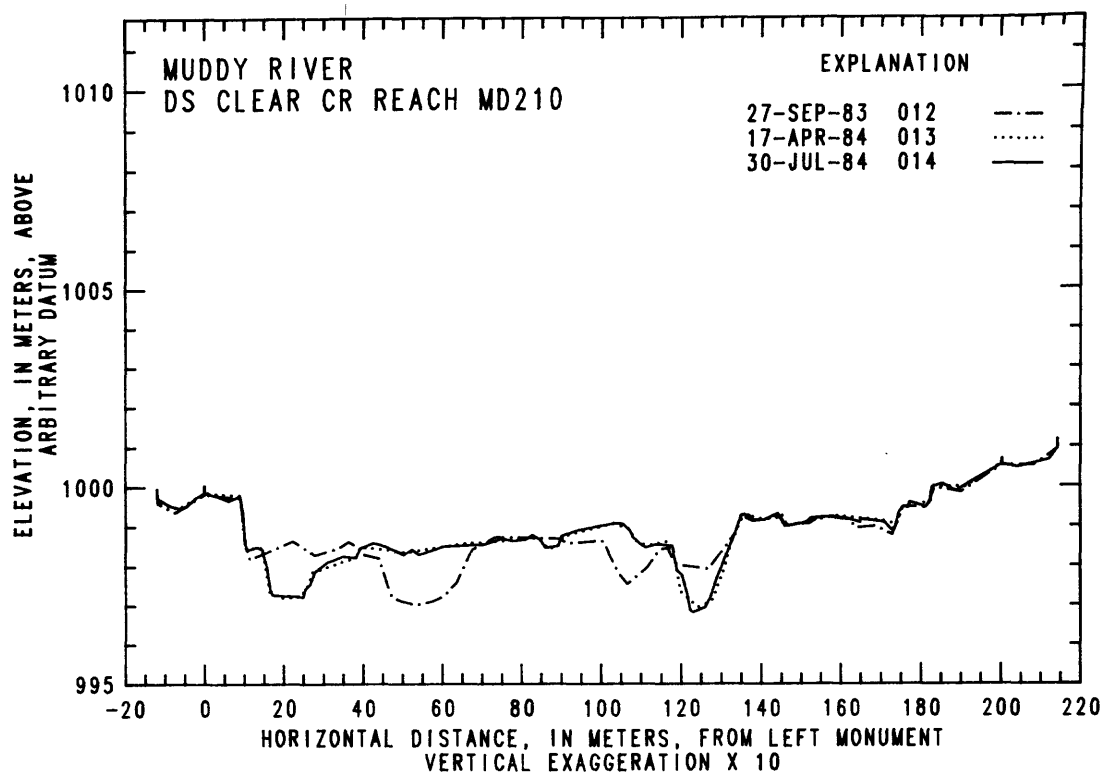


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

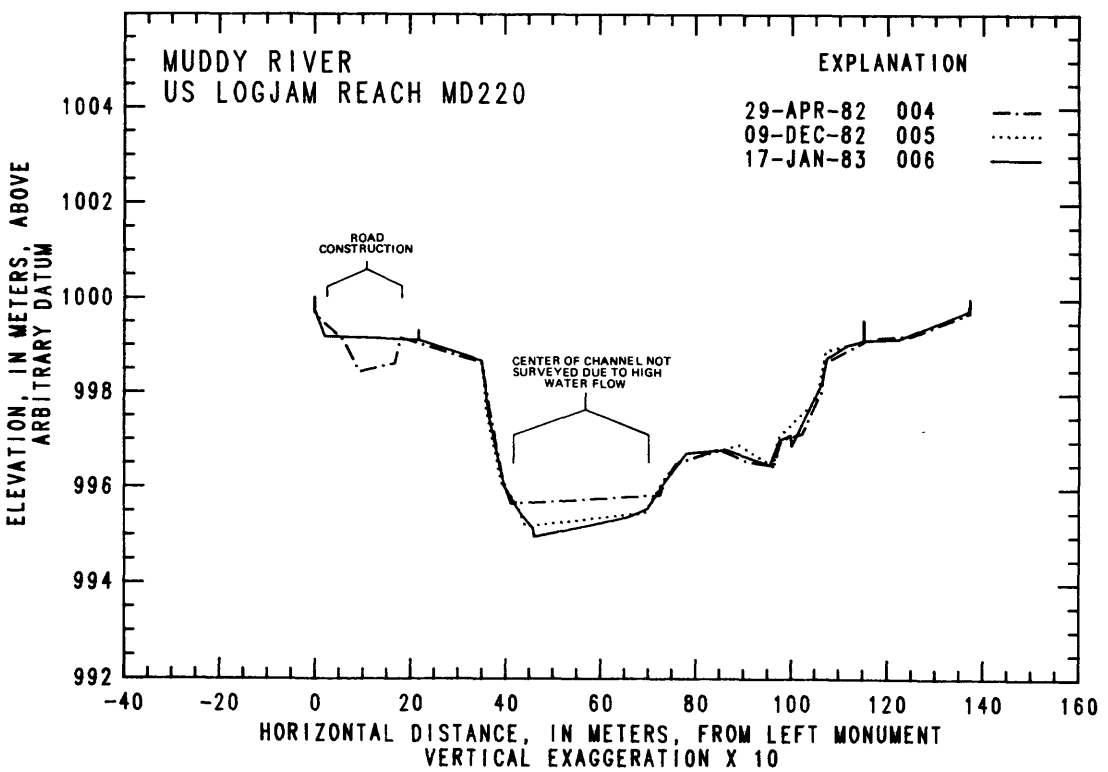


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

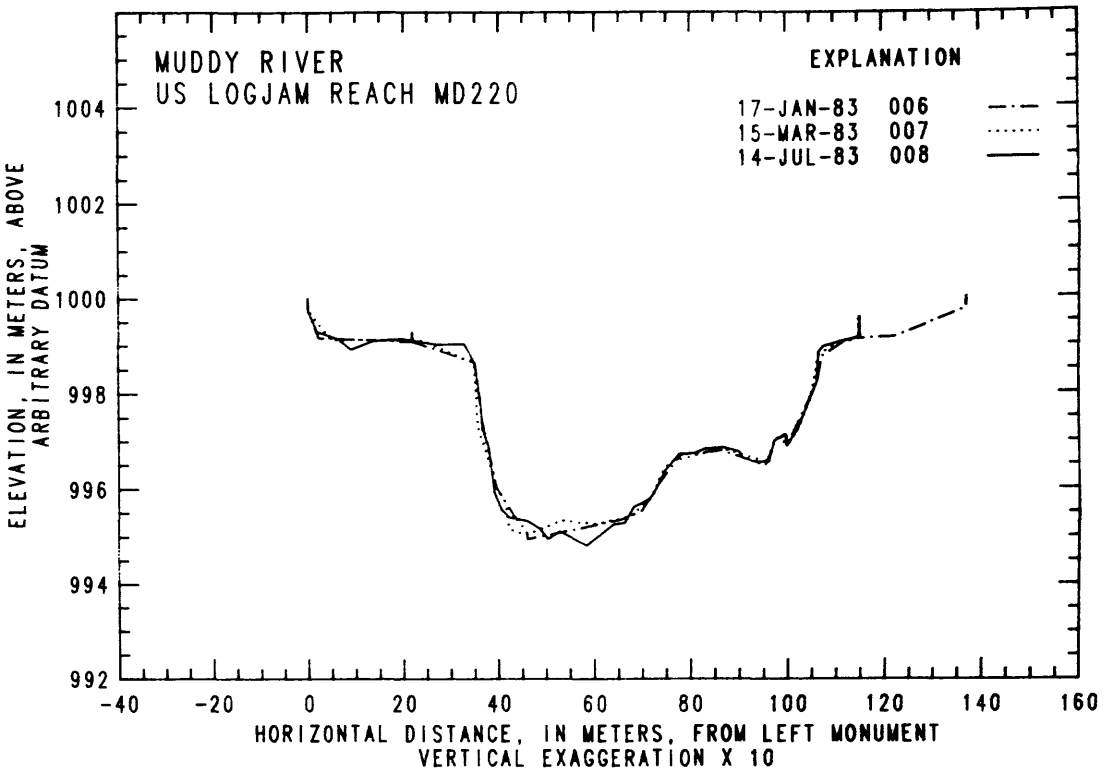


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

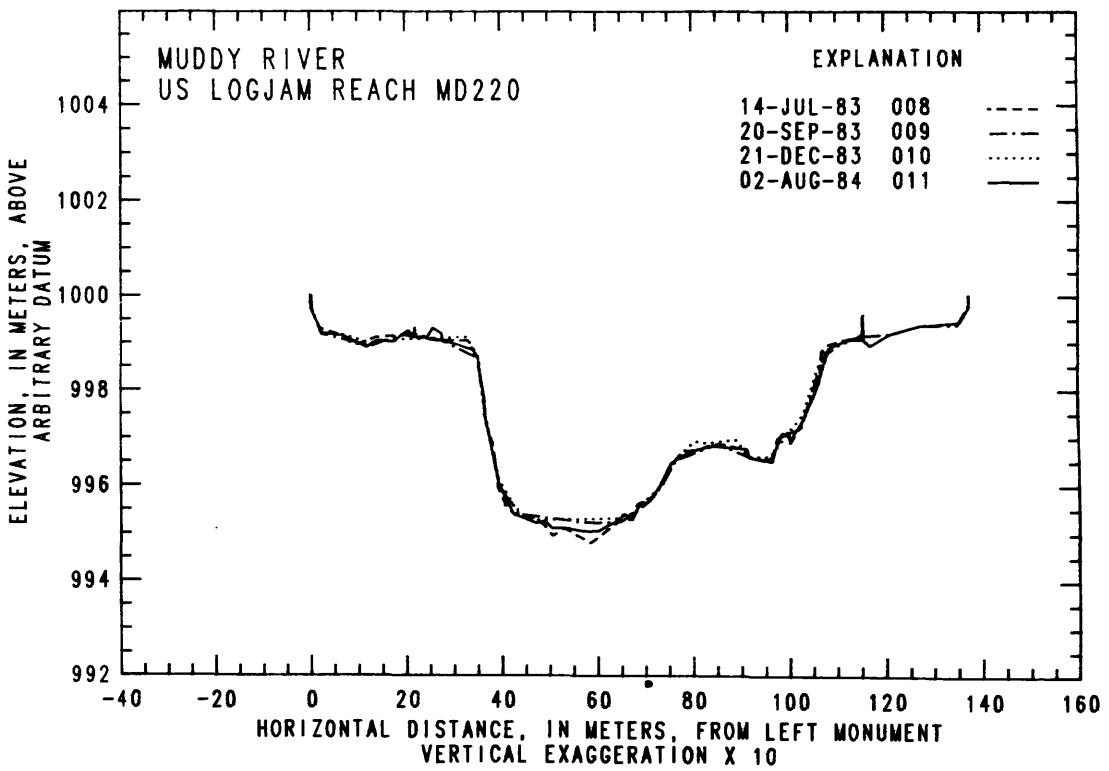


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

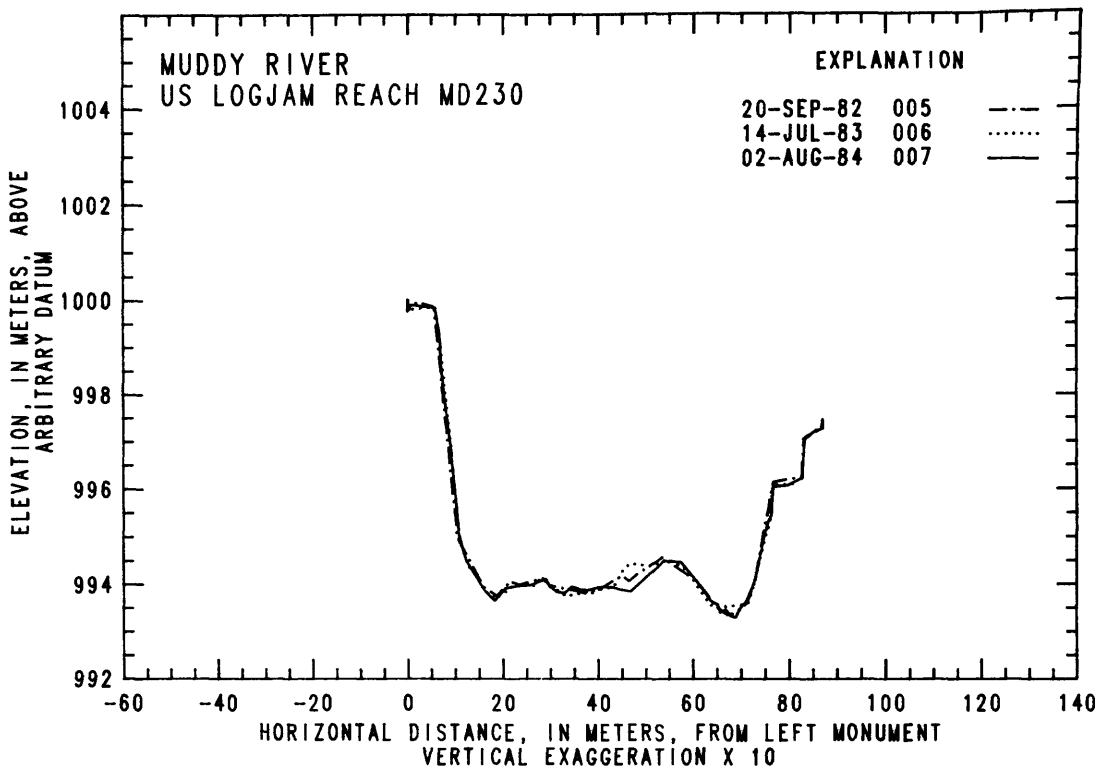


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

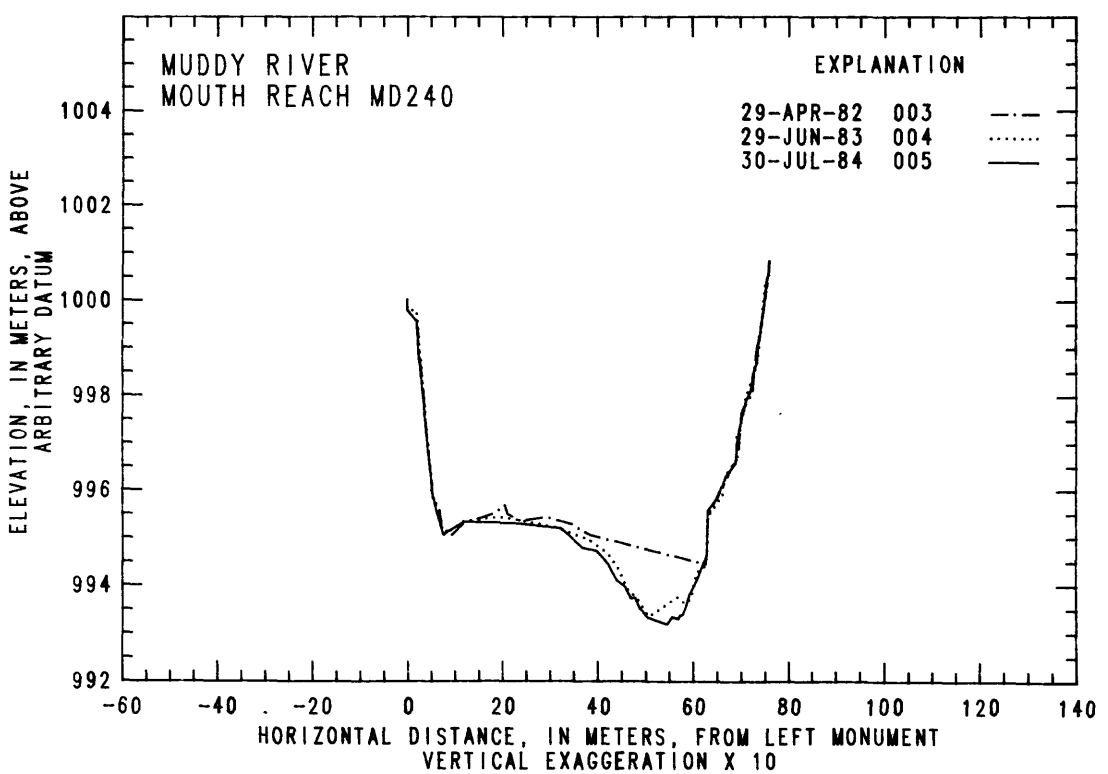


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

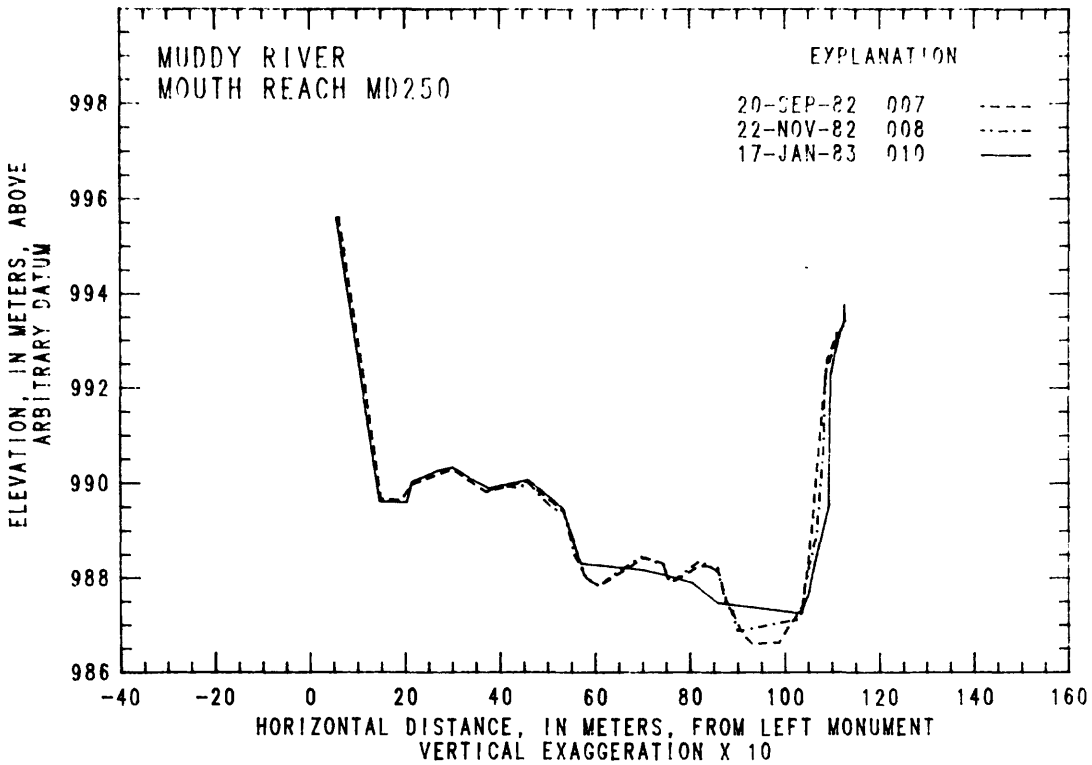


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

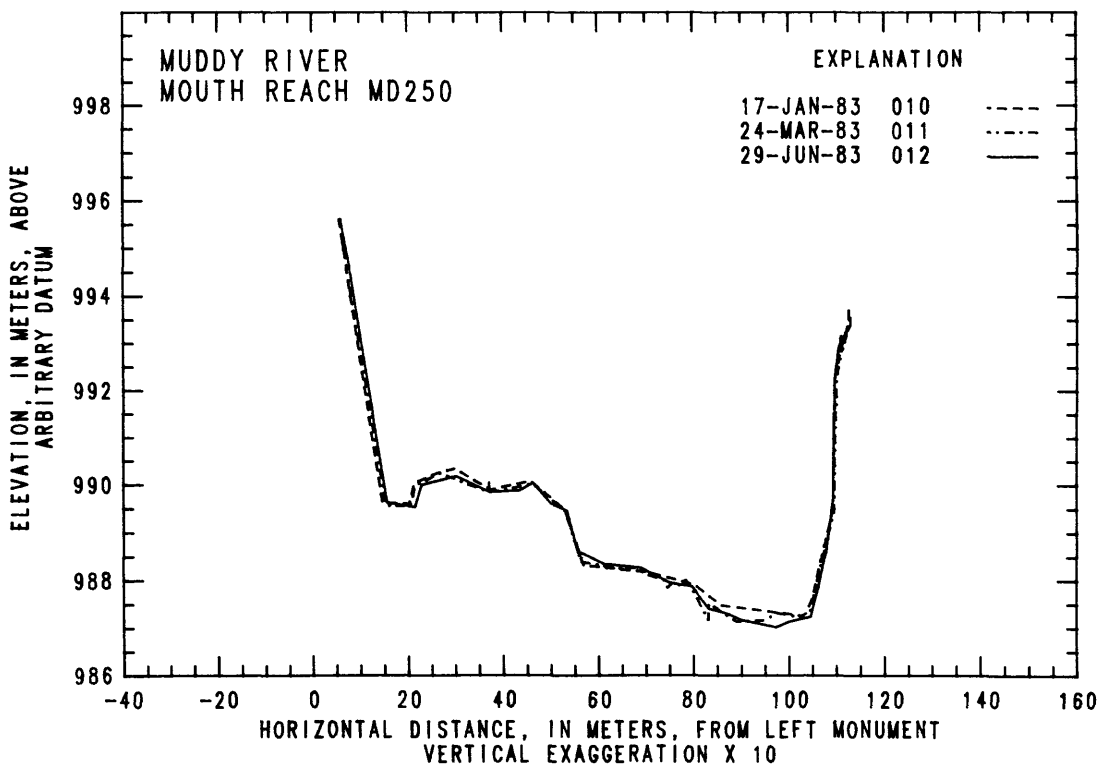


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

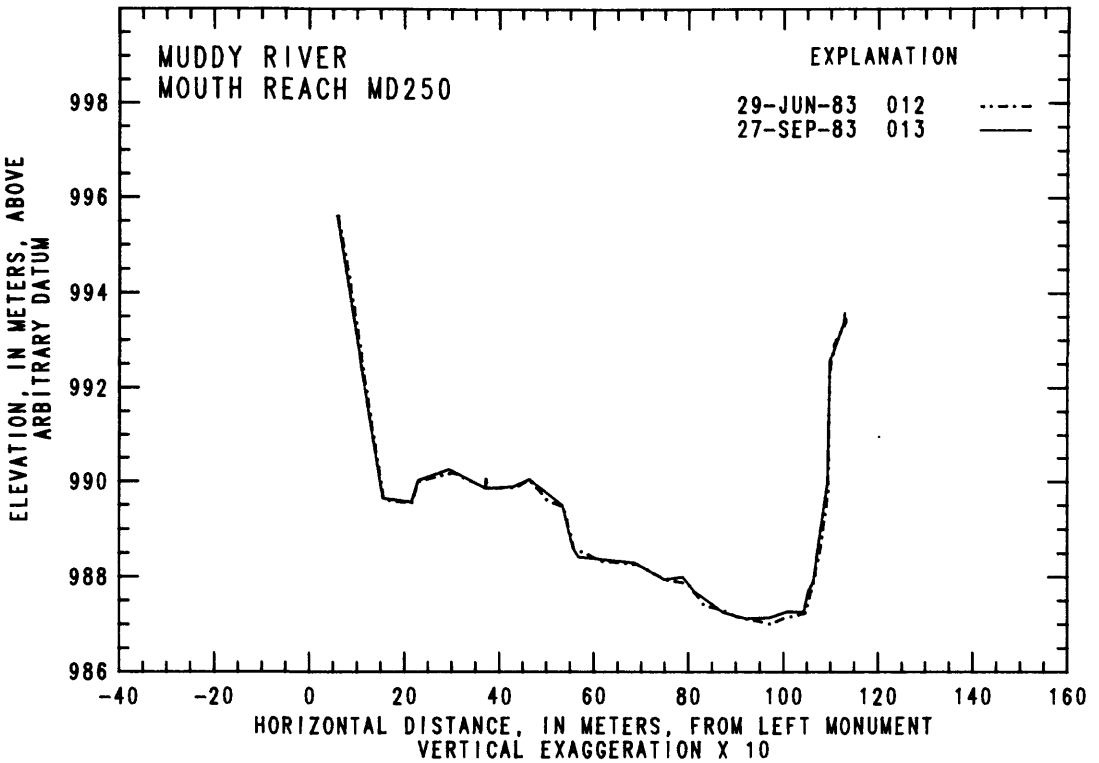
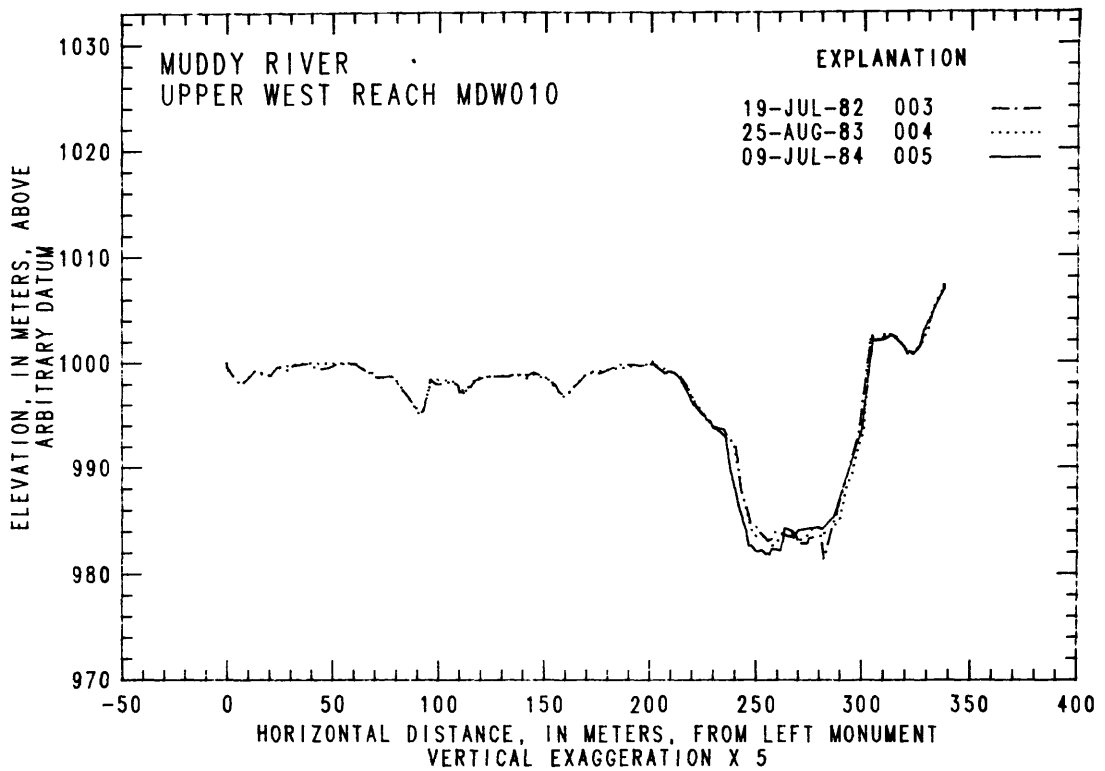


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



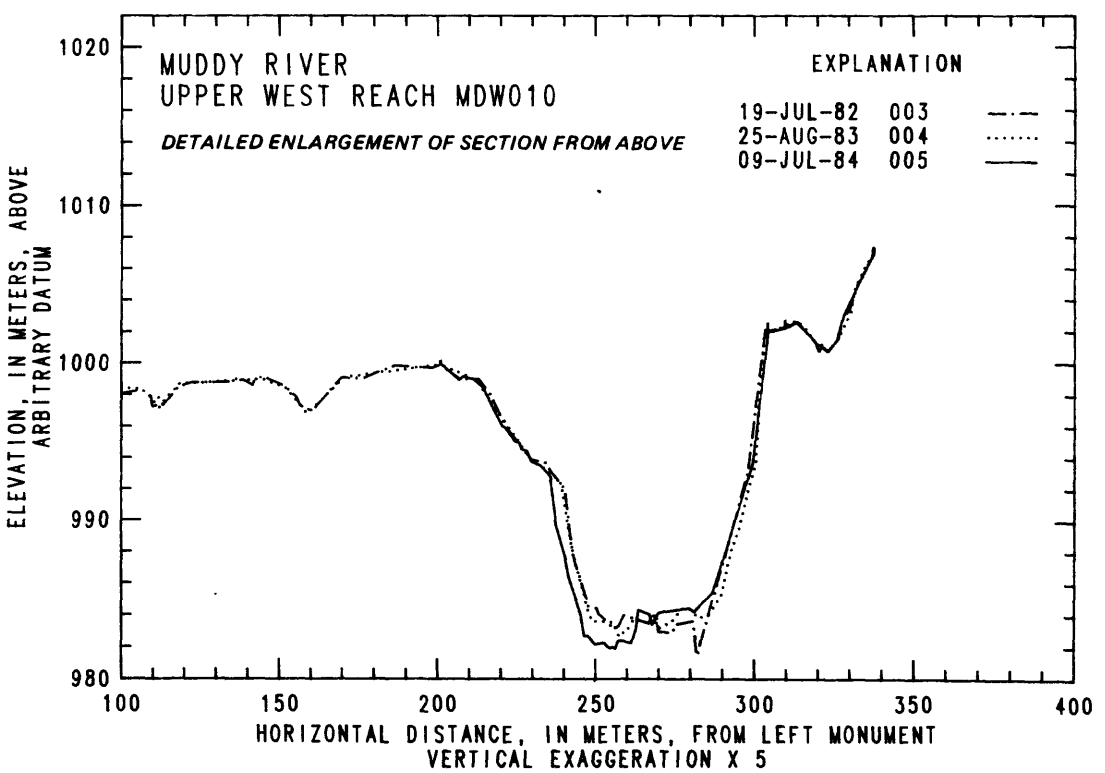
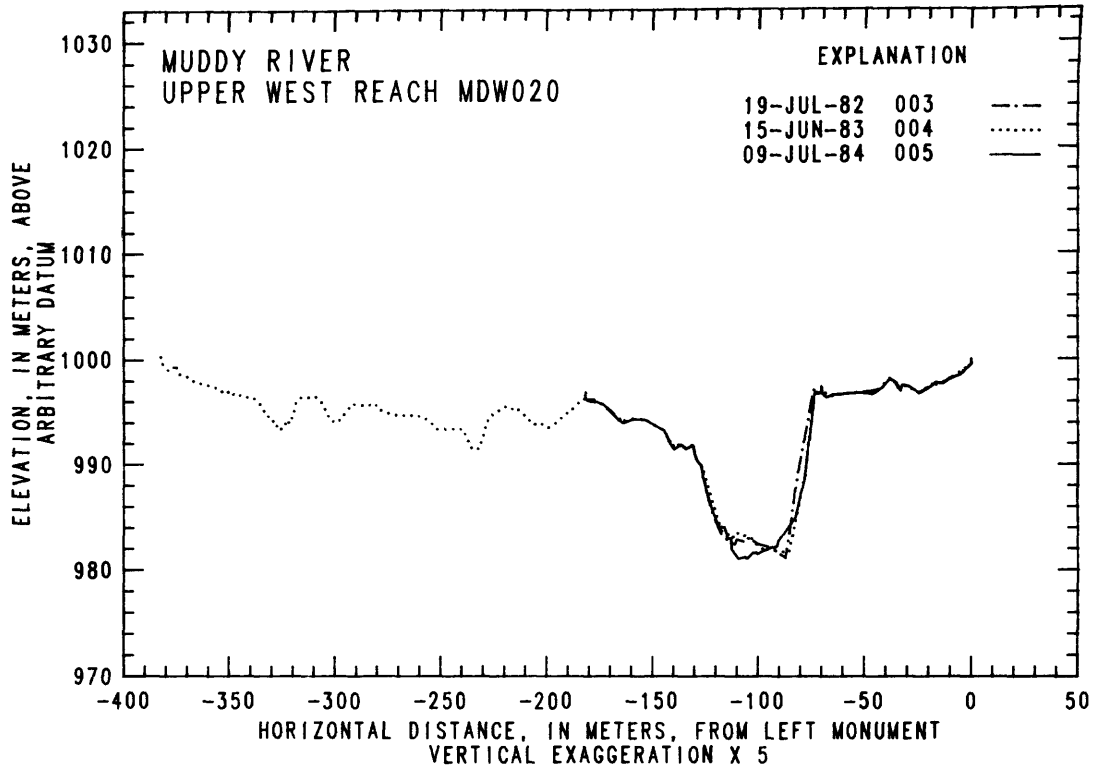


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



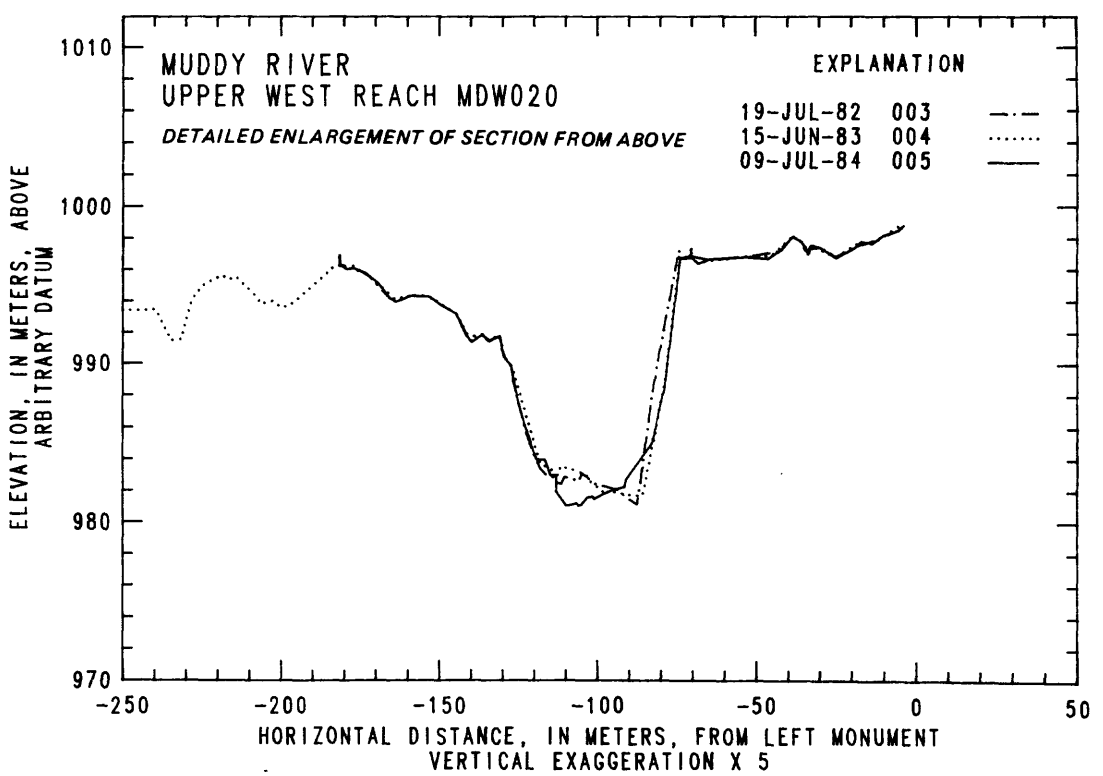
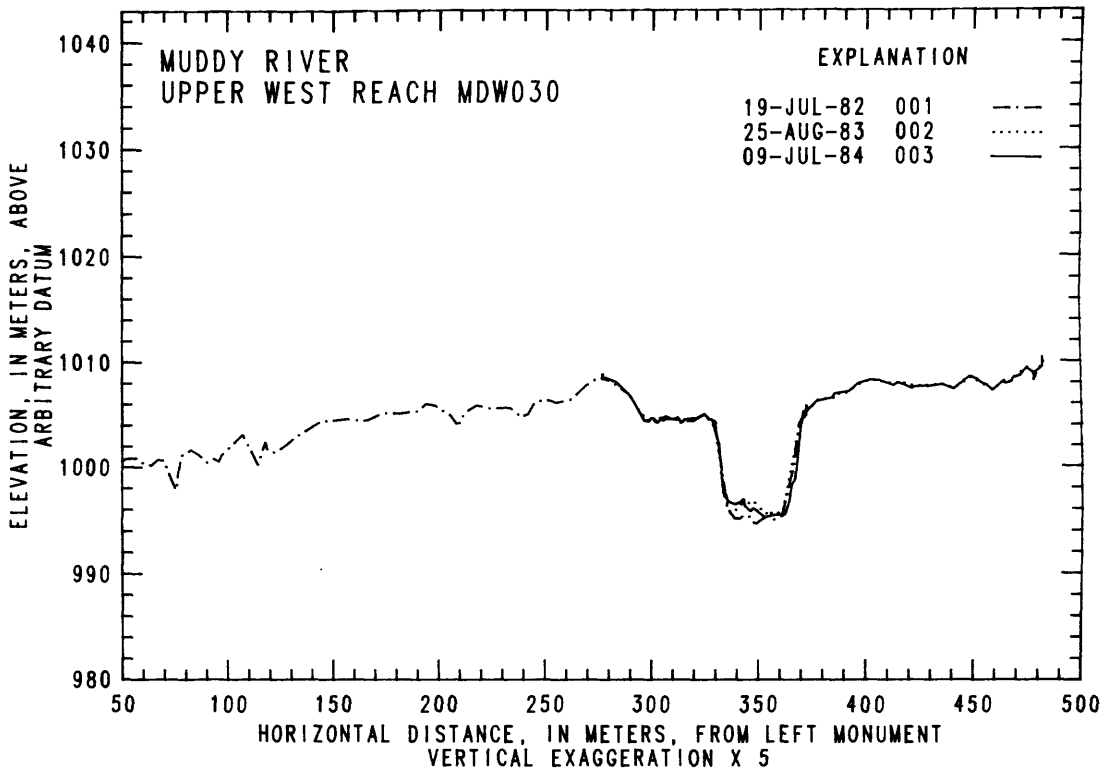


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.



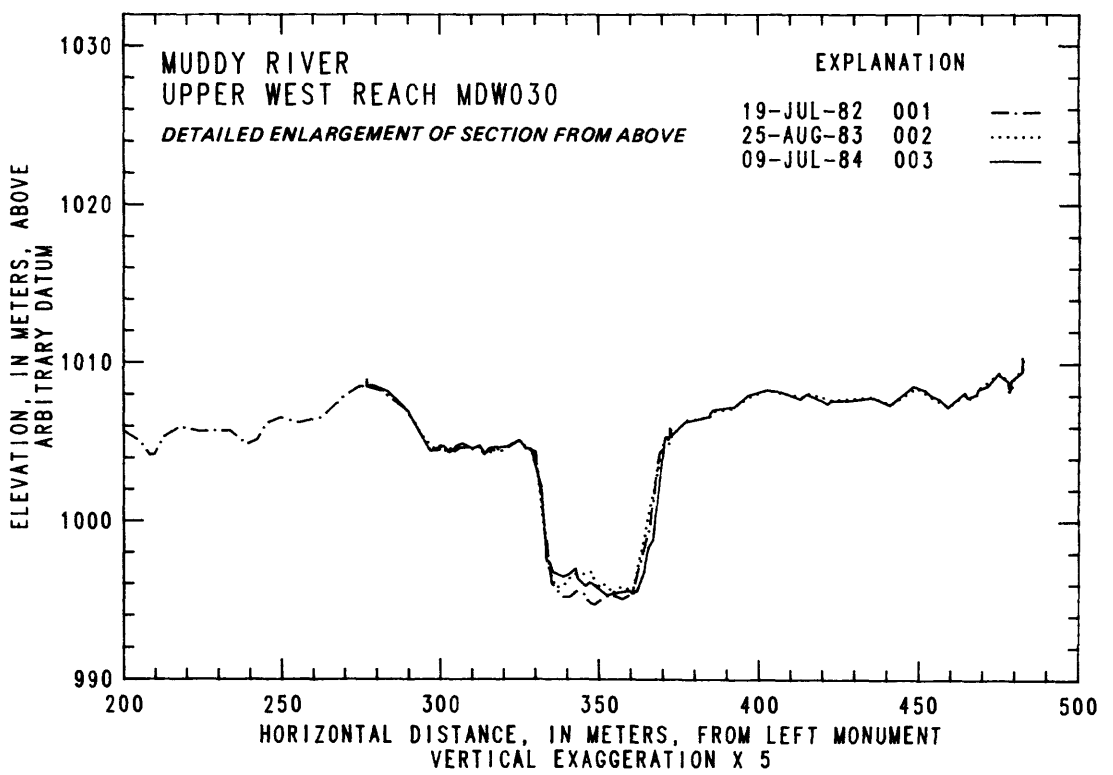


FIGURE 9. – Cross-section profiles for selected sites, Muddy River – continued.

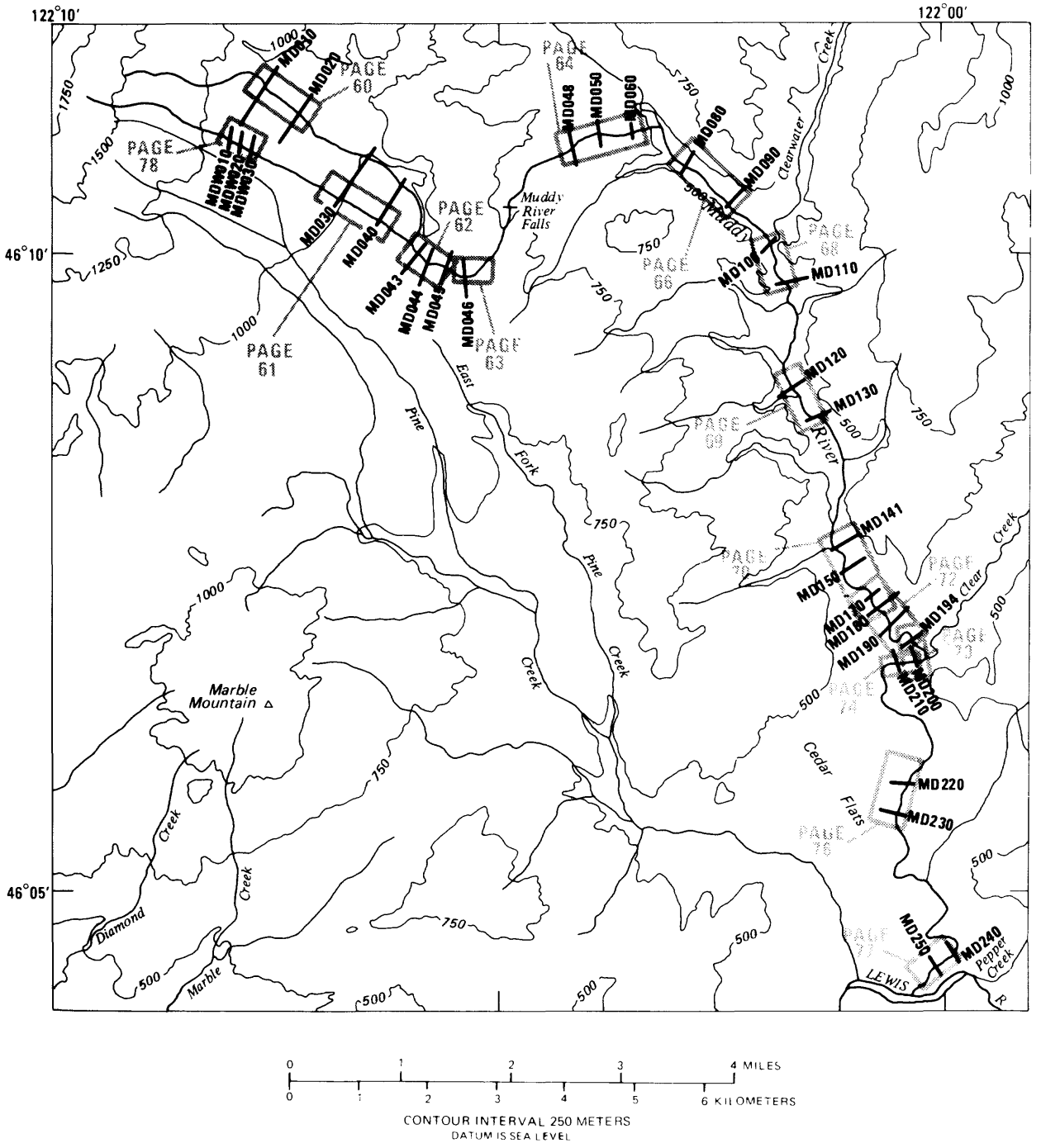
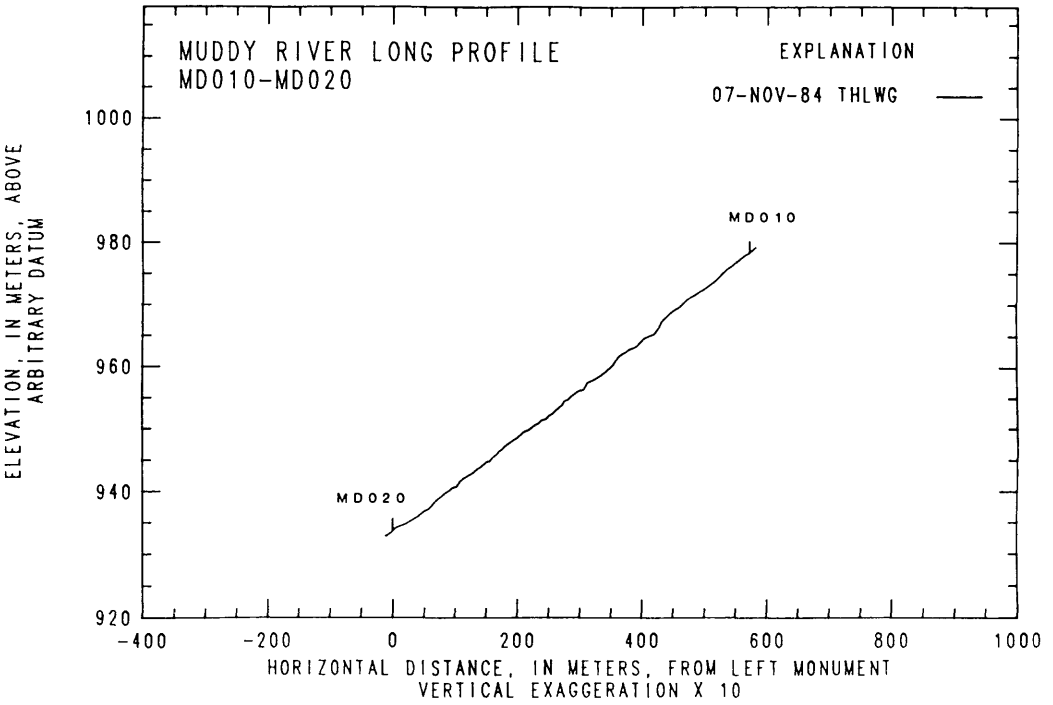


FIGURE 10. – Locations of surveyed longitudinal profiles and corresponding map views, Muddy River.



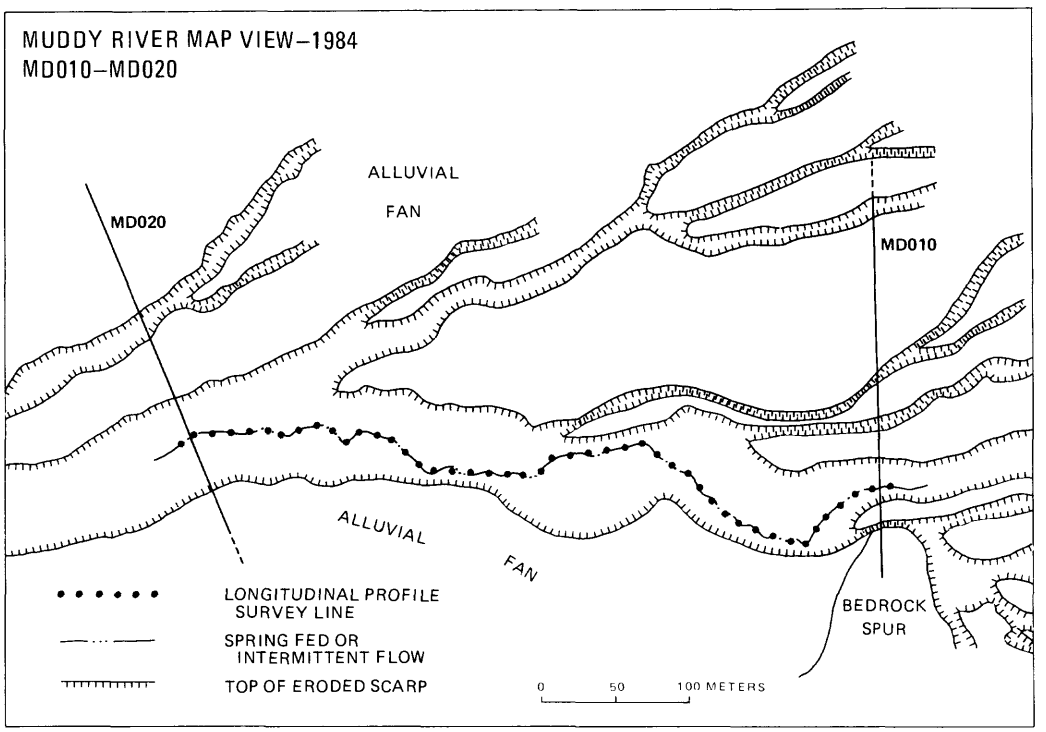
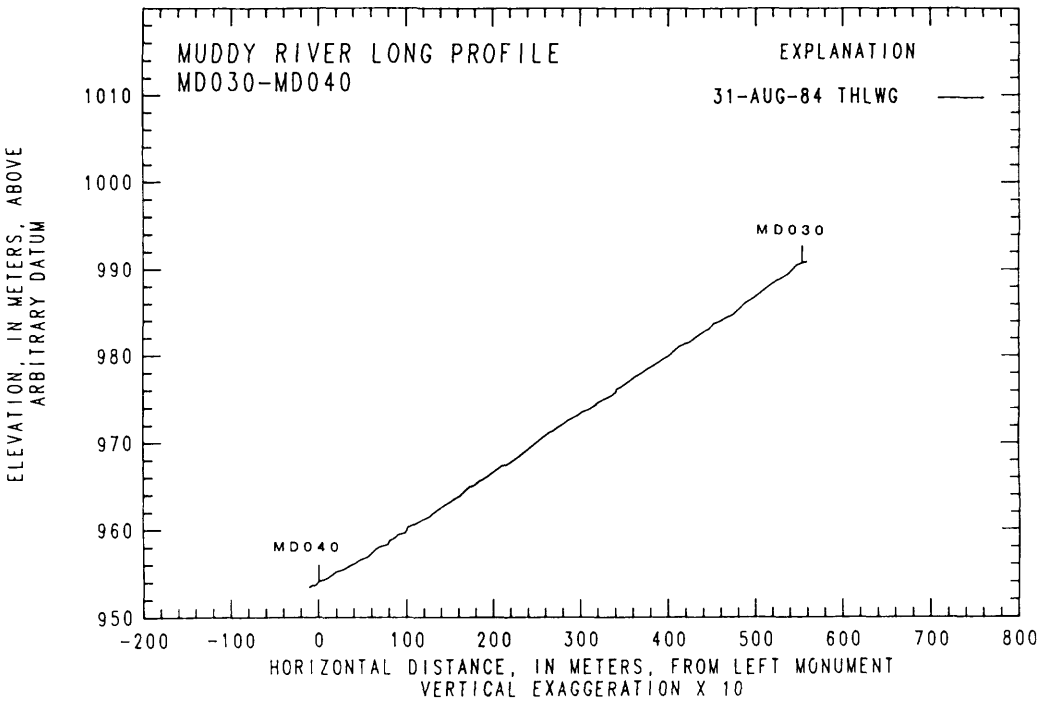


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River.



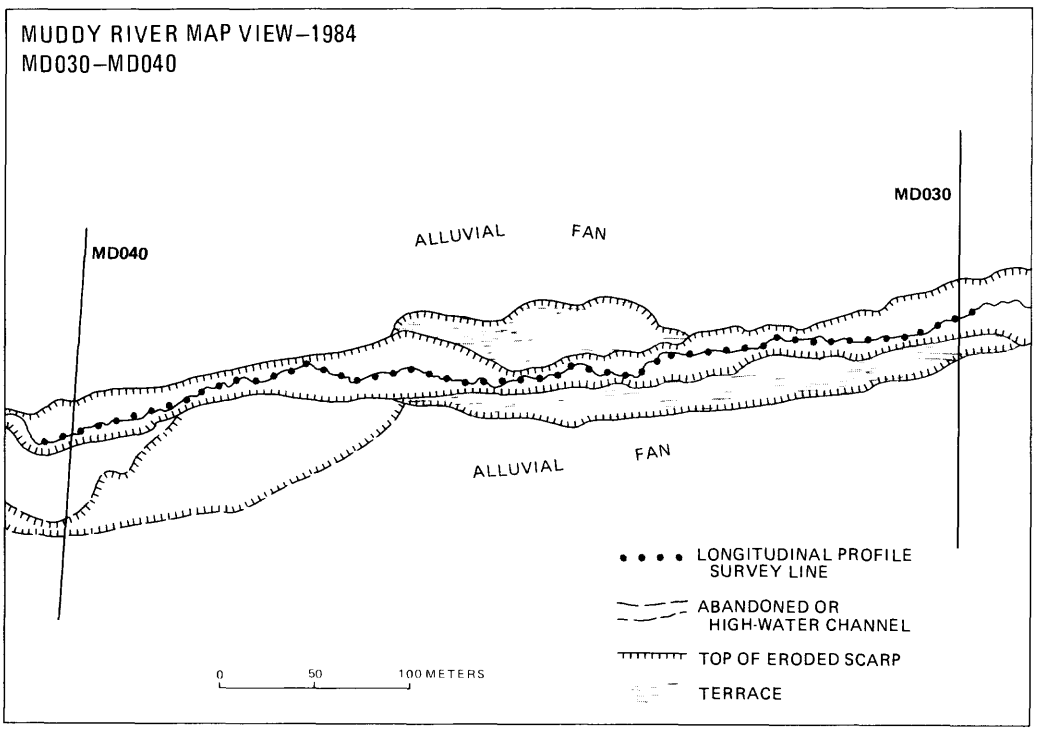
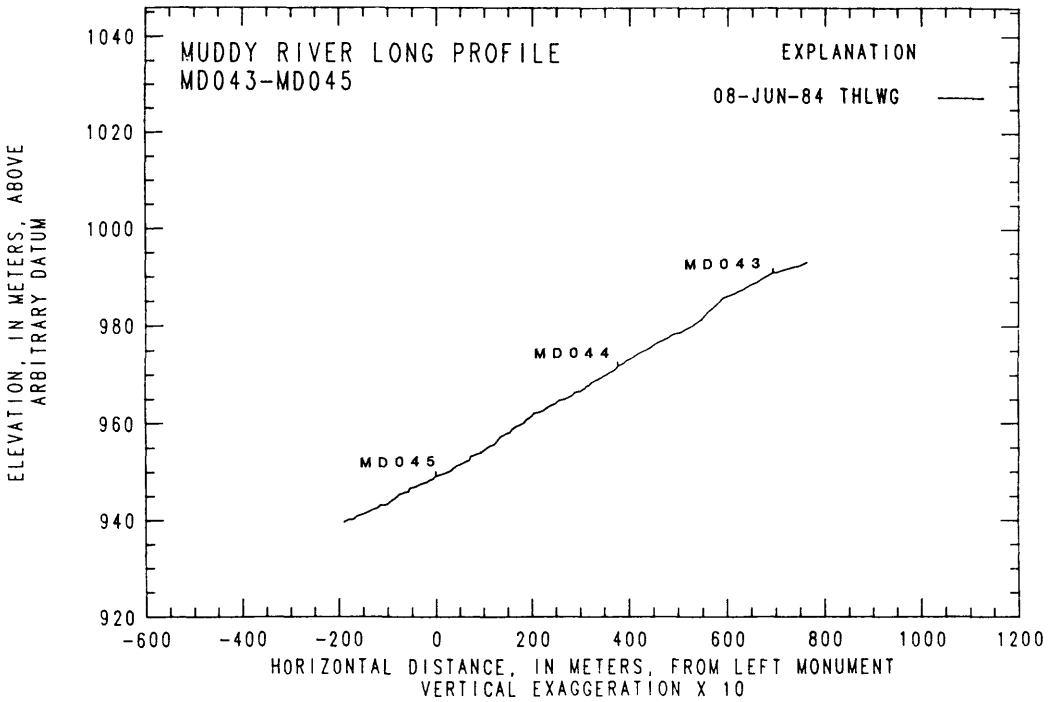


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



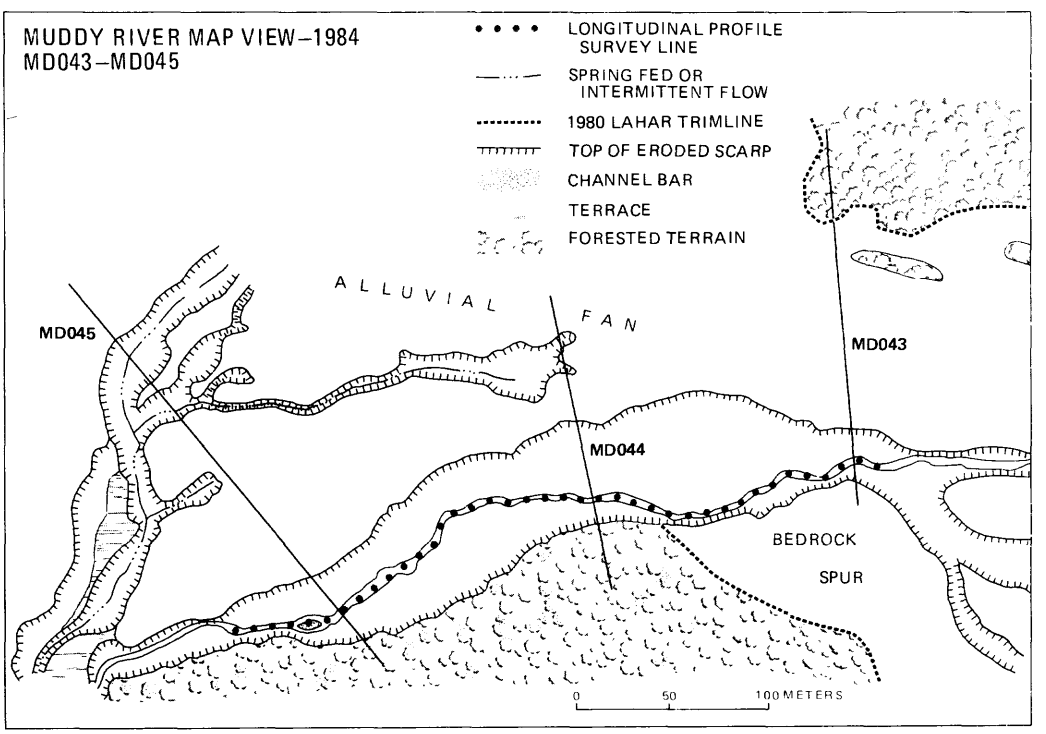
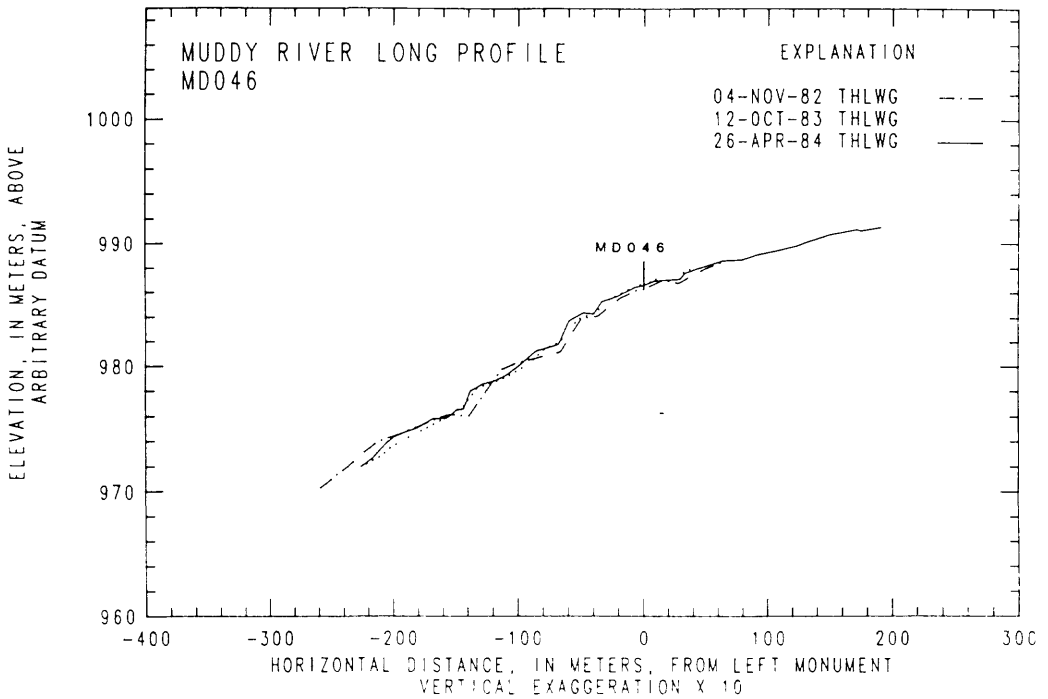


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



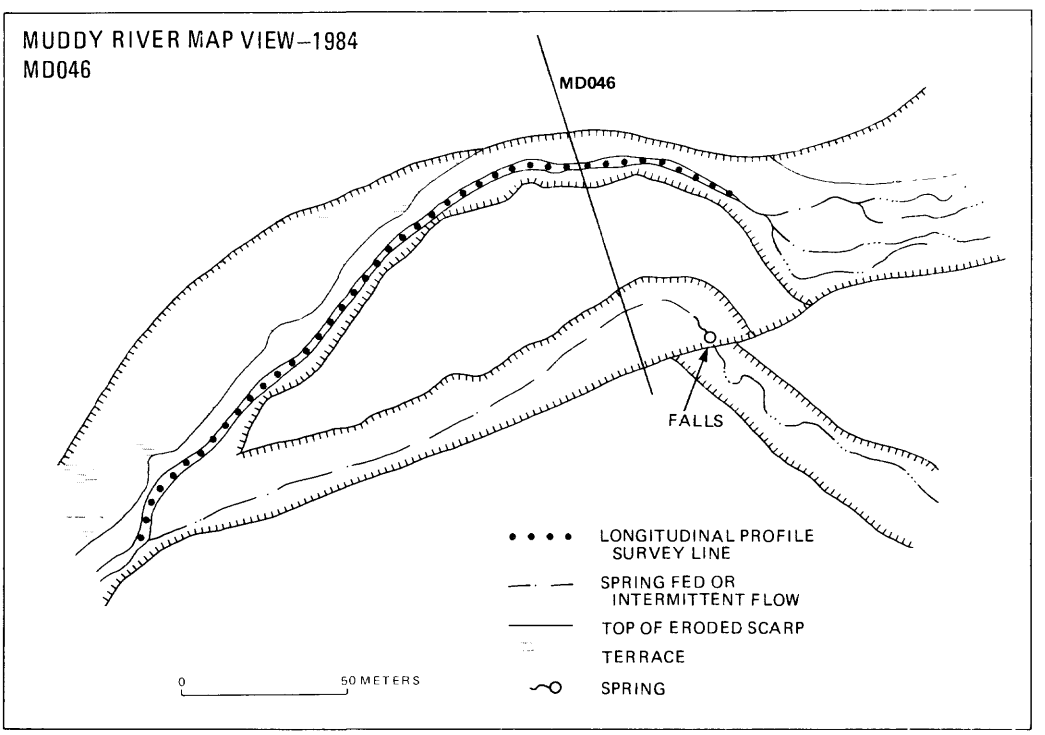
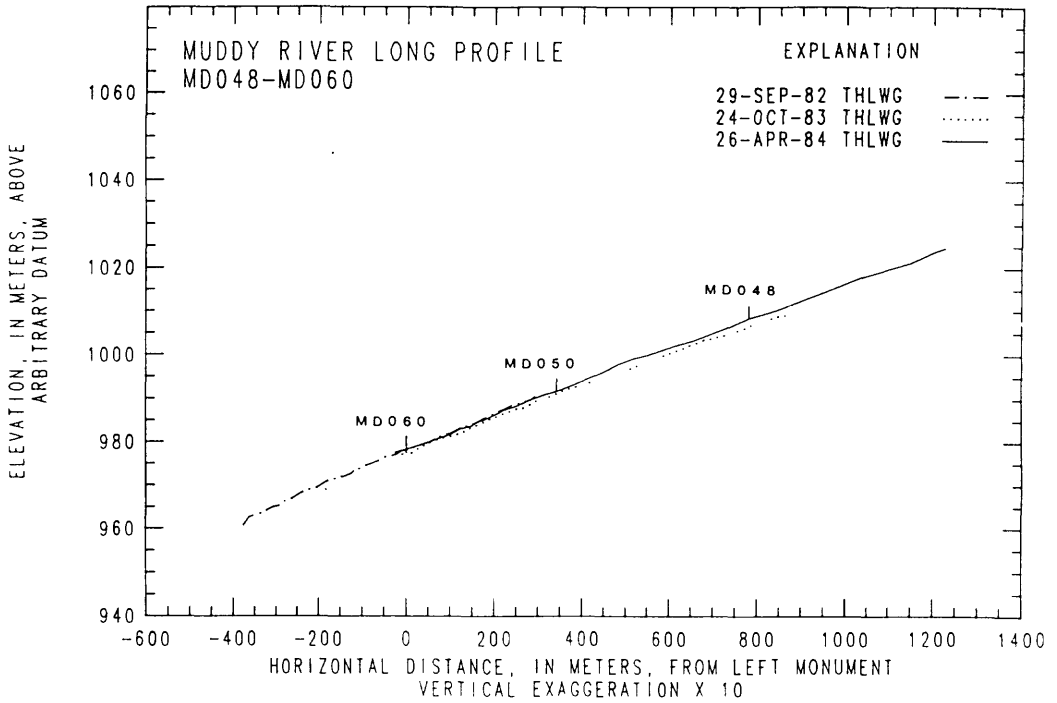


