HEAVY METALS STUDY

1979 Progress Report on the Field Leaching and Reclaimation Program and the Removal of Metals from Stockpile Runoff by Peat and Tailings

Appendices

Minnesota Department of Natural Resources
Division of Minerals

1980

APPENDICES

Appendix I

Stockpile Characterazation

AMAX

MINNAMAX PROJECT

January 24, 1980

Mr. Paul Eger
Dept. of Natural Resources
345 Centennial Office
658 Cedar Street
St. Paul, Minnesota 55155

Dear Paul:

Pursuant to your request, herewith, is a listing of the rounds (with assays) that make up the leach piles. In addition, grades and tonnages have been recalculated for the leach piles from these figures.

Individual rounds were assigned to one of three locations: leach piles 1-4, pile 5, or pile 6. Leach piles 1, 2, 3, and 4 must be dealt with as one unit. These four piles were constructed from a single pile of shaft muck which was stockpiled on surface until the leach pads were constructed. Leach piles 5 and 6 were differentiated by individual rounds according to when the round was stockpiled and the date of leach pile construction. Shaft rounds were selected for leach testing based only on assay value. Drift rounds were selected either by assay value or a visual estimate of grade. Several drift rounds, therefore, fell outside the 0.20% to 0.59% Cu cut-off.

There are no significant changes in grades or tonnages compared to originally reported values. The newly calculated tonnages for piles 5 and 6 are larger due to using larger drift dimensions (10' x 10'). A tonnage factor, of 9 tons per linear foot of drift, was used. The new leach pile tonnage and grade figures are:

	Leach Pile Number					
	1	2	3	4	5	6
% Cu	.348	.348	.348	.348	.300	.339
% Ni	.083	.083	.083	.083	.085	.084
% S	.634	.634	.634	.634	1.414	.787
Tons	1784	1784	1784	1784	2370	1723

Sincerely yours,

James E. Kulas
Geologist

JEK:es
Enclosures
cc: J. B. Malcolm
J. A. Sturgess
S. N. Watowich
A. Weir
File 5.1, 3.17, 6.3.2.2

AMAX INC. • P.O. BOX C, BABBITT, MINNESOTA 55706 • TELEPHONE (218) 827-2161

Shaft Rounds Placed in Leach Piles 1-4

Round No.	Thickness	Grade % Cu	% Ni	% S
115	7	.20	.06	.45
117	6	.40	.10	.69
118	6	.30	.08	.54
119	5	.26	.07	.40
120	7	.32	.08	.46
121	6	.22	.06	.31
122	7	.21	.05	.27
141	7	.25	.05	.33
143	7	.46	.12	.48
144	6	.25	.05	.29
145	6	.48	.11	.62
146	7	.43	.10	.60
147	6	.39	.11	.58
148	6	.36	.09	.50
149	7	.36	.09	.50
150	6	.42	.10	.63
151	7	.42	.14	.88
152	7	.55	.12	1.05
153	7	.34	.09	.81
154	6	.32	.08	.66
155	7	.35	.08	.72
156	7	.28	.07	.53
157	6	.22	.07	.40
158	7	.23	.07	.39
159	5	.20	.06	.38
166	6	.23	.06	.29
171	6	.38	.08	.44
172	6	.28	.06	.32
180	7	.30	.05	.39
181	7	.37	.09	.47
184	5	.27	.05	.37
185	7	.30	.06	.56
186	7	.35	.06	.47
187	6	.32	.06	.62
188	7	.20	.04	.64
190	8	.23	.06	.69
191	6	.29	.07	.79
192	7	.24	.06	.50
193	6	.25	.06	.53
194	6	.22	.05	.41
195	5	.31	.07	.66
196	8	.44	.10	.90
197	7	.47	.11	.84
199	7	.56	.12	1.12
200	6	.56	.12	.72
201	7	.56	.13	.87
208	7	.58	.15	1.07
209	6	.55	.12	.94
216	6	.56	.13	1.11
219	4	.54	.10	1.29
220	6	.53	.10	1.18
221	7	.41	.08	.91
222	6	.48	.11	.81
223	7	.33	.10	.57
224	6	.32	.08	.62
225	7	.31	.08	.68
226	5	.37	.10	.82
227	6	.44	.13	1.28
228	6	.42	.12	1.21
229	7	.42	.09	.93
230	6	.27	.05	.54
232	6	.26	.05	.54
233	9	.20	.05	.29
235	6	.22	.04	.36
238	5	.23	.04	.31
243	6	.33	.07	.61
245	6	.22	.06	.40
TOTAL	428'	.348	..083	.634
TONS	7135	(1784 tons per pile)		

Drift Rounds Placed in Leach Pile 5

Round No.	Thick-ness	Grade % Cu	% Ni	% S
26	4.6	.50	.09	1.77
28	8	.68	.10	2.09
29	6.4	.57	.08	1.40
31	8.8	.18	.02	.41
34	6	.27	.04	.72
36	6	.12	.02	.58
37	4.5	.40	.06	1.42
41	4.6	.41	.10	2.13
47	7	.17	.04	.54
49	5.7	.27	.05	1.00
51	6.3	.27	.06	.81
55	4.5	.61	.24	4.39
57	9	1.04	.43	7.65
58	4	.27	.12	2.20
66	4.5	.27	.13	2.27
68	5.5	.27	.12	1.86
70	7	.20	.08	1.24
76	7.6	.24	.07	1.14
78	5.1	.45	.06	1.01
80	6.6	.50	.09	1.69
82	6	.34	.09	1.39
84	5	.20	.06	.95
88	10	.15	.05	.84
90	7	.22	.06	.85
92	5	.20	.04	.90
94	9	.22	.04	.71
96	7	.18	.02	.53

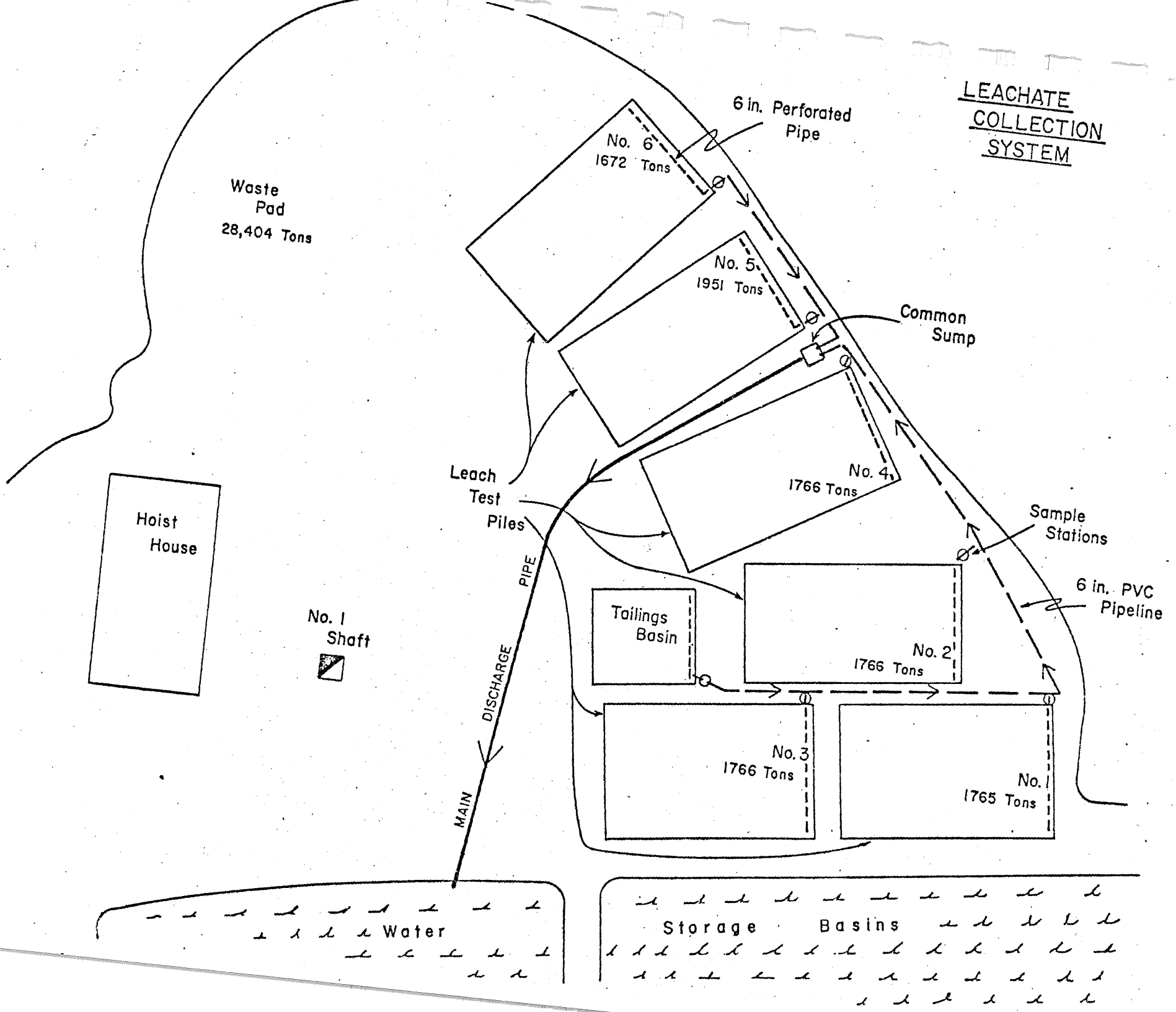
Round No.	Thick-ness	Grade % Cu	% Ni	% S
102	6	.45	.22	3.39
104	7	.40	.20	2.89
116	9	.16	.03	.54
127	7.7	.26	.08	1.24
129	8	.26	.06	1.14
133	7	.09	.02	.64
135	8	.10	.04	.92
139	7	.22	.05	1.03
142	8	.29	.09	1.08
144	8	.16	.06	.48
146	8	.14	.08	.48
148	9	.22	.08	.39
TOTAL	263.4'	.300	.085	1.414
TONS	2370			

Drift Rounds Placed in Leach Pile 6

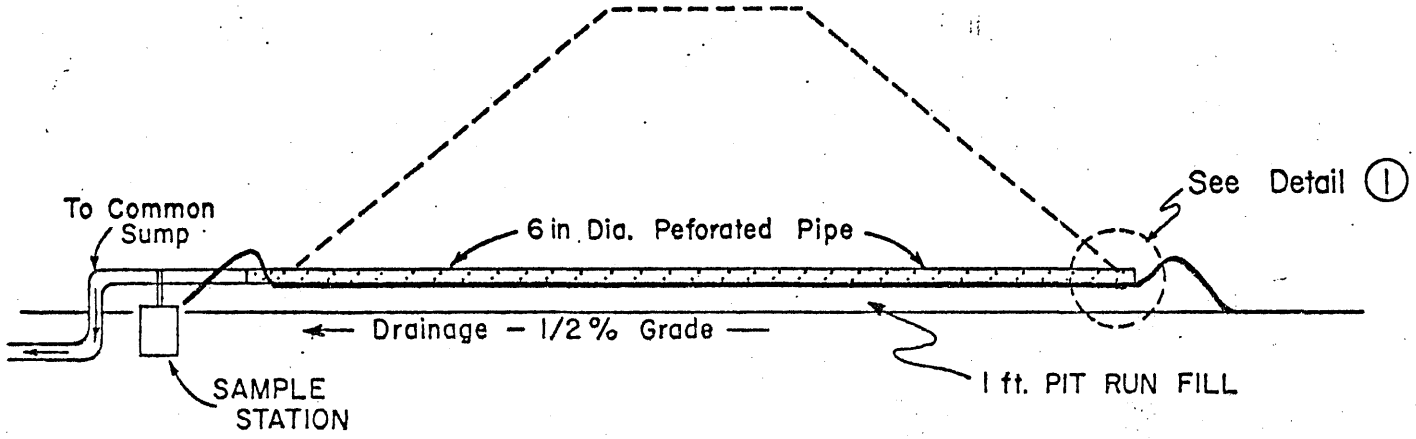
Round No.	Thick-ness	Grade % Cu	% N	% S
151	8	.27	.12	.97
153	8	.20	.09	.64
155	9	.56	.12	1.24
156	9	.20	.04	.65
158	6	.36	.10	1.15
159	8	.25	.20	.90
160	9	.28	.06	.73
161	7	.54	.14	1.37
164	8	.22	.03	.50
165	8	.46	.10	1.04
166	7	.22	.04	.25
167	8	.54	.09	1.00
171	7	.10	.03	.62
172	7	.30	.14	.64
173	7	.14	.04	.46
177	8	.38	.08	.74
180*	5 (1/2)	.39	.08	.78
187	6	.42	.12	1.10
188*	6 (1/2)	.42	.10	.70
189	6	.21	.03	.34
191	10	.42	.05	.66
192	6	.39	.07	.77
194*	7	.20	.05	.33
196	6	.50	.11	.73
211	9	.43	.07	.79
212	8	.36	.05	.95
221	8 (1/2)	.54	.18	1.30
TOTAL	191.5'	.339	.084	.787

TONS 1723

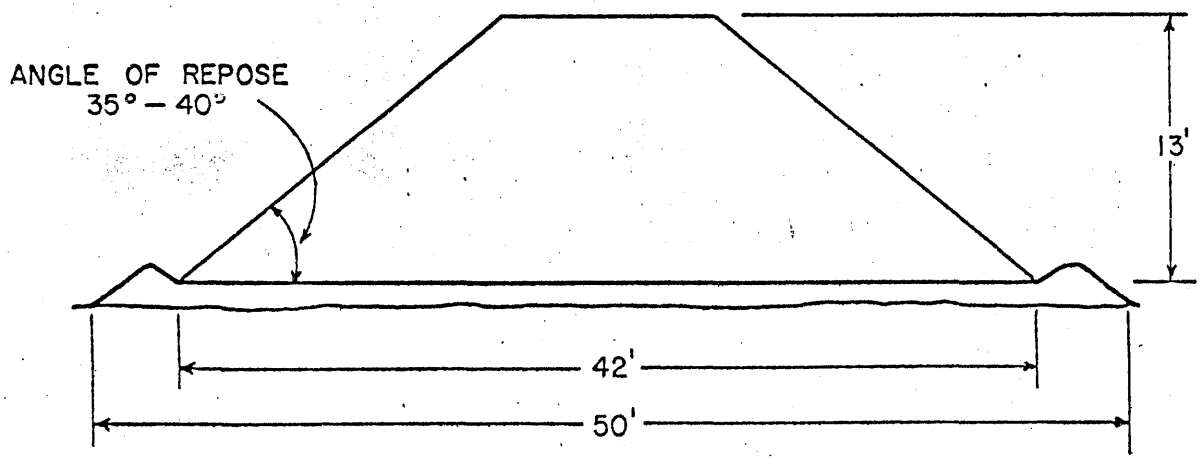
* 1/2 of the round was used for metallurgical testing.


LEACHATE COLLECTION SYSTEM
6 in. Perforated Pipe
No. 6
1672 Tons
No. 5
1951 Tons
No. 4
1766 Tons
No. 2
1766 Tons
No. 3
1766 Tons
No. 1
1765 Tons
Waste Pad
28,404 Tons
Common Sump
Leach Test Piles
Sample Stations
6 in. PVC Pipeline
Tailings Basin
Hoist House
No. 1 Shaft
DISCHARGE PIPE
MAIN
Water
Storage Basins

LEACHATE COLLECTION SAMPLER ATTACHMENT ON INDIVIDUAL LEACH PILES

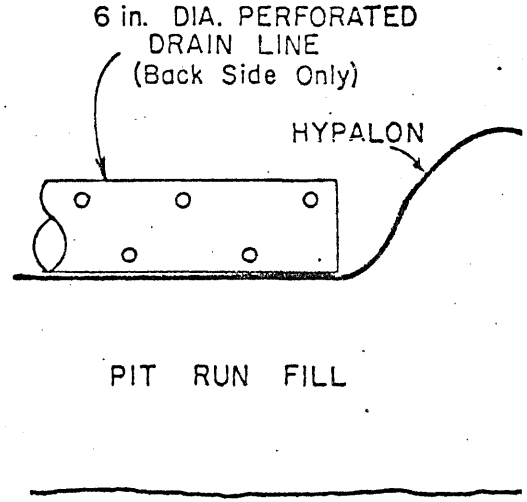


SECTION B-B
1" = 10'



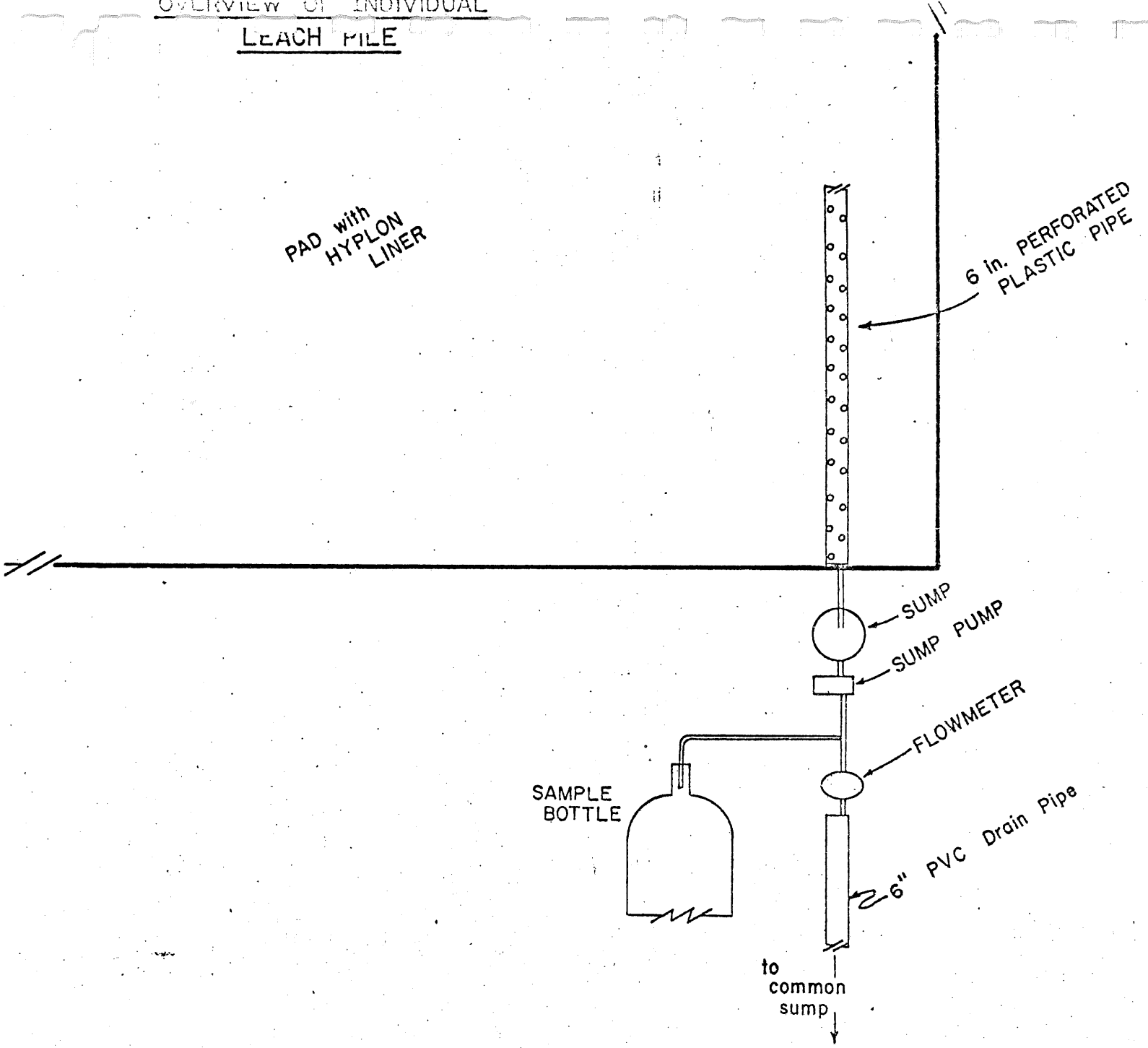
SECTION C-C
1" = 10'

DETAIL (1)
(NOT TO SCALE)

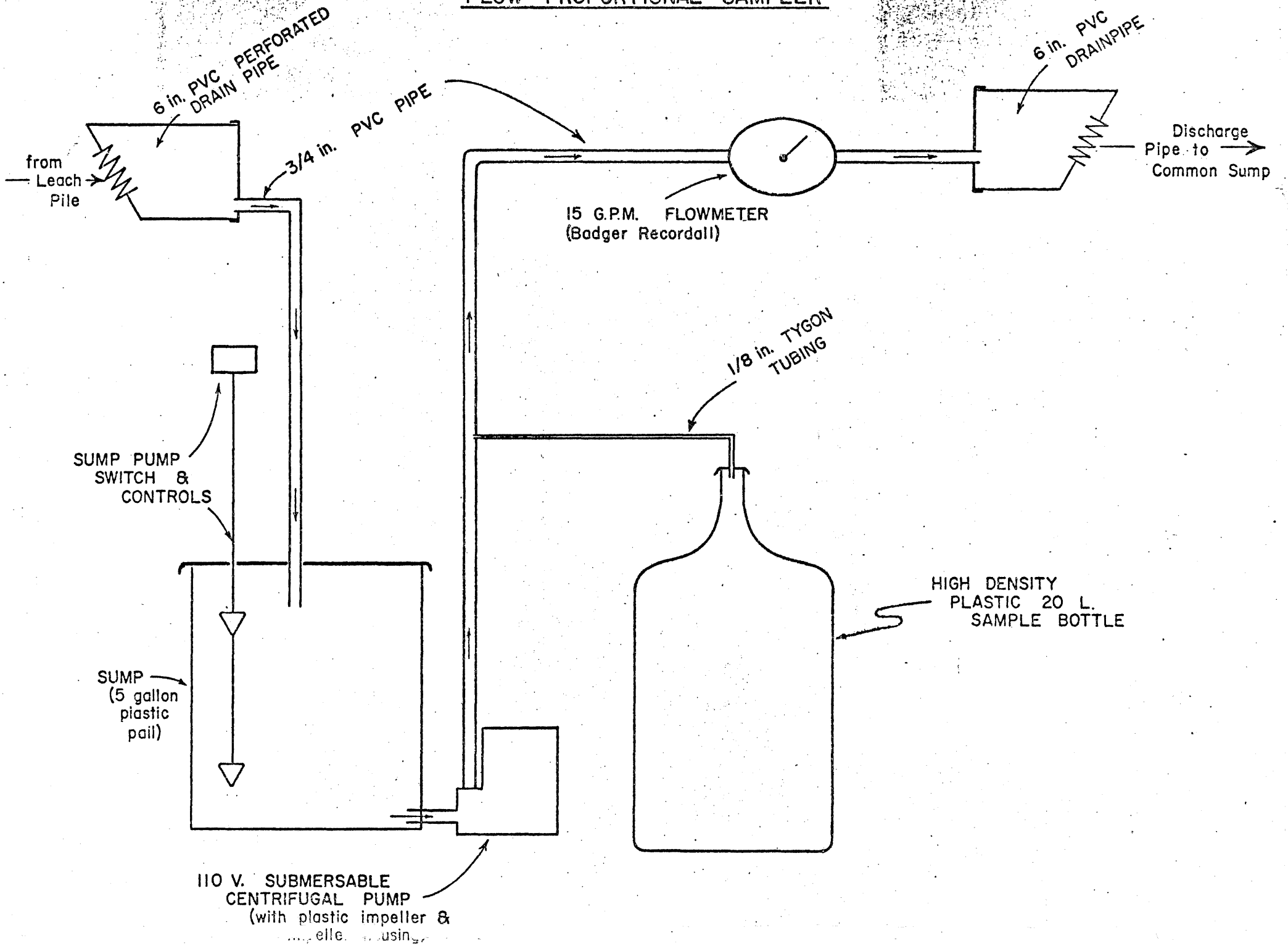


OVERVIEW OF INDIVIDUAL

LEACH PILE

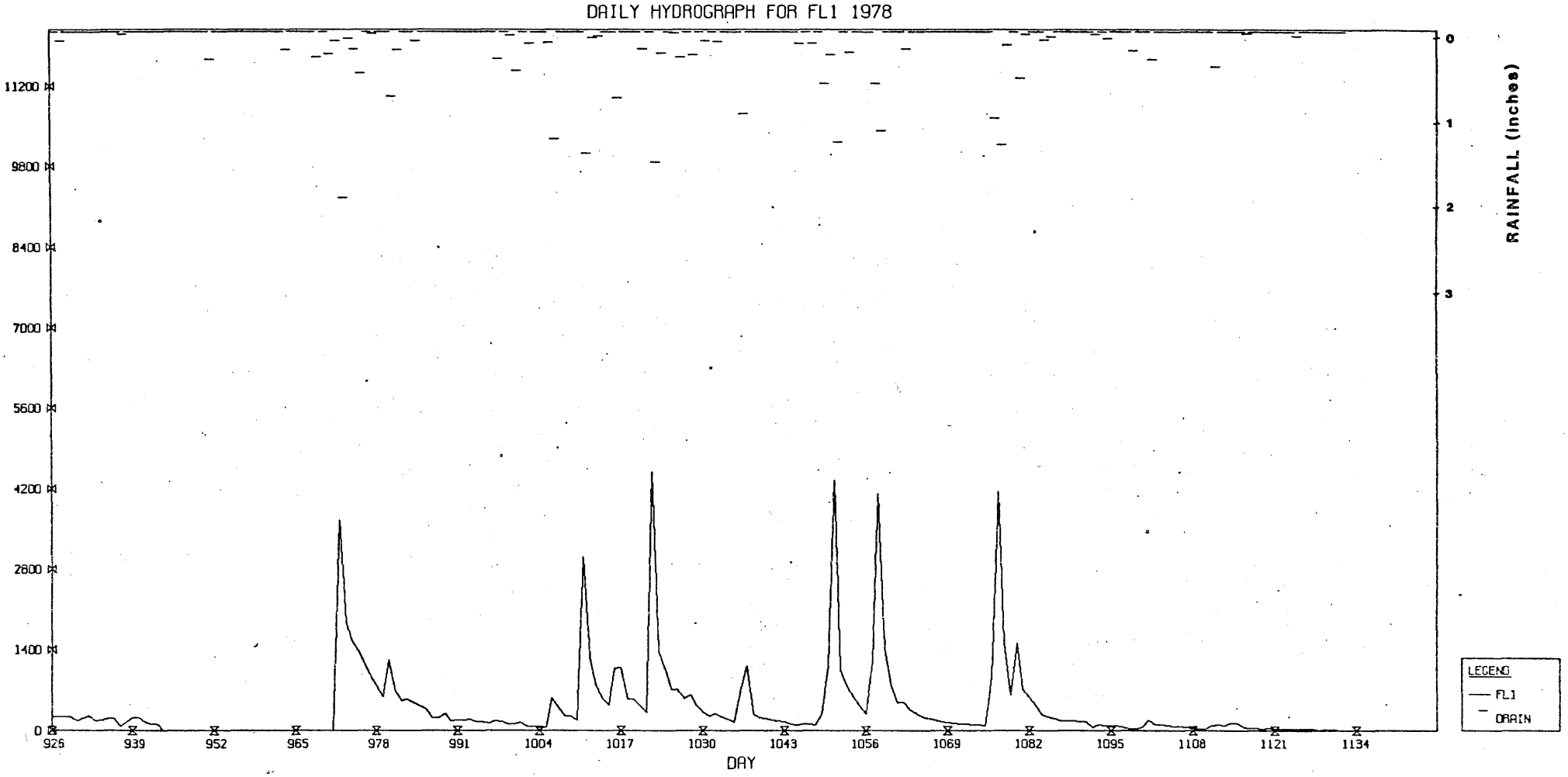


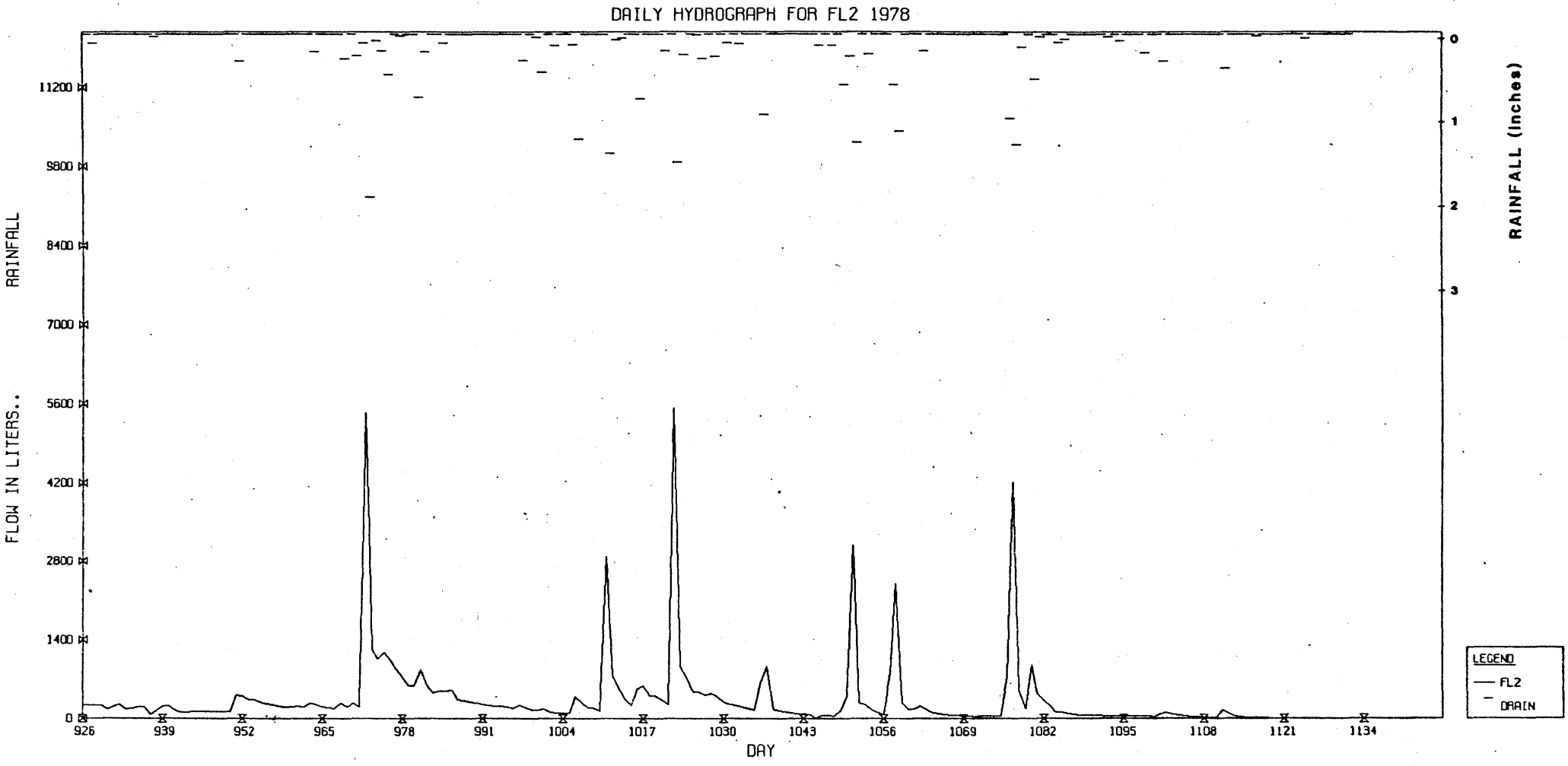
FLOW PROPORTIONAL SAMPLER

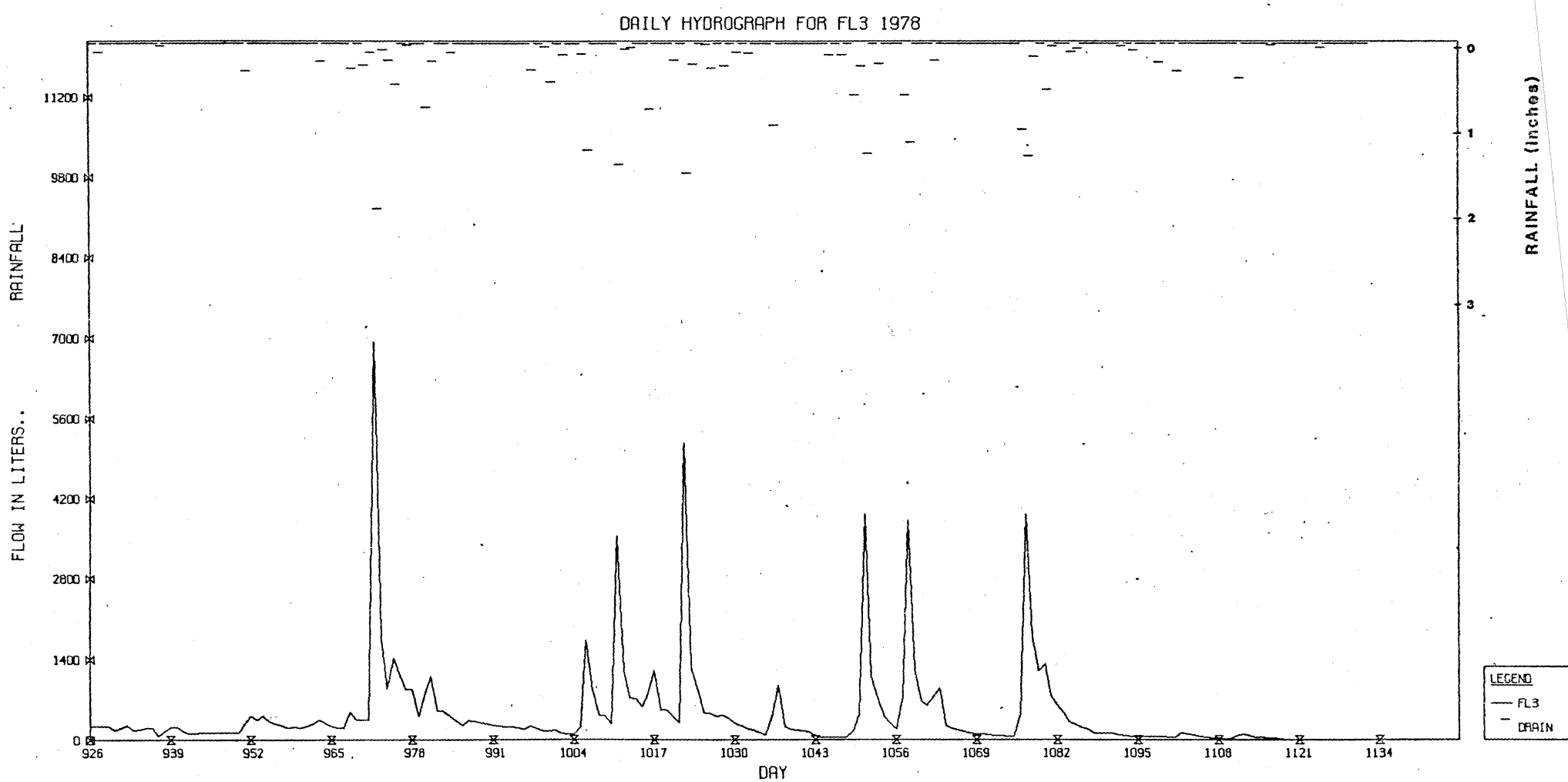


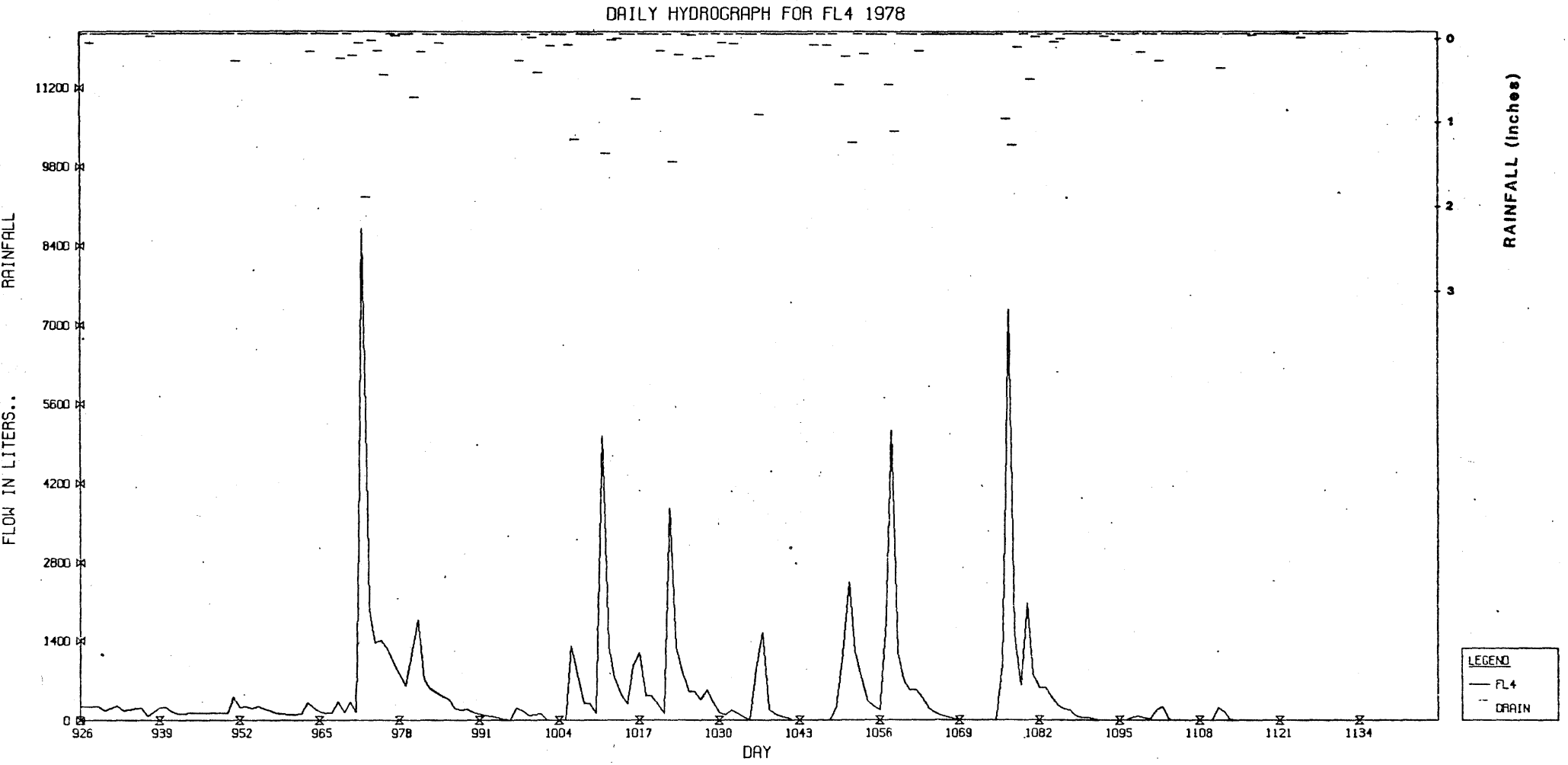
Appendix II

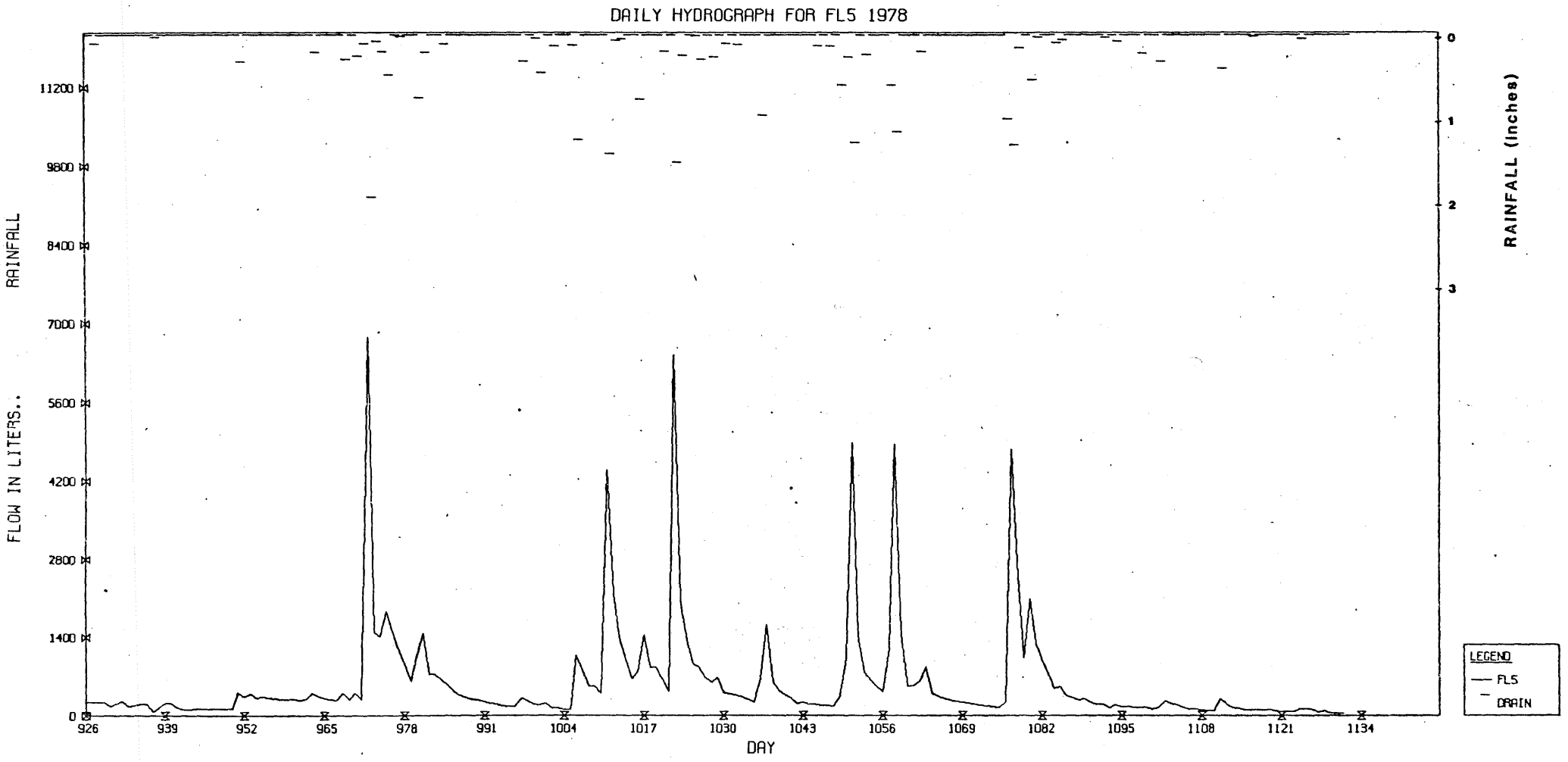
Yearly Hydrographs; 1978, 1979

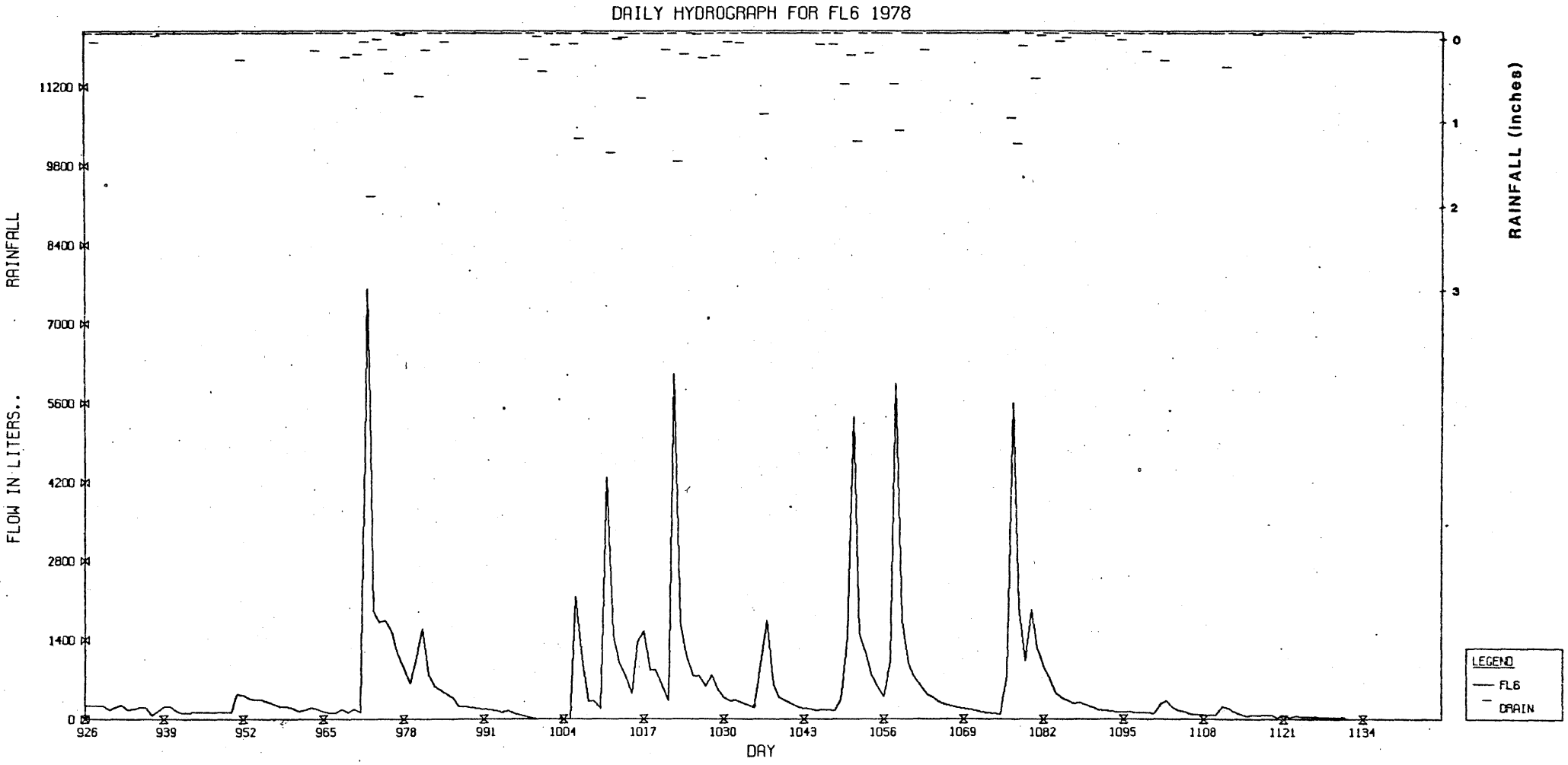

DAILY HYDROGRAPH FOR FL1 1978
11200
9800
8400
7000
5600
4200
2800
1400
0
926
939
952
965
978
991
1004
1017
1030
1043
1056
1069
1082
1095
1108
1121
1134
DAY
0
1
2
3
RAINFALL (Inches)
LEGEND
FL1
DRAIN

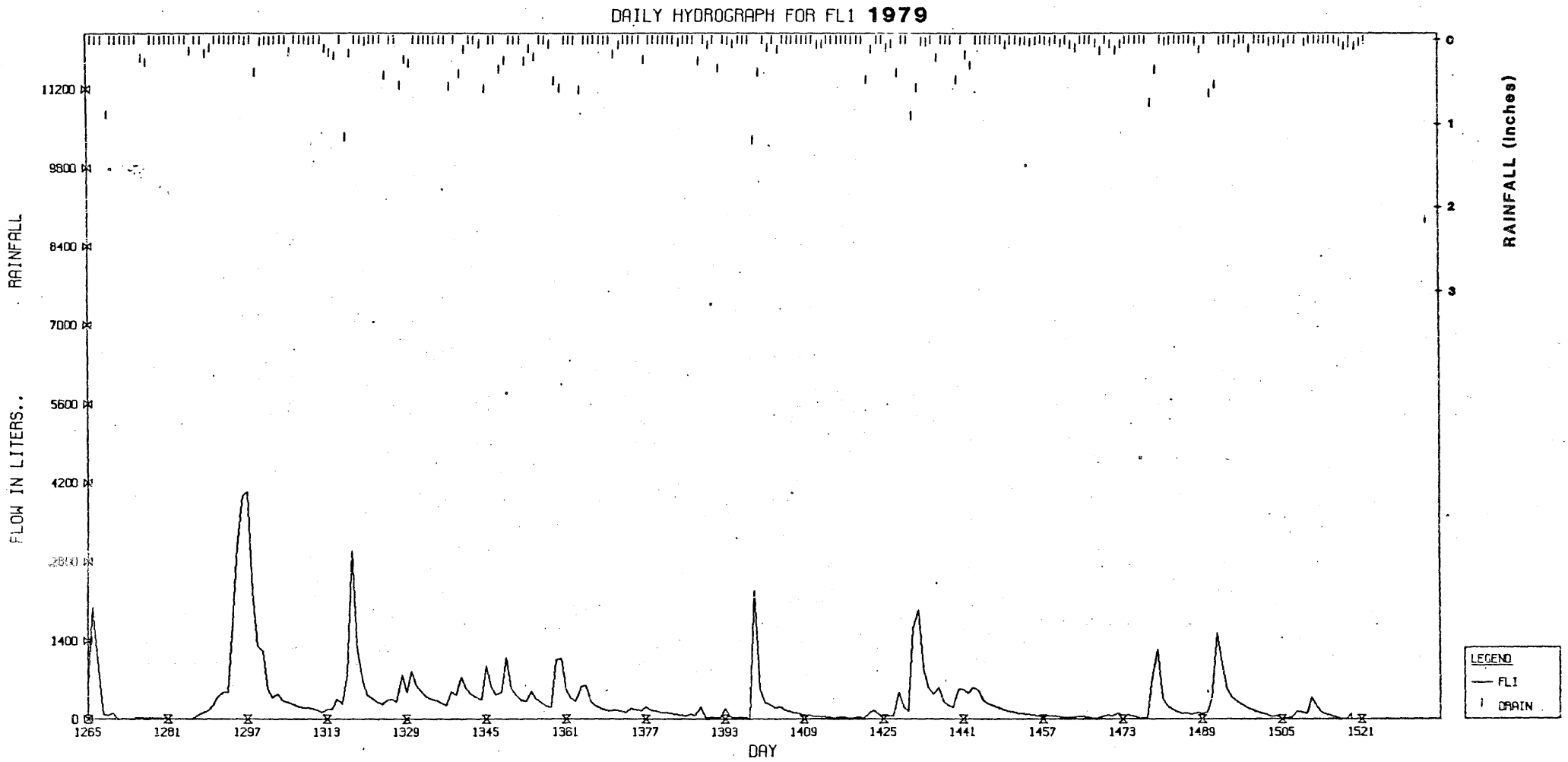

DAILY HYDROGRAPH FOR FL2 1978
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
926
939
952
965
978
991
1004
1017
1030
1043
1056
1069
1082
1095
1108
1121
1134
DAY
0
1
2
3
RAINFALL (Inches)
LEGEND
FL2
RAIN

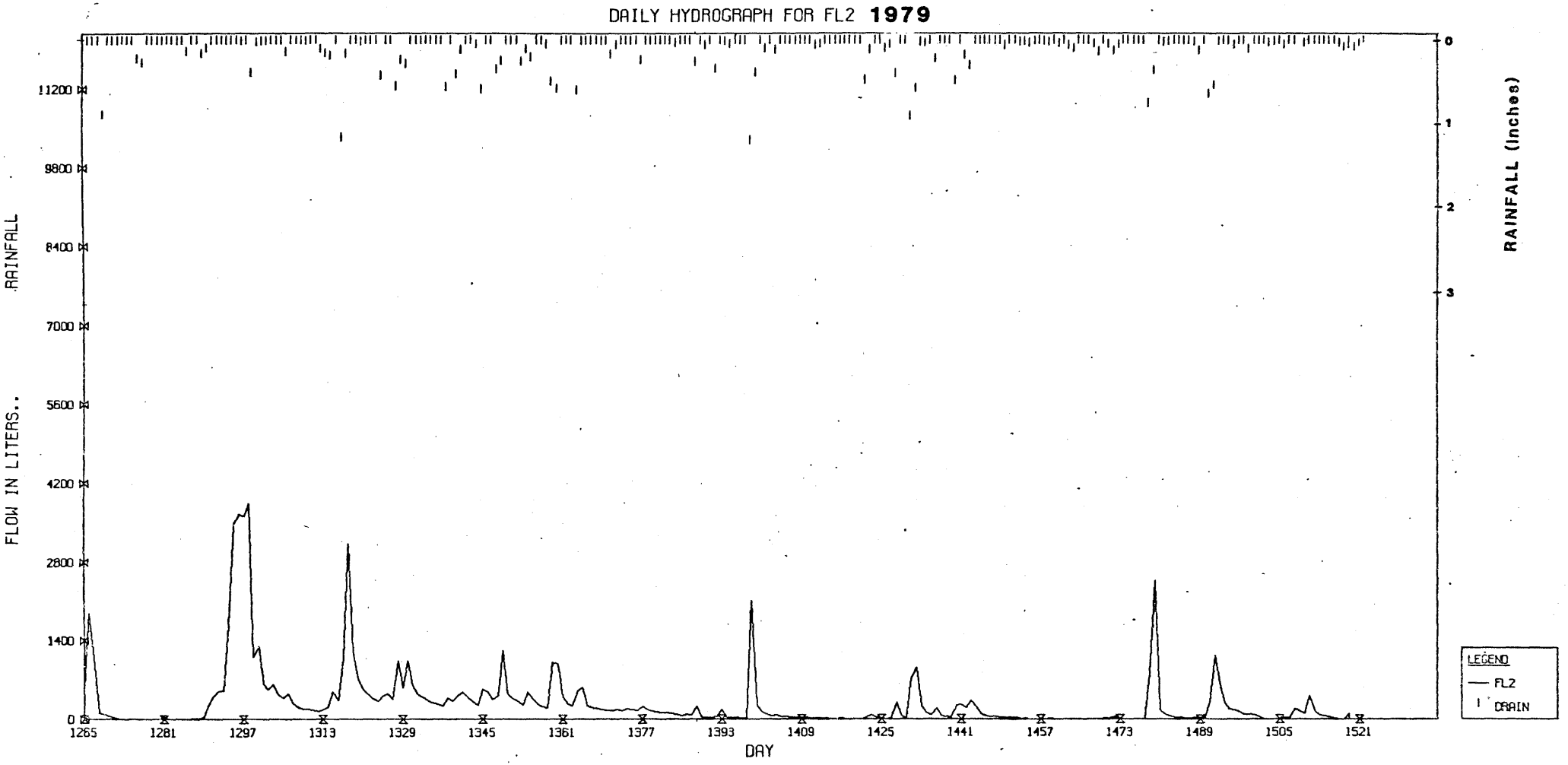

DAILY HYDROGRAPH FOR FL3 1978
RAINFALL
FLOW IN LITERS..
RAINFALL (inches)
11200
9800
8400
7000
5600
4200
2800
1400
0
0
1
2
3
926
939
952
965
978
991
1004
1017
1030
1043
1056
1069
1082
1095
1108
1121
1134
DAY
LEGEND
FL3
DRAIN

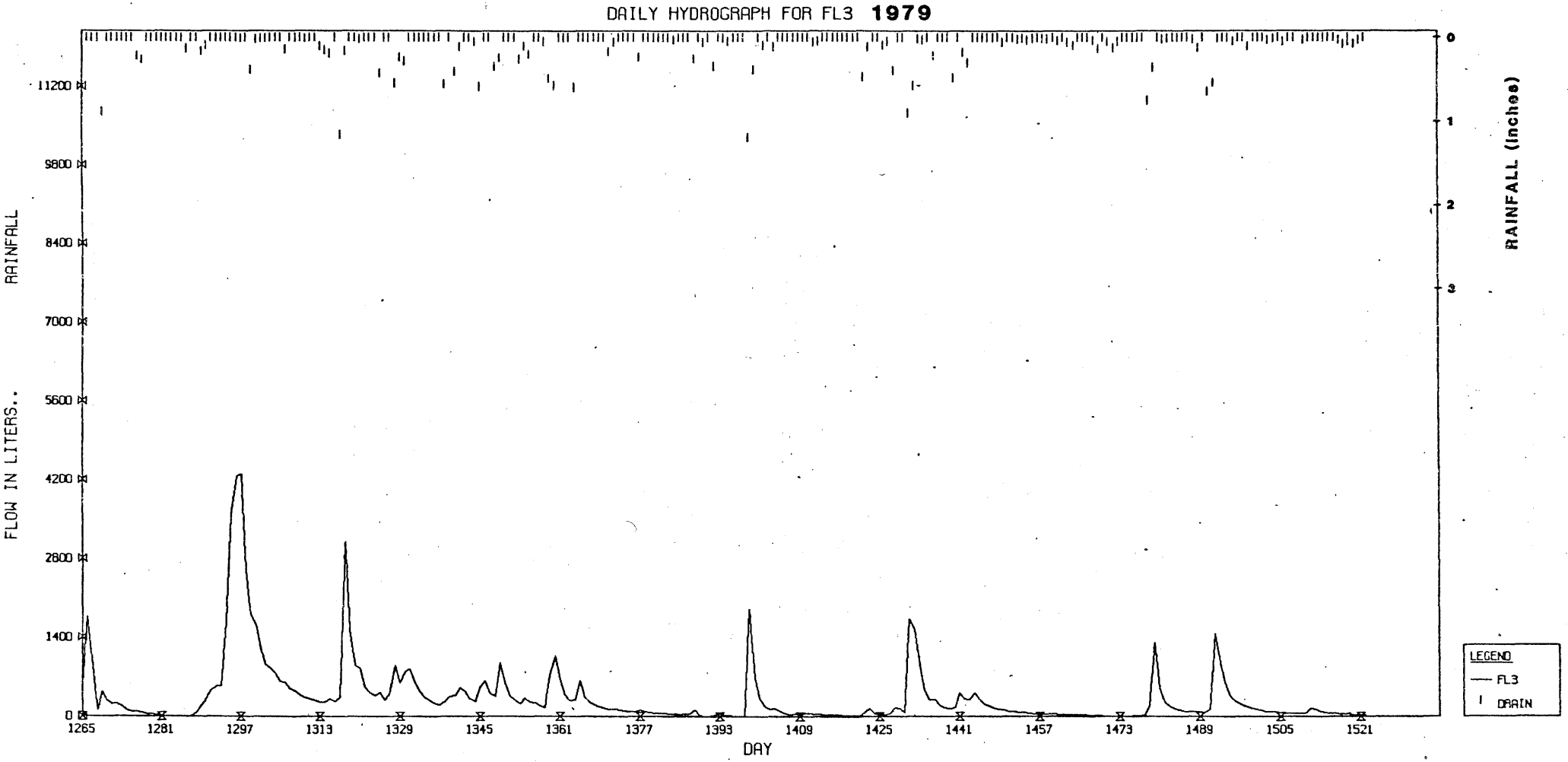

DAILY HYDROGRAPH FOR FL4 1978
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
926
939
952
965
978
991
1004
1017
1030
1043
1056
1069
1082
1095
1108
1121
1134
DAY
RAINFALL (Inches)
0
1
2
3
LEGEND
FL4
DRAIN

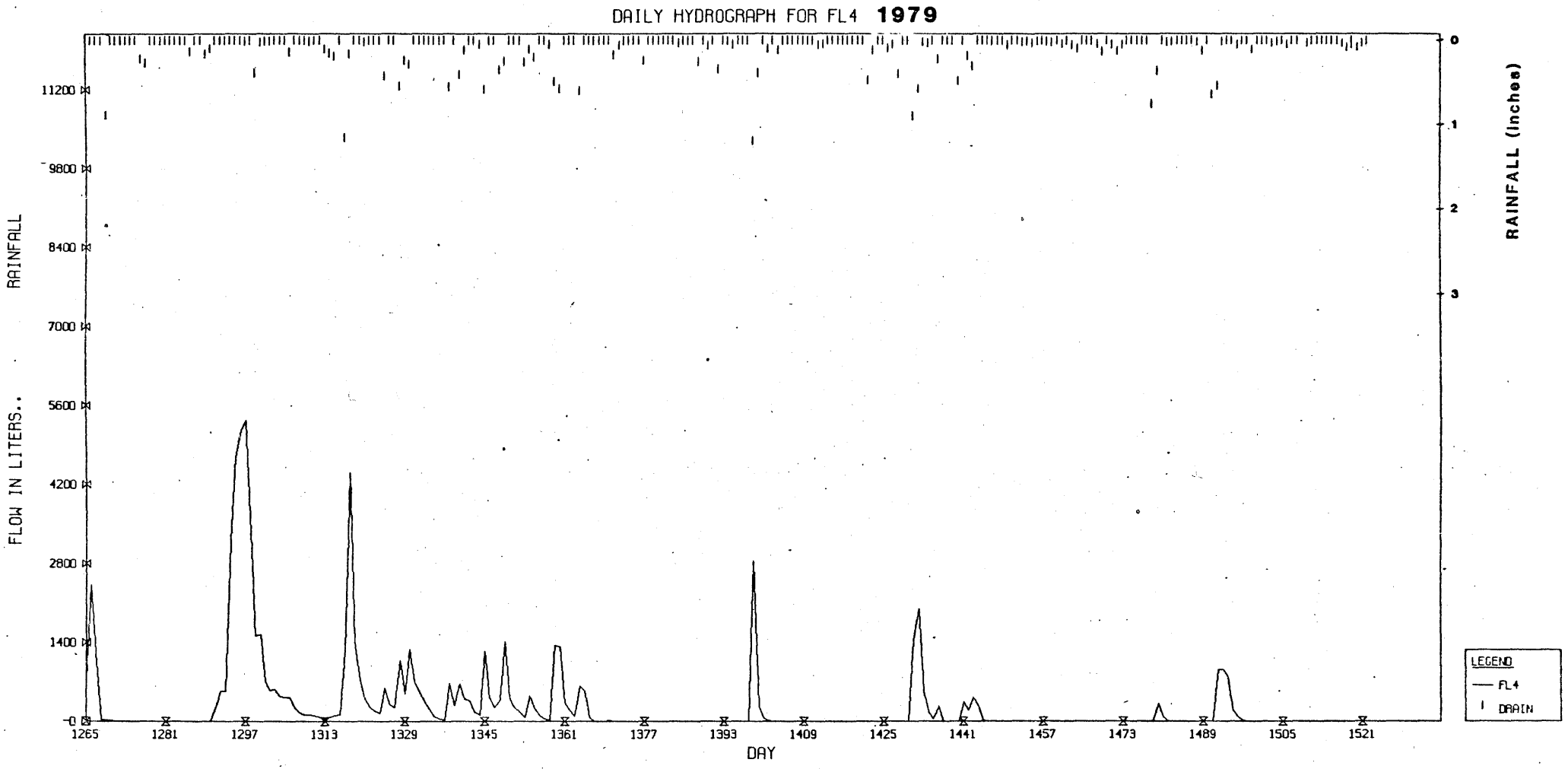

DAILY HYDROGRAPH FOR FL5 1978
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
926
939
952
965
978
991
1004
1017
1030
1043
1056
1069
1082
1095
1108
1121
1134
DAY
RAINFALL (inches)
0
1
2
3
LEGEND
FL5
DRAIN

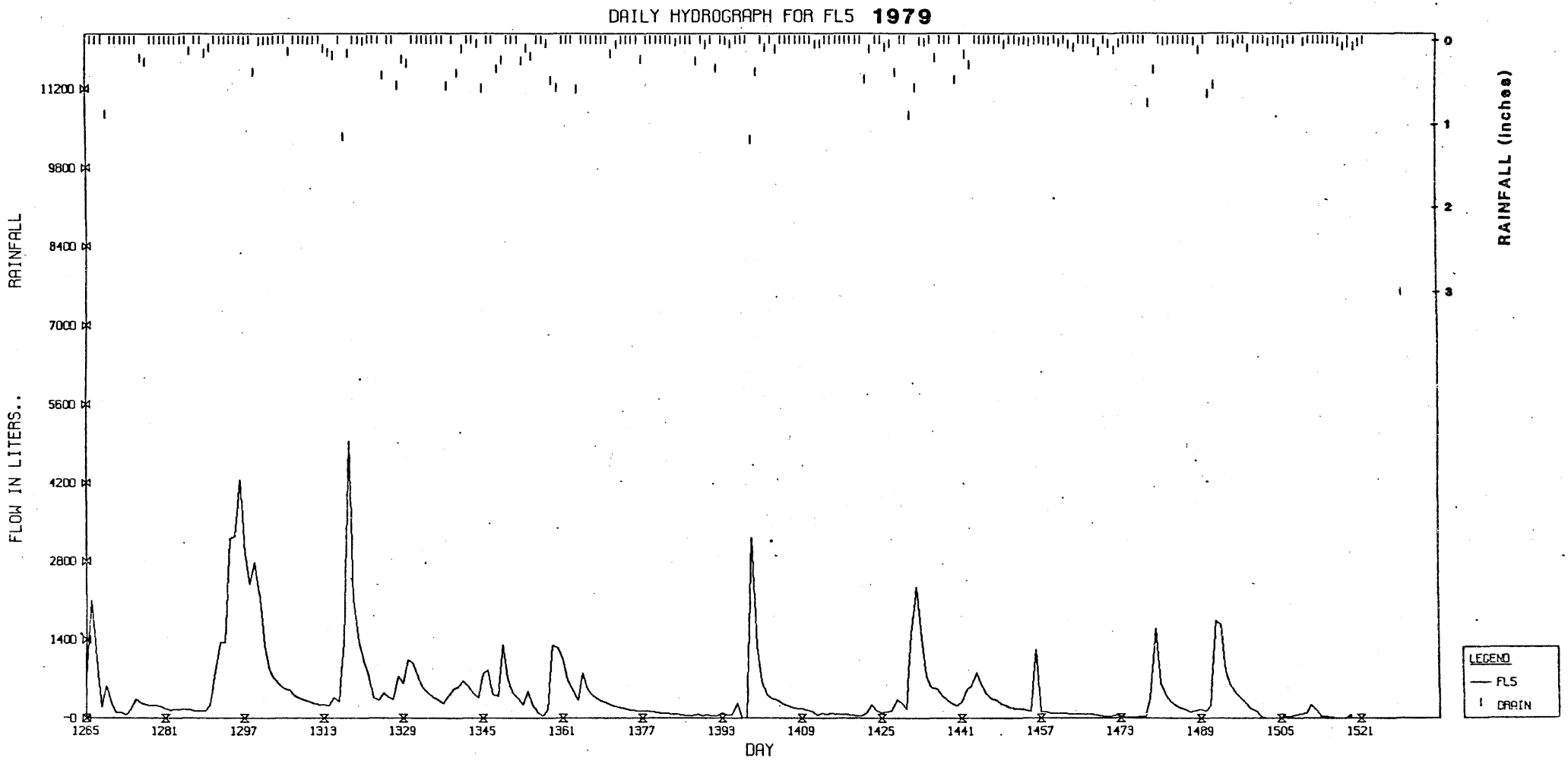

DAILY HYDROGRAPH FOR FL6 1978
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
926
939
952
965
978
991
1004
1017
1030
1043
1056
1069
1082
1095
1108
1121
1134
DAY
RAINFALL (inches)
0
1
2
3
LEGEND
FL6
DRAIN

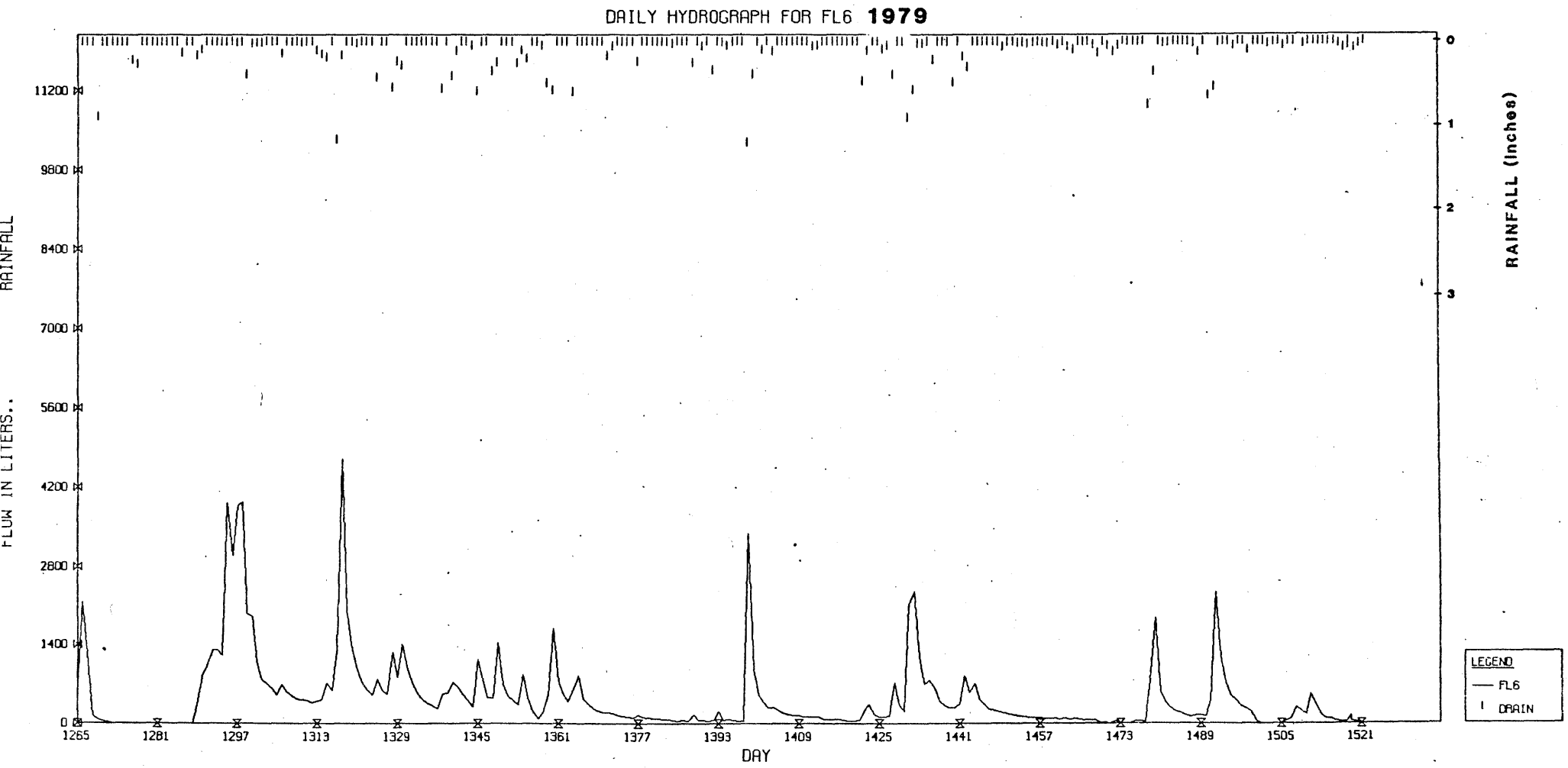

DAILY HYDROGRAPH FOR FL1 1979
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
RAINFALL (Inches)
0
1
2
3
LEGEND
FL1
DRAIN


DAILY HYDROGRAPH FOR FL2 1979
FLOW IN LITERS..
RAINFALL
RAINFALL (Inches)
11200
9800
8400
7000
5600
4200
2800
1400
0
0
1
2
3
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
LEGEND
FL2
DRAIN


DAILY HYDROGRAPH FOR FL3 1979
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
0
1
2
3
RAINFALL (inches)
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
LEGEND
FL3
DRAIN


DAILY HYDROGRAPH FOR FL4 1979
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
RAINFALL (Inches)
0
1
2
3
LEGEND
FL4
DRAIN


DAILY HYDROGRAPH FOR FL5 1979
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
-0
0
1
2
3
RAINFALL (inches)
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
LEGEND
FL5
RAIN

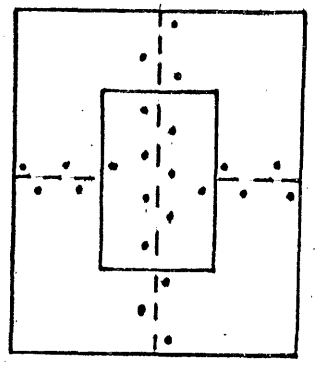

DAILY HYDROGRAPH FOR FL6 1979
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
RAINFALL (inches)
0
1
2
3
LEGEND
FL6
DRAIN

Appendix III

Snow Measurements

Snow Measurements

The general sampling scheme that was used to determine the amount of water on the pile is shown below:



Measurements of snow depth and density were recorded at each site. Approximately 24 measurements were made on each pile, readings were taken every 154 cm.

The results are summarized below:

Pile	Average Snow Depth (cm)	Average Moisture Content (%)	Water in Snow Pack (cm)	Volume of Water on pile (liters)
1	51.6	19	9.8	28,901
2	53.3	18	9.6	32,811
3	50.0	22	11.0	32,476
4	51.1	18	9.2	30,107
5	62.6	19	11.9	40,377
6	47.2	18	8.5	27,227

Appendix IV

Water Quality Data

PILE 1

DATE	ALKALINITY	PH	TEMP. (C)	SP. COND.	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM
3/19/79	21.0	7.45	NA	807.	164.0	13.2	43.0	13.0
4/13/79	41.0	7.10	NA	693.	109.0	9.4	36.8	11.2
4/18/79	33.0	7.20	NA	436.	78.0	5.6	27.0	6.0
4/19/79	35.0	7.10	NA	360.	69.0	4.8	27.0	5.0
4/20/79	39.0	6.60	NA	534.	100.0	7.8	55.0	7.2
4/22/79	27.0	7.65	NA	1193.	185.9	18.1	69.8	15.5
5/ 9/79	NA	7.50	NA	983.	173.0	15.2	60.6	14.8
5/10/79	NA	7.30	NA	1057.	162.8	15.6	57.6	15.4
5/20/79	NA	7.10	NA	1144.	179.6	17.8	75.6	16.2
5/22/79	NA	7.70	NA	897.	144.4	13.8	60.4	14.0
5/23/79	NA	7.50	NA	1720.	232.4	23.6	118.4	21.4
6/ 1/79	NA	7.30	NA	1185.	170.2	17.2	88.8	18.4
6/ 6/79	NA	7.50	NA	1204.	174.0	17.0	53.0	21.2
6/10/79	54.0	7.40	20.0	1168.	166.0	16.4	49.9	20.4
6/12/79	45.0	7.20	NA	1687.	245.8	24.0	67.0	32.8
6/15/79	48.4	7.40	20.0	1488.	234.8	23.0	68.4	28.6
6/21/79	30.0	7.10	15.0	1030.	144.0	15.0	60.0	19.0
6/30/79	NA	7.40	19.0	1349.	338.0	33.0	160.0	32.0
7/10/79	37.0	7.60	18.0	2120.	371.0	37.0	164.0	37.0
7/30/79	20.8	7.40	23.0	1221.	208.5	18.5	50.0	22.0
8/ 4/79	26.8	7.60	23.0	2094.	439.0	34.0	106.0	41.0
8/28/79	18.0	7.30	20.0	1642.	298.0	25.4	95.0	29.8
9/ 1/79	23.2	7.50	22.0	2014.	364.0	31.0	80.2	33.0
9/ 5/79	25.2	7.40	18.0	2145.	427.2	39.0	134.4	42.2
8/13/79	31.2	7.30	13.0	2562.	488.8	49.0	260.0	52.0
8/23/79	24.8	7.30	9.0	1976.	394.8	33.2	174.0	38.6
9/10/79	24.0	7.35	17.5	1794.	343.4	29.2	135.0	35.9
9/13/79	24.0	7.50	16.0	2112.	428.2	37.6	165.6	41.0
9/19/79	25.2	7.40	11.5	3010.	590.8	52.0	232.0	53.2
10/18/79	20.8	7.10	NA	2603.	502.0	45.4	204.0	46.4
10/19/79	19.2	6.80	NA	1318.	223.0	19.6	56.0	20.8
10/31/79	20.8	6.80	NA	1959.	374.0	32.6	90.0	30.8
11/ 1/79	24.8	7.20	10.0	2364.	412.0	38.2	114.0	34.2

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 1

DATE	COPPER	NICKEL	IRON	MANGANESE	COBALT	ZINC	SULFATE	CHLORIDE
3/19/79	.030	.330	.02	.08	.040	.04	NA	3.0
4/13/79	.028	.210	.02	.05	.012	.03	335.	4.0
4/18/79	.023	.106	.02	.04	.008	.02	190.	1.0
4/19/79	.025	.102	.02	.03	.008	.01	165.	2.0
4/20/79	.025	.138	.02	.05	.080	.02	250.	2.0
4/22/79	.028	.315	.02	.09	.020	.04	633.	4.0
5/ 9/79	.025	.250	.02	.08	.015	.02	483.	4.0
5/10/79	.027	.260	.01	.10	.015	.03	467.	3.0
5/20/79	.031	.320	.03	.10	.020	.03	667.	3.0
5/22/79	.027	.220	.01	.09	.015	.02	533.	1.0
5/23/79	.031	.340	.02	.13	.023	.03	900.	3.0
6/ 1/79	.033	.290	.03	.12	.020	.02	700.	2.0
6/ 6/79	.028	.260	.01	.09	.017	.01	675.	3.0
6/10/79	.030	.225	.01	.09	.011	.01	580.	3.0
6/12/79	.028	.280	.01	.12	.013	.02	780.	4.0
6/15/79	.028	.270	.01	.11	.009	.01	740.	5.0
6/21/79	.020	.170	.04	.07	.012	.01	450.	2.0
6/30/79	.030	.370	.02	.11	.025	.02	1280.	4.0
7/10/79	.030	.380	.01	.15	.025	.02	1600.	4.0
7/30/79	.020	.210	.01	.07	.014	.01	589.	3.0
8/ 4/79	.020	.390	.02	.12	.025	.02	1520.	3.0
8/28/79	.040	.320	.05	.09	.015	.03	1130.	28.0
9/ 1/79	.040	.450	.03	.10	.020	.03	1250.	5.0
9/ 5/79	.040	.490	.02	.12	.008	.03	1520.	4.0
8/13/79	.040	.530	.03	.17	.023	.03	1920.	5.0
8/23/79	.030	.430	.02	.13	.023	.03	1500.	5.0
9/10/79	.035	.415	.02	.10	.018	.03	1290.	5.0
9/13/79	.050	.520	.01	.12	.023	.03	1600.	5.0
9/19/79	.050	.660	.03	.12	.060	.04	2200.	8.0
10/18/79	.050	.640	.01	.12	.030	.04	1900.	11.0
10/19/79	.040	.460	.01	.05	.021	.03	750.	3.0
10/31/79	.041	.740	.02	.10	.026	.04	1300.	3.0
11/ 1/79	.030	.820	.02	.10	.060	.05	1000.	6.0

NA =NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 1

DATE	NITRATE	AMMONIA	PHOSPHORUS	DISS.ORG.C	VOLUME (L)	DAILY FLOW
3/19/79	NA	NA	NA	2.9	2631.	1986.
4/13/79	NA	NA	NA	3.6	2616.	390.
4/18/79	1.3	NA	NA	NA	3665.	3966.
4/19/79	.8	.12	NA	NA	4652.	4029.
4/20/79	1.0	.10	NA	3.1	3664.	2274.
4/22/79	2.2	.23	NA	NA	4153.	1200.
5/ 9/79	NA	NA	NA	NA	685.	815.
5/10/79	NA	NA	NA	NA	6572.	2979.
5/20/79	NA	NA	NA	6.9	2990.	784.
5/22/79	NA	NA	NA	6.0	1385.	848.
5/23/79	NA	NA	NA	5.0	2400.	596.
6/ 1/79	NA	NA	NA	6.9	2468.	737.
6/ 6/79	NA	NA	NA	NA	2230.	941.
6/10/79	NA	NA	NA	NA	2143.	1098.
6/12/79	NA	NA	NA	NA	1181.	416.
6/15/79	NA	NA	NA	NA	545.	494.
6/21/79	NA	NA	NA	NA	2343.	1073.
6/30/79	NA	NA	NA	12.0	488.	149.
7/10/79	NA	NA	NA	11.0	1132.	137.
7/30/79	NA	NA	NA	6.3	3448.	2274.
8/ 4/79	NA	NA	NA	6.1	1314.	212.
8/28/79	NA	NA	NA	8.3	548.	458.
9/ 1/79	NA	NA	NA	7.8	3710.	1929.
9/ 5/79	NA	NA	NA	10.0	742.	550.
8/13/79	NA	NA	NA	11.0	345.	500.
8/23/79	NA	NA	NA	9.1	371.	84.
9/10/79	NA	NA	NA	8.9	2608.	516.
9/13/79	NA	NA	NA	9.3	1408.	500.
9/19/79	NA	NA	NA	12.0	886.	141.
10/18/79	NA	NA	NA	11.0	352.	733.
10/19/79	NA	NA	NA	5.9	821.	1222.
10/31/79	NA	NA	NA	7.2	4315.	1513.
11/ 1/79	NA	NA	NA	8.5	2695.	966.

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 2

DATE	ALKALINITY	PH	TEMP. (C)	SP. COND.	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM
3/19/79	NA	7.70	NA	1043.	83.2	11.0	43.8	15.8
3/27/79	NA	NA	NA	NA	205.0	28.4	86.0	24.6
4/17/79	22.0	6.90	NA	388.	74.2	5.8	25.6	11.8
4/18/79	16.5	6.90	NA	177.	27.5	2.6	18.0	6.1
4/20/79	21.0	6.50	NA	296.	49.0	5.6	22.0	8.0
4/22/79	18.0	7.50	NA	1163.	175.4	24.2	82.8	18.6
5/ 9/79	NA	7.40	NA	1217.	154.6	22.0	83.0	18.1
5/10/79	NA	7.40	NA	1009.	144.4	20.0	59.6	16.6
5/20/79	NA	6.90	NA	1562.	233.4	32.6	116.8	23.2
5/22/79	NA	7.40	NA	1128.	165.8	22.8	83.6	18.4
5/23/79	NA	7.60	NA	1976.	286.0	39.2	174.4	28.6
6/ 2/79	NA	7.60	NA	1683.	217.2	31.8	164.2	24.0
6/ 6/79	NA	7.80	NA	1749.	220.8	33.8	85.0	29.6
6/10/79	45.0	7.60	22.0	1414.	173.4	27.8	71.8	24.6
6/12/79	43.0	7.00	NA	2317.	277.0	44.6	107.2	40.0
6/16/79	51.0	7.70	25.0	2365.	307.4	49.1	179.0	39.8
6/20/79	36.0	7.10	18.0	1363.	158.0	27.0	139.0	22.0
6/30/79	59.0	7.60	12.0	2536.	336.0	55.0	339.0	31.0
7/10/79	45.0	7.70	19.0	3294.	420.0	72.0	430.0	38.0
7/30/79	17.8	7.10	22.0	980.	106.0	18.0	88.0	17.0
8/ 4/79	30.8	7.70	23.0	1826.	253.0	36.0	183.0	32.0
8/28/79	13.6	7.20	23.0	1338.	157.0	25.2	132.6	20.0
9/ 1/79	18.4	7.10	21.0	1087.	142.8	19.8	84.2	19.8
9/ 4/79	20.8	7.20	20.0	1380.	211.4	29.0	101.4	25.8
8/13/79	NA	NA	NA	NA	385.6	66.6	408.0	38.6
8/23/79	NA	NA	NA	NA	217.2	33.2	200.0	25.8
9/10/79	15.2	7.20	17.0	1134.	165.6	22.0	104.0	21.2
9/13/79	17.6	7.30	18.0	1587.	233.8	31.6	156.0	26.8
9/19/79	20.8	7.30	18.0	2592.	379.0	53.4	238.2	37.2
10/19/79	12.8	6.60	NA	914.	112.5	16.1	64.0	14.9
10/31/79	13.6	6.70	NA	1319.	194.0	25.2	84.0	20.8
11/ 1/79	17.6	7.20	NA	1659.	280.0	34.2	98.0	25.8

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 2

DATE	COPPER	NICKEL	IRON	MANGANESE	COBALT	ZINC	SULFATE	CHLORIDE
3/19/79	.119	.170	.06	.08	.016	.05	NA	NA
3/27/79	.180	.460	.05	.18	.060	.06	NA	NA
4/17/79	.108	.134	.06	.05	.008	.03	136.	10.0
4/18/79	.091	.040	.05	.03	.004	.02	51.	5.5
4/20/79	.113	.080	.06	.05	.008	.02	100.	12.0
4/22/79	.100	.300	.04	.16	.020	.06	633.	30.0
5/ 9/79	.084	.295	.03	.14	.020	.04	500.	26.0
5/10/79	.100	.250	.03	.13	.015	.04	400.	22.0
5/20/79	.100	.330	.03	.18	.023	.05	800.	25.0
5/22/79	.180	.280	.04	.14	.020	.04	567.	20.0
5/23/79	.100	.440	.21	.23	.027	.07	NA	NA
6/ 2/79	.160	.340	.07	.18	.023	.05	883.	23.0
6/ 6/79	.170	.300	.03	.17	.021	.05	900.	23.0
6/10/79	.190	.270	.06	.13	.013	.03	580.	19.0
6/12/79	.132	.370	.02	.29	.017	.07	1200.	27.0
6/16/79	.131	.415	.03	.23	.028	.08	1350.	31.0
6/20/79	.130	.220	.04	.12	.017	.04	570.	15.0
6/30/79	.070	.430	.03	.13	.036	.09	1450.	31.0
7/10/79	.060	.590	.02	.34	.052	.11	2300.	28.0
7/30/79	.110	.170	.03	.09	.014	.03	480.	16.0
8/ 4/79	.070	.360	.07	.19	.030	.07	1020.	15.0
8/28/79	.150	.360	.07	.15	.021	.06	NA	NA
9/ 1/79	.150	.280	.05	.10	.020	.05	650.	9.0
9/ 4/79	.120	.370	.02	.16	.020	.07	NA	NA
8/13/79	.050	.650	.04	.30	.035	.08	NA	NA
8/23/79	.100	.470	.04	.21	.027	.07	NA	NA
9/10/79	.150	.340	.03	.14	.020	.05	600.	9.0
9/13/79	.150	.450	.05	.20	.026	.09	NA	NA
9/19/79	.060	.760	.02	.30	.070	.12	NA	NA
10/19/79	.195	.365	.05	.10	.020	.04	542.	5.0
10/31/79	.160	.490	.05	.16	.050	.09	817.	4.0
11/ 1/79	.110	.550	.02	.16	.060	.08	975.	10.0

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 2

DATE	NITRATE	AMMONIA	PHOSPHORUS	DISS.ORG.C	VOLUME (L)	DAILY FLOW
3/19/79	NA	NA	NA	12.0	2612.	1891.
3/27/79	NA	NA	NA	NA	53.	NA
4/17/79	136.0	NA	NA	14.0	5151.	3480.
4/18/79	1.1	NA	NA	10.5	6056.	3654.
4/20/79	2.2	.45	NA	11.0	3263.	3830.
4/22/79	11.0	.11	NA	NA	5020.	1296.
5/ 9/79	NA	NA	NA	NA	825.	1083.
5/10/79	NA	NA	NA	NA	6810.	3129.
5/20/79	NA	NA	NA	14.0	3611.	1034.
5/22/79	NA	NA	NA	16.0	1639.	1041.
5/23/79	NA	NA	NA	4.7	2286.	609.
6/ 2/79	NA	NA	NA	16.0	1518.	474.
6/ 6/79	NA	NA	NA	NA	1999.	531.
6/10/79	NA	NA	NA	NA	2021.	1211.
6/12/79	NA	NA	NA	NA	1033.	361.
6/16/79	NA	NA	NA	NA	1344.	368.
6/20/79	NA	NA	NA	NA	2200.	1011.
6/30/79	NA	NA	NA	16.0	1132.	170.
7/10/79	NA	NA	NA	NA	1249.	142.
7/30/79	NA	NA	NA	14.0	2779.	2096.
8/ 4/79	NA	NA	NA	9.2	443.	65.
8/28/79	NA	NA	NA	15.0	326.	293.
9/ 1/79	NA	NA	NA	13.0	1525.	905.
9/ 4/79	NA	NA	NA	13.0	1775.	179.
8/13/79	NA	NA	NA	NA	91.	11.
8/23/79	NA	NA	NA	14.0	114.	70.
9/10/79	NA	NA	NA	14.0	1268.	249.
9/13/79	NA	NA	NA	14.0	367.	211.
9/19/79	NA	NA	NA	13.0	129.	22.
10/19/79	NA	NA	NA	14.0	1726.	2456.
10/31/79	NA	NA	NA	13.0	2835.	1118.
11/ 1/79	NA	NA	NA	13.0	1215.	637.

