SEDIMENT DYNAMICS IN THE BUFFALO RIVER

by

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Mr. Lloyd Wagner, Water Resources Division, Geological Survey, U.S. Department of Interior, Albany, New York, provided the daily streamflow data for Buffalo Creek, Cayuga Creek and Cazenovia Creek.

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Mr. Donald Parsons assisted in the interpretation of the U.S. Agricultural Research Service sediment studies on Buffalo Creek, Cayuga Creek and Cazenovia Creek.

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1. INTRODUCTION

The Buffalo River, located in Erie County, New York has three tributaries: Cayuga Creek, Buffalo Creek, and Cazenovia Creek. Historically, the Buffalo River has served as an important waterway, providing an avenue for transport of raw materials and products for industry. The river has also served as a receiving waterbody for industrial and domestic wastes. Because of its importance as a navigable waterway, the U.S. Army Corps of Engineers conducts a dredging program in order to maintain the depth of the shipping channel, which extends some five miles upstream from the Buffalo harbor.

The present study was aimed at the development of a technical knowledge base, which would enable a better understanding of sediment dynamics in the Buffalo River.

The Buffalo River drainage basin is shown in Figure 1.1, along with the sub-basins for the three main tributaries and the location of the stream gaging stations operated by the USGS and New York State. The navigable portion of the Buffalo River is shown at a larger scale in Figure 1.2. The reach of interest in the present study extends from the confluence of the Buffalo River with the Buffalo Ship Canal (Station 510 + 30) to the upstream project limit for the dredging program (Station 788 + 78).

The study approach involved an analysis of the historical runoff record for the three upstream tributary basins. The upstream tributary flows were estimated by standard hydrologic methods utilizing the records from gaging stations on Cazenovia Creek at Ebenezer, Buffalo Creek at Gardenville, and Cayuga Creek at Lancaster.

Sediment yields from the drainage basin were estimated from

FIGURE 1.1
BUFFALO RIVER
DRAINAGE BASIN
Scale 1" = 250,000"

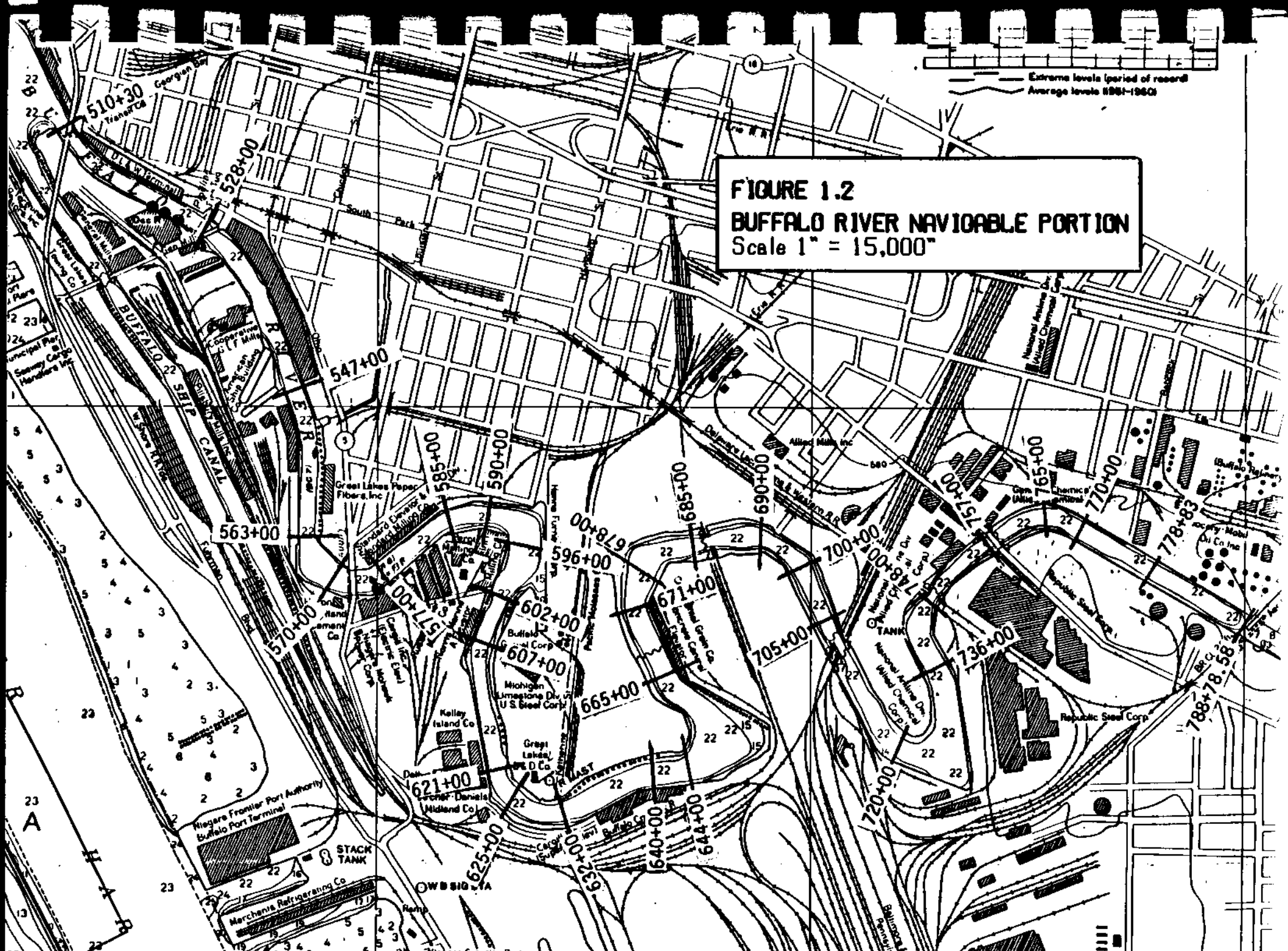


FIGURE 1.2
BUFFALO RIVER NAVIGABLE PORTION
Scale 1" = 15,000'

correlations of suspended sediment concentration and flow discharge developed in a U.S. Agricultural Research Service study of sediment yields from the three tributary basins. This analysis provided the inflow sediment load associated with each inflow water discharge from the upstream drainage basin to the Buffalo River.

The dynamics of sediment transport, deposition, and scour within the navigable portion of the Buffalo River was investigated through analysis of bathymetric survey data provided by the U.S. Army Corps of Engineers and by application of the HEC-6 Generalized Computer Program dealing with scour and deposition in rivers.

The above study components are more fully described in the following sections of this report. The findings from these study components are summarized in the final section to this report with inferences and tentative conclusions.

2. HYDROLOGY OF THE BUFFALO RIVER WATERSHED

2.1. Description

Buffalo Creek, Cayuga Creek and Cazenovia Creek merge to form the Buffalo River. The Buffalo River flows into Lake Erie. The river meanders from the junction with Cazenovia Creek to Lake Erie. The channel length for this reach is approximately 5.7 miles over a distance of about 3.4 miles. The drainage area upstream of the junction with Cazenovia Creek is 408.6 square miles. Downstream of the junction with Cazenovia Creek the area has been developed such that sewers and surface drainage facilities have altered the natural drainage pattern in the vicinity of the river so that much of the runoff is diverted. The surface runoff into the river over this downstream reach was assumed to be small and ignored in this study.

The Buffalo River is in U.S. Department of Interior, Geological Survey (USGS) hydrologic unit 04120103 in Erie County, New York. The USGS 7.5 minute series topographic maps were used to determine drainage areas and stream lengths. The following 1965 quadrangle maps with a scale of 1 to 24000 were used: Buffalo NE, Buffalo SE, Clarence, East Aurora, Lancaster, and Orchard Park.

2.2. Records

The U.S. Department of Interior, Geological Survey has had four stream gaging stations in the Buffalo River Basin. The station on Buffalo Creek at Wales had daily stream flow records only for the period March 1963 through September 1968 and its records were not used in this study. The daily discharge data for the station on Buffalo Creek at Gardenville, the station on Cayuga Creek at Lancaster and the station on Cazenovia Creek at Ebenezer were obtained from the USGS, Water Resources Division office in

Albany, New York and used in this study.

USGS stream flow records are reported as excellent, good, fair, or poor. Excellent indicates that about 95 percent of the reported daily discharges are considered to be within 5 percent of the actual values. Good indicates that about 95 percent of the reported daily discharges are considered to be within 10 percent of the actual values. Fair indicates that about 95 percent of the reported daily discharges are considered to be within 15 percent of the actual values. Poor indicates that the reported daily discharges have less than fair accuracy.

Buffalo Creek at Gardenville, New York

The USGS maintains a water-stage recorder on Buffalo Creek at Gardenville, New York approximately 2 miles upstream of the junction with Cayuga Creek. The drainage area above the gaging station is 144 square miles. The daily discharge values were obtained for the period October 1938 to September 1985. The records are reported as good except for winter periods which are reported as fair. There is an additional 2.2 square mile of drainage area between the gaging station and the downstream junction with Cayuga Creek. Therefore, the total Buffalo Creek drainage area tributary to Buffalo River is 146.2 square miles.

Cayuga Creek near Lancaster, New York

The USGS maintains a water-stage recorder on Cayuga Creek near Lancaster, New York approximately 8.7 miles upstream from the junction with Buffalo Creek. The drainage area above the gaging station is 94.9 square miles. The daily discharge values were obtained for the period October 1938 through September 1968 and May 1974 through September 1985. Peaks only are available for the period October 1971 through April 1974. The records are reported as good except for winter periods which are reported

as fair. A low concrete dam acts as control and this dam configuration was modified in September 1974 resulting in a lower point of zero flow. Since August 1962 an undetermined amount of flow has been diverted by the Lancaster Country Club for irrigation upstream of the station. There is an additional 29.5 square miles of drainage area between the gaging station and the mouth of the creek. Therefore, the total Cayuga Creek drainage area tributary to Buffalo River is 124.4 square miles.

Cazenovia Creek at Ebenezer, New York

The USGS maintains a water-stage recorder on Cazenovia Creek at Ebenezer, New York approximately 4 miles upstream from the junction with Buffalo River. The drainage area above the gaging station is 134 square miles. The daily discharge values were obtained for the period June 1940 through September 1985. The records are reported as good except for winter periods which are reported as poor. There is an additional 1.4 square miles of drainage area between the gaging station and the mouth of the creek. Therefore, the total Cazenovia Creek drainage area tributary to Buffalo River is 135.4 square miles.

2.3. Other records

The Buffalo River Improvement Corporation has been adding inflow in the lower reaches of the river. This is water that has been used for industrial purposes. This inflow, which was previously on the order of 100 million gallons per day, was at the level of 20 million gallons per day over the years 1976-1980. It was assumed to not be relevant to this study.

There is approximately 2.6 square miles of unsewered area between the junction of Buffalo Creek and Cayuga Creek and the junction of Buffalo River and Cazenovia Creek. There is also inflow from treatment plants and some runoff from roadways and developed areas. The inflow from this area

was assumed not to be relevant to the study.

2.4. Synthesis of hydrologic records

Missing data

There were no daily flow records for Cayuga Creek for the period October 1968 through April 1974. The records for daily flow in Cayuga Creek and Buffalo Creek for the periods of October 1938 through September 1968 and May 1974 through September 1985 were used in a linear regression analysis to obtain a relationship to estimate flow in Cayuga Creek as a function of flow in Buffalo Creek. The following relationship was accepted.

$$Q_{cy} = -3.58 + 0.669*Q_{bc} \qquad (2.1)$$

where Q_{cy} = daily flow in Cayuga Creek in cfs, and

Q_{bc} = daily flow in Buffalo Creek in cfs.

The coefficient of correlation, r, is equal to 0.94, which indicates that 88 percent of the variation in the the Cayuga Creek daily flows can be explained by the linear function of Buffalo Creek daily flows. This equation was then used to estimate daily flow values for Cayuga Creek for the period of October 1968 through April 1974.

Inflow to Buffalo River from tributaries

The values for daily flow are for flow at the gaging station. In order to obtain the flow at the junction with Buffalo River the daily flows were increased in direct proportion to the increase in drainage area. Thus the daily flow into the Buffalo River from a tributary was computed from the following equation.

$$Q_T = Q_g*(A_T/A_g) \qquad (2.2)$$

where Q_T = daily flow from tributary into Buffalo River in cfs,

Q_g = daily flow at gage on tributary in cfs,

A_T = total drainage area at mouth of tributary in square miles, and

A_g = drainage area upstream of gage in square miles.

The daily flow records for Cayuga Creek and Buffalo Creek began in October 1938 but the daily flow records for Cazenovia Creek did not begin until October 1940. The daily flow records for all stations, after determining estimates for Cayuga for October 1968 through April 1974, were available through September 1985. Therefore, the period of analysis for Buffalo River was chosen as October 1940 through September 1985. The total daily inflow to the Buffalo River from the three tributaries was then determined as the sum of the daily inflow from the tributaries. This total daily inflow was then assumed to be the inflow to the upstream end of the reach for which the sediment study was to be performed. This location coincides with the upstream limit at station 788+78 of the Federal Project as defined by the U.S. Army Corps of Engineers.

Annual flows

The volume of annual flows are shown for Buffalo Creek, Cayuga Creek, Cazenovia Creek, and Buffalo River in Figures 2.1, 2.2, 2.3, and 2.4 respectively. One cfs*day is equal to 86,400 cubic feet which is approximately 2 acre-feet. The Buffalo River monthly and annual discharge volumes are given in Table 2.1.

Flow duration studies

The daily flow duration curves for Buffalo Creek, Cayuga Creek, Cazenovia Creek, and Buffalo Rive are shown in Figures 2.5, 2.6, 2.7, and 2.8 respectively. The flow duration curve indicates the percent of time that a daily flow will be equalled or exceeded. Thus, Figure 2.5 indicates that for Buffalo Creek a daily flow of 2,000 cfs is equalled or exceeded one percent of the time. This means that the daily flow at the mouth of

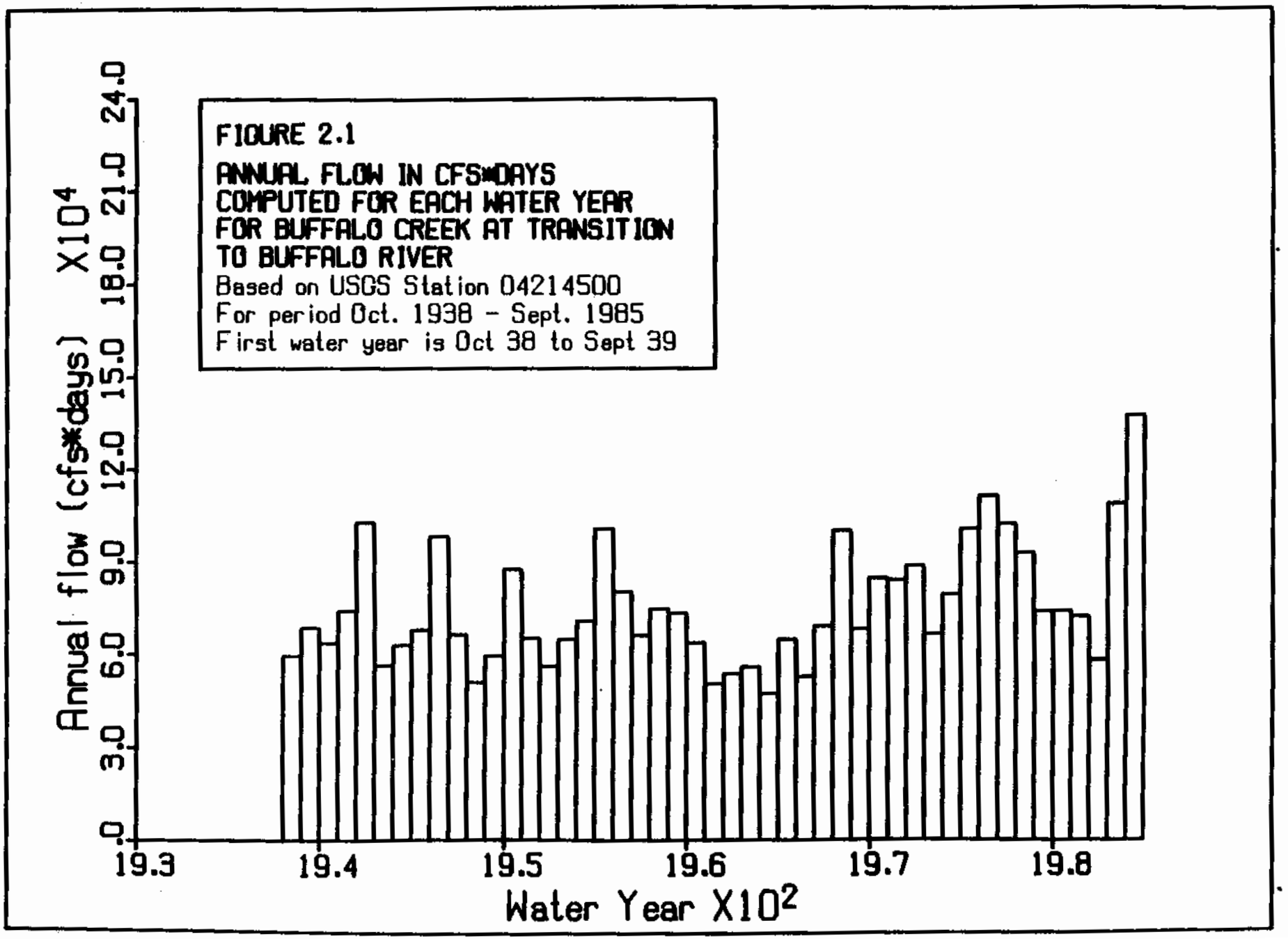


FIGURE 2.1
ANNUAL FLOW IN CFS*DAYS
COMPUTED FOR EACH WATER YEAR
FOR BUFFALO CREEK AT TRANSITION
TO BUFFALO RIVER
Based on USGS Station 04214500
For period Oct. 1938 - Sept. 1985
First water year is Oct 38 to Sept 39
Annual flow (cfs*days) X10^4
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
19.3
19.4
19.5
19.6
19.7
19.8
Water Year X10^2

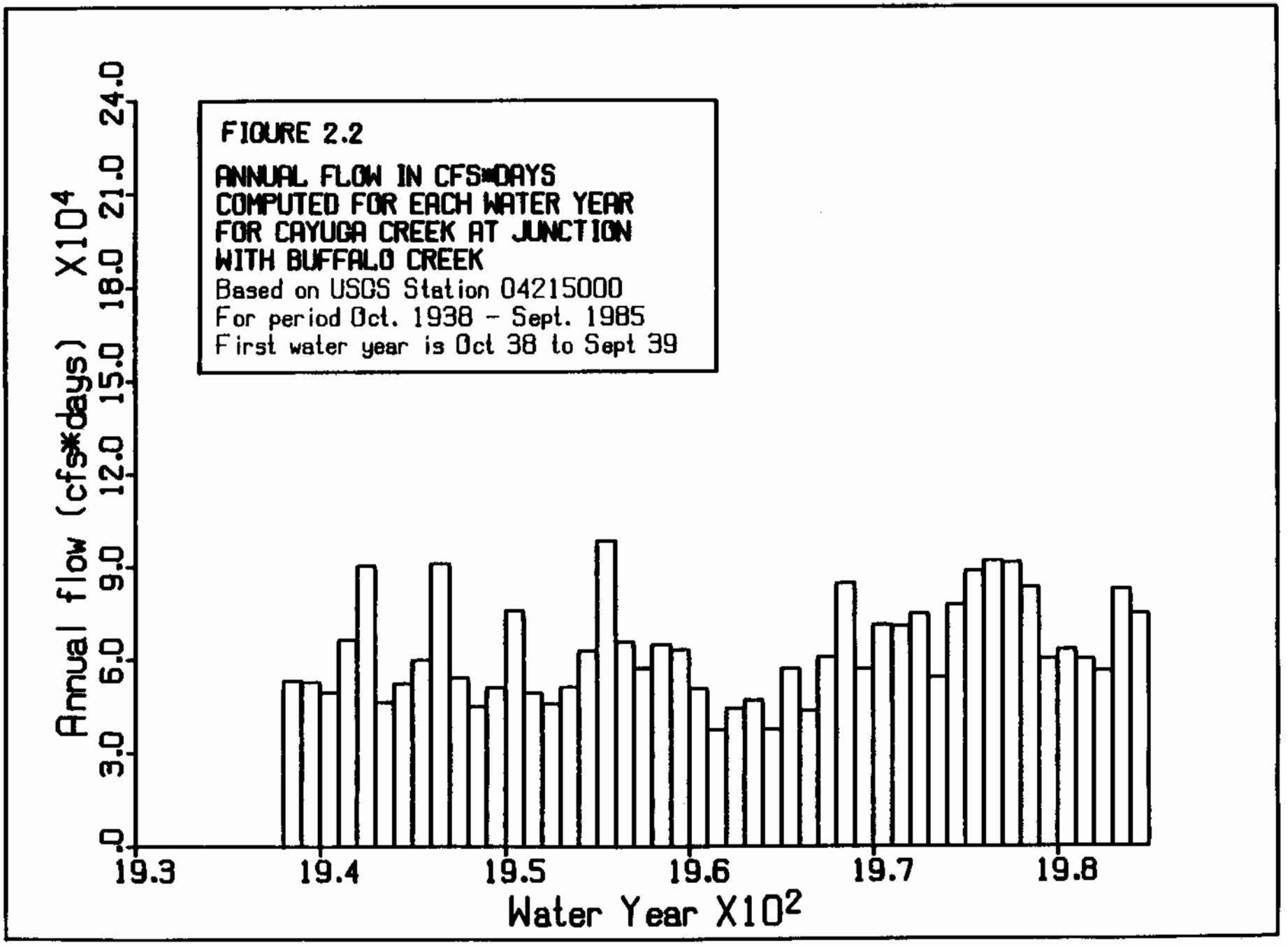


FIGURE 2.2
ANNUAL FLOW IN CFS*DAYS
COMPUTED FOR EACH WATER YEAR
FOR CAYUGA CREEK AT JUNCTION
WITH BUFFALO CREEK
Based on USGS Station 04215000
For period Oct. 1938 - Sept. 1985
First water year is Oct 38 to Sept 39
Annual flow (cfs*days) X10^4
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
19.3
19.4
19.5
19.6
19.7
19.8
Water Year X10^2

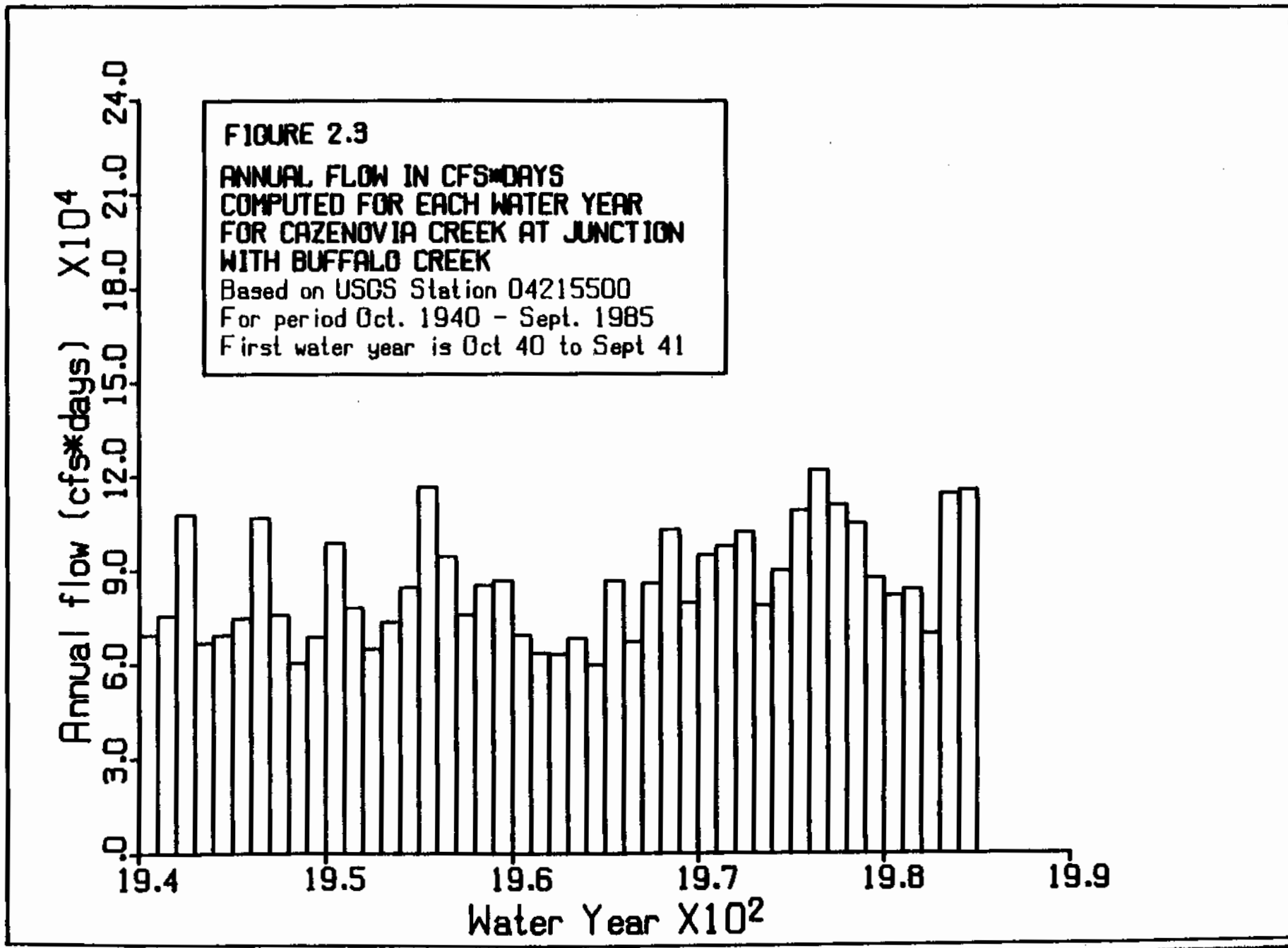


FIGURE 2.3
ANNUAL FLOW IN CFS*DAYS
COMPUTED FOR EACH WATER YEAR
FOR CAZENOVIA CREEK AT JUNCTION
WITH BUFFALO CREEK
Based on USGS Station 04215500
For period Oct. 1940 - Sept. 1985
First water year is Oct 40 to Sept 41
Annual flow (cfs*days) X10^4
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
19.4
19.5
19.6
19.7
19.8
19.9
Water Year X10^2

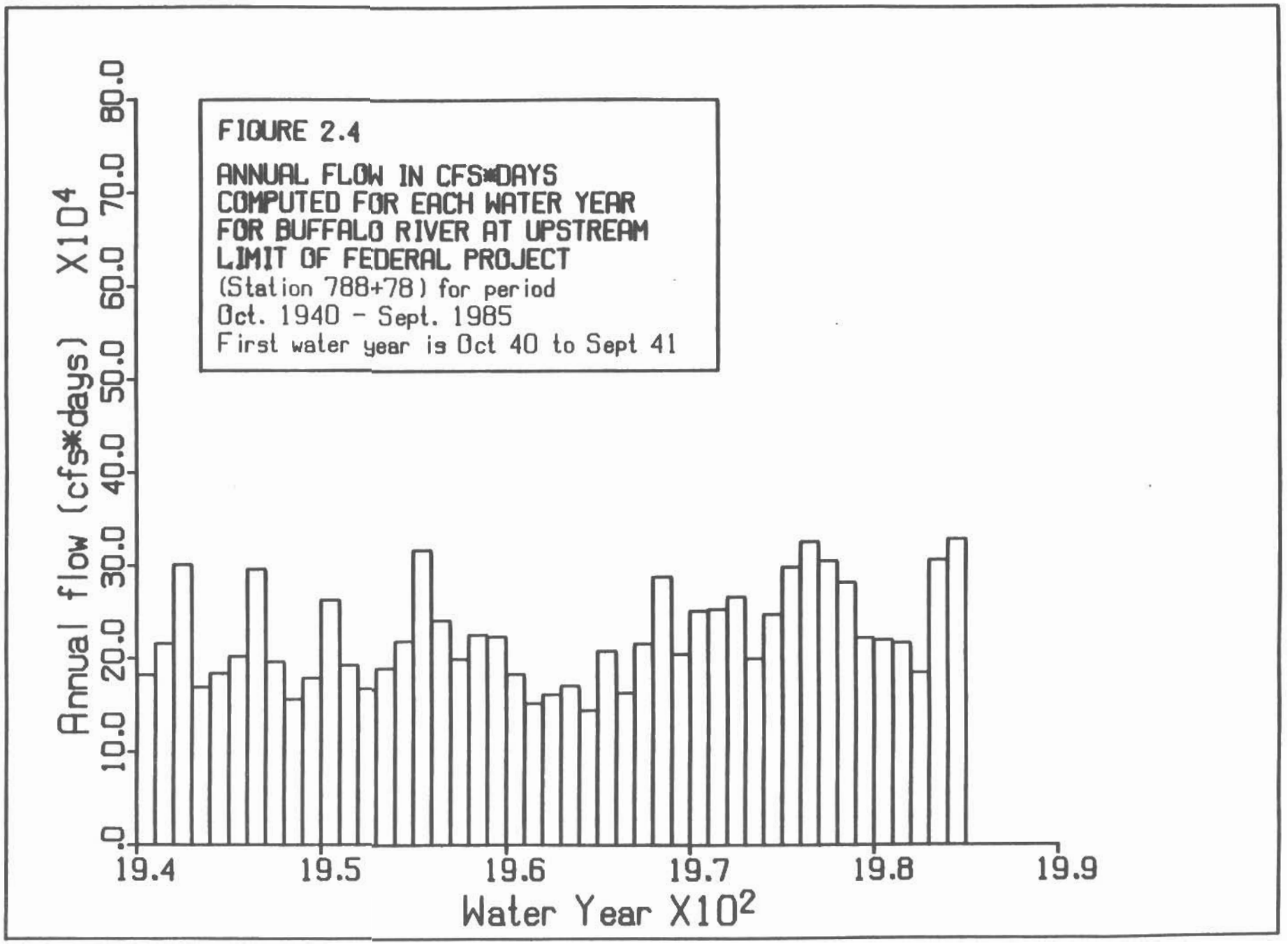


FIGURE 2.4
ANNUAL FLOW IN CFS*DAYS
COMPUTED FOR EACH WATER YEAR
FOR BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
First water year is Oct 40 to Sept 41
Annual flow (cfs*days) X10^4
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
19.4
19.5
19.6
19.7
19.8
19.9
Water Year X10^2

TABLE 2.1. Buffalo River Monthly and Annual Water Year Discharge Volumes in cfs*days

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Annual
1941	2063	13317	51764	20744	7439	38138	39793	3337	1744	944	847	2549	182678
1942	3506	6922	14220	17595	17674	90713	42699	8472	2860	4132	978	6404	216174
1943	11680	47913	44142	22591	40822	34664	37636	40389	14792	2220	2966	1200	301014
1944	5648	12691	6334	9216	16658	37481	43885	16924	16864	1754	948	1438	169841
1945	1580	2422	5013	3765	25362	90381	23742	16605	6302	4626	1645	3485	184928
1946	33782	25859	25666	31746	10045	40437	5954	13176	8816	2546	3252	1593	202871
1947	3719	14617	20589	42311	12315	43655	82999	43422	20588	8032	1879	2143	296269
1948	1075	8779	30939	4986	45307	49565	24204	22789	4770	1414	1040	1704	196569
1949	7831	13100	12544	33489	23352	28973	26093	5701	1695	1411	905	1281	156375
1950	1005	4728	18278	37938	18819	58899	26305	5824	2372	1425	1110	2671	179375
1951	3547	28146	36739	44432	38906	53453	36502	8724	6020	4170	758	1342	262738
1952	1255	14506	17956	42153	22321	44720	21261	22253	2440	794	1023	2211	192891
1953	1310	3876	18840	24670	16989	37338	15996	33055	5250	2217	6467	1386	167393
1954	735	2636	12894	24152	41169	36285	51126	10917	5760	1289	1079	2051	190093
1955	22403	17743	40410	15410	27127	64452	23153	4506	1239	451	1299	590	218781
1956	19873	22121	33147	6860	33948	72032	53758	34827	7667	3216	12129	17012	316589
1957	4682	8407	41992	48247	30685	24078	42838	25235	6386	5935	973	1830	241288
1958	1239	14036	26277	6242	10390	45877	36776	12071	20960	9223	3220	13431	199741
1959	6656	14633	13607	43564	32593	48460	47766	9256	5145	1803	1295	746	225525
1960	13122	18959	39931	30951	29265	37642	34030	9494	7488	1361	1186	501	223929
1961	981	1215	1412	2447	36639	31241	62833	20321	12852	2207	10154	1852	184153
1962	2083	8632	15492	22575	20121	40659	27610	8714	2512	794	859	1998	152048
1963	2507	6162	7259	6621	3641	83895	26071	9004	2030	3849	9301	1383	161721
1964	862	9649	12468	34333	8353	63805	27333	8083	3094	1717	1275	542	171515
1965	869	3195	12796	21272	40649	21816	34941	4665	1401	1138	1369	1020	145131
1966	1704	16297	37992	14605	38991	52224	26131	13744	4163	1015	822	1049	208736
1967	826	7791	24121	17506	13735	32287	24489	22537	2014	1788	1418	15159	163669
1968	18843	41684	21994	25891	17115	43450	19497	11103	10134	1962	2406	2219	216298
1969	4979	38715	46638	45623	13319	25381	49927	36852	12694	9570	2684	1898	288278
1970	3525	21658	31154	22021	23718	32801	39058	15728	3681	5402	1896	4589	205231
1971	12496	47139	32755	15565	35049	36716	39870	10250	11289	5825	2462	1927	251342

TABLE 2.1. Continued

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Annual
1972	1597	7428	33646	22292	13298	78962	32644	18409	30118	8926	2745	3197	253262
1973	12007	29550	54758	22565	18882	52102	37170	20668	11456	3531	2095	1627	266410
1974	2439	16240	28078	23788	16362	40285	38513	22220	7170	1742	1648	1798	200283
1975	2628	22936	25886	45078	39655	39092	22029	14129	19140	2763	8023	6366	247725
1976	5033	13524	34573	27502	67108	61424	26393	23805	7492	15507	10357	6178	298894
1977	21611	12433	14703	7439	23754	73638	38750	8426	3818	7829	36019	77302	325721
1978	20517	37939	60833	22705	9095	76393	41794	21381	5116	1322	1614	6339	305047
1979	12284	5130	32004	46842	18850	81855	34039	11295	3845	1857	5754	28066	281820
1980	22810	22064	42185	17490	8998	51771	22594	6820	10382	4787	4096	8452	222448
1981	21520	18522	31446	7464	50879	18908	23151	11558	6924	8615	5102	15788	219876
1982	17266	25871	22346	16680	8753	68791	28349	5877	12323	4001	2429	4293	216978
1983	4759	48511	35450	7606	12545	23106	18755	21145	5048	1399	3809	2906	185037
1984	4417	24560	45045	16350	51219	34622	33829	46726	24997	4609	5000	15265	306638
1985	4185	13132	54655	53881	95460	58684	24513	8367	6033	3280	1631	5101	328921

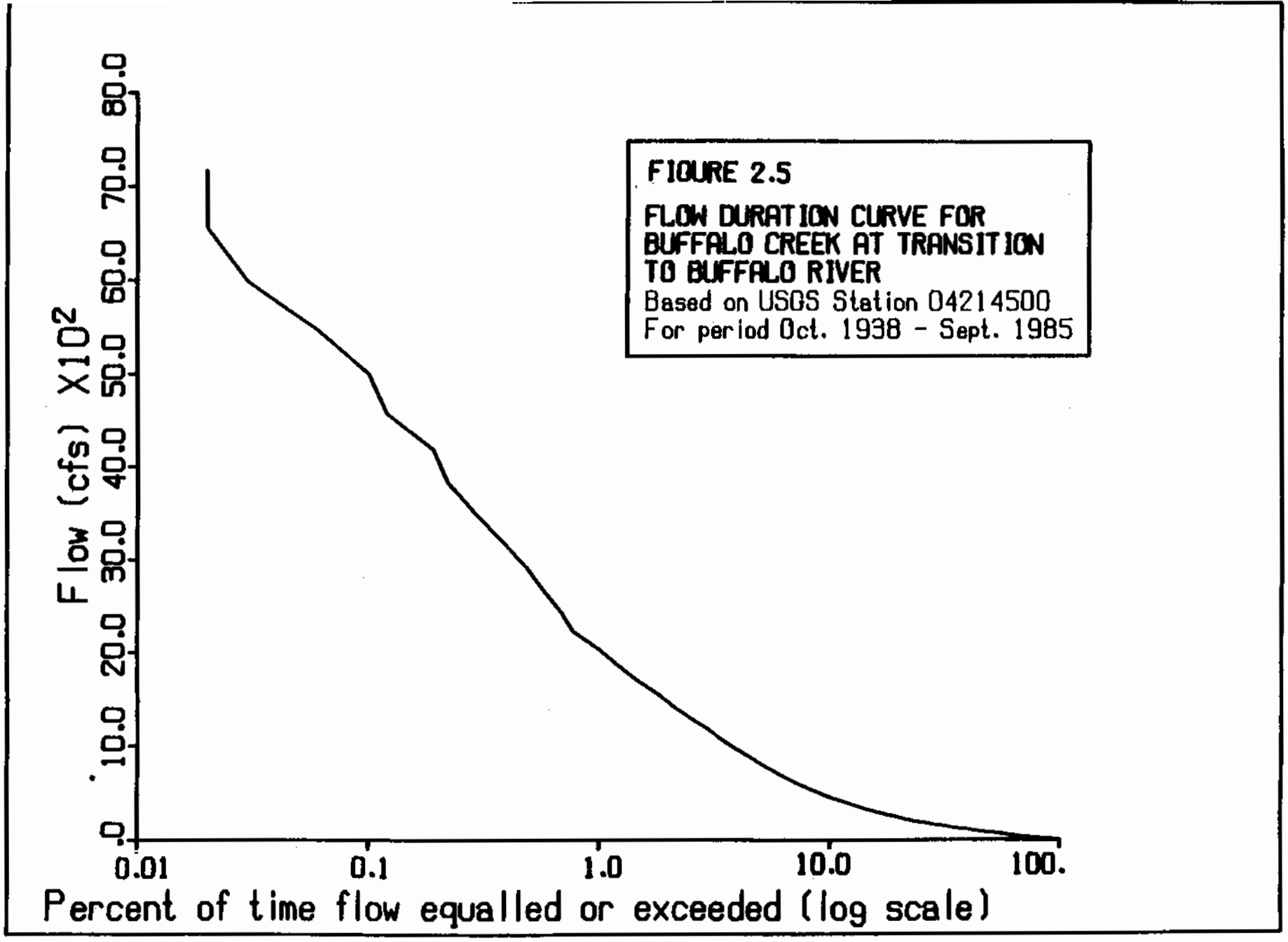


FIGURE 2.5
FLOW DURATION CURVE FOR BUFFALO CREEK AT TRANSITION TO BUFFALO RIVER
Based on USGS Station 04214500
For period Oct. 1938 - Sept. 1985
Flow (cfs) X10²
0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
0.01
0.1
1.0
10.0
100.
Percent of time flow equalled or exceeded (log scale)

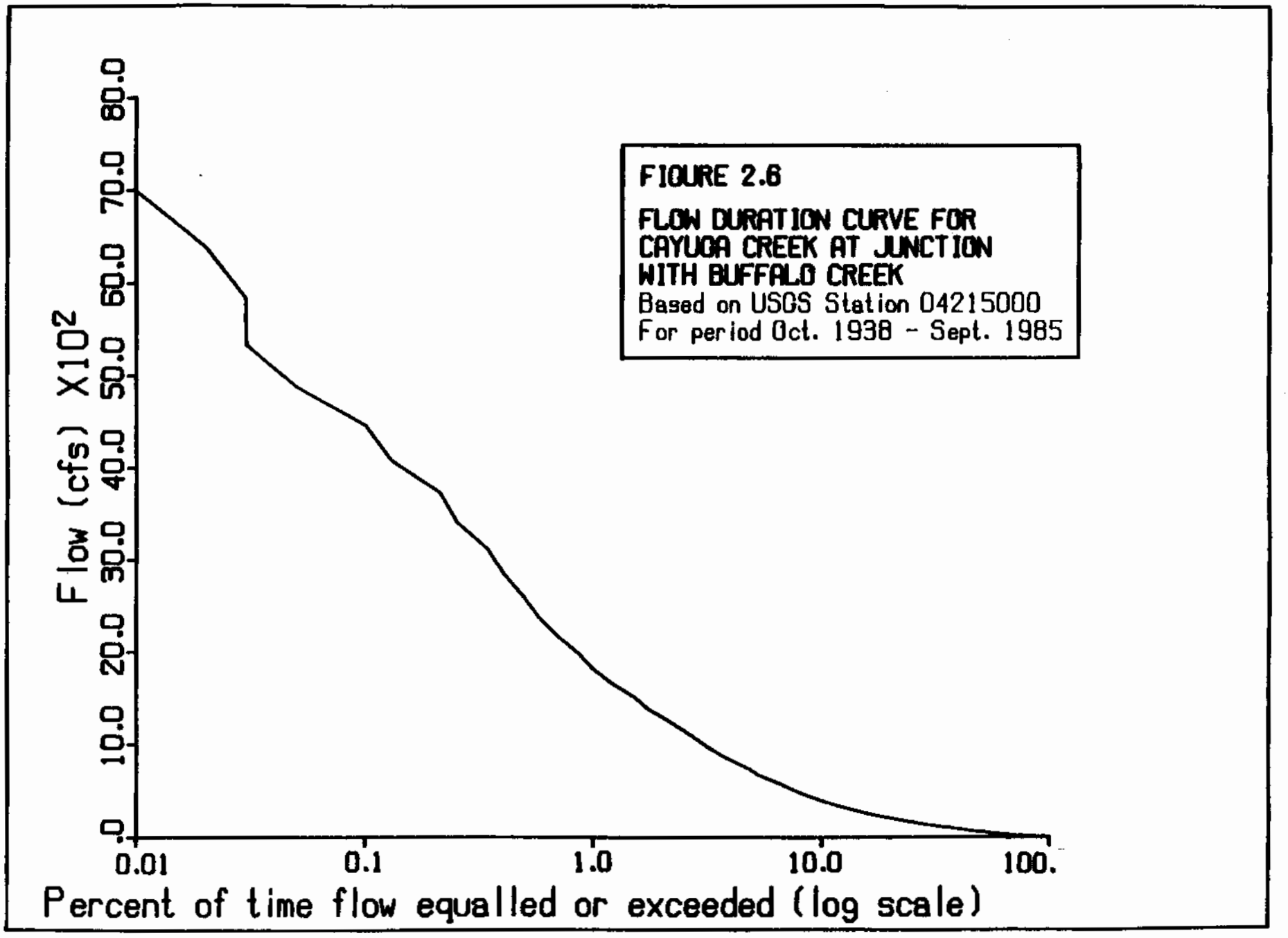


FIGURE 2.6
FLOW DURATION CURVE FOR
CAYUGA CREEK AT JUNCTION
WITH BUFFALO CREEK
Based on USGS Station 04215000
For period Oct. 1938 - Sept. 1985
Flow (cfs) X10²
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
0.01
0.1
1.0
10.0
100.
Percent of time flow equalled or exceeded (log scale)

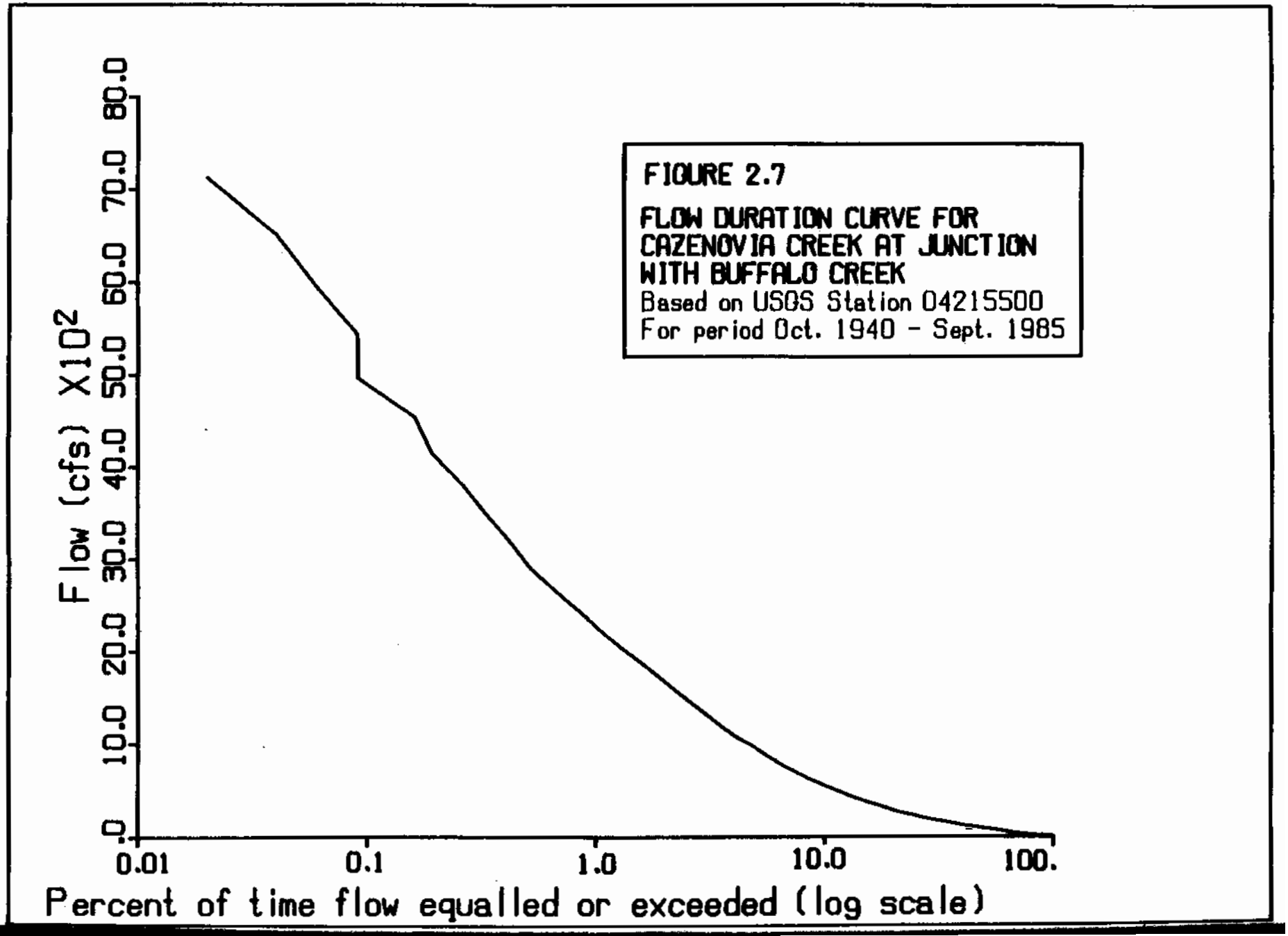


FIGURE 2.7
FLOW DURATION CURVE FOR CAZENOVIA CREEK AT JUNCTION WITH BUFFALO CREEK
Based on USGS Station 04215500
For period Oct. 1940 - Sept. 1985
Flow (cfs) X10²
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
0.01
0.1
1.0
10.0
100.
Percent of time flow equalled or exceeded (log scale)

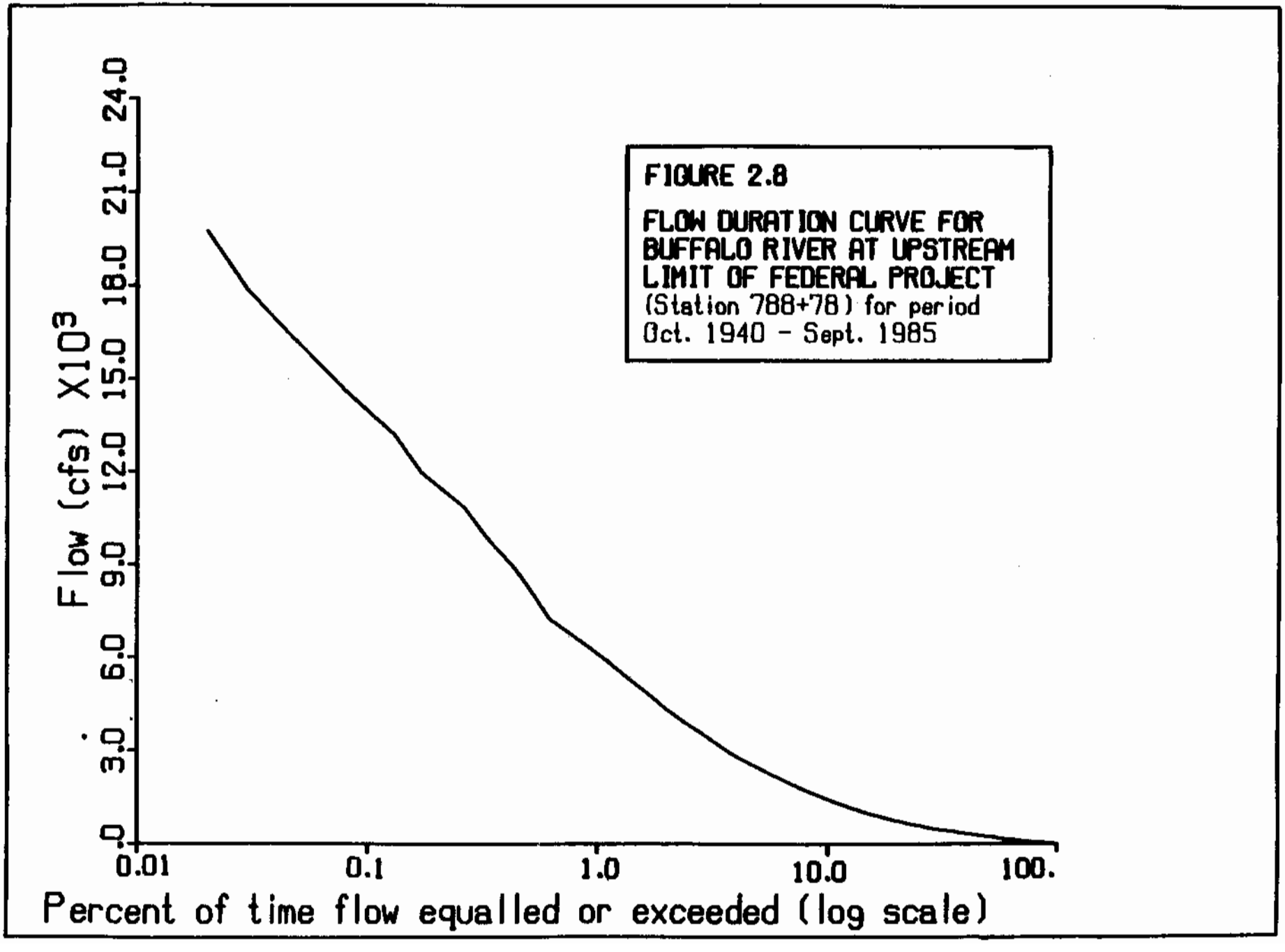


FIGURE 2.8
FLOW DURATION CURVE FOR BUFFALO RIVER AT UPSTREAM LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
Flow (cfs) X10³
0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
0.01
0.1
1.0
10.0
100.
Percent of time flow equalled or exceeded (log scale)

Buffalo Creek is 2,000 cfs or greater one percent of the time.

Figures 2.9, 2.10, and 2.11 show the daily flow duration curves for Buffalo River by month. Thus, Figure 2.9 indicates that a daily flow 3,900 cfs is equalled or exceeded one percent of the time in the month of May.

Frequency Analysis

The summary for the 45 annual flow volumes are given in Table 2.2. Figures 2.12, 2.13, 2.14, and 2.15 show the normal, log-normal, Pearson Type III, and log-Pearson Type III fit for the recurrence for the annual flows.

TABLE 2.2 Summary of Annual Flow Volumes

	Arithmetic (cfs*days)	Log value
Maximum	328,921	5.5171
Minimum	145,131	5.1618
Mean	225,161	5.3414
Standard deviation	52,060	0.0987
Coefficient of skewness	0.505	0.199

mean annual flow = 600 cfs

Table 2.3 presents a summary of annual peak daily flows for the 45 water years. The normal, log-normal, Pearson Type III, and log-Pearson

TABLE 2.3 Summary of Annual Peak Daily Flows

	Arithmetic (cfs)	Log values
Maximum	21,832	4.3391
Minimum	5,074	3.7054
Mean	12,327	4.0654
Standard deviation	4,226	0.1524
Coefficient of skewness	0.5445	-0.22

Type III fit for the recurrence interval for annual peak daily flows are shown in Figures 2.16, 2.17, 2.18, and 2.19 respectively. The log-Pearson

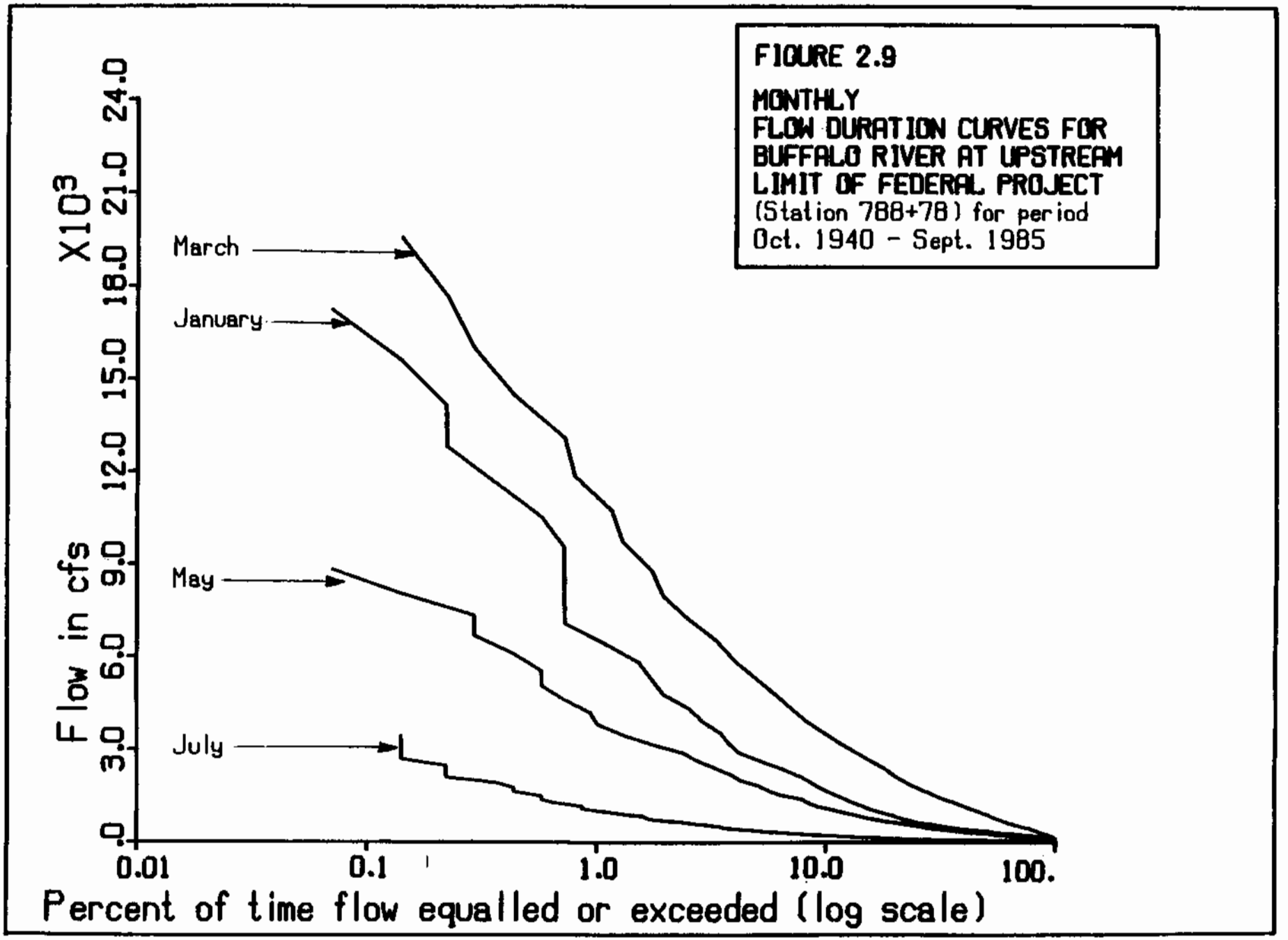


FIGURE 2.9
MONTHLY
FLOW DURATION CURVES FOR
BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
March
January
May
July
X10³
Flow in cfs
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
0.01
0.1
1.0
10.0
100.
Percent of time flow equalled or exceeded (log scale)

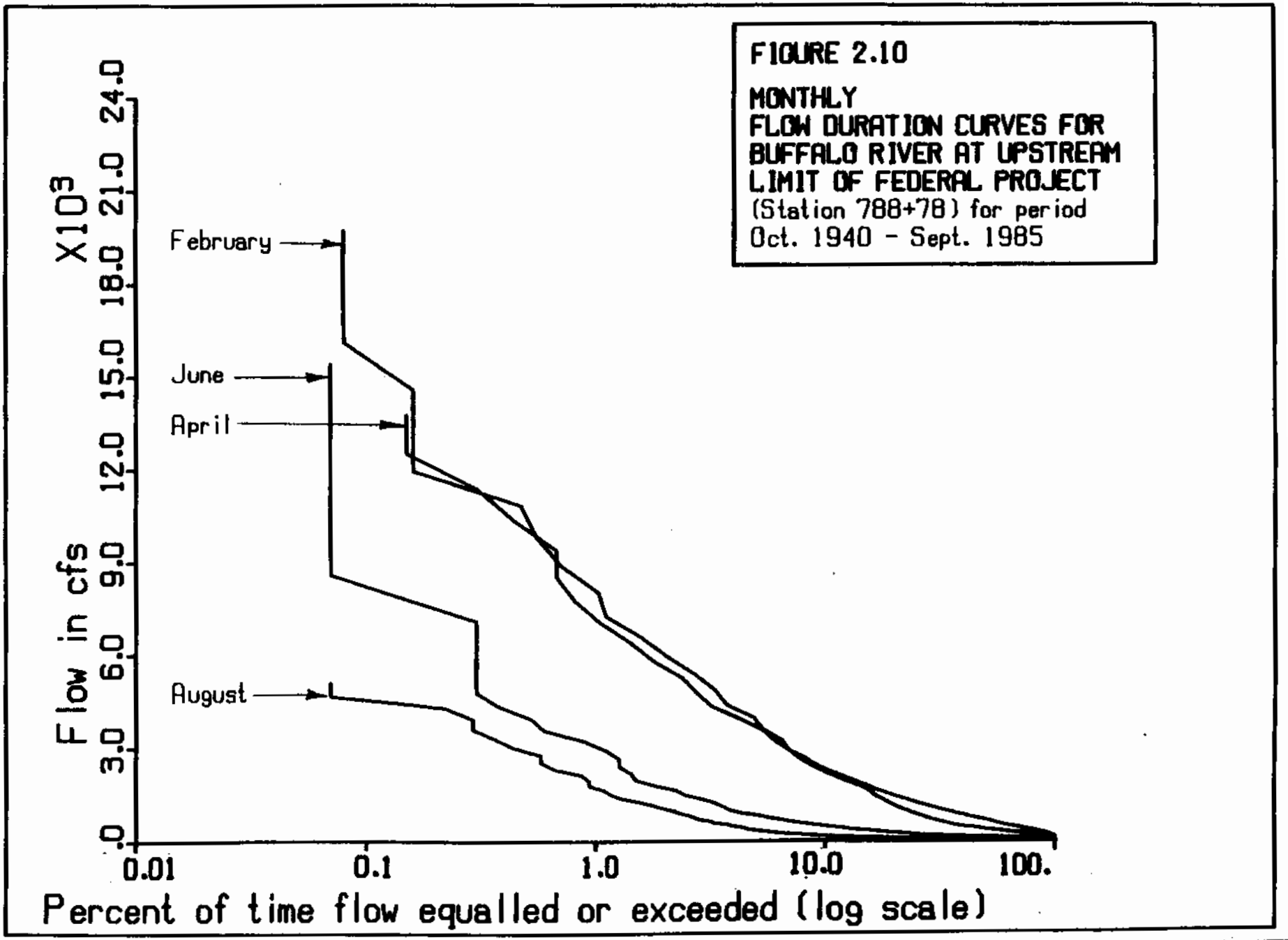
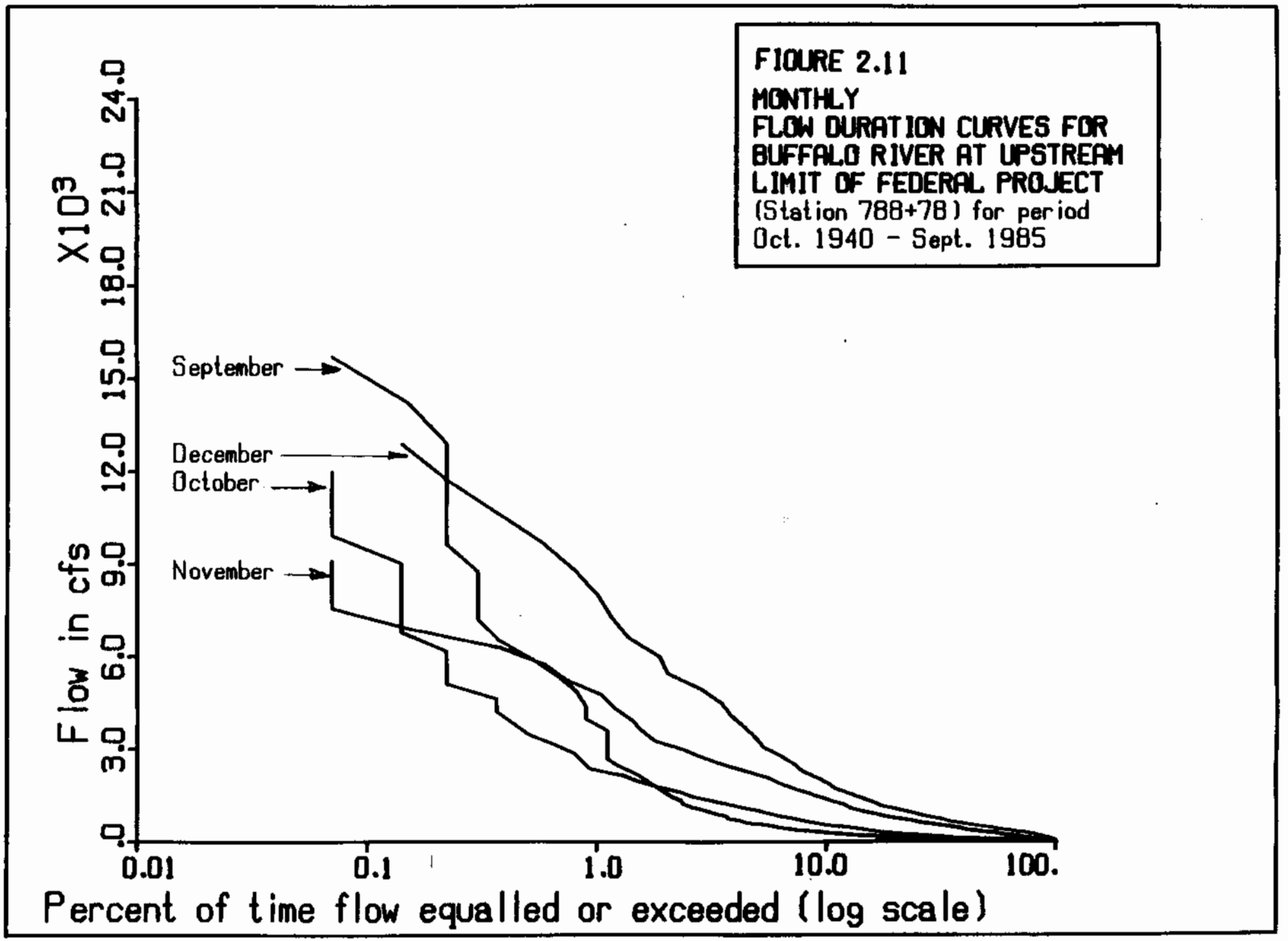