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



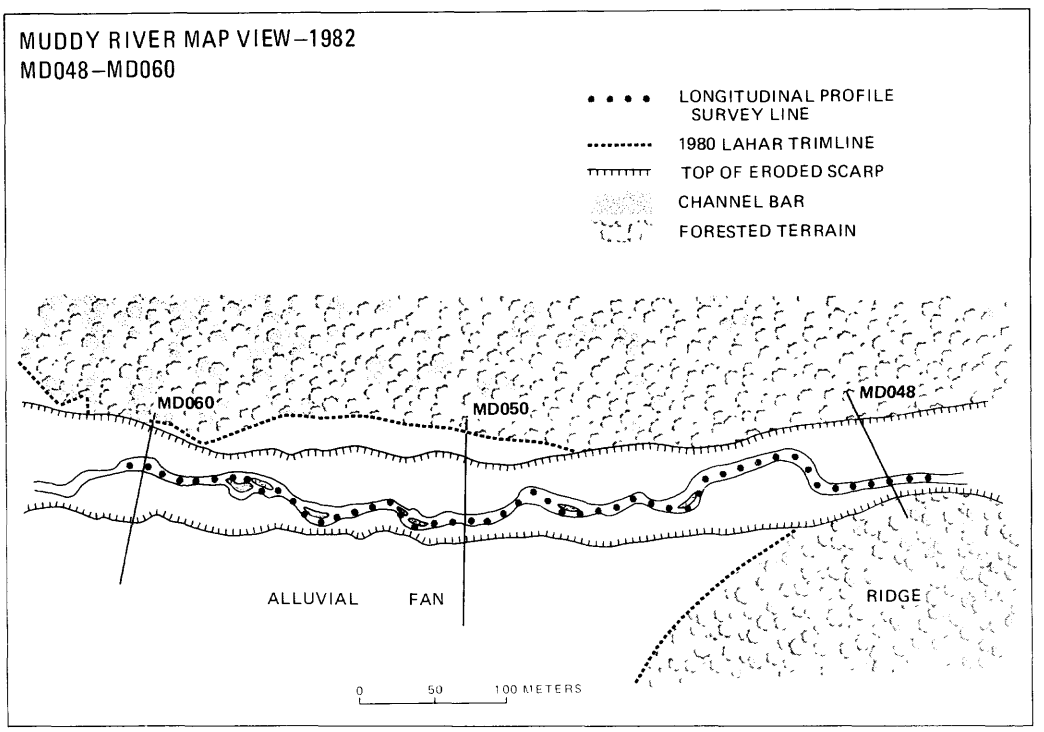
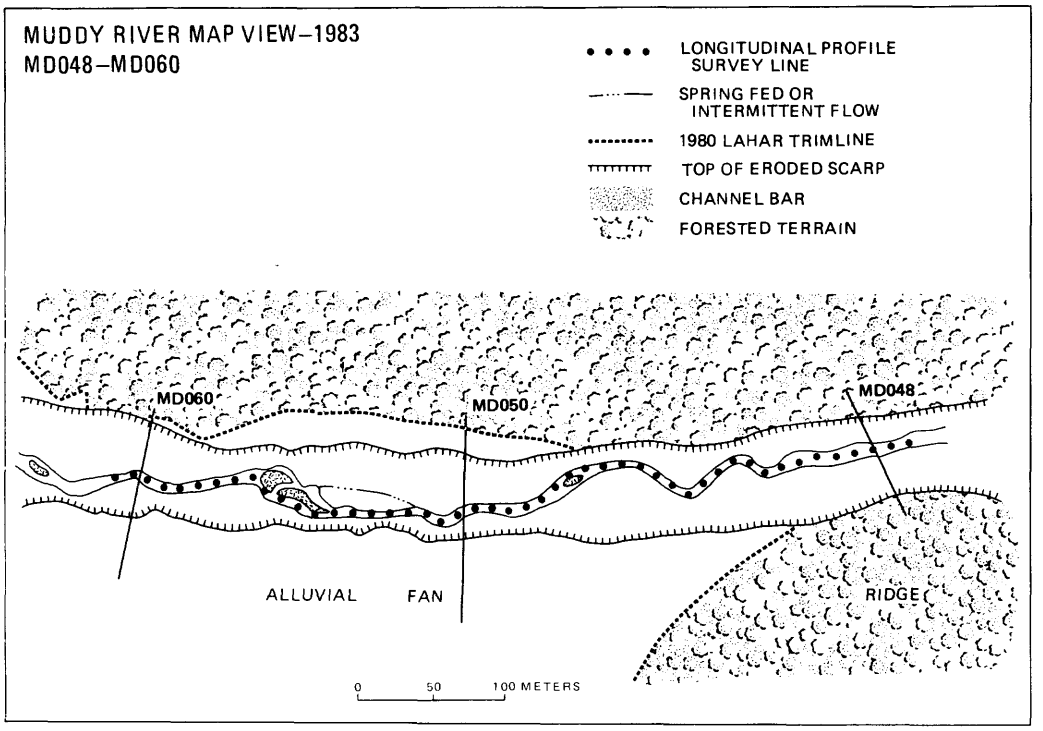


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



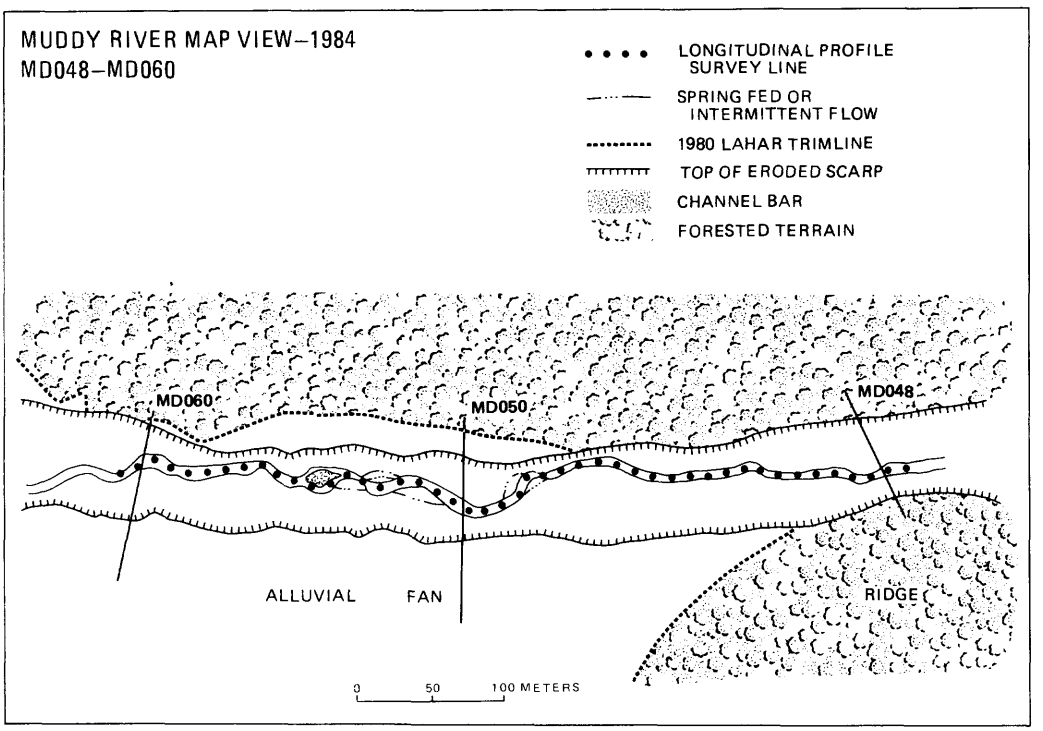
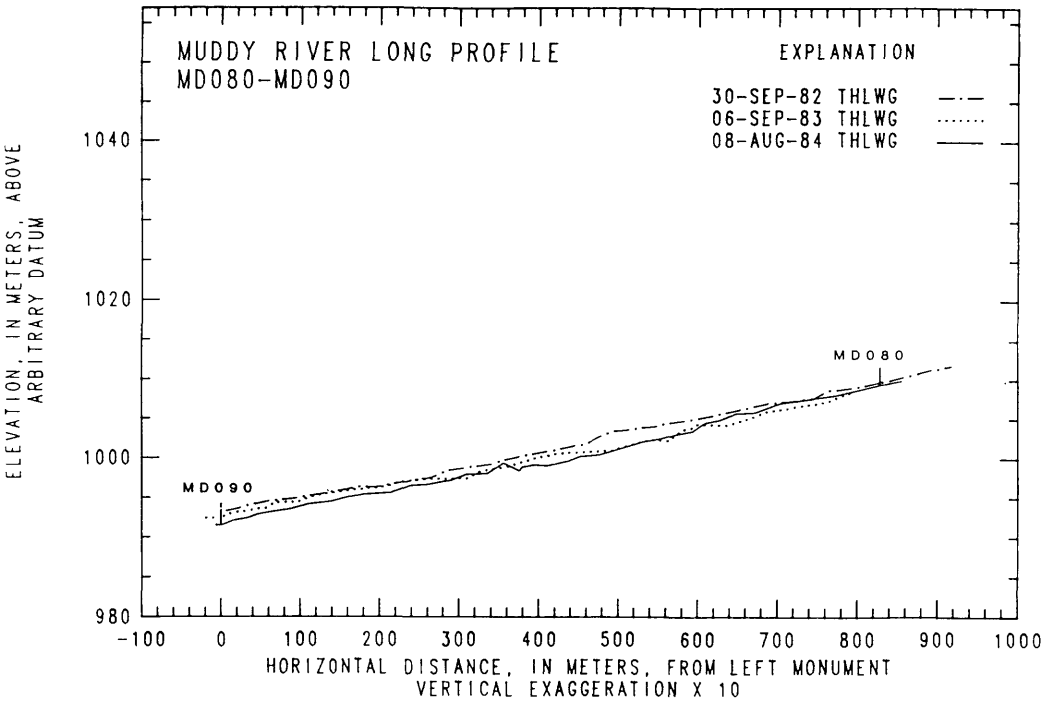


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



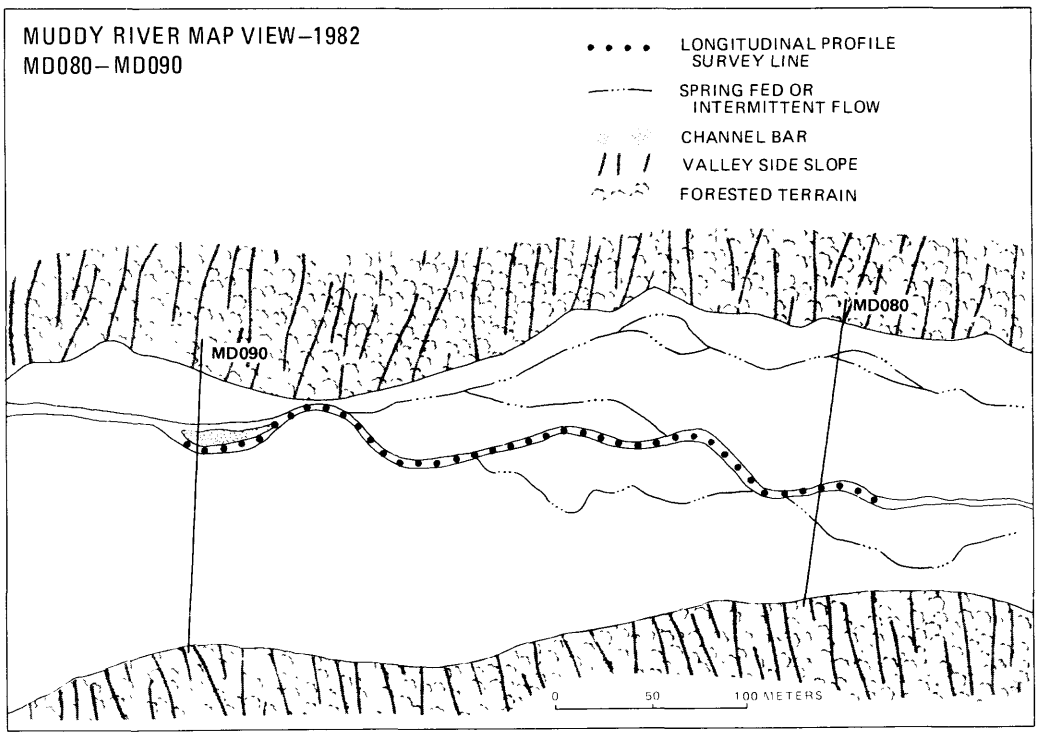
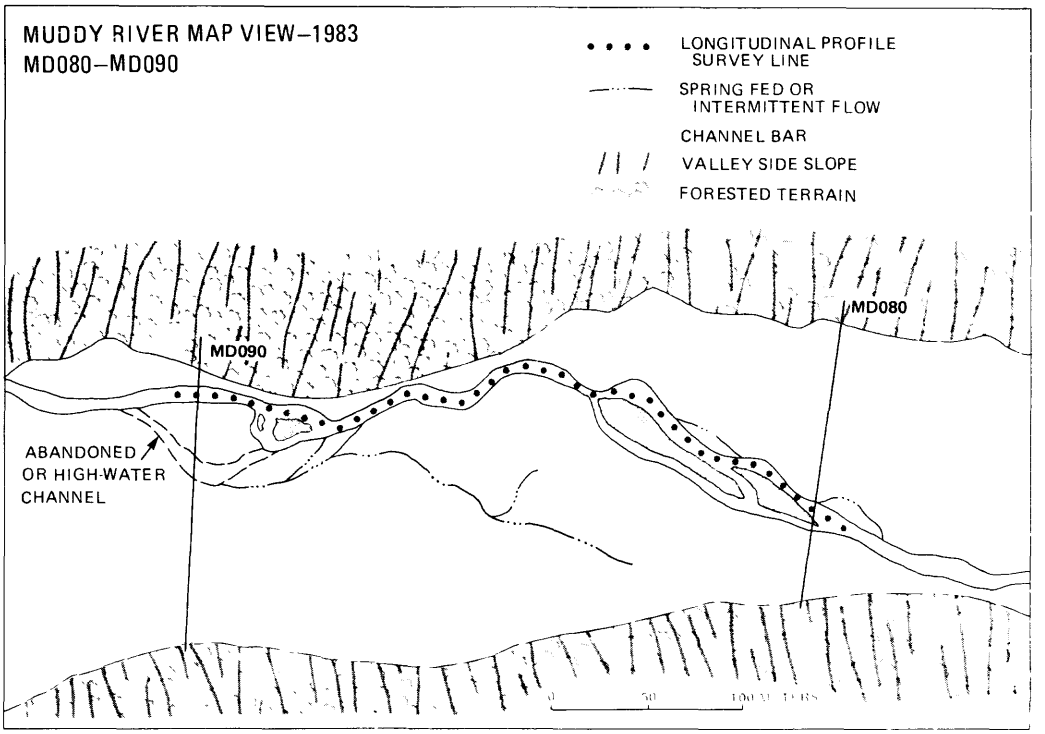


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



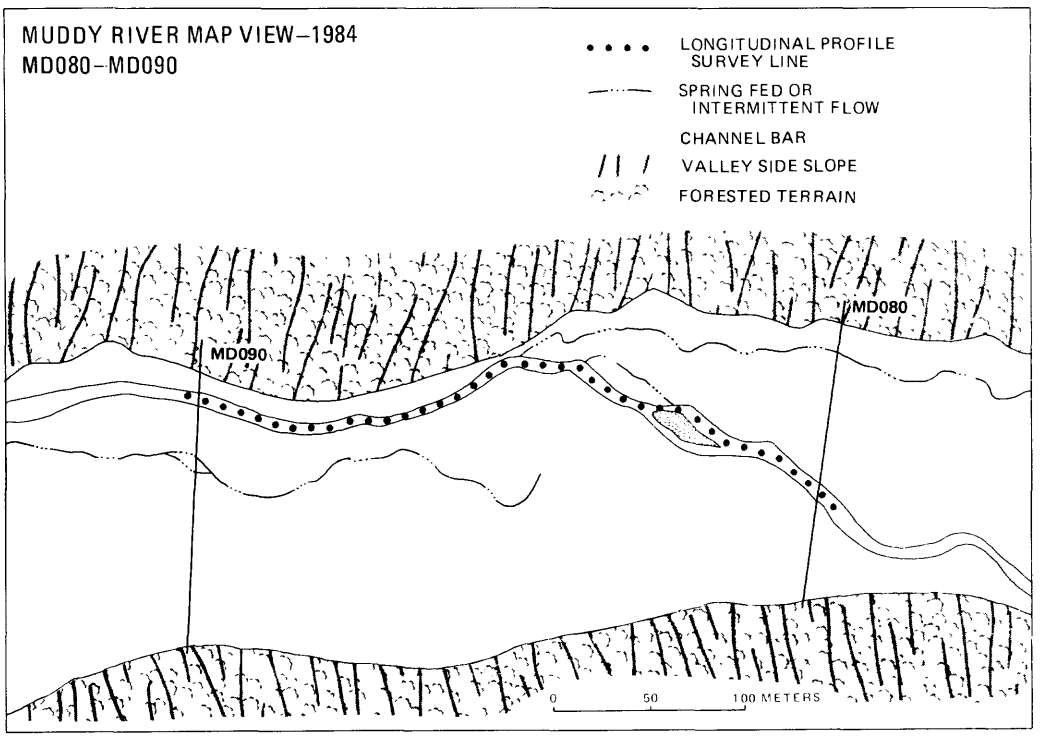
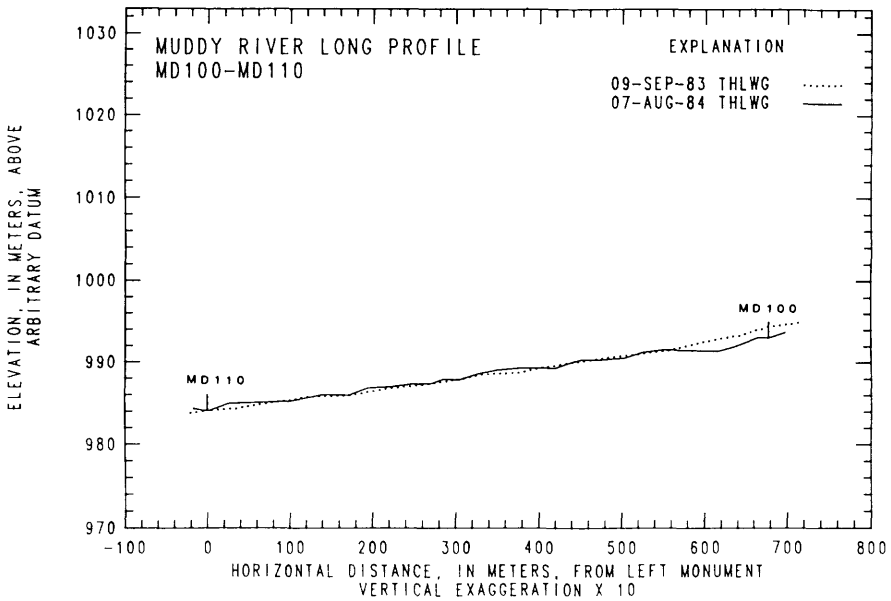


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



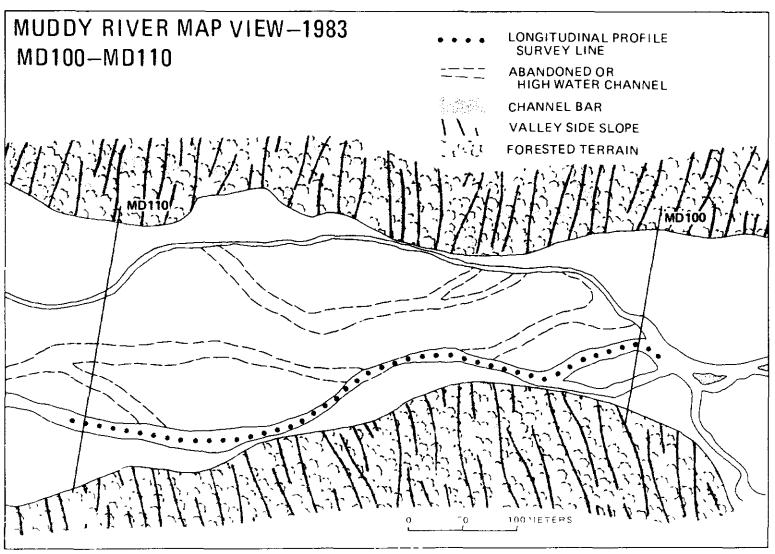
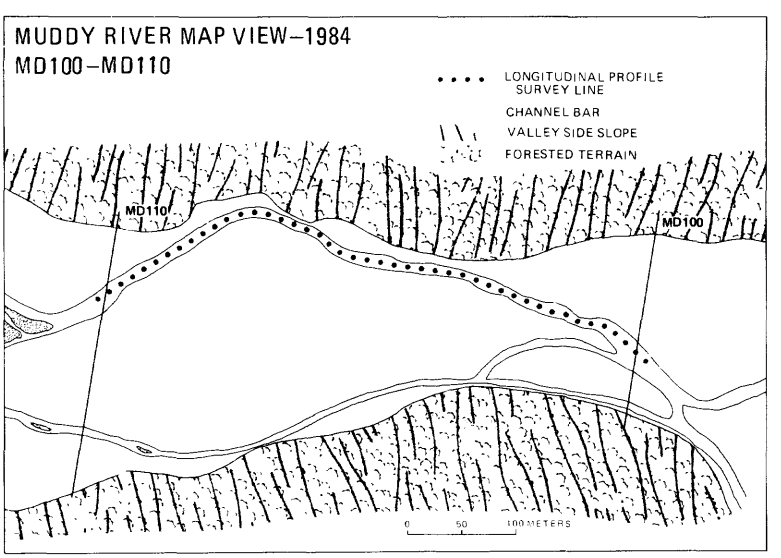
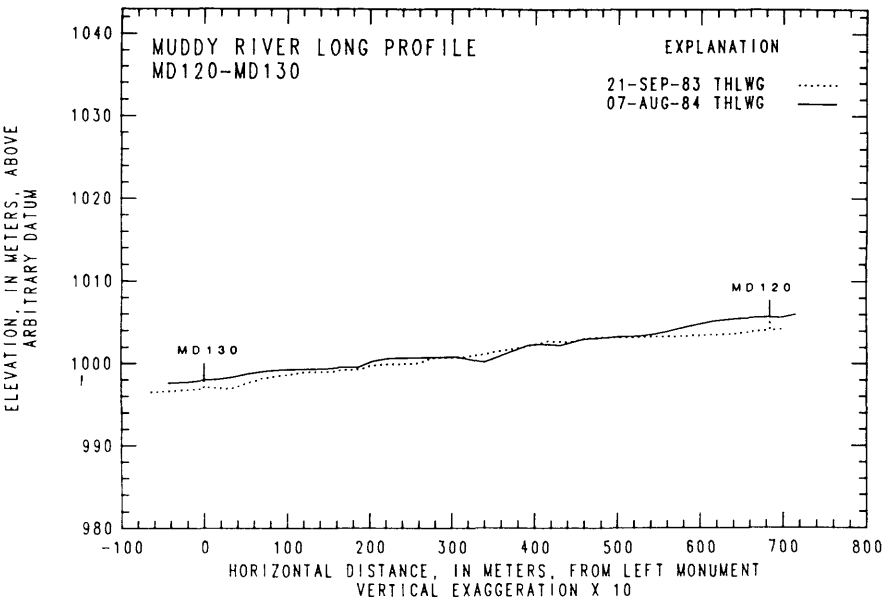


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.





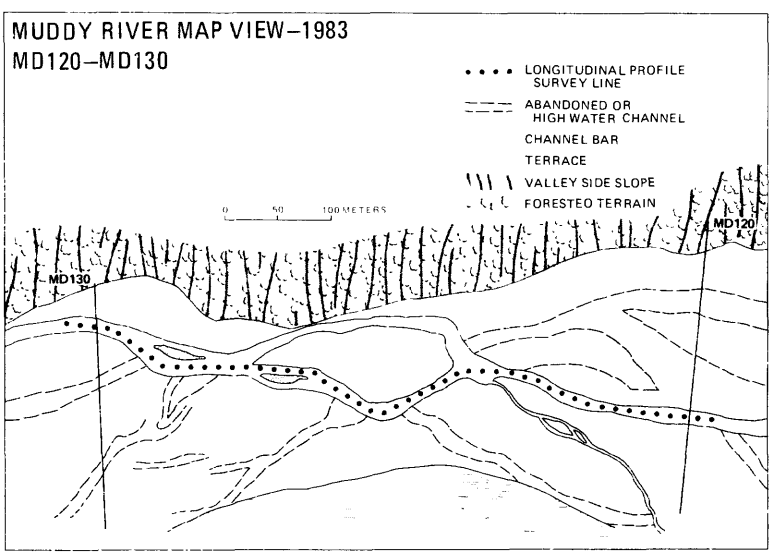
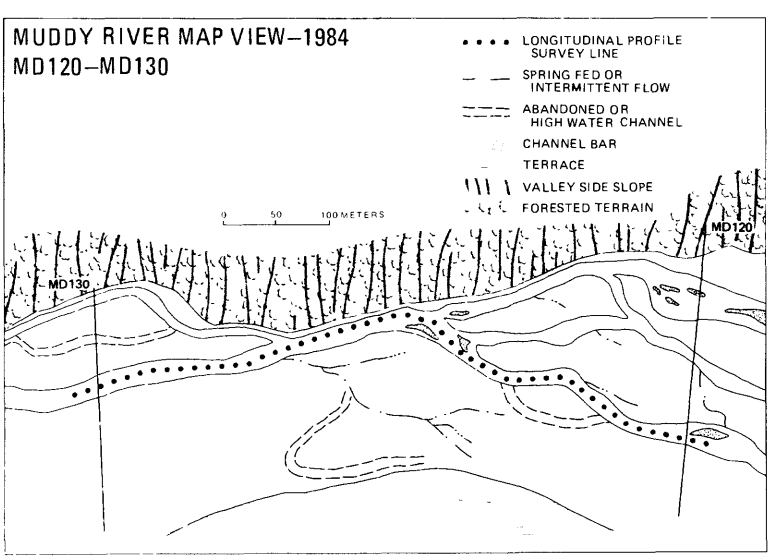
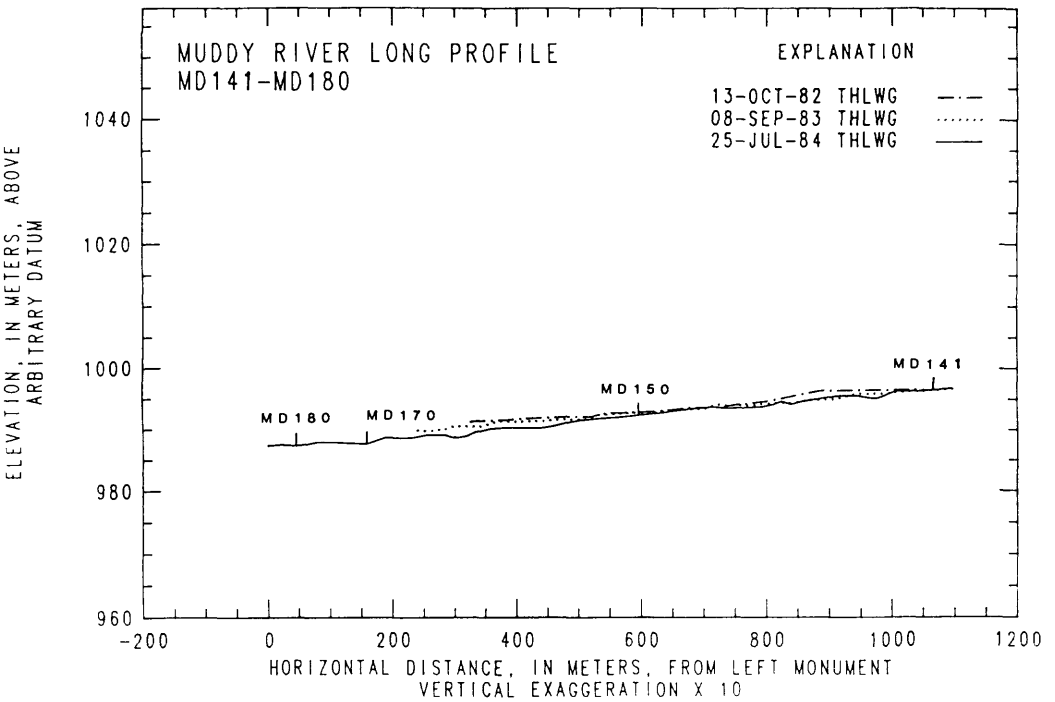


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.





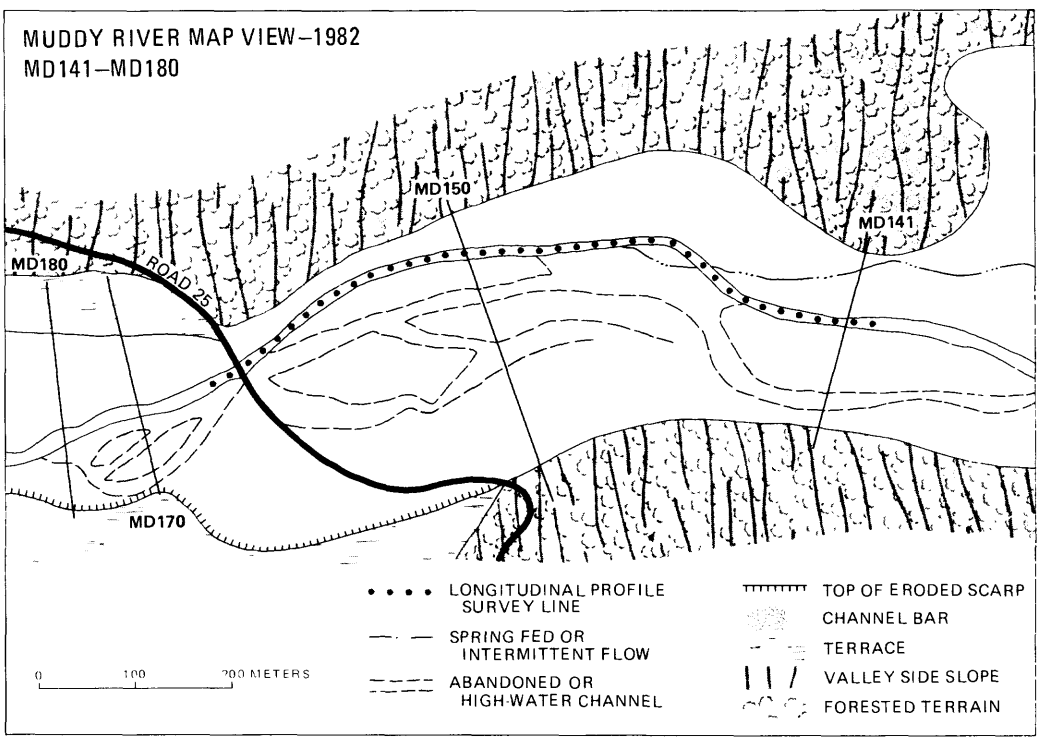
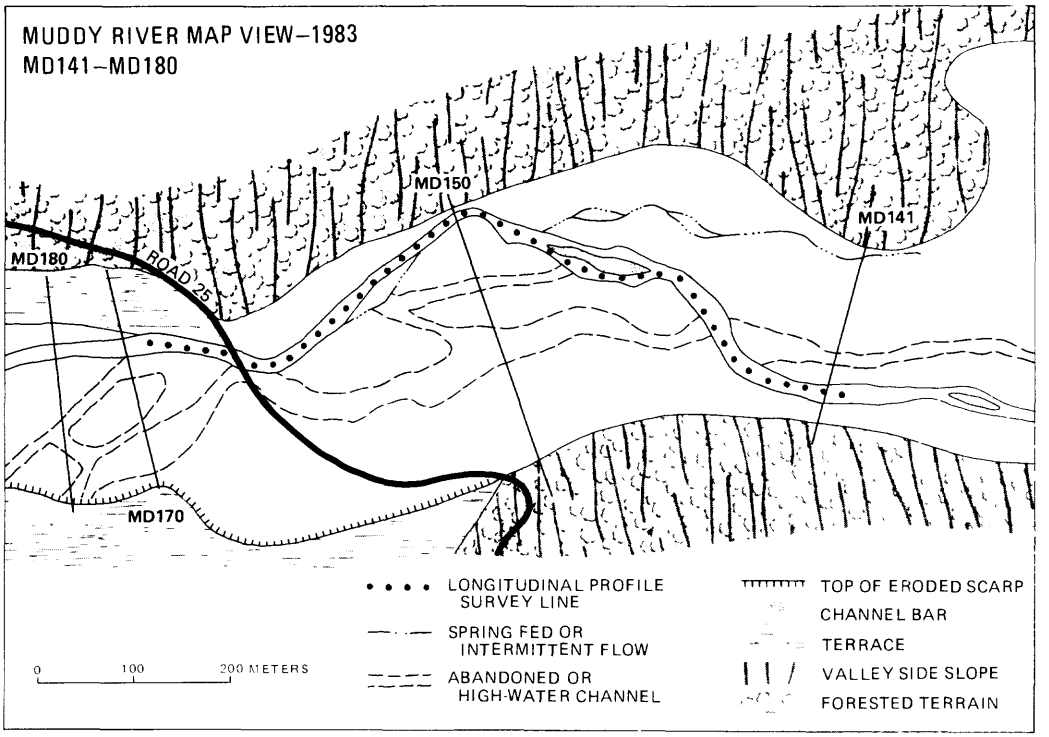


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



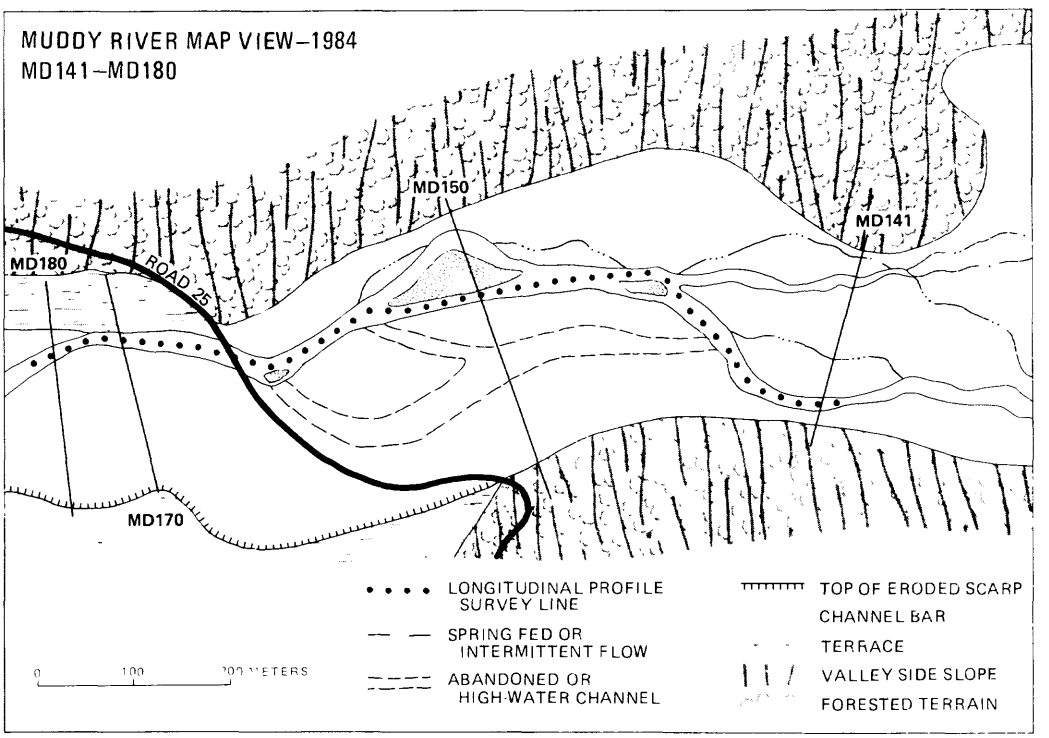
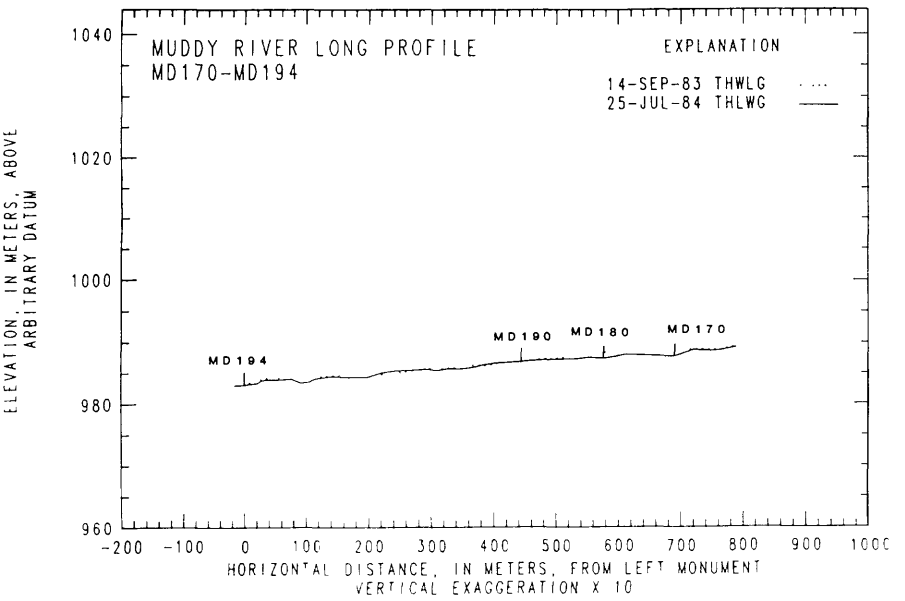


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



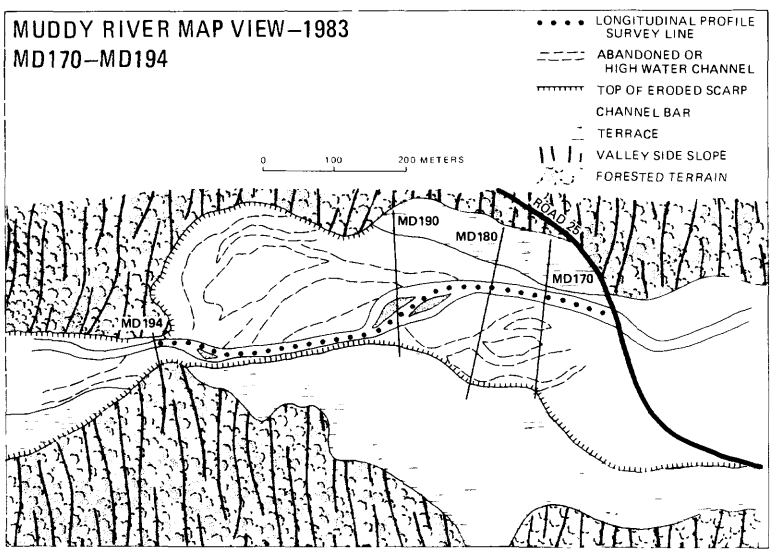
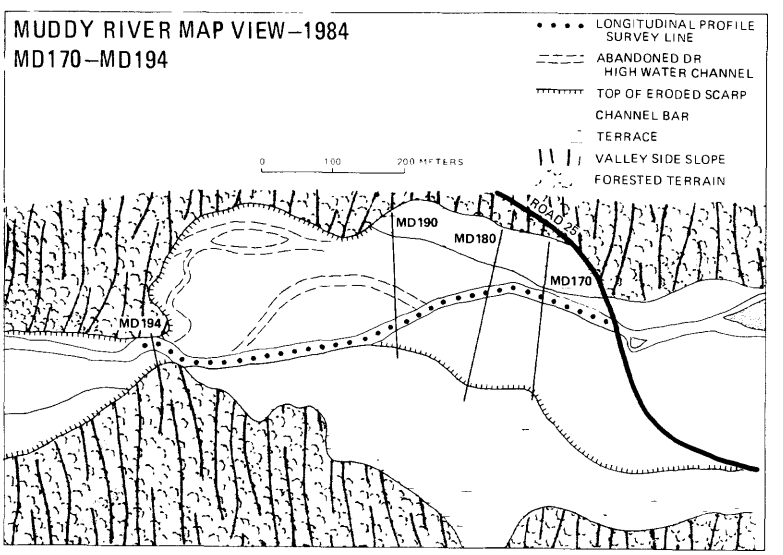
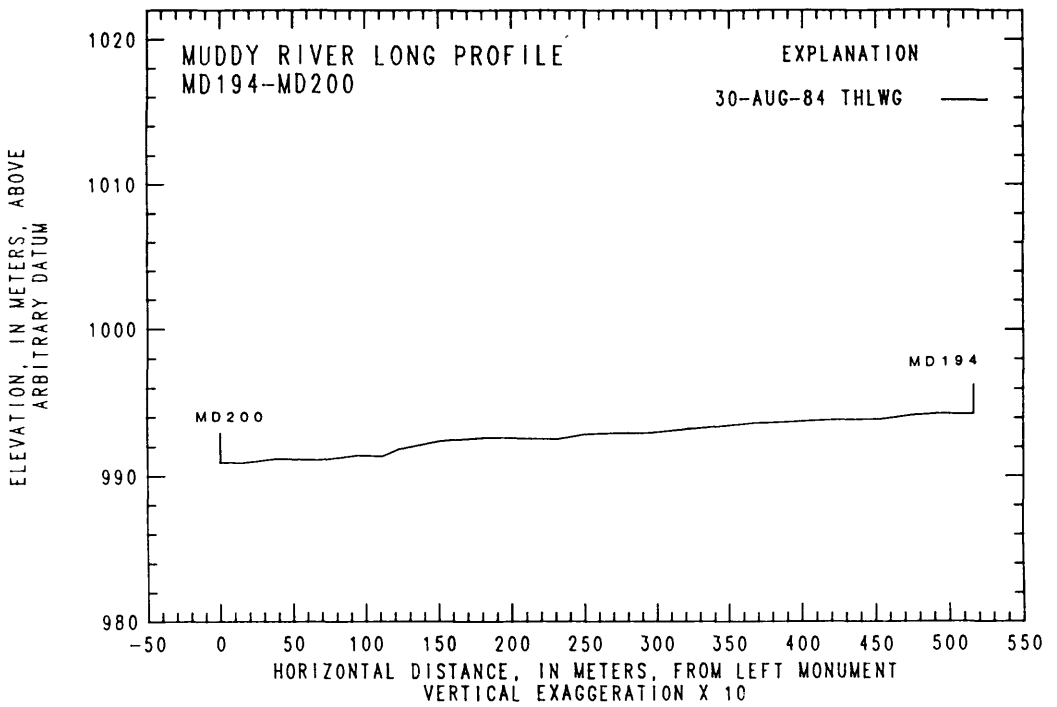


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.





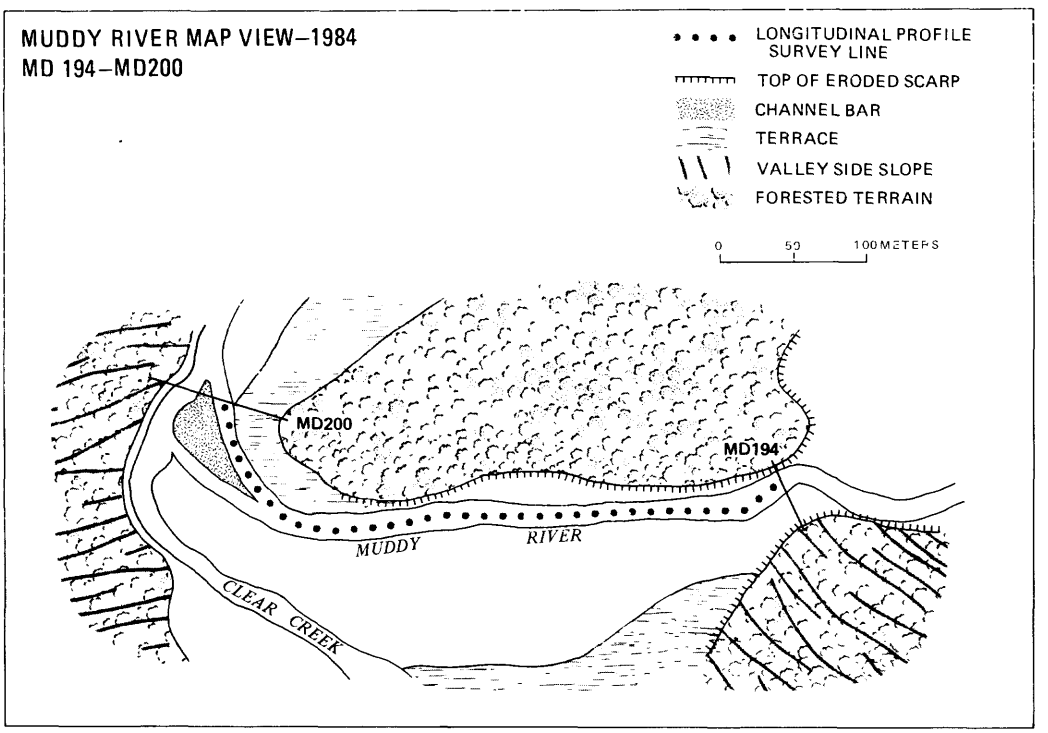
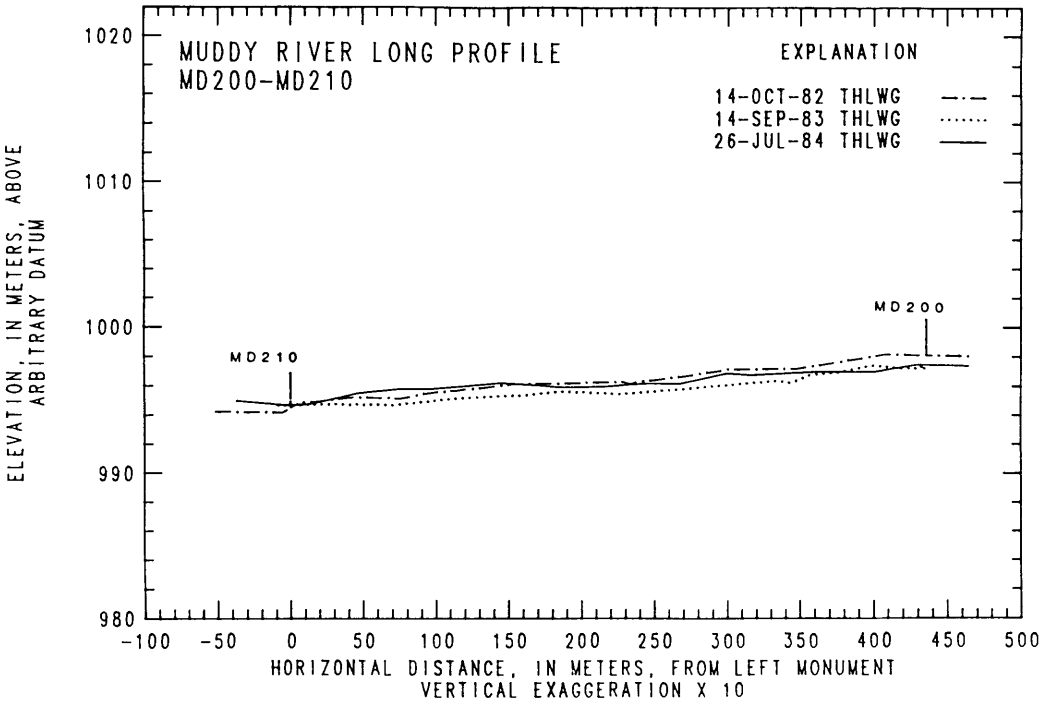


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



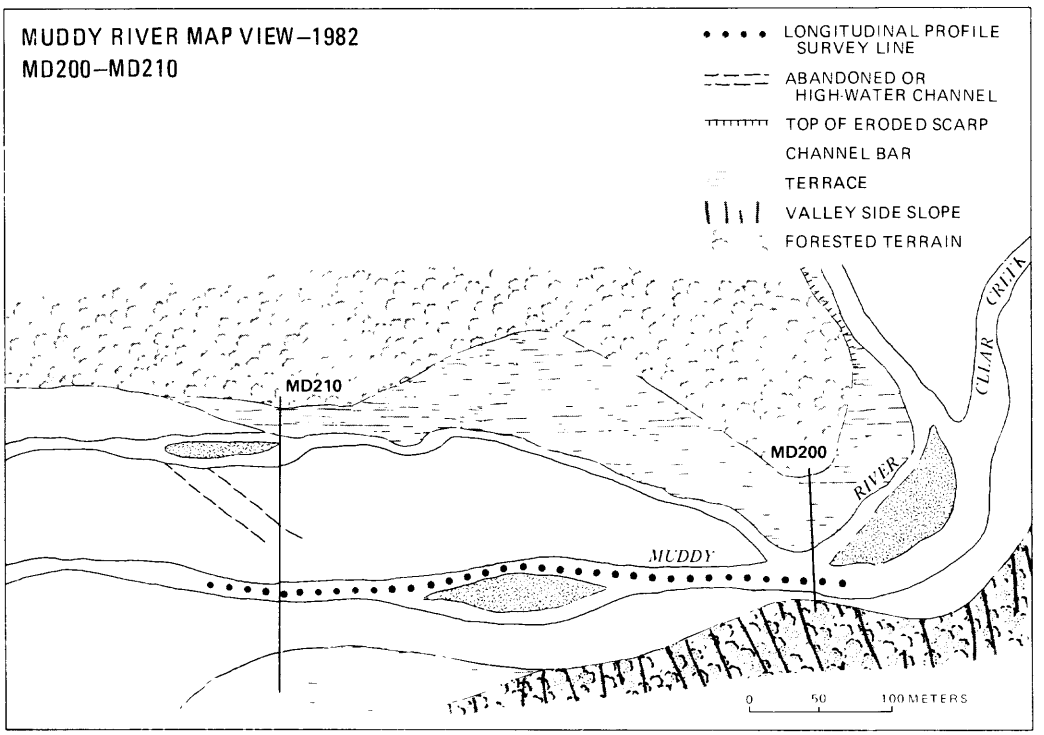
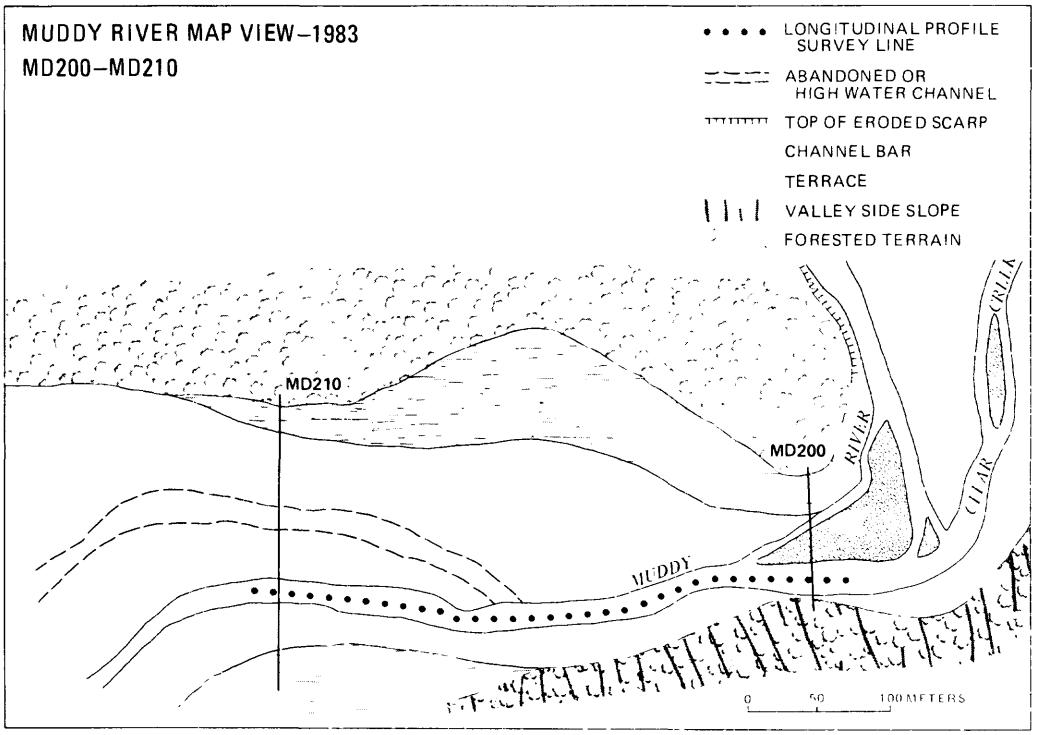


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



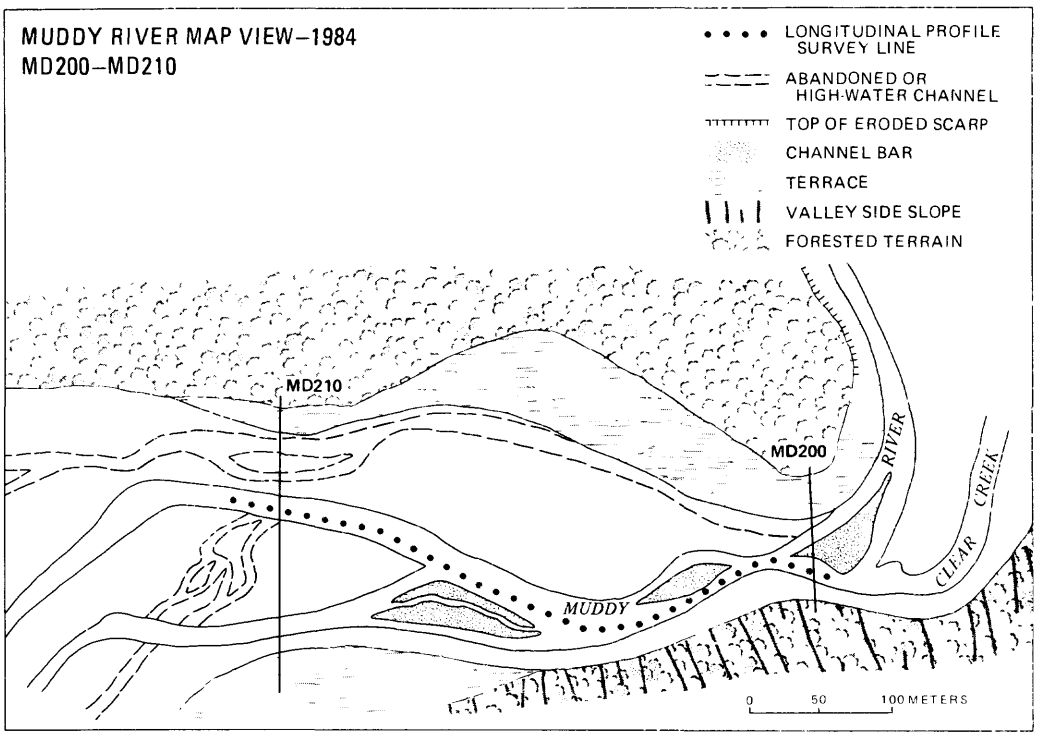
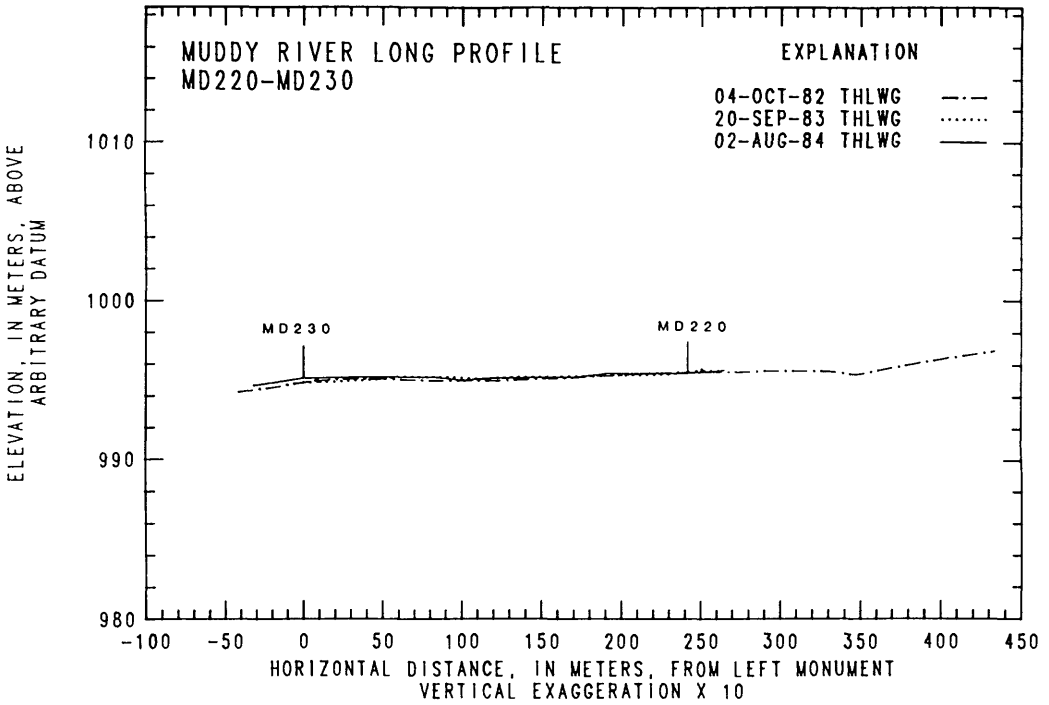


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



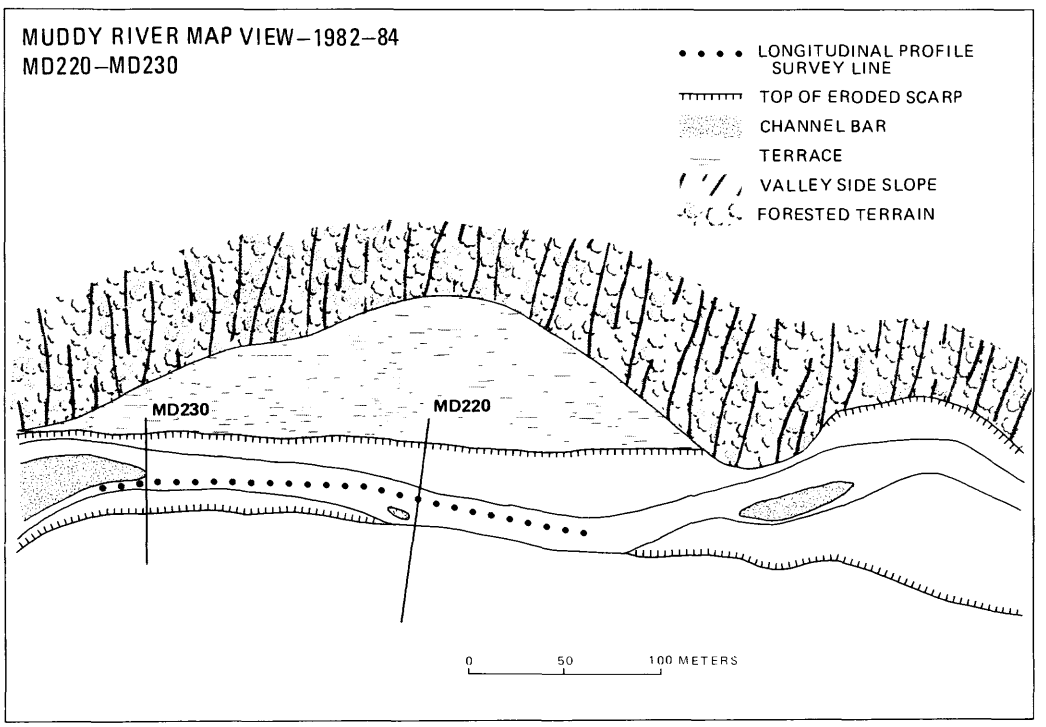
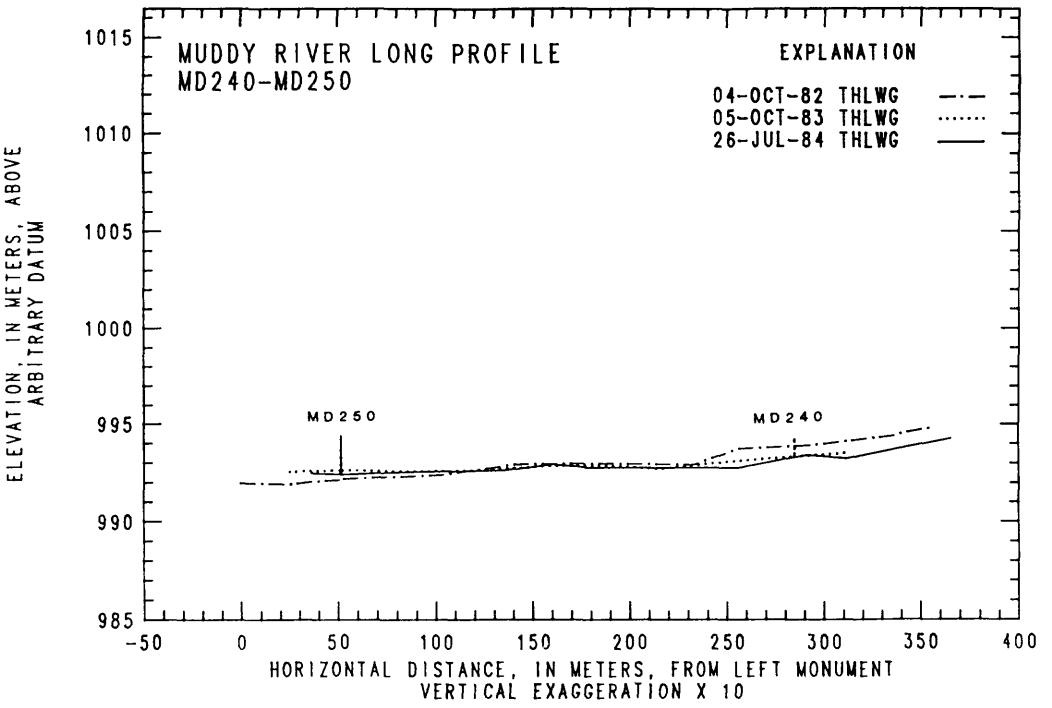


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



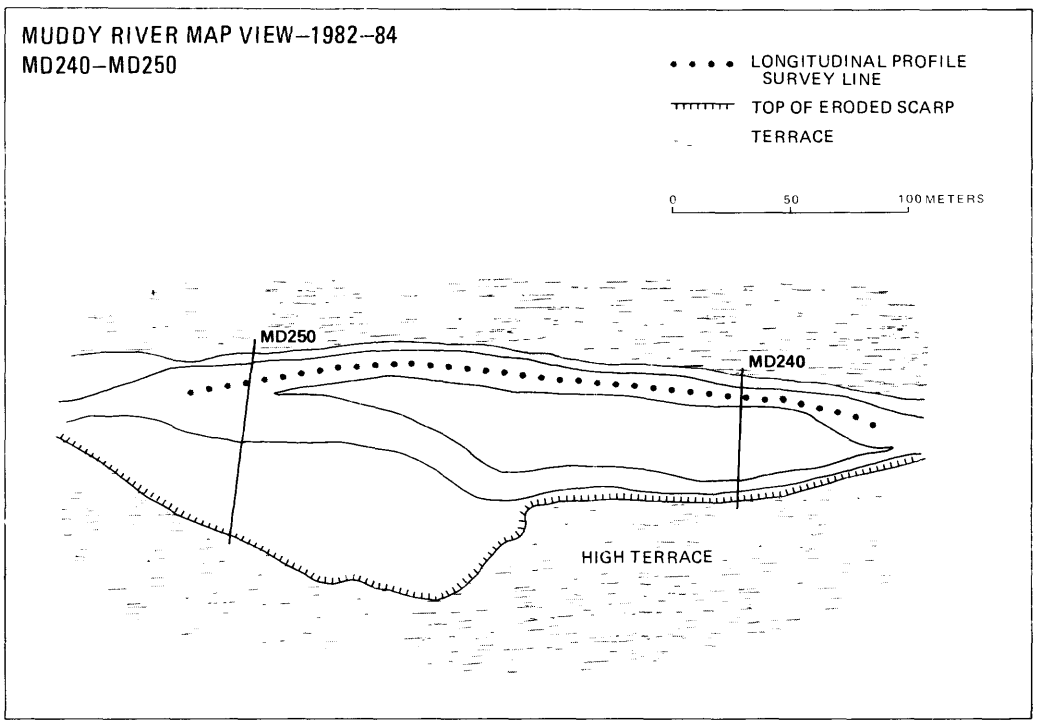
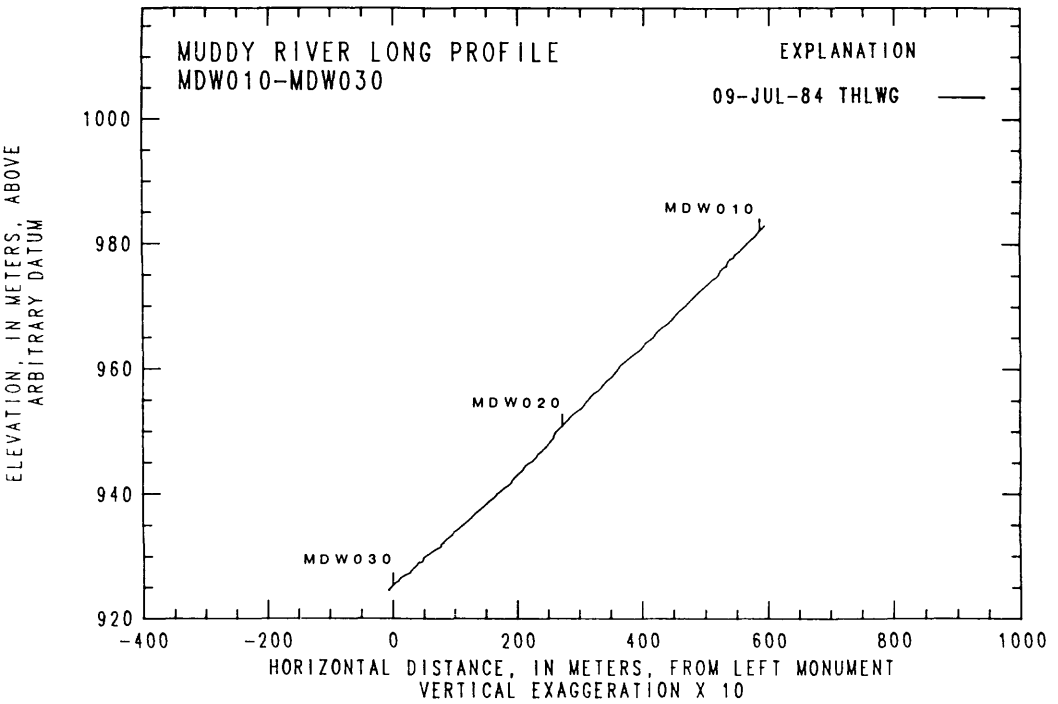


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.