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 3

DATE	ALKALINITY	PH	TEMP. (C)	SP. COND.	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM
3/19/79	NA	7.08	NA	794.	118.8	25.9	50.1	15.9
4/13/79	40.0	7.20	NA	1233.	162.0	36.8	73.8	22.2
4/13/79	NA	6.75	NA	484.	61.9	12.8	29.6	10.1
4/17/79	28.0	6.70	NA	587.	69.8	13.8	32.2	10.8
4/19/79	27.0	7.10	NA	532.	83.0	12.6	31.0	8.6
4/19/79	23.0	6.80	NA	503.	80.5	13.4	41.5	9.3
4/20/79	33.0	6.70	NA	623.	100.0	17.6	42.0	11.0
4/22/79	19.0	7.20	NA	1356.	206.4	44.6	121.6	24.8
5/ 7/79	NA	7.30	NA	1562.	209.2	49.0	131.6	27.6
5/10/79	NA	7.40	NA	959.	123.2	26.4	62.4	17.0
5/20/79	NA	6.70	NA	1711.	229.2	52.6	130.8	29.6
5/22/79	NA	7.60	NA	1537.	120.4	26.2	60.8	16.8
5/23/79	NA	7.50	NA	1331.	180.4	37.4	92.2	24.4
6/ 1/79	NA	7.60	NA	998.	122.8	26.6	59.8	17.4
6/ 6/79	NA	7.50	NA	824.	101.0	21.8	33.4	15.6
6/10/79	35.0	7.20	20.0	725.	173.8	38.0	50.8	38.8
6/12/79	33.0	6.80	NA	912.	118.8	25.2	36.0	22.8
6/15/79	33.0	7.30	20.0	1081.	143.8	30.4	42.4	23.4
6/21/79	30.5	7.05	16.5	823.	101.0	23.5	42.0	19.0
6/30/79	29.0	7.20	12.0	1175.	158.0	35.0	68.0	25.0
7/10/79	26.0	7.50	18.0	1649.	241.0	52.0	105.0	37.0
7/30/79	12.0	7.10	23.0	772.	98.0	21.0	31.0	19.0
8/ 4/79	13.4	7.05	23.0	1277.	204.5	36.0	53.0	33.0
8/28/79	12.4	7.10	21.0	1172.	177.8	36.8	50.0	27.2
9/ 1/79	12.0	6.90	20.0	1002.	156.6	29.8	36.6	23.2
9/ 5/79	12.0	6.90	18.0	1575.	269.6	52.0	69.0	36.6
8/13/79	12.0	6.90	14.0	2064.	368.0	77.6	150.8	55.2
9/10/79	9.6	6.80	18.0	1401.	235.6	42.6	77.4	33.0
9/13/79	11.2	7.00	17.0	1499.	231.8	44.0	80.6	32.8
9/19/79	12.0	6.80	15.0	2598.	430.8	84.8	144.0	56.8
10/17/79	7.2	6.40	NA	2192.	363.2	73.4	122.8	48.0
10/19/79	8.0	6.30	NA	938.	124.4	28.0	44.0	18.8
10/31/79	9.6	6.40	0	1233.	172.0	36.5	54.2	23.9
11/ 1/79	12.8	6.80	12.0	1258.	182.0	39.6	60.0	25.6

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 3

DATE	COPPER	NICKEL	IRON	MANGANESE	COBALT	ZINC	SULFATE	CHLORIDE
3/19/79	.080	.790	.08	.10	.050	.11	NA	NA
4/13/79	.060	.780	.02	.12	.070	.11	NA	NA
4/13/79	.106	.296	.13	.06	.024	.04	233.	5.0
4/17/79	.088	.292	.09	.08	.026	.05	235.	8.0
4/19/79	.072	.238	.05	.07	.020	.05	205.	4.0
4/19/79	.064	.220	.12	.07	.020	.04	215.	5.0
4/20/79	.069	.278	.06	.09	.032	.05	310.	4.0
4/22/79	.056	.920	.03	.17	.051	.12	833.	11.0
5/ 7/79	.046	.890	.03	.18	.047	.11	NA	NA
5/10/79	.068	.520	.03	.11	.031	.07	433.	10.0
5/20/79	.060	.750	.02	.16	.047	.12	933.	13.0
5/22/79	.090	.440	.04	.08	.023	.08	500.	6.0
5/23/79	.058	.620	.04	.12	.040	.08	750.	7.0
6/ 1/79	.100	.460	.08	.10	.023	.06	517.	6.0
6/ 6/79	.081	.370	.03	.08	.021	.05	400.	4.0
6/10/79	.100	.310	.02	.05	.010	.04	320.	4.0
6/12/79	.071	.410	.01	.07	.013	.07	420.	5.0
6/15/79	.061	.470	.01	.08	.013	.05	533.	7.0
6/21/79	.070	.340	.02	.06	.021	.04	409.	4.0
6/30/79	.050	.490	.02	.24	.032	.07	725.	5.0
7/10/79	.040	1.700	.01	.16	.046	.09	1100.	12.0
7/30/79	.090	.580	.01	.10	.040	.06	390.	1.0
8/ 4/79	.080	.980	.03	.15	.045	.11	809.	4.0
8/28/79	.170	1.190	.01	.20	.080	.14	720.	14.0
9/ 1/79	.150	1.280	.01	.13	.062	.11	650.	4.0
9/ 5/79	.140	1.640	.01	.17	.090	.15	1200.	5.0
8/13/79	.100	1.460	.04	.23	.090	.18	1850.	10.0
9/10/79	.140	1.440	.02	.17	.110	.13	975.	6.0
9/13/79	.150	1.630	.03	.18	.090	.13	950.	6.0
9/19/79	.180	2.570	.02	.26	.140	.26	1900.	12.0
10/17/79	.190	2.560	.01	.29	.140	.27	NA	NA
10/19/79	.190	1.630	.03	.13	.070	.14	600.	3.0
10/31/79	.220	2.840	.02	.19	.140	.20	725.	3.0
11/ 1/79	.190	2.540	.02	.15	.120	.18	NA	NA

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 3

DATE	NITRATE	AMMONIA	PHOSPHORUS	DISS.ORG.C	VOLUME (L)	DAILY FLOW
3/19/79	NA	NA	NA	9.3	3179.	1765.
4/13/79	NA	NA	NA	NA	1877.	442.
4/13/79	NA	NA	NA	NA	1877.	442.
4/17/79	NA	NA	NA	5.3	3039.	3576.
4/19/79	1.5	NA	NA	11.0	3312.	4304.
4/19/79	1.5	.10	NA	NA	4341.	4304.
4/20/79	3.4	.10	NA	4.7	4126.	2592.
4/22/79	6.9	.04	NA	NA	8607.	1630.
5/ 7/79	NA	NA	NA	NA	479.	308.
5/10/79	NA	NA	NA	NA	7070.	3099.
5/20/79	NA	NA	NA	5.9	2619.	900.
5/22/79	NA	NA	NA	7.6	1559.	784.
5/23/79	NA	NA	NA	4.9	2449.	838.
6/ 1/79	NA	NA	NA	6.7	1938.	369.
6/ 6/79	NA	NA	NA	NA	1768.	515.
6/10/79	NA	NA	NA	NA	1771.	938.
6/12/79	NA	NA	NA	NA	1011.	361.
6/15/79	NA	NA	NA	NA	329.	325.
6/21/79	NA	NA	NA	NA	2195.	1070.
6/30/79	NA	NA	NA	5.6	1389.	169.
7/10/79	NA	NA	NA	5.3	734.	74.
7/30/79	NA	NA	NA	7.7	2596.	1907.
8/ 4/79	NA	NA	NA	9.6	602.	138.
8/28/79	NA	NA	NA	8.2	208.	161.
9/ 1/79	NA	NA	NA	6.1	3895.	1538.
9/ 5/79	NA	NA	NA	6.2	500.	292.
8/13/79	NA	NA	NA	5.2	295.	46.
9/10/79	NA	NA	NA	5.7	1983.	408.
9/13/79	NA	NA	NA	5.3	1332.	408.
9/19/79	NA	NA	NA	5.0	863.	109.
10/17/79	NA	NA	NA	4.6	337.	200.
10/19/79	NA	NA	NA	5.9	1177.	1297.
10/31/79	NA	NA	NA	4.5	3963.	1450.
11/ 1/79	NA	NA	NA	4.5	3316.	944.

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 4

DATE	ALKALINITY	PH	TEMP. (C)	SP. COND.	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM
3/19/79	NA	NA	NA	861.	96.6	18.2	39.4	11.2
4/17/79	7.0	5.90	NA	635.	77.0	14.0	34.4	10.6
4/19/79	21.0	7.10	NA	391.	65.0	5.0	23.0	8.6
4/18/79	22.0	6.80	NA	401.	66.0	6.0	25.0	9.0
4/20/79	22.0	6.40	NA	364.	67.0	4.8	24.0	17.8
4/20/79	29.0	6.90	NA	568.	106.0	8.6	NA	14.2
4/22/79	19.0	7.40	NA	980.	171.0	15.8	42.6	24.4
5/ 9/79	NA	7.50	NA	1039.	171.2	15.8	48.2	27.4
5/10/79	NA	7.50	NA	1010.	162.4	16.6	50.4	25.6
5/20/79	NA	6.90	NA	1363.	227.8	23.6	77.9	35.2
5/22/79	NA	7.60	NA	984.	178.4	18.8	68.8	30.0
5/23/79	NA	7.20	NA	1264.	193.4	21.6	74.0	32.8
6/ 1/79	NA	7.70	NA	1334.	201.8	22.0	80.4	34.8
6/ 6/79	NA	7.60	NA	1213.	180.6	19.4	48.4	48.2
6/10/79	36.0	7.30	22.0	1116.	159.4	18.0	45.0	41.6
6/12/79	32.0	7.30	NA	1107.	157.0	17.2	43.6	40.8
6/15/79	33.0	7.30	21.0	1138.	160.4	18.4	45.8	37.6
6/20/79	30.0	7.10	17.0	1347.	171.0	21.0	72.0	38.0
6/30/79	NA	NA	NA	NA	176.0	21.0	73.0	35.0
7/30/79	32.0	5.75	23.0	907.	118.0	22.0	38.0	20.0
9/ 1/79	10.4	7.00	20.5	1112.	189.6	16.8	40.4	33.8
9/ 5/79	14.4	7.10	20.0	1333.	246.4	22.4	46.8	40.0
9/12/79	12.8	7.00	20.0	1250.	228.6	20.0	45.6	38.2
9/13/79	NA	7.20	20.0	1321.	237.8	21.4	55.6	43.4
10/19/79	7.2	6.40	NA	980.	166.4	14.6	24.0	27.8
10/31/79	8.8	6.60	NA	1025.	152.0	15.0	38.0	28.8

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 4

DATE	COPPER	NICKEL	IRON	MANGANESE	COBALT	ZINC	SULFATE	CHLORIDE
3/19/79	3.000	14.600	.03	1.03	.256	.40	380.	8.0
4/17/79	1.120	12.310	1.46	1.11	.240	.24	325.	7.0
4/19/79	.016	.093	.02	.07	.008	.04	170.	1.0
4/18/79	.069	.373	.02	.15	.064	.05	170.	3.0
4/20/79	.014	.089	.02	.07	.008	.03	145.	2.0
4/20/79	.064	.210	.02	.10	.008	.04	285.	3.0
4/22/79	.021	.270	.03	.14	.020	.07	483.	4.0
5/ 9/79	.016	.310	.03	.17	.023	.07	NA	NA
5/10/79	.021	.280	.01	.15	.020	.06	532.	4.0
5/20/79	.026	.375	.02	.17	.029	.08	817.	5.0
5/22/79	.025	.320	.01	.15	.023	.08	583.	3.0
5/23/79	.030	.360	.02	.16	.027	.07	700.	4.0
6/ 1/79	.027	.350	.03	.17	.027	.08	800.	5.0
6/ 6/79	.023	.300	.01	.14	.021	.08	700.	5.0
6/10/79	.023	.240	.03	.11	.013	.06	560.	4.0
6/12/79	.013	.240	.01	.11	.009	.06	NA	NA
6/15/79	.016	.280	.01	.12	.009	.06	NA	NA
6/20/79	.020	.260	.03	.97	.020	.07	570.	5.0
6/30/79	.010	.270	.01	.10	.020	.05	NA	NA
7/30/79	.700	4.140	.01	.55	.260	.18	460.	11.0
9/ 1/79	.040	.510	.01	.14	.028	.09	650.	4.0
9/ 5/79	.040	.670	.01	.19	.034	.12	NA	NA
9/12/79	.060	.780	.01	.19	.060	.13	800.	6.0
9/13/79	.030	.710	.02	.18	.035	.11	NA	NA
10/19/79	.080	1.260	.01	.13	.070	.16	600.	2.0
10/31/79	.080	1.040	.01	.12	.060	.14	550.	3.0

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 4

DATE	NITRATE	AMMONIA	PHOSPHORUS	DISS.ORG.C	VOLUME (L)	DAILY FLOW
3/19/79	NA	NA	NA	4.1	2660.	2428.
4/17/79	NA	NA	NA	3.5	6041.	4676.
4/19/79	.5	NA	NA	NA	5560.	5332.
4/18/79	1.2	NA	NA	NA	4644.	5152.
4/20/79	.4	.05	NA	NA	3077.	3329.
4/20/79	.6	.12	NA	2.2	4364.	3329.
4/22/79	1.0	.03	NA	NA	4599.	1534.
5/ 9/79	NA	NA	NA	NA	647.	1239.
5/10/79	NA	NA	NA	NA	8717.	4417.
5/20/79	NA	NA	NA	5.7	3062.	1080.
5/22/79	NA	NA	NA	3.5	1904.	1278.
5/23/79	NA	NA	NA	4.5	3357.	699.
6/ 1/79	NA	NA	NA	4.7	2290.	662.
6/ 6/79	NA	NA	NA	NA	2044.	1227.
6/10/79	NA	NA	NA	NA	2161.	1411.
6/12/79	NA	NA	NA	NA	681.	245.
6/15/79	NA	NA	NA	NA	469.	442.
6/20/79	NA	NA	NA	NA	2854.	1339.
6/30/79	NA	NA	NA	NA	526.	NA
7/30/79	NA	NA	NA	4.9	2324.	2847.
9/ 1/79	NA	NA	NA	4.0	4307.	1988.
9/ 5/79	NA	NA	NA	5.1	337.	270.
9/12/79	NA	NA	NA	3.7	1158.	417.
9/13/79	NA	NA	NA	NA	91.	270.
10/19/79	NA	NA	NA	1.9	541.	307.
10/31/79	NA	NA	NA	2.2	1764.	908.

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 5

DATE	ALKALINITY	PH	TEMP. (C)	SP. COND.	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM
3/23/79	NA	3.70	NA	2445.	271.6	108.0	121.8	14.8
4/ 3/79	NA	3.60	NA	4435.	395.0	231.0	286.0	28.0
4/11/79	NA	3.60	NA	4766.	430.0	280.0	338.0	30.0
4/16/79	NA	3.50	NA	2822.	269.0	124.0	146.8	15.2
4/18/79	NA	3.40	NA	1769.	213.0	62.4	68.0	7.2
4/17/79	NA	3.30	NA	1769.	197.0	70.6	70.0	8.2
4/19/79	NA	3.40	NA	1475.	193.0	42.2	52.0	6.4
4/20/79	NA	3.50	NA	1380.	178.0	49.0	65.0	6.6
4/24/79	NA	3.30	NA	2332.	286.0	89.2	130.0	11.2
4/30/79	NA	3.50	NA	2562.	294.8	100.0	185.6	12.2
5/11/79	NA	3.50	NA	2341.	254.0	89.0	133.0	9.0
5/23/79	NA	3.20	NA	2713.	288.2	105.8	162.8	14.0
5/22/79	NA	5.80	NA	1767.	201.0	64.0	79.0	7.0
5/31/79	NA	3.38	NA	2578.	285.4	57.7	151.2	13.1
6/ 1/79	NA	3.60	NA	2227.	239.2	54.6	121.4	11.6
6/ 6/79	NA	3.90	NA	2154.	243.8	77.2	60.8	9.2
6/10/79	NA	3.40	NA	2538.	287.6	93.0	68.2	11.0
6/16/79	NA	3.60	23.0	2890.	324.0	110.0	115.0	14.8
6/20/79	NA	3.50	19.0	1891.	203.0	68.0	71.0	11.0
6/30/79	NA	3.30	14.0	2754.	328.0	117.0	132.0	16.5
7/10/79	NA	3.30	19.0	3830.	462.0	180.0	204.0	29.0
7/30/79	NA	3.50	22.0	1926.	229.0	82.0	63.0	12.0
8/ 4/79	NA	3.20	23.0	3170.	416.0	144.0	120.0	21.0
8/28/79	NA	3.40	20.0	3332.	365.0	122.2	158.6	21.8
9/ 1/79	NA	3.20	21.0	2923.	296.4	115.8	98.2	18.0
9/ 5/79	NA	3.20	19.0	4197.	420.2	128.6	192.8	28.4
8/13/79	NA	3.40	14.0	4636.	514.8	130.4	322.0	32.6
8/23/79	NA	3.50	12.0	3708.	463.2	230.2	202.0	27.2
9/13/79	NA	3.30	17.0	3906.	372.8	234.0	192.6	26.6
9/13/79	NA	3.30	17.0	4120.	363.8	239.6	197.0	26.2
9/19/79	NA	3.30	12.0	5852.	522.0	384.0	286.0	39.2
10/18/79	NA	3.40	NA	5446.	518.0	398.0	272.0	36.4
10/19/79	NA	3.60	NA	2356.	185.6	138.0	76.0	12.8
10/31/79	NA	3.30	NA	3937.	320.0	260.0	150.0	22.0
11/ 1/79	NA	3.40	NA	3567.	294.0	244.0	132.0	22.6

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 5

DATE	COPPER	NICKEL	IRON	MANGANESE	COBALT	ZINC	SULFATE	CHLORIDE
3/23/79	44.0	169.0	4.01	11.80	14.0	5.00	2100.	11.0
4/ 3/79	91.0	335.0	11.00	28.00	25.0	11.00	3000.	18.0
4/11/79	107.0	406.0	10.00	35.00	31.0	13.00	4600.	22.0
4/16/79	38.0	173.0	8.73	15.70	14.0	5.00	2350.	14.0
4/18/79	13.0	74.0	13.33	7.22	5.2	1.90	1100.	5.0
4/17/79	15.0	87.0	7.70	8.50	6.0	2.08	1050.	8.0
4/19/79	9.0	48.0	11.62	4.89	3.7	1.36	833.	2.0
4/20/79	14.0	53.0	3.78	5.35	4.3	1.89	867.	4.0
4/24/79	37.0	111.0	7.07	9.49	7.6	3.76	NA	NA
4/30/79	40.0	107.4	4.54	10.72	8.4	3.95	2100.	13.0
5/11/79	33.0	94.0	1.80	9.60	7.4	3.60	NA	NA
5/23/79	41.6	116.0	4.03	10.09	8.6	4.16	2100.	12.0
5/22/79	23.0	71.0	3.61	6.65	4.9	2.37	1150.	9.0
5/31/79	35.9	104.0	4.64	9.42	7.8	3.68	2200.	12.0
6/ 1/79	30.8	84.6	3.00	7.75	5.6	3.00	1800.	10.0
6/ 6/79	26.0	80.0	3.17	7.49	5.2	2.83	1430.	12.0
6/10/79	30.0	94.0	7.32	8.70	6.3	3.31	1750.	13.0
6/16/79	40.0	115.0	5.41	10.10	7.6	4.13	2100.	11.0
6/20/79	14.0	59.0	3.06	.11	4.3	2.22	1150.	7.0
6/30/79	25.5	96.5	6.78	9.38	7.2	3.89	2225.	19.0
7/10/79	50.0	163.0	4.83	14.10	14.0	5.95	3200.	28.0
7/30/79	7.0	46.0	2.10	6.32	4.4	2.32	1400.	6.0
8/ 4/79	25.0	132.0	8.49	13.32	8.2	4.47	2800.	13.0
8/28/79	26.0	142.0	5.24	14.20	12.0	5.80	3050.	15.0
9/ 1/79	31.0	138.0	19.60	13.34	8.0	4.56	1400.	17.0
9/ 5/79	77.0	227.0	26.20	20.20	18.0	8.49	3300.	39.0
8/13/79	76.0	259.0	11.10	22.80	19.0	9.59	4650.	82.0
8/23/79	44.0	202.0	6.90	17.89	12.0	7.46	3600.	9.0
9/13/79	78.0	219.0	22.00	19.00	16.0	8.29	3580.	14.0
9/13/79	77.0	224.0	22.85	19.20	17.0	8.14	3600.	10.0
9/19/79	131.0	348.0	25.50	28.00	24.0	10.13	5700.	51.0
10/18/79	91.0	347.0	15.76	28.00	25.0	10.13	6330.	9.0
10/19/79	18.0	115.0	4.16	10.09	10.0	4.39	1700.	3.0
10/31/79	49.0	268.0	10.60	19.45	25.1	8.11	3310.	6.0
11/ 1/79	63.0	268.0	11.77	18.60	24.6	8.00	3180.	8.0

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 5

DATE	NITRATE	AMMONIA	PHOSPHORUS	DISS.ORG.C	VOLUME (L)	DAILY FLOW
3/23/79	NA	NA	NA	7.6	2801.	283.
4/ 3/79	NA	NA	NA	NA	2574.	167.
4/11/79	NA	NA	NA	NA	1983.	129.
4/16/79	NA	NA	NA	NA	4148.	3192.
4/18/79	8.1	NA	NA	NA	6906.	4242.
4/17/79	9.8	NA	NA	NA	5098.	3235.
4/19/79	5.5	.40	NA	NA	1843.	2946.
4/20/79	8.5	.64	NA	3.3	7210.	2394.
4/24/79	NA	NA	NA	NA	NA	866.
4/30/79	26.0	1.10	NA	NA	6431.	364.
5/11/79	NA	NA	NA	NA	409.	2115.
5/23/79	NA	NA	NA	5.4	3157.	982.
5/22/79	NA	NA	NA	6.9	1813.	1031.
5/31/79	NA	NA	NA	3.7	3073.	508.
6/ 1/79	NA	NA	NA	3.9	2290.	561.
6/ 6/79	NA	NA	NA	NA	2358.	788.
6/10/79	NA	NA	NA	NA	3407.	1308.
6/16/79	NA	NA	NA	NA	935.	244.
6/20/79	NA	NA	NA	NA	1798.	1300.
6/30/79	NA	NA	NA	4.8	1904.	296.
7/10/79	NA	NA	NA	5.4	1348.	110.
7/30/79	NA	NA	NA	6.5	3179.	3202.
8/ 4/79	NA	NA	NA	5.6	1442.	322.
8/28/79	NA	NA	NA	8.3	424.	330.
9/ 1/79	NA	NA	NA	6.2	5708.	2338.
9/ 5/79	NA	NA	NA	8.6	11.	523.
8/13/79	NA	NA	NA	8.7	712.	87.
8/23/79	NA	NA	NA	8.7	855.	243.
9/13/79	NA	NA	NA	8.3	2615.	811.
9/13/79	NA	NA	NA	7.7	2449.	811.
9/19/79	NA	NA	NA	11.0	1726.	220.
10/18/79	NA	NA	NA	10.0	840.	360.
10/19/79	NA	NA	NA	5.4	1730.	1591.
10/31/79	NA	NA	NA	7.0	4046.	1743.
11/ 1/79	NA	NA	NA	6.2	4345.	1671.

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 6

DATE	ALKALINITY	PH	TEMP. (C)	SP. COND.	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM
3/23/79	10.0	6.85	NA	1562.	200.0	54.0	97.2	4.0
4/12/79	NA	6.00	NA	2714.	327.0	93.2	201.0	6.2
4/16/79	NA	6.60	NA	1358.	152.6	74.2	91.6	3.4
4/17/79	12.0	6.60	NA	1146.	124.6	31.6	76.2	3.0
4/18/79	16.0	6.80	NA	1318.	162.0	38.4	86.0	2.6
4/17/79	32.0	7.00	NA	501.	83.0	13.8	31.0	9.4
4/19/79	15.0	6.50	NA	1054.	141.0	34.0	72.0	2.0
4/20/79	16.5	6.70	NA	1498.	185.0	56.1	95.0	3.0
5/ 2/79	14.0	6.65	NA	2613.	292.4	103.4	205.6	4.6
4/25/79	4.0	6.40	NA	3460.	394.4	149.0	270.0	7.0
5/ 9/79	NA	6.60	NA	3482.	312.0	122.0	238.0	4.0
5/10/79	NA	7.00	NA	2432.	240.2	104.2	200.2	4.4
5/20/79	NA	NA	NA	NA	341.0	130.0	292.0	5.0
5/22/79	NA	7.20	NA	2201.	211.0	86.0	170.0	3.0
5/23/79	NA	7.00	NA	3377.	316.0	60.4	269.0	6.6
6/ 1/79	NA	6.90	NA	2668.	231.2	56.6	212.6	5.2
6/ 6/79	NA	6.40	NA	2196.	199.4	79.8	86.6	2.0
6/10/79	14.0	6.90	20.0	1916.	184.8	77.6	79.4	3.8
6/12/79	10.0	6.60	NA	2673.	266.3	107.5	154.0	3.3
6/16/79	9.9	6.70	23.0	3450.	325.6	127.0	189.0	4.4
6/21/79	11.0	6.70	13.0	2411.	202.0	87.0	155.0	4.0
6/30/79	6.6	6.30	NA	3074.	308.0	136.0	249.0	6.0
7/10/79	4.8	6.20	19.0	4599.	467.0	193.5	409.5	9.5
7/30/79	3.0	5.50	22.0	2006.	209.0	97.0	105.0	4.0
8/ 4/79	4.0	5.40	23.0	3438.	444.0	169.0	242.0	9.0
8/28/79	6.0	5.30	20.0	3154.	345.0	112.6	260.0	8.2
9/ 1/79	2.0	5.00	22.0	2576.	327.2	112.4	136.0	6.8
9/ 5/79	.4	4.70	18.0	3819.	478.8	121.6	308.0	10.6
8/13/79	2.4	5.00	14.0	4690.	540.0	126.2	438.0	13.8
8/23/79	1.6	4.80	9.0	3739.	439.4	174.0	232.0	11.4
9/11/79	2.0	4.90	17.0	3364.	398.8	160.8	229.0	9.8
9/13/79	2.8	4.90	19.0	3745.	444.0	175.0	238.0	10.2
9/19/79	2.4	4.70	13.5	5710.	692.0	272.0	478.0	16.2
10/18/79	.8	4.60	NA	5168.	646.0	254.0	450.0	14.6
10/19/79	2.4	4.70	NA	2356.	251.0	106.0	142.0	5.6
10/31/79	.8	4.60	NA	3448.	408.0	177.0	198.0	7.8
11/ 1/79	NA	4.50	NA	3701.	447.0	203.5	230.0	9.1

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 6

DATE	COPPER	NICKEL	IRON	MANGANESE	COBALT	ZINC	SULFATE	CHLORIDE
3/23/79	.2	4.6	.02	1.74	.4	.15	600.	10.0
4/12/79	.7	10.3	.03	3.40	.7	.29	1400.	95.0
4/16/79	.1	2.3	1.02	1.17	.2	.08	560.	45.0
4/17/79	.1	2.3	.02	1.18	.2	.09	440.	28.0
4/18/79	.2	2.6	.02	1.38	.2	.10	488.	30.0
4/17/79	.1	.3	.07	.07	.0	.04	255.	5.0
4/19/79	.1	2.1	.03	1.12	.2	.19	210.	29.0
4/20/79	.1	3.1	.02	1.58	.3	.10	559.	51.0
5/ 2/79	.3	5.3	.03	2.74	.4	.20	NA	110.0
4/25/79	.5	9.0	.05	4.07	.6	.30	1650.	171.0
5/ 9/79	.5	7.0	.04	3.23	.5	.27	1030.	15.0
5/10/79	.3	4.5	.01	2.48	.4	.18	867.	111.0
5/20/79	.5	7.4	.03	3.23	.5	.29	1750.	152.0
5/22/79	.3	3.9	.02	2.02	.3	.17	883.	94.0
5/23/79	.5	6.1	.06	3.05	.5	.25	1700.	143.0
6/ 1/79	.4	4.2	.05	2.28	.4	.21	1050.	111.5
6/ 6/79	.3	3.4	.01	1.79	.2	.17	867.	94.0
6/10/79	.4	3.5	.02	1.60	.1	.14	700.	79.0
6/12/79	.4	4.5	.01	2.26	.4	.21	1200.	104.0
6/16/79	.5	5.7	.04	2.77	.4	.29	1230.	139.0
6/21/79	.4	3.9	.01	5.57	.2	.18	750.	91.0
6/30/79	.7	5.8	.03	2.59	.4	.32	1450.	128.0
7/10/79	1.8	10.0	.03	4.10	.6	.66	2200.	220.0
7/30/79	1.5	6.0	.01	2.04	.4	.29	925.	79.0
8/ 4/79	2.7	10.1	.04	3.72	.7	.58	1670.	118.0
8/28/79	3.8	13.7	.06	4.23	1.0	.70	1400.	113.0
9/ 1/79	3.4	11.3	.05	3.35	.8	.51	1200.	86.0
9/ 5/79	5.3	16.2	.05	5.33	1.2	.84	1980.	102.0
8/13/79	4.8	15.0	.07	6.13	1.1	1.01	2420.	181.0
8/23/79	4.2	14.3	.03	5.24	1.1	.84	1800.	153.0
9/11/79	4.7	14.0	.06	4.70	1.0	.72	1650.	107.0
9/13/79	5.0	15.4	.08	5.00	1.1	.76	1800.	29.0
9/19/79	6.8	23.6	.16	8.10	1.7	1.31	2680.	201.0
10/18/79	6.0	26.6	.30	8.45	1.9	1.34	2600.	174.0
10/19/79	4.4	15.5	.04	3.70	1.1	.63	1050.	64.0
10/31/79	7.2	24.0	.11	5.78	2.1	1.02	1650.	99.0
11/ 1/79	8.5	25.5	.13	6.18	2.2	1.09	1750.	102.0

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 6

DATE	NITRATE	AMMONIA	PHOSPHORUS	DISS.ORG.C	VOLUME (L)	DAILY FLOW
3/23/79	NA	NA	NA	5.7	2290.	46.
4/12/79	NA	NA	NA	NA	1665.	840.
4/16/79	NA	NA	NA	NA	3168.	1308.
4/17/79	NA	NA	NA	4.7	3641.	3916.
4/18/79	62.0	NA	NA	NA	6529.	2997.
4/17/79	1.3	NA	NA	NA	3642.	3916.
4/19/79	50.0	11.00	NA	NA	3971.	3862.
4/20/79	67.5	13.50	NA	4.2	5257.	3929.
5/ 2/79	120.0	24.00	NA	NA	5001.	719.
4/25/79	190.0	23.00	NA	NA	3387.	1902.
5/ 9/79	NA	NA	NA	NA	1654.	1286.
5/10/79	NA	NA	NA	NA	10250.	4690.
5/20/79	NA	NA	NA	8.6	4644.	1266.
5/22/79	NA	NA	NA	16.0	2188.	1399.
5/23/79	NA	NA	NA	7.9	2653.	1007.
6/ 1/79	NA	NA	NA	7.1	2567.	729.
6/ 6/79	NA	NA	NA	NA	2570.	1130.
6/10/79	NA	NA	NA	NA	2574.	1433.
6/12/79	NA	NA	NA	NA	1506.	494.
6/16/79	NA	NA	NA	NA	1612.	442.
6/21/79	NA	NA	NA	NA	2233.	1687.
6/30/79	NA	NA	NA	8.9	1991.	230.
7/10/79	NA	NA	NA	9.0	1628.	98.
7/30/79	NA	NA	NA	6.3	5269.	3374.
8/ 4/79	NA	NA	NA	8.7	1957.	284.
8/28/79	NA	NA	NA	6.6	848.	709.
9/ 1/79	NA	NA	NA	6.3	5553.	2337.
9/ 5/79	NA	NA	NA	7.8	988.	611.
8/13/79	NA	NA	NA	9.1	753.	108.
8/23/79	NA	NA	NA	8.3	1192.	342.
9/11/79	NA	NA	NA	7.3	3842.	846.
9/13/79	NA	NA	NA	9.8	2112.	699.
9/19/79	NA	NA	NA	9.0	1567.	176.
10/18/79	NA	NA	NA	8.5	931.	758.
10/19/79	NA	NA	NA	4.3	2161.	1863.
10/31/79	NA	NA	NA	5.8	6423.	2331.
11/ 1/79	NA	NA	NA	6.7	4920.	1170.

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 7

DATE	ALKALINITY	PH	TEMP. (C)	SP. COND.	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM
3/23/79	NA	NA	NA	NA	430.0	505.0	1220.0	52.0
6/ 7/79	NA	7.80	NA	3377.	276.1	147.0	219.5	37.4
6/ 8/79	108.0	8.30	23.0	6696.	426.8	312.0	405.0	82.8
6/22/79	97.0	7.90	19.0	3477.	306.0	158.0	350.0	30.0
9/ 1/79	NA	NA	14.0	1297.	231.2	51.6	39.2	17.2
9/10/79	20.0	7.40	11.0	1773.	306.0	79.6	94.8	22.6
9/12/79	43.2	7.70	20.0	3225.	446.8	152.6	229.6	41.0
9/13/79	43.2	7.90	8.0	3534.	424.8	150.2	240.0	38.2
11/ 2/79	49.6	7.50	NA	4713.	474.0	266.0	476.0	44.0
11/ 1/79	52.8	7.60	NA	6596.	498.0	396.0	740.0	53.2

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 7

DATE	COPPER	NICKEL	IRON	MANGANESE	COBALT	ZINC	SULFATE	CHLORIDE
3/23/79	.1	.3	.05	.24	.1	.02	2750.	2410.0
6/ 7/79	.0	.1	.02	.07	.0	.01	NA	NA
6/ 8/79	.1	.2	.06	.13	.0	.68	2100.	1230.0
6/22/79	.0	.1	.02	.07	.0	.01	1220.	513.0
9/ 1/79	.0	.1	.02	.04	.0	.01	1400.	446.0
9/10/79	.0	.1	.05	.02	.0	.01	1150.	116.0
9/12/79	.0	.1	.02	.03	.0	.01	1700.	310.0
9/13/79	.0	.1	.06	.03	.0	.01	1700.	330.0
11/ 2/79	.0	.1	.03	.07	.0	.01	NA	NA
11/ 1/79	.0	.2	.03	.02	.1	.02	NA	NA

NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

PILE 7

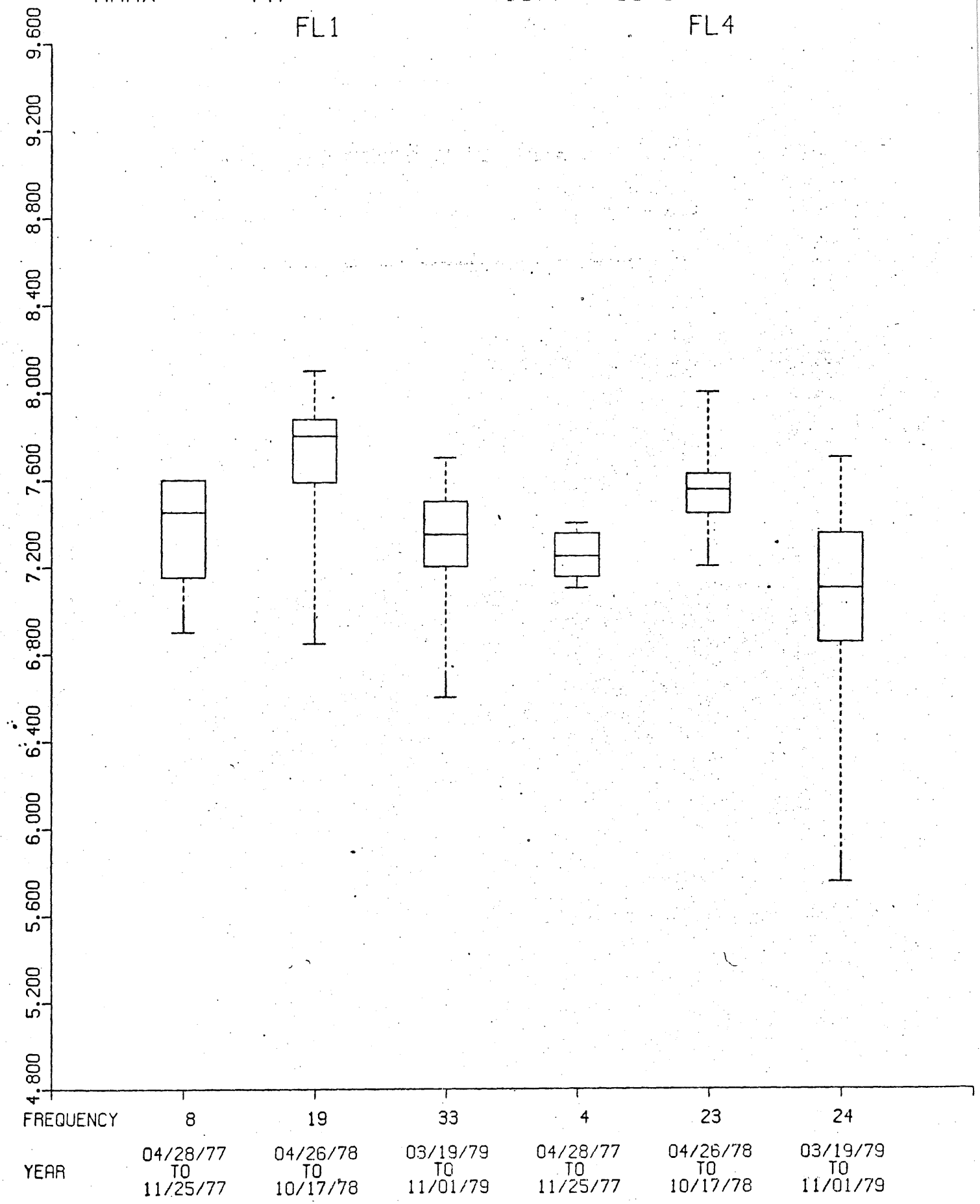
DATE	NITRATE	AMMONIA	PHOSPHORUS	DISS.ORG.C	VOLUME (L)	DAILY FLOW
3/23/79	NA	NA	NA	NA	NA	NA
6/ 7/79	NA	NA	NA	NA	61.	29.
6/ 8/79	NA	NA	NA	NA	19.	20.
6/22/79	NA	NA	NA	6.3	23.	4.
9/ 1/79	NA	NA	NA	12.0	11.	4.
9/10/79	NA	NA	NA	5.3	76.	45.
9/12/79	NA	NA	NA	6.8	83.	29.
9/13/79	NA	NA	NA	7.0	23.	41.
11/ 2/79	NA	NA	NA	6.5	34.	20.
11/ 1/79	NA	NA	NA	8.9	NA	53.

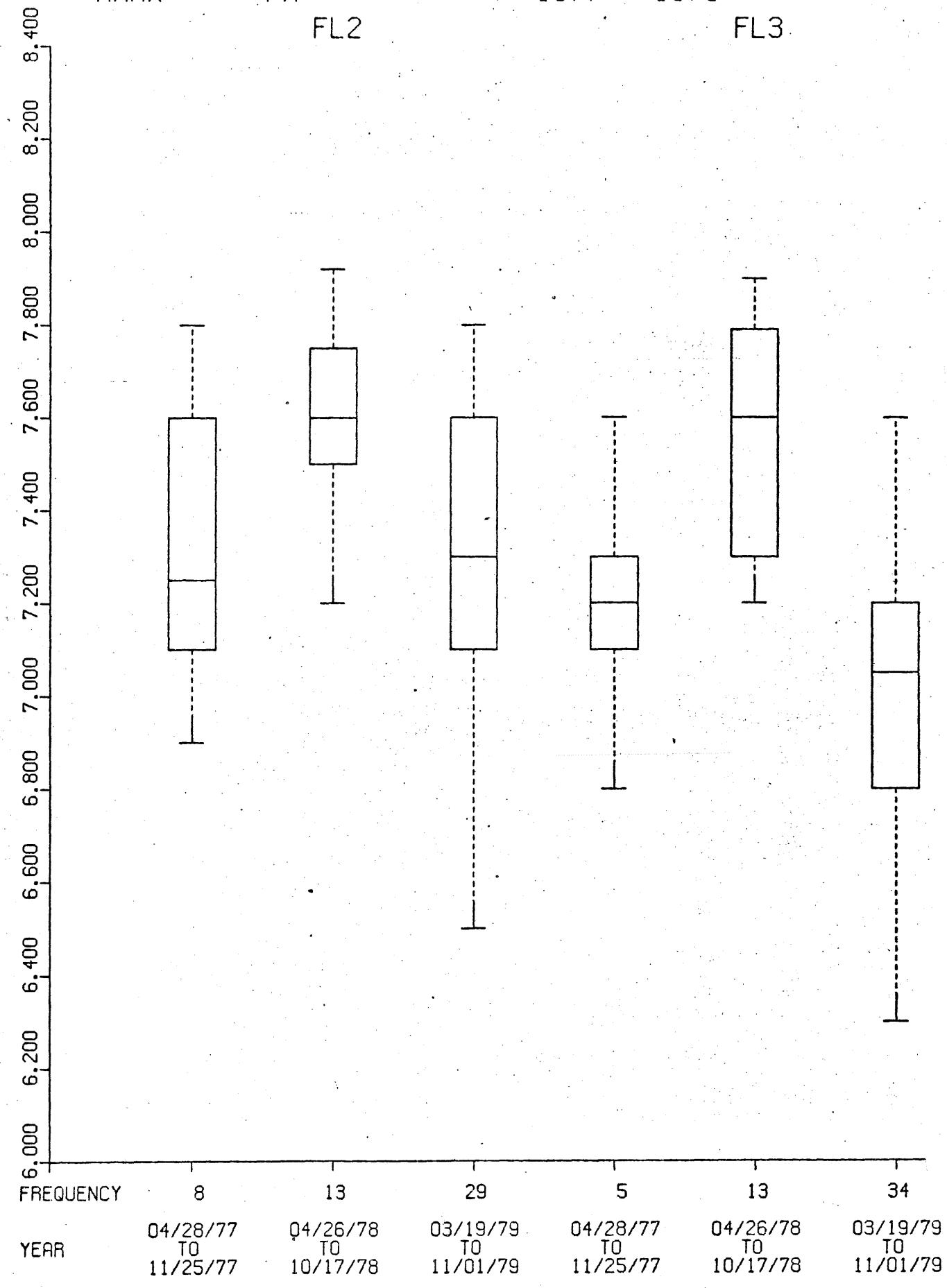
NA=NOT ANALYZED MEASUREMENTS ARE IN MILLIGRAMS/LITER

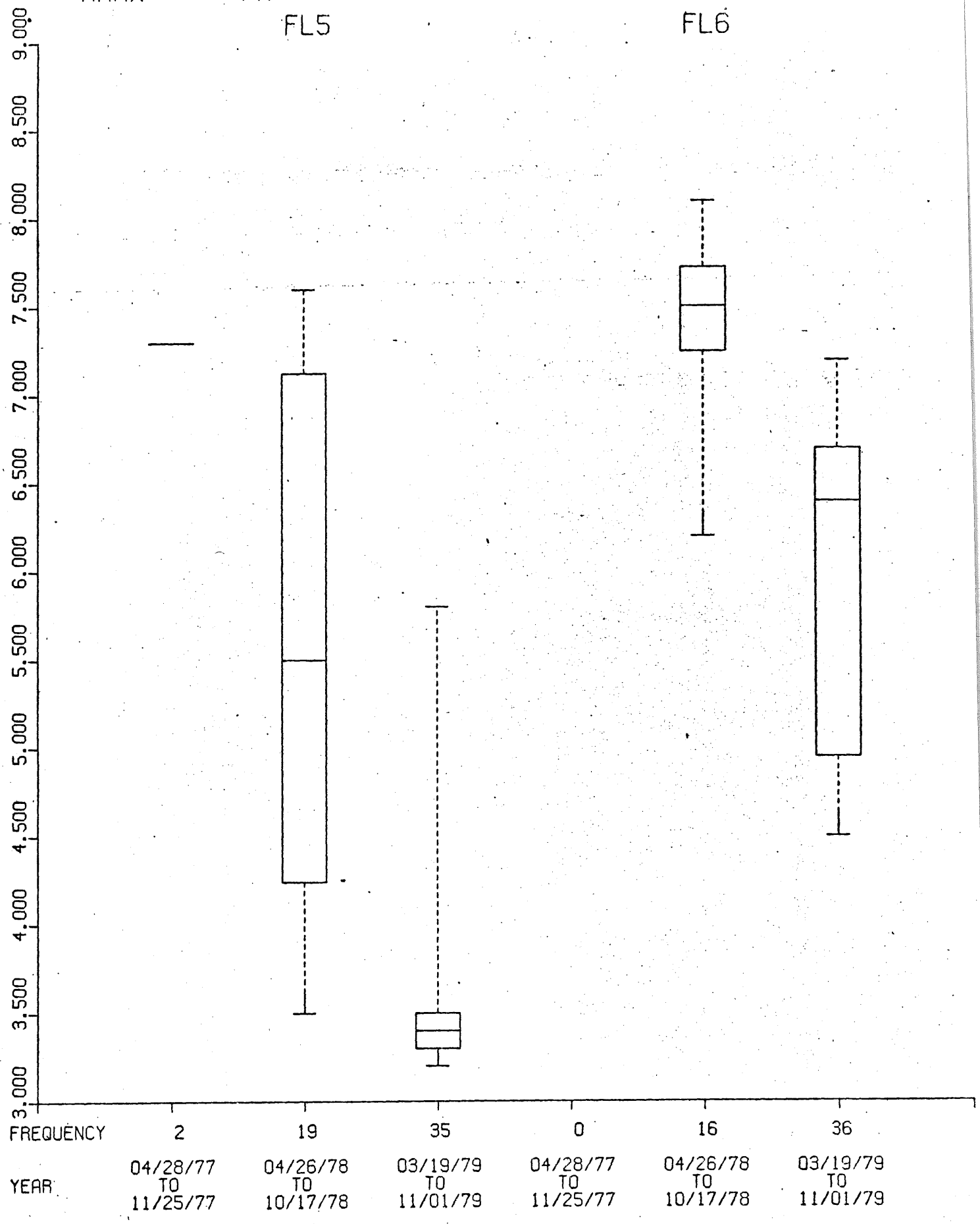
Appendix V

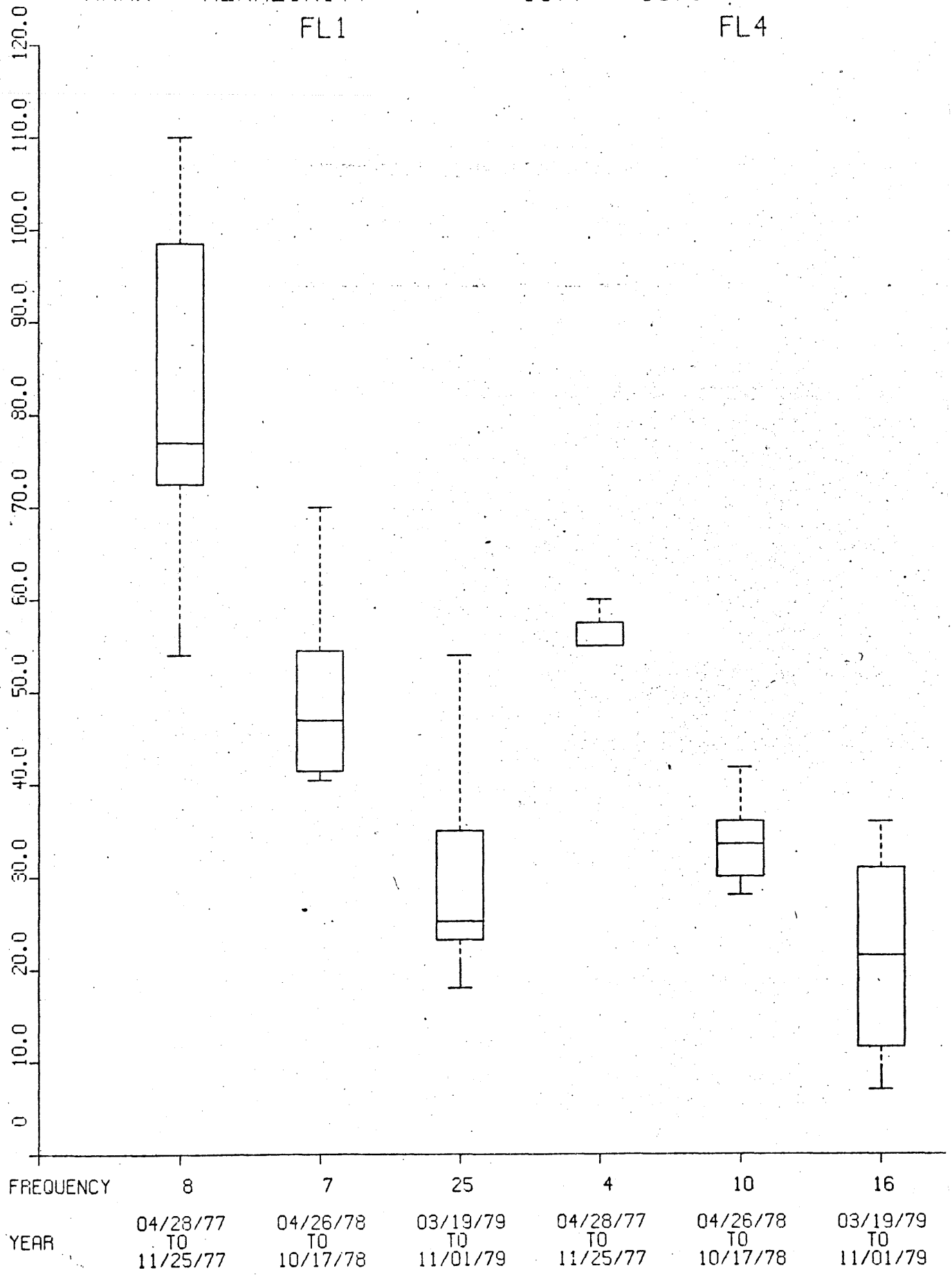
Box Plot Summaries

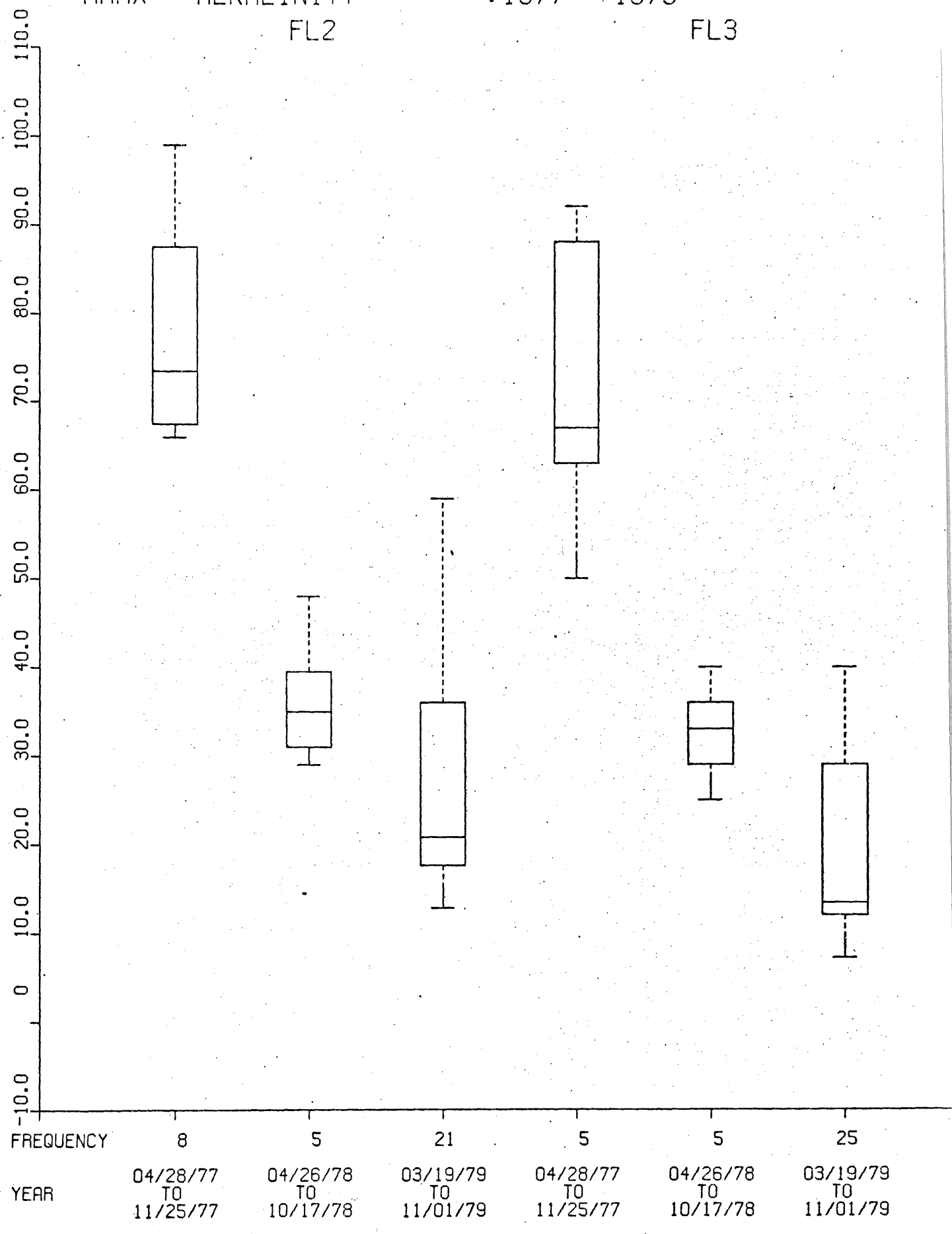
1977-79

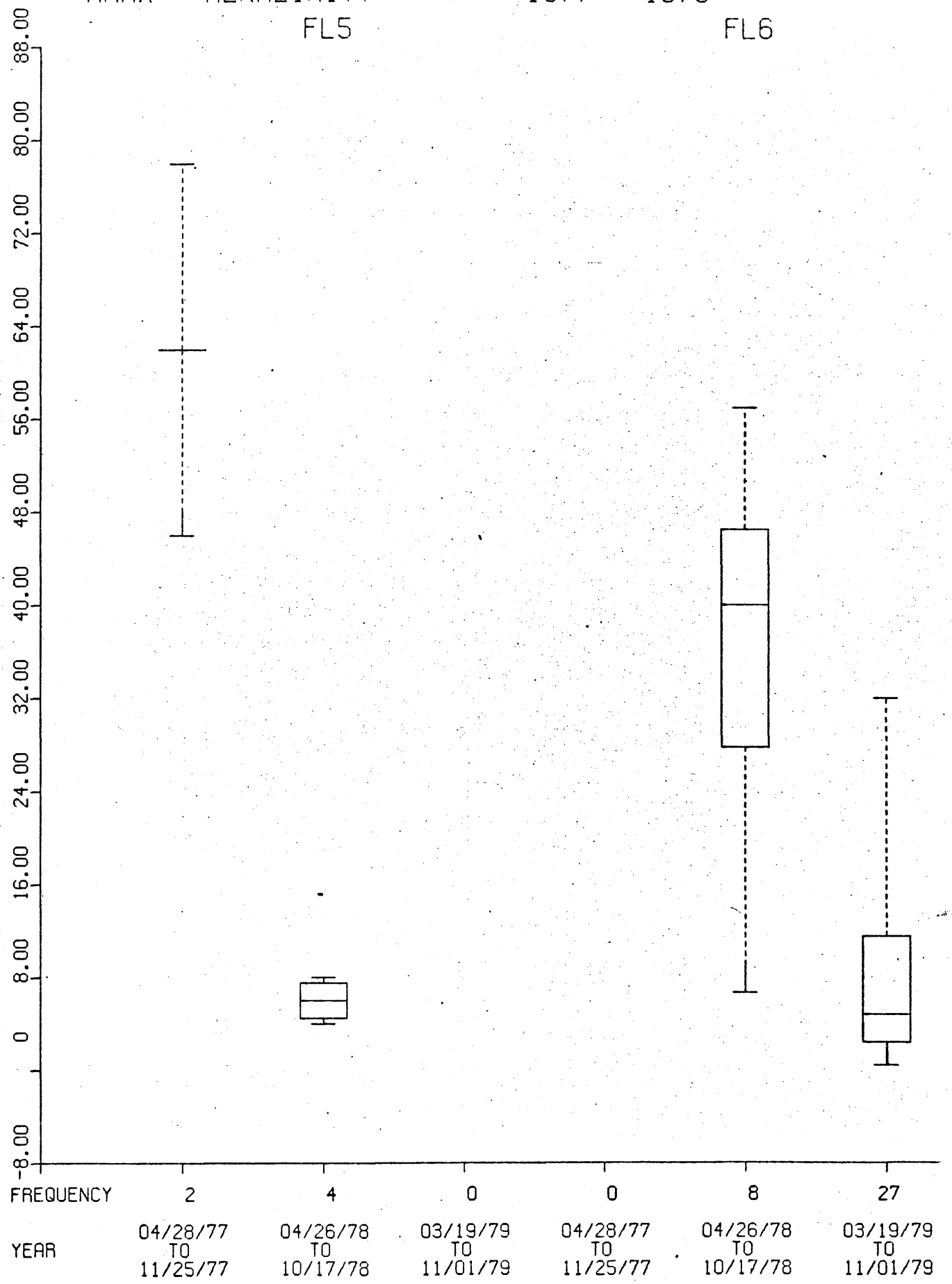

AMAX PH :1977 - 1979
FL1
FL4
9.600
9.200
8.800
8.400
8.000
7.600
7.200
6.800
6.400
6.000
5.600
5.200
4.800
FREQUENCY 8 19 33 4 23 24
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX PH :1977 - 1979
FL2
FL3
8.400
8.200
8.000
7.800
7.600
7.400
7.200
7.000
6.800
6.600
6.400
6.200
6.000
FREQUENCY
8
13
29
5
13
34
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

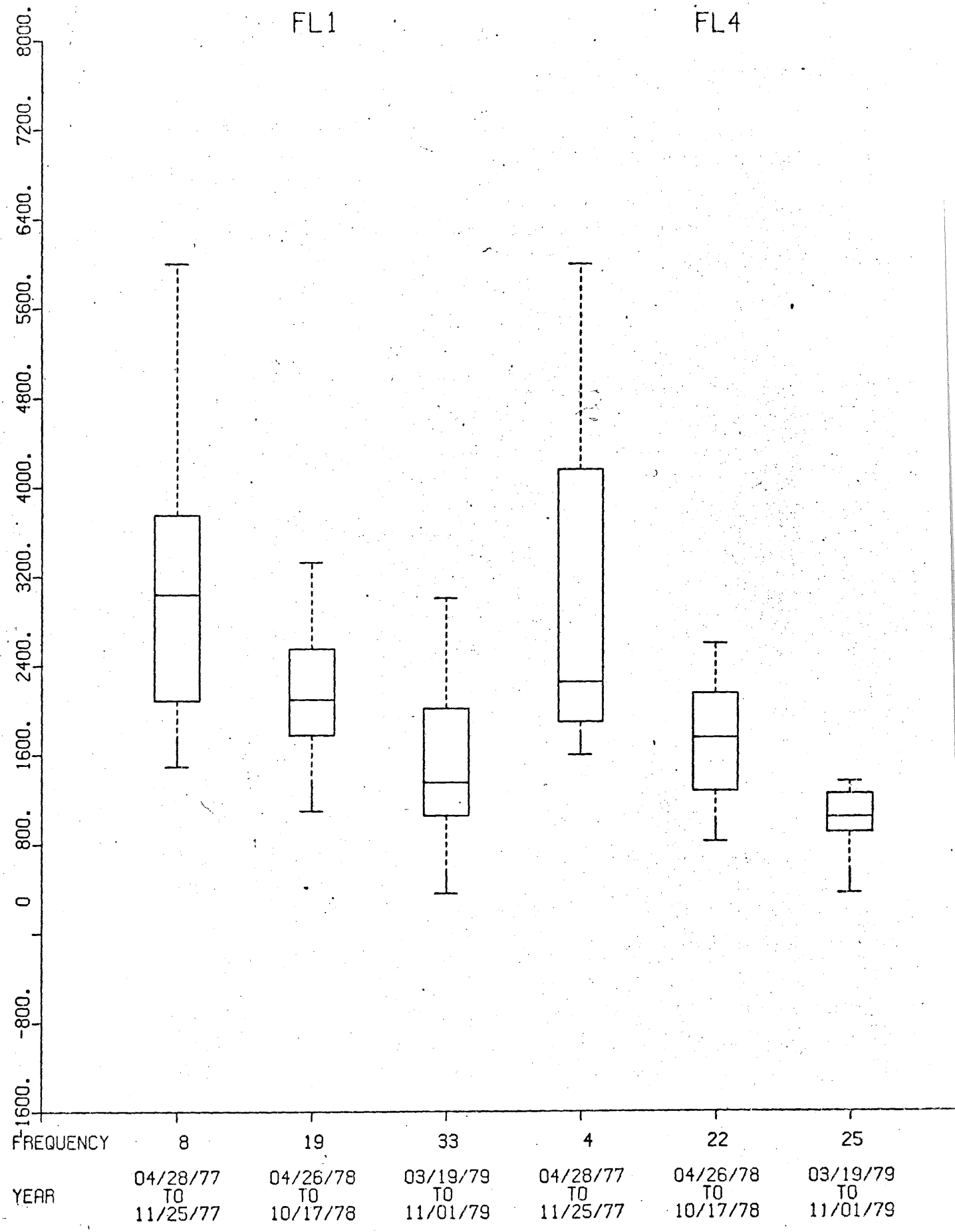

AMAX PH :1977 - 1979
FL5
FL6
9.000
8.500
8.000
7.500
7.000
6.500
6.000
5.500
5.000
4.500
4.000
3.500
3.000
FREQUENCY 2 19 35 0 16 36
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

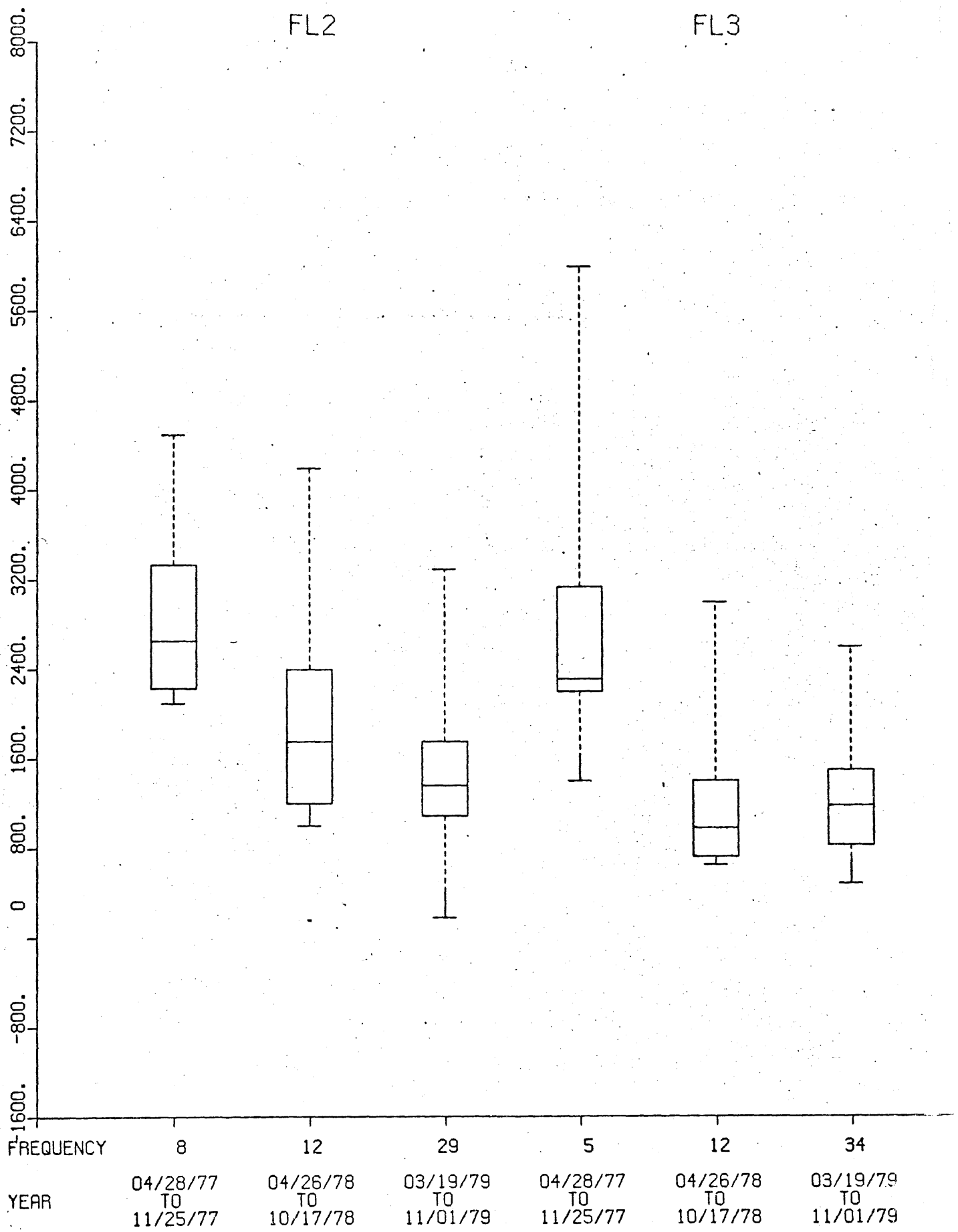

AMAX ALKALINITY :1977 - 1979
FL1
FL4
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
FREQUENCY 8 7 25 4 10 16
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX ALKALINITY :1977 - 1979
FL2
FL3
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
FREQUENCY 8 5 21 5 5 25
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

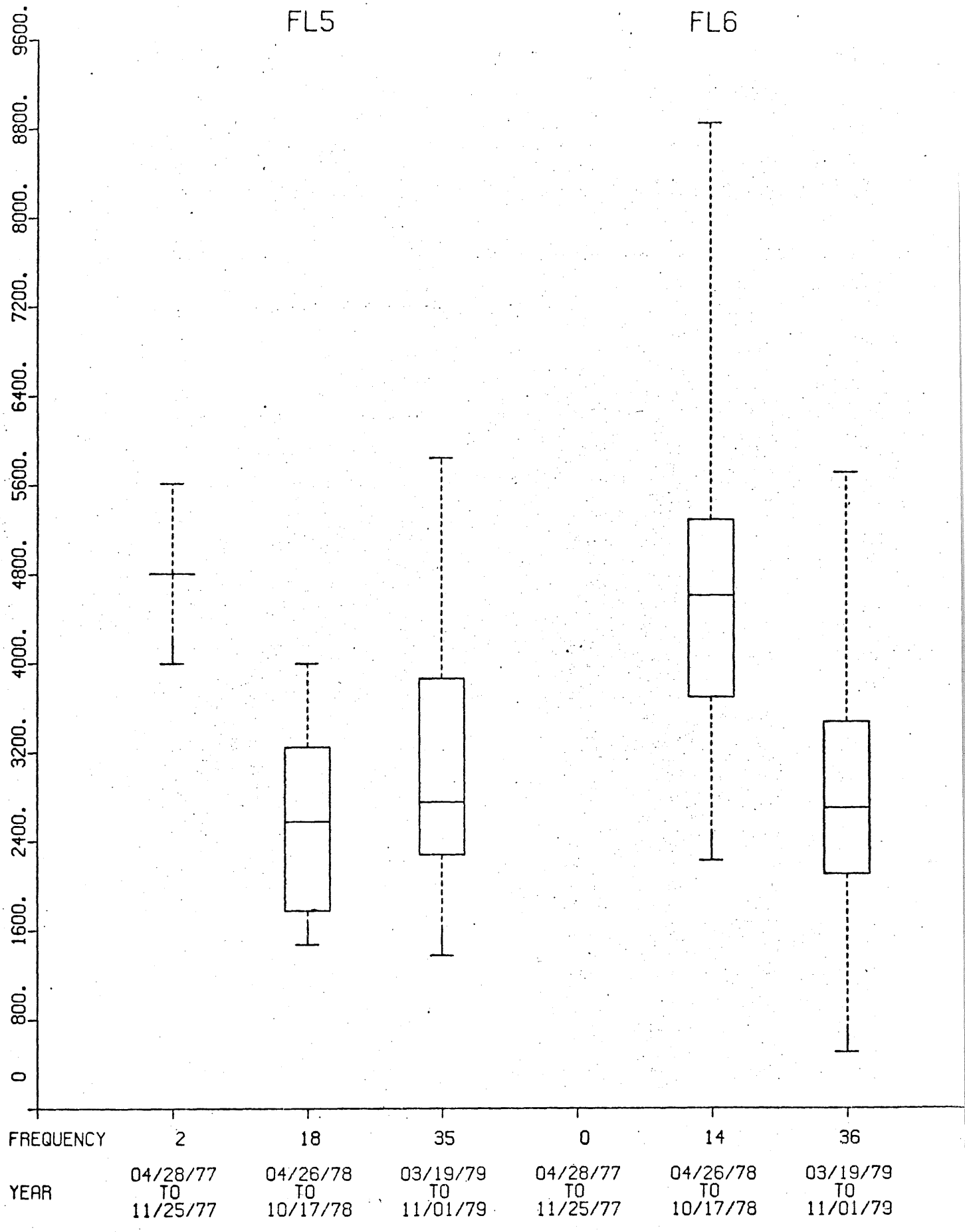

AMAX ALKALINITY :1977 - 1979
FL5
FL6
88.00
80.00
72.00
64.00
56.00
48.00
40.00
32.00
24.00
16.00
8.00
0
-8.00
FREQUENCY
2
4
0
0
8
27
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

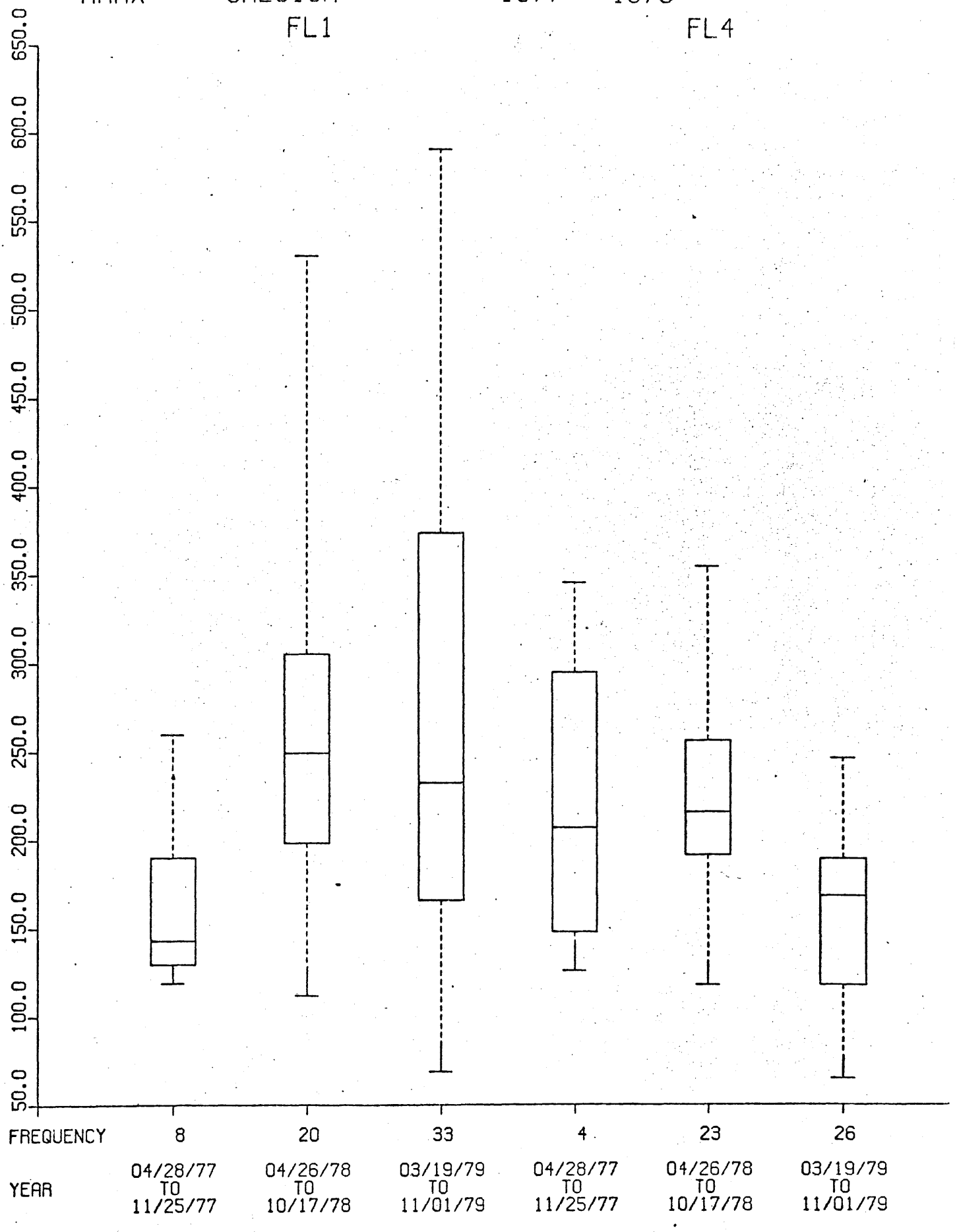
AMAX SPECIFIC CONDUCTANCE: 1977 - 1979

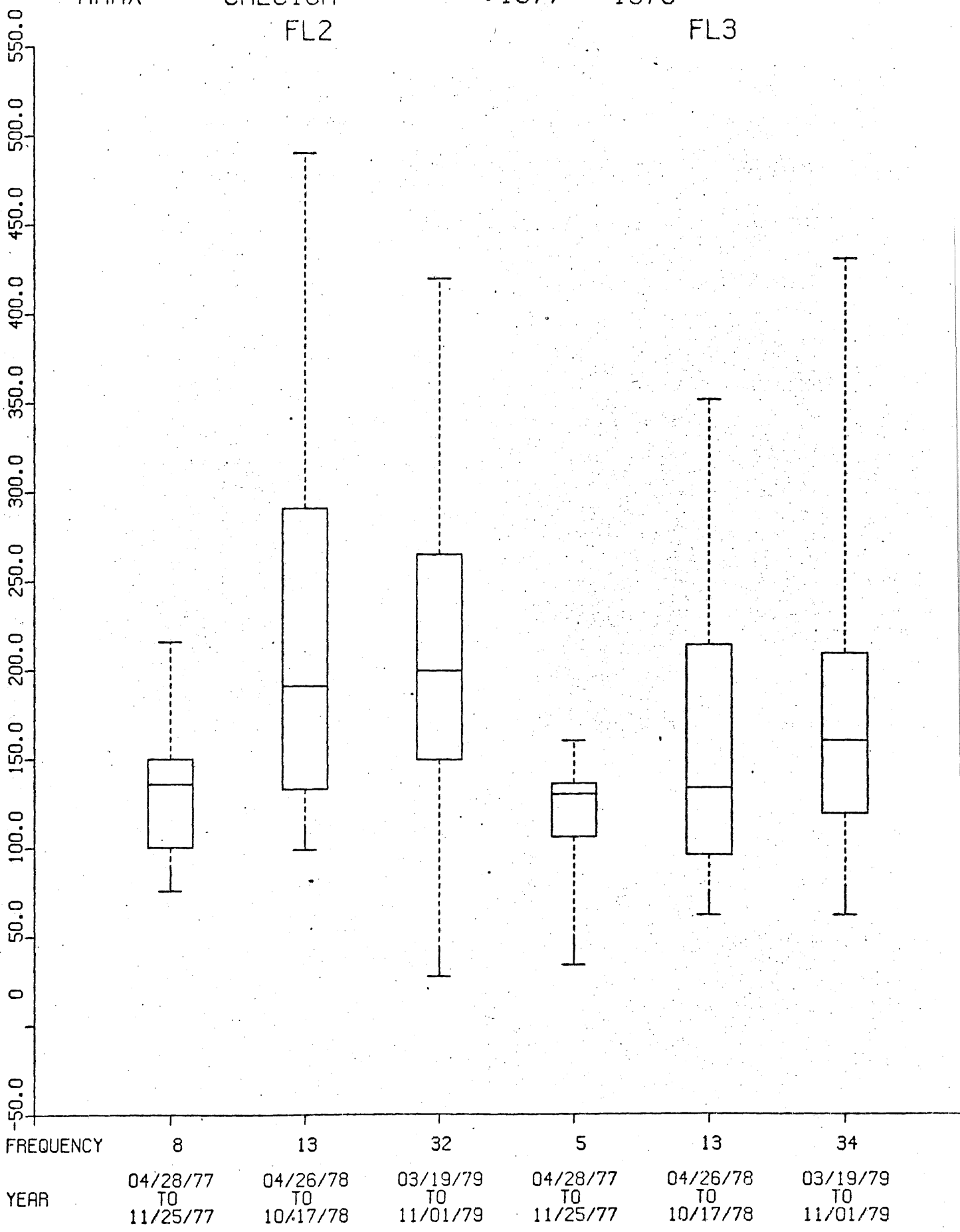


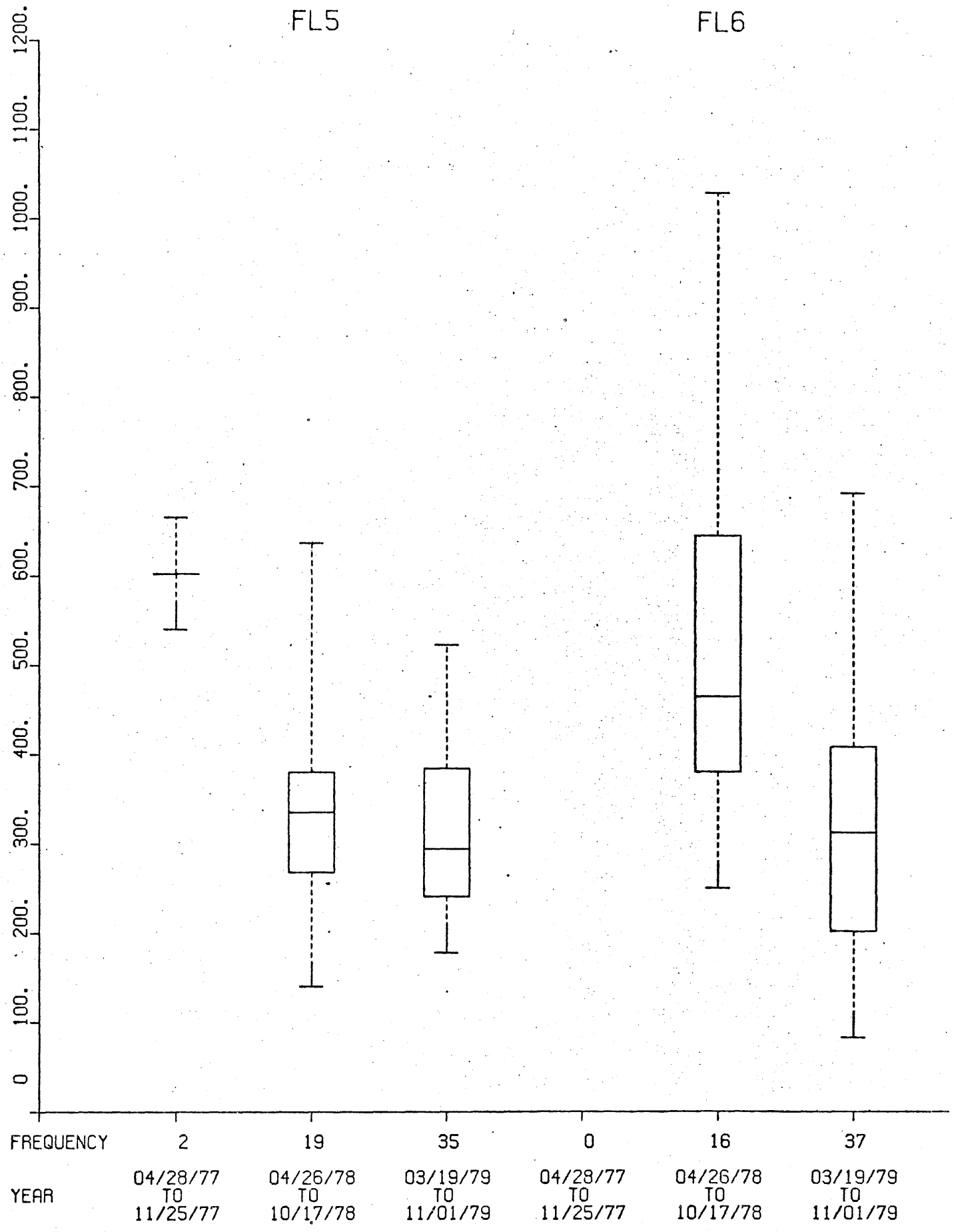

AMAX SPECIFIC CONDUCTANCE: 1977 - 1979
FL2
FL3
8000.
7200.
6400.
5600.
4800.
4000.
3200.
2400.
1600.
800.
0
-800.
-1600.
FREQUENCY
8
12
29
5
12
34
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