FIGURE 2.10
MONTHLY
FLOW DURATION CURVES FOR
BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
February
June
April
August
X10³
Flow in cfs
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
0.01
0.1
1.0
10.0
100.
Percent of time flow equalled or exceeded (log scale)


FIOURE 2.11
MONTHLY
FLOW DURATION CURVES FOR
BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
X10³
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
.0
Flow in cfs
September
December
October
November
0.01
0.1
1.0
10.0
100.
Percent of time flow equalled or exceeded (log scale)

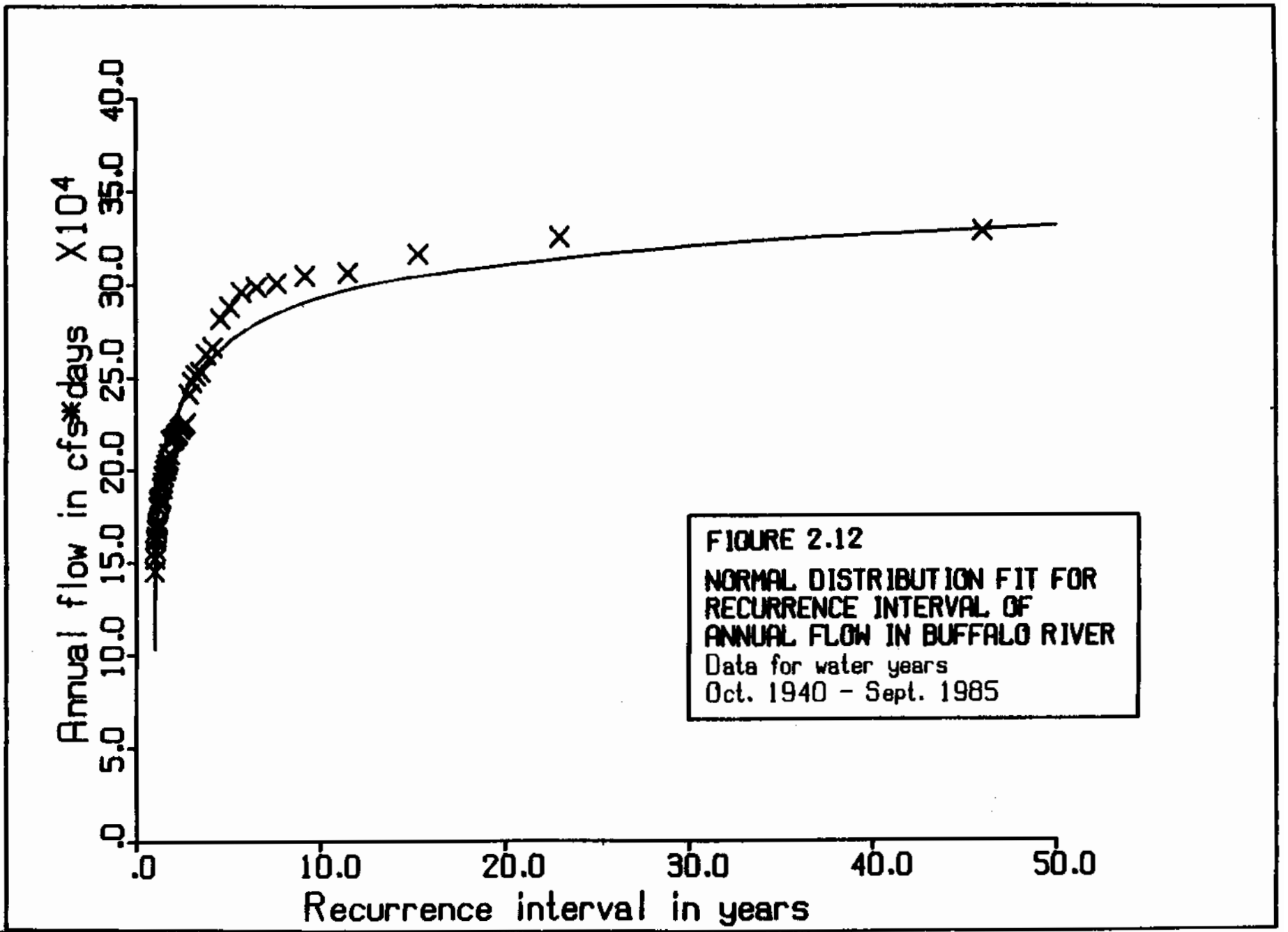


FIGURE 2.12

NORMAL DISTRIBUTION FIT FOR RECURRENCE INTERVAL OF ANNUAL FLOW IN BUFFALO RIVER

Data for water years
Oct. 1940 - Sept. 1985

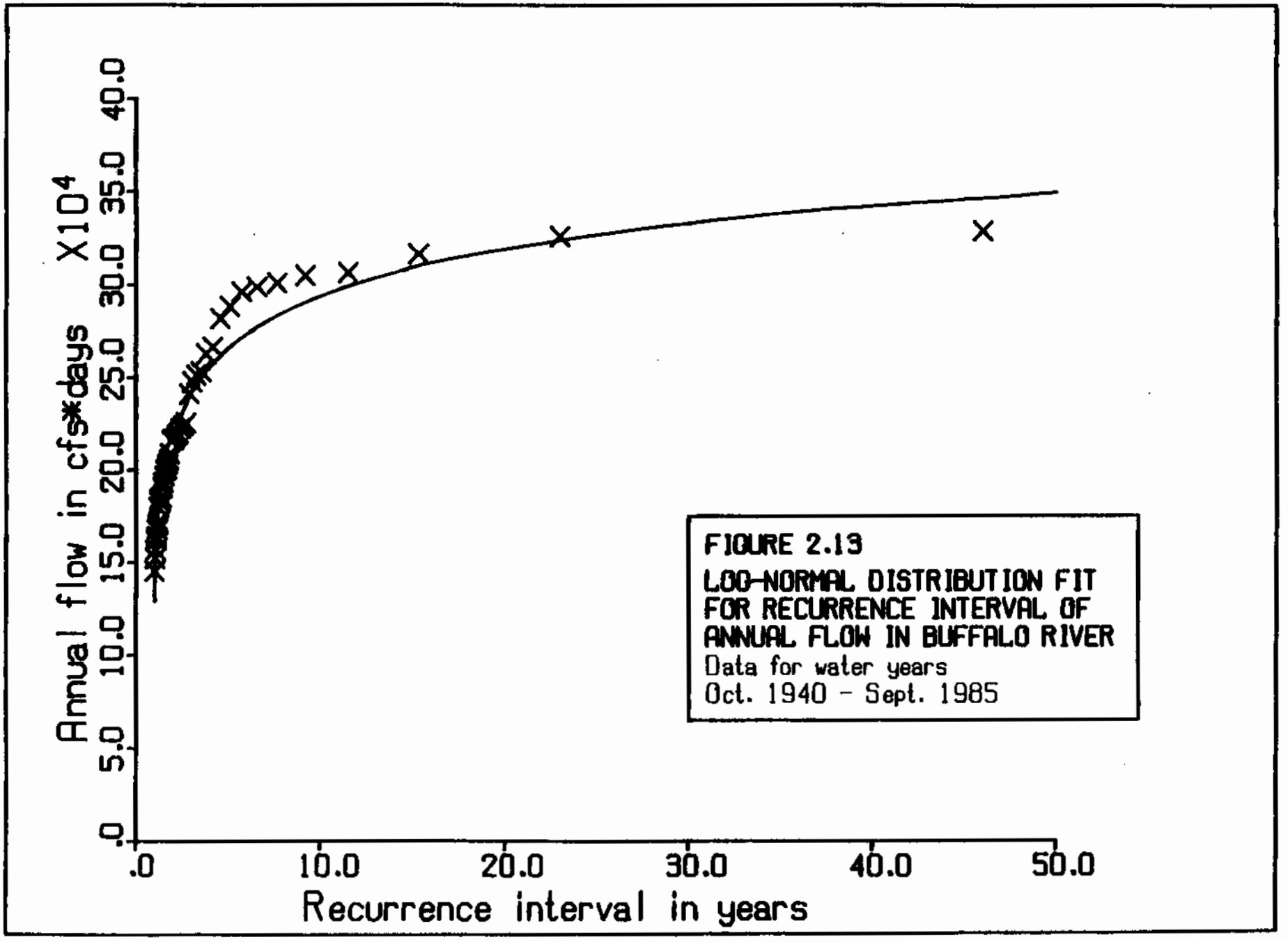
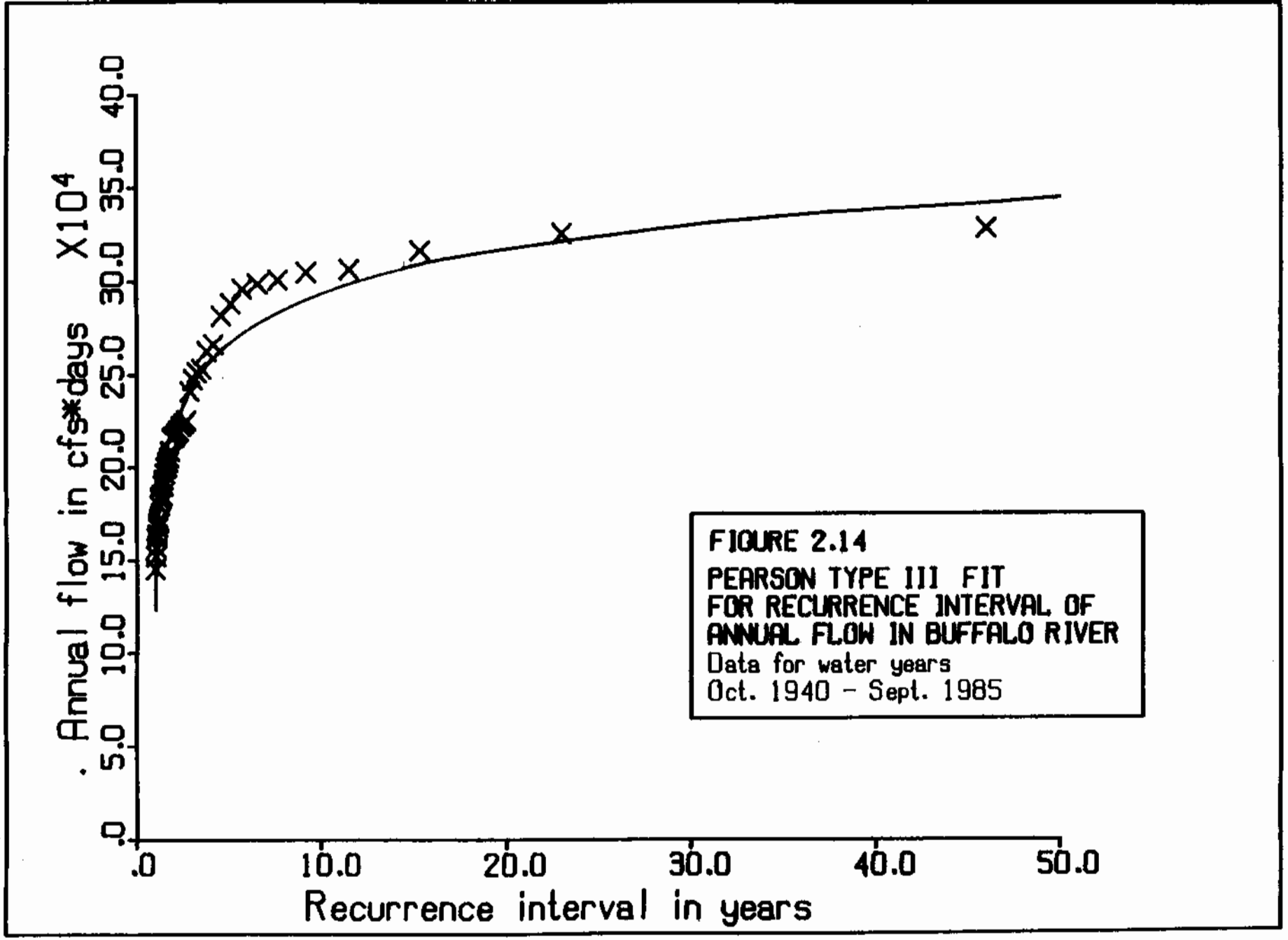
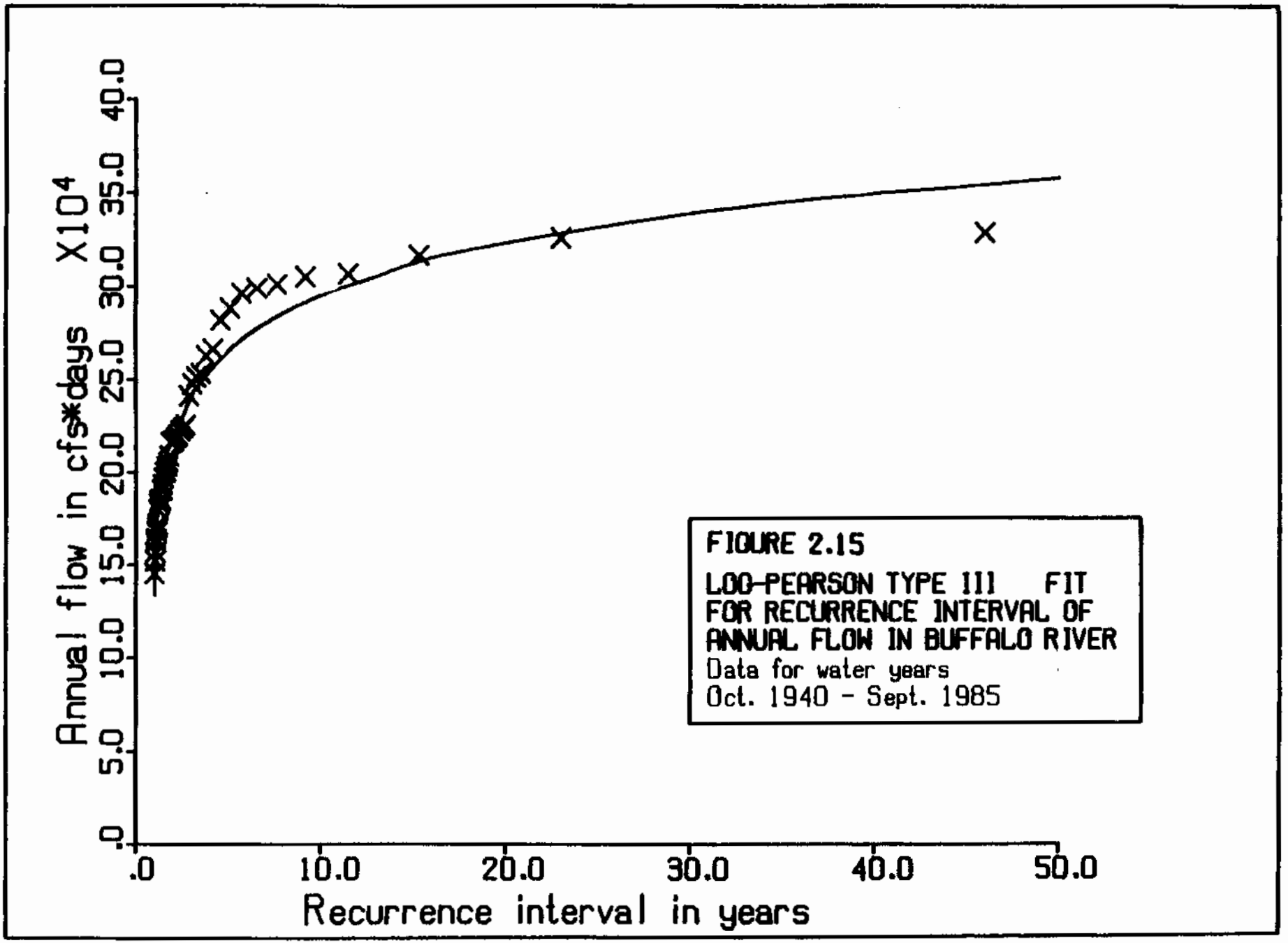


FIGURE 2.13
LOG-NORMAL DISTRIBUTION FIT FOR RECURRENCE INTERVAL OF ANNUAL FLOW IN BUFFALO RIVER
Data for water years
Oct. 1940 - Sept. 1985


Annual flow in cfs*days X10^4
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
.0
10.0
20.0
30.0
40.0
50.0
Recurrence interval in years
FIGURE 2.14
PEARSON TYPE III FIT
FOR RECURRENCE INTERVAL OF
ANNUAL FLOW IN BUFFALO RIVER
Data for water years
Oct. 1940 - Sept. 1985


Annual flow in cfs*days X10^4
.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
.0
10.0
20.0
30.0
40.0
50.0
Recurrence interval in years
FIGURE 2.15
LOG-PEARSON TYPE III FIT FOR RECURRENCE INTERVAL OF ANNUAL FLOW IN BUFFALO RIVER
Data for water years
Oct. 1940 - Sept. 1985

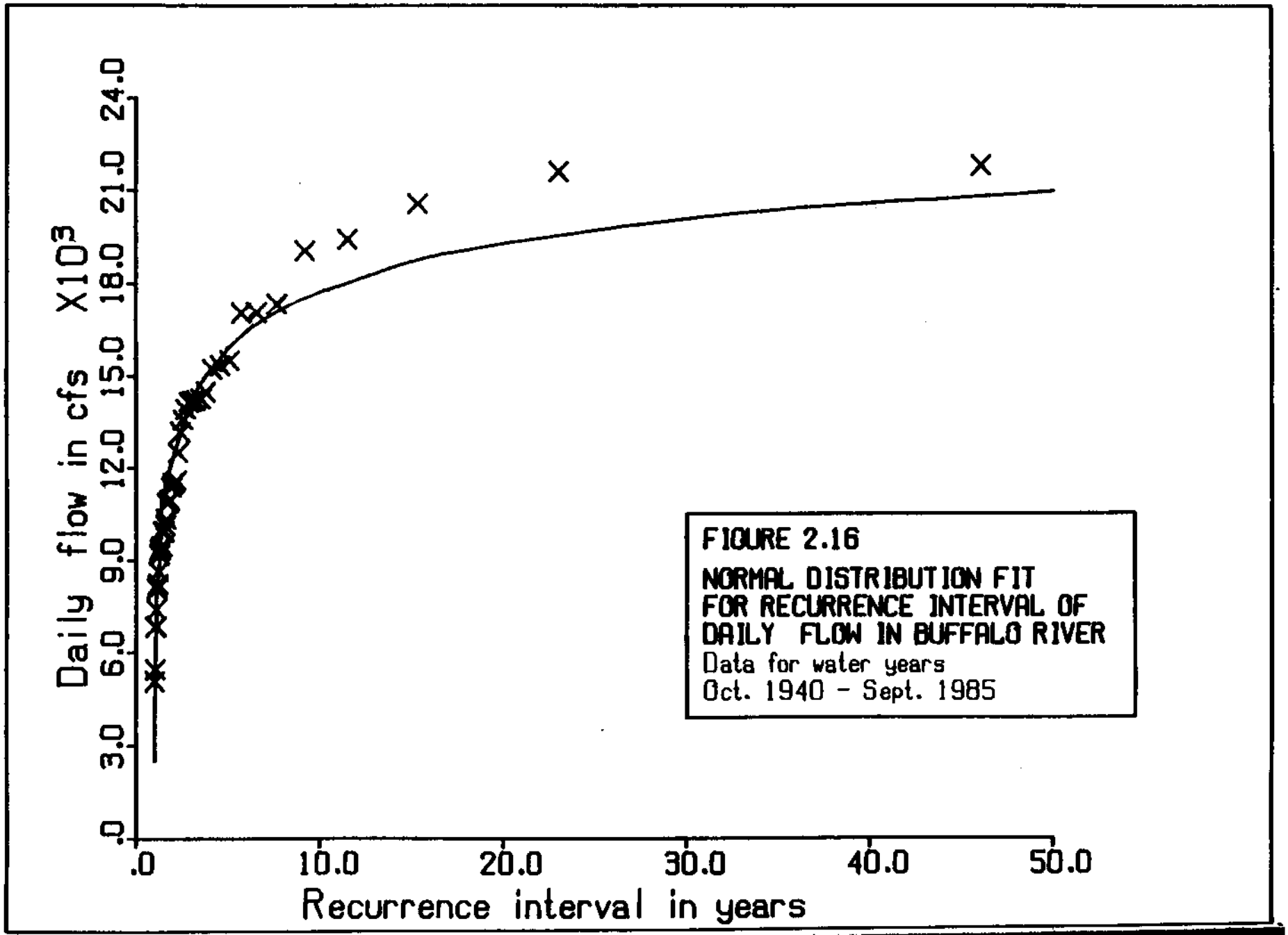
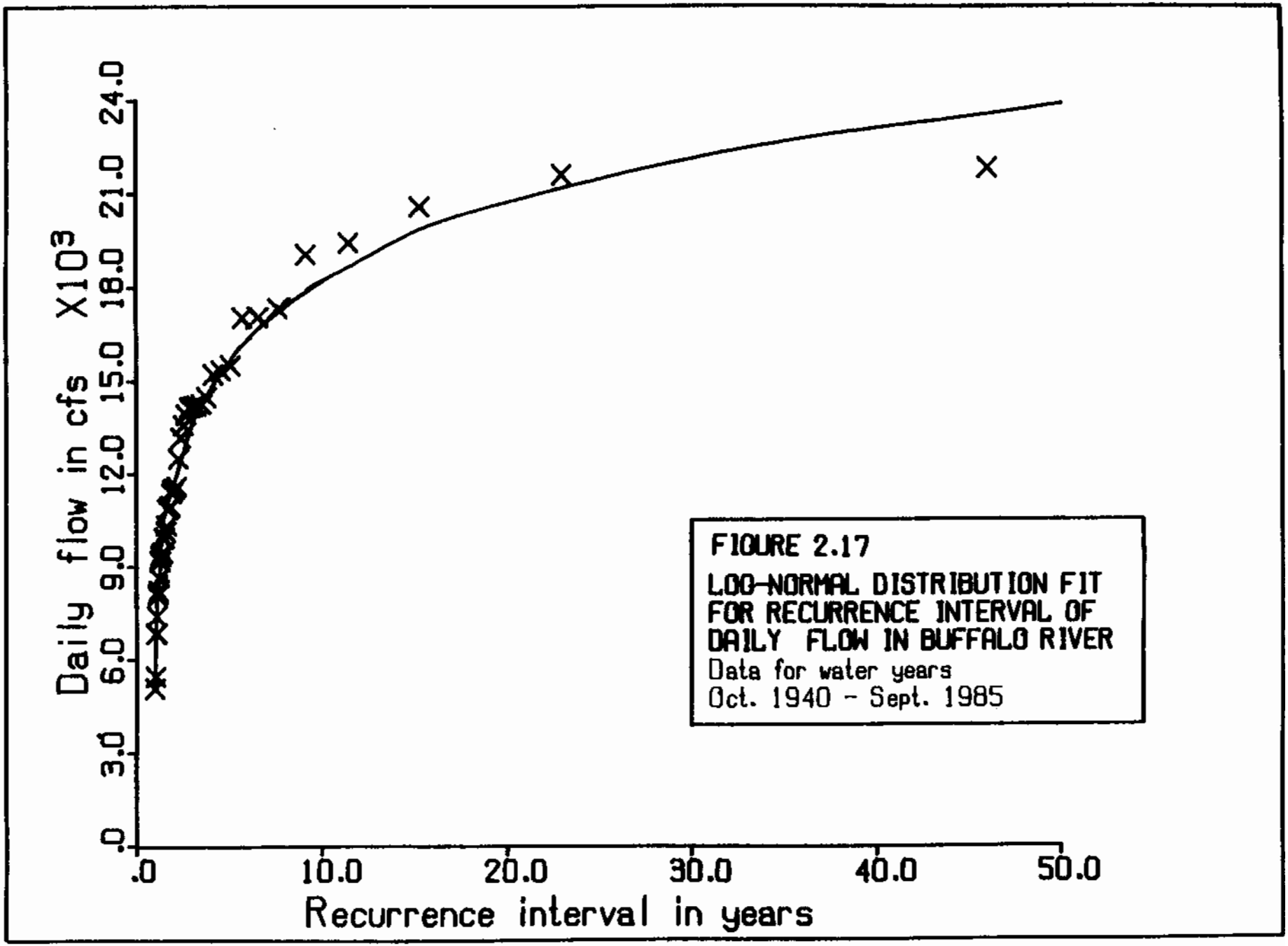
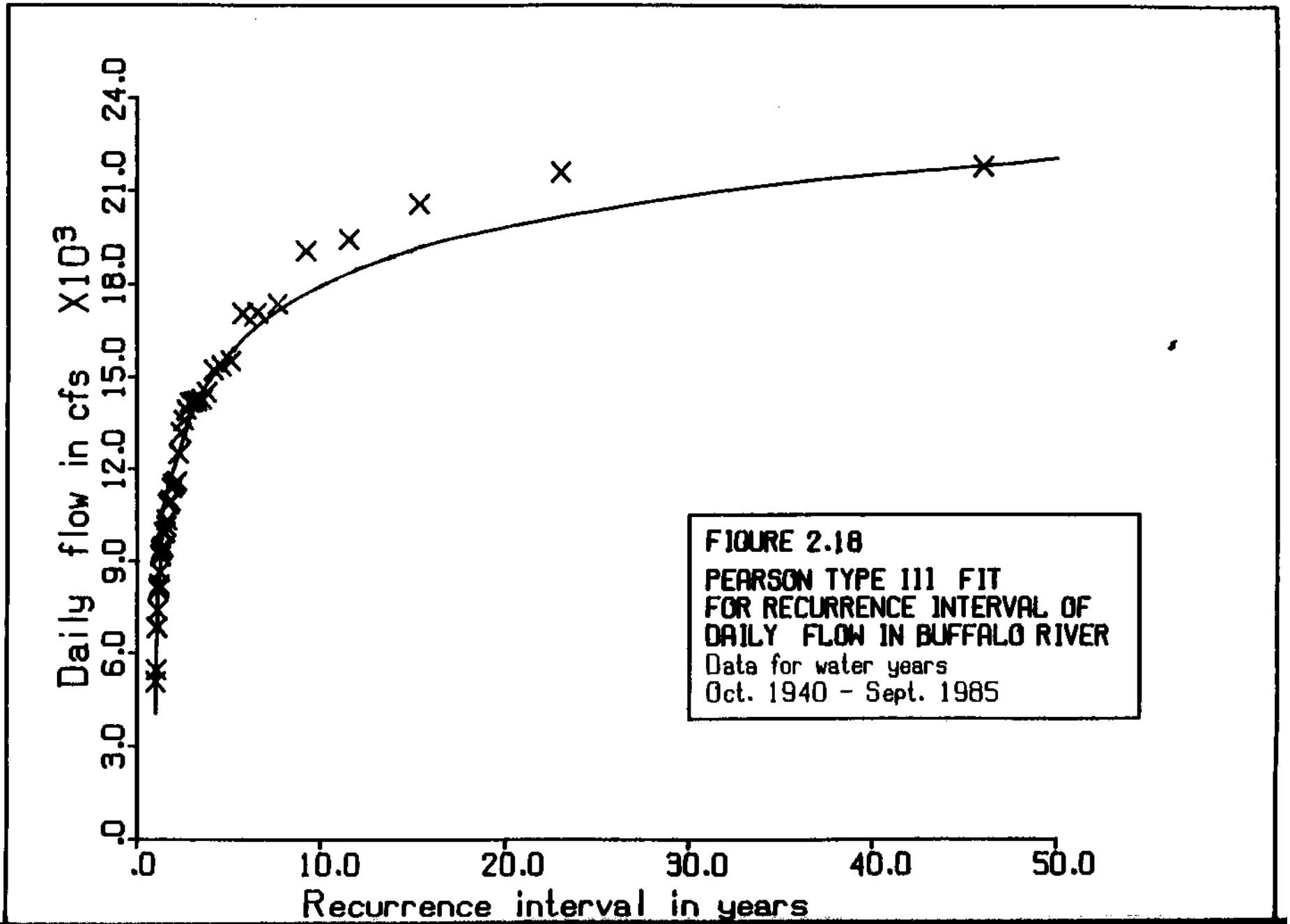


FIGURE 2.16

NORMAL DISTRIBUTION FIT FOR RECURRENCE INTERVAL OF DAILY FLOW IN BUFFALO RIVER

Data for water years
Oct. 1940 - Sept. 1985


Daily flow in cfs X10³
0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
.0
10.0
20.0
30.0
40.0
50.0
Recurrence interval in years
FIGURE 2.17
LOG-NORMAL DISTRIBUTION FIT FOR RECURRENCE INTERVAL OF DAILY FLOW IN BUFFALO RIVER
Data for water years
Oct. 1940 - Sept. 1985


Daily flow in cfs X10³
0.0
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
.0
10.0
20.0
30.0
40.0
50.0
Recurrence interval in years
FIGURE 2.18
PEARSON TYPE III FIT
FOR RECURRENCE INTERVAL OF
DAILY FLOW IN BUFFALO RIVER
Data for water years
Oct. 1940 - Sept. 1985

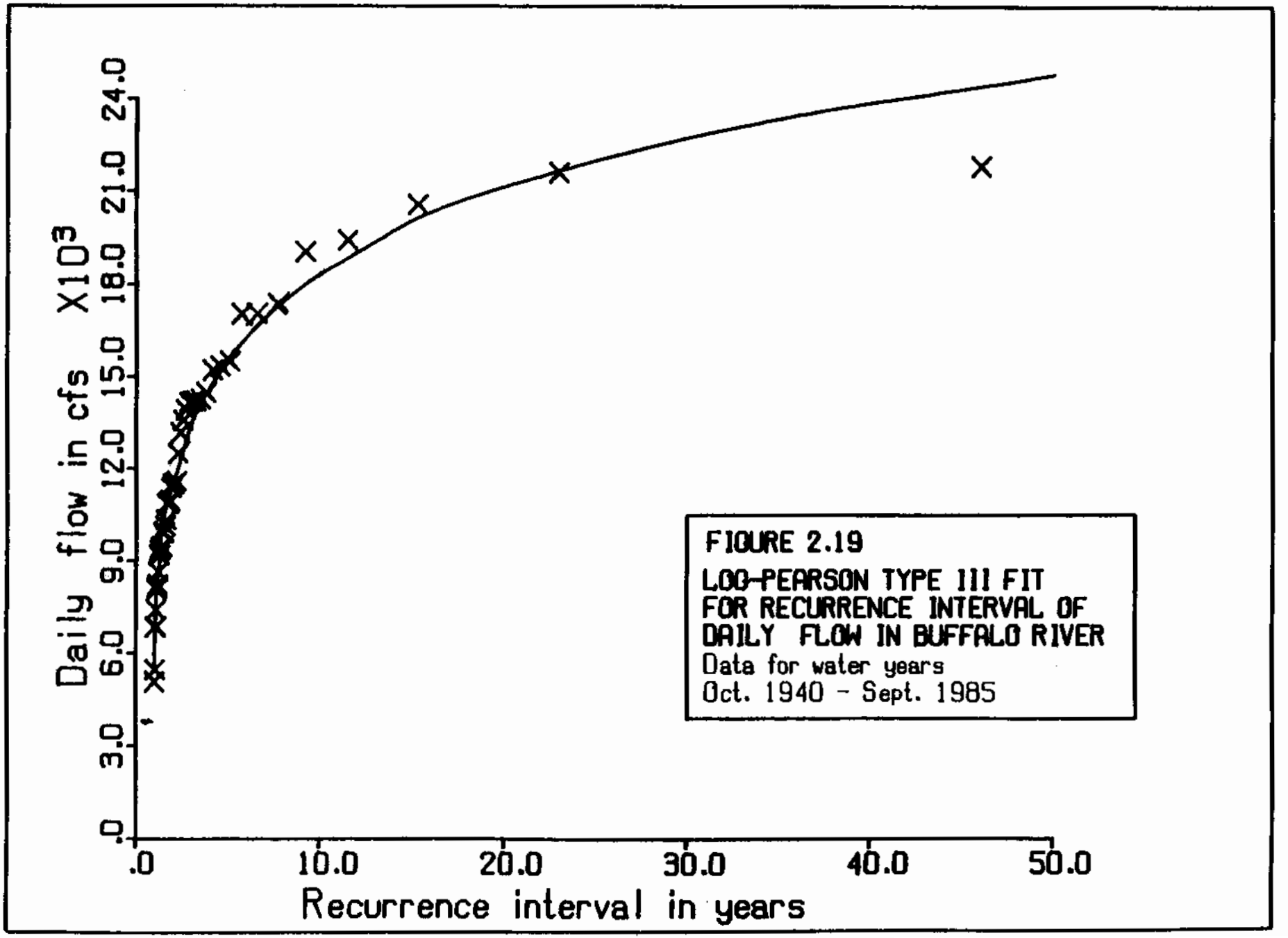


FIGURE 2.19
LOG-PEARSON TYPE III FIT FOR RECURRENCE INTERVAL OF DAILY FLOW IN BUFFALO RIVER
Data for water years
Oct. 1940 - Sept. 1985

Type III appears to provide the best fit.

The difference between the two largest values in a series was less than one percent for both the annual discharge volume series and the annual peak daily flow series. This indicates that the two largest values in the series should have approximately the same recurrence interval rather than the recurrence interval of the largest at twice the recurrence interval of the second largest value of the series.

3. SEDIMENT YIELD FROM THE BUFFALO RIVER WATERSHED

Sediment yield from a drainage basin involves many factors, and efforts to estimate its magnitude are fraught with uncertainty. Even for a given drainage basin and specified water flow discharge, sediment yield will vary seasonally and will depend on the temporal and spatial distribution of the applied precipitation. Longer-term variations may result from land use changes within the drainage basin. Various methodologies are available for estimating sediment yields, but the best estimate involves direct measurement of suspended sediment concentrations during flow events for the basin in question.

3.1. ARS Flow-sediment study

Fortunately, the Agricultural Research Service, USDA, conducted a program of flood water sampling over a period of nine years (1953-1962) from Cayuga Creek at Lancaster, Buffalo Creek at Gardenville, and Cazenovia Creek at Ebenezer (D.A. Parsons, R.P. Apmann, and G.H. Decker, "The Determination of Sediment Yeilds from Flood Water Sampling," Publication No. 65, International Association of Scientific Hydrology, 1963, pp. 7-15). The purpose of that sampling program was to determine the changes in sediment delivery of these streams with the application of soil erosion prevention measures. The findings from this earlier investigation have been used in the present study to generate estimates of sediment yields as a function of water discharge for the three basins tributary to the Buffalo River.

The USDA field sampling program resulted in the following equation relating sediment concentration to water discharge:

$$C = KQ^{0.85} \qquad (3.1)$$

in which, C = sediment concentration in ppm

Q = water discharge in cfs, and

K = empirical coefficient indicative of the erodibilities and exposures of the soils in the source areas

The K-values were found to vary seasonally and differed slightly fo each of the three drainage basins as shown in Table 3.1.

TABLE 3.1 Seasonal Variations in the Measure of Watershed Erodibilities, K, for Cayuga, Cazenovia, and Buffalo Creeks, New York

MONTH	DRAINAGE BASIN		
	Cayuga Creek	Cazenovia Creek	Buffalo Creek
Jan.	0.8	1.0	1.5
Feb.	1.1	1.2	1.4
Mar.	1.6	1.7	2.0
Apr.	1.6	2.0	1.8
May.	1.7	2.1	1.9
June	2.2	2.6	2.7
July	2.4	2.9	2.8
Aug.	2.4	2.9	3.1
Sept.	2.3	2.5	2.7
Oct.	2.1	1.8	2.2
Nov.	1.7	1.6	1.8
Dec.	0.9	1.0	1.4

3.2. Estimated Sediment Yields

Equation3.1 can be modified in order to estimate sediment yield in tons per day as a function of the mean daily discharge for each of the three drainage basins. The modified equation is as follows:

$$Q_s = (2.694 \times 10^{-3}) K Q^{1.85} \qquad (3.2)$$

in which; Q_s = sediment yield in tons/day

Q = mean daily discharge in cfs, and

K = erodibility coefficient.

The hydrographs developed in Section 2 were utilized with equation 3.

to generate estimates of sediment yields from the tributary basins. These sediment yield estimates for the tributaries were then combined to produce the estimated sediment yield for the Buffalo River drainage basin. The estimates of the monthly and water year sediment yield for the Buffalo River are presented in Table 3.2.

The estimated sediment yields from the three tributary basins for each water year for which runoff records were available are displayed in Figures 3.1 to 3.3. The combined estimated sediment yield for the Buffalo River drainage basin for the period 1940 to 1985 is shown in Figure 3.4. The range of annual sediment yield for the Buffalo River drainage basin extends from approximately 140,000 tons per year to 900,000 tons per year. The size of the Buffalo River drainage basin is 408.6 square miles, giving a yield per unit area ranging from 343 tons per square mile to 2,202 tons per square mile.

The seasonal distribution of sediment yield from the Buffalo River drainage basin is displayed in Figures 3.5 and 3.6. A study of these two figures reveals the importance of one or two wet months in the accumulation of sediment yield for any particular year.

The historical record of estimated sediment yields for Cayuga Creek is portrayed in Figure 3.7 in terms of the percent yield associated with a stated flow interval. The relative importance of high runoff discharges is again revealed by this figure. For example, all the recorded flows less than 170 cfs contribute less than 3 percent of the total sediment yield. Thus, flows equal to or less than the mean annual discharge contribute approximately 2.5 percent of the total sediment yield. Stated another way, runoff flows greater than 750 cfs occur less than 10 percent of the time but contribute approximately 80 percent of the total sediment yield.

TABLE 3.2. Estimated Monthly and Annual Water Year Sediment Yields for Buffalo River in tons

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Annual
1941	180	7935	52334	12520	1518	49689	108050	410	215	81	86	1515	234530
1942	1519	1834	8363	7962	8953	362840	78134	3297	514	3146	63	4789	481410
1943	9007	85415	81879	9670	41244	51563	71199	55887	17804	298	1299	88	425350
1944	3988	5394	978	4769	14677	62417	98247	15390	51911	192	75	183	258230
1945	124	329	1036	285	25574	211630	24919	9765	2503	2583	335	1784	280870
1946	110490	31605	15058	49326	6962	70297	1392	11212	6271	772	4752	245	308390
1947	1022	14293	15478	50077	3765	97252	250280	63515	56455	5156	238	369	557900
1948	54	4035	32135	496	68551	113910	21974	26379	1401	130	88	406	269560
1949	5288	9624	5643	27492	19547	36586	20022	1404	258	214	95	106	126280
1950	46	1465	8787	33881	12923	197880	35285	1550	425	158	115	592	293110
1951	1018	36667	82099	87532	46273	88487	41796	3287	2860	1613	46	146	391830
1952	82	8625	6741	44321	20849	118380	19402	35127	351	51	106	507	254550
1953	78	871	11640	12785	8825	50239	8153	60926	2093	1034	16036	186	172870
1954	26	292	6776	31744	83140	49968	89269	5273	4382	157	83	291	271410
1955	33131	11714	47996	8454	25460	233790	19474	722	105	25	269	28	381170
1956	22626	16429	47628	1010	27935	297560	102470	53682	4550	689	20574	19696	614860
1957	1122	3965	56142	160210	38294	25694	71364	60178	5055	5746	72	298	428150
1958	81	27569	17966	736	7211	55395	44001	6172	37964	7991	889	15252	221230
1959	1808	9166	3119	100660	24246	67916	119400	3080	2685	249	186	46	332570
1960	12690	10768	39828	29109	37594	165130	49357	3157	8029	132	124	20	355940
1961	58	59	52	160	62651	27180	171100	19970	15707	299	11960	304	309500
1962	215	5558	6228	20075	19025	52116	22697	4232	366	44	59	936	131550
1963	318	1492	1071	830	332	244430	34662	3655	274	2191	14224	115	303600
1964	36	7164	3182	28755	1559	169020	28725	2834	591	324	175	30	242400
1965	36	1786	7143	18280	71538	16575	44865	879	138	140	156	87	161620
1966	138	12376	34040	6746	72775	74278	27617	7762	1553	73	58	118	237540
1967	33	3244	26143	10201	9526	39053	25728	23903	254	419	180	73061	211750
1968	32802	59426	8173	40949	13972	63131	27397	5168	14865	316	712	740	267650
1969	1291	60306	65138	70224	5573	29280	103150	88978	11556	5887	515	207	442100
1970	555	16237	44917	16124	17628	37006	82153	14599	677	2250	257	1570	233980
1971	6994	96650	23086	5985	61805	60686	53370	4379	18484	2647	382	213	334680

TABLE 3.2. Continued

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Annual
1972	106	2612	24053	8852	3560	233750	35805	15302	199730	5122	445	1027	530370
1973	7549	23386	90244	12864	19076	94534	59729	14126	9012	823	280	161	331790
1974	304	14096	35957	16270	15001	86267	57667	28793	5117	192	197	225	260090
1975	311	35768	12535	73282	75014	57614	13980	11576	23423	488	32536	2229	338760
1976	1865	6823	28048	19614	129890	216060	36577	25062	3635	40193	15543	3787	527100
1977	25340	6093	4186	1067	24399	174510	120680	3940	1717	6968	82959	419950	871820
1978	17703	43316	93901	14142	1665	246670	79360	21406	1626	119	181	6775	526870
1979	8611	936	28730	73661	8964	208910	35821	5796	1051	237	6667	207750	587130
1980	20142	17648	43438	8567	3451	86855	16477	1709	7747	1802	2152	8453	218440
1981	64426	12447	28841	1045	85664	10228	17624	5514	3960	7458	2437	32022	271670
1982	11397	24311	16286	9581	1729	169270	28473	1534	18410	1338	398	1685	284420
1983	2147	74956	32179	1165	6070	20011	9241	22874	1949	164	2345	1677	174780
1984	1245	20132	40083	4670	70664	49809	44295	82366	78996	1564	3208	33941	430970
1985	716	5764	92879	83201	302790	94933	29389	4017	2548	832	325	6458	623860

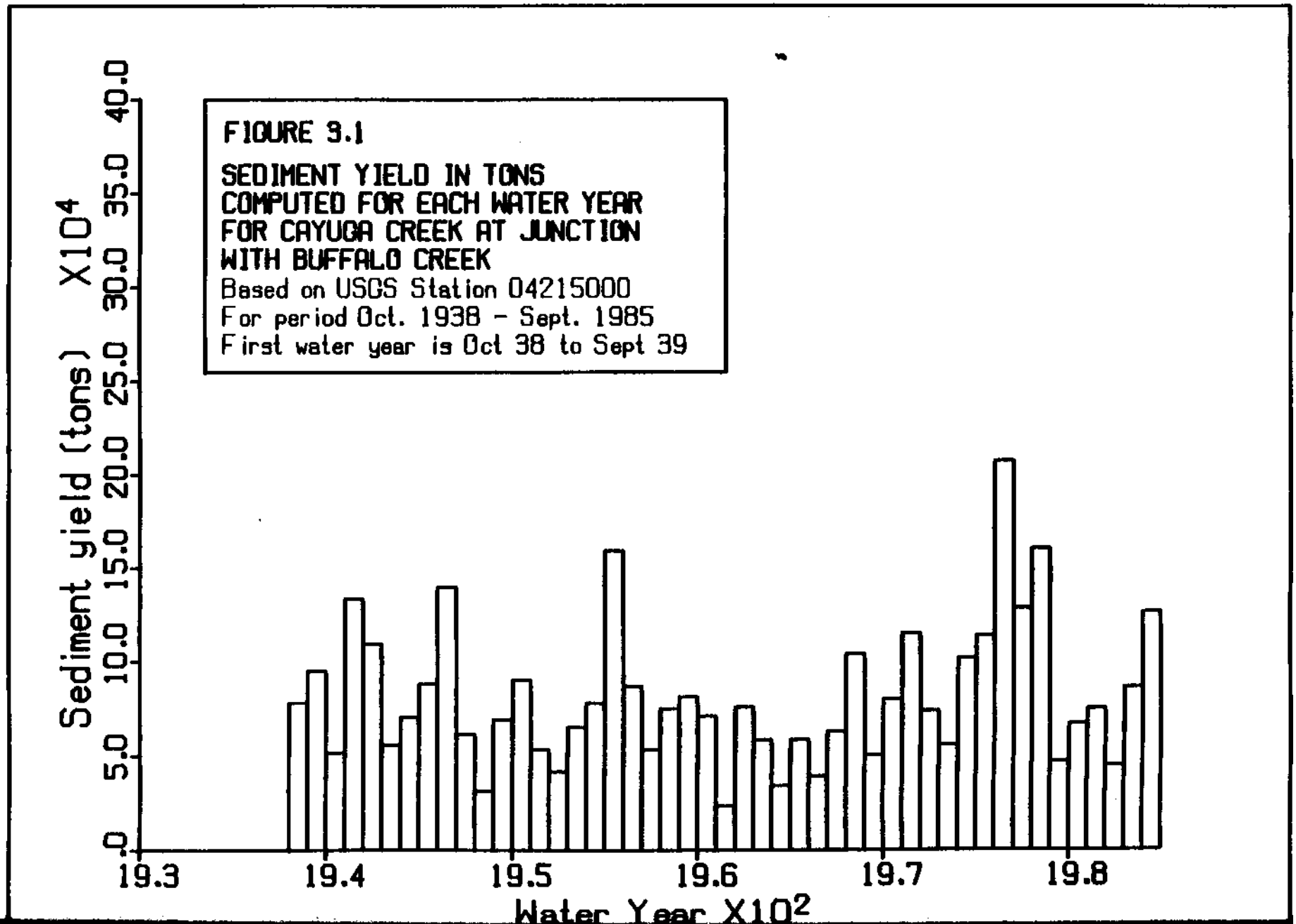


FIGURE 9.1
SEDIMENT YIELD IN TONS
COMPUTED FOR EACH WATER YEAR
FOR CAYUGA CREEK AT JUNCTION
WITH BUFFALO CREEK
Based on USGS Station 04215000
For period Oct. 1938 - Sept. 1985
First water year is Oct 38 to Sept 39
Sediment yield (tons) X10⁴
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
19.3
19.4
19.5
19.6
19.7
19.8
Water Year X10²

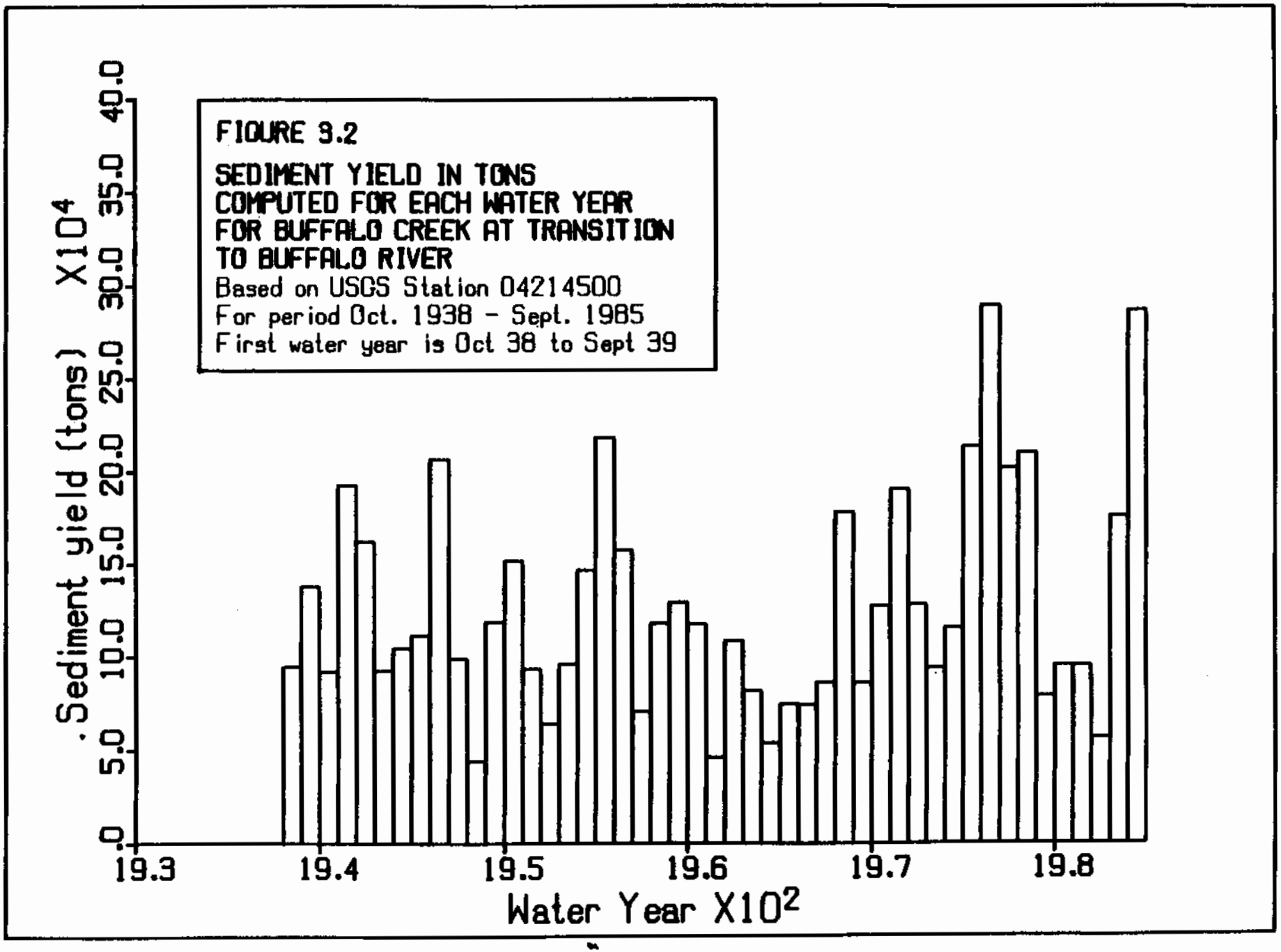


FIGURE 3.2
SEDIMENT YIELD IN TONS
COMPUTED FOR EACH WATER YEAR
FOR BUFFALO CREEK AT TRANSITION
TO BUFFALO RIVER
Based on USGS Station 04214500
For period Oct. 1938 - Sept. 1985
First water year is Oct 38 to Sept 39
.Sediment yield (tons) X10⁴
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
19.3
19.4
19.5
19.6
19.7
19.8
Water Year X10²

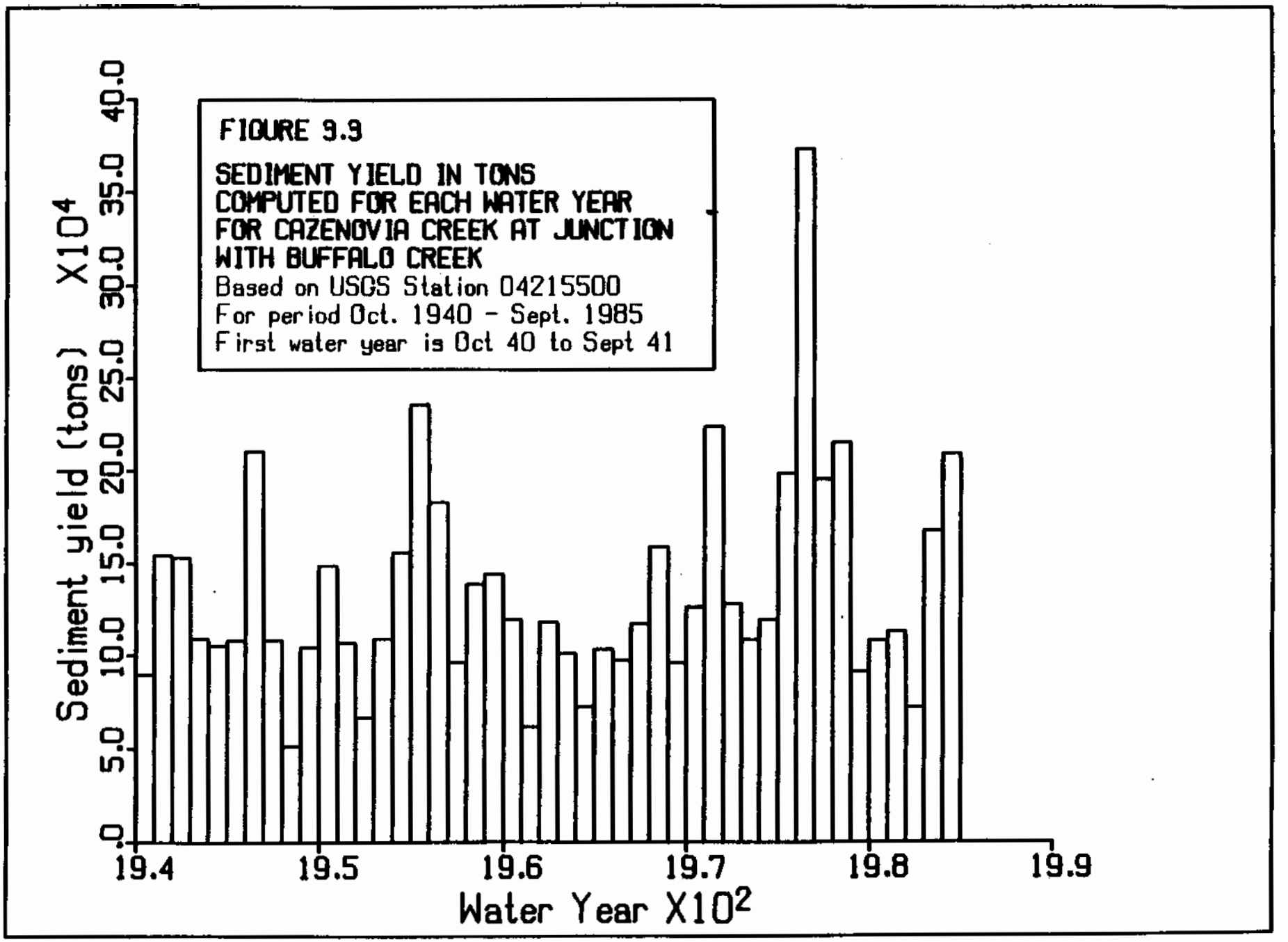


FIGURE 9.9
SEDIMENT YIELD IN TONS
COMPUTED FOR EACH WATER YEAR
FOR CAZENOVIA CREEK AT JUNCTION
WITH BUFFALO CREEK
Based on USGS Station 04215500
For period Oct. 1940 - Sept. 1985
First water year is Oct 40 to Sept 41
Sediment yield (tons) X10⁴
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
19.4
19.5
19.6
19.7
19.8
19.9
Water Year X10²

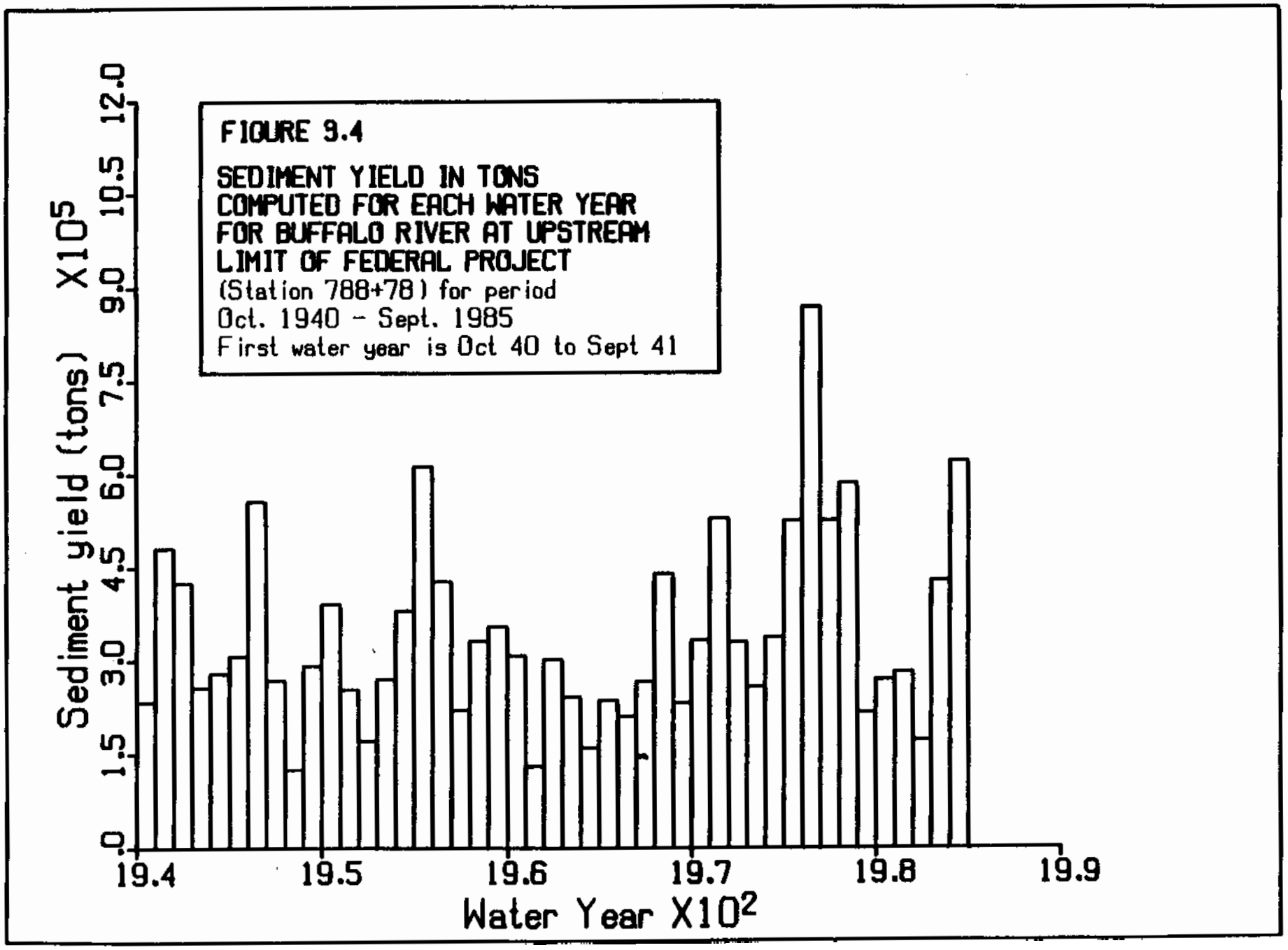


FIGURE 3.4
SEDIMENT YIELD IN TONS
COMPUTED FOR EACH WATER YEAR
FOR BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
First water year is Oct 40 to Sept 41
Sediment yield (tons) X10^5
0
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
19.4
19.5
19.6
19.7
19.8
19.9
Water Year X10^2