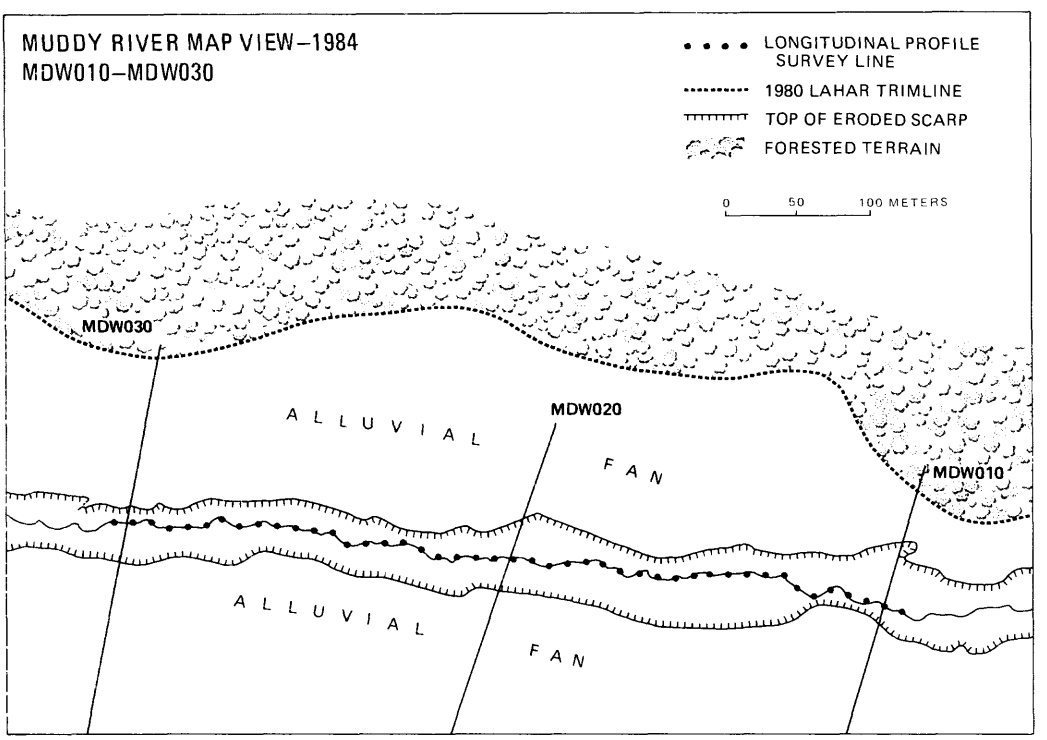


FIGURE 11. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Muddy River – continued.

INDEX TO SMITH CREEK CROSS-SECTION SITES

As an aid to the reader, listed below are the individual cross-section site numbers and corresponding page number of the plot.

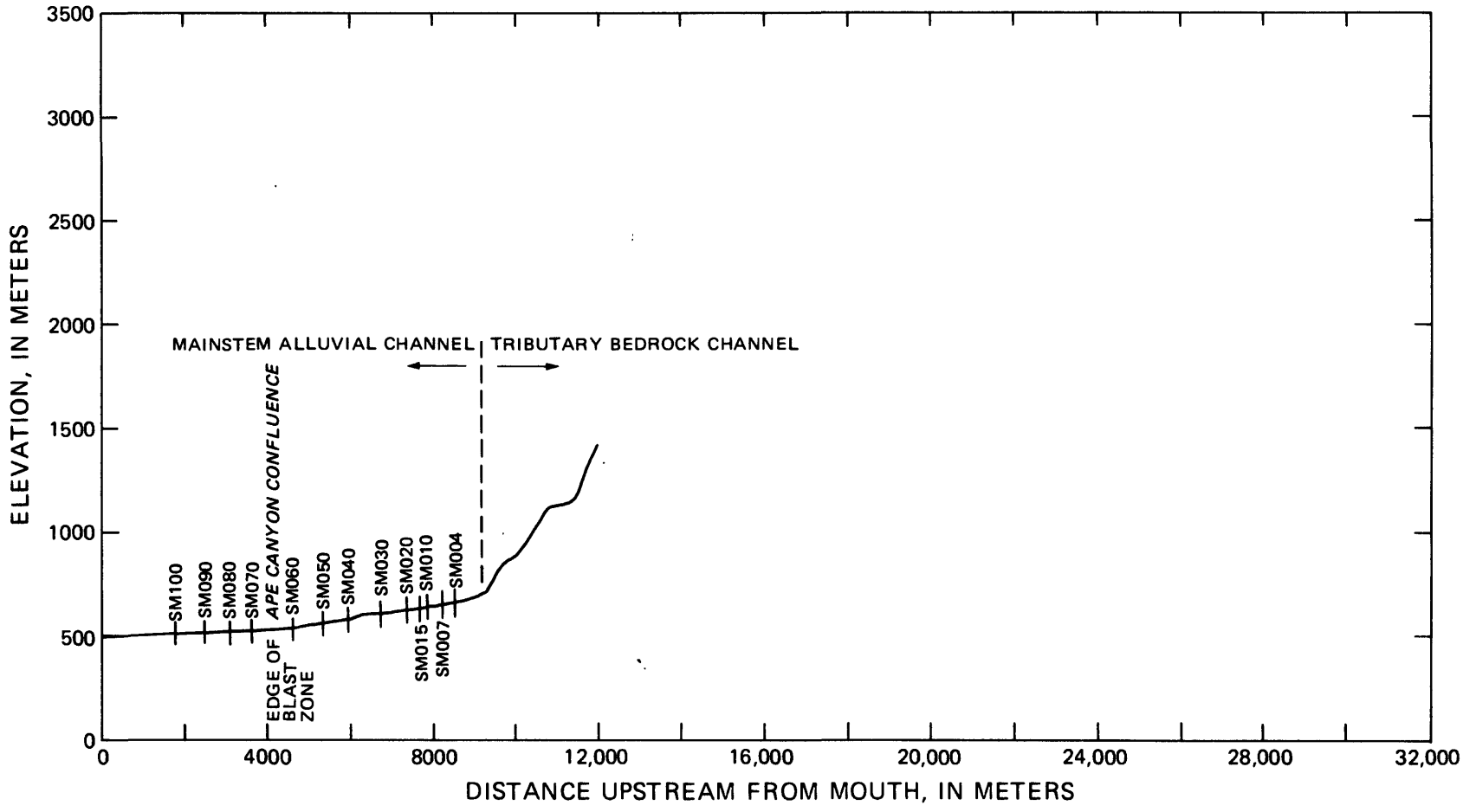


FIGURE 12. – Longitudinal profile of Smith Creek, showing locations of cross-section survey sites. Channel distance upstream from mouth and elevation above sea level are determined from U.S. Geological Survey topographic map, 7.5-minute series, Mount St. Helens NE quadrangle.

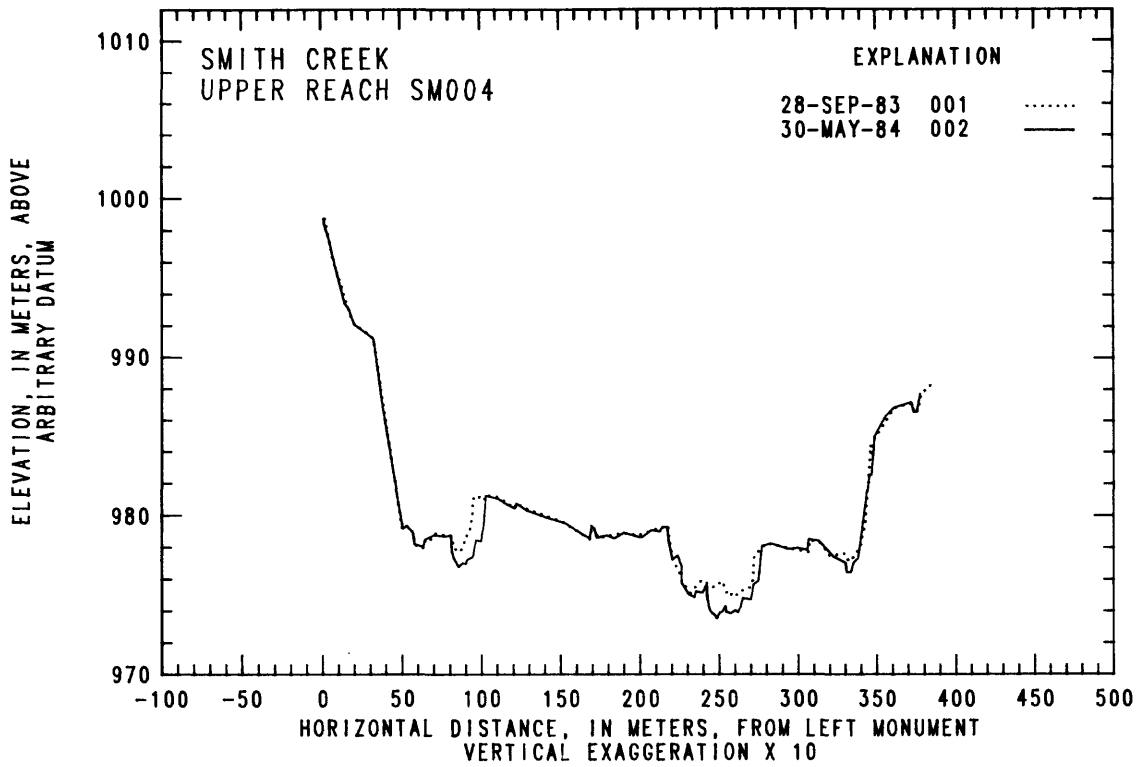


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek.