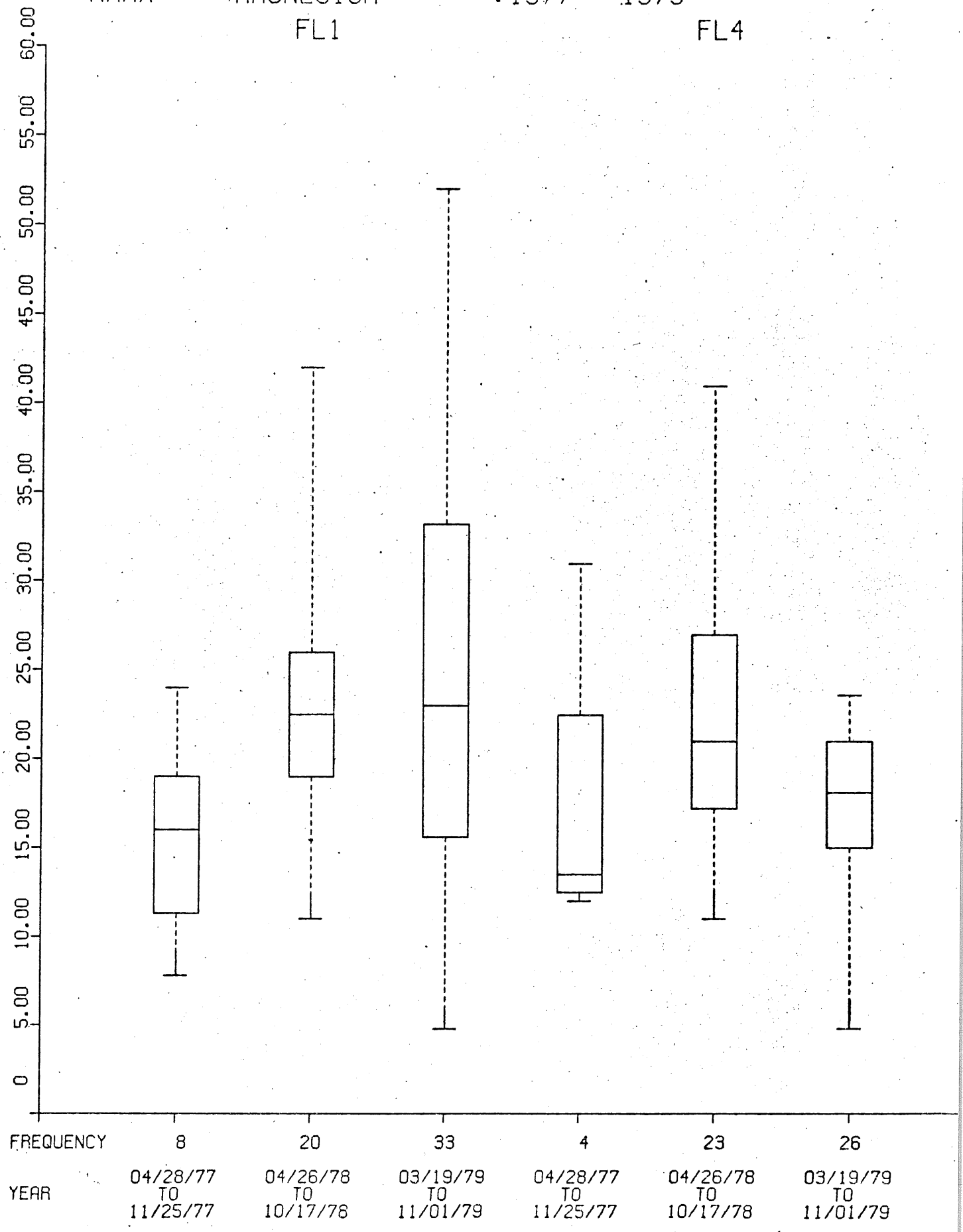
AMAX SPECIFIC CONDUCTANCE: 1977 - 1979

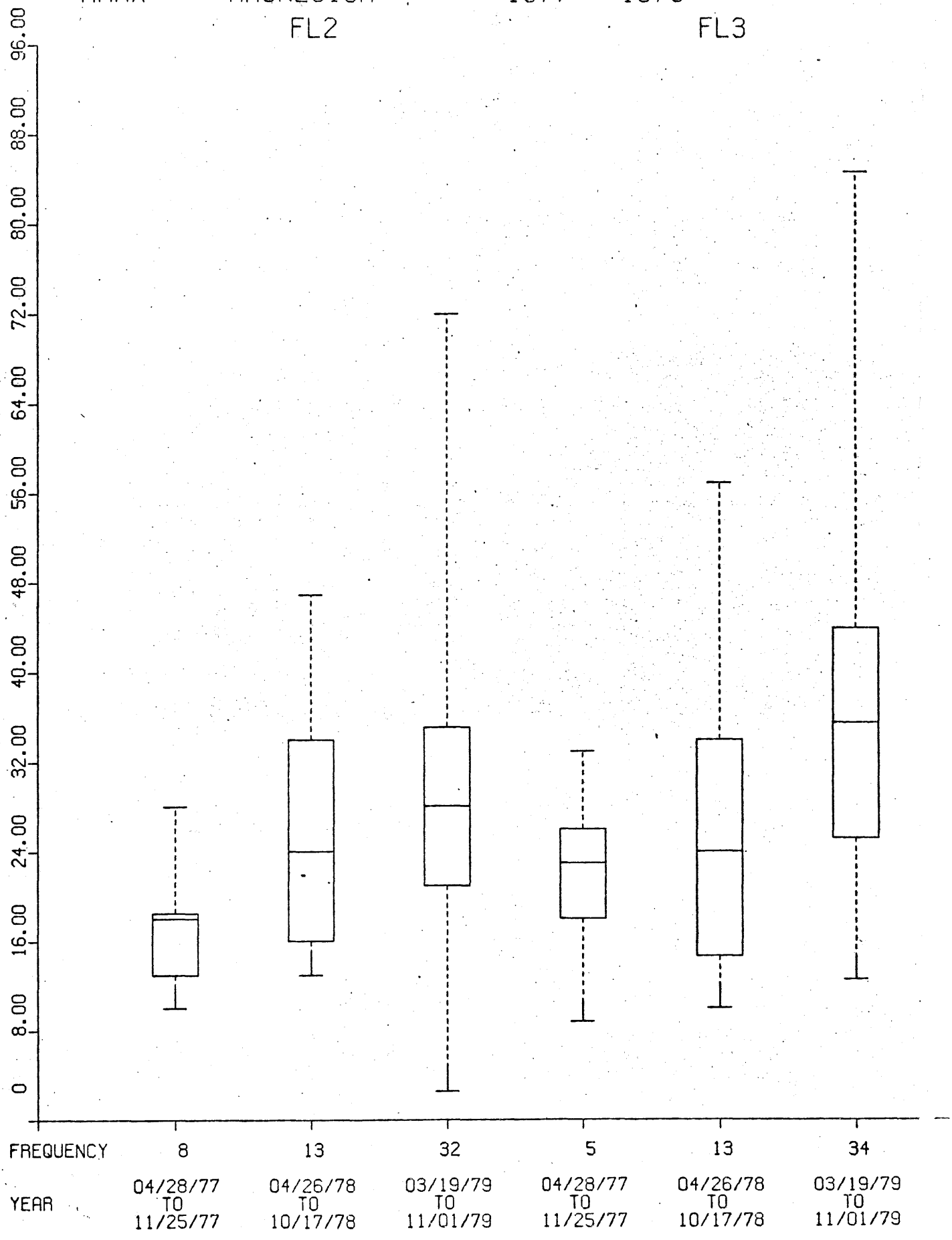


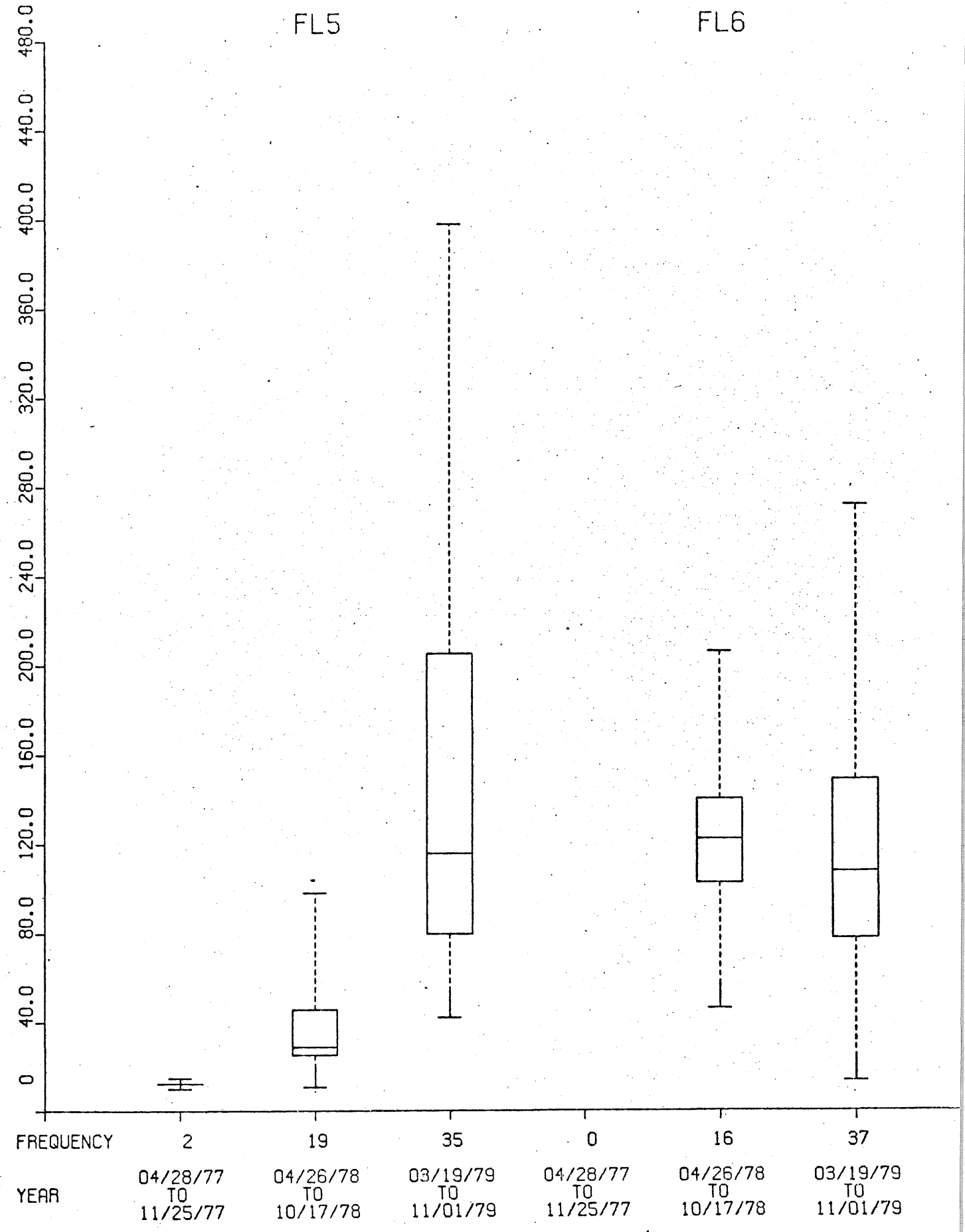

AMAX CALCIUM :1977 - 1979
FL1
FL4
650.0
600.0
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
FREQUENCY 8 20 33 4 23 26
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

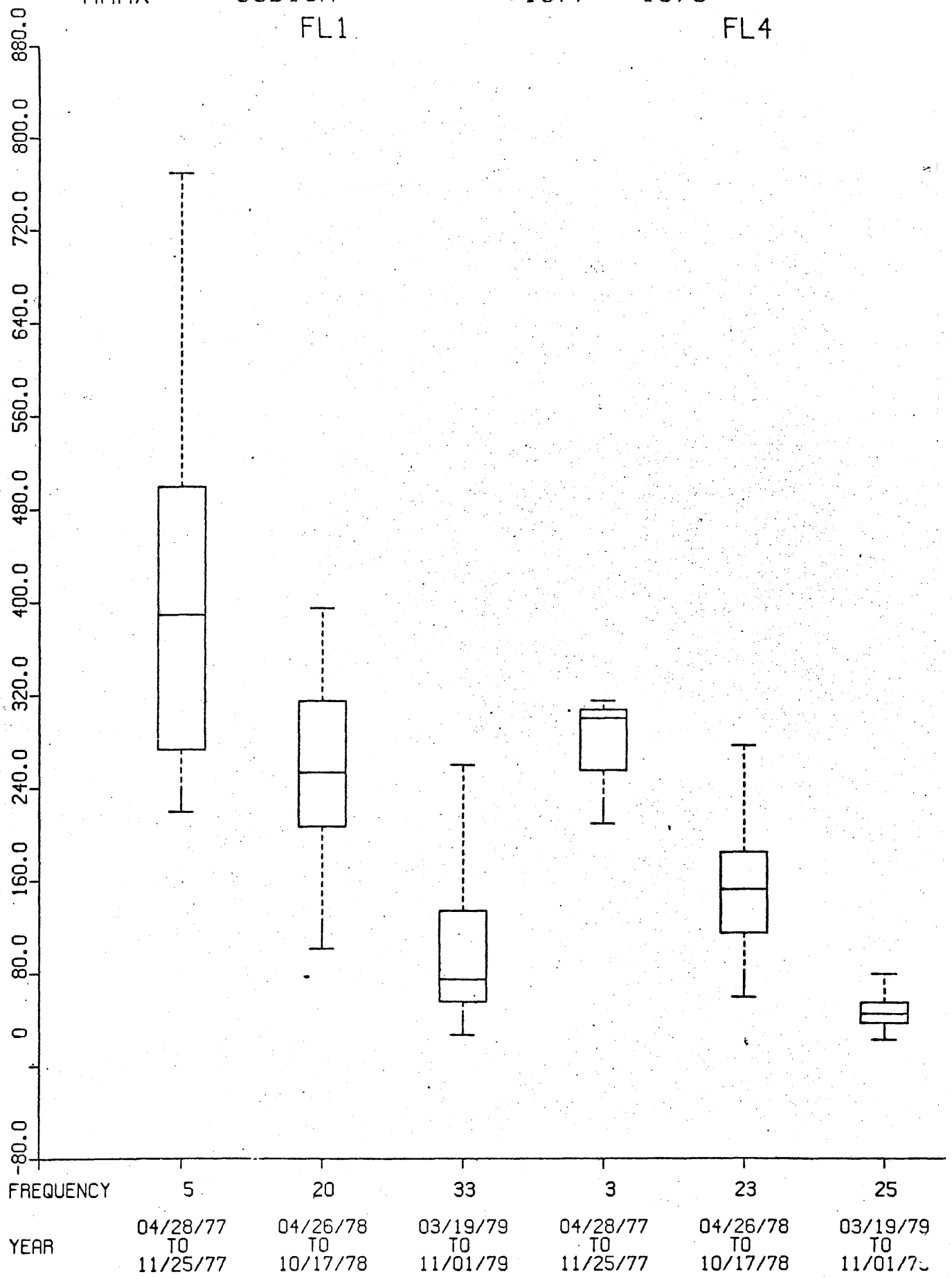

AMAX CALCIUM :1977 - 1979
FL2
FL3
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0
-50.0
FREQUENCY 8 13 32 5 13 34
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX CALCIUM :1977 - 1979
FL5
FL6
1200.
1100.
1000.
900.
800.
700.
600.
500.
400.
300.
200.
100.
0
FREQUENCY 2 19 35 0 16 37
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

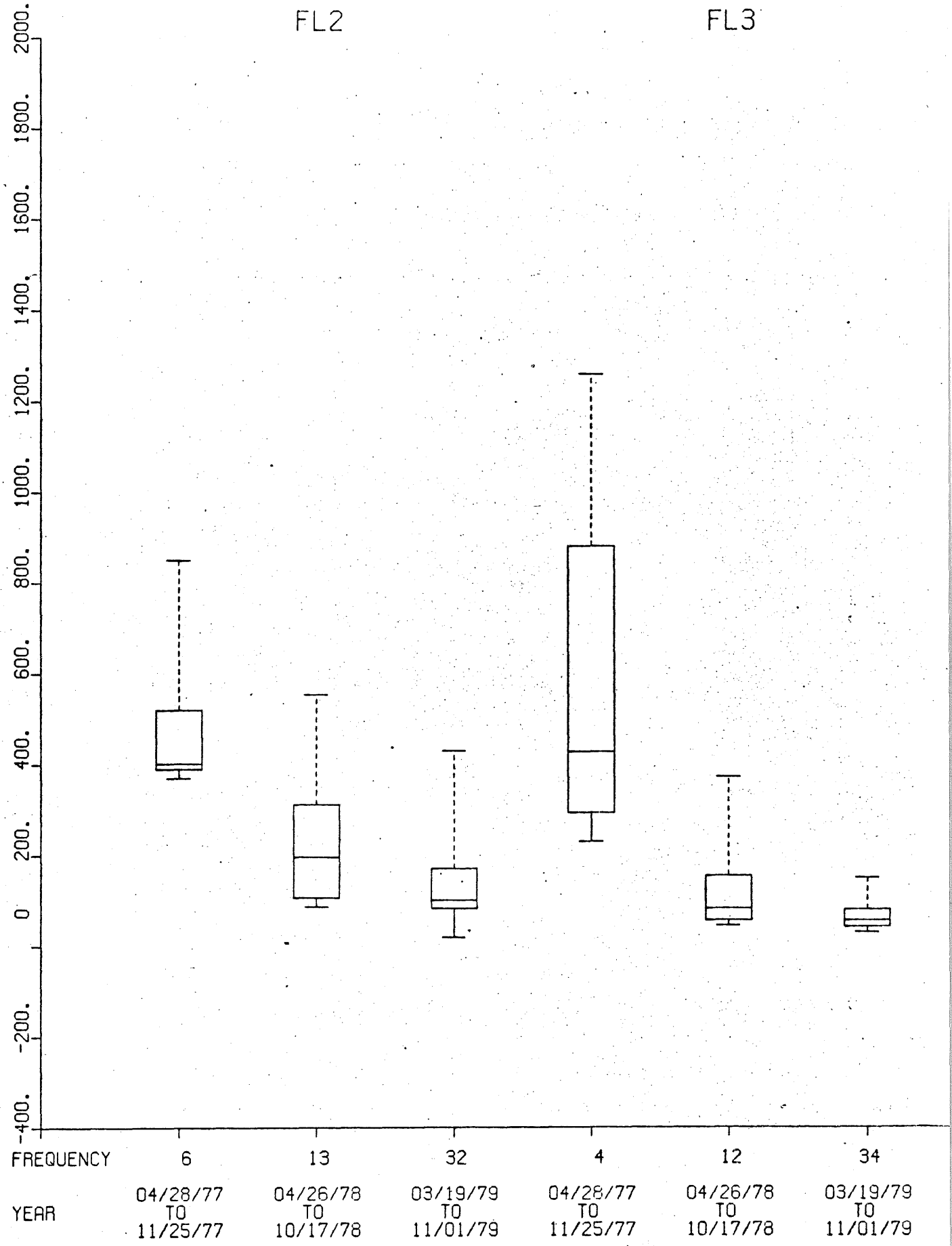

AMAX MAGNESIUM : 1977 - 1979
FL1
FL4
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0
FREQUENCY 8 20 33 4 23 26
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

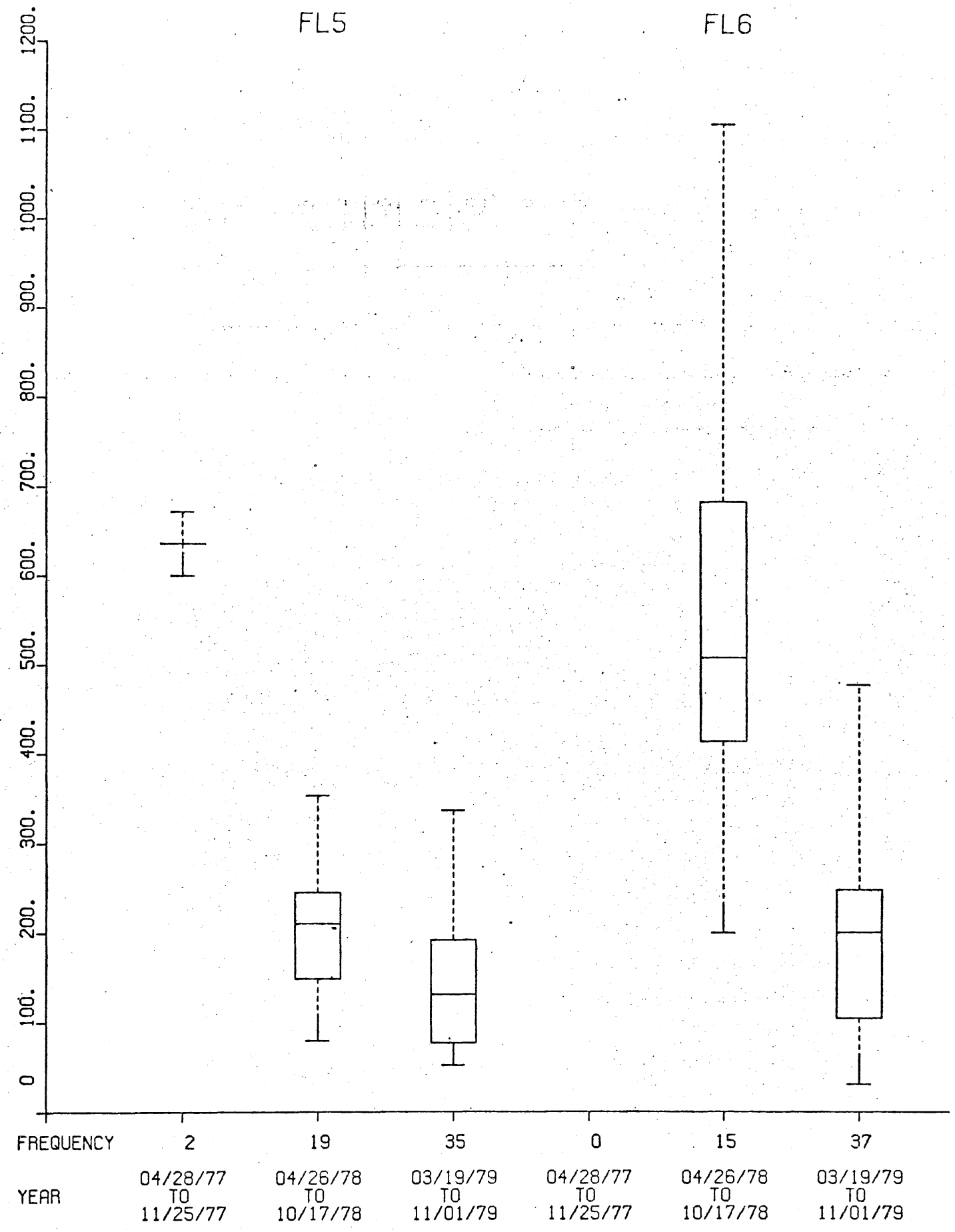

AMAX MAGNESIUM :1977 - 1979
FL2
FL3
96.00
88.00
80.00
72.00
64.00
56.00
48.00
40.00
32.00
24.00
16.00
8.00
0
FREQUENCY
8
13
32
5
13
34
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

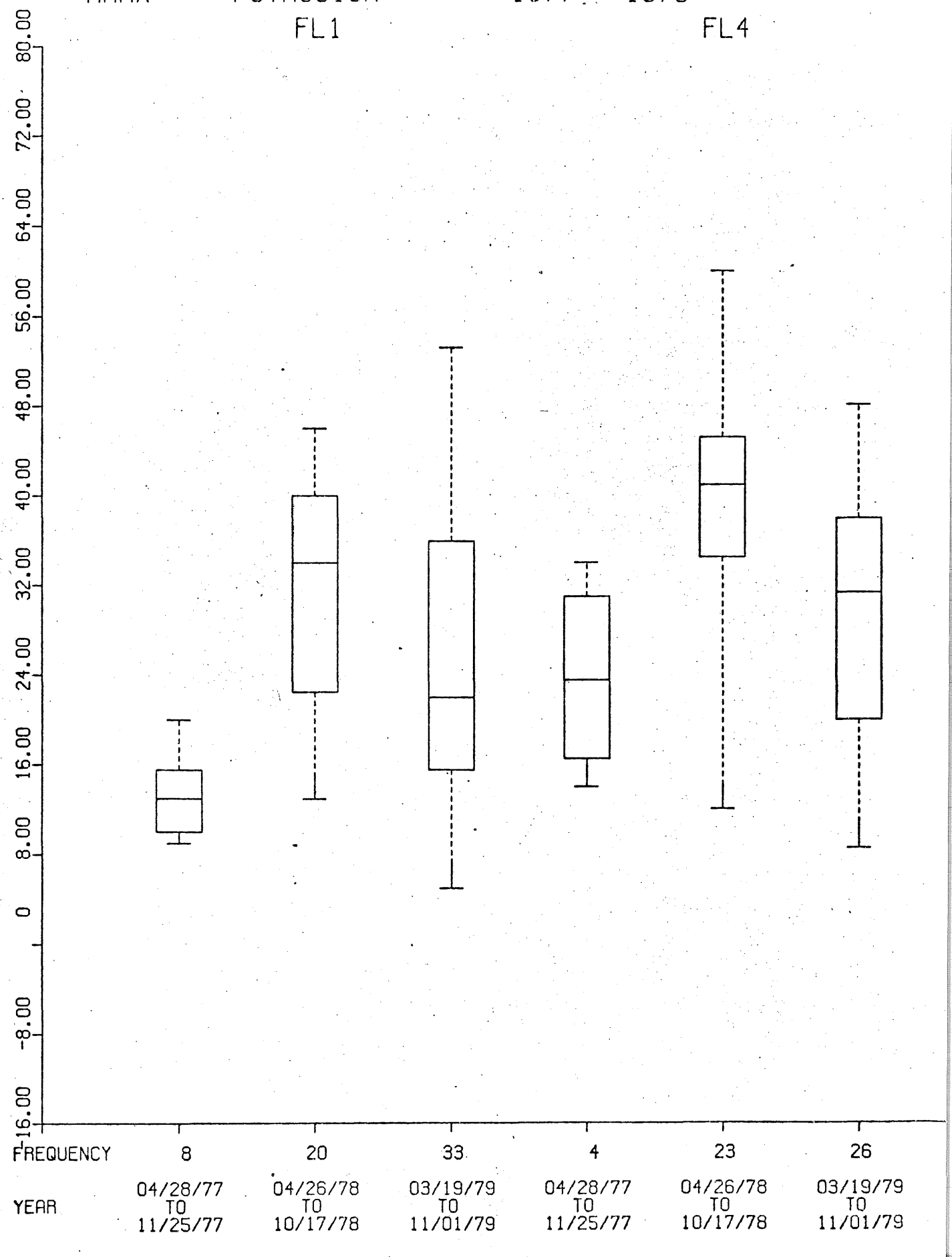

AMAX MAGNESIUM :1977 - 1979
FL5
FL6
480.0
440.0
400.0
360.0
320.0
280.0
240.0
200.0
160.0
120.0
80.0
40.0
0
FREQUENCY
2
19
35
0
16
37
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

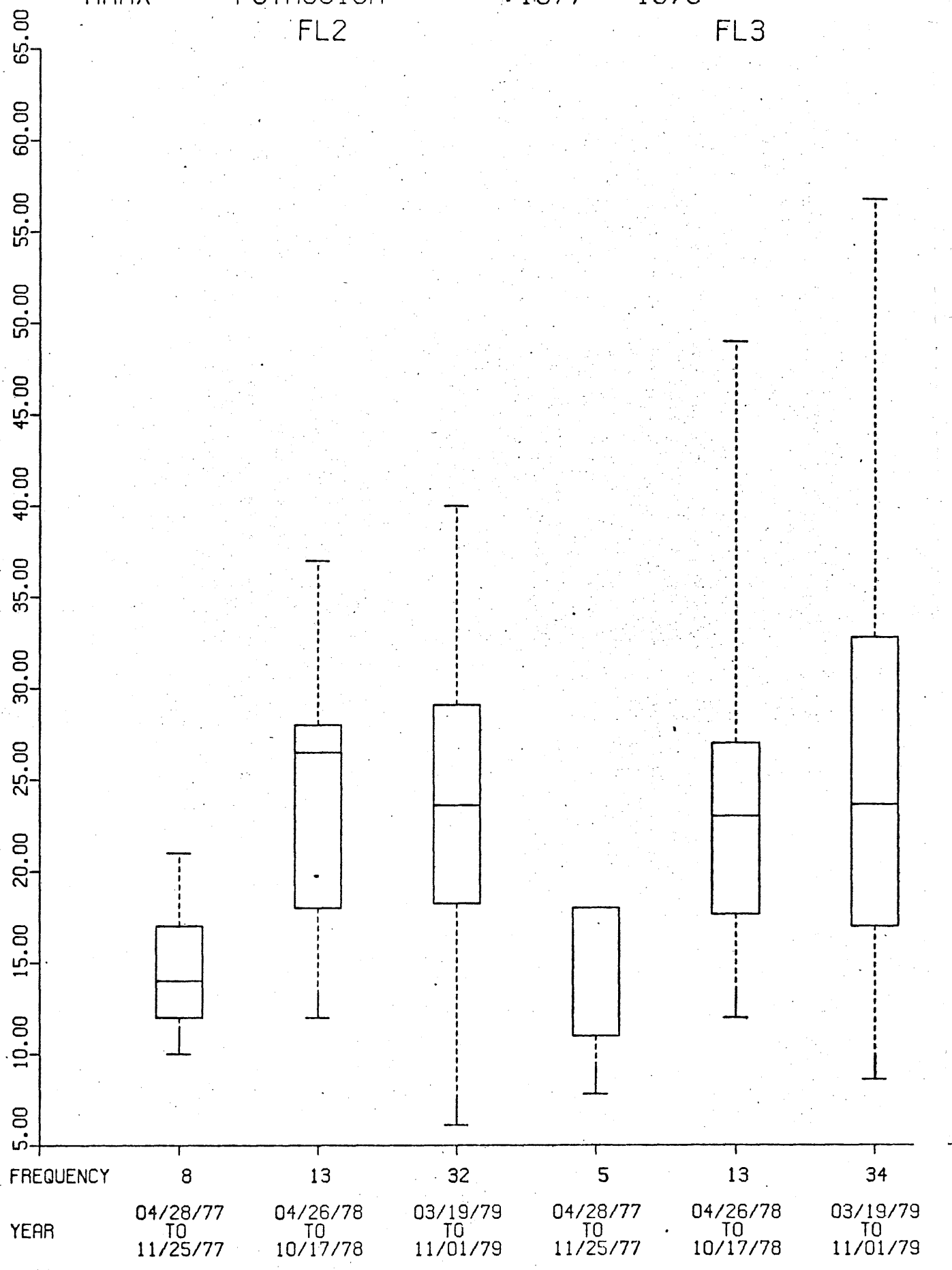

AMAX SODIUM :1977 - 1979
FL1
FL4
880.0
800.0
720.0
640.0
560.0
480.0
400.0
320.0
240.0
160.0
80.0
0
-80.0
FREQUENCY
5
20
33
3
23
25
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/7

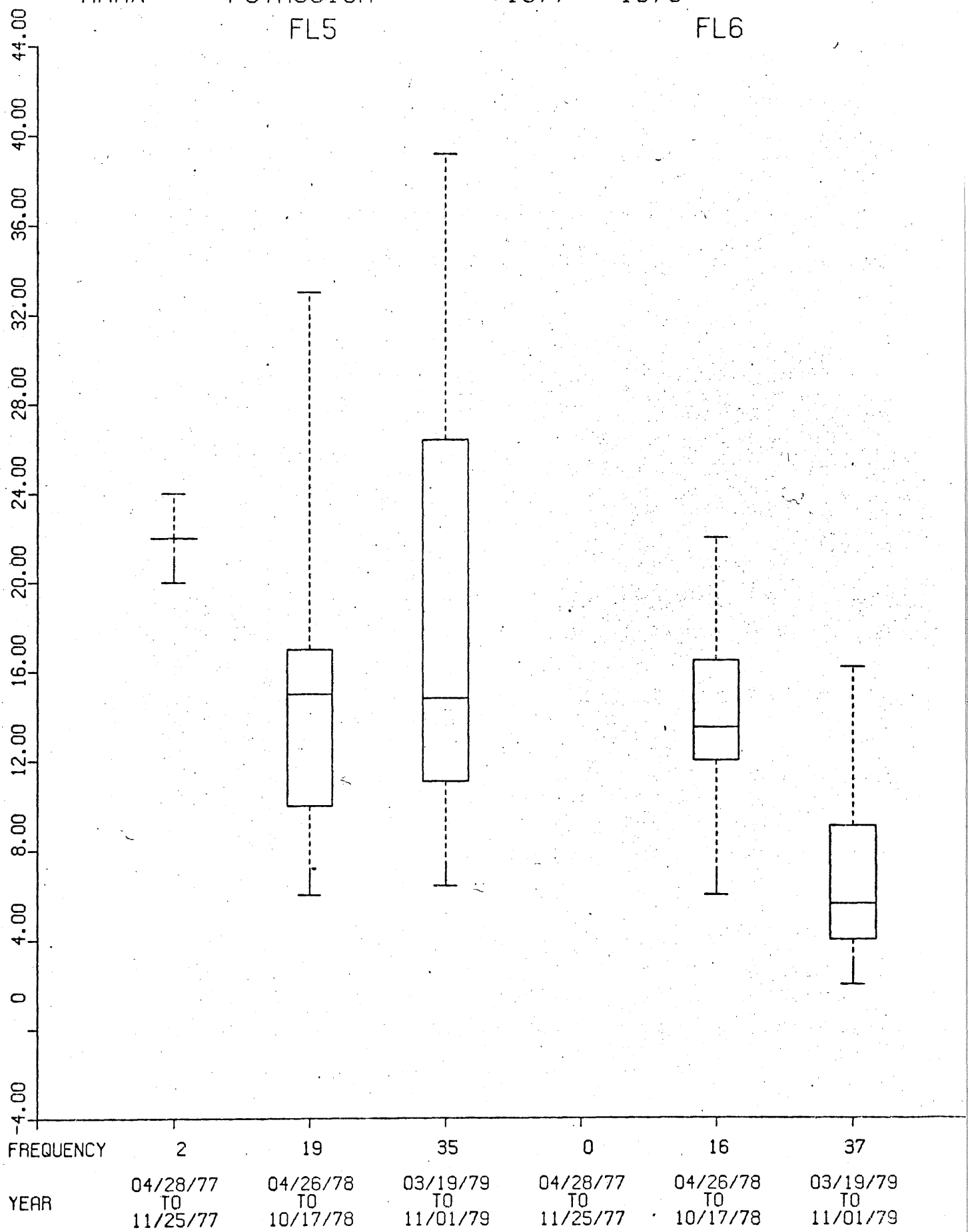
AMAX SODIUM :1977 - 1979

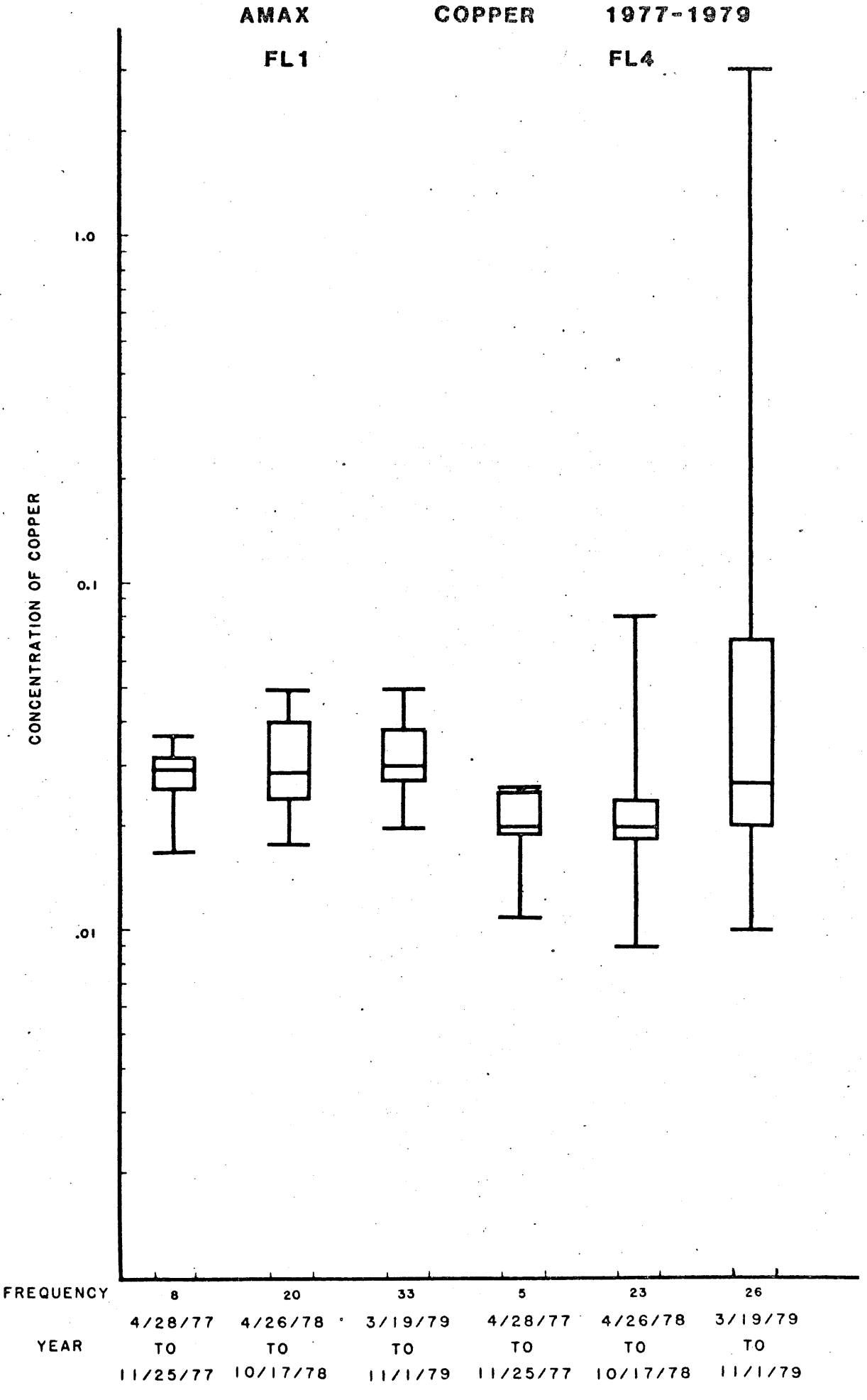


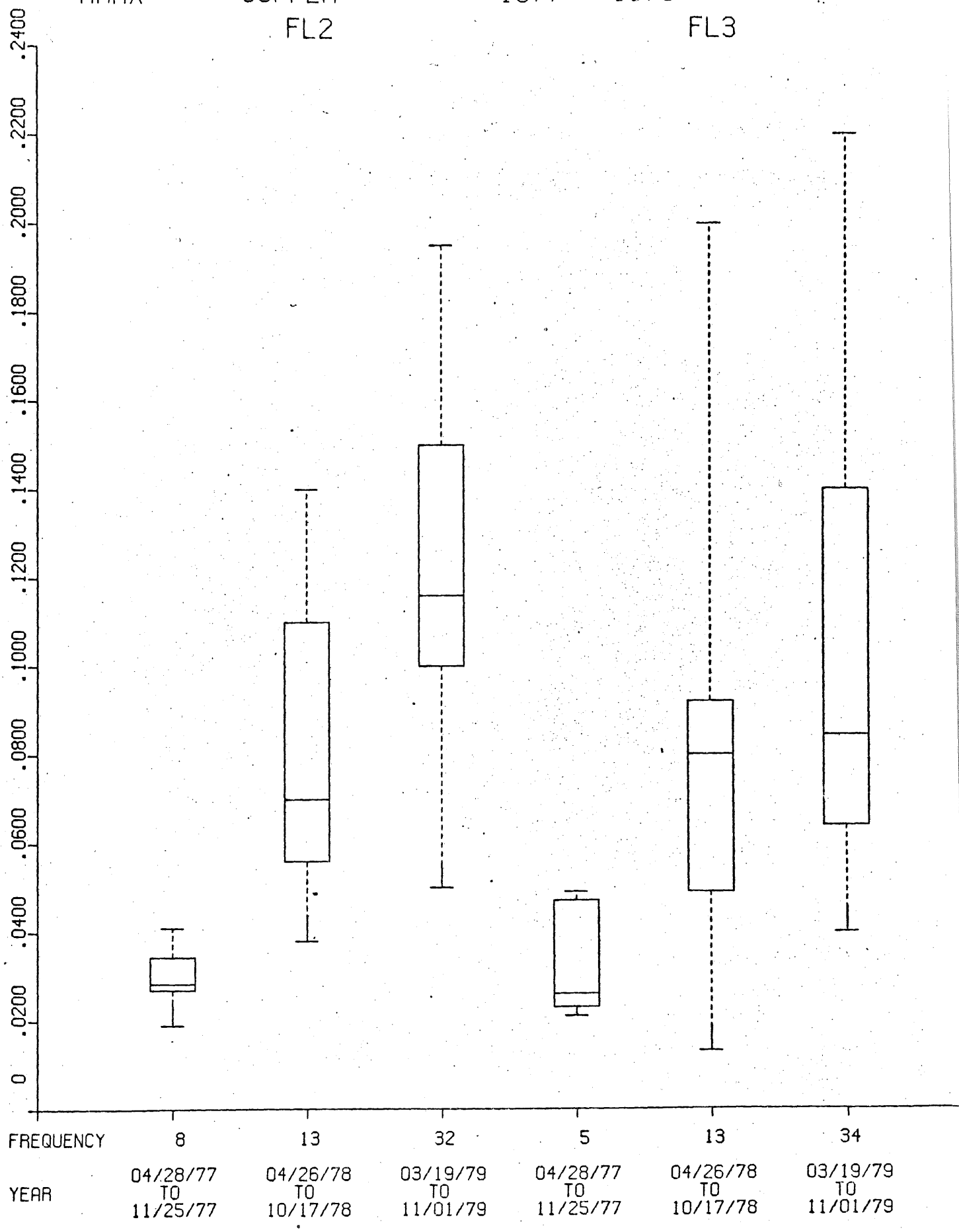

AMAX SODIUM :1977 - 1979
FL5
FL6
1200.
1100.
1000.
900.
800.
700.
600.
500.
400.
300.
200.
100.
0
FREQUENCY
2
19
35
0
15
37
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

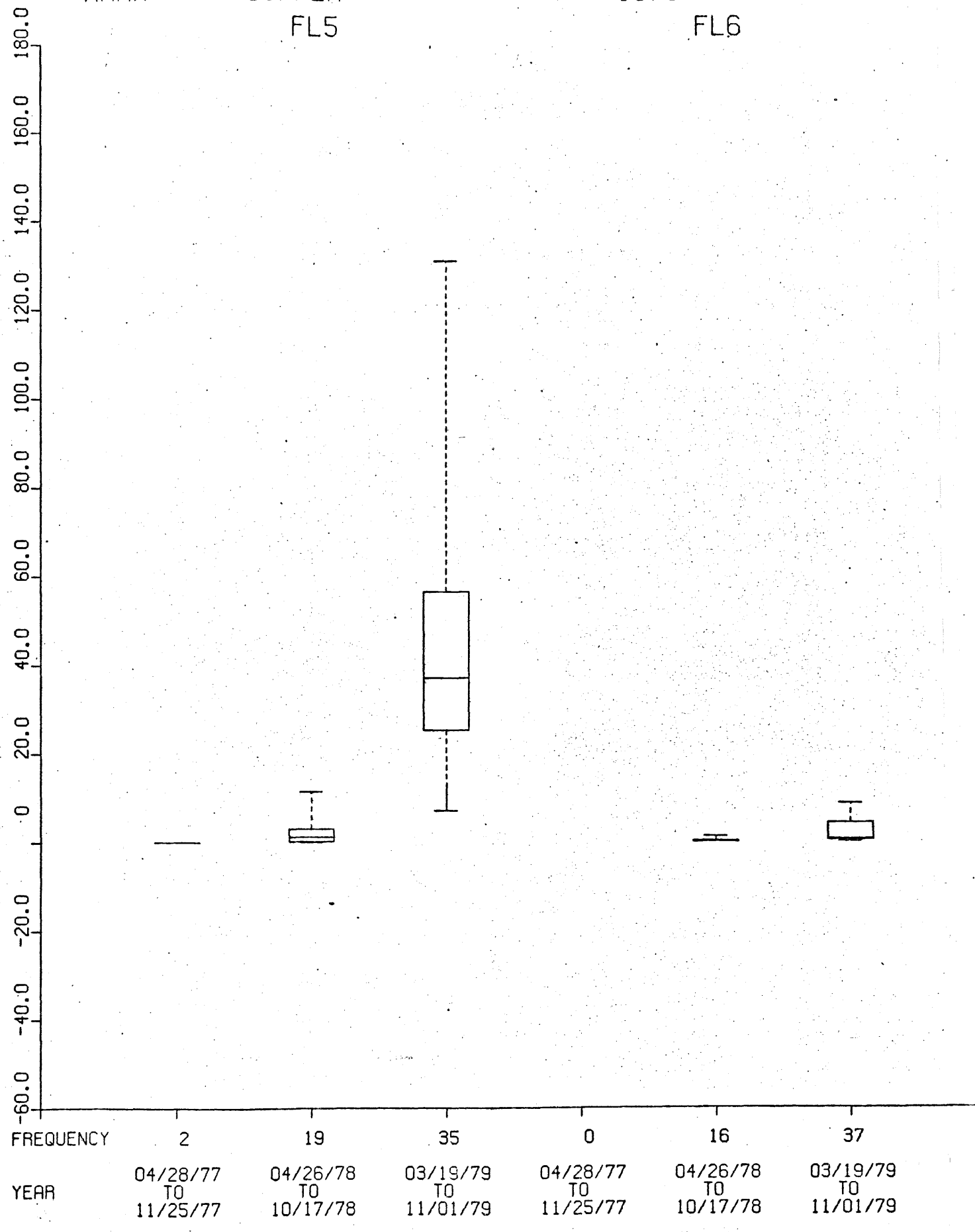

AMAX POTASSIUM :1977 - 1979
FL1
FL4
80.00
72.00
64.00
56.00
48.00
40.00
32.00
24.00
16.00
8.00
0
-8.00
-16.00
FREQUENCY
8
20
33
4
23
26
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

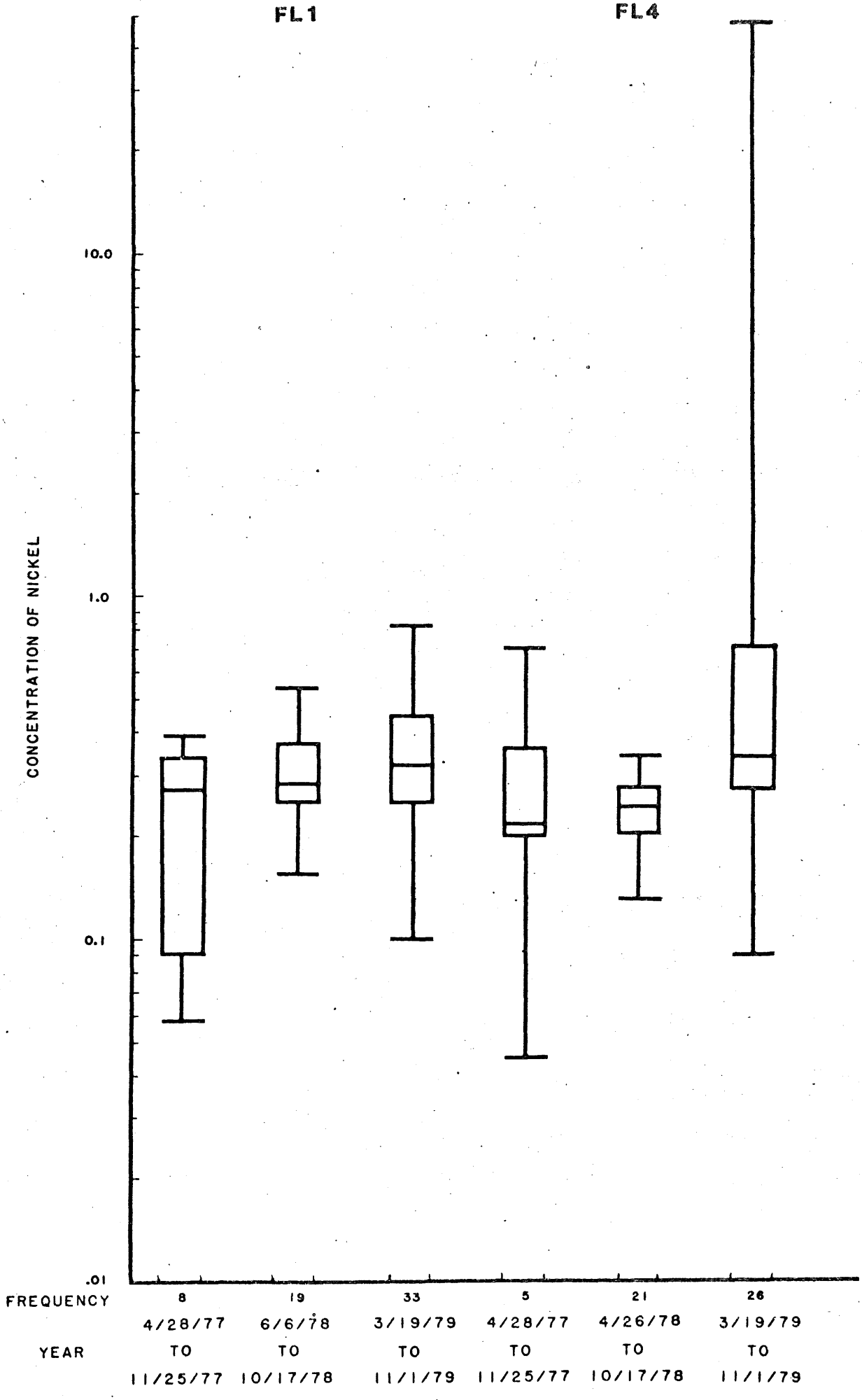

AMAX POTASSIUM :1977 - 1979
FL2
FL3
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
FREQUENCY 8 13 32 5 13 34
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

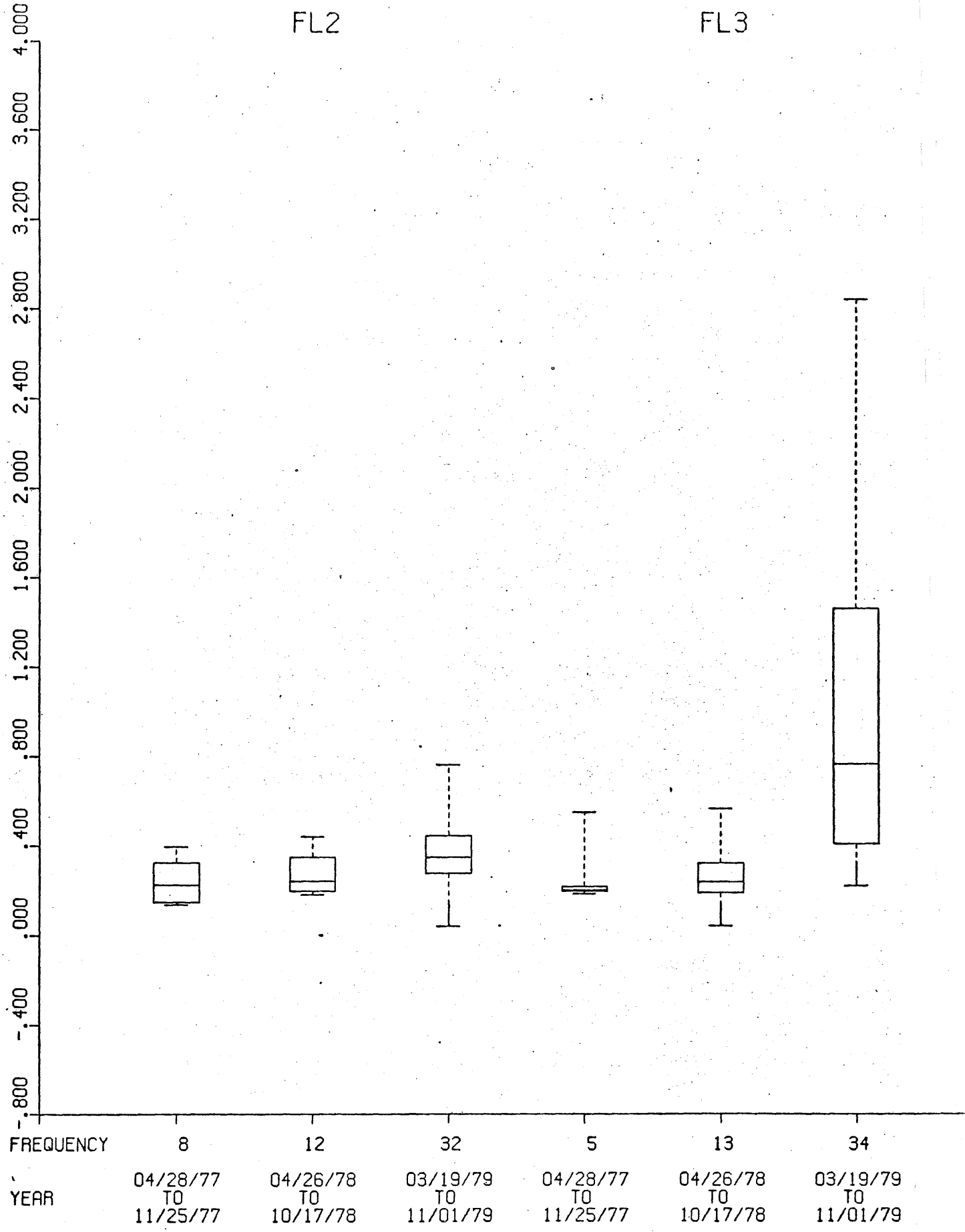

AMAX POTASSIUM :1977 - 1979
FL5
FL6
44.00
40.00
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
0
-4.00
FREQUENCY 2 19 35 0 16 37
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX COPPER 1977-1979
FL1
FL4
1.0
0.1
.01
CONCENTRATION OF COPPER
FREQUENCY 8 20 33 5 23 26
YEAR 4/28/77 TO 11/25/77
4/26/78 TO 10/17/78
3/19/79 TO 11/1/79
4/28/77 TO 11/25/77
4/26/78 TO 10/17/78
3/19/79 TO 11/1/79

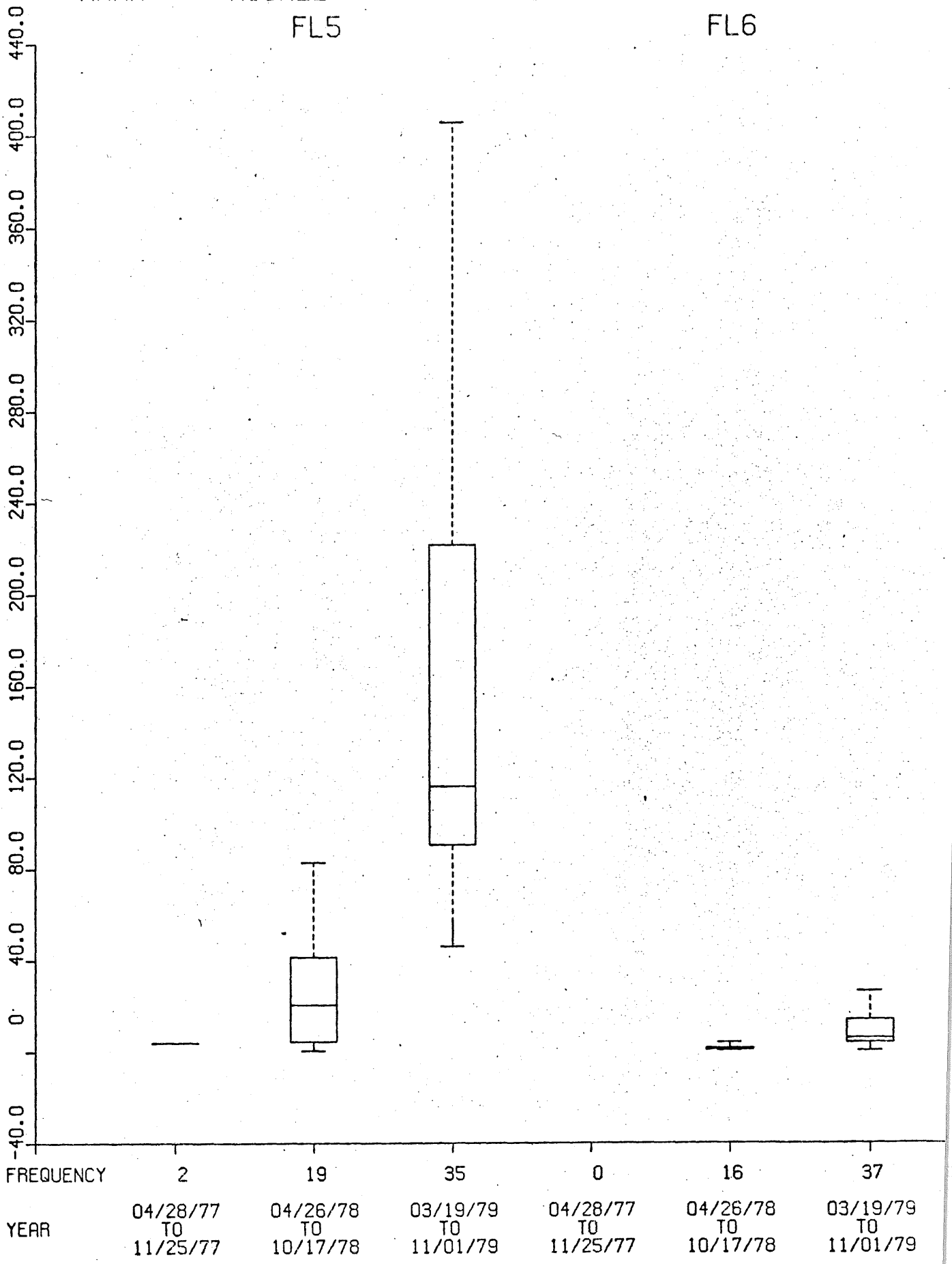

AMAX COPPER : 1977 - 1979
FL2
FL3
0
.0200
.0400
.0600
.0800
.1000
.1200
.1400
.1600
.1800
.2000
.2200
.2400
FREQUENCY 8 13 32 5 13 34
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

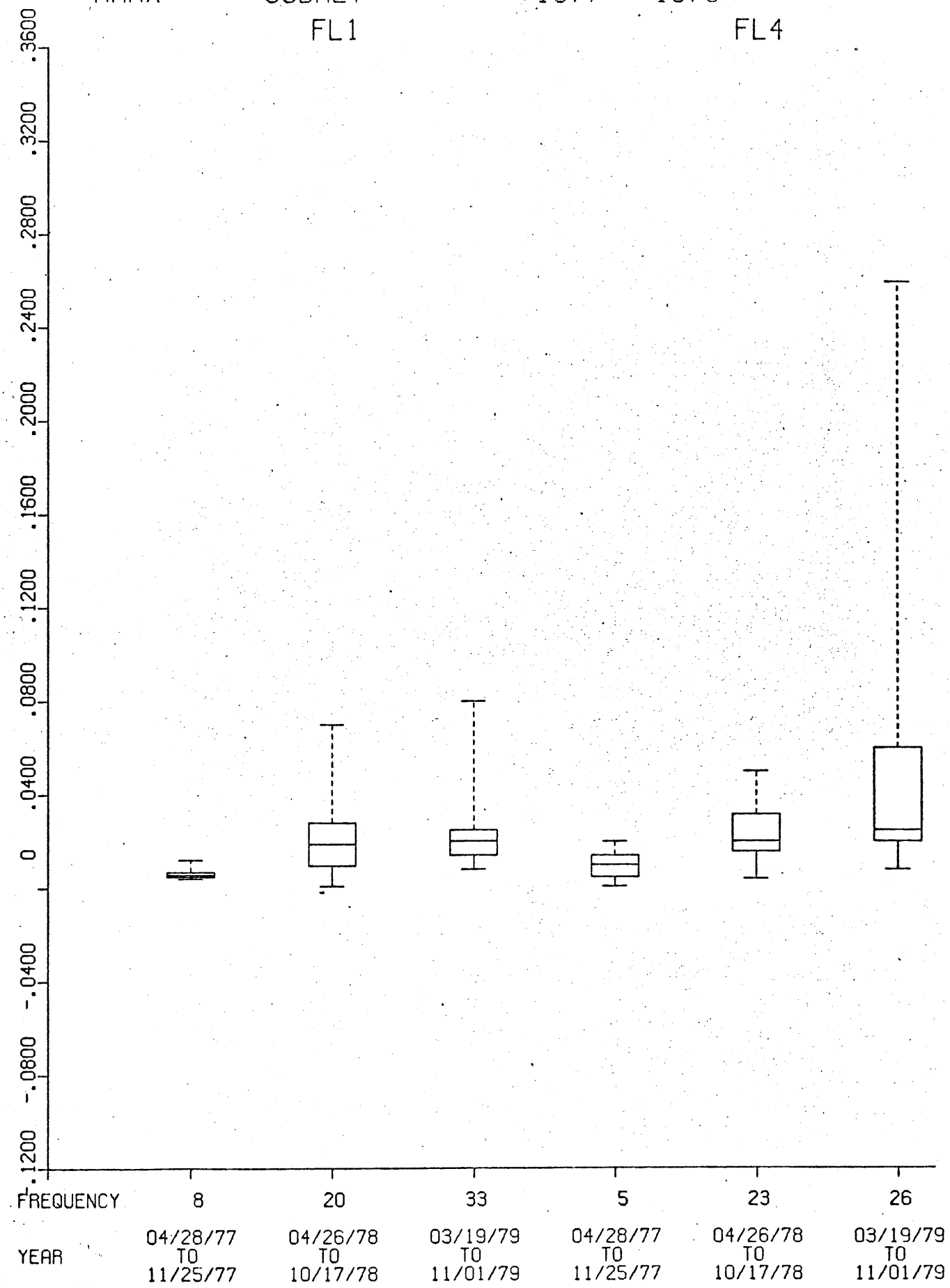

AMAX COPPER : 1977 - 1979
FL5
FL6
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0
-20.0
-40.0
-60.0
FREQUENCY 2 19 35 0 16 37
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

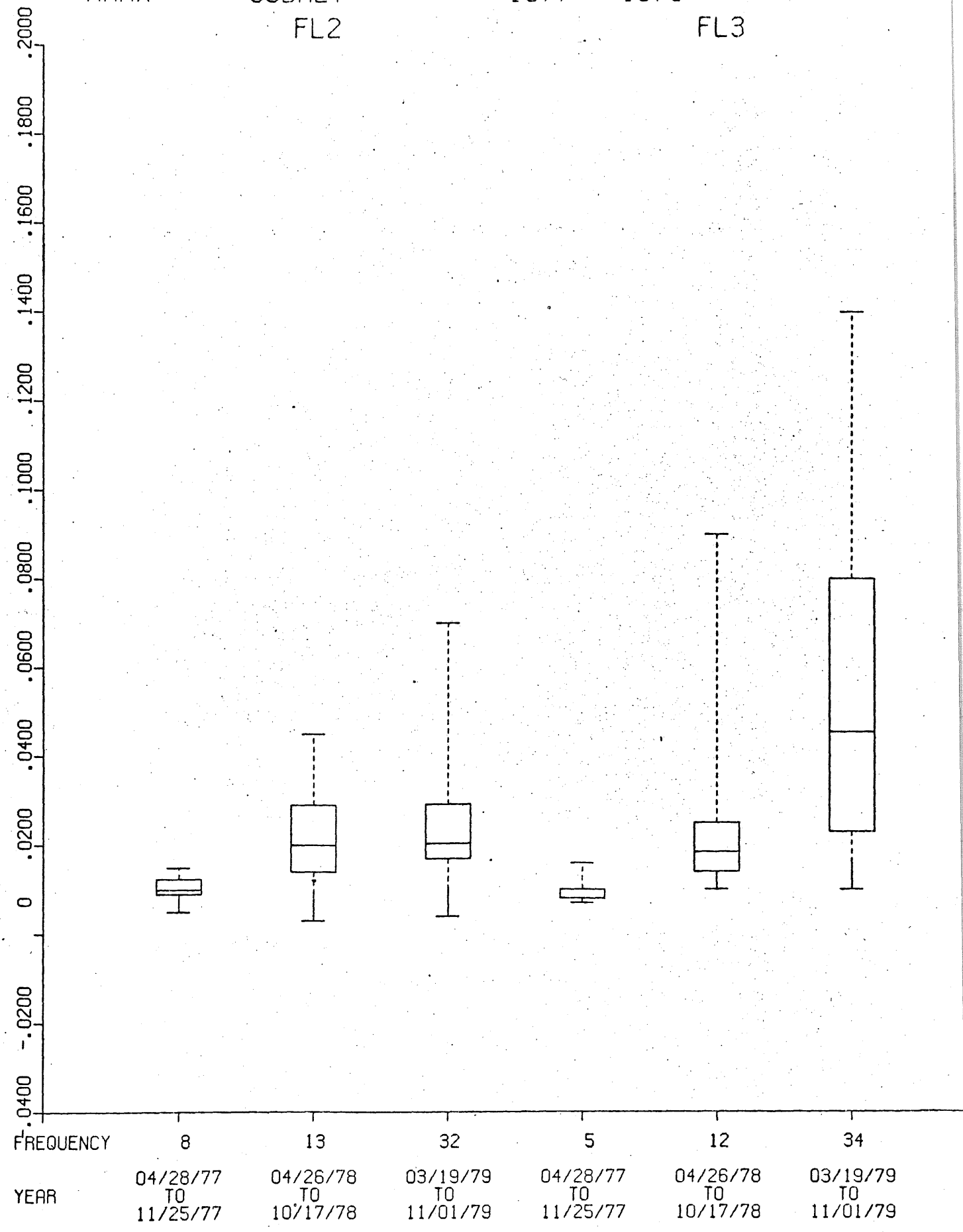

AMAX
NICKEL
1977-1979
FL1
FL4
CONCENTRATION OF NICKEL
10.0
1.0
0.1
.01
FREQUENCY
8
19
33
5
21
26
YEAR
4/28/77 TO 11/25/77
6/6/78 TO 10/17/78
3/19/79 TO 11/1/79
4/28/77 TO 11/25/77
4/26/78 TO 10/17/78
3/19/79 TO 11/1/79

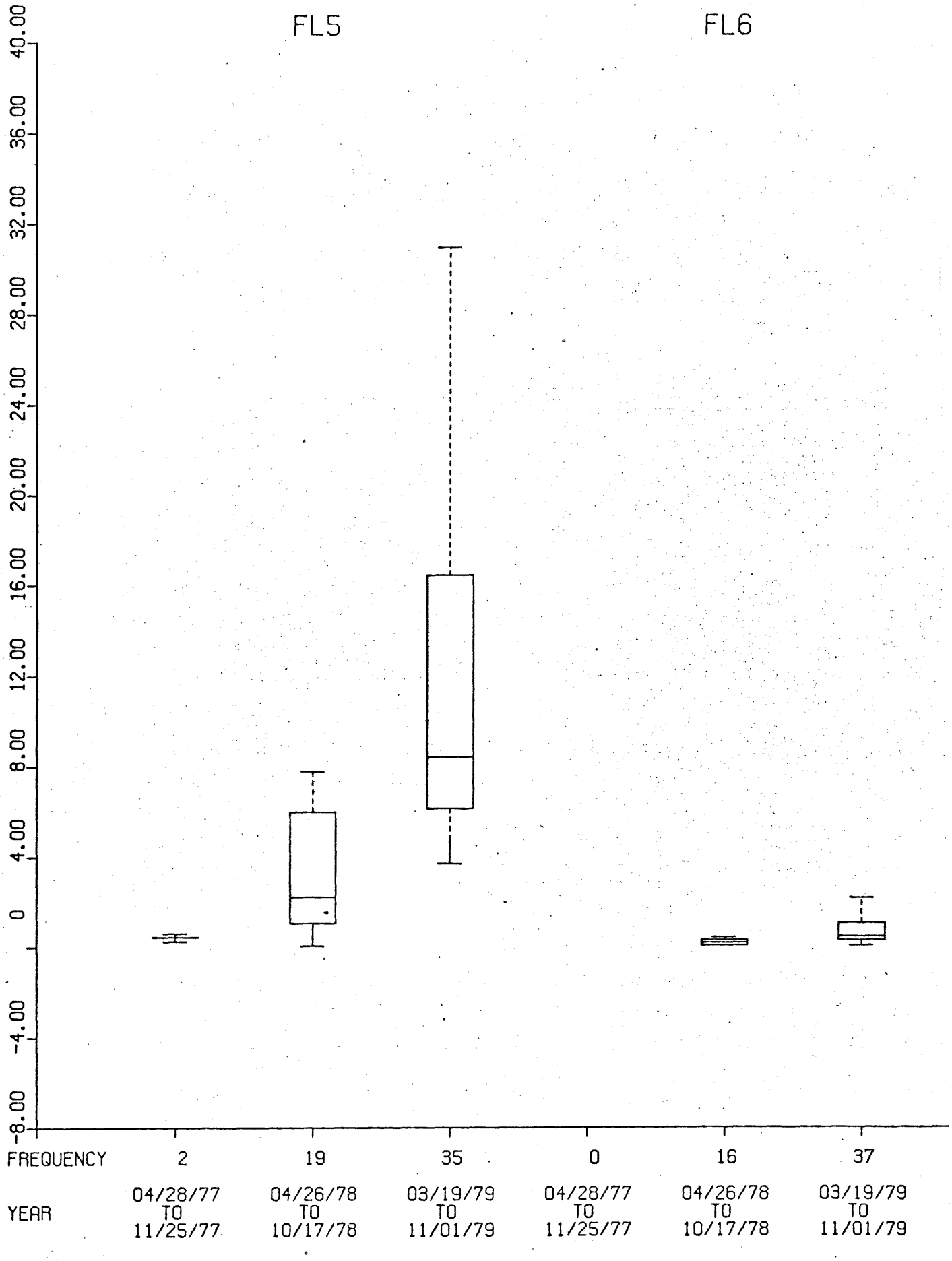

AMAX NICKEL :1977 - 1979
FL2
FL3
4.000
3.600
3.200
2.800
2.400
2.000
1.600
1.200
.800
.400
.000
-.400
-.800
FREQUENCY
8
12
32
5
13
34
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

AMAX NICKEL :1977 - 1979



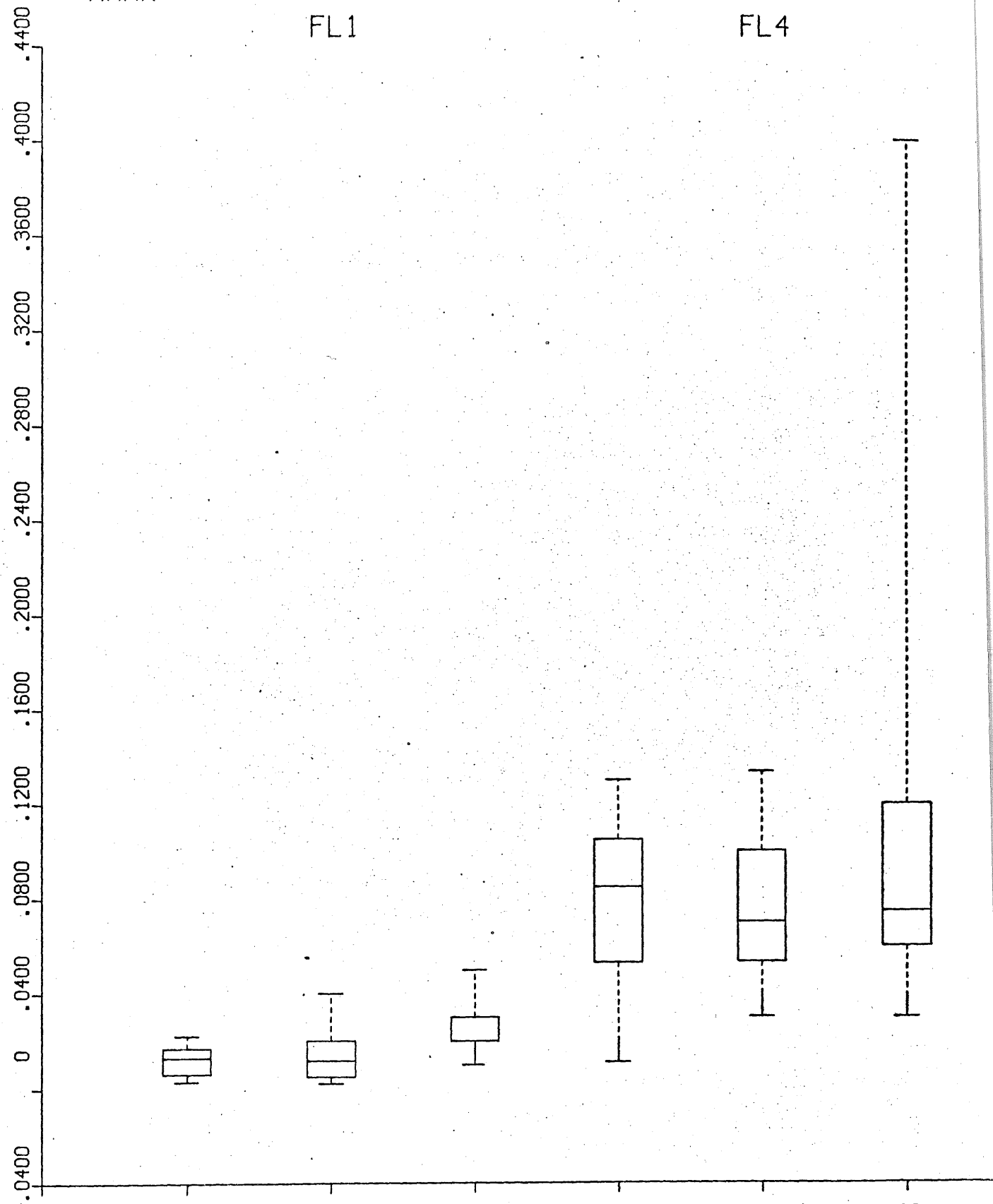

AMAX COBALT :1977 - 1979
FL1
FL4
.3600
.3200
.2800
.2400
.2000
.1600
.1200
.0800
.0400
0
-.0400
-.0800
-.1200
FREQUENCY 8 20 33 5 23 26
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX COBALT :1977 - 1979
FL2
FL3
.2000
.1800
.1600
.1400
.1200
.1000
.0800
.0600
.0400
.0200
0
-.0200
-.0400
FREQUENCY
8
13
32
5
12
34
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX COBALT :1977 - 1979
FL5
FL6
40.00
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
0
-4.00
-8.00
FREQUENCY
2
19
35
0
16
37
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

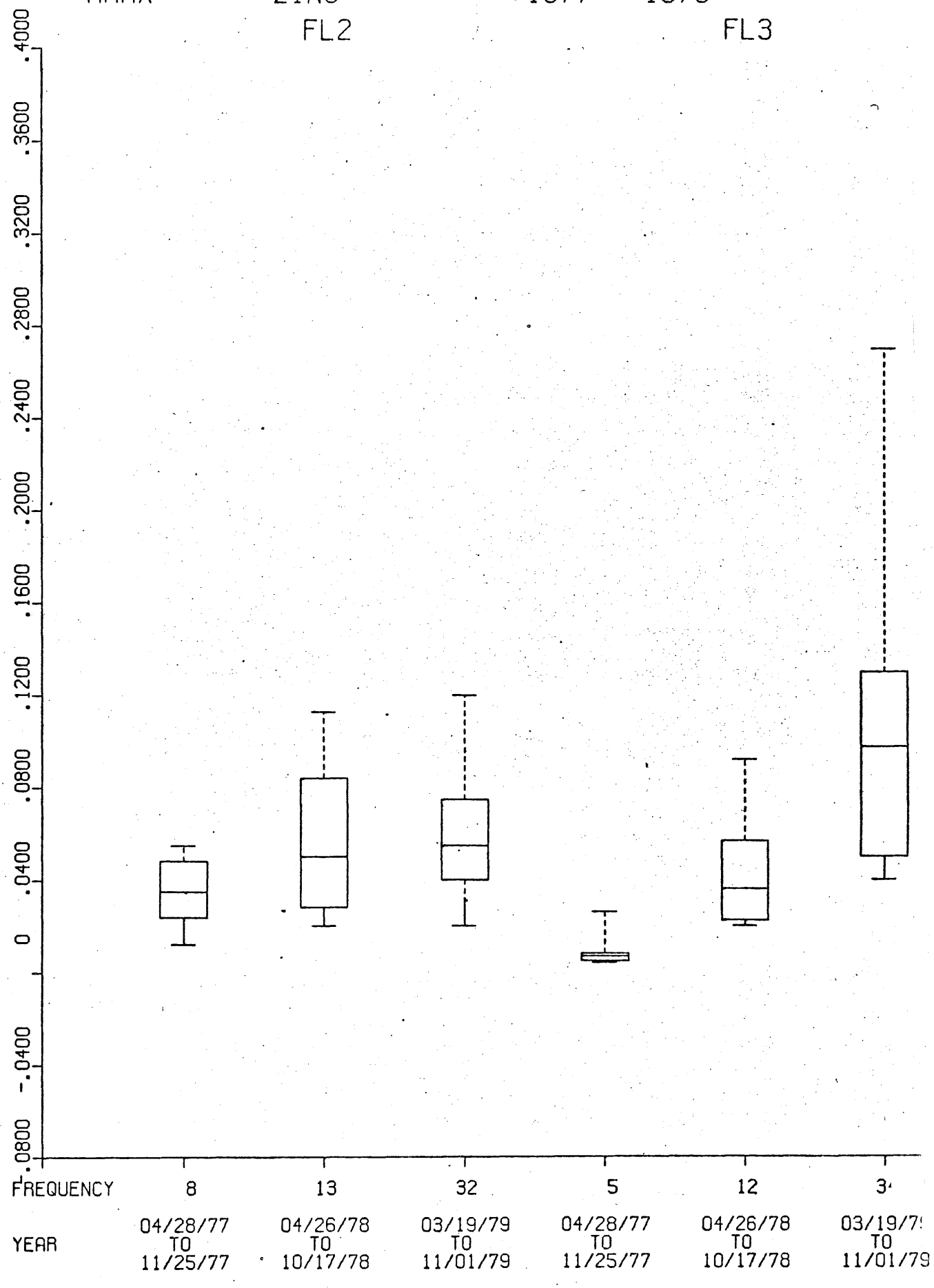
AMAX ZINC :1977 - 1979

FL1 FL4

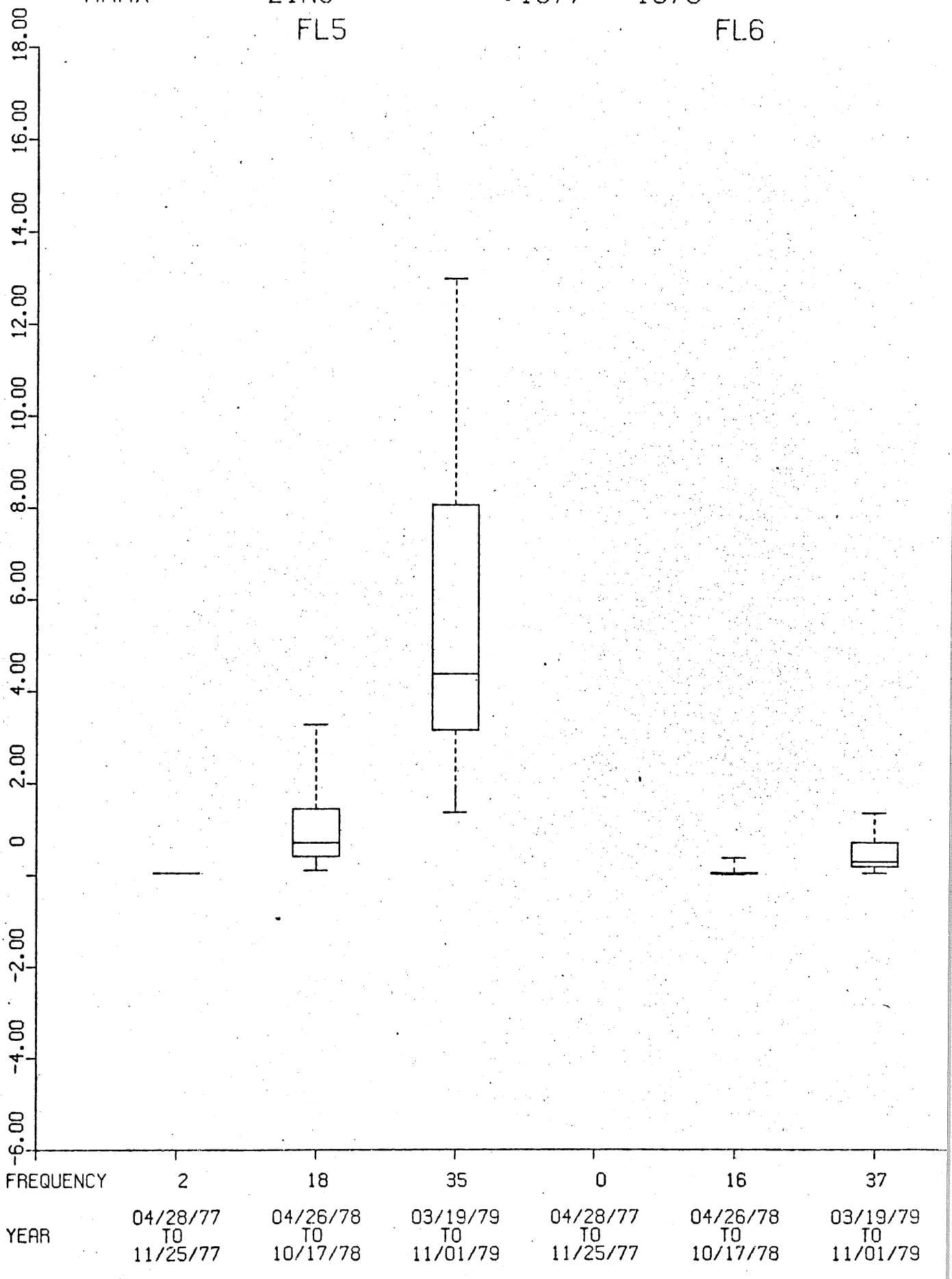


FREQUENCY	8	18	33	5	21	26
YEAR	04/28/77 TO 11/25/77	04/26/78 TO 10/17/78	03/19/79 TO 11/01/79	04/28/77 TO 11/25/77	04/26/78 TO 10/17/78	03/19/79 TO 11/01/79