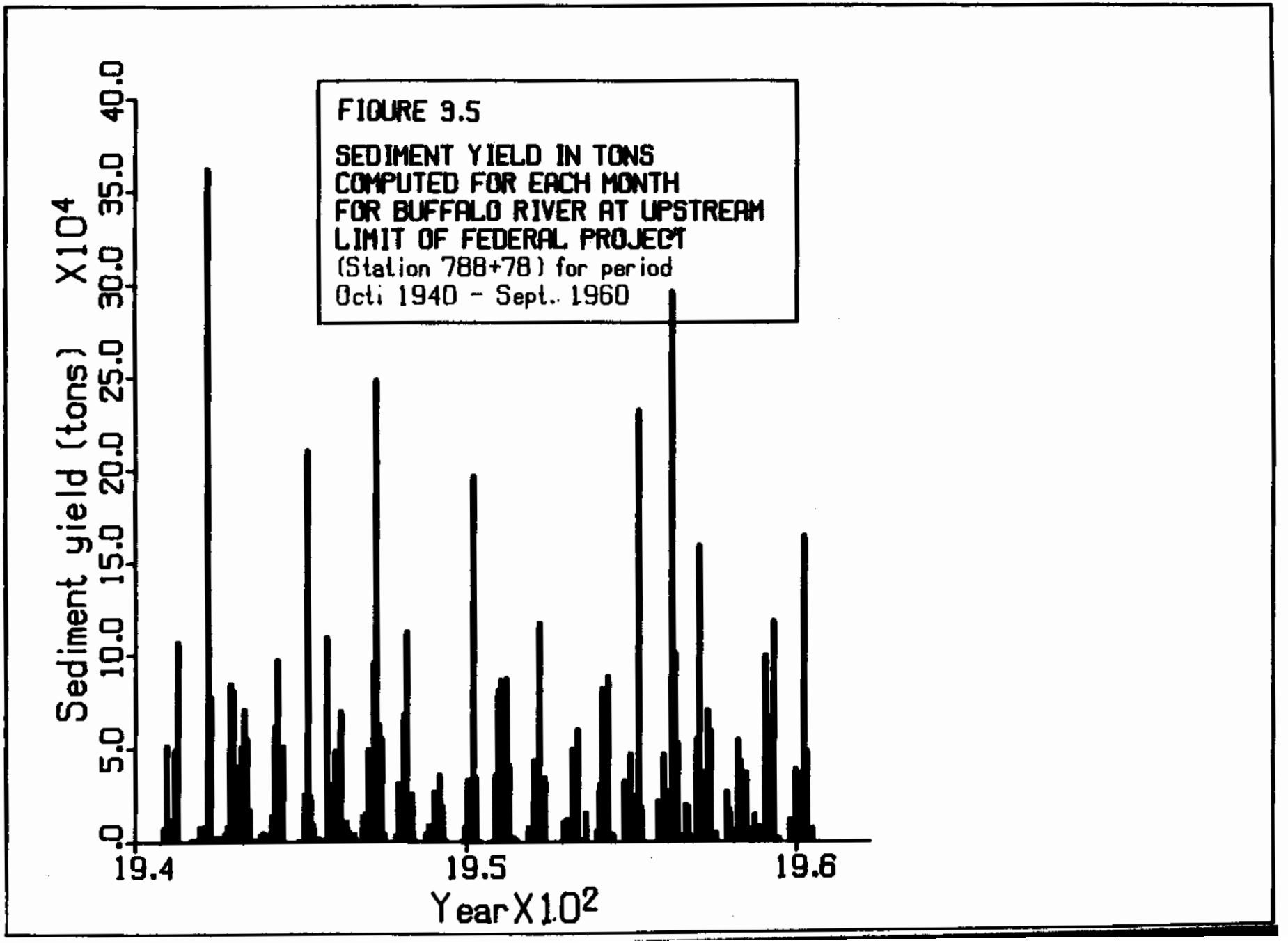


FIGURE 9.5
SEDIMENT YIELD IN TONS
COMPUTED FOR EACH MONTH
FOR BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1960
Sediment yield (tons) X10⁴
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
19.4
19.5
19.6
Year X10²

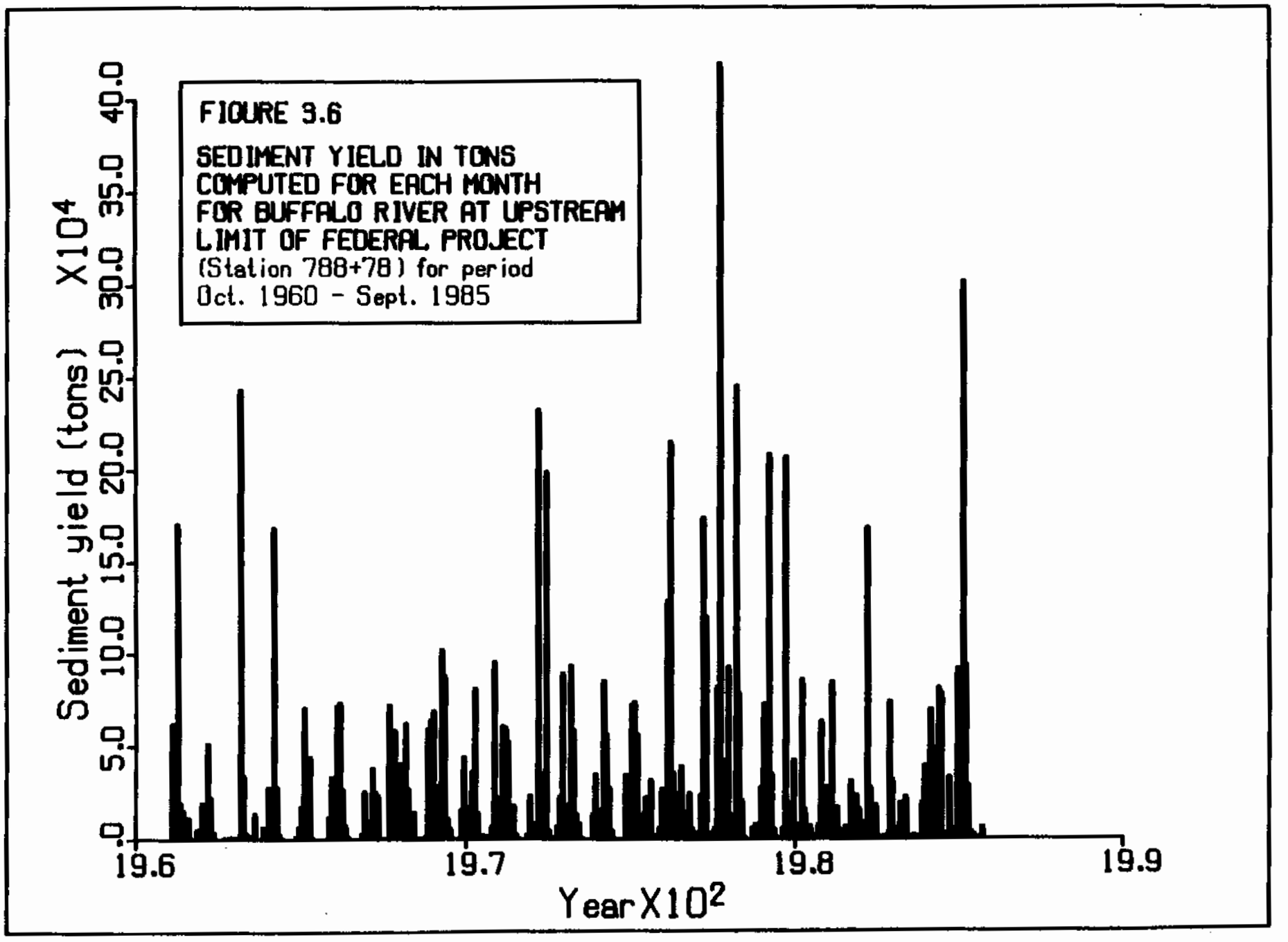


FIGURE 3.6
SEDIMENT YIELD IN TONS
COMPUTED FOR EACH MONTH
FOR BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1960 - Sept. 1985
Sediment yield (tons) X10⁴
0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
19.6
19.7
19.8
19.9
Year X10²

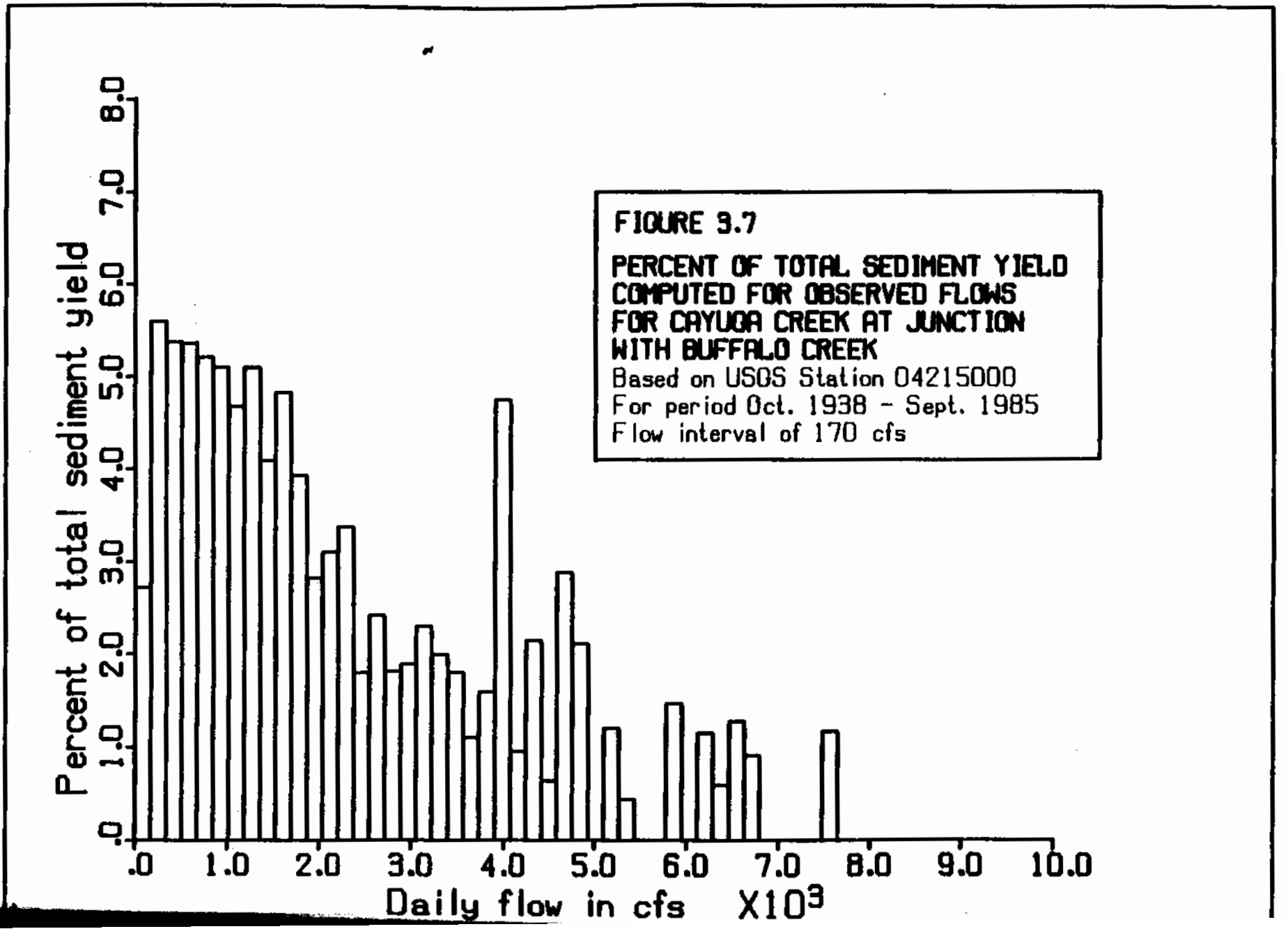


FIGURE 3.7

PERCENT OF TOTAL SEDIMENT YIELD COMPUTED FOR OBSERVED FLOWS FOR CAYUGA CREEK AT JUNCTION WITH BUFFALO CREEK

Based on USGS Station 04215000
For period Oct. 1938 - Sept. 1985
Flow interval of 170 cfs

Figure 3.8 is similar to Figure 3.7, except the flow interval has been changed to 280 cfs. Similar findings for the other two tributary basins are portrayed in Figures 3.9 to 3.12.

A composite sediment yield for the entire Buffalo River drainage basin is portrayed in Figures 3.13 and 3.14 in terms of the percent total sediment yield associated with a stated flow discharge interval. Approximately 4 percent of the total sediment yield is contributed by flow discharges less than or equal to the mean annual discharge. One rare high flow discharge event can contribute almost as much total sediment yield as all of the combined flow discharges equal to or less than the mean annual discharge.

In Figure 3.15 the estimated annual sediment yields for the years of record (1940-1985) for the Buffalo River drainage basin have been correlated with the associated maximum monthly water volume discharge for the same year. A dependency is suggested with a correlation coefficient, $r = 0.67$.

A stronger correlation is obtained between the estimated annual sediment yields and the total water volume discharge for similar years ($r = 0.86$). The following regression equation is obtained,

$$ASY = -226{,}000 + 2{,}536\ (AWVD) \qquad (3.3)$$

in which; ASY = annual sediment yield in tons, and

AWVD = annual water volume discharge in cfs*days.

This correlation is portrayed in Figure 3.16. As an example, the regression equation, which has the effect of smoothing the data, would predict a total sediment yield of 3.29×10^5 tons for total annual water volume discharge in which the mean daily flow equaled 600 cfs for every day of the year.

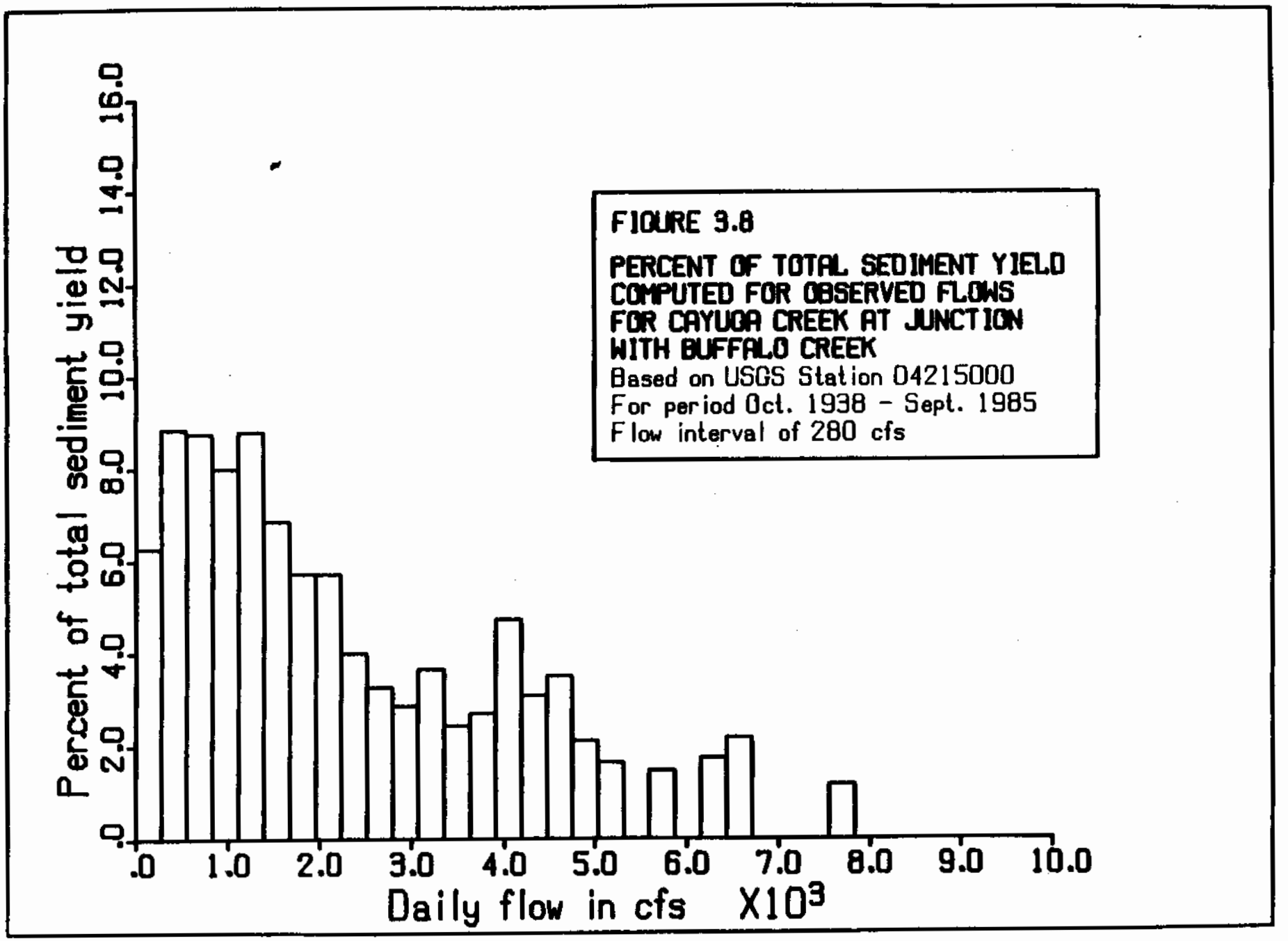


FIGURE 3.8

PERCENT OF TOTAL SEDIMENT YIELD COMPUTED FOR OBSERVED FLOWS FOR CAYUGA CREEK AT JUNCTION WITH BUFFALO CREEK

Based on USGS Station 04215000
For period Oct. 1938 - Sept. 1985
Flow interval of 280 cfs

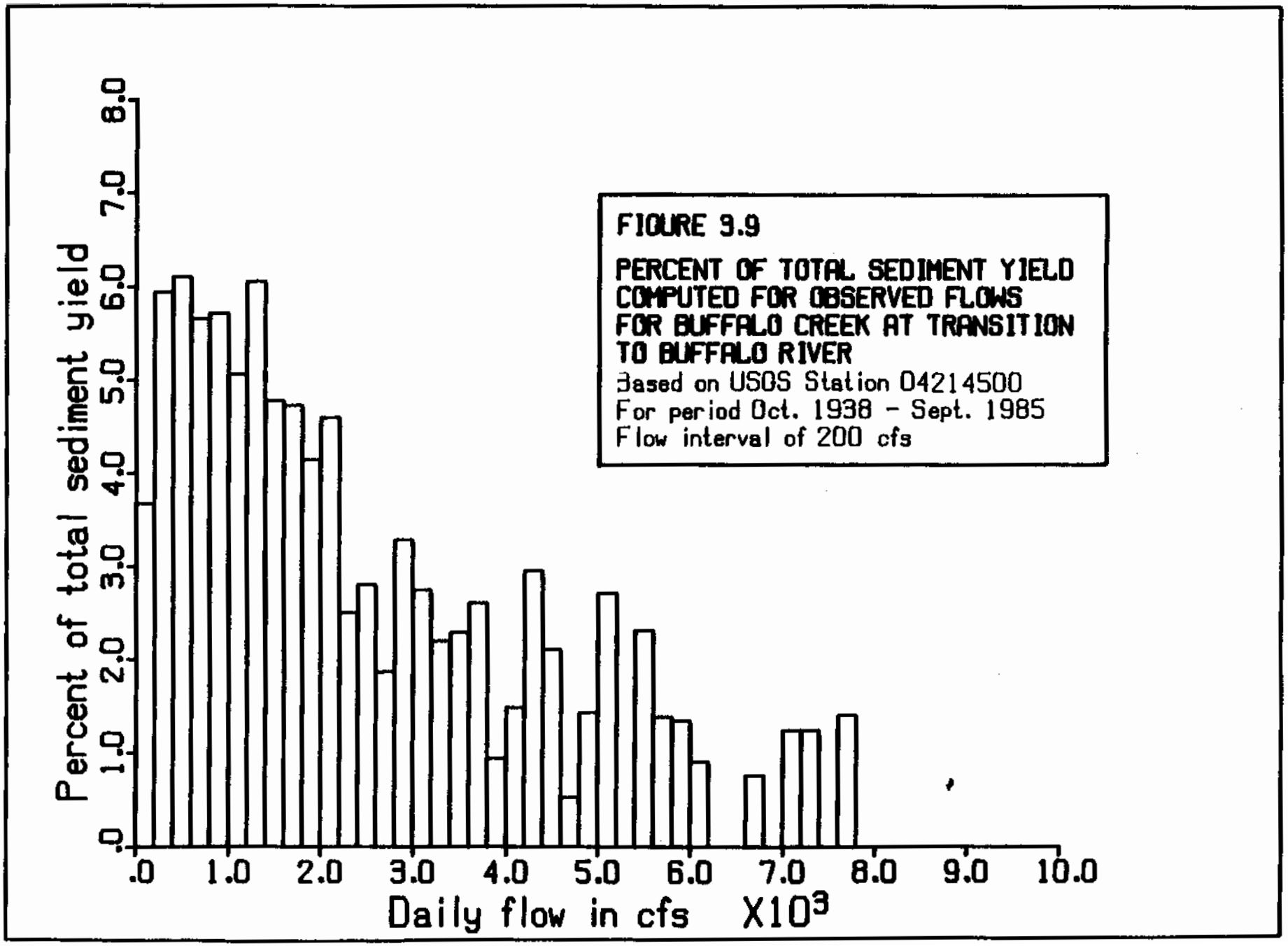


FIGURE 9.9

PERCENT OF TOTAL SEDIMENT YIELD COMPUTED FOR OBSERVED FLOWS FOR BUFFALO CREEK AT TRANSITION TO BUFFALO RIVER

Based on USGS Station 04214500
For period Oct. 1938 - Sept. 1985
Flow interval of 200 cfs

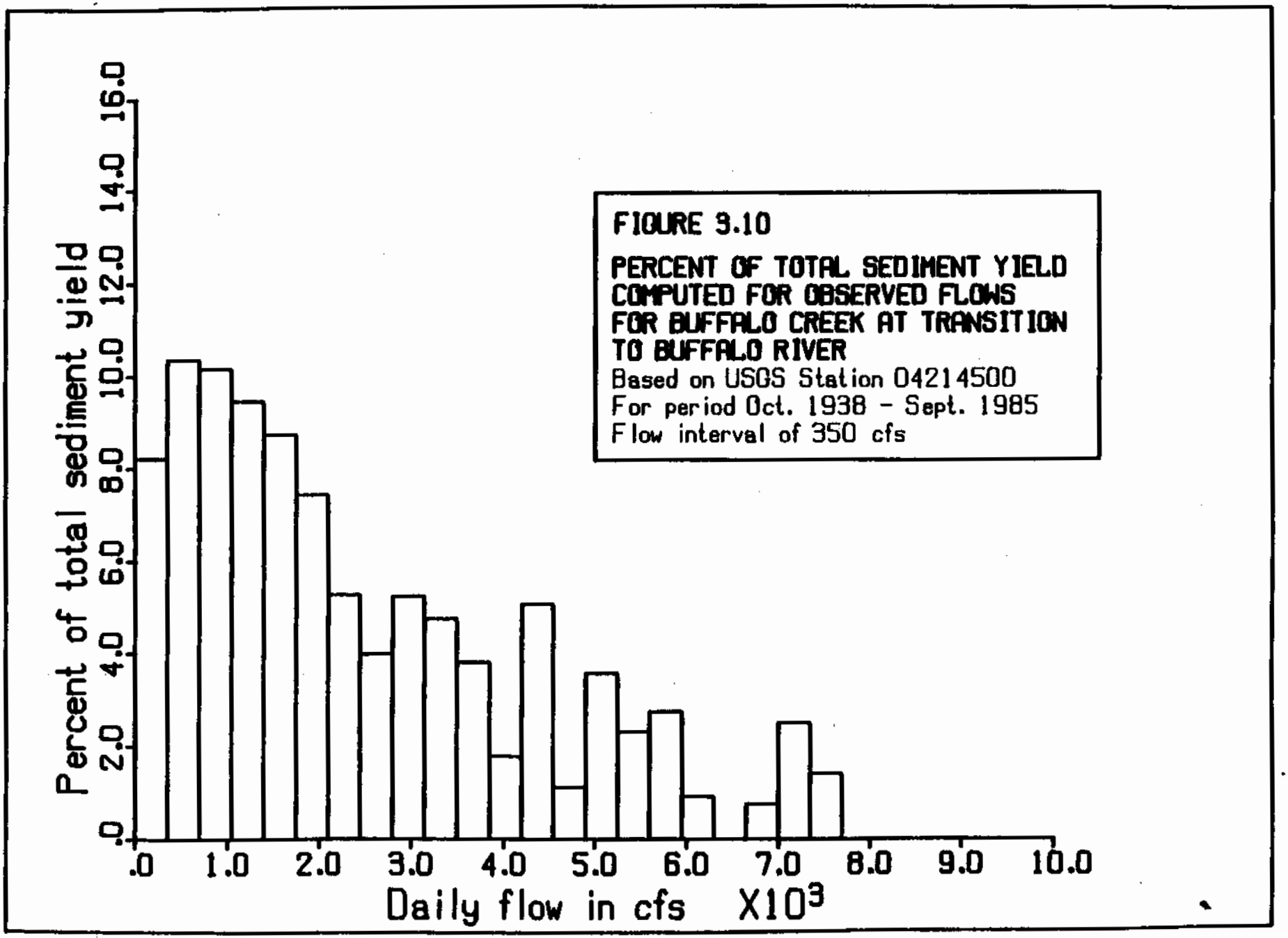
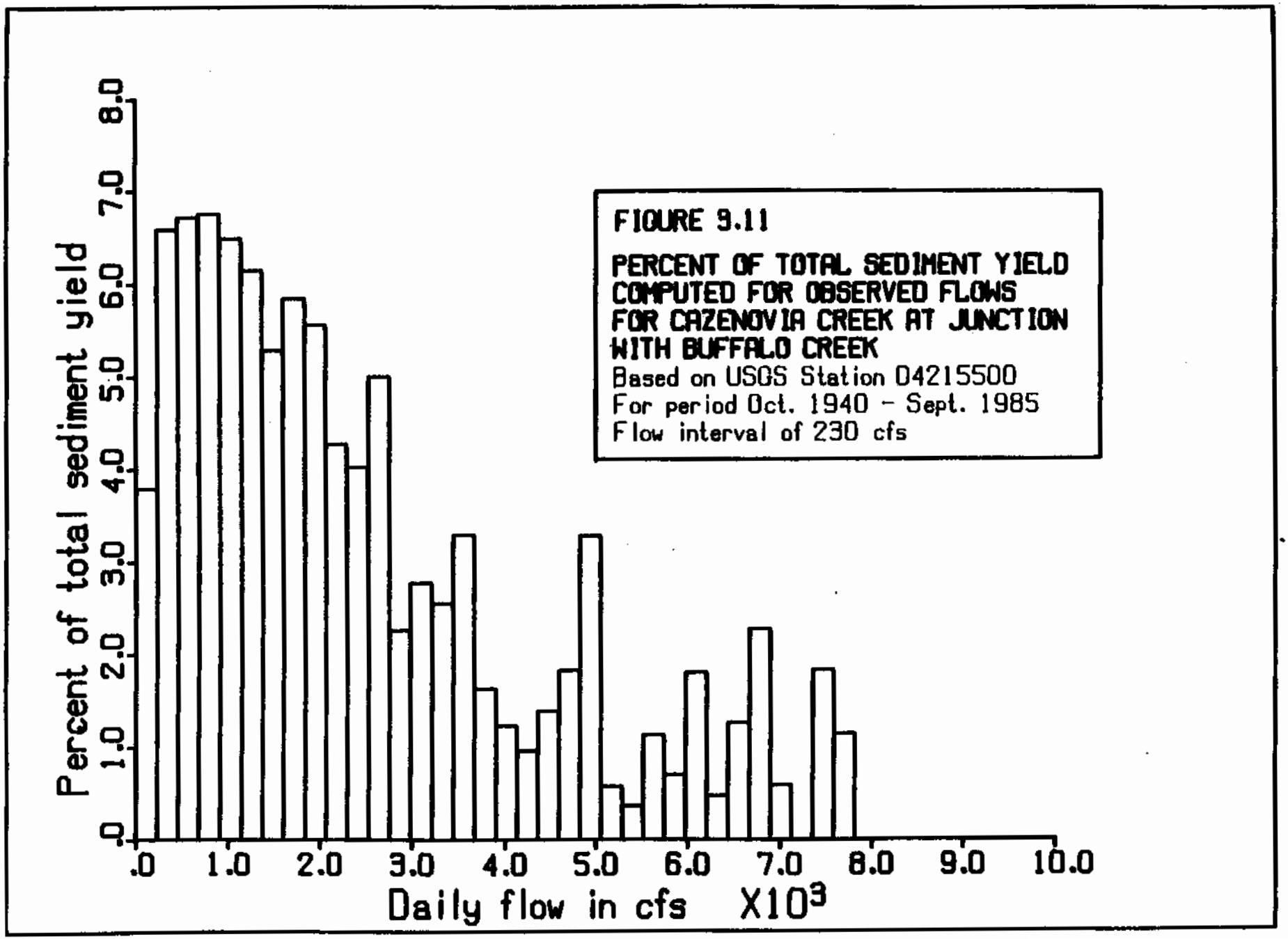


FIGURE 3.10

PERCENT OF TOTAL SEDIMENT YIELD COMPUTED FOR OBSERVED FLOWS FOR BUFFALO CREEK AT TRANSITION TO BUFFALO RIVER

Based on USGS Station 04214500
For period Oct. 1938 - Sept. 1985
Flow interval of 350 cfs


FIOURE 9.11
PERCENT OF TOTAL SEDIMENT YIELD COMPUTED FOR OBSERVED FLOWS FOR CAZENOVIA CREEK AT JUNCTION WITH BUFFALO CREEK
Based on USGS Station 04215500
For period Oct. 1940 - Sept. 1985
Flow interval of 230 cfs
Percent of total sediment yield
.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Daily flow in cfs X10^3

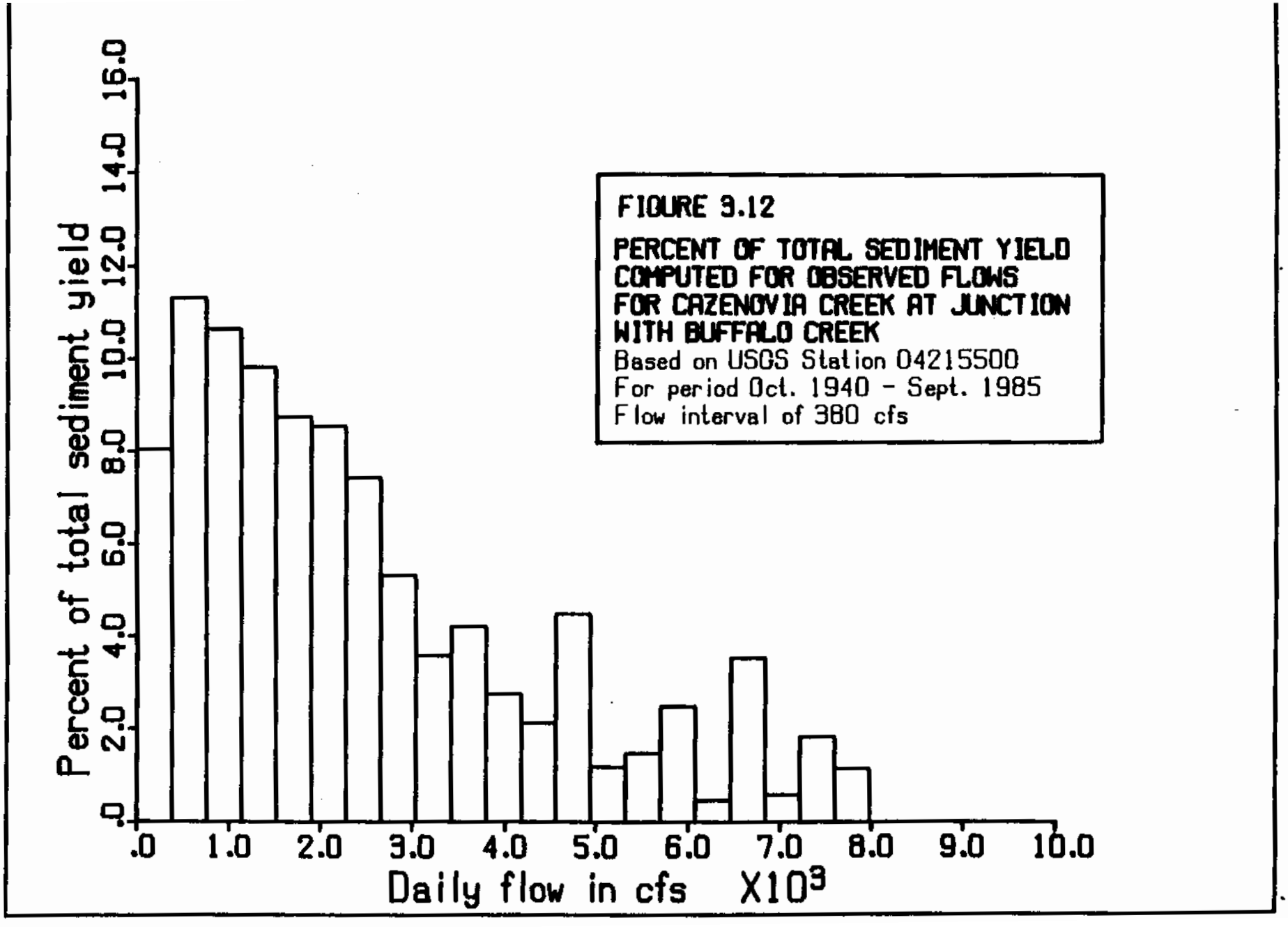


FIGURE 3.12

PERCENT OF TOTAL SEDIMENT YIELD COMPUTED FOR OBSERVED FLOWS FOR CAZENOVIA CREEK AT JUNCTION WITH BUFFALO CREEK

Based on USGS Station 04215500
For period Oct. 1940 - Sept. 1985
Flow interval of 380 cfs

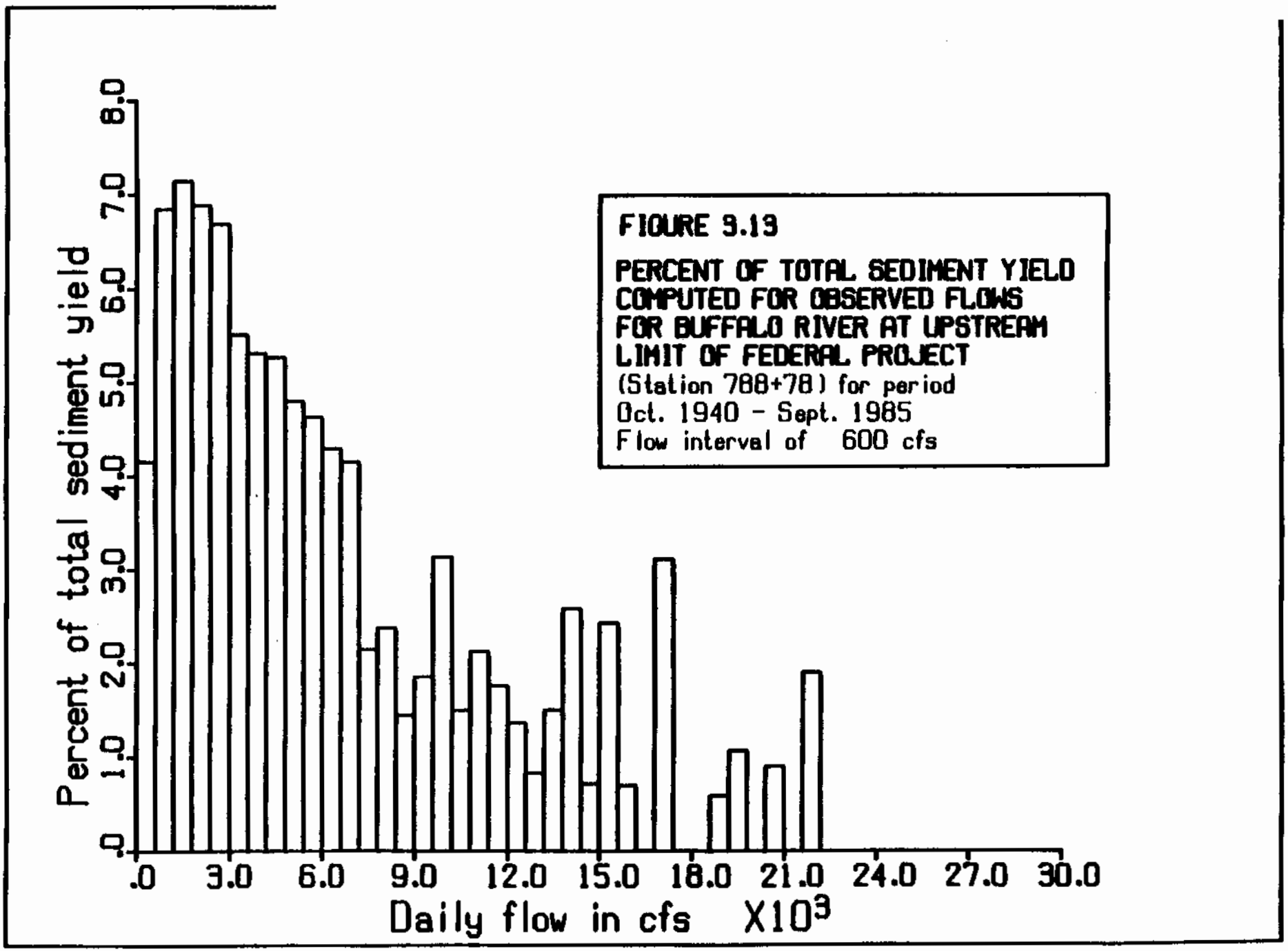


FIGURE 3.13

PERCENT OF TOTAL SEDIMENT YIELD COMPUTED FOR OBSERVED FLOWS FOR BUFFALO RIVER AT UPSTREAM LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
Flow interval of 600 cfs

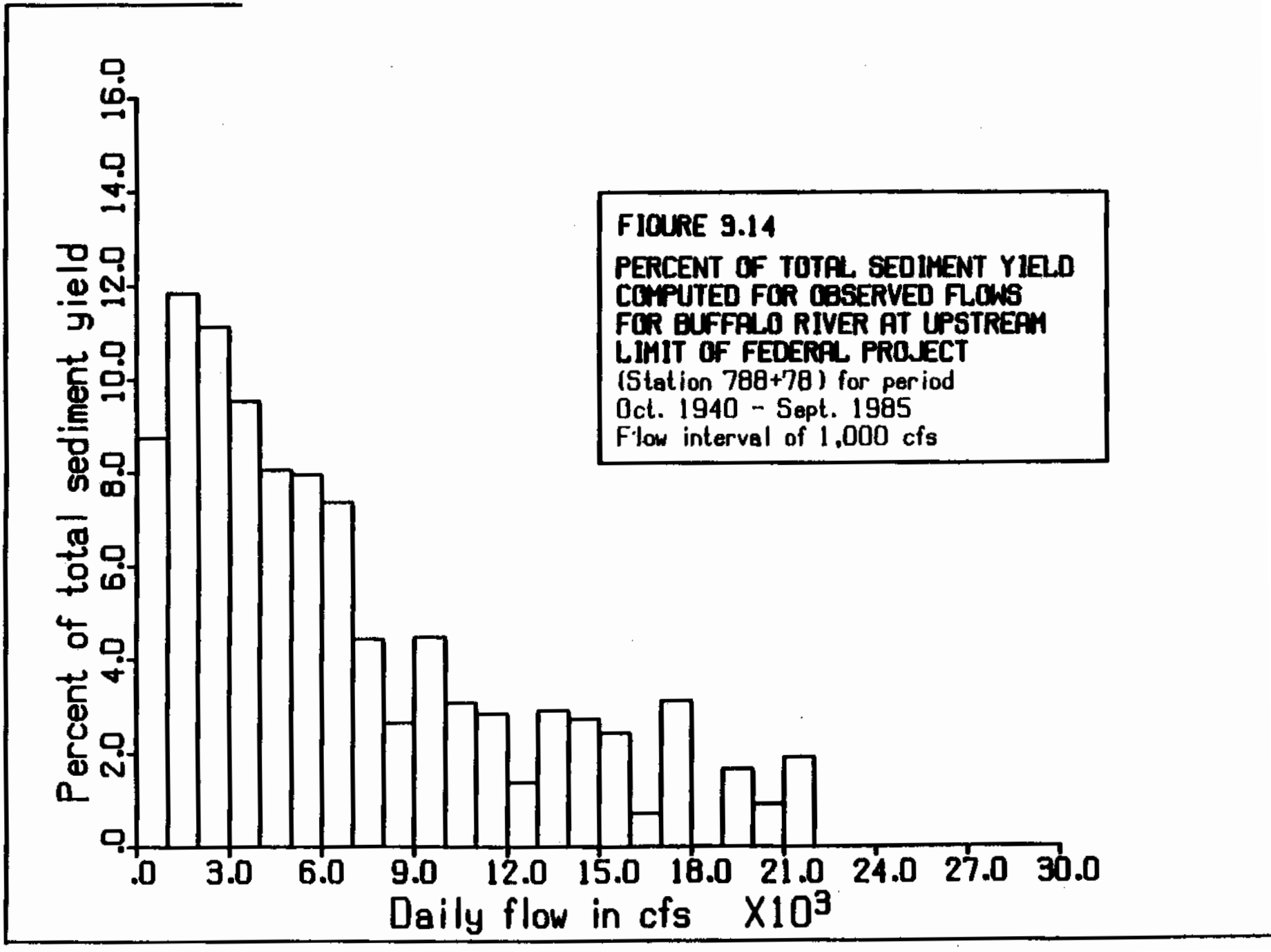


FIGURE 9.14

PERCENT OF TOTAL SEDIMENT YIELD COMPUTED FOR OBSERVED FLOWS FOR BUFFALO RIVER AT UPSTREAM LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
Flow interval of 1,000 cfs

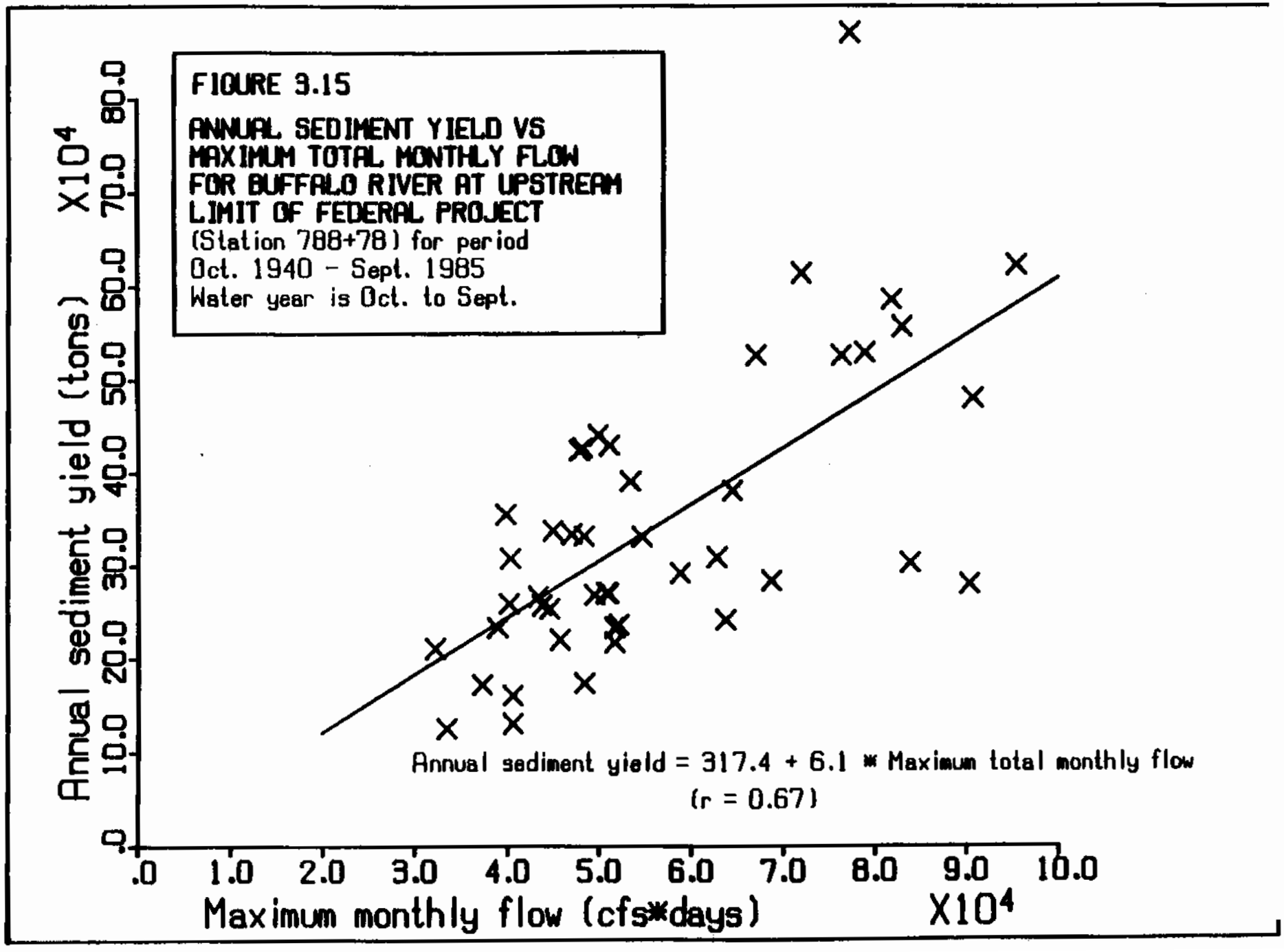


FIGURE 3.15
ANNUAL SEDIMENT YIELD VS
MAXIMUM TOTAL MONTHLY FLOW
FOR BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
Water year is Oct. to Sept.
Annual sediment yield (tons) X10⁴
.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Maximum monthly flow (cfs*days) X10⁴
Annual sediment yield = 317.4 + 6.1 * Maximum total monthly flow
(r = 0.67)

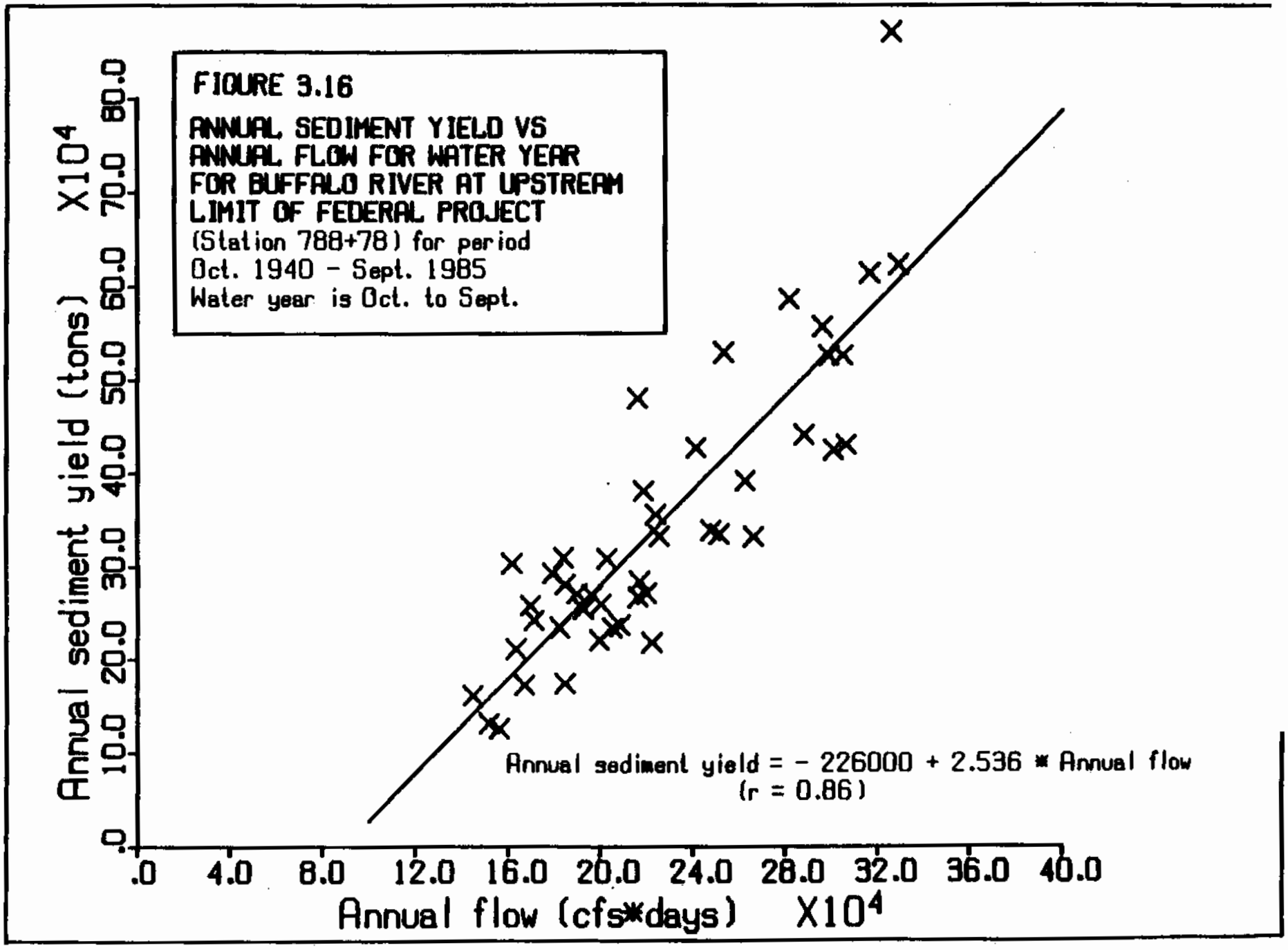


FIGURE 3.16
ANNUAL SEDIMENT YIELD VS
ANNUAL FLOW FOR WATER YEAR
FOR BUFFALO RIVER AT UPSTREAM
LIMIT OF FEDERAL PROJECT
(Station 788+78) for period
Oct. 1940 - Sept. 1985
Water year is Oct. to Sept.
Annual sediment yield (tons) X10⁴
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
Annual flow (cfs*days) X10⁴
.0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0
36.0
40.0
Annual sediment yield = - 226000 + 2.536 * Annual flow
(r = 0.86)

4. BUFFALO RIVER SEDIMENT SURVEYS

4.1. Available Records

Because of its importance as a navigable waterway, the U.S. Army Corps of Engineers conducts a dredging program in order to maintain the desired depth for navigation. Dredging is performed in Lake Erie in the south entrance channel, the outer harbor, the north entrance channel, the Black Rock entrance channel, and the Buffalo River entrance channel. Dredging is also performed in the Buffalo River and the Buffalo Ship Canal. This study is only for the Buffalo River between the confluence of the Buffalo River with the Buffalo Ship Canal (Station 510 + 00) to the upstream project limit for the dredging program (Station 788 + 78).

The U.S. Army Corps of Engineers conducts periodic bathymetric surveys to determine the need for dredging in the river. If the survey indicates the need for dredging, the Corps will schedule to have the river dredged to predetermined depths. Formerly the Corps did much of the dredging itself, but now the Corps contracts the dredging with private companies. In order to determine the quantity dredged the Corps will conduct a bathymetric survey just before the dredging begins and again just after the completion of dredging. The two bathymetric surveys can then be used to compute the volume of sediment removed from the river.

The bathymetric survey data for the period 1976 through 1985 were obtained from the Buffalo District of the U.S. Army Corps of Engineers on magnetic tape and transferred to floppy disks for use on a microcomputer. A bathymetric survey may be for the entire river or only for selected reaches of the river. The Corps usually conducted precontract surveys to determine areas where sediment had accumulated to a depth that would require dredging. These precontract surveys are usually for much of the

river and are usually more nearly complete surveys. The surveys just before and just after the contract are often only for selected reaches of the river and can not be used to evaluate the entire record. Table 4.1 lists the type and date of the available surveys.

TABLE 4.1. Type and Date of Bathymetric Surveys

TYPE	DATE OF SURVEY
Precontract	Aug. 1976
After	Oct. 1976
Before	July-Aug. 1977
After	Oct. 1977
Precontract	June 1978
Before	Aug.-Sept. 1978
Precontract	Aug. 1979
After	Dec. 1979
Precontract	June 1980
Before	Aug.-Oct. 1980
After	Oct.-Nov. 1980
Precontract	May 1981
Before	Aug.-Sept. 1981
After	Nov. 1981
After	Dec. 1981
Precontract	June-July 1982
Before	Sept. 1982
After	Nov. 1982
Precontract	May-June 1983
Before	April-May 1984
After	June 1984
Precontract	May-June 1985
Before	July 1985
After	Aug.-Sept. 1985

Precontract = Bathymetric survey to determine need for dredging
Before = Bathymetric survey before dredging
After = Bathymetric survey after dredging

The bathymetric survey data for each station surveyed consists of a series of soundings of depth below low water datum at that station and the distance the depth soundings are from a baseline. The low water datum (LWD) is 568.6 feet above MSL. The baseline is periodically established by

topographic survey. The bathymetric surveys did not extend the full width of the river because they were made by boat and the boat could not go all the way to the bank. Therefore, the river width at each section was measured from plan drawings of the river prepared by the U.S. Army Corps of Engineers.

4.2. Analysis of Data

The bathymetric survey data were used to compute the total change in volume of deposited material in the river between any two surveys. This was done in a three step procedure. The first step was to compute the cross sectional area at each station in each survey. The trapezoidal rule was used to compute the cross sectional area at the station as the area below the low water datum. The change in cross sectional area between surveys was then computed. This was done by substracting the cross sectional area obtained from the latter survey from the cross sectional area obtained from the earlier survey. Finally the volume of change between stations was computed by the average end method. The total weight of the change in sediment was then computed using a specific gravity of 2.65 and a porosity of 0.6.

It was believed that most of the changes in volume of bed material occurred below the low water datum; that is where the dredging was performed and where most deposition occurs. The study was concerned with the changes in the quantity of bed material and not with the total cross sectional area below bank elevation. Therefore, the area below low water datum could be used in the computation procedure without introducing significant error.

4.3. Results

The computation for change in volume and change in weight of bed

material between various surveys was performed and the results are presented in Table 4.2. A negative change in volume indicates that the bed material was removed and a positive change in volume indicates that bed material was deposited in the river.

The computation does not have to be for consecutive surveys and not all surveys were pertinent to the study. For example the 1984 surveys after dredging were for dredging activities in the Buffalo River Entrance Channel only. Therefore, they were for an area outside of the reach of concern. Another example are the surveys of September 1982 and November 1982. They are for only a portion of the river as shown in Figure 4.1. Therefore, the results of the computations give results only for that selected reach of the river and cannot be used to generalize for the entire river. Also, if the computations are performed using surveys from each side of this period such as June 1982 and May 1983 then the results integrate the effects during the 1982 to 1983 period and include the dredging in only selected areas. Under these circumstances one must be careful when trying to draw conclusions for the entire river.

Several items in Table 4.2 need to be explained. "Activity", column 4, indicates whether there was dredging in the river during the period of time between the two surveys. A "D" indicates that the surveys were just before and just after dredging and, therefore, the results indicate only the dredging effects. A "d" indicates that there was dredging sometime between the surveys but that the surveys were not just before and just after the dredging and, therefore, the effects of deposition and erosion are included with the dredging effects. A blank indicates that only the natural deposition and erosion effects are indicated by the results.

"Length", column 5, provides an indication of the extent of the

TABLE 4.2. Change in Volume and Weight of Bed Material between Surveys

Survey Interval	Volume (cubic yards)	* Weight (tons)	** Activity	*** Reach	Figure Number
OCT. 1976 TO JULY 1977	-.34029E+06	-.30386E+06		Most	8.1
AUG. 1976 TO JULY 1977	-.43726E+06	-.39045E+06	d	Most	8.2
AUG. 1976 TO AUG. 1978	-.17275E+06	-.15426E+06	d	Most	8.3
AUG. 1976 TO JULY 1985	.97940E+05	.87455E+05	d	Most	8.4
AUG. 1976 TO MAY 1985	.41678E+05	.37216E+05	d	Most	8.5
AUG. 1976 TO OCT. 1976	-.11161E+06	-.99658E+05	D	Most	8.6
OCT. 1977 TO JUNE 1978	.48676E+06	.43465E+06		Partial	8.7
JULY 1977 TO OCT. 1977	-.92632E+05	-.82715E+05	D	Partial	8.8
JULY 1977 TO AUG. 1978	.27554E+06	.24604E+06	d	Most	8.9
JULY 1977 TO JUNE 1978	.51257E+06	.45770E+06	d	Most	8.10
AUG. 1978 TO AUG. 1979	.15263E+05	.13629E+05		Entire	8.11
JUNE 1978 TO AUG. 1979	-.21180E+06	-.18913E+06		Entire	8.12
JUNE 1978 TO AUG. 1978	-.23064E+06	-.20595E+06		Entire	8.13
DEC. 1979 TO JUNE 1980	.15624E+05	.13951E+05		Partial	8.14
AUG. 1979 TO AUG. 1980	.30229E+05	.26992E+05	d	Entire	8.15
AUG. 1979 TO JUNE 1980	-.10413E+05	-.92987E+04	d	Most	8.16
AUG. 1979 TO DEC. 1979	-.44568E+05	-.39796E+05	D	Partial	8.17
OCT. 1980 TO MAY 1981	.25321E+05	.22611E+05		Most	8.18
AUG. 1980 TO OCT. 1980	-.75688E+05	-.67585E+05	D	Most	8.19
AUG. 1980 TO AUG. 1981	-.72900E+05	-.65096E+05	d	Entire	8.20
JUNE 1980 TO MAY 1981	-.81772E+04	-.73018E+04	d	Most	8.21
JUNE 1980 TO AUG. 1980	.40642E+05	.36291E+05		Most	8.22
AUG. 1981 TO JUNE 1982	.11359E+06	.10143E+06	d	Entire	8.23
AUG. 1981 TO NOV. 1981	.16300E+04	.14555E+04	D	Partial	8.24
AUG. 1981 TO DEC. 1981	.38809E+05	.34655E+05	d	Partial	8.25
AUG. 1981 TO SEPT 1982	.54695E+05	.48839E+05	d	Partial	8.26
MAY 1981 TO JUNE 1982	.85178E+05	.76059E+05	d	Entire	8.27
MAY 1981 TO MAY 1983	-.78307E+05	-.69924E+05	d	Most	8.28
MAY 1981 TO AUG. 1981	-.30375E+05	-.27123E+05		Most	8.29
NOV. 1982 TO MAY 1983	-.18598E+05	-.16607E+05		Most	8.30
SEPT 1982 TO NOV. 1982	-.49614E+05	-.44303E+05	D	Partial	4.1
JUNE 1982 TO MAY 1983	-.16788E+06	-.14991E+06	d	Most	8.31
JUNE 1982 TO SEPT 1982	-.13047E+05	-.11651E+05		Partial	8.32
MAY 1983 TO APR. 1984	.97092E+05	.86698E+05		Most	8.33
MAY 1983 TO MAY 1985	.31296E+06	.27946E+06		Most	4.2
APR. 1984 TO MAY 1985	.21349E+06	.19064E+06		Entire	8.34
JULY 1985 TO SEPT 1985	-.58352E+05	-.52105E+05	D	Entire	8.35
MAY 1985 TO SEPT 1985	.95804E+03	.85548E+03	d	Entire	8.36
MAY 1985 TO JULY 1985	.56027E+05	.50029E+05		Entire	8.37

* Computed with porosity of 0.6 and specific gravity of 2.65

** D = period in which dredging was performed in Buffalo River
d = period that overlapped a dredging period

*** Entire = entire reach of concern of Buffalo River included
Most = only a few stations missing
Partial = only part of reach included

surveys. "Entire" indicates that the survey included the entire reach of concern. There may have been one or two stations not included, but the data from the beginning and ending surveys could be used to estimate the effects over the entire reach. "Most" indicates that most of the stations were included in both surveys but there were two or more breaks in the survey data and one must be less confident in using the results to estimate effects over the entire reach. Figure 4.2 presents an example of surveys of this extent. There are two gaps between station 510 and 550. The gaps are usually of this magnitude for this classification. "Partial" indicates that only a part or parts of the reach are included in one or both surveys. Sometimes the extent of the survey may be more or less that as indicated in Figure 4.1.