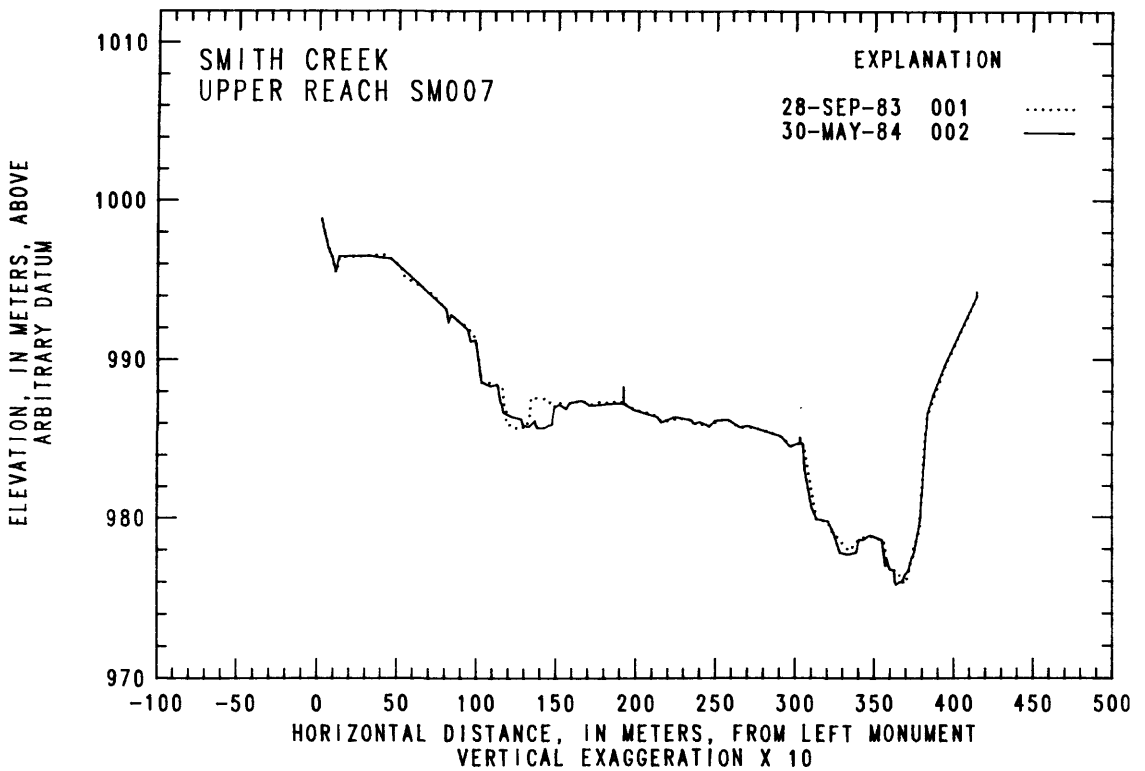


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

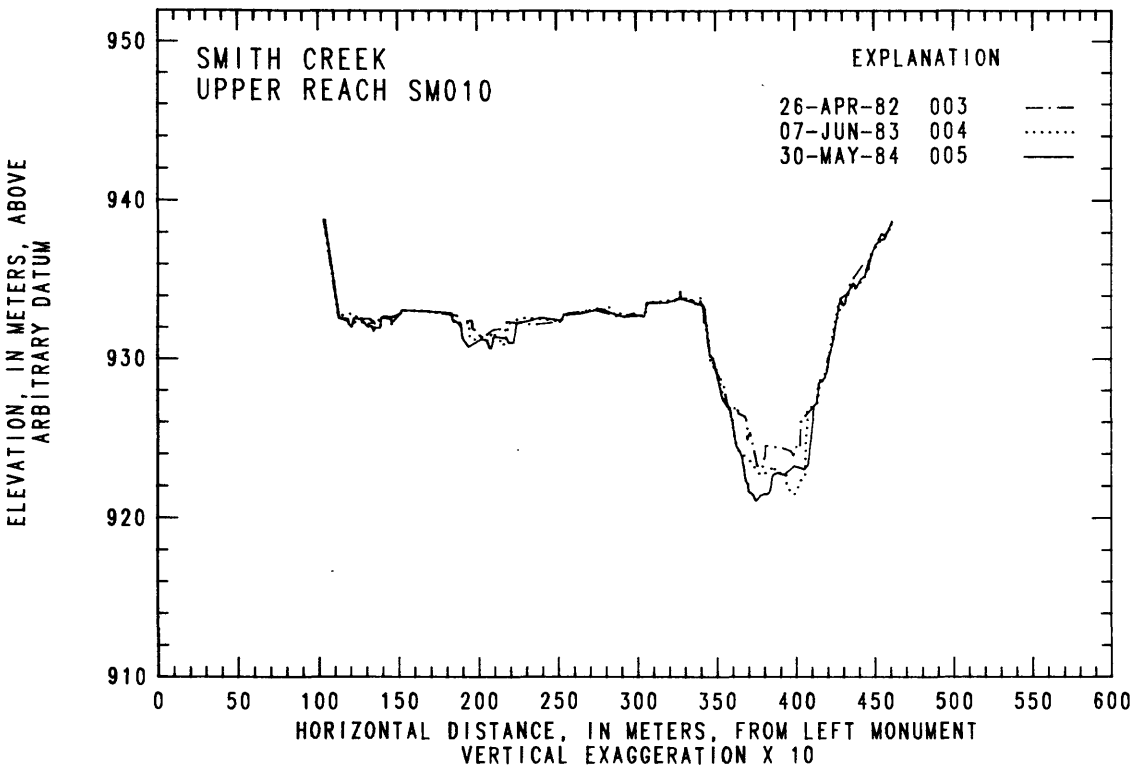


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

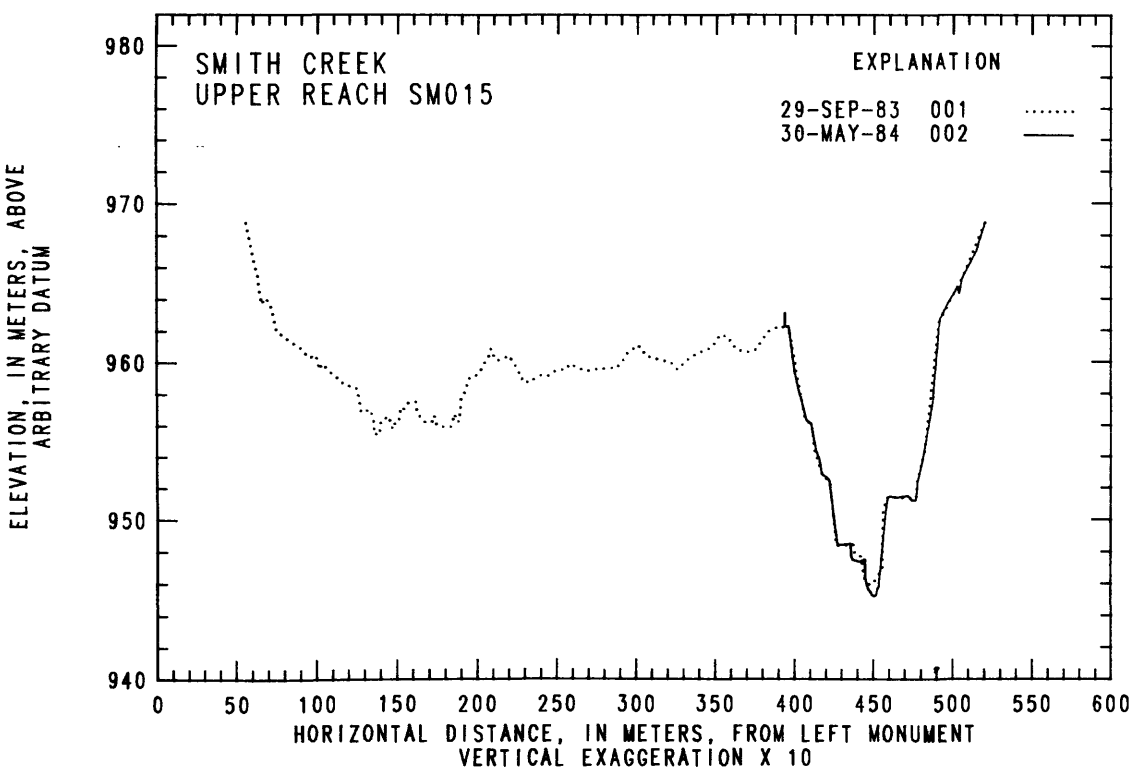


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

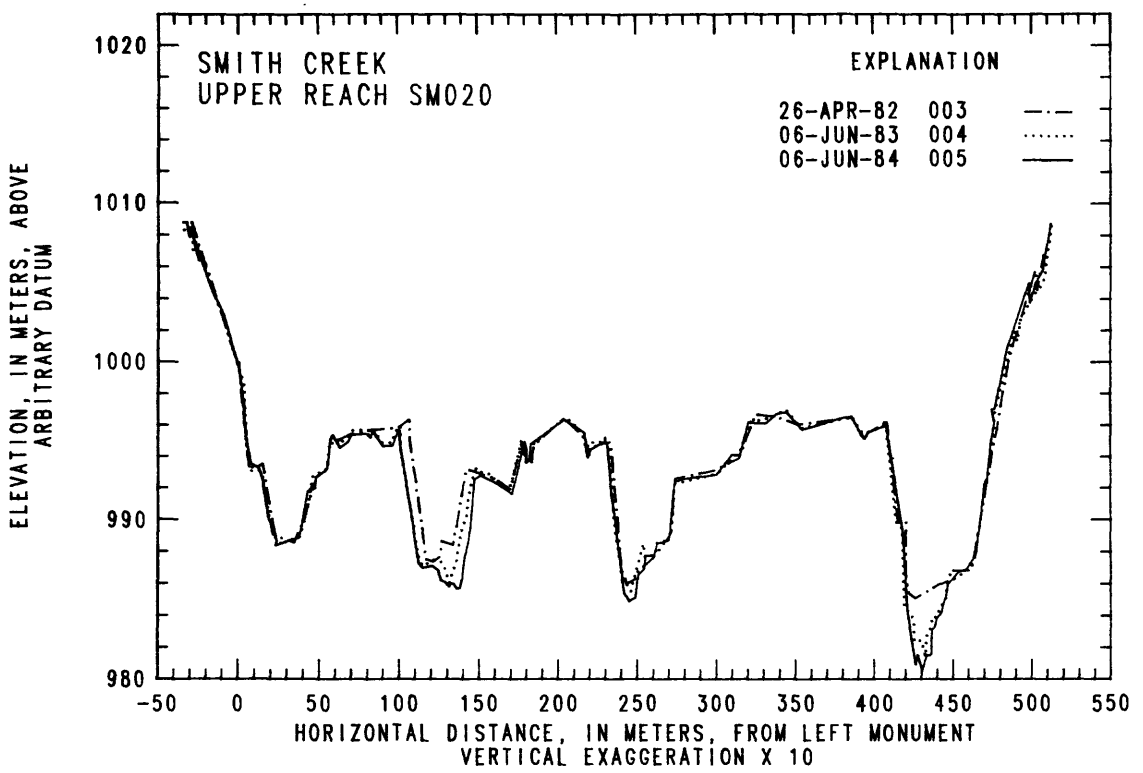


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

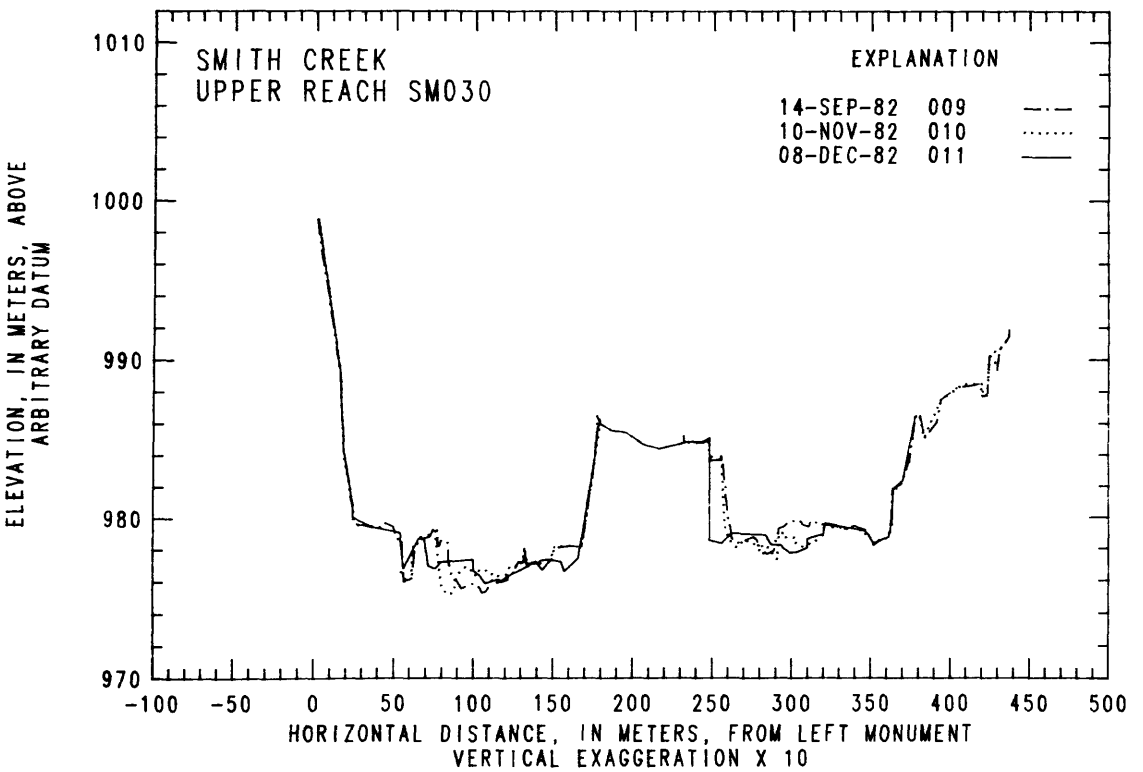


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

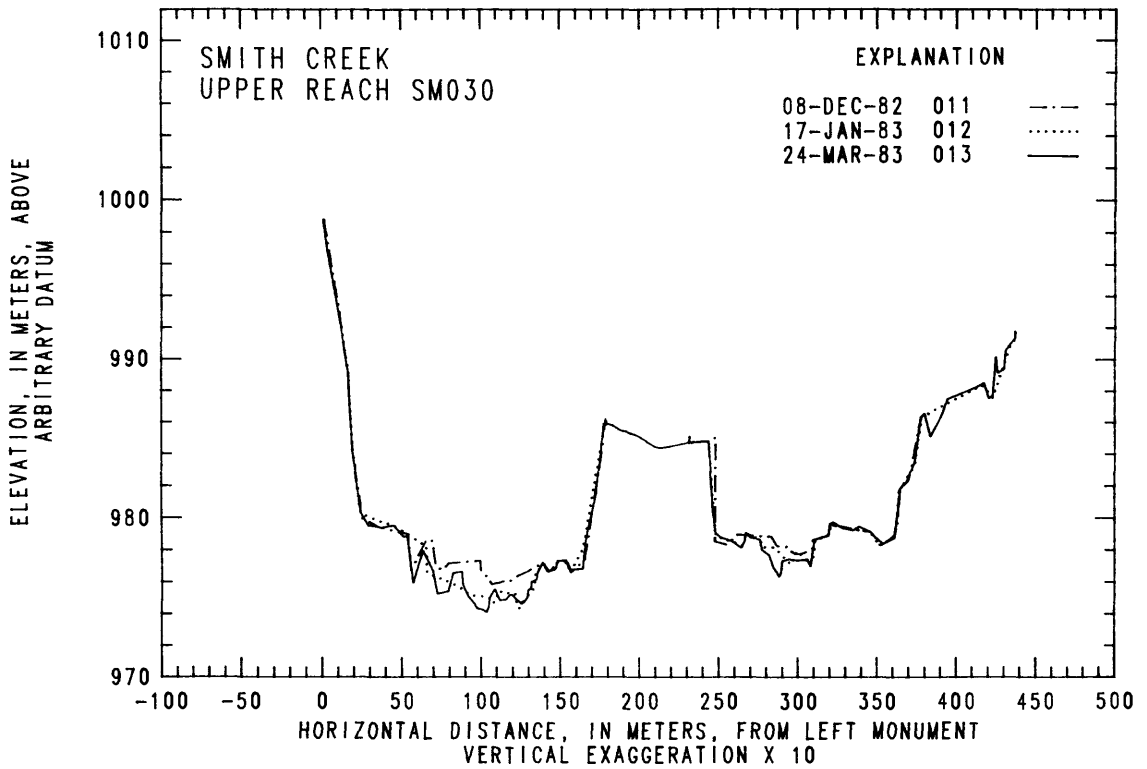


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

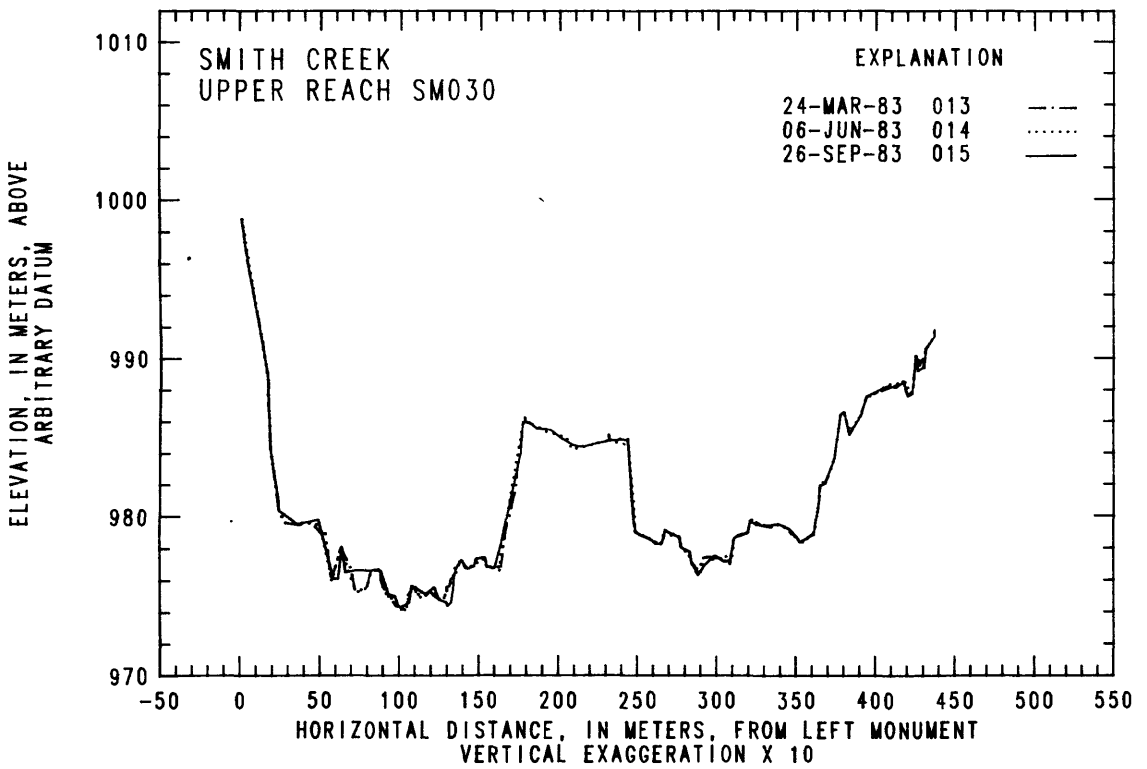


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

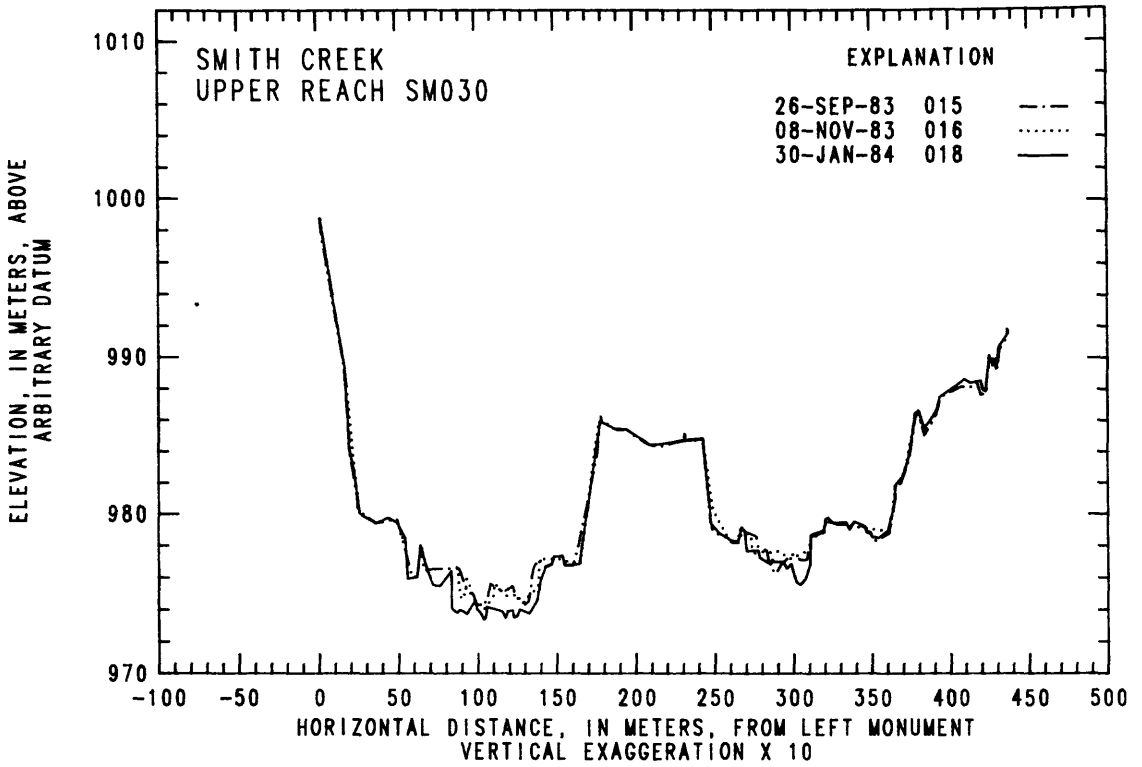


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

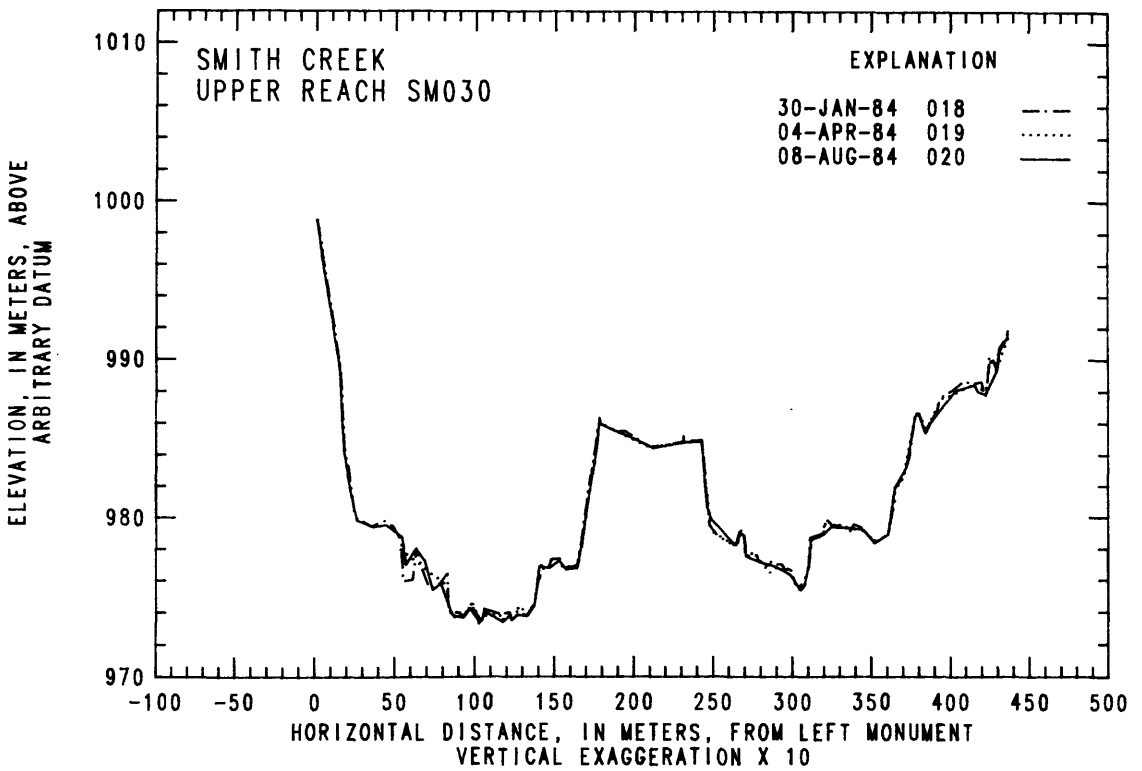


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

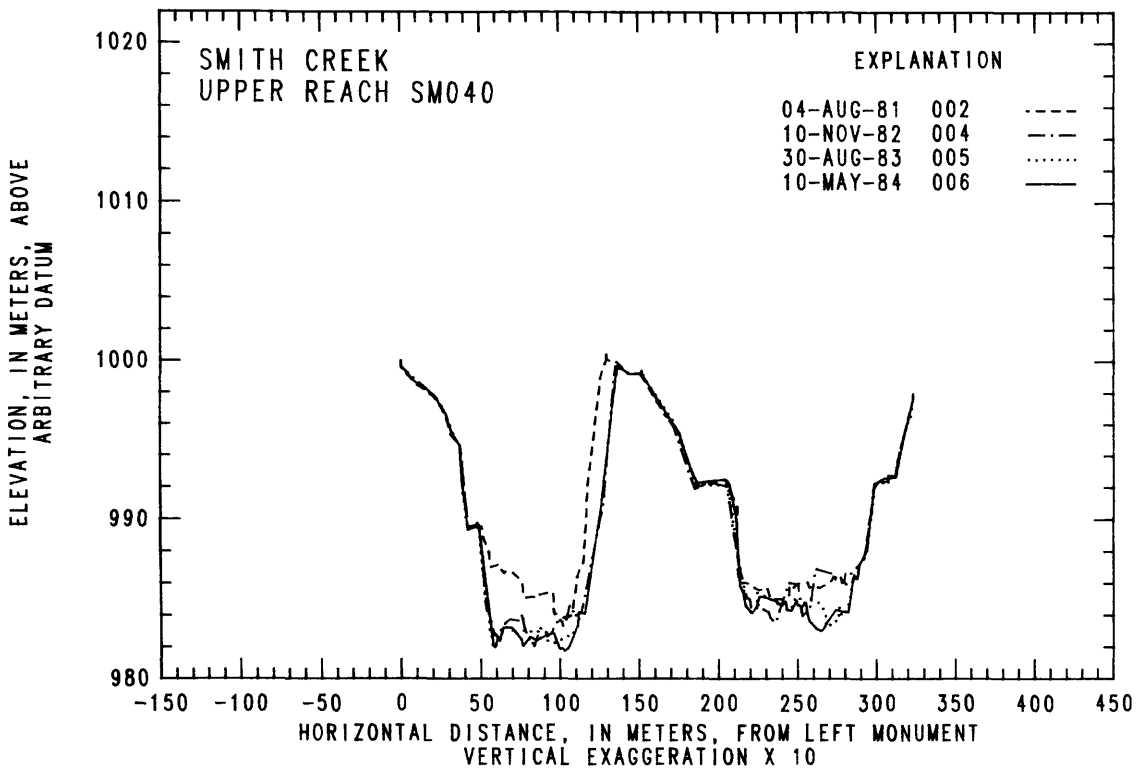


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

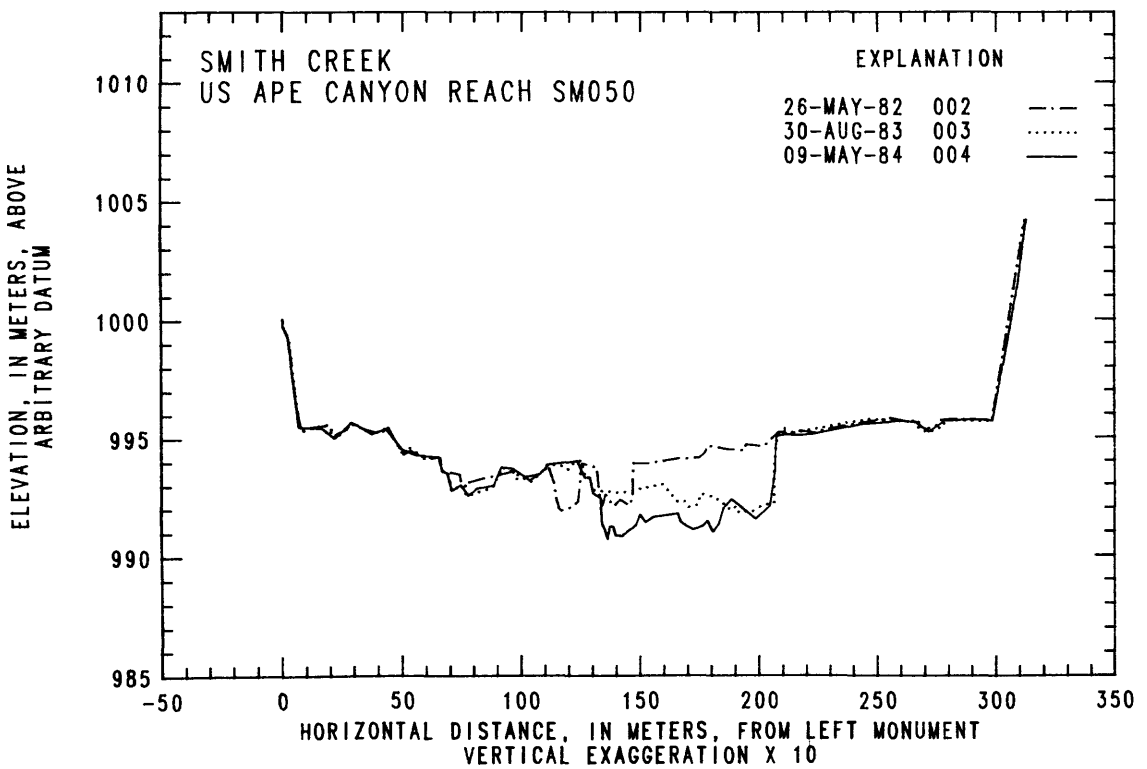


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

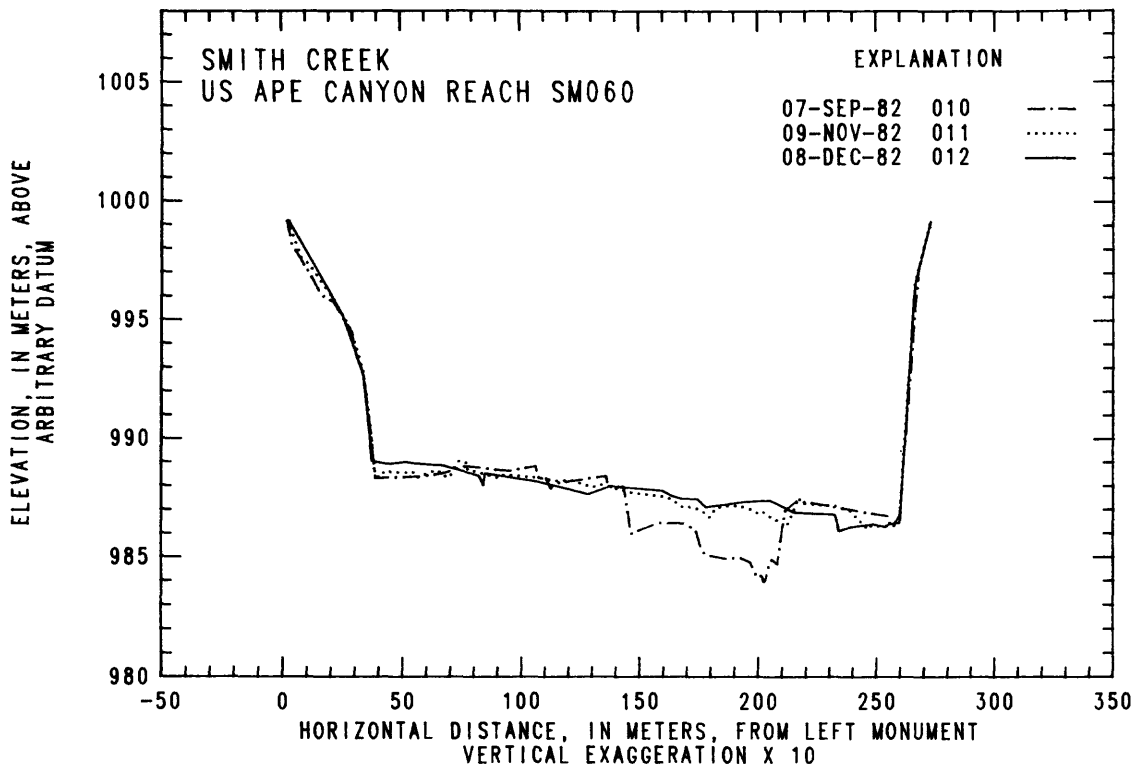


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

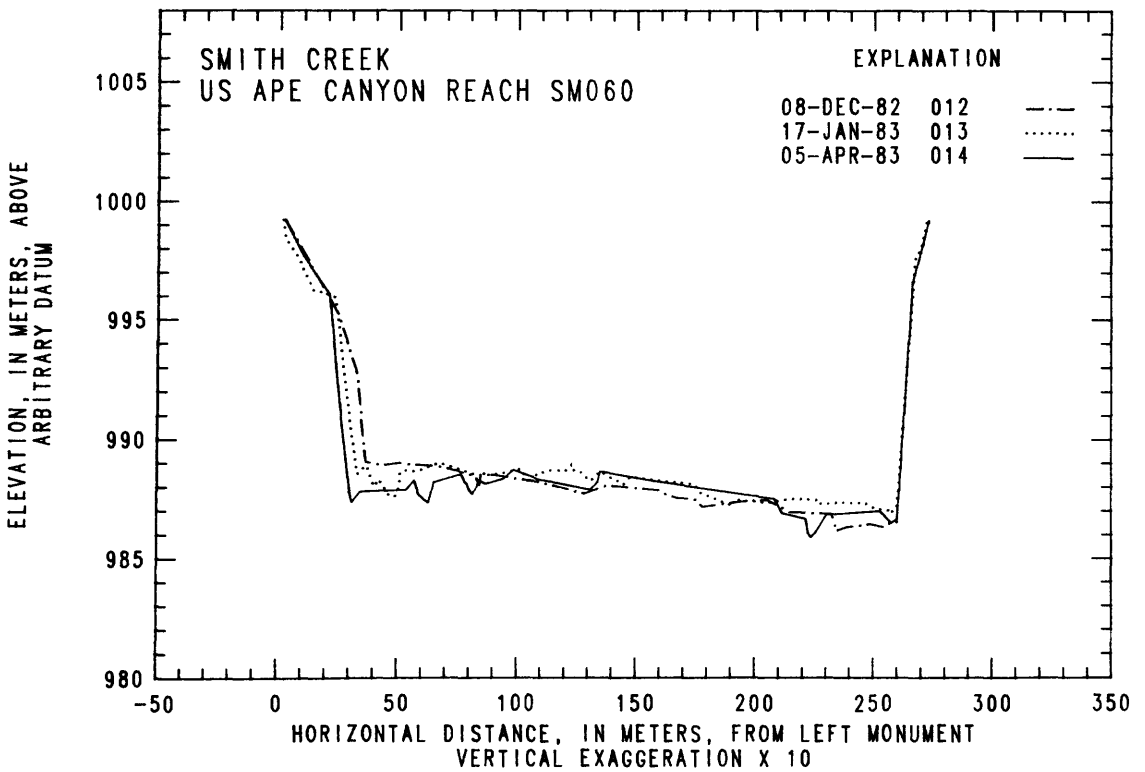


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

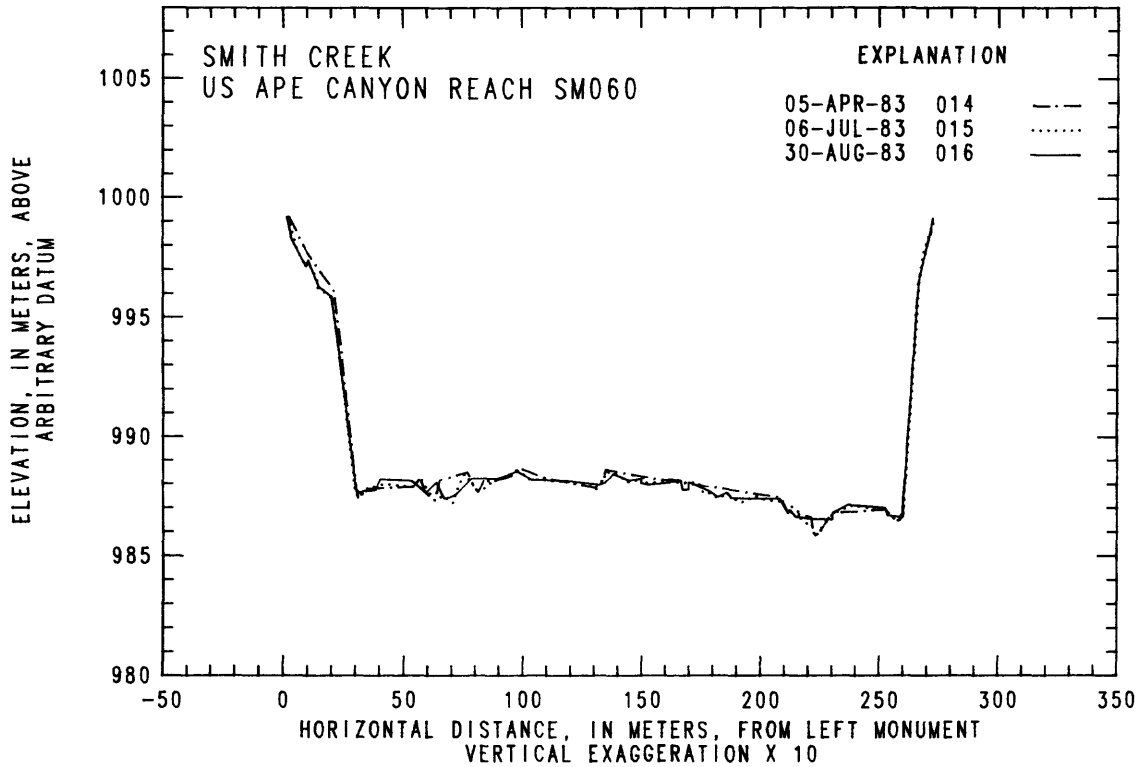


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

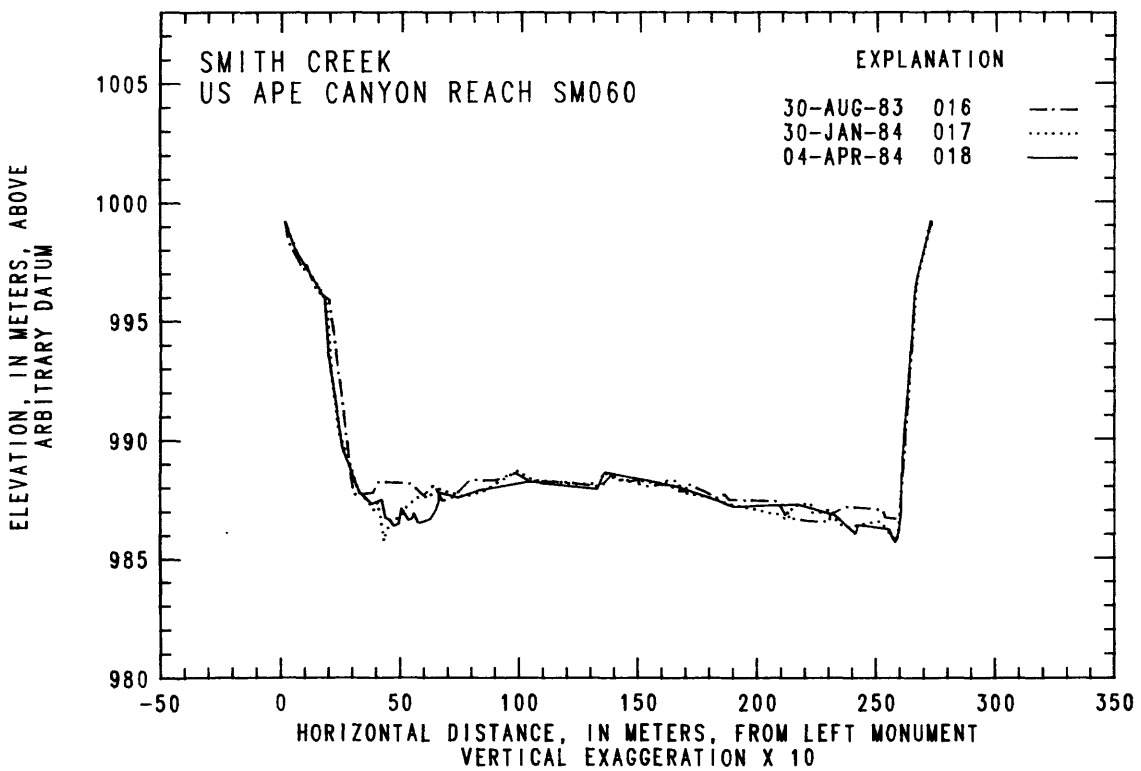


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

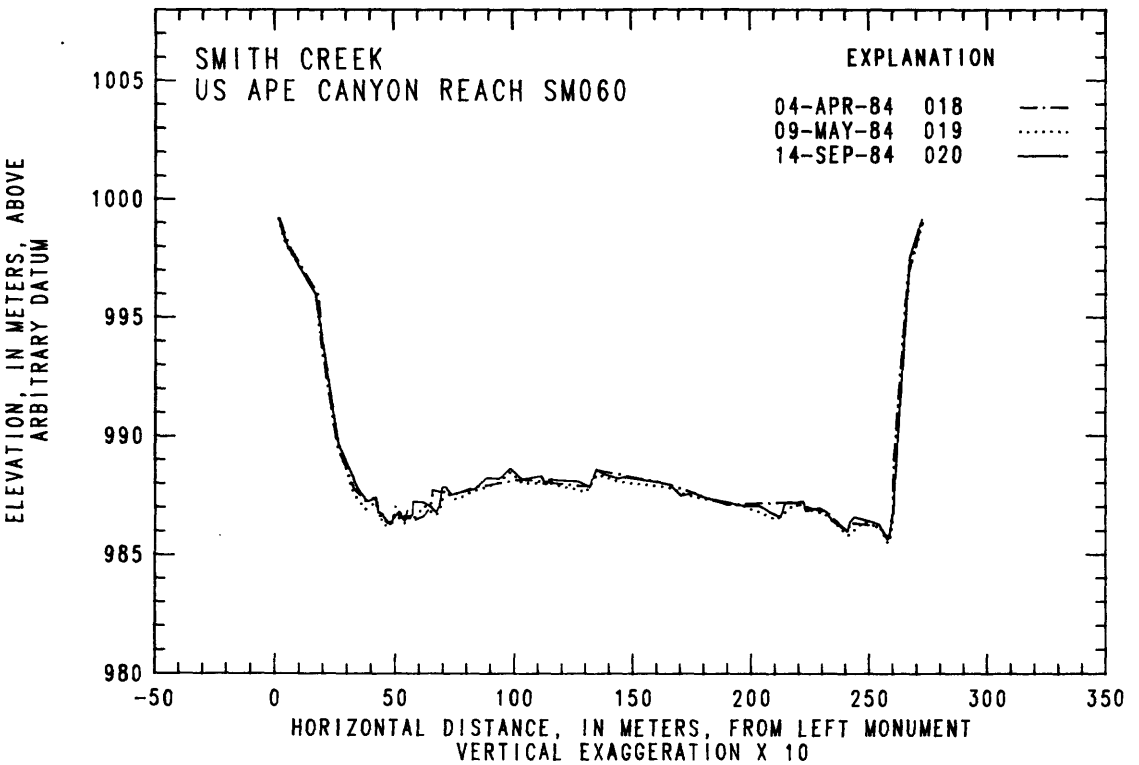


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

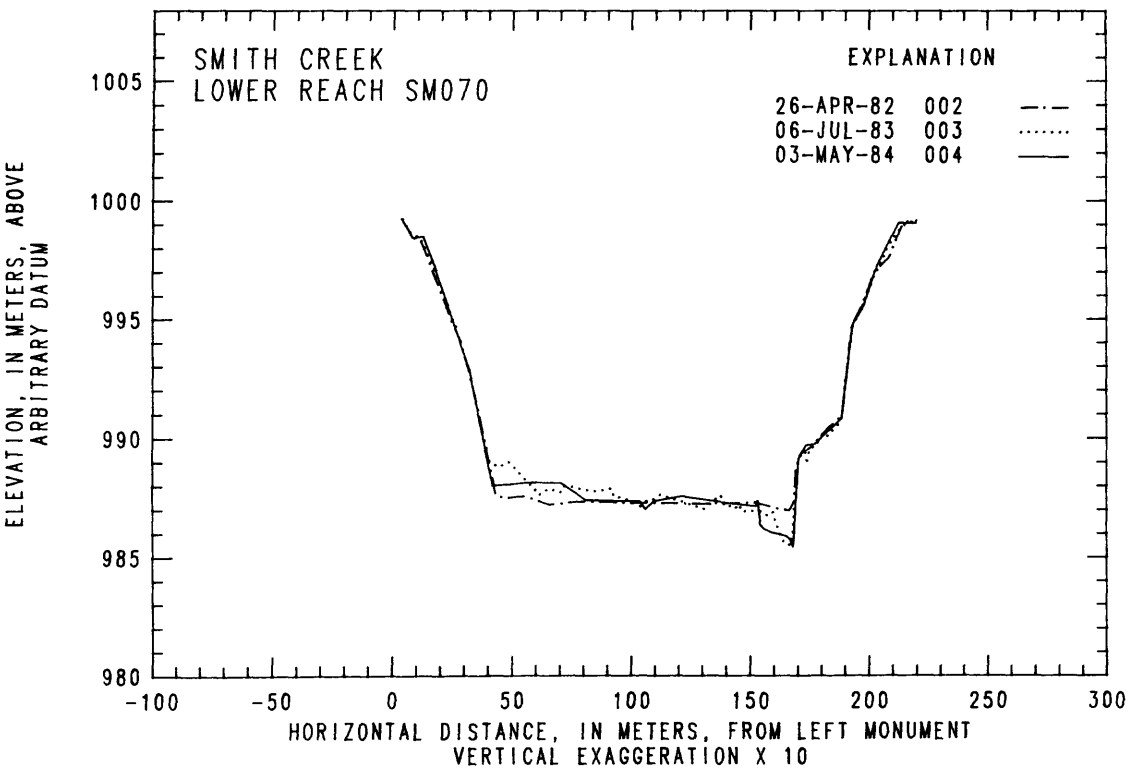


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

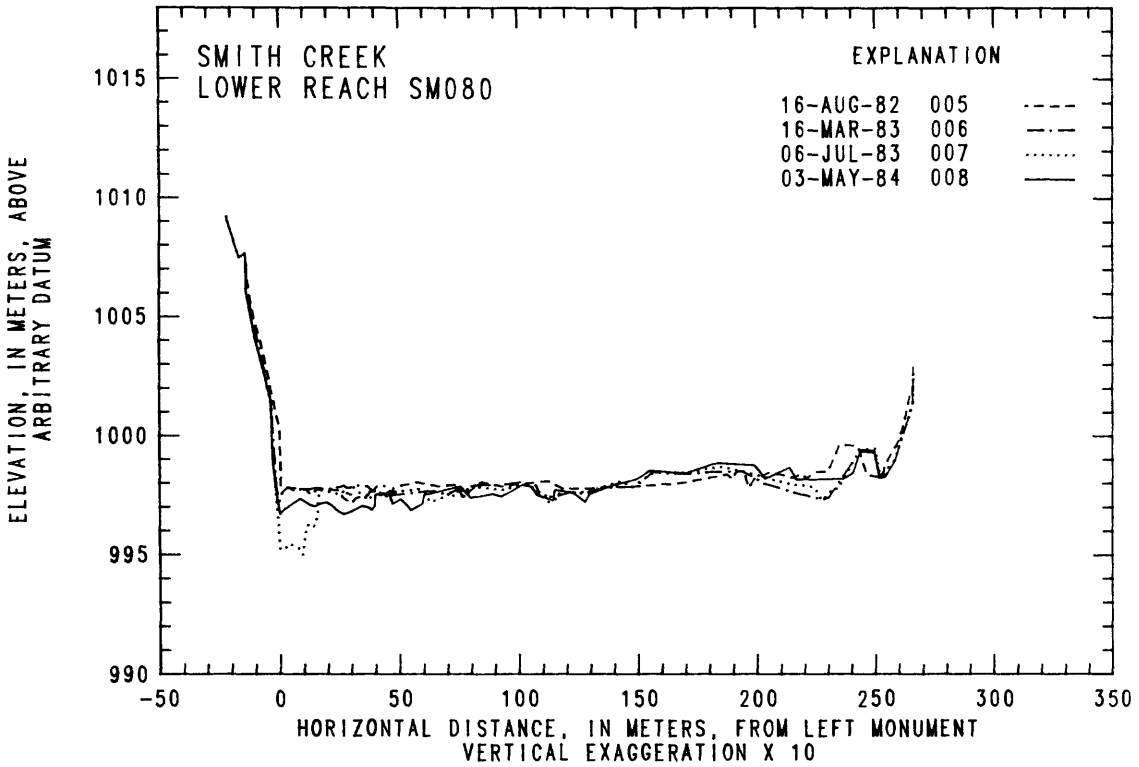


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

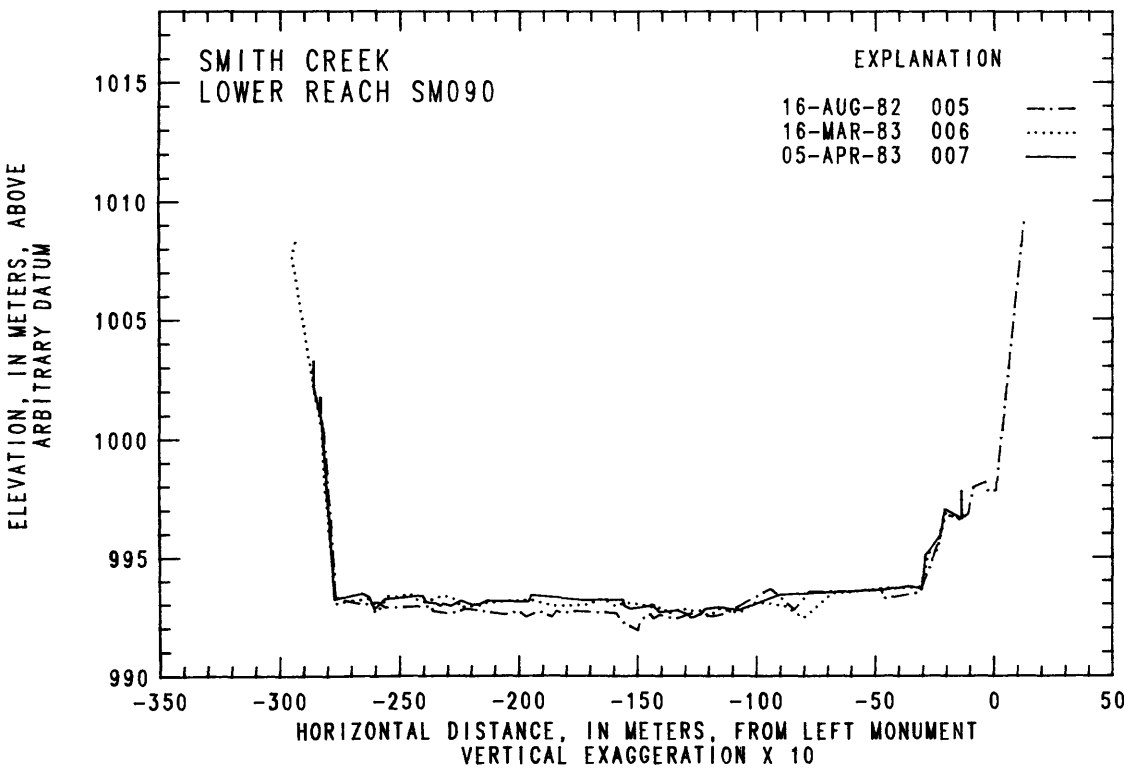


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

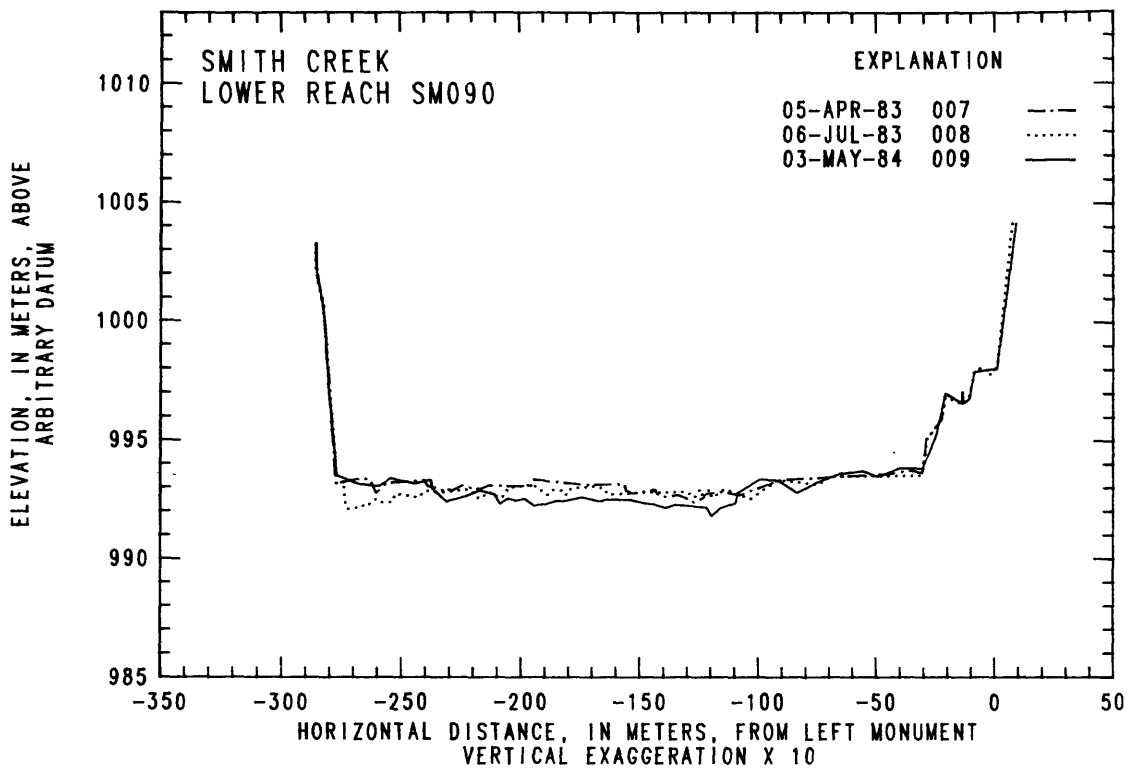


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

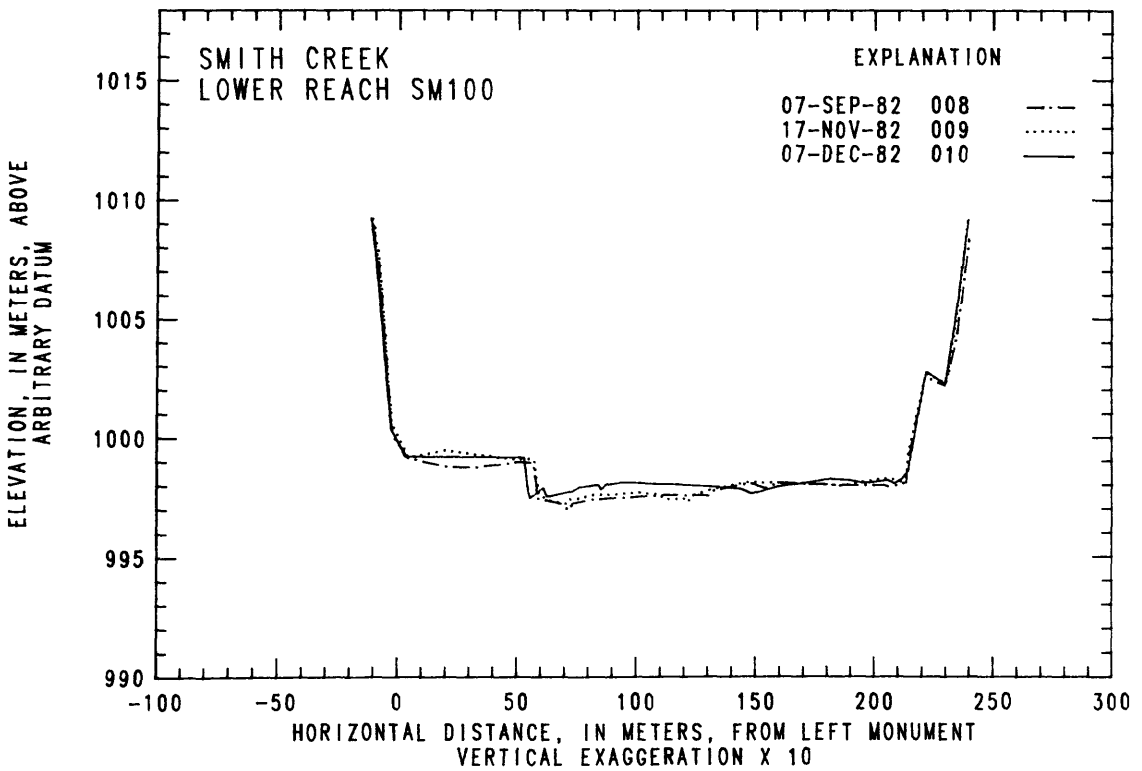


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

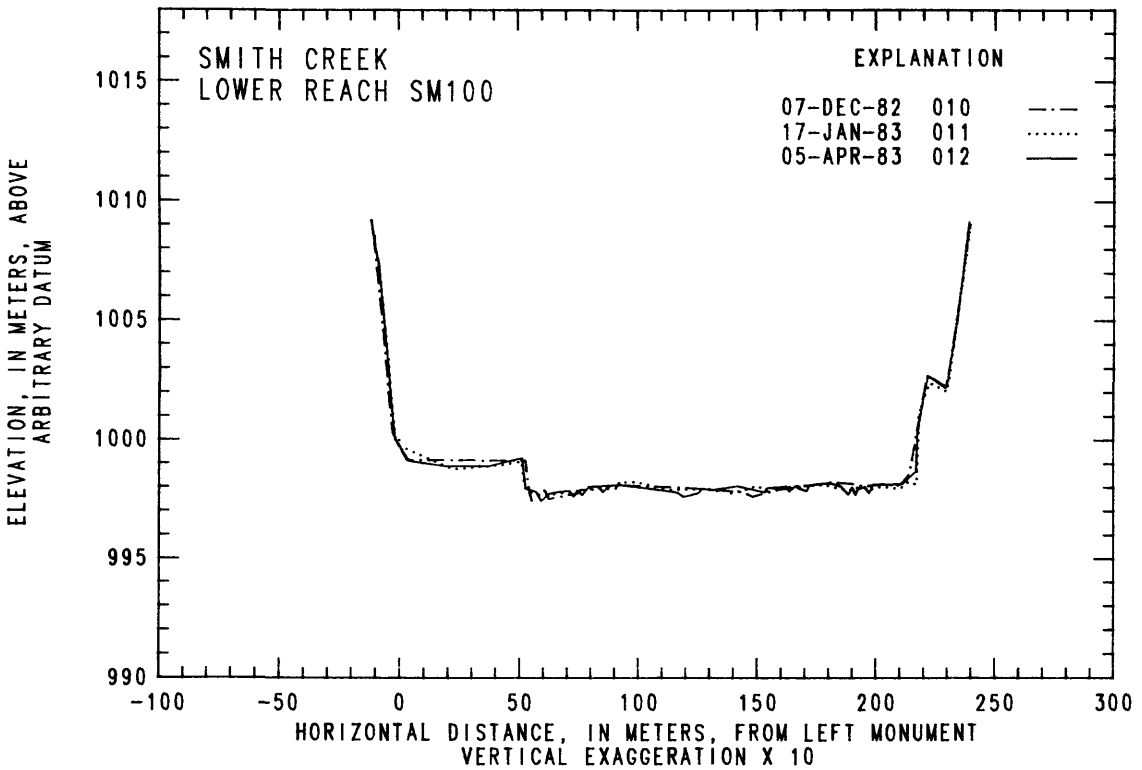


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

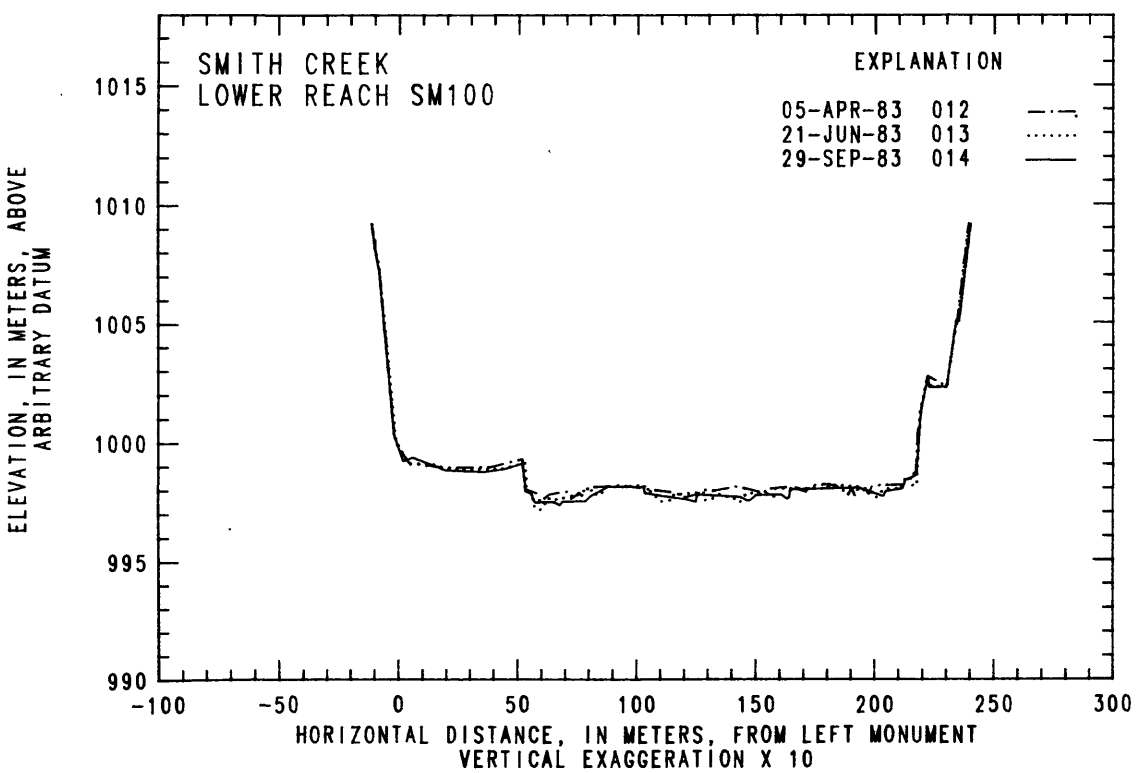


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

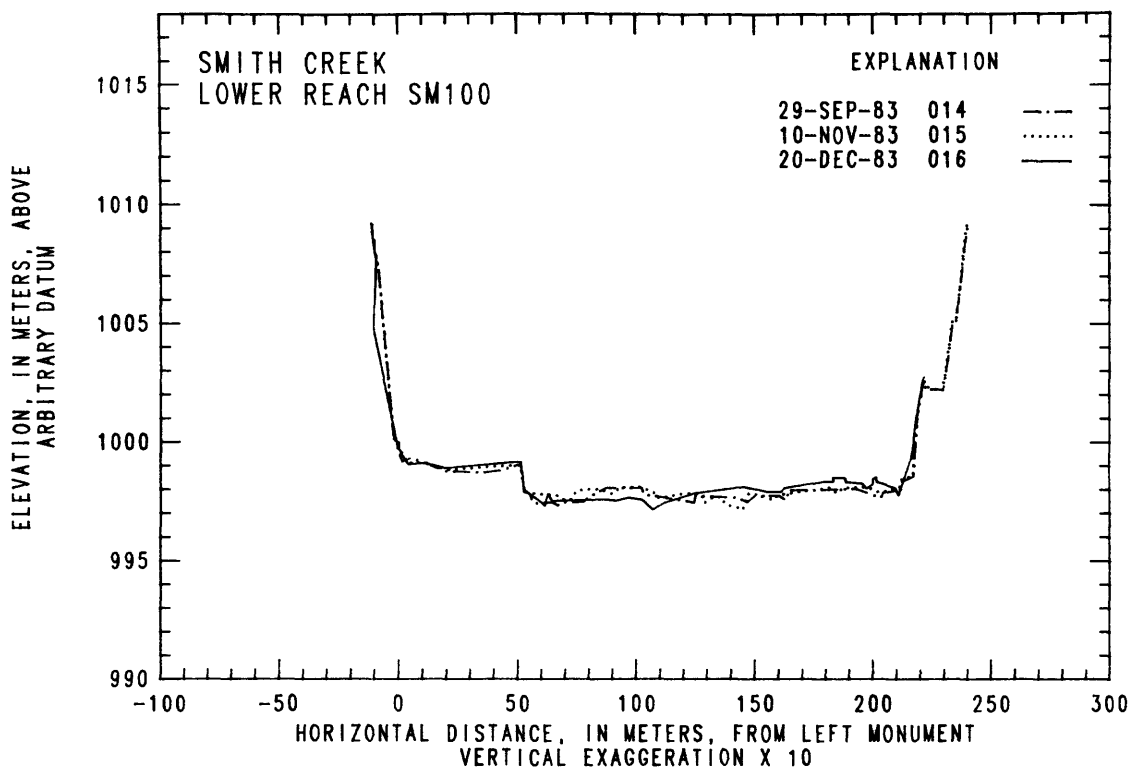


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

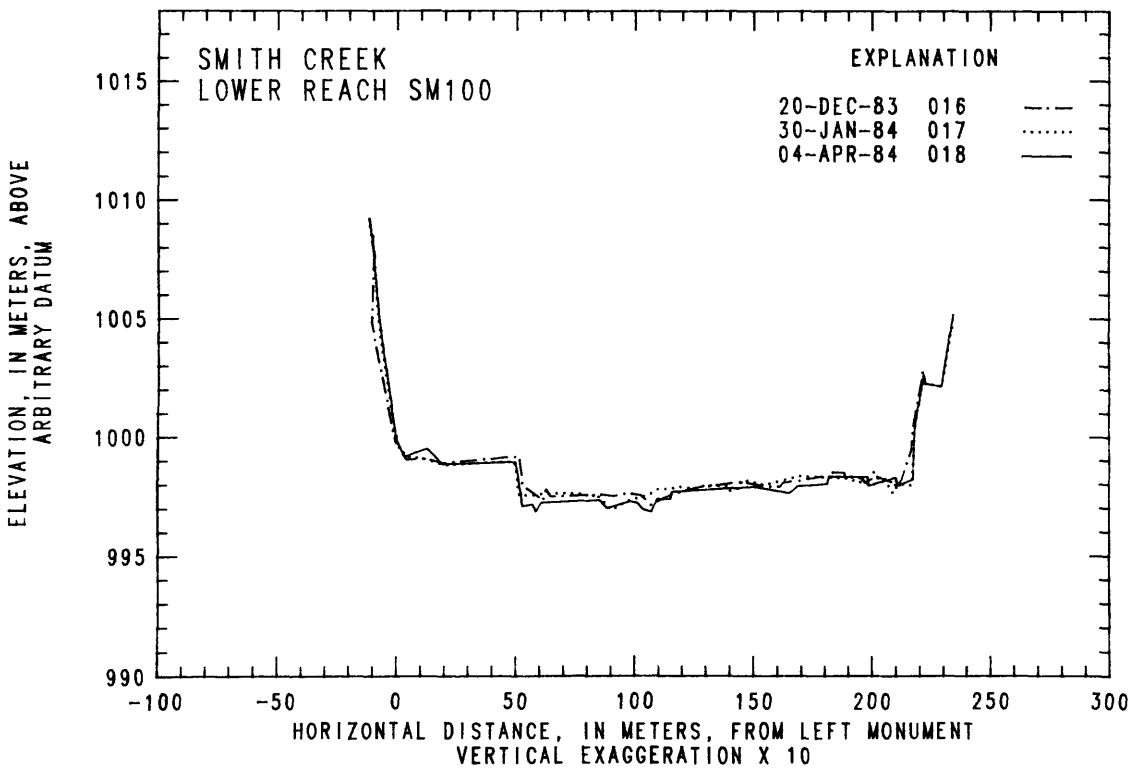


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

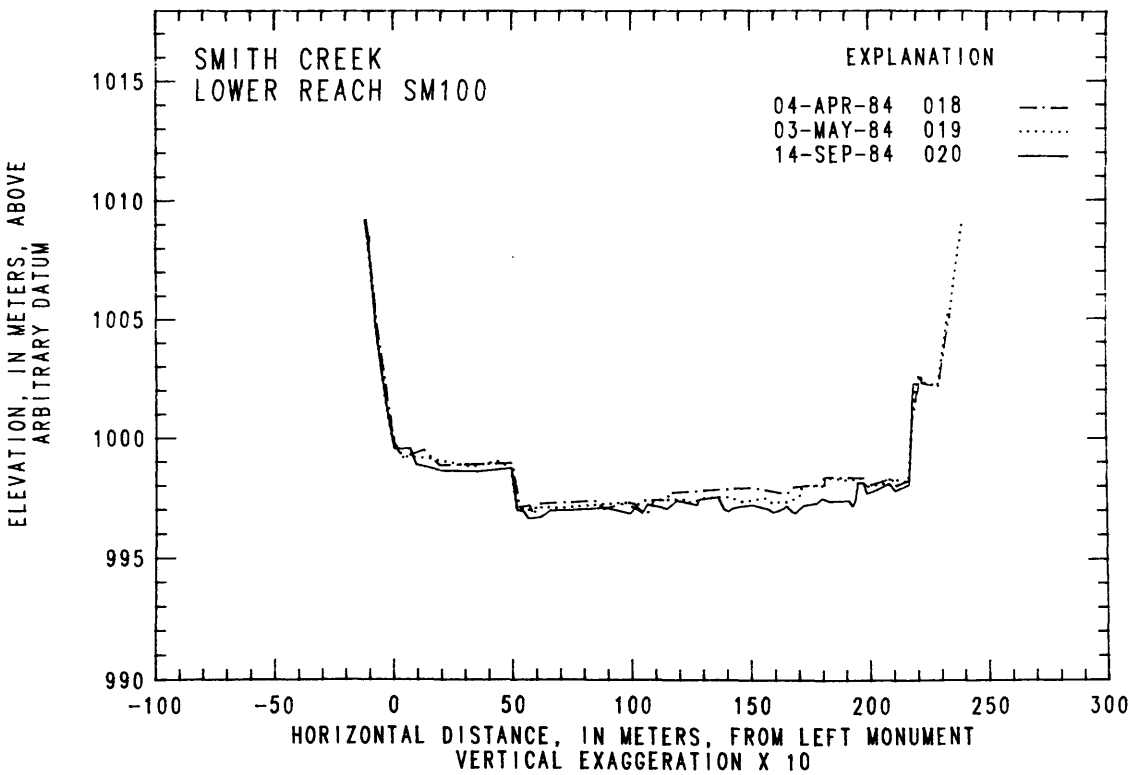


FIGURE 13. – Cross-section profiles for selected sites, Smith Creek – continued.

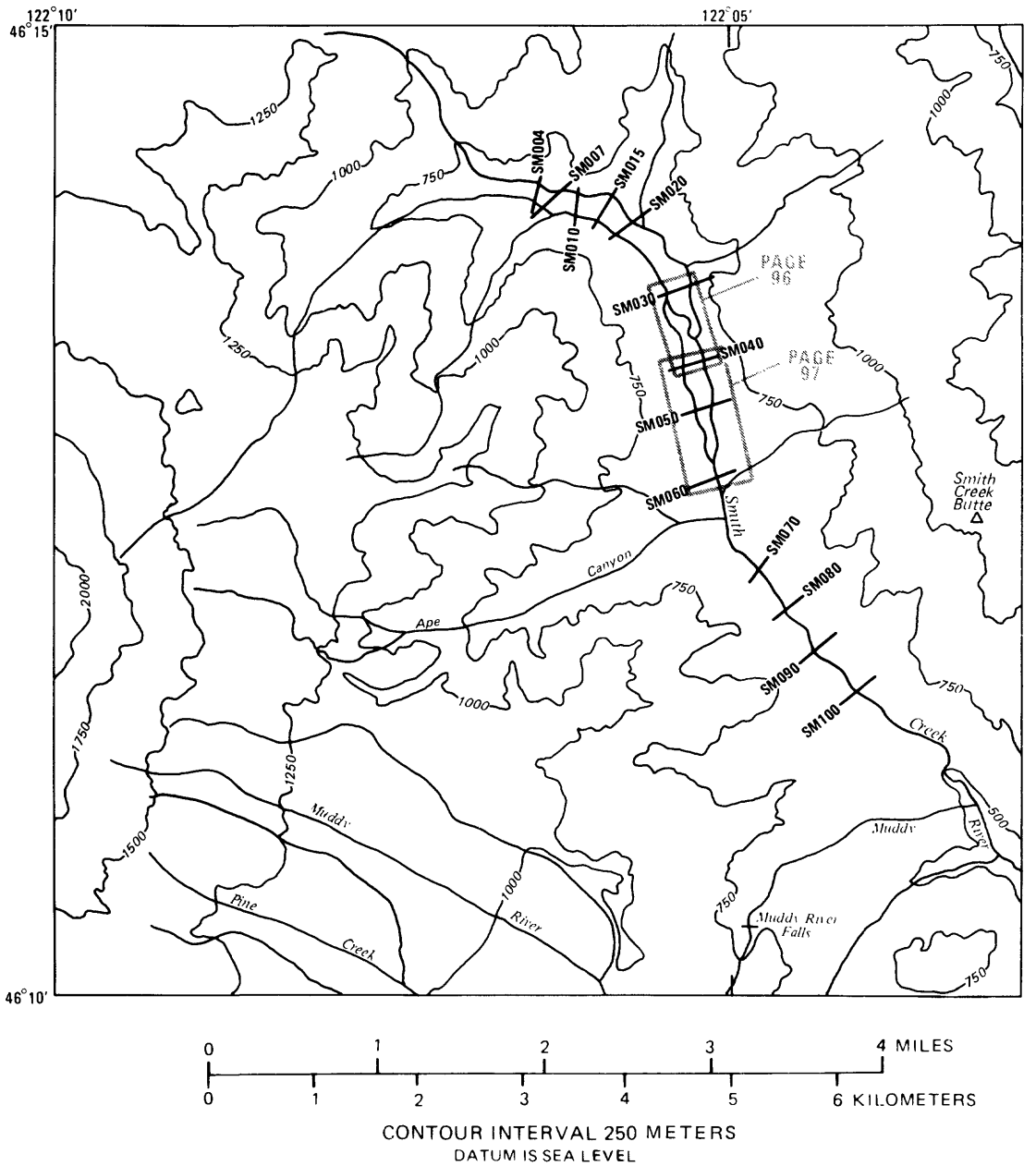
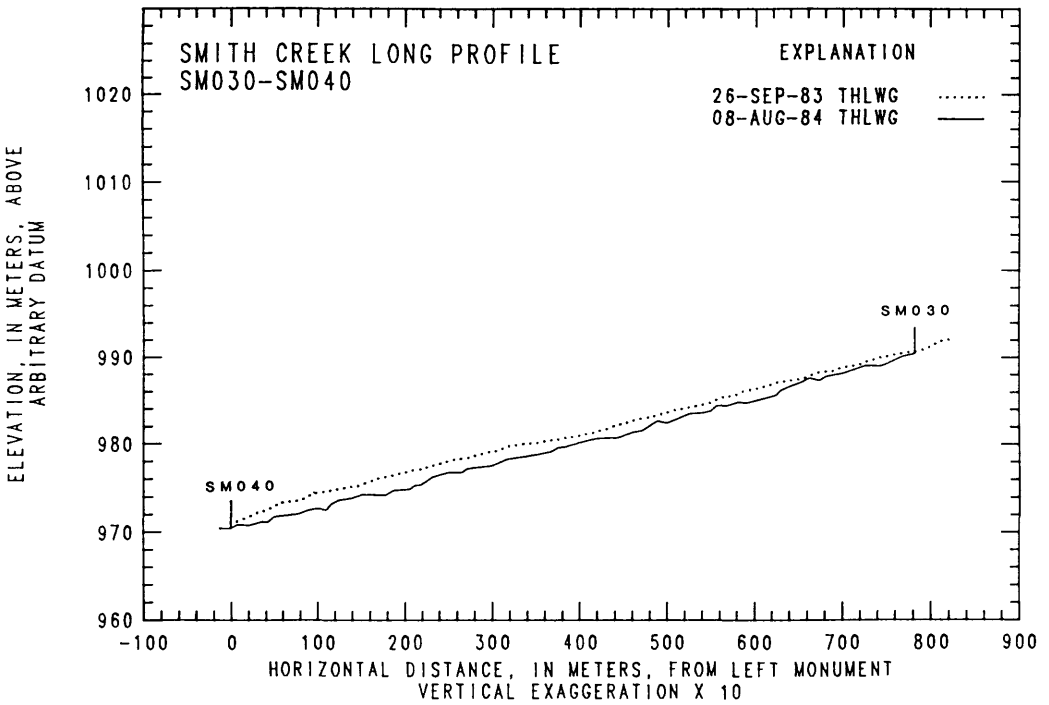


FIGURE 14. – Locations of surveyed longitudinal profiles and corresponding map views, Smith Creek.



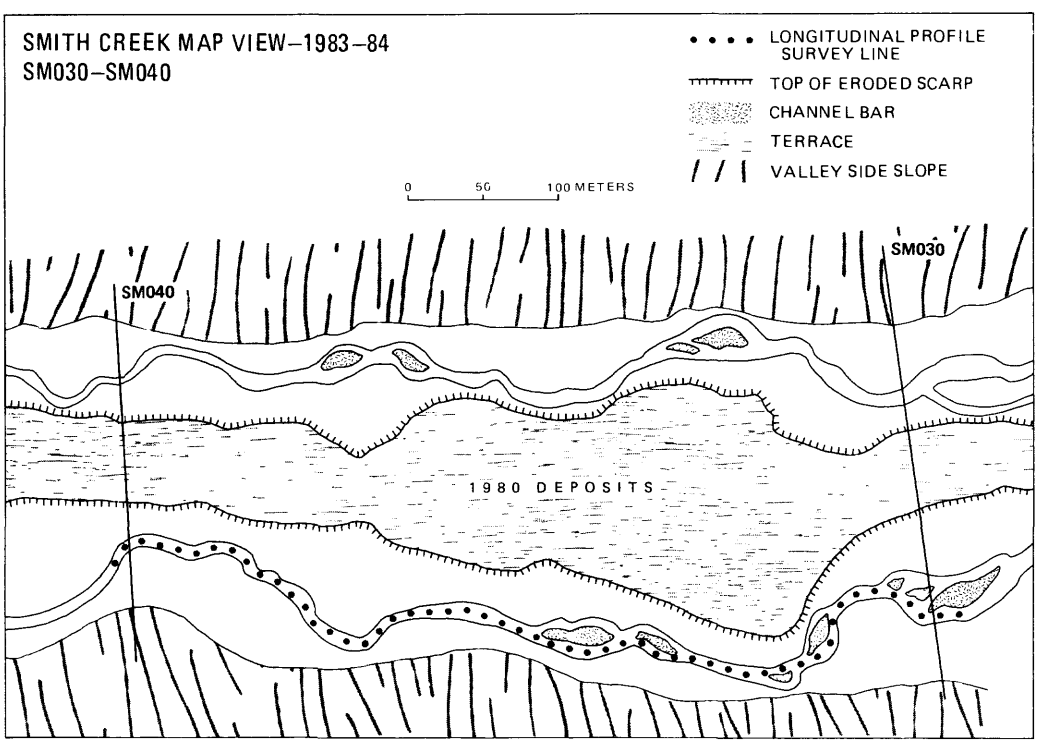
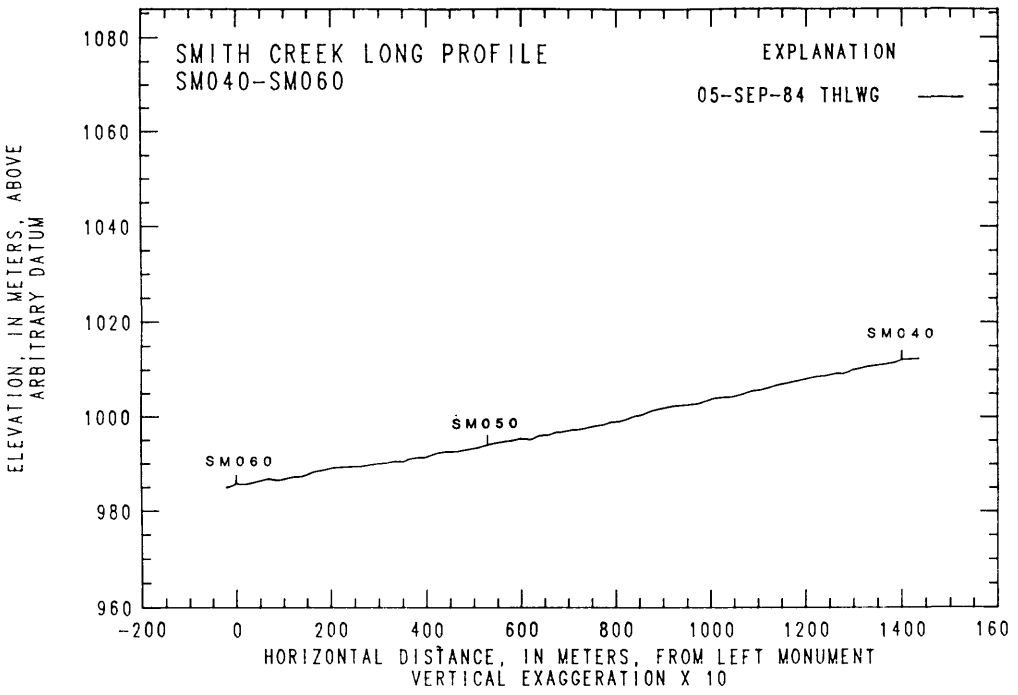
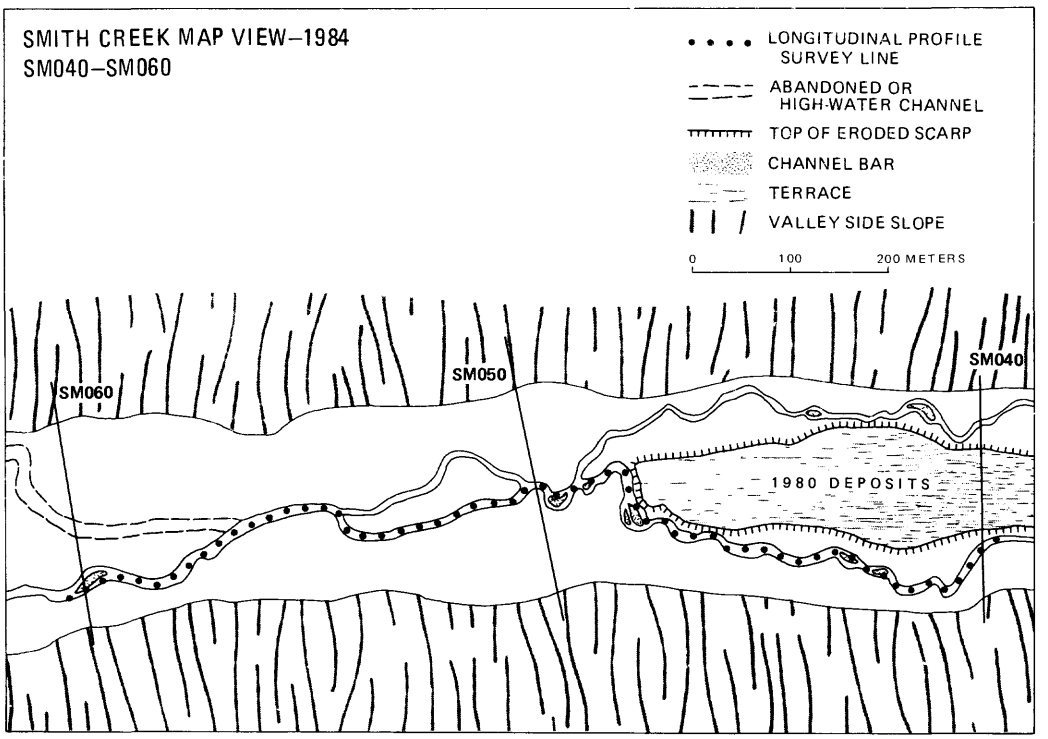


FIGURE 15. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Smith Creek.





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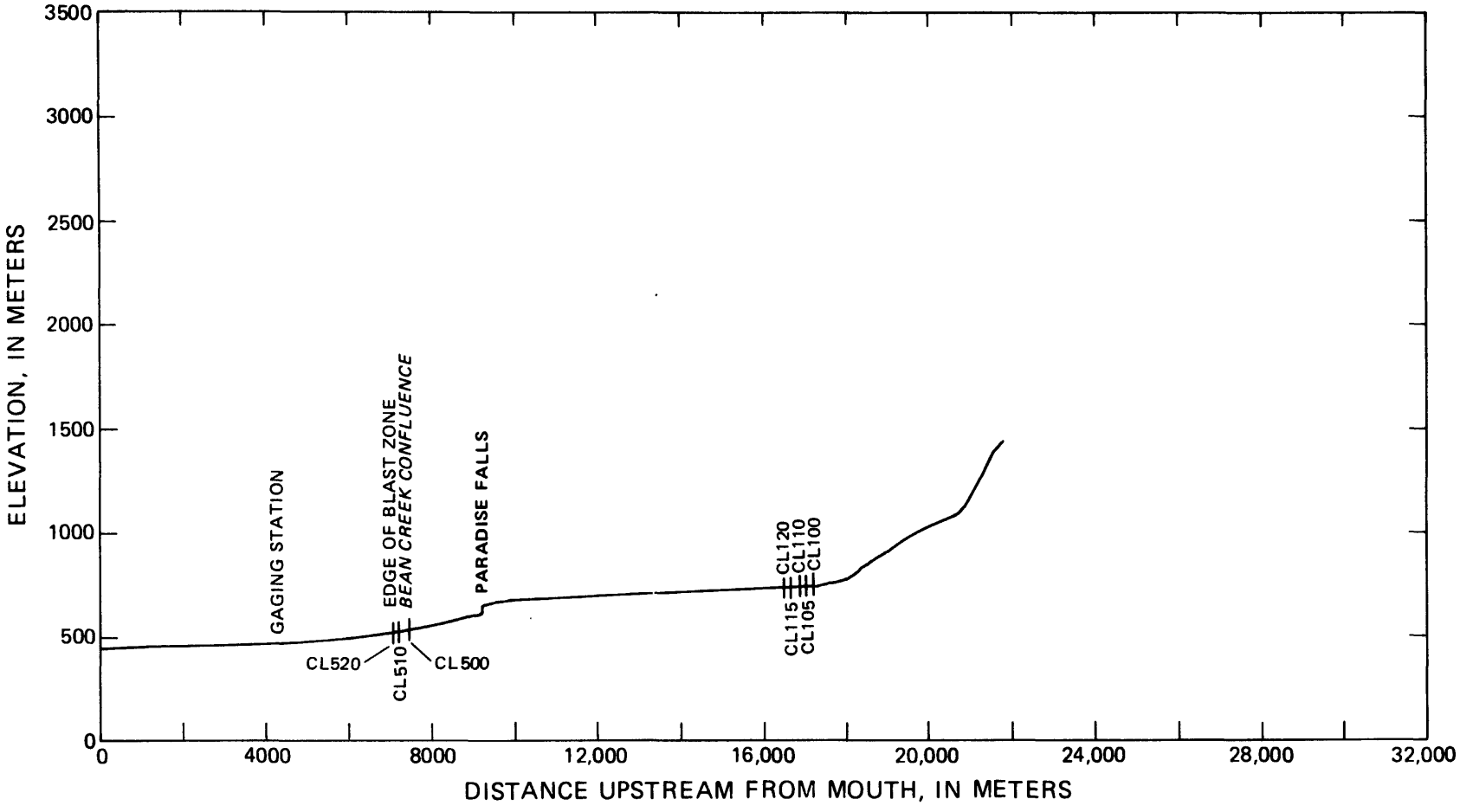


FIGURE 16. – Longitudinal profile of Clearwater Creek, showing locations of cross-section survey sites. Channel distance upstream from mouth and elevation above sea level are determined from U.S. Geological Survey topographic maps, 7.5-minute series, Mount St. Helens NE and Spirit Lake SE quadrangles.

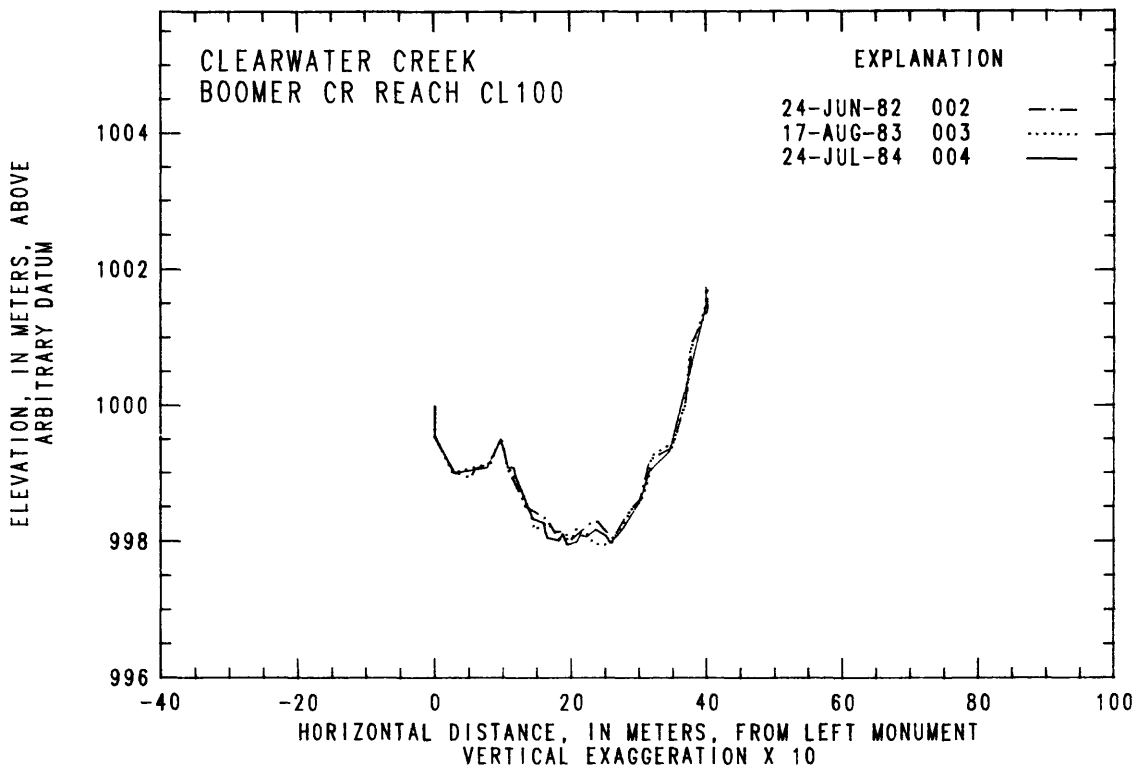


FIGURE 17. – Cross-section profiles for selected sites, Clearwater Creek.

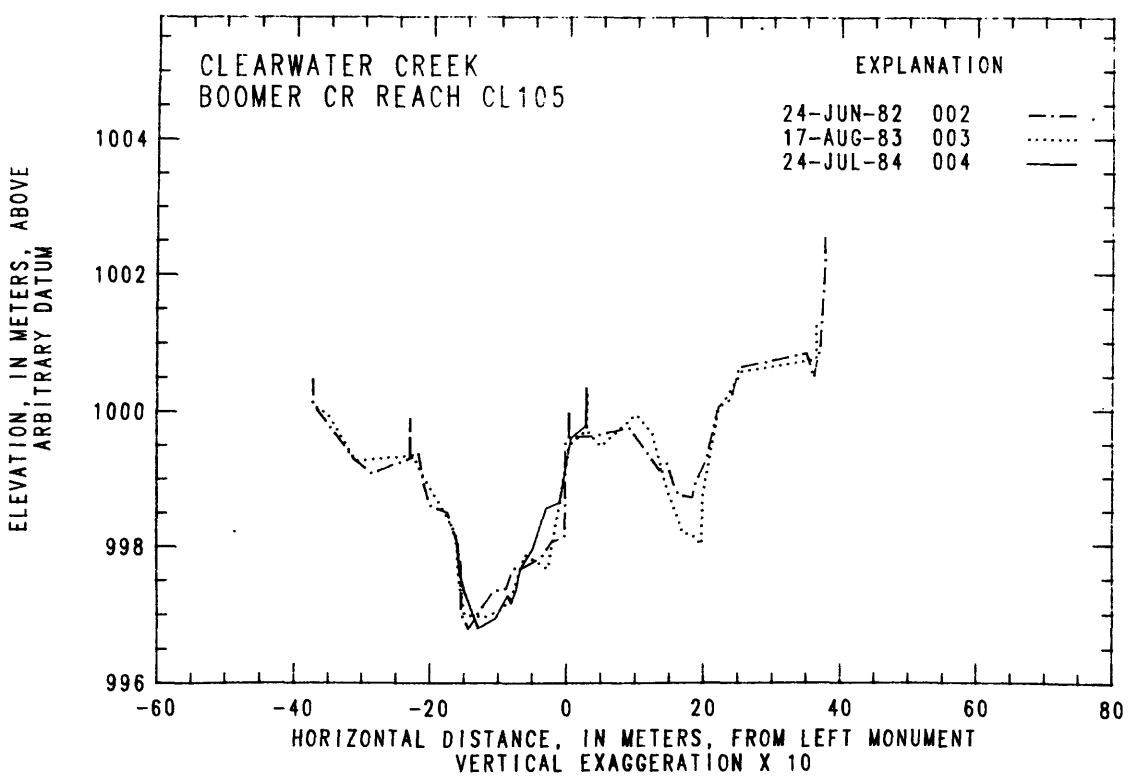


FIGURE 17. – Cross-section profiles for selected sites, Clearwater Creek – continued.

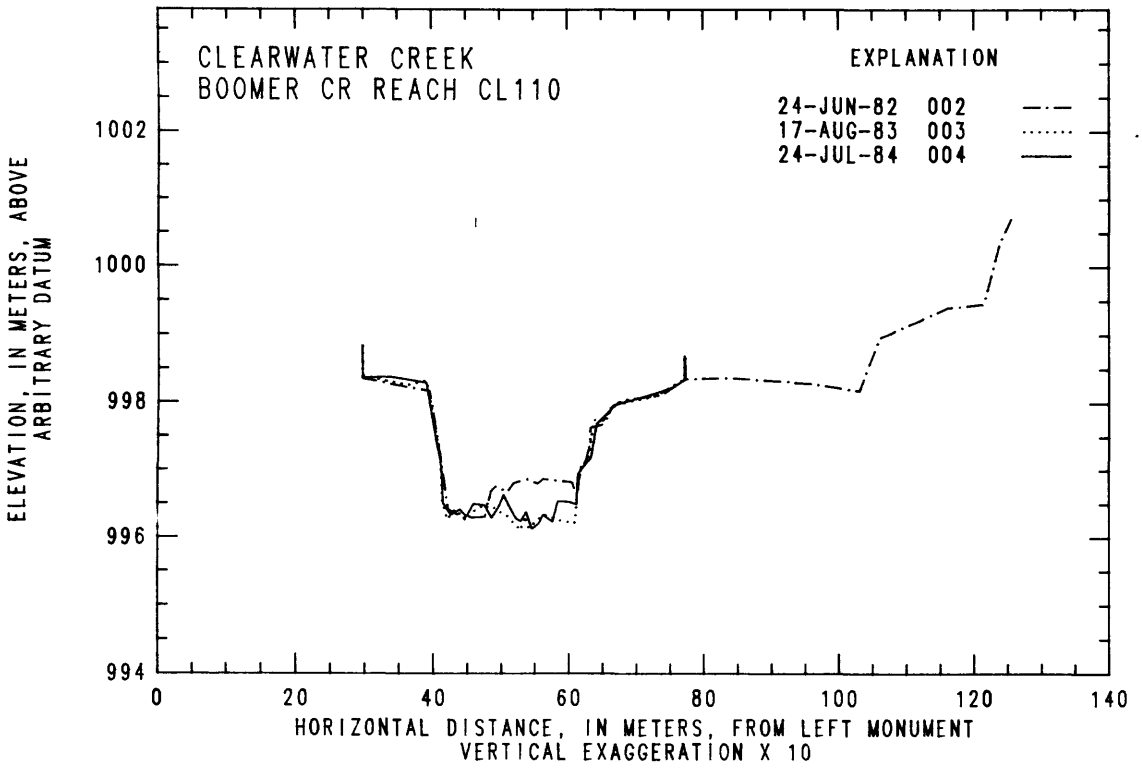


FIGURE 17. – Cross-section profiles for selected sites, Clearwater Creek – continued.

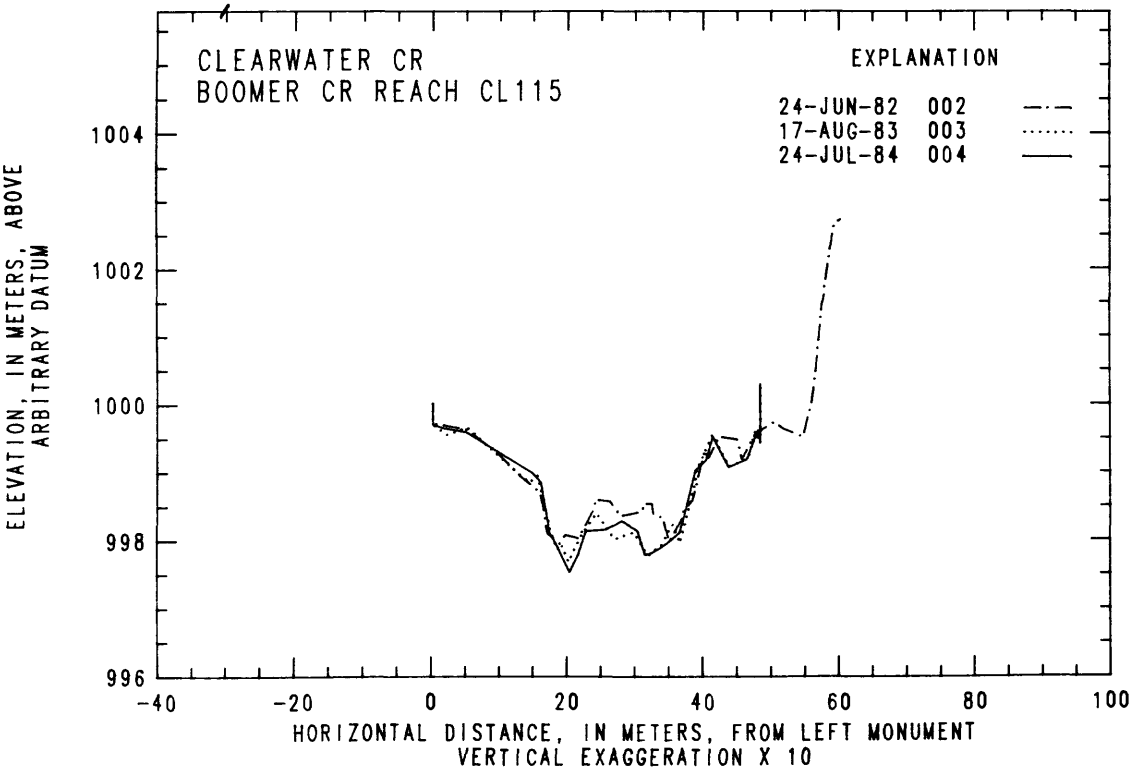


FIGURE 17. – Cross-section profiles for selected sites, Clearwater Creek – continued.

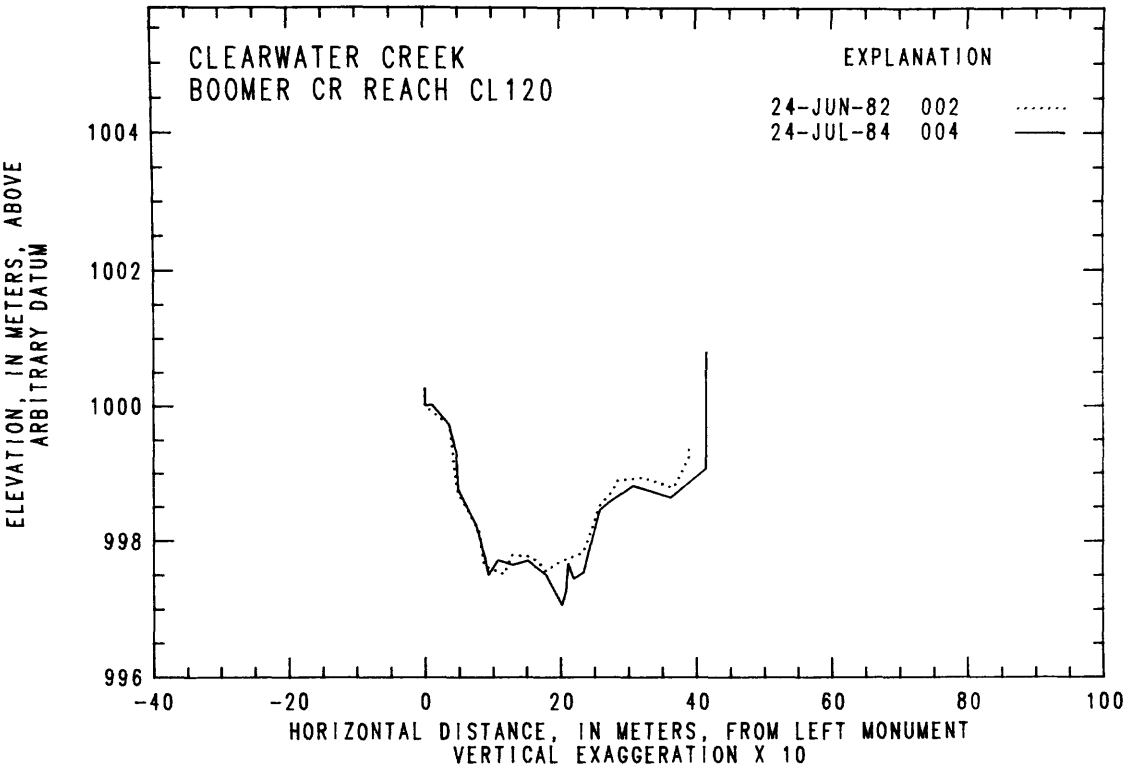
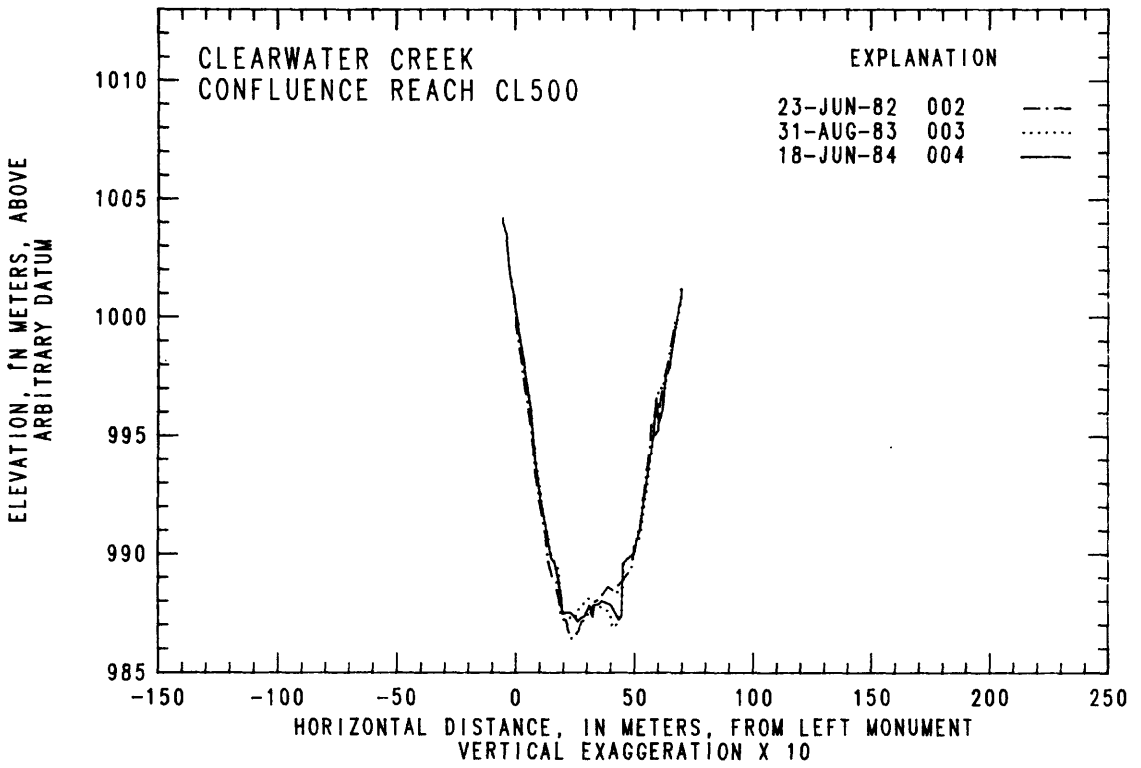


FIGURE 17. – Cross-section profiles for selected sites, Clearwater Creek – continued.



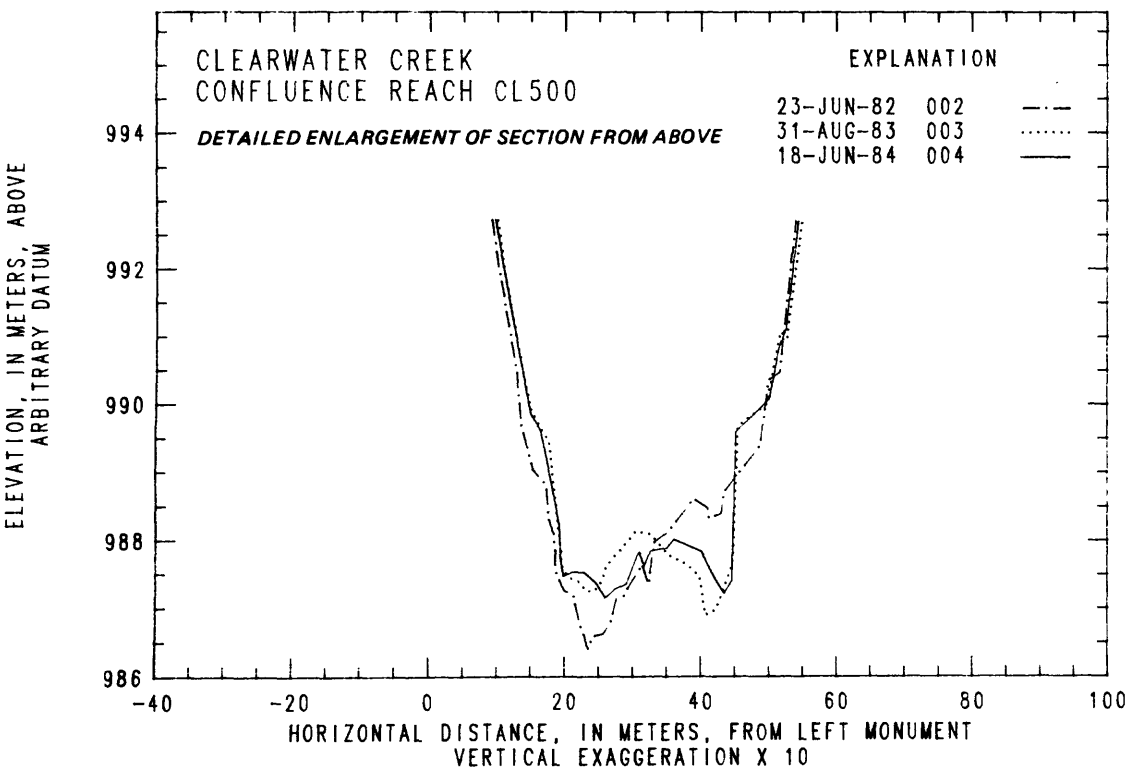


FIGURE 17. – Cross-section profiles for selected sites, Clearwater Creek – continued.

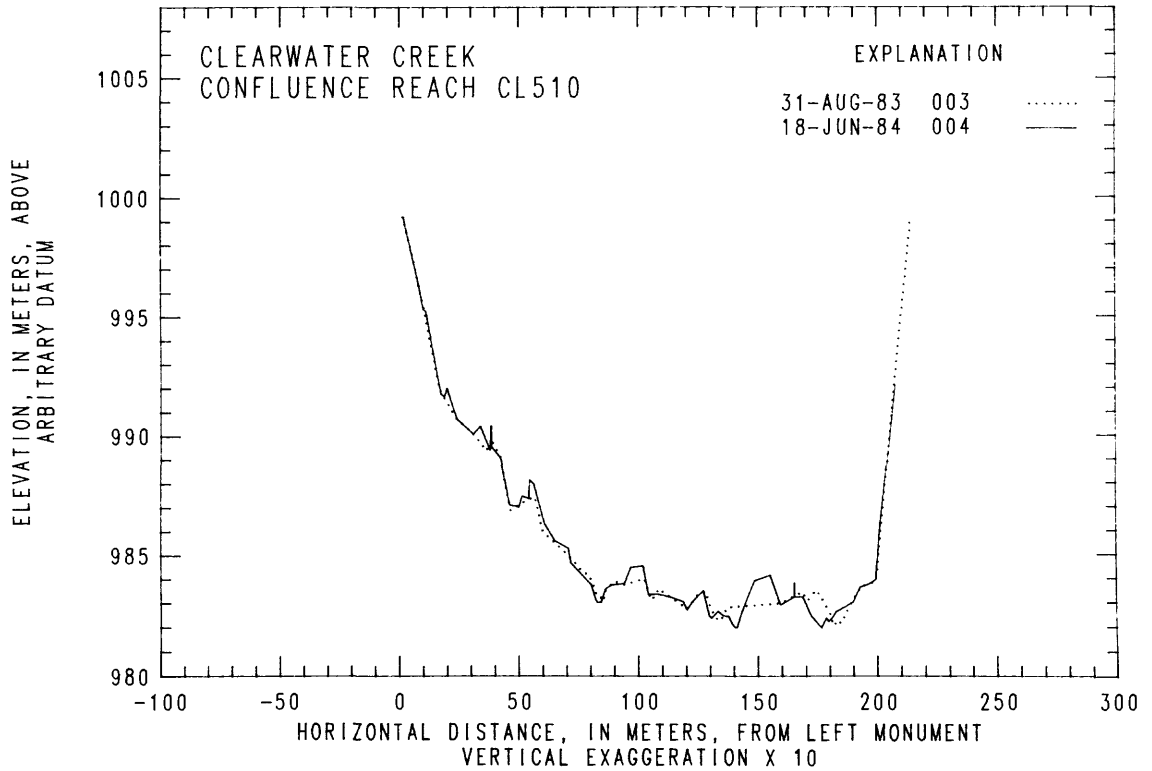
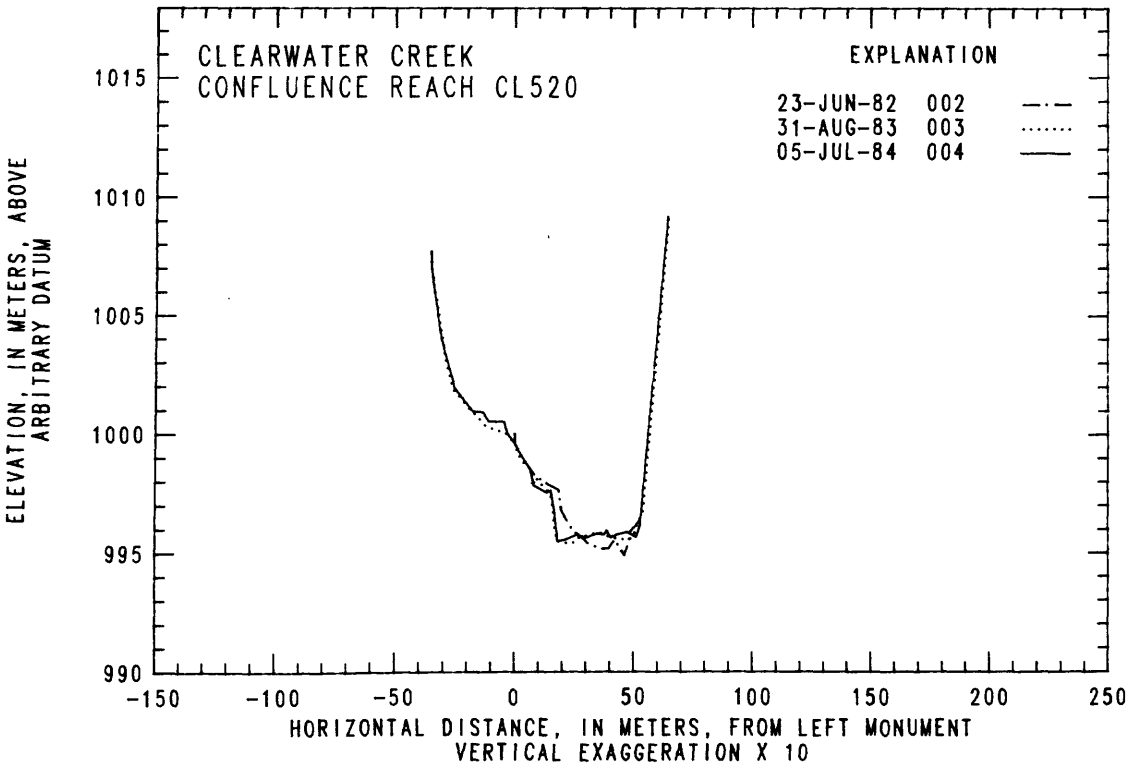


FIGURE 17. – Cross-section profiles for selected sites, Clearwater Creek – continued.



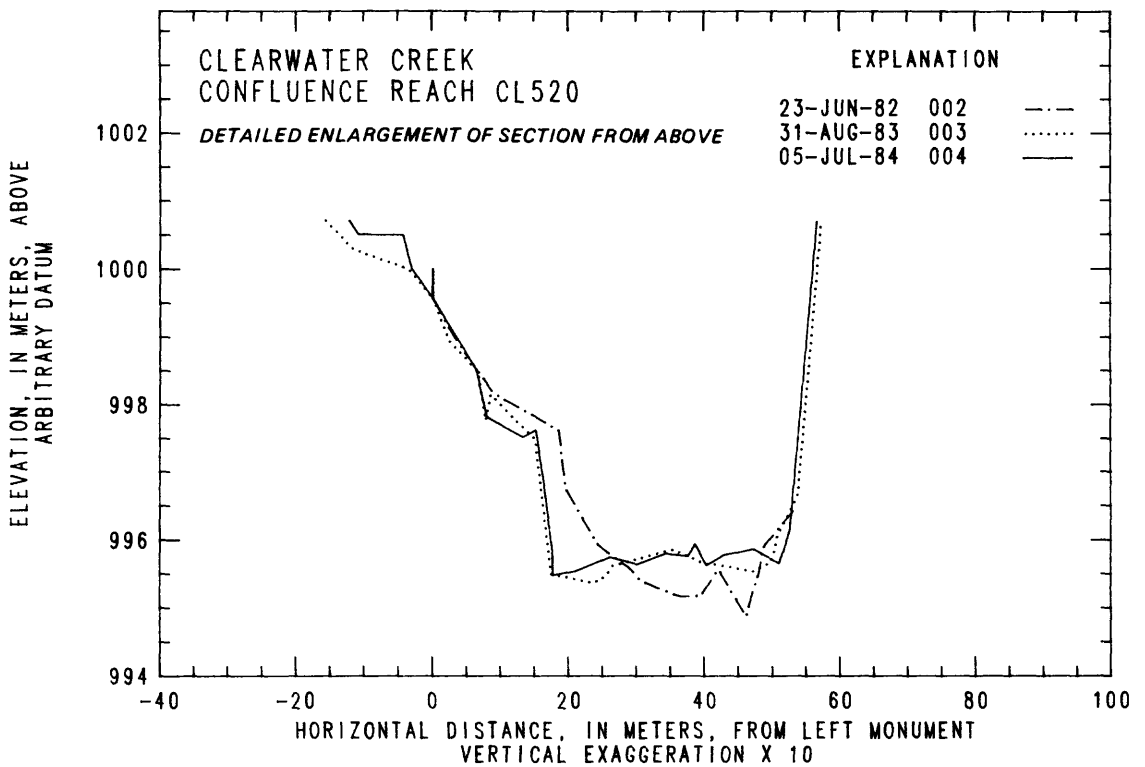


FIGURE 17. – Cross-section profiles for selected sites, Clearwater Creek – continued.