AMAX ZINC :1977 - 1979

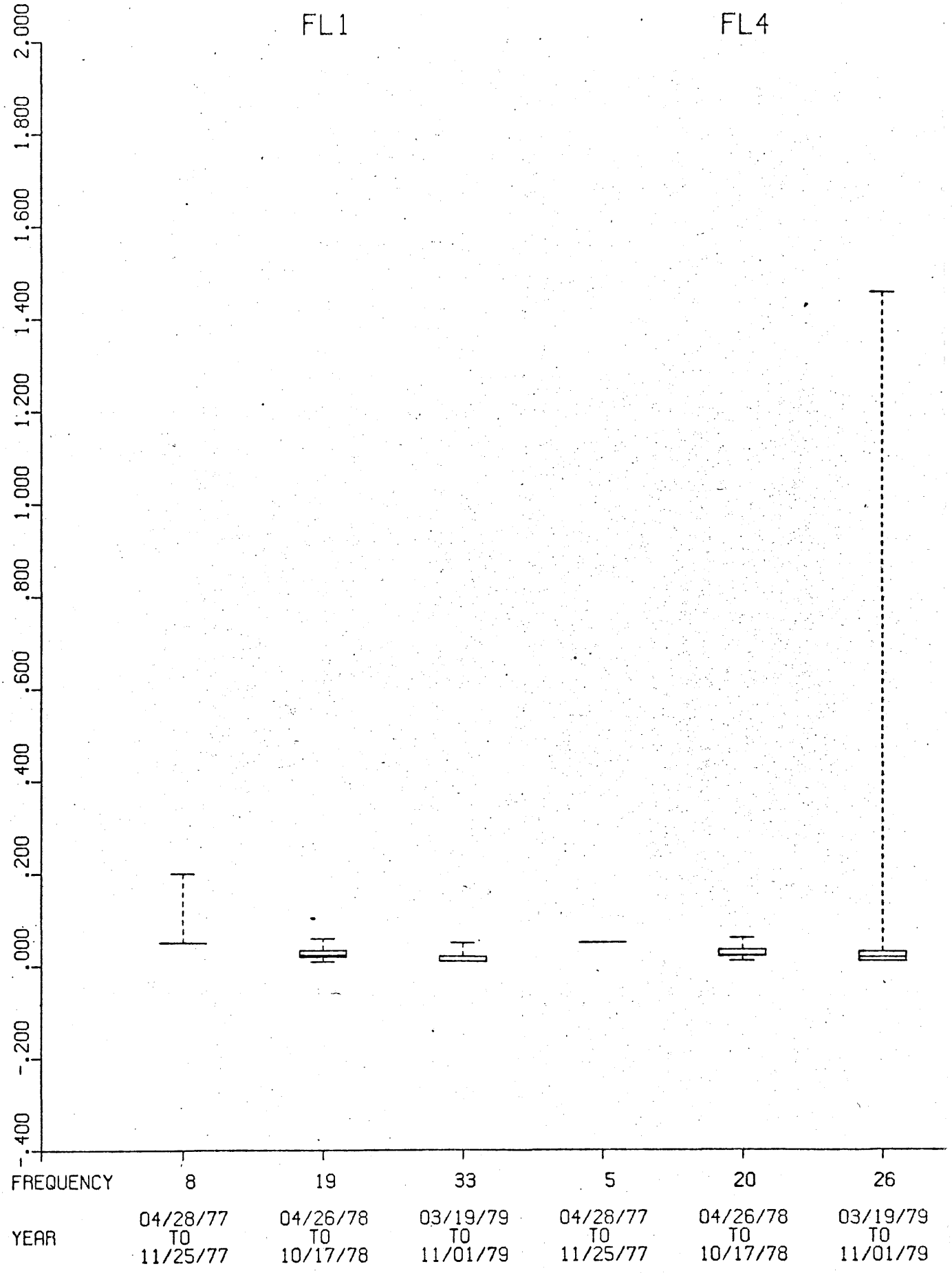


AMAX ZINC :1977 - 1979

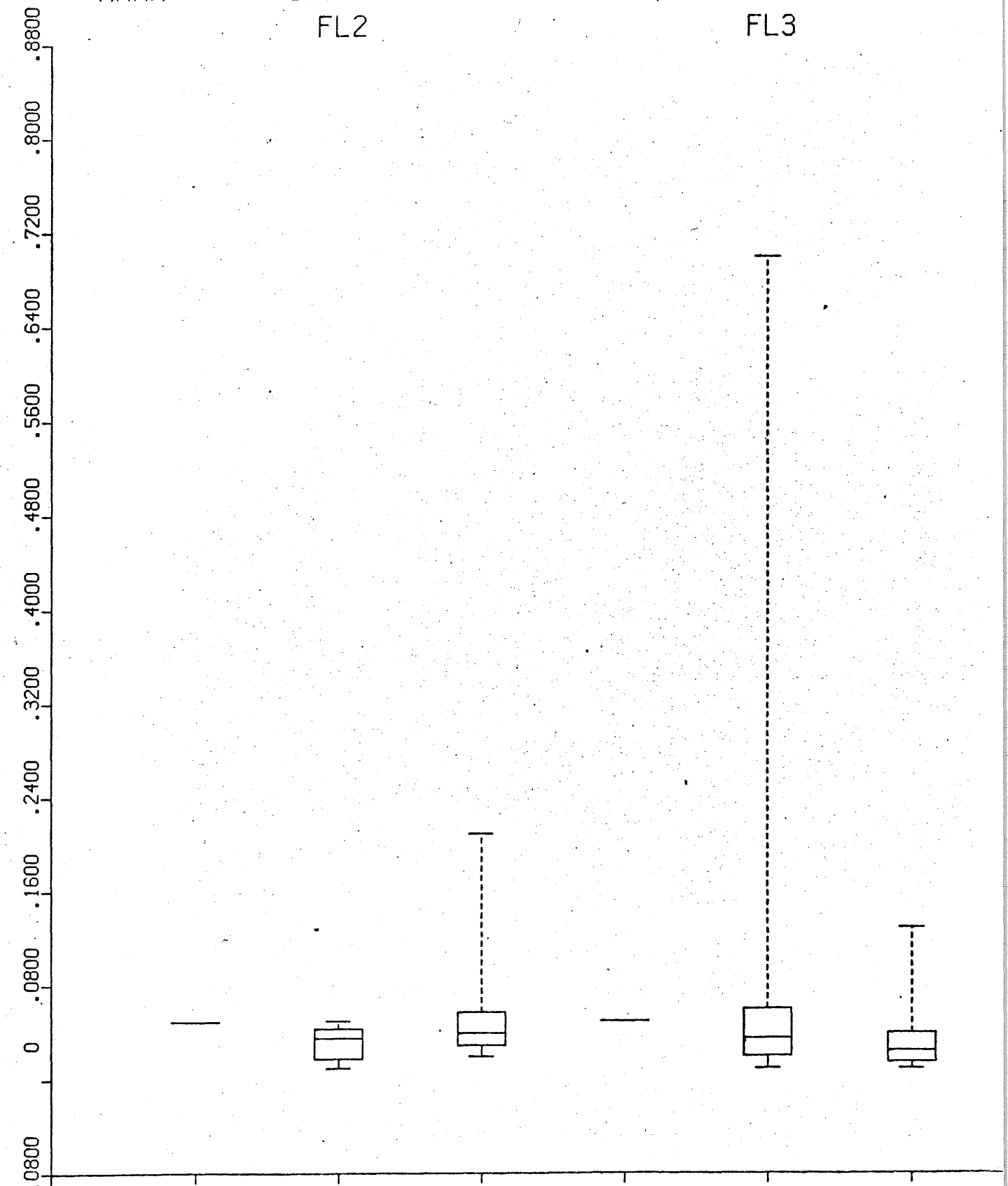


AMAX IRON :1977 - 1979

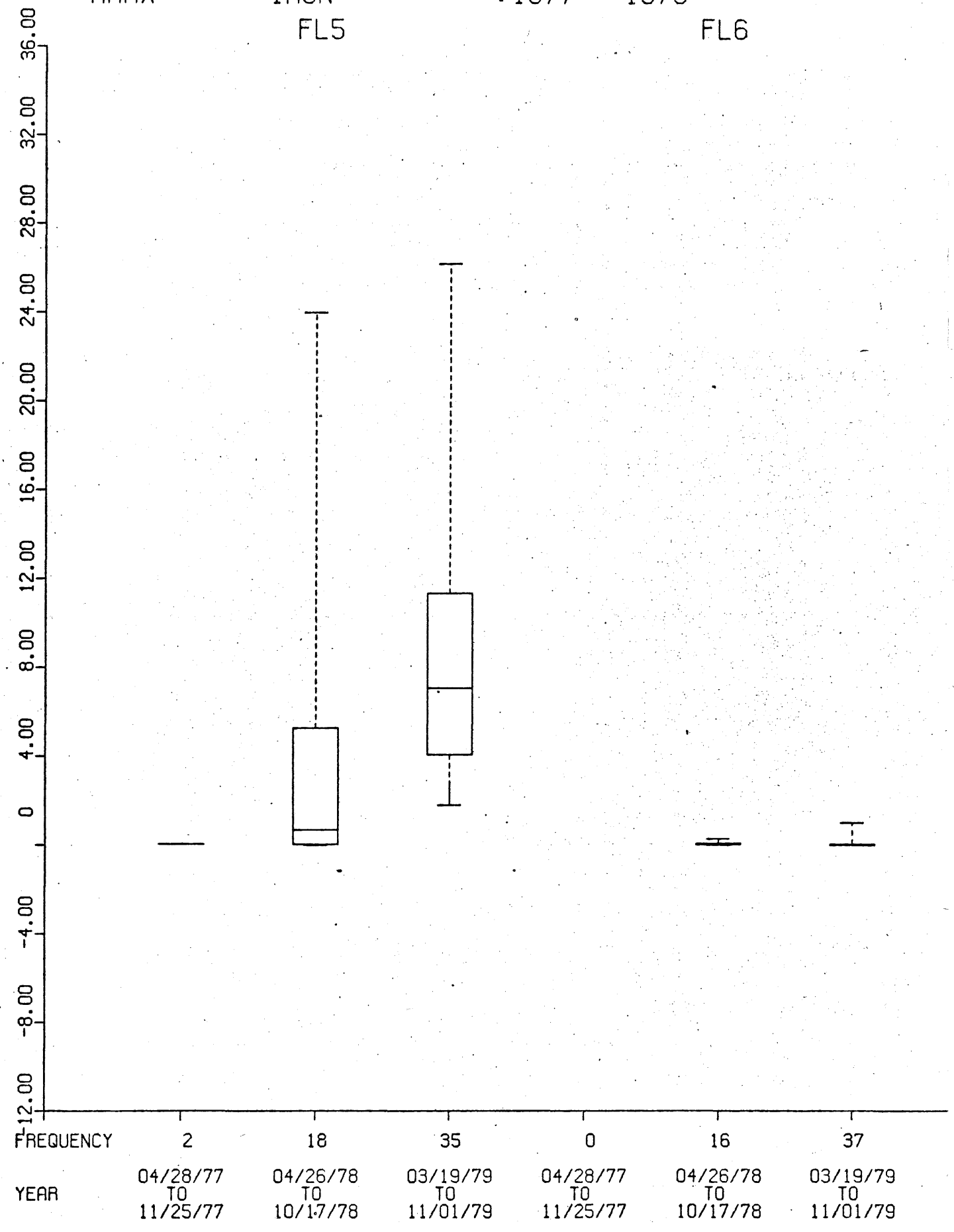
FL1 FL4

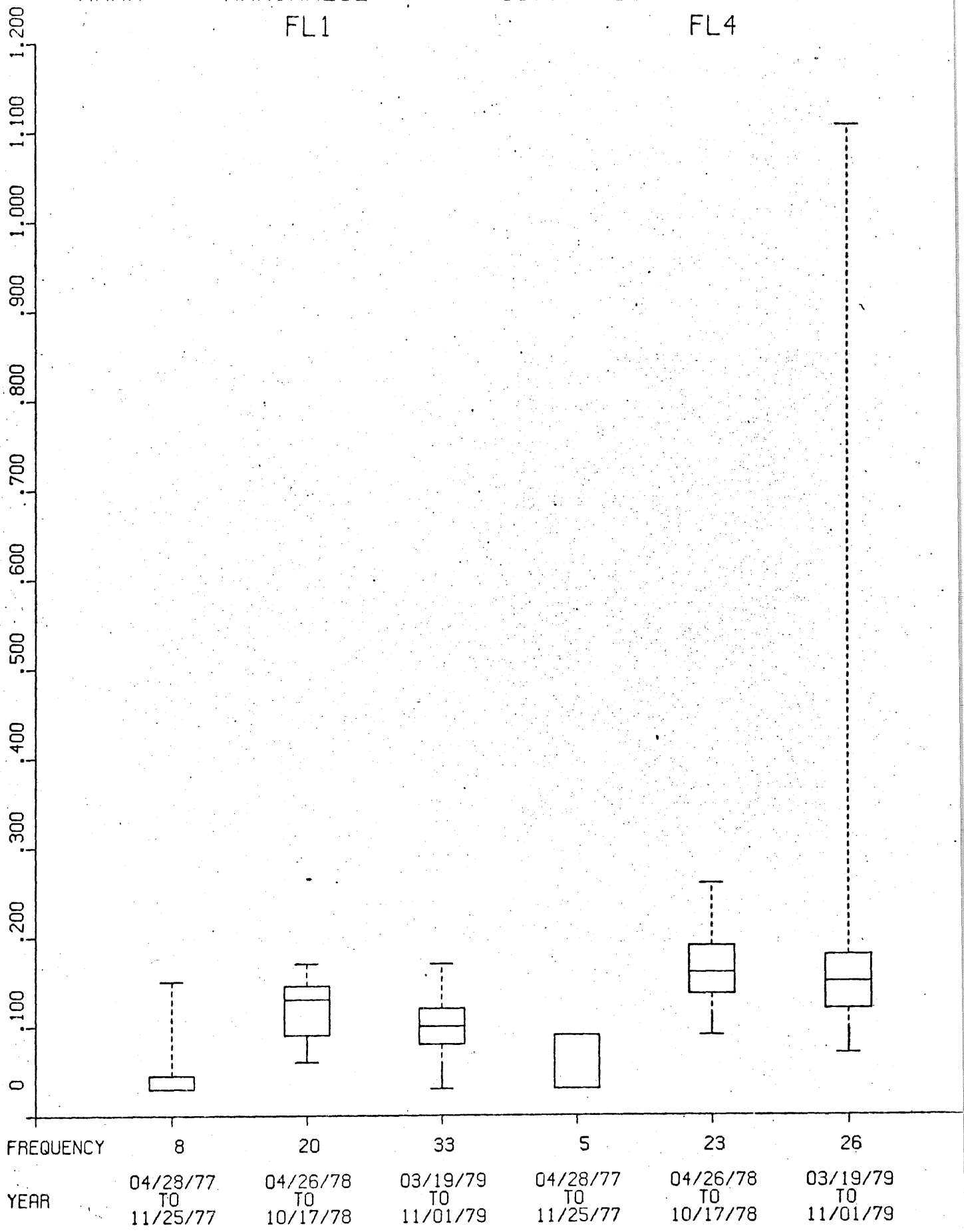


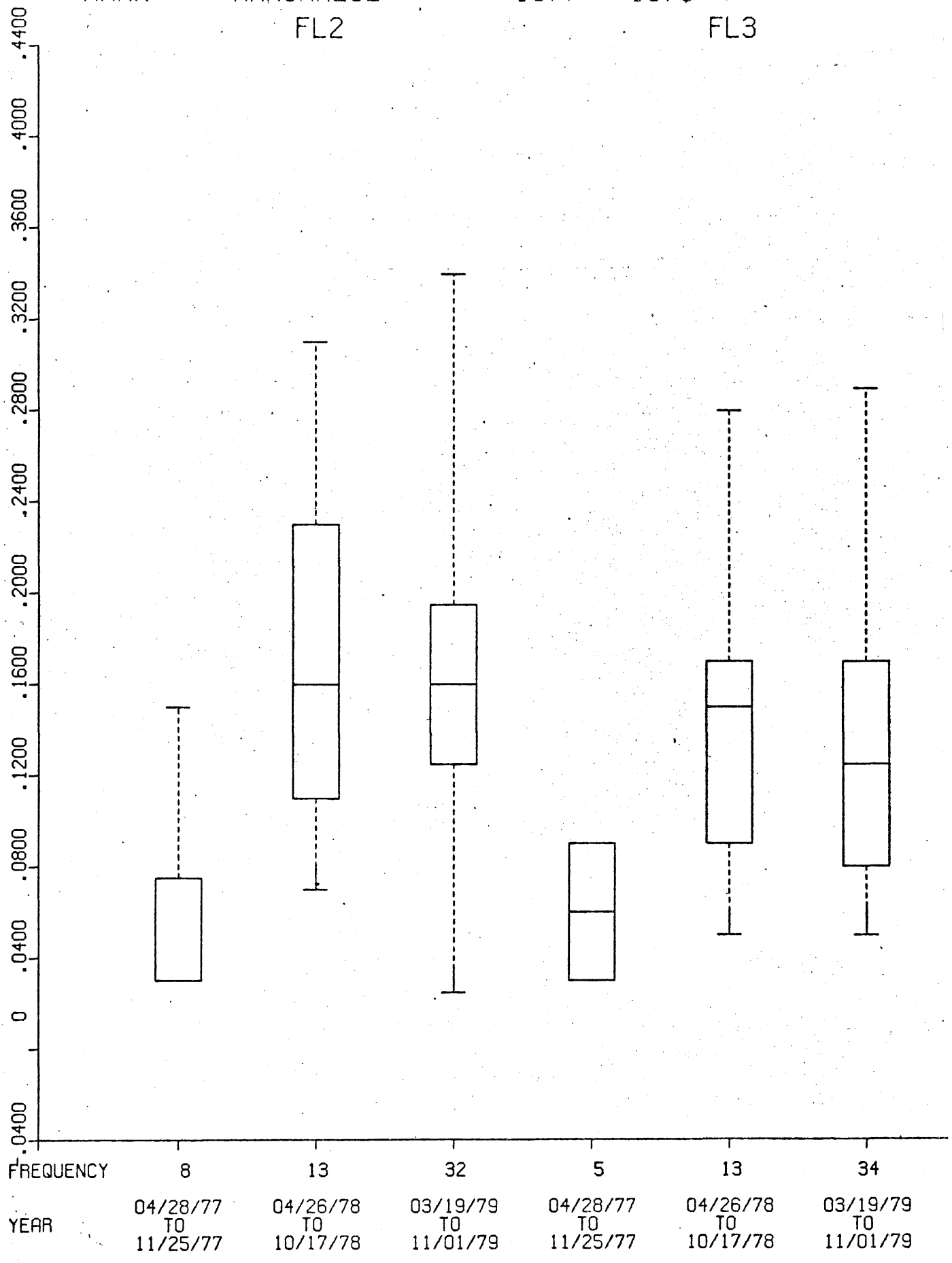
AMAX IRON :1977 - 1979

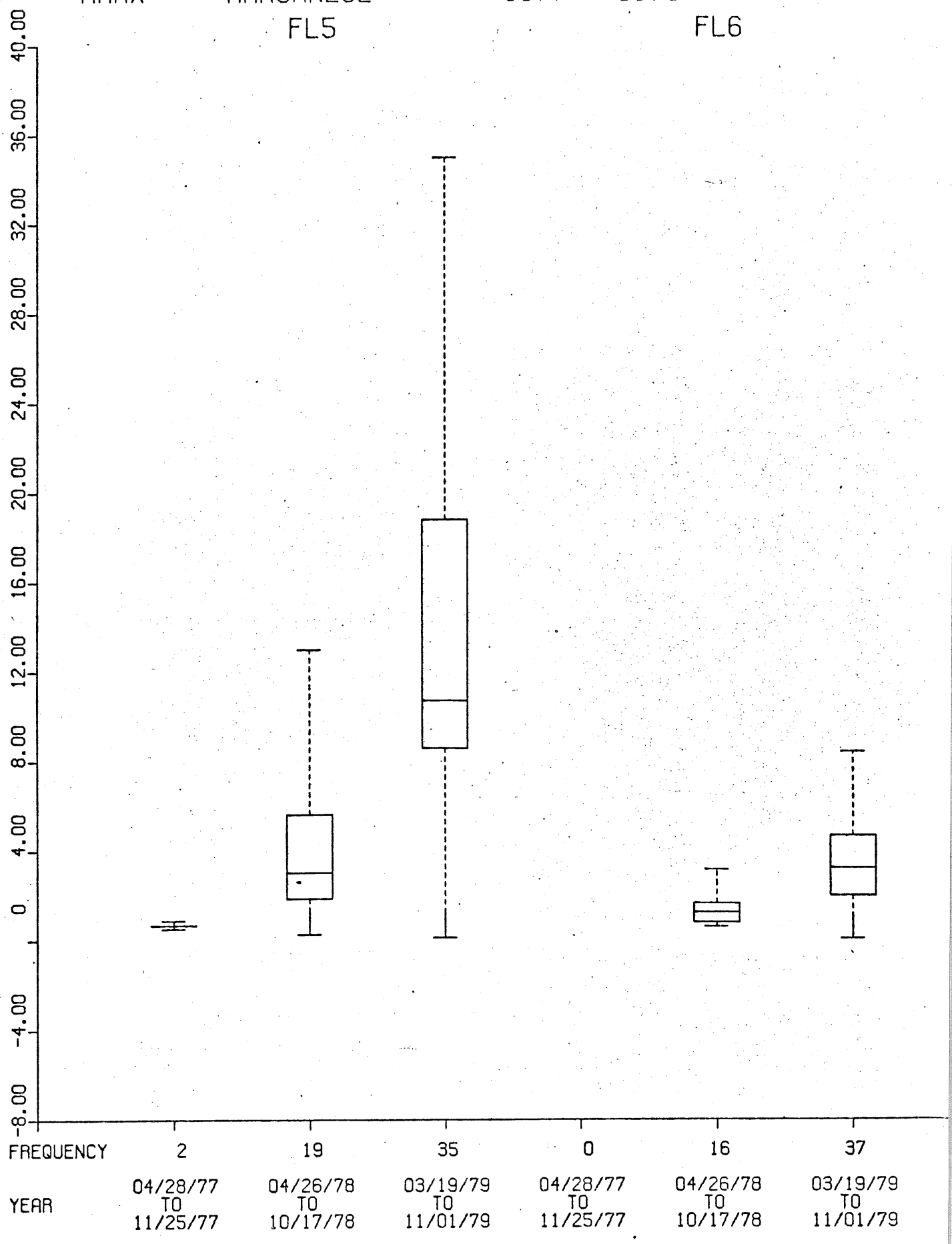


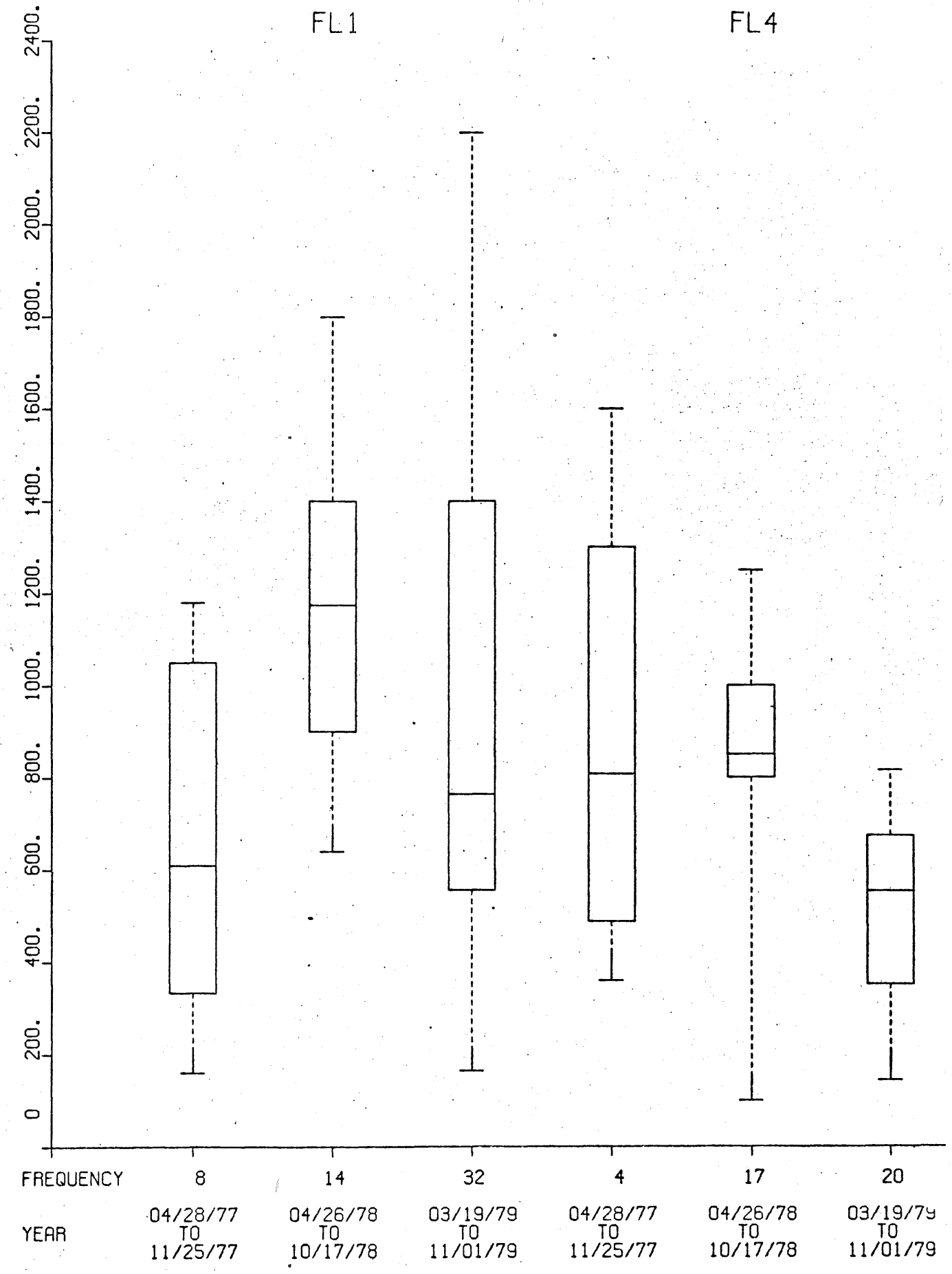
FREQUENCY	8	12	32	5	13	34
YEAR	04/28/77 TO 11/25/77	04/26/78 TO 10/17/78	03/19/79 TO 11/01/79	04/28/77 TO 11/25/77.	04/26/78 TO 10/17/78	03/19/79 TO 11/01/79

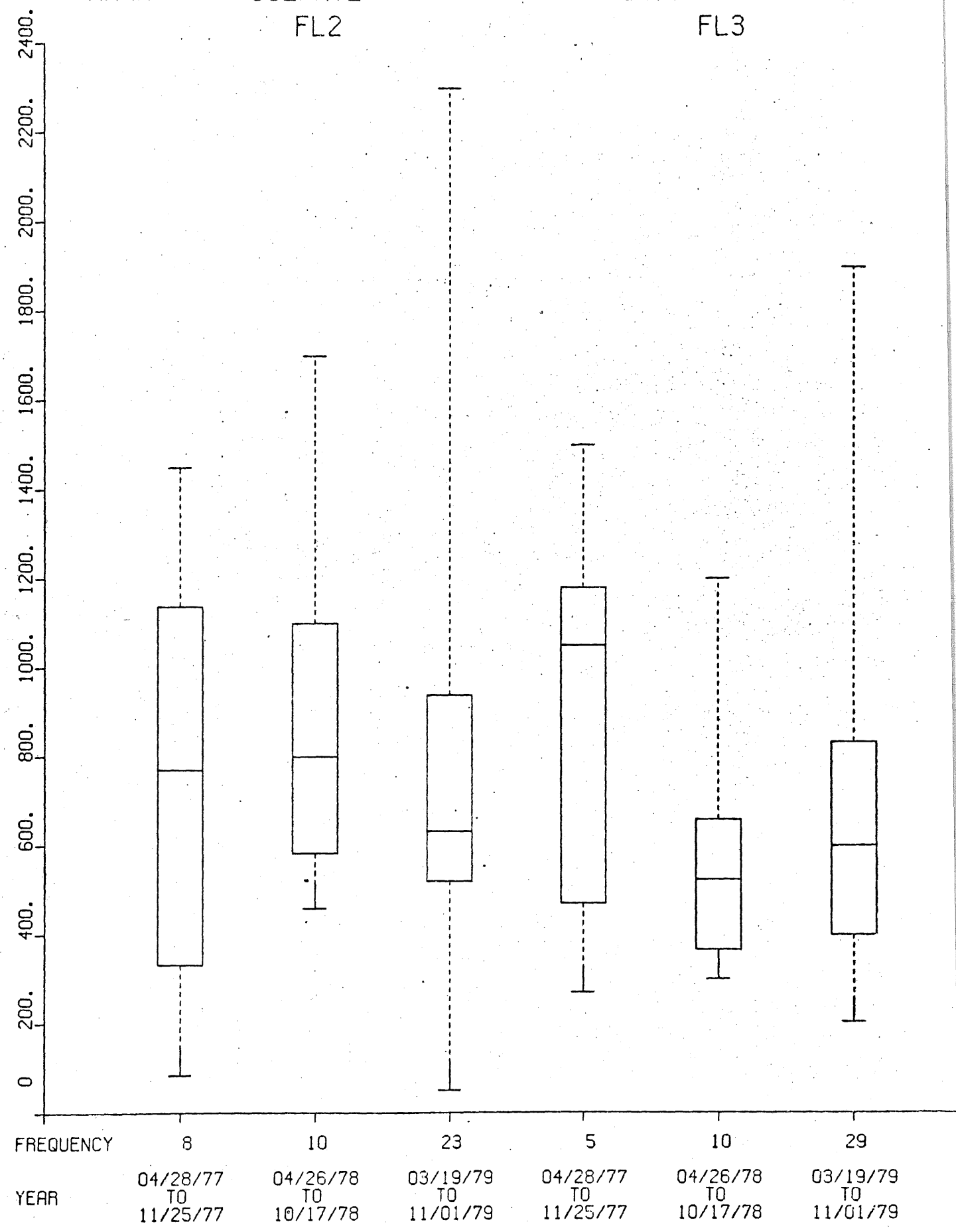

AMAX IRON :1977 - 1979
FL5
FL6
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
0
-4.00
-8.00
-12.00
FREQUENCY 2 18 35 0 16 37
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

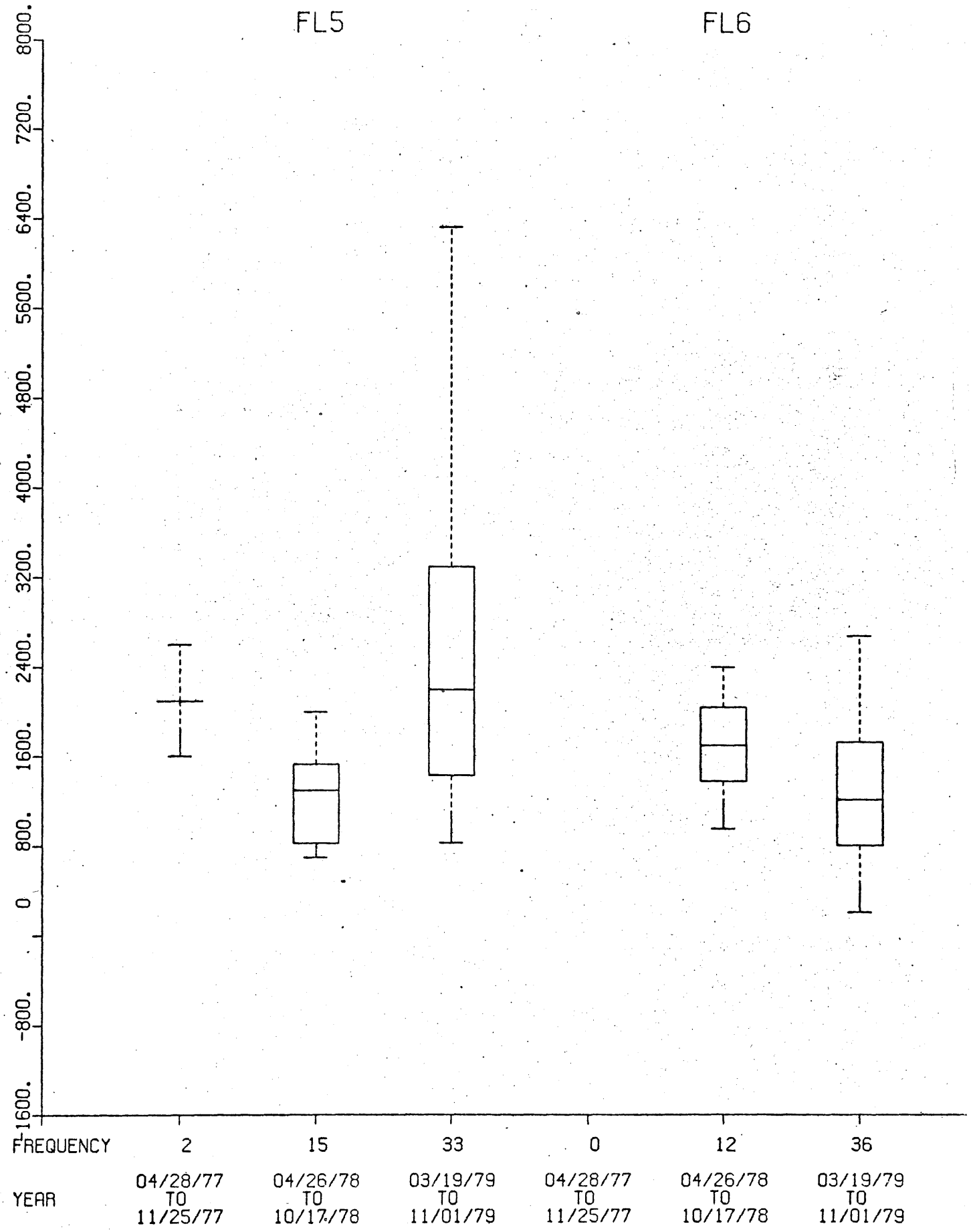

AMAX MANGANESE :1977 - 1979
FL1
FL4
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
FREQUENCY
8
20
33
5
23
26
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

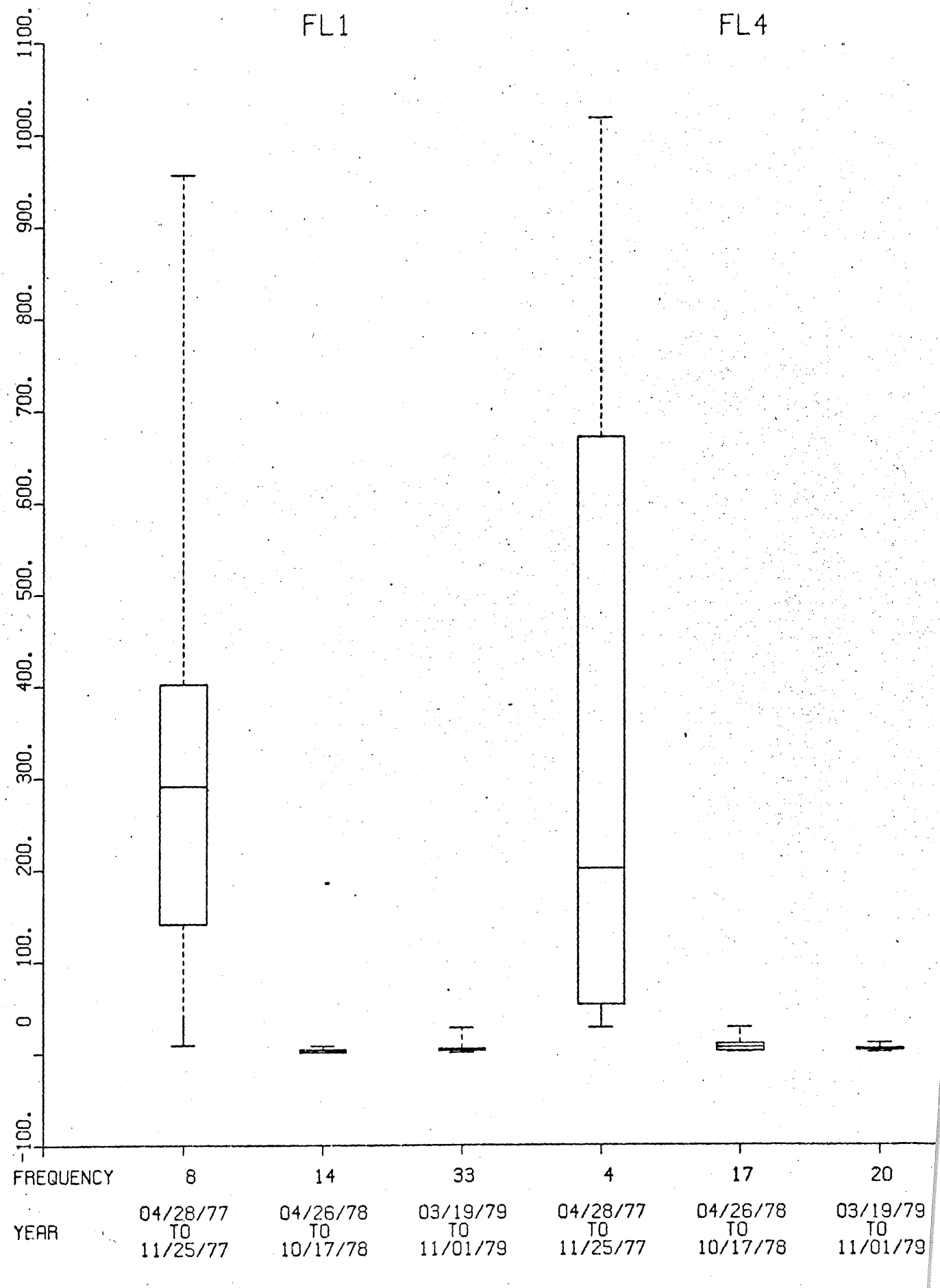

AMAX MANGANESE :1977 - 1979
FL2
FL3
.4400
.4000
.3600
.3200
.2800
.2400
.2000
.1600
.1200
.0800
.0400
0
.0400
FREQUENCY
8
13
32
5
13
34
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

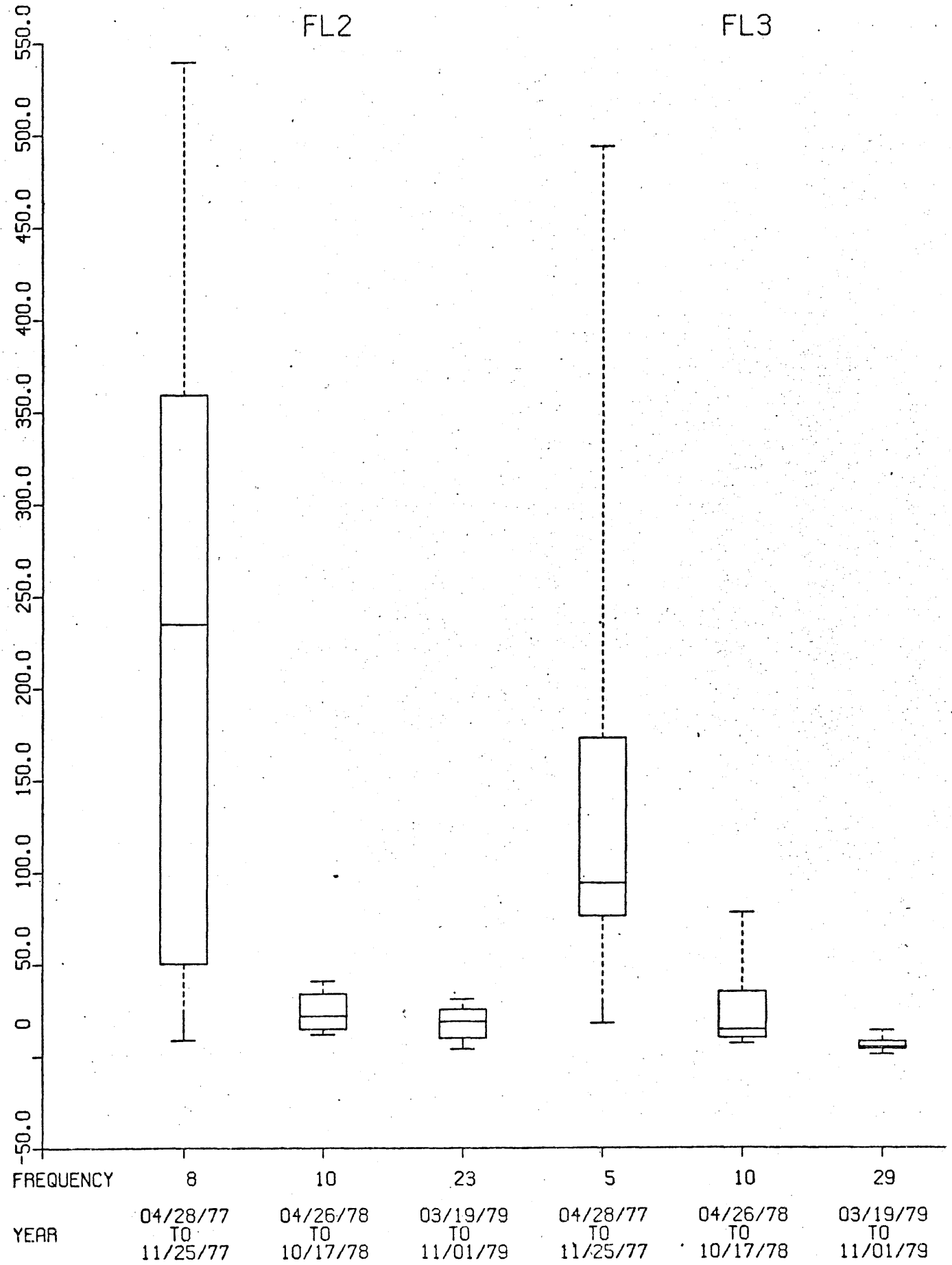

AMAX MANGANESE :1977 - 1979
FL5
FL6
40.00
36.00
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
0
-4.00
-8.00
FREQUENCY
2
19
35
0
16
37
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

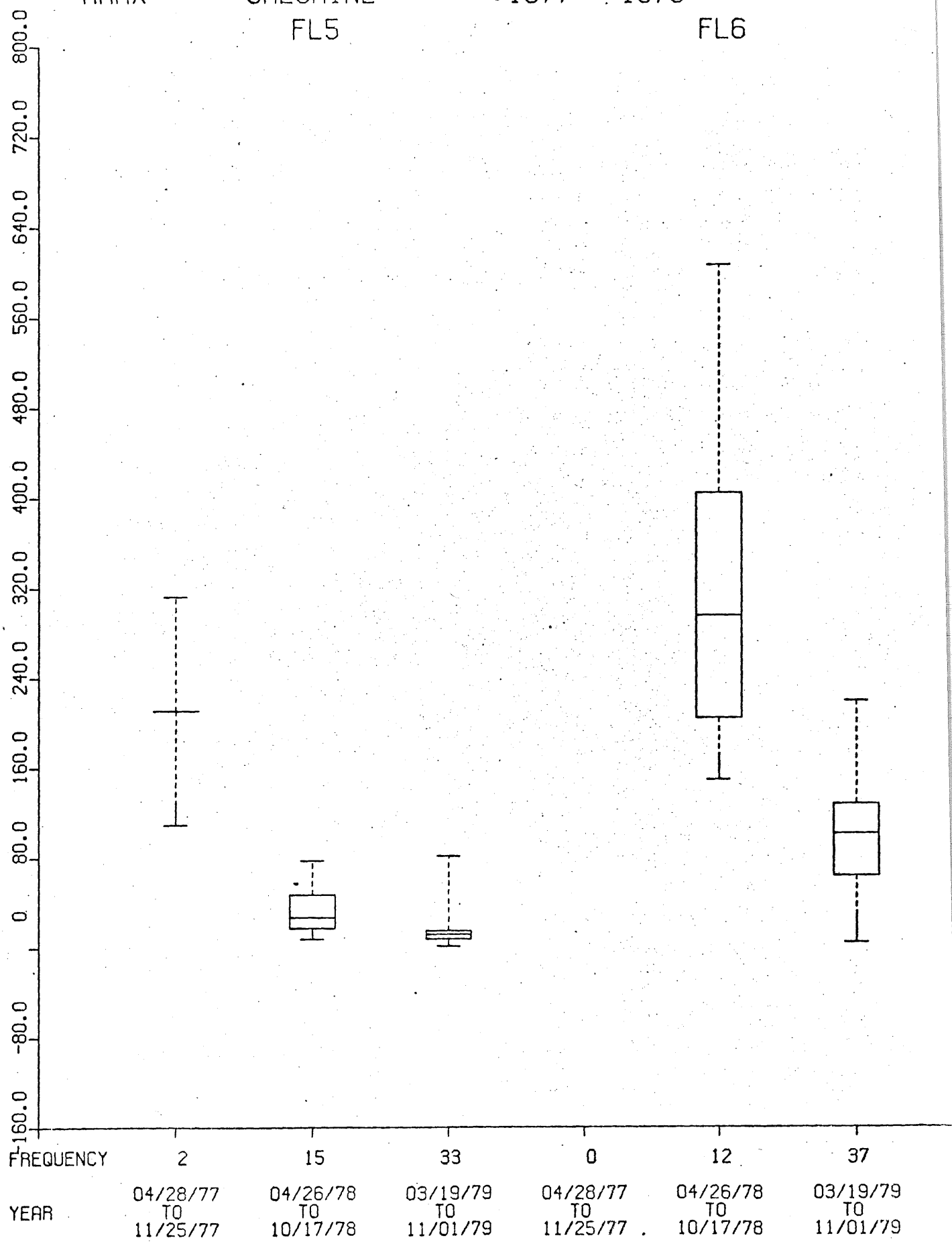

AMAX SULFATE : 1977 - 1979
FL1
FL4
2400.
2200.
2000.
1800.
1600.
1400.
1200.
1000.
800.
600.
400.
200.
0
FREQUENCY 8 14 32 4 17 20
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

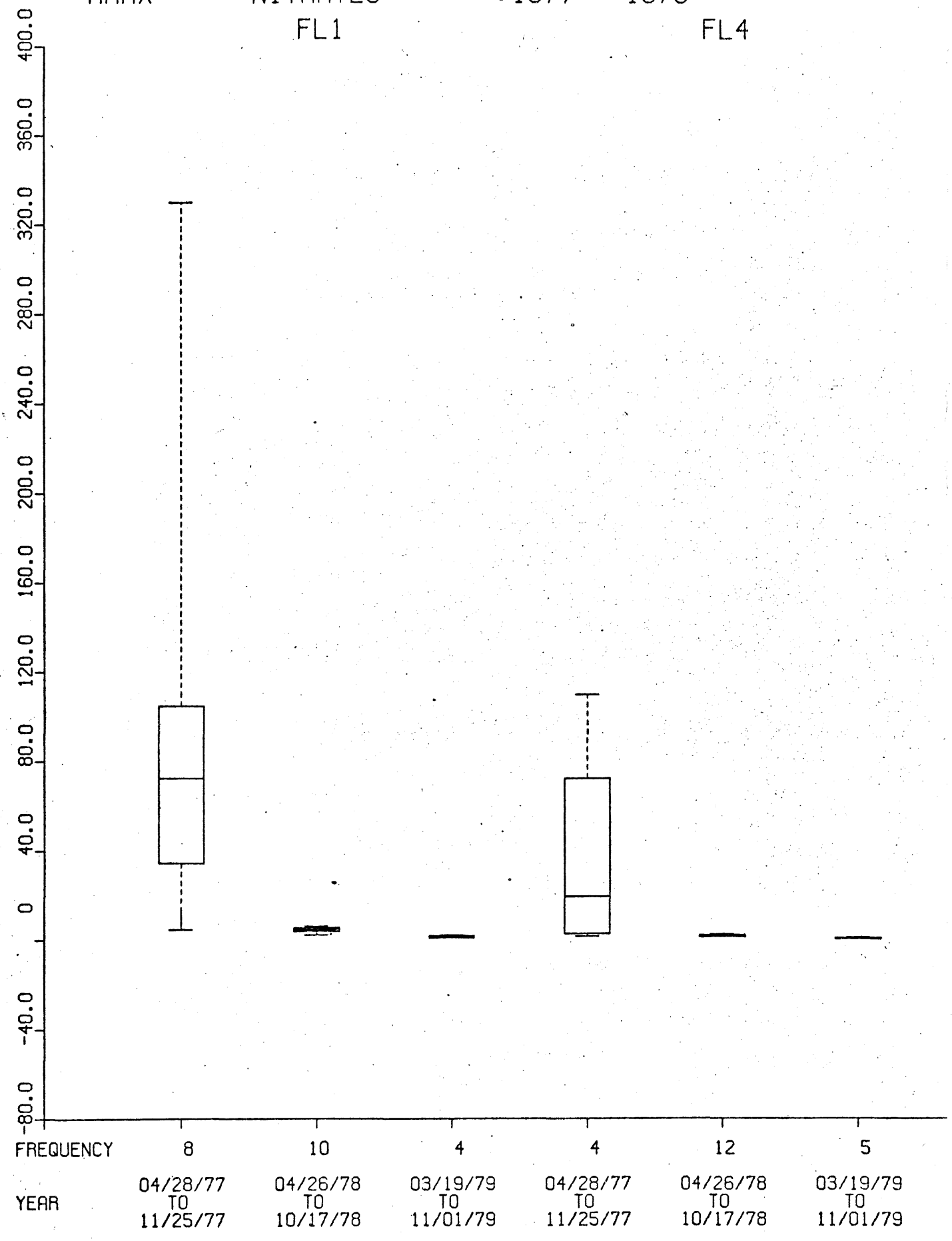

AMAX SULFATE :1977 - 1979
FL2
FL3
2400.
2200.
2000.
1800.
1600.
1400.
1200.
1000.
800.
600.
400.
200.
0
FREQUENCY 8 10 23 5 10 29
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

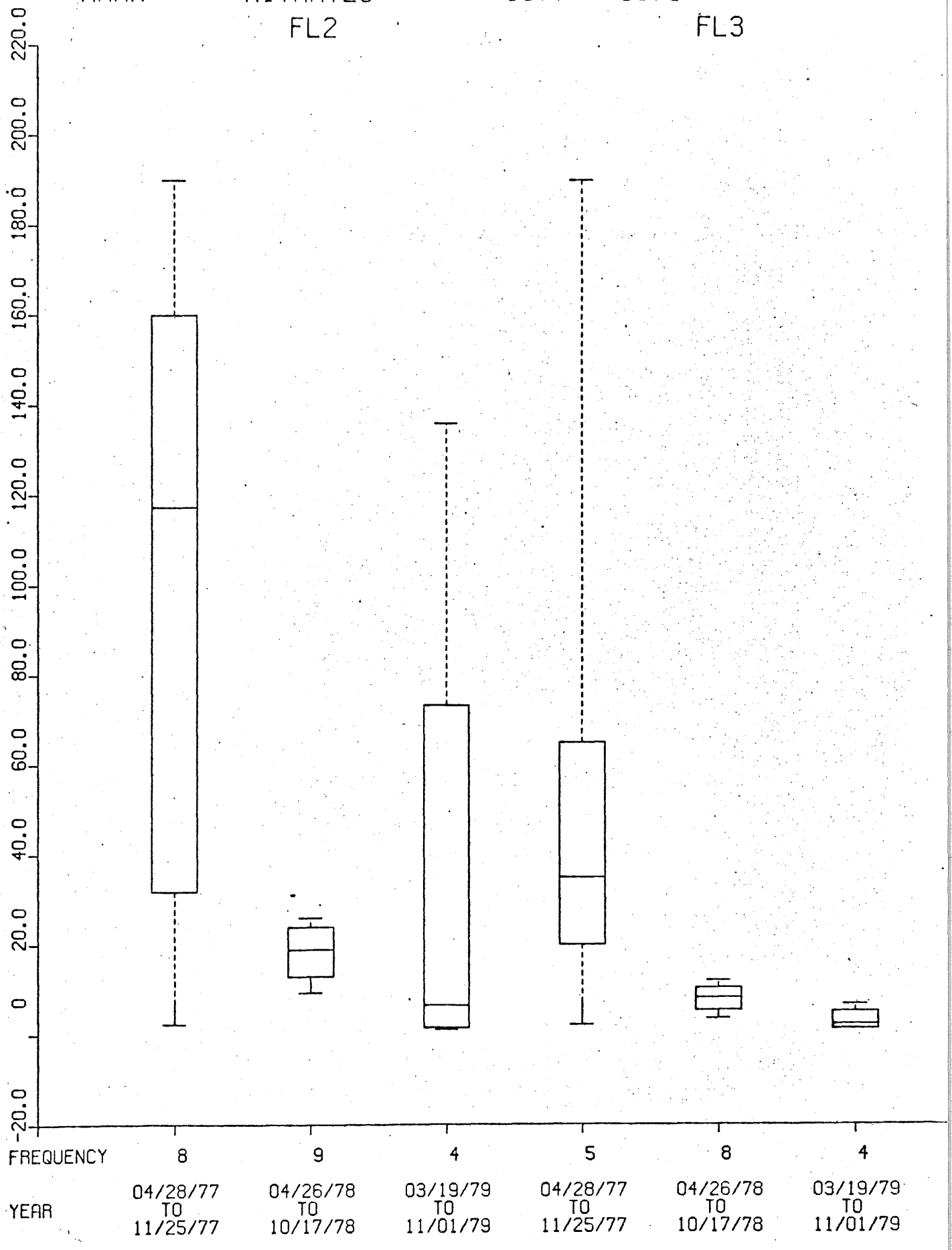

AMAX SULFATE :1977 - 1979
FL5
FL6
8000.
7200.
6400.
5600.
4800.
4000.
3200.
2400.
1600.
800.
0
-800.
-1600.
FREQUENCY 2 15 33 0 12 36
YEAR 04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

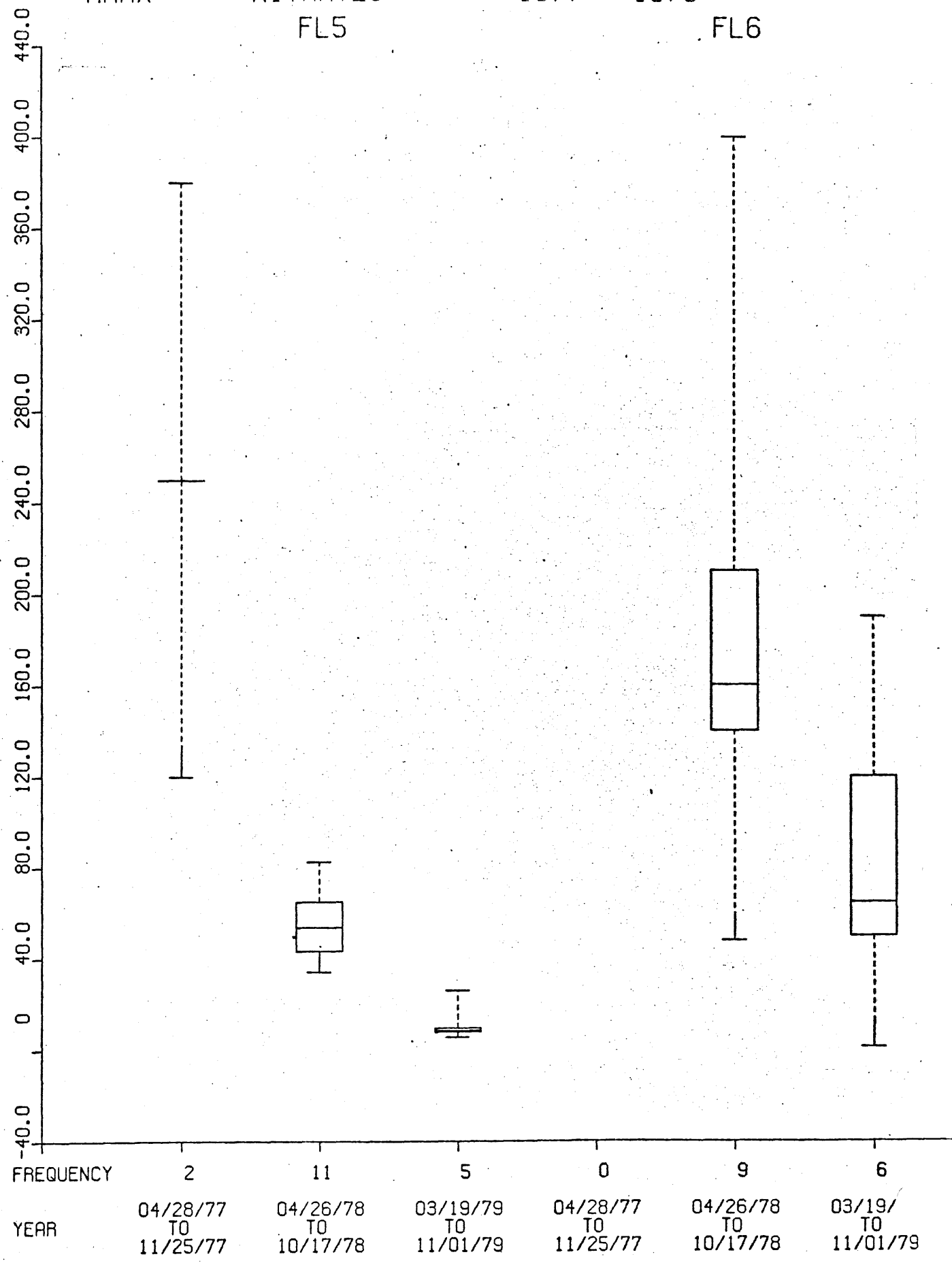

AMAX CHLORINE :1977 - 1979
FL1
FL4
1100.
1000.
900.
800.
700.
600.
500.
400.
300.
200.
100.
0
-100.
FREQUENCY
8
14
33
4
17
20
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

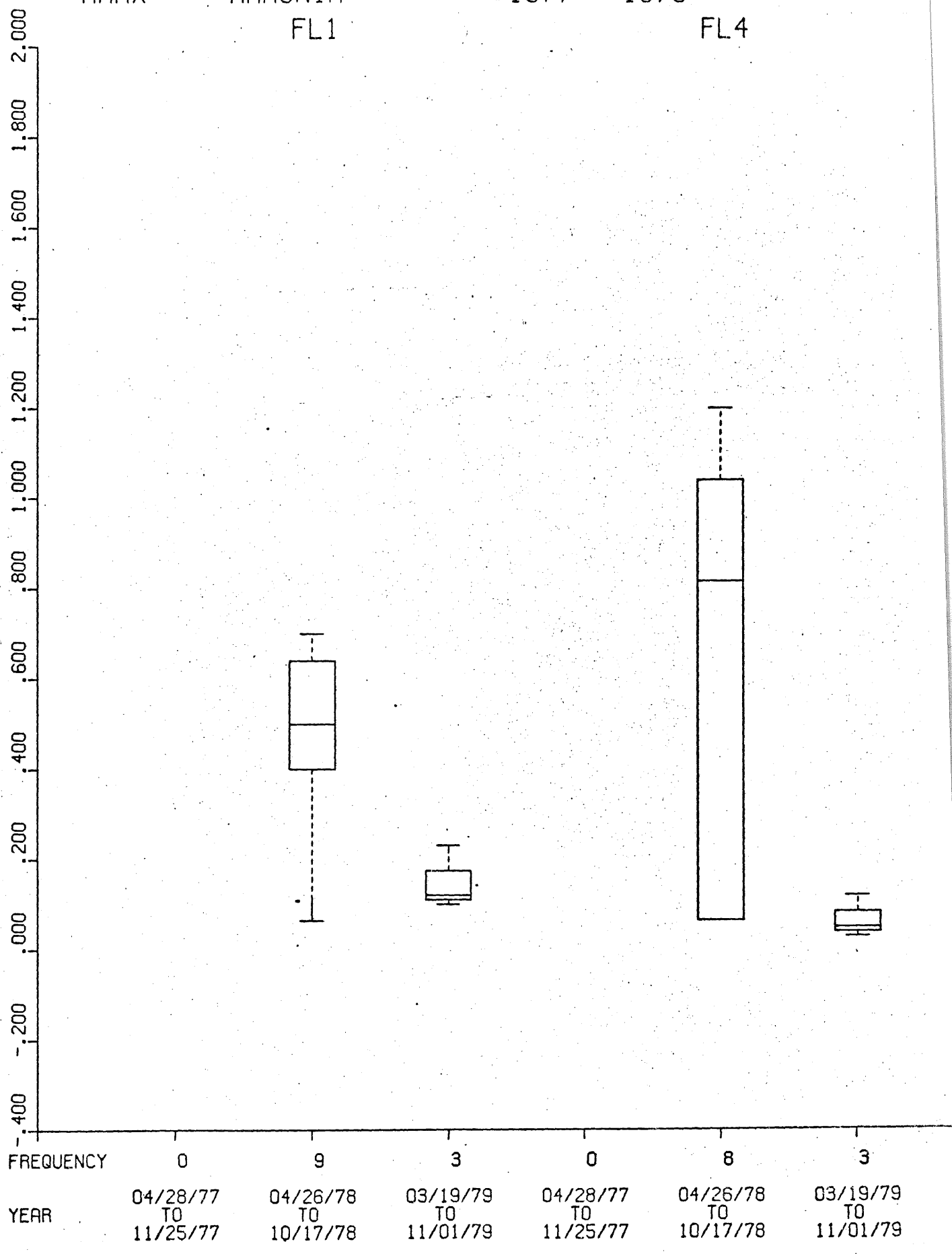

AMAX CHLORINE :1977 - 1979
FL2
FL3
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0
-50.0
FREQUENCY 8 10 23 5 10 29
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

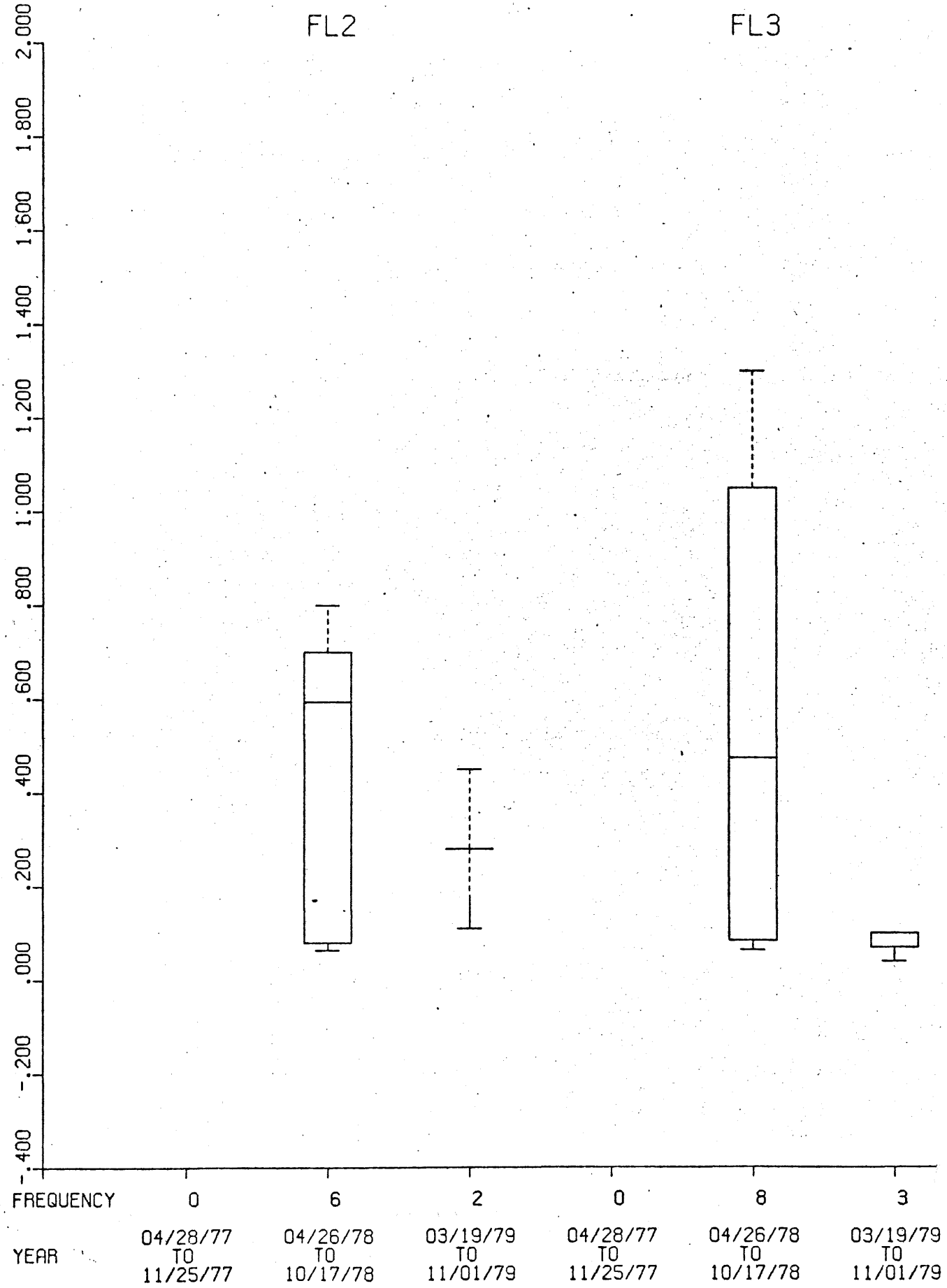

AMAX CHLORINE :1977 - 1979
FL5
FL6
800.0
720.0
640.0
560.0
480.0
400.0
320.0
240.0
160.0
80.0
0
-80.0
-160.0
FREQUENCY 2 15 33 0 12 37
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

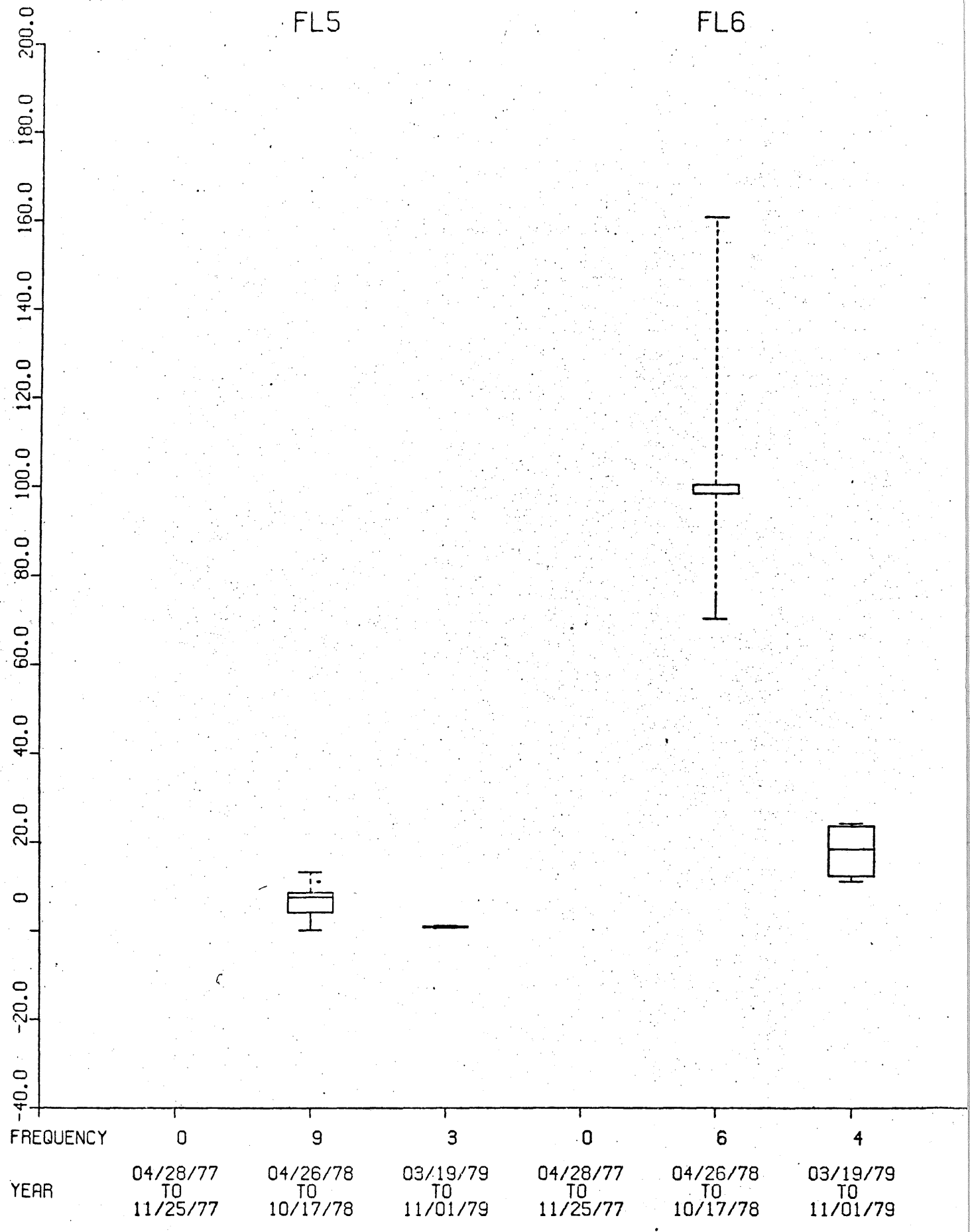

AMAX NITRATES :1977 - 1979
FL1
FL4
400.0
360.0
320.0
280.0
240.0
200.0
160.0
120.0
80.0
40.0
0
-40.0
-80.0
FREQUENCY 8 10 4 4 12 5
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

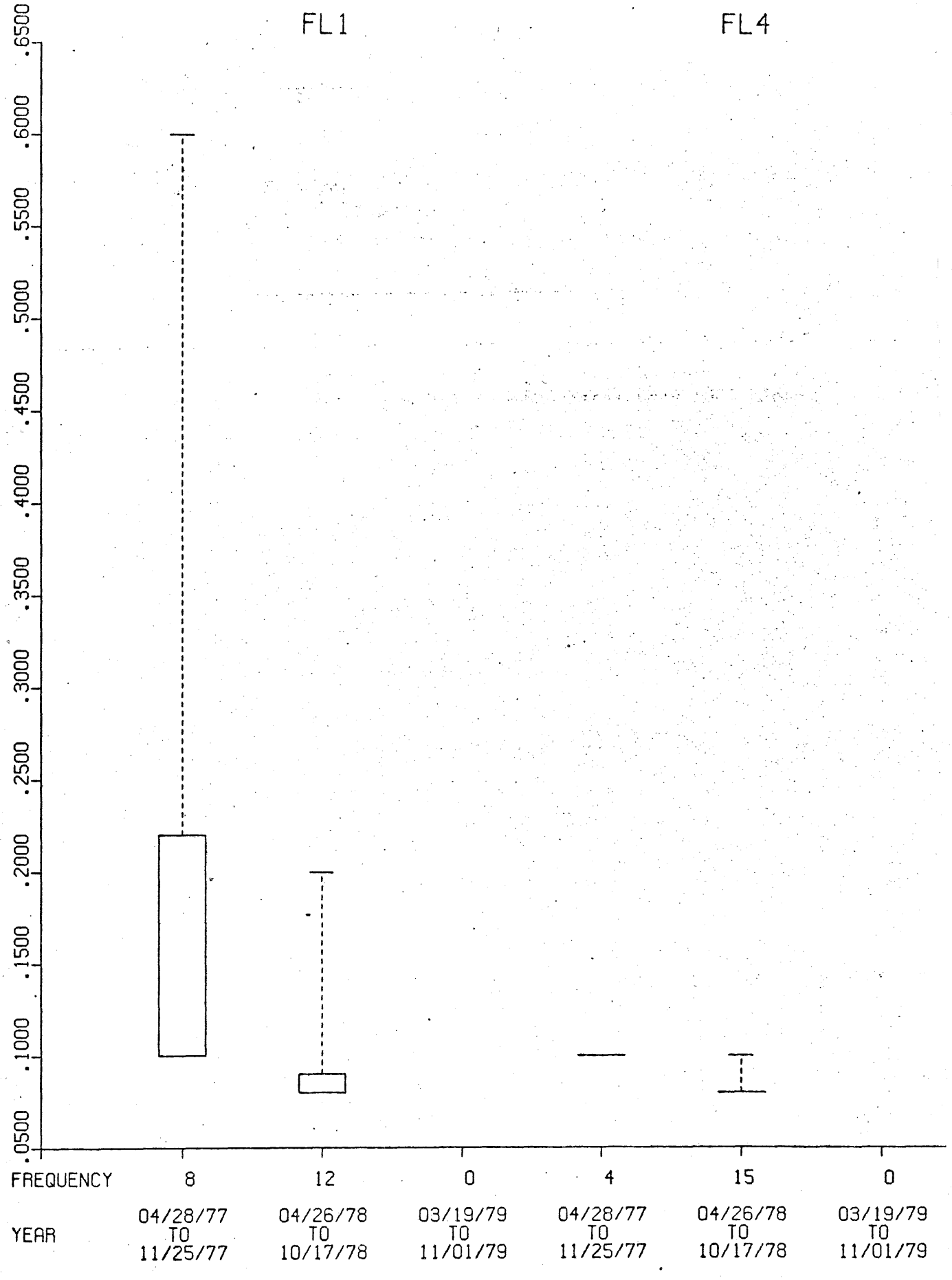

AMAX NITRATES :1977 - 1979
FL2
FL3
220.0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0
-20.0
FREQUENCY
8
9
4
5
8
4
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX NITRATES :1977 - 1979
FL5
FL6
440.0
400.0
360.0
320.0
280.0
240.0
200.0
160.0
120.0
80.0
40.0
0
-40.0
FREQUENCY 2 11 5 0 9 6
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/ TO 11/01/79

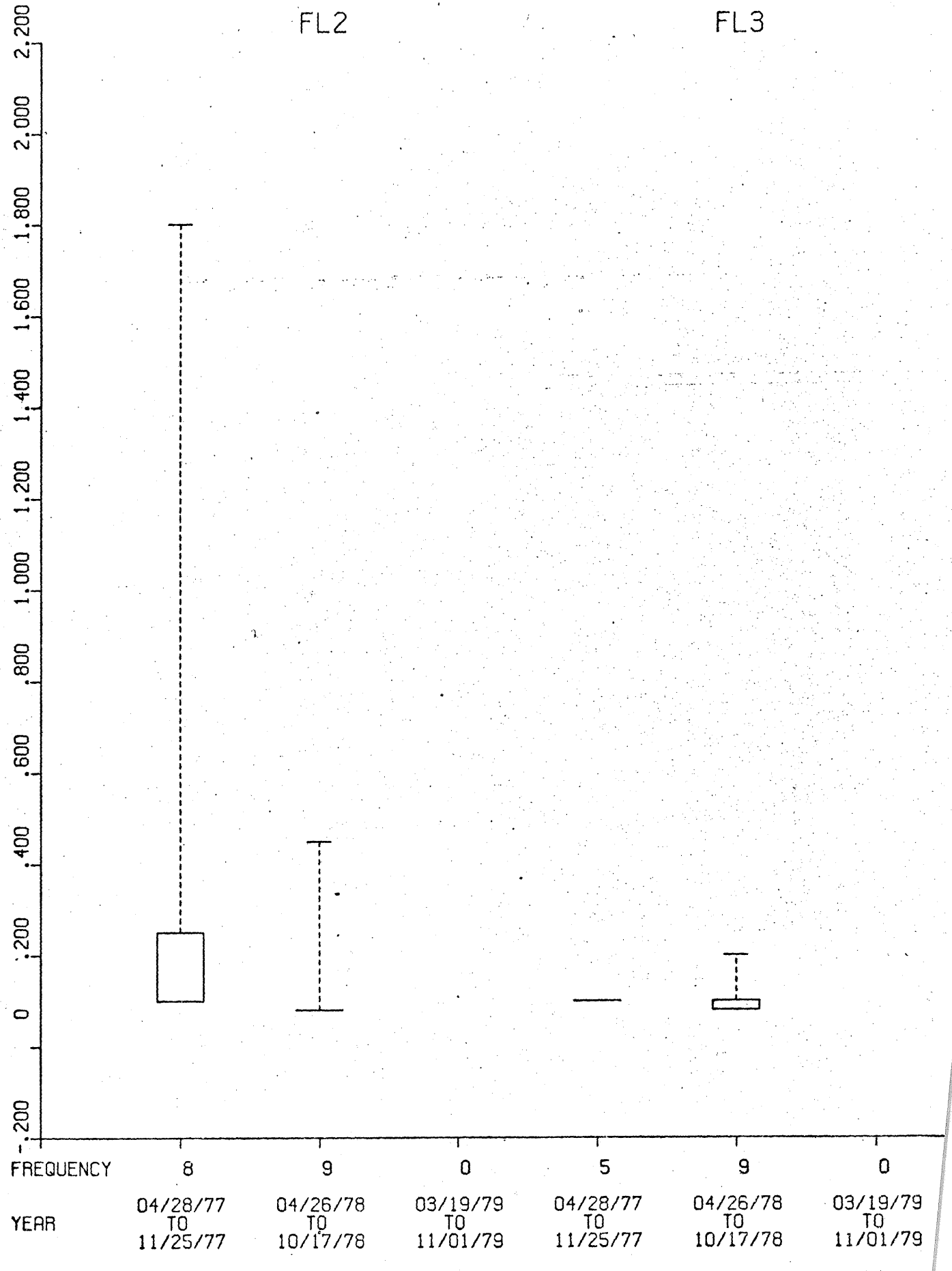

AMAX AMMONIA :1977 - 1979
FL1
FL4
2.000
1.800
1.600
1.400
1.200
1.000
.800
.600
.400
.200
.000
-.200
-.400
FREQUENCY 0 9 3 0 8 3
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

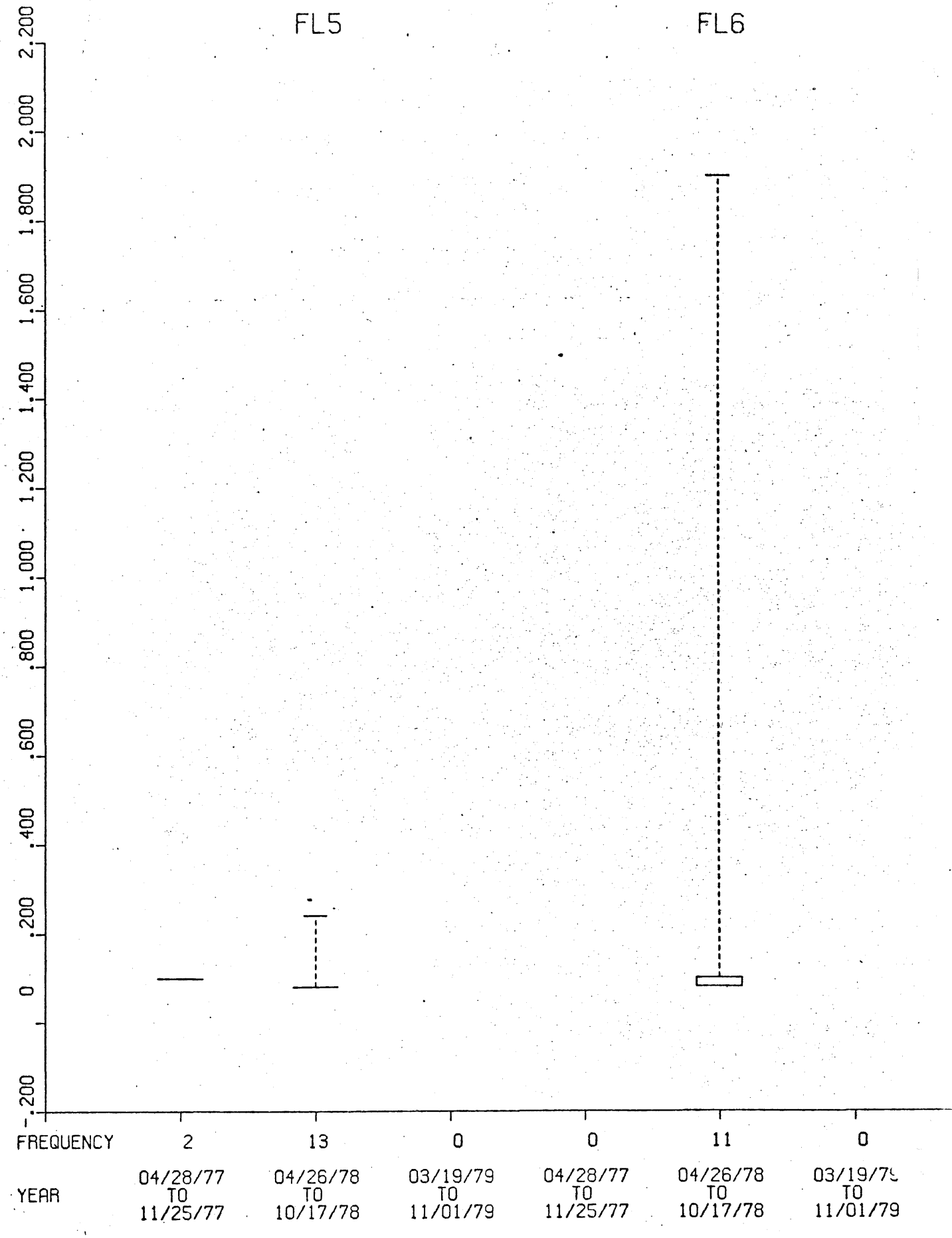

AMAX AMMONIA :1977 - 1979
FL2
FL3
2.000
1.800
1.600
1.400
1.200
1.000
.800
.600
.400
.200
.000
-.200
-.400
FREQUENCY 0 6 2 0 8 3
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

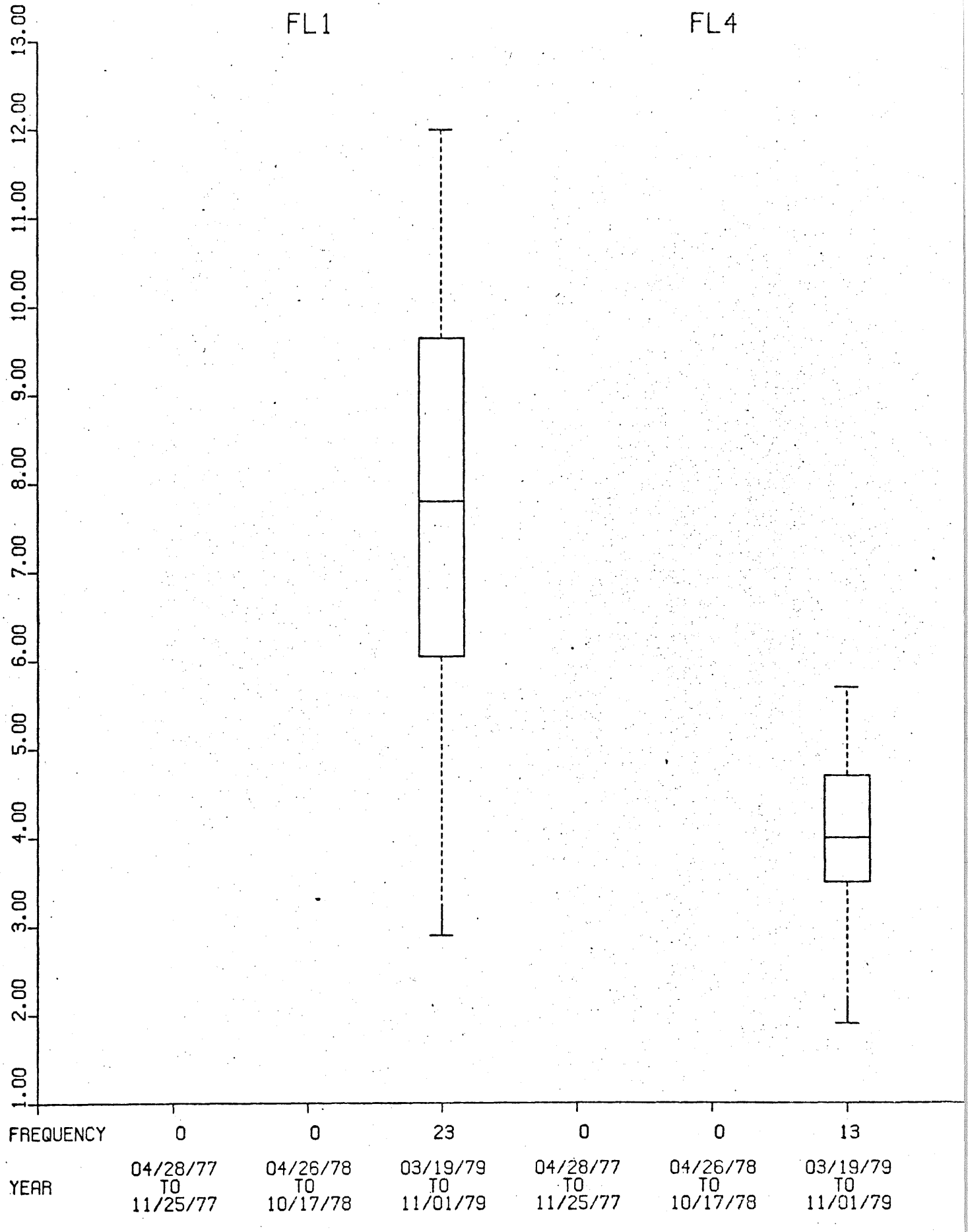

AMAX AMMONIA :1977 - 1979
FL5
FL6
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0
-20.0
-40.0
FREQUENCY 0 9 3 0 6 4
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX PHOSPHORUS :1977 - 1979
FL1
FL4
.6500
.6000
.5500
.5000
.4500
.4000
.3500
.3000
.2500
.2000
.1500
.1000
.0500
FREQUENCY 8 12 0 4 15 0
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

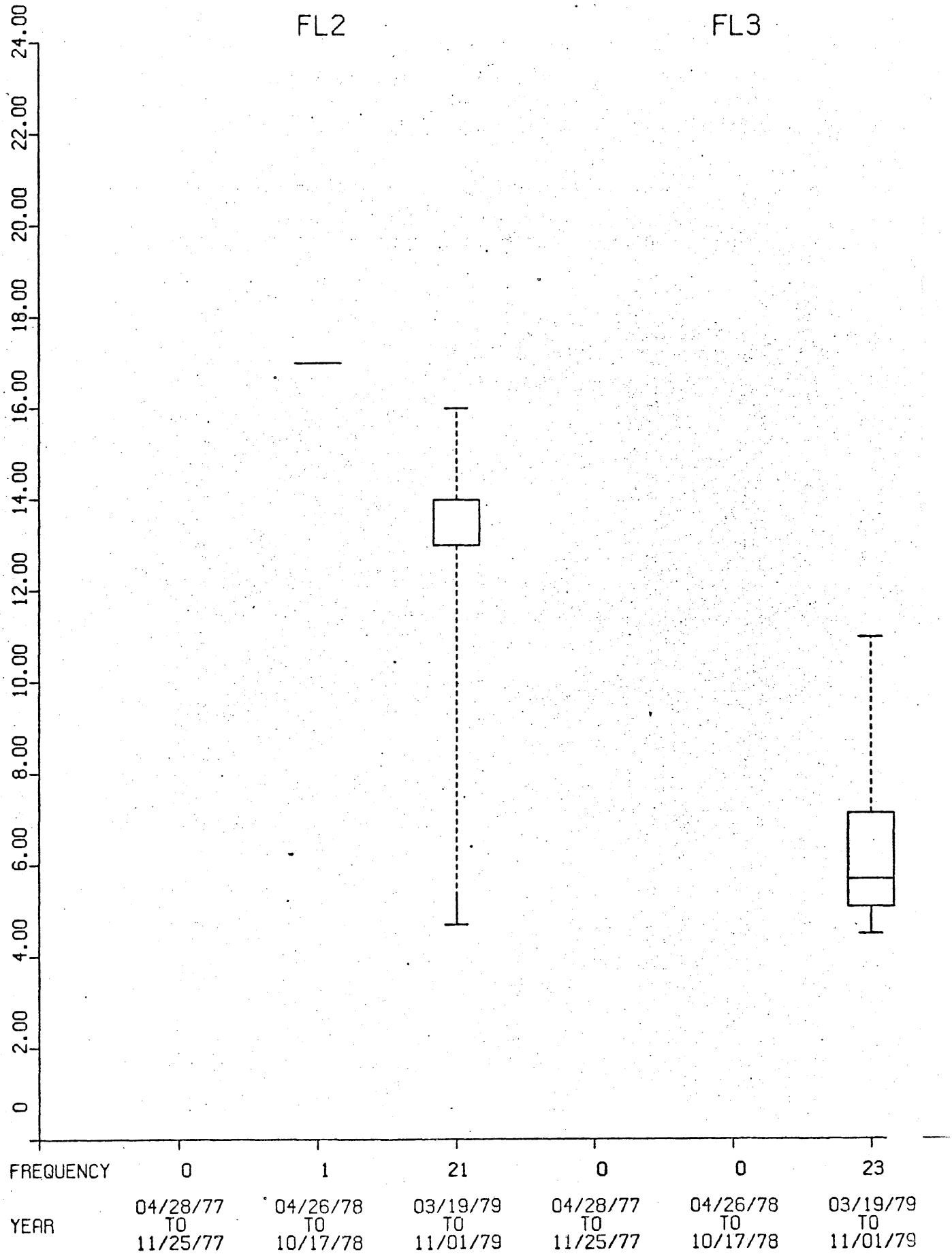
AMAX PHOSPHORUS :1977 - 1979

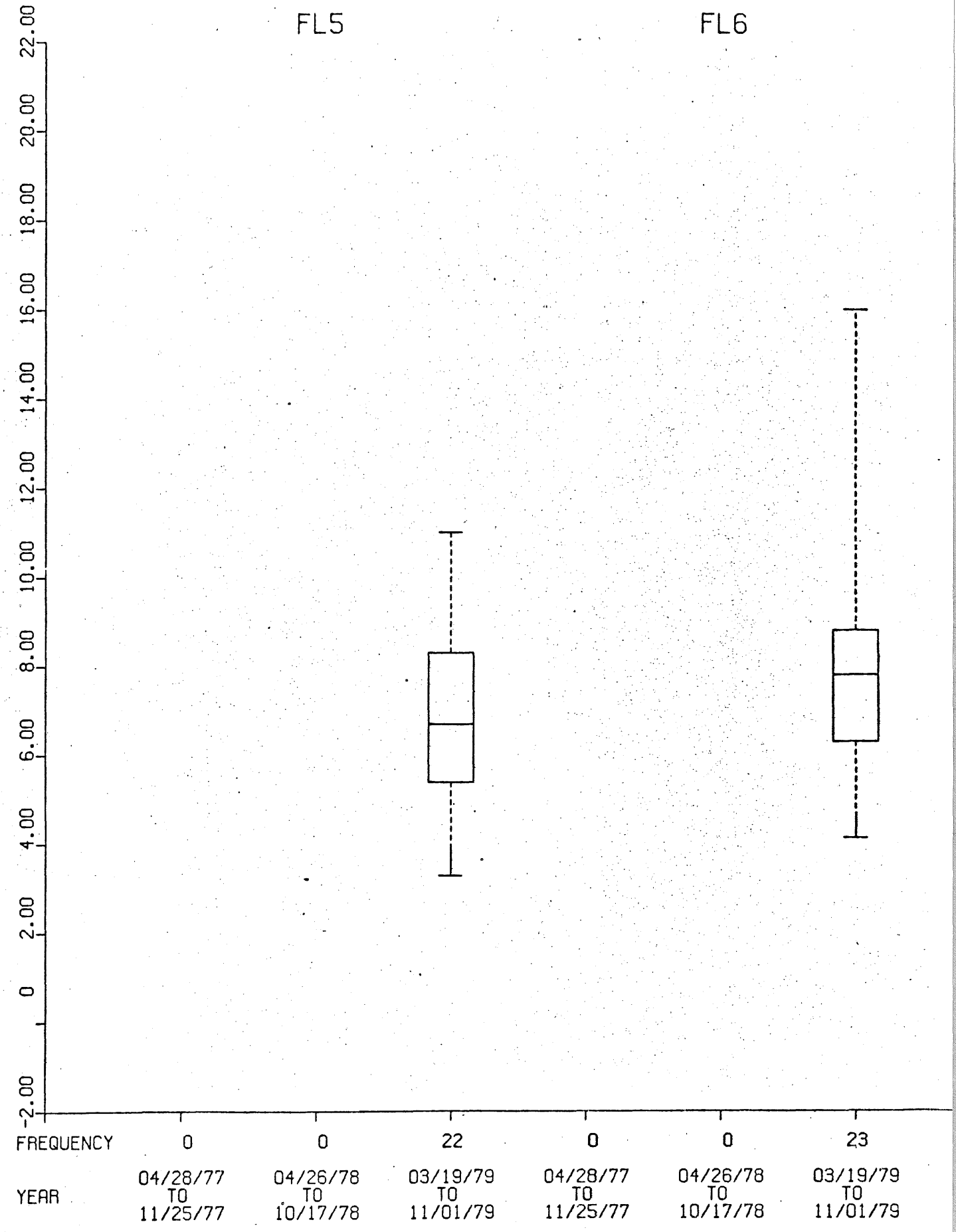



AMAX PHOSPHORUS :1977 - 1979
FL5
FL6
2.200
2.000
1.800
1.600
1.400
1.200
1.000
.800
.600
.400
.200
0
-.200
FREQUENCY 2 13 0 0 11 0
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79


AMAX DISS. ORGANIC CARBON: 1977 - 1979
FL1
FL4
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
FREQUENCY
0
0
23
0
0
13
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