The survey data from May 1983 through May 1985 are summarized in Table 4.3. This period had no dredging operation and was chosen for further

TABLE 4.3. Summary of 1983-1985 survey data

Period between surveys	Change in volume (cu yd)	Sediment Inflow (tons)	Trap Efficiency (percent)
May 1983 - April 1984	97,092	237,036	36
April 1984 - May 1985	213,490	813,764	23

analysis to determine the behavior of the river. The river appears to behave as expected for a meandering stream. Thus without dredging the predominate behavior appears to be one of deposition of bed material. The change in average bed elevation along the river over this period is shown in Figure 4.2. The large amount deposited in the stream during the period April 1984 through May 1985 included most of water year 1985 which had the

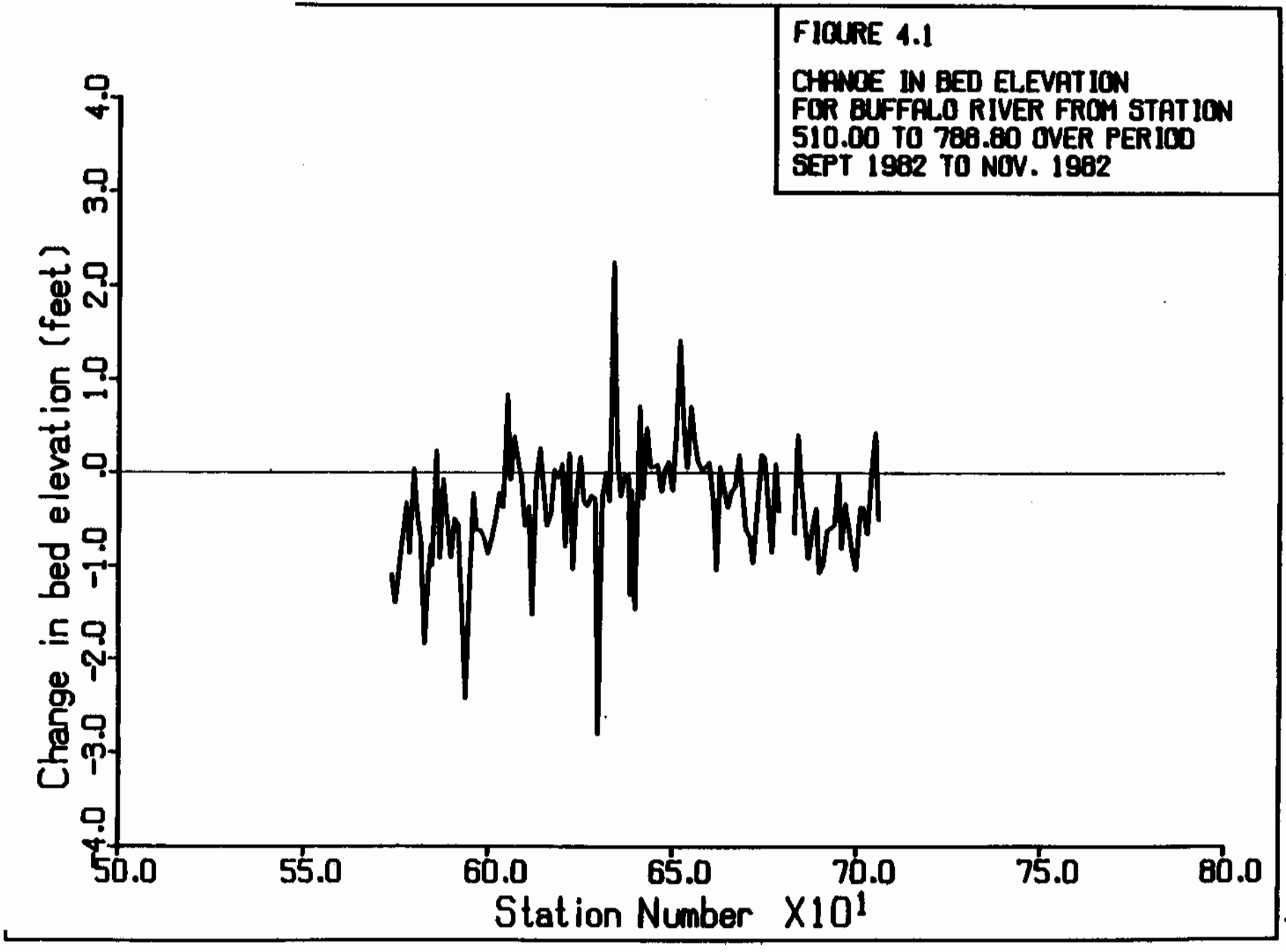
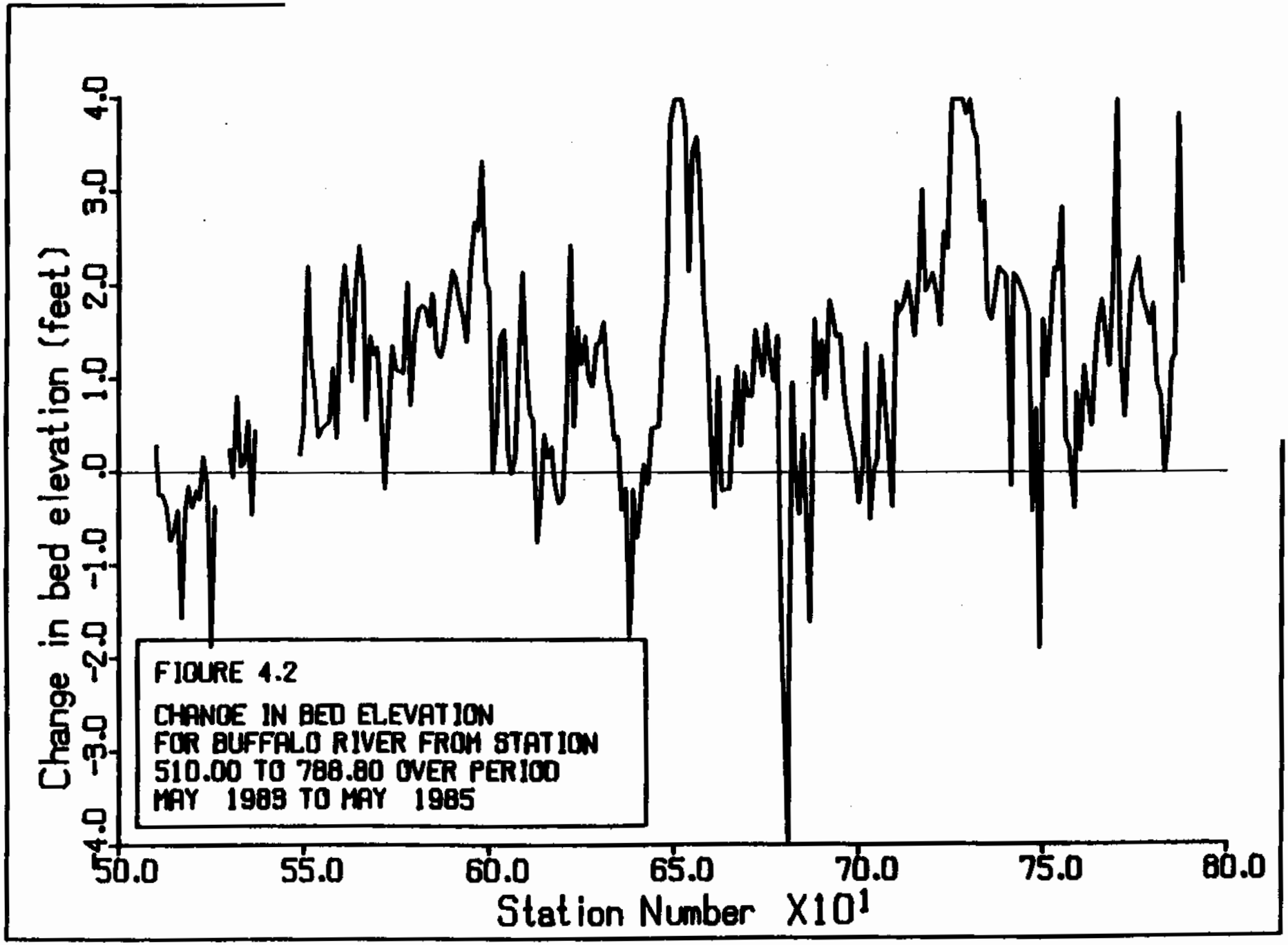


FIGURE 4.1
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
SEPT 1982 TO NOV. 1982
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹


Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹
FIGURE 4.2
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
MAY 1983 TO MAY 1985

largest volume of annual runoff and the second largest volume of annual sediment production for the period 1940 through 1985. The part of water year 1985 that wasn't included was low flow months of June, July, August and September. The amount of streamflow during the 1983 to 1984 portion was equivalent to the mean annual flow.

5. SEDIMENT TRANSPORT IN BUFFALO RIVER

The fate of sediments introduced into the navigable portion of the Buffalo River from the upstream drainage basin depends on several factors. These include:

(1) the capacity of river flows to transport incoming sediment loads,

(2) the selective deposition of suspended materials from the sediment loads carried by the river flows,

(3) the scour, resuspension, and transport of river sediments during periods of high discharge, and

(4) the physical characteristics of the sediment materials, including particle size distributions, and whether cohesive or noncohesive in nature.

5.1 Sediment particle size distribution

The U. S. Army Corps of Engineers, Buffalo District, provided information on the particle size distributions for samples taken from the bottom sediments of the Buffalo River. A summary of sample location, water depth, and date taken is presented in Table 5.1. Particle size distributions are presented in Tables 5.2 and 5.3.

Sample No. 12 was analyzed using an HIAC Model 7200 particle size analyzer, which essentially counts particles in the size range 0.005 mm to 0.25 mm. Since the actual fraction of material smaller than 0.005 mm is unknown for sample No. 12, the particle size distribution can only be inferred. Approximately 65 percent of the sample was found to be comprised of particle sizes between .015 mm and .035 mm. This finding is somewhat inconsistent with the trend established by the other 11 samples. For later purposes, the size distribution found for sample No. 11 was combined with the sieve analysis findings for sample No. 12 to produce a

TABLE 5.1 Sediment Samples from Buffalo River

Sample No	Location	Water Depth	Date Sampled
1	Station 787+00, 30' R	18'-19'	8/12/81
2	Station 782+00, 20' R	18'-19'	8/12/81
3	Station 765+50, 20' R	17'-19'	8/12/81
4	Station 740+00, 20' L	14'-16'	8/12/81
5	Station 729+00, 40' L	19'-21'	8/12/81
6	Above Conrail Bridge, 30' R	20'-21'	8/12/81
7	Station 669+00, 30' R	19'-21'	8/12/81
8	Superior Turning Basin, 30' L	17'-19'	8/12/81
9	Station 593+00, 20' R	19'-21'	8/12/81
10	Station 569+00, 20' L	16'-18'	8/12/81
11	Station 564+00, 30' L	19'-21	8/12/81
12	Station 524+00, North Side		11/14/85

synthesized particle size distribution for sample No. 12.

5.2 HEC-6 simulation program

A simulation program prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, was utilized to obtain a first-order understanding of the sediment dynamics in the Buffalo River. The program, HEC-6 (version 2.7), was designed to analyze scour and deposition by modeling the interaction between the water-sediment mixture, the sediment material forming the stream's boundary, and the hydraulics of river flows.

Upon review of the requirements for input data needed to operate the model, it was determined that sufficient data were available for the Buffalo River system. Both the inflow hydrographs and associated sediment loads were available, as discussed in Sections 2 and 3. Particle size distributions for the sediment material forming the river's boundary could be approximated using the data given in Tables 5.2 and 5.3. The particle size distribution for the incoming sediment load from the upstream drainage

TABLE 5.2. Particle Size Distributions by Sieve Analysis for Buffalo River Sediment Samples

SPECIFIC GRAVITY (ASTM D-854-58)

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12
Specific Gravity	2.64	2.65	2.66	2.80	2.69	2.62	2.68	2.70	2.68	2.68	2.70	-

PERCENT FINER BY WEIGHT (ASTM D-421-58)

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12
Sieve: 1/2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-
#4	100%	100%	100%	100%	95.1%	100%	98.5%	100%	98.6%	100%	100%	-
#10	100%	100%	100%	99.9%	94.2%	99.8%	97.9%	99.9%	96.9%	99.9%	99.9%	-
#20	99.6%	99.5%	99.8%	97.2%	93.2%	99.1%	96.8%	99.9%	96.0%	99.5%	99.8%	-
#40	98.4%	98.5%	99.6%	92.1%	92.2%	98.3%	95.4%	99.6%	95.2%	99.0%	99.5%	97.7%
#100	73.8%	84.6%	98.2%	79.4%	88.7%	90.7%	91.6%	98.5%	91.6%	96.7%	98.1%	95.8%
#200	54.3%	68.7%	86.9%	66.6%	78.2%	74.4%	83.8%	93.3%	83.8%	90.5%	93.6%	93.0%
#400	-	-	-	-	-	-	-	-	-	-	-	88.3%

TABLE 5.3 Particle Size Distributions from Hydrometer Analysis for Buffalo River Sediment Samples

HYDROMETER ASTM D422-63

Sample No. 1

Percent Passing	Particle Diameter(mm)
40.7%	.0428
34.9%	.0309
28.5%	.0199
23.7%	.0143
16.6%	.0084
12.8%	.0060
9.4%	.0043
5.1%	.0013

Sample No. 2

Percent Passing	Particle Diameter(mm)
57.4%	.0425
52.5%	.0306
46.1%	.0198
39.7%	.0143
30.0%	.0085
23.6%	.0062
20.3%	.0044
9.7%	.0013

Sample No. 3

Percent Passing	Particle Diameter(mm)
66.5%	.0393
57.5%	.0288
46.6%	.0190
37.7%	.0138
28.1%	.0084
19.3%	.0056
7.3%	.0013

Sample No. 4

Percent Passing	Particle Diameter(mm)
51.1%	.0454
44.2%	.0327
36.0%	.0211
29.9%	.0151
21.7%	.0089
16.3%	.0064
5.3%	.0013

Sample No. 5

Percent Passing	Particle Diameter(mm)
62.2%	.0394
56.2%	.0286
47.2%	.0188
38.2%	.0137
26.3%	.0081
20.3%	.0059
14.6%	.0042
6.2%	.0013

Sample No. 6

Percent Passing	Particle Diameter(mm)
59.3%	.0400
52.8%	.0290
44.8%	.0189
38.3%	.0136
25.4%	.0072
22.2%	.0058
17.5%	.0042
8.4%	.0013

Table 5.3 (Continued)

Sample No. 7

Percent Passing	Particle Diameter(mm)
66.8%	.0384
61.9%	.0279
54.1%	.0182
36.9%	.0090
33.8%	.0079
27.0%	.0057
20.0%	.0042
8.1%	.0013

Sample No. 8

Percent Passing	Particle Diameter(mm)
77.4%	.0387
71.1%	.0282
61.6%	.0185
52.0%	.0136
37/1%	.0183
29.7%	.0060
23.3%	.0044
11.1%	.0013

Sample No. 9

Percent Passing	Particle Diameter(mm)
72.2%	.0394
66.0%	.0287
56.8%	.0189
47.5%	.0138
35.1%	.0084
27.3%	.0061
21.1%	.0044
8.7%	.0013

Sample No. 10

Percent Passing	Particle Diameter(mm)
76.7%	.0389
71.3%	.0282
61.8%	.0186
50.6%	.0131
39.4%	.0083
31.4%	.0060
25.0%	.0043
12.1%	.0013

Sample No. 11

Percent Passing	Particle Diameter(mm)
82.0%	.0381
75.6%	.0277
67.1%	.0182
59.8%	.0133
45.5%	.0081
35.9%	.0059
28.0%	.0043
12.0%	.0013

basin was assigned using the bed size distribution from Station 564+00 (Sample No. 11). It was felt that this sample would be most representative of the washload brought in by the upstream flows.

River cross sections were provided by the Buffalo District, U.S. Army Corps of Engineers (see Section 4 and Figure 1.2). The Buffalo District also provided results of a flood frequency study for the Buffalo River using a backwater curve simulation program developed by The Hydrologic Engineering Center. The resistance coefficient of n = 0.03 used in that flood study was also utilized in the present investigation.

In order to employ the HEC-6 simulation program, the inflow hydrograph was discretized into a histogram approximation. The time step for each composite bar of the histogram can vary. The hydraulic backwater curve is calculated for each discretized inflow utilizing the steady-state version of the governing equations.

During the time period over which the inflow is maintained constant, sediment dynamics computations are carried out for shorter time intervals. In the present case, 10 iterations were carried out on sediment transport and exchange with the river bed during the time step for which the river flow was assumed constant. During these iterations, computations are carried out which allow for sedimentation of suspended particles, transport of suspended sediment, and erosion of sand-size particles from the river bed. No provision is made for scour of silts and clays from the river bed. The program accounts for the available size fractions in the bed, thus permitting hydraulic sorting and bed armoring to take place. A more complete description of the program can be found in "Scour and Deposition in Rivers and Reservoirs: Users Manual for HEC-6," Report 732-G2-L2470, Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

5.3. Applications of HEC-6

In all of the applications made of the HEC-6 simulation program, the downstream water elevation in Buffalo harbor was specified at IGLD 571.6 feet. This elevation was selected because it represents a compromise between the long-term lake levels and the recent higher levels experienced during the past few years. The following applications of the HEC-6 simulation program were made.

1. Scouring in Buffalo River. The scour and transport of river bed materials were studied using the HEC-6 program for the special case of zero incoming sediment load. A series of test cases were run with this stipulation for river flows varying from 2,000 CFS to 20,000 CFS. These hypothetical flow conditions were carried out at two water temperatures (34 degrees Fahrenheit and 55 degrees Fahrenheit) to examine the sensitivity of scour to water temperature.

2. Trap-Efficiency of the Buffalo River. The trap efficiency of the Buffalo River system was studied by conducting a series of test runs for which the water discharge varied from 250 CFS to 20,000 CFS. The sediment load associated with each river discharge was based on the findings from Section 3. The effect of water temperature was again studied by carrying out the above computations with water temperatures of 34 degrees Fahrenheit and 55 degrees Fahrenheit.

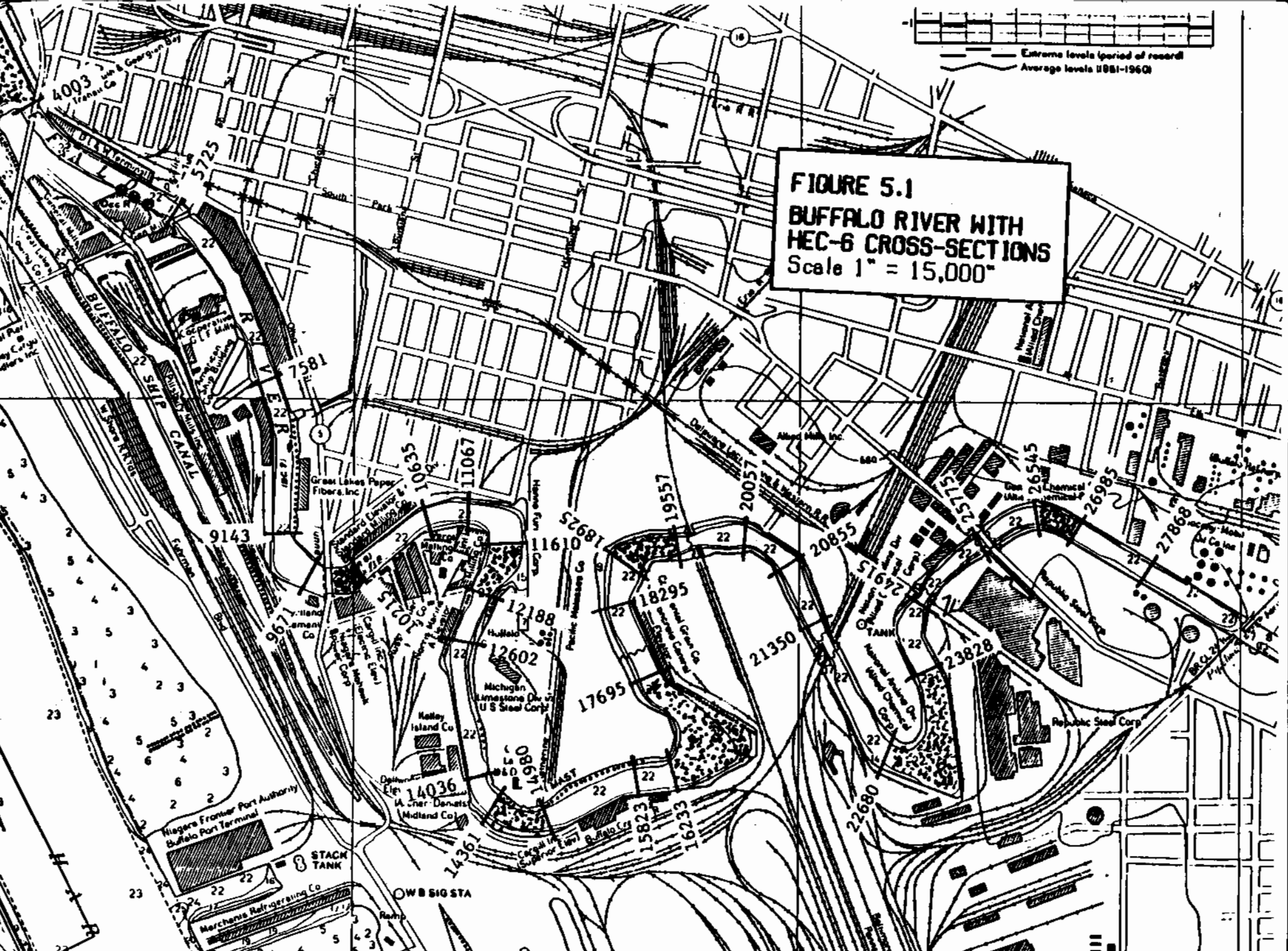
3. Sediment Dynamics in Buffalo River, May 1, 1983 to April 30, 1985. The period May 1, 1983 to May 1, 1985 was selected because no dredging activity occurred in the Buffalo River during this time period. Survey cross-sections were available near the beginning and ending of this time period; thus, this time period presented the best opportunity for comparison of computer output with observed conditions in the river system.

The actual inflow hydrograph for this period was simulated along with the estimated sediment load associated with each discharge. The water temperature was varied seasonally in accordance with USGS records for Buffalo Creek at Gardenville, New York.

As stated earlier, the decision to apply the HEC-6 simulation program in this study was based on the opinion that the findings would provide a first-order understanding of sediment dynamics in the Buffalo River system. The HEC-6 simulation program has limitations that result from simplifying assumptions and incomplete understanding of the physics of such natural systems. The most unfortunate limitation in the present case is the inability of HEC-6 to provide for scour of particle sizes in the silt and clay range. However, it is not uncommon for materials in this size range to exhibit cohesive properties. The literature strongly suggests that such cohesive sediments may require tractive stresses equal to or greater than those for noncohesive materials in a greater size range. Thus, the results for scour of sands may provide a good indication of scour in the Buffalo River system as a function of river discharge. Finally, no account has been made for ice in these analyses.

5.4. Scouring in Buffalo River

The Buffalo River section numbers used in the HEC-6 computations are shown in Figure 5.1. The corresponding Corps of Engineers survey stations are shown in Figure 1.2. The sections used in the present study are identical to those selected by the Corps of Engineers in their flood-frequency studies of the Buffalo River. In the present application of HEC-6, the backwater computations were terminated at Section No. 27868 (or Station No. 778+83), approximately 1,000 feet downstream of the Conrail Bridge, which represents the upstream limit of the federal project.


Extreme levels (period of record)
Average levels (1951-1960)
FIGURE 5.1
BUFFALO RIVER WITH
HEC-6 CROSS-SECTIONS
Scale 1" = 15,000'
4093
5725
7581
9143
9671
10635
10944
11067
11610
12188
12602
14036
14361
17695
18295
18925
19557
20057
20855
21350
22680
23828
26545
26985
27868
BUFFALO RIVER
SHIP CANAL
Great Lakes Paper Fibers, Inc
Republic Steel Corp
Niagara Frontier Port Authority
Buffalo Port Terminal
STACK TANK
Merchants Refrigerating Co
Kelley Island Co
Michigan Limestone Div of U S Steel Corp
Midland Co
Ramp
WB SIG STA

The results of the scouring computational test runs are presented in Tables 5.4 to 5.22. Each table presents the results for a specific river discharge, beginning with Q = 2,000 cfs and ending with Q = 20,000 cfs. All of the presented results are for a water temperature equal to 55 degrees Fahrenheit. For each discharge, the sediment scouring computations were carried out for five consecutive days. Only the results for the fifth day are presented. The results for days one through four are similar. The test runs with water temperature at 34 degrees Fahrenheit showed a slightly higher amount of scouring due to the increase in water viscosity. However, there were no significant qualitative differences between the results for water temperatures of 34 degrees Fahrenheit and 55 degrees Fahrenheit.

It can be seen that sand scouring begins at Section No. 27868 at a discharge of Q = 6,000 cfs. An estimate of the average bed shear stress at this section for Q = 6,000 cfs can be obtained from the HEC-6 results using the computed hydraulic radius and energy grade line at that section. The estimate gives a shear stress value of 0.024 pounds per square foot, which agrees well with reported critical tractive shear stresses for sand.

At higher discharges, there is a progressive increase in the number of sections undergoing scouring of sand. At the highest discharge of Q = 20,000 cfs, a significant amount of sand is being removed from the river bed and transported to the Buffalo harbor area downstream of Section No. 4003 (on the order of 7,000 tons per day).

A careful study of the scour-deposition patterns in the river system at intermediate discharges (6,000 cfs $\leq$ Q $\leq$ 20,000 cfs) reveals the sections where scouring is greatest and the sections where deposition

TABLE 5.4. SCOUR FLOW TEST WITH FLOW 2,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 2000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.57	0.00	0.00	0.65	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.00	571.58	550.00	2000.	0.	0.	0.
26985.000	0.00	571.58	545.80	2000.	0.	0.	0.
26545.000	0.00	571.58	544.30	2000.	0.	0.	0.
25775.000	0.00	571.58	545.10	2000.	0.	0.	0.
24915.000	0.00	571.58	542.00	2000.	0.	0.	0.
23828.000	0.00	571.58	545.10	2000.	0.	0.	0.
22680.000	0.00	571.58	543.50	2000.	0.	0.	0.
21350.000	0.00	571.57	542.90	2000.	0.	0.	0.
20855.000	0.00	571.57	542.70	2000.	0.	0.	0.
20057.000	0.00	571.57	544.60	2000.	0.	0.	0.
19557.000	0.00	571.57	540.70	2000.	0.	0.	0.
18925.000	0.00	571.57	541.50	2000.	0.	0.	0.
18295.000	0.00	571.57	540.70	2000.	0.	0.	0.
17695.000	0.00	571.57	543.80	2000.	0.	0.	0.
16233.000	0.00	571.57	539.40	2000.	0.	0.	0.
15823.000	0.00	571.57	544.80	2000.	0.	0.	0.
14980.000	0.00	571.57	543.00	2000.	0.	0.	0.
14361.000	0.00	571.57	541.50	2000.	0.	0.	0.
14036.000	0.00	571.57	543.60	2000.	0.	0.	0.
12602.000	0.00	571.57	544.80	2000.	0.	0.	0.
12188.000	0.00	571.57	545.60	2000.	0.	0.	0.
11610.000	0.00	571.57	543.50	2000.	0.	0.	0.
11067.000	0.00	571.57	543.50	2000.	0.	0.	0.
10635.000	0.00	571.57	542.70	2000.	0.	0.	0.
10215.000	0.00	571.57	542.30	2000.	0.	0.	0.
9671.000	0.00	571.57	542.50	2000.	0.	0.	0.
9148.000	0.00	571.56	542.40	2000.	0.	0.	0.
7581.000	0.00	571.56	542.10	2000.	0.	0.	0.
5725.000	0.00	571.56	541.30	2000.	0.	0.	0.
4003.000	0.00	571.56	541.40	2000.	0.	0.	0.
3458.000	0.00	571.56	543.00	2000.	0.	0.	0.
2817.000	0.00	571.56	543.00	2000.	0.	0.	0.
1729.000	0.00	571.56	541.10	2000.	0.	0.	0.
1022.000	0.00	571.56	542.20	2000.	0.	0.	0.
418.000	0.00	571.56	542.60	2000.	0.	0.	0.
0.000	0.00	571.56	542.70	2000.	0.	0.	0.

TABLE 5.5. SCOUR FLOW TEST WITH FLOW 3,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 3000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP E
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.43	0.00	0.00	0.79	0.00	0.00	1.

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.00	571.60	550.00	3000.	0.	0.	0.
26985.000	0.00	571.60	545.80	3000.	0.	0.	0.
26545.000	0.00	571.60	544.30	3000.	0.	0.	0.
25775.000	0.00	571.60	545.10	3000.	0.	0.	0.
24915.000	0.00	571.60	542.00	3000.	0.	0.	0.
23828.000	0.00	571.60	545.10	3000.	0.	0.	0.
22680.000	0.00	571.59	543.50	3000.	0.	0.	0.
21350.000	0.00	571.59	542.90	3000.	0.	0.	0.
20855.000	0.00	571.59	542.70	3000.	0.	0.	0.
20057.000	0.00	571.59	544.60	3000.	0.	0.	0.
19557.000	0.00	571.59	540.70	3000.	0.	0.	0.
18925.000	0.00	571.59	541.50	3000.	0.	0.	0.
18295.000	0.00	571.59	540.70	3000.	0.	0.	0.
17695.000	0.00	571.59	543.80	3000.	0.	0.	0.
16233.000	0.00	571.59	539.40	3000.	0.	0.	0.
15823.000	0.00	571.58	544.80	3000.	0.	0.	0.
14980.000	0.00	571.58	543.00	3000.	0.	0.	0.
14361.000	0.00	571.58	541.50	3000.	0.	0.	0.
14036.000	0.00	571.58	543.60	3000.	0.	0.	0.
12602.000	0.00	571.58	544.80	3000.	0.	0.	0.
12188.000	0.00	571.58	545.60	3000.	0.	0.	0.
11610.000	0.00	571.58	543.50	3000.	0.	0.	0.
11067.000	0.00	571.58	543.50	3000.	0.	0.	0.
10635.000	0.00	571.57	542.70	3000.	0.	0.	0.
10215.000	0.00	571.57	542.30	3000.	0.	0.	0.
9671.000	0.00	571.57	542.50	3000.	0.	0.	0.
9148.000	0.00	571.57	542.40	3000.	0.	0.	0.
7581.000	0.00	571.57	542.10	3000.	0.	0.	0.
5725.000	0.00	571.56	541.30	3000.	0.	0.	0.
4003.000	0.00	571.56	541.40	3000.	0.	0.	0.
3458.000	0.00	571.56	543.00	3000.	0.	0.	0.
2817.000	0.00	571.56	543.00	3000.	0.	0.	0.
1729.000	0.00	571.56	541.10	3000.	0.	0.	0.
1022.000	0.00	571.56	542.20	3000.	0.	0.	0.
418.000	0.00	571.56	542.60	3000.	0.	0.	0.
0.000	0.00	571.56	542.70	3000.	0.	0.	0.

TABLE 5.6. SCOUR FLOW TEST WITH FLOW 4,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 4000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.34	0.00	0.00	0.74	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.00	571.64	550.00	4000.	0.	0.	0.
26985.000	0.00	571.64	545.80	4000.	0.	0.	0.
26545.000	0.00	571.64	544.30	4000.	0.	0.	0.
25775.000	0.00	571.63	545.10	4000.	0.	0.	0.
24915.000	0.00	571.62	542.00	4000.	0.	0.	0.
23828.000	0.00	571.62	545.10	4000.	0.	0.	0.
22680.000	0.00	571.62	543.50	4000.	0.	0.	0.
21350.000	0.00	571.62	542.90	4000.	0.	0.	0.
20855.000	0.00	571.62	542.70	4000.	0.	0.	0.
20057.000	0.00	571.61	544.60	4000.	0.	0.	0.
19557.000	0.00	571.61	540.70	4000.	0.	0.	0.
18925.000	0.00	571.61	541.50	4000.	0.	0.	0.
18295.000	0.00	571.61	540.70	4000.	0.	0.	0.
17695.000	0.00	571.61	543.80	4000.	0.	0.	0.
16233.000	0.00	571.61	539.40	4000.	0.	0.	0.
15823.000	0.00	571.60	544.80	4000.	0.	0.	0.
14980.000	0.00	571.60	543.00	4000.	0.	0.	0.
14361.000	0.00	571.60	541.50	4000.	0.	0.	0.
14036.000	0.00	571.60	543.60	4000.	0.	0.	0.
12602.000	0.00	571.59	544.80	4000.	0.	0.	0.
12188.000	0.00	571.59	545.60	4000.	0.	0.	0.
11610.000	0.00	571.59	543.50	4000.	0.	0.	0.
11067.000	0.00	571.59	543.50	4000.	0.	0.	0.
10635.000	0.00	571.59	542.70	4000.	0.	0.	0.
10215.000	0.00	571.58	542.30	4000.	0.	0.	0.
9671.000	0.00	571.59	542.50	4000.	0.	0.	0.
9148.000	0.00	571.58	542.40	4000.	0.	0.	0.
7581.000	0.00	571.57	542.10	4000.	0.	0.	0.
5725.000	0.00	571.57	541.30	4000.	0.	0.	0.
4003.000	0.00	571.56	541.40	4000.	0.	0.	0.
3458.000	0.00	571.56	543.00	4000.	0.	0.	0.
2817.000	0.00	571.56	543.00	4000.	0.	0.	0.
1729.000	0.00	571.56	541.10	4000.	0.	0.	0.
1022.000	0.00	571.56	542.20	4000.	0.	0.	0.
418.000	0.00	571.56	542.60	4000.	0.	0.	0.
0.000	0.00	571.56	542.70	4000.	0.	0.	0.

TABLE 5.7. SCOUR FLOW TEST WITH FLOW 5,000 CFS .

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 5000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.28	0.00	0.00	0.69	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.00	571.68	550.00	5000.	0.	0.	0.
26985.000	0.00	571.68	545.80	5000.	0.	0.	0.
26545.000	0.00	571.68	544.30	5000.	0.	0.	0.
25775.000	0.00	571.66	545.10	5000.	0.	0.	0.
24915.000	0.00	571.66	542.00	5000.	0.	0.	0.
23828.000	0.00	571.66	545.10	5000.	0.	0.	0.
22680.000	0.00	571.66	543.50	5000.	0.	0.	0.
21350.000	0.00	571.65	542.90	5000.	0.	0.	0.
20855.000	0.00	571.65	542.70	5000.	0.	0.	0.
20057.000	0.00	571.65	544.60	5000.	0.	0.	0.
19557.000	0.00	571.64	540.70	5000.	0.	0.	0.
18925.000	0.00	571.64	541.50	5000.	0.	0.	0.
18295.000	0.00	571.64	540.70	5000.	0.	0.	0.
17695.000	0.00	571.63	543.80	5000.	0.	0.	0.
16233.000	0.00	571.63	539.40	5000.	0.	0.	0.
15823.000	0.00	571.63	544.80	5000.	0.	0.	0.
14980.000	0.00	571.62	543.00	5000.	0.	0.	0.
14361.000	0.00	571.62	541.50	5000.	0.	0.	0.
14036.000	0.00	571.62	543.60	5000.	0.	0.	0.
12602.000	0.00	571.61	544.80	5000.	0.	0.	0.
12188.000	0.00	571.61	545.60	5000.	0.	0.	0.
11610.000	0.00	571.61	543.50	5000.	0.	0.	0.
11067.000	0.00	571.61	543.50	5000.	0.	0.	0.
10635.000	0.00	571.60	542.70	5000.	0.	0.	0.
10215.000	0.00	571.60	542.30	5000.	0.	0.	0.
9671.000	0.00	571.60	542.50	5000.	0.	0.	0.
9148.000	0.00	571.59	542.40	5000.	0.	0.	0.
7581.000	0.00	571.58	542.10	5000.	0.	0.	0.
5725.000	0.00	571.57	541.30	5000.	0.	0.	0.
4003.000	0.00	571.56	541.40	5000.	0.	0.	0.
3458.000	0.00	571.57	543.00	5000.	0.	0.	0.
2817.000	0.00	571.57	543.00	5000.	0.	0.	0.
1729.000	0.00	571.56	541.10	5000.	0.	0.	0.
1022.000	0.00	571.56	542.20	5000.	0.	0.	0.
418.000	0.00	571.56	542.60	5000.	0.	0.	0.
0.000	0.00	571.56	542.70	5000.	0.	0.	0.

TABLE 5.8. SCOUR FLOW TEST WITH FLOW 6,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 6000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.22	0.00	0.00	0.64	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-0.02	571.73	549.98	6000.	0.	0.	9.
26985.000	0.01	571.73	545.81	6000.	0.	0.	0.
26545.000	0.00	571.73	544.30	6000.	0.	0.	0.
25775.000	0.00	571.71	545.10	6000.	0.	0.	0.
24915.000	0.00	571.71	542.00	6000.	0.	0.	0.
23828.000	0.00	571.70	545.10	6000.	0.	0.	0.
22680.000	0.00	571.70	543.50	6000.	0.	0.	0.
21350.000	0.00	571.69	542.90	6000.	0.	0.	0.
20855.000	0.00	571.69	542.70	6000.	0.	0.	0.
20057.000	0.00	571.68	544.60	6000.	0.	0.	0.
19557.000	0.00	571.68	540.70	6000.	0.	0.	0.
18925.000	0.00	571.68	541.50	6000.	0.	0.	0.
18295.000	0.00	571.67	540.70	6000.	0.	0.	0.
17695.000	0.00	571.67	543.80	6000.	0.	0.	0.
16233.000	0.00	571.67	539.40	6000.	0.	0.	0.
15823.000	0.00	571.65	544.80	6000.	0.	0.	0.
14980.000	0.00	571.65	543.00	6000.	0.	0.	0.
14361.000	0.00	571.65	541.50	6000.	0.	0.	0.
14036.000	0.00	571.64	543.60	6000.	0.	0.	0.
12602.000	0.00	571.63	544.80	6000.	0.	0.	0.
12188.000	0.00	571.63	545.60	6000.	0.	0.	0.
11610.000	0.00	571.63	543.50	6000.	0.	0.	0.
11067.000	0.00	571.63	543.50	6000.	0.	0.	0.
10635.000	0.00	571.62	542.70	6000.	0.	0.	0.
10215.000	0.00	571.61	542.30	6000.	0.	0.	0.
9671.000	0.00	571.62	542.50	6000.	0.	0.	0.
9148.000	0.00	571.60	542.40	6000.	0.	0.	0.
7581.000	0.00	571.58	542.10	6000.	0.	0.	0.
5725.000	0.00	571.57	541.30	6000.	0.	0.	0.
4003.000	0.00	571.56	541.40	6000.	0.	0.	0.
3458.000	0.00	571.57	543.00	6000.	0.	0.	0.
2817.000	0.00	571.57	543.00	6000.	0.	0.	0.
1729.000	0.00	571.56	541.10	6000.	0.	0.	0.
1022.000	0.00	571.56	542.20	6000.	0.	0.	0.
418.000	0.00	571.56	542.60	6000.	0.	0.	0.
0.000	0.00	571.56	542.70	6000.	0.	0.	0.

TABLE 5.9. SCOUR FLOW TEST WITH FLOW 7,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 7000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.17	0.00	0.00	0.58	0.00	0.00	1.(

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-0.09	571.79	549.91	7000.	0.	0.	23.
26985.000	0.05	571.79	545.85	7000.	0.	0.	0.
26545.000	0.00	571.80	544.30	7000.	0.	0.	0.
25775.000	-0.04	571.76	545.06	7000.	0.	0.	56.
24915.000	0.03	571.76	542.03	7000.	0.	0.	0.
23828.000	0.00	571.75	545.10	7000.	0.	0.	0.
22680.000	0.00	571.75	543.50	7000.	0.	0.	0.
21350.000	0.00	571.74	542.90	7000.	0.	0.	0.
20855.000	0.00	571.73	542.70	7000.	0.	0.	0.
20057.000	0.00	571.73	544.60	7000.	0.	0.	0.
19557.000	0.00	571.72	540.70	7000.	0.	0.	0.
18925.000	0.00	571.72	541.50	7000.	0.	0.	0.
18295.000	0.00	571.71	540.70	7000.	0.	0.	0.
17695.000	0.00	571.71	543.80	7000.	0.	0.	0.
16233.000	0.00	571.70	539.40	7000.	0.	0.	0.
15823.000	0.00	571.69	544.80	7000.	0.	0.	0.
14980.000	0.00	571.69	543.00	7000.	0.	0.	0.
14361.000	0.00	571.69	541.50	7000.	0.	0.	0.
14036.000	0.00	571.67	543.60	7000.	0.	0.	0.
12602.000	0.00	571.66	544.80	7000.	0.	0.	0.
12188.000	0.00	571.66	545.60	7000.	0.	0.	0.
11610.000	0.00	571.66	543.50	7000.	0.	0.	0.
11067.000	0.00	571.65	543.50	7000.	0.	0.	0.
10635.000	0.00	571.64	542.70	7000.	0.	0.	0.
10215.000	0.00	571.63	542.30	7000.	0.	0.	0.
9671.000	0.00	571.64	542.50	7000.	0.	0.	0.
9148.000	0.00	571.61	542.40	7000.	0.	0.	0.
7581.000	0.00	571.59	542.10	7000.	0.	0.	0.
5725.000	0.00	571.58	541.30	7000.	0.	0.	0.
4003.000	0.00	571.56	541.40	7000.	0.	0.	0.
3458.000	0.00	571.57	543.00	7000.	0.	0.	0.
2817.000	0.00	571.57	543.00	7000.	0.	0.	0.
1729.000	0.00	571.56	541.10	7000.	0.	0.	0.
1022.000	0.00	571.56	542.20	7000.	0.	0.	0.
418.000	0.00	571.56	542.60	7000.	0.	0.	0.
0.000	0.00	571.56	542.70	7000.	0.	0.	0.

TABLE 5.10. SCOUR FLOW TEST WITH FLOW 8,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 8000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.12	0.00	0.00	0.48	0.00	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-0.28	571.86	549.72	8000.	0.	0.	72.
26985.000	0.15	571.86	545.95	8000.	0.	0.	0.
26545.000	0.00	571.87	544.30	8000.	0.	0.	0.
25775.000	-0.25	571.82	544.85	8000.	0.	0.	333.
24915.000	0.22	571.82	542.22	8000.	0.	0.	0.
23828.000	0.00	571.81	545.10	8000.	0.	0.	0.
22680.000	0.00	571.80	543.50	8000.	0.	0.	0.
21350.000	0.00	571.79	542.90	8000.	0.	0.	0.
20855.000	0.00	571.79	542.70	8000.	0.	0.	0.
20057.000	0.00	571.78	544.60	8000.	0.	0.	0.
19557.000	0.00	571.77	540.70	8000.	0.	0.	0.
18925.000	0.00	571.77	541.50	8000.	0.	0.	0.
18295.000	0.00	571.76	540.70	8000.	0.	0.	0.
17695.000	0.00	571.75	543.80	8000.	0.	0.	0.
16233.000	0.00	571.75	539.40	8000.	0.	0.	0.
15823.000	0.00	571.73	544.80	8000.	0.	0.	0.
14980.000	0.00	571.72	543.00	8000.	0.	0.	0.
14361.000	0.00	571.72	541.50	8000.	0.	0.	0.
14036.000	0.00	571.70	543.60	8000.	0.	0.	0.
12602.000	0.00	571.69	544.80	8000.	0.	0.	0.
12188.000	0.00	571.69	545.60	8000.	0.	0.	0.
11610.000	0.00	571.69	543.50	8000.	0.	0.	0.
11067.000	0.00	571.68	543.50	8000.	0.	0.	0.
10635.000	0.00	571.66	542.70	8000.	0.	0.	0.
10215.000	0.00	571.66	542.30	8000.	0.	0.	0.
9671.000	0.00	571.66	542.50	8000.	0.	0.	0.
9148.000	0.00	571.63	542.40	8000.	0.	0.	0.
7581.000	0.00	571.60	542.10	8000.	0.	0.	0.
5725.000	0.00	571.58	541.30	8000.	0.	0.	0.
4003.000	0.00	571.56	541.40	8000.	0.	0.	0.
3458.000	0.00	571.57	543.00	8000.	0.	0.	0.
2817.000	0.00	571.58	543.00	8000.	0.	0.	0.
1729.000	0.00	571.56	541.10	8000.	0.	0.	0.
1022.000	0.00	571.55	542.20	8000.	0.	0.	0.
418.000	0.00	571.56	542.60	8000.	0.	0.	0.
0.000	0.00	571.56	542.70	8000.	0.	0.	0.

TABLE 5.11. SCOUR FLOW TEST WITH FLOW 9,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 9000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY		CLAY			SILT			SAND		
DAYS	POINT	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.05	0.00	0.00	0.31	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-0.44	571.94	549.56	9000.	0.	0.	92.
26985.000	0.05	571.94	545.85	9000.	0.	0.	197.
26545.000	0.17	571.95	544.47	9000.	0.	0.	0.
25775.000	-0.59	571.89	544.51	9000.	0.	0.	710.
24915.000	0.37	571.88	542.37	9000.	0.	0.	297.
23828.000	0.09	571.88	545.19	9000.	0.	0.	0.
22680.000	0.00	571.87	543.50	9000.	0.	0.	0.
21350.000	0.00	571.85	542.90	9000.	0.	0.	0.
20855.000	0.00	571.85	542.70	9000.	0.	0.	0.
20057.000	0.00	571.83	544.60	9000.	0.	0.	0.
19557.000	0.00	571.83	540.70	9000.	0.	0.	0.
18925.000	0.00	571.83	541.50	9000.	0.	0.	0.
18295.000	0.00	571.81	540.70	9000.	0.	0.	0.
17695.000	0.00	571.80	543.80	9000.	0.	0.	0.
16233.000	0.00	571.80	539.40	9000.	0.	0.	0.
15823.000	0.00	571.77	544.30	9000.	0.	0.	0.
14980.000	0.00	571.77	543.00	9000.	0.	0.	0.
14361.000	0.00	571.77	541.50	9000.	0.	0.	0.
14036.000	0.00	571.74	543.60	9000.	0.	0.	0.
12602.000	0.00	571.72	544.80	9000.	0.	0.	0.
12188.000	0.00	571.72	545.60	9000.	0.	0.	0.
11610.000	0.00	571.73	543.50	9000.	0.	0.	0.
11067.000	0.00	571.71	543.50	9000.	0.	0.	0.
10635.000	0.00	571.69	542.70	9000.	0.	0.	0.
10215.000	0.00	571.68	542.30	9000.	0.	0.	0.
9671.000	0.00	571.69	542.50	9000.	0.	0.	0.
9148.000	-0.06	571.64	542.34	9000.	0.	0.	84.
7581.000	-0.01	571.61	542.09	9000.	0.	0.	103.
5725.000	0.03	571.59	541.33	9000.	0.	0.	0.
4003.000	-0.01	571.55	541.39	9000.	0.	0.	13.
3458.000	0.01	571.58	543.01	9000.	0.	0.	0.
2817.000	0.00	571.58	543.00	9000.	0.	0.	0.
1729.000	0.00	571.56	541.10	9000.	0.	0.	0.
1022.000	0.00	571.55	542.20	9000.	0.	0.	0.
418.000	0.00	571.56	542.60	9000.	0.	0.	0.
0.000	0.00	571.56	542.70	9000.	0.	0.	0.

TABLE 5.12. SCOUR FLOW TEST WITH FLOW 10,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 10000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.03	0.00	0.00	0.21	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-0.76	572.03	549.24	10000.	0.	0.	149.
26985.000	0.08	572.03	545.88	10000.	0.	0.	133.
26545.000	0.29	572.03	544.59	10000.	0.	0.	0.
25775.000	-0.94	571.97	544.16	10000.	0.	0.	658.
24915.000	0.31	571.96	542.31	10000.	0.	0.	920.
23828.000	0.22	571.95	545.32	10000.	0.	0.	292.
22680.000	0.08	571.94	543.58	10000.	0.	0.	0.
21350.000	0.00	571.92	542.90	10000.	0.	0.	0.
20855.000	0.00	571.91	542.70	10000.	0.	0.	0.
20057.000	0.00	571.90	544.60	10000.	0.	0.	0.
19557.000	0.00	571.89	540.70	10000.	0.	0.	0.
18925.000	0.00	571.89	541.50	10000.	0.	0.	0.
18295.000	0.00	571.87	540.70	10000.	0.	0.	0.
17695.000	0.00	571.85	543.80	10000.	0.	0.	0.
16233.000	0.00	571.85	539.40	10000.	0.	0.	0.
15823.000	0.00	571.82	544.80	10000.	0.	0.	0.
14980.000	0.00	571.81	543.00	10000.	0.	0.	0.
14361.000	0.00	571.81	541.50	10000.	0.	0.	0.
14036.000	-0.02	571.78	543.58	10000.	0.	0.	36.
12602.000	-0.01	571.76	544.79	10000.	0.	0.	60.
12188.000	0.05	571.76	545.65	10000.	0.	0.	0.
11610.000	0.00	571.76	543.50	10000.	0.	0.	0.
11067.000	0.00	571.74	543.50	10000.	0.	0.	0.
10635.000	-0.03	571.72	542.67	10000.	0.	0.	16.
10215.000	-0.04	571.71	542.26	10000.	0.	0.	33.
9671.000	0.04	571.72	542.54	10000.	0.	0.	0.
9148.000	-0.21	571.66	542.19	10000.	0.	0.	284.
7581.000	-0.03	571.63	542.07	10000.	0.	0.	411.
5725.000	0.07	571.60	541.37	10000.	0.	0.	219.
4003.000	-0.01	571.55	541.39	10000.	0.	0.	216.
3458.000	0.10	571.58	543.10	10000.	0.	0.	0.
2817.000	0.00	571.58	543.00	10000.	0.	0.	0.
1729.000	0.00	571.56	541.10	10000.	0.	0.	0.
1022.000	0.00	571.55	542.20	10000.	0.	0.	0.
418.000	0.00	571.56	542.60	10000.	0.	0.	0.
0.000	0.00	571.56	542.70	10000.	0.	0.	0.

TABLE 5.13. SCOUR FLOW TEST WITH FLOW 11,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 11000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.02	0.00	0.00	0.14	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-1.56	572.13	548.44	11000.	0.	0.	135.
26985.000	0.05	572.12	545.85	11000.	0.	0.	372.
26545.000	0.49	572.12	544.79	11000.	0.	0.	500.
25775.000	-0.99	572.05	544.11	11000.	0.	0.	568.
24915.000	0.04	572.04	542.04	11000.	0.	0.	1658.
23828.000	0.35	572.03	545.45	11000.	0.	0.	932.
22680.000	0.25	572.01	543.75	11000.	0.	0.	0.
21350.000	-0.02	571.99	542.88	11000.	0.	0.	46.
20855.000	0.03	571.98	542.73	11000.	0.	0.	0.
20057.000	0.00	571.97	544.60	11000.	0.	0.	0.
19557.000	-0.05	571.95	540.65	11000.	0.	0.	54.
18925.000	0.03	571.96	541.53	11000.	0.	0.	0.
18295.000	0.00	571.94	540.70	11000.	0.	0.	0.
17695.000	-0.02	571.91	543.78	11000.	0.	0.	20.
16233.000	0.02	571.91	539.42	11000.	0.	0.	0.
15823.000	-0.08	571.87	544.72	11000.	0.	0.	102.
14980.000	0.06	571.86	543.06	11000.	0.	0.	0.
14361.000	0.00	571.87	541.50	11000.	0.	0.	0.
14036.000	-0.16	571.83	543.44	11000.	0.	0.	258.
12602.000	-0.05	571.80	544.75	11000.	0.	0.	376.
12188.000	0.27	571.80	545.87	11000.	0.	0.	62.
11610.000	0.02	571.81	543.52	11000.	0.	0.	0.
11067.000	0.00	571.78	543.50	11000.	0.	0.	0.
10635.000	-0.06	571.75	542.64	11000.	0.	0.	2.
10215.000	-0.07	571.74	542.23	11000.	0.	0.	8.
9671.000	0.08	571.75	542.58	11000.	0.	0.	0.
9148.000	-0.36	571.69	542.04	11000.	0.	0.	266.
7581.000	-0.13	571.64	541.97	11000.	0.	0.	843.
5725.000	0.09	571.60	541.39	11000.	0.	0.	676.
4003.000	-0.04	571.55	541.36	11000.	0.	0.	698.
3458.000	0.32	571.59	543.32	11000.	0.	0.	0.
2817.000	0.00	571.59	543.00	11000.	0.	0.	0.
1729.000	0.00	571.56	541.10	11000.	0.	0.	0.
1022.000	0.00	571.55	542.20	11000.	0.	0.	0.
418.000	0.00	571.55	542.60	11000.	0.	0.	0.
0.000	0.00	571.56	542.70	11000.	0.	0.	0.

TABLE 5.14. SCOUR FLOW TEST WITH FLOW 12,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 12000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY		CLAY			SILT			SAND		
DAYS	POINT	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.01	0.00	0.00	0.10	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-1.78	572.23	548.22	12000.	0.	0.	233.
26985.000	0.02	572.22	545.82	12000.	0.	0.	185.
26545.000	0.21	572.23	544.51	12000.	0.	0.	1049.
25775.000	-1.02	572.14	544.08	12000.	0.	0.	1172.
24915.000	-0.27	572.13	541.73	12000.	0.	0.	2567.
23828.000	0.45	572.11	545.55	12000.	0.	0.	2005.
22680.000	0.50	572.09	544.00	12000.	0.	0.	258.
21350.000	-0.03	572.06	542.87	12000.	0.	0.	234.
20855.000	0.06	572.06	542.76	12000.	0.	0.	155.
20057.000	-0.03	572.04	544.57	12000.	0.	0.	176.
19557.000	-0.06	572.02	540.64	12000.	0.	0.	229.
18925.000	0.13	572.03	541.63	12000.	0.	0.	0.
18295.000	-0.06	572.00	540.64	12000.	0.	0.	71.
17695.000	-0.03	571.98	543.77	12000.	0.	0.	86.
16233.000	0.05	571.97	539.45	12000.	0.	0.	0.
15823.000	-0.26	571.93	544.54	12000.	0.	0.	296.
14980.000	0.13	571.92	543.13	12000.	0.	0.	149.
14361.000	0.09	571.92	541.59	12000.	0.	0.	0.
14036.000	-0.34	571.88	543.26	12000.	0.	0.	450.
12602.000	-0.15	571.84	544.65	12000.	0.	0.	839.
12188.000	0.33	571.84	545.93	12000.	0.	0.	560.
11610.000	0.28	571.85	543.78	12000.	0.	0.	0.
11067.000	-0.03	571.82	543.47	12000.	0.	0.	25.
10635.000	-0.07	571.79	542.63	12000.	0.	0.	28.
10215.000	-0.08	571.77	542.22	12000.	0.	0.	30.
9671.000	0.13	571.79	542.63	12000.	0.	0.	0.
9148.000	-0.39	571.71	542.01	12000.	0.	0.	24.
7581.000	-0.32	571.66	541.78	12000.	0.	0.	906.
5725.000	0.03	571.61	541.33	12000.	0.	0.	1382.
4003.000	-0.03	571.55	541.37	12000.	0.	0.	1416.
3458.000	0.65	571.59	543.65	12000.	0.	0.	0.
2817.000	0.00	571.59	543.00	12000.	0.	0.	0.
1729.000	0.00	571.56	541.10	12000.	0.	0.	0.
1022.000	0.00	571.55	542.20	12000.	0.	0.	0.
418.000	0.00	571.55	542.60	12000.	0.	0.	0.
0.000	0.00	571.56	542.70	12000.	0.	0.	0.

TABLE 5.15. SCOUR FLOW TEST WITH FLOW 13,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 13000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	1.

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-2.02	572.34	547.98	13000.	0.	0.	379.
26985.000	-0.03	572.33	545.77	13000.	0.	0.	174.
26545.000	-0.14	572.33	544.16	13000.	0.	0.	1513.
25775.000	-1.07	572.23	544.03	13000.	0.	0.	1703.
24915.000	-0.61	572.22	541.39	13000.	0.	0.	3201.
23828.000	0.49	572.20	545.59	13000.	0.	0.	3348.
22680.000	0.78	572.18	544.28	13000.	0.	0.	911.
21350.000	0.01	572.15	542.91	13000.	0.	0.	679.
20855.000	0.08	572.14	542.78	13000.	0.	0.	531.
20057.000	-0.01	572.12	544.59	13000.	0.	0.	496.
19557.000	-0.07	572.10	540.63	13000.	0.	0.	529.
18925.000	0.29	572.11	541.79	13000.	0.	0.	0.
18295.000	-0.12	572.07	540.58	13000.	0.	0.	110.
17695.000	-0.05	572.04	543.75	13000.	0.	0.	141.
16233.000	0.10	572.04	539.50	13000.	0.	0.	0.
15823.000	-0.42	571.99	544.38	13000.	0.	0.	280.
14980.000	0.04	571.98	543.04	13000.	0.	0.	508.
14361.000	0.33	571.98	541.83	13000.	0.	0.	0.
14036.000	-0.45	571.93	543.15	13000.	0.	0.	205.
12602.000	-0.35	571.89	544.45	13000.	0.	0.	1037.
12188.000	0.26	571.89	545.86	13000.	0.	0.	1257.
11610.000	0.69	571.90	544.19	13000.	0.	0.	0.
11067.000	-0.06	571.86	543.44	13000.	0.	0.	4.
10635.000	-0.09	571.83	542.61	13000.	0.	0.	6.
10215.000	-0.10	571.81	542.20	13000.	0.	0.	8.
9671.000	0.12	571.82	542.62	13000.	0.	0.	92.
9148.000	-0.41	571.73	541.99	13000.	0.	0.	121.
7581.000	-0.39	571.68	541.71	13000.	0.	0.	344.
5725.000	-0.17	571.62	541.13	13000.	0.	0.	1876.
4003.000	-0.10	571.55	541.30	13000.	0.	0.	2209.
3458.000	1.10	571.60	544.10	13000.	0.	0.	0.
2817.000	0.00	571.60	543.00	13000.	0.	0.	0.
1729.000	0.00	571.55	541.10	13000.	0.	0.	0.
1022.000	0.00	571.55	542.20	13000.	0.	0.	0.
418.000	0.00	571.55	542.60	13000.	0.	0.	0.
0.000	0.00	571.56	542.70	13000.	0.	0.	0.

TABLE 5.16. SCOUR FLOW TEST WITH FLOW 14,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 14000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP E
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	1.

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-2.31	572.45	547.69	14000.	0.	0.	500.
26985.000	-0.22	572.44	545.58	14000.	0.	0.	285.
26545.000	-0.41	572.45	543.89	14000.	0.	0.	1718.
25775.000	-1.10	572.33	544.00	14000.	0.	0.	1738.
24915.000	-0.82	572.32	541.18	14000.	0.	0.	2874.
23828.000	0.52	572.30	545.62	14000.	0.	0.	3005.
22680.000	0.94	572.27	544.44	14000.	0.	0.	1979.
21350.000	0.08	572.23	542.98	14000.	0.	0.	1489.
20855.000	0.12	572.22	542.82	14000.	0.	0.	1168.
20057.000	0.02	572.20	544.62	14000.	0.	0.	1036.
19557.000	-0.09	572.18	540.61	14000.	0.	0.	1030.
18925.000	0.53	572.19	542.03	14000.	0.	0.	0.
18295.000	-0.18	572.15	540.52	14000.	0.	0.	136.
17695.000	-0.07	572.12	543.73	14000.	0.	0.	159.
16233.000	0.14	572.11	539.54	14000.	0.	0.	0.
15823.000	-0.46	572.05	544.34	14000.	0.	0.	24.
14980.000	-0.21	572.04	542.79	14000.	0.	0.	813.
14361.000	0.54	572.04	542.04	14000.	0.	0.	274.
14036.000	-0.44	571.99	543.16	14000.	0.	0.	258.
12602.000	-0.44	571.94	544.36	14000.	0.	0.	460.
12188.000	-0.14	571.94	545.46	14000.	0.	0.	1723.
11610.000	1.20	571.95	544.70	14000.	0.	0.	0.
11067.000	-0.06	571.91	543.44	14000.	0.	0.	2.
10635.000	-0.12	571.87	542.58	14000.	0.	0.	2.
10215.000	-0.15	571.85	542.15	14000.	0.	0.	13.
9671.000	-0.11	571.86	542.39	14000.	0.	0.	274.
9148.000	-0.44	571.76	541.96	14000.	0.	0.	375.
7581.000	-0.39	571.69	541.71	14000.	0.	0.	436.
5725.000	-0.32	571.63	540.98	14000.	0.	0.	1592.
4003.000	-0.20	571.55	541.20	14000.	0.	0.	2197.
3458.000	1.59	571.60	544.59	14000.	0.	0.	0.
2817.000	0.00	571.61	543.00	14000.	0.	0.	0.
1729.000	0.00	571.55	541.10	14000.	0.	0.	0.
1022.000	0.00	571.54	542.20	14000.	0.	0.	0.
418.000	0.00	571.55	542.60	14000.	0.	0.	0.
0.000	0.00	571.56	542.70	14000.	0.	0.	0.

TABLE 5.17. SCOUR FLOW TEST WITH FLOW 15,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 15000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	@ CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-2.59	572.57	547.41	15000.	0.	0.	466.
26985.000	-0.75	572.56	545.05	15000.	0.	0.	434.
26545.000	-0.62	572.57	543.68	15000.	0.	0.	2319.
25775.000	-1.10	572.43	544.00	15000.	0.	0.	2443.
24915.000	-0.89	572.42	541.11	15000.	0.	0.	3059.
23828.000	0.54	572.40	545.64	15000.	0.	0.	3224.
22680.000	1.02	572.37	544.52	15000.	0.	0.	3338.
21350.000	0.17	572.33	543.07	15000.	0.	0.	2705.
20855.000	0.20	572.31	542.90	15000.	0.	0.	2148.
20057.000	0.07	572.29	544.67	15000.	0.	0.	1873.
19557.000	-0.08	572.27	540.62	15000.	0.	0.	1801.
18925.000	0.73	572.27	542.23	15000.	0.	0.	498.
18295.000	-0.20	572.23	540.50	15000.	0.	0.	528.
17695.000	-0.08	572.19	543.72	15000.	0.	0.	532.
16233.000	0.25	572.19	539.65	15000.	0.	0.	0.
15823.000	-0.46	572.12	544.34	15000.	0.	0.	0.
14980.000	-0.42	572.11	542.58	15000.	0.	0.	613.
14361.000	0.41	572.11	541.91	15000.	0.	0.	867.
14036.000	-0.44	572.05	543.16	15000.	0.	0.	890.
12602.000	-0.44	571.99	544.36	15000.	0.	0.	896.
12188.000	-0.36	571.99	545.24	15000.	0.	0.	1549.
11610.000	1.55	572.00	545.05	15000.	0.	0.	552.
11067.000	-0.06	571.96	543.44	15000.	0.	0.	511.
10635.000	-0.11	571.91	542.59	15000.	0.	0.	513.
10215.000	-0.13	571.89	542.17	15000.	0.	0.	550.
9671.000	-0.17	571.91	542.33	15000.	0.	0.	521.
9148.000	-0.48	571.79	541.92	15000.	0.	0.	656.
7581.000	-0.40	571.71	541.70	15000.	0.	0.	749.
5725.000	-0.35	571.64	540.95	15000.	0.	0.	822.
4003.000	-0.27	571.55	541.13	15000.	0.	0.	1115.
3458.000	1.87	571.61	544.87	15000.	0.	0.	0.
2817.000	0.00	571.61	543.00	15000.	0.	0.	0.
1729.000	-0.01	571.55	541.09	15000.	0.	0.	19.
1022.000	-0.01	571.54	542.19	15000.	0.	0.	37.
418.000	0.02	571.55	542.62	15000.	0.	0.	0.
0.000	0.00	571.56	542.70	15000.	0.	0.	0.