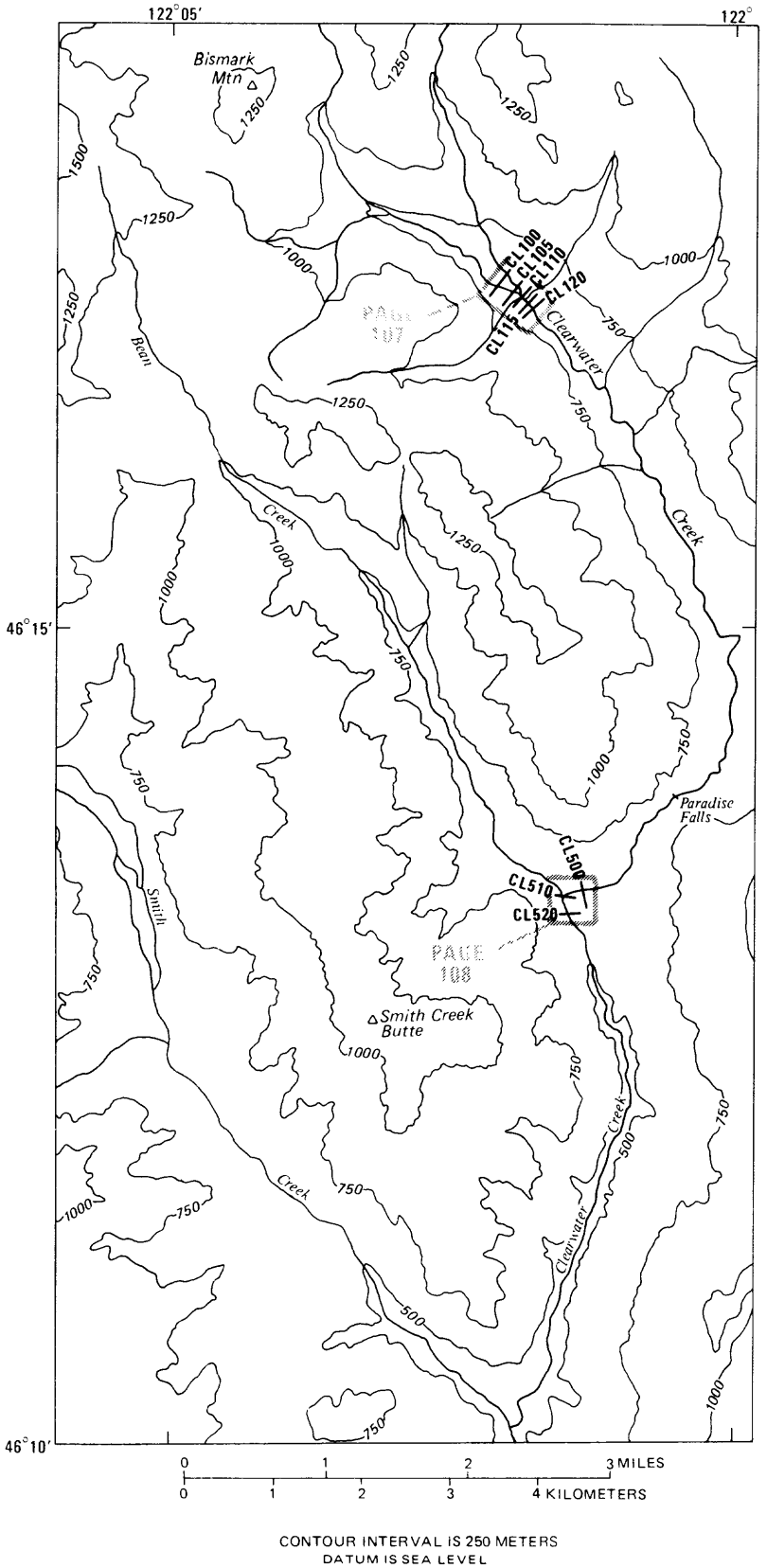
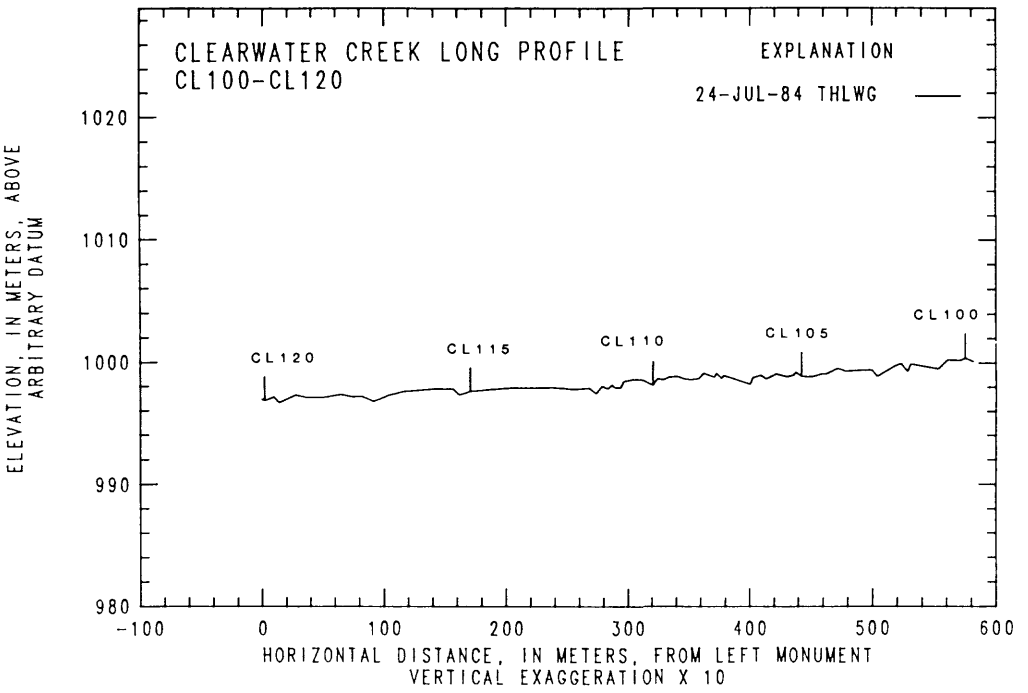


FIGURE 18. – Locations of surveyed longitudinal profiles and corresponding map views, Clearwater Creek.



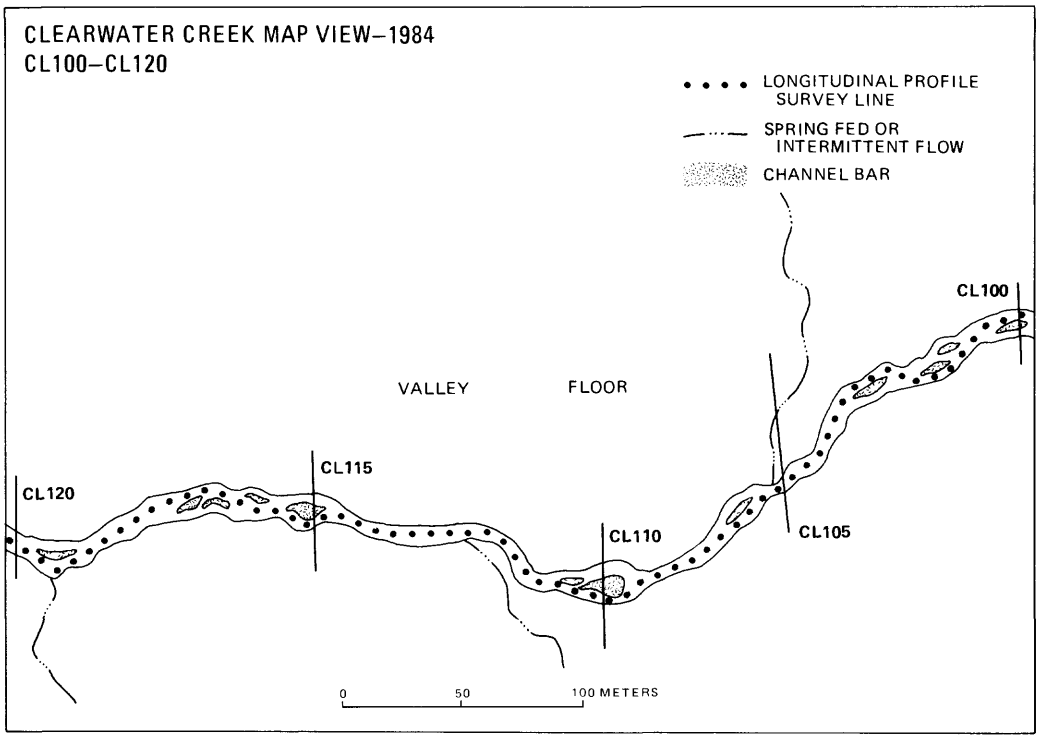
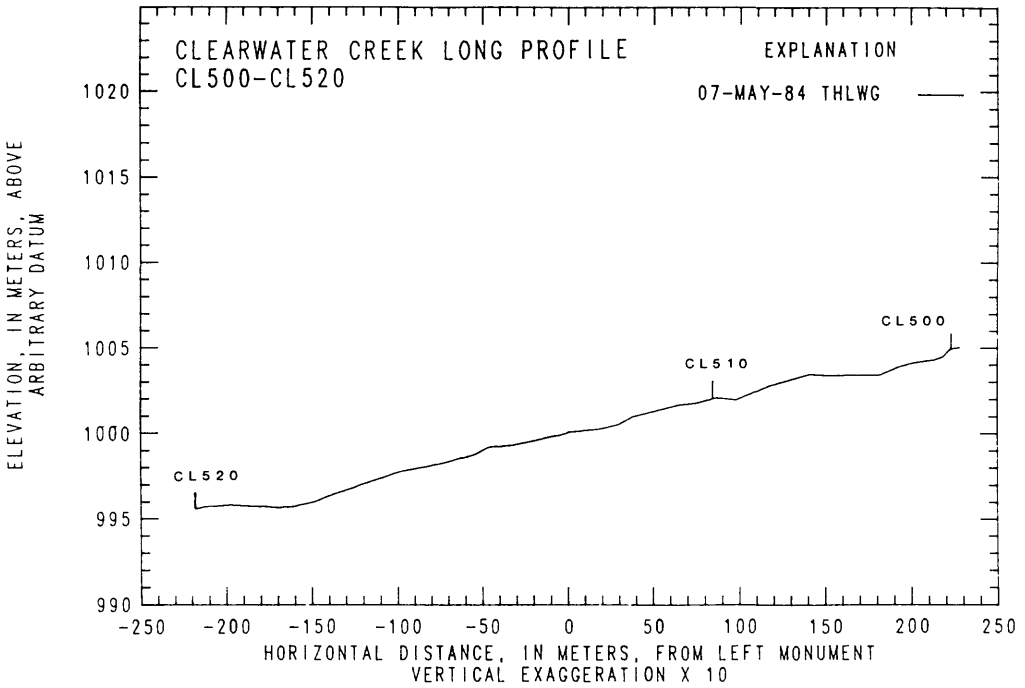


FIGURE 19. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Clearwater Creek.



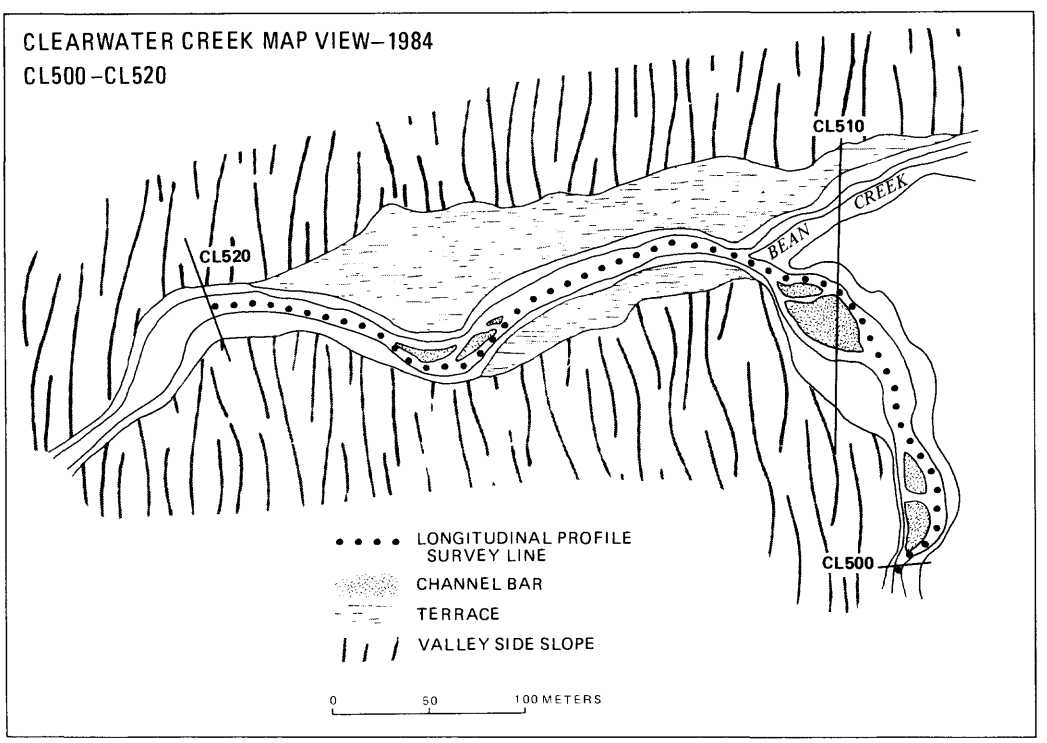


FIGURE 19. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Clearwater Creek – continued.

INDEX TO BEAN CREEK CROSS-SECTION SITES

As an aid to the reader, listed below are the individual cross-section site numbers and corresponding page number of the plot.

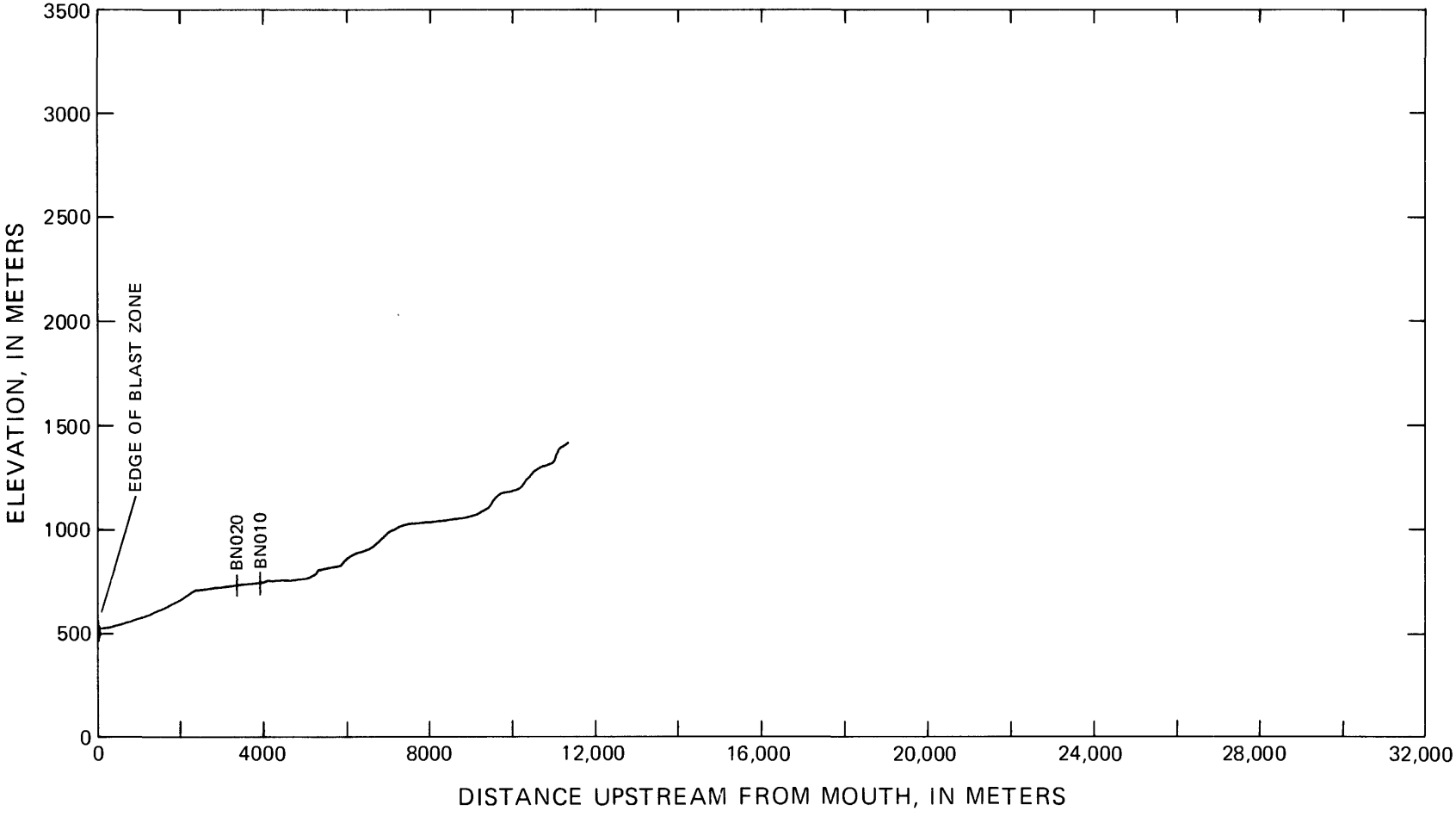


FIGURE 20.– Longitudinal profile of Bean Creek, showing locations of cross-section survey sites. Channel distance upstream from mouth and elevation above sea level are determined from U.S. Geological Survey topographic map, 7.5-minute series, Mount St. Helens NE quadrangle.

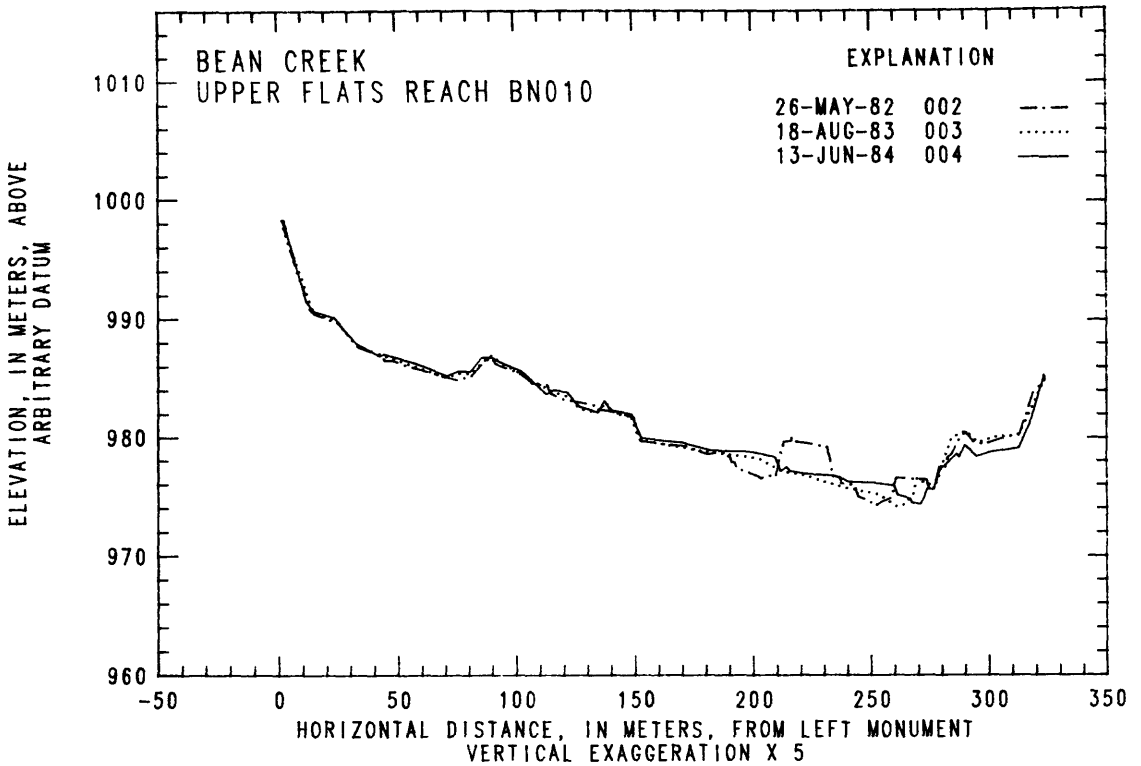


FIGURE 21. – Cross-section profiles for selected sites, Bean Creek.

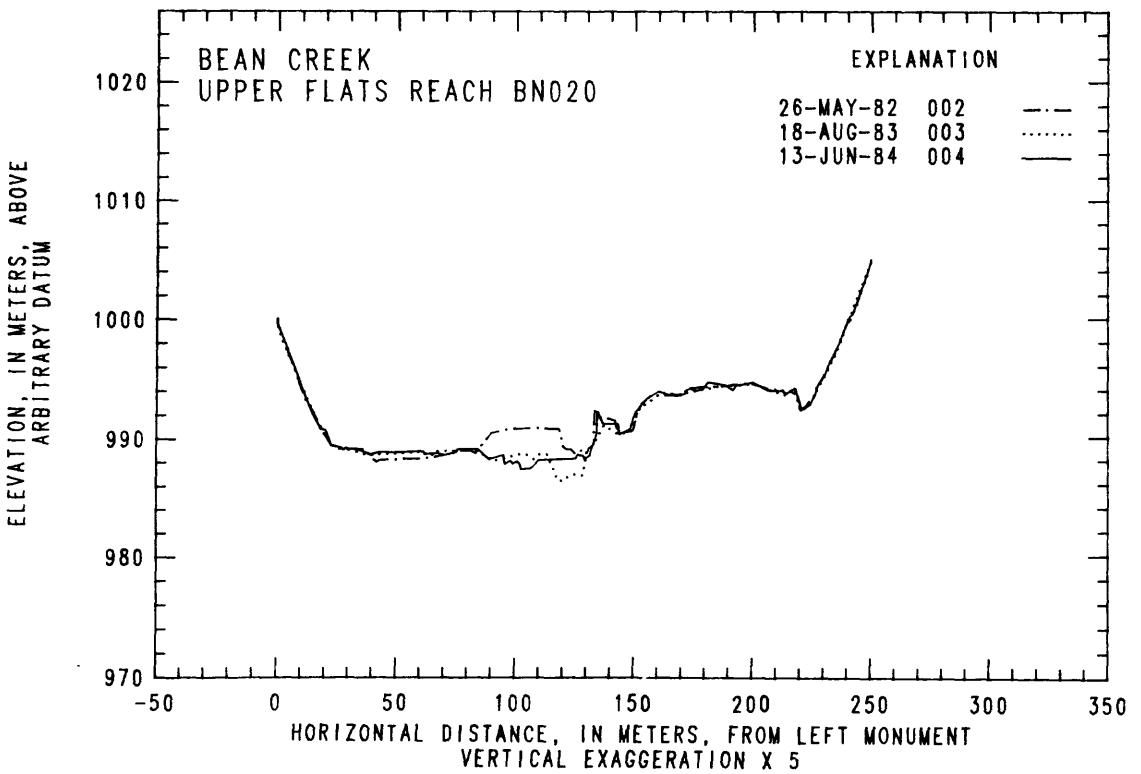


FIGURE 21. – Cross-section profiles for selected sites, Bean Creek – continued.

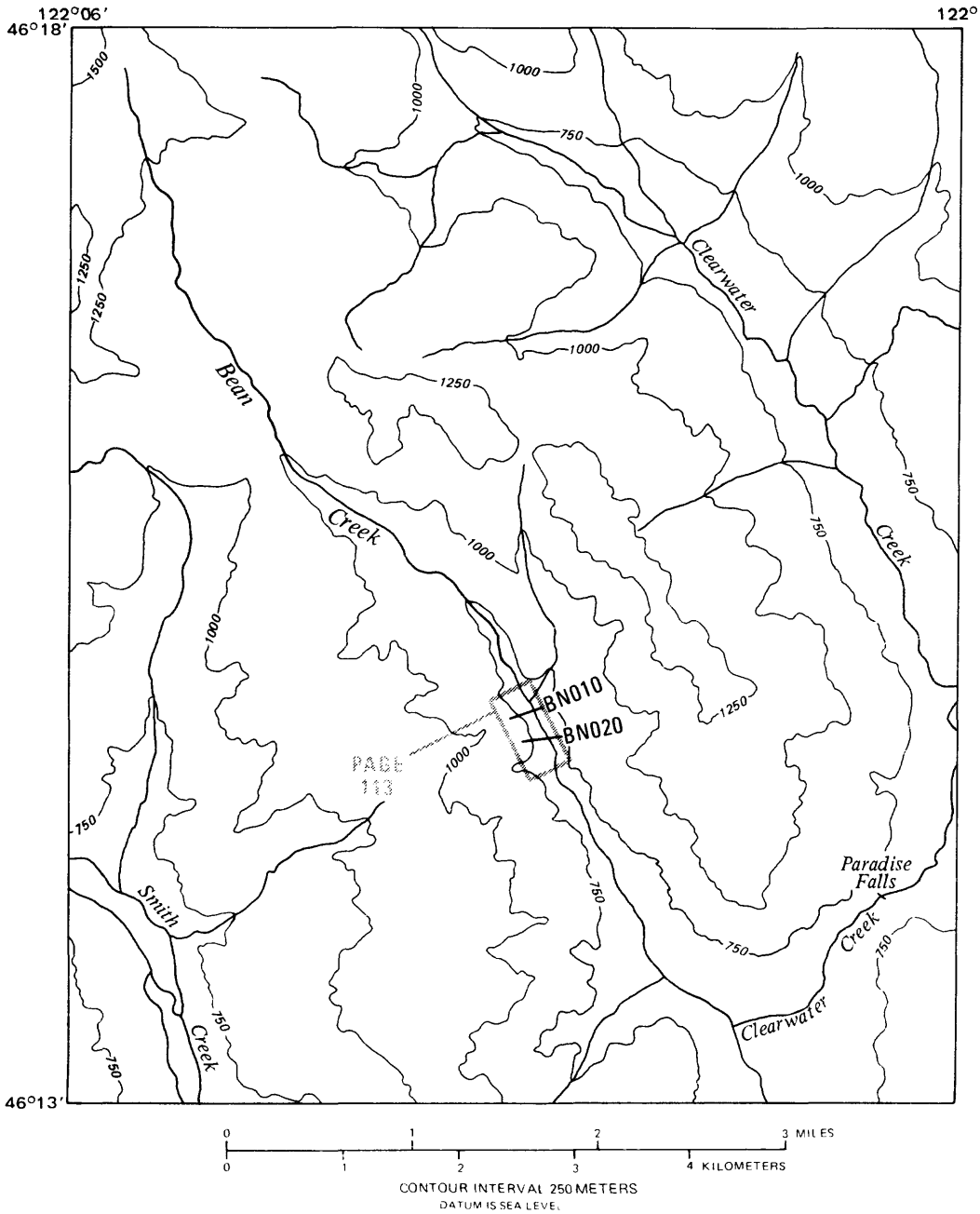
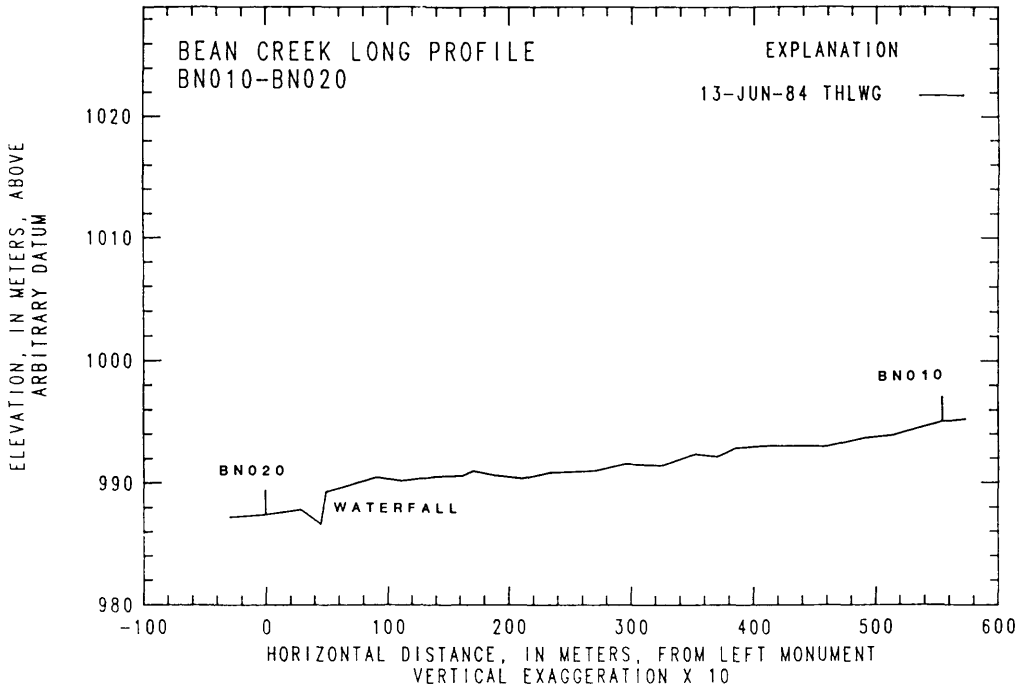


FIGURE 22. – Location of surveyed longitudinal profile and corresponding map view, Bean Creek.



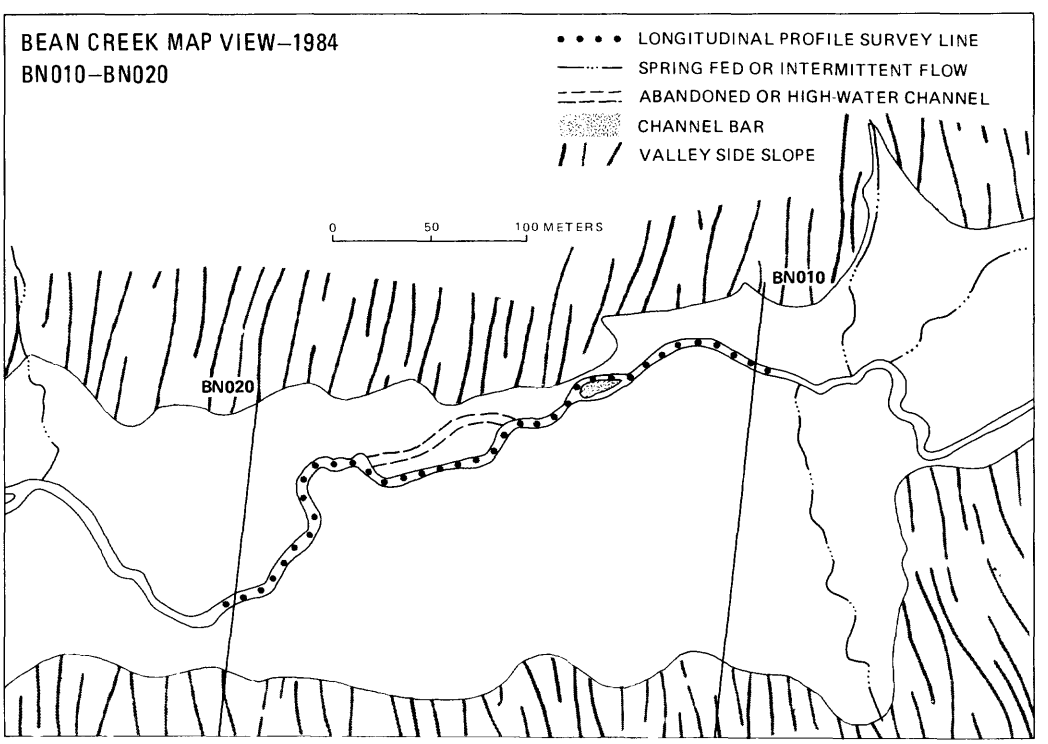


FIGURE 23. – Surveyed longitudinal profile and corresponding map view for selected reach, Bean Creek.

INDEX TO PINE CREEK CROSS-SECTION SITES

As an aid to the reader, listed below are the individual cross-section site numbers and corresponding page number of the plot.

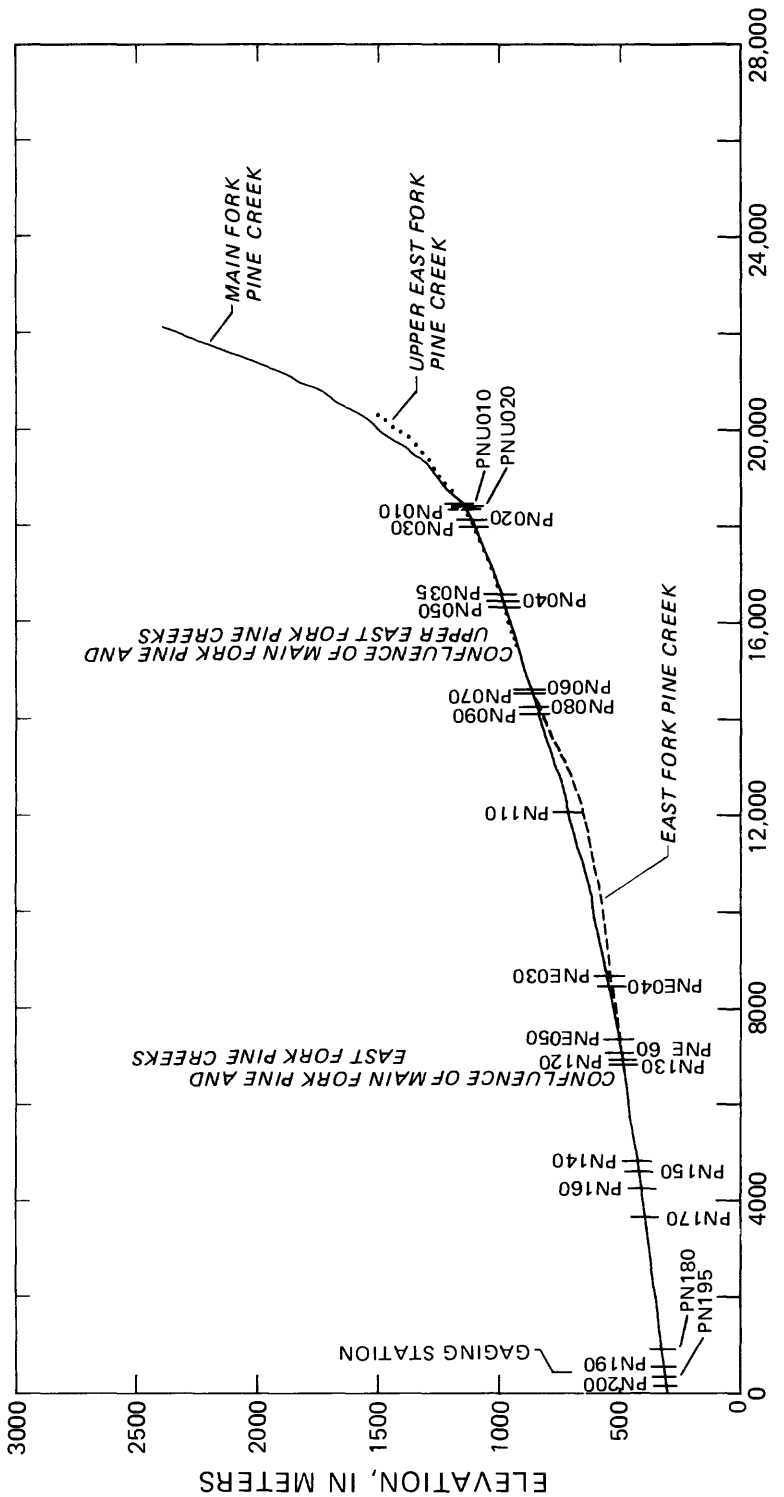
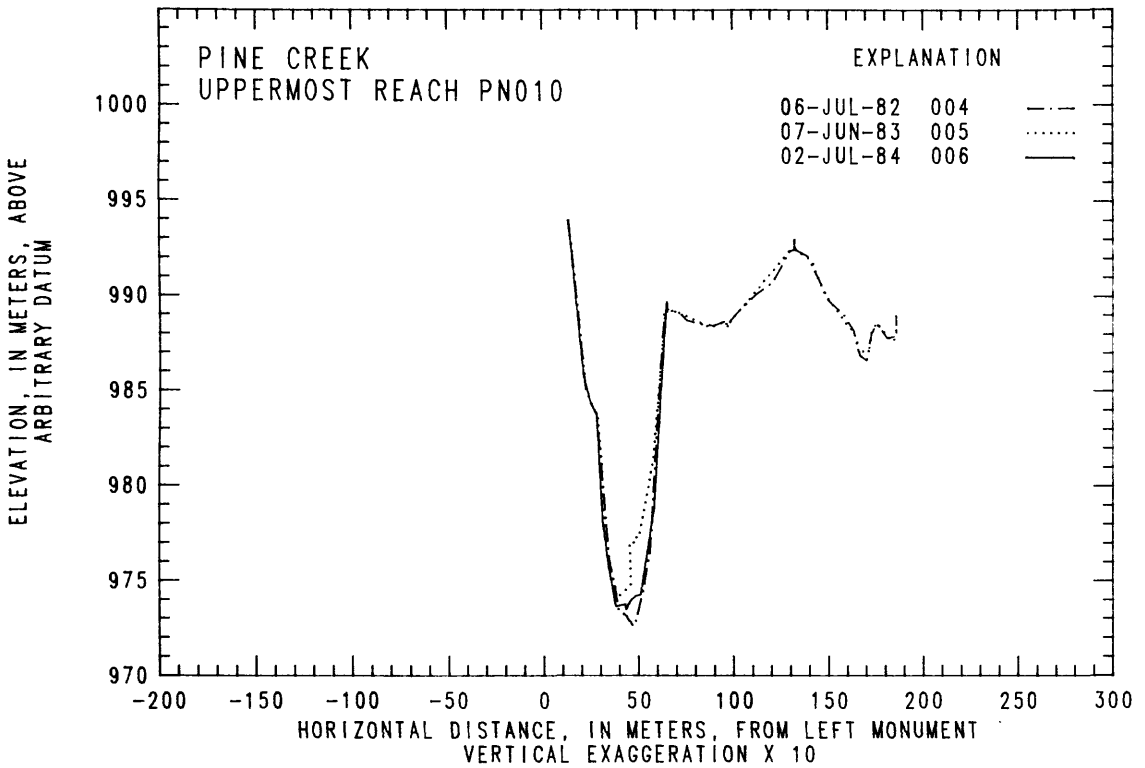


FIGURE 24. – Longitudinal profile of Pine Creek, showing locations of cross-section survey sites. Channel distance upstream from mouth and elevation above sea level are determined from U.S. Geological Survey topographic maps, 7.5-minute series, Mount St. Helens SE and Mount St. Helens NE quadrangles.



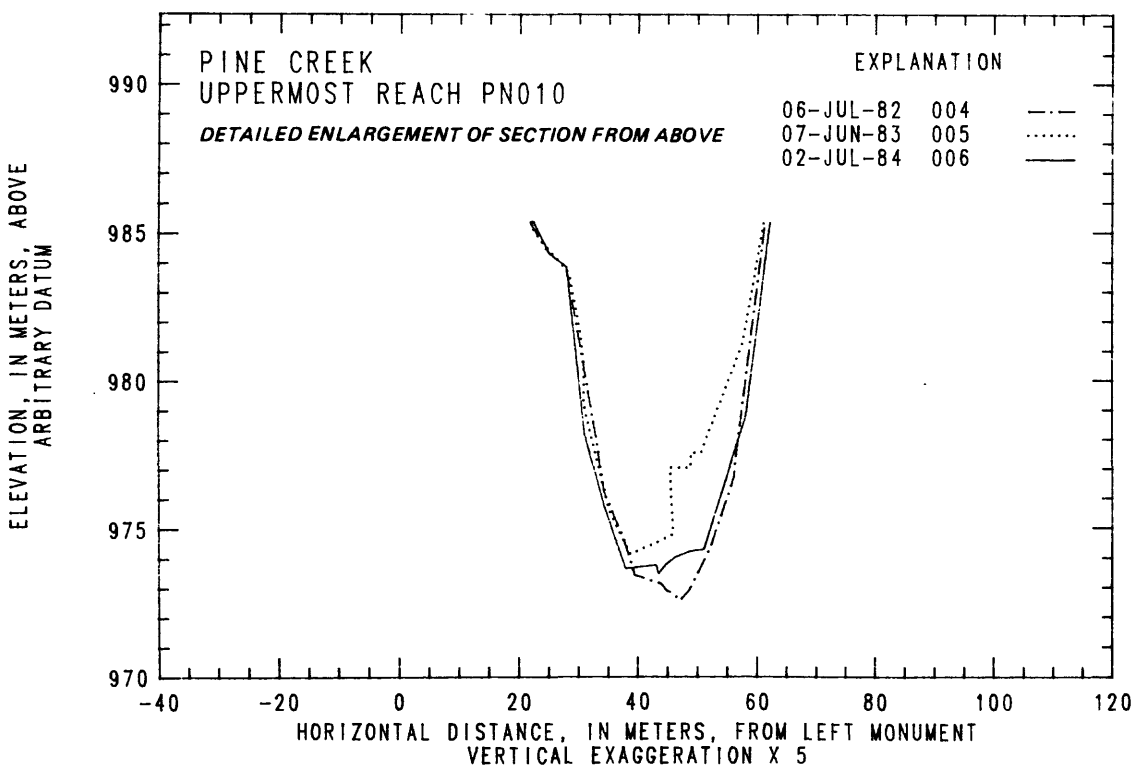


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek.

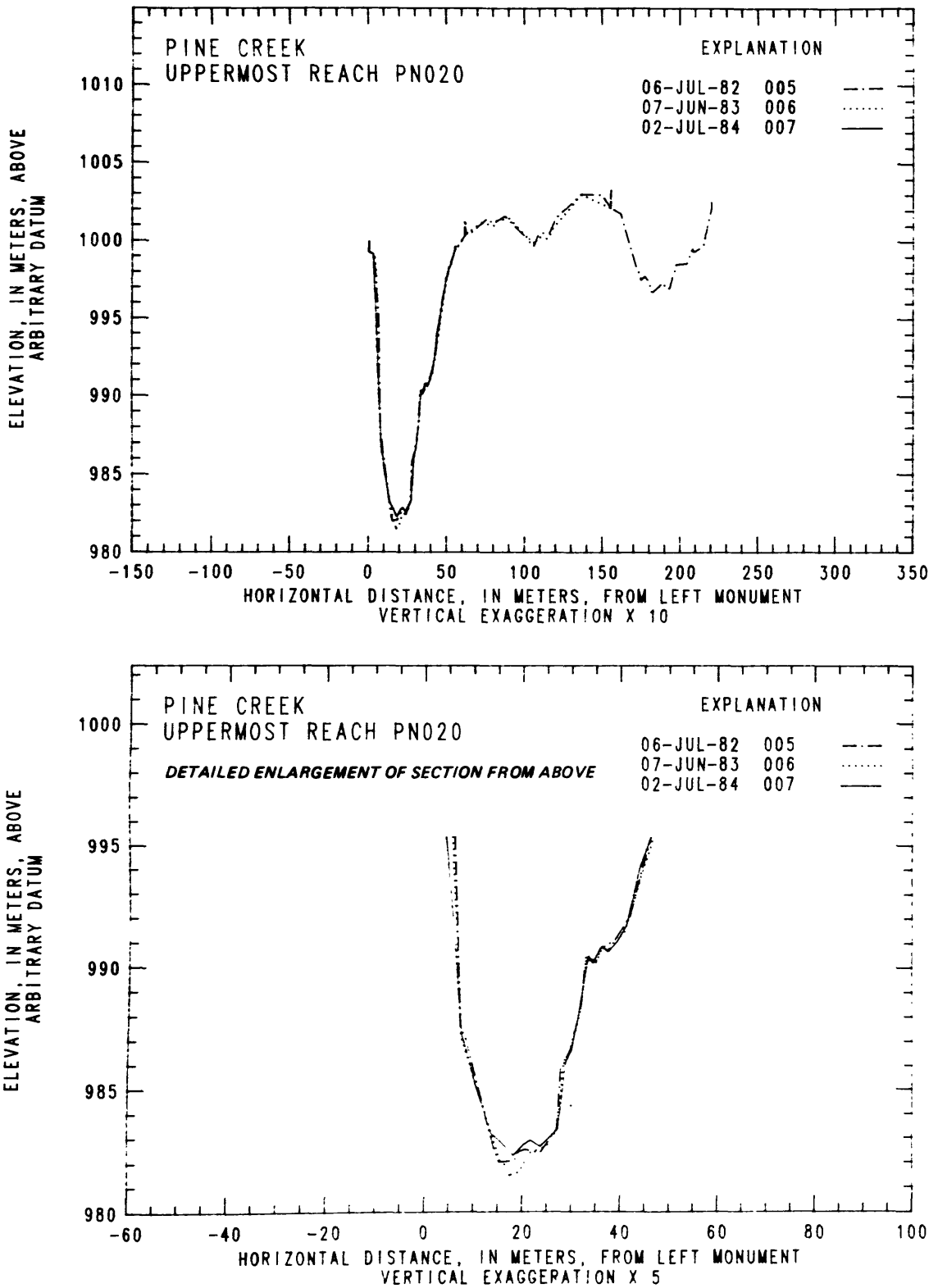
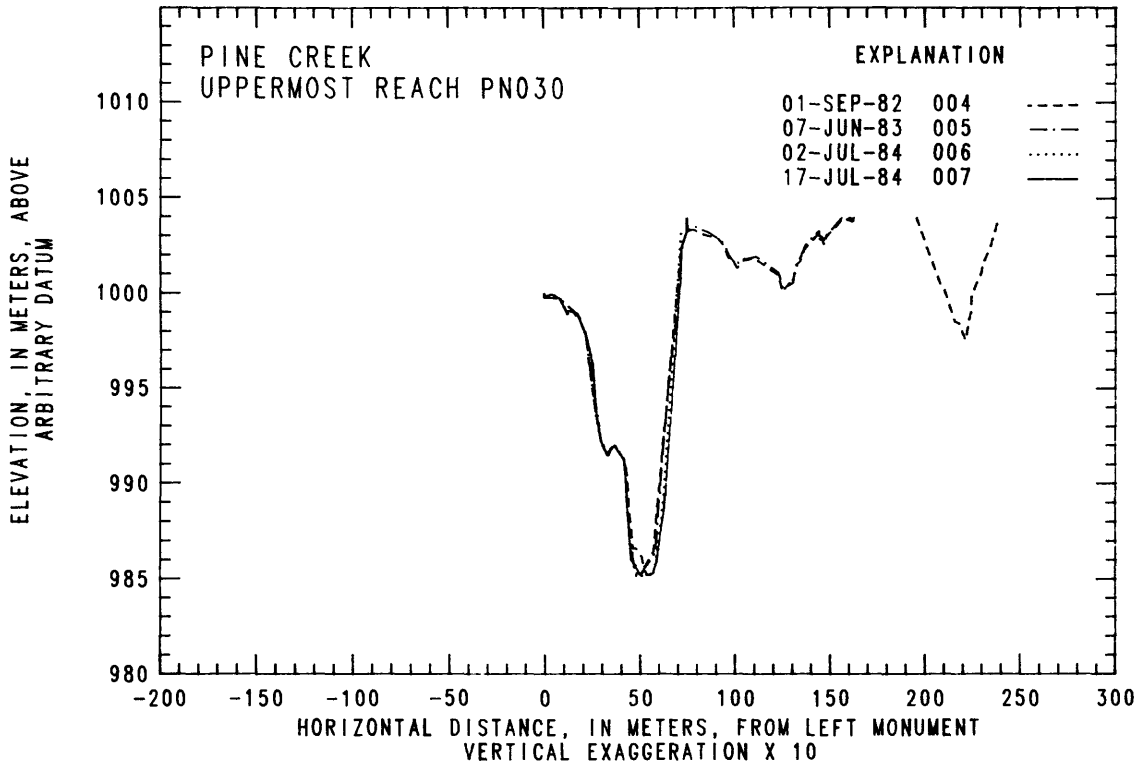


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



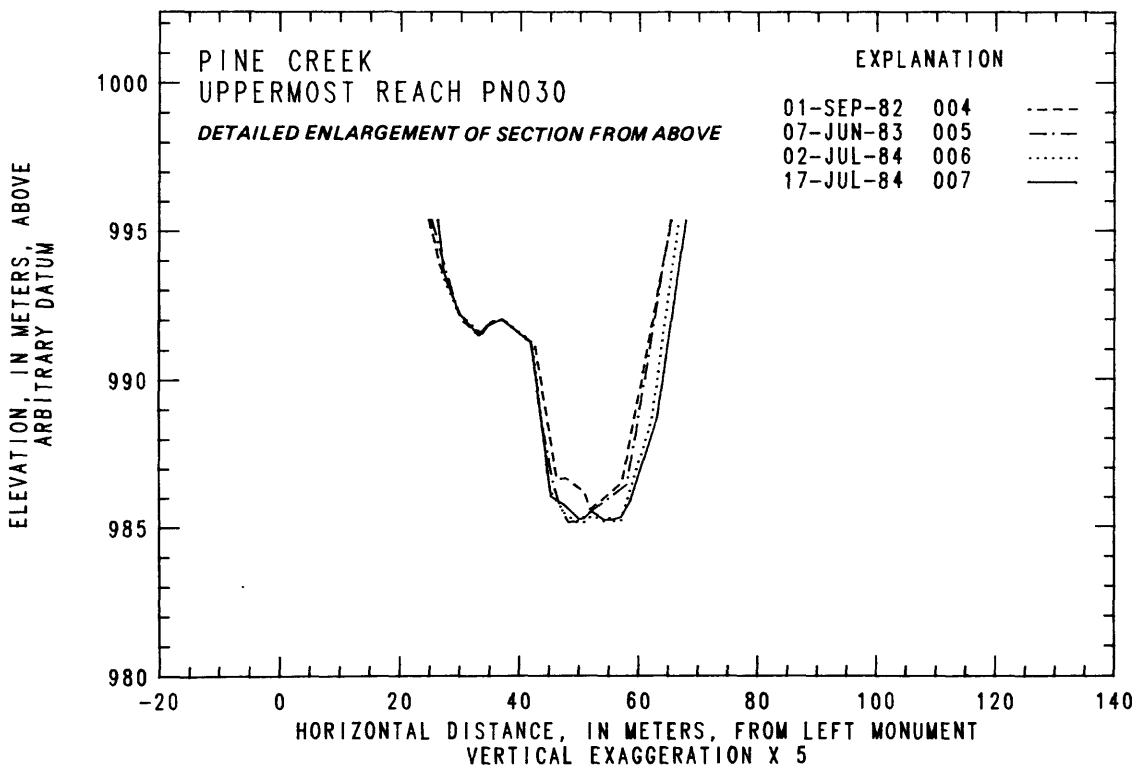
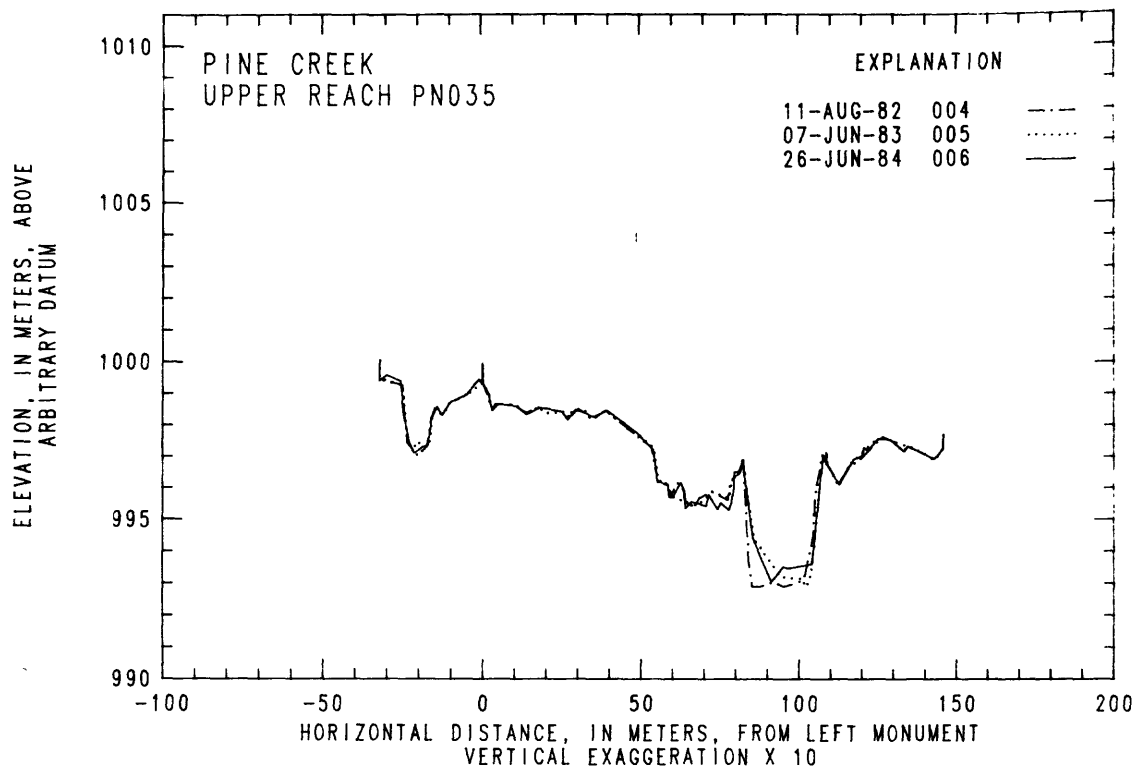


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



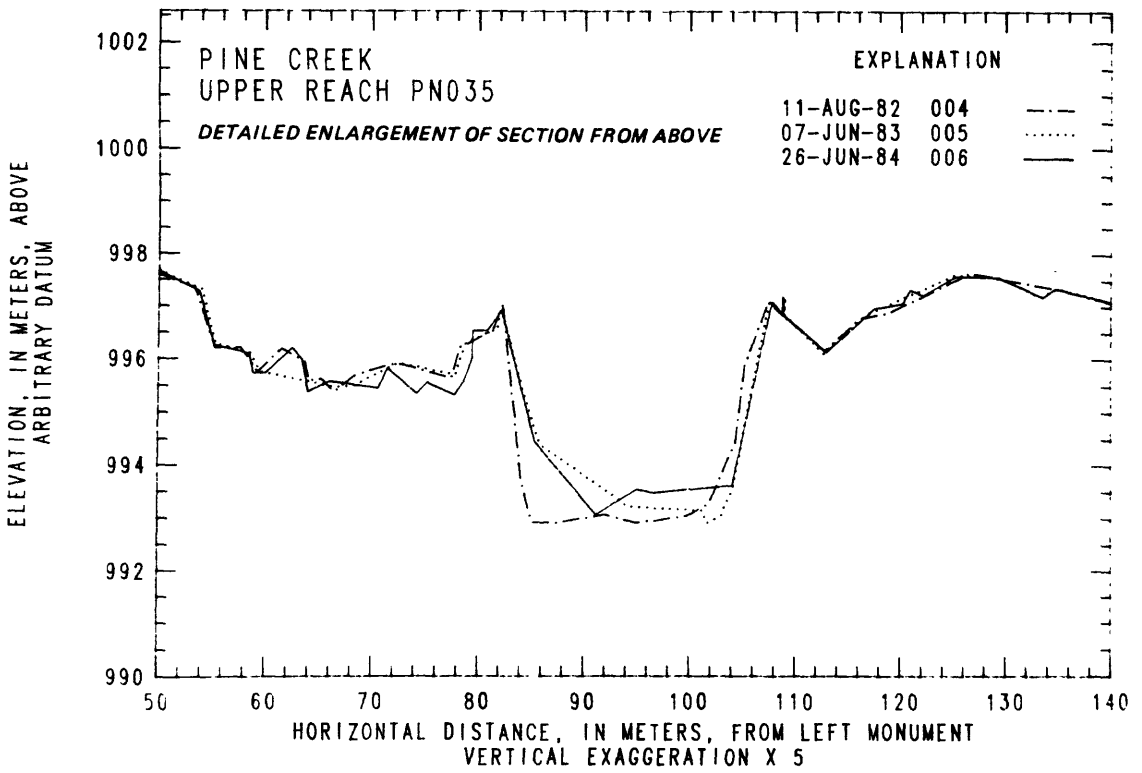
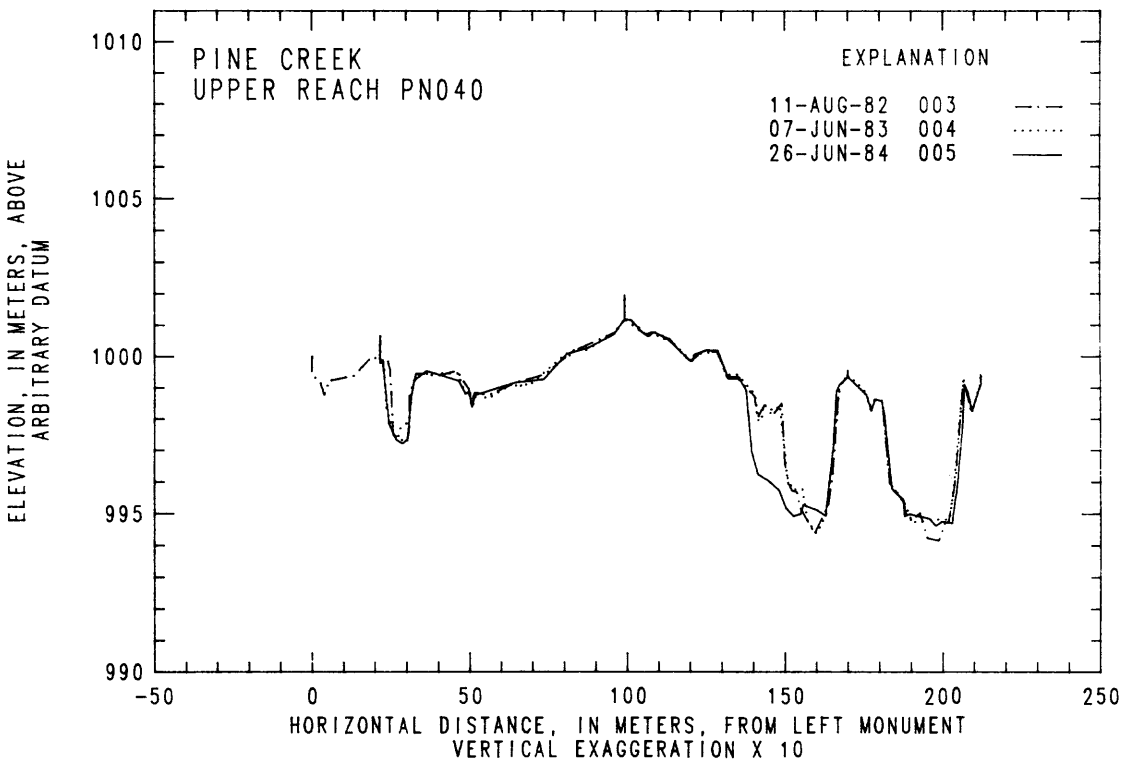


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



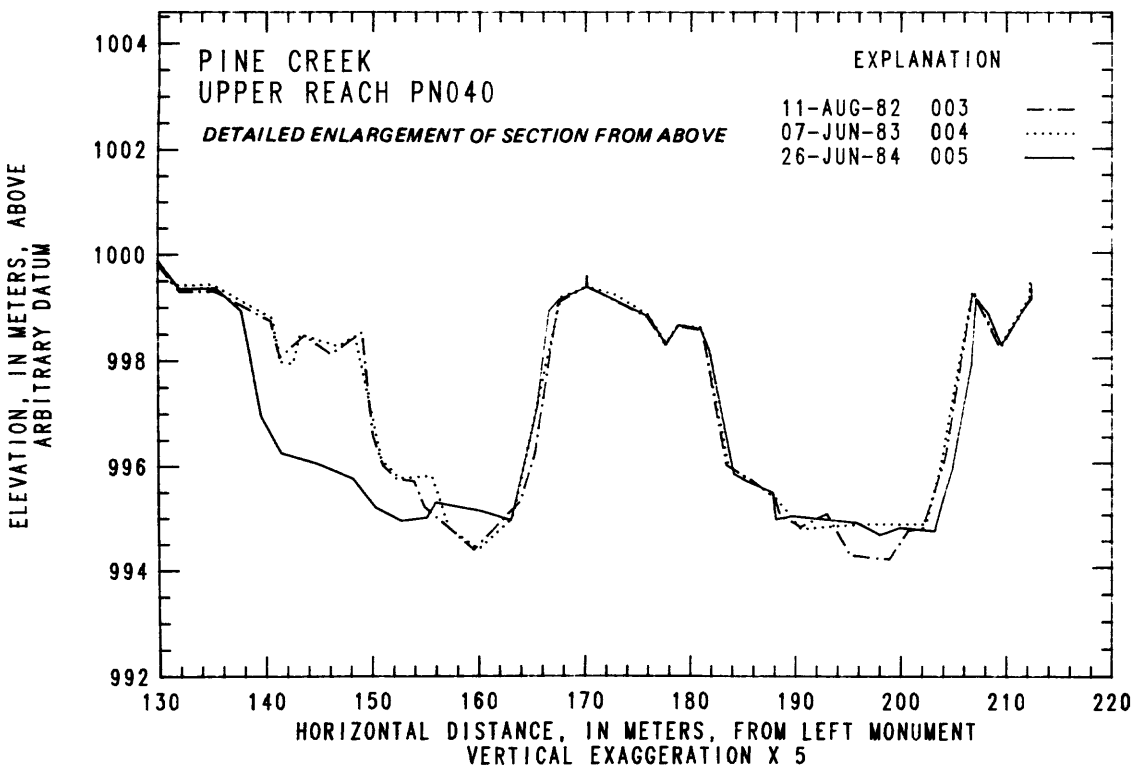


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

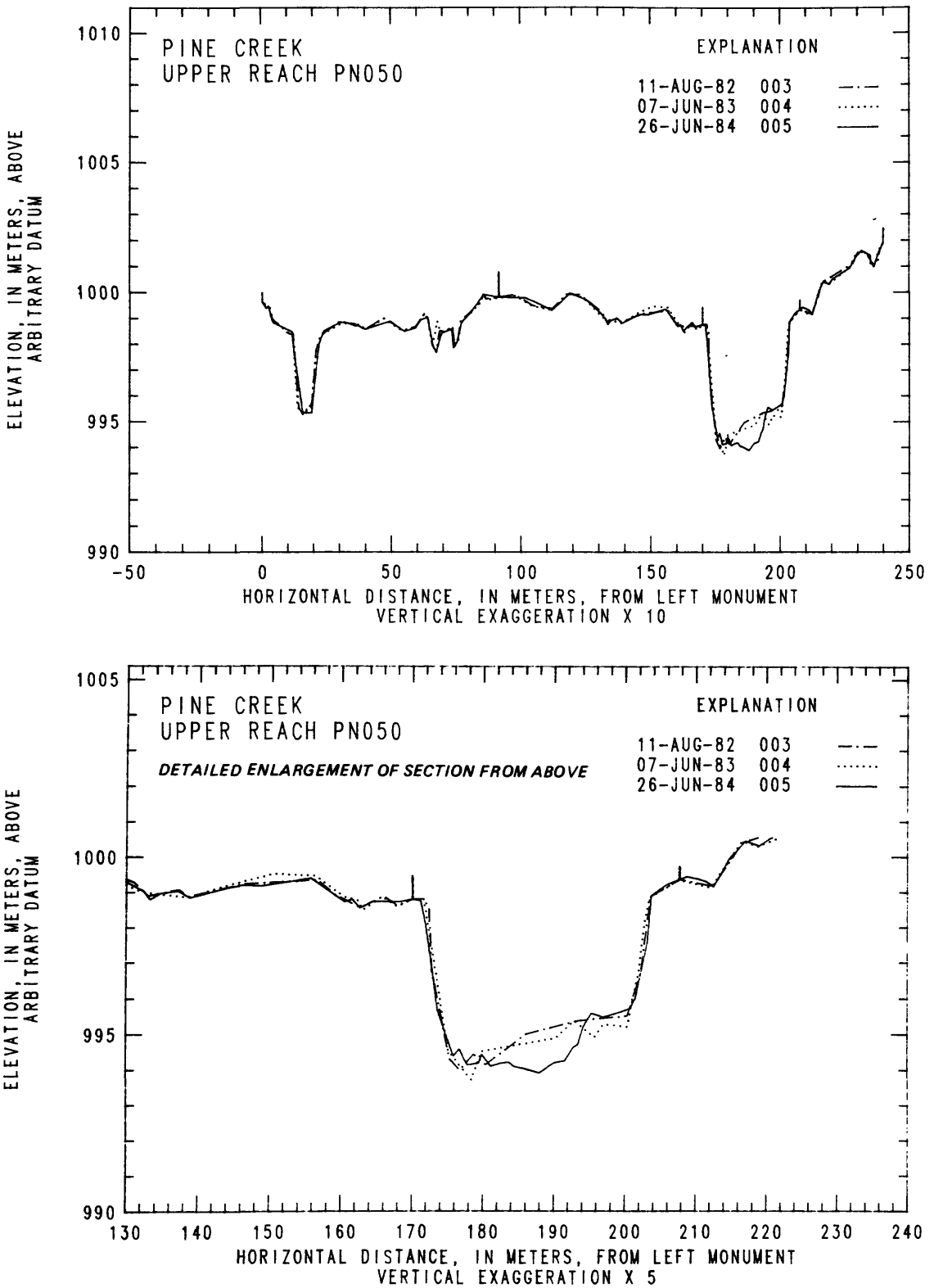
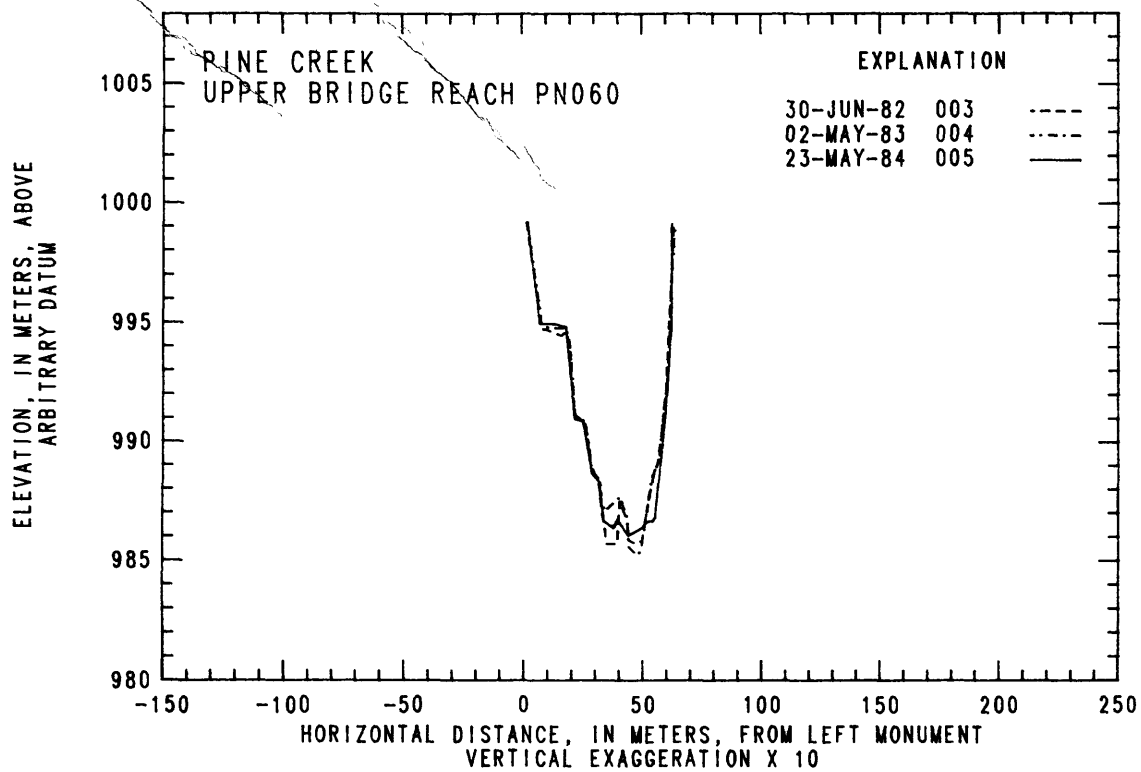