AMAX DISS. ORGANIC CARBON: 1977 - 1979

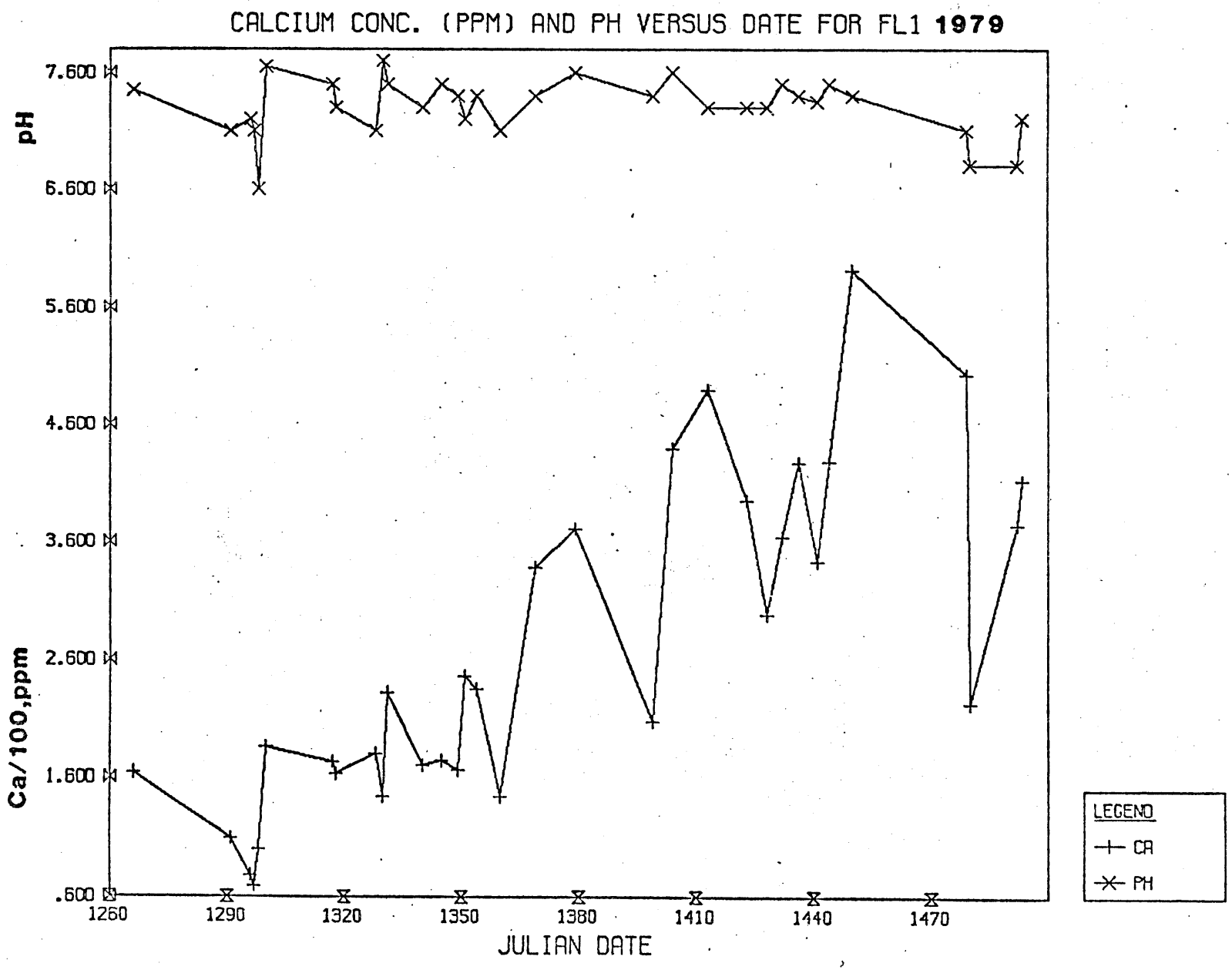


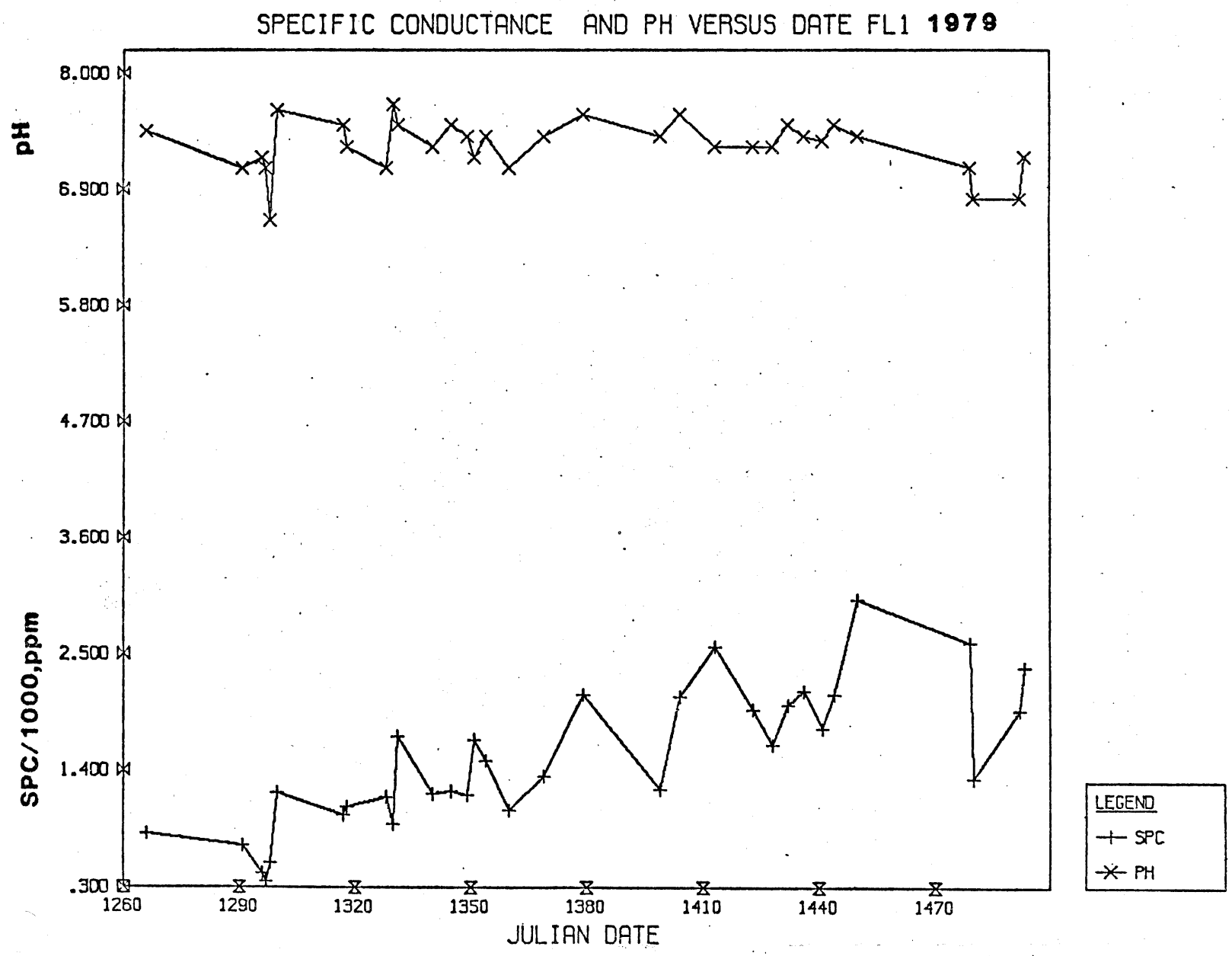

AMAX DISS. ORGANIC CARBON: 1977 - 1979
FL5
FL6
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0
-2.00
FREQUENCY
0
0
22
0
0
23
YEAR
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79
04/28/77 TO 11/25/77
04/26/78 TO 10/17/78
03/19/79 TO 11/01/79

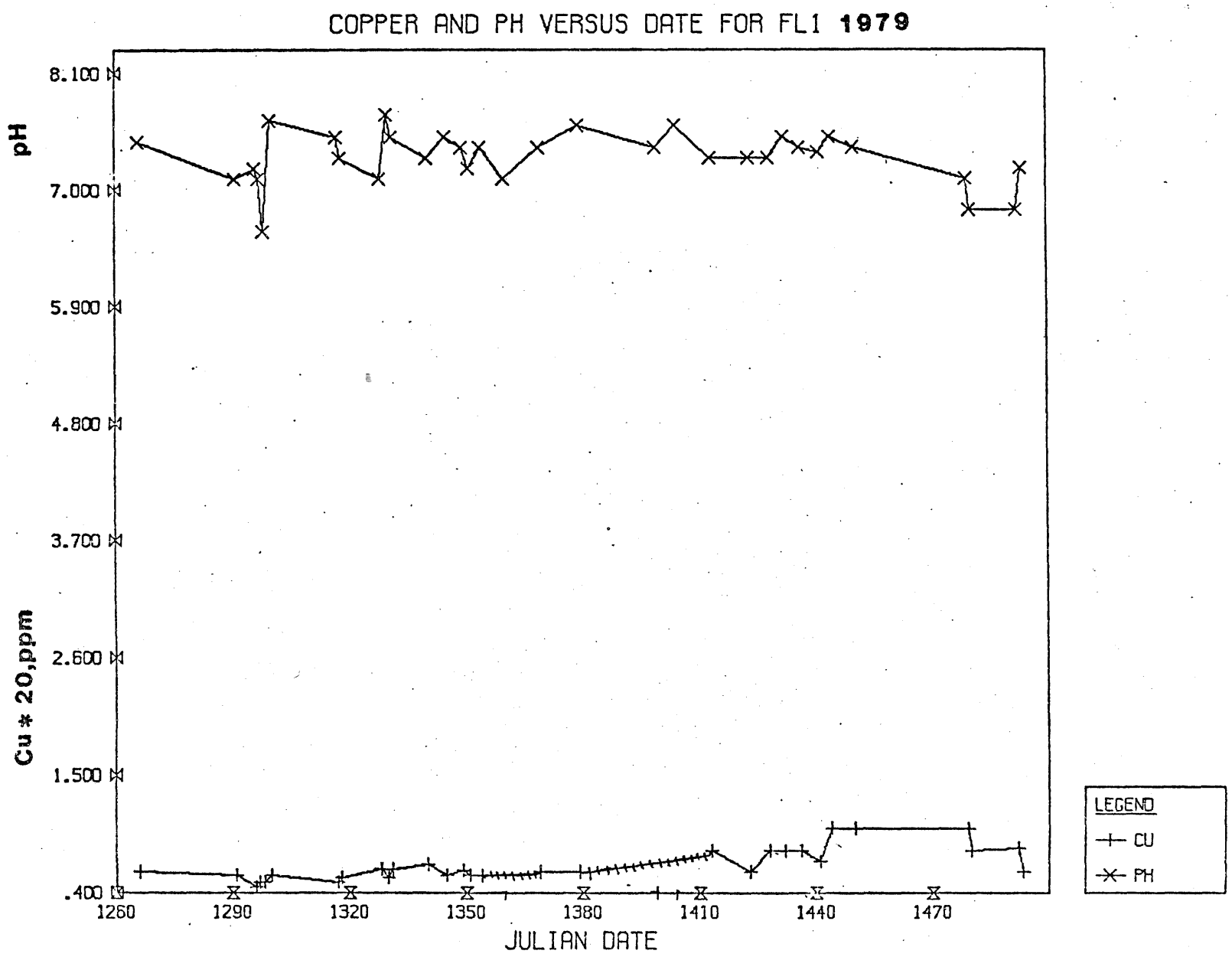
Appendix VI

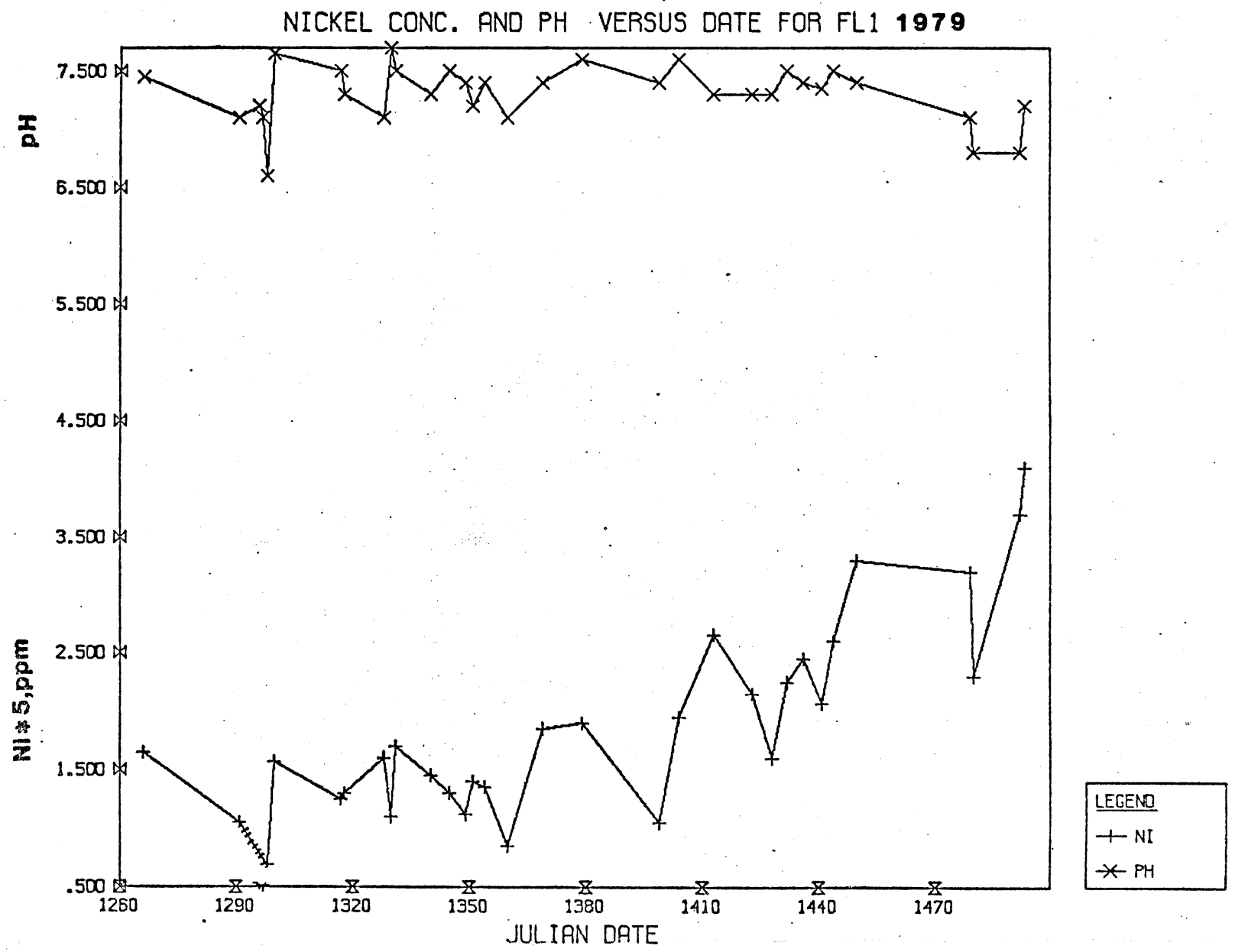
Concentration vs Time

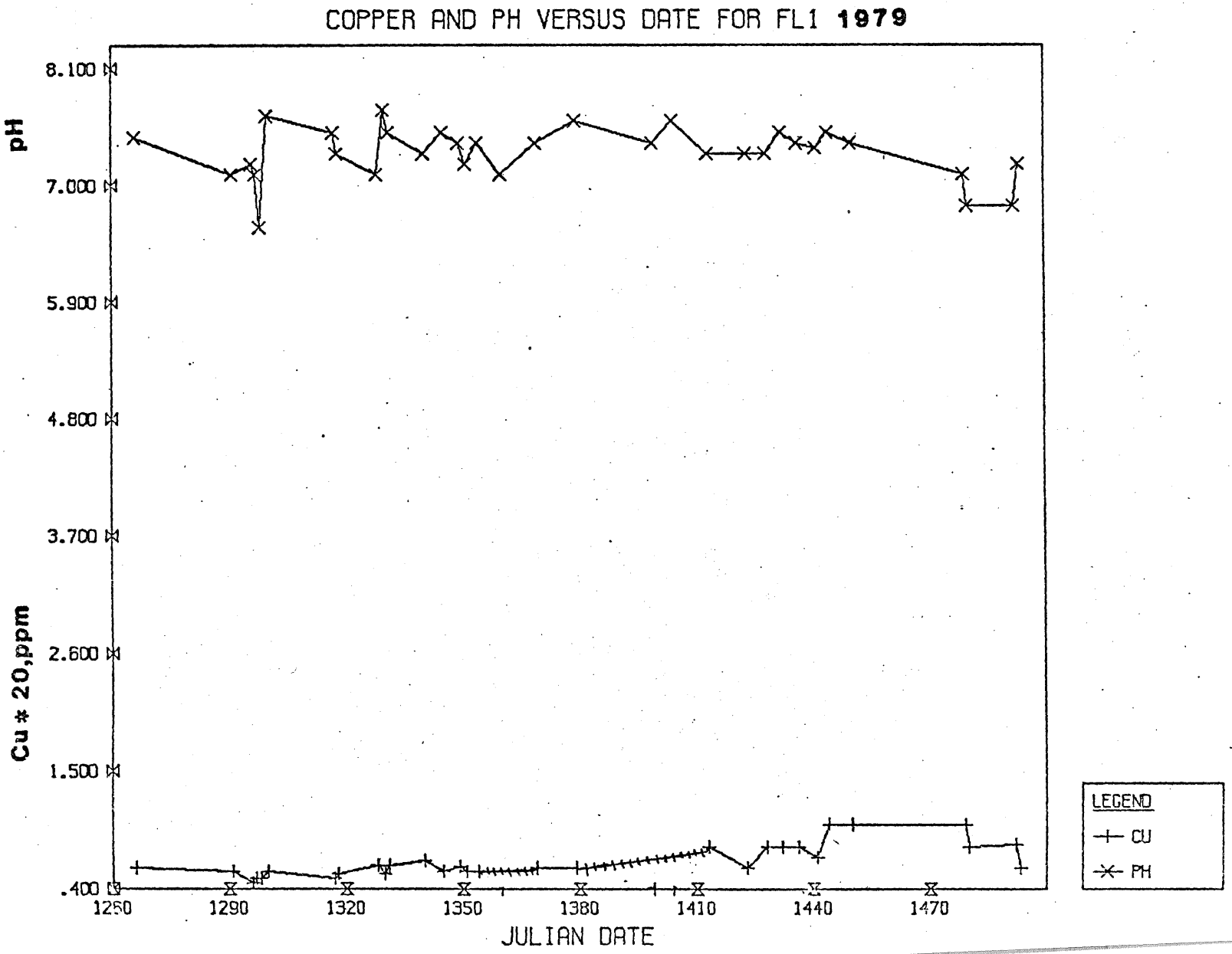
Concentration vs Flow

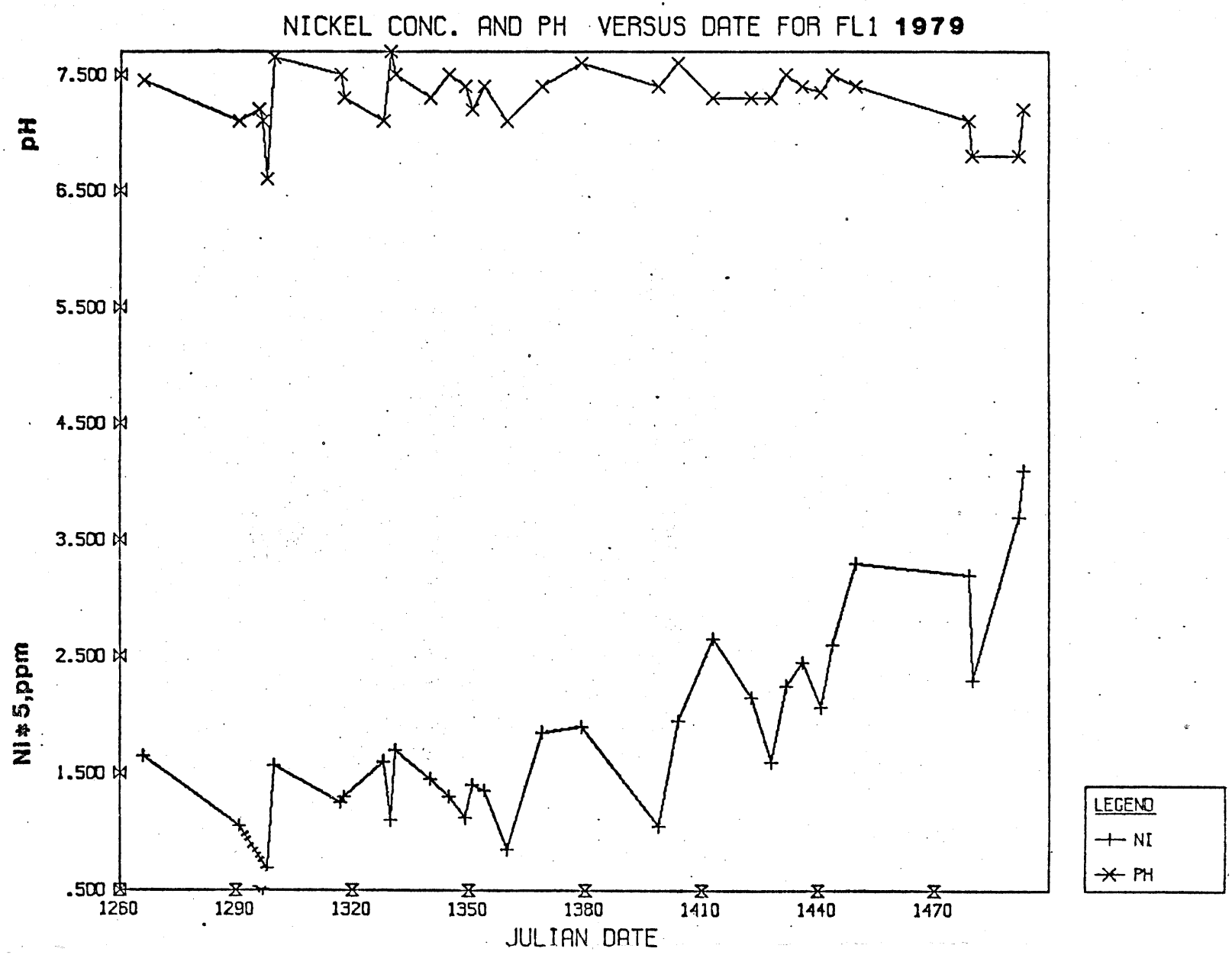

CALCIUM CONC. (PPM) AND PH VERSUS DATE FOR FL1 1979
pH
Ca/100,ppm
7.600
6.600
5.600
4.600
3.600
2.600
1.600
.600
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CA
PH

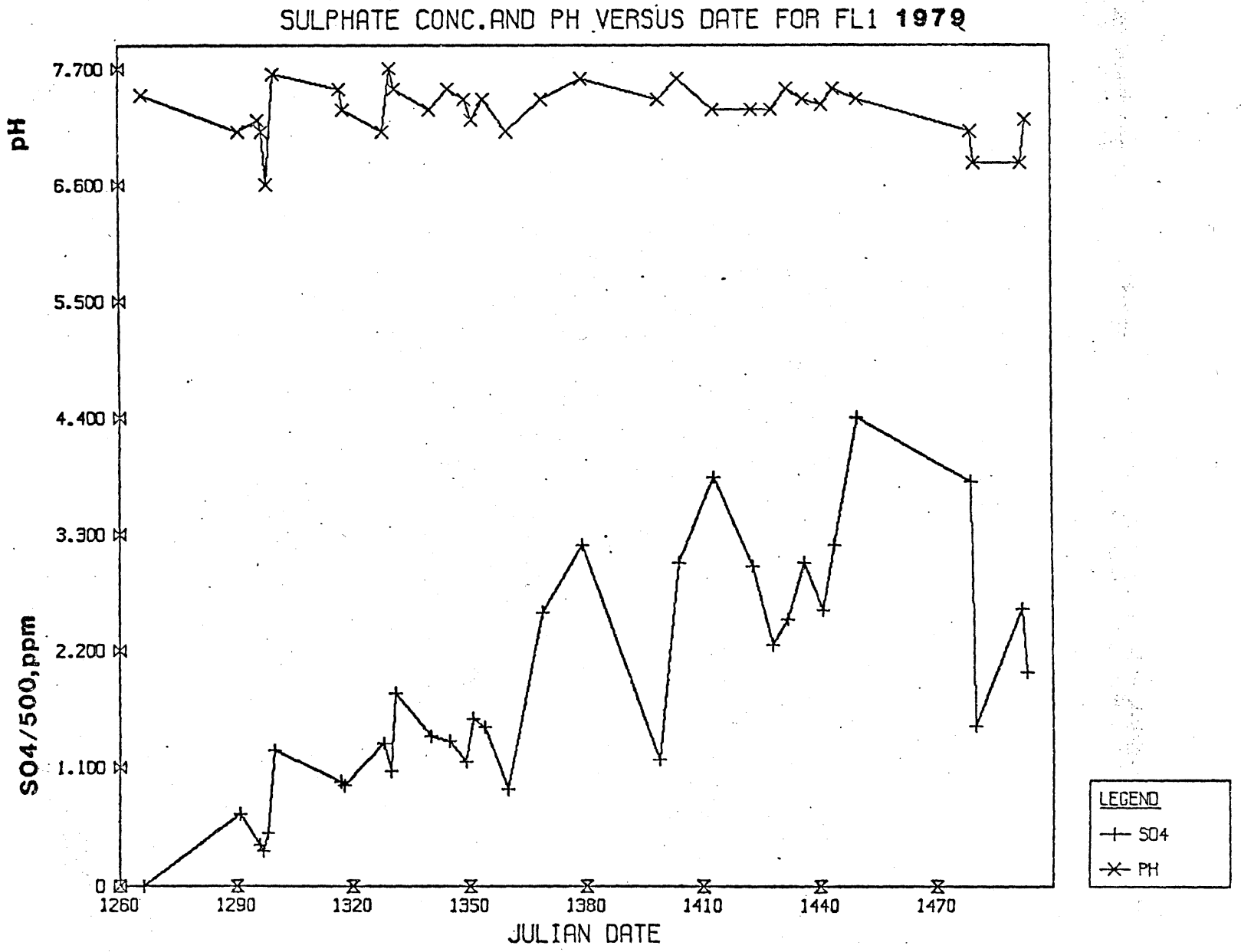

SPECIFIC CONDUCTANCE AND PH VERSUS DATE FL1 1979
pH
8.000
6.900
5.800
4.700
3.600
2.500
1.400
.300
SPC/1000,ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
SPC
PH

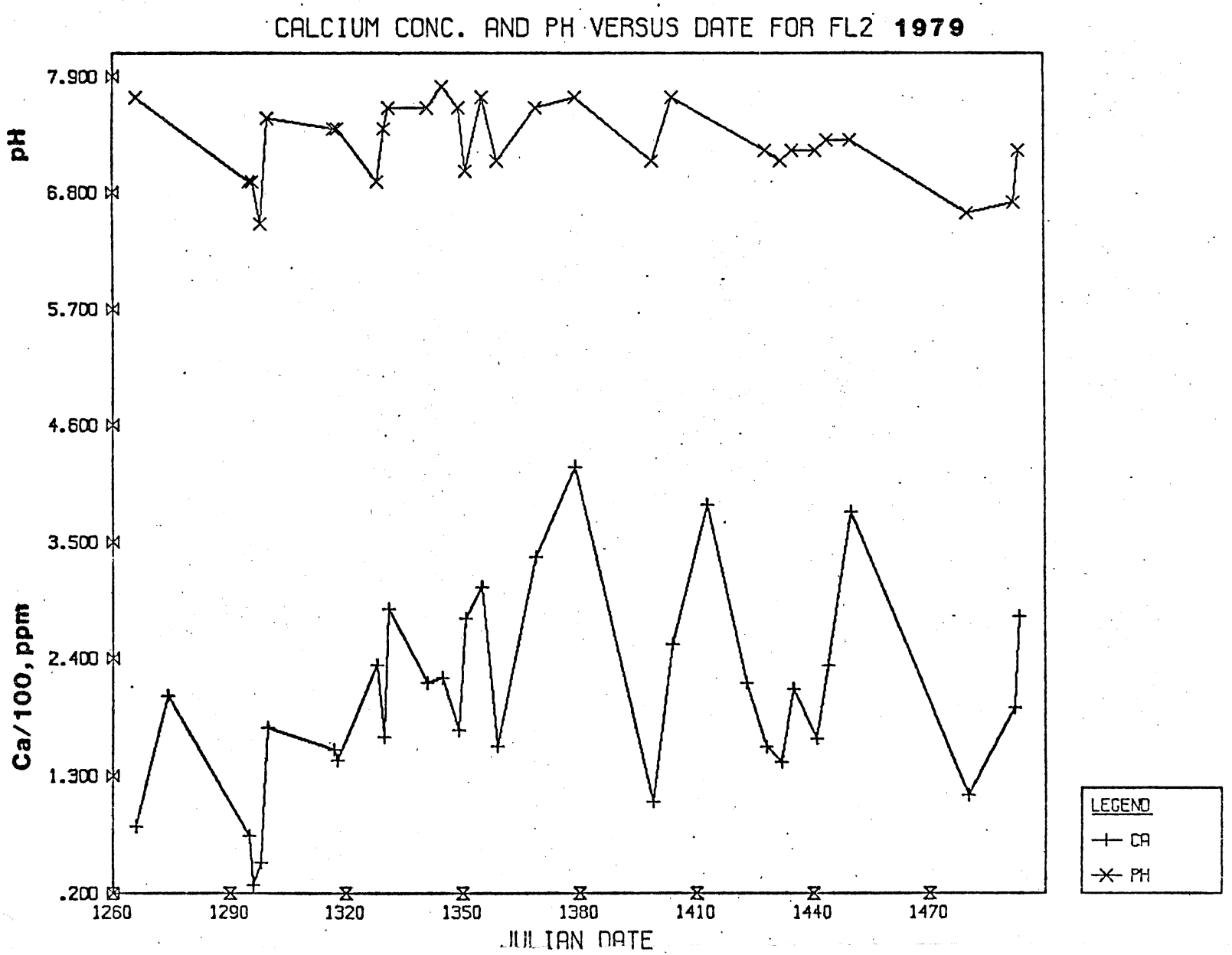

COPPER AND PH VERSUS DATE FOR FL1 1979
8.100
7.000
5.900
4.800
3.700
2.600
1.500
.400
pH
Cu * 20,ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CU
PH

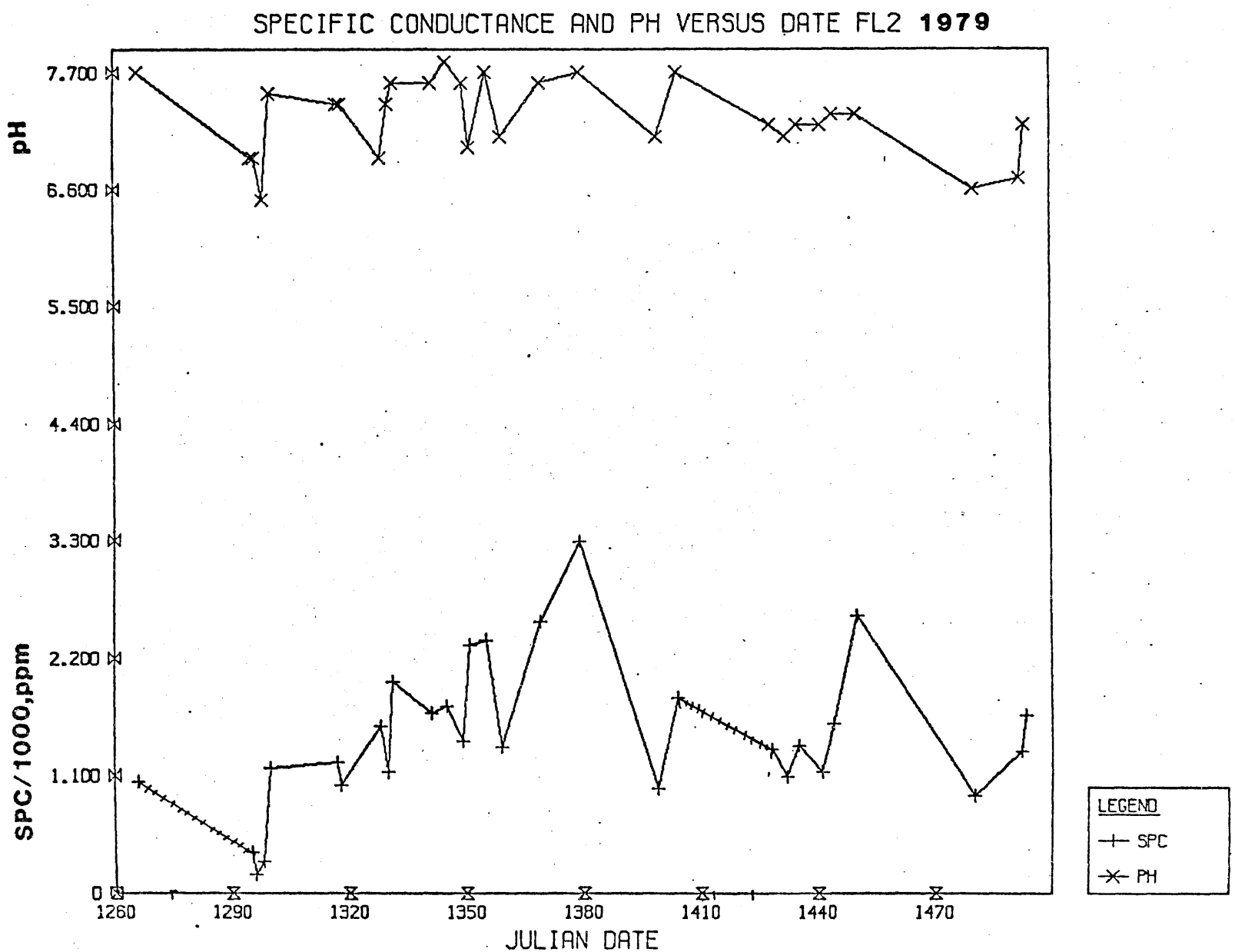

NICKEL CONC. AND PH VERSUS DATE FOR FL1 1979
pH
Ni*5,ppm
7.500
6.500
5.500
4.500
3.500
2.500
1.500
.500
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
NI
PH

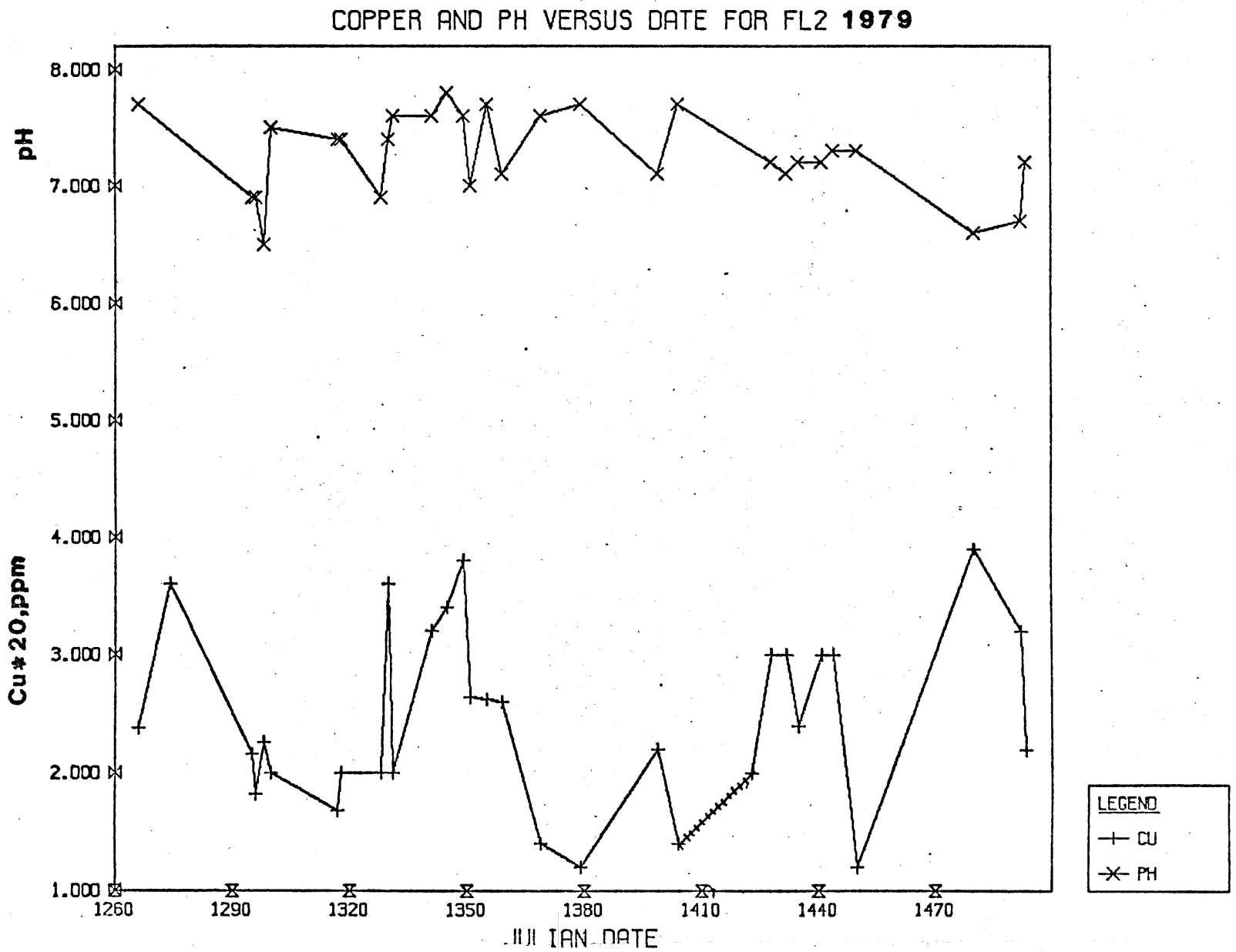

COPPER AND PH VERSUS DATE FOR FL1 1979
pH
8.100
7.000
5.900
4.800
3.700
2.600
1.500
.400
Cu * 20,ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CU
PH

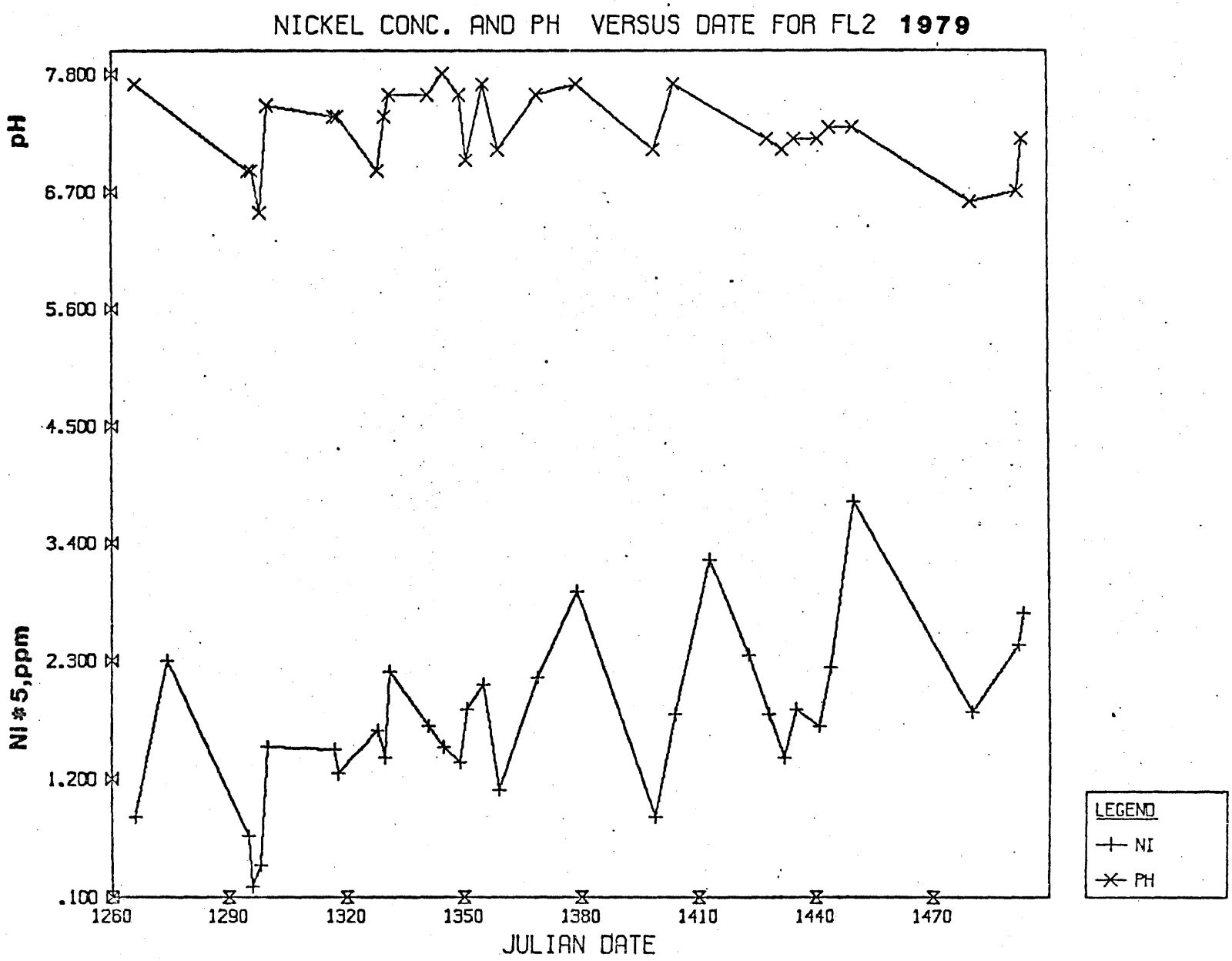

NICKEL CONC. AND PH VERSUS DATE FOR FL1 1979
pH
Ni*5,ppm
7.500
6.500
5.500
4.500
3.500
2.500
1.500
.500
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
NI
PH

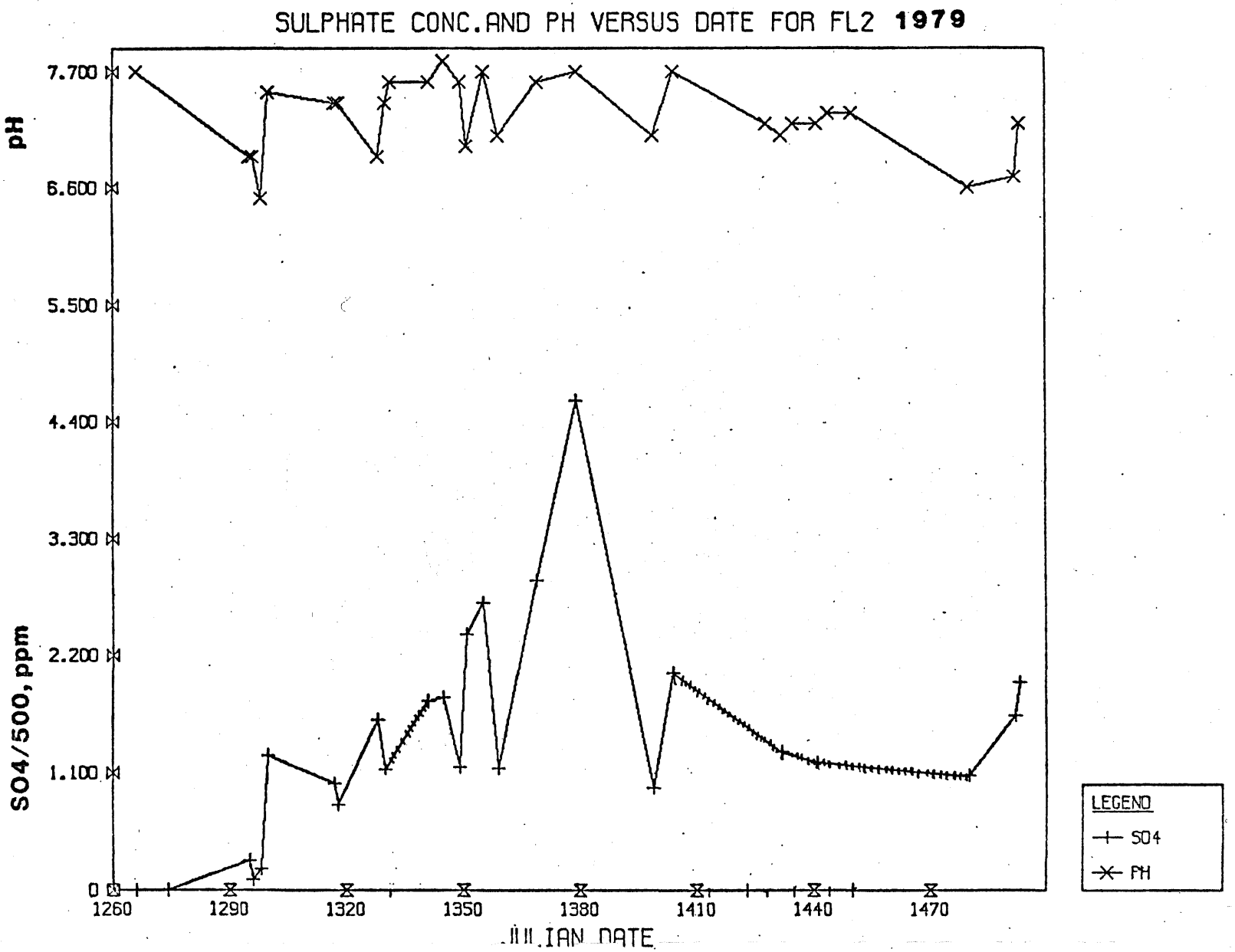

SULPHATE CONC.AND PH VERSUS DATE FOR FL1 1979
pH
7.700
6.600
5.500
4.400
3.300
2.200
1.100
0
SO4/500,ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
SO4
PH

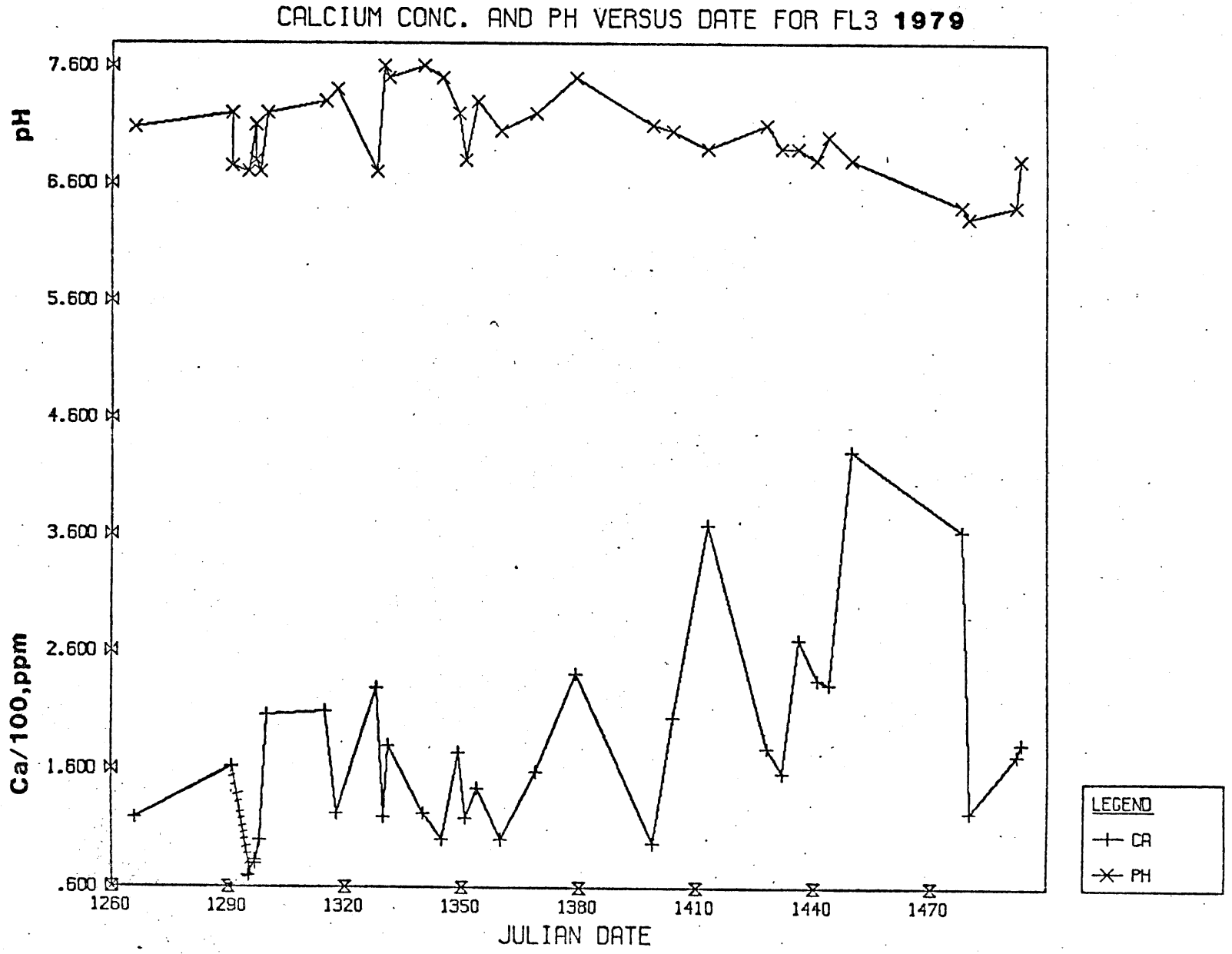

CALCIUM CONC. AND PH VERSUS DATE FOR FL2 1979
pH
7.900
6.800
5.700
4.600
3.500
2.400
1.300
.200
Ca/100, ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CA
PH

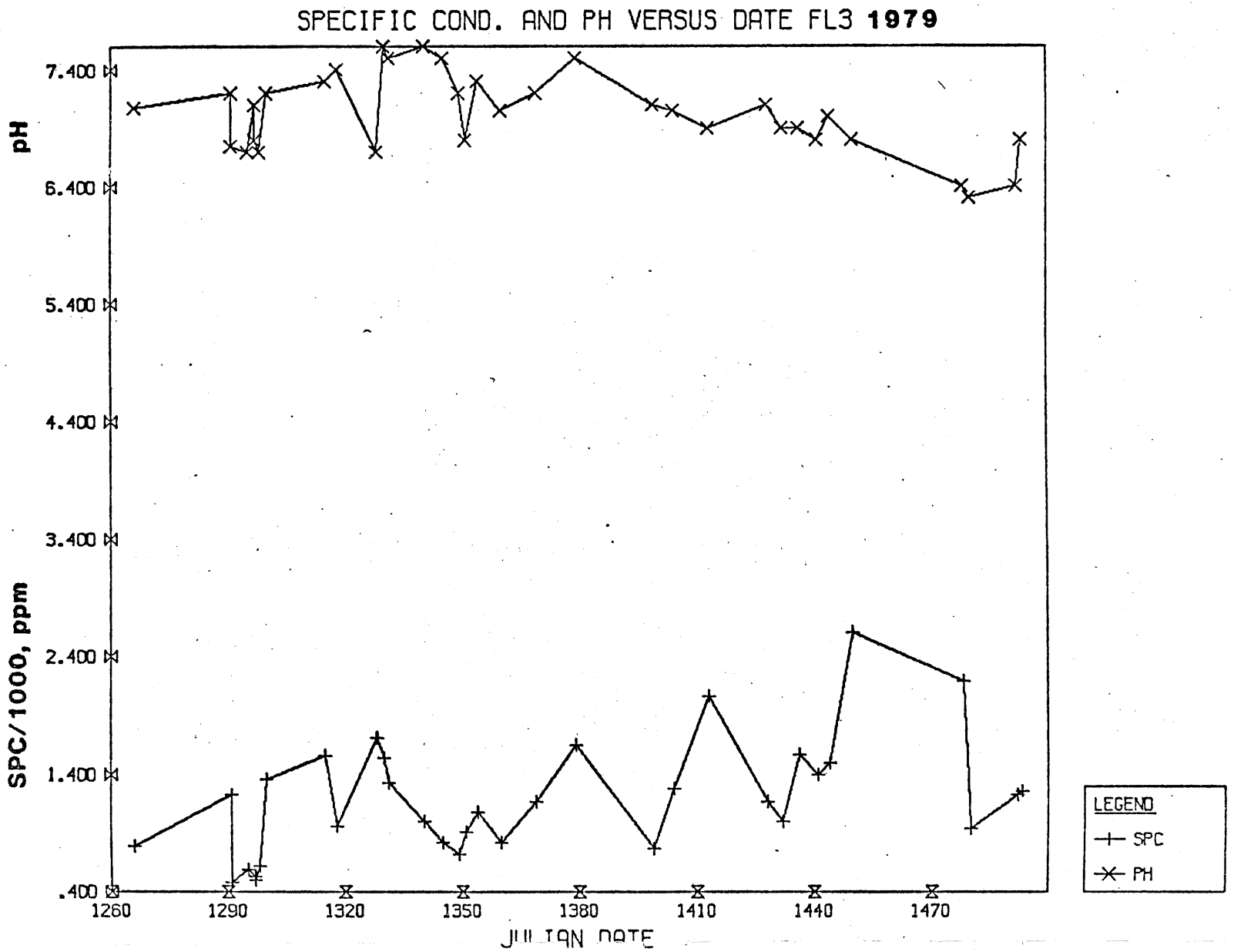

SPECIFIC CONDUCTANCE AND PH VERSUS DATE FL2 1979
pH
7.700
6.600
5.500
4.400
3.300
2.200
1.100
0
SPC/1000,ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
SPC
PH

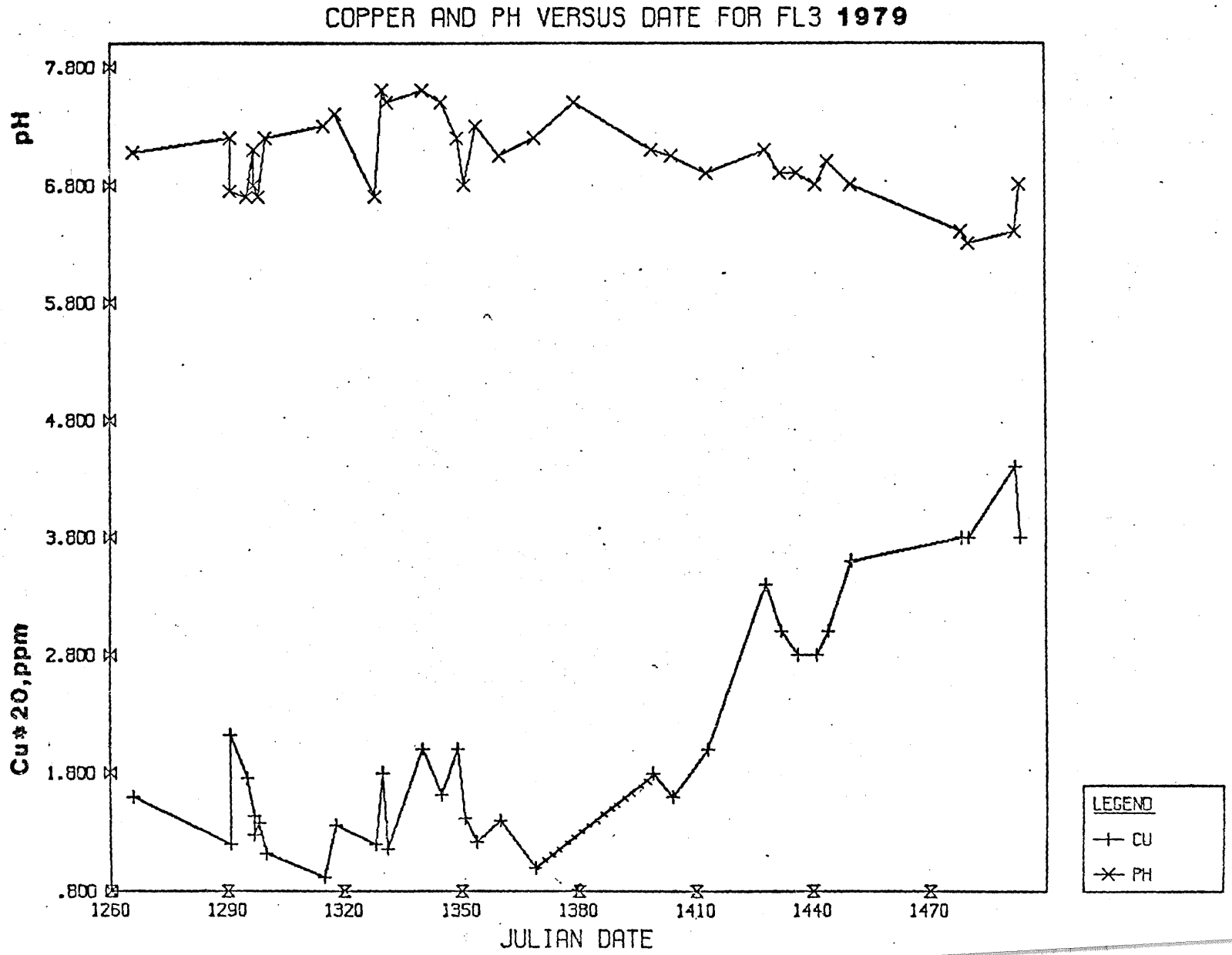

COPPER AND PH VERSUS DATE FOR FL2 1979
pH
Cu*20,ppm
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CU
PH

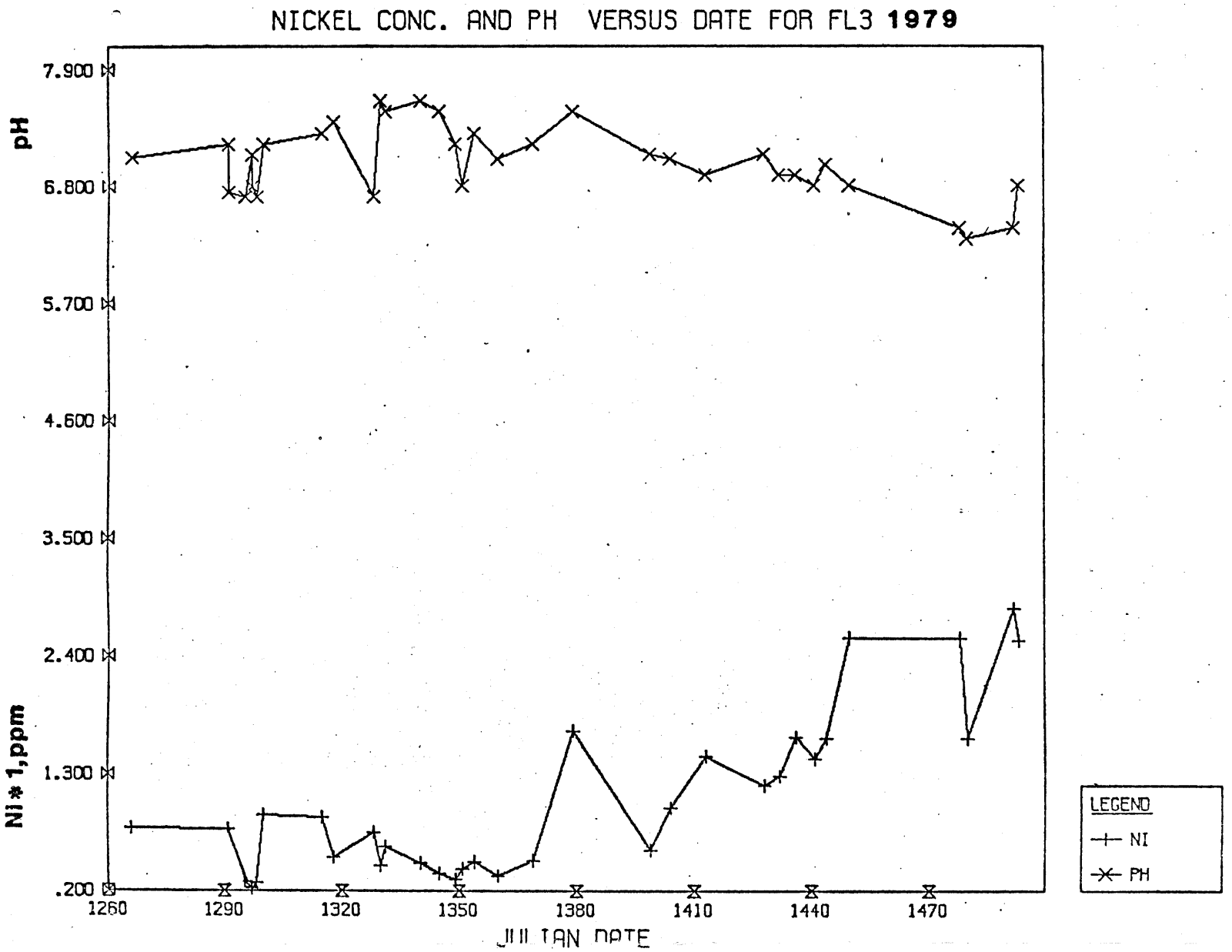

NICKEL CONC. AND PH VERSUS DATE FOR FL2 1979
pH
Ni*5,ppm
7.800
6.700
5.600
4.500
3.400
2.300
1.200
.100
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
NI
PH

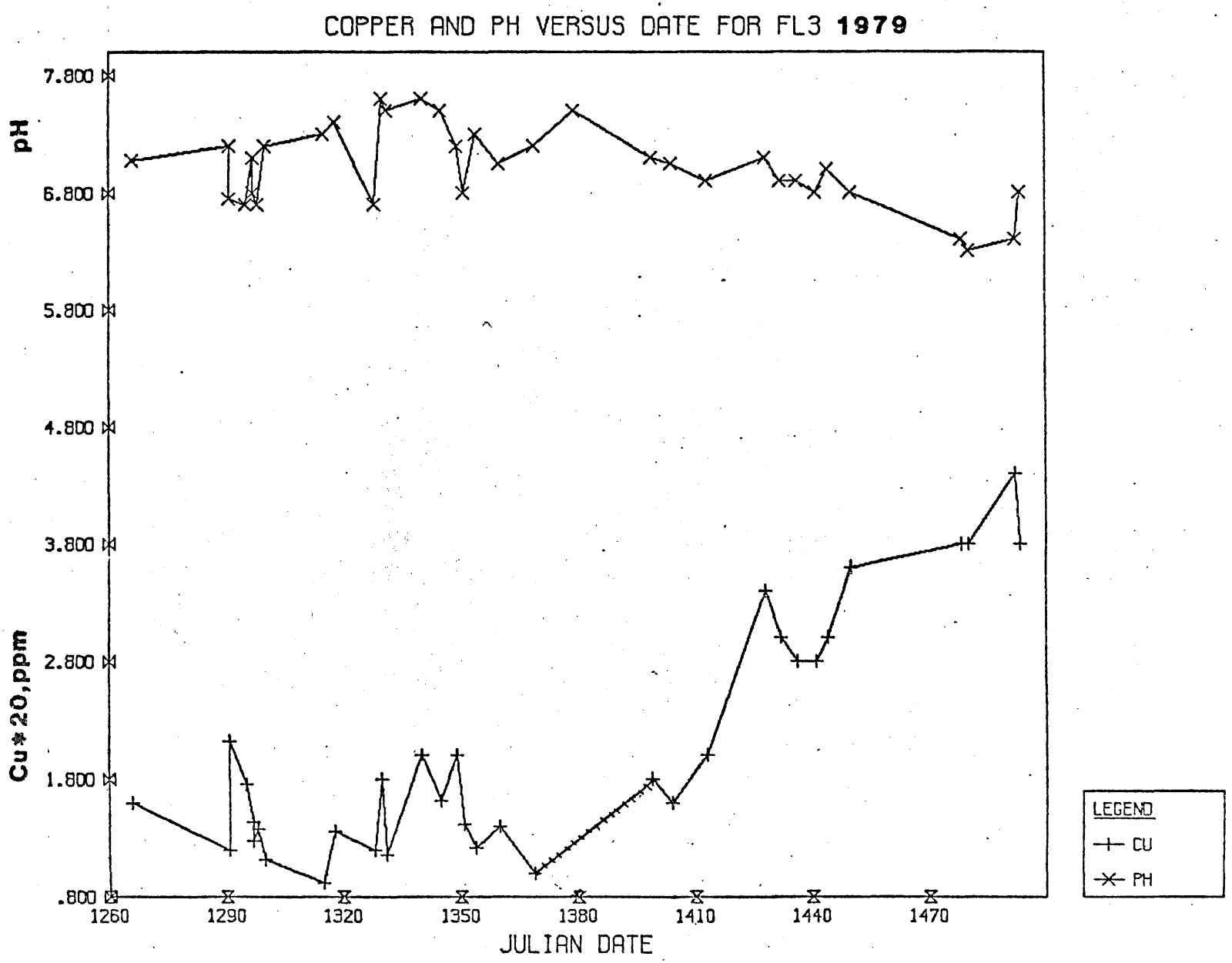

SULPHATE CONC.AND PH VERSUS DATE FOR FL2 1979
pH
7.700
6.600
5.500
4.400
3.300
2.200
1.100
0
SO4/500, ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
SO4
PH

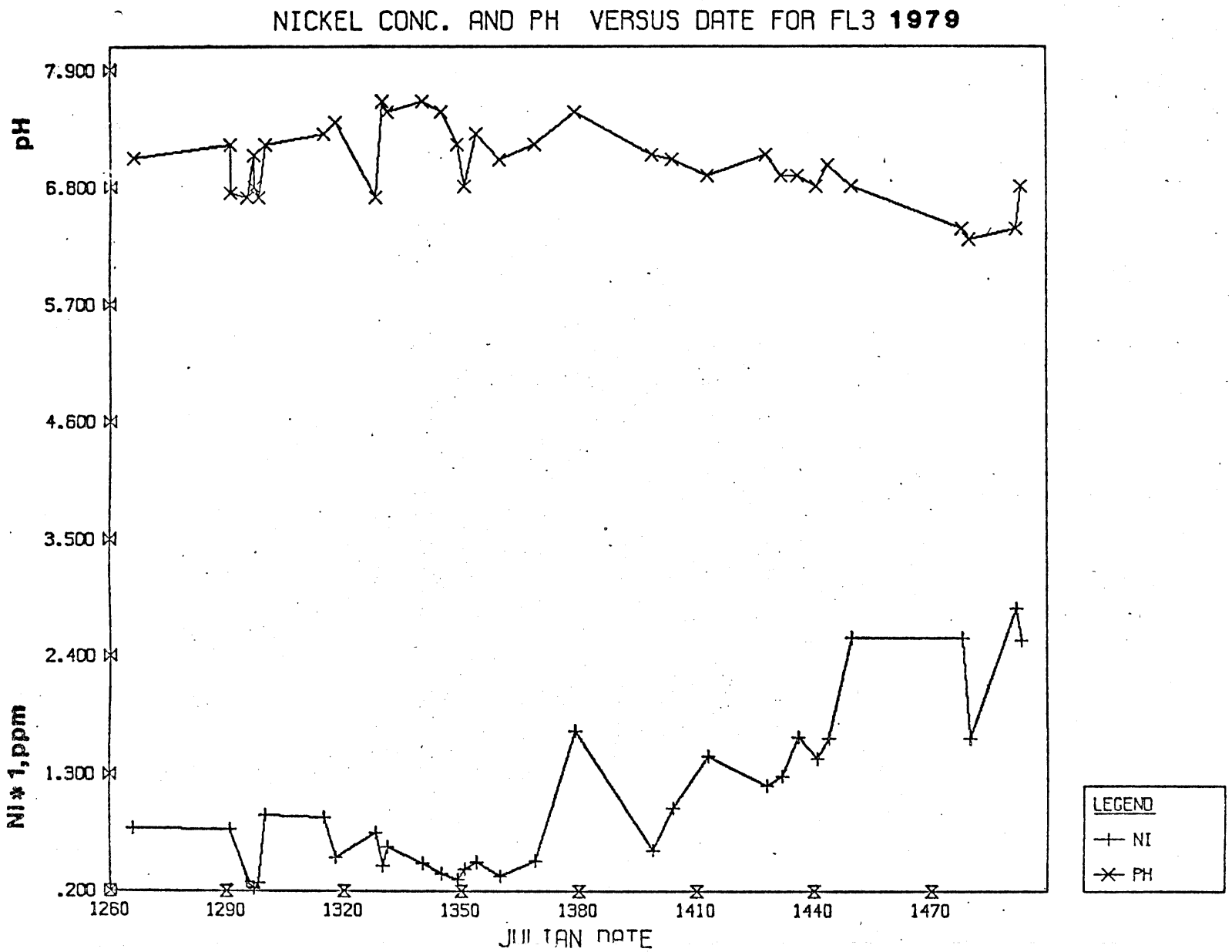

CALCIUM CONC. AND PH VERSUS DATE FOR FL3 1979
pH
Ca/100,ppm
7.600
6.600
5.600
4.600
3.600
2.600
1.600
.600
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CA
PH

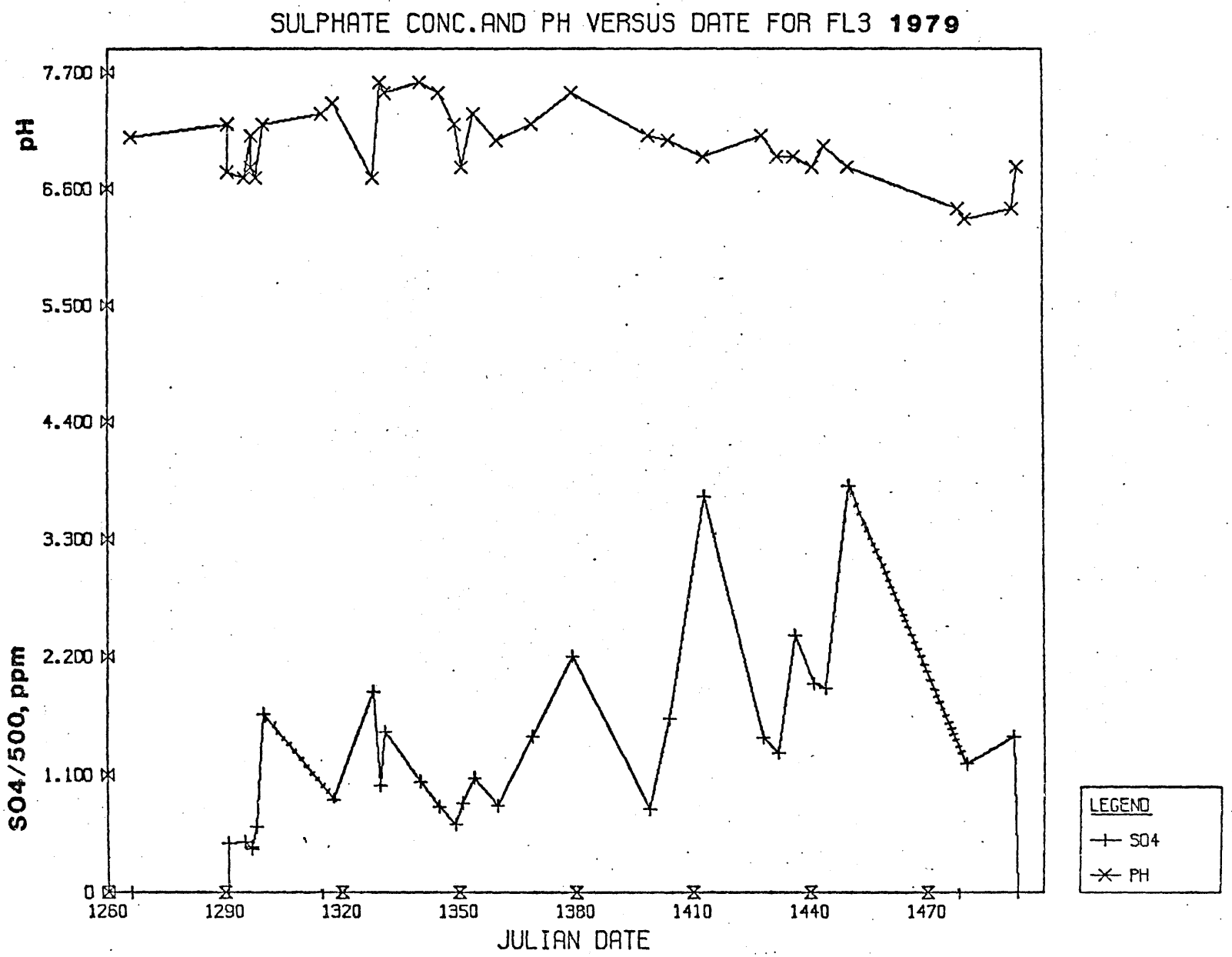

SPECIFIC COND. AND PH VERSUS DATE FL3 1979
pH
SPC/1000, ppm
7.400
6.400
5.400
4.400
3.400
2.400
1.400
.400
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
SPC
PH

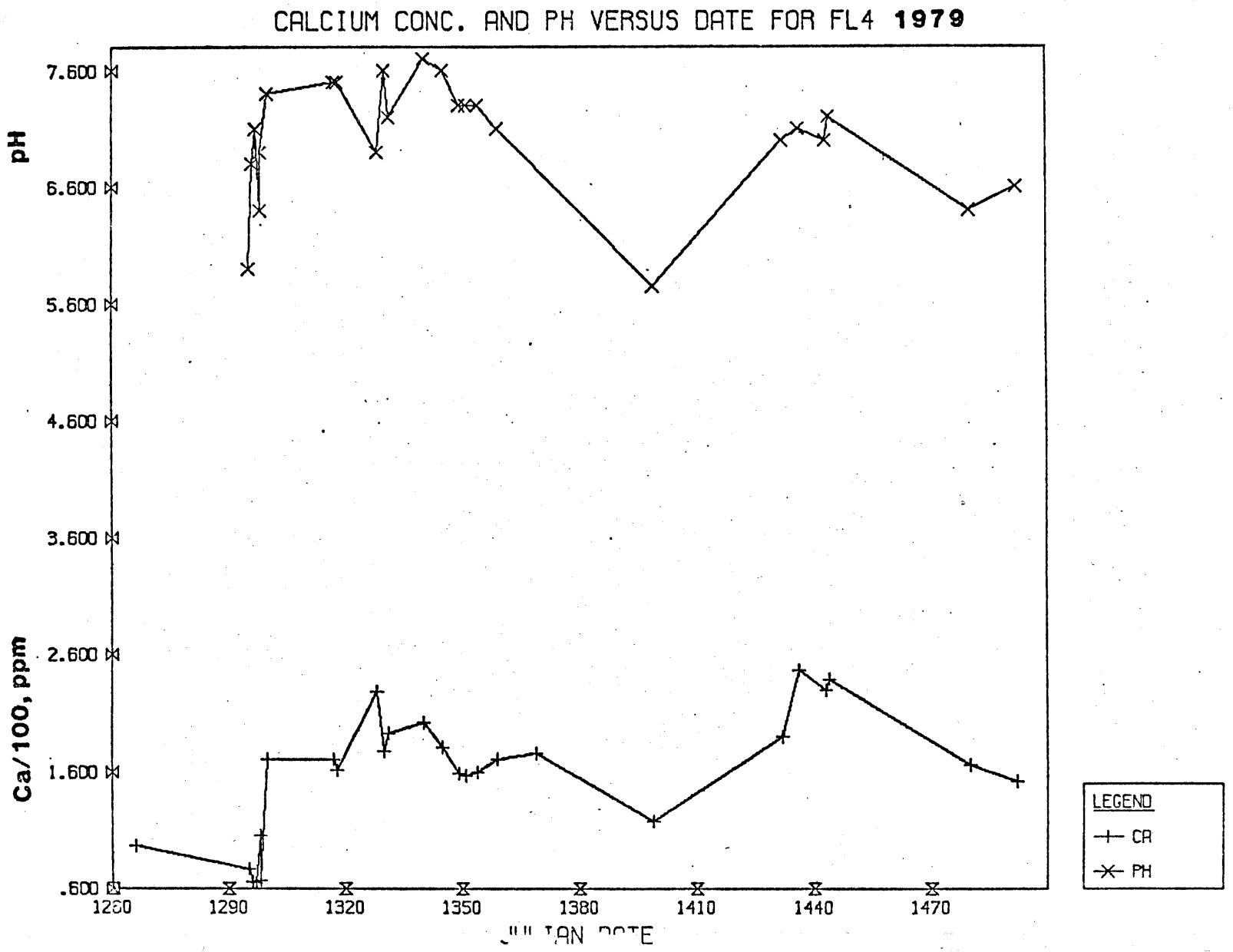


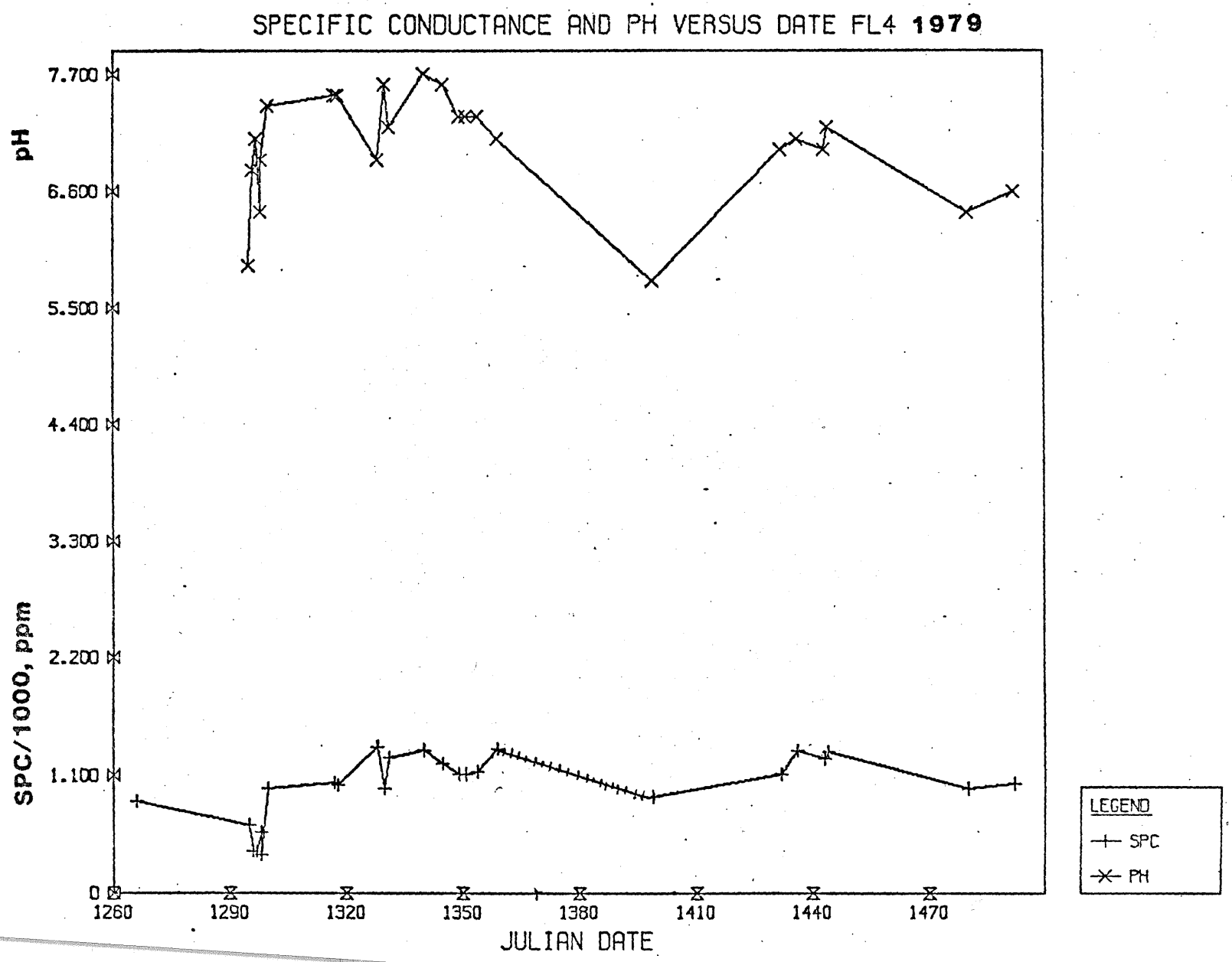

NICKEL CONC. AND PH VERSUS DATE FOR FL3 1979
pH
Ni * 1,ppm
7.900
6.800
5.700
4.600
3.500
2.400
1.300
.200
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
NI
PH

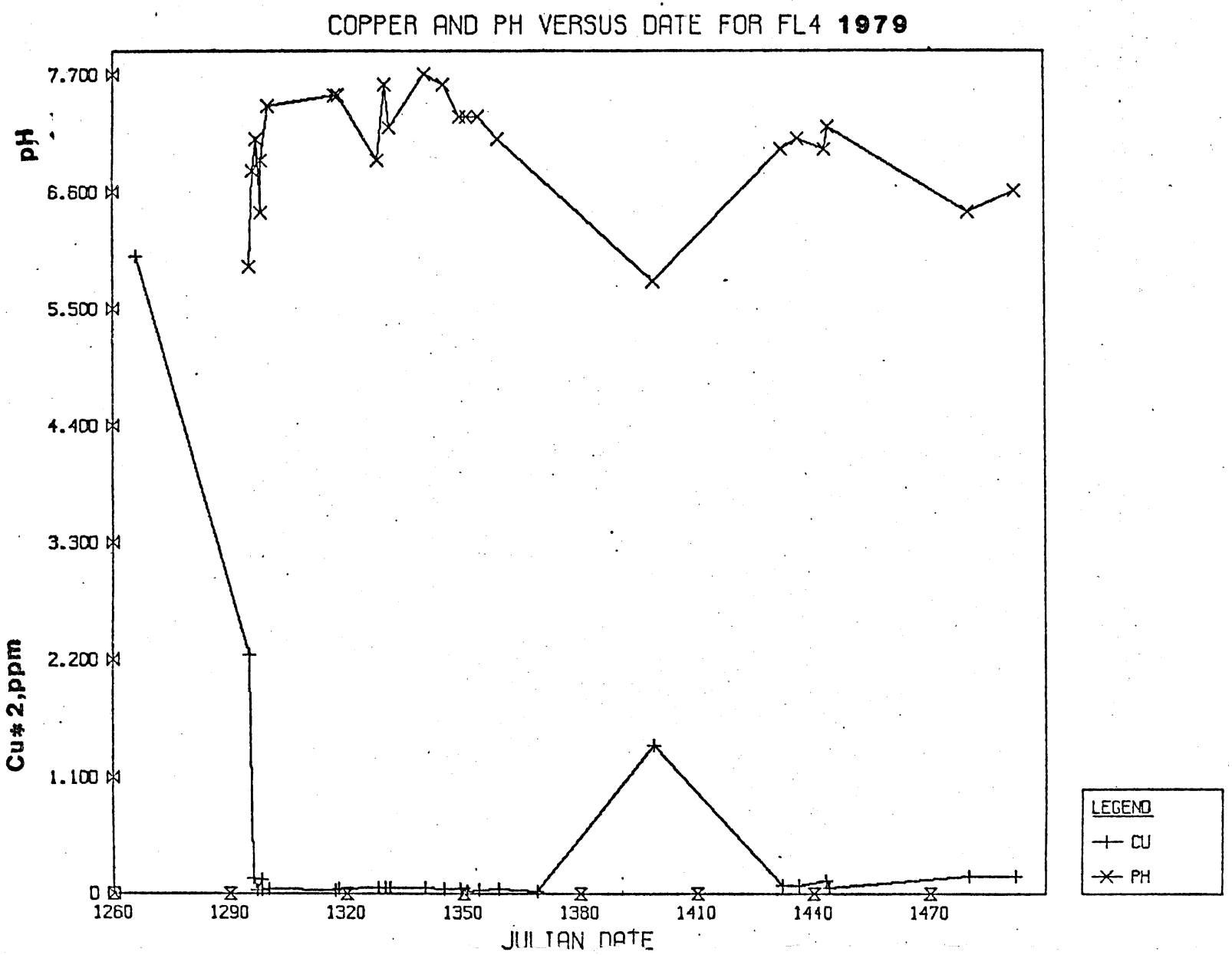

COPPER AND PH VERSUS DATE FOR FL3 1979
pH
Cu*20,ppm
7.800
6.800
5.800
4.800
3.800
2.800
1.800
.800
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CU
PH

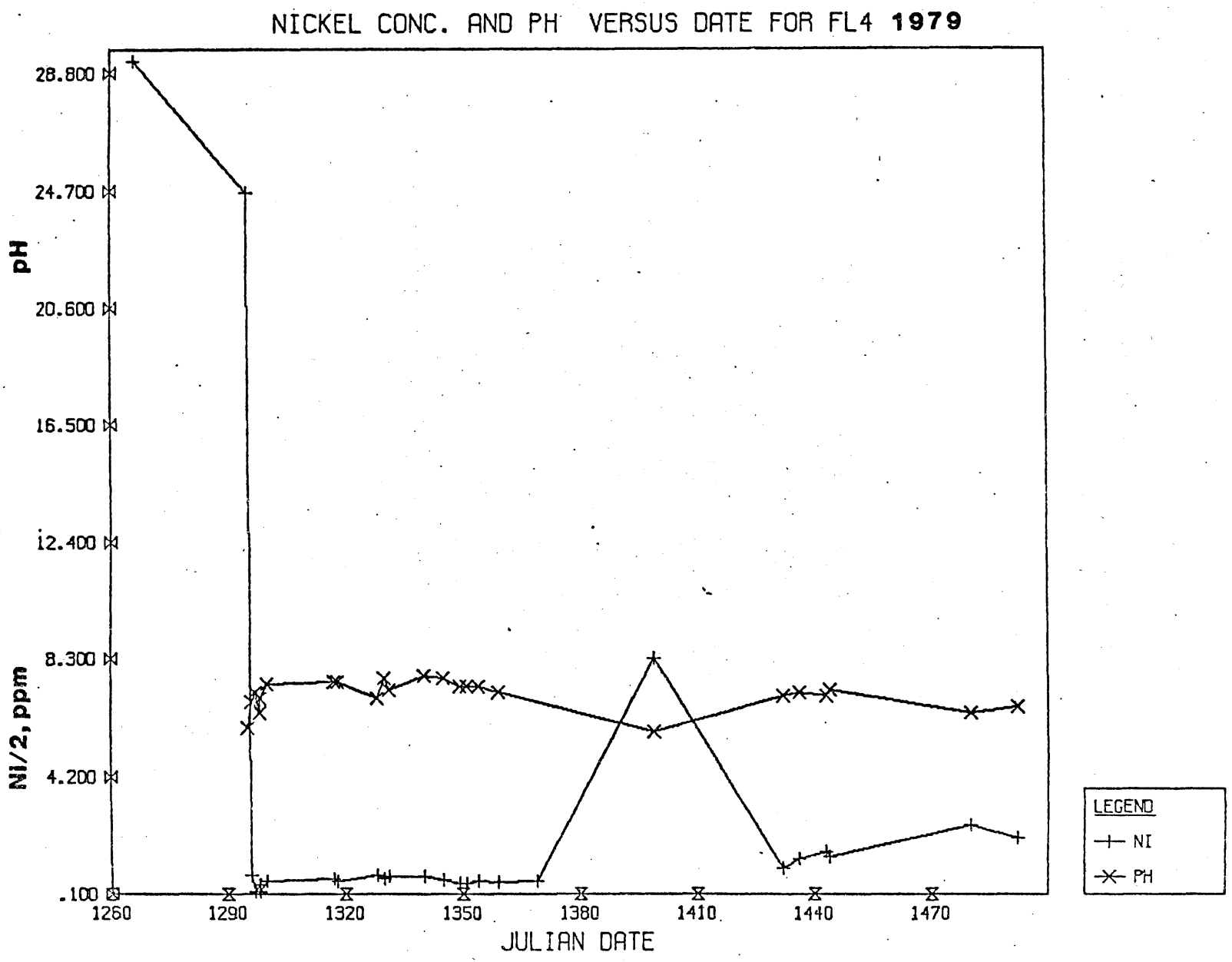

NICKEL CONC. AND PH VERSUS DATE FOR FL3 1979
pH
7.900
6.800
5.700
4.600
3.500
2.400
1.300
.200
Ni * 1,ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
NI
PH