TABLE 5.18. SCOUR FLOW TEST WITH FLOW 16,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 16000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY POINT		CLAY			SILT			SAND		
DAYS		INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-2.70	572.70	547.30	16000.	0.	0.	75.
26985.000	-1.08	572.69	544.72	16000.	0.	0.	552.
26545.000	-0.68	572.70	543.62	16000.	0.	0.	1039.
25775.000	-1.13	572.55	543.97	16000.	0.	0.	1044.
24915.000	-1.00	572.54	541.00	16000.	0.	0.	1639.
23828.000	0.54	572.52	545.64	16000.	0.	0.	1879.
22680.000	0.95	572.47	544.45	16000.	0.	0.	3308.
21350.000	0.13	572.43	543.03	16000.	0.	0.	4131.
20855.000	0.30	572.41	543.00	16000.	0.	0.	3543.
20057.000	0.12	572.38	544.72	16000.	0.	0.	3079.
19557.000	-0.09	572.36	540.61	16000.	0.	0.	2946.
18925.000	0.92	572.37	542.42	16000.	0.	0.	1296.
18295.000	-0.16	572.32	540.54	16000.	0.	0.	1205.
17695.000	-0.10	572.28	543.70	16000.	0.	0.	1208.
16233.000	0.44	572.27	539.84	16000.	0.	0.	71.
15823.000	-0.47	572.20	544.33	16000.	0.	0.	87.
14980.000	-0.44	572.18	542.56	16000.	0.	0.	88.
14361.000	0.03	572.18	541.53	16000.	0.	0.	1183.
14036.000	-0.47	572.11	543.13	16000.	0.	0.	1316.
12602.000	-0.45	572.05	544.35	16000.	0.	0.	1405.
12188.000	-0.34	572.05	545.26	16000.	0.	0.	1386.
11610.000	1.52	572.06	545.02	16000.	0.	0.	1440.
11067.000	-0.05	572.01	543.45	16000.	0.	0.	1418.
10635.000	-0.12	571.96	542.58	16000.	0.	0.	1440.
10215.000	-0.18	571.93	542.12	16000.	0.	0.	1512.
9671.000	-0.15	571.95	542.35	16000.	0.	0.	1324.
9148.000	-0.51	571.82	541.89	16000.	0.	0.	1460.
7581.000	-0.42	571.73	541.68	16000.	0.	0.	1695.
5725.000	-0.33	571.65	540.97	16000.	0.	0.	1586.
4003.000	-0.29	571.55	541.11	16000.	0.	0.	1668.
3458.000	2.24	571.61	545.24	16000.	0.	0.	0.
2817.000	0.00	571.62	543.00	16000.	0.	0.	0.
1729.000	-0.02	571.55	541.08	16000.	0.	0.	17.
1022.000	-0.02	571.54	542.18	16000.	0.	0.	35.
418.000	0.04	571.55	542.64	16000.	0.	0.	0.
0.000	0.00	571.56	542.70	16000.	0.	0.	0.

TABLE 5.19. SCOUR FLOW TEST WITH FLOW 17,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 17000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-2.72	572.83	547.28	17000.	0.	0.	15.
26985.000	-1.29	572.83	544.51	17000.	0.	0.	702.
26545.000	-0.55	572.84	543.75	17000.	0.	0.	228.
25775.000	-1.13	572.66	543.97	17000.	0.	0.	244.
24915.000	-1.08	572.65	540.92	17000.	0.	0.	644.
23828.000	0.45	572.63	545.55	17000.	0.	0.	910.
22680.000	0.91	572.58	544.41	17000.	0.	0.	978.
21350.000	-0.09	572.53	542.81	17000.	0.	0.	3437.
20855.000	0.17	572.52	542.87	17000.	0.	0.	4685.
20057.000	0.13	572.48	544.73	17000.	0.	0.	4701.
19557.000	-0.10	572.46	540.60	17000.	0.	0.	4573.
18925.000	1.15	572.47	542.65	17000.	0.	0.	2467.
18295.000	-0.14	572.42	540.56	17000.	0.	0.	2300.
17695.000	-0.18	572.37	543.62	17000.	0.	0.	2237.
16233.000	0.59	572.36	539.99	17000.	0.	0.	846.
15823.000	-0.49	572.27	544.31	17000.	0.	0.	911.
14980.000	-0.39	572.26	542.61	17000.	0.	0.	804.
14361.000	-0.18	572.26	541.32	17000.	0.	0.	1795.
14036.000	-0.51	572.18	543.09	17000.	0.	0.	1966.
12602.000	-0.46	572.11	544.34	17000.	0.	0.	2108.
12188.000	-0.30	572.11	545.30	17000.	0.	0.	2041.
11610.000	1.44	572.12	544.94	17000.	0.	0.	2476.
11067.000	-0.05	572.07	543.45	17000.	0.	0.	2516.
10635.000	-0.17	572.01	542.53	17000.	0.	0.	2569.
10215.000	-0.23	571.98	542.07	17000.	0.	0.	2668.
9671.000	-0.08	572.00	542.42	17000.	0.	0.	2485.
9148.000	-0.49	571.85	541.91	17000.	0.	0.	2488.
7581.000	-0.47	571.75	541.63	17000.	0.	0.	2859.
5725.000	-0.32	571.67	540.98	17000.	0.	0.	2860.
4003.000	-0.30	571.55	541.10	17000.	0.	0.	2905.
3458.000	2.67	571.62	545.67	17000.	0.	0.	625.
2817.000	0.04	571.63	543.04	17000.	0.	0.	0.
1729.000	-0.13	571.55	540.97	17000.	0.	0.	258.
1022.000	-0.03	571.54	542.17	17000.	0.	0.	300.
418.000	0.16	571.55	542.76	17000.	0.	0.	0.
0.000	0.00	571.56	542.70	17000.	0.	0.	0.

TABLE 5.20. SCOUR FLOW TEST WITH FLOW 18,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 18000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	ENTRY POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-2.74	572.97	547.26	18000.	0.	0.	33.
26985.000	-1.53	572.97	544.27	18000.	0.	0.	952.
26545.000	-0.41	572.97	543.89	18000.	0.	0.	287.
25775.000	-1.13	572.78	543.97	18000.	0.	0.	329.
24915.000	-1.10	572.77	540.90	18000.	0.	0.	509.
23828.000	-0.16	572.75	544.94	18000.	0.	0.	1022.
22680.000	0.90	572.70	544.40	18000.	0.	0.	1601.
21350.000	-0.17	572.64	542.73	18000.	0.	0.	5709.
20855.000	0.25	572.63	542.95	18000.	0.	0.	7139.
20057.000	0.22	572.59	544.82	18000.	0.	0.	6966.
19557.000	-0.11	572.56	540.59	18000.	0.	0.	6635.
18925.000	1.39	572.57	542.89	18000.	0.	0.	4117.
18295.000	-0.12	572.51	540.58	18000.	0.	0.	3886.
17695.000	-0.19	572.46	543.61	18000.	0.	0.	3782.
16233.000	0.72	572.45	540.12	18000.	0.	0.	1894.
15823.000	-0.52	572.36	544.28	18000.	0.	0.	1985.
14980.000	-0.36	572.34	542.64	18000.	0.	0.	1892.
14361.000	-0.24	572.34	541.26	18000.	0.	0.	2317.
14036.000	-0.53	572.25	543.07	18000.	0.	0.	2437.
12602.000	-0.50	572.18	544.30	18000.	0.	0.	2671.
12188.000	-0.29	572.18	545.31	18000.	0.	0.	2651.
11610.000	1.29	572.19	544.79	18000.	0.	0.	3695.
11067.000	-0.06	572.13	543.44	18000.	0.	0.	3772.
10635.000	-0.22	572.06	542.48	18000.	0.	0.	3859.
10215.000	-0.28	572.03	542.02	18000.	0.	0.	3994.
9671.000	-0.04	572.06	542.46	18000.	0.	0.	3922.
9148.000	-0.47	571.89	541.93	18000.	0.	0.	3924.
7581.000	-0.51	571.78	541.59	18000.	0.	0.	4242.
5725.000	-0.36	571.68	540.94	18000.	0.	0.	4675.
4003.000	-0.31	571.55	541.09	18000.	0.	0.	4745.
3458.000	2.93	571.62	545.93	18000.	0.	0.	2342.
2817.000	0.24	571.64	543.24	18000.	0.	0.	0.
1729.000	-0.19	571.55	540.91	18000.	0.	0.	277.
1022.000	-0.14	571.53	542.06	18000.	0.	0.	544.
418.000	0.30	571.55	542.90	18000.	0.	0.	0.
0.000	0.00	571.56	542.70	18000.	0.	0.	0.

TABLE 5.21. SCOUR FLOW TEST WITH FLOW 19,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 19000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-2.76	573.11	547.24	19000.	0.	0.	45.
26985.000	-1.81	573.11	543.99	19000.	0.	0.	1205.
26545.000	-0.29	573.12	544.01	19000.	0.	0.	560.
25775.000	-1.14	572.91	543.96	19000.	0.	0.	581.
24915.000	-1.09	572.89	540.91	19000.	0.	0.	581.
23828.000	-0.53	572.88	544.57	19000.	0.	0.	1936.
22680.000	0.76	572.82	544.26	19000.	0.	0.	2616.
21350.000	-0.34	572.76	542.56	19000.	0.	0.	8049.
20855.000	0.24	572.74	542.94	19000.	0.	0.	9353.
20057.000	0.32	572.69	544.92	19000.	0.	0.	9100.
19557.000	-0.18	572.66	540.52	19000.	0.	0.	8476.
18925.000	1.55	572.67	543.05	19000.	0.	0.	6154.
18295.000	-0.12	572.61	540.58	19000.	0.	0.	5948.
17695.000	-0.19	572.55	543.61	19000.	0.	0.	5804.
16233.000	0.88	572.54	540.28	19000.	0.	0.	3343.
15823.000	-0.55	572.44	544.25	19000.	0.	0.	3470.
14980.000	-0.36	572.42	542.64	19000.	0.	0.	3465.
14361.000	-0.16	572.42	541.34	19000.	0.	0.	3234.
14036.000	-0.52	572.32	543.08	19000.	0.	0.	3296.
12602.000	-0.51	572.24	544.29	19000.	0.	0.	3306.
12188.000	-0.33	572.24	545.27	19000.	0.	0.	3418.
11610.000	1.06	572.26	544.56	19000.	0.	0.	4932.
11067.000	-0.09	572.19	543.41	19000.	0.	0.	5057.
10635.000	-0.27	572.11	542.43	19000.	0.	0.	5185.
10215.000	-0.59	572.08	541.71	19000.	0.	0.	5363.
9671.000	0.01	572.11	542.51	19000.	0.	0.	5417.
9148.000	-0.45	571.92	541.95	19000.	0.	0.	5449.
7581.000	-0.52	571.80	541.58	19000.	0.	0.	5467.
5725.000	-0.44	571.69	540.86	19000.	0.	0.	6205.
4003.000	-0.35	571.54	541.05	19000.	0.	0.	6434.
3458.000	3.20	571.63	546.20	19000.	0.	0.	4267.
2817.000	0.55	571.65	543.55	19000.	0.	0.	0.
1729.000	-0.22	571.55	540.88	19000.	0.	0.	205.
1022.000	-0.20	571.53	542.00	19000.	0.	0.	480.
418.000	0.39	571.54	542.99	19000.	0.	0.	0.
0.000	0.00	571.56	542.70	19000.	0.	0.	0.

TABLE 5.22. SCOUR FLOW TEST WITH FLOW 20,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 20000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.00			0.00			0.00		
TOTAL=	0.000	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-2.78	573.25	547.22	20000.	0.	0.	36.
26985.000	-2.10	573.26	543.70	20000.	0.	0.	1385.
26545.000	-0.22	573.26	544.08	20000.	0.	0.	935.
25775.000	-1.13	573.03	543.97	20000.	0.	0.	942.
24915.000	-1.09	573.02	540.91	20000.	0.	0.	927.
23828.000	-0.87	573.00	544.23	20000.	0.	0.	2572.
22680.000	0.76	572.94	544.26	20000.	0.	0.	3154.
21350.000	-0.63	572.88	542.27	20000.	0.	0.	8746.
20855.000	0.15	572.85	542.85	20000.	0.	0.	11131.
20057.000	0.27	572.81	544.87	20000.	0.	0.	11354.
19557.000	-0.26	572.78	540.44	20000.	0.	0.	10782.
18925.000	1.69	572.78	543.19	20000.	0.	0.	8596.
18295.000	-0.10	572.72	540.60	20000.	0.	0.	8022.
17695.000	-0.22	572.65	543.58	20000.	0.	0.	7857.
16233.000	1.02	572.64	540.42	20000.	0.	0.	5307.
15823.000	-0.55	572.53	544.25	20000.	0.	0.	5320.
14980.000	-0.40	572.51	542.60	20000.	0.	0.	5449.
14361.000	-0.03	572.51	541.47	20000.	0.	0.	4891.
14036.000	-0.50	572.40	543.10	20000.	0.	0.	4888.
12602.000	-0.50	572.31	544.30	20000.	0.	0.	4943.
12188.000	-0.44	572.31	545.16	20000.	0.	0.	5353.
11610.000	0.97	572.33	544.47	20000.	0.	0.	6201.
11067.000	-0.12	572.25	543.38	20000.	0.	0.	6344.
10635.000	-0.69	572.18	542.01	20000.	0.	0.	6625.
10215.000	-0.74	572.14	541.56	20000.	0.	0.	6889.
9671.000	-0.01	572.17	542.49	20000.	0.	0.	7099.
9148.000	-0.52	571.96	541.88	20000.	0.	0.	7116.
7581.000	-0.46	571.83	541.64	20000.	0.	0.	7180.
5725.000	-0.48	571.71	540.82	20000.	0.	0.	7587.
4003.000	-0.36	571.54	541.04	20000.	0.	0.	7961.
3458.000	3.43	571.64	546.43	20000.	0.	0.	6416.
2817.000	0.93	571.65	543.93	20000.	0.	0.	0.
1729.000	-0.24	571.55	540.86	20000.	0.	0.	98.
1022.000	-0.23	571.53	541.97	20000.	0.	0.	258.
418.000	0.43	571.54	543.03	20000.	0.	0.	0.
0.000	0.00	571.56	542.70	20000.	0.	0.	0.

occurs. The deposition areas have been indicated in Figure 5.1 by shading the affected reaches. A discharge of Q = 12,000 cfs was selected for the purpose of establishing the deposition areas. According to the findings of Section 2, this flow is exceeded 0.16 percent of the time over the historical record. A slightly different pattern would be obtained by selecting a different discharge. However, the sharp bends persist as regions where deposition can be expected to occur regularly. For a discharge of Q = 20,000 cfs, which is only exceeded .02 percent of the time over the historic record, deposition occurs downstream of Section Nos. 23828, 20855, 19557, 17695, 14980, 12188, and 4003. It will be seen that these regions correspond to the bends in the river system.

A review of the literature concerning the scouring of silts and clays (cohesive sediments) indicates that tractive stresses higher than the critical tractive shear stress for sand will be required to erode these finer sediments. On this basis, it is felt that the river discharge of Q = 6,000 cfs is probably a good first estimate for scouring to first occur in the Buffalo River system. A discharge of 6,000 cfs will be exceeded approximately 1 percent of the time.

5.5. Trap Efficiency of Buffalo River

Based on the scour test run results, it can be expected that for 99 percent of the time river discharges will be less than the critical discharge of Q = 6,000 cfs required to cause significant scouring. An important related question then deals with the efficiency of the Buffalo River system to trap the suspended sediment load brought in from the upstream drainage basin.

In order to obtain an estimate of this trap efficiency, a series of

test runs were made using HEC-6, similar to the scour test runs; except in the trap efficiency runs, the runoff inflow to the upstream limit of the river system carried its associated sediment load for the assigned discharge. By varying the river discharge from Q = 250 cfs to Q = 20,000 cfs, it was possible to delineate the efficiency of the river system as a sediment trap for suspended materials in the clay, silt, and sand-size ranges.

The results of these trap efficiency test runs are depicted in Figure 5.2. The results represent the trap efficiencies after five days of sediment transport with the river discharge held constant. Trap efficiency was found to be independent of time. One important finding from this series of test runs is that for river discharges less than Q = 500 cfs, the river system serves as an efficient trap for the collection of all suspended sediment associated with these flows. Stated another way, 68 percent of the time the flows will be less than Q = 500 cfs; therefore, 68 percent of the time all incoming sediment will be deposited in the river system.

Other findings are as follows:

(1) the river system serves as a perfect trap for sand for all discharges equal or less than Q = 20,000 cfs,

(2) the effect of water temperature is greatest at the silt-size range with trap efficiency increasing with warmer water temperatures,

(3) for a river discharge equal to or exceeding Q = 14,000 cfs, practically all incoming suspended sediment in the silt and clay-size range is transported through the river system to the Buffalo harbor area, i.e., trap efficiencies are less than 5 percent at these flows,

(4) at a river discharge of Q = 6,000 cfs, the estimated critical

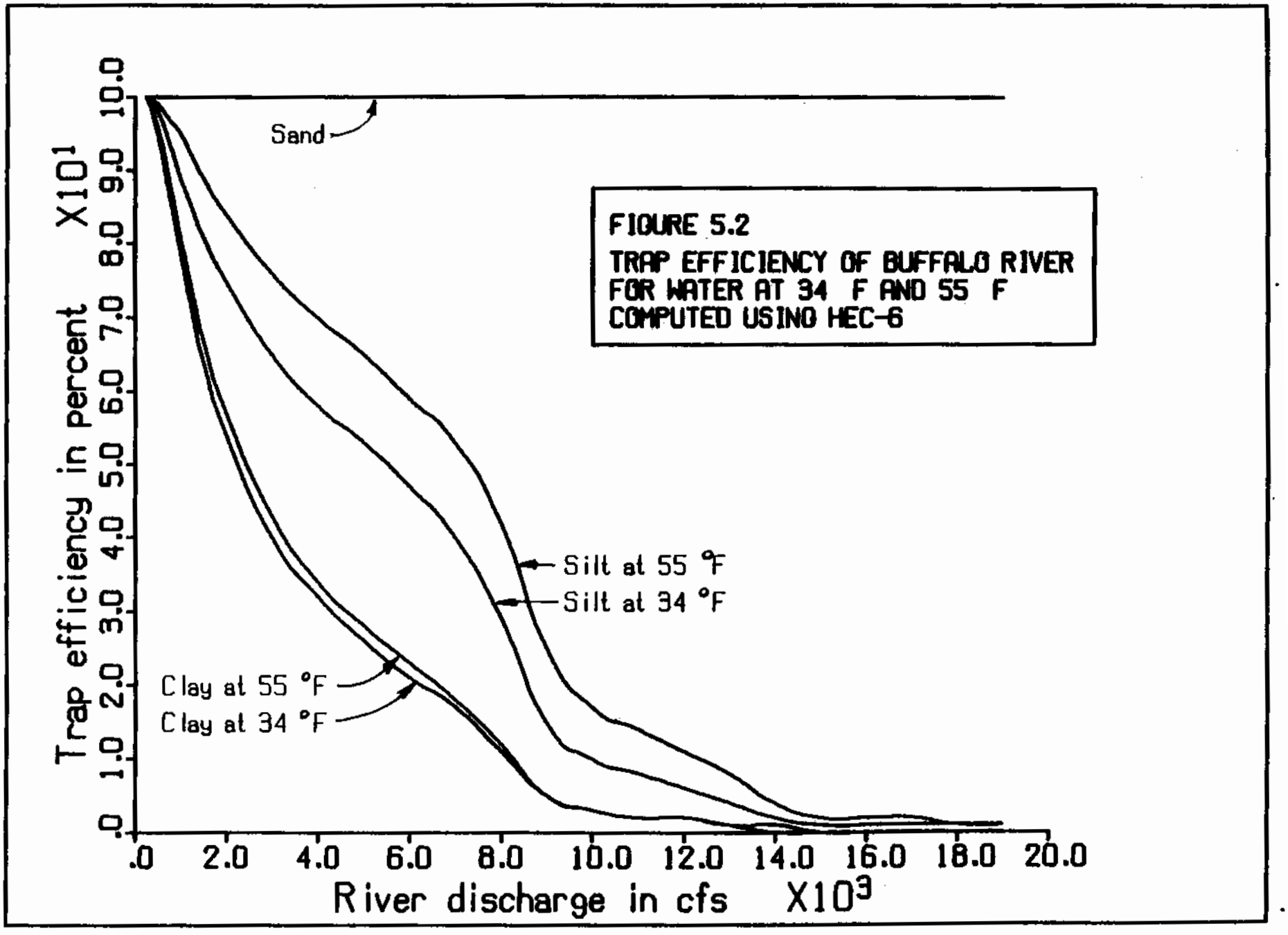


FIGURE 5.2
TRAP EFFICIENCY OF BUFFALO RIVER FOR WATER AT 34 F AND 55 F COMPUTED USING HEC-6

discharge to induce scour of bottom materials, the river system still serves as a trap for almost 60 percent of the silt-size materials and 23 percent of the clay-size materials delivered to the river system by the upstream drainage basin (at water temperature of 55 degrees Fahrenheit),

(5) there is a noticeable reduction in trap efficiency for silts and clays between river discharges equal to Q = 8,000 cfs and Q = 10,000 cfs, with a reduction of over 20 percent in trap efficiency for silts and approximately 8 percent for clays, and

(6) the river bends serve as the most efficient trap regions for the Buffalo River system, continuing to collect sediments at the higher discharges while much of the remainder of the river system undergoes degradation due to scouring.

The tabular results of the trap efficiency runs are presented in Tables 5.23 to 5.47. The rate of deposition as a function of distance along the river channel can be determined for each river discharge. The river sections where deposition occurs can also be determined for each river discharge in terms of the change in elevation of the river bed. All of the results presented in Tables 5.23 to 5.47 are for water temperature of 55 degrees Fahrenheit. The results for water temperature 34 degrees Fahrenheit are qualitatively similar, but the trap efficiencies are reduced from that given when the water temperature is 55 degrees Fahrenheit, as previously discussed.

5.6. Sediment Dynamics in Buffalo River - May 1, 1983 to April 30, 1985

The actual flow runoff and sediment yield conditions for the period May 1, 1983 to April 30, 1985 were simulated using the HEC-6 program for scour and deposition in rivers. The inflow hydrograph and the histograph approximation used in the computations can be seen in Figure 5.3. The

TABLE 5.23. TRAP EFFICIENCY STUDY WITH FLOW 250 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 250.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.15			0.17			0.01		
TOTAL=	0.000	0.15	0.00	1.00	0.17	0.00	1.00	0.01	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.04	571.56	550.04	250.	19.	32.	0.
26985.000	0.01	571.56	545.81	250.	16.	21.	0.
26545.000	0.01	571.56	544.31	250.	14.	16.	0.
25775.000	0.01	571.56	545.11	250.	12.	12.	0.
24915.000	0.01	571.56	542.01	250.	10.	10.	0.
23828.000	0.00	571.56	545.10	250.	8.	7.	0.
22680.000	0.00	571.56	543.50	250.	6.	4.	0.
21350.000	0.00	571.56	542.90	250.	5.	3.	0.
20855.000	0.00	571.56	542.70	250.	4.	3.	0.
20057.000	0.00	571.56	544.60	250.	3.	2.	0.
19557.000	0.00	571.56	540.70	250.	3.	2.	0.
18925.000	0.00	571.56	541.50	250.	2.	1.	0.
18295.000	0.00	571.56	540.70	250.	2.	1.	0.
17695.000	0.00	571.56	543.80	250.	2.	1.	0.
16233.000	0.00	571.56	539.40	250.	1.	1.	0.
15823.000	0.00	571.56	544.80	250.	1.	1.	0.
14980.000	0.00	571.56	543.00	250.	1.	0.	0.
14361.000	0.00	571.56	541.50	250.	1.	0.	0.
14036.000	0.00	571.56	543.60	250.	1.	0.	0.
12602.000	0.00	571.56	544.80	250.	1.	0.	0.
12188.000	0.00	571.56	545.60	250.	0.	0.	0.
11610.000	0.00	571.56	543.50	250.	0.	0.	0.
11067.000	0.00	571.56	543.50	250.	0.	0.	0.
10635.000	0.00	571.56	542.70	250.	0.	0.	0.
10215.000	0.00	571.56	542.30	250.	0.	0.	0.
9671.000	0.00	571.56	542.50	250.	0.	0.	0.
9148.000	0.00	571.56	542.40	250.	0.	0.	0.
7581.000	0.00	571.56	542.10	250.	0.	0.	0.
5725.000	0.00	571.56	541.30	250.	0.	0.	0.
4003.000	0.00	571.56	541.40	250.	0.	0.	0.
3458.000	0.00	571.56	543.00	250.	0.	0.	0.
2817.000	0.00	571.56	543.00	250.	0.	0.	0.
1729.000	0.00	571.56	541.10	250.	0.	0.	0.
1022.000	0.00	571.56	542.20	250.	0.	0.	0.
418.000	0.00	571.56	542.60	250.	0.	0.	0.
0.000	0.00	571.56	542.70	250.	0.	0.	0.

TABLE 5.24. TRAP EFFICIENCY STUDY WITH FLOW 500 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 500.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	0.52			0.56			0.04		
TOTAL=	0.000	0.52	0.02	0.96	0.56	0.00	0.99	0.04	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.08	571.56	550.08	500.	66.	128.	0.
26985.000	0.04	571.56	545.84	500.	61.	97.	0.
26545.000	0.02	571.56	544.32	500.	57.	78.	0.
25775.000	0.02	571.56	545.12	500.	53.	67.	0.
24915.000	0.02	571.56	542.02	500.	49.	57.	0.
23828.000	0.01	571.56	545.11	500.	43.	45.	0.
22680.000	0.01	571.56	543.51	500.	37.	35.	0.
21350.000	0.01	571.56	542.91	500.	33.	29.	0.
20855.000	0.01	571.56	542.71	500.	30.	26.	0.
20057.000	0.01	571.56	544.61	500.	28.	23.	0.
19557.000	0.01	571.56	540.71	500.	26.	21.	0.
18925.000	0.01	571.56	541.51	500.	24.	18.	0.
18295.000	0.00	571.56	540.70	500.	22.	17.	0.
17695.000	0.00	571.56	543.80	500.	20.	14.	0.
16233.000	0.00	571.56	539.40	500.	17.	12.	0.
15823.000	0.00	571.56	544.80	500.	16.	11.	0.
14980.000	0.00	571.56	543.00	500.	15.	10.	0.
14361.000	0.00	571.56	541.50	500.	14.	9.	0.
14036.000	0.00	571.56	543.60	500.	13.	8.	0.
12602.000	0.00	571.56	544.80	500.	11.	7.	0.
12188.000	0.00	571.56	545.60	500.	11.	7.	0.
11610.000	0.00	571.56	543.50	500.	10.	6.	0.
11067.000	0.00	571.56	543.50	500.	9.	6.	0.
10635.000	0.00	571.56	542.70	500.	9.	5.	0.
10215.000	0.00	571.56	542.30	500.	9.	5.	0.
9671.000	0.00	571.56	542.50	500.	8.	5.	0.
9148.000	0.00	571.56	542.40	500.	7.	4.	0.
7581.000	0.00	571.56	542.10	500.	7.	4.	0.
5725.000	0.00	571.56	541.30	500.	6.	3.	0.
4003.000	0.00	571.56	541.40	500.	5.	3.	0.
3458.000	0.00	571.56	543.00	500.	5.	3.	0.
2817.000	0.00	571.56	543.00	500.	4.	2.	0.
1729.000	0.00	571.56	541.10	500.	3.	2.	0.
1022.000	0.00	571.56	542.20	500.	3.	2.	0.
418.000	0.00	571.56	542.60	500.	3.	1.	0.
0.000	0.00	571.56	542.70	500.	2.	1.	0.

TABLE 5.25. TRAP EFFICIENCY STUDY WITH FLOW 750 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 750.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	1.07			1.16			0.08		
TOTAL=	0.000	1.07	0.12	0.89	1.16	0.03	0.97	0.08	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.13	571.56	550.13	750.	136.	281.	0.
26985.000	0.06	571.56	545.86	750.	130.	227.	0.
26545.000	0.04	571.56	544.34	750.	124.	190.	0.
25775.000	0.03	571.56	545.13	750.	119.	167.	0.
24915.000	0.03	571.56	542.03	750.	112.	147.	0.
23828.000	0.02	571.56	545.12	750.	103.	122.	0.
22680.000	0.02	571.56	543.52	750.	93.	101.	0.
21350.000	0.02	571.56	542.92	750.	86.	89.	0.
20855.000	0.01	571.56	542.71	750.	82.	81.	0.
20057.000	0.01	571.56	544.61	750.	77.	74.	0.
19557.000	0.01	571.56	540.71	750.	74.	69.	0.
18925.000	0.01	571.56	541.51	750.	69.	63.	0.
18295.000	0.01	571.56	540.71	750.	66.	58.	0.
17695.000	0.01	571.56	543.81	750.	61.	52.	0.
16233.000	0.01	571.56	539.41	750.	56.	45.	0.
15823.000	0.01	571.56	544.81	750.	53.	42.	0.
14980.000	0.01	571.56	543.01	750.	50.	39.	0.
14361.000	0.01	571.56	541.51	750.	48.	37.	0.
14036.000	0.01	571.56	543.61	750.	45.	34.	0.
12602.000	0.01	571.56	544.81	750.	43.	31.	0.
12188.000	0.01	571.56	545.61	750.	41.	30.	0.
11610.000	0.01	571.56	543.51	750.	39.	28.	0.
11067.000	0.01	571.56	543.51	750.	37.	26.	0.
10635.000	0.01	571.56	542.71	750.	36.	25.	0.
10215.000	0.01	571.56	542.31	750.	35.	25.	0.
9671.000	0.00	571.56	542.50	750.	34.	23.	0.
9148.000	0.00	571.56	542.40	750.	32.	22.	0.
7581.000	0.00	571.56	542.10	750.	29.	19.	0.
5725.000	0.00	571.56	541.30	750.	27.	17.	0.
4003.000	0.00	571.56	541.40	750.	25.	16.	0.
3458.000	0.00	571.56	543.00	750.	23.	15.	0.
2817.000	0.00	571.56	543.00	750.	20.	12.	0.
1729.000	0.00	571.56	541.10	750.	18.	11.	0.
1022.000	0.00	571.56	542.20	750.	17.	10.	0.
418.000	0.00	571.56	542.60	750.	16.	9.	0.
0.000	0.00	571.56	542.70	750.	15.	9.	0.

TABLE 5.26. TRAP EFFICIENCY STUDY WITH FLOW 1,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 1000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	1.78			1.93			0.13		
TOTAL=	0.000	1.78	0.34	0.81	1.93	0.10	0.95	0.13	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.18	571.56	550.18	1000.	228.	484.	0.
26985.000	0.09	571.56	545.89	1000.	221.	407.	0.
26545.000	0.06	571.56	544.36	1000.	213.	350.	0.
25775.000	0.05	571.56	545.15	1000.	206.	314.	0.
24915.000	0.04	571.56	542.04	1000.	197.	279.	0.
23828.000	0.03	571.56	545.13	1000.	185.	238.	0.
22680.000	0.03	571.56	543.53	1000.	171.	203.	0.
21350.000	0.02	571.56	542.92	1000.	162.	182.	0.
20855.000	0.02	571.56	542.72	1000.	156.	169.	0.
20057.000	0.02	571.56	544.62	1000.	149.	157.	0.
19557.000	0.02	571.56	540.72	1000.	144.	149.	0.
18925.000	0.02	571.56	541.52	1000.	137.	137.	0.
18295.000	0.02	571.56	540.72	1000.	133.	129.	0.
17695.000	0.02	571.56	543.82	1000.	125.	118.	0.
16233.000	0.01	571.56	539.41	1000.	116.	106.	0.
15823.000	0.01	571.56	544.81	1000.	113.	100.	0.
14980.000	0.01	571.56	543.01	1000.	108.	94.	0.
14361.000	0.01	571.56	541.51	1000.	104.	90.	0.
14036.000	0.01	571.56	543.61	1000.	100.	84.	0.
12602.000	0.01	571.56	544.81	1000.	95.	79.	0.
12188.000	0.01	571.56	545.61	1000.	93.	75.	0.
11610.000	0.01	571.56	543.51	1000.	89.	71.	0.
11067.000	0.01	571.56	543.51	1000.	86.	68.	0.
10635.000	0.01	571.56	542.71	1000.	85.	67.	0.
10215.000	0.01	571.56	542.31	1000.	83.	65.	0.
9671.000	0.01	571.56	542.51	1000.	80.	62.	0.
9148.000	0.01	571.56	542.41	1000.	77.	58.	0.
7581.000	0.01	571.56	542.11	1000.	72.	54.	0.
5725.000	0.01	571.56	541.31	1000.	67.	49.	0.
4003.000	0.01	571.56	541.41	1000.	64.	46.	0.
3458.000	0.01	571.56	543.01	1000.	61.	43.	0.
2817.000	0.01	571.56	543.01	1000.	54.	37.	0.
1729.000	0.01	571.56	541.11	1000.	51.	34.	0.
1022.000	0.00	571.56	542.20	1000.	48.	32.	0.
418.000	0.00	571.56	542.60	1000.	46.	30.	0.
0.000	0.00	571.56	542.70	1000.	44.	28.	0.

TABLE 5.27. TRAP EFFICIENCY STUDY WITH FLOW 1,250 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 1250.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	2.64			2.86			0.20		
TOTAL=	0.000	2.64	0.70	0.74	2.86	0.23	0.92	0.20	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.24	571.57	550.24	1250.	340.	735.	0.
26985.000	0.11	571.57	545.91	1250.	331.	636.	0.
26545.000	0.08	571.57	544.38	1250.	321.	557.	0.
25775.000	0.07	571.57	545.17	1250.	313.	505.	0.
24915.000	0.06	571.57	542.06	1250.	303.	455.	0.
23828.000	0.05	571.57	545.15	1250.	288.	395.	0.
22680.000	0.04	571.57	543.54	1250.	270.	342.	0.
21350.000	0.03	571.57	542.93	1250.	259.	311.	0.
20855.000	0.03	571.57	542.73	1250.	250.	292.	0.
20057.000	0.03	571.57	544.63	1250.	242.	273.	0.
19557.000	0.03	571.57	540.73	1250.	236.	261.	0.
18925.000	0.03	571.57	541.53	1250.	227.	243.	0.
18295.000	0.02	571.56	540.72	1250.	220.	231.	0.
17695.000	0.02	571.56	543.82	1250.	210.	214.	0.
16233.000	0.02	571.56	539.42	1250.	199.	195.	0.
15823.000	0.02	571.56	544.82	1250.	193.	187.	0.
14980.000	0.02	571.56	543.02	1250.	187.	177.	0.
14361.000	0.02	571.56	541.52	1250.	182.	170.	0.
14036.000	0.02	571.56	543.62	1250.	176.	161.	0.
12602.000	0.02	571.56	544.82	1250.	169.	152.	0.
12188.000	0.02	571.56	545.62	1250.	165.	147.	0.
11610.000	0.02	571.56	543.52	1250.	160.	139.	0.
11067.000	0.01	571.56	543.51	1250.	156.	135.	0.
10635.000	0.01	571.56	542.71	1250.	154.	132.	0.
10215.000	0.01	571.56	542.31	1250.	151.	128.	0.
9671.000	0.01	571.56	542.51	1250.	147.	124.	0.
9148.000	0.01	571.56	542.41	1250.	143.	118.	0.
7581.000	0.01	571.56	542.11	1250.	135.	110.	0.
5725.000	0.01	571.56	541.31	1250.	128.	101.	0.
4003.000	0.01	571.56	541.41	1250.	123.	96.	0.
3458.000	0.01	571.56	543.01	1250.	118.	91.	0.
2817.000	0.01	571.56	543.01	1250.	107.	79.	0.
1729.000	0.01	571.56	541.11	1250.	102.	75.	0.
1022.000	0.01	571.56	542.21	1250.	98.	71.	0.
418.000	0.01	571.56	542.61	1250.	94.	67.	0.
0.000	0.01	571.56	542.71	1250.	91.	64.	0.

TABLE 5.28. TRAP EFFICIENCY STUDY WITH FLOW 1,500 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 1500.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	3.65			3.95			0.27		
TOTAL=	0.000	3.65	1.20	0.67	3.95	0.42	0.89	0.27	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.30	571.57	550.30	1500.	471.	1031.	0.
26985.000	0.13	571.57	545.93	1500.	461.	909.	0.
26545.000	0.10	571.57	544.40	1500.	449.	809.	0.
25775.000	0.09	571.57	545.19	1500.	439.	740.	0.
24915.000	0.08	571.57	542.08	1500.	428.	673.	0.
23828.000	0.06	571.57	545.16	1500.	410.	591.	0.
22680.000	0.05	571.57	543.55	1500.	389.	518.	0.
21350.000	0.04	571.57	542.94	1500.	375.	476.	0.
20855.000	0.04	571.57	542.74	1500.	365.	449.	0.
20057.000	0.03	571.57	544.63	1500.	355.	424.	0.
19557.000	0.03	571.57	540.73	1500.	347.	406.	0.
18925.000	0.03	571.57	541.53	1500.	336.	381.	0.
18295.000	0.03	571.57	540.73	1500.	328.	365.	0.
17695.000	0.03	571.57	543.83	1500.	316.	341.	0.
16233.000	0.03	571.57	539.43	1500.	301.	313.	0.
15823.000	0.03	571.57	544.83	1500.	294.	302.	0.
14980.000	0.03	571.57	543.03	1500.	286.	288.	0.
14361.000	0.02	571.57	541.52	1500.	280.	278.	0.
14036.000	0.02	571.57	543.62	1500.	272.	265.	0.
12602.000	0.02	571.56	544.82	1500.	263.	252.	0.
12188.000	0.02	571.56	545.62	1500.	258.	244.	0.
11610.000	0.02	571.56	543.52	1500.	251.	234.	0.
11067.000	0.02	571.56	543.52	1500.	246.	227.	0.
10635.000	0.02	571.56	542.72	1500.	243.	223.	0.
10215.000	0.02	571.56	542.32	1500.	240.	218.	0.
9671.000	0.02	571.56	542.52	1500.	234.	211.	0.
9148.000	0.02	571.56	542.42	1500.	228.	202.	0.
7581.000	0.02	571.56	542.12	1500.	219.	190.	0.
5725.000	0.02	571.56	541.32	1500.	208.	177.	0.
4003.000	0.02	571.56	541.42	1500.	202.	169.	0.
3458.000	0.02	571.56	543.02	1500.	195.	161.	0.
2817.000	0.01	571.56	543.01	1500.	180.	143.	0.
1729.000	0.01	571.56	541.11	1500.	173.	136.	0.
1022.000	0.01	571.56	542.21	1500.	168.	130.	0.
418.000	0.01	571.56	542.61	1500.	162.	124.	0.
0.000	0.01	571.56	542.71	1500.	157.	119.	0.

TABLE 5.29. TRAP EFFICIENCY STUDY WITH FLOW 2,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 2000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	6.08			6.57			0.45		
TOTAL=	0.000	6.08	2.64	0.57	6.57	1.03	0.84	0.45	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.44	571.58	550.44	2000.	787.	1749.	0.
26985.000	0.18	571.58	545.98	2000.	773.	1586.	0.
26545.000	0.15	571.58	544.45	2000.	759.	1441.	0.
25775.000	0.12	571.58	545.22	2000.	747.	1338.	0.
24915.000	0.11	571.58	542.11	2000.	732.	1234.	0.
23828.000	0.09	571.58	545.19	2000.	708.	1101.	0.
22680.000	0.08	571.58	543.58	2000.	681.	982.	0.
21350.000	0.06	571.57	542.96	2000.	663.	913.	0.
20855.000	0.06	571.57	542.76	2000.	649.	868.	0.
20057.000	0.05	571.57	544.65	2000.	636.	826.	0.
19557.000	0.05	571.57	540.75	2000.	625.	796.	0.
18925.000	0.05	571.57	541.55	2000.	610.	756.	0.
18295.000	0.05	571.57	540.75	2000.	599.	728.	0.
17695.000	0.05	571.57	543.85	2000.	583.	687.	0.
16233.000	0.04	571.57	539.44	2000.	562.	640.	0.
15823.000	0.04	571.57	544.84	2000.	552.	621.	0.
14980.000	0.04	571.57	543.04	2000.	541.	598.	0.
14361.000	0.03	571.57	541.53	2000.	532.	580.	0.
14036.000	0.04	571.57	543.64	2000.	521.	558.	0.
12602.000	0.03	571.57	544.83	2000.	508.	535.	0.
12188.000	0.03	571.57	545.63	2000.	501.	522.	0.
11610.000	0.03	571.57	543.53	2000.	491.	504.	0.
11067.000	0.03	571.57	543.53	2000.	484.	492.	0.
10635.000	0.03	571.57	542.73	2000.	479.	484.	0.
10215.000	0.03	571.57	542.33	2000.	474.	475.	0.
9671.000	0.03	571.57	542.53	2000.	466.	463.	0.
9148.000	0.03	571.56	542.43	2000.	457.	448.	0.
7581.000	0.03	571.56	542.13	2000.	442.	426.	0.
5725.000	0.03	571.56	541.33	2000.	426.	402.	0.
4003.000	0.03	571.56	541.43	2000.	417.	388.	0.
3458.000	0.03	571.56	543.03	2000.	406.	372.	0.
2817.000	0.02	571.56	543.02	2000.	382.	339.	0.
1729.000	0.02	571.56	541.12	2000.	371.	325.	0.
1022.000	0.02	571.56	542.22	2000.	362.	314.	0.
418.000	0.02	571.56	542.62	2000.	353.	302.	0.
0.000	0.02	571.56	542.72	2000.	345.	293.	0.

TABLE 5.30. TRAP EFFICIENCY STUDY WITH FLOW 3,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 3000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY		CLAY			SILT			SAND		
DAYS	POINT	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EF
5.00	27868.000	12.46			13.47			0.92		
TOTAL=	0.000	12.46	7.15	0.43	13.47	3.23	0.76	0.92	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.75	571.60	550.75	3000.	1618.	3659.	0.
26985.000	0.26	571.60	546.06	3000.	1600.	3417.	0.
26545.000	0.23	571.60	544.53	3000.	1580.	3188.	0.
25775.000	0.20	571.60	545.30	3000.	1562.	3015.	0.
24915.000	0.19	571.60	542.19	3000.	1541.	2831.	0.
23828.000	0.16	571.60	545.26	3000.	1508.	2586.	0.
22680.000	0.14	571.59	543.64	3000.	1470.	2354.	0.
21350.000	0.11	571.59	543.01	3000.	1443.	2216.	0.
20855.000	0.10	571.59	542.80	3000.	1424.	2126.	0.
20057.000	0.09	571.59	544.69	3000.	1404.	2041.	0.
19557.000	0.09	571.59	540.79	3000.	1389.	1981.	0.
18925.000	0.09	571.59	541.59	3000.	1366.	1898.	0.
18295.000	0.08	571.59	540.78	3000.	1350.	1841.	0.
17695.000	0.08	571.59	543.88	3000.	1324.	1758.	0.
16233.000	0.07	571.59	539.47	3000.	1292.	1662.	0.
15823.000	0.07	571.58	544.87	3000.	1278.	1621.	0.
14980.000	0.07	571.58	543.07	3000.	1261.	1574.	0.
14361.000	0.06	571.58	541.56	3000.	1247.	1536.	0.
14036.000	0.07	571.58	543.67	3000.	1229.	1491.	0.
12602.000	0.06	571.58	544.86	3000.	1209.	1444.	0.
12188.000	0.06	571.58	545.66	3000.	1197.	1416.	0.
11610.000	0.06	571.58	543.56	3000.	1181.	1378.	0.
11067.000	0.06	571.58	543.56	3000.	1170.	1352.	0.
10635.000	0.06	571.57	542.76	3000.	1162.	1335.	0.
10215.000	0.06	571.57	542.36	3000.	1154.	1317.	0.
9671.000	0.06	571.57	542.56	3000.	1141.	1290.	0.
9148.000	0.06	571.57	542.46	3000.	1126.	1259.	0.
7581.000	0.05	571.57	542.15	3000.	1102.	1211.	0.
5725.000	0.05	571.56	541.35	3000.	1075.	1159.	0.
4003.000	0.05	571.56	541.45	3000.	1059.	1129.	0.
3458.000	0.05	571.56	543.05	3000.	1040.	1094.	0.
2817.000	0.05	571.56	543.05	3000.	999.	1022.	0.
1729.000	0.04	571.56	541.14	3000.	980.	989.	0.
1022.000	0.04	571.56	542.24	3000.	965.	965.	0.
418.000	0.04	571.56	542.64	3000.	948.	937.	0.
0.000	0.04	571.56	542.74	3000.	935.	916.	0.

TABLE 5.31. TRAP EFFICIENCY STUDY WITH FLOW 4,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 4000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	20.74			22.42			1.53		
TOTAL=	0.000	20.74	13.67	0.34	22.42	6.79	0.70	1.53	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	1.12	571.64	551.12	4000.	2697.	6153.	0.
26985.000	0.34	571.64	546.14	4000.	2674.	5838.	0.
26545.000	0.30	571.64	544.60	4000.	2649.	5529.	0.
25775.000	0.28	571.63	545.38	4000.	2627.	5288.	0.
24915.000	0.27	571.63	542.27	4000.	2601.	5023.	0.
23828.000	0.23	571.62	545.33	4000.	2559.	4658.	0.
22680.000	0.20	571.62	543.70	4000.	2510.	4301.	0.
21350.000	0.17	571.62	543.07	4000.	2475.	4081.	0.
20855.000	0.15	571.62	542.85	4000.	2450.	3937.	0.
20057.000	0.14	571.62	544.74	4000.	2424.	3800.	0.
19557.000	0.14	571.61	540.84	4000.	2405.	3703.	0.
18925.000	0.14	571.61	541.64	4000.	2376.	3567.	0.
18295.000	0.13	571.61	540.83	4000.	2354.	3473.	0.
17695.000	0.12	571.61	543.92	4000.	2321.	3337.	0.
16233.000	0.11	571.61	539.51	4000.	2279.	3178.	0.
15823.000	0.11	571.60	544.91	4000.	2260.	3111.	0.
14980.000	0.11	571.60	543.11	4000.	2237.	3032.	0.
14361.000	0.10	571.60	541.60	4000.	2218.	2970.	0.
14036.000	0.10	571.60	543.70	4000.	2194.	2895.	0.
12602.000	0.10	571.59	544.90	4000.	2168.	2816.	0.
12188.000	0.09	571.59	545.69	4000.	2152.	2769.	0.
11610.000	0.09	571.59	543.59	4000.	2130.	2705.	0.
11067.000	0.09	571.59	543.59	4000.	2114.	2663.	0.
10635.000	0.09	571.59	542.79	4000.	2104.	2635.	0.
10215.000	0.09	571.58	542.39	4000.	2093.	2604.	0.
9671.000	0.09	571.59	542.59	4000.	2075.	2559.	0.
9148.000	0.08	571.58	542.48	4000.	2055.	2507.	0.
7581.000	0.08	571.57	542.18	4000.	2022.	2426.	0.
5725.000	0.08	571.57	541.38	4000.	1985.	2338.	0.
4003.000	0.07	571.56	541.47	4000.	1963.	2287.	0.
3458.000	0.07	571.56	543.07	4000.	1937.	2229.	0.
2817.000	0.07	571.56	543.07	4000.	1879.	2106.	0.
1729.000	0.07	571.56	541.17	4000.	1851.	2049.	0.
1022.000	0.06	571.56	542.26	4000.	1830.	2008.	0.
418.000	0.06	571.56	542.66	4000.	1805.	1959.	0.
0.000	0.06	571.56	542.76	4000.	1787.	1924.	0.

TABLE 5.32. TRAP EFFICIENCY STUDY WITH FLOW 5,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 5000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	30.78			33.28			2.27		
TOTAL=	0.000	30.78	22.06	0.28	33.28	11.75	0.65	2.27	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	1.56	571.68	551.56	5000.	4007.	9191.	0.
26985.000	0.41	571.68	546.21	5000.	3980.	8807.	0.
26545.000	0.37	571.68	544.67	5000.	3950.	8422.	0.
25775.000	0.35	571.66	545.45	5000.	3924.	8116.	0.
24915.000	0.34	571.66	542.34	5000.	3893.	7773.	0.
23828.000	0.31	571.66	545.41	5000.	3842.	7287.	0.
22680.000	0.26	571.66	543.76	5000.	3783.	6798.	0.
21350.000	0.23	571.65	543.13	5000.	3742.	6491.	0.
20855.000	0.21	571.65	542.91	5000.	3711.	6287.	0.
20057.000	0.19	571.65	544.79	5000.	3680.	6092.	0.
19557.000	0.19	571.64	540.89	5000.	3656.	5952.	0.
18925.000	0.19	571.65	541.69	5000.	3621.	5756.	0.
18295.000	0.18	571.64	540.88	5000.	3595.	5620.	0.
17695.000	0.17	571.64	543.97	5000.	3554.	5421.	0.
16233.000	0.15	571.63	539.55	5000.	3502.	5188.	0.
15823.000	0.15	571.63	544.95	5000.	3479.	5089.	0.
14980.000	0.15	571.62	543.15	5000.	3450.	4973.	0.
14361.000	0.13	571.62	541.63	5000.	3427.	4882.	0.
14036.000	0.14	571.62	543.74	5000.	3398.	4771.	0.
12602.000	0.13	571.61	544.93	5000.	3365.	4654.	0.
12188.000	0.12	571.61	545.72	5000.	3345.	4585.	0.
11610.000	0.13	571.61	543.63	5000.	3318.	4491.	0.
11067.000	0.12	571.61	543.62	5000.	3299.	4429.	0.
10635.000	0.12	571.60	542.82	5000.	3285.	4386.	0.
10215.000	0.12	571.60	542.42	5000.	3271.	4341.	0.
9671.000	0.12	571.60	542.62	5000.	3250.	4275.	0.
9148.000	0.12	571.59	542.52	5000.	3224.	4197.	0.
7581.000	0.11	571.58	542.21	5000.	3183.	4077.	0.
5725.000	0.11	571.57	541.41	5000.	3136.	3946.	0.
4003.000	0.10	571.56	541.50	5000.	3108.	3870.	0.
3458.000	0.10	571.57	543.10	5000.	3075.	3783.	0.
2817.000	0.10	571.57	543.10	5000.	3001.	3599.	0.
1729.000	0.09	571.56	541.19	5000.	2966.	3514.	0.
1022.000	0.09	571.56	542.29	5000.	2939.	3452.	0.
418.000	0.08	571.56	542.68	5000.	2907.	3380.	0.
0.000	0.09	571.56	542.79	5000.	2883.	3327.	0.

TABLE 5.33. TRAP EFFICIENCY STUDY WITH FLOW 6,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 6000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	42.51			45.97			3.13		
TOTAL=	0.000	42.51	32.96	0.22	45.97	19.02	0.59	3.13	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	1.37	571.73	551.37	6000.	5555.	13015.	214.
26985.000	0.08	571.74	545.88	6000.	5555.	13015.	0.
26545.000	0.49	571.74	544.79	6000.	5520.	12498.	0.
25775.000	0.46	571.71	545.56	6000.	5490.	12081.	0.
24915.000	0.00	571.71	542.00	6000.	5490.	12081.	0.
23828.000	0.45	571.71	545.55	6000.	5431.	11342.	0.
22680.000	0.39	571.70	543.89	6000.	5362.	10592.	0.
21350.000	0.33	571.69	543.23	6000.	5312.	10118.	0.
20855.000	0.31	571.69	543.01	6000.	5276.	9802.	0.
20057.000	0.28	571.68	544.88	6000.	5239.	9499.	0.
19557.000	0.28	571.68	540.98	6000.	5211.	9281.	0.
18925.000	0.27	571.68	541.77	6000.	5169.	8977.	0.
18295.000	0.25	571.68	540.95	6000.	5138.	8766.	0.
17695.000	0.25	571.67	544.05	6000.	5089.	8458.	0.
16233.000	0.22	571.67	539.62	6000.	5028.	8098.	0.
15823.000	0.22	571.66	545.02	6000.	5000.	7946.	0.
14980.000	0.21	571.65	543.21	6000.	4965.	7767.	0.
14361.000	0.19	571.65	541.69	6000.	4937.	7628.	0.
14036.000	0.19	571.64	543.79	6000.	4902.	7459.	0.
12602.000	0.19	571.63	544.99	6000.	4863.	7281.	0.
12188.000	0.17	571.63	545.77	6000.	4839.	7175.	0.
11610.000	0.18	571.63	543.68	6000.	4806.	7034.	0.
11067.000	0.17	571.63	543.67	6000.	4783.	6939.	0.
10635.000	0.17	571.62	542.87	6000.	4767.	6875.	0.
10215.000	0.17	571.61	542.47	6000.	4750.	6808.	0.
9671.000	0.16	571.62	542.66	6000.	4724.	6707.	0.
9148.000	0.16	571.60	542.56	6000.	4693.	6591.	0.
7581.000	0.15	571.58	542.25	6000.	4643.	6411.	0.
5725.000	0.15	571.57	541.45	6000.	4586.	6215.	0.
4003.000	0.00	571.56	541.40	6000.	4586.	6215.	0.
3458.000	0.14	571.57	543.14	6000.	4545.	6081.	0.
2817.000	0.14	571.57	543.14	6000.	4454.	5800.	0.
1729.000	0.13	571.56	541.23	6000.	4410.	5670.	0.
1022.000	0.12	571.56	542.32	6000.	4377.	5576.	0.
418.000	0.11	571.56	542.71	6000.	4337.	5466.	0.
0.000	0.12	571.56	542.82	6000.	4307.	5385.	0.

TABLE 5.34. TRAP EFFICIENCY STUDY WITH FLOW 7,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 7000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	55.85			60.39			4.12		
TOTAL=	0.000	55.85	46.18	0.17	60.39	28.97	0.52	4.12	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	1.38	571.80	551.38	7000.	7298.	17099.	670.
26985.000	0.33	571.80	546.13	7000.	7298.	17099.	0.
26545.000	0.00	571.80	544.30	7000.	7298.	17099.	0.
25775.000	-0.04	571.76	545.06	7000.	7298.	17099.	56.
24915.000	0.03	571.76	542.03	7000.	7298.	17099.	0.
23828.000	0.58	571.76	545.68	7000.	7231.	16112.	0.
22680.000	0.51	571.75	544.01	7000.	7152.	15096.	0.
21350.000	0.44	571.74	543.34	7000.	7095.	14448.	0.
20855.000	0.41	571.74	543.11	7000.	7054.	14013.	0.
20057.000	0.38	571.73	544.98	7000.	7011.	13594.	0.
19557.000	0.37	571.73	541.07	7000.	6979.	13292.	0.
18925.000	0.36	571.73	541.86	7000.	6931.	12867.	0.
18295.000	0.34	571.72	541.04	7000.	6895.	12573.	0.
17695.000	0.33	571.71	544.13	7000.	6839.	12141.	0.
16233.000	0.29	571.71	539.69	7000.	6768.	11637.	0.
15823.000	0.29	571.69	545.09	7000.	6736.	11424.	0.
14980.000	0.28	571.69	543.28	7000.	6696.	11172.	0.
14361.000	0.25	571.69	541.75	7000.	6664.	10977.	0.
14036.000	0.26	571.67	543.86	7000.	6623.	10739.	0.
12602.000	0.25	571.66	545.05	7000.	6578.	10490.	0.
12188.000	0.23	571.66	545.83	7000.	6550.	10341.	0.
11610.000	0.23	571.66	543.73	7000.	6511.	10143.	0.
11067.000	0.22	571.65	543.72	7000.	6485.	10011.	0.
10635.000	0.22	571.64	542.92	7000.	6466.	9921.	0.
10215.000	0.22	571.63	542.52	7000.	6446.	9826.	0.
9671.000	0.00	571.64	542.50	7000.	6446.	9826.	0.
9148.000	0.00	571.61	542.40	7000.	6446.	9826.	0.
7581.000	0.21	571.59	542.31	7000.	6387.	9556.	0.
5725.000	0.20	571.58	541.50	7000.	6320.	9266.	0.
4003.000	0.00	571.56	541.40	7000.	6320.	9266.	0.
3458.000	0.00	571.57	543.00	7000.	6320.	9266.	0.
2817.000	0.19	571.57	543.19	7000.	6211.	8832.	0.
1729.000	0.18	571.56	541.28	7000.	6159.	8635.	0.
1022.000	0.17	571.56	542.37	7000.	6119.	8491.	0.
418.000	0.16	571.56	542.76	7000.	6072.	8326.	0.
0.000	0.16	571.56	542.86	7000.	6036.	8204.	0.

TABLE 5.35. TRAP EFFICIENCY STUDY WITH FLOW 8,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 8000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	70.75			76.50			5.22		
TOTAL=	0.000	70.75	62.56	0.12	76.50	44.12	0.42	5.22	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	1.27	571.87	551.27	8000.	9245.	21660.	1204.
26985.000	0.65	571.87	546.45	8000.	9245.	21660.	114.
26545.000	0.02	571.87	544.32	8000.	9245.	21660.	0.
25775.000	-0.25	571.83	544.85	8000.	9245.	21660.	332.
24915.000	0.22	571.82	542.22	8000.	9245.	21660.	0.
23828.000	0.00	571.82	545.10	8000.	9245.	21660.	0.
22680.000	0.64	571.81	544.14	8000.	9156.	20369.	0.
21350.000	0.55	571.79	543.45	8000.	9093.	19537.	0.
20855.000	0.52	571.79	543.22	8000.	9047.	18974.	0.
20057.000	0.48	571.78	545.08	8000.	8999.	18430.	0.
19557.000	0.47	571.77	541.17	8000.	8963.	18036.	0.
18925.000	0.46	571.78	541.96	8000.	8908.	17480.	0.
18295.000	0.43	571.76	541.13	8000.	8868.	17094.	0.
17695.000	0.42	571.75	544.22	8000.	8805.	16524.	0.
16233.000	0.37	571.75	539.77	8000.	8725.	15856.	0.
15823.000	0.37	571.73	545.17	8000.	8689.	15573.	0.
14980.000	0.35	571.72	543.35	8000.	8644.	15239.	0.
14361.000	0.32	571.72	541.82	8000.	8608.	14978.	0.
14036.000	0.00	571.70	543.60	8000.	8608.	14978.	0.
12602.000	0.00	571.69	544.80	8000.	8608.	14978.	0.
12188.000	0.00	571.69	545.60	8000.	8608.	14978.	0.
11610.000	0.33	571.69	543.83	8000.	8563.	14674.	0.
11067.000	0.31	571.68	543.81	8000.	8532.	14471.	0.
10635.000	0.32	571.66	543.02	8000.	8511.	14334.	0.
10215.000	0.00	571.66	542.30	8000.	8511.	14334.	0.
9671.000	0.00	571.66	542.50	8000.	8511.	14334.	0.
9148.000	0.00	571.63	542.40	8000.	8511.	14334.	0.
7581.000	0.00	571.60	542.10	8000.	8511.	14334.	0.
5725.000	0.00	571.58	541.30	8000.	8511.	14334.	0.
4003.000	0.00	571.56	541.40	8000.	8511.	14334.	0.
3458.000	0.00	571.57	543.00	8000.	8511.	14334.	0.
2817.000	0.29	571.58	543.29	8000.	8383.	13569.	0.
1729.000	0.27	571.56	541.37	8000.	8321.	13227.	0.
1022.000	0.26	571.55	542.46	8000.	8274.	12981.	0.
418.000	0.24	571.56	542.84	8000.	8218.	12701.	0.
0.000	0.24	571.56	542.94	8000.	8176.	12496.	0.

TABLE 5.36. TRAP EFFICIENCY STUDY WITH FLOW 9,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 9000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	87.15			94.24			6.43		
TOTAL=	0.000	87.15	82.71	0.05	94.24	70.73	0.25	6.43	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	1.12	571.94	551.12	9000.	11389.	26682.	1722.
26985.000	0.69	571.94	546.49	9000.	11389.	26682.	811.
26545.000	0.34	571.95	544.64	9000.	11389.	26682.	0.
25775.000	-0.59	571.89	544.51	9000.	11389.	26682.	711.
24915.000	0.37	571.89	542.37	9000.	11389.	26682.	296.
23828.000	0.09	571.88	545.19	9000.	11389.	26682.	0.
22680.000	0.00	571.87	543.50	9000.	11389.	26682.	0.
21350.000	0.27	571.85	543.17	9000.	11389.	26682.	0.
20855.000	0.00	571.85	542.70	9000.	11389.	26682.	0.
20057.000	0.66	571.84	545.26	9000.	11336.	25881.	0.
19557.000	0.00	571.83	540.70	9000.	11336.	25881.	0.
18925.000	0.67	571.83	542.17	9000.	11274.	25020.	0.
18295.000	0.62	571.81	541.32	9000.	11229.	24421.	0.
17695.000	0.00	571.80	543.80	9000.	11229.	24421.	0.
16233.000	0.00	571.80	539.40	9000.	11229.	24421.	0.
15823.000	0.00	571.77	544.80	9000.	11229.	24421.	0.
14980.000	0.00	571.77	543.00	9000.	11229.	24421.	0.
14361.000	0.00	571.77	541.50	9000.	11229.	24421.	0.
14036.000	0.00	571.74	543.60	9000.	11229.	24421.	0.
12602.000	0.00	571.72	544.80	9000.	11229.	24421.	0.
12188.000	0.00	571.72	545.60	9000.	11229.	24421.	0.
11610.000	0.00	571.73	543.50	9000.	11229.	24421.	0.
11067.000	0.00	571.71	543.50	9000.	11229.	24421.	0.
10635.000	0.00	571.69	542.70	9000.	11229.	24421.	0.
10215.000	0.00	571.68	542.30	9000.	11229.	24421.	0.
9671.000	0.00	571.69	542.50	9000.	11229.	24421.	0.
9148.000	-0.06	571.65	542.34	9000.	11229.	24421.	84.
7581.000	-0.01	571.62	542.09	9000.	11229.	24421.	103.
5725.000	0.03	571.59	541.33	9000.	11229.	24421.	0.
4003.000	-0.01	571.56	541.39	9000.	11229.	24421.	13.
3458.000	0.01	571.58	543.01	9000.	11229.	24421.	0.
2817.000	0.58	571.58	543.58	9000.	11079.	22631.	0.
1729.000	0.51	571.56	541.61	9000.	11006.	21856.	0.
1022.000	0.48	571.55	542.68	9000.	10951.	21309.	0.
418.000	0.43	571.56	543.03	9000.	10885.	20694.	0.
0.000	0.44	571.56	543.14	9000.	10835.	20253.	0.