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



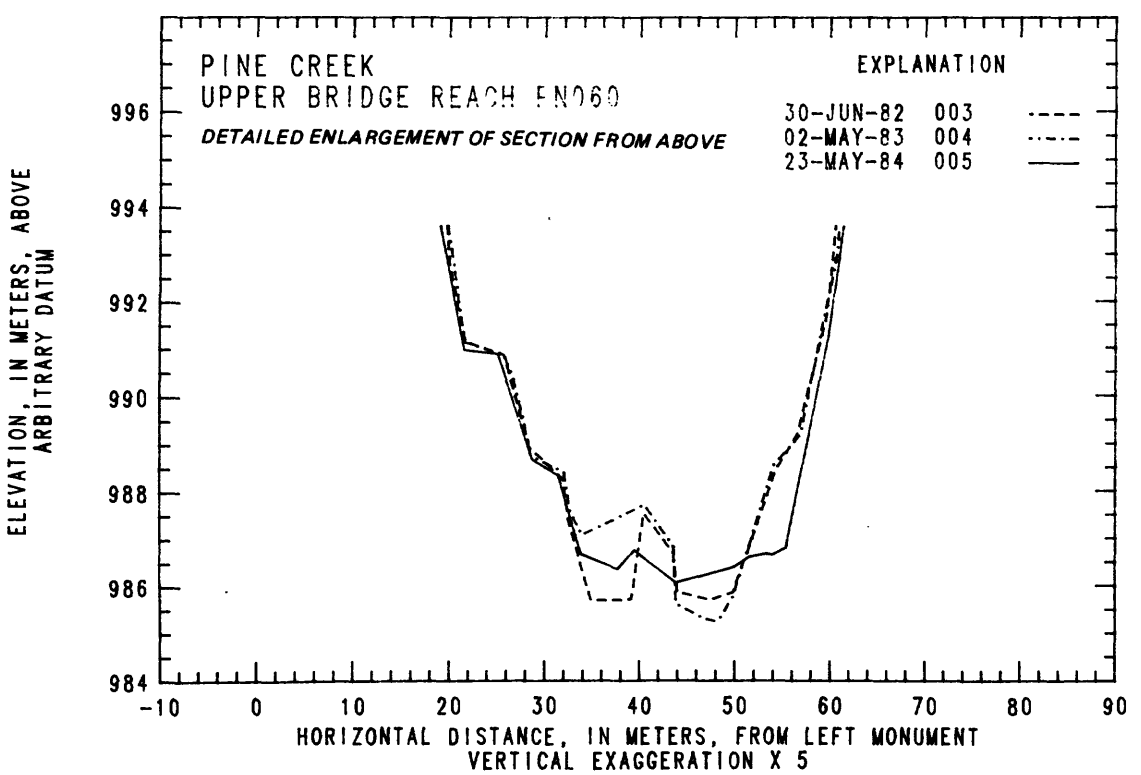


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

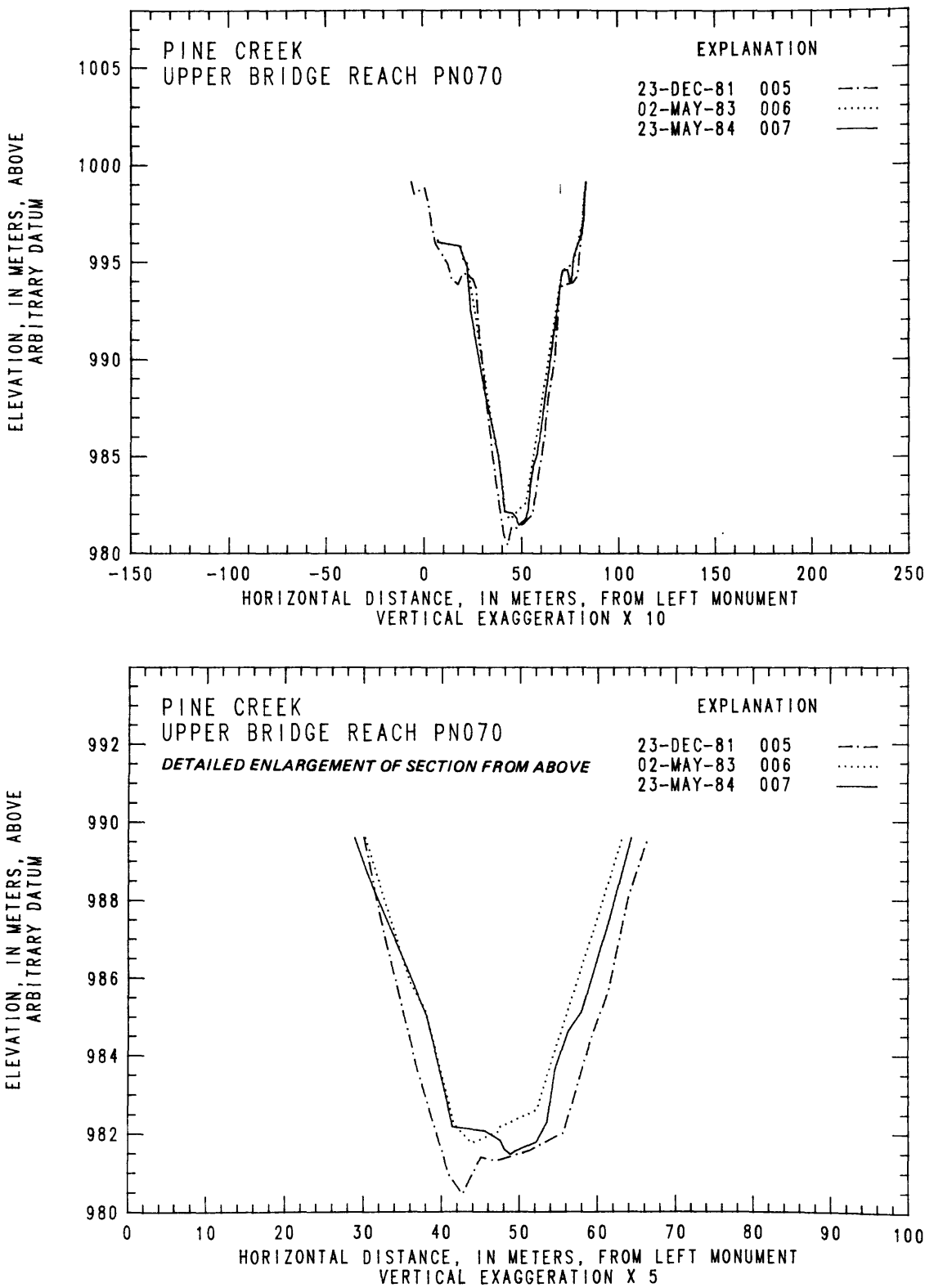
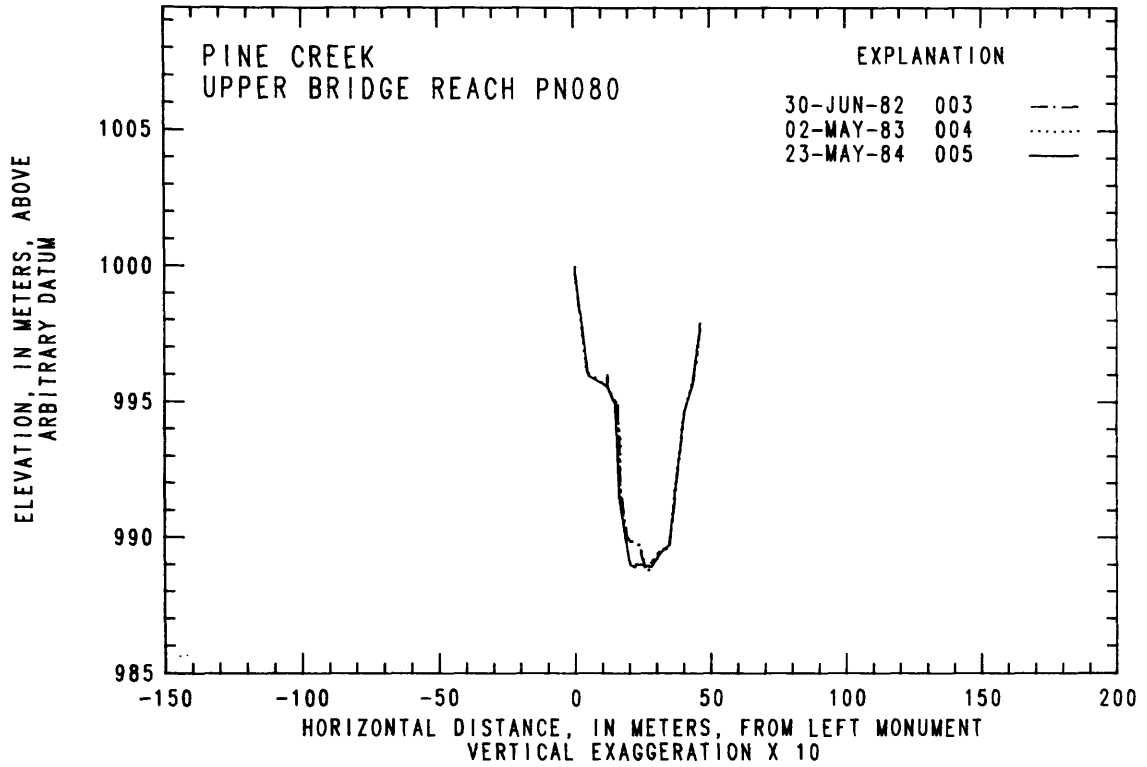


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



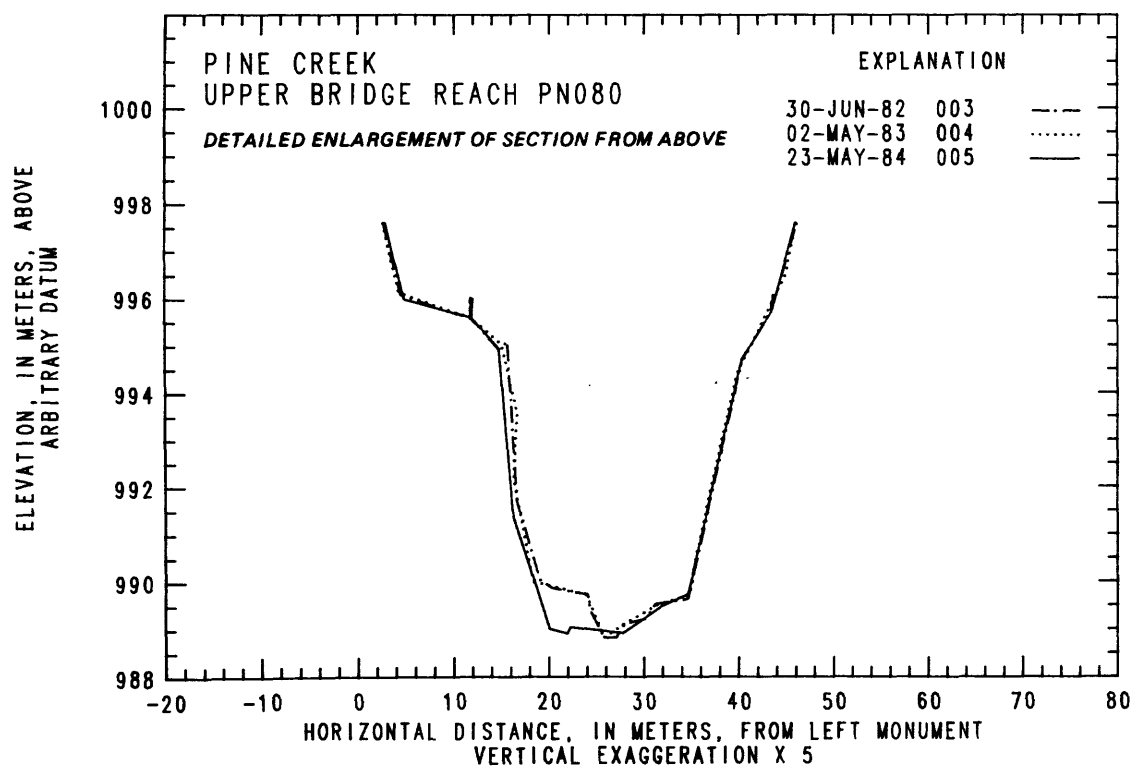
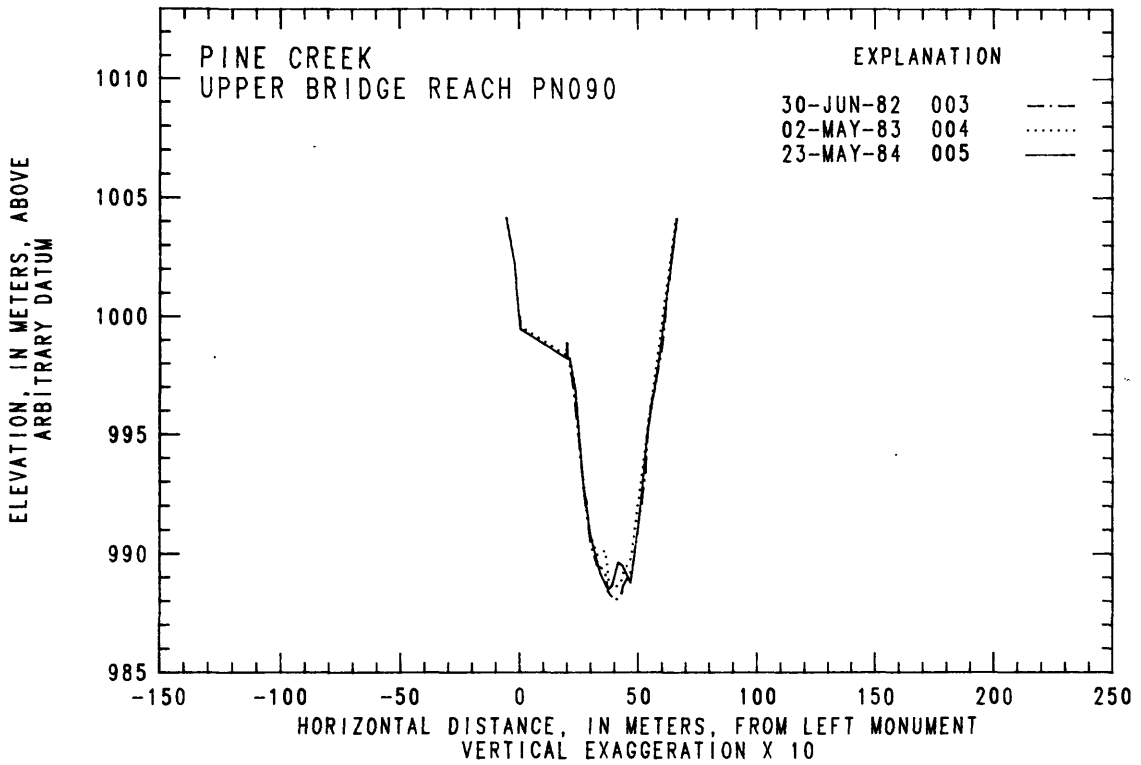


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



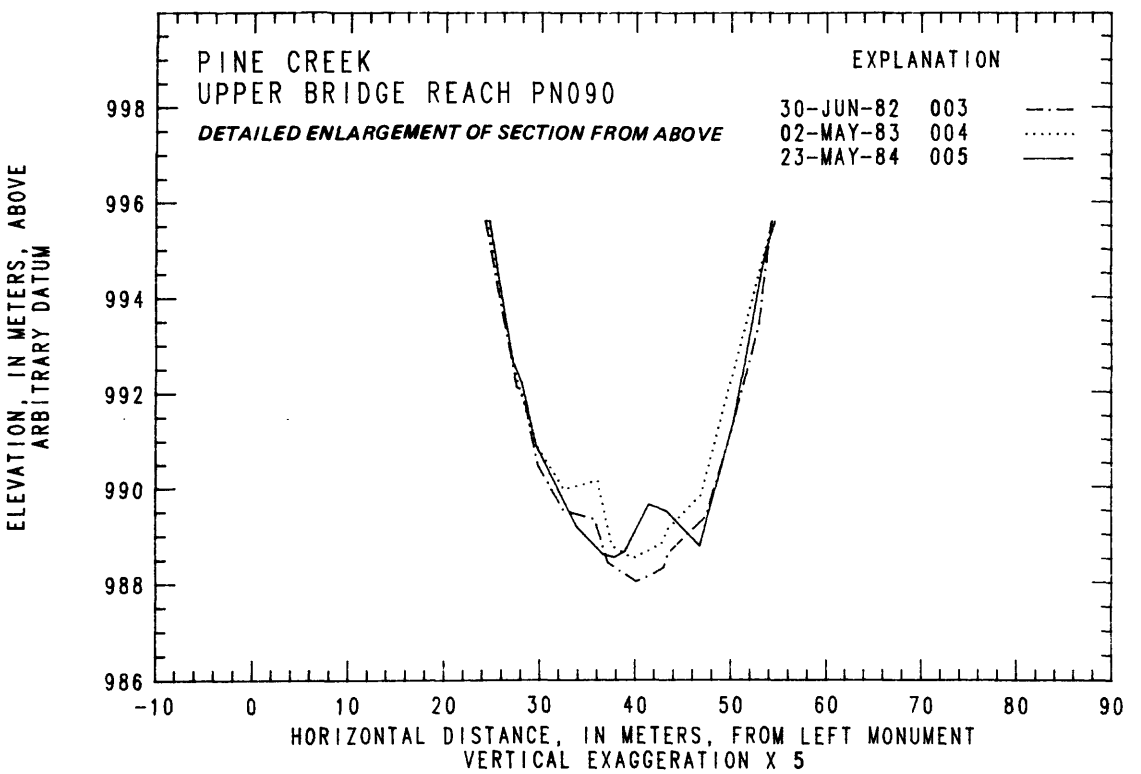
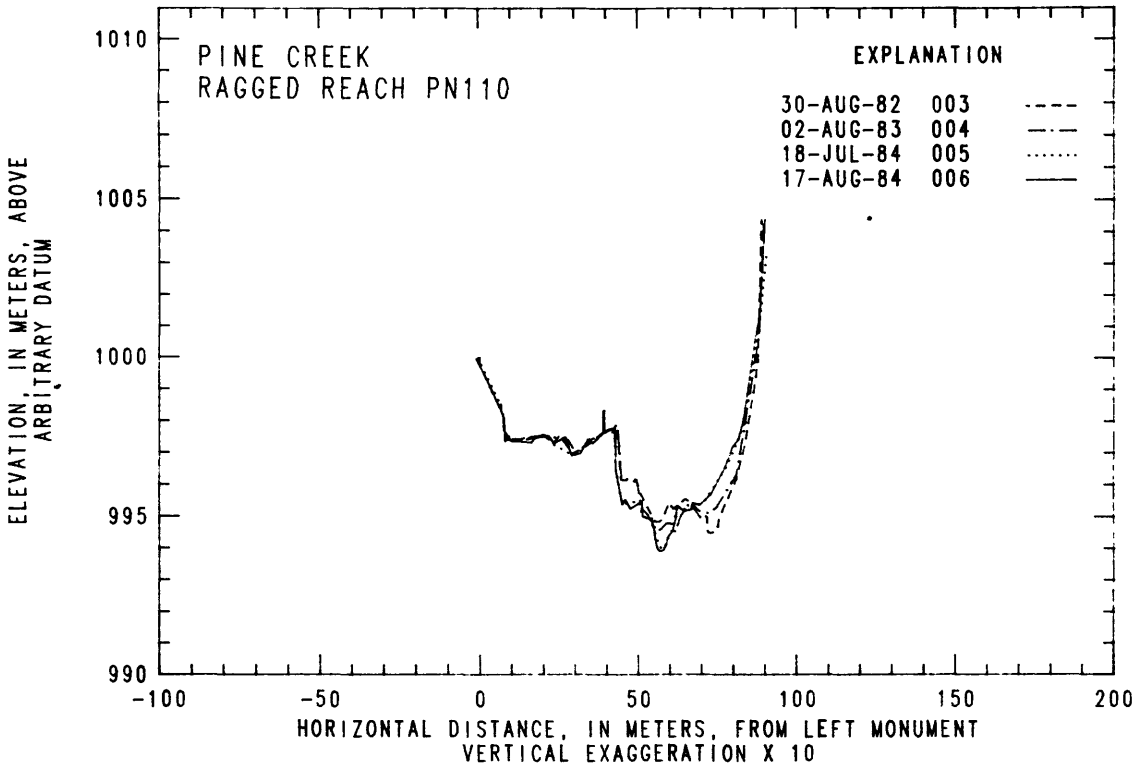


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



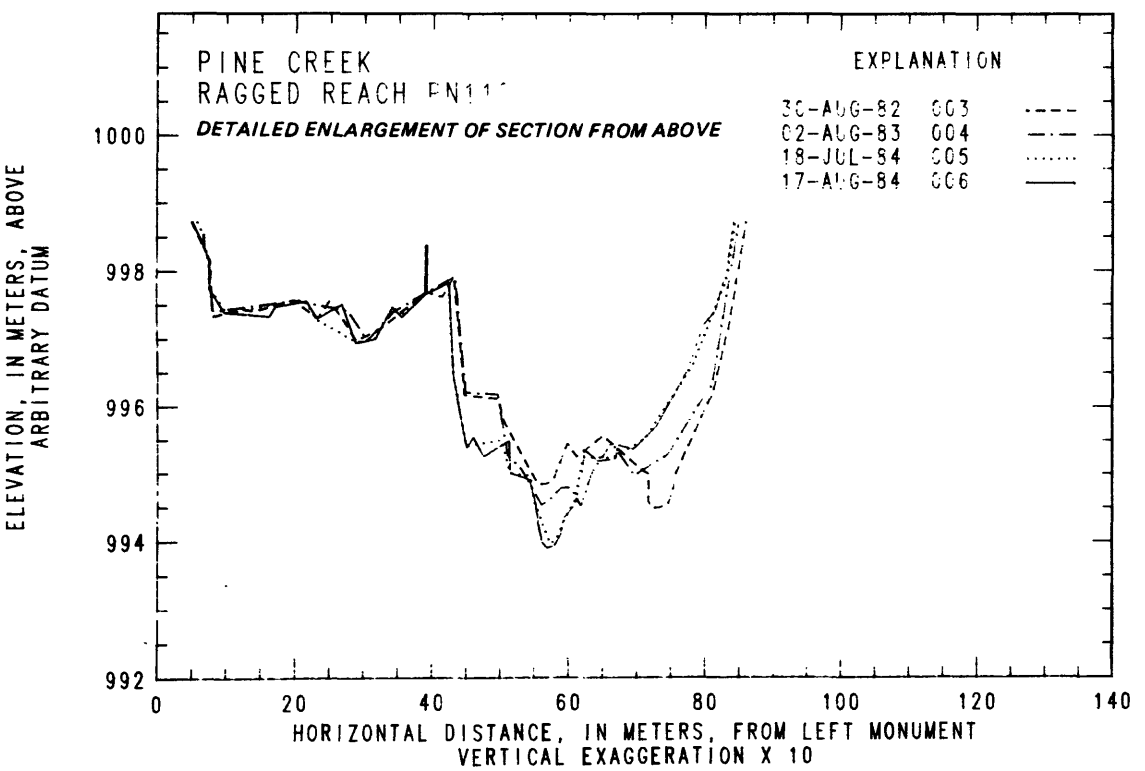
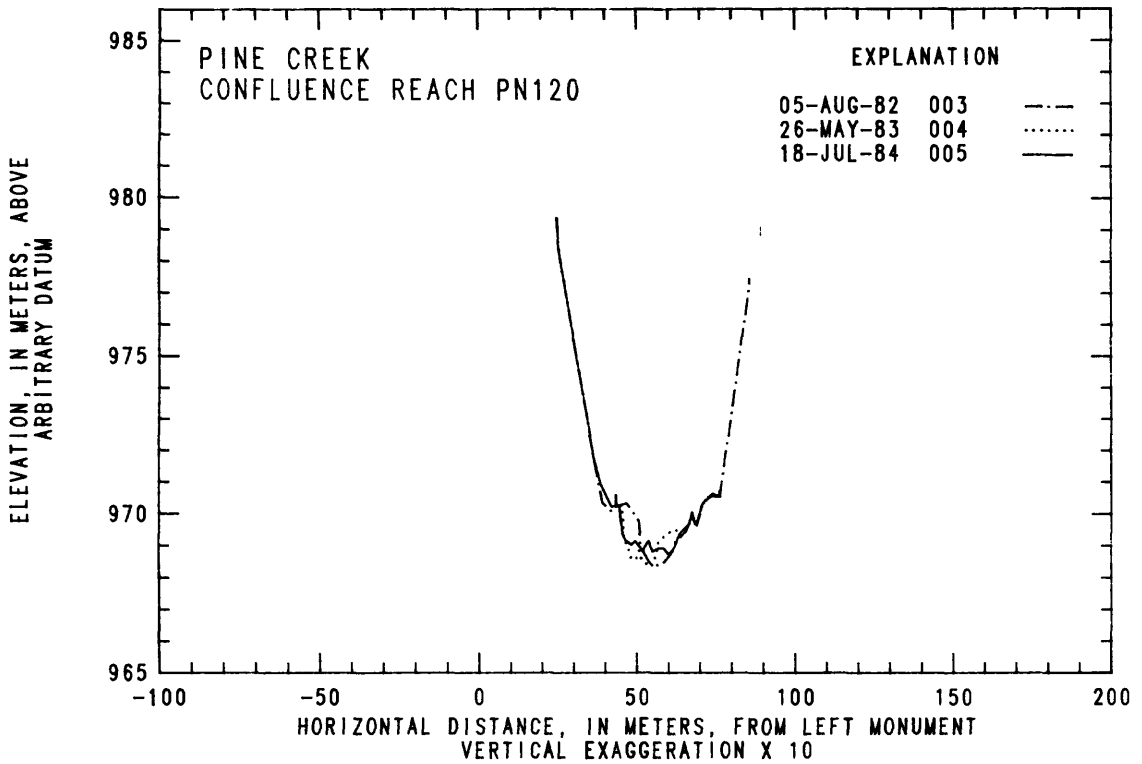


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



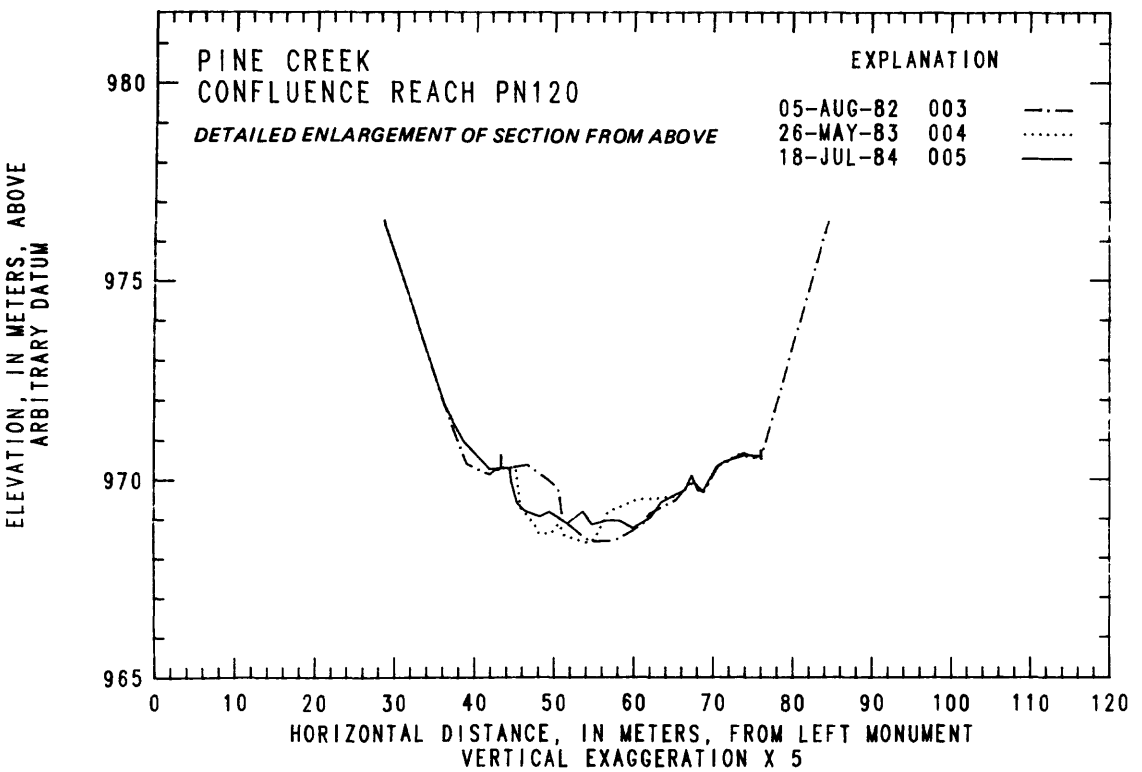


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

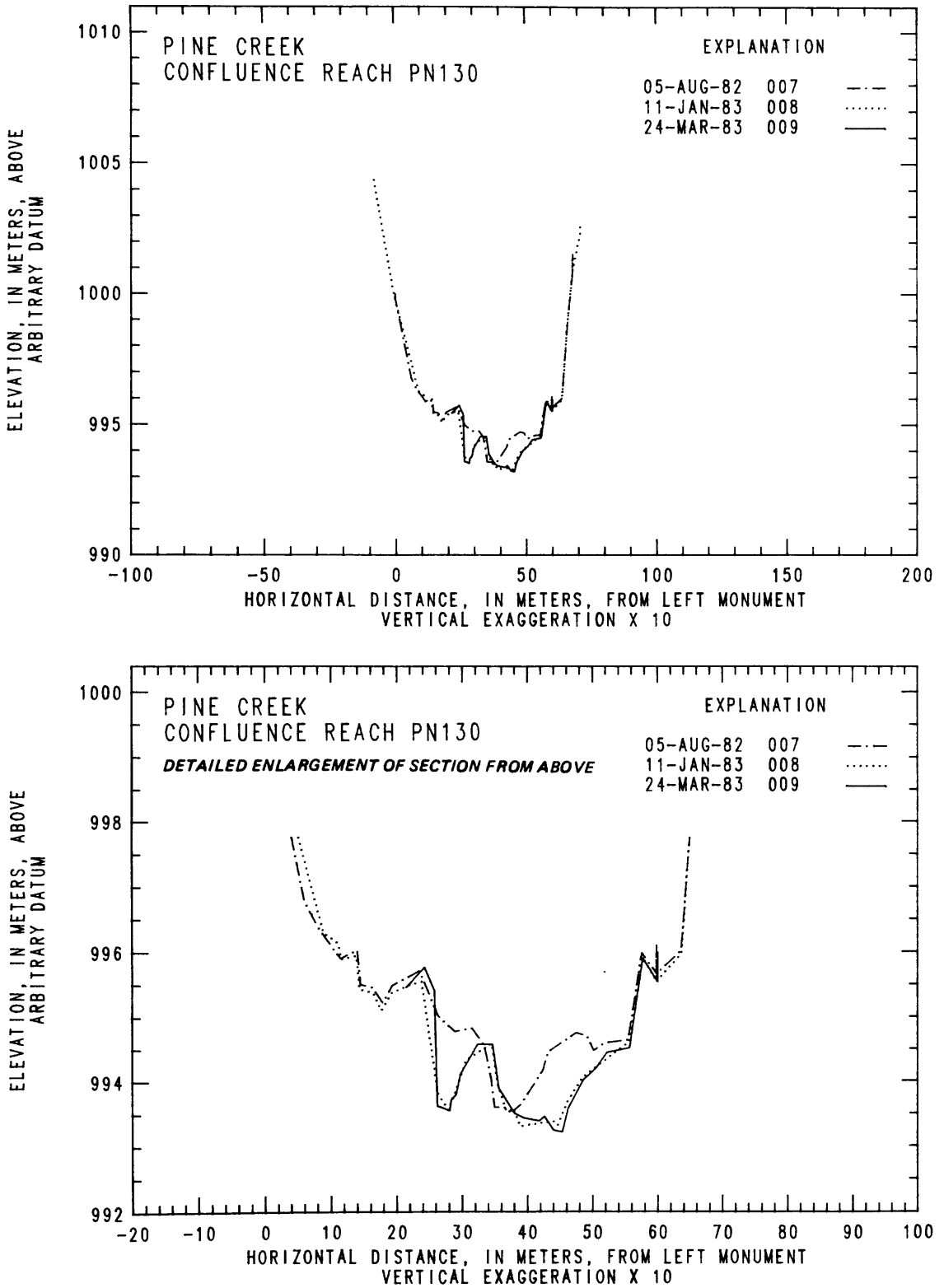
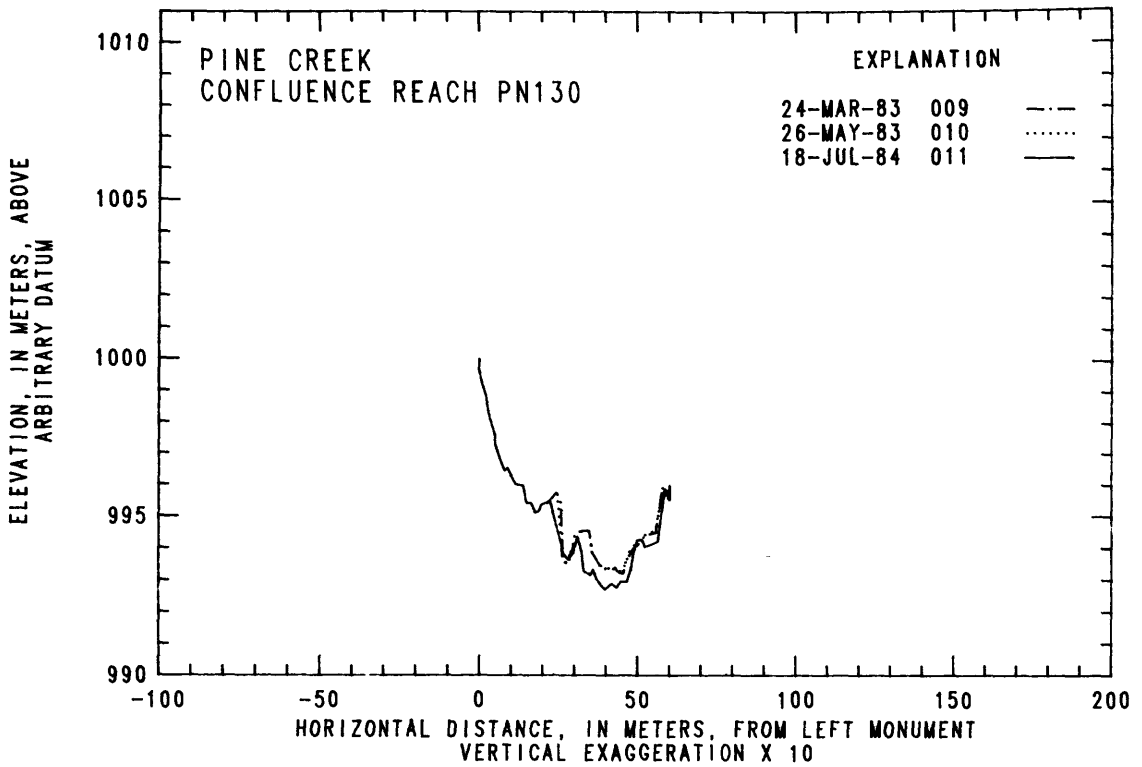


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



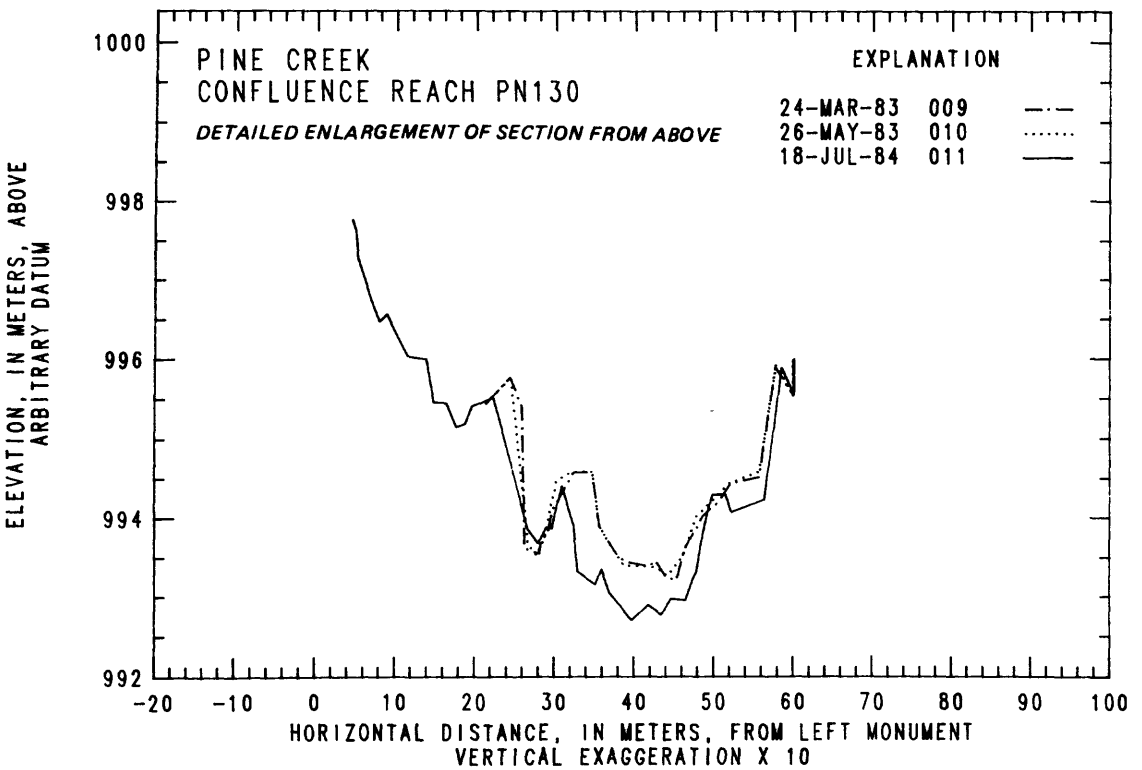


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

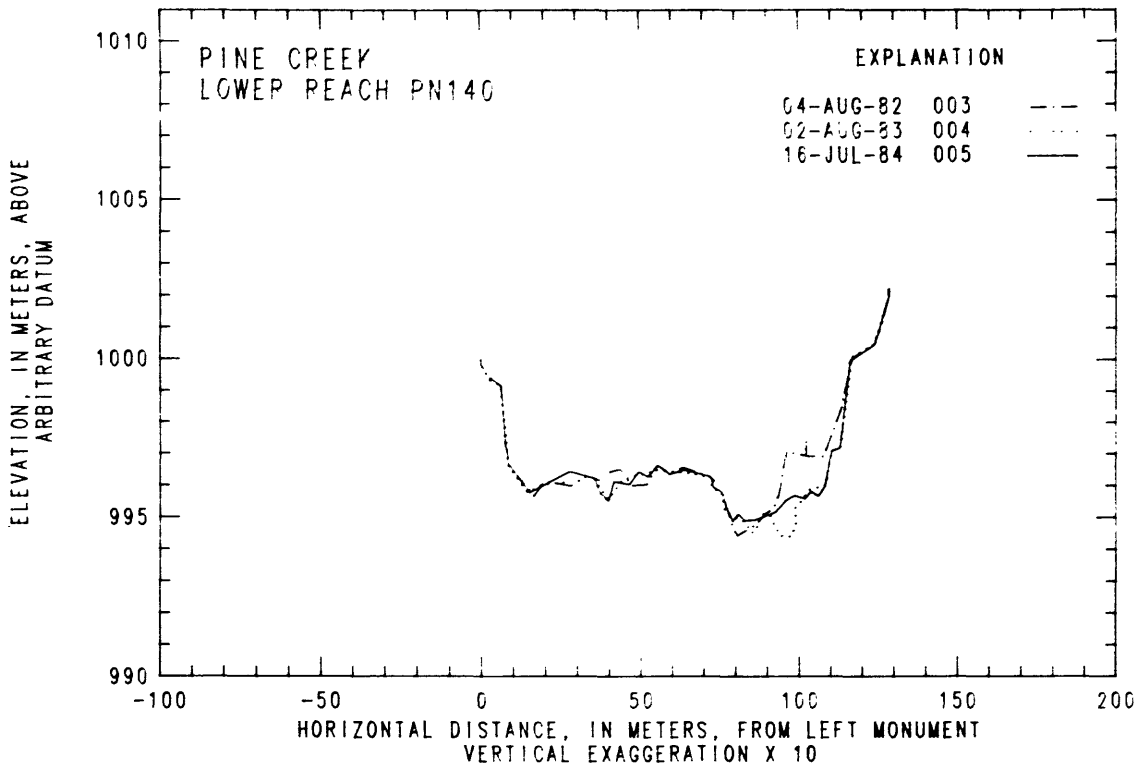


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

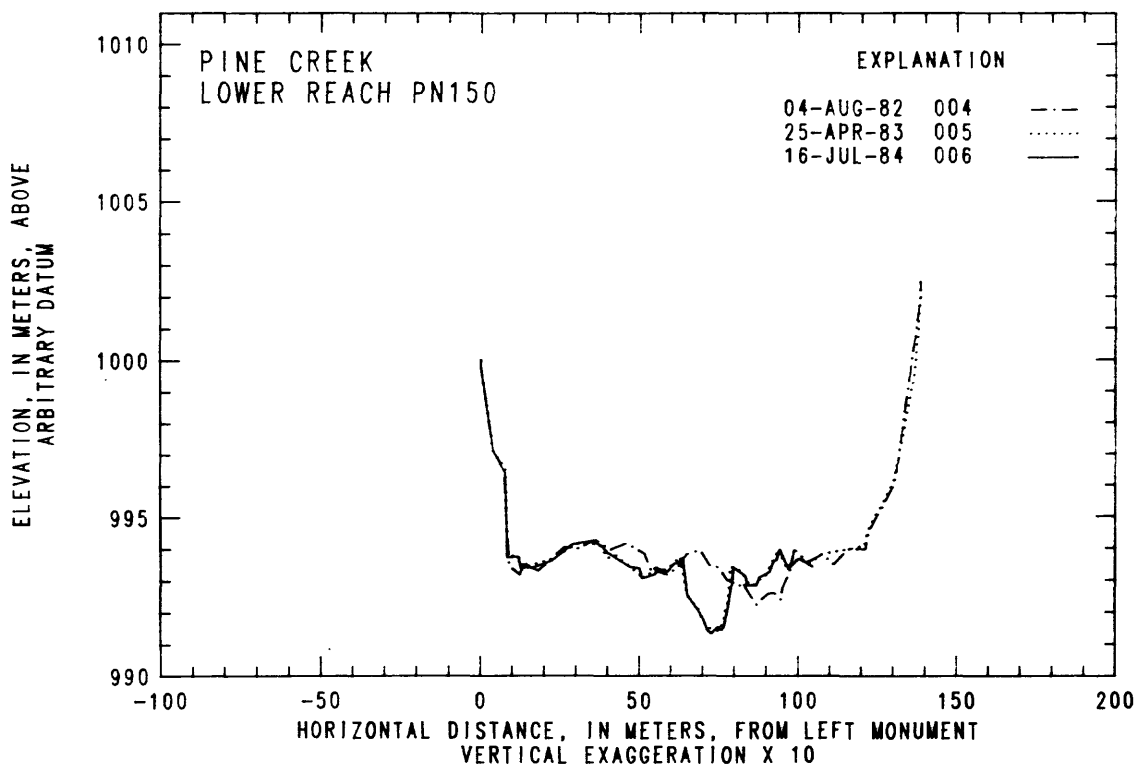
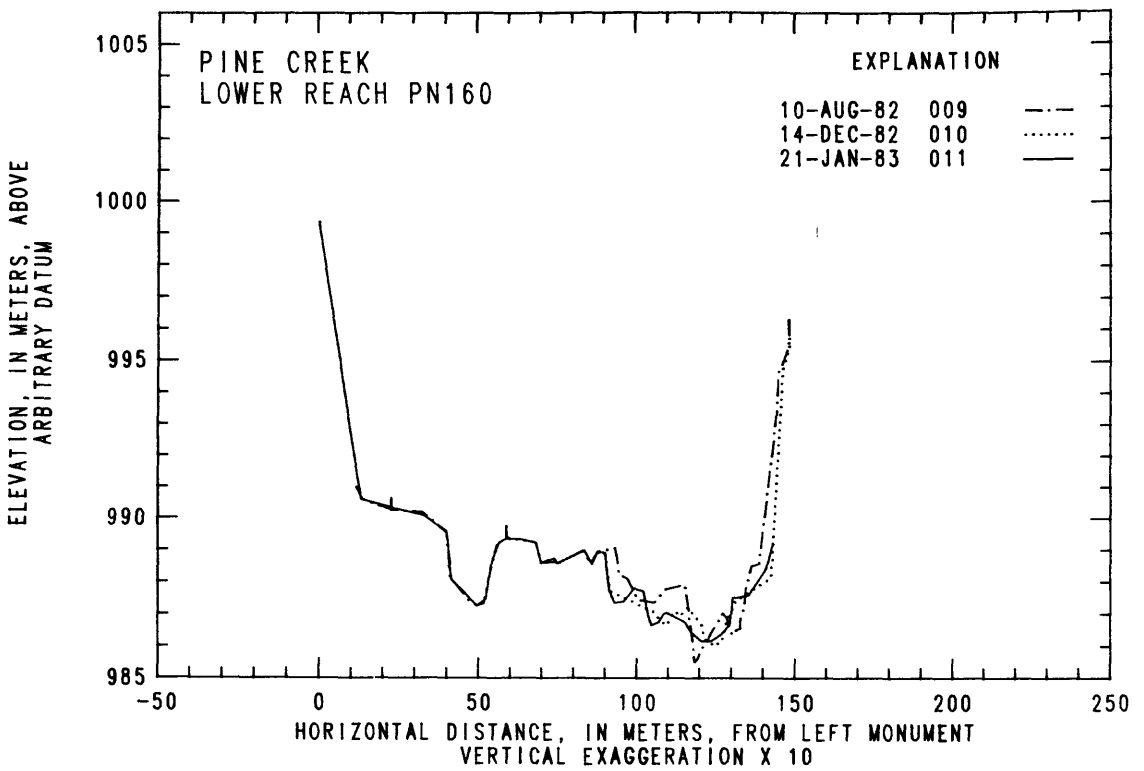


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



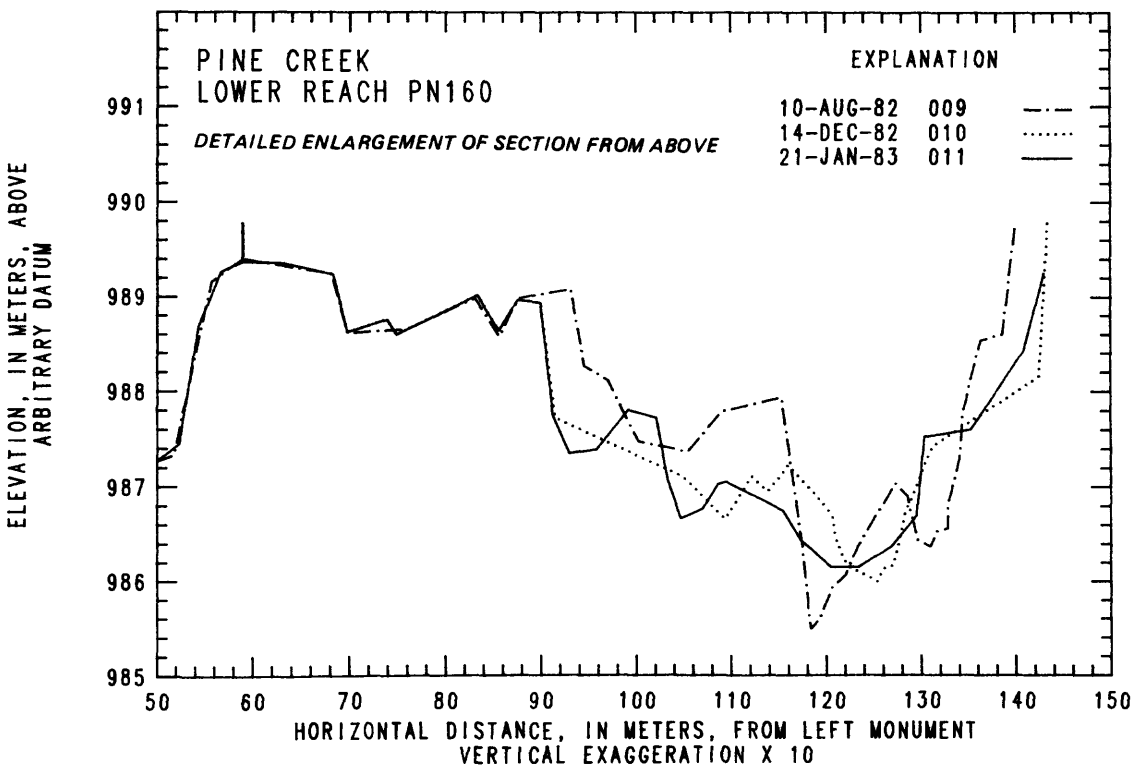
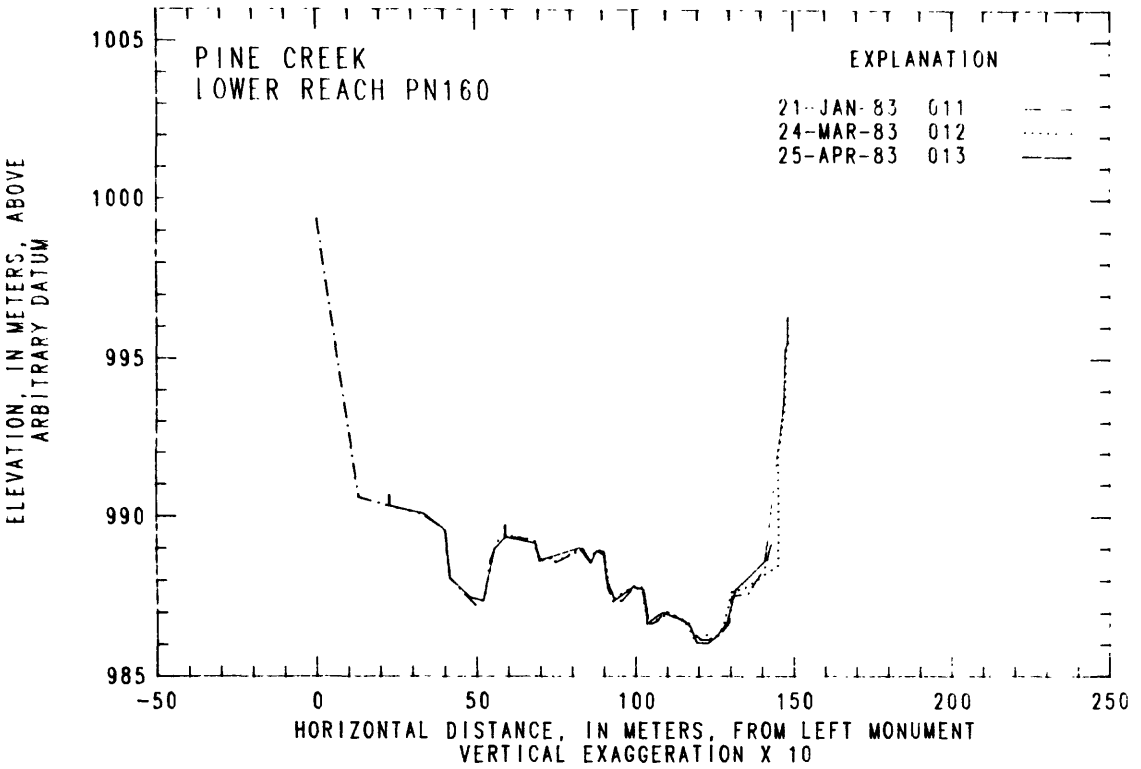


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



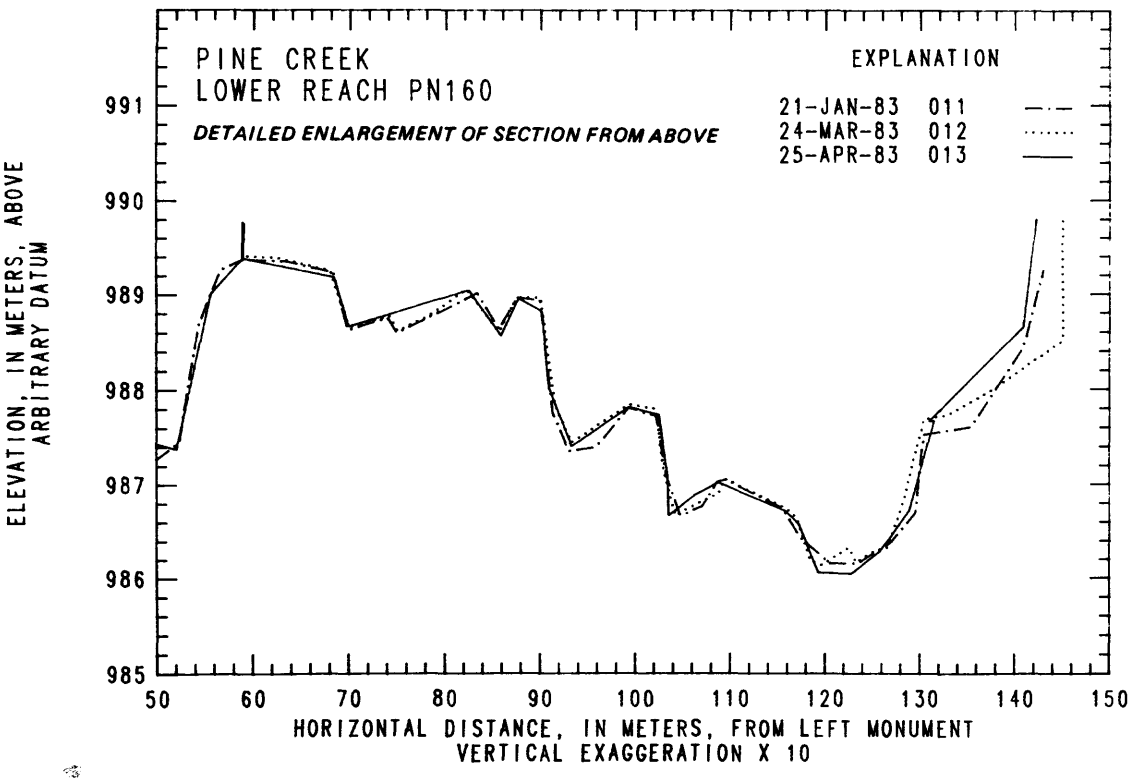
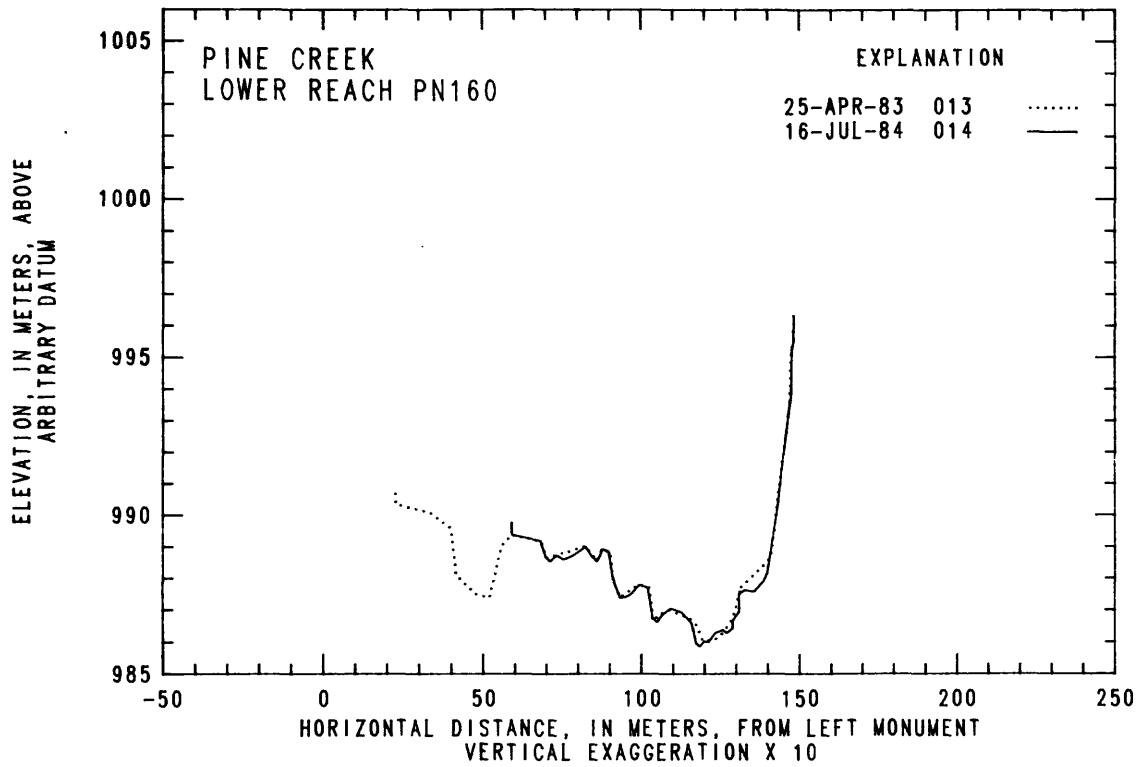