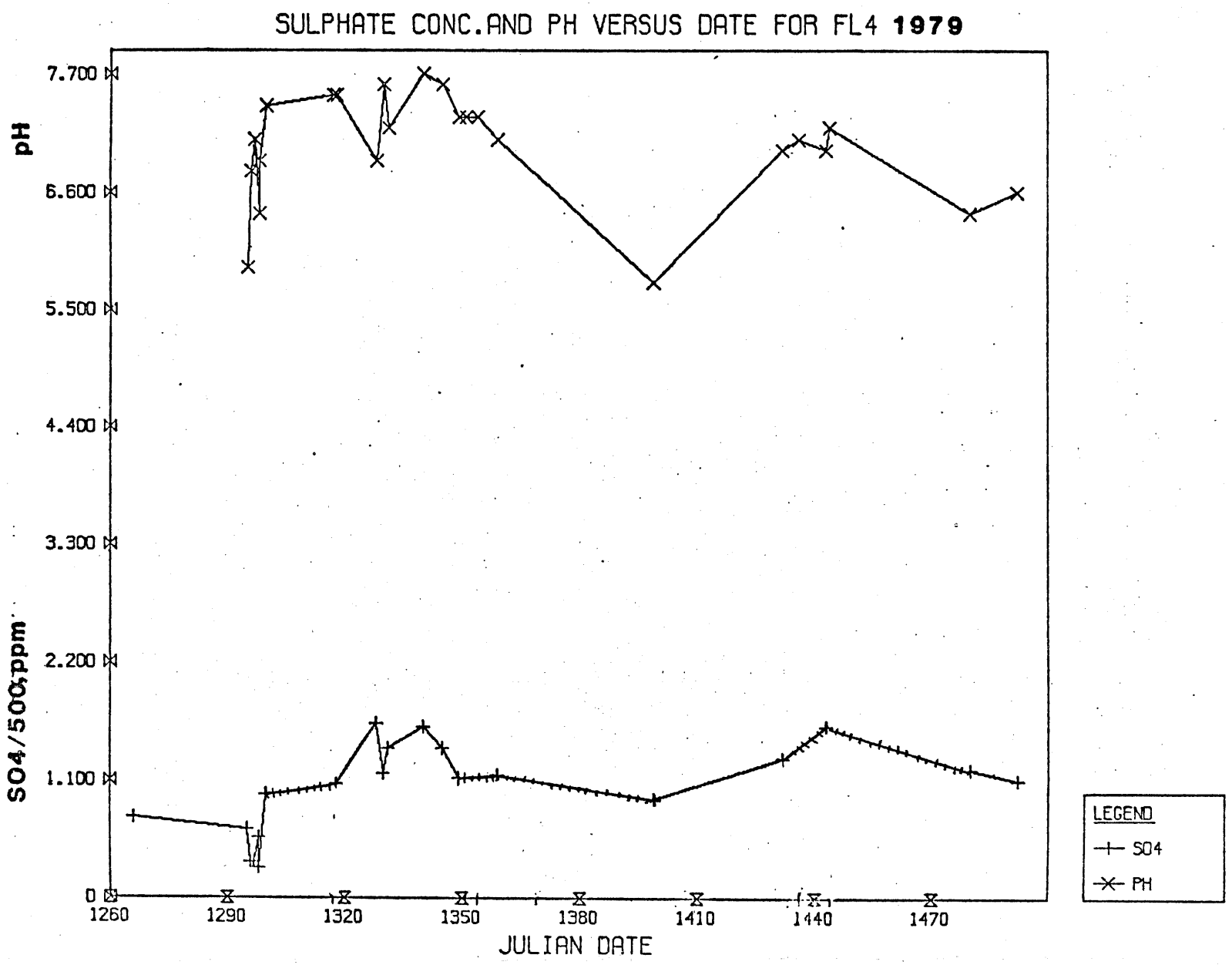

SULPHATE CONC.AND PH VERSUS DATE FOR FL3 1979
pH
7.700
6.600
5.500
4.400
3.300
2.200
1.100
0
SO4/500, ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
SO4
PH

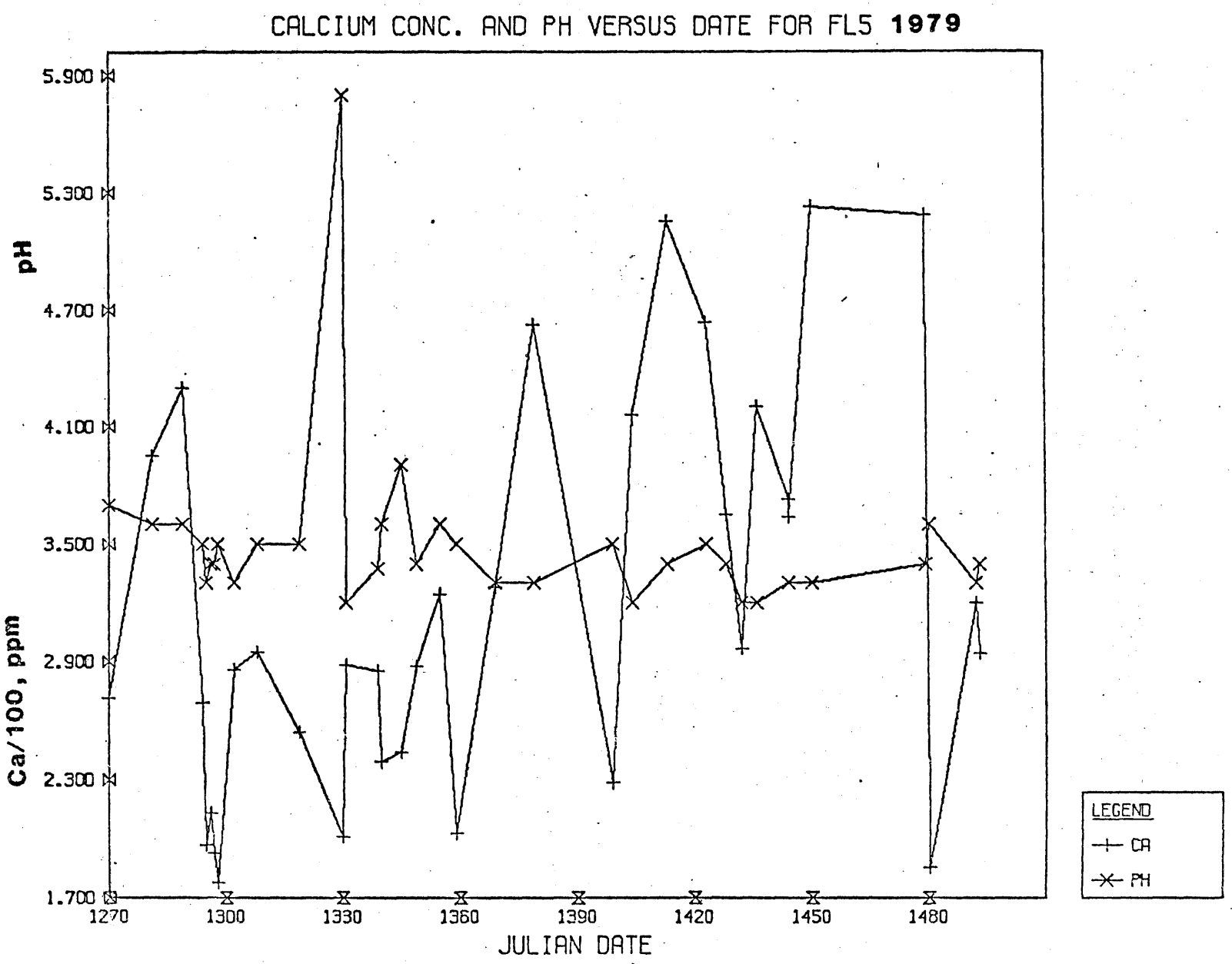

CALCIUM CONC. AND PH VERSUS DATE FOR FL4 1979
pH
7.600
6.600
5.600
4.600
3.600
2.600
1.600
.600
Ca/100, ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CA
PH

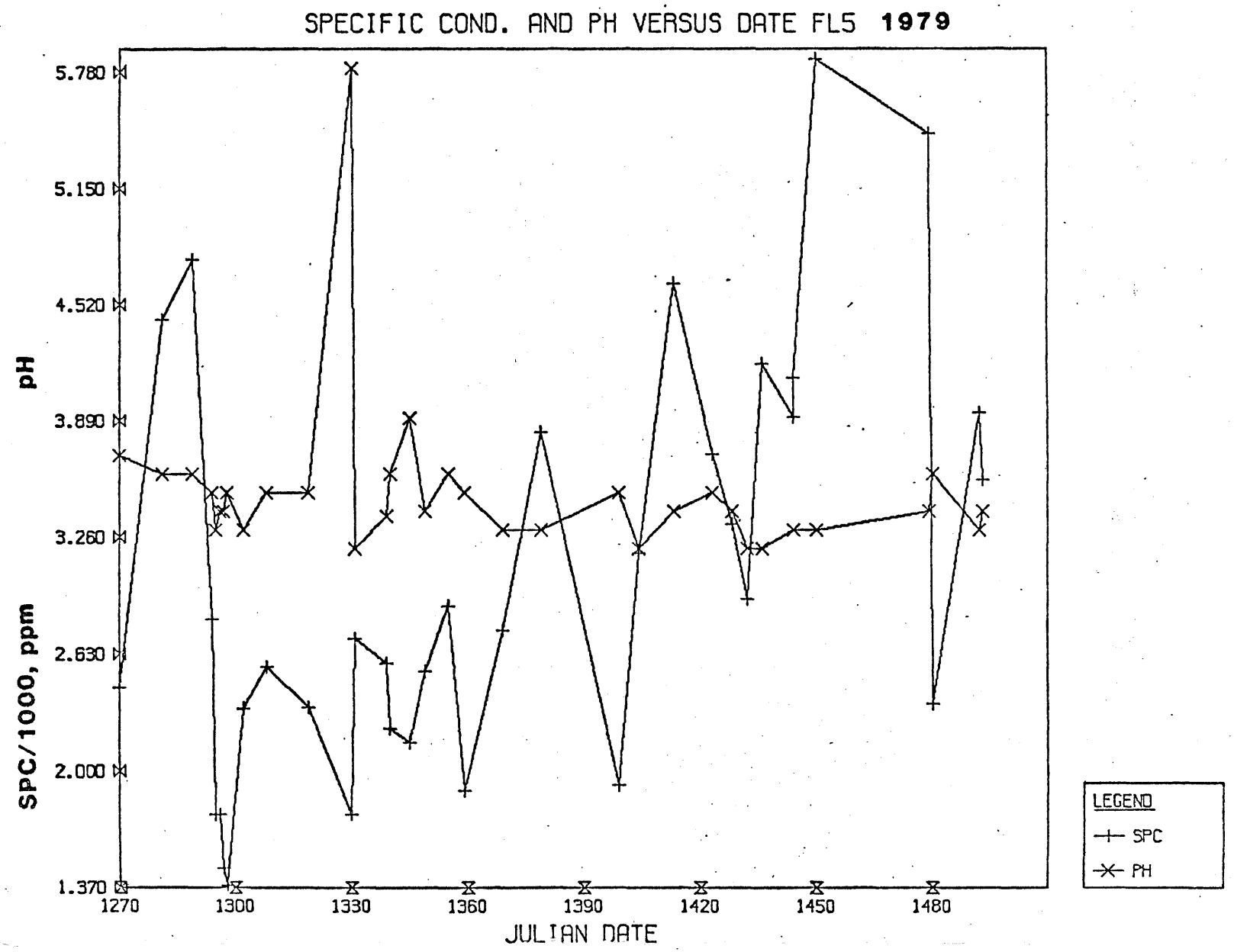

SPECIFIC CONDUCTANCE AND PH VERSUS DATE FL4 1979
pH
7.700
6.600
5.500
4.400
3.300
2.200
1.100
0
SPC/1000, ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
SPC
PH

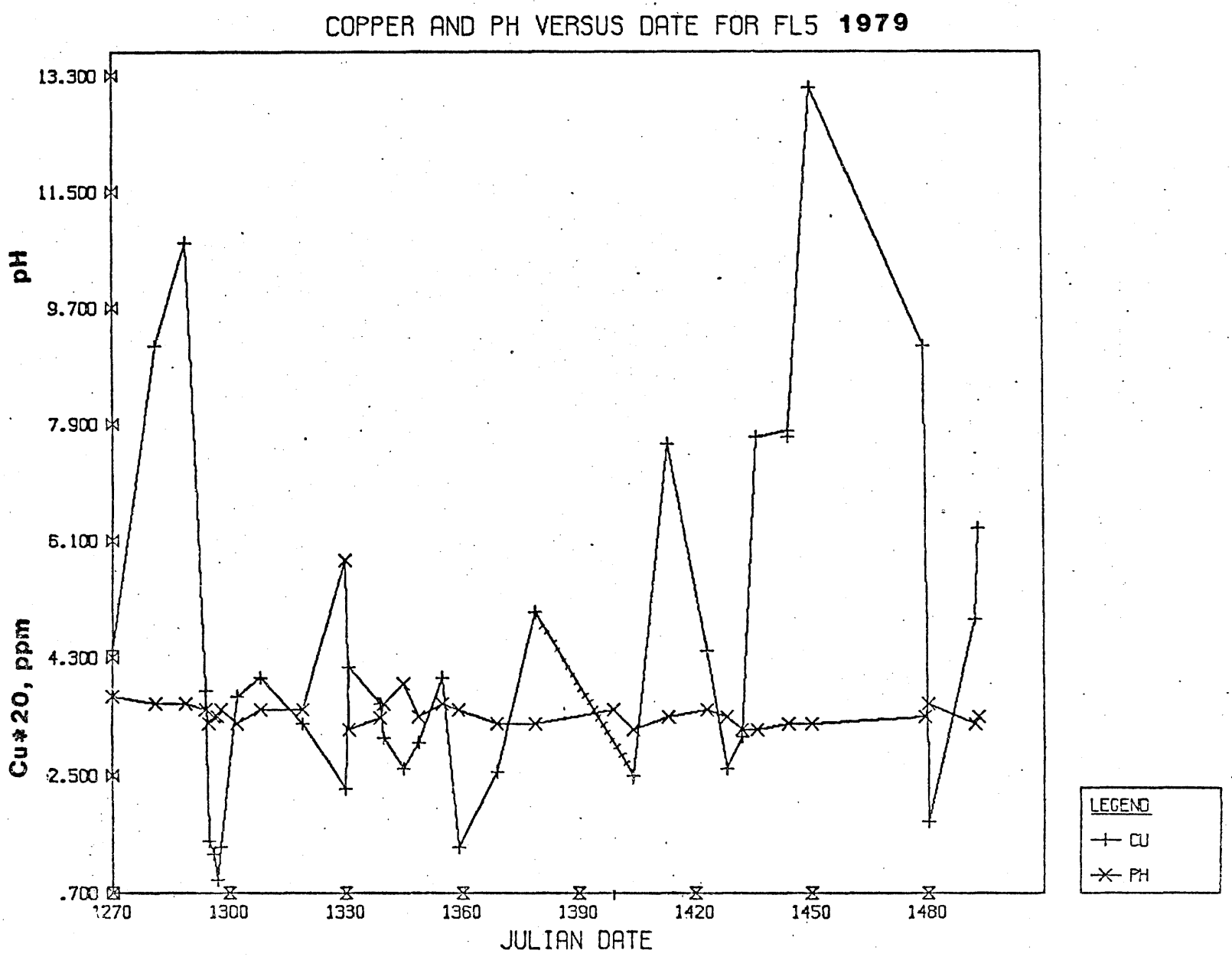

COPPER AND PH VERSUS DATE FOR FL4 1979
pH
7.700
6.600
5.500
4.400
3.300
2.200
1.100
0
Cu#2,ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
CU
PH

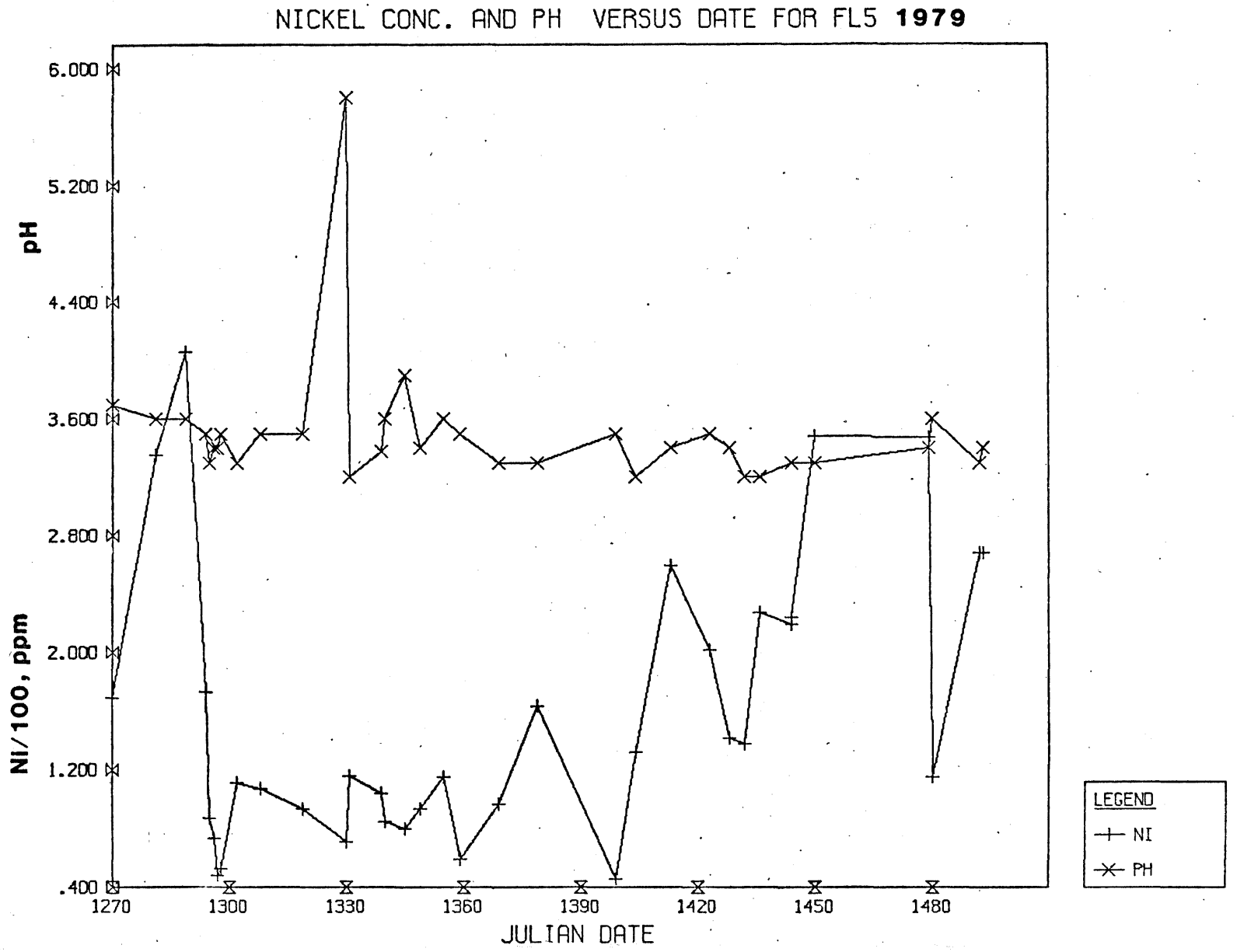

NICKEL CONC. AND PH VERSUS DATE FOR FL4 1979
28.800
24.700
20.600
16.500
12.400
8.300
4.200
.100
pH
Ni/2, ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
NI
PH

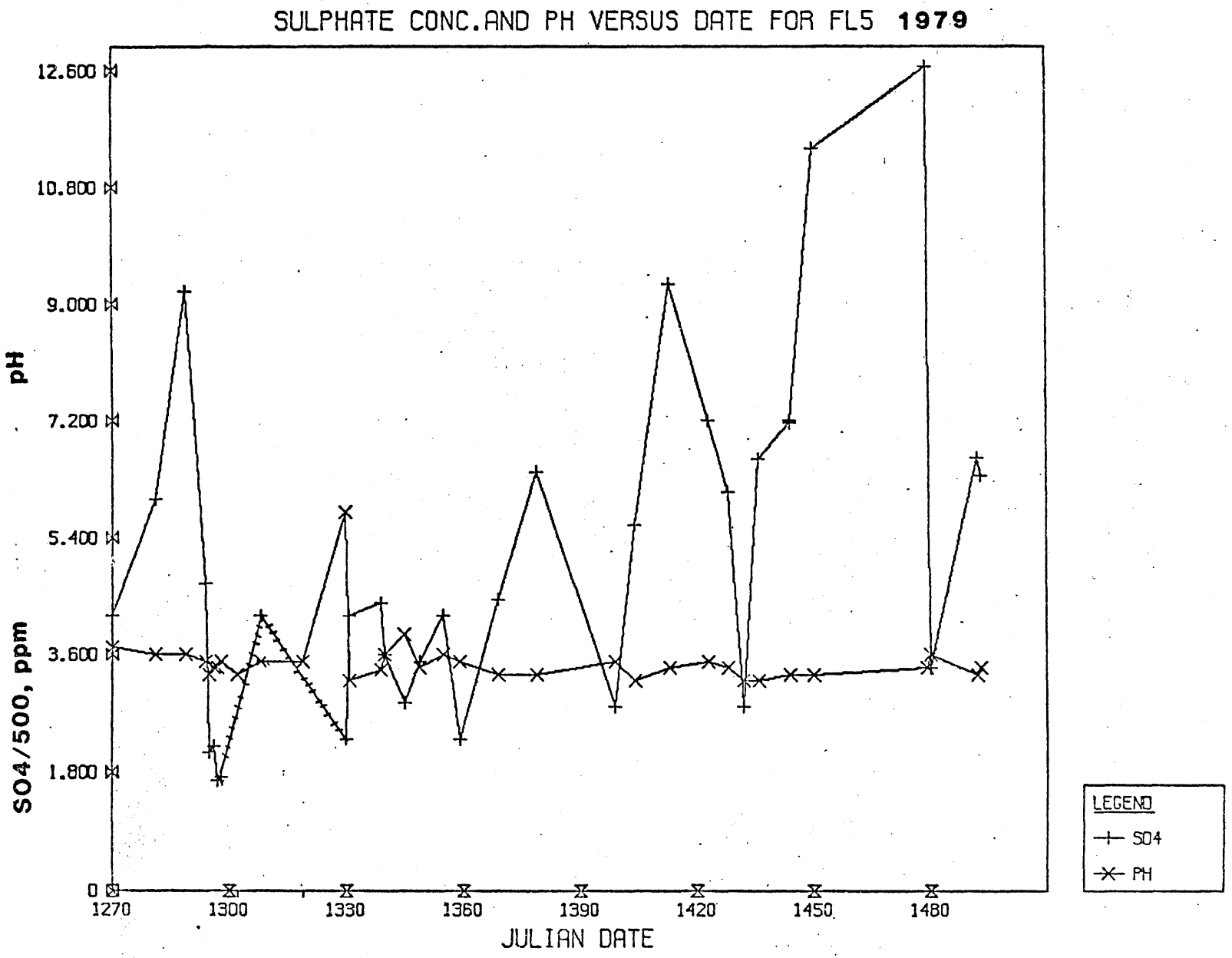

SULPHATE CONC.AND PH VERSUS DATE FOR FL4 1979
pH
7.700
6.600
5.500
4.400
3.300
2.200
1.100
0
SO4/500;ppm
1260
1290
1320
1350
1380
1410
1440
1470
JULIAN DATE
LEGEND
SO4
PH

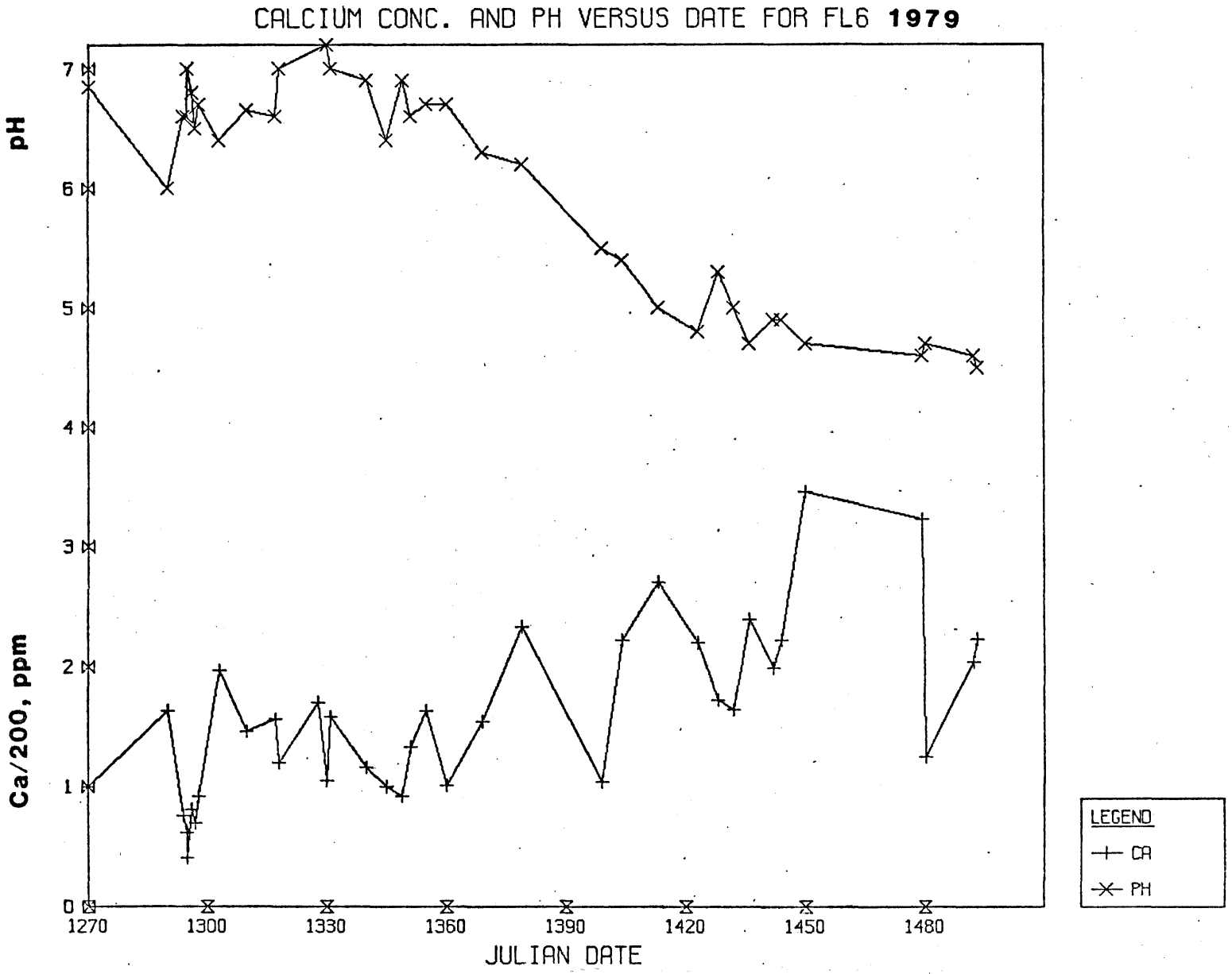

CALCIUM CONC. AND PH VERSUS DATE FOR FL5 1979
5.900
5.300
4.700
4.100
3.500
2.900
2.300
1.700
pH
Ca/100, ppm
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
CA
PH

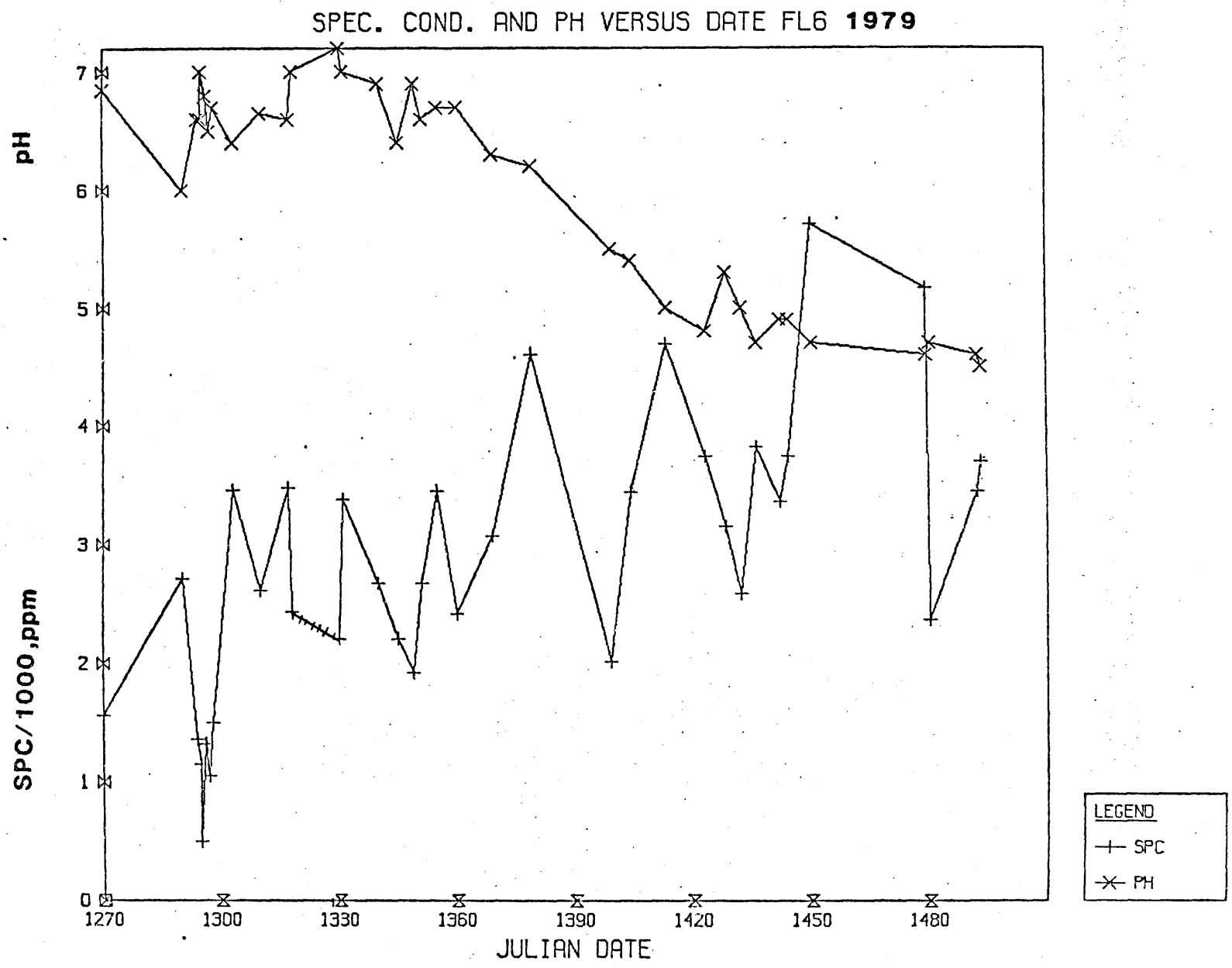

SPECIFIC COND. AND PH VERSUS DATE FL5 1979
5.780
5.150
4.520
3.890
3.260
2.630
2.000
1.370
pH
SPC/1000, ppm
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
SPC
PH

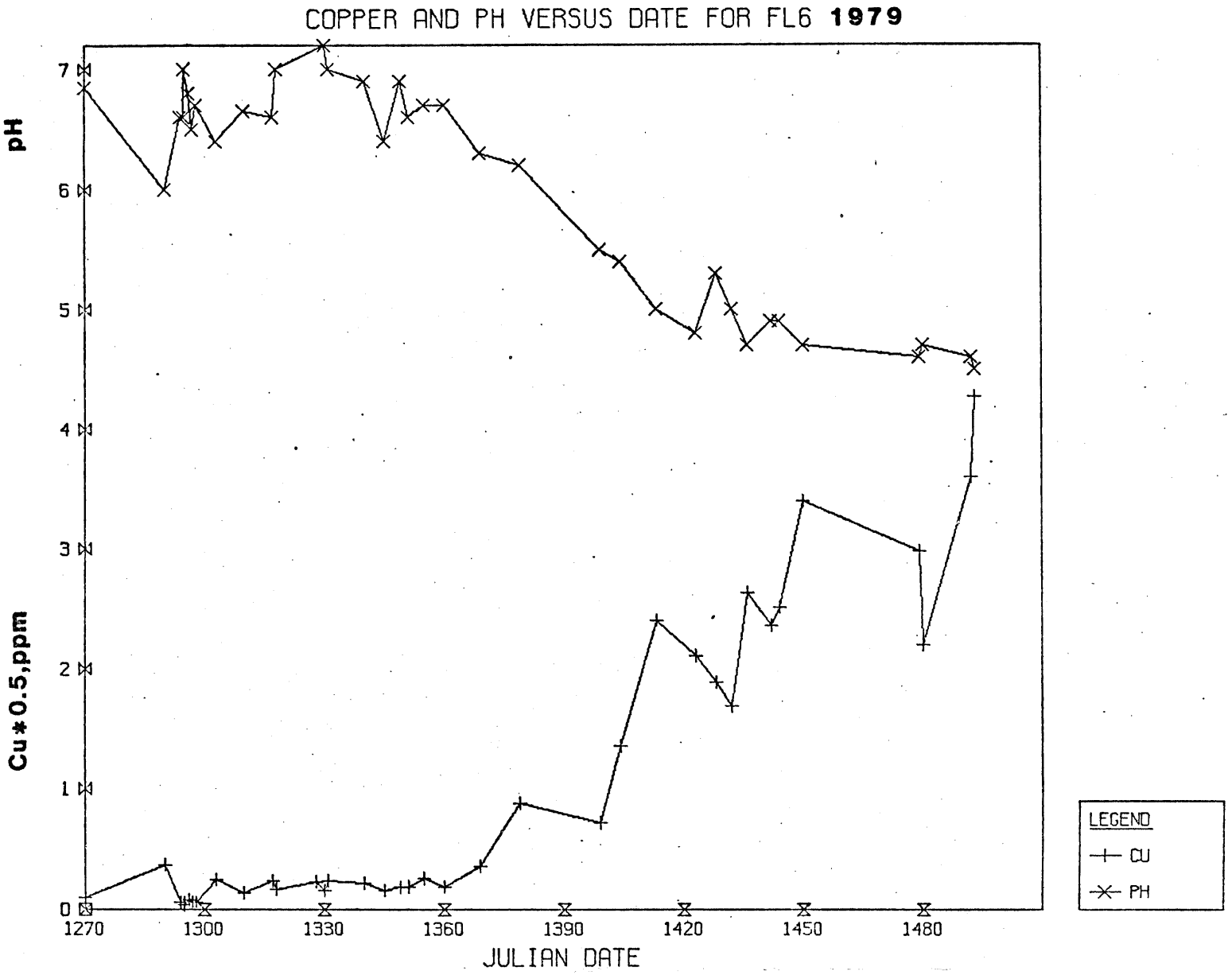

COPPER AND PH VERSUS DATE FOR FL5 1979
13.300
11.500
9.700
7.900
6.100
4.300
2.500
.700
pH
Cu*20, ppm
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
CU
PH

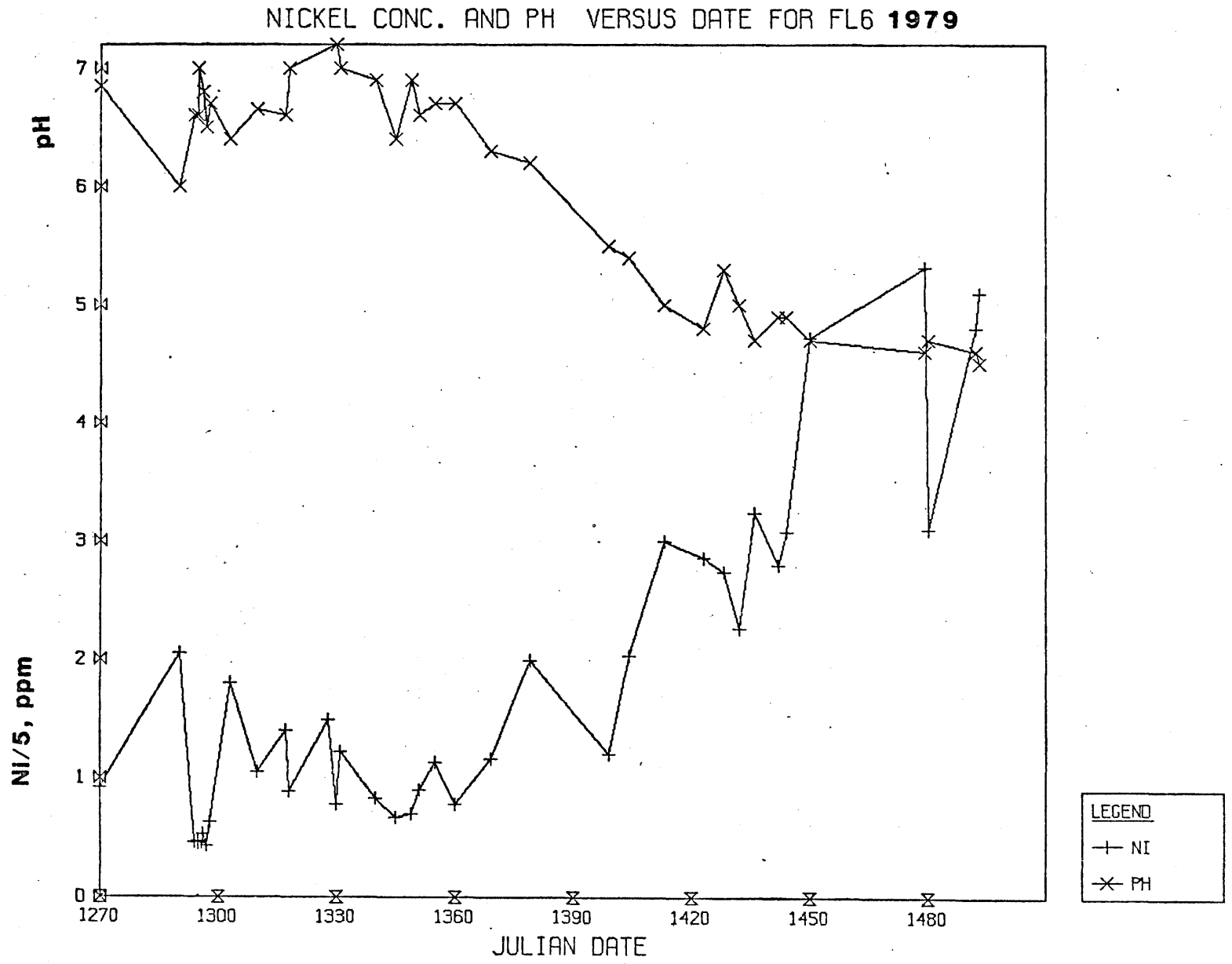

NICKEL CONC. AND PH VERSUS DATE FOR FL5 1979
6.000
5.200
4.400
3.600
2.800
2.000
1.200
.400
pH
Ni/100, ppm
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
NI
PH

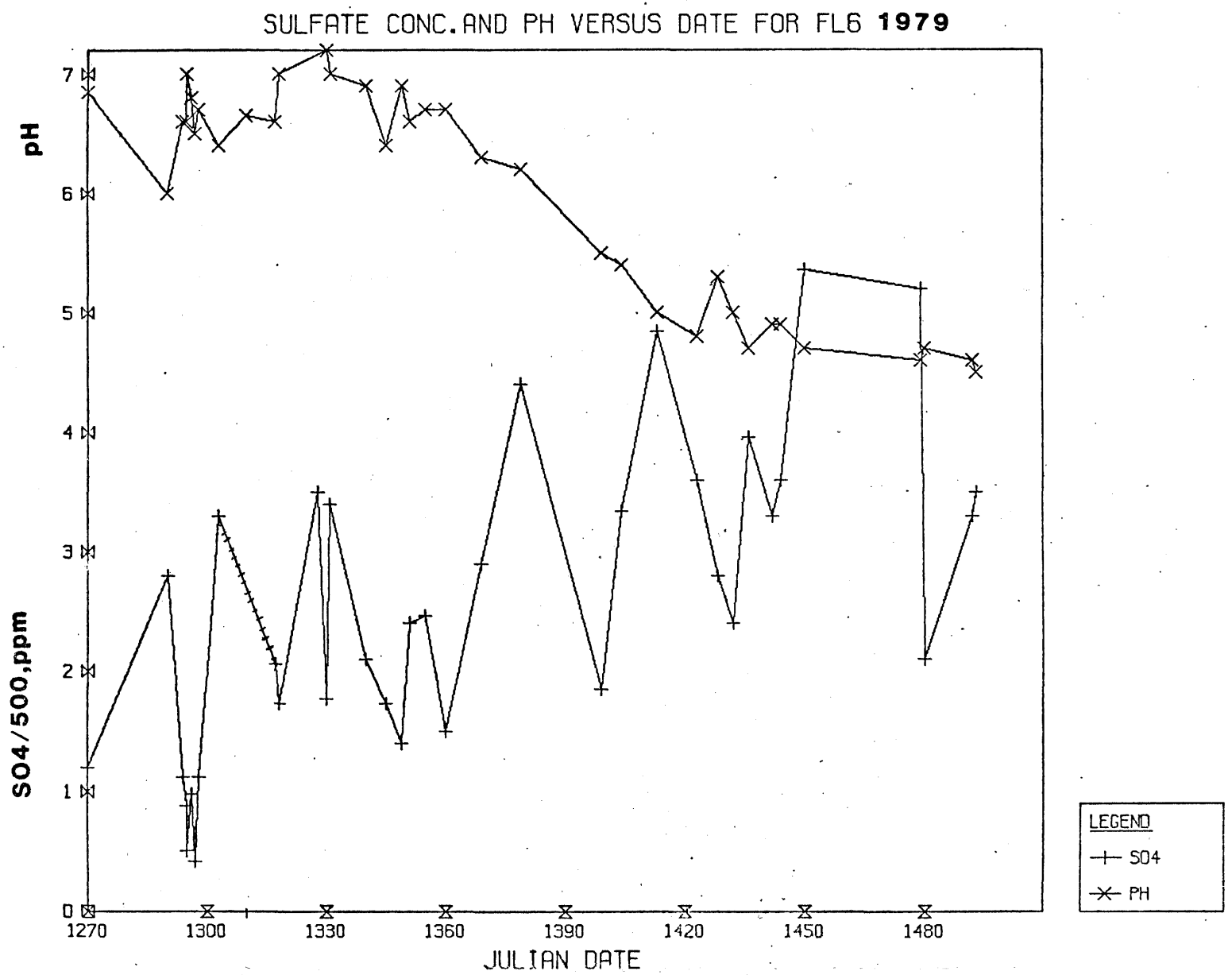

SULPHATE CONC.AND PH VERSUS DATE FOR FL5 1979
12.600
10.800
9.000
7.200
5.400
3.600
1.800
0
pH
SO4/500, ppm
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
SO4
PH


CALCIUM CONC. AND PH VERSUS DATE FOR FL6 1979
pH
Ca/200, ppm
0
1
2
3
4
5
6
7
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
CA
PH

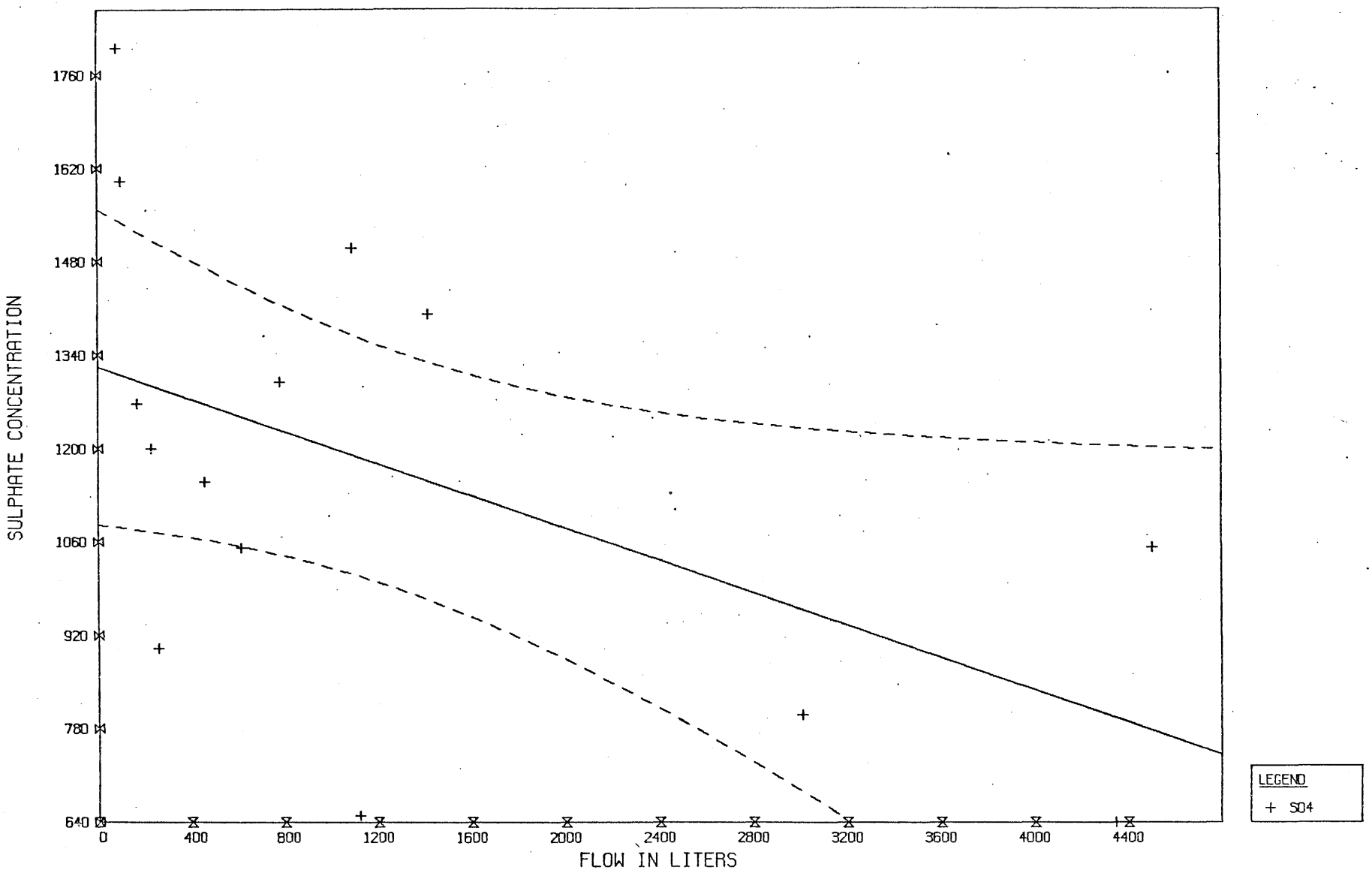

SPEC. COND. AND PH VERSUS DATE FL6 1979
pH
SPC/1000,ppm
0
1
2
3
4
5
6
7
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
SPC
PH


COPPER AND PH VERSUS DATE FOR FL6 1979
pH
Cu*0.5,ppm
0
1
2
3
4
5
6
7
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
CU
PH

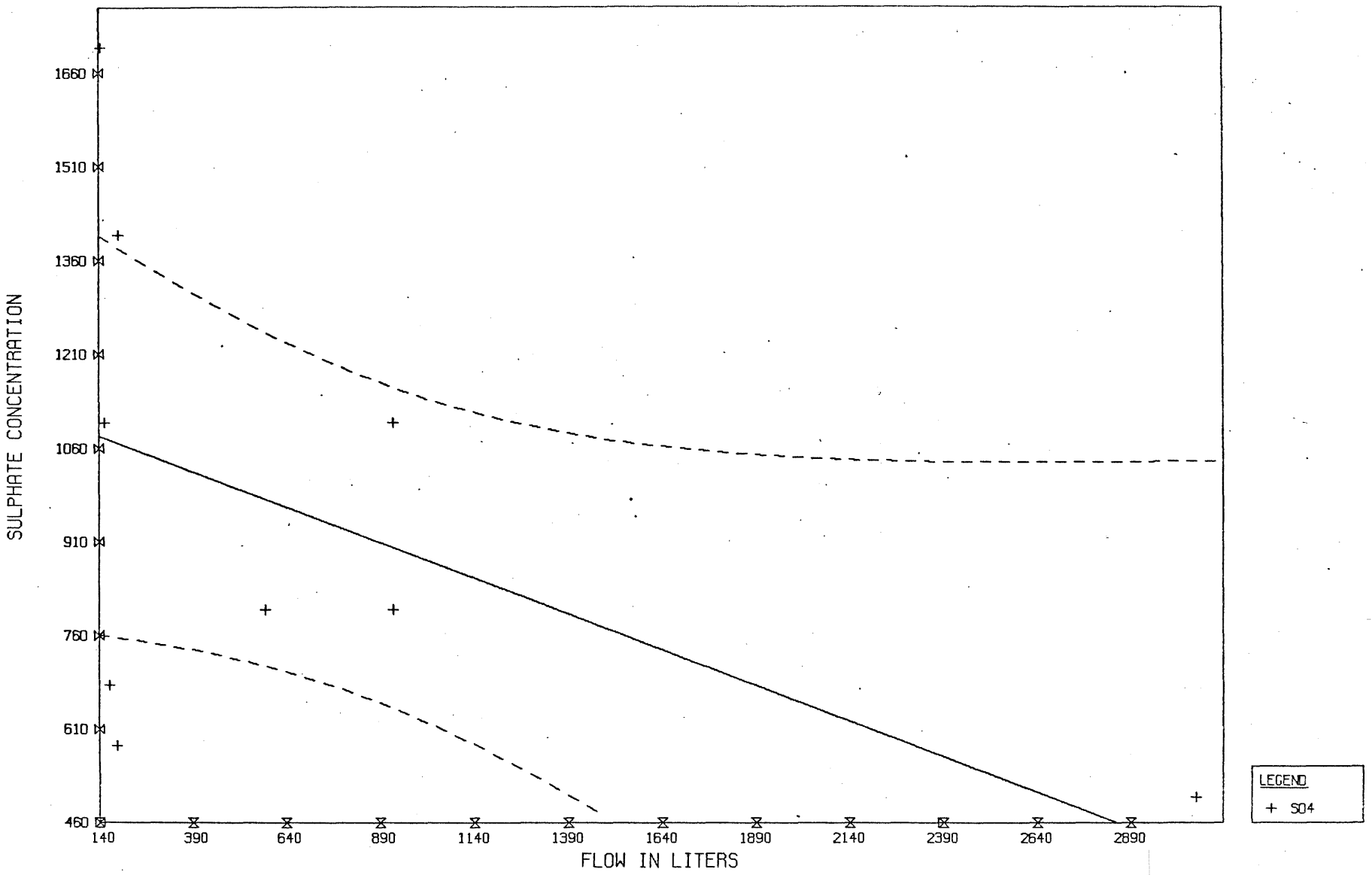

NICKEL CONC. AND PH VERSUS DATE FOR FL6 1979
pH
Ni/5, ppm
0
1
2
3
4
5
6
7
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
NI
PH

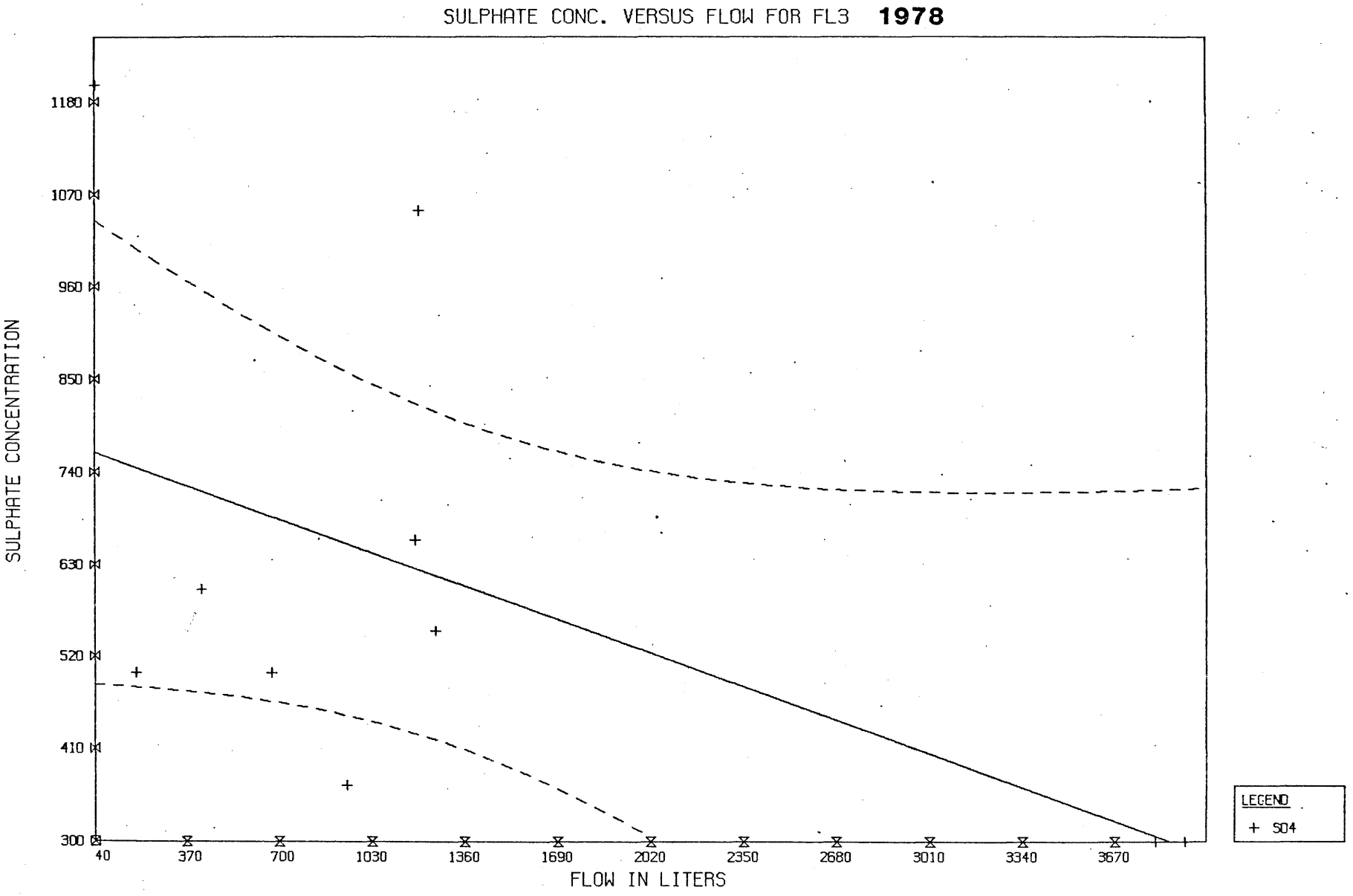

SULFATE CONC. AND PH VERSUS DATE FOR FL6 1979
pH
SO4/500,ppm
0
1
2
3
4
5
6
7
1270
1300
1330
1360
1390
1420
1450
1480
JULIAN DATE
LEGEND
SO4
PH

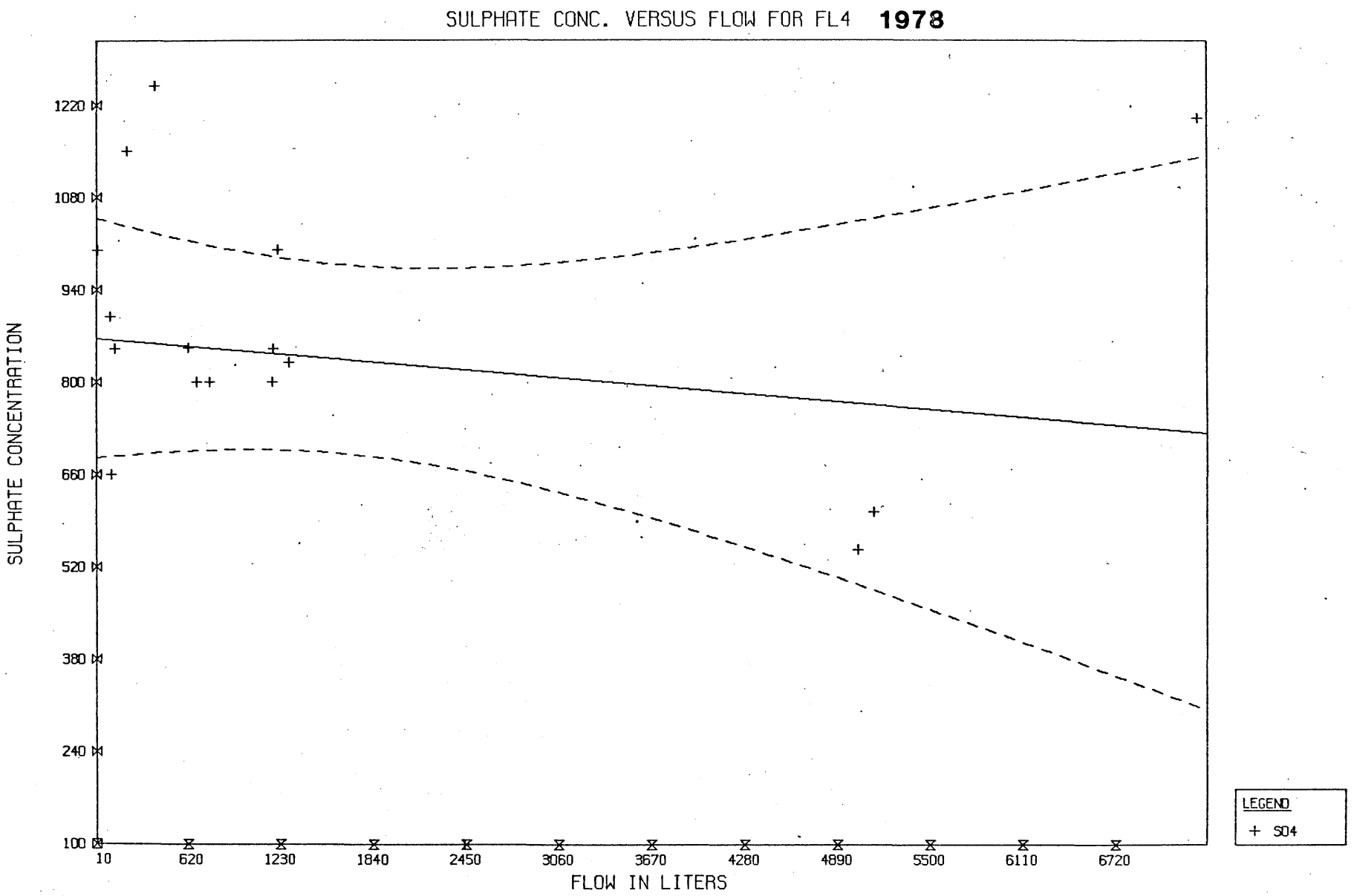
SULPHATE CONC. VERSUS FLOW FOR FL1 **1978**

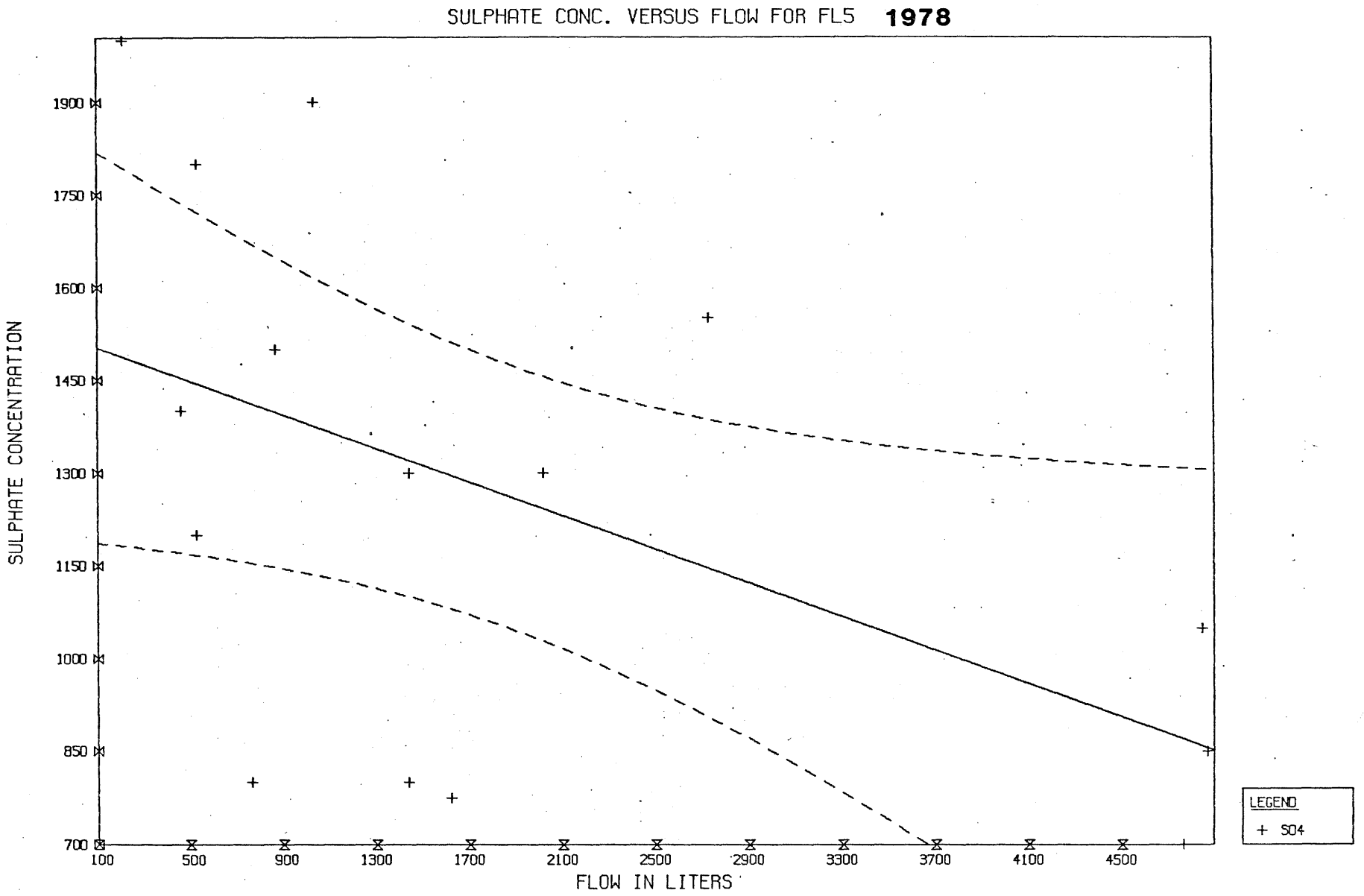


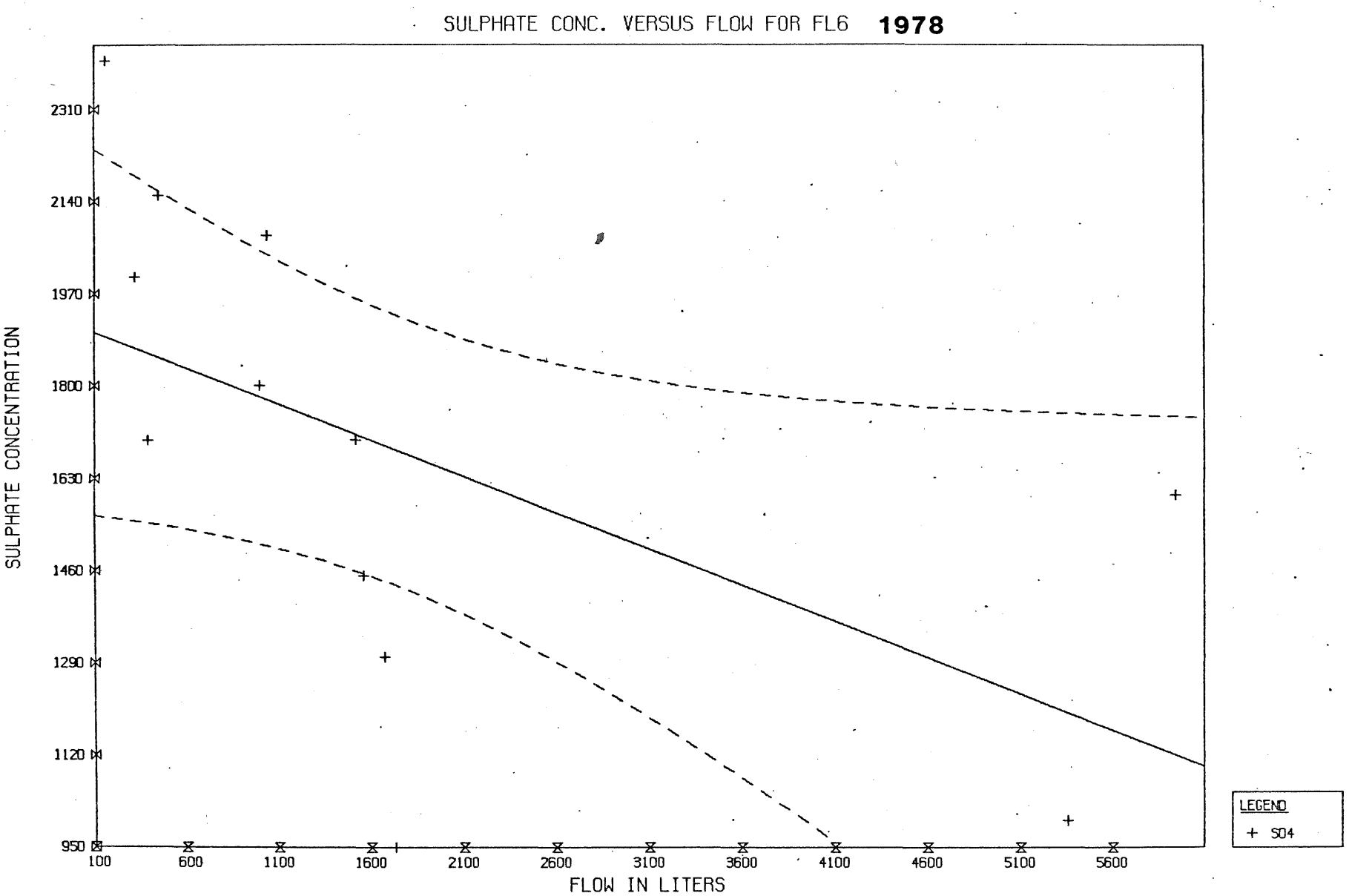
SULPHATE CONC. VERSUS FLOW FOR FL2 **1978**

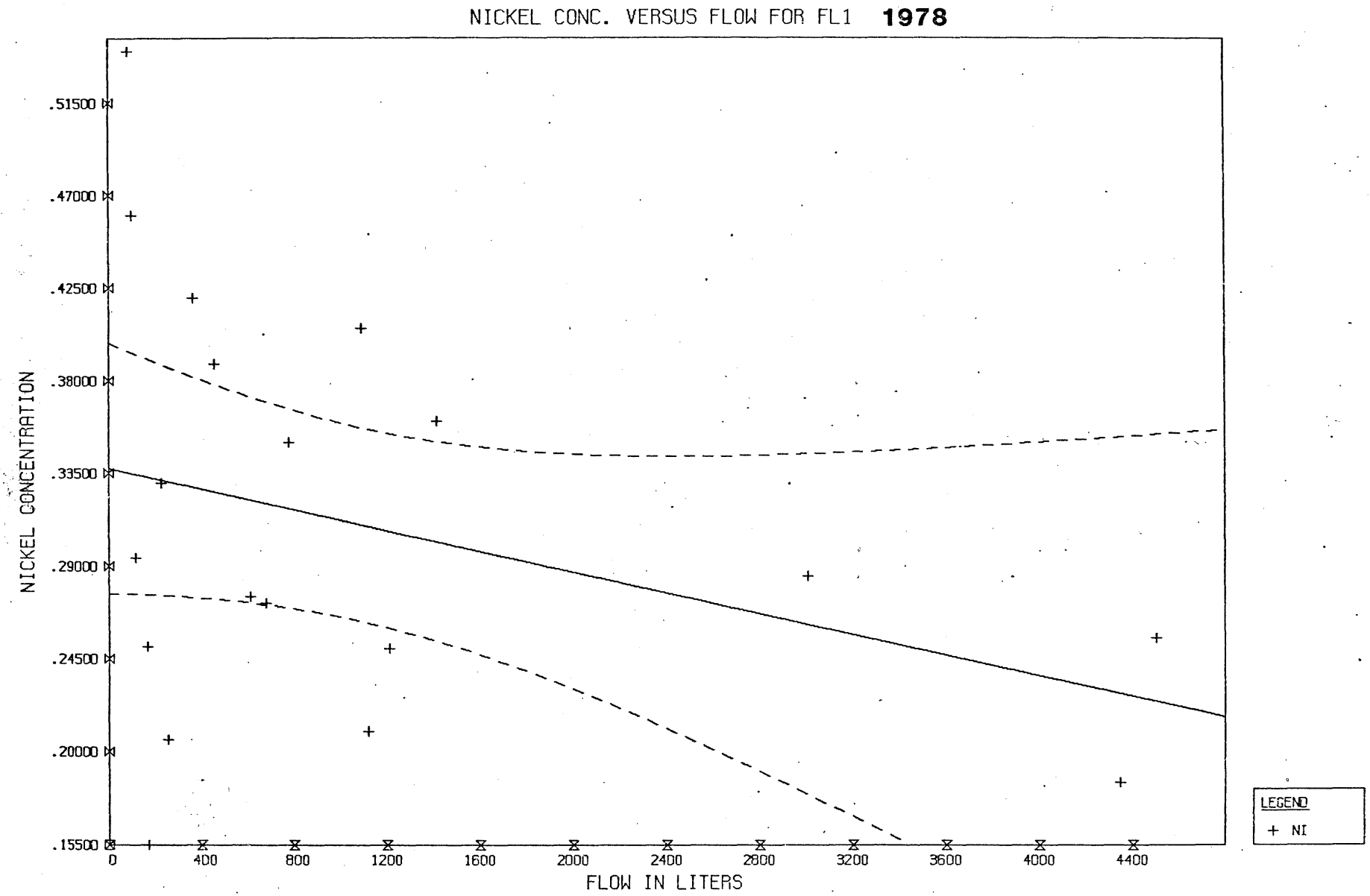


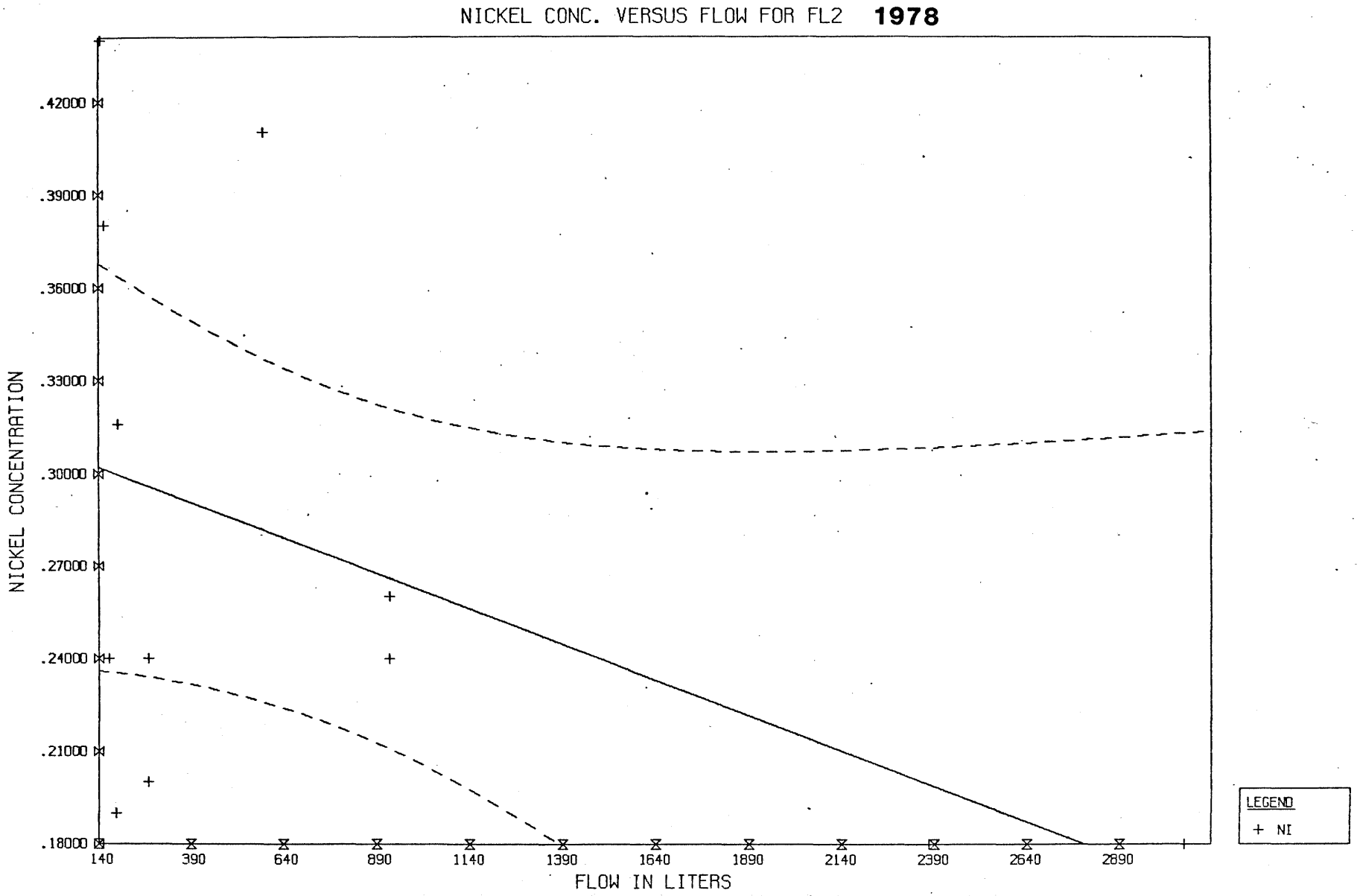

SULPHATE CONC. VERSUS FLOW FOR FL3 1978
SULPHATE CONCENTRATION
1180
1070
960
850
740
630
520
410
300
40
370
700
1030
1360
1690
2020
2350
2680
3010
3340
3670
FLOW IN LITERS
LEGEND
+ SO4

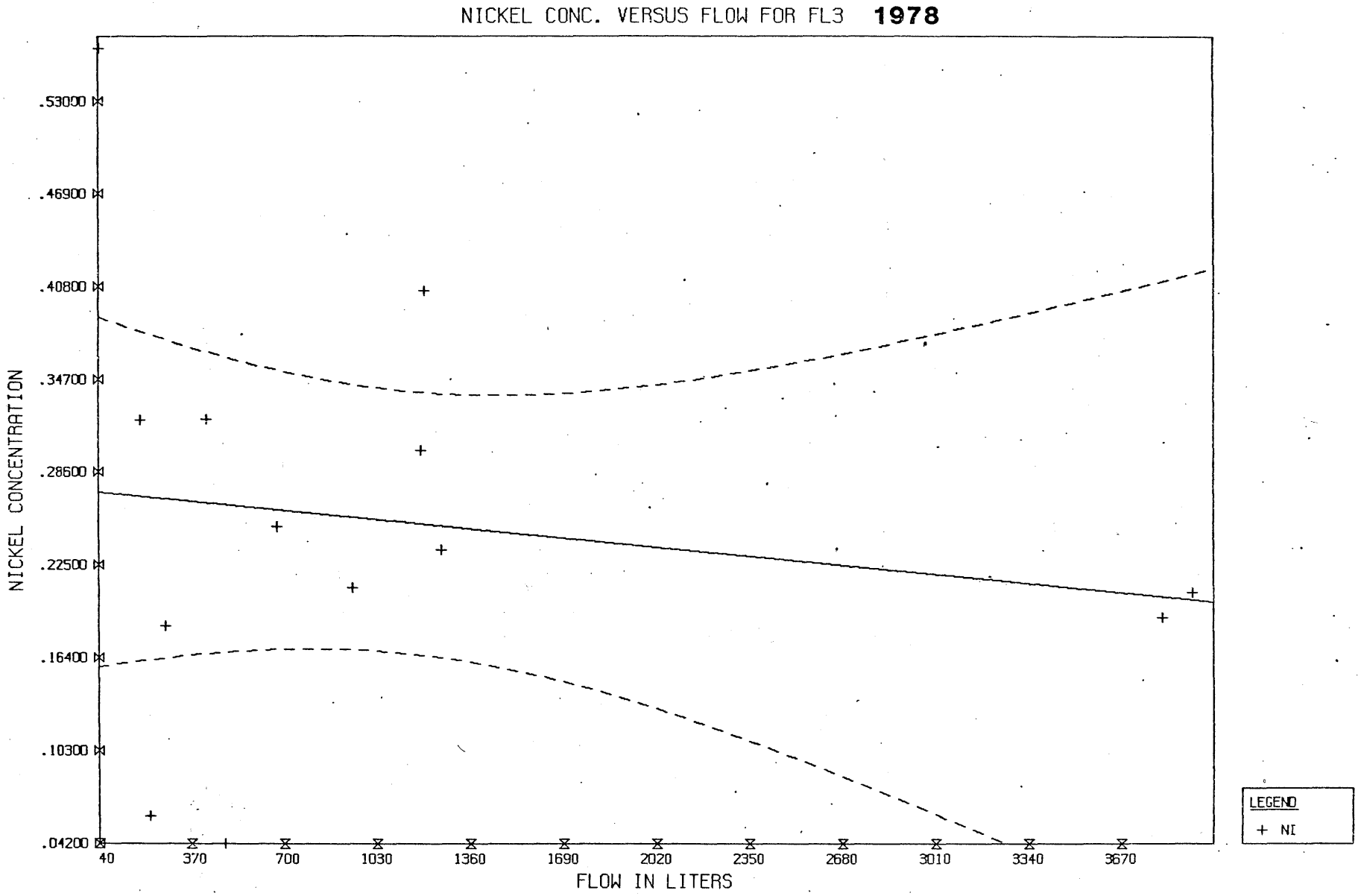

SULPHATE CONC. VERSUS FLOW FOR FL4 1978
SULPHATE CONCENTRATION
1220
1080
940
800
660
520
380
240
100
10
620
1230
1840
2450
3060
3670
4280
4890
5500
6110
6720
FLOW IN LITERS
LEGEND
+ SO4

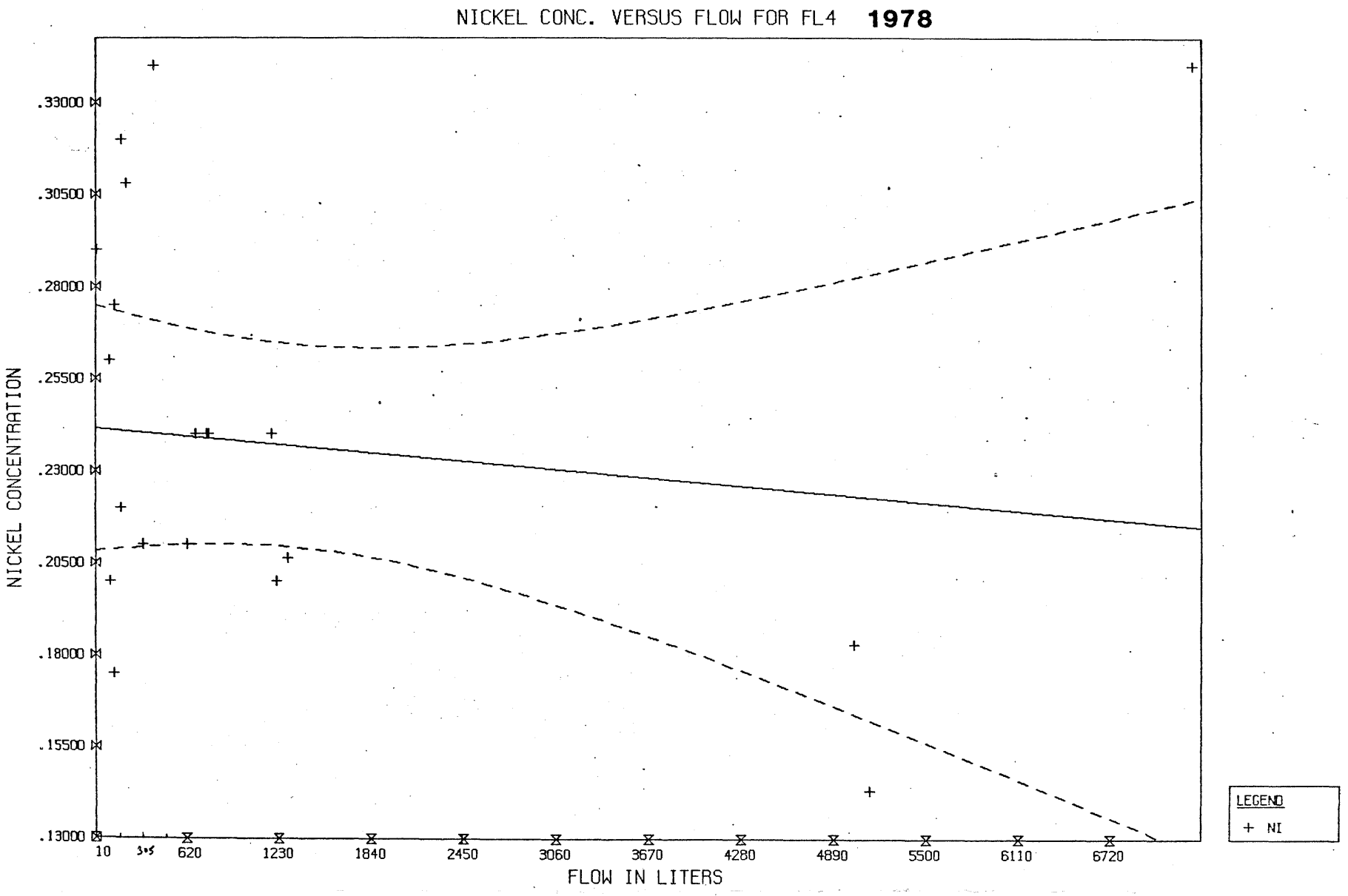

SULPHATE CONC. VERSUS FLOW FOR FL5 1978
SULPHATE CONCENTRATION
1900
1750
1600
1450
1300
1150
1000
850
700
100
500
900
1300
1700
2100
2500
2900
3300
3700
4100
4500
FLOW IN LITERS
LEGEND
+ SO4

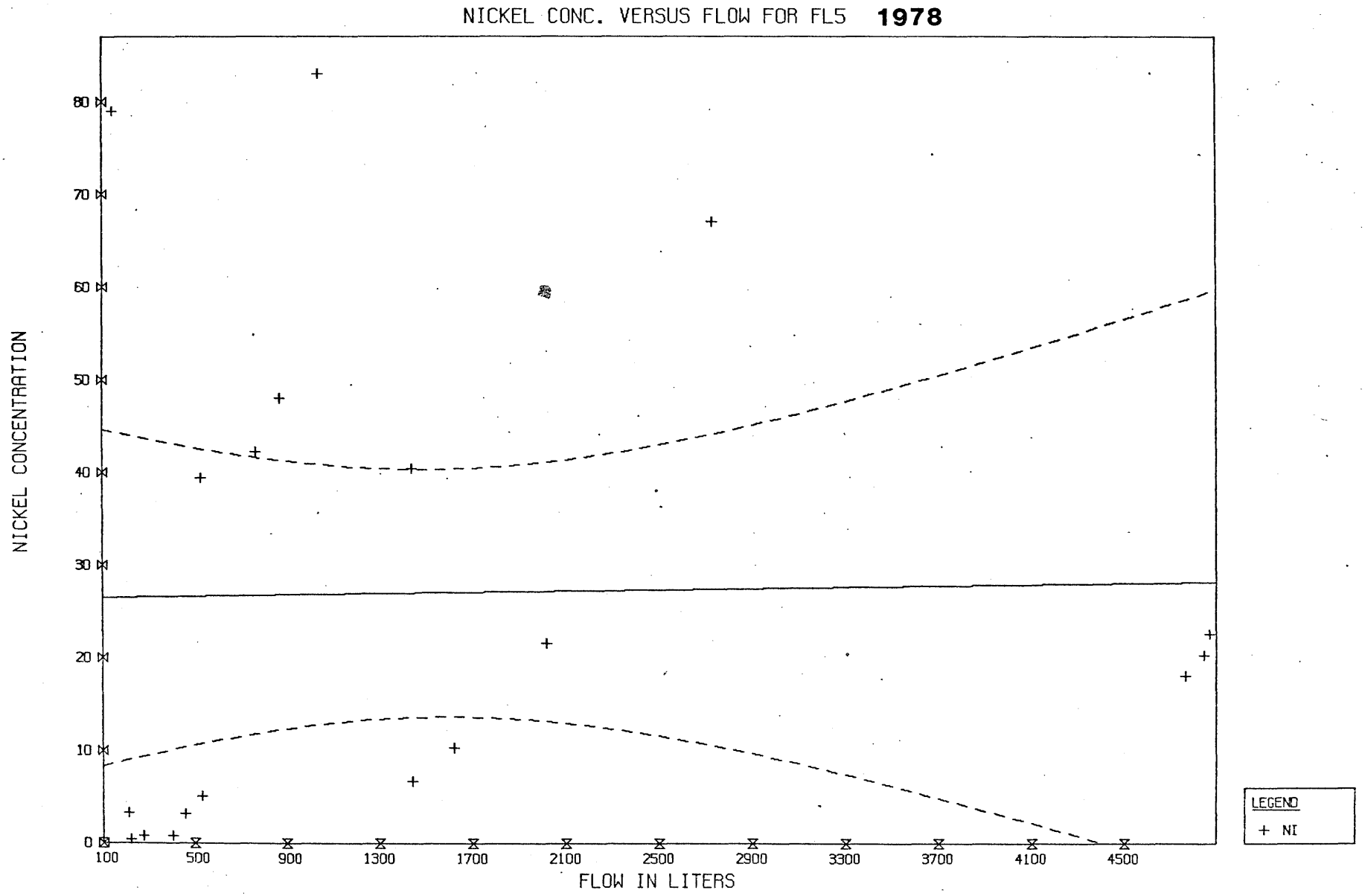

SULPHATE CONC. VERSUS FLOW FOR FL6 1978
SULPHATE CONCENTRATION
2310
2140
1970
1800
1630
1460
1290
1120
950
100
600
1100
1600
2100
2600
3100
3600
4100
4600
5100
5600
FLOW IN LITERS
LEGEND
+ SO4


NICKEL CONC. VERSUS FLOW FOR FL1 1978
NICKEL CONCENTRATION
.51500
.47000
.42500
.38000
.33500
.29000
.24500
.20000
.15500
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
4400
FLOW IN LITERS
LEGEND
+ NI