TABLE 5.37. TRAP EFFICIENCY STUDY WITH FLOW 10,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 10000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	102.54			110.88			7.56		
TOTAL=	0.000	102.54	99.29	0.03	110.88	91.77	0.17	7.56	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.79	572.03	550.79	10000.	13400.	31393.	2252.
26985.000	0.63	572.03	546.43	10000.	13400.	31393.	1618.
26545.000	0.83	572.03	545.13	10000.	13400.	31393.	29.
25775.000	-0.94	571.97	544.16	10000.	13400.	31393.	670.
24915.000	0.31	571.96	542.31	10000.	13400.	31393.	921.
23828.000	0.22	571.95	545.32	10000.	13400.	31393.	292.
22680.000	0.08	571.94	543.58	10000.	13400.	31393.	0.
21350.000	0.00	571.92	542.90	10000.	13400.	31393.	0.
20855.000	0.00	571.91	542.70	10000.	13400.	31393.	0.
20057.000	0.00	571.90	544.60	10000.	13400.	31393.	0.
19557.000	0.00	571.89	540.70	10000.	13400.	31393.	0.
18925.000	0.00	571.89	541.50	10000.	13400.	31393.	0.
18295.000	0.00	571.87	540.70	10000.	13400.	31393.	0.
17695.000	0.00	571.86	543.80	10000.	13400.	31393.	0.
16233.000	0.00	571.85	539.40	10000.	13400.	31393.	0.
15823.000	0.00	571.82	544.80	10000.	13400.	31393.	0.
14980.000	0.00	571.81	543.00	10000.	13400.	31393.	0.
14361.000	0.00	571.82	541.50	10000.	13400.	31393.	0.
14036.000	-0.02	571.78	543.58	10000.	13400.	31393.	36.
12602.000	-0.01	571.76	544.79	10000.	13400.	31393.	60.
12188.000	0.05	571.76	545.65	10000.	13400.	31393.	0.
11610.000	0.00	571.77	543.50	10000.	13400.	31393.	0.
11067.000	0.00	571.74	543.50	10000.	13400.	31393.	0.
10635.000	-0.03	571.72	542.67	10000.	13400.	31393.	16.
10215.000	-0.04	571.71	542.26	10000.	13400.	31393.	33.
9671.000	0.04	571.72	542.54	10000.	13400.	31393.	0.
9148.000	-0.21	571.67	542.19	10000.	13400.	31393.	284.
7581.000	-0.03	571.63	542.07	10000.	13400.	31393.	411.
5725.000	0.07	571.60	541.37	10000.	13400.	31393.	219.
4003.000	-0.01	571.56	541.39	10000.	13400.	31393.	216.
3458.000	0.10	571.58	543.10	10000.	13400.	31393.	0.
2817.000	0.75	571.59	543.75	10000.	13238.	29081.	0.
1729.000	0.66	571.56	541.76	10000.	13160.	28075.	0.
1022.000	0.62	571.55	542.82	10000.	13100.	27363.	0.
418.000	0.56	571.56	543.16	10000.	13030.	26563.	0.
0.000	0.56	571.56	543.26	10000.	12976.	25987.	0.

TABLE 5.38. TRAP EFFICIENCY STUDY WITH FLOW 11,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 11000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	116.70			126.18			8.60		
TOTAL=	0.000	116.70	114.36	0.02	126.18	111.48	0.12	8.60	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	0.24	572.12	550.24	11000.	15250.	35728.	2651.
26985.000	0.57	572.12	546.37	11000.	15250.	35728.	2273.
26545.000	1.10	572.12	545.40	11000.	15250.	35728.	812.
25775.000	-0.97	572.05	544.13	11000.	15250.	35728.	821.
24915.000	0.08	572.04	542.08	11000.	15250.	35728.	1704.
23828.000	0.35	572.03	545.45	11000.	15250.	35728.	934.
22680.000	0.25	572.01	543.75	11000.	15250.	35728.	0.
21350.000	-0.02	571.99	542.88	11000.	15250.	35728.	46.
20855.000	0.03	571.98	542.73	11000.	15250.	35728.	0.
20057.000	0.00	571.97	544.60	11000.	15250.	35728.	0.
19557.000	-0.05	571.95	540.65	11000.	15250.	35728.	54.
18925.000	0.03	571.96	541.53	11000.	15250.	35728.	0.
18295.000	0.00	571.94	540.70	11000.	15250.	35728.	0.
17695.000	-0.02	571.91	543.78	11000.	15250.	35728.	20.
16233.000	0.02	571.91	539.42	11000.	15250.	35728.	0.
15823.000	-0.08	571.87	544.72	11000.	15250.	35728.	102.
14980.000	0.06	571.87	543.06	11000.	15250.	35728.	0.
14361.000	0.00	571.87	541.50	11000.	15250.	35728.	0.
14036.000	-0.16	571.83	543.44	11000.	15250.	35728.	258.
12602.000	-0.05	571.80	544.75	11000.	15250.	35728.	375.
12188.000	0.27	571.80	545.87	11000.	15250.	35728.	62.
11610.000	0.02	571.81	543.52	11000.	15250.	35728.	0.
11067.000	0.00	571.78	543.50	11000.	15250.	35728.	0.
10635.000	-0.06	571.75	542.64	11000.	15250.	35728.	2.
10215.000	-0.07	571.74	542.23	11000.	15250.	35728.	8.
9671.000	0.08	571.75	542.58	11000.	15250.	35728.	0.
9148.000	-0.36	571.69	542.04	11000.	15250.	35728.	266.
7581.000	-0.13	571.64	541.97	11000.	15250.	35728.	843.
5725.000	0.09	571.60	541.39	11000.	15250.	35728.	676.
4003.000	-0.04	571.55	541.36	11000.	15250.	35728.	697.
3458.000	0.32	571.59	543.32	11000.	15250.	35728.	0.
2817.000	0.78	571.59	543.78	11000.	15083.	33317.	0.
1729.000	0.70	571.56	541.80	11000.	15001.	32257.	0.
1022.000	0.00	571.55	542.20	11000.	15001.	32257.	0.
418.000	0.00	571.56	542.60	11000.	15001.	32257.	0.
0.000	0.66	571.56	543.36	11000.	14945.	31565.	0.

TABLE 5.39. TRAP EFFICIENCY STUDY WITH FLOW 12,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 12000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	131.32			142.00			9.68		
TOTAL=	0.000	131.32	129.56	0.01	142.00	130.41	0.08	9.68	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-0.06	572.22	549.94	12000.	17161.	40206.	3149.
26985.000	0.51	572.22	546.31	12000.	17161.	40206.	2620.
26545.000	1.02	572.22	545.32	12000.	17161.	40206.	1797.
25775.000	-0.99	572.14	544.11	12000.	17161.	40206.	1858.
24915.000	-0.15	572.13	541.85	12000.	17161.	40206.	2744.
23828.000	0.47	572.12	545.57	12000.	17161.	40206.	2020.
22680.000	0.50	572.09	544.00	12000.	17161.	40206.	258.
21350.000	-0.03	572.06	542.87	12000.	17161.	40206.	234.
20855.000	0.06	572.06	542.76	12000.	17161.	40206.	154.
20057.000	-0.03	572.04	544.57	12000.	17161.	40206.	176.
19557.000	-0.06	572.02	540.64	12000.	17161.	40206.	229.
18925.000	0.13	572.03	541.63	12000.	17161.	40206.	0.
18295.000	-0.06	572.00	540.64	12000.	17161.	40206.	71.
17695.000	-0.03	571.98	543.77	12000.	17161.	40206.	86.
16233.000	0.05	571.97	539.45	12000.	17161.	40206.	0.
15823.000	-0.26	571.93	544.54	12000.	17161.	40206.	296.
14980.000	0.13	571.92	543.13	12000.	17161.	40206.	149.
14361.000	0.09	571.92	541.59	12000.	17161.	40206.	0.
14036.000	-0.34	571.88	543.26	12000.	17161.	40206.	450.
12602.000	-0.15	571.84	544.65	12000.	17161.	40206.	839.
12188.000	0.33	571.84	545.93	12000.	17161.	40206.	560.
11610.000	0.28	571.85	543.78	12000.	17161.	40206.	0.
11067.000	-0.03	571.82	543.47	12000.	17161.	40206.	25.
10635.000	-0.07	571.79	542.63	12000.	17161.	40206.	28.
10215.000	-0.08	571.77	542.22	12000.	17161.	40206.	30.
9671.000	0.13	571.79	542.63	12000.	17161.	40206.	0.
9148.000	-0.39	571.71	542.01	12000.	17161.	40206.	24.
7581.000	-0.32	571.66	541.78	12000.	17161.	40206.	906.
5725.000	0.03	571.61	541.33	12000.	17161.	40206.	1382.
4003.000	-0.03	571.55	541.37	12000.	17161.	40206.	1416.
3458.000	0.65	571.59	543.65	12000.	17161.	40206.	0.
2817.000	0.81	571.59	543.81	12000.	16989.	37704.	0.
1729.000	0.00	571.56	541.10	12000.	16989.	37704.	0.
1022.000	0.00	571.55	542.20	12000.	16989.	37704.	0.
418.000	0.00	571.55	542.60	12000.	16989.	37704.	0.
0.000	0.73	571.56	543.43	12000.	16930.	36925.	0.

TABLE 5.40. TRAP EFFICIENCY STUDY WITH FLOW 13,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 13000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY		CLAY			SILT			SAND		
DAYS	POINT	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF
5.00	27868.000	146.39			158.29			10.79		
TOTAL=	0.000	146.39	145.92	0.00	158.29	155.03	0.02	10.79	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-0.32	572.33	549.68	13000.	19130.	44819.	3704.
26985.000	0.45	572.33	546.25	13000.	19130.	44819.	3085.
26545.000	0.77	572.33	545.07	13000.	19130.	44819.	2800.
25775.000	-1.05	572.23	544.05	13000.	19130.	44819.	2975.
24915.000	-0.39	572.22	541.61	13000.	19130.	44819.	3874.
23828.000	0.56	572.20	545.66	13000.	19130.	44819.	3568.
22680.000	0.79	572.18	544.29	13000.	19130.	44819.	915.
21350.000	0.01	572.15	542.91	13000.	19130.	44819.	680.
20855.000	0.08	572.14	542.78	13000.	19130.	44819.	531.
20057.000	-0.01	572.12	544.59	13000.	19130.	44819.	496.
19557.000	-0.07	572.10	540.63	13000.	19130.	44819.	529.
18925.000	0.29	572.11	541.79	13000.	19130.	44819.	0.
18295.000	-0.12	572.08	540.58	13000.	19130.	44819.	110.
17695.000	-0.05	572.04	543.75	13000.	19130.	44819.	141.
16233.000	0.10	572.04	539.50	13000.	19130.	44819.	0.
15823.000	-0.42	571.99	544.38	13000.	19130.	44819.	280.
14980.000	0.04	571.98	543.04	13000.	19130.	44819.	508.
14361.000	0.33	571.98	541.83	13000.	19130.	44819.	0.
14036.000	-0.45	571.93	543.15	13000.	19130.	44819.	205.
12602.000	-0.35	571.89	544.45	13000.	19130.	44819.	1037.
12188.000	0.26	571.89	545.86	13000.	19130.	44819.	1257.
11610.000	0.69	571.90	544.19	13000.	19130.	44819.	0.
11067.000	-0.06	571.86	543.44	13000.	19130.	44819.	4.
10635.000	-0.09	571.83	542.61	13000.	19130.	44819.	6.
10215.000	-0.10	571.81	542.20	13000.	19130.	44819.	8.
9671.000	0.12	571.82	542.62	13000.	19130.	44819.	92.
9148.000	-0.41	571.73	541.99	13000.	19130.	44819.	121.
7581.000	-0.39	571.68	541.71	13000.	19130.	44819.	344.
5725.000	-0.17	571.62	541.13	13000.	19130.	44819.	1876.
4003.000	-0.10	571.55	541.30	13000.	19130.	44819.	2209.
3458.000	1.10	571.60	544.10	13000.	19130.	44819.	0.
2817.000	0.00	571.60	543.00	13000.	19130.	44819.	0.
1729.000	0.00	571.56	541.10	13000.	19130.	44819.	0.
1022.000	0.00	571.55	542.20	13000.	19130.	44819.	0.
418.000	0.00	571.55	542.60	13000.	19130.	44819.	0.
0.000	0.86	571.56	543.56	13000.	19069.	43895.	0.

TABLE 5.41. TRAP EFFICIENCY STUDY WITH FLOW 14,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 14000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	161.88			175.04			11.94		
TOTAL=	0.000	161.88	161.40	0.00	175.04	171.68	0.02	11.94	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-0.62	572.44	549.38	14000.	21154.	49560.	4284.
26985.000	0.22	572.44	546.02	14000.	21154.	49560.	3655.
26545.000	0.51	572.45	544.81	14000.	21154.	49560.	3980.
25775.000	-1.10	572.33	544.00	14000.	21154.	49560.	4144.
24915.000	-0.57	572.32	541.43	14000.	21154.	49560.	4921.
23828.000	0.58	572.30	545.68	14000.	21154.	49560.	5159.
22680.000	1.10	572.27	544.60	14000.	21154.	49560.	2041.
21350.000	0.09	572.23	542.99	14000.	21154.	49560.	1497.
20855.000	0.12	572.22	542.82	14000.	21154.	49560.	1169.
20057.000	0.02	572.20	544.62	14000.	21154.	49560.	1036.
19557.000	-0.09	572.18	540.61	14000.	21154.	49560.	1030.
18925.000	0.53	572.19	542.03	14000.	21154.	49560.	0.
18295.000	-0.18	572.15	540.52	14000.	21154.	49560.	136.
17695.000	-0.07	572.12	543.73	14000.	21154.	49560.	159.
16233.000	0.14	572.11	539.54	14000.	21154.	49560.	0.
15823.000	-0.46	572.05	544.34	14000.	21154.	49560.	24.
14980.000	-0.21	572.04	542.79	14000.	21154.	49560.	813.
14361.000	0.54	572.04	542.04	14000.	21154.	49560.	274.
14036.000	-0.44	571.99	543.16	14000.	21154.	49560.	258.
12602.000	-0.44	571.94	544.36	14000.	21154.	49560.	460.
12188.000	-0.14	571.94	545.46	14000.	21154.	49560.	1723.
11610.000	1.19	571.95	544.69	14000.	21154.	49560.	0.
11067.000	-0.06	571.91	543.44	14000.	21154.	49560.	2.
10635.000	-0.12	571.87	542.58	14000.	21154.	49560.	2.
10215.000	-0.15	571.85	542.15	14000.	21154.	49560.	13.
9671.000	-0.11	571.86	542.39	14000.	21154.	49560.	274.
9148.000	-0.44	571.76	541.96	14000.	21154.	49560.	375.
7581.000	-0.39	571.69	541.71	14000.	21154.	49560.	436.
5725.000	-0.32	571.63	540.98	14000.	21154.	49560.	1592.
4003.000	-0.20	571.55	541.20	14000.	21154.	49560.	2197.
3458.000	1.59	571.60	544.59	14000.	21154.	49560.	0.
2817.000	0.00	571.61	543.00	14000.	21154.	49560.	0.
1729.000	0.00	571.55	541.10	14000.	21154.	49560.	0.
1022.000	0.00	571.54	542.20	14000.	21154.	49560.	0.
418.000	0.00	571.55	542.60	14000.	21154.	49560.	0.
0.000	0.88	571.56	543.58	14000.	21092.	48611.	0.

TABLE 5.42. TRAP EFFICIENCY STUDY WITH FLOW 15,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 15000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	177.76			192.22			13.11		
TOTAL=	0.000	177.76	177.27	0.00	192.22	188.77	0.02	13.11	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-1.00	572.57	549.00	15000.	23230.	54424.	4869.
26985.000	-0.09	572.56	545.71	15000.	23230.	54424.	4266.
26545.000	0.26	572.57	544.56	15000.	23230.	54424.	4954.
25775.000	-1.06	572.44	544.04	15000.	23230.	54424.	5037.
24915.000	-0.74	572.42	541.26	15000.	23230.	54424.	5572.
23828.000	0.59	572.41	545.69	15000.	23230.	54424.	5534.
22680.000	1.30	572.37	544.80	15000.	23230.	54424.	3677.
21350.000	0.20	572.33	543.10	15000.	23230.	54424.	2766.
20855.000	0.20	572.31	542.90	15000.	23230.	54424.	2157.
20057.000	0.07	572.29	544.67	15000.	23230.	54424.	1875.
19557.000	-0.08	572.27	540.62	15000.	23230.	54424.	1801.
18925.000	0.73	572.27	542.23	15000.	23230.	54424.	498.
18295.000	-0.20	572.23	540.50	15000.	23230.	54424.	528.
17695.000	-0.08	572.19	543.72	15000.	23230.	54424.	532.
16233.000	0.25	572.19	539.65	15000.	23230.	54424.	0.
15823.000	-0.46	572.12	544.34	15000.	23230.	54424.	0.
14980.000	-0.42	572.11	542.58	15000.	23230.	54424.	613.
14361.000	0.41	572.11	541.91	15000.	23230.	54424.	867.
14036.000	-0.44	572.05	543.16	15000.	23230.	54424.	890.
12602.000	-0.44	571.99	544.36	15000.	23230.	54424.	896.
12188.000	-0.36	571.99	545.24	15000.	23230.	54424.	1549.
11610.000	1.55	572.00	545.05	15000.	23230.	54424.	552.
11067.000	-0.06	571.96	543.44	15000.	23230.	54424.	511.
10635.000	-0.11	571.91	542.59	15000.	23230.	54424.	513.
10215.000	-0.13	571.89	542.17	15000.	23230.	54424.	550.
9671.000	-0.17	571.91	542.33	15000.	23230.	54424.	521.
9148.000	-0.48	571.79	541.92	15000.	23230.	54424.	656.
7581.000	-0.40	571.71	541.70	15000.	23230.	54424.	749.
5725.000	-0.35	571.64	540.95	15000.	23230.	54424.	822.
4003.000	-0.27	571.55	541.13	15000.	23230.	54424.	1115.
3458.000	1.87	571.61	544.87	15000.	23230.	54424.	0.
2817.000	0.00	571.61	543.00	15000.	23230.	54424.	0.
1729.000	-0.01	571.55	541.09	15000.	23230.	54424.	19.
1022.000	-0.01	571.54	542.19	15000.	23230.	54424.	37.
418.000	0.02	571.55	542.62	15000.	23230.	54424.	0.
0.000	0.90	571.56	543.60	15000.	23166.	53450.	0.

TABLE 5.43. TRAP EFFICIENCY STUDY WITH FLOW 16,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 16000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	194.03			209.81			14.31		
TOTAL=	0.000	194.03	193.53	0.00	209.81	206.28	0.02	14.31	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-1.34	572.70	548.66	16000.	25356.	59406.	5348.
26985.000	-0.25	572.69	545.55	16000.	25356.	59406.	4818.
26545.000	-0.04	572.70	544.26	16000.	25356.	59406.	5297.
25775.000	-1.06	572.55	544.04	16000.	25356.	59406.	5402.
24915.000	-0.89	572.54	541.11	16000.	25356.	59406.	6026.
23828.000	0.61	572.52	545.71	16000.	25356.	59406.	6095.
22680.000	1.32	572.47	544.82	16000.	25356.	59406.	5469.
21350.000	0.30	572.43	543.20	16000.	25356.	59406.	4586.
20855.000	0.35	572.41	543.05	16000.	25356.	59406.	3616.
20057.000	0.13	572.38	544.73	16000.	25356.	59406.	3094.
19557.000	-0.09	572.36	540.61	16000.	25356.	59406.	2952.
18925.000	0.92	572.37	542.42	16000.	25356.	59406.	1296.
18295.000	-0.16	572.32	540.54	16000.	25356.	59406.	1205.
17695.000	-0.10	572.28	543.70	16000.	25356.	59406.	1208.
16233.000	0.44	572.27	539.84	16000.	25356.	59406.	71.
15823.000	-0.47	572.20	544.33	16000.	25356.	59406.	87.
14980.000	-0.44	572.18	542.56	16000.	25356.	59406.	88.
14361.000	0.03	572.18	541.53	16000.	25356.	59406.	1183.
14036.000	-0.47	572.11	543.13	16000.	25356.	59406.	1316.
12602.000	-0.45	572.05	544.35	16000.	25356.	59406.	1405.
12188.000	-0.34	572.05	545.26	16000.	25356.	59406.	1385.
11610.000	1.52	572.06	545.02	16000.	25356.	59406.	1440.
11067.000	-0.05	572.01	543.45	16000.	25356.	59406.	1418.
10635.000	-0.12	571.96	542.58	16000.	25356.	59406.	1440.
10215.000	-0.18	571.93	542.12	16000.	25356.	59406.	1512.
9671.000	-0.15	571.95	542.35	16000.	25356.	59406.	1324.
9148.000	-0.51	571.82	541.89	16000.	25356.	59406.	1459.
7581.000	-0.42	571.73	541.68	16000.	25356.	59406.	1695.
5725.000	-0.33	571.65	540.97	16000.	25356.	59406.	1586.
4003.000	-0.29	571.55	541.11	16000.	25356.	59406.	1668.
3458.000	2.24	571.61	545.24	16000.	25356.	59406.	0.
2817.000	0.00	571.62	543.00	16000.	25356.	59406.	0.
1729.000	-0.02	571.55	541.08	16000.	25356.	59406.	17.
1022.000	-0.02	571.54	542.18	16000.	25356.	59406.	35.
418.000	0.04	571.55	542.64	16000.	25356.	59406.	0.
0.000	0.92	571.56	543.62	16000.	25291.	58407.	0.

TABLE 5.44. TRAP EFFICIENCY STUDY WITH FLOW 17,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 17000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY		CLAY			SILT			SAND		
DAYS	POINT	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF
5.00	27868.000	210.67			227.80			15.53		
TOTAL=	0.000	210.67	210.16	0.00	227.80	224.19	0.02	15.53	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-1.57	572.83	548.43	17000.	27531.	64500.	5754.
26985.000	-0.38	572.83	545.42	17000.	27531.	64500.	5473.
26545.000	-0.08	572.84	544.22	17000.	27531.	64500.	4692.
25775.000	-1.13	572.67	543.97	17000.	27531.	64500.	4700.
24915.000	-1.01	572.66	540.99	17000.	27531.	64500.	5205.
23828.000	0.50	572.63	545.60	17000.	27531.	64500.	5346.
22680.000	1.23	572.58	544.73	17000.	27531.	64500.	6244.
21350.000	0.28	572.53	543.18	17000.	27531.	64500.	6845.
20855.000	0.49	572.52	543.19	17000.	27531.	64500.	5811.
20057.000	0.23	572.48	544.83	17000.	27531.	64500.	4934.
19557.000	-0.08	572.46	540.62	17000.	27531.	64500.	4678.
18925.000	1.16	572.47	542.66	17000.	27531.	64500.	2471.
18295.000	-0.14	572.42	540.56	17000.	27531.	64500.	2302.
17695.000	-0.18	572.37	543.62	17000.	27531.	64500.	2237.
16233.000	0.59	572.36	539.99	17000.	27531.	64500.	846.
15823.000	-0.49	572.28	544.31	17000.	27531.	64500.	911.
14980.000	-0.39	572.26	542.61	17000.	27531.	64500.	803.
14361.000	-0.18	572.26	541.32	17000.	27531.	64500.	1794.
14036.000	-0.51	572.18	543.09	17000.	27531.	64500.	1966.
12602.000	-0.46	572.11	544.34	17000.	27531.	64500.	2108.
12188.000	-0.30	572.11	545.30	17000.	27531.	64500.	2040.
11610.000	1.44	572.12	544.94	17000.	27531.	64500.	2475.
11067.000	-0.05	572.07	543.45	17000.	27531.	64500.	2515.
10635.000	-0.17	572.01	542.53	17000.	27531.	64500.	2568.
10215.000	-0.23	571.98	542.07	17000.	27531.	64500.	2668.
9671.000	-0.08	572.00	542.42	17000.	27531.	64500.	2484.
9148.000	-0.49	571.85	541.91	17000.	27531.	64500.	2488.
7581.000	-0.47	571.75	541.63	17000.	27531.	64500.	2858.
5725.000	-0.32	571.67	540.98	17000.	27531.	64500.	2859.
4003.000	-0.30	571.55	541.10	17000.	27531.	64500.	2905.
3458.000	2.67	571.62	545.67	17000.	27531.	64500.	625.
2817.000	0.04	571.63	543.04	17000.	27531.	64500.	0.
1729.000	-0.13	571.55	540.97	17000.	27531.	64500.	258.
1022.000	-0.03	571.54	542.17	17000.	27531.	64500.	300.
418.000	0.16	571.55	542.76	17000.	27531.	64500.	0.
0.000	0.95	571.56	543.65	17000.	27464.	63478.	0.

TABLE 5.45. TRAP EFFICIENCY STUDY WITH FLOW 18,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 18000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EF
5.00	27868.000	227.66			246.17			16.79		
TOTAL=	0.000	227.66	227.14	0.00	246.17	242.49	0.01	16.79	0.00	1.0

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-1.70	572.97	548.30	18000.	29751.	69702.	6181.
26985.000	-0.59	572.97	545.21	18000.	29751.	69702.	6187.
26545.000	0.04	572.98	544.34	18000.	29751.	69702.	4908.
25775.000	-1.07	572.79	544.03	18000.	29751.	69702.	4952.
24915.000	-1.04	572.78	540.96	18000.	29751.	69702.	4902.
23828.000	0.01	572.76	545.11	18000.	29751.	69702.	6141.
22680.000	1.18	572.70	544.68	18000.	29751.	69702.	8110.
21350.000	0.27	572.64	543.17	18000.	29751.	69702.	9587.
20855.000	0.59	572.63	543.29	18000.	29751.	69702.	8494.
20057.000	0.34	572.59	544.94	18000.	29751.	69702.	7266.
19557.000	-0.08	572.56	540.62	18000.	29751.	69702.	6750.
18925.000	1.40	572.57	542.90	18000.	29751.	69702.	4124.
18295.000	-0.12	572.51	540.58	18000.	29751.	69702.	3888.
17695.000	-0.19	572.46	543.61	18000.	29751.	69702.	3783.
16233.000	0.72	572.45	540.12	18000.	29751.	69702.	1894.
15823.000	-0.52	572.36	544.28	18000.	29751.	69702.	1985.
14980.000	-0.36	572.34	542.64	18000.	29751.	69702.	1891.
14361.000	-0.24	572.34	541.26	18000.	29751.	69702.	2316.
14036.000	-0.53	572.25	543.07	18000.	29751.	69702.	2437.
12602.000	-0.50	572.18	544.30	18000.	29751.	69702.	2671.
12188.000	-0.29	572.18	545.31	18000.	29751.	69702.	2651.
11610.000	1.29	572.19	544.79	18000.	29751.	69702.	3695.
11067.000	-0.06	572.13	543.44	18000.	29751.	69702.	3771.
10635.000	-0.22	572.06	542.48	18000.	29751.	69702.	3858.
10215.000	-0.28	572.03	542.02	18000.	29751.	69702.	3993.
9671.000	-0.04	572.06	542.46	18000.	29751.	69702.	3921.
9148.000	-0.47	571.89	541.93	18000.	29751.	69702.	3924.
7581.000	-0.51	571.78	541.59	18000.	29751.	69702.	4241.
5725.000	-0.36	571.68	540.94	18000.	29751.	69702.	4674.
4003.000	-0.31	571.55	541.09	18000.	29751.	69702.	4744.
3458.000	2.93	571.62	545.93	18000.	29751.	69702.	2341.
2817.000	0.24	571.64	543.24	18000.	29751.	69702.	0.
1729.000	-0.19	571.55	540.91	18000.	29751.	69702.	277.
1022.000	-0.14	571.54	542.06	18000.	29751.	69702.	544.
418.000	0.30	571.55	542.90	18000.	29751.	69702.	0.
0.000	0.97	571.56	543.67	18000.	29683.	68658.	0.

TABLE 5.46. TRAP EFFICIENCY STUDY WITH FLOW 19,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 19000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY		CLAY			SILT			SAND		
DAYS	POINT	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF	INFLOW	OUTFLOW	TRAP EFF
5.00	27868.000	245.00			264.91			18.06		
TOTAL=	0.000	245.00	244.46	0.00	264.91	261.15	0.01	18.06	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-1.76	573.12	548.24	19000.	32016.	75008.	6839.
26985.000	-0.83	573.11	544.97	19000.	32016.	75008.	7032.
26545.000	0.18	573.12	544.48	19000.	32016.	75008.	5612.
25775.000	-1.13	572.91	543.97	19000.	32016.	75008.	5622.
24915.000	-1.03	572.90	540.97	19000.	32016.	75008.	5615.
23828.000	-0.20	572.88	544.90	19000.	32016.	75008.	6946.
22680.000	1.01	572.82	544.51	19000.	32016.	75008.	8316.
21350.000	0.17	572.75	543.07	19000.	32016.	75008.	11480.
20855.000	0.52	572.74	543.22	19000.	32016.	75008.	11063.
20057.000	0.50	572.69	545.10	19000.	32016.	75008.	9487.
19557.000	-0.13	572.67	540.57	19000.	32016.	75008.	8601.
18925.000	1.57	572.67	543.07	19000.	32016.	75008.	6170.
18295.000	-0.11	572.61	540.59	19000.	32016.	75008.	5954.
17695.000	-0.19	572.55	543.61	19000.	32016.	75008.	5807.
16233.000	0.88	572.54	540.28	19000.	32016.	75008.	3342.
15823.000	-0.55	572.44	544.25	19000.	32016.	75008.	3469.
14980.000	-0.36	572.42	542.64	19000.	32016.	75008.	3465.
14361.000	-0.16	572.42	541.34	19000.	32016.	75008.	3234.
14036.000	-0.52	572.32	543.08	19000.	32016.	75008.	3295.
12602.000	-0.51	572.24	544.29	19000.	32016.	75008.	3305.
12188.000	-0.33	572.24	545.27	19000.	32016.	75008.	3418.
11610.000	1.06	572.26	544.56	19000.	32016.	75008.	4931.
11067.000	-0.09	572.19	543.41	19000.	32016.	75008.	5056.
10635.000	-0.27	572.11	542.43	19000.	32016.	75008.	5184.
10215.000	-0.59	572.08	541.71	19000.	32016.	75008.	5362.
9671.000	0.01	572.11	542.51	19000.	32016.	75008.	5417.
9148.000	-0.45	571.92	541.95	19000.	32016.	75008.	5448.
7581.000	-0.52	571.80	541.58	19000.	32016.	75008.	5466.
5725.000	-0.44	571.69	540.86	19000.	32016.	75008.	6204.
4003.000	-0.35	571.55	541.05	19000.	32016.	75008.	6433.
3458.000	3.20	571.63	546.20	19000.	32016.	75008.	4266.
2817.000	0.55	571.65	543.55	19000.	32016.	75008.	0.
1729.000	-0.22	571.55	540.88	19000.	32016.	75008.	205.
1022.000	-0.20	571.53	542.00	19000.	32016.	75008.	480.
418.000	0.39	571.54	542.99	19000.	32016.	75008.	0.
0.000	0.99	571.56	543.69	19000.	31946.	73943.	0.

TABLE 5.47. TRAP EFFICIENCY STUDY WITH FLOW 20,000 CFS

DOWNSTREAM BOUNDARY DATA
WATER DISCHARGE= 20000.00
ELEVATION= 571.56
TEMPERATURE= 55.00
FLOW DURATION(DAYS) 1.00

ACCUMULATED AC-FT BY ENTRY DAYS	POINT	CLAY INFLOW	CLAY OUTFLOW	CLAY TRAP EFF	SILT INFLOW	SILT OUTFLOW	SILT TRAP EFF	SAND INFLOW	SAND OUTFLOW	SAND TRAP EFF
5.00	27868.000	262.66			284.01			19.37		
TOTAL=	0.000	262.66	262.11	0.00	284.01	280.17	0.01	19.37	0.00	1.00

SECTION ID NO	BED CHANGE FEET	WS ELEV FEET	THALWEG EL FEET	Q CFS	SEDIMENT LOAD IN TONS/DAY CLAY	SILT	SAND
27868.000	-1.78	573.26	548.22	20000.	34324.	80415.	7276.
26985.000	-1.14	573.26	544.66	20000.	34324.	80415.	7704.
26545.000	0.29	573.27	544.59	20000.	34324.	80415.	6411.
25775.000	-1.13	573.04	543.97	20000.	34324.	80415.	6417.
24915.000	-1.01	573.03	540.99	20000.	34324.	80415.	6366.
23828.000	-0.44	573.01	544.66	20000.	34324.	80415.	7640.
22680.000	0.99	572.95	544.49	20000.	34324.	80415.	8287.
21350.000	-0.12	572.88	542.78	20000.	34324.	80415.	12532.
20855.000	0.51	572.85	543.21	20000.	34324.	80415.	13334.
20057.000	0.50	572.81	545.10	20000.	34324.	80415.	12018.
19557.000	-0.19	572.78	540.51	20000.	34324.	80415.	11014.
18925.000	1.72	572.79	543.22	20000.	34324.	80415.	8637.
18295.000	-0.10	572.72	540.60	20000.	34324.	80415.	8031.
17695.000	-0.22	572.65	543.58	20000.	34324.	80415.	7861.
16233.000	1.02	572.64	540.42	20000.	34324.	80415.	5307.
15823.000	-0.55	572.53	544.25	20000.	34324.	80415.	5319.
14980.000	-0.40	572.51	542.60	20000.	34324.	80415.	5448.
14361.000	-0.03	572.51	541.47	20000.	34324.	80415.	4890.
14036.000	-0.50	572.40	543.10	20000.	34324.	80415.	4887.
12602.000	-0.50	572.31	544.30	20000.	34324.	80415.	4942.
12188.000	-0.44	572.32	545.16	20000.	34324.	80415.	5352.
11610.000	0.97	572.33	544.47	20000.	34324.	80415.	6200.
11067.000	-0.12	572.25	543.38	20000.	34324.	80415.	6343.
10635.000	-0.69	572.18	542.01	20000.	34324.	80415.	6624.
10215.000	-0.74	572.14	541.56	20000.	34324.	80415.	6888.
9671.000	-0.01	572.17	542.49	20000.	34324.	80415.	7098.
9148.000	-0.52	571.96	541.88	20000.	34324.	80415.	7115.
7581.000	-0.46	571.83	541.64	20000.	34324.	80415.	7179.
5725.000	-0.48	571.71	540.82	20000.	34324.	80415.	7586.
4003.000	-0.36	571.54	541.04	20000.	34324.	80415.	7960.
3458.000	3.43	571.64	546.43	20000.	34324.	80415.	6415.
2817.000	0.93	571.65	543.93	20000.	34324.	80415.	0.
1729.000	-0.24	571.55	540.86	20000.	34324.	80415.	98.
1022.000	-0.23	571.53	541.97	20000.	34324.	80415.	258.
418.000	0.43	571.54	543.03	20000.	34324.	80415.	0.
0.000	1.00	571.56	543.70	20000.	34253.	79330.	0.

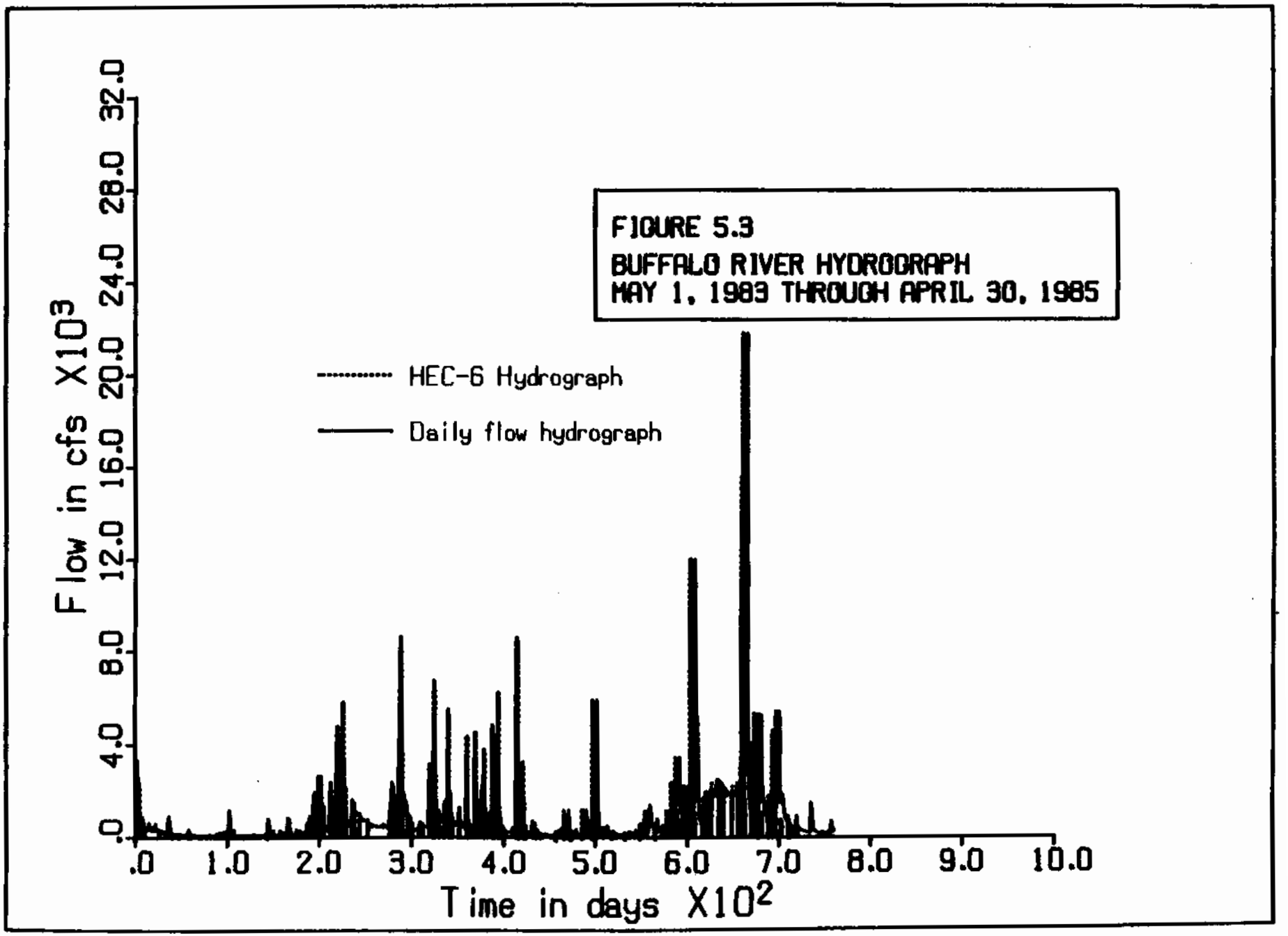


FIGURE 5.3
BUFFALO RIVER HYDROGRAPH
MAY 1, 1983 THROUGH APRIL 30, 1985
HEC-6 Hydrograph
Daily flow hydrograph
Flow in cfs X10³
0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0
.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Time in days X10²

water temperatures were varied seasonally.

The sediment load, Q_S, rating curve was obtained by selecting the low flow of record with its associated sediment load, the high flow of record with its associated sediment load, and two intermediate flows with their associated sediment loads. The HEC-6 program then interpolates linearly on a log Q versus Q_S. This approximation was a simplification since it tends to smooth out the seasonal variations for sediment yield from the tributary basins as discussed in Section 3.

The results of this simulation run are not conclusive because of the program limitation that does not account for scouring of silts and clays from the river bed. There are still, however, some findings of interest.

The total load delivered to the river system from the upstream basin is calculated by the program to be 1,199,482 tons. This includes 335,847 tons of clay, 786,846 tons of silt, and 76,788 tons of sand. This compares favorably with the value of 1,069,657 tons computed from the accumulation of day-by-day sediment loads based on the mean daily discharges over the same time period. Two factors contribute to this difference of approximately 12 percent. Firstly, the histograph approximation to the inflow hydrograph would produce a difference. Secondly, the Q versus Q_s rating curve approximation would produce a difference. The agreement is considered satisfactory.

For the period May 1, 1983 through April 1984 the simulation results indicate that 62 percent of the sediment inflow was trapped by the river. The simulation results indicate that 40 percent of the sediment inflow was trapped during the period May 1, 1984 through April 1985. This compares with 36 and 23 percent from Table 4.3 for the bathymetric survey data for the same time periods.

The results indicate that over the two-year period 31 percent of the clay-size materials introduced to the river from the upstream basin were trapped in the river system. Similarly, 48 percent of the silt-size particles were trapped, and all of the sand was trapped. Considering all of the sediment load entering the river system over the simulation period, approximately 46 percent was trapped; i.e., 553,700 tons of sediment. Approximately 54 percent of the incoming sediment load passed through the river system during the simulation period; i.e., 645,782 tons of sediment in the clay and silt-size ranges. An internal check on the volume of trapped sediment was carried out by integrating the computed changes in bed elevation throughout the river system. Based on an average bed porosity of 0.6, the agreement between the amount of sediment trapped and the bed volume change was very good.

A separate computation was made of bed volume change using the survey data provided by the Corps of Engineers. Again, using a bed porosity of 0.6, the computed change in bed volume over the simulation time period was calculated to be approximately 280,000 tons.

The large discrepancy between the program simulation result of 553,700 tons of trapped sediment and the survey result of 280,000 tons could be due to the following:

(1) The simulation program does not account for scouring of silts and clays; therefore, one would expect the simulation result to be higher than that measured in the field.

(2) The several assumptions contained in the simulation program regarding bed porosities, sediment load calculations, simplification of the inflow hydrograph, etc., would produce errors.

(3) The sections used in computing bed change volume from the survey

data corresponded to the sections surveyed in the field. This number greatly exceeded the sections selected for the computer simulation runs.

Of the three possible causes for discrepancy listed above, it is difficult to assess which may have had the more significant effect. Undoubtedly, there would have been more scouring in the actual river than was provided by the computer simulation program. Also, the actual input of sediment to the Buffalo River was estimated based on data collected in the late 1950's and early 1960's. There is no way to assess the accuracy of the estimated sediment load calculations.

Suffice it to say that the observed discrepancy errs in the expected direction; i.e., more sediment was trapped using the computer simulation than was measured from field data.

Trap efficiency of the river varies inversely with the quantity of stream flow during the period for which trap efficiency is computed. The ratio of trap efficiency for the bathymetric survey data to trap efficiency for the simulation results remain at about 0.58 for both the high flow year and the below average flow year.

6. SUMMARY AND CONCLUSIONS

Streamflow and bathymetric survey data were obtained and used with published research results and an existing hydraulic model to analyze the sediment dynamics in the navigable portion of the Buffalo River. The results indicate that the river behaves as one would expect for a meandering, aggrading river.

6.1. Hydrology

The daily streamflow data for the three tributaries for the Buffalo River were adequate to establish a 45 year, October 1940 through September 1985, daily flow hydrograph at the upstream limit of the navigable section of the river. This daily flow hydrograph was then used to compute monthly and annual volumes of flow, flow duration curves for daily flows, and recurrence intervals for annual peak daily flows and total annual flows. The daily flow hydrograph and the hydrologic computation results were then used in the analysis and interpretation of the river sediment dynamics.

6.2. Sediment Inflow

The sediment inflow to the Buffalo River was estimated for each day of the period October 1940 through September 1985. The sediment inflows were estimated using the daily mean flow and an empirical relationship between the quantity of flow and the sediment concentration. The empirical relationship was developed by the Agricultural Research Service, USDA, from survey data during flooding periods. The relationship may not be as applicable during non-flood times. Whereas a few flood flows can cause a significant amount of sediment inflow, as indicated by Figure 3-13, there are many low flows and the use of the relationship indicates that collectively they generate a significant portion of the total sediment

inflow. Therefore, the estimates of the sediment inflow during low flow periods may be too large and the estimate of the total inflow may also be too large.

A linear regression analysis indicated that 86 percent of the variation in annual sediment yield could be explained by a linear relationship with annual water volume discharge. Thus, total annual streamflow can be used to determine a first order estimate of annual sediment yield for the river.

6.3. Sediment Surveys

Many bathymetric survey data sets were available. However, many of the surveys had been made for the purpose of determining the quantity dredged from specific reaches of the stream or harbor entrance and hence were not useful for this study. The survey data were used to estimate the change in the amount of sediment in the reach between two surveys. Often when two sets of survey data were available for the entire navigable portion of the river there would be a reach of the river that had been dredged between the time the two surveys were made and this made it difficult to determine the natural behavior of the river.

There was one period of two years, May 1983 to May 1985, during which no dredging had taken place and which had survey data for most of the navigable portion of the river. The data for this period were used to estimate the change in bed sediment for two time periods. Each time period was approximately one year in length. The results indicate that the trap efficiency of the river varies inversely with the annual flow volume. An annual flow with a recurrence interval of appoximately 50 years had a trap efficiency of 23 percent and an annual flow with a recurrence interval of approximately 3 years had a trap efficiency of 36 percent.

6.4. Sediment Transport in Buffalo River

The HEC-6 model was used to investigate scour-deposition patterns in the Buffalo River system with the assumption of no inflow of sediment material. The results indicate that sand begins to scour at a discharge of about 6,000 cfs. This scour activity begins at the upstream limit of the reach. For a discharge of 12,000 cfs the deposition occurs at the upstream end of the bends of the river. This pattern is consistent with that for a meandering stream.

The model was then used to study the trap efficiency of the river with sediment inflow. The river trapped all of the sand inflow at all discharges below 20,000 cfs. For discharges less than 500 cfs the river system serves as an efficient trap for the collection of all suspended sediment associated with these flows. Thus 68 percent of the time the river behaves as an efficient trap for incoming sediment. The trap efficiency for silt and clay was almost zero above 14,000 cfs. The river bends serve as the most efficient trap regions and continue to collect sediments at large discharge values while much of the remainder of the river system undergoes degradation due to scouring.

The HEC-6 model was used to simulate the two year period when there was no dredging in the river. Because of approximations in the sediment and discharge data for the computer input the model computed a 12 percent larger value for the sediment inflow during the period. The simulation results indicated that the trap efficiency of the river during the annual flow with a 3 year recurrence interval was 60 percent and the trap efficiency during the annual flow with approximately a 50 year recurrence interval was 40 percent. These values are much larger than the values

obtained from the bathymetric survey data. Part of the difference is because the model does not account for scour of silt and clay.

6.5. Study Extensions

The results of this study present a general picture of the river system behavior and indicate that the river behaves as a meandering, aggrading stream. There are some areas that would be profitable for further study.

Because of the limited time for this study it was not possible to use all of the bathymetric survey data. More information on trap efficiency and specific locations of scour and deposition could be obtained if more of the bathymetric survey data were used. This would require that time be spent with the U.S. Army Corps Engineers personnel to work out the intricacies of the survey data. Items such as baseline changes could be accounted for and improved computation procedures could be used.

The field study for the sediment yield was done in the 1950s and 1960s. The sediment yields are dependent on activities in the drainage basin and more recent information might lead to different sediment yields. A sampling program to duplicate the ARS study would indicate whether the sediment yields have significantly changed. Also the program should be extended to cover some of the lower flows to determine if the relationship is valid for the entire flow range.

Another area of investigation would be to study the effect of lake level on the behavior of the river. This study used only one lake level: a value closely approximating the average of recent high levels and long term mean levels. A study to indicate the sensitivity of the behavior of the river to changing lake levels could be run with existing data and models. One aspect would be to do the simulation runs at different lake levels to

determine the effect the lake level has on river behavior. Another aspect would be to simulate the behavior of the river for the two year period using the actual lake level for each time increment in the simulation. This sounds simple and easy but would require several days to set up the input data for the runs.

A new hydraulic model has become available for hydraulic and sediment scour and deposition simulation ("User's Manual for the Generalized Computer Program System: Open-Channel Flow and Sedimentation, TABS-2", Instruction Report HL-85-1, by W.A. Thomas and W.H. McAnally, Jr., U.S. Department of Army, Waterways Experiment Station, Vicksburgh, MI, August 1985). This new model incorporates silt and clay scour and thus would allow for a better simulation and analysis of the behavior of the river. It also provides for a two-dimensional representation of the river channel. Thus, deposition and scour patterns would be seen across a river section as well as along the channel.

APPENDIX A: CONVERSION FACTORS

Lenght, Volume and Weight

1 inch = 2.54 centimeters

1 foot = 0.3048 meters

1 mile = 1.60935 kilometers

1 square mile = 2.59 square kilometers

1 cubic foot = 0.028317 cubic meters

1 cubic foot per second = 28.317 liters per second

1 ton = 907.185 kilograms

Shear Stress

1 pound per square foot = 47.88 pascal (Pa)

Temperature

$^{o}F = {}^{o}C(9/5) + 32$

$^{o}C = (5/9)\,(^{o}F - 32)$

APPENDIX B: GRAPHS OF CHANGE IN BED ELEVATION FROM BATHYMETRIC SURVEYS

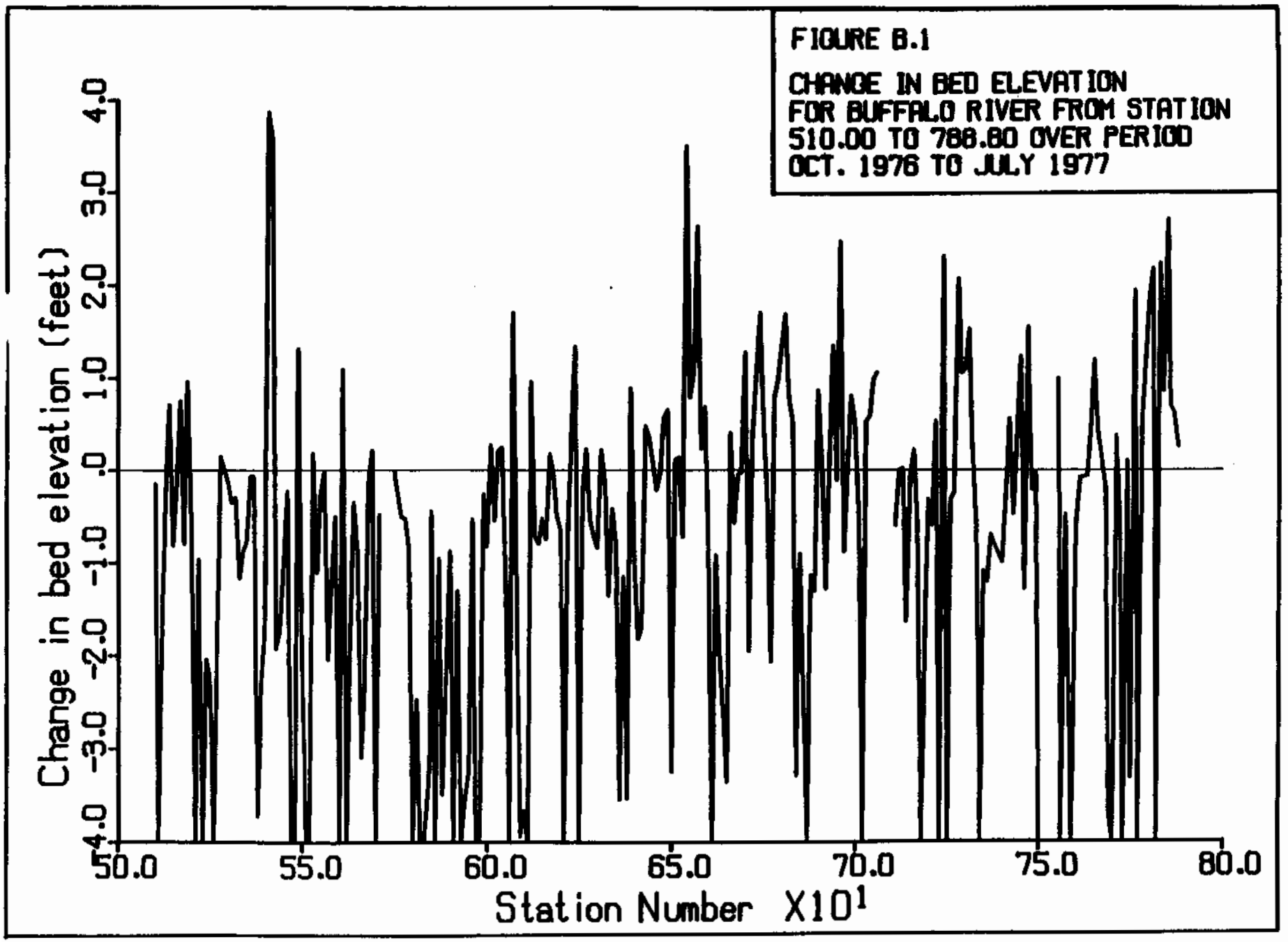


FIGURE B.1
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
OCT. 1976 TO JULY 1977
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

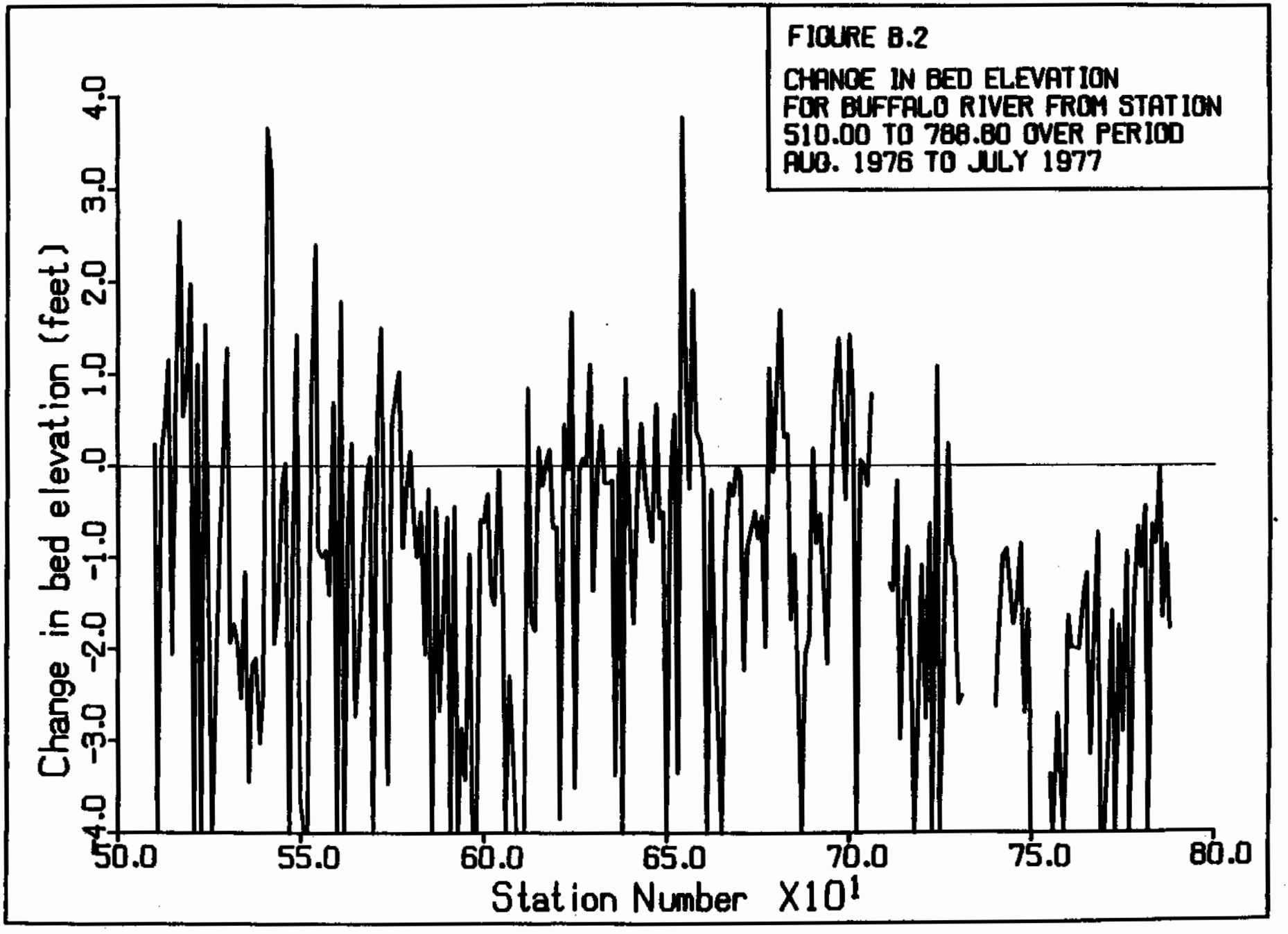


FIGURE 8.2
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1976 TO JULY 1977
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

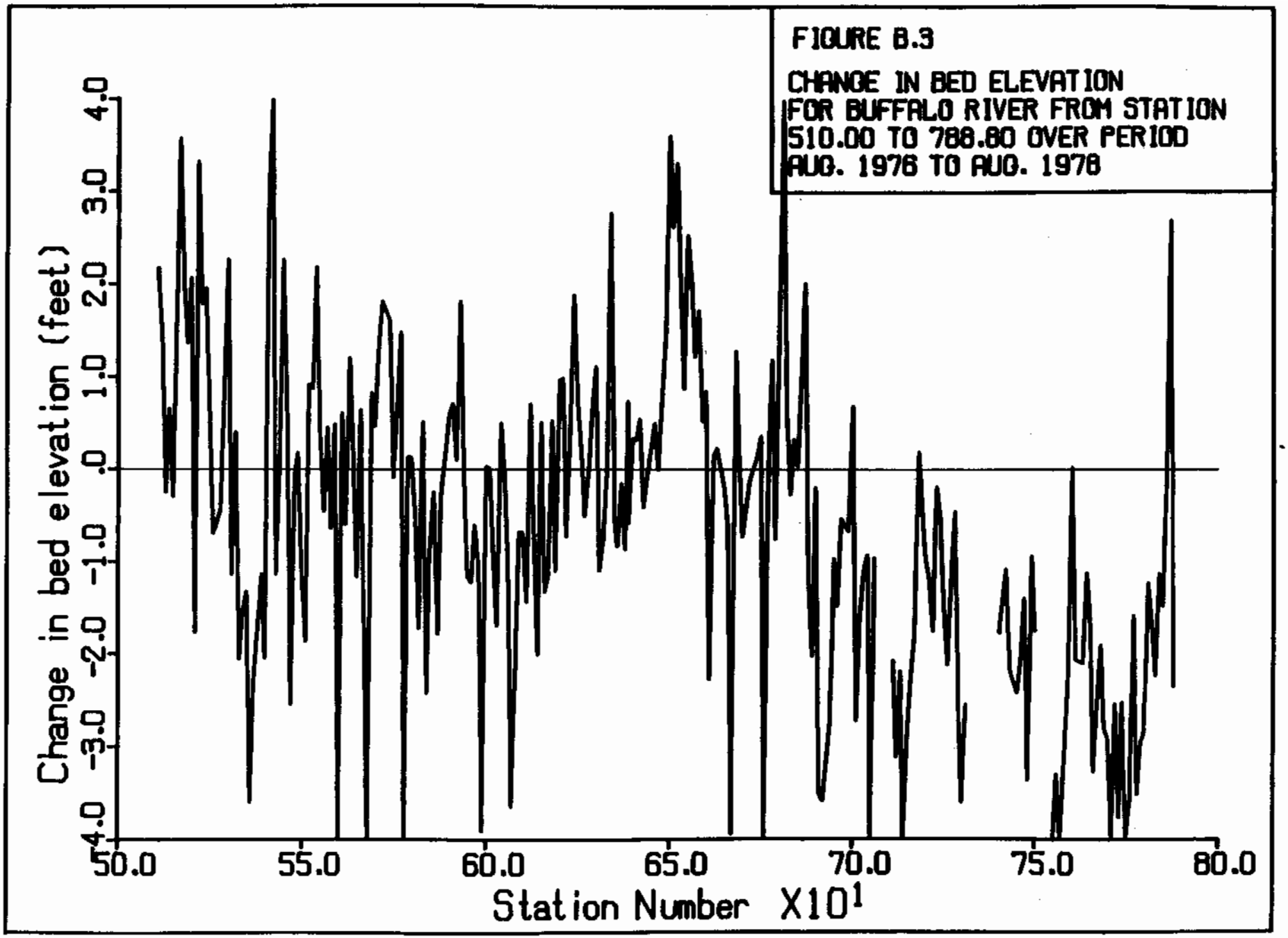


FIGURE B.3
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1976 TO AUG. 1978
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

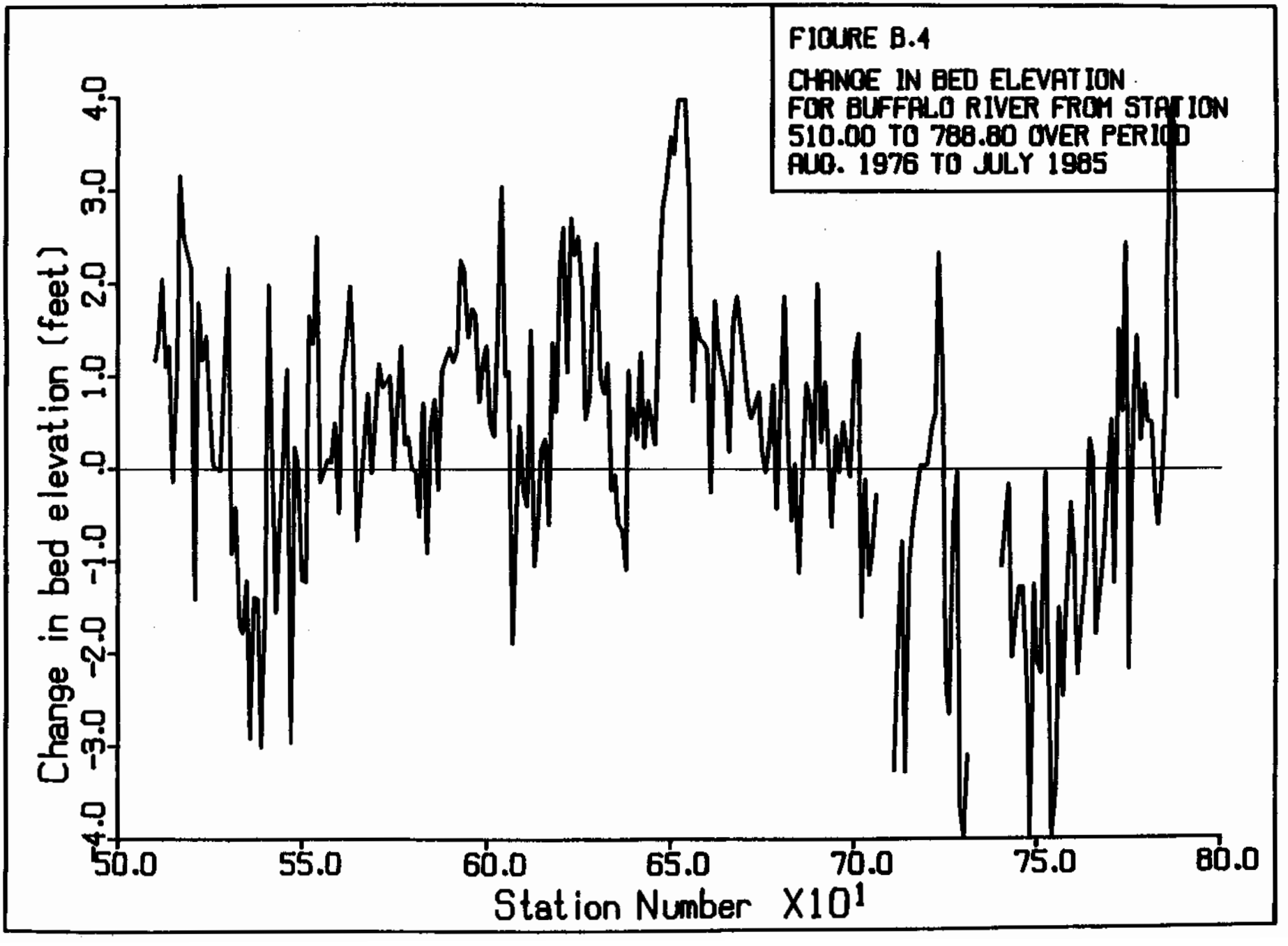


FIGURE B.4
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1976 TO JULY 1985
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