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



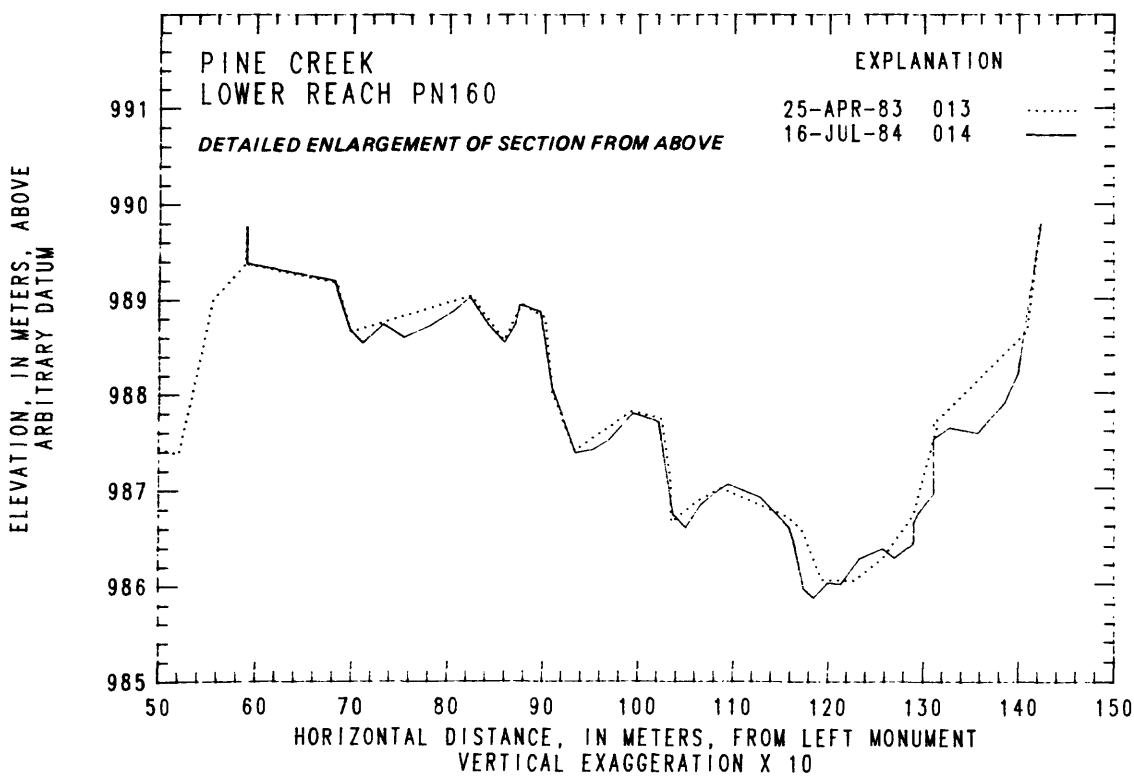


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

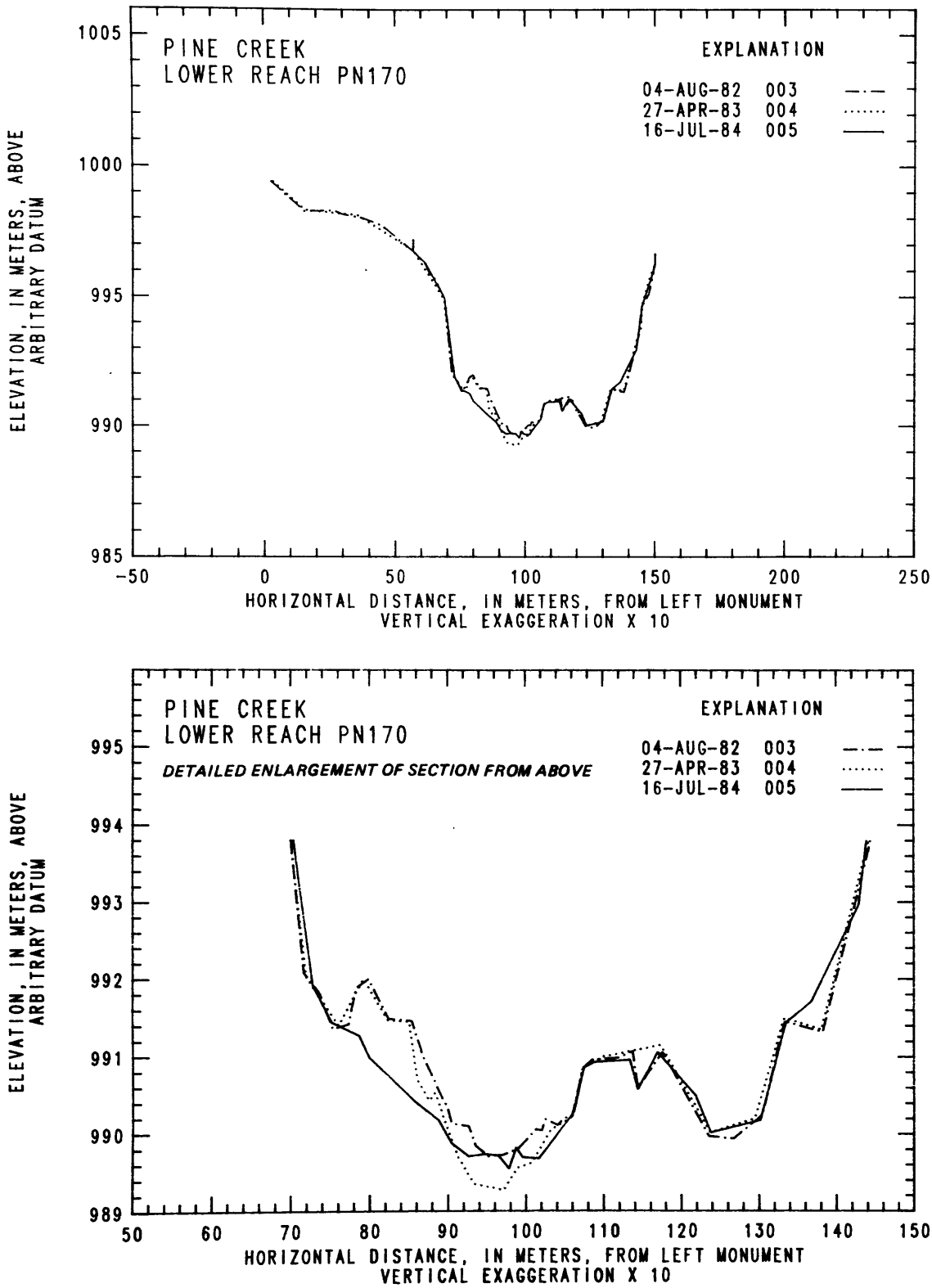


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

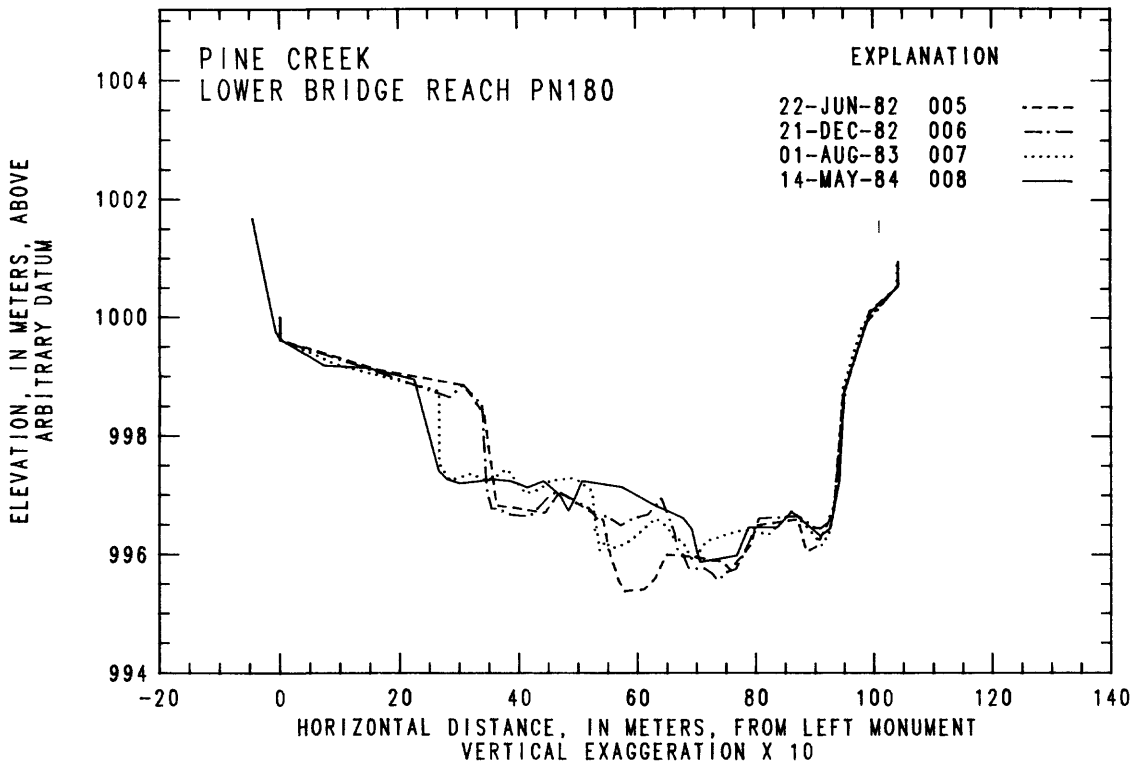


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

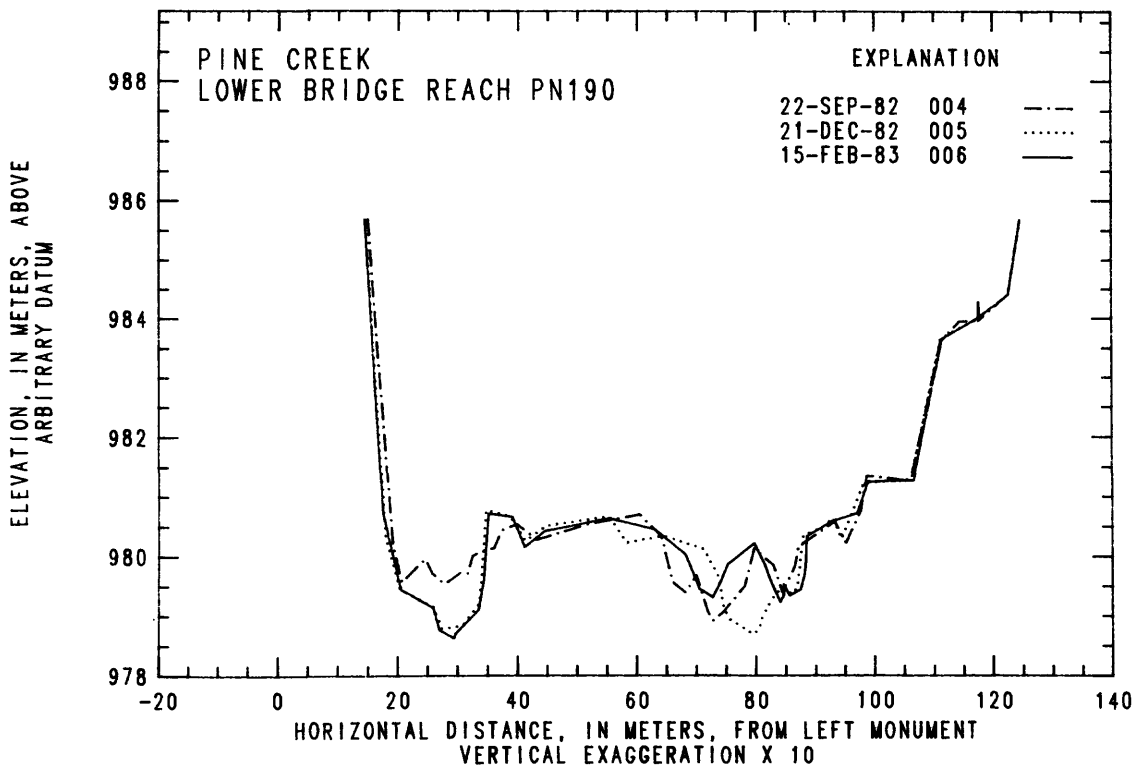


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

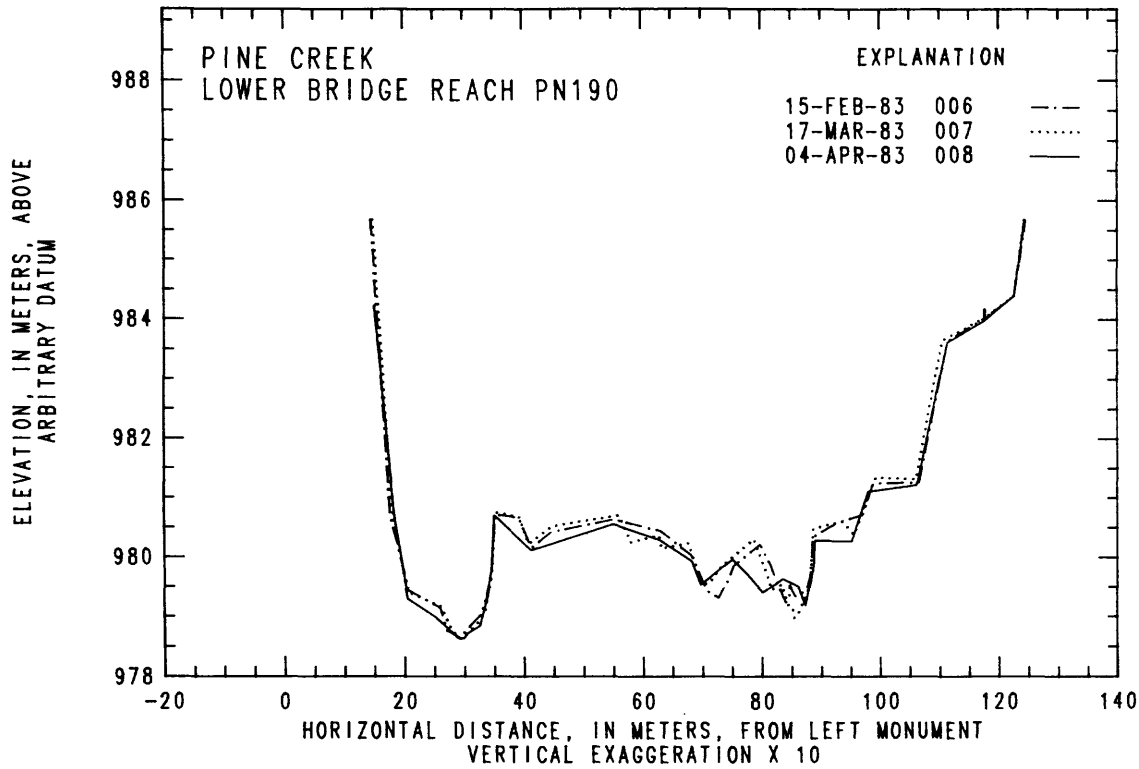


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

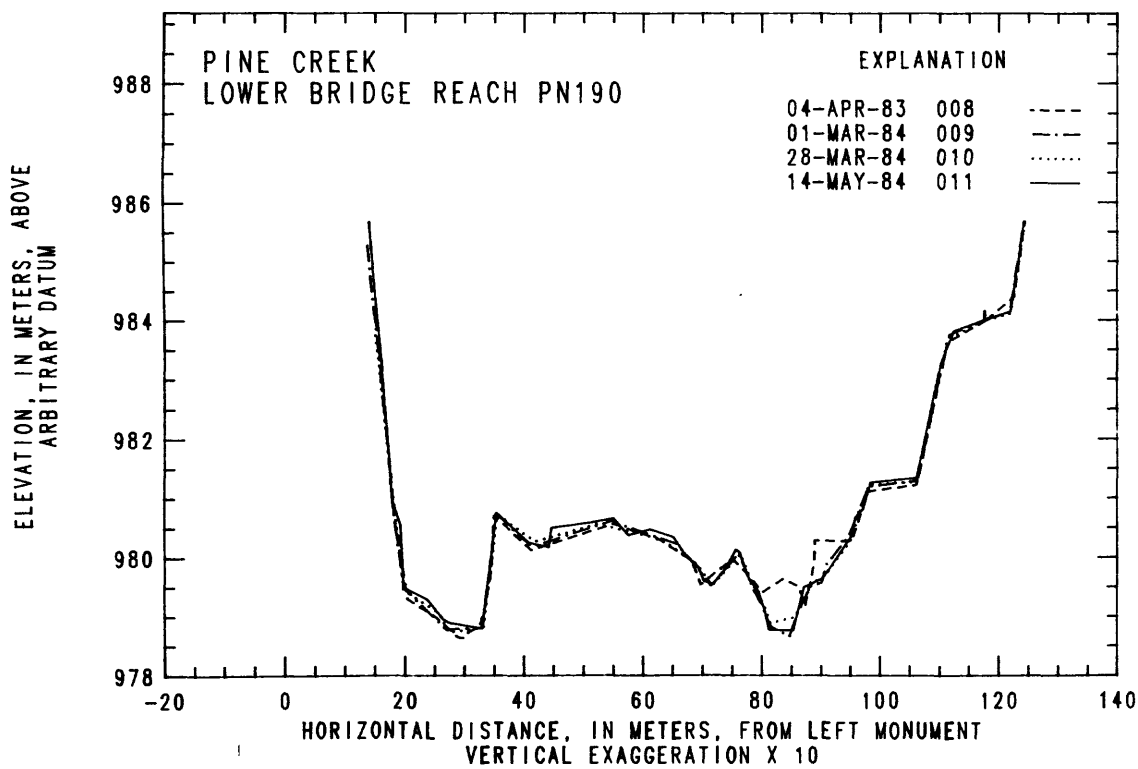


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

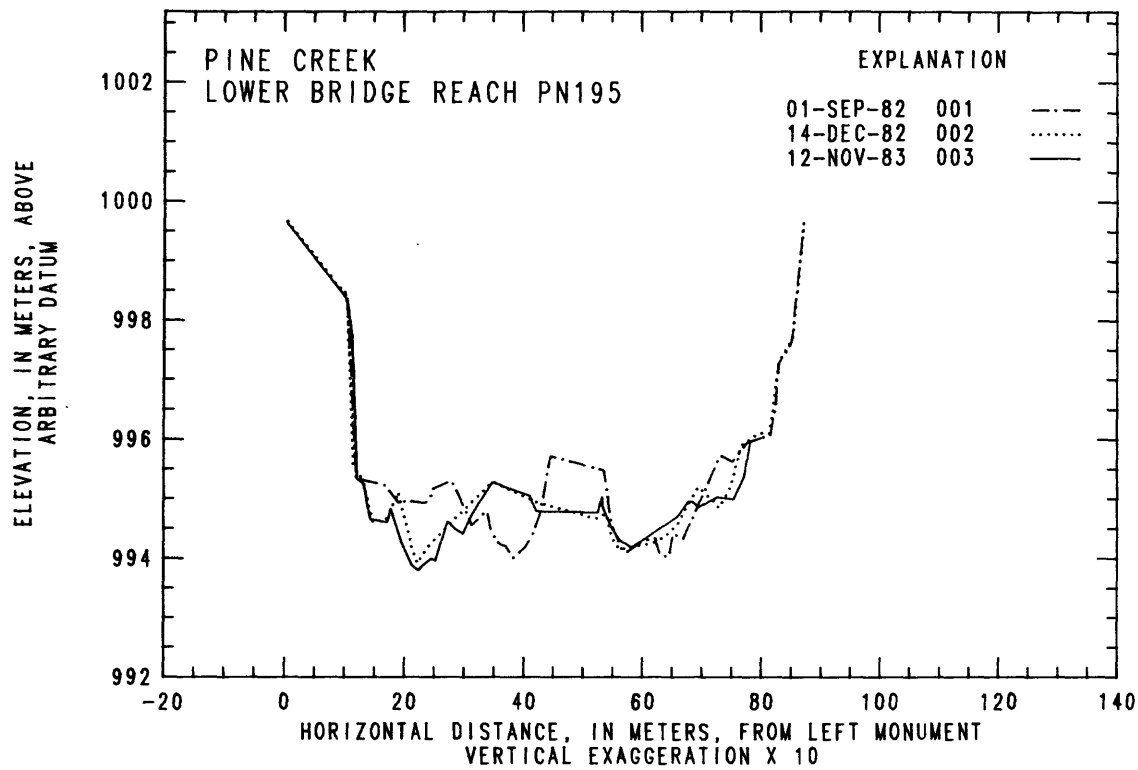


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

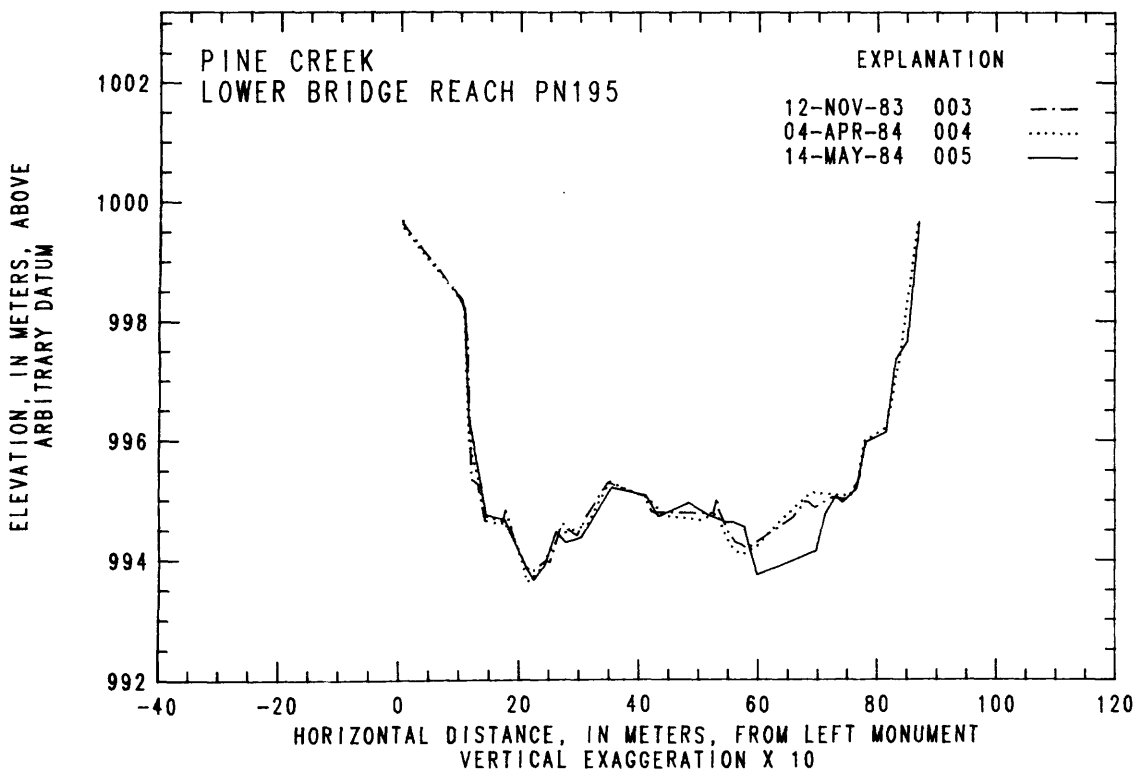
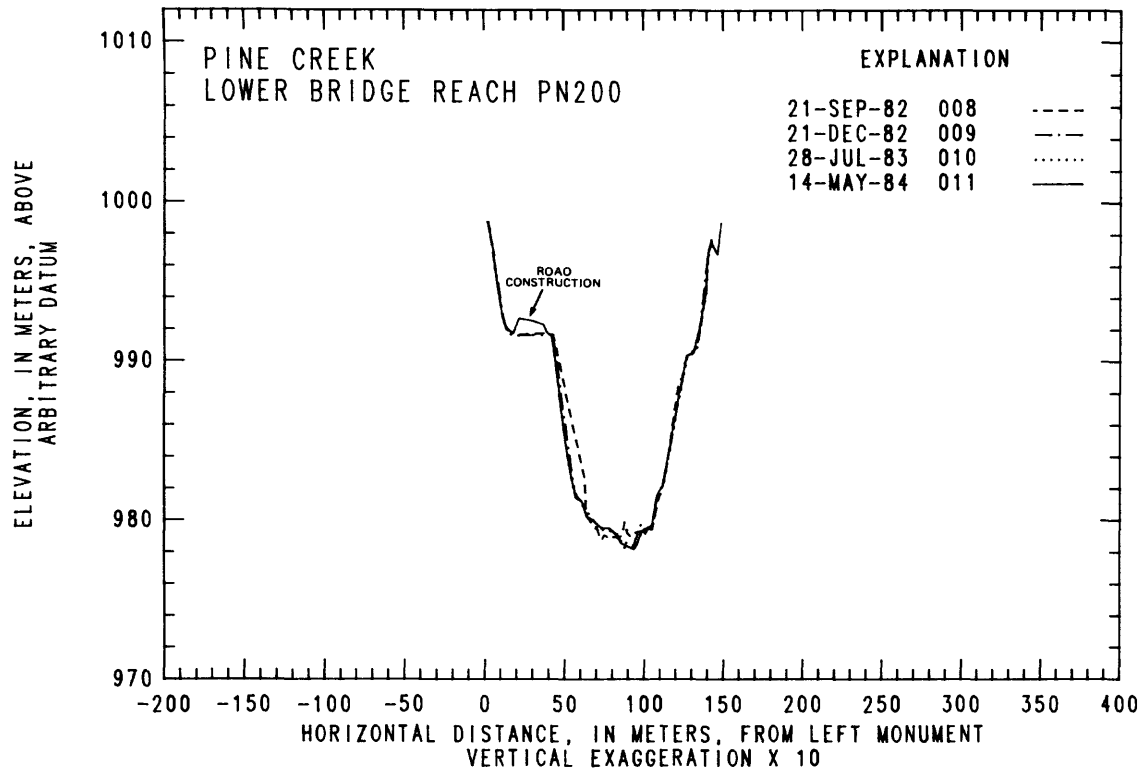


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



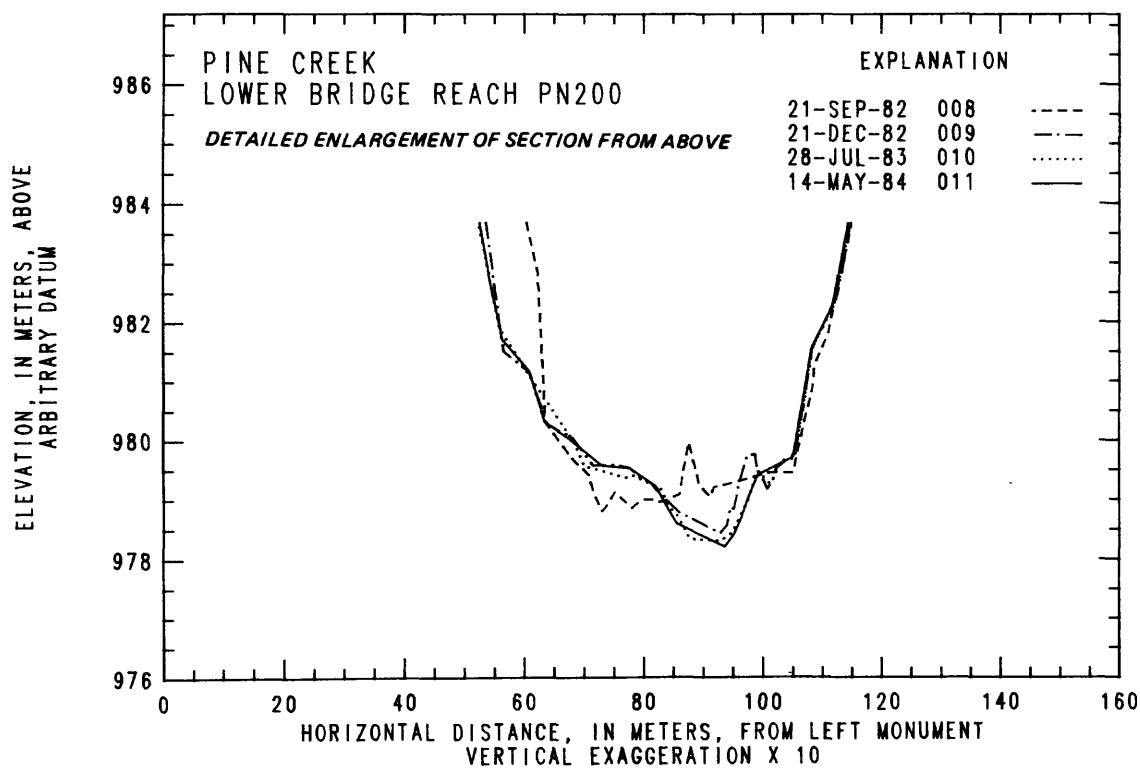


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

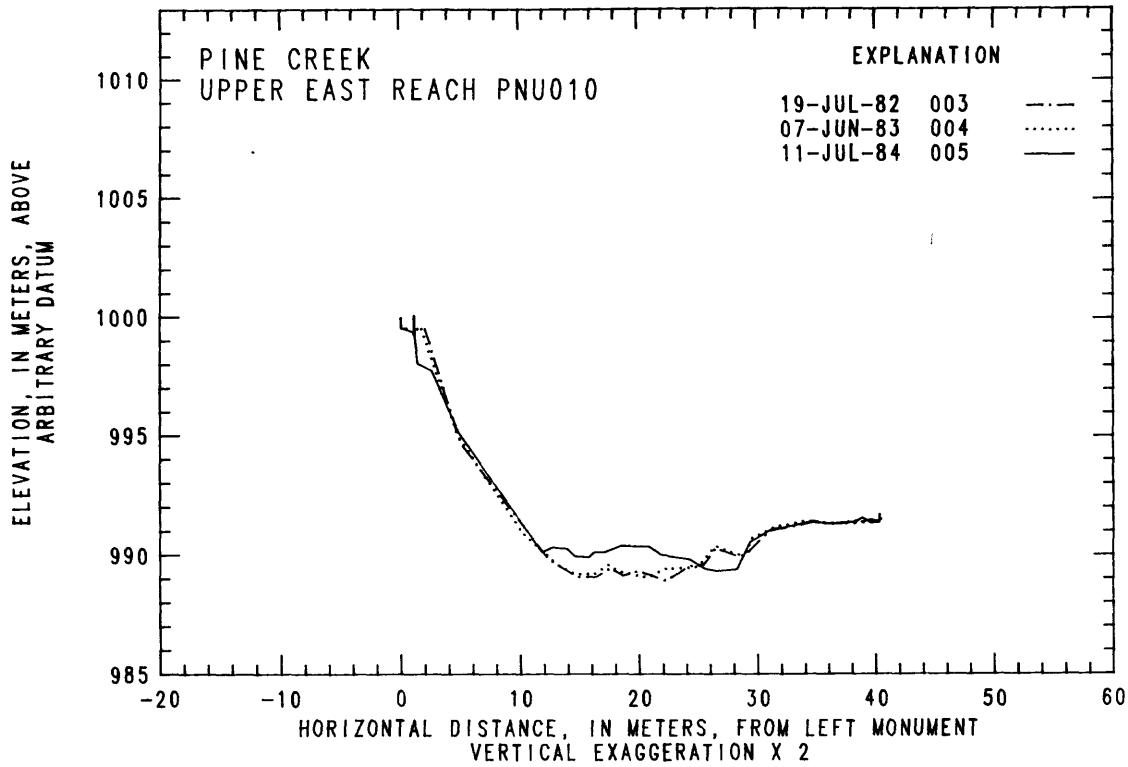


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

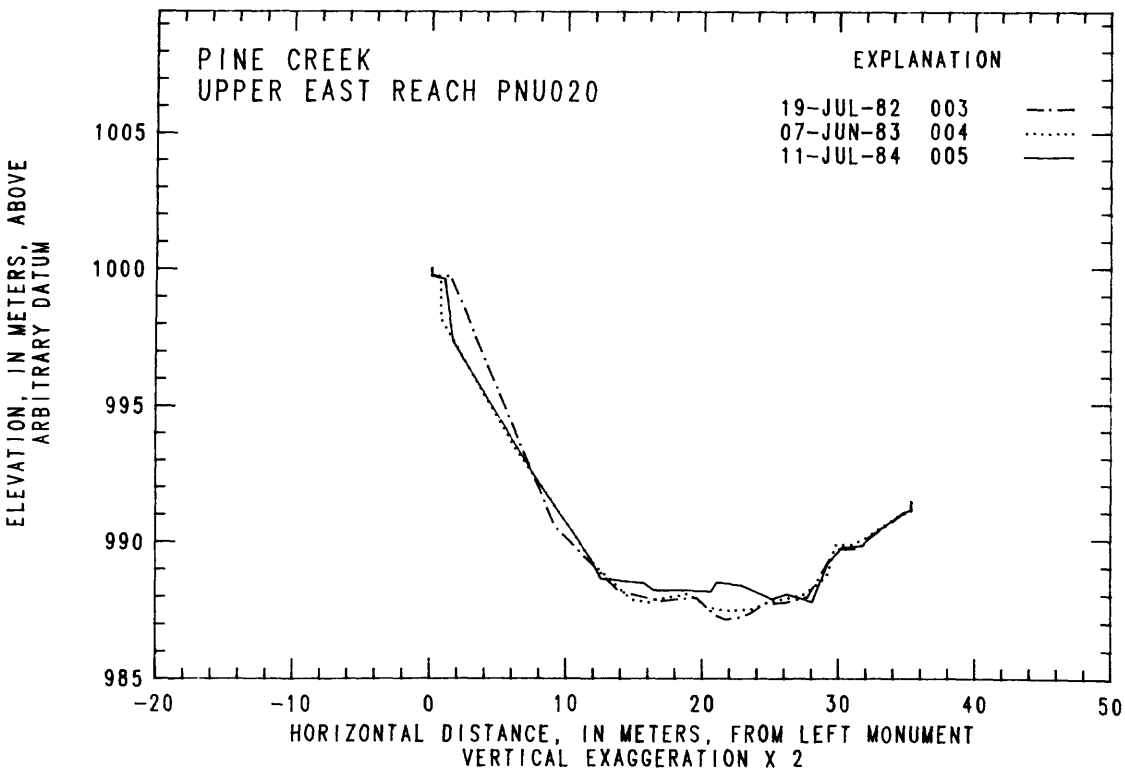
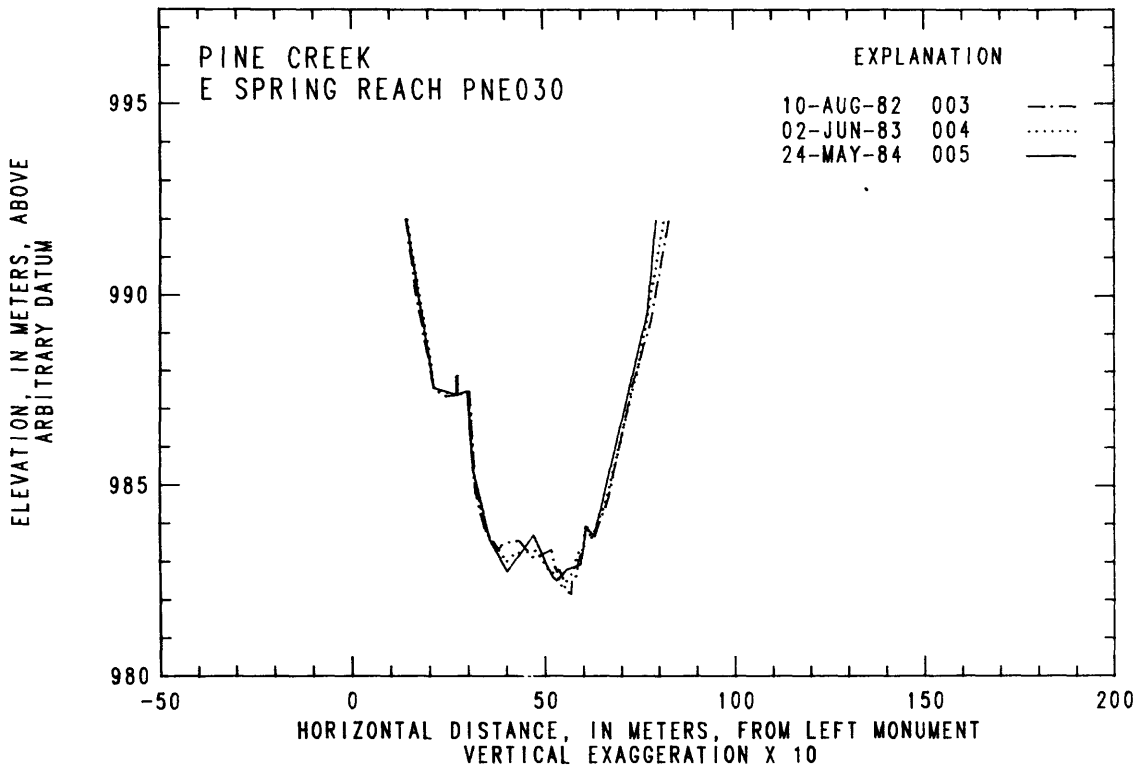


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



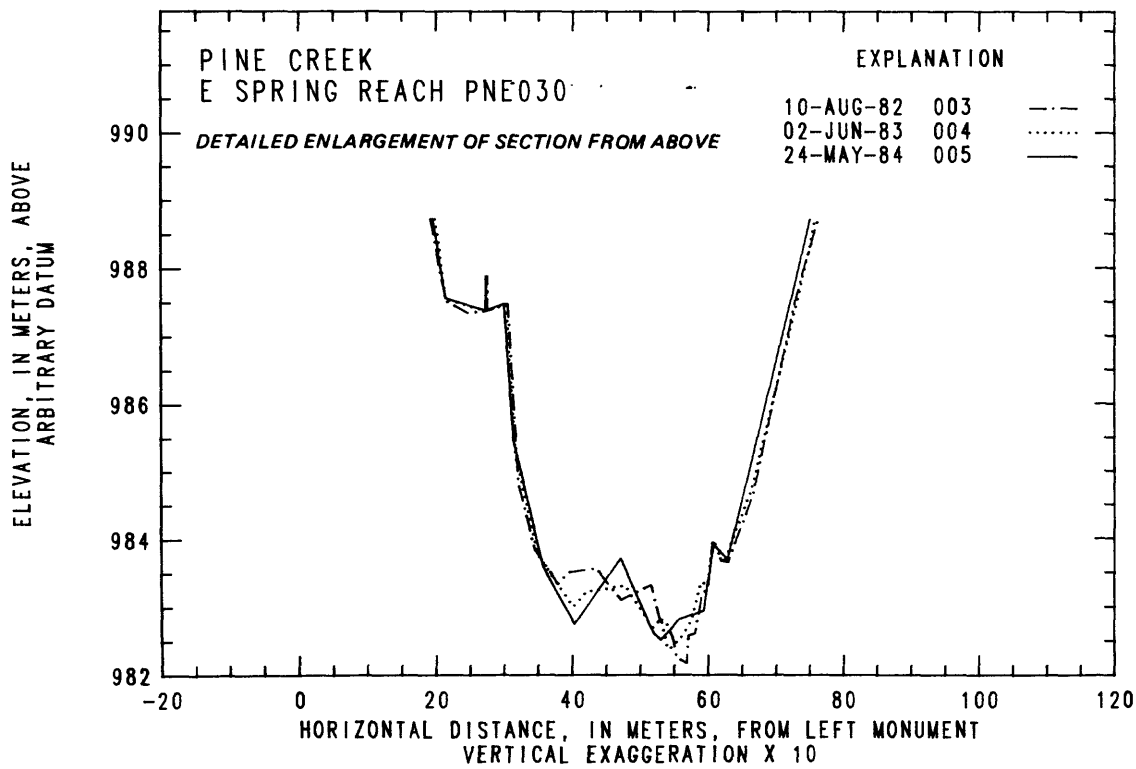
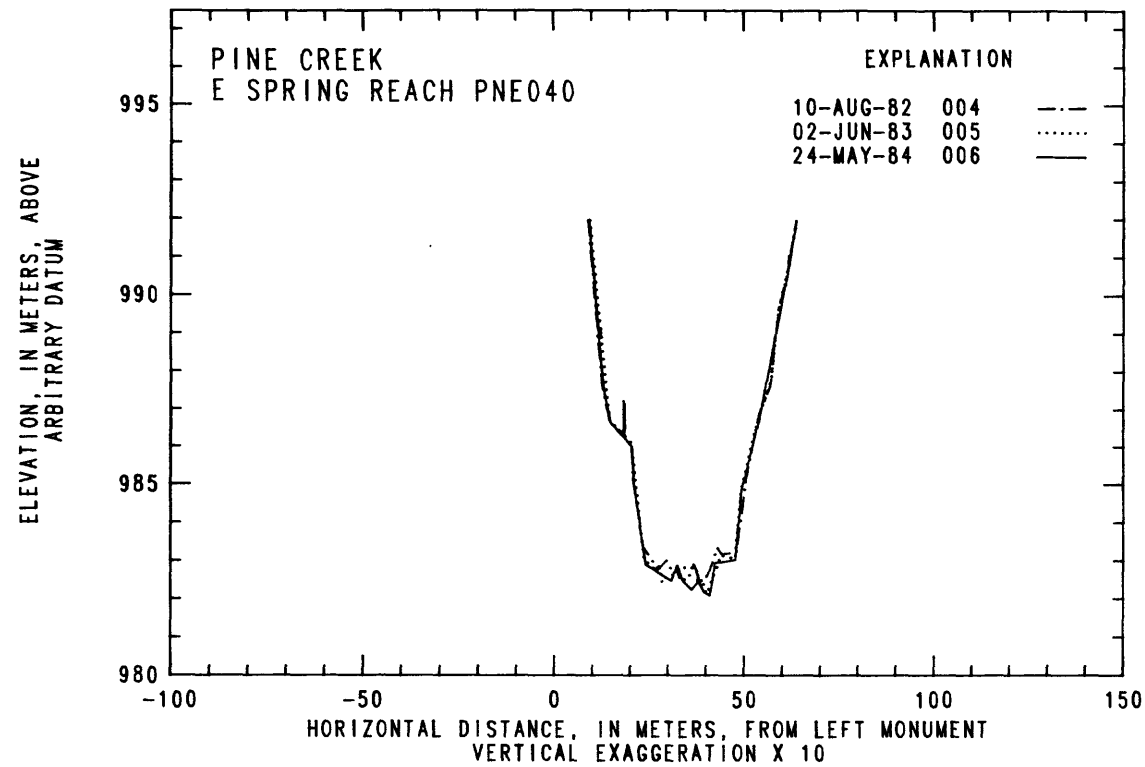


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



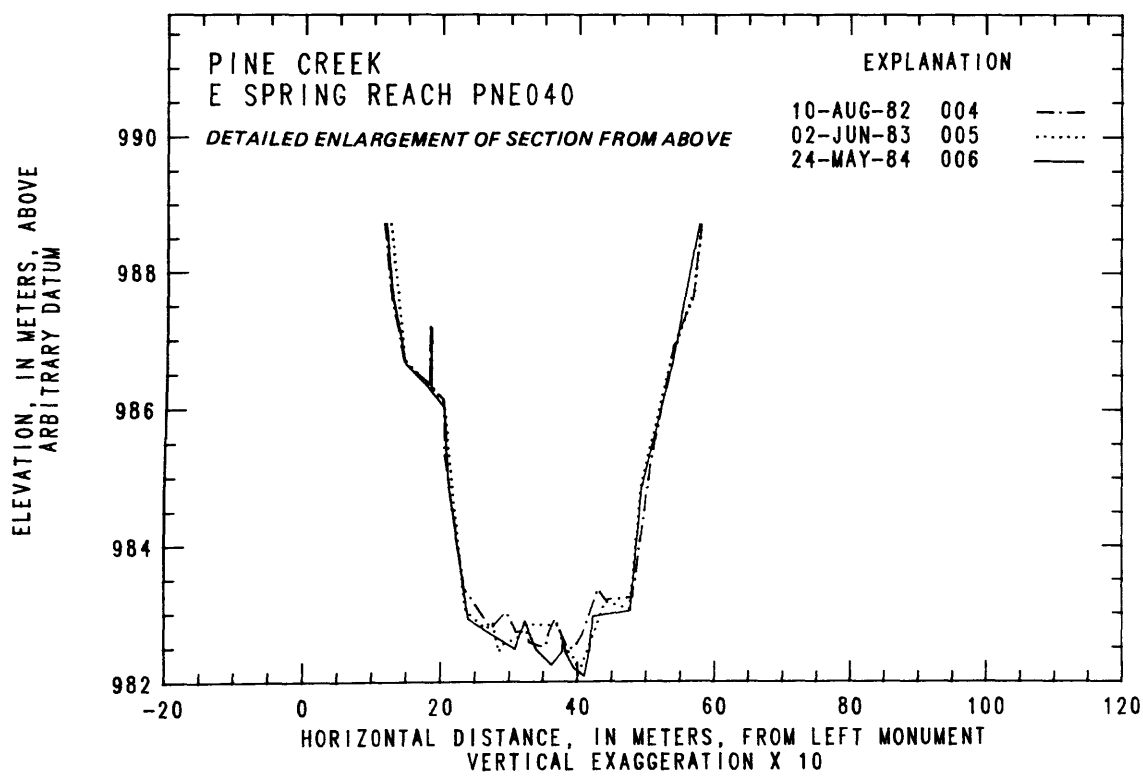
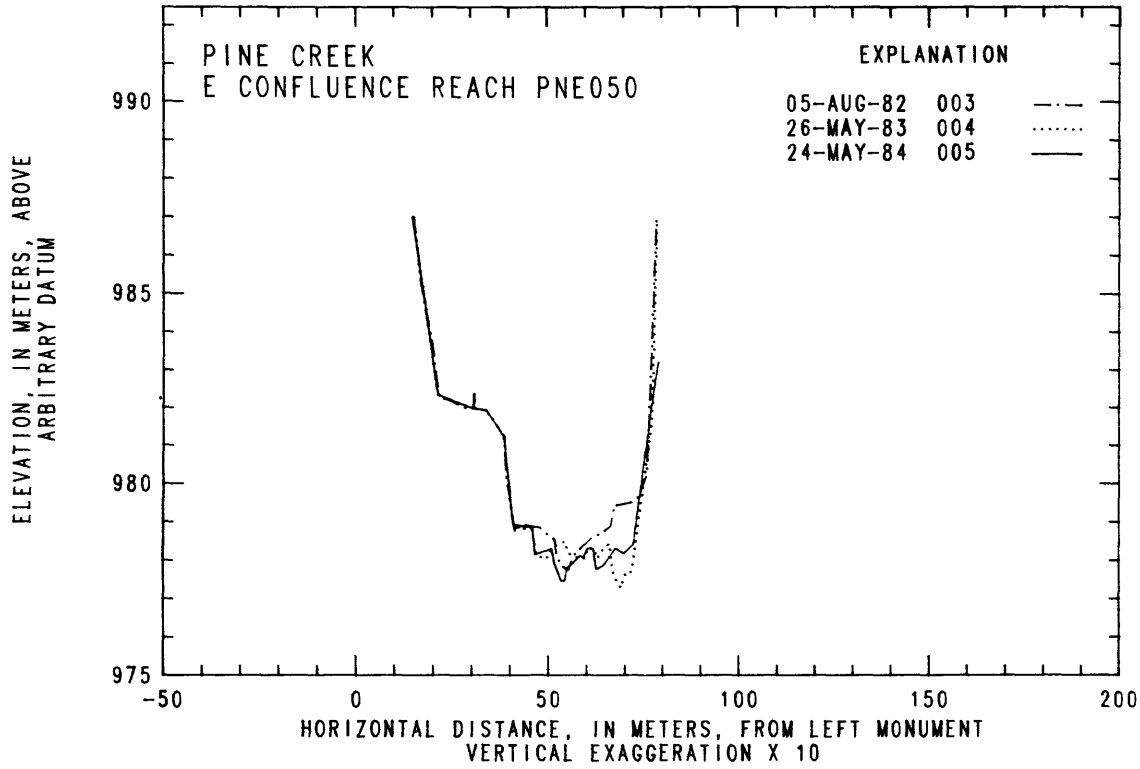


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



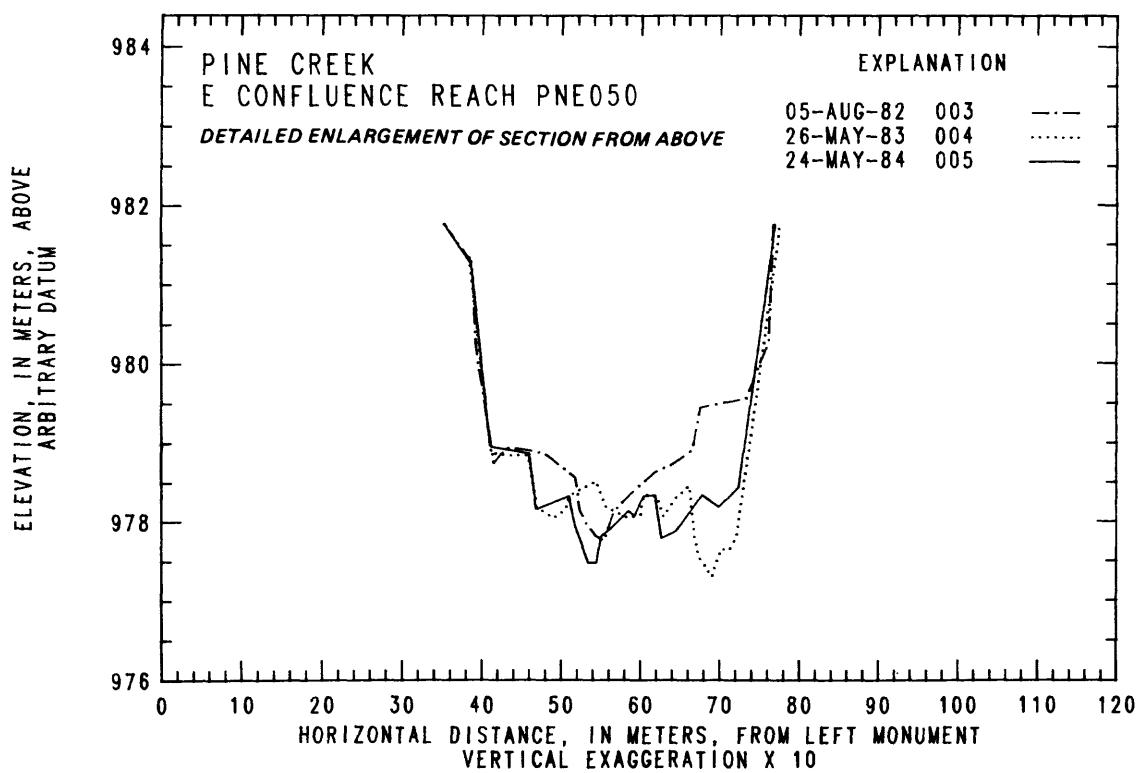
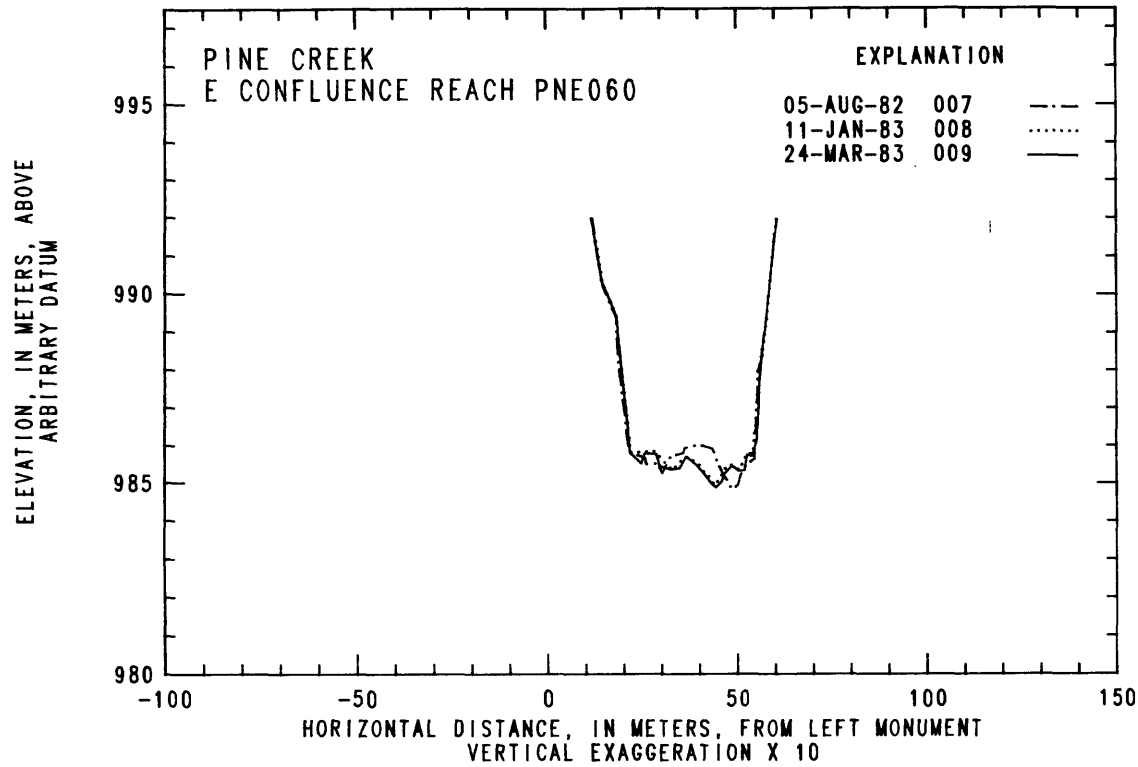


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



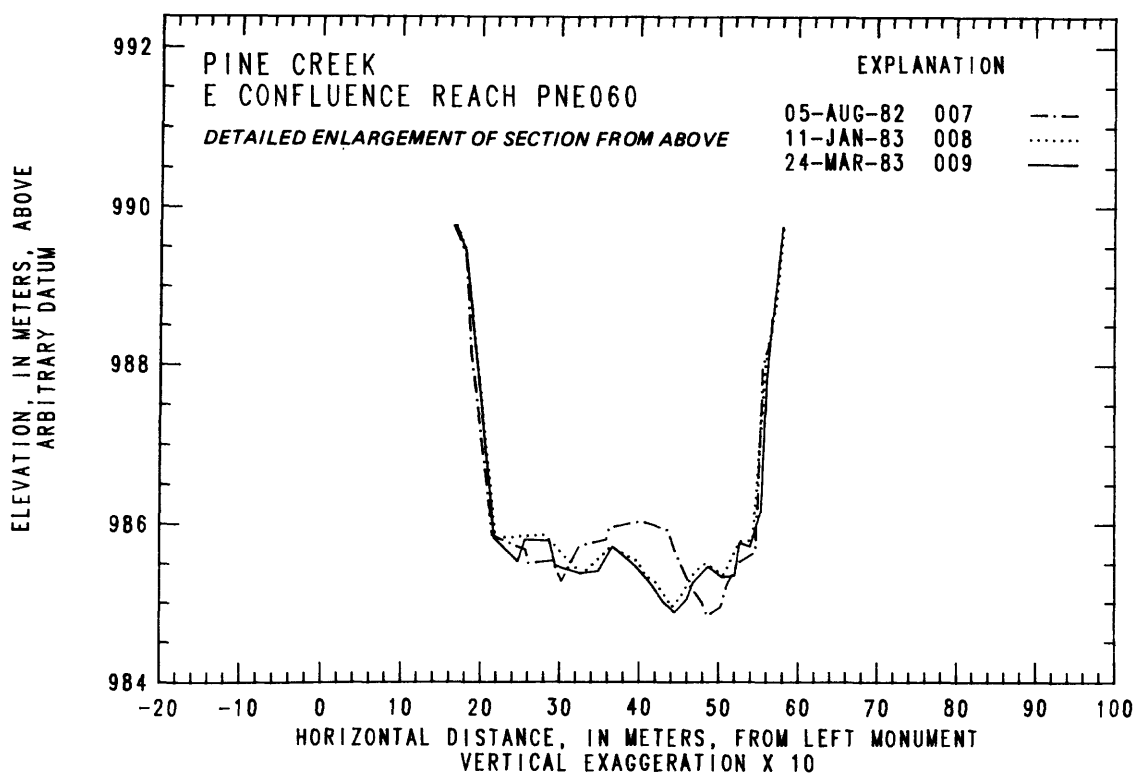
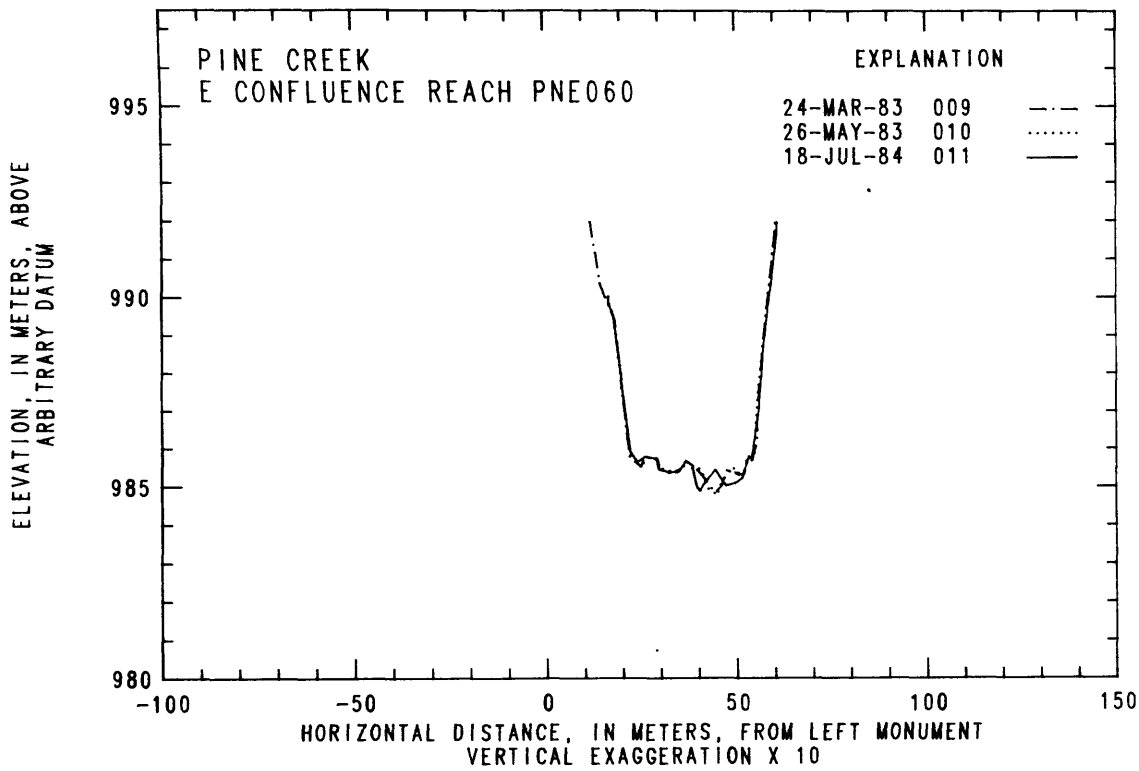


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.



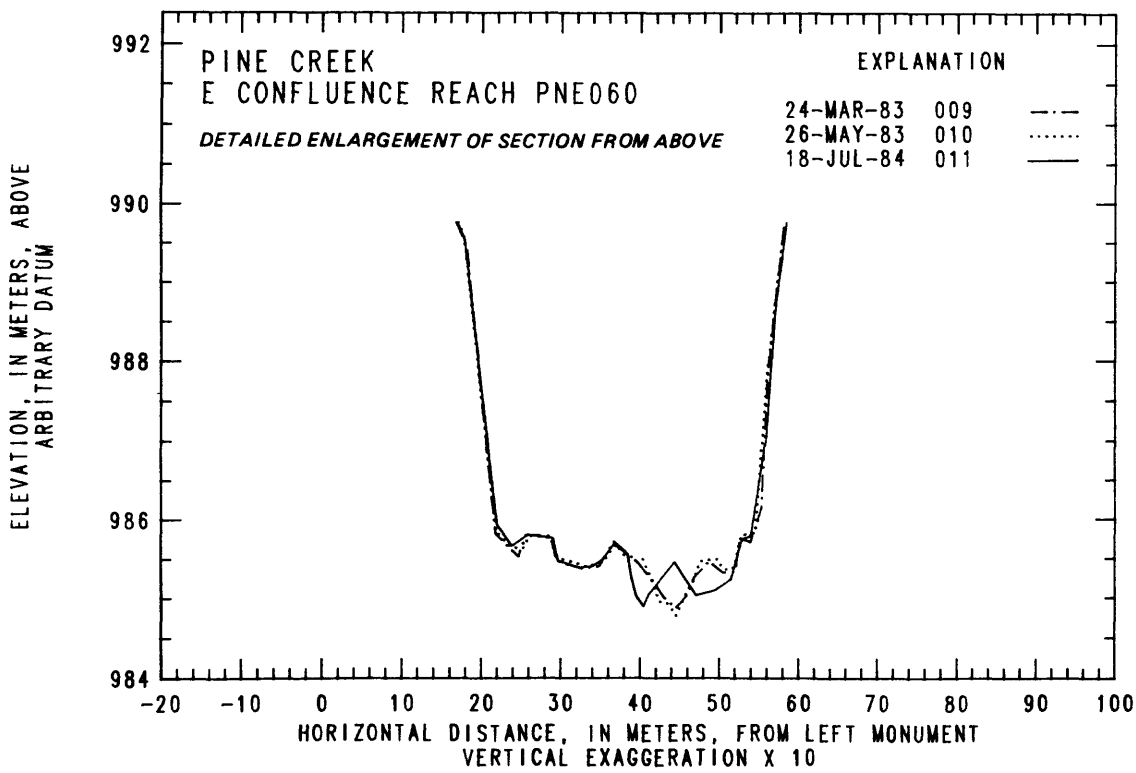


FIGURE 25. – Cross-section profiles for selected sites, Pine Creek – continued.

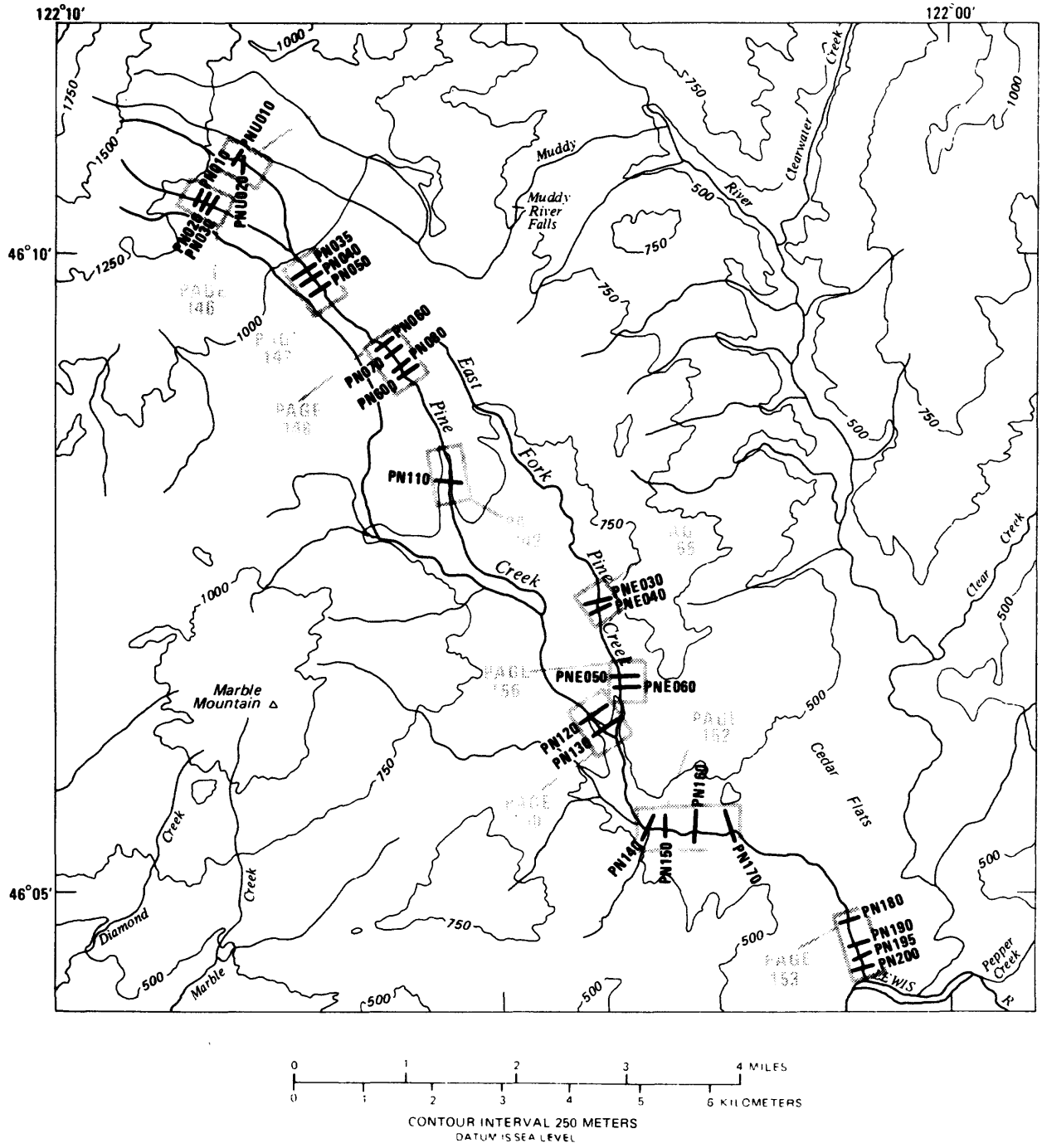
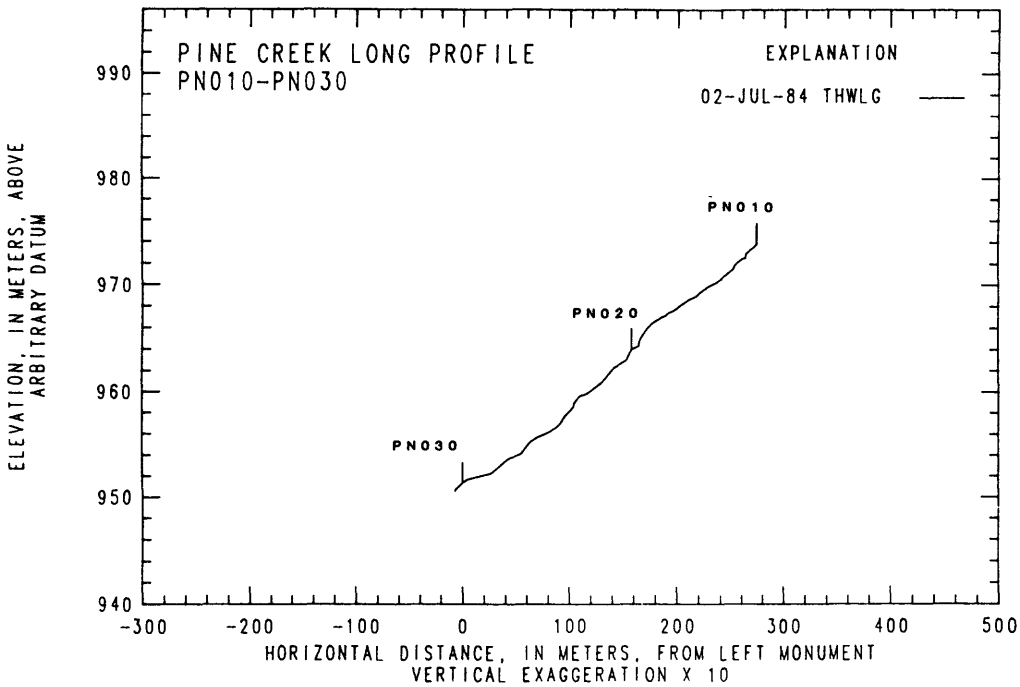


FIGURE 26. – Locations of surveyed longitudinal profiles and corresponding map views, Pine Creek.