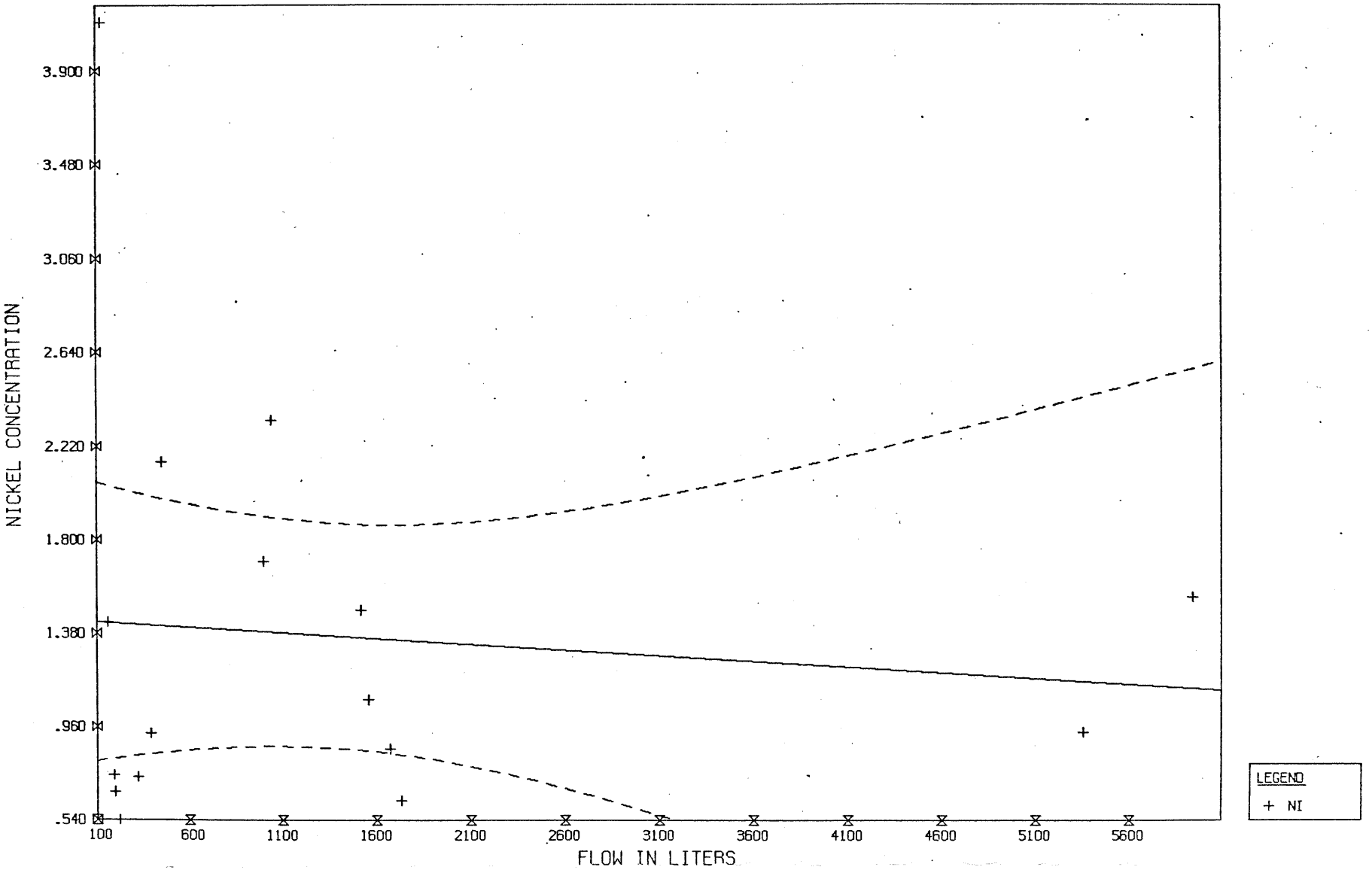

NICKEL CONC. VERSUS FLOW FOR FL2 1978
NICKEL CONCENTRATION
.42000
.39000
.36000
.33000
.30000
.27000
.24000
.21000
.18000
140
390
640
890
1140
1390
1640
1890
2140
2390
2640
2890
FLOW IN LITERS
LEGEND
+ NI

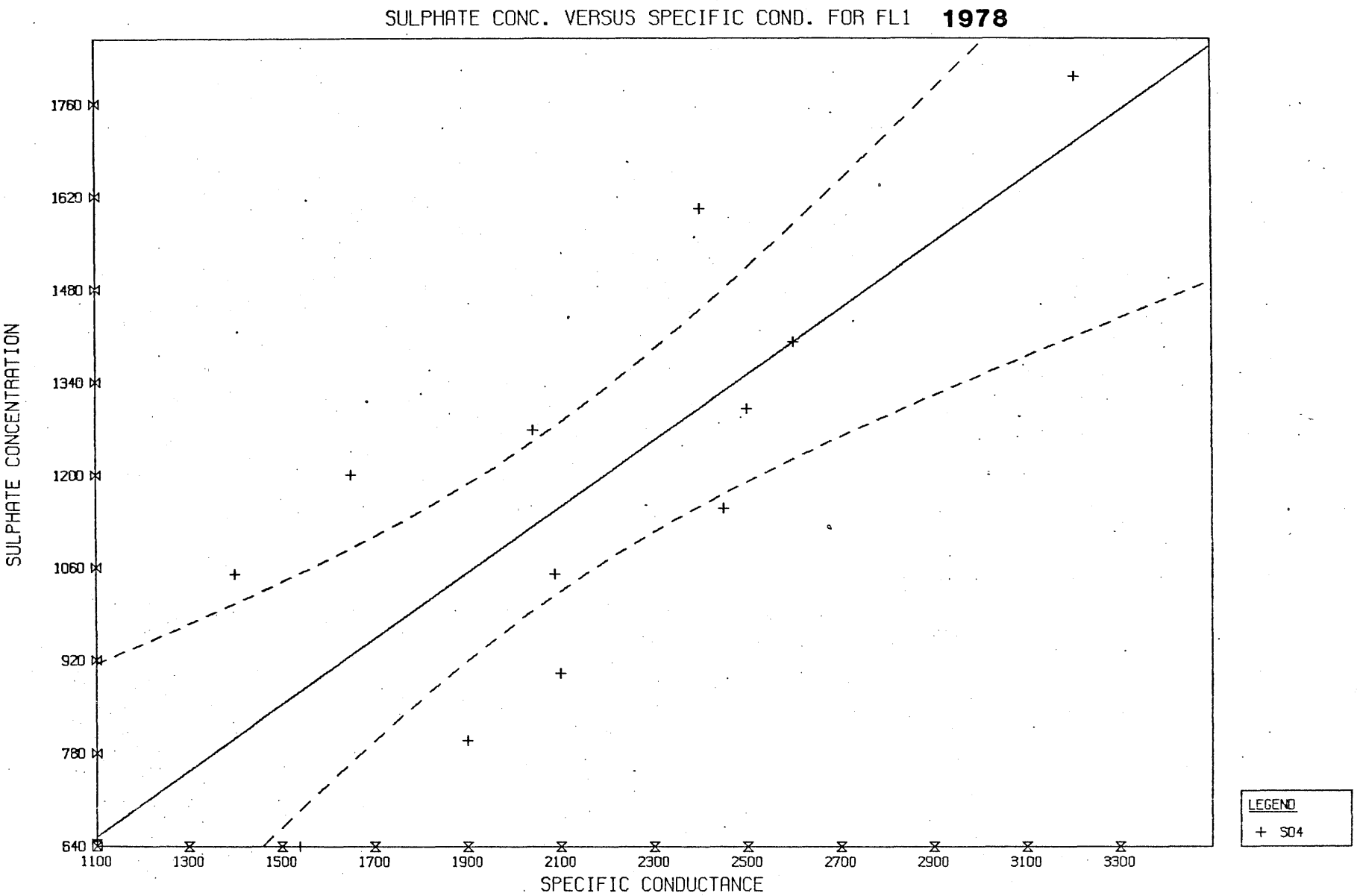

NICKEL CONC. VERSUS FLOW FOR FL3 1978
NICKEL CONCENTRATION
.53000
.46900
.40800
.34700
.28600
.22500
.16400
.10300
.04200
40
370
700
1030
1360
1690
2020
2350
2680
3010
3340
3670
FLOW IN LITERS
LEGEND
+ NI

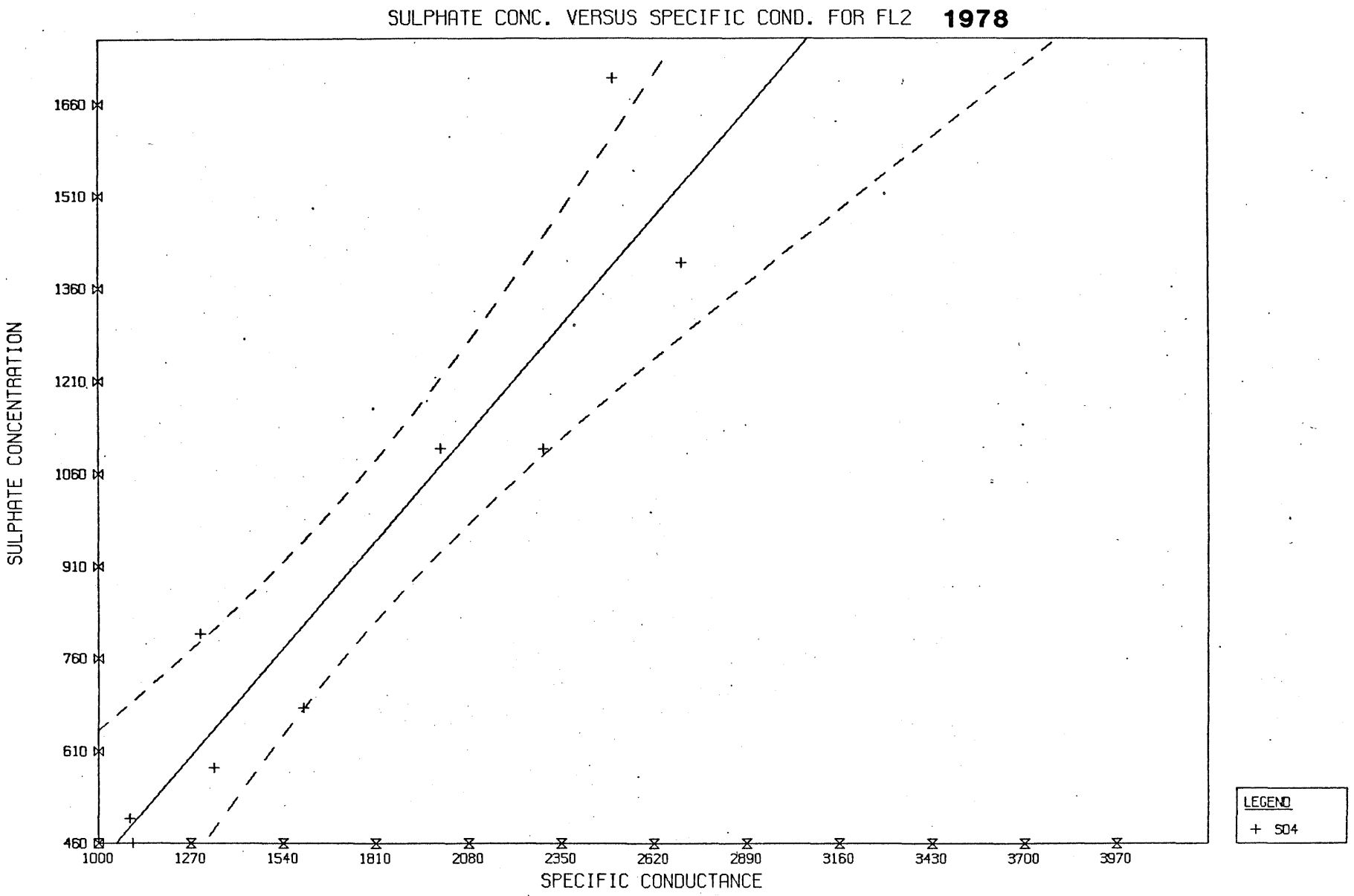

NICKEL CONC. VERSUS FLOW FOR FL4 1978
NICKEL CONCENTRATION
.33000
.30500
.28000
.25500
.23000
.20500
.18000
.15500
.13000
10
305
620
1230
1840
2450
3060
3670
4280
4890
5500
6110
6720
FLOW IN LITERS
LEGEND
+ NI

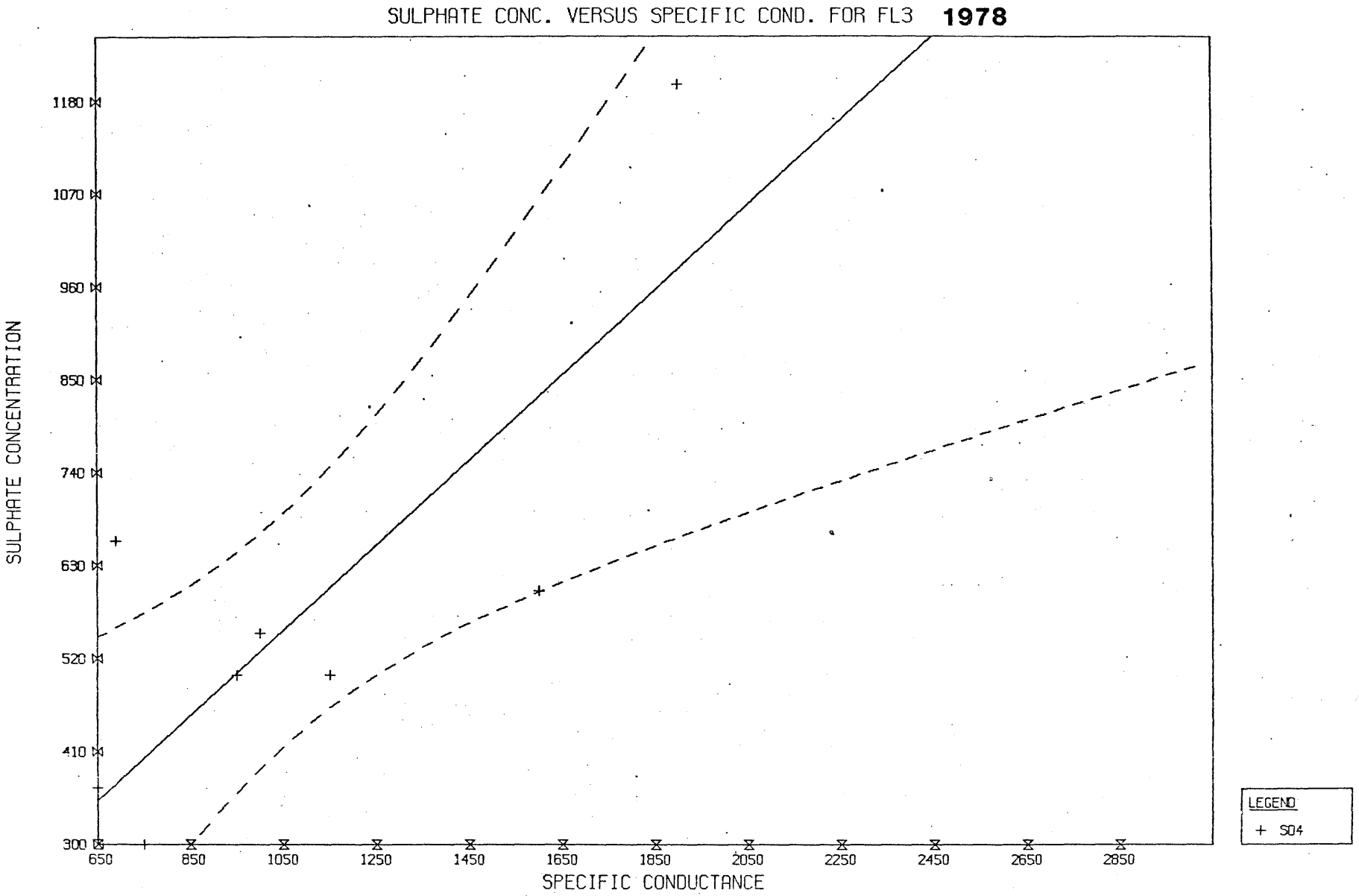

NICKEL CONC. VERSUS FLOW FOR FL5 1978
NICKEL CONCENTRATION
80
70
60
50
40
30
20
10
0
100
500
900
1300
1700
2100
2500
2900
3300
3700
4100
4500
FLOW IN LITERS
LEGEND
+ NI

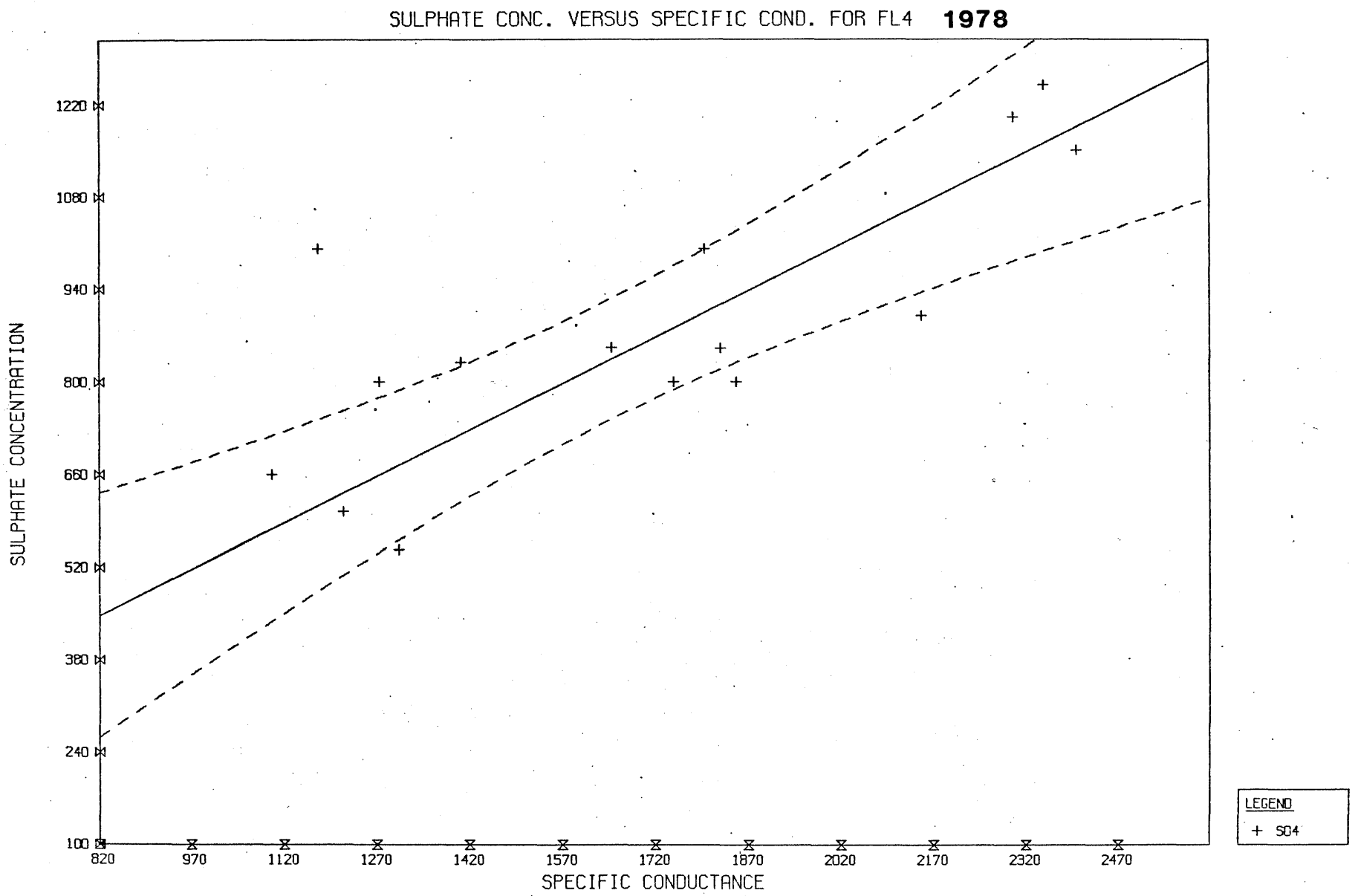
NICKEL CONC. VERSUS FLOW FOR FL6 **1978**

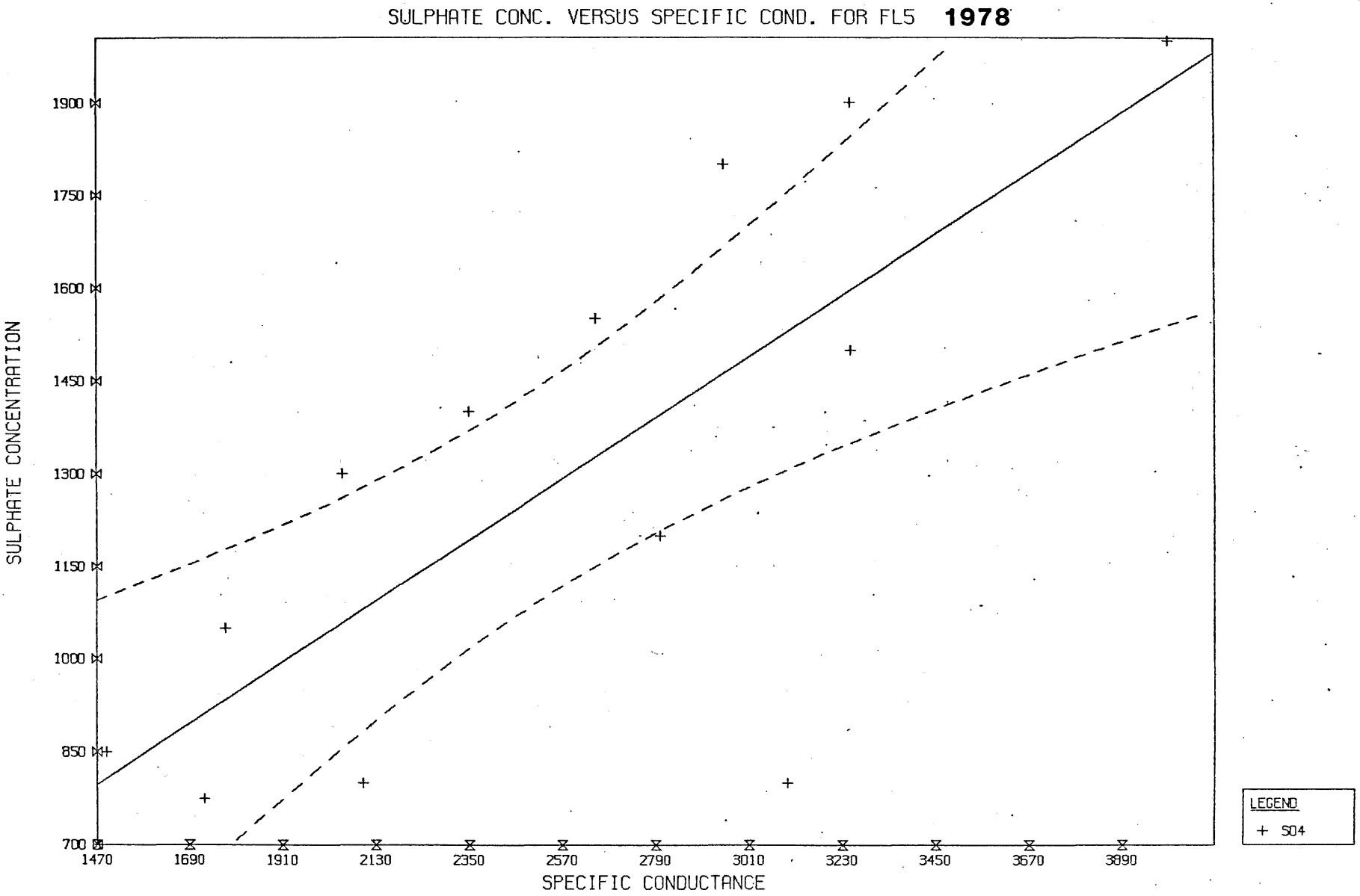



SULPHATE CONC. VERSUS SPECIFIC COND. FOR FL1 1978
SULPHATE CONCENTRATION
1760
1620
1480
1340
1200
1060
920
780
640
1100
1300
1500
1700
1900
2100
2300
2500
2700
2900
3100
3300
SPECIFIC CONDUCTANCE
LEGEND
+ SO4

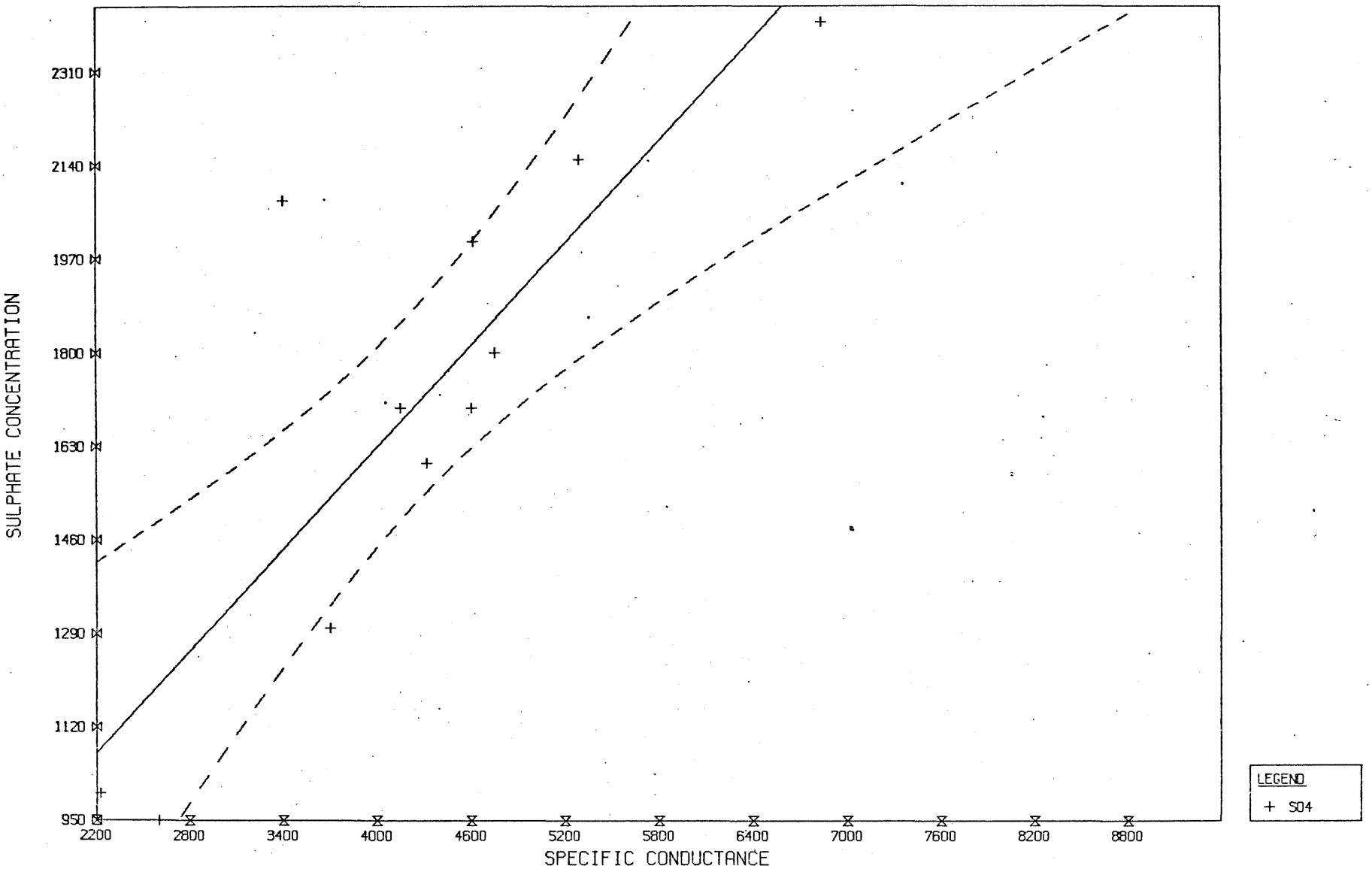

SULPHATE CONC. VERSUS SPECIFIC COND. FOR FL2 1978
SULPHATE CONCENTRATION
1660
1510
1360
1210
1060
910
760
610
460
1000
1270
1540
1810
2080
2350
2620
2890
3160
3430
3700
3970
SPECIFIC CONDUCTANCE
LEGEND
+ SO4

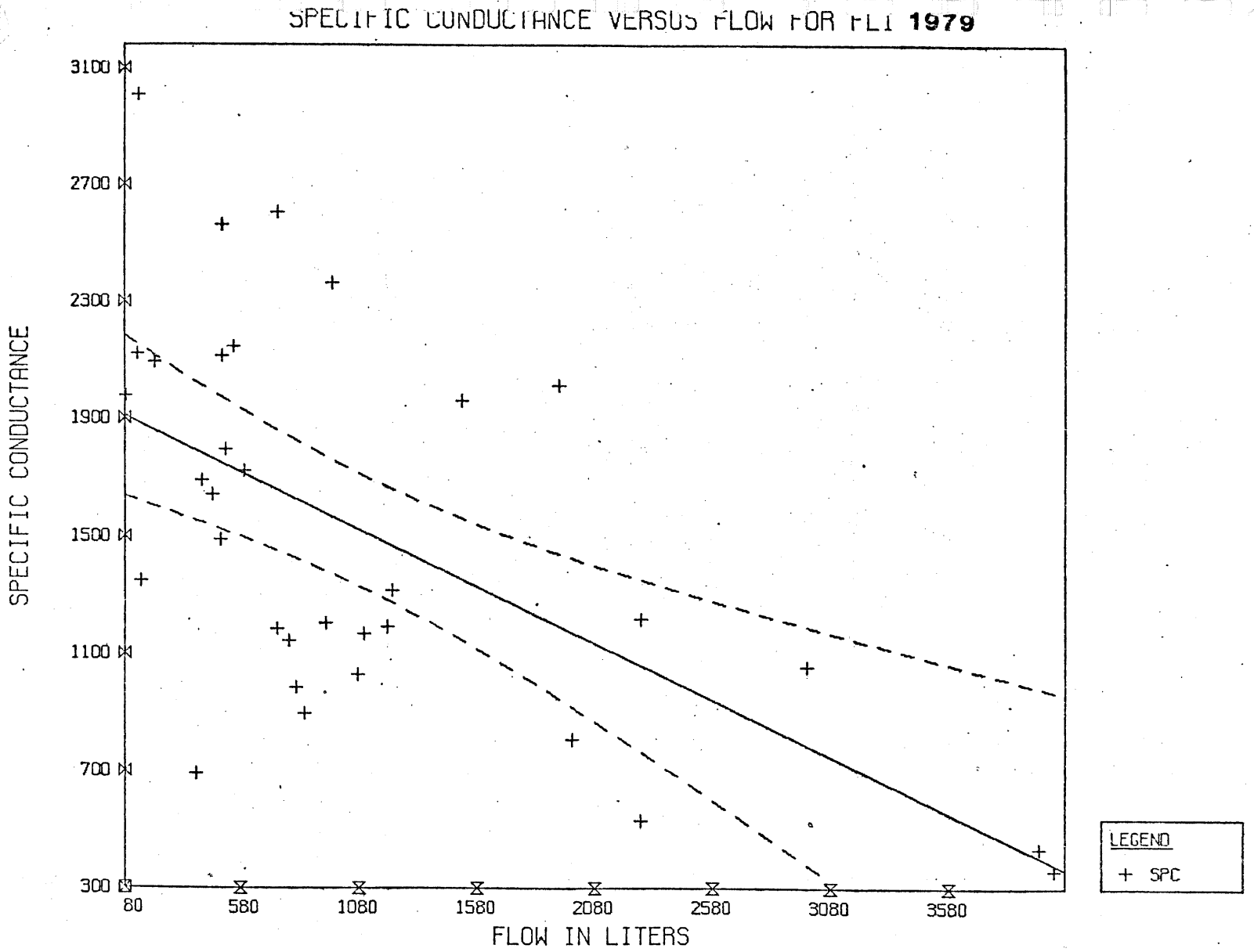

SULPHATE CONC. VERSUS SPECIFIC COND. FOR FL3 1978
SULPHATE CONCENTRATION
1180
1070
960
850
740
630
520
410
300
650
850
1050
1250
1450
1650
1850
2050
2250
2450
2650
2850
SPECIFIC CONDUCTANCE
LEGEND
+ SO4

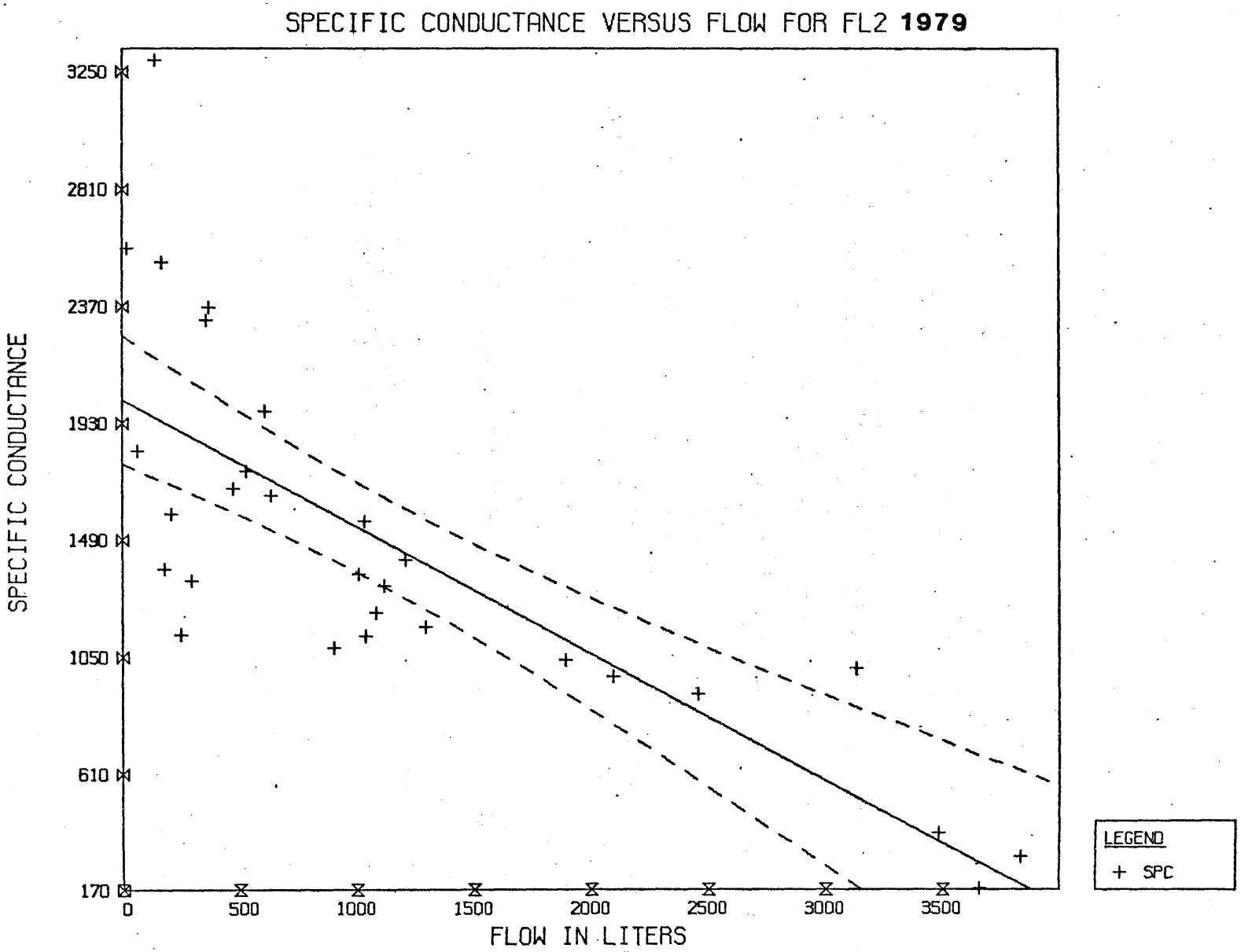

SULPHATE CONC. VERSUS SPECIFIC COND. FOR FL4 1978
SULPHATE CONCENTRATION
1220
1080
940
800
660
520
380
240
100
820
970
1120
1270
1420
1570
1720
1870
2020
2170
2320
2470
SPECIFIC CONDUCTANCE
LEGEND
+ SO4

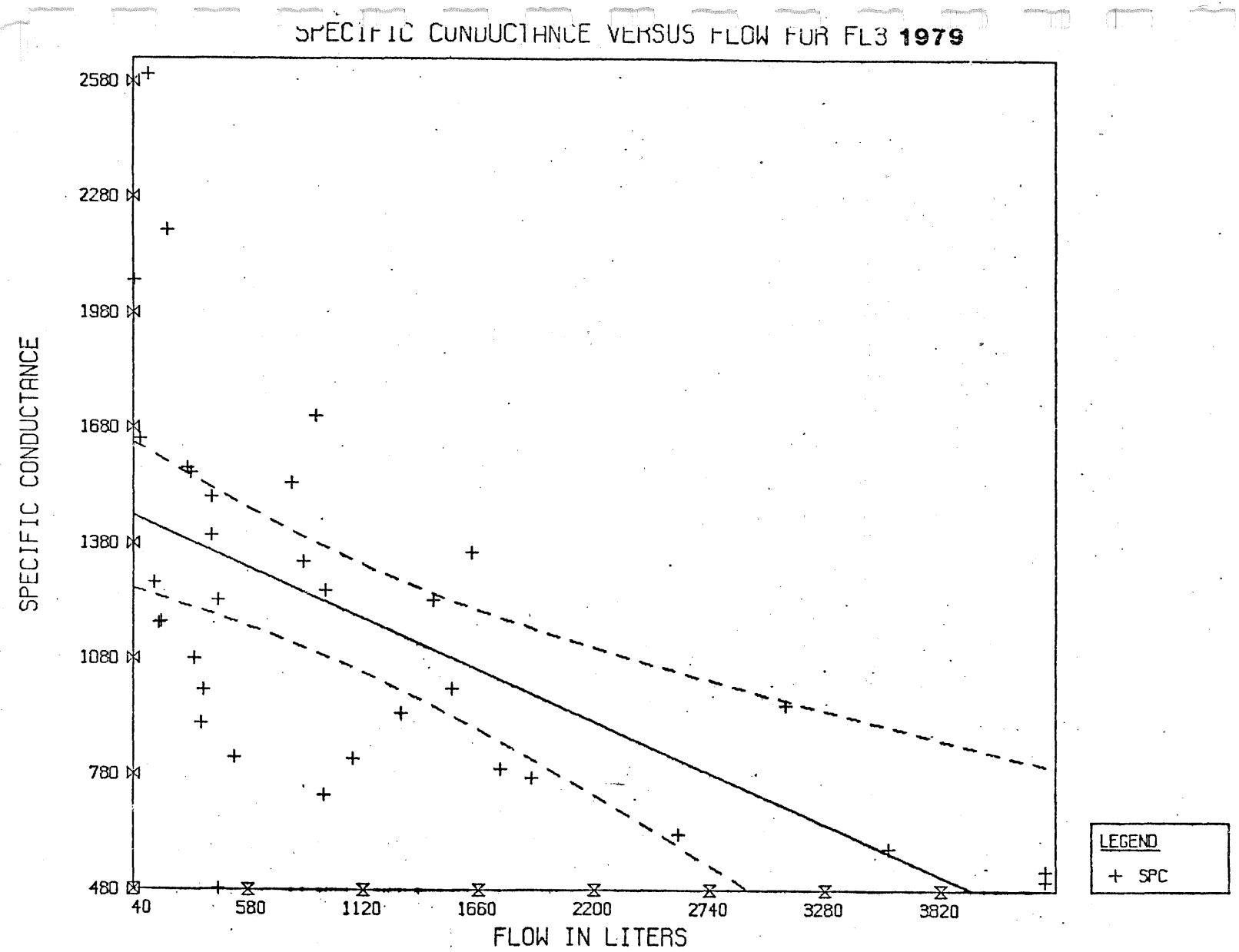

SULPHATE CONC. VERSUS SPECIFIC COND. FOR FL5 1978
SULPHATE CONCENTRATION
1900
1750
1600
1450
1300
1150
1000
850
700
1470
1690
1910
2130
2350
2570
2790
3010
3230
3450
3670
3890
SPECIFIC CONDUCTANCE
LEGEND
+ SO4

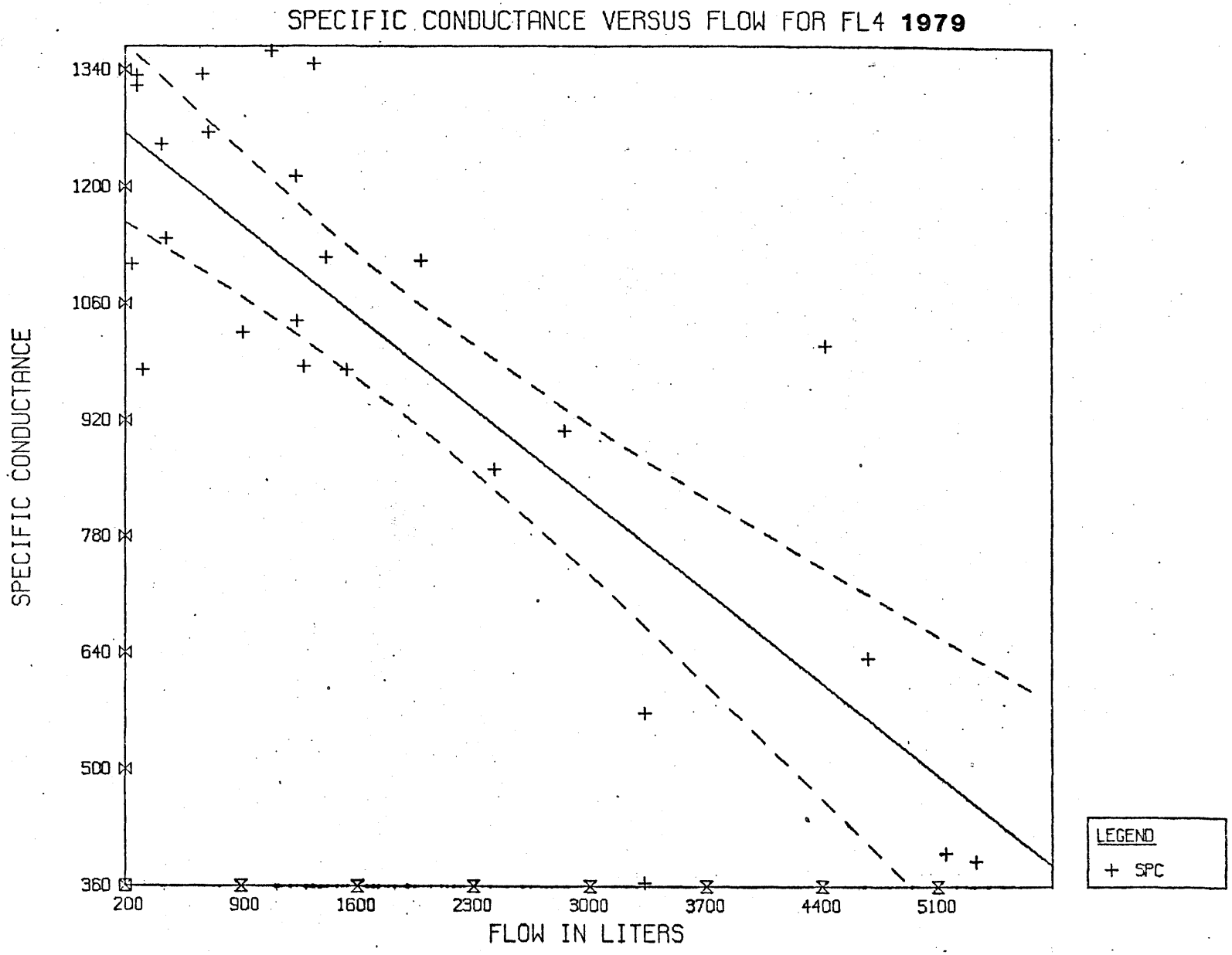
SULPHATE CONC. VERSUS SPECIFIC COND. FOR FL6 **1978**

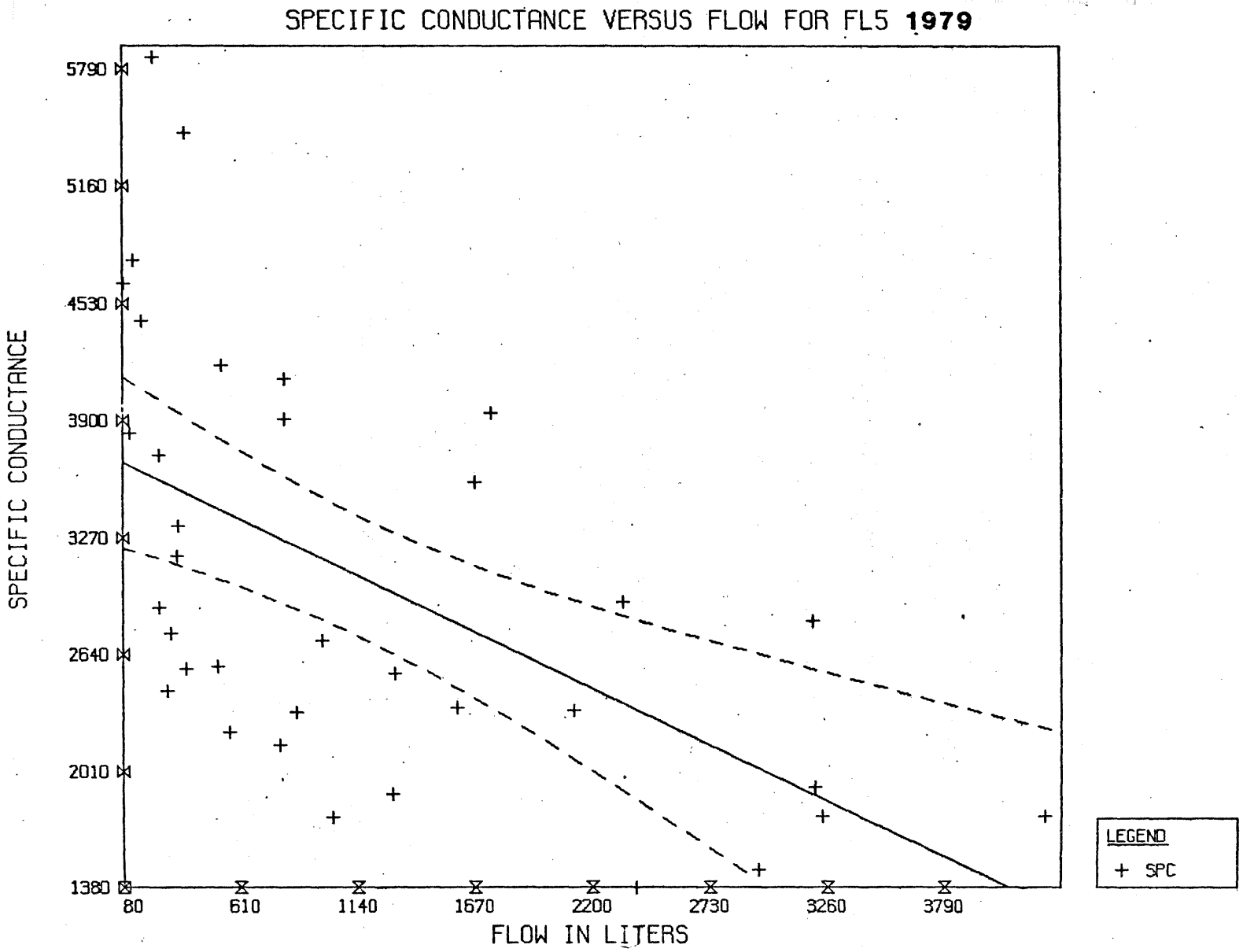


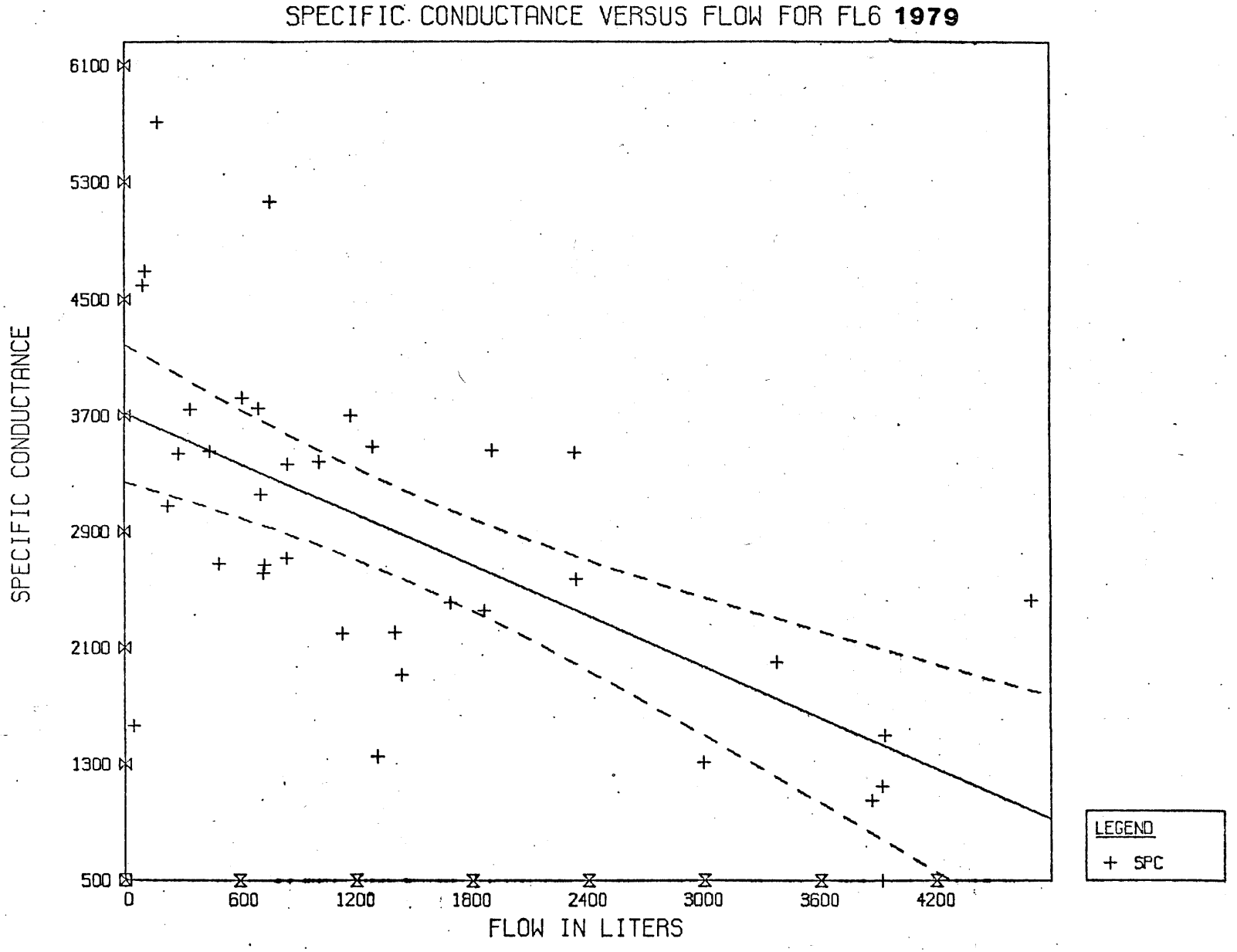

SPECIFIC CONDUCTANCE VERSUS FLOW FOR FLI 1979
SPECIFIC CONDUCTANCE
3100
2700
2300
1900
1500
1100
700
300
80
580
1080
1580
2080
2580
3080
3580
FLOW IN LITERS
LEGEND
+ SPC

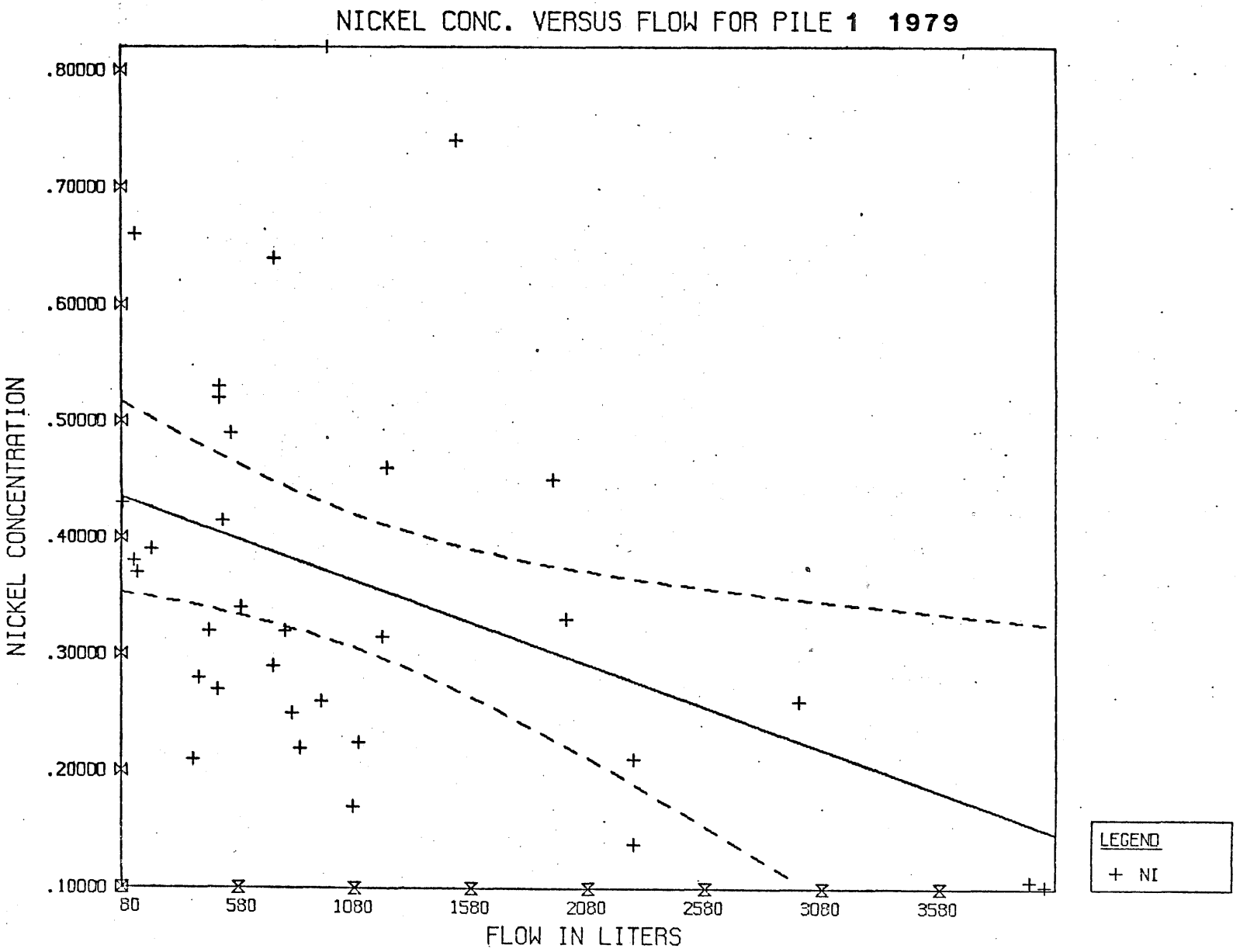

SPECIFIC CONDUCTANCE VERSUS FLOW FOR FL2 1979
SPECIFIC CONDUCTANCE
3250
2810
2370
1930
1490
1050
610
170
0
500
1000
1500
2000
2500
3000
3500
FLOW IN LITERS
LEGEND
+ SPC

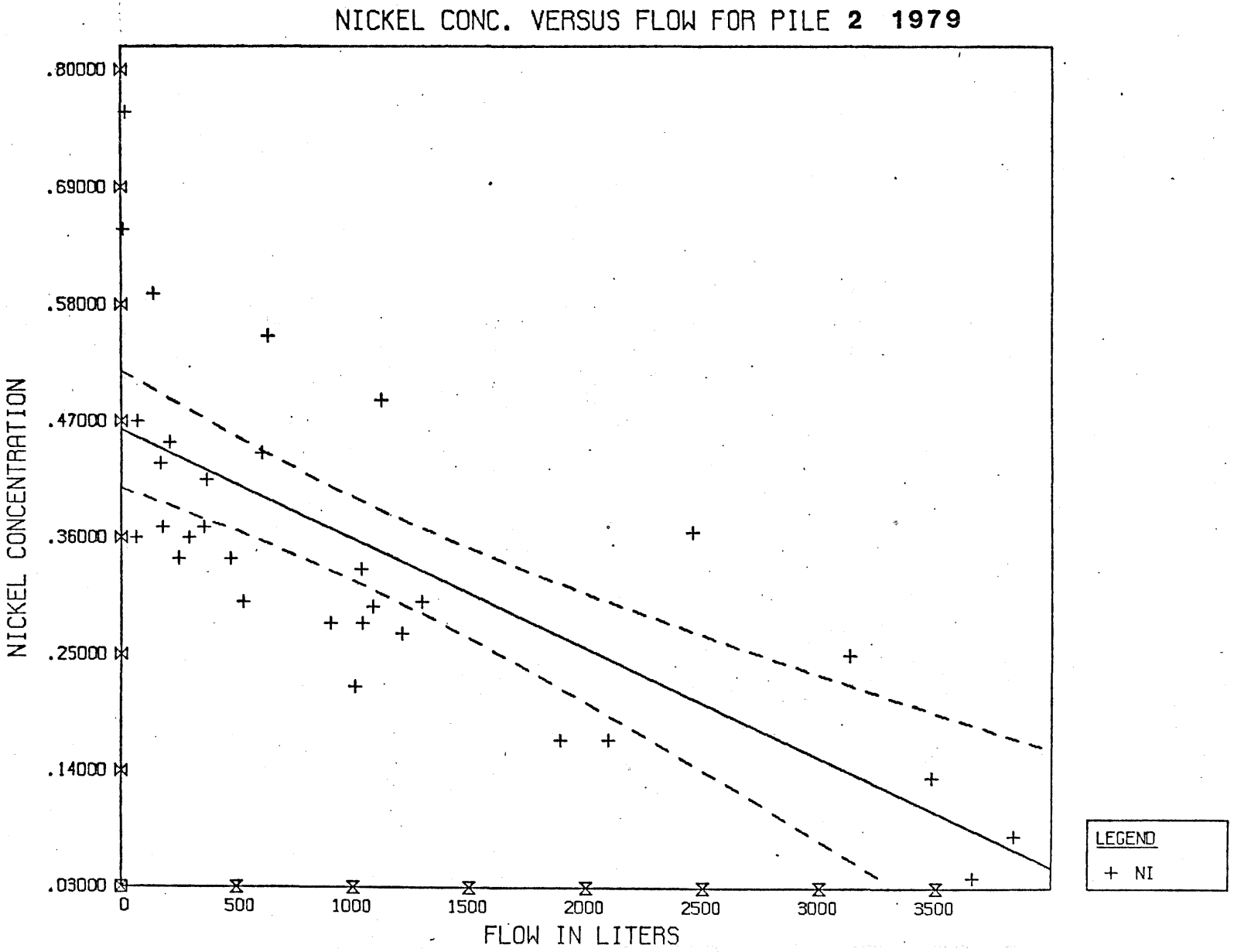

SPECIFIC CONDUCTANCE VERSUS FLOW FOR FL3 1979
SPECIFIC CONDUCTANCE
2580
2280
1980
1680
1380
1080
780
480
40
580
1120
1660
2200
2740
3280
3820
FLOW IN LITERS
LEGEND
+ SPC

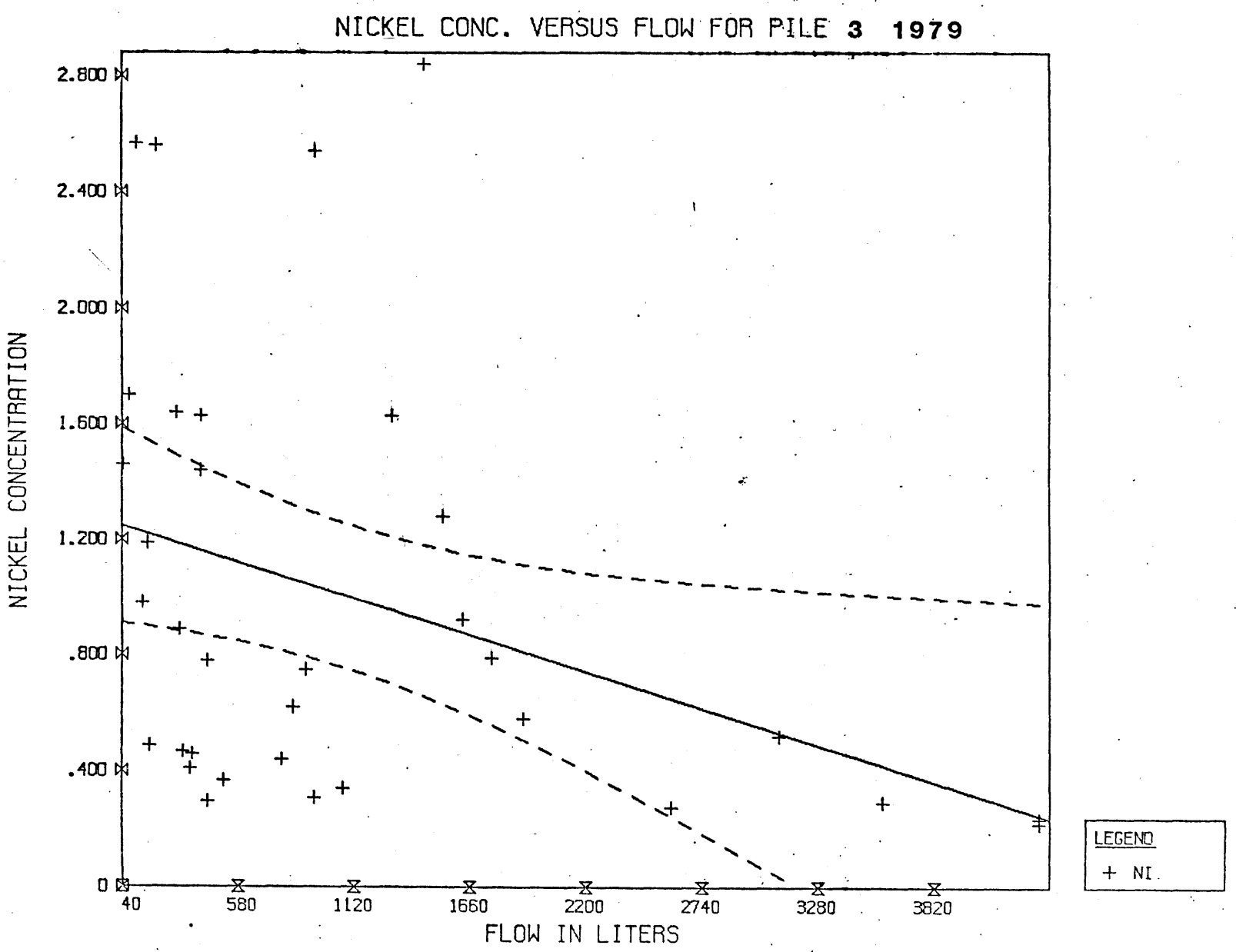

SPECIFIC CONDUCTANCE VERSUS FLOW FOR FL4 1979
SPECIFIC CONDUCTANCE
1340
1200
1060
920
780
640
500
360
200
900
1600
2300
3000
3700
4400
5100
FLOW IN LITERS
LEGEND
+ SPC

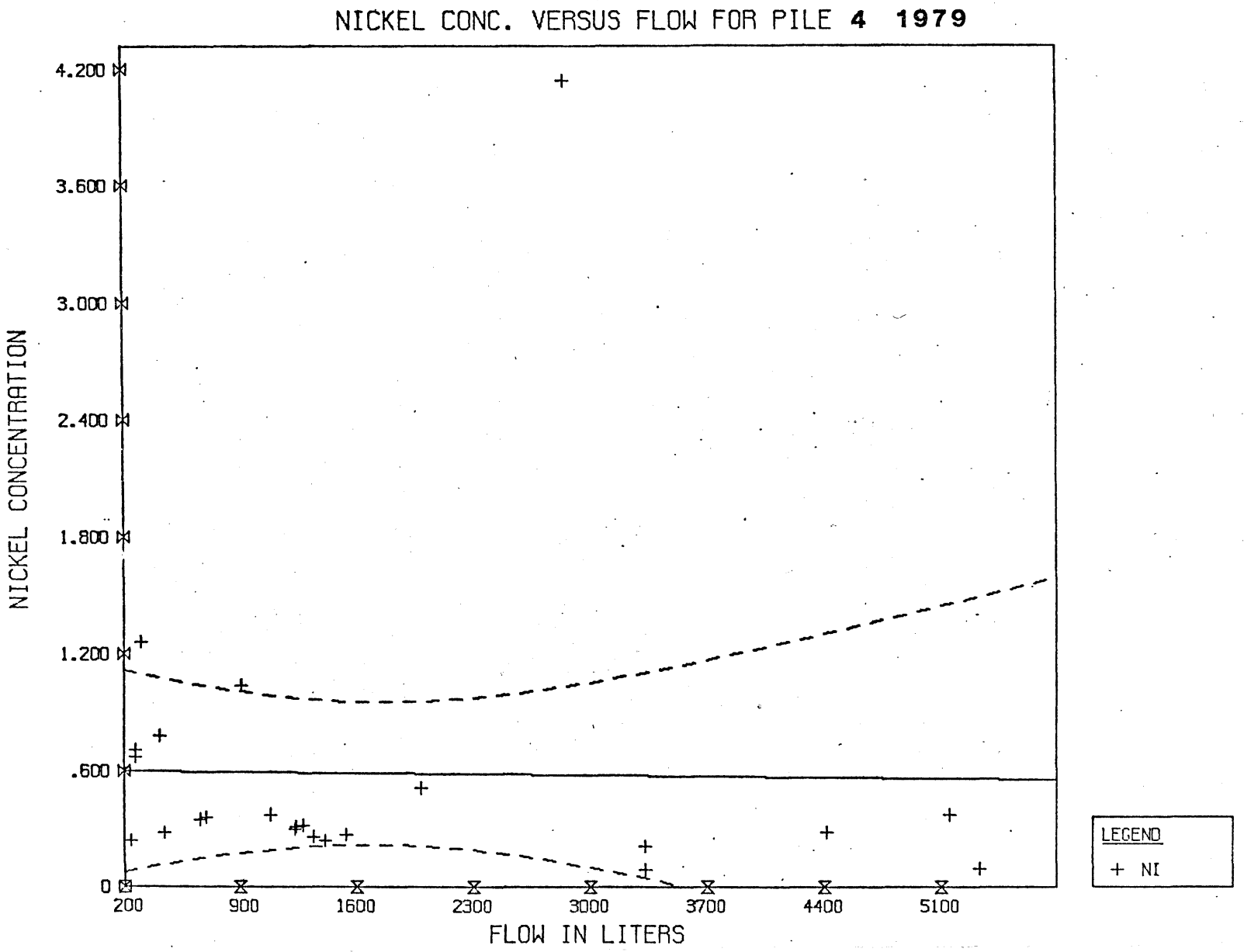

SPECIFIC CONDUCTANCE VERSUS FLOW FOR FL5 1979
SPECIFIC CONDUCTANCE
5790
5160
4530
3900
3270
2640
2010
1380
80
610
1140
1670
2200
2730
3260
3790
FLOW IN LITERS
LEGEND
+ SPC

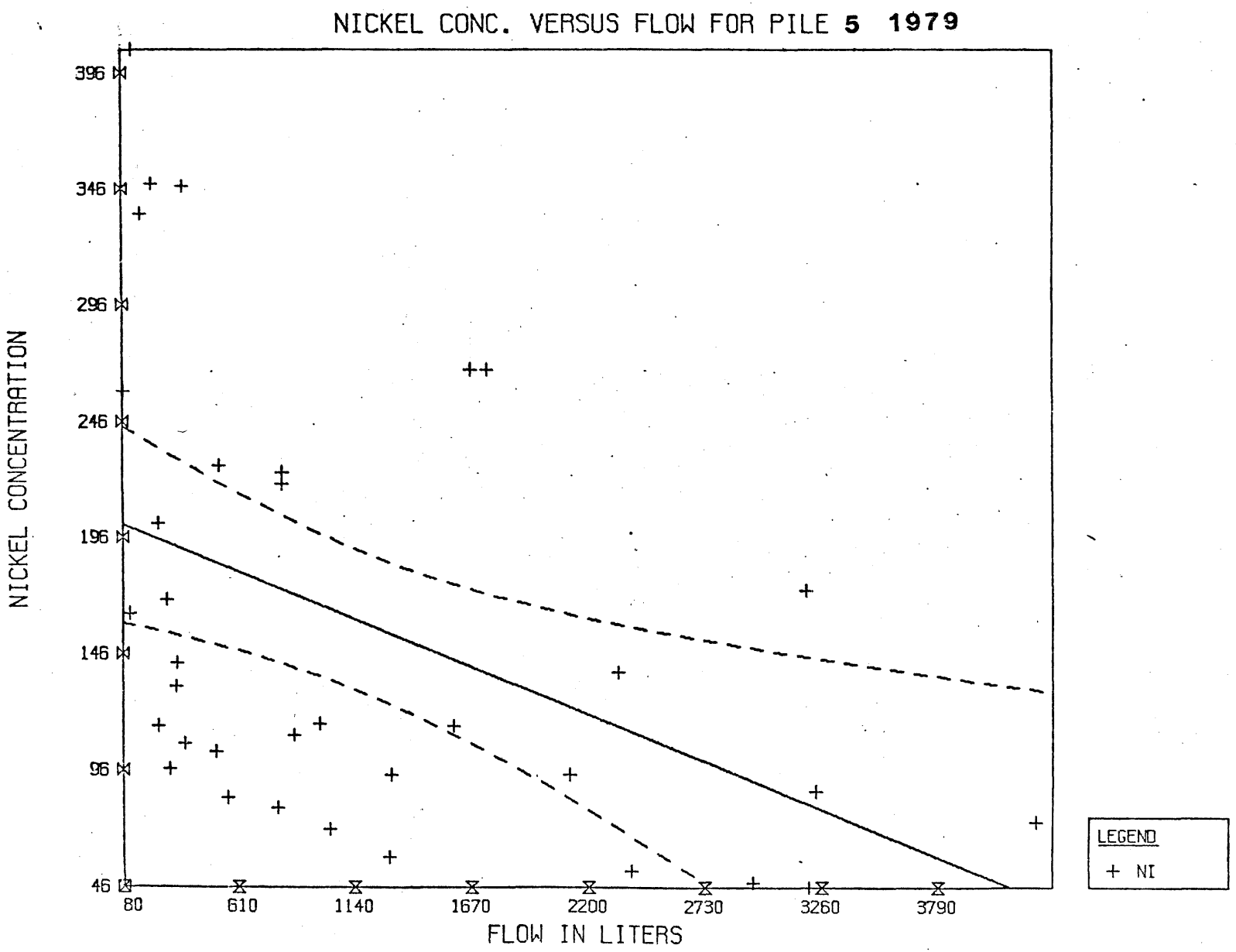

SPECIFIC CONDUCTANCE VERSUS FLOW FOR FL6 1979
SPECIFIC CONDUCTANCE
6100
5300
4500
3700
2900
2100
1300
500
0
600
1200
1800
2400
3000
3600
4200
FLOW IN LITERS
LEGEND
+ SPC

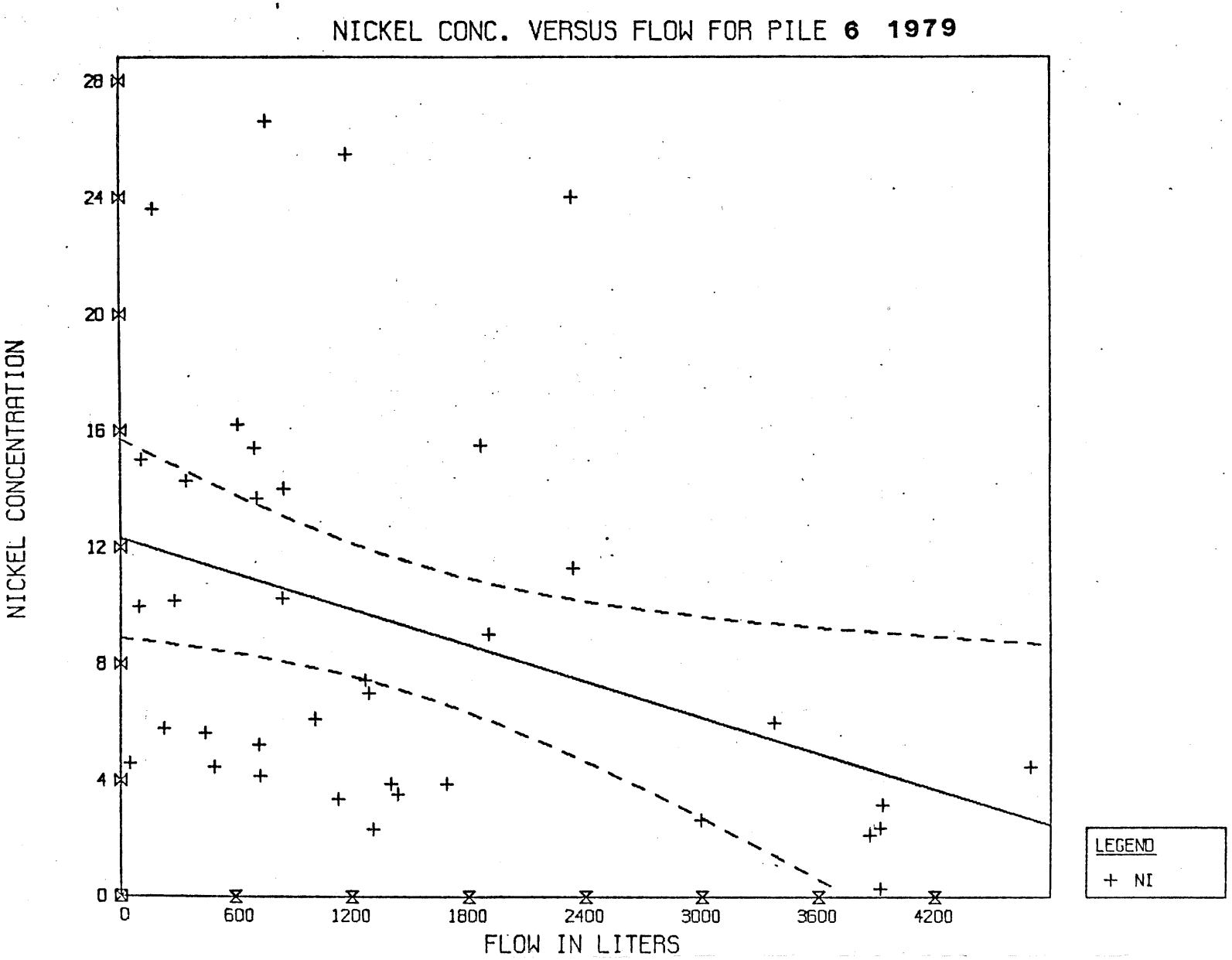

NICKEL CONC. VERSUS FLOW FOR PILE 1 1979
NICKEL CONCENTRATION
.80000
.70000
.60000
.50000
.40000
.30000
.20000
.10000
80
580
1080
1580
2080
2580
3080
3580
FLOW IN LITERS
LEGEND
+ NI

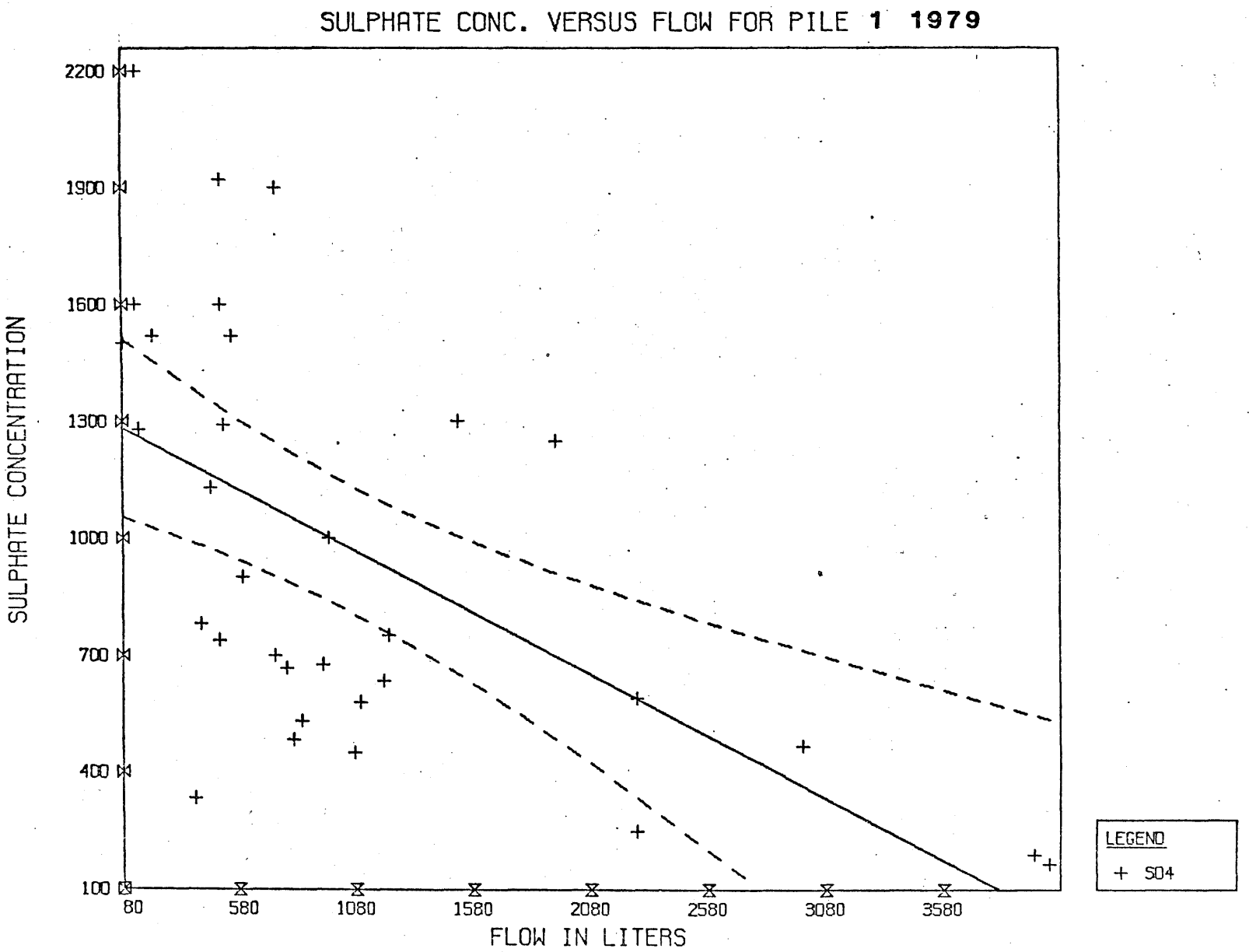

NICKEL CONC. VERSUS FLOW FOR PILE 2 1979
NICKEL CONCENTRATION
.80000
.69000
.58000
.47000
.36000
.25000
.14000
.03000
0
500
1000
1500
2000
2500
3000
3500
FLOW IN LITERS
LEGEND
+ NI

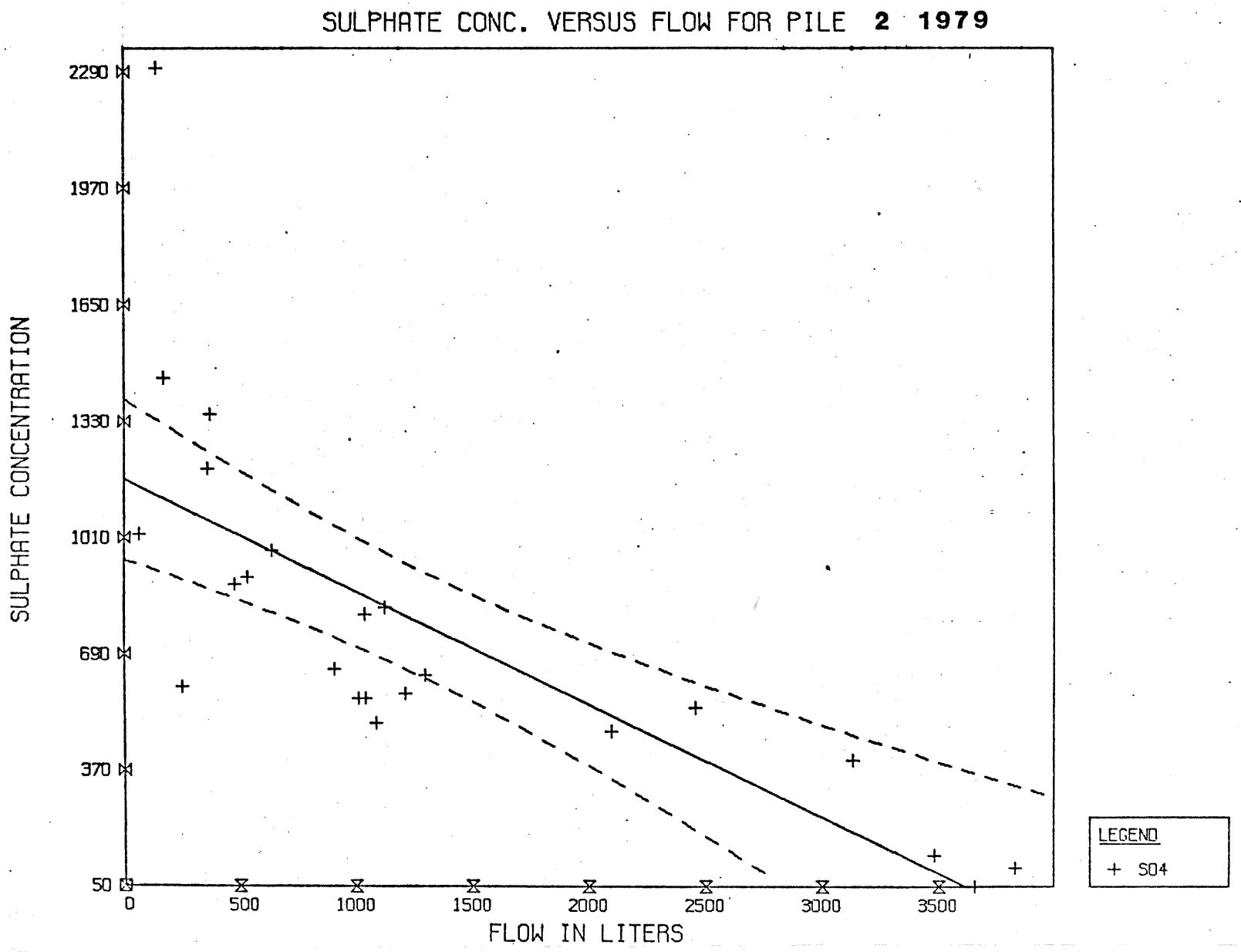

NICKEL CONC. VERSUS FLOW FOR PILE 3 1979
NICKEL CONCENTRATION
2.800
2.400
2.000
1.600
1.200
.800
.400
0
40
580
1120
1660
2200
2740
3280
3820
FLOW IN LITERS
LEGEND
+ NI

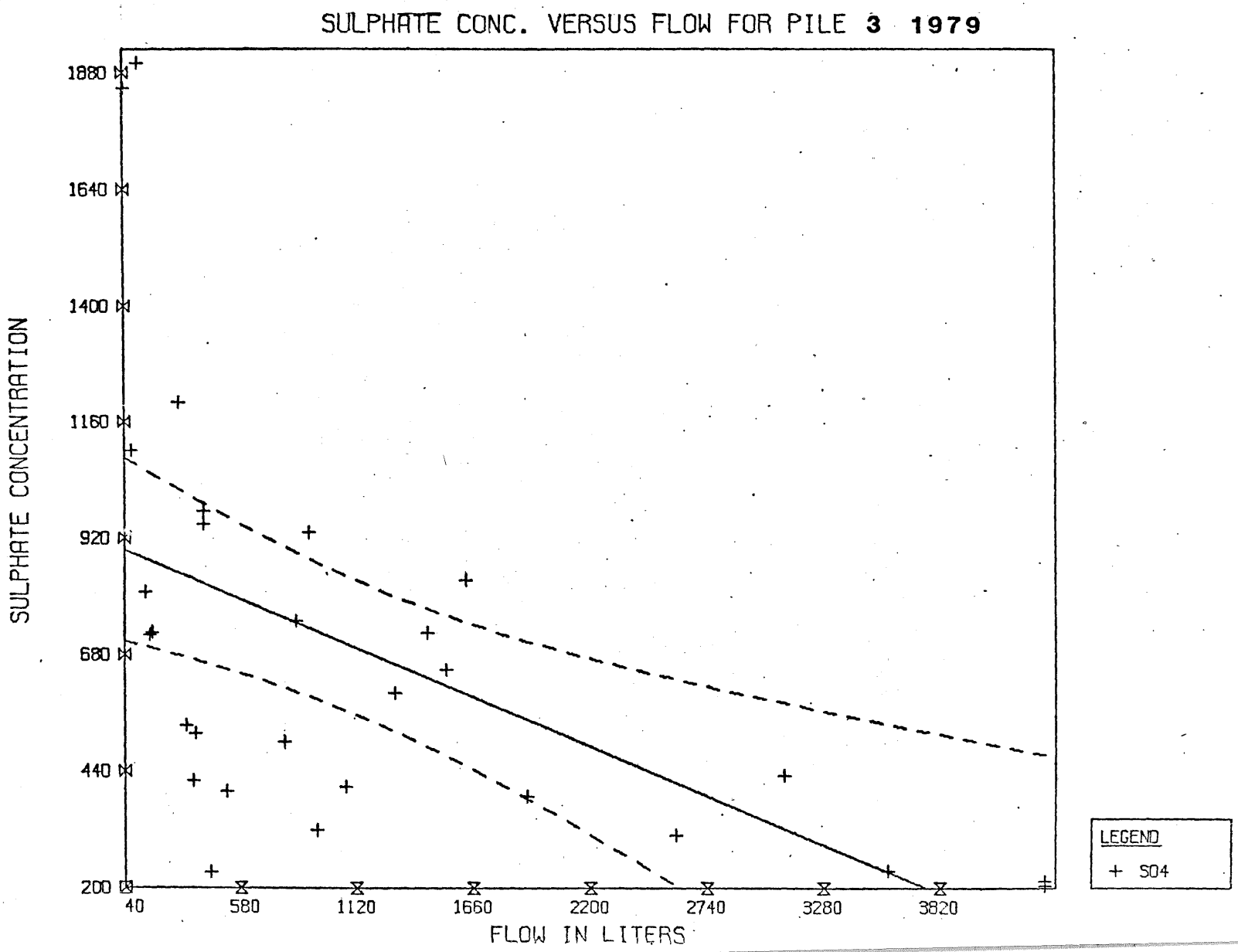

NICKEL CONC. VERSUS FLOW FOR PILE 4 1979
NICKEL CONCENTRATION
4.200
3.600
3.000
2.400
1.800
1.200
.600
0
200
900
1600
2300
3000
3700
4400
5100
FLOW IN LITERS
LEGEND
+ NI