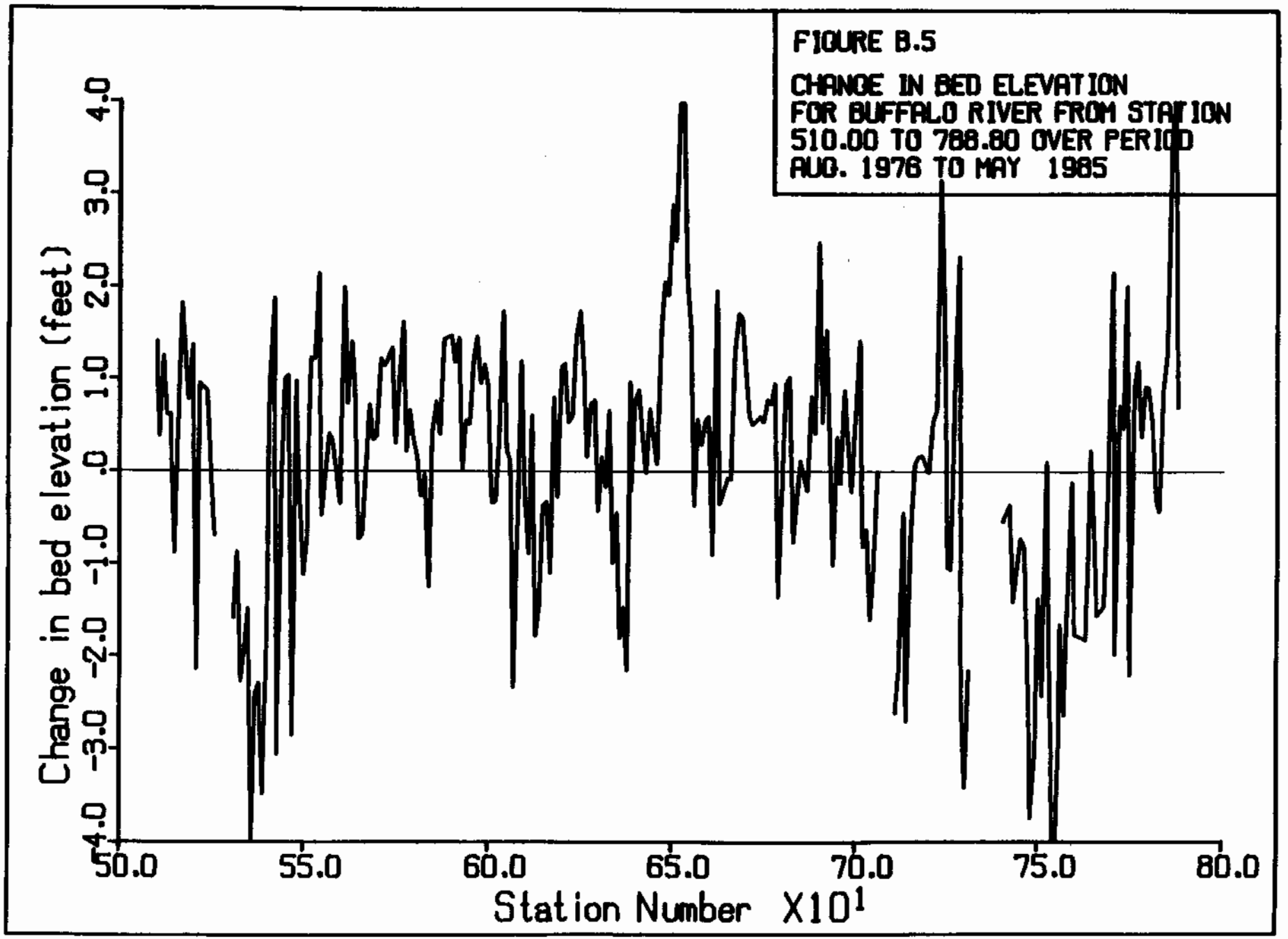


FIGURE B.5
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1976 TO MAY 1985
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

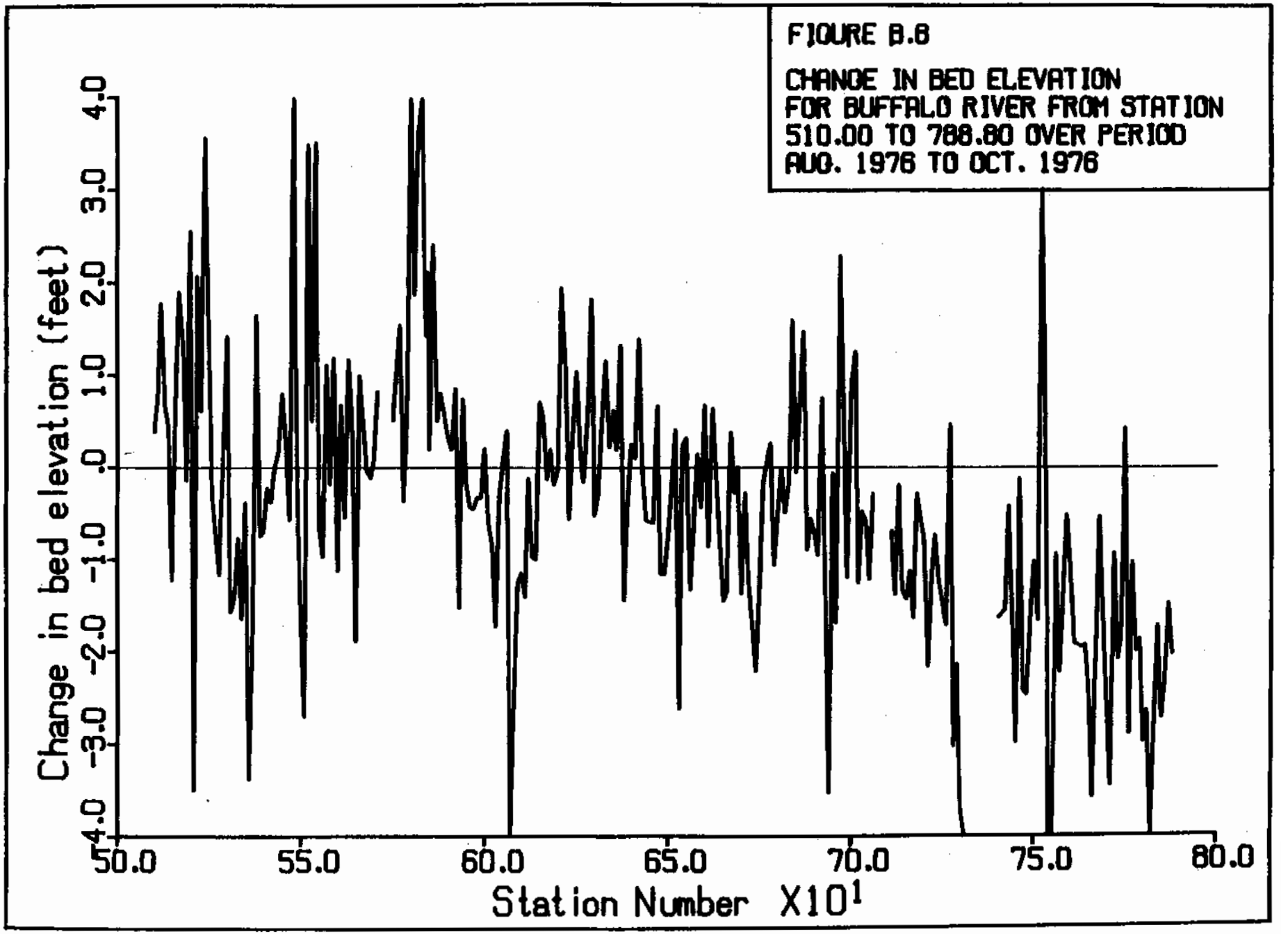
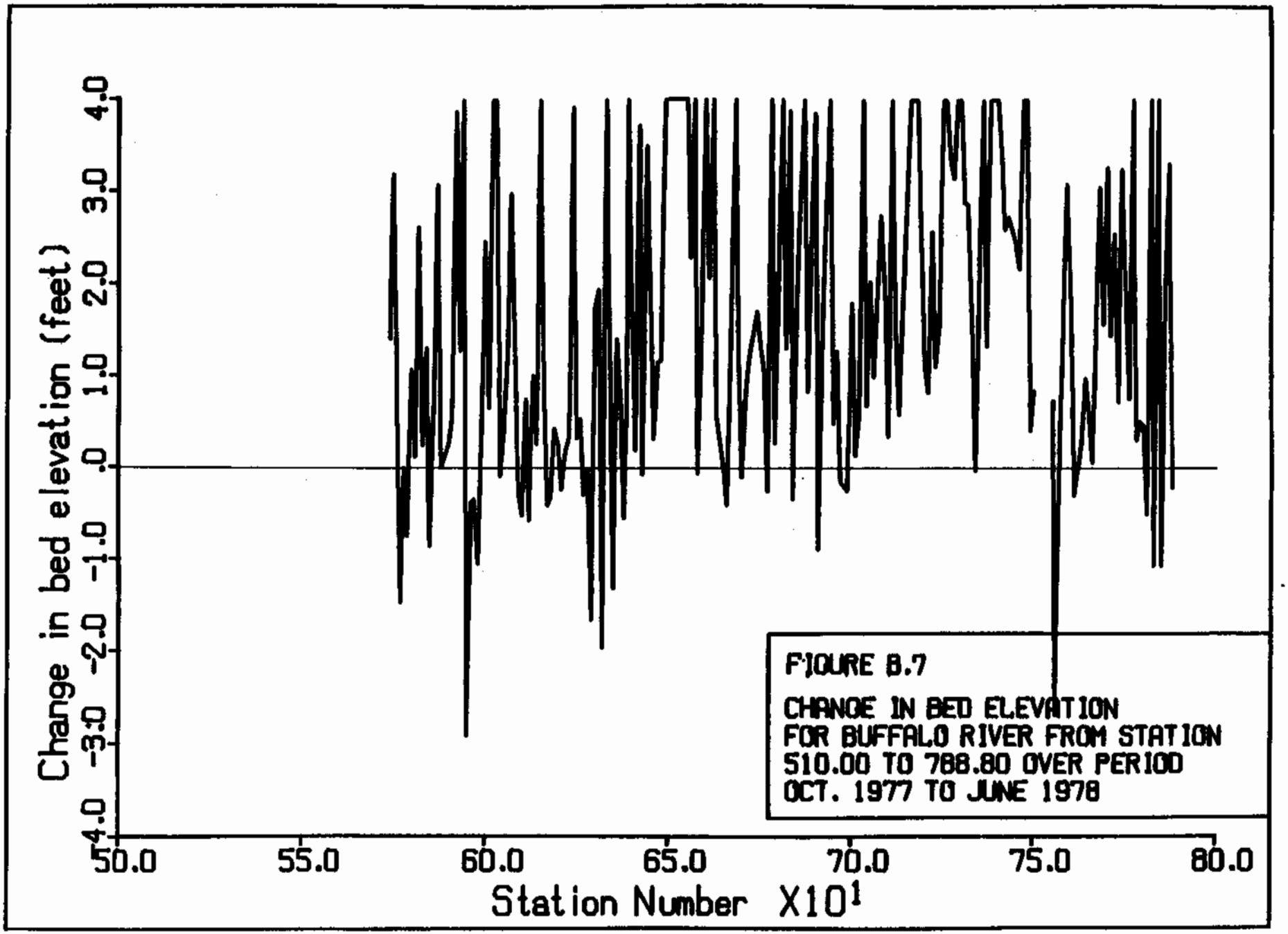
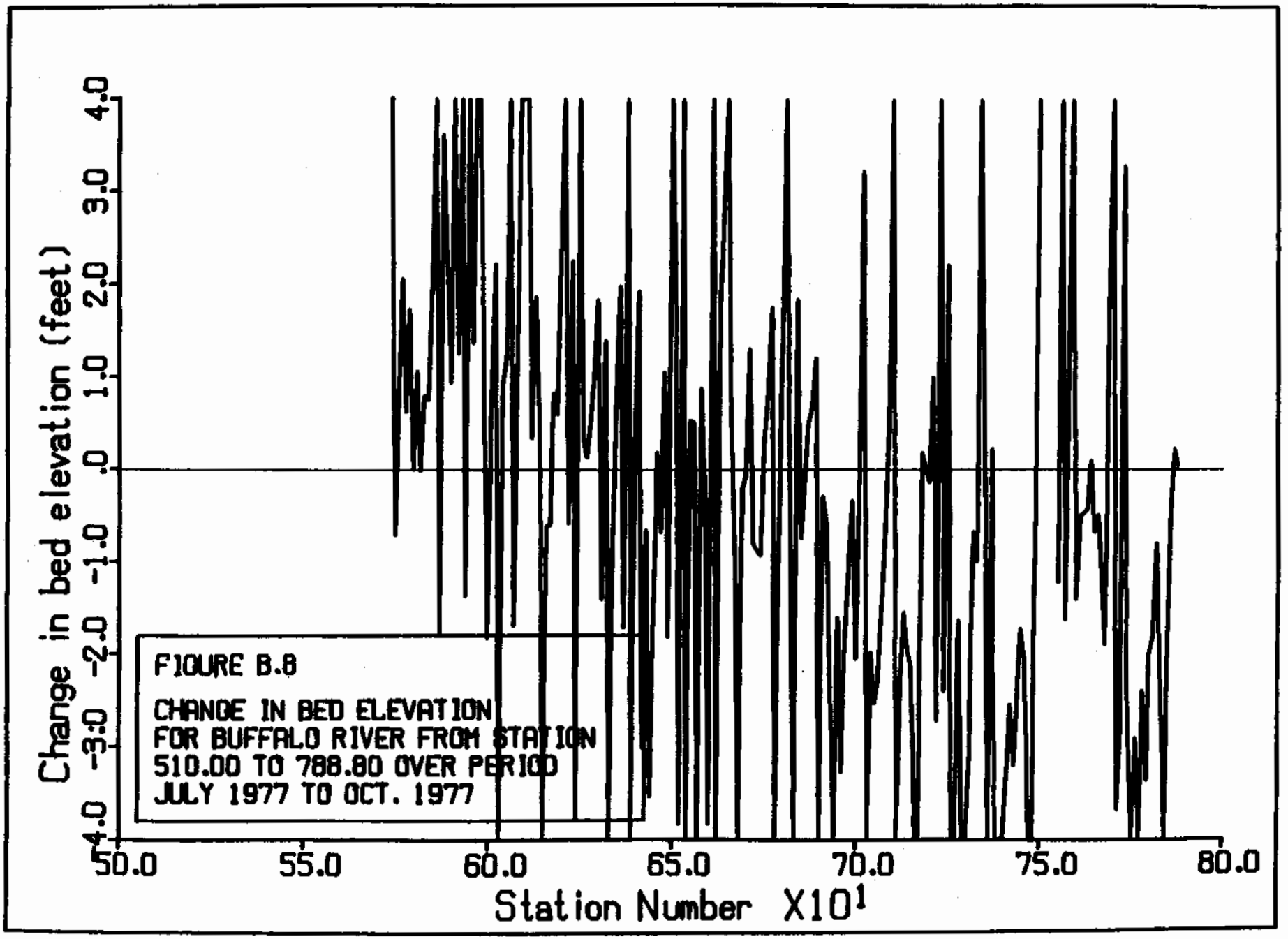


FIGURE B.6
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1976 TO OCT. 1976
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹


Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹
FIGURE B.7
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
OCT. 1977 TO JUNE 1978


Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹
FIGURE B.8
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JULY 1977 TO OCT. 1977

Change in bed elevation (feet)
4.0
3.0
2.0
1.0
0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹
FIGURE 8.9
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JULY 1977 TO AUG. 1978

Change in bed elevation (feet)
-4.0
-3.0
-2.0
-1.0
.0
1.0
2.0
3.0
4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹
FIGURE B.10
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JULY 1977 TO JUNE 1978

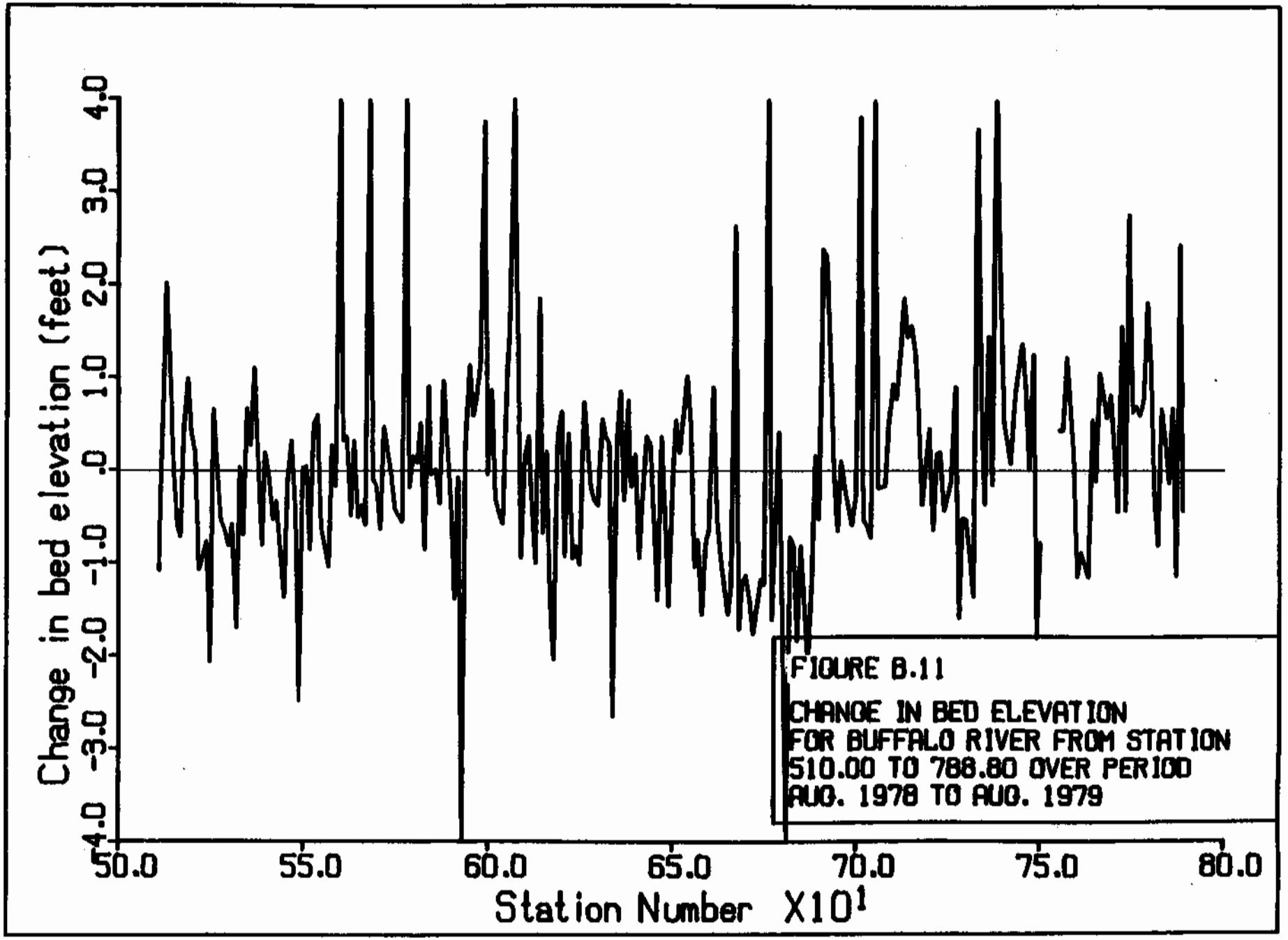


FIGURE 8.11

CHANGE IN BED ELEVATION FOR BUFFALO RIVER FROM STATION 510.00 TO 788.80 OVER PERIOD AUG. 1978 TO AUG. 1979

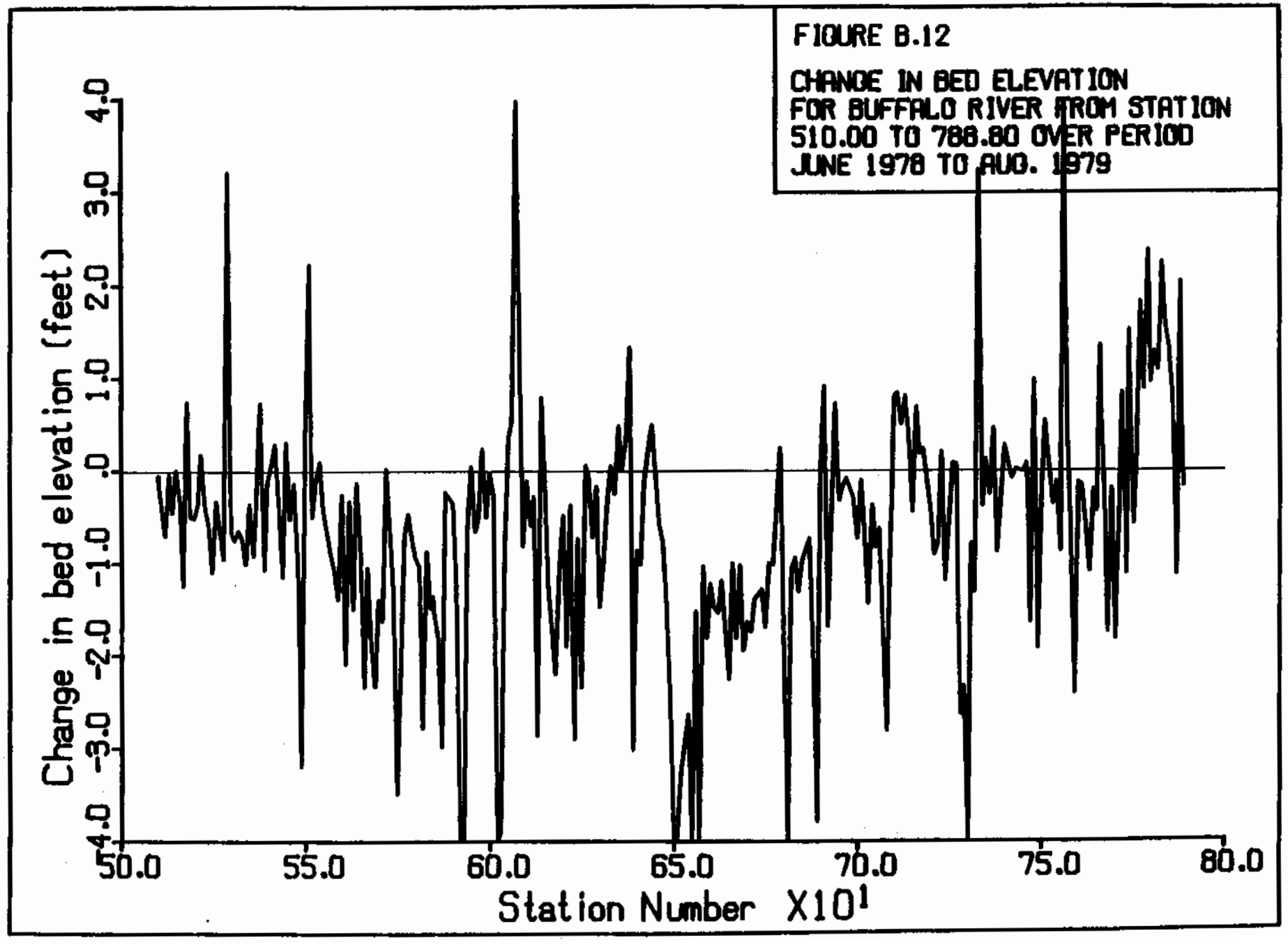


FIGURE B.12
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JUNE 1978 TO AUG. 1979
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

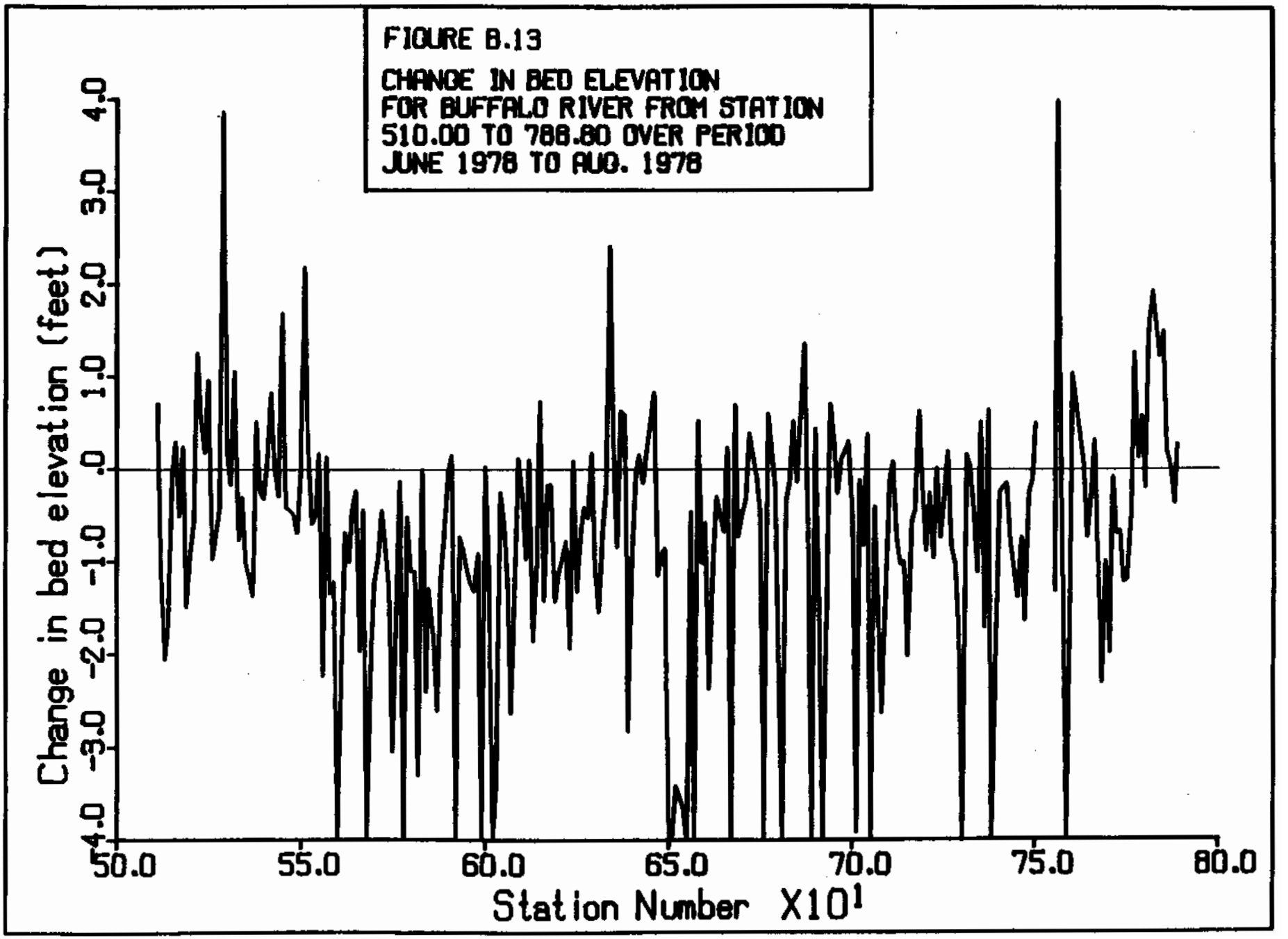


FIGURE B.13
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 786.80 OVER PERIOD
JUNE 1978 TO AUG. 1978
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

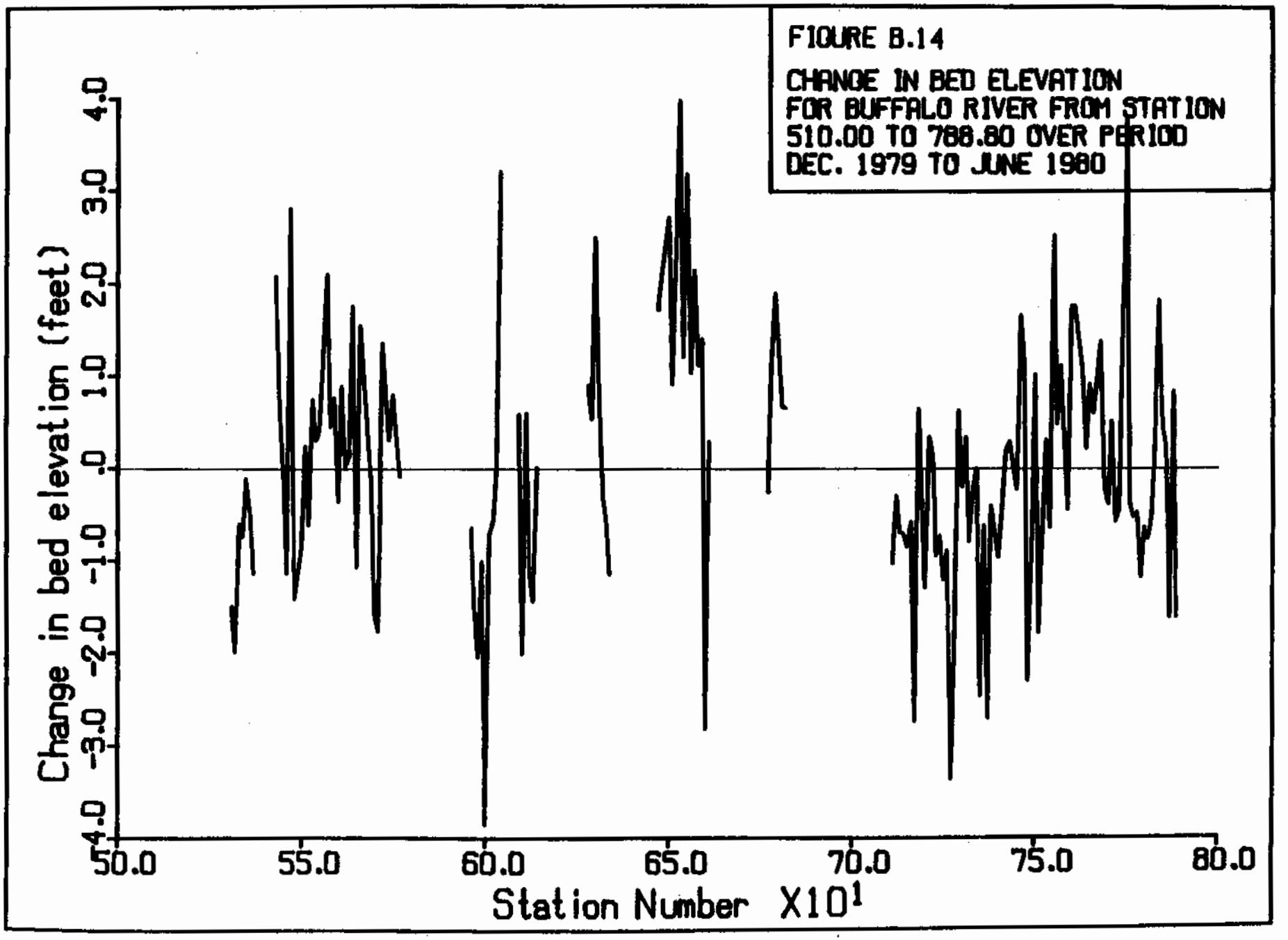


FIGURE B.14
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
DEC. 1979 TO JUNE 1980
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

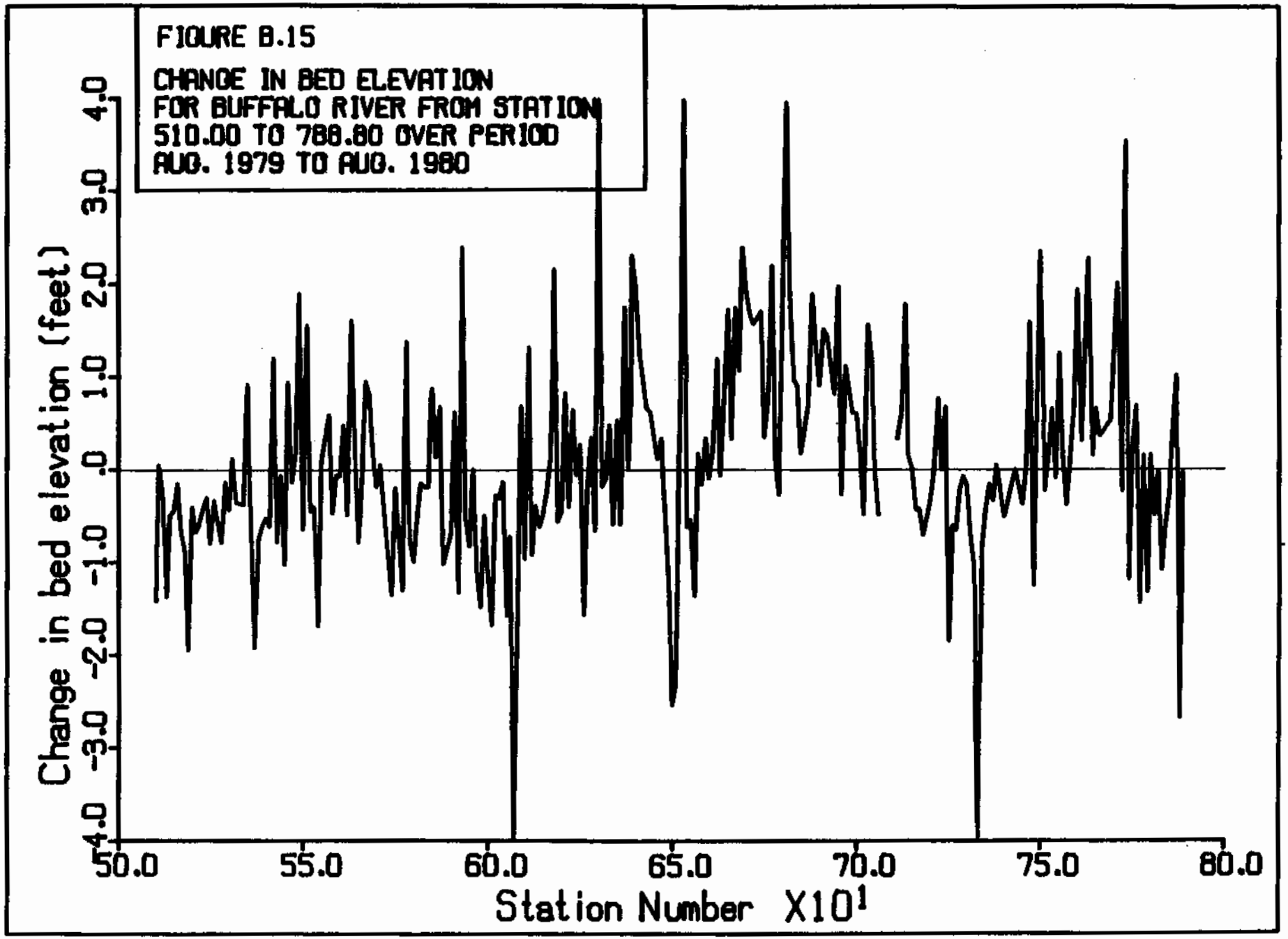


FIGURE B.15
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1979 TO AUG. 1980
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

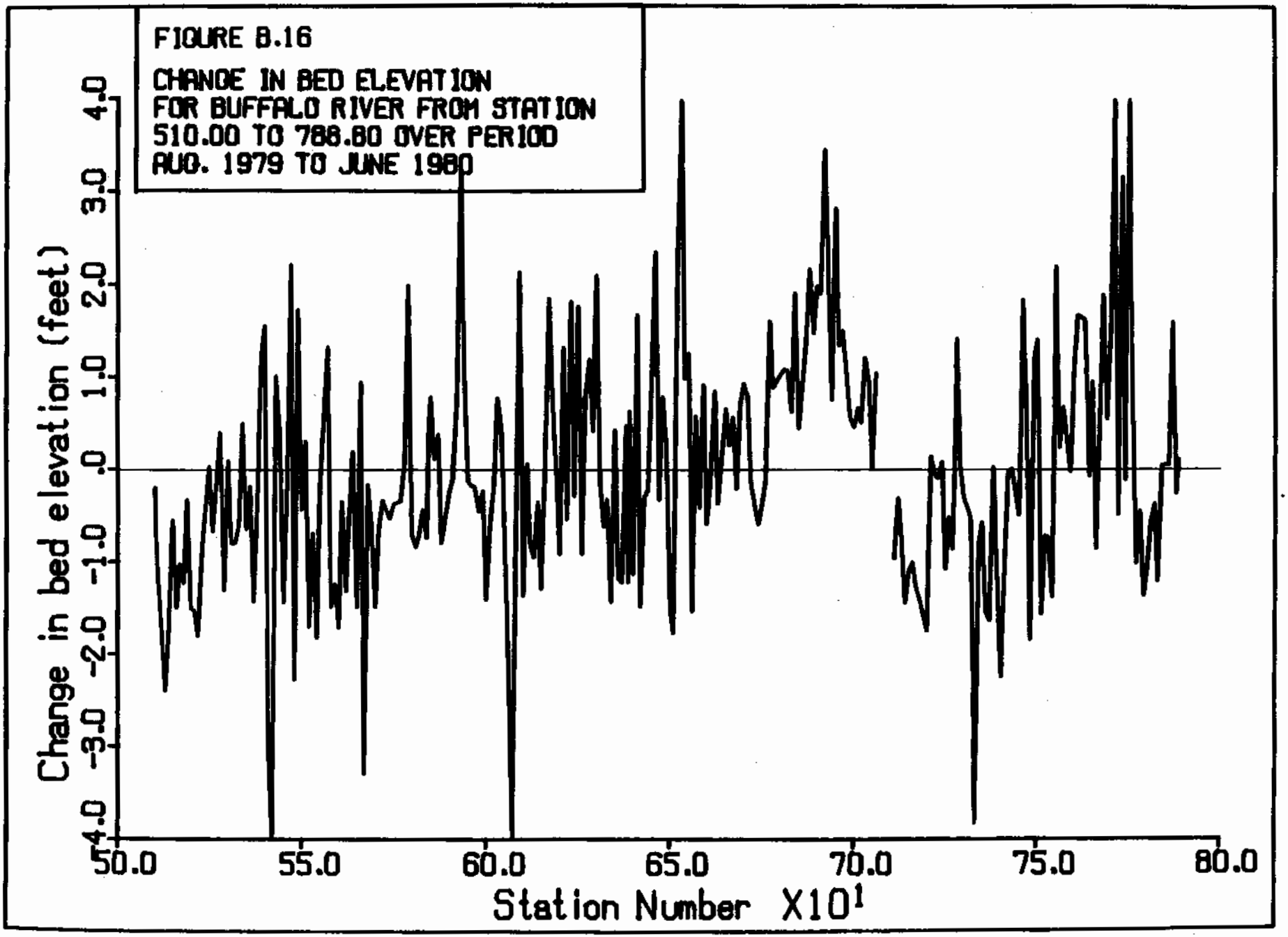


FIGURE 8.16
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1979 TO JUNE 1980
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

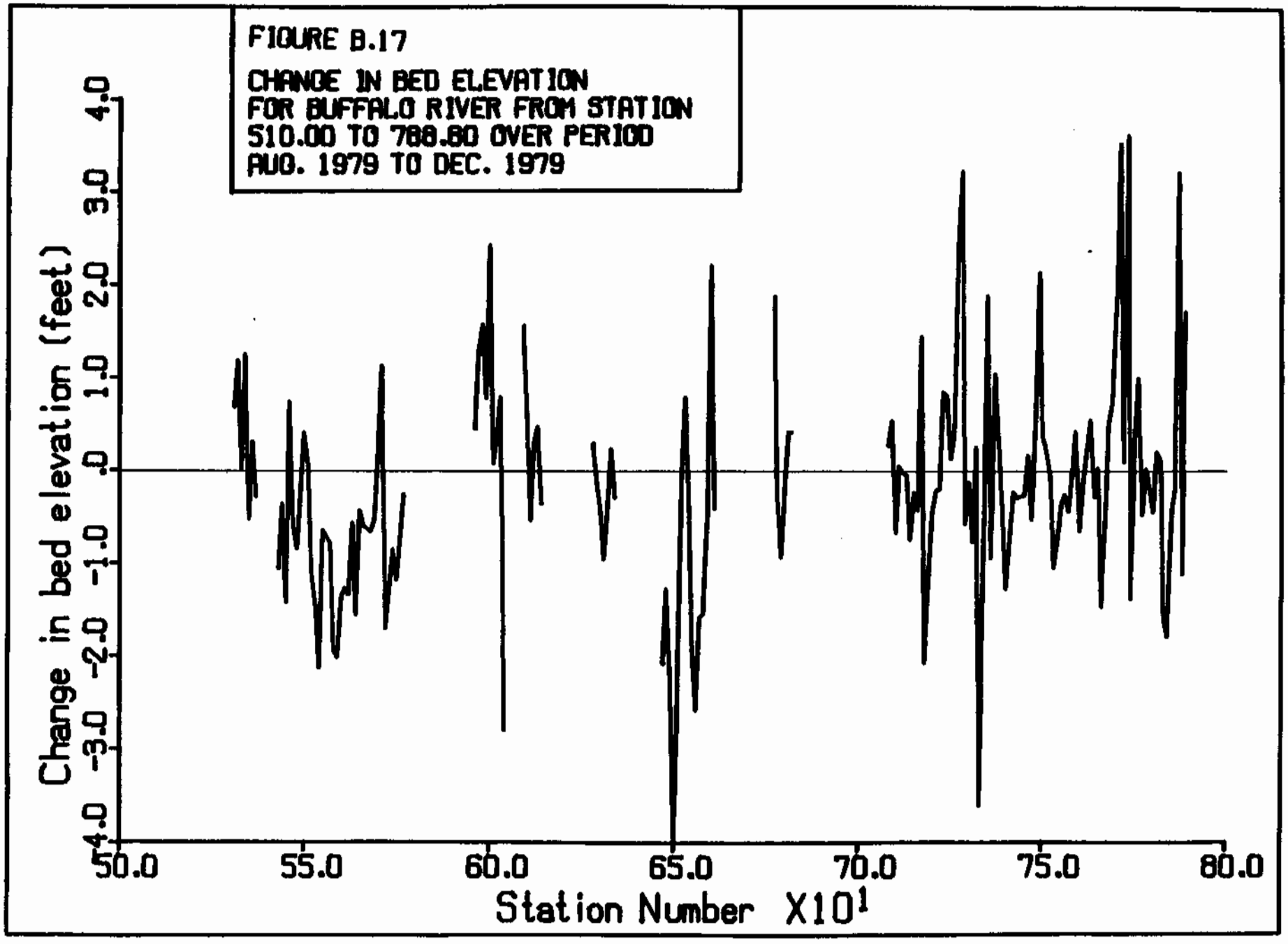


FIGURE B.17
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1979 TO DEC. 1979
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

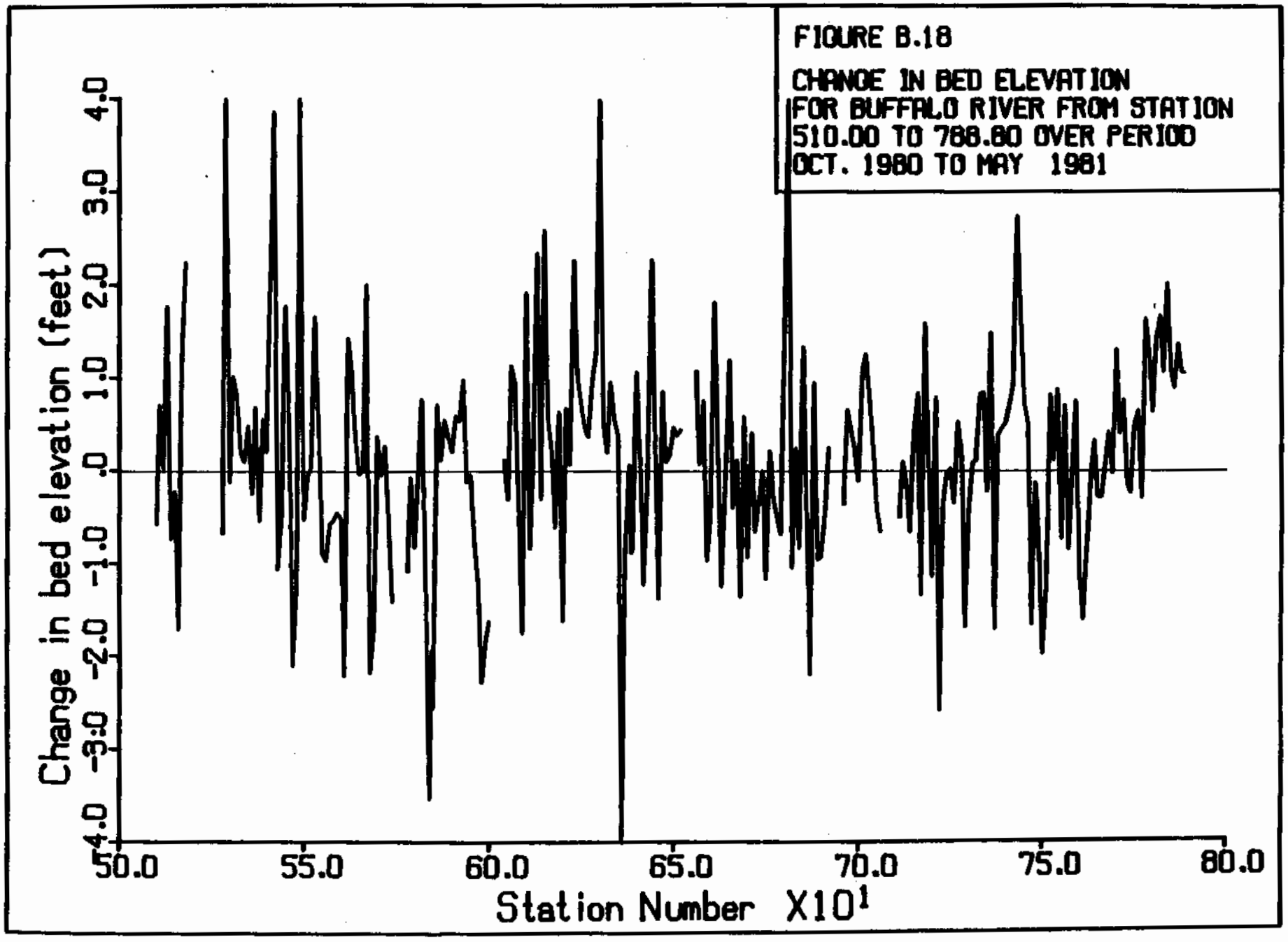


FIGURE B.18
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
OCT. 1980 TO MAY 1981
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

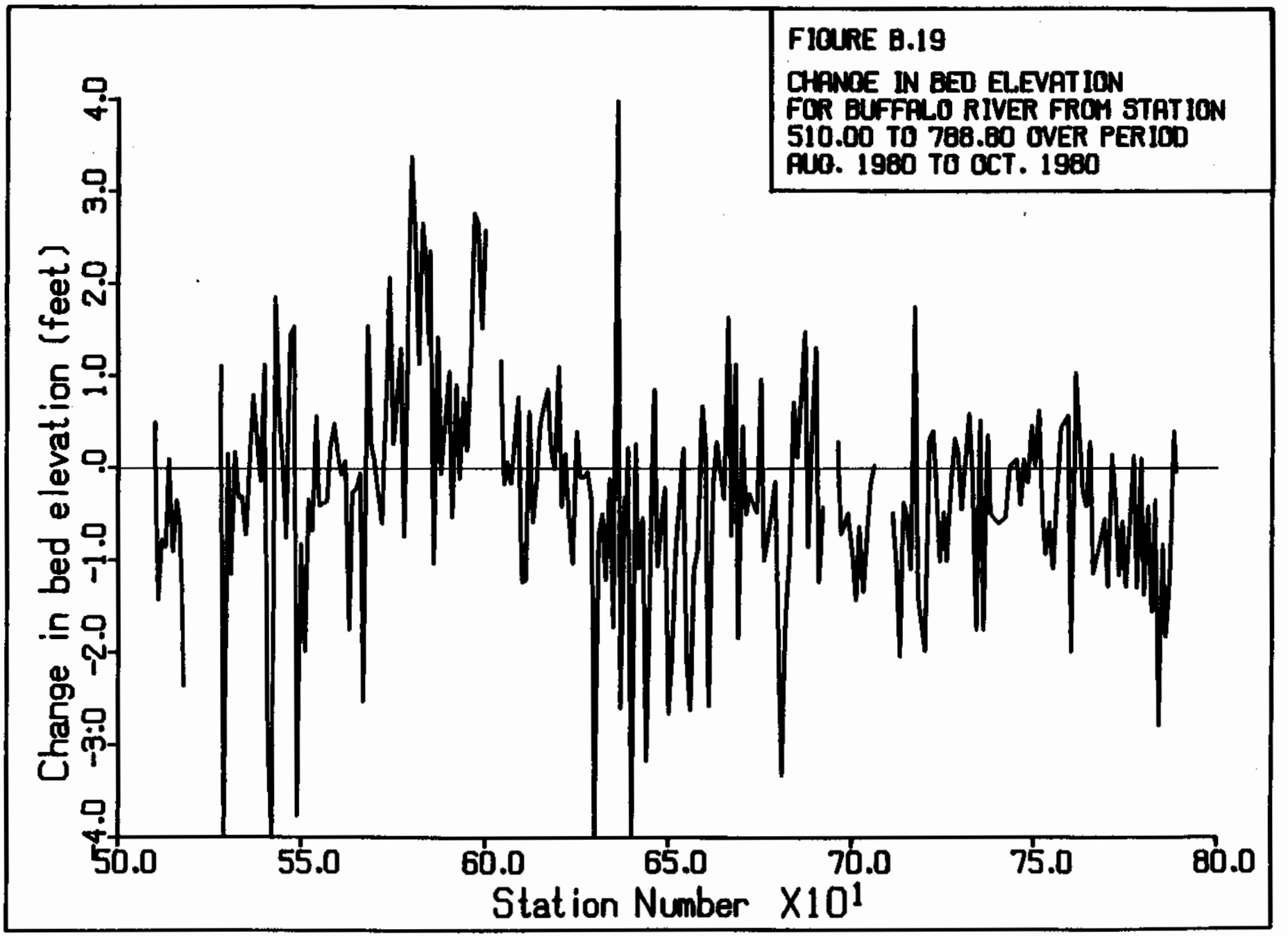


FIGURE B.19
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1980 TO OCT. 1980
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

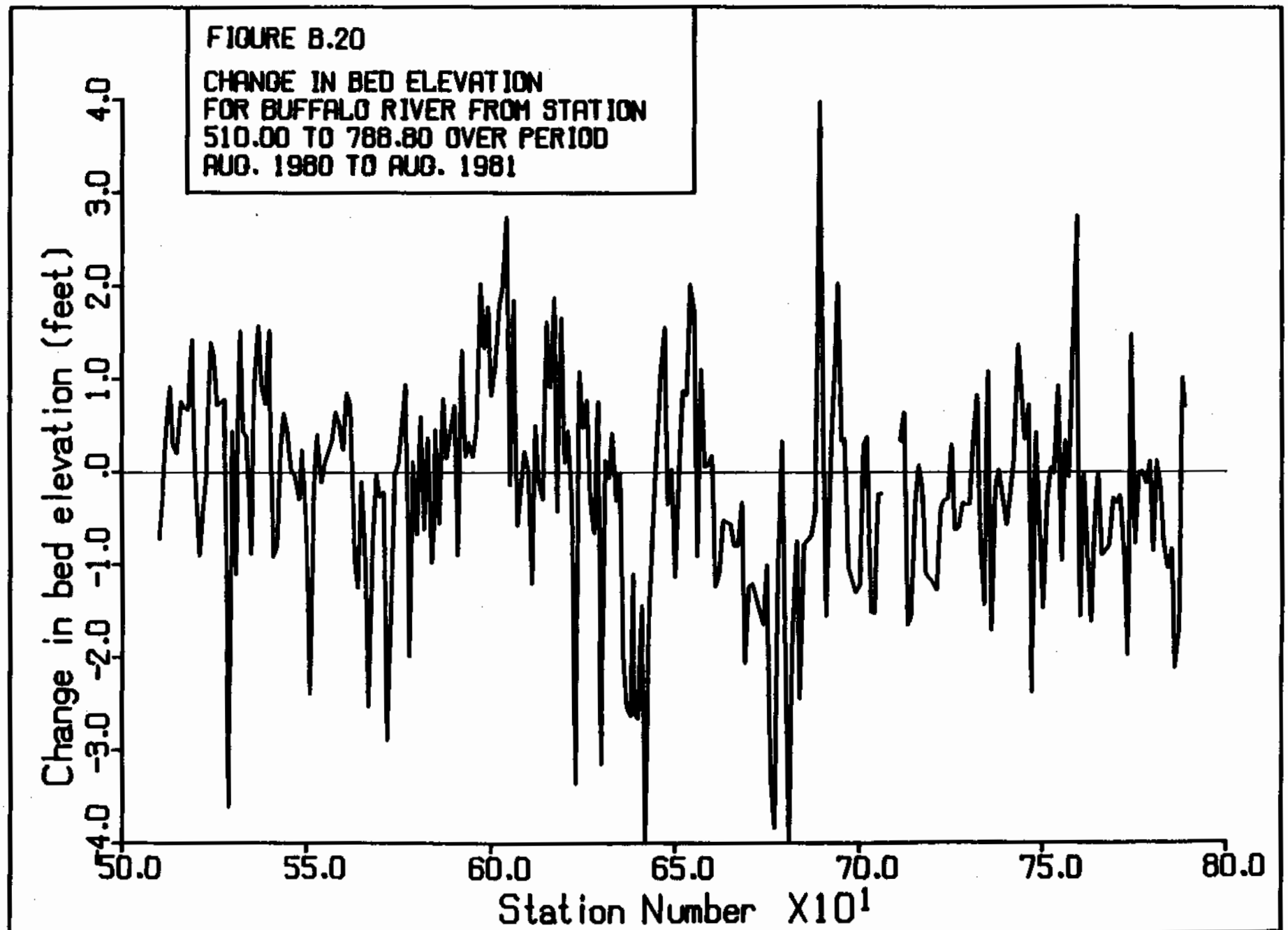


FIGURE B.20
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1980 TO AUG. 1981
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

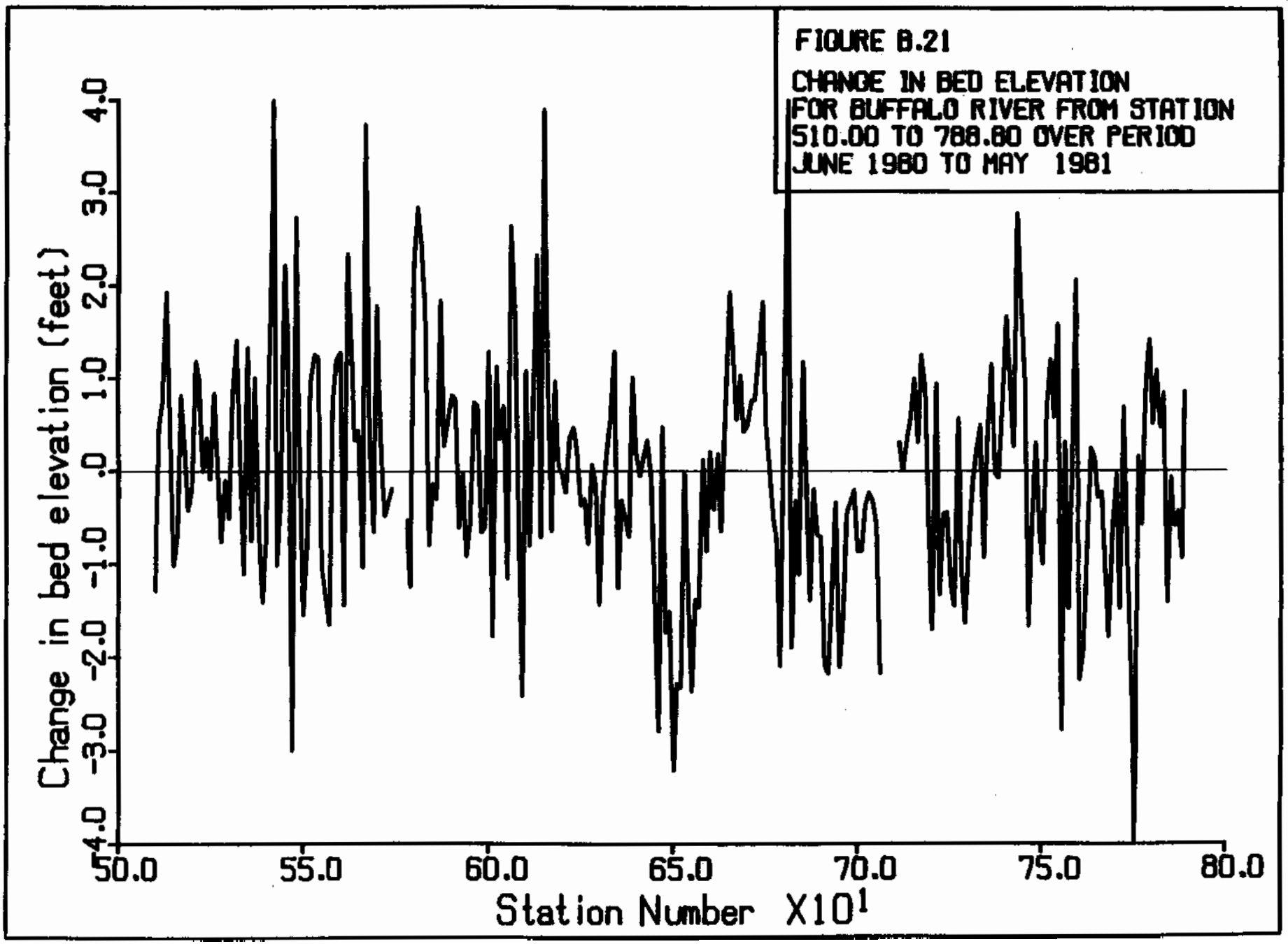


FIGURE B.21
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JUNE 1980 TO MAY 1981
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