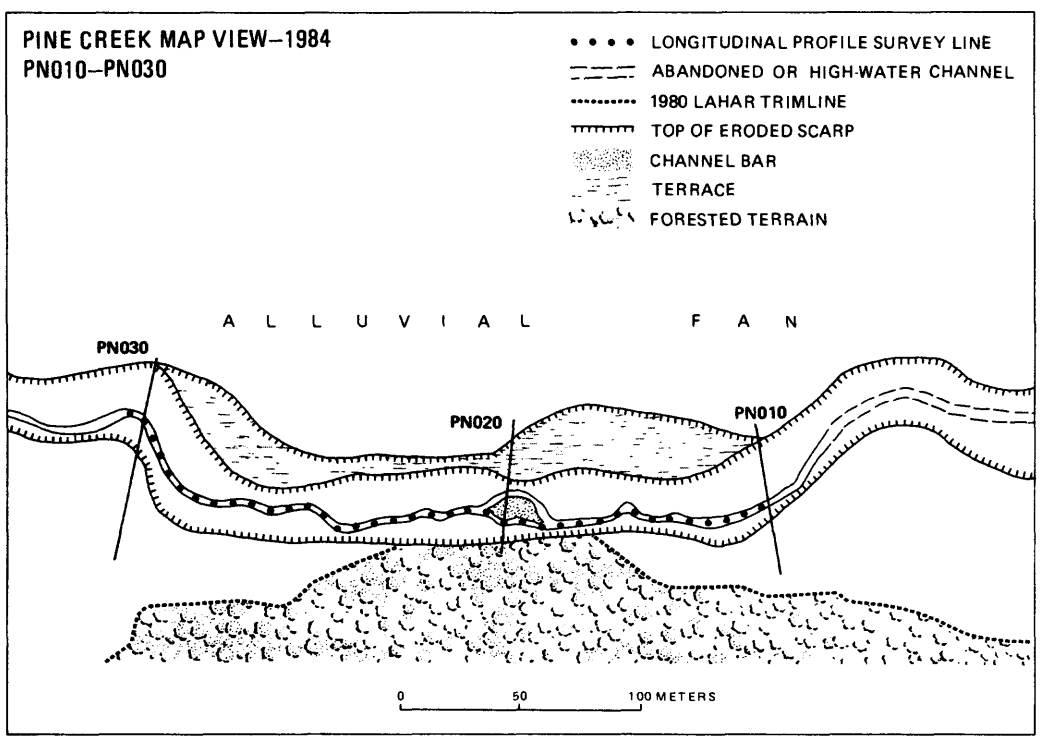
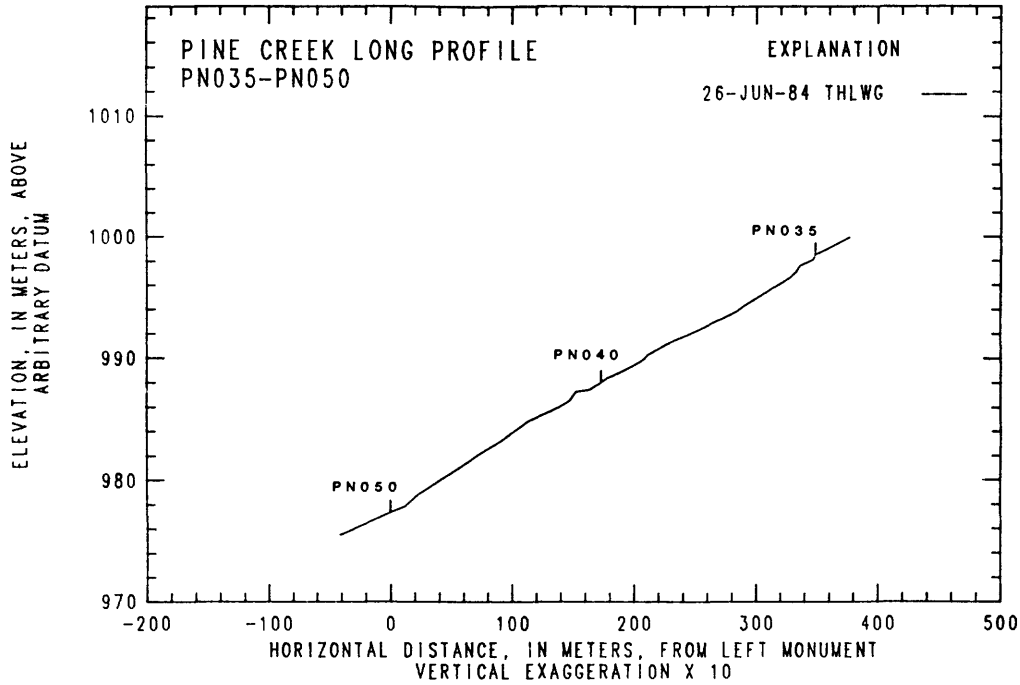


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek.



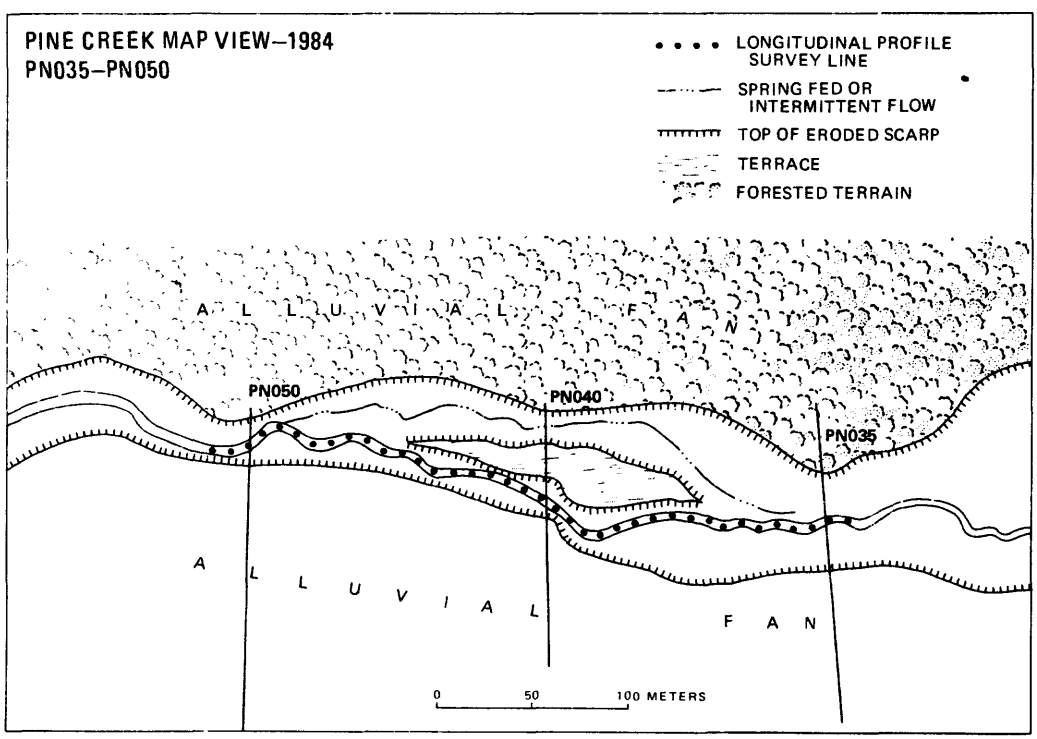
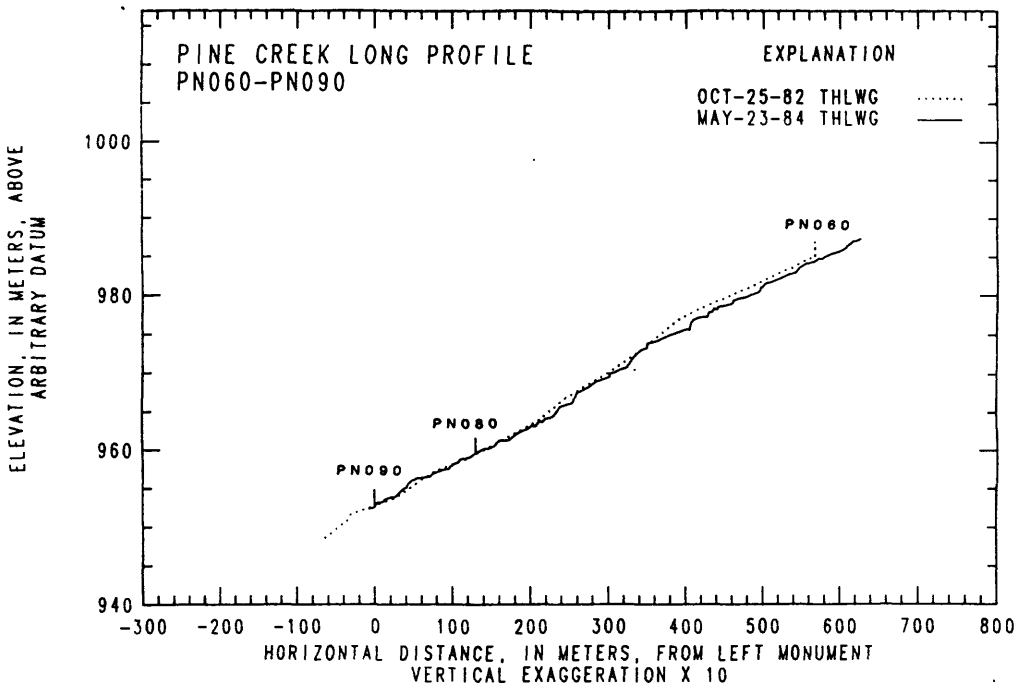


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



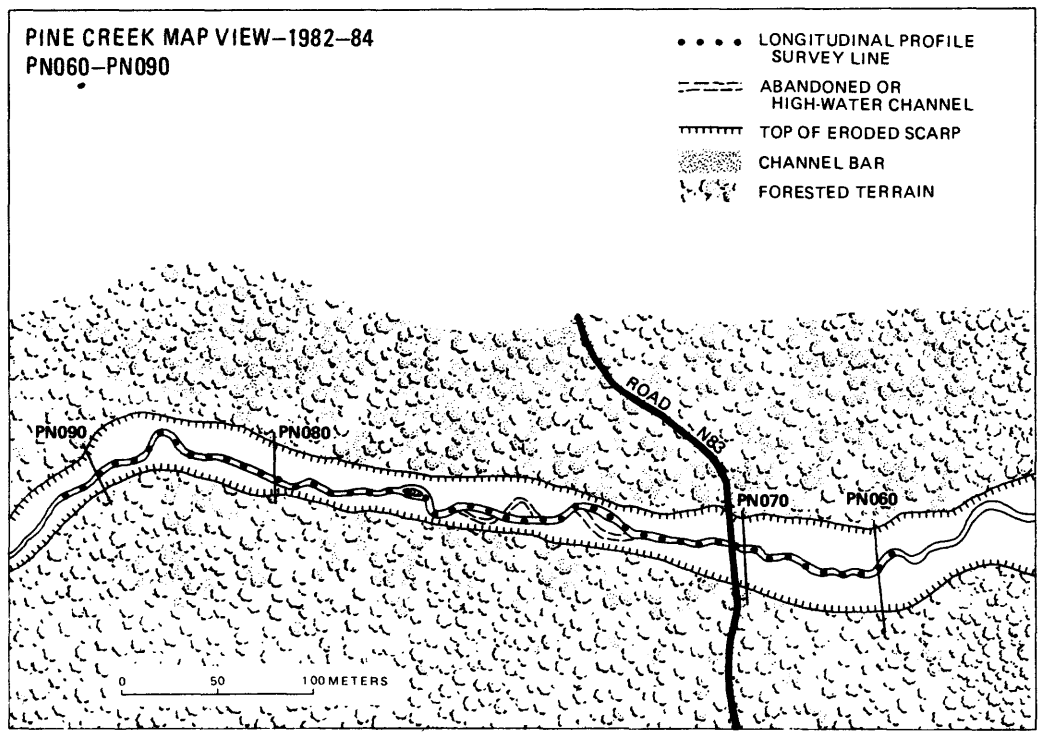
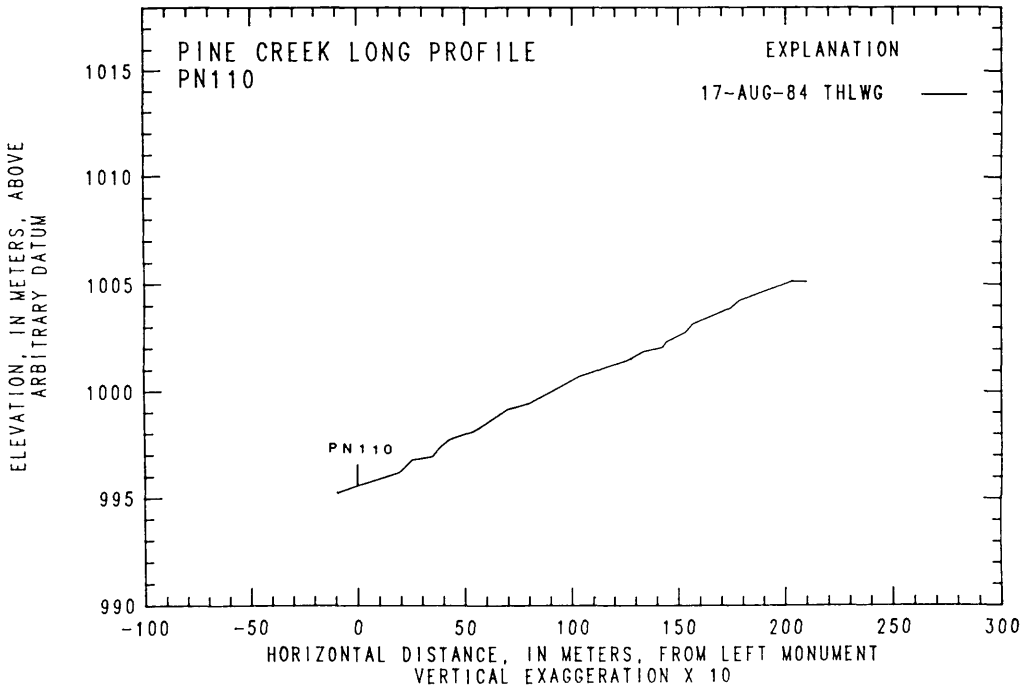


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



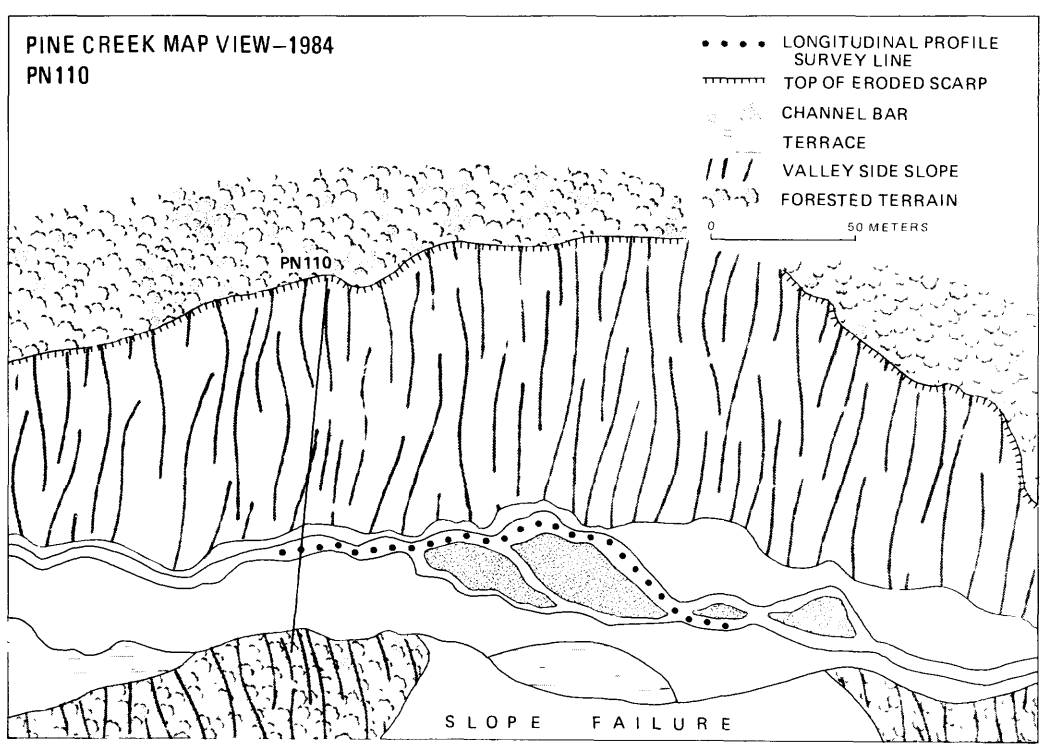
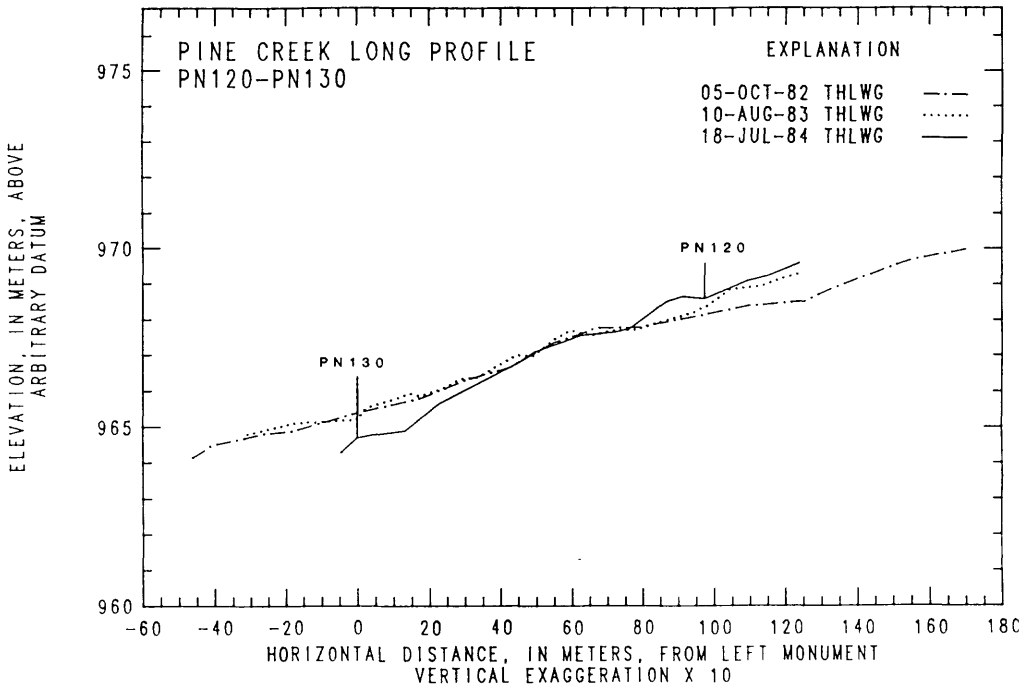


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



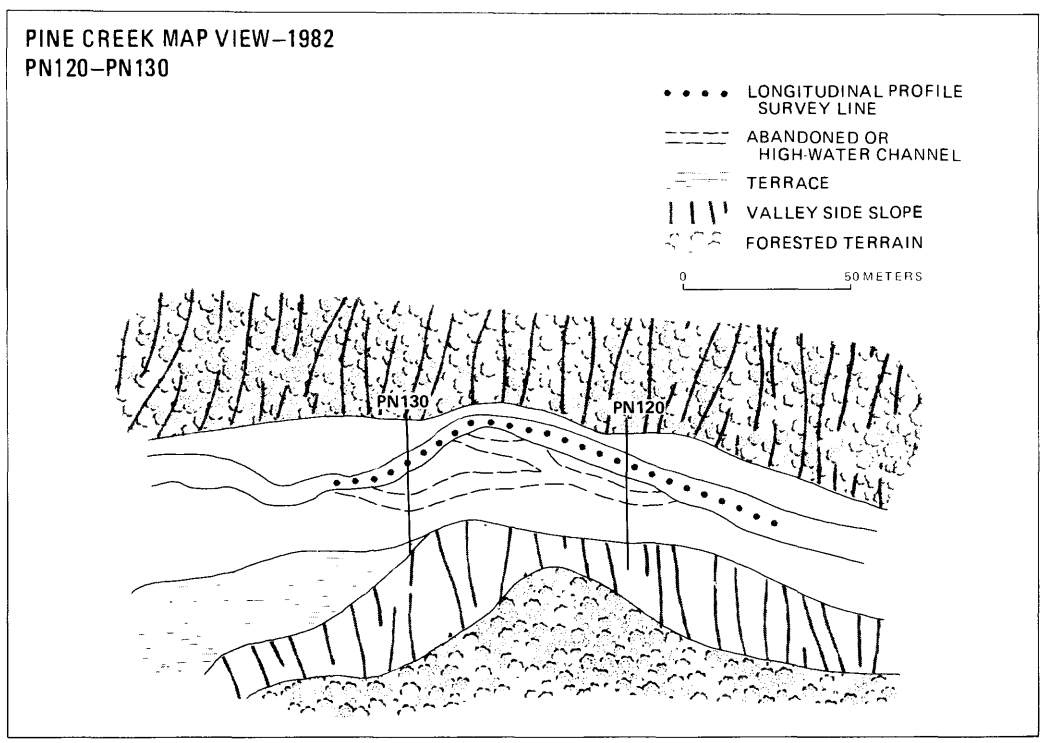
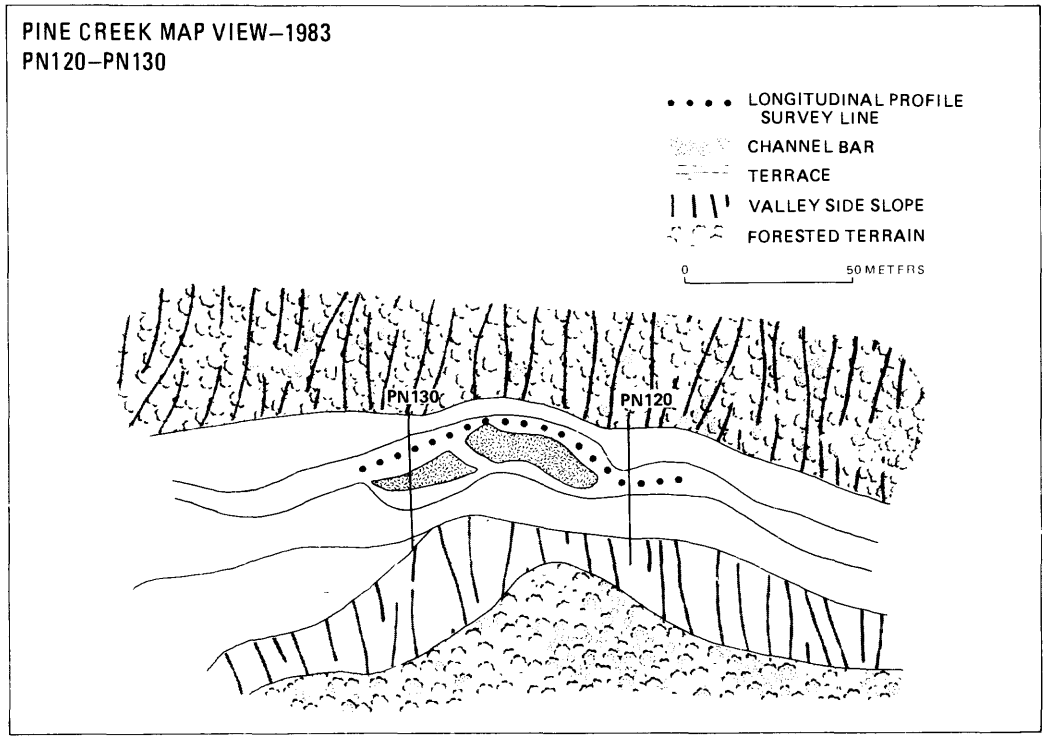


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



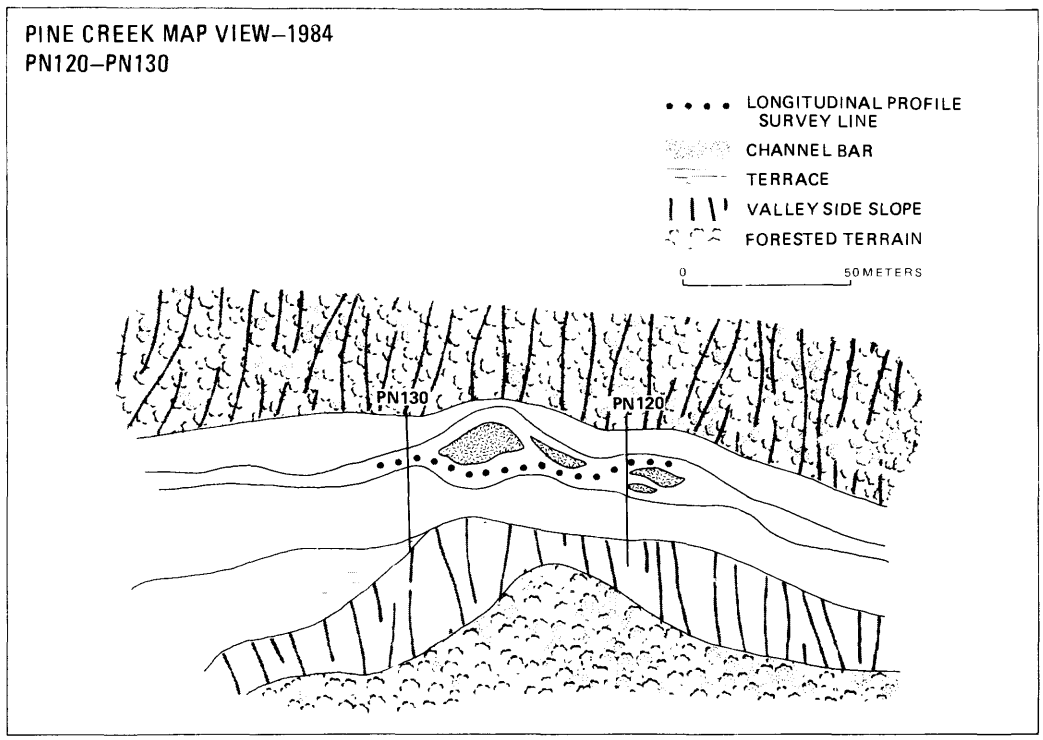
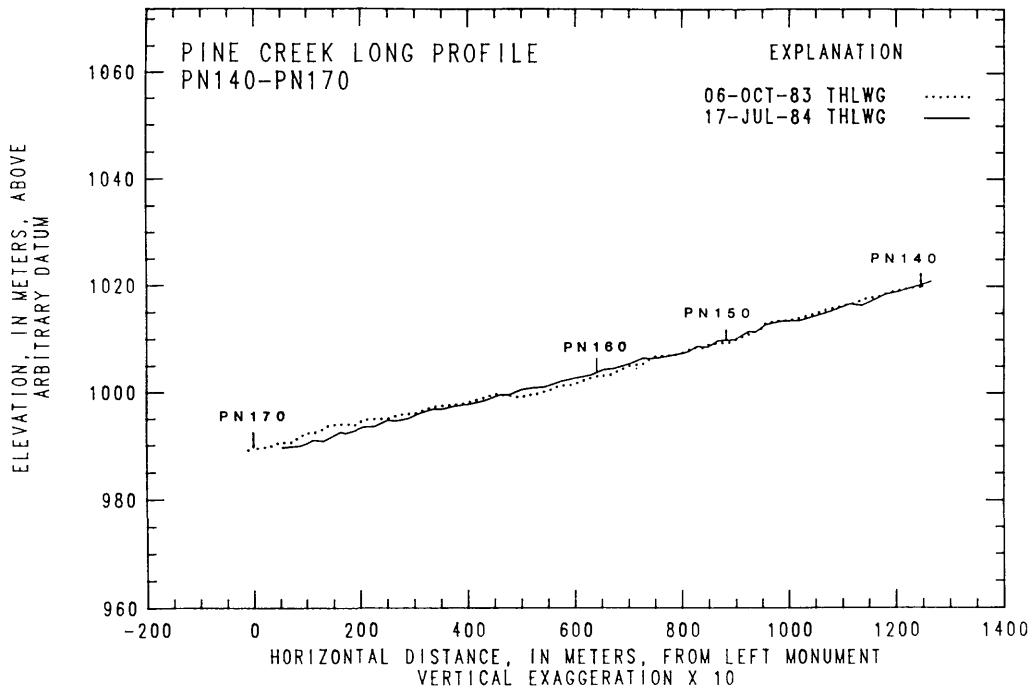


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



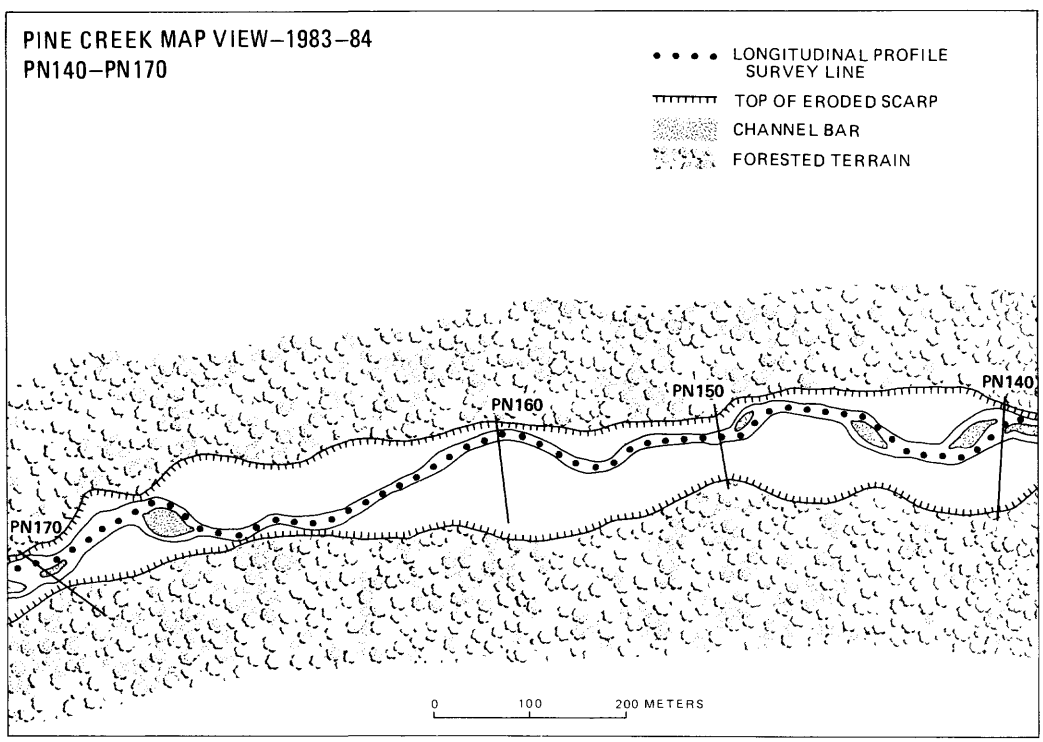
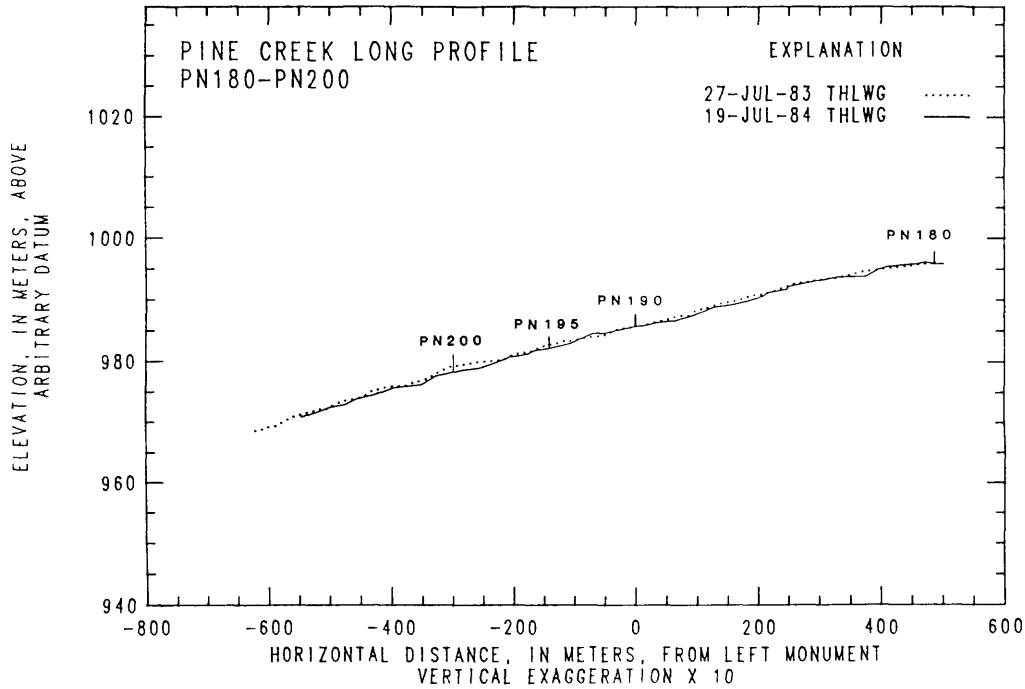


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



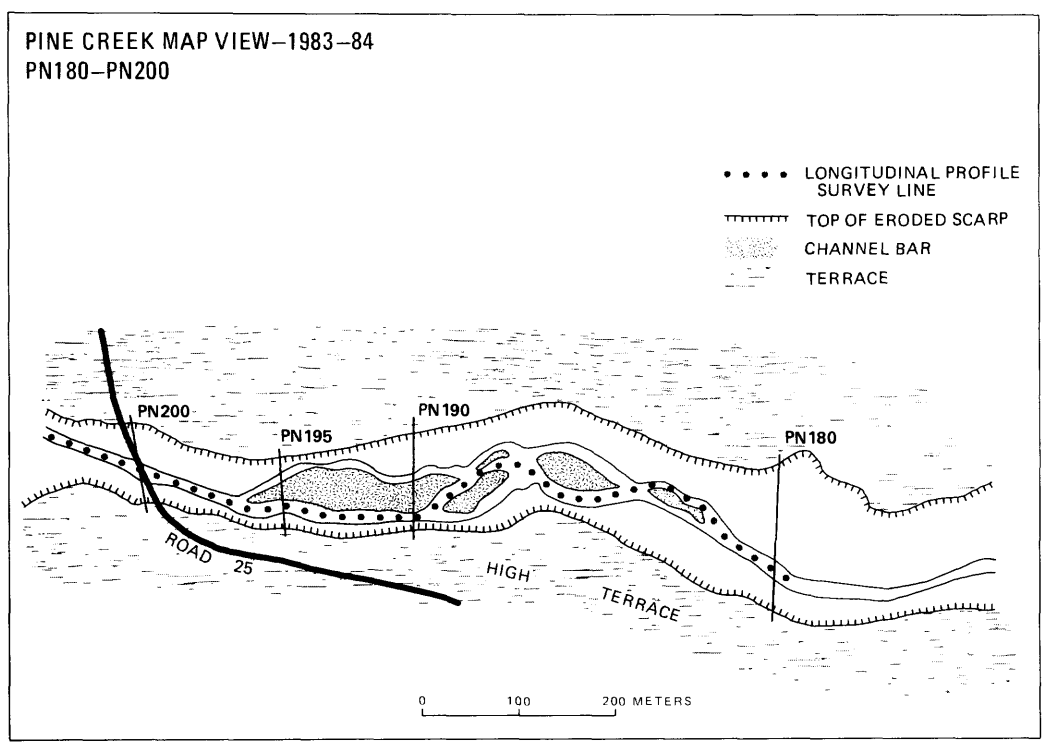
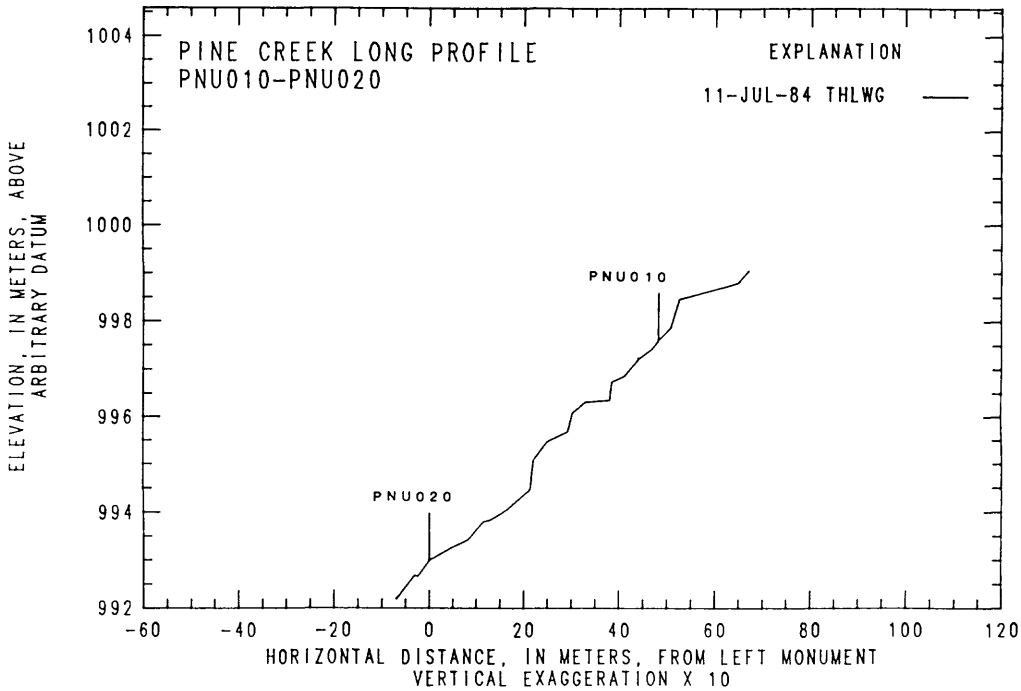


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



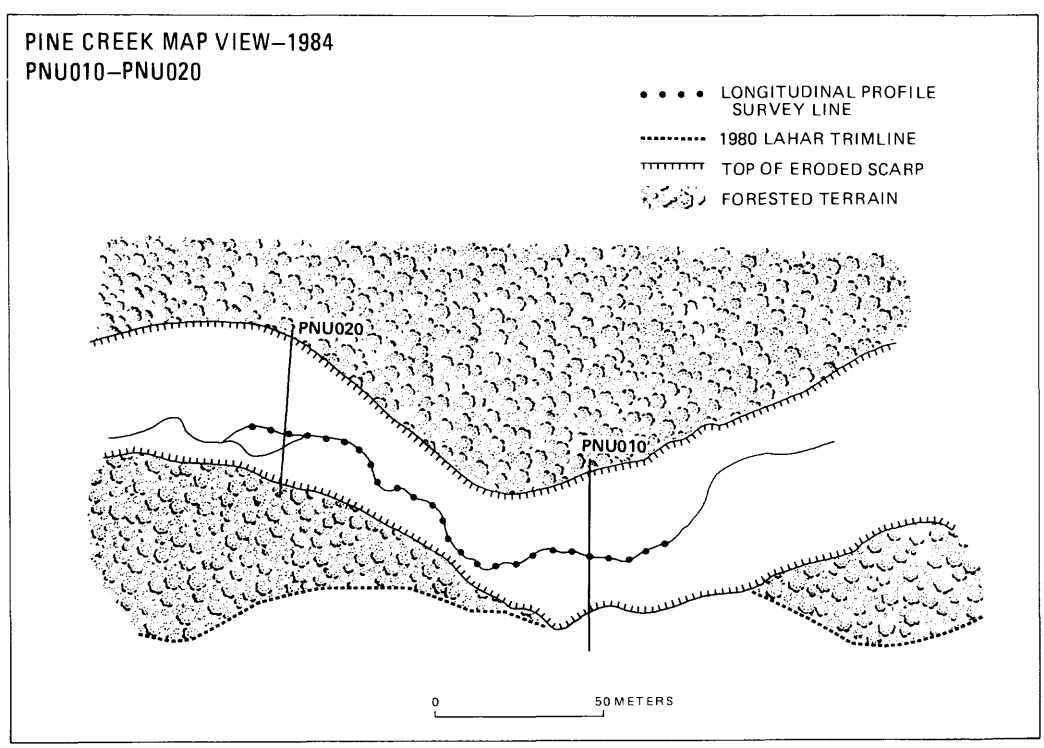
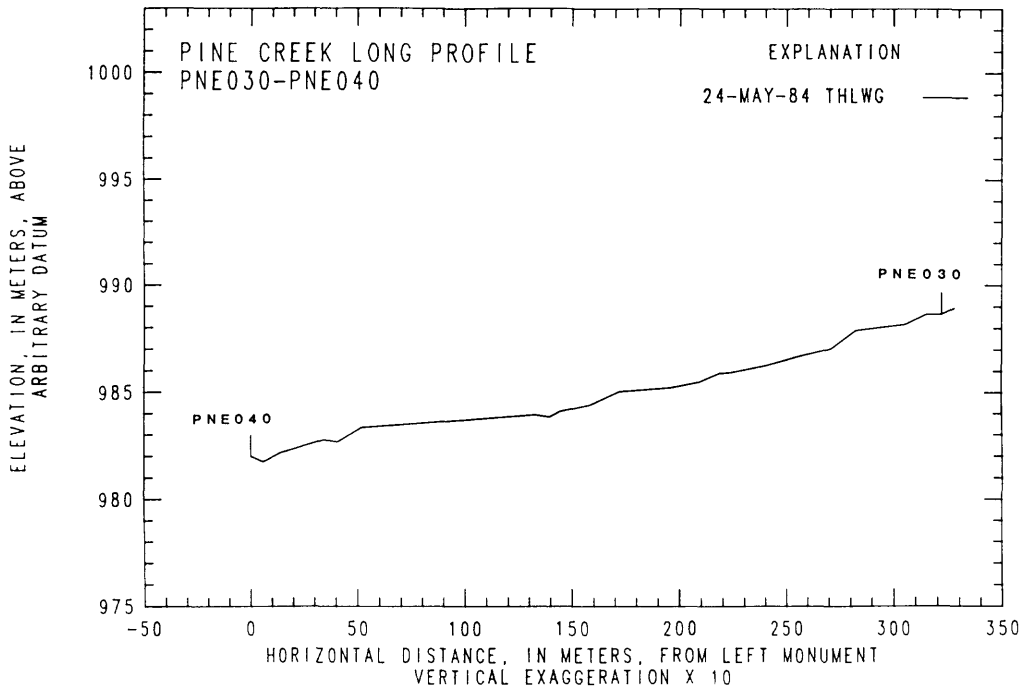


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



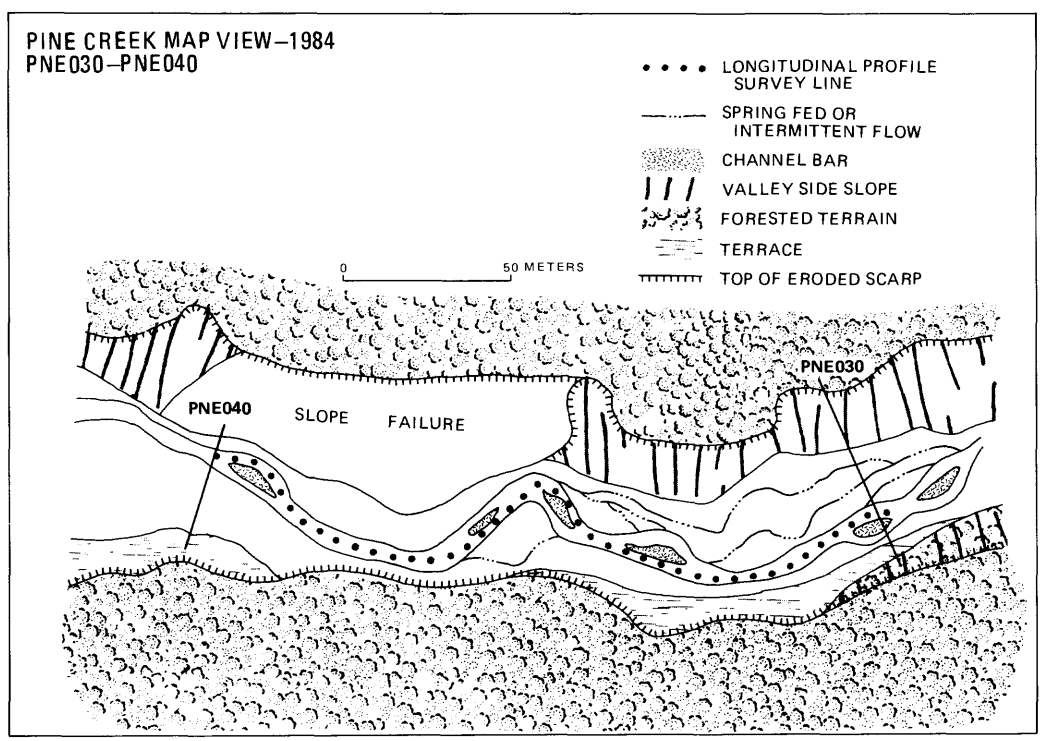
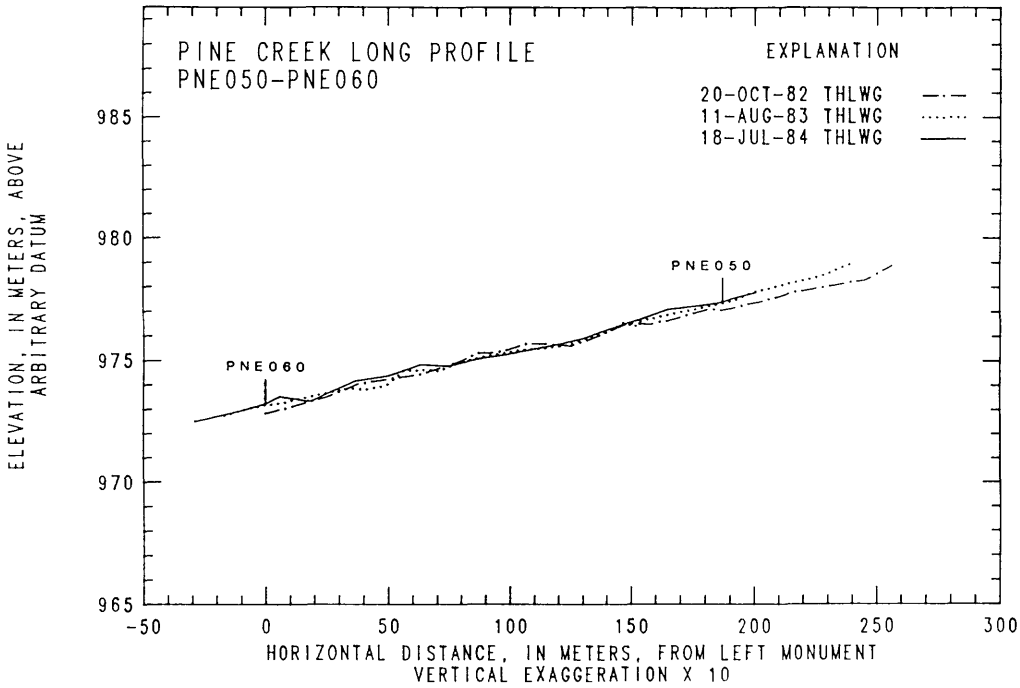


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



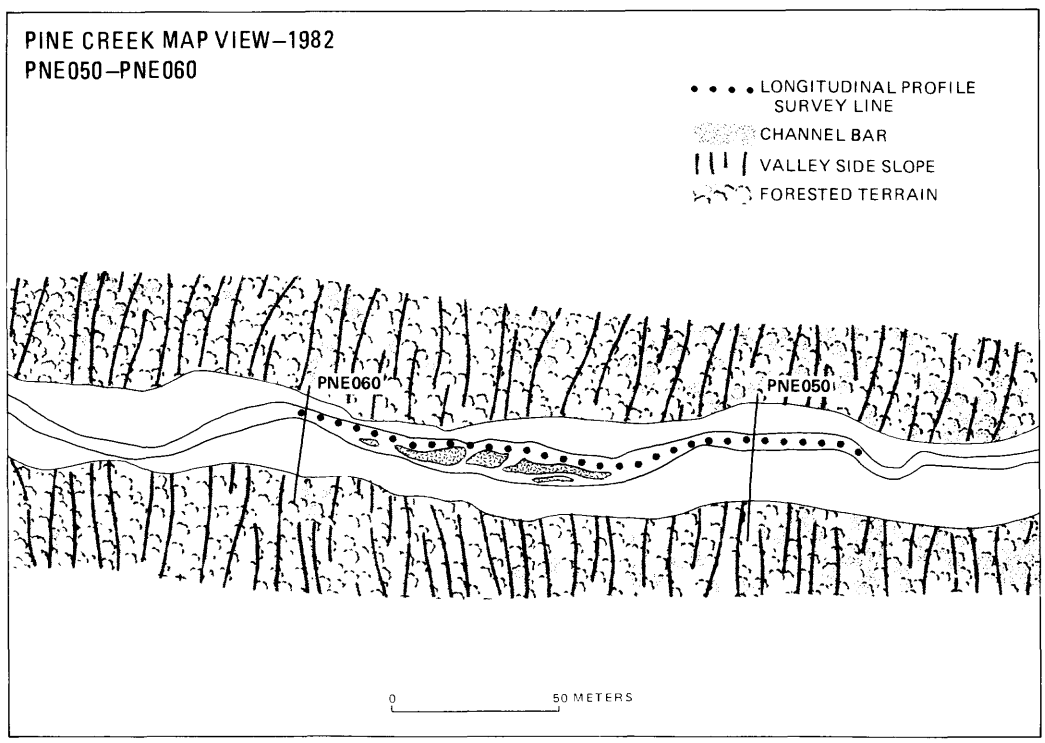
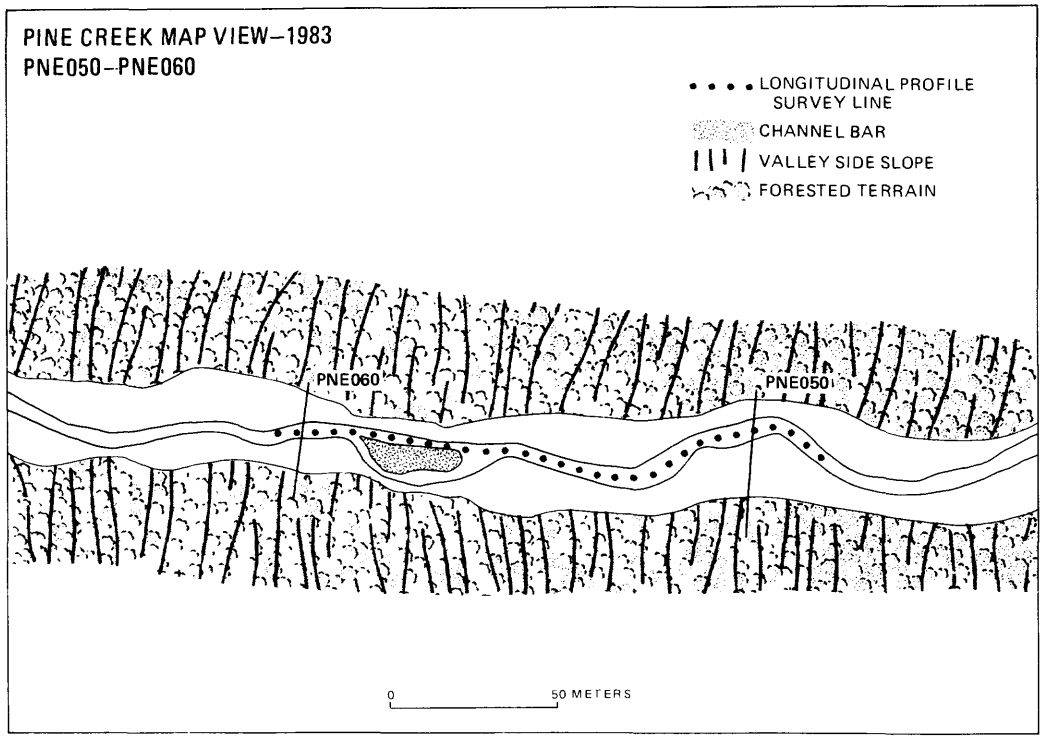


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.



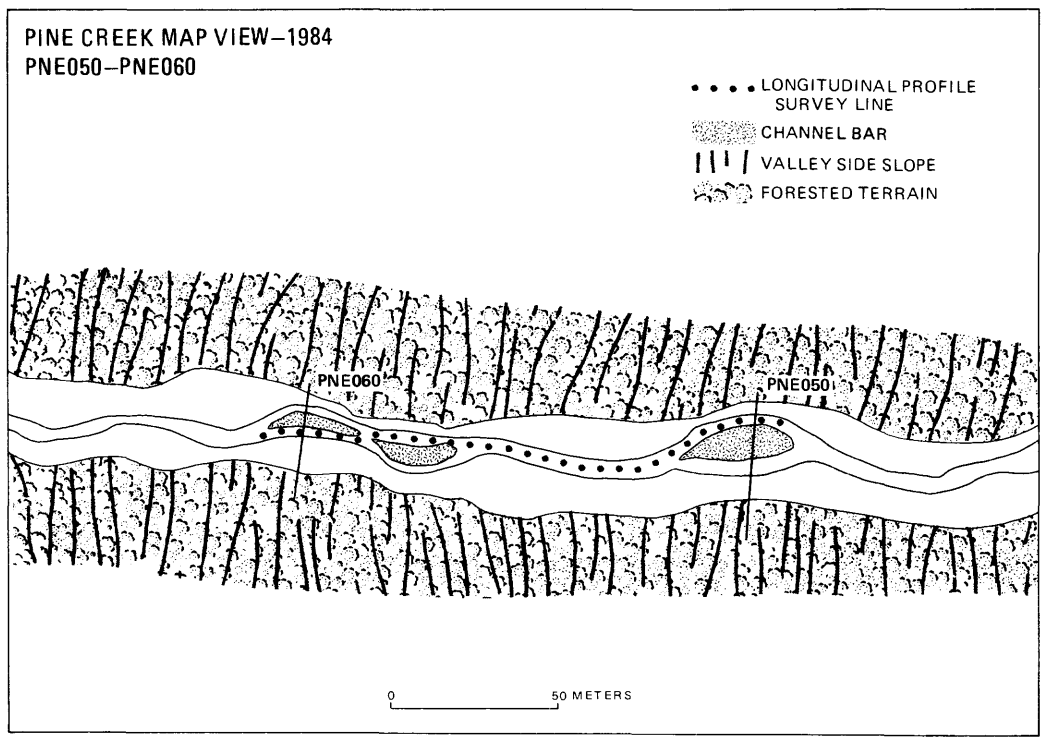


FIGURE 27. – Surveyed longitudinal profiles and corresponding map views for selected reaches, Pine Creek – continued.

INDEX TO SWIFT CREEK CROSS-SECTION SITES

As an aid to the reader, listed below are the individual cross-section site numbers and corresponding page number of the plot.

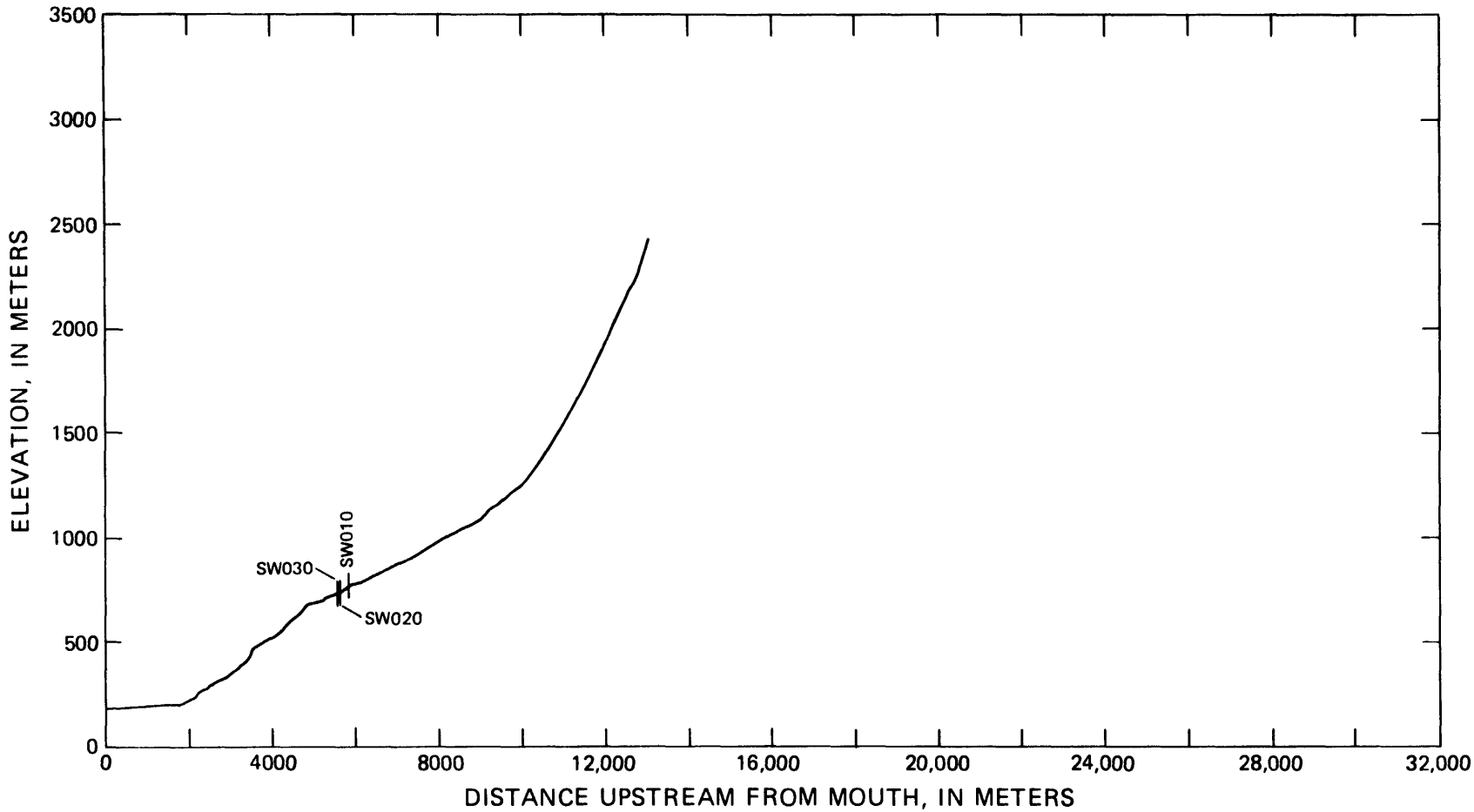


FIGURE 28. – Longitudinal profile of Swift Creek, showing locations of cross-section survey sites. Channel distance upstream from mouth and elevation above sea level are determined from U.S. Geological Survey topographic map, 7.5-minute series, Mount St. Helens SW quadrangle.

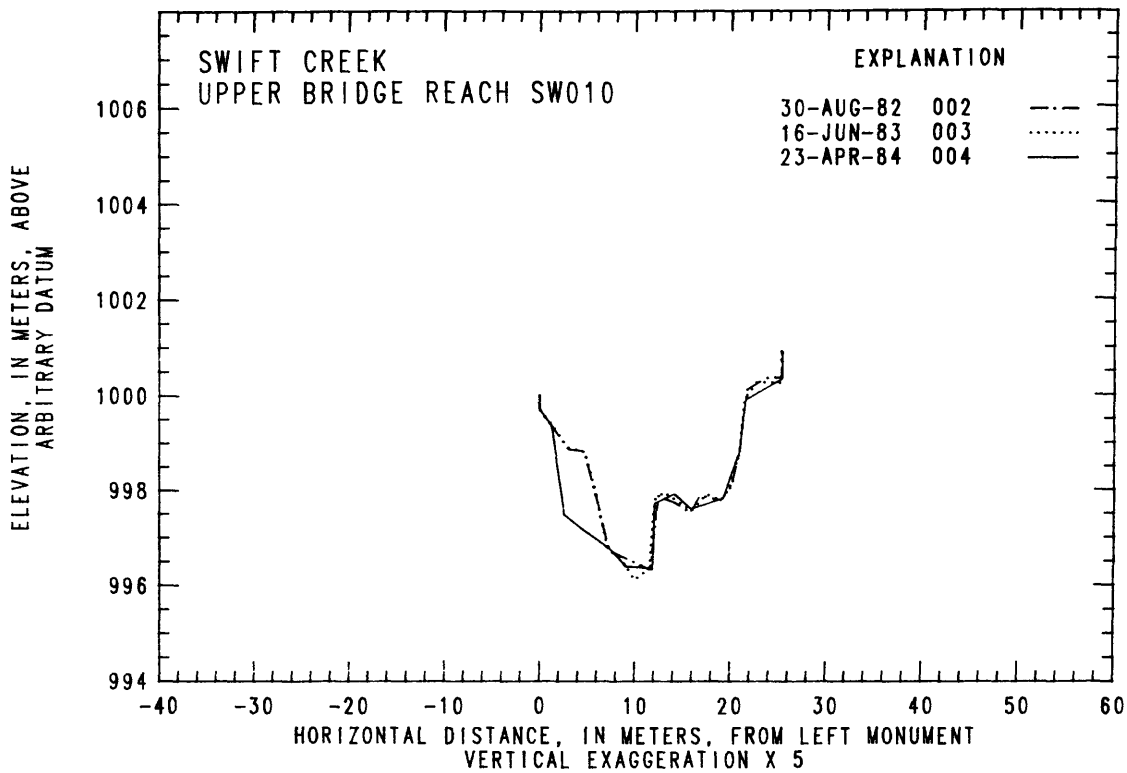


FIGURE 29. – Cross-section profiles for selected sites, Swift Creek.

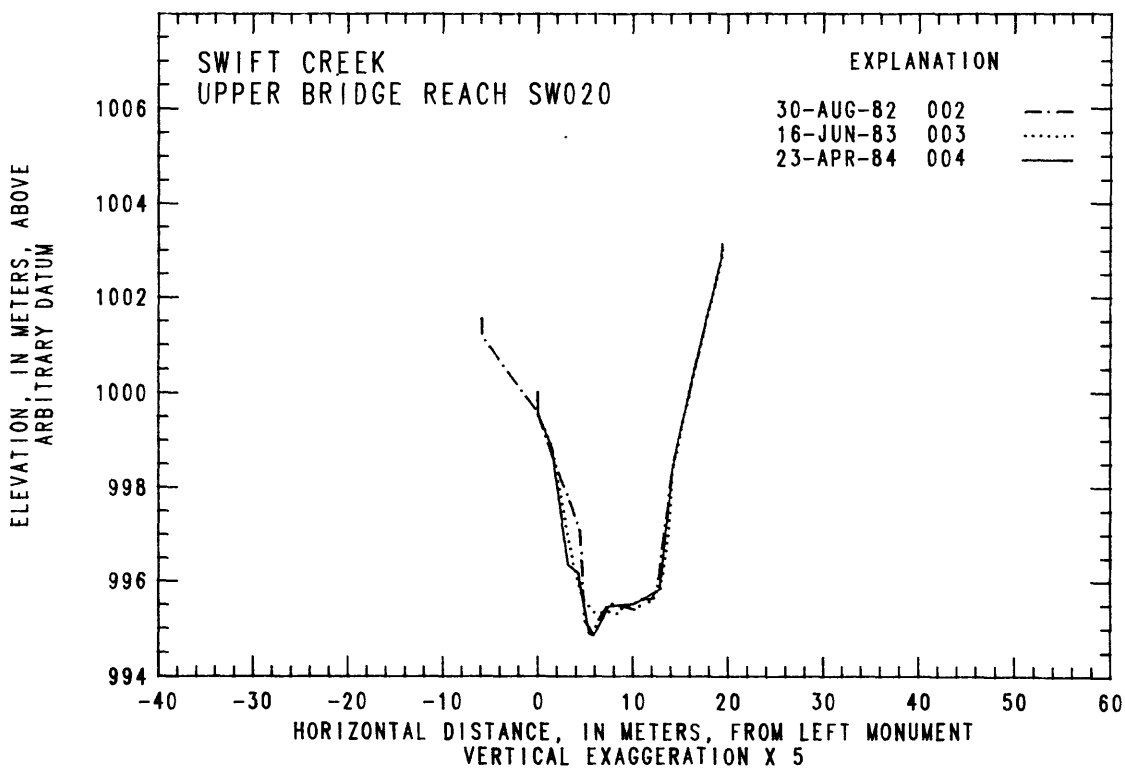


FIGURE 29. – Cross-section profiles for selected sites, Swift Creek –continued.

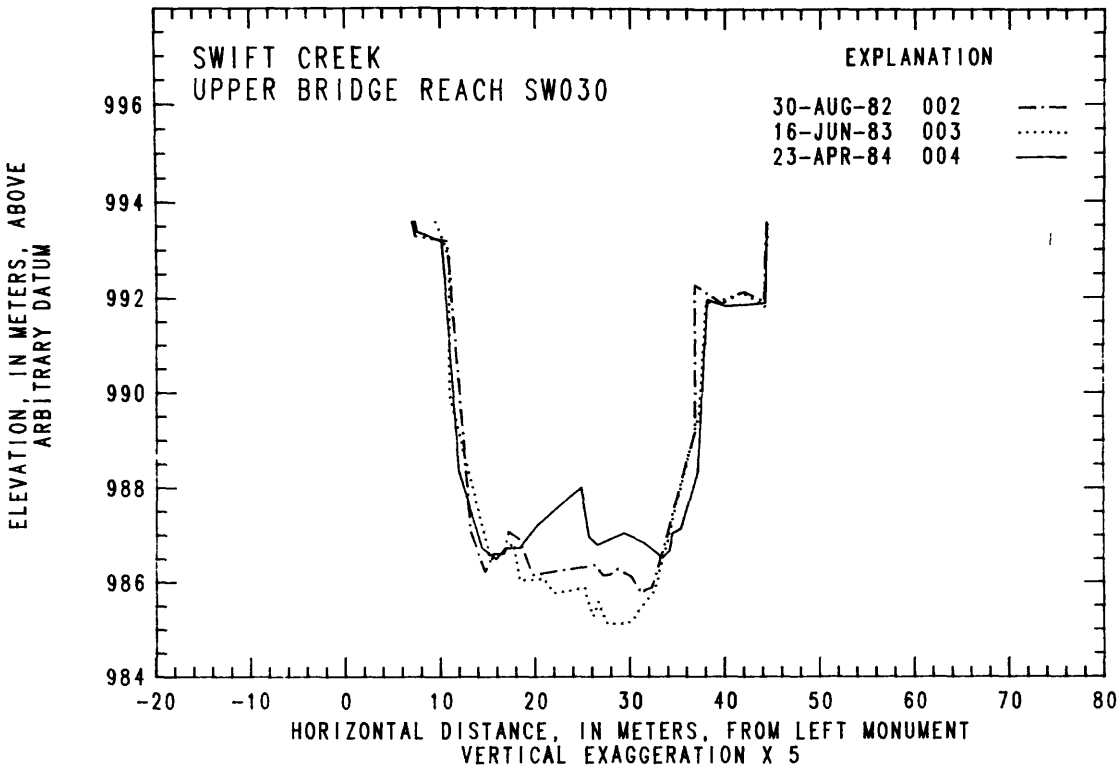


FIGURE 29. – Cross-section profiles for selected sites, Swift Creek –continued.