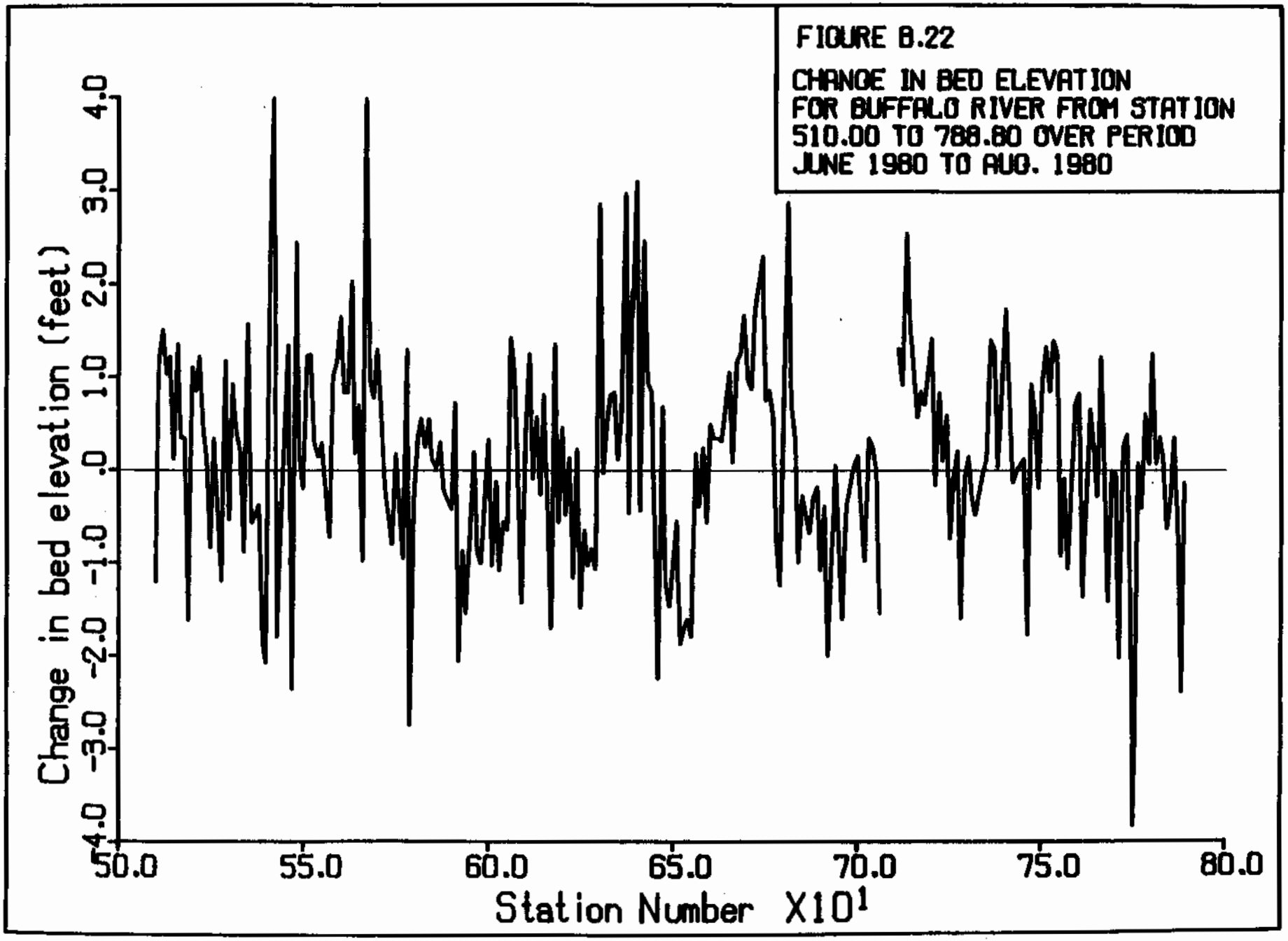
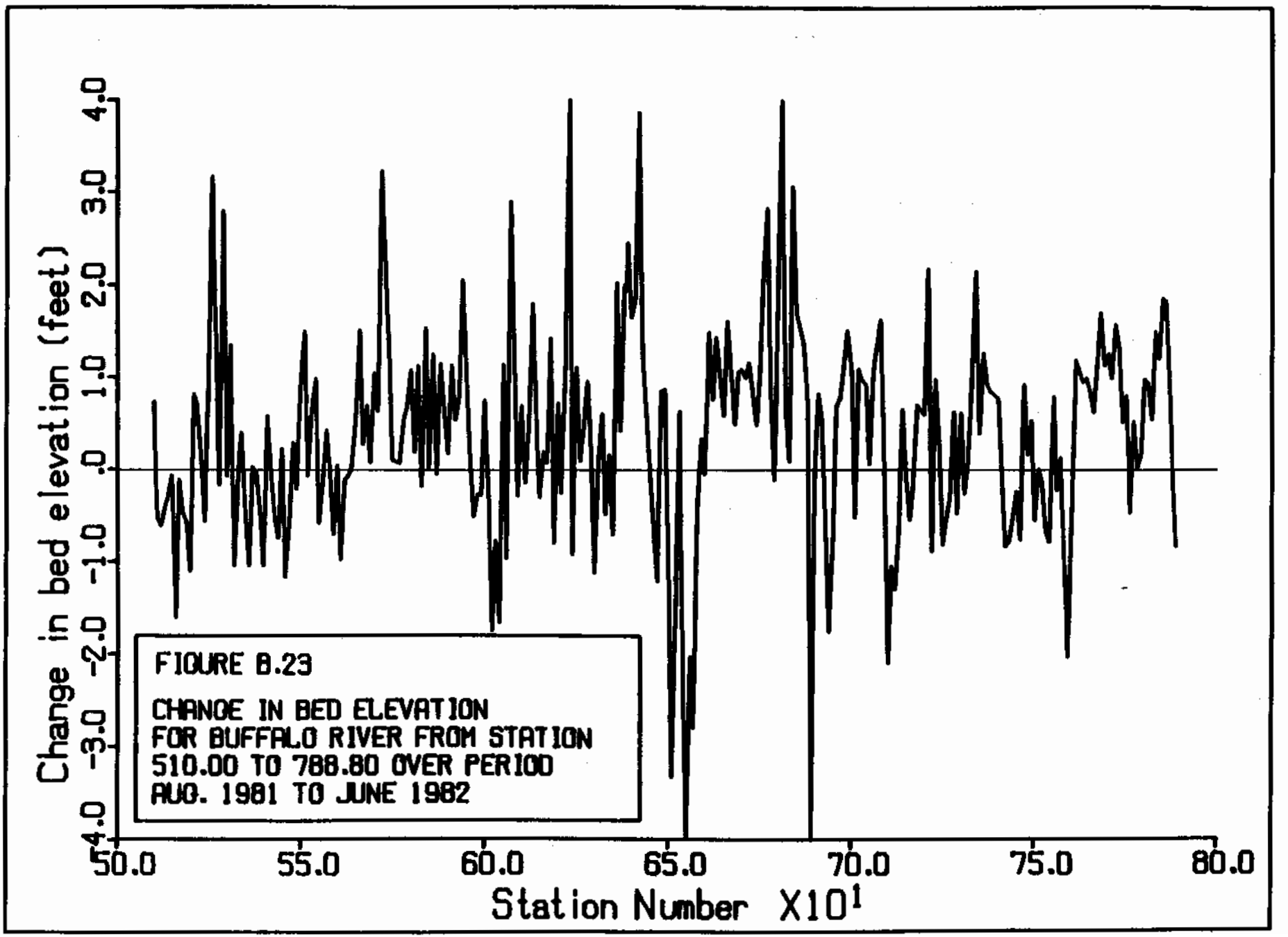


FIGURE B.22
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JUNE 1980 TO AUG. 1980
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹


Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹
FIGURE 8.23
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1981 TO JUNE 1982

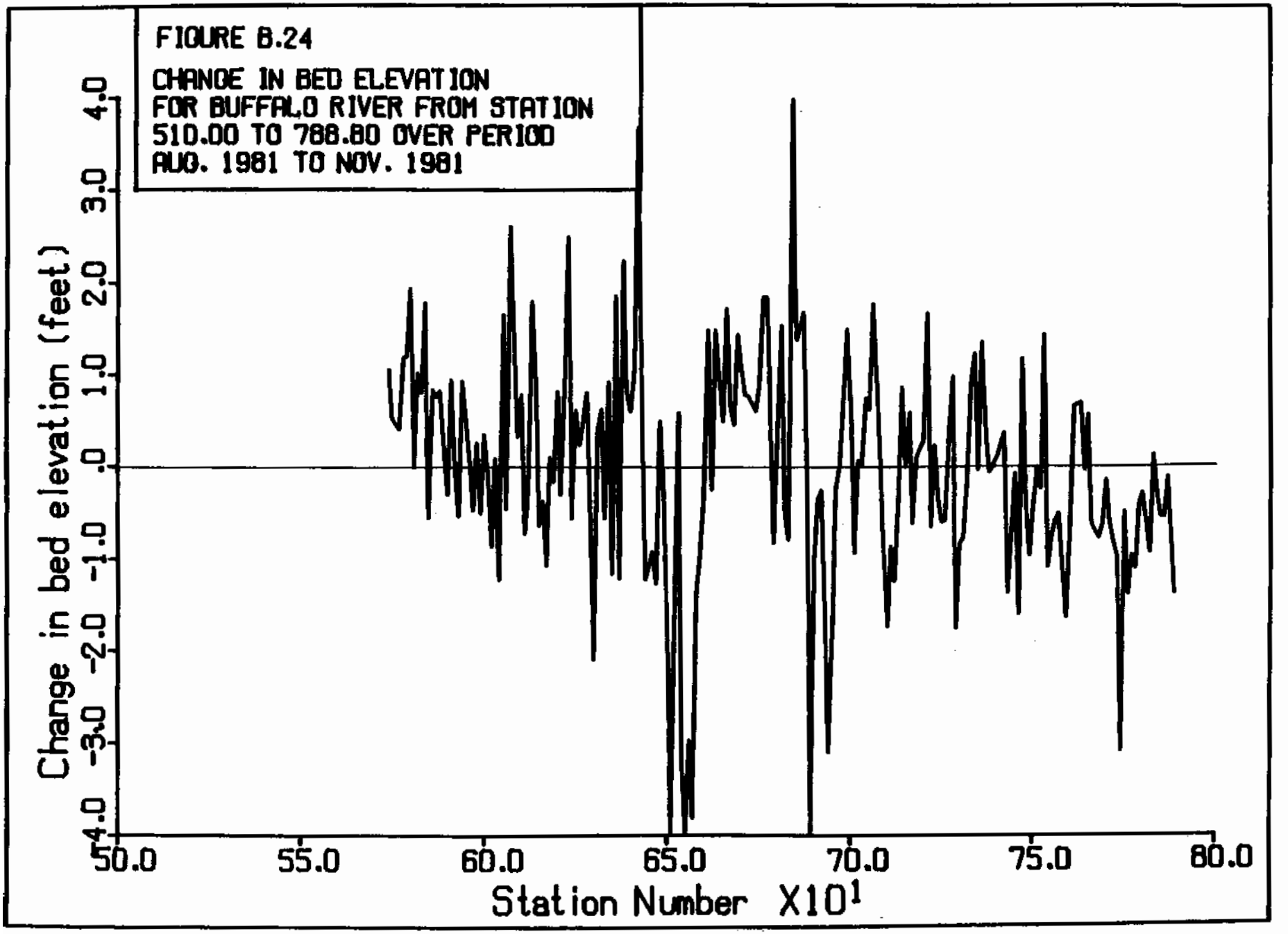


FIGURE B.24
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1981 TO NOV. 1981
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

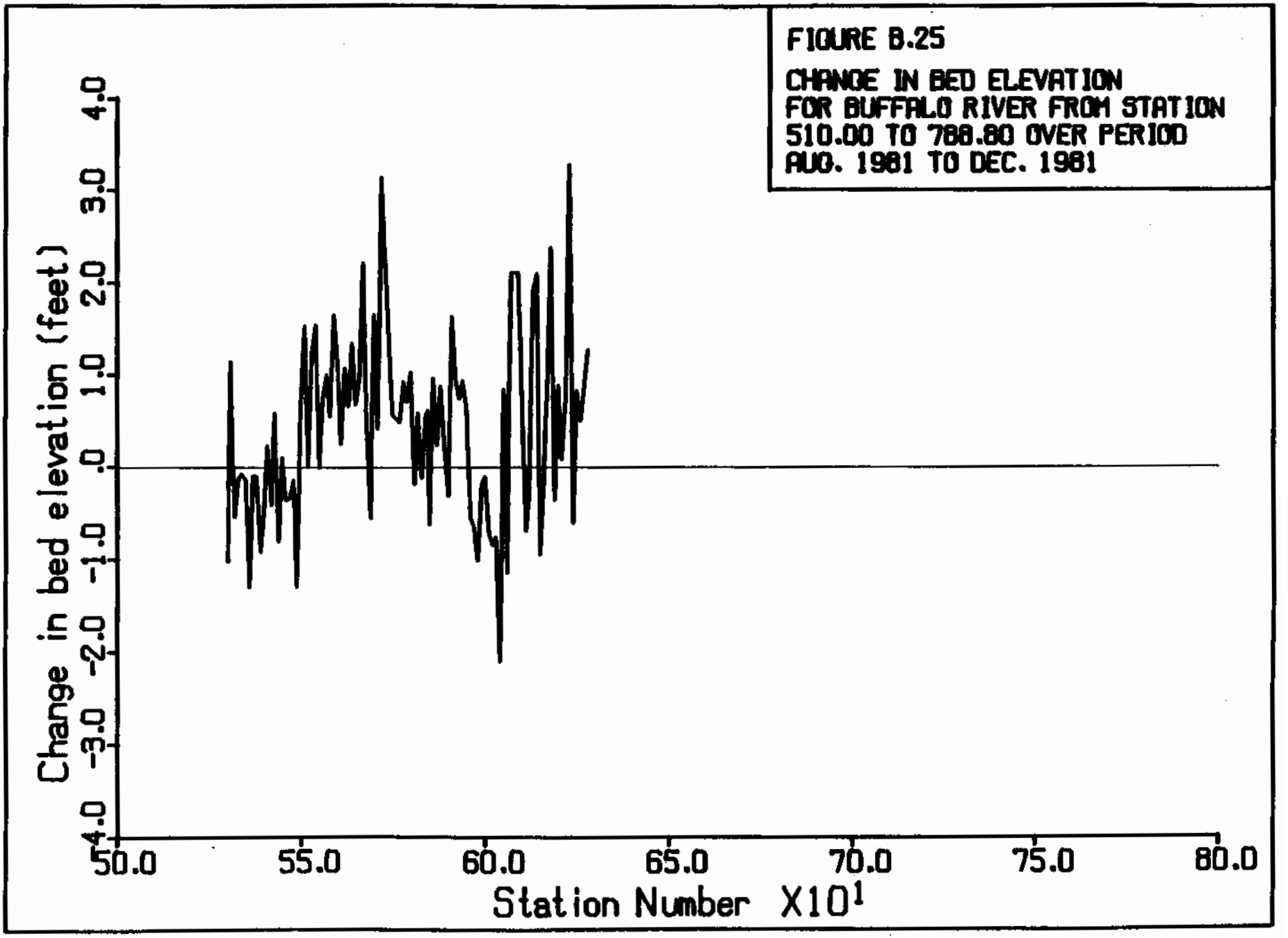


FIGURE B.25
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1981 TO DEC. 1981
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

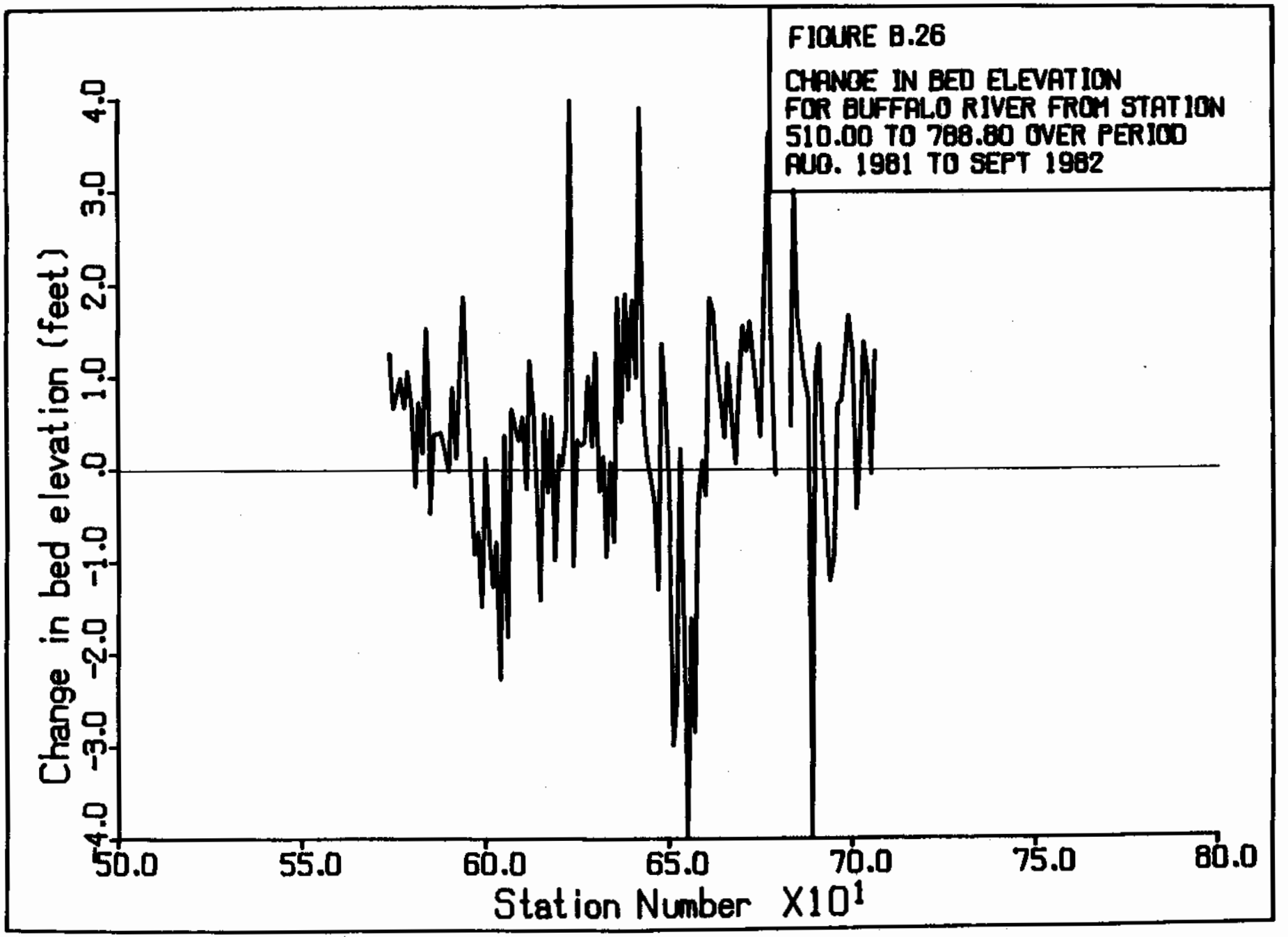


FIGURE B.26
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
AUG. 1981 TO SEPT 1982
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

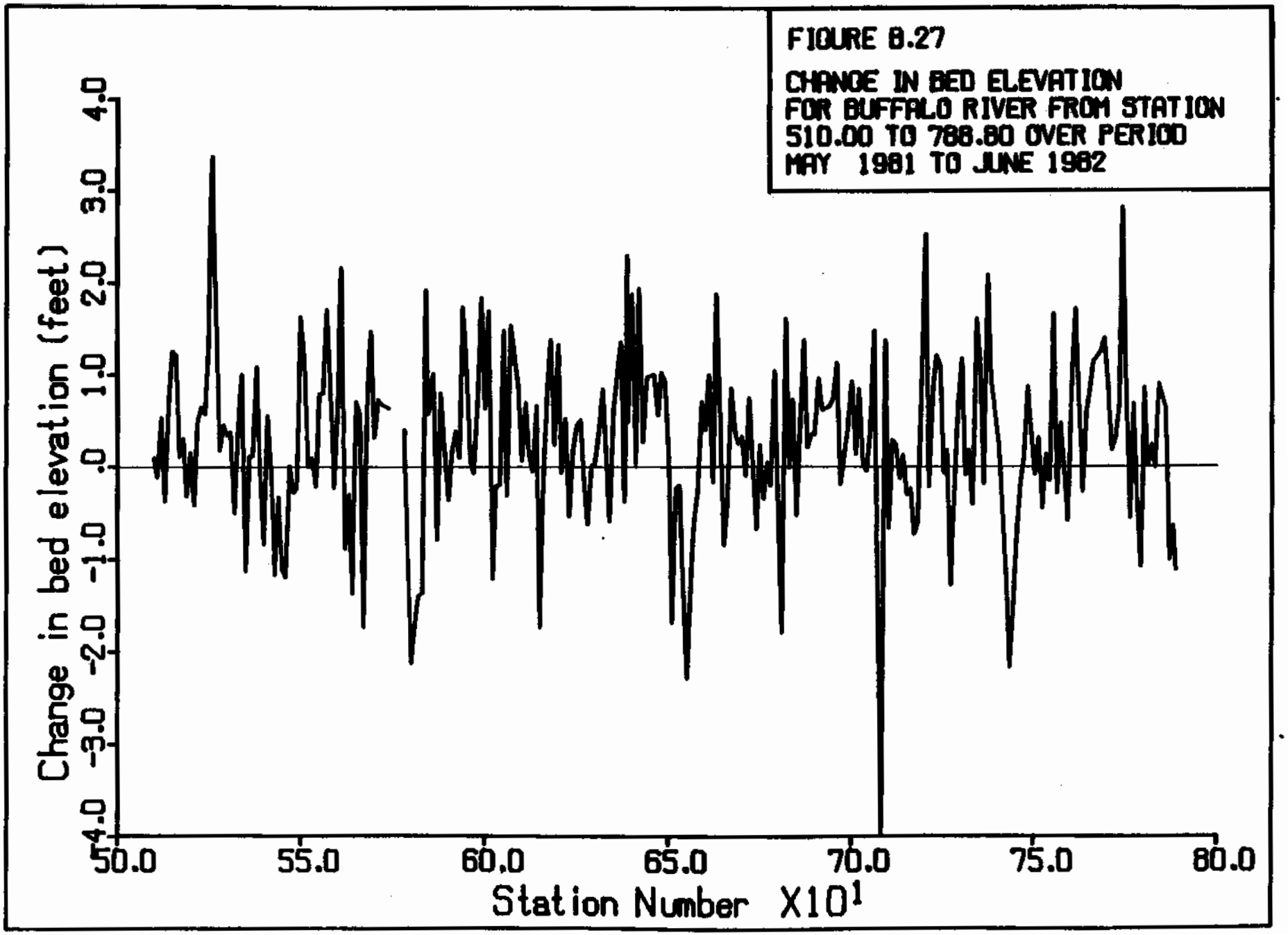


FIGURE 8.27
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
MAY 1981 TO JUNE 1982
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

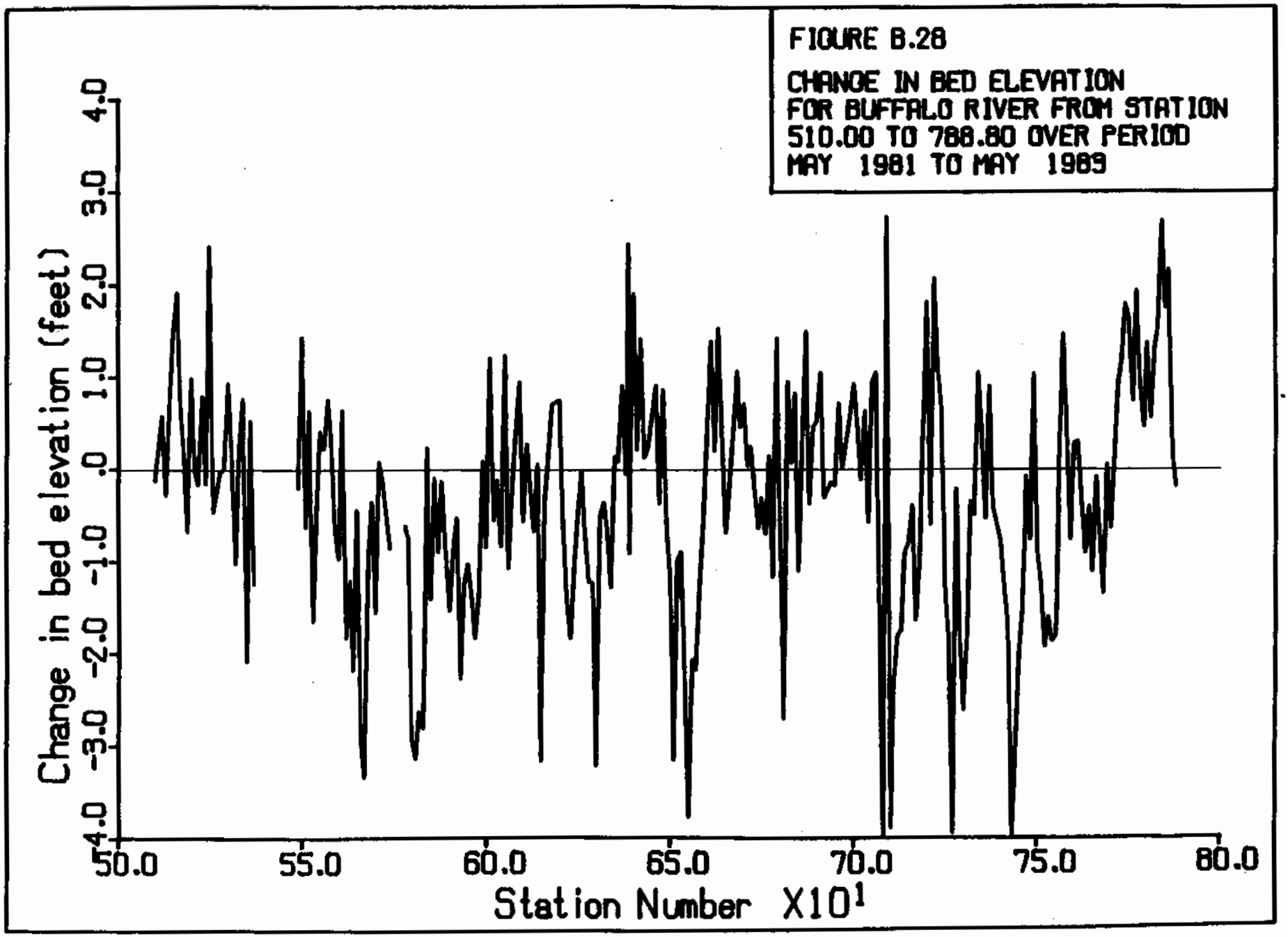


FIGURE B.28
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
MAY 1981 TO MAY 1989
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

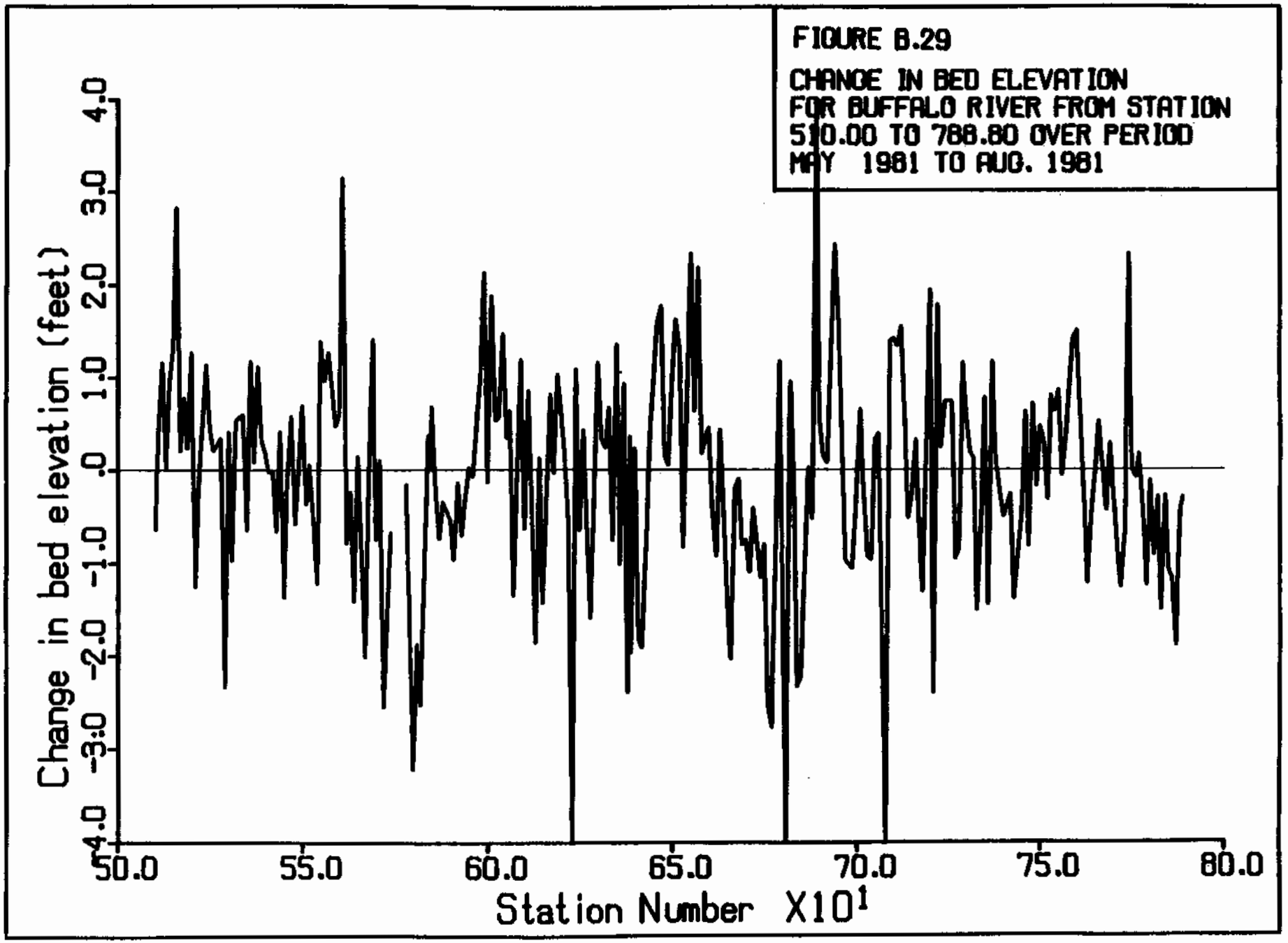


FIGURE B.29
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
MAY 1981 TO AUG. 1981
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

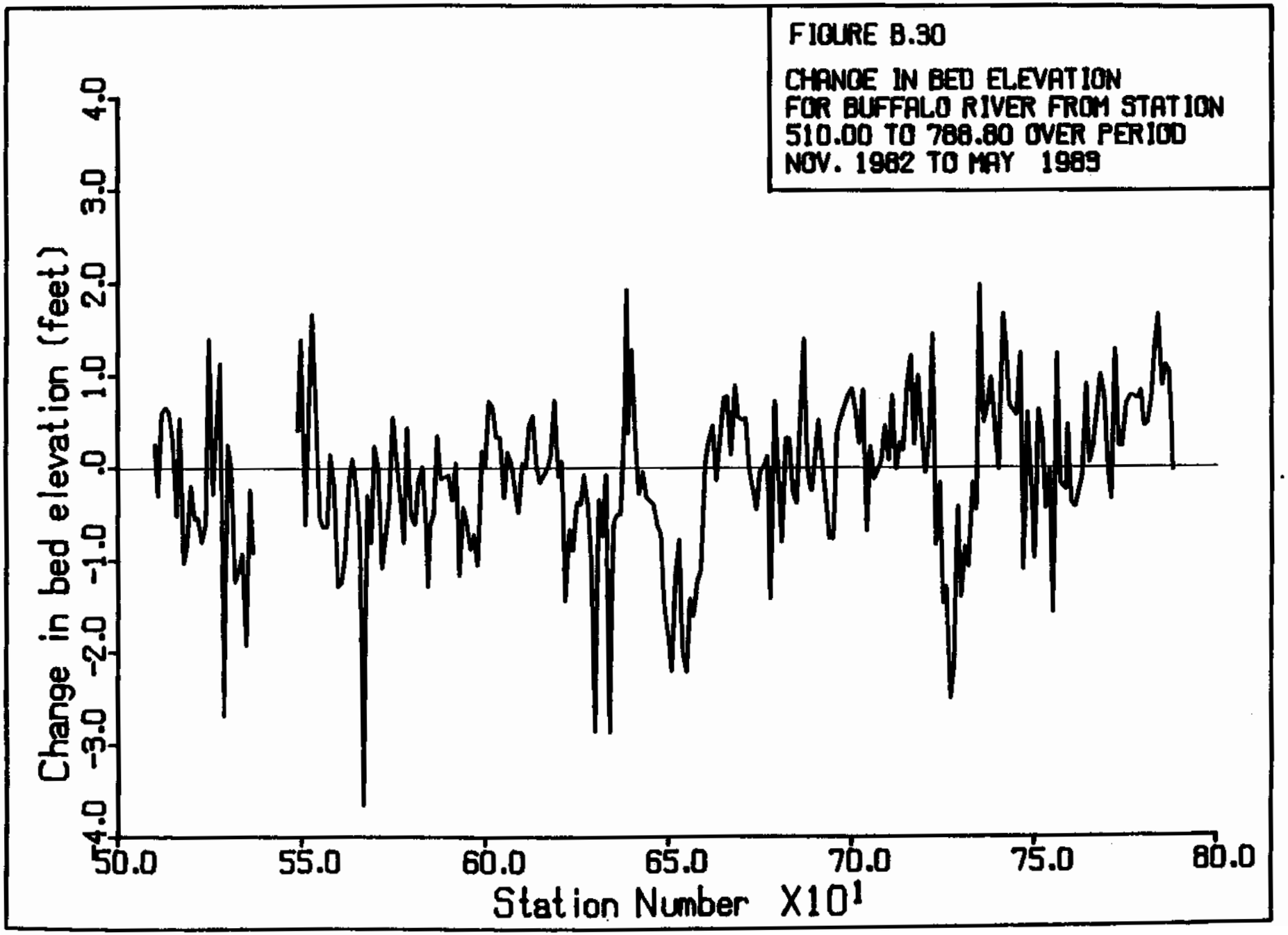


FIGURE B.30
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
NOV. 1982 TO MAY 1989
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

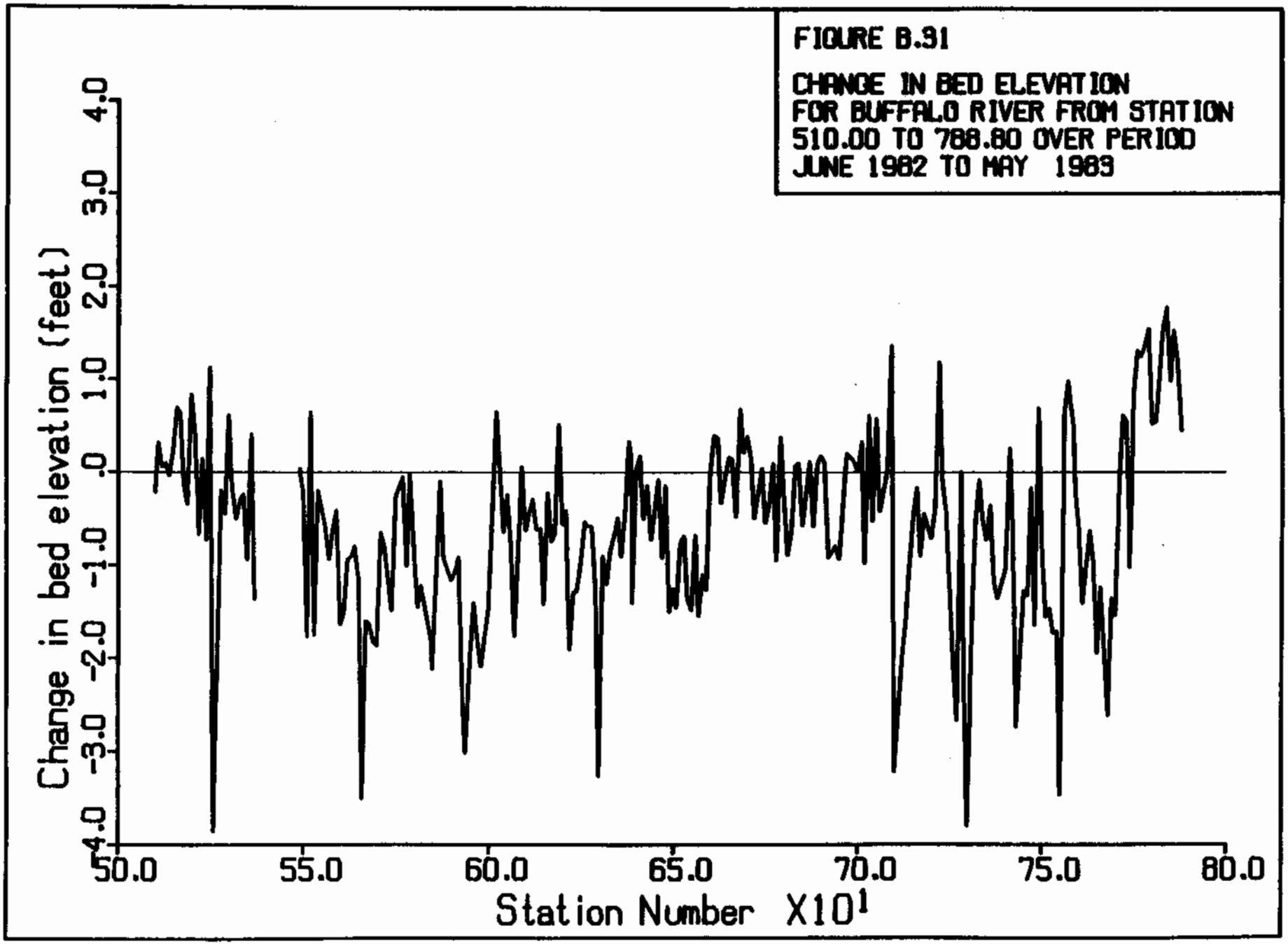


FIGURE B.31
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JUNE 1982 TO MAY 1983
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

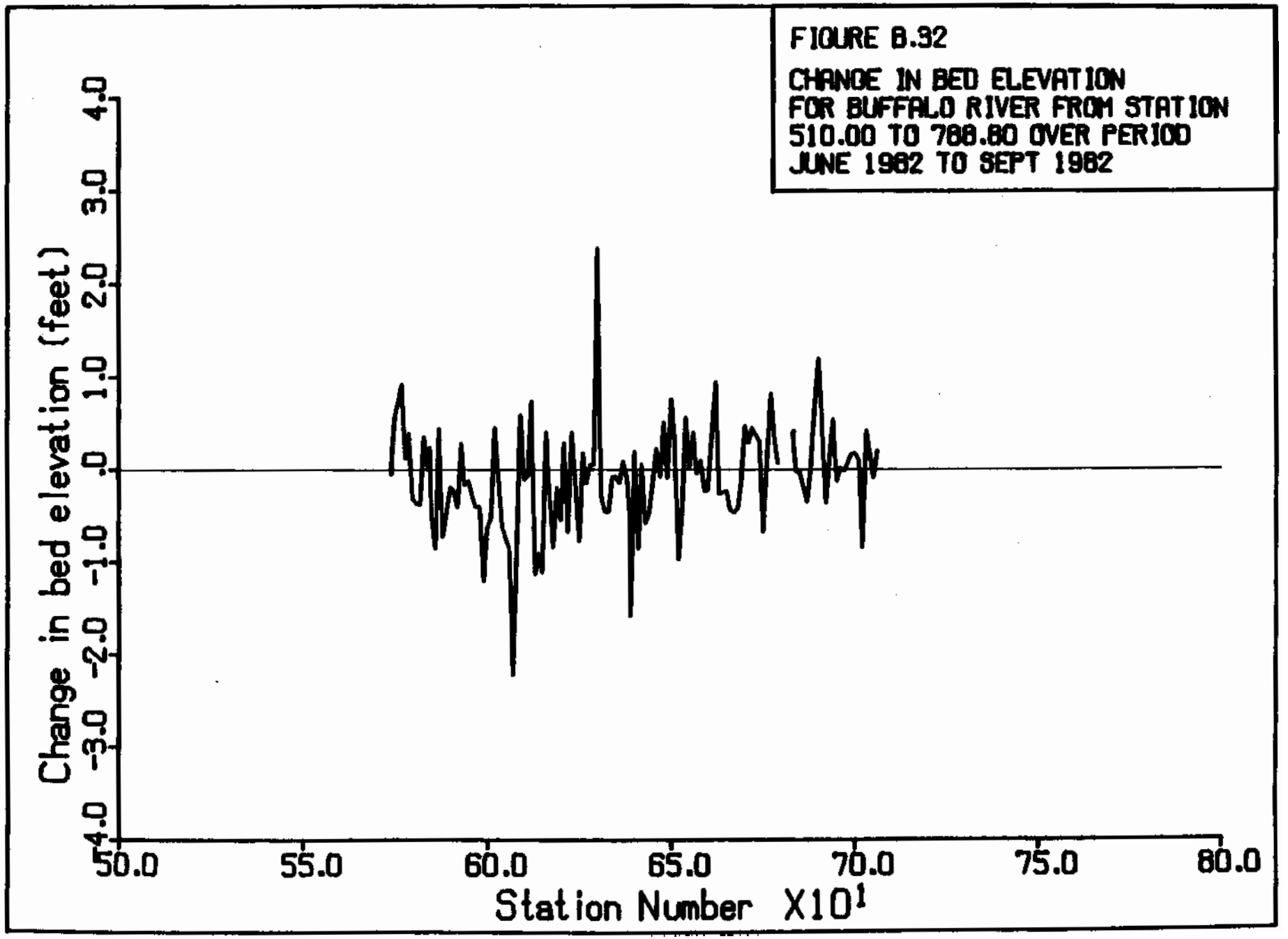


FIGURE B.32
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JUNE 1982 TO SEPT 1982
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

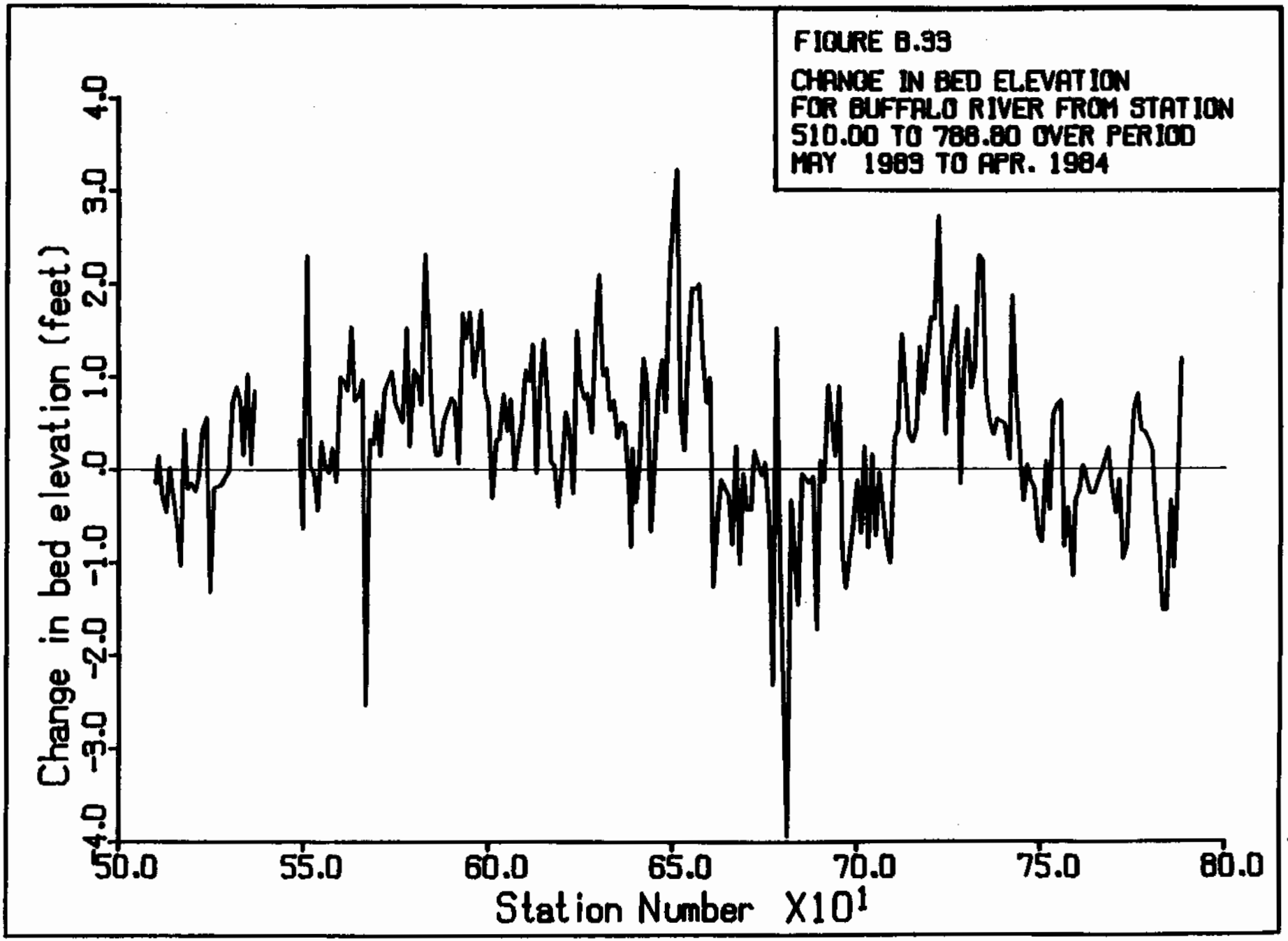
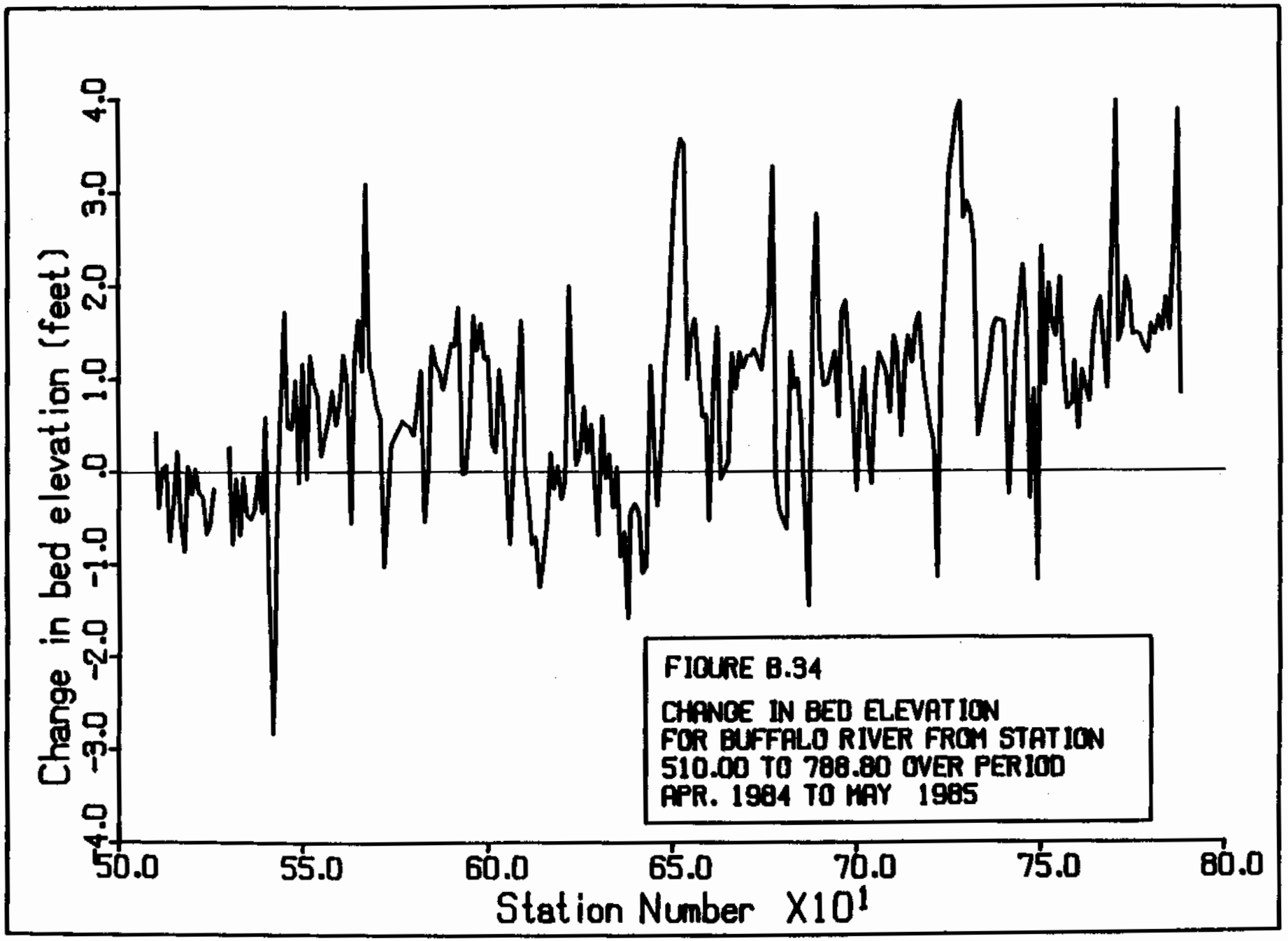


FIGURE B.33
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
MAY 1983 TO APR. 1984
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹


Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹
FIGURE B.34
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
APR. 1984 TO MAY 1985

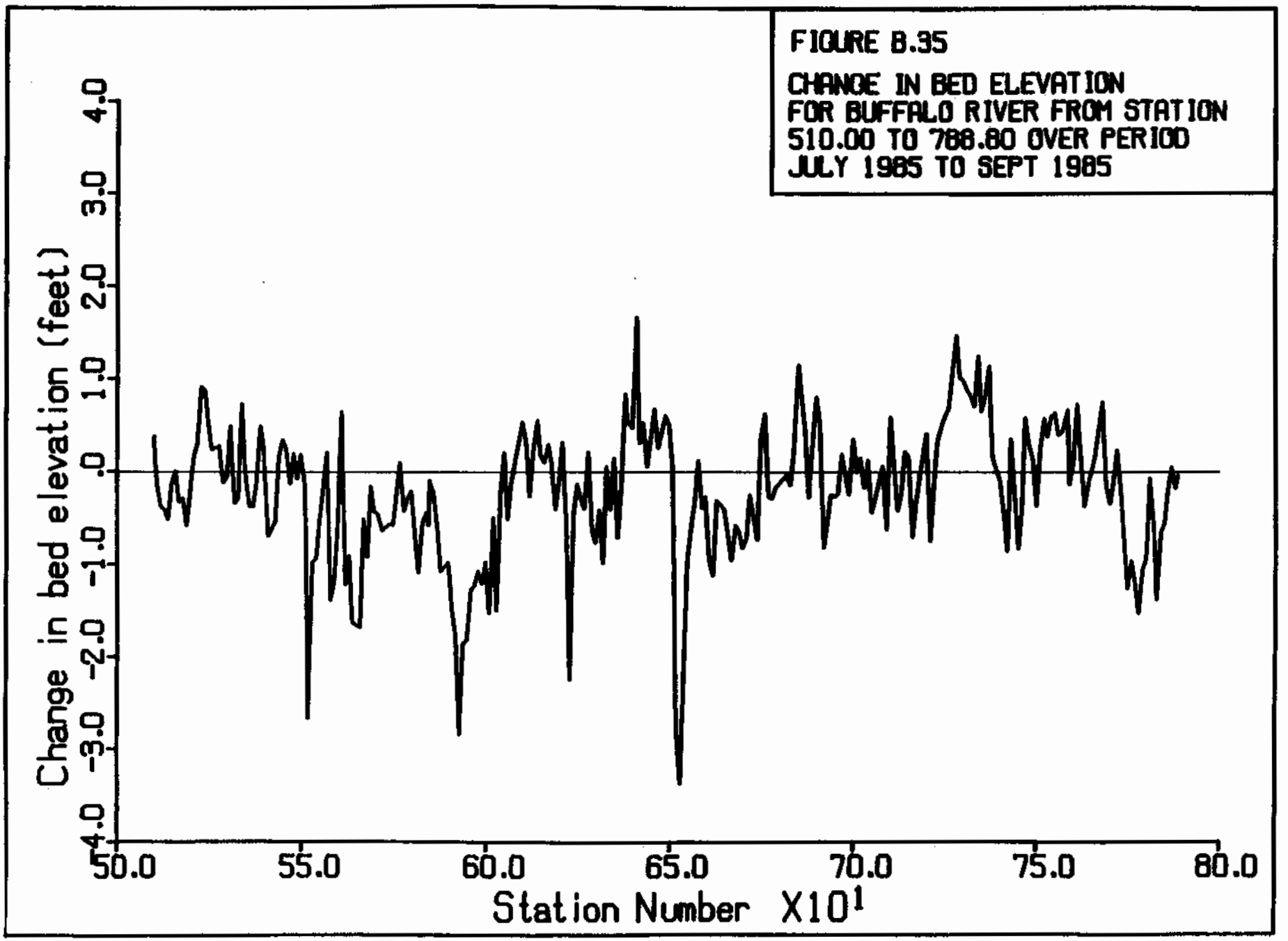


FIGURE B.35
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
JULY 1985 TO SEPT 1985
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

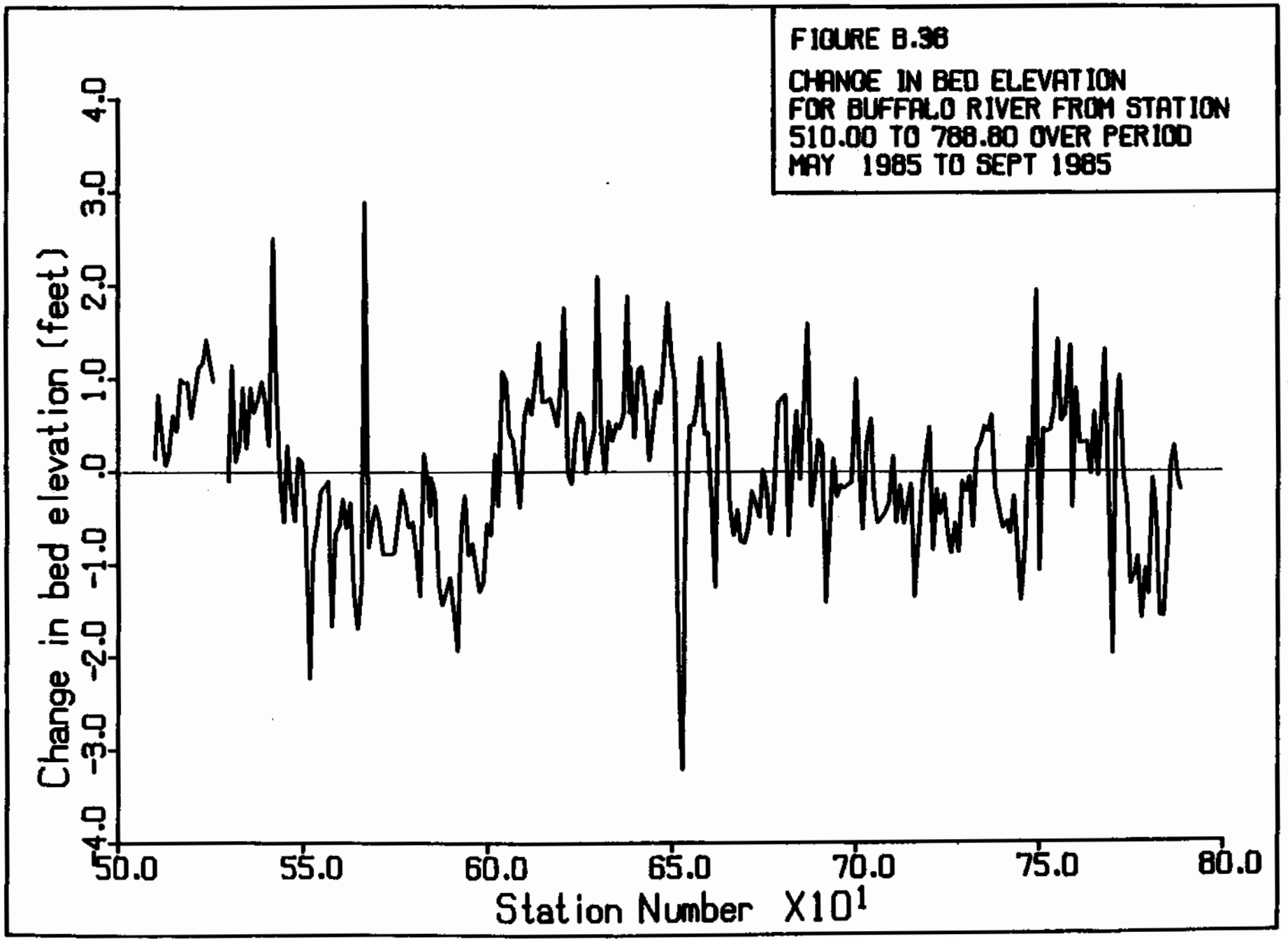


FIGURE B.36
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
MAY 1985 TO SEPT 1985
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

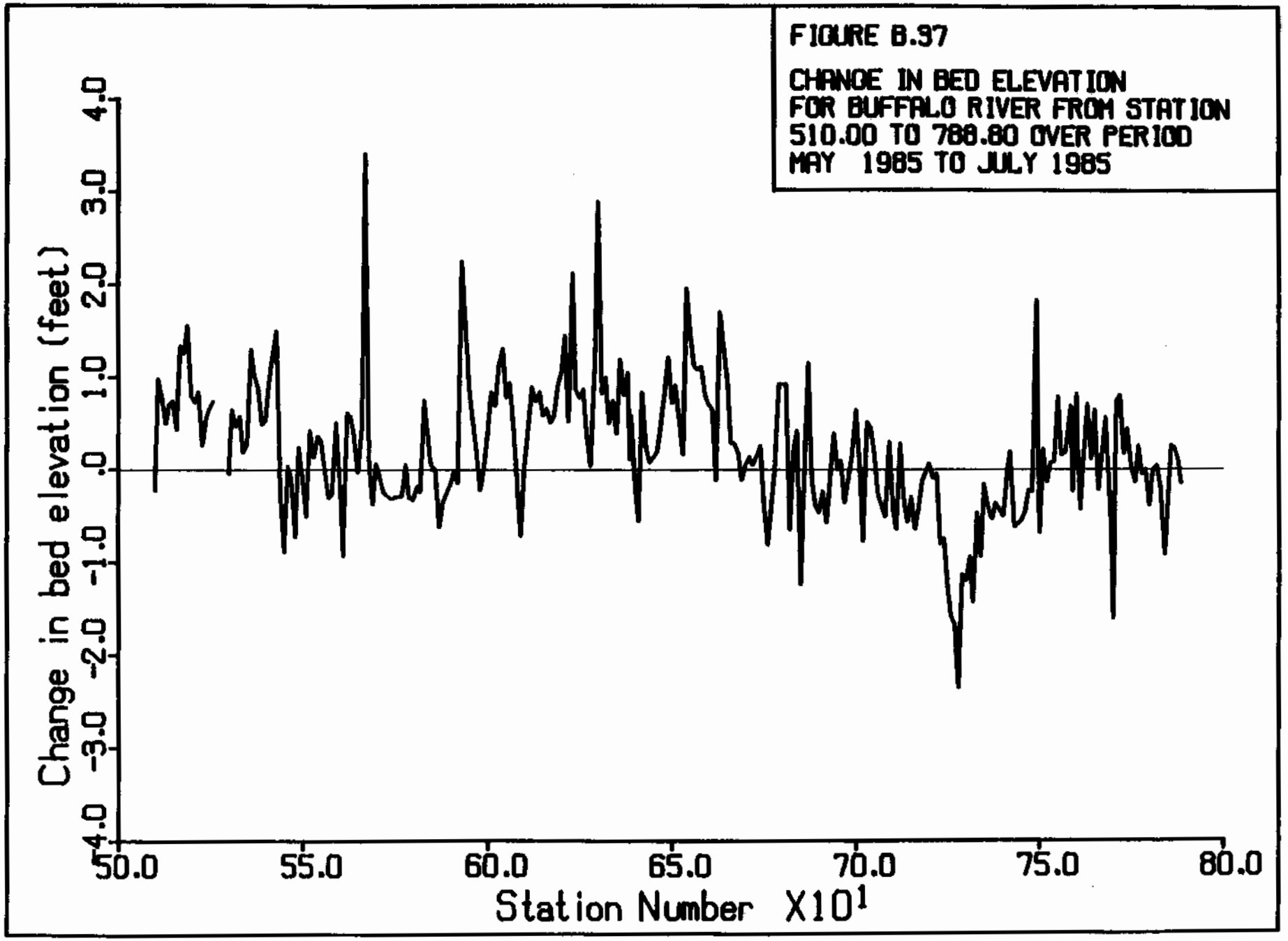


FIGURE B.37
CHANGE IN BED ELEVATION
FOR BUFFALO RIVER FROM STATION
510.00 TO 788.80 OVER PERIOD
MAY 1985 TO JULY 1985
Change in bed elevation (feet)
4.0
3.0
2.0
1.0
.0
-1.0
-2.0
-3.0
-4.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
Station Number X10¹

APPENDIX C: LIST OF DATA FILES ON DISKETTES

File Name	File .ext	Size (bytes)	Contents
Volume in drive A is DEC-BUF-R01[1]			
BRE75B	ORG[2]	35328	Bathymetric survey data from US Army Corps
BRE75A	ORG	45440	Format is Station Number,distance from bank, and
B76PC	ORG	68096	depth below low water datum with one line for
B76A	ORG	94848	each depth measurement. Low water datum is
4 File(s)		116736 bytes free	
Volume in drive A is DEC-BUF-R02			
B77B	ORG	104064	568.6 feet above MSL. The station numbers are
B77A	ORG	87552	given as follows:
B78B	ORG	109440	10510 is at station 510+00 with measurements
3 File(s)		60416 bytes free	
Volume in drive A is DEC-BUF-R03			
B78PC	ORG	99712	from right bank
B79PC	ORG	103168	00510 is at station 510+00 with measurements
B79A	ORG	56064	from left bank
3 File(s)		102400 bytes free	
Volume in drive A is DEC-BUF-R04			
B80PC	ORG	112896	left or right bank is determined from a position
B80B	ORG	114176	looking downstream
B80A	ORG	102400	
3 File(s)		31744 bytes free	
Volume in drive A is DEC-BUF-R05			
B81PC	ORG	103424	
B81B	ORG	107904	
B81A1	ORG	112128	
B81A2	ORG	37248	
4 File(s)		0 bytes free	
Volume in drive A is DEC-BUF-R06			
B82PC	ORG	211840	
B82B	ORG	88064	
2 File(s)		62464 bytes free	

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 Volume in drive A is DEC-BUF-R07

B82A     ORG   156672
B85PC    ORG   178688
       2 File(s)     26624 bytes free

 Volume in drive A is DEC-BUF-R08

B83PC    ORG   206464
       1 File(s)    155648 bytes free

 Volume in drive A is DEC-BUF-R09

B84B     ORG   200704
B84A     ORG    40832
       2 File(s)    120832 bytes free

 Volume in drive A is DEC-BUF-R10

B85B     ORG   207744
       1 File(s)    154624 bytes free

 Volume in drive A is DEC-BUF-R11

B85A     ORG   175744
       1 File(s)    186368 bytes free

 Volume in drive A is DEC-BUF-R12
                                        Records from USGS
BCGARDEN D85   185216   Buffalo Creek at Gardenville, daily flows thur 1985
BCGARDEN P83     8064   Buffalo Creek at Gardenville, peak flows thur 1983
BCWALES  D68    21632   Buffalo Creek at Wales, daily flows thur 1968
BCWALES  P74     1536   Buffalo Creek at Wales, peak flows thur 1974
CAYLANCA P83     9088   Cayuga Creek at Lancaster, peak flows thur 1983
CAZEBENE P83     9088   Cazenovia Creek at Ebenezer, peak flows thur 1983
       6 File(s)    125952 bytes free

 Volume in drive A is DEC-BUF-R13

CAYLANCA D85   163328   Cayuga Creek at Lancaster, daily flows thur 1985
CAZEBENE D85   177280   Cazenovia Creek at Ebenezer, daily flows thur 1985
       2 File(s)     20480 bytes free
```

NOTES:

1. DEC-BUF-R01 is the disk identification number

2. Bathymetric survey data files are identified as follows:
   - Prefix BRE is Buffalo River Entrance
     - B is Buffalo River
   - Numerals, i.e., 75, are last two digits of year
   - Suffix PC is precontract survey to determine need to dredge
     - B is survey before dredging
     - A is survey after dredging
   - File extension ORG indicates orginal data from US Army Corps

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