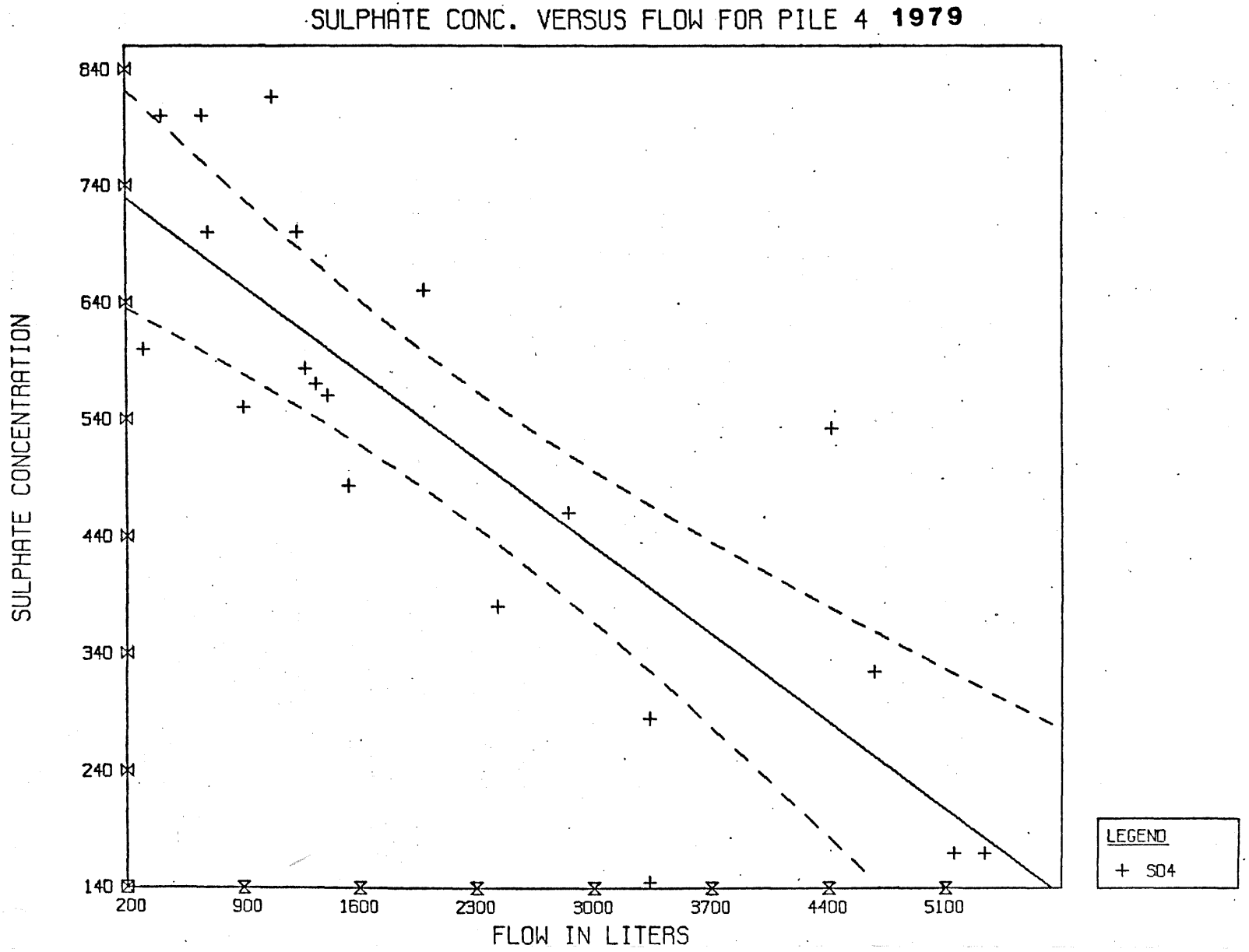

NICKEL CONC. VERSUS FLOW FOR PILE 5 1979
NICKEL CONCENTRATION
396
346
296
246
196
146
96
46
80
610
1140
1670
2200
2730
3260
3790
FLOW IN LITERS
LEGEND
+ NI

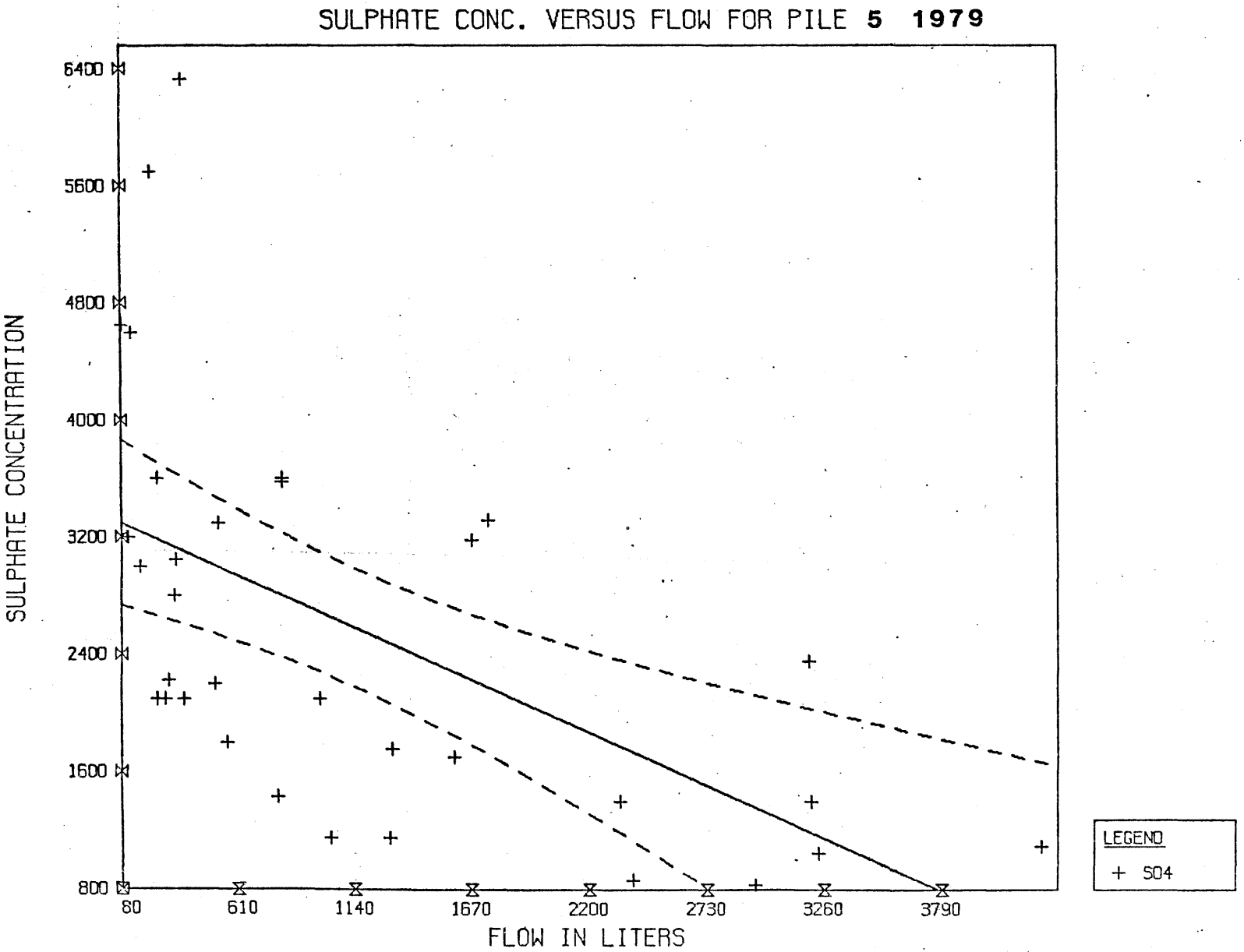

NICKEL CONC. VERSUS FLOW FOR PILE 6 1979
NICKEL CONCENTRATION
28
24
20
16
12
8
4
0
0
600
1200
1800
2400
3000
3600
4200
FLOW IN LITERS
LEGEND
+ NI

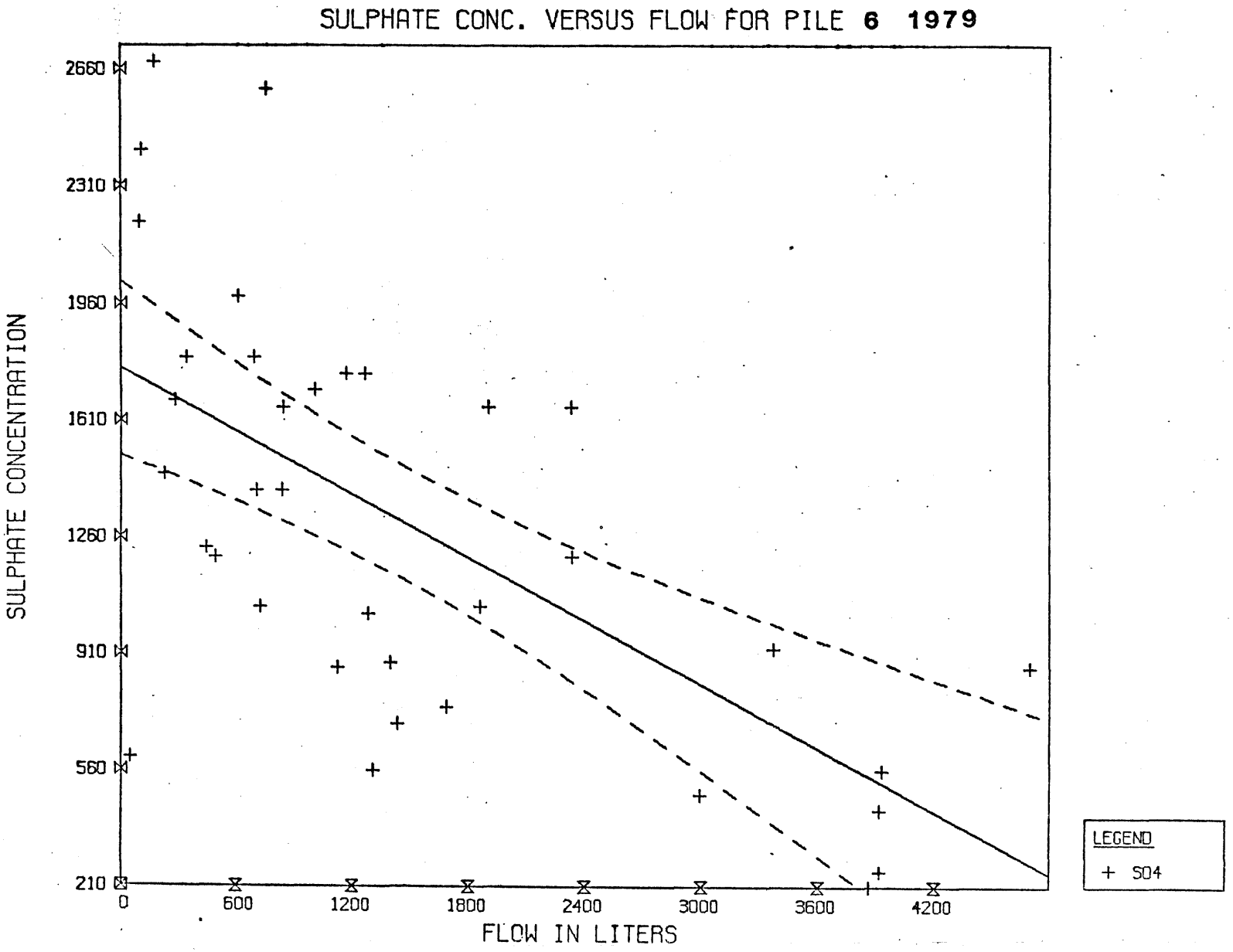

SULPHATE CONC. VERSUS FLOW FOR PILE 1 1979
SULPHATE CONCENTRATION
2200
1900
1600
1300
1000
700
400
100
80
580
1080
1580
2080
2580
3080
3580
FLOW IN LITERS
LEGEND
+ SO4

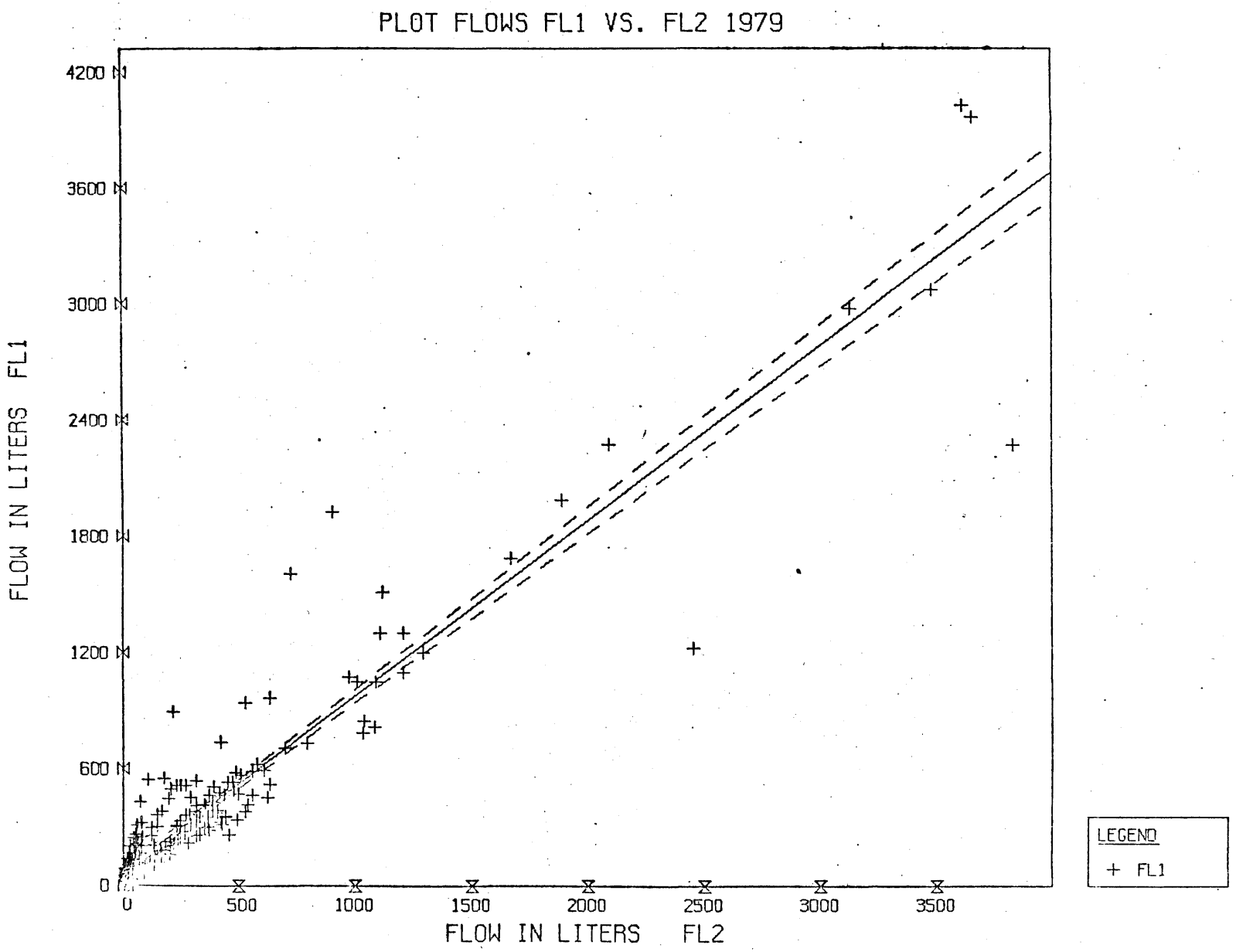

SULPHATE CONC. VERSUS FLOW FOR PILE 2 1979
SULPHATE CONCENTRATION
2290
1970
1650
1330
1010
690
370
50
0
500
1000
1500
2000
2500
3000
3500
FLOW IN LITERS
LEGEND
+ SO4

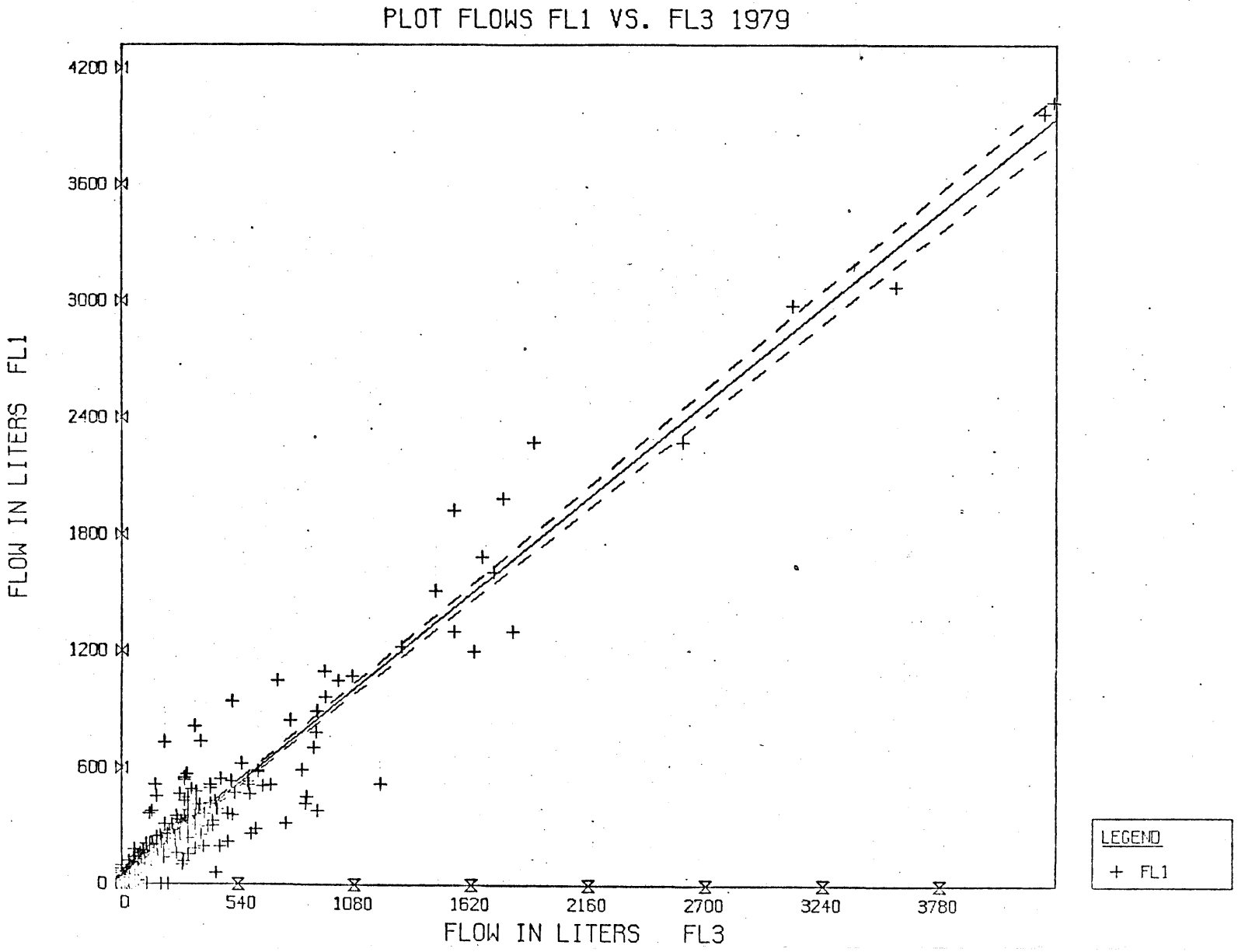

SULPHATE CONC. VERSUS FLOW FOR PILE 3 1979
SULPHATE CONCENTRATION
1880
1640
1400
1160
920
680
440
200
40
580
1120
1660
2200
2740
3280
3820
FLOW IN LITERS
LEGEND
+ SO4

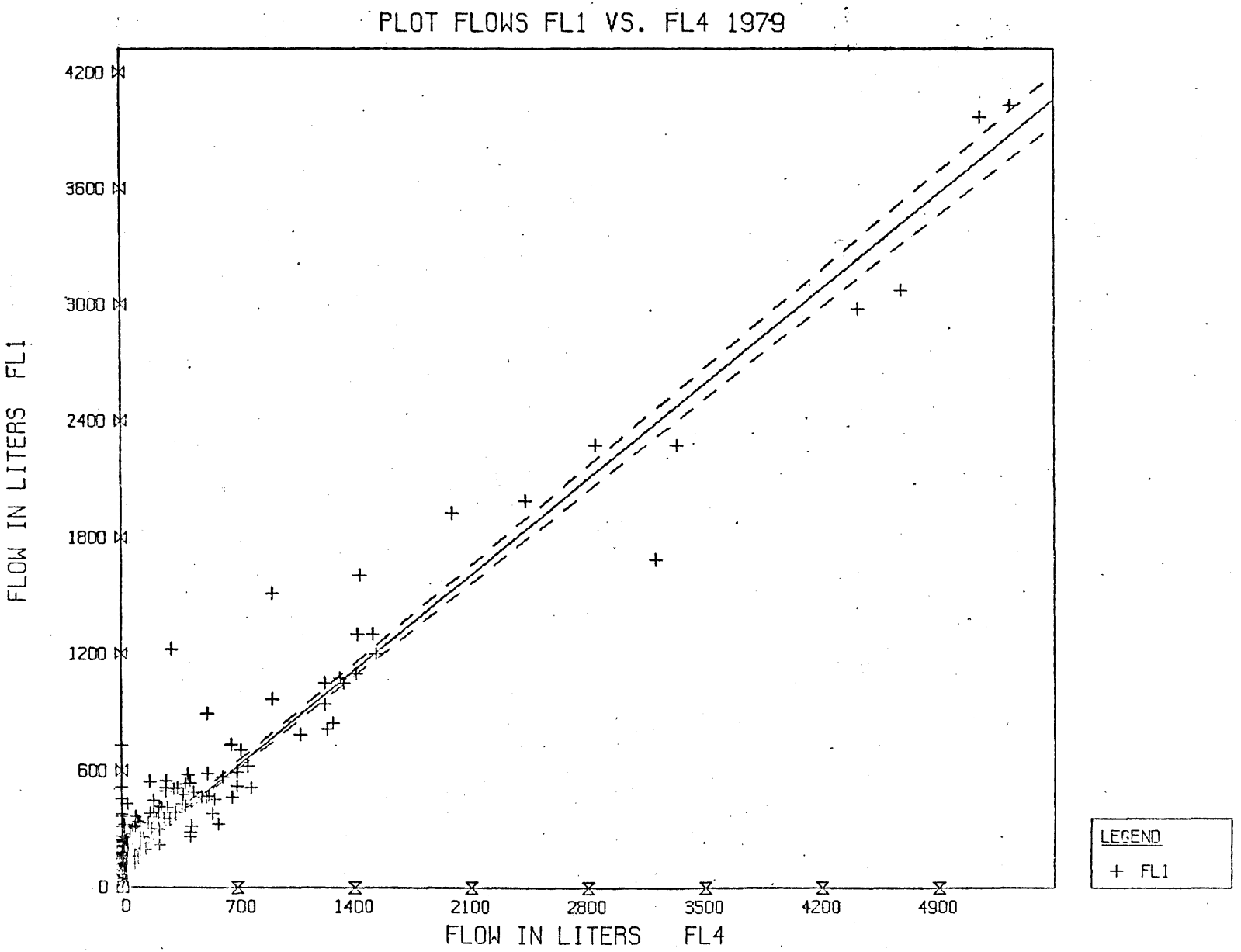

SULPHATE CONC. VERSUS FLOW FOR PILE 4 1979
SULPHATE CONCENTRATION
840
740
640
540
440
340
240
140
200
900
1600
2300
3000
3700
4400
5100
FLOW IN LITERS
LEGEND
+ SO4

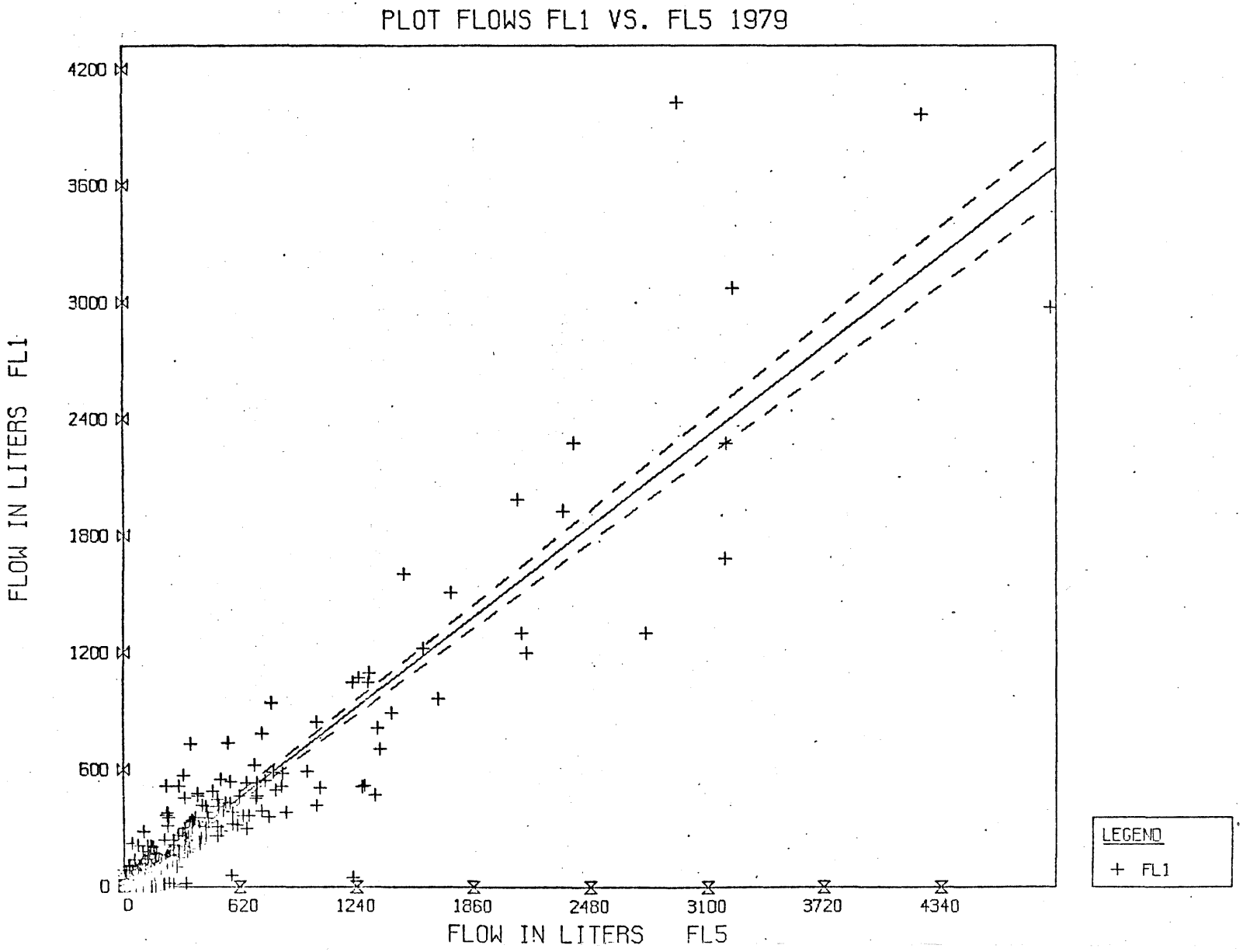

SULPHATE CONC. VERSUS FLOW FOR PILE 5 1979
SULPHATE CONCENTRATION
6400
5600
4800
4000
3200
2400
1600
800
80
610
1140
1670
2200
2730
3260
3790
FLOW IN LITERS
LEGEND
+ SO4

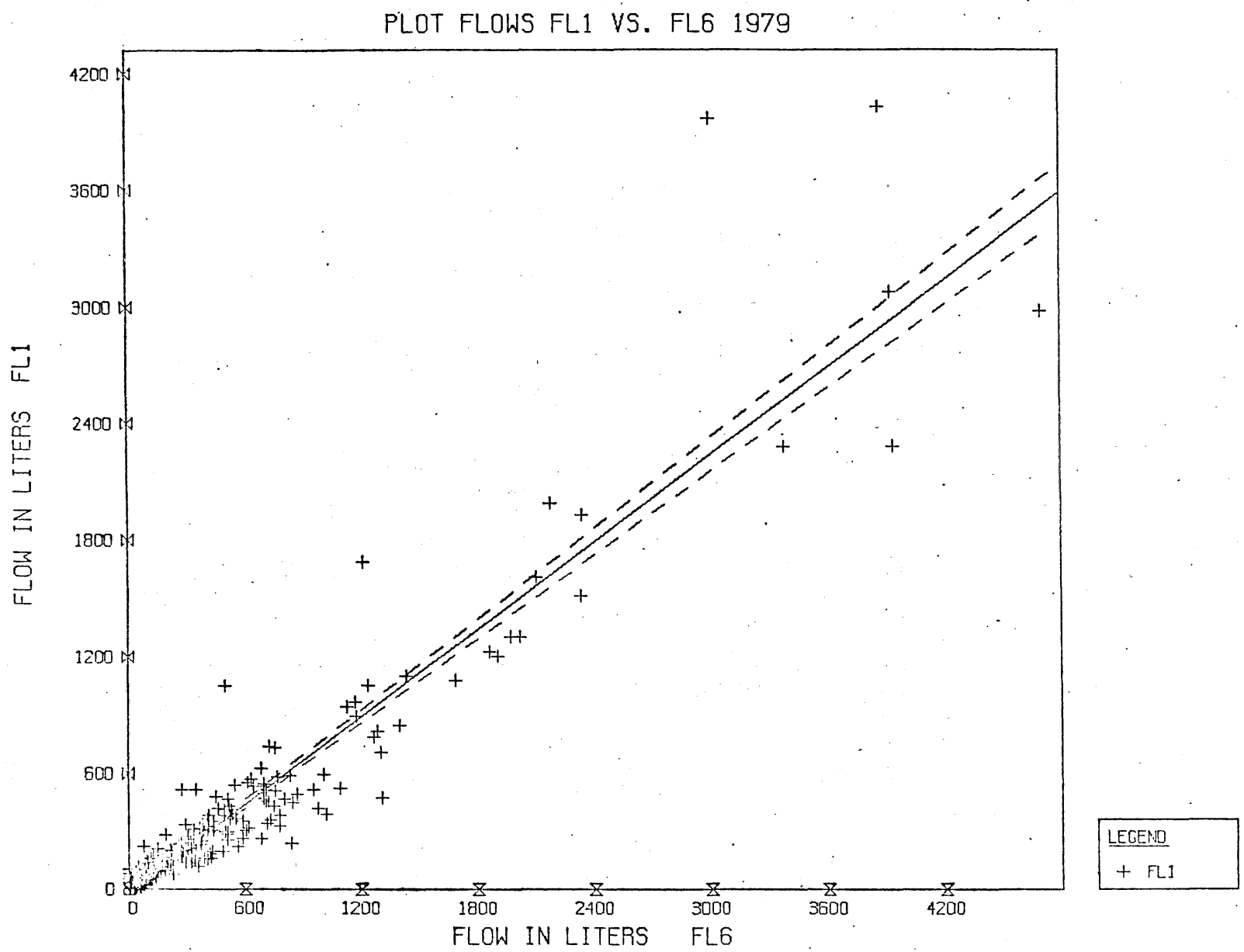

SULPHATE CONC. VERSUS FLOW FOR PILE 6 1979
SULPHATE CONCENTRATION
2660
2310
1960
1610
1260
910
560
210
0
600
1200
1800
2400
3000
3600
4200
FLOW IN LITERS
LEGEND
+ SO4

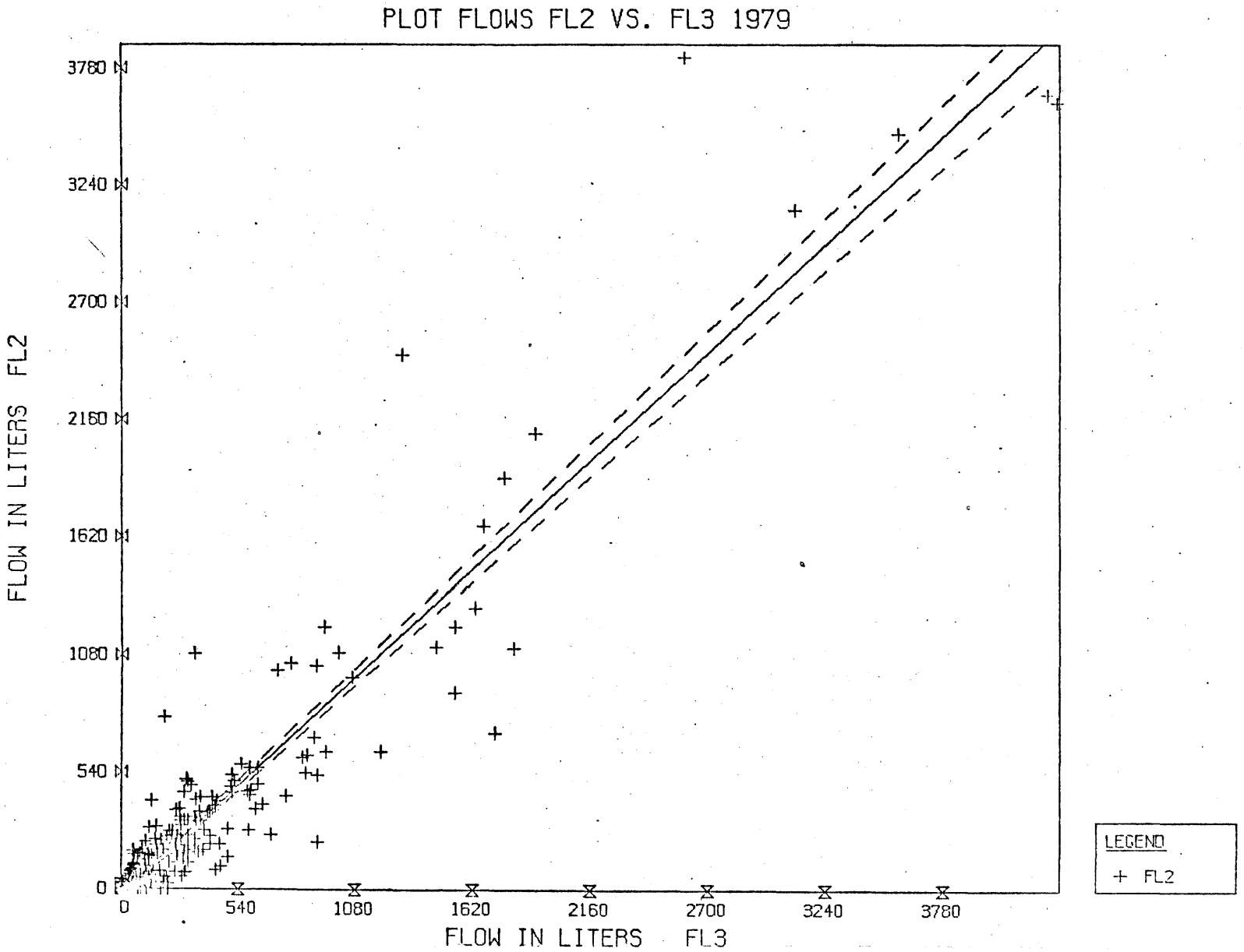

PLOT FLOWS FL1 VS. FL2 1979
FLOW IN LITERS FL1
4200
3600
3000
2400
1800
1200
600
0
0
500
1000
1500
2000
2500
3000
3500
FLOW IN LITERS FL2
LEGEND
+ FL1

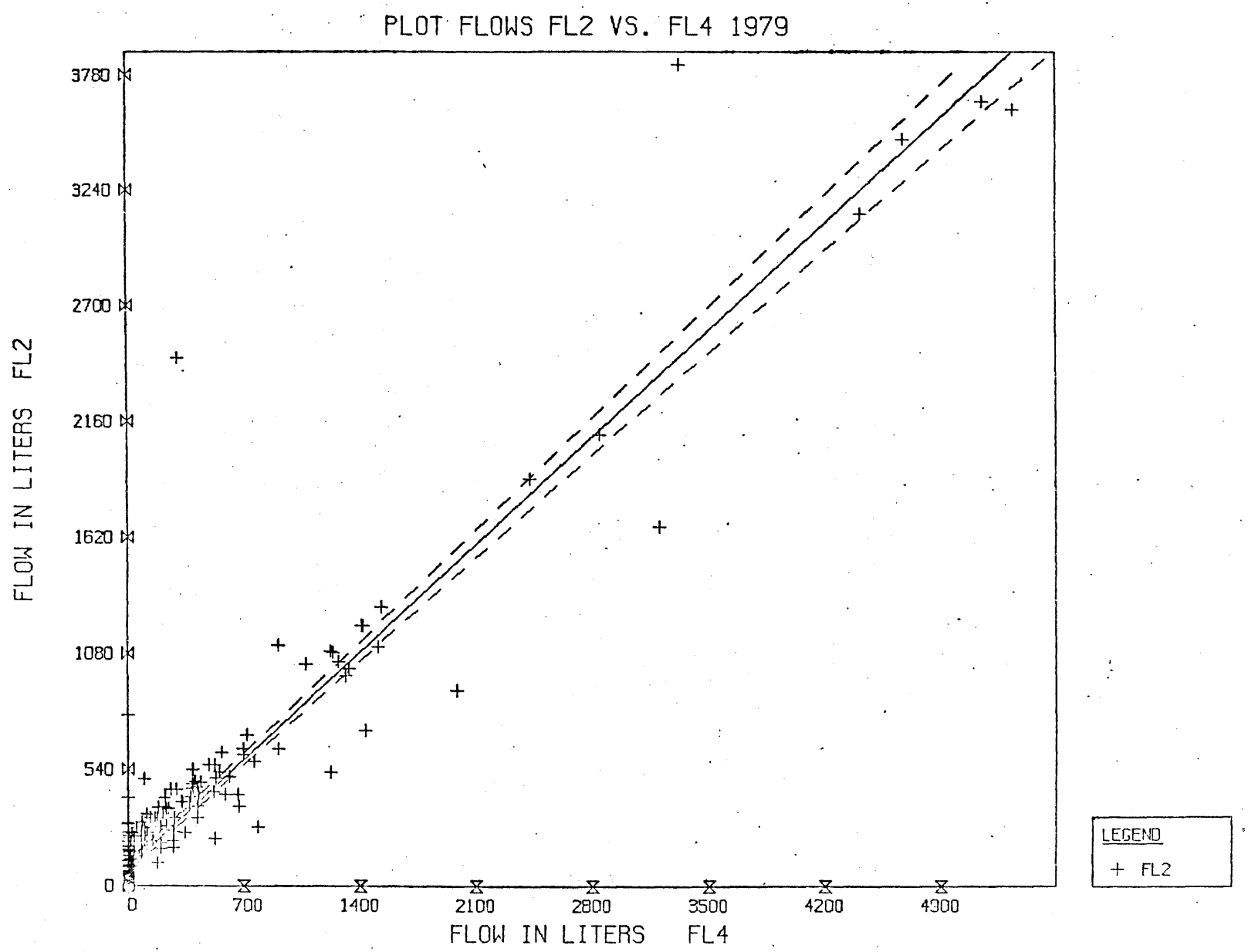

PLOT FLOWS FL1 VS. FL3 1979
FLOW IN LITERS FL1
4200
3600
3000
2400
1800
1200
600
0
0
540
1080
1620
2160
2700
3240
3780
FLOW IN LITERS FL3
LEGEND
+ FL1

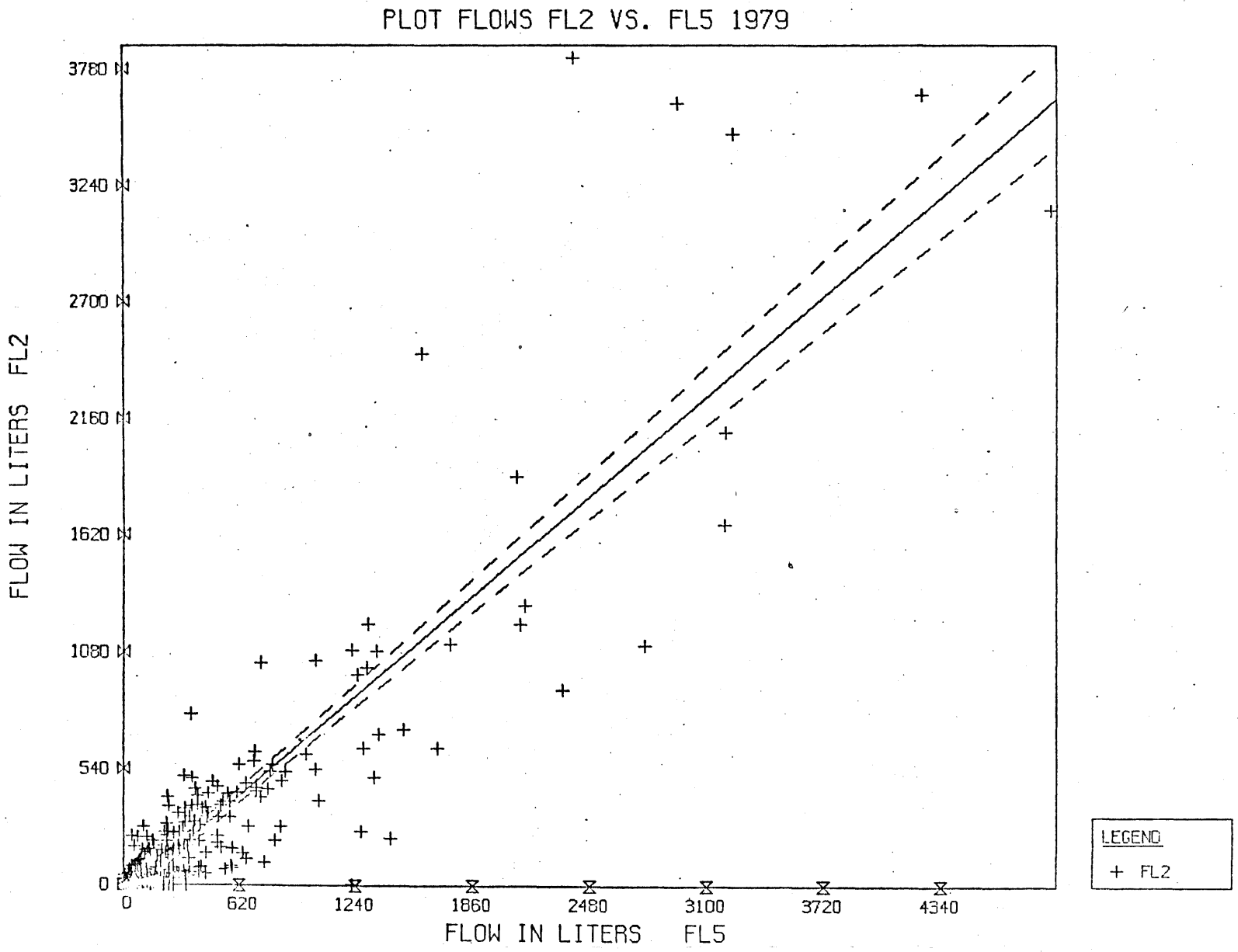

PLOT FLOWS FL1 VS. FL4 1979
FLOW IN LITERS FL1
4200
3600
3000
2400
1800
1200
600
0
0
700
1400
2100
2800
3500
4200
4900
FLOW IN LITERS FL4
LEGEND
+ FL1

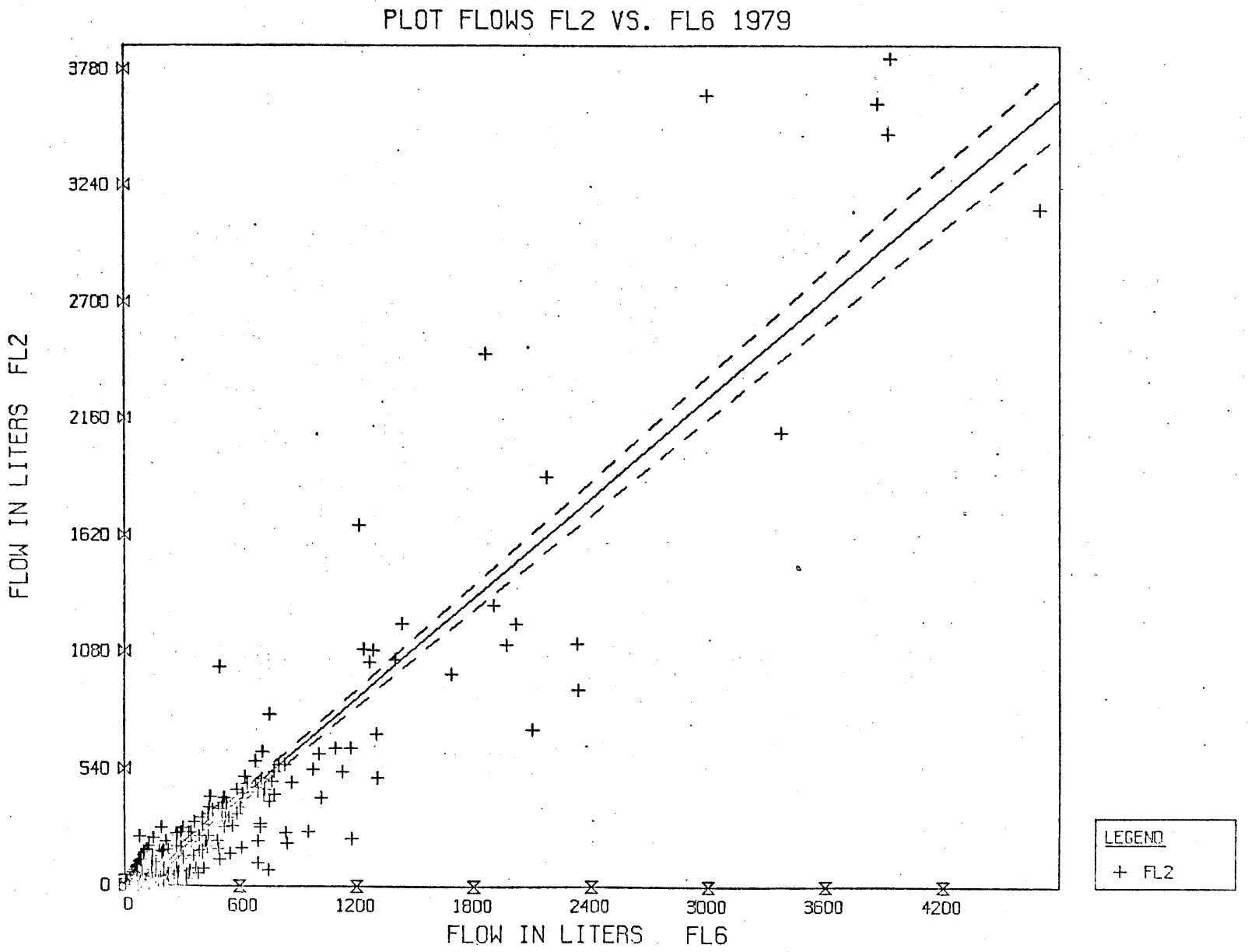

PLOT FLOWS FL1 VS. FL5 1979
FLOW IN LITERS FL1
4200
3600
3000
2400
1800
1200
600
0
0
620
1240
1860
2480
3100
3720
4340
FLOW IN LITERS FL5
LEGEND
+ FL1

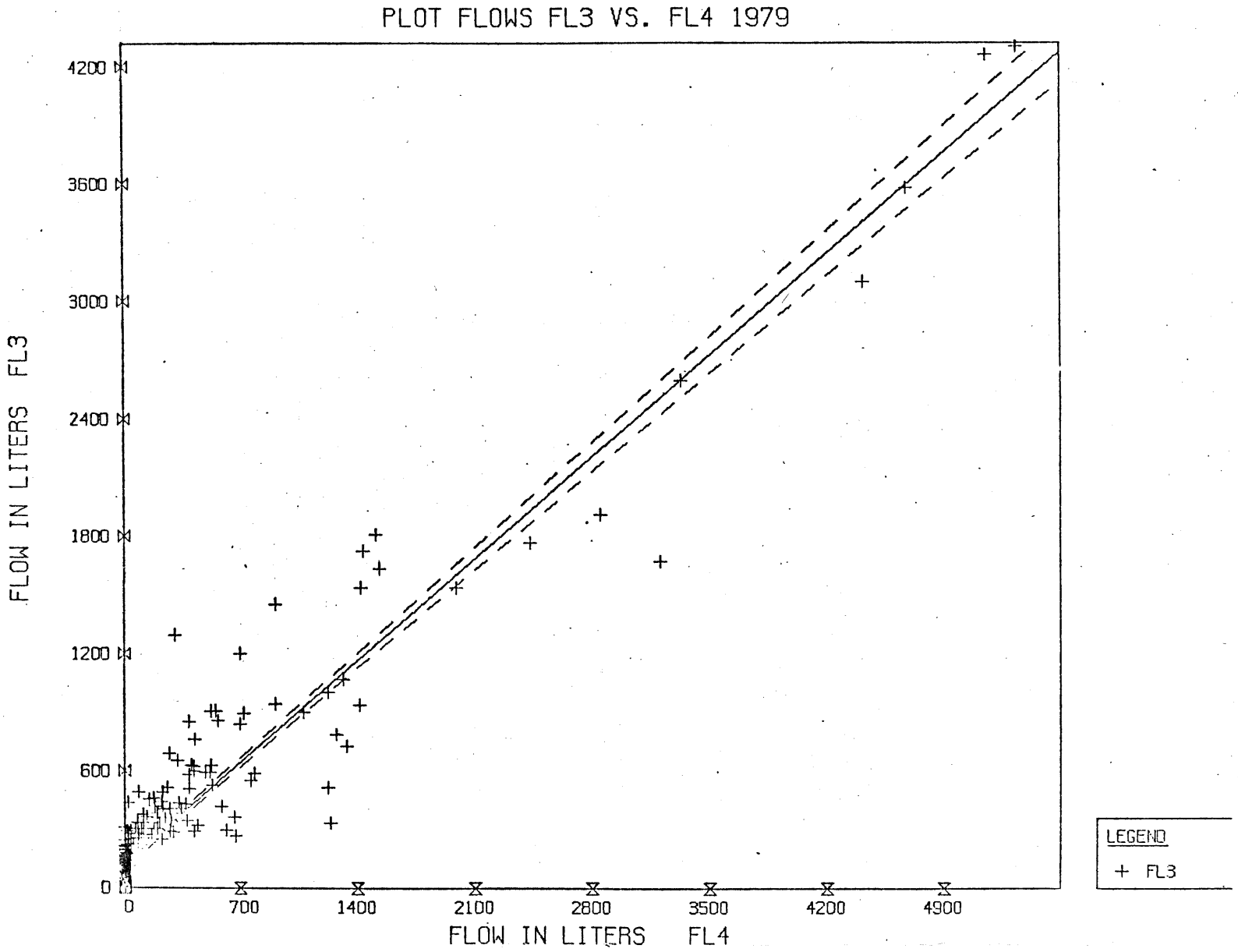

PLOT FLOWS FL1 VS. FL6 1979
FLOW IN LITERS FL1
4200
3600
3000
2400
1800
1200
600
0
0
600
1200
1800
2400
3000
3600
4200
FLOW IN LITERS FL6
LEGEND
+ FL1

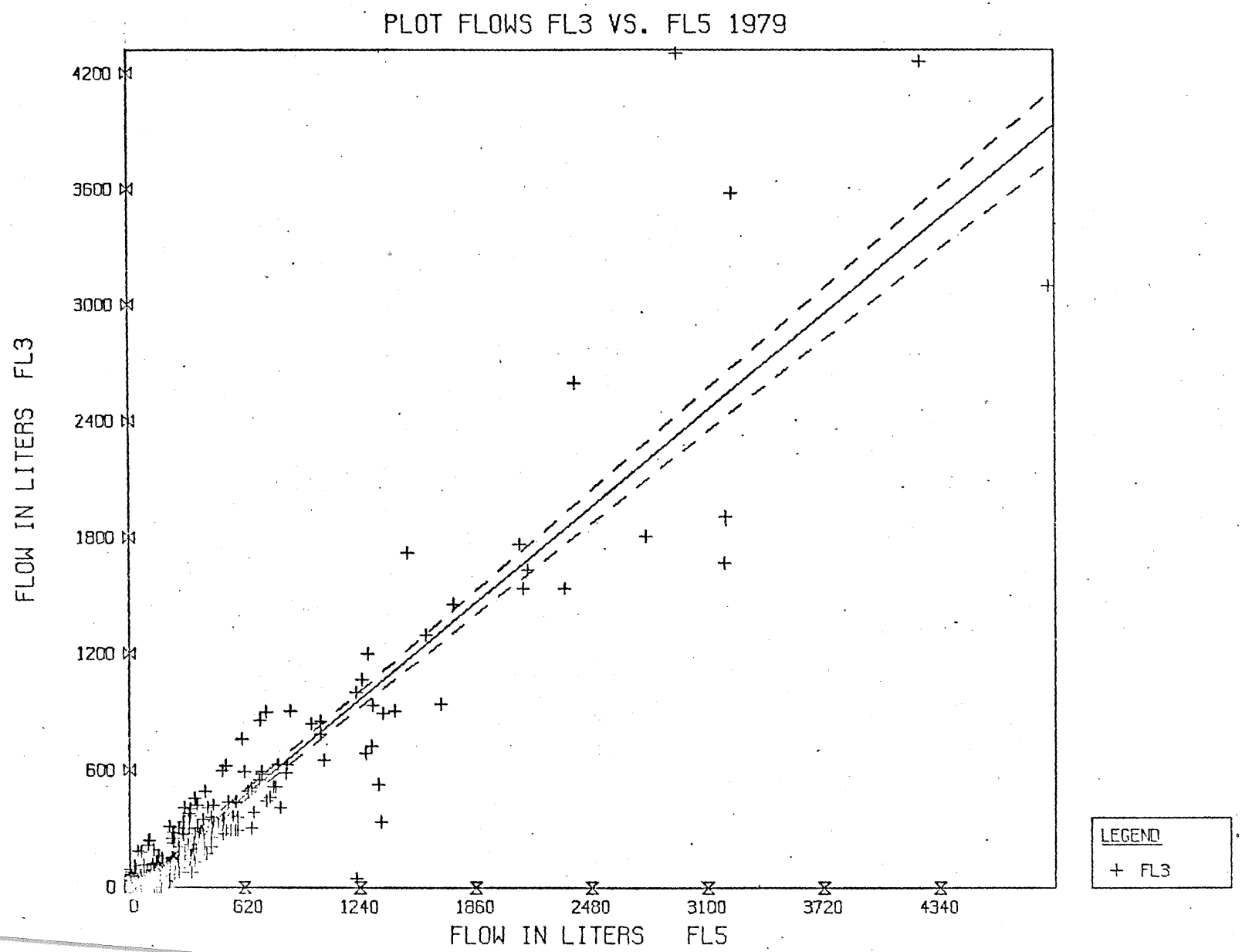

PLOT FLOWS FL2 VS. FL3 1979
FLOW IN LITERS FL2
3780
3240
2700
2160
1620
1080
540
0
0
540
1080
1620
2160
2700
3240
3780
FLOW IN LITERS FL3
LEGEND
+ FL2

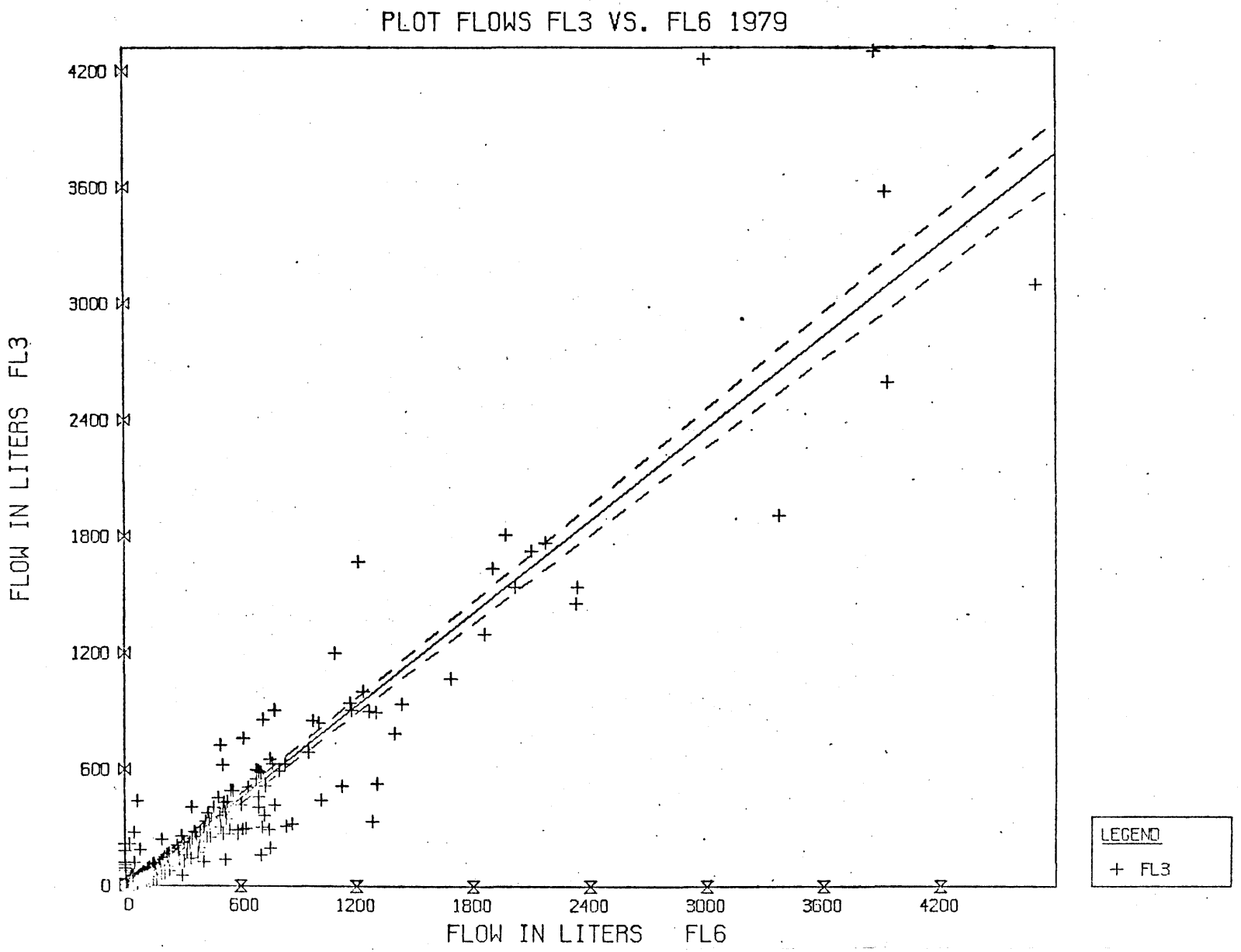

PLOT FLOWS FL2 VS. FL4 1979
FLOW IN LITERS FL2
3780
3240
2700
2160
1620
1080
540
0
0
700
1400
2100
2800
3500
4200
4900
FLOW IN LITERS FL4
LEGEND
+ FL2

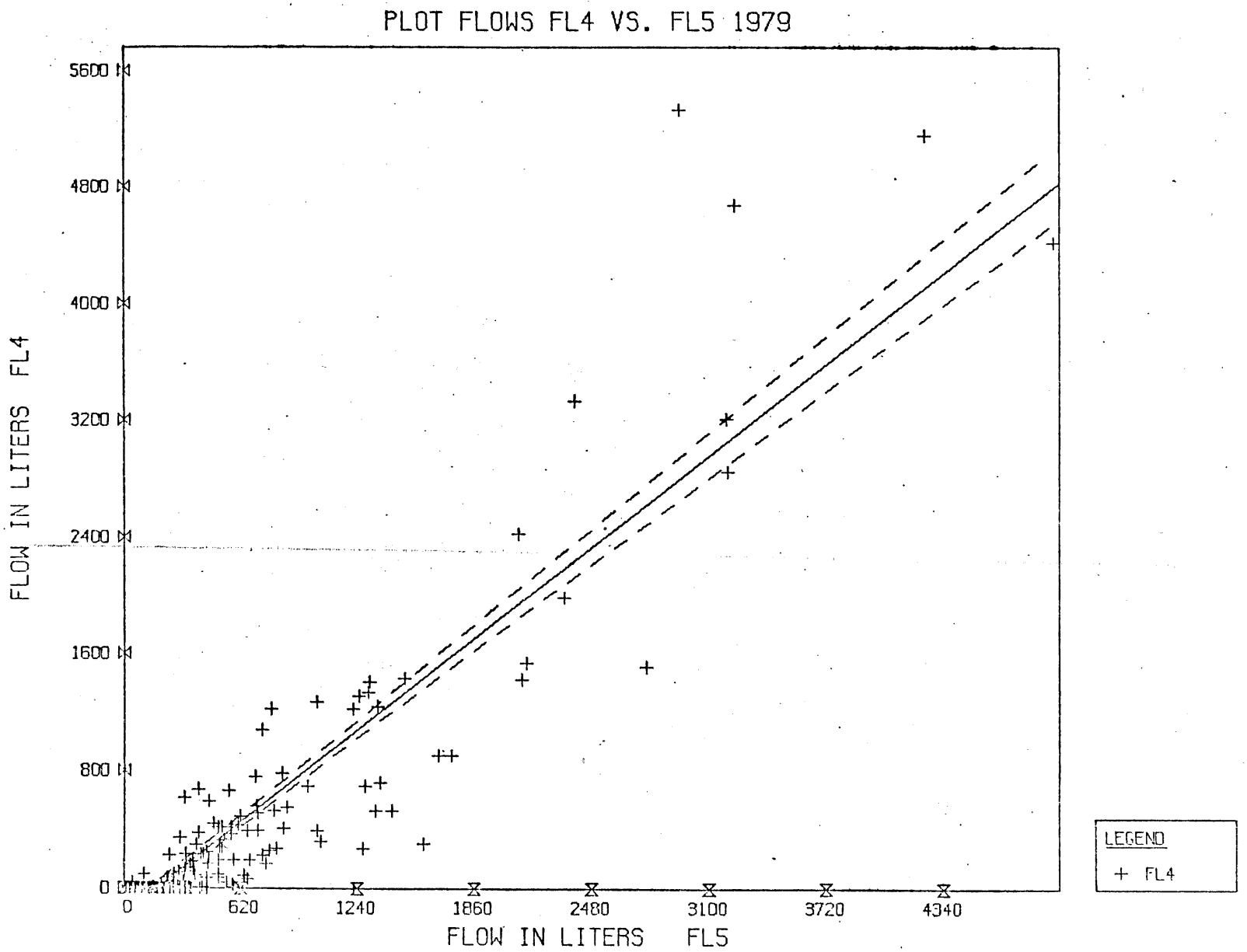

PLOT FLOWS FL2 VS. FL5 1979
FLOW IN LITERS FL2
3780
3240
2700
2160
1620
1080
540
0
0
620
1240
1860
2480
3100
3720
4340
FLOW IN LITERS FL5
LEGEND
+ FL2

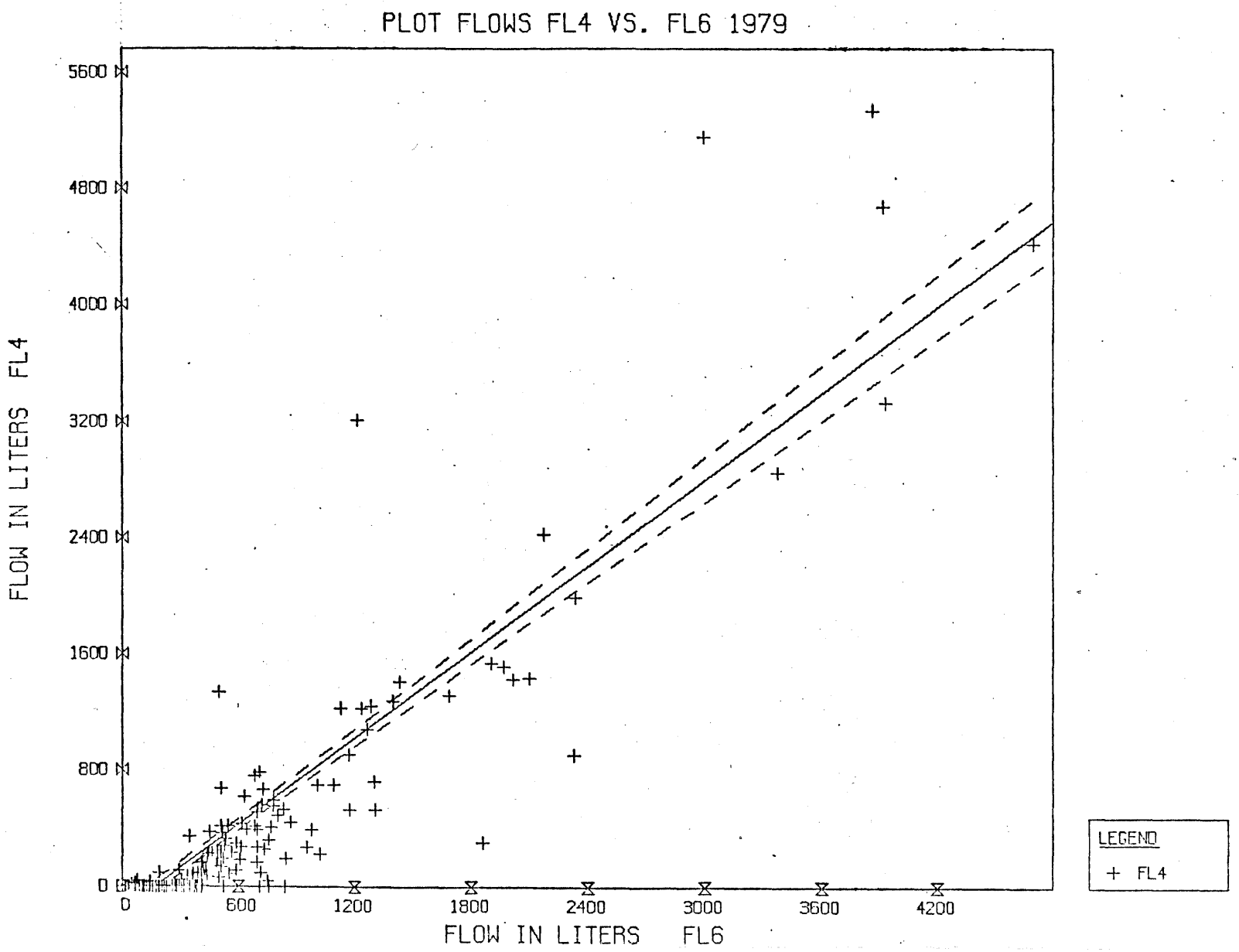

PLOT FLOWS FL2 VS. FL6 1979
FLOW IN LITERS FL2
3780
3240
2700
2160
1620
1080
540
0
0
600
1200
1800
2400
3000
3600
4200
FLOW IN LITERS FL6
LEGEND
+ FL2

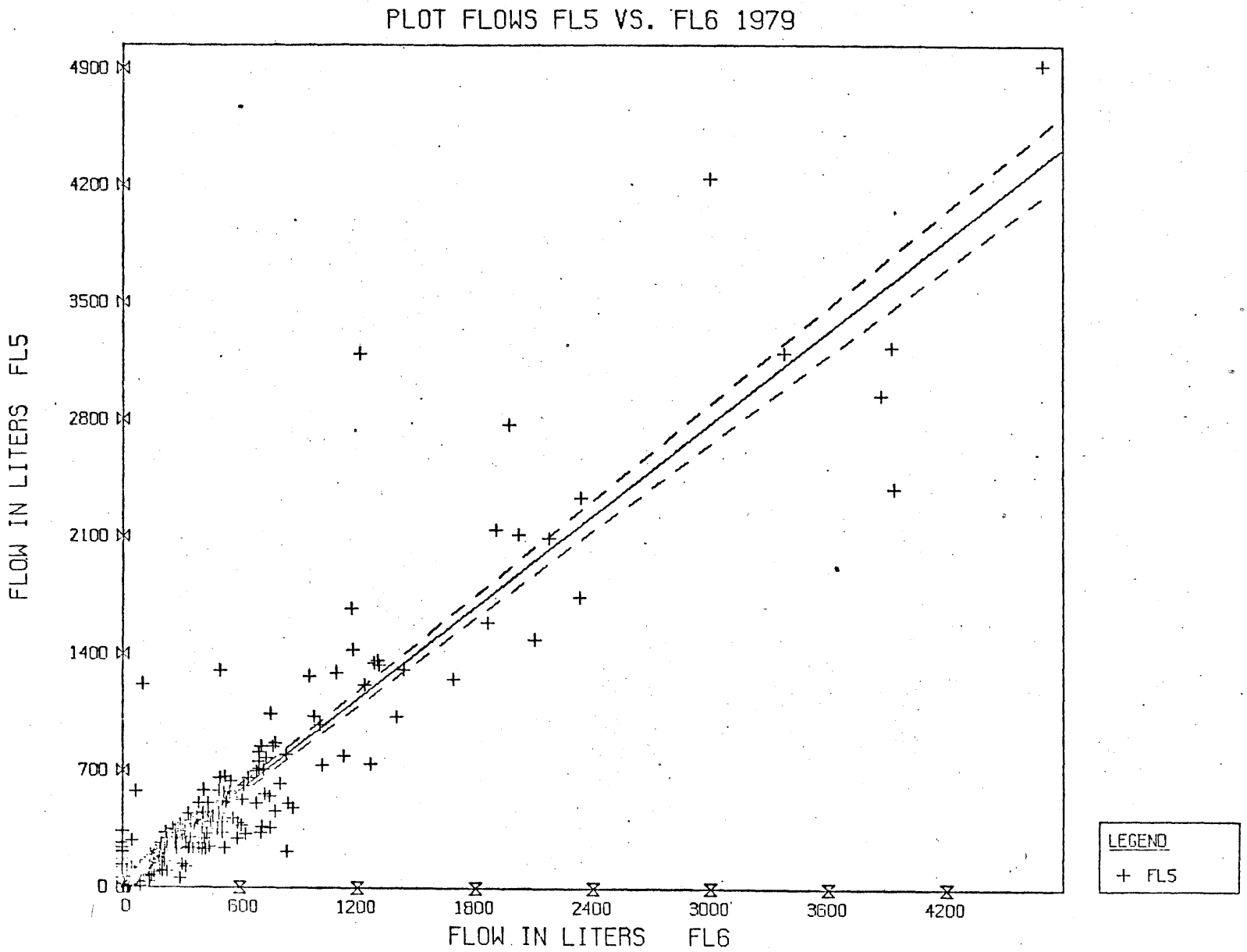

PLOT FLOWS FL3 VS. FL4 1979
FLOW IN LITERS FL3
4200
3600
3000
2400
1800
1200
600
0
0
700
1400
2100
2800
3500
4200
4900
FLOW IN LITERS FL4
LEGEND
+ FL3


PLOT FLOWS FL3 VS. FL5 1979
FLOW IN LITERS FL3
4200
3600
3000
2400
1800
1200
600
0
0
620
1240
1860
2480
3100
3720
4340
FLOW IN LITERS FL5
LEGEND
+ FL3


PLOT FLOWS FL3 VS. FL6 1979
FLOW IN LITERS FL3
4200
3600
3000
2400
1800
1200
600
0
0
600
1200
1800
2400
3000
3600
4200
FLOW IN LITERS FL6
LEGEND
+ FL3


PLOT FLOWS FL4 VS. FL5 1979
FLOW IN LITERS FL4
5600
4800
4000
3200
2400
1600
800
0
0
620
1240
1860
2480
3100
3720
4340
FLOW IN LITERS FL5
LEGEND
+ FL4


PLOT FLOWS FL4 VS. FL6 1979
FLOW IN LITERS FL4
5600
4800
4000
3200
2400
1600
800
0
0
600
1200
1800
2400
3000
3600
4200
FLOW IN LITERS FL6
LEGEND
+ FL4


PLOT FLOWS FL5 VS. FL6 1979
FLOW IN LITERS FL5
4900
4200
3500
2800
2100
1400
700
0
0
600
1200
1800
2400
3000
3600
4200
FLOW IN LITERS FL6
LEGEND
+ FL5

Appendix VII

Mass Calculations

Mass Calculations

Several different methods were used to calculate the total mass release from each pile. In 1977, there was only a limited amount of water quality and flow data, so the mass was estimated by :

mass release = average concentration X total 1977 rainfall from date of construction to freeze up. X collecting area X percent runoff

A runoff coefficient of .5 was used for piles 1-4 and .65 for 5 and 6. The data sets have improved as the program has developed, and better mass estimates can be made.

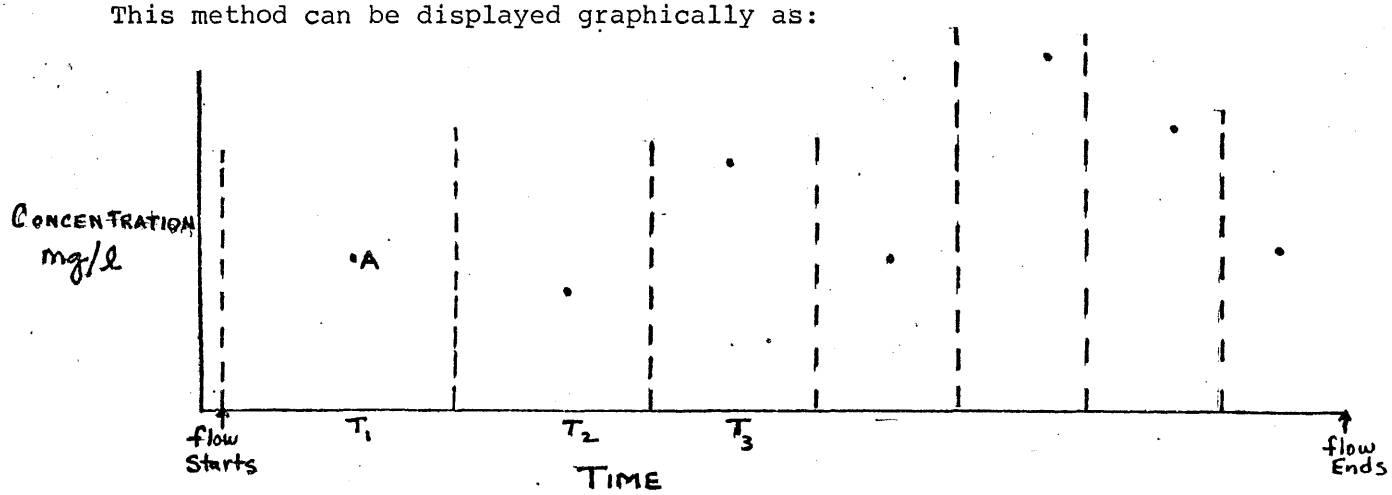
Two methods were used to estimate the mass released in 1978:

1. Mass = average concentration X total outflow
   (Ave) (mg/l) (liters)

2. Mass = $\sum_{i=1}^{n}$ concentration of sample at time Ti X total flow that occurred in the time interval $\frac{T_{i-1} + Ti}{2}$ to $\frac{Ti + Ti+1}{2}$

(Method I)

This method can be displayed graphically as:



The concentration at point A is multiplied by the total flow that occurs in this time interval. This yields the total mass released in the time interval and by summing each time interval the total mass released during the year can be calculated. Comparison of these two methods are shown in Table AVII-1.

In 1978, both methods generally agree within 10%. Due to the start up nature of the project, the first sulfate samples were not collected until June. Using Method I over weights the first sample (Table AVII-2). This method assigns the concentration of one sample to 26.9 to 50.2 percent of the total flow. Given this problem, the average method was selected as the most accurate estimate for 1978.

Three methods were used to estimate the mass released during 1979. The first two are identical to those used in 1978. The third is:

Table AVII-1 Comparisons of Mass Release Calculations, 1978

Parameter	1		2		3		4		5		6	
	I	Ave	I	Ave	I	Ave	I	Ave	I	Ave	I	Ave
Calcium	21.37	22.8	14.3	15.6	13.41	14.79	19.55	20.2	39.66	41.1	64.46	62.65
Magnesium	1.69	1.83	1.72	1.89	2.48	2.54	1.86	2.03	3.89	4.46	14.52	14.70
Sodium	18.14	20.78	16.0	16.3	11.72	10.80	14.30	14.76	25.89	25.1	66.75	65.66
Potassium	2.57	2.66	1.55	1.75	1.95	2.18	3.70	3.69	1.61	1.81	1.69	1.69
Copper	.0027	.0027	.0049	.0058	.0068	.007	.0018	.0021	.23	.31	.020	.024
Nickel	.0231	.0258	.0159	.0192	.0184	.023	.0211	.0219	2.56	3.25	.146	.165
Iron	.0022	.0022	.0060	.0022	.0035	.0079	.0027	.0026	.42	.55	.0092	.0098
Manganese	.0096	.01	.0116	.0127	.0119	.0134	.0147	.0148	.42	.52	.149	.16
Cobalt	.0017	.0018	.0011	.0015	.0024	.0024	.002	.0021	.27	.40	.0155	.02
Zinc	.0009	.0012	.0032	.0039	.0032	.0038	.0071	.0071	.084	.122	.0053	.0069
Sulfate	92.02	96.8	74.24	64.0	52.16	54.6	86.10	77.0	178.80	152.	206.4	202.0
Chloride	.24	.266	2.02	1.69	4.10	2.35	1.19	.75	5.92	3.93	40.2	39.5

Table AVII-2

Pile	First Sulfate sample	Flow assigned to first sample (liters)	Percent of total flow
1	6-16	22,348	26.9
2	7-5	35,212	50.2
3	7-5	42,080	46.5
4	6-23	32,398	35.1
5	7-5	48,147	39.9
6	7-5	44,521	38.0

$$\text{Mass} = \sum_{i=1}^{n} \text{concentration of flow weighted composite}_i \text{ (mg/l)} \times \text{total volume over which composite i was collected (liters)}$$

(Method II)

$$\frac{N \sum_{i=1}^{n} \text{total volume over which composite i was collected}}{\text{total outflow from the pile.}}$$

In 1979, all the samples that were collected were flow weighted composites, so there is a representative concentration that can be assigned to a specific volume of water. This will yield the best estimate of the mass released during the time over which the composite is collected. The flow weighted composite sample is comparable to collecting all the runoff in one large reservoir, mixing it, and then sampling. The denominator corrects for the fact that some of the runoff escapes without being sampled. The data in Table AVII-3 shows that 85-99% of the flow was sampled.

The results of the different calculation methods are shown in Table AVII-4.

The agreement between Methods I and II is generally well within 10%. Using the average concentration times the total outflow generally gives a higher mass release than the other two methods.

Due to the flow weighted sample and the high percentage of the flow that was sampled, Method II appears to be the most accurate estimate of the total mass released in 1979.

Figure AVII-1 shows the percent of copper, nickel and sulfur that has been released from each pile since its consturction. The percent of sulfur that has been removed from each pile is comparable, ranging from .56% to .96%. Piles 1 thorugh 4 released small percentages of the trace metals; copper .0001% to .0003% and nickel .005% to .01%. The release from FL 5 has been much greater, nickel and copper release are about two orders of magnitude higher, 1.1% and .08%. FL 6 has released .1% of its nickel content and .005% of its copper.

Table AVII-3

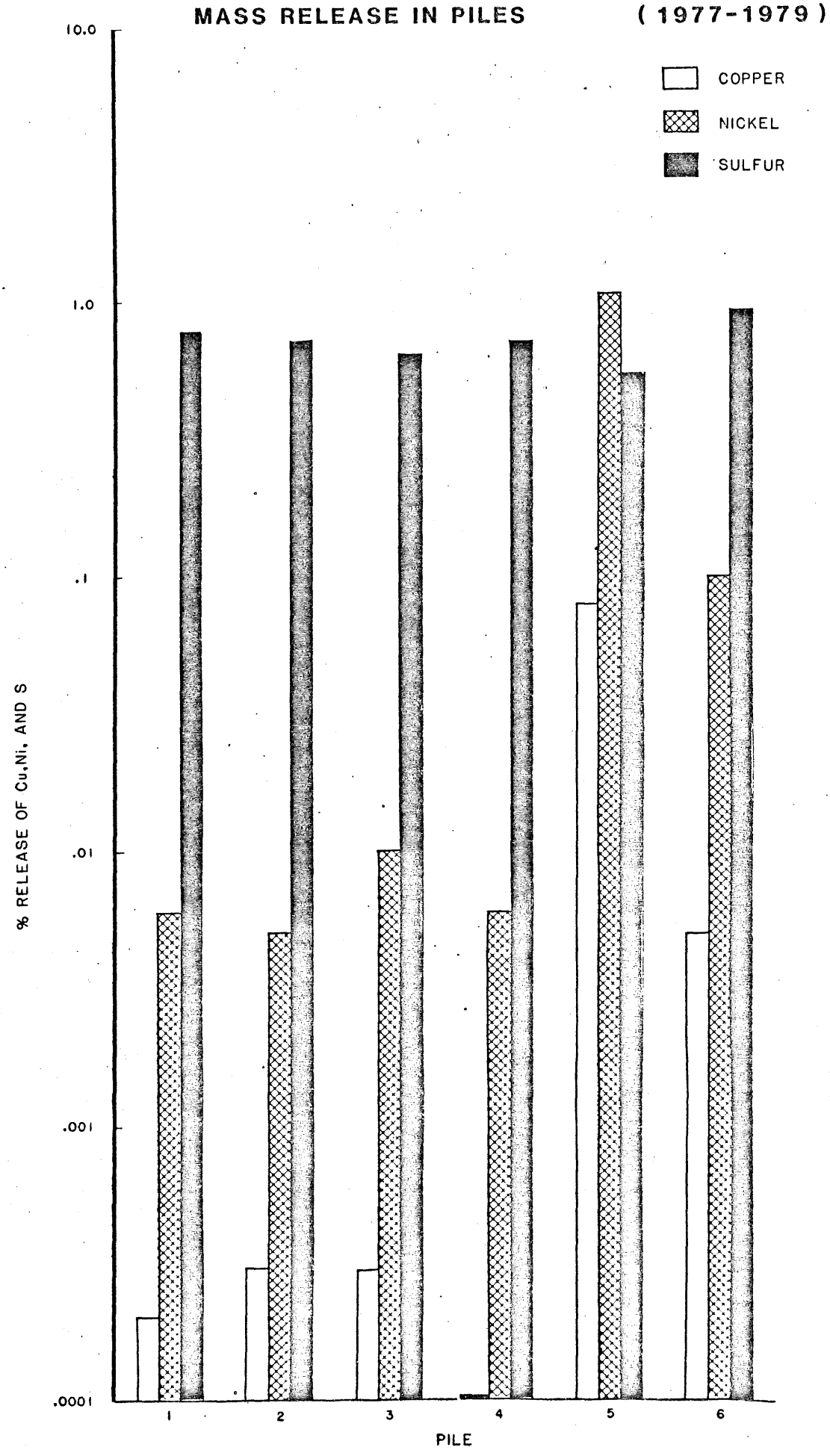
Percentage of Flow Sampled

File	Vol. Sampled	Total Outflow	% of Flow Sampled
1	78,926	86,013	91.8
2	64,414	74,320	86.7
3	76,739	86,358	88.9
4	71,884	74,695	96.2
5	97,835	114,656	85.3
6	119,373	119,505	99.9

Table AVII-4

COMPARISON OF MASS RELEASE CALCULATIONS, 1979
Mass (Kg)

Parameter	1			2			3			4			5			6		
	Ave	I	II	Ave	I	II	Ave	I	II	Ave	I	II	Ave	I	II	Ave	I	II
Calcium	23.3	19.70	19.37	15.2	11.80	12.11	15.0	12.80	13.43	11.9	10.1	10.50	36.4	33.10	33.10	37.8	34.4	34.39
Magnesium	2.1	1.80	1.75	2.2	1.70	1.72	3.1	2.70	2.79	1.3	1.10	1.14	16.5	14.4	14.78	13.8	12.7	12.95
Sodium		6.70	6.57		7.10	6.86		5.50	5.74		3.20	3.31		14.9	15.10		22.0	21.64
Potassium		1.90	1.83		1.4	1.46		1.80	1.89		1.70	1.81		1.8	1.79		.30	.677
Copper	.003	.0026	.0025	.009	.009	0.009	.009	.008	.0085	.016	.028	.02	5.1	4.4	4.37	.25	.216	.230
Nickel	.031	.0280	.0280	.029	.0200	.0204	.086	.074	.0808	.117	.211	.156	18.3	16.0	16.58	1.1	1.00	1.03
Iron		.0020	.0017		.0040	.0036		.004	.0033		.015	.011		.96	1.01		.008	.0085
Manganese		.0070	.0075		.0090	.0097		.011	.011		.028	.023		1.37	1.43		.378	.372
Cobalt	.002	.0020	.0019	.002	.0020	.0015	.006	.004	.0045	.004	.006	.0046	1.4	1.23	1.28	.08	.076	.079
Zinc	.002	.0020	.0023	.002	.004	.0036	.009	.008	.0085	.008	.008	.0075	.6	.53	.54	.05	.045	.046
Sulfate	78 est.	64.80	63.26	56.6	41.80	38.25	59.1	47.3	51.5	38.4	34.4	33.79	294.3	246.2	245.9	150.0	138.5	130.66
Chloride		.320	.302		1.24	1.14		.57	.52		.34	.31		1.49	1.39		10.80	10.96
Dissolved Organic Carbon		.57			1.0			.53			.29			.65			.80	


MASS RELEASE IN PILES (1977-1979)
COPPER
NICKEL
SULFUR
10.0
1.0
.1
.01
.001
.0001
% RELEASE OF Cu, Ni, AND S
1
2
3
4
5
6
PILE

Appendix VIII

Toxicity Calculations

Toxicity Calculations

The toxicity predictions are summarized in Tables AVIII-1 to AVIII-5. The acute toxicity predictions are based on the equations developed by Lind:

Copper

Fathead minnow: log 96hr LC50 = 1.37 + 1.20 log Toc R^2=.957 (1)

Daphnia Pulicaric: log 48 hr LC50 = .301 + 1.33 log Toc R^2=.925 (2)

Nickel

Fathead minnow: log 96 hr LC50 = 1.95 + 1.05 log hardness R^2=.707 (3)

Daphnia Pulicaric: log 48 hr LC50 = .207 + .710 log hardenss R^2 = .705 (4)

Predictions were made using the minimum, maximum and median concentration of the independent variables. (DOC was substituted for TOC and total hardness was estimated from the concentrations of calcium and magnesium). The predicted values were then compared with the minimum, maximum and median concentrations of the metals in the runoff. (Tables AVIII-1, AVIII-2) The range of independent valuables for which the predictive equations were developed are: TOC, 3-30 mg/l; hardness, natural waters 28-120, experimental 47 to 200 mg/l (Lake Superior water + added hardness).

The concept of copper equavalent units was developed by the Regional Copper-Nickel Study and is defined as

Copper Equvalent Unit (CEU) = [Cu] + [Co] + .1 [Ni] .1 [Zn] (5)

(All concentrations in µg/l

and where

CEU = 0-5, no effect

5-30, low probability of measurable impact

30-100, probable chronic impacts

100-600, potential acute impacts

600, definite acute impacts

Minimum, maximum and median trace metal concentrations were used to calculate a range of CEU values (Table AVIII-3).

The combined toxicity of copper and nickel was examined using the method in Lind et al., 1978.

$$\text{relative toxicity of the mixture} = \frac{\text{concentration of copper}}{\text{predicted LC50 for copper}} + \frac{\text{concentration of nickel}}{\text{predicted LC50 for nickel}}$$

where the predicted values for the individual metals are calculated from equations (1) thorugh (4). Median values were used for all calcualtions. The results are interpreted as :

if sum ≤ 1, mixture is below the LC50
$= 1$, mixture is the LC50
> 1, mixture is above the LC50

For Daphnia, the runoff from all piles is at or greater than the predicted LC50 while only FL 5 and 6 exceed the LC50 for the fathead minnow (Table AVIII-5).

Table AVIII-1

ACUTE TOXICITY OF COPPER, 1979 (µg/l)

	F. Minnows*	Daphnia+	Cu	DOC
PILE 1				
Med.	275.4	30.9	30.0	7.8
Max.	467.7	55.0	50.0	12.0
Min.	83.2	8.3	20.0	2.9
PILE 2				
Med.	501.0	63.1	113	13.8
Max.	630.0	79.4	195	16.0
Min	158.0	15.8	50	4.7
PILE 3				
Med.	189.3	20.2	82.0	5.7
Max.	416.6	48.5	220.0	11.0
Min.	142.5	14.8	40.0	4.5
PILE 4				
Med.	123.7	12.6	27.0	4.0
Max.	189.3	20.2	3000.	5.7
Min.	50.6	4.7	10.0	1.9
PILE 5				
Med.	223.6	24.4	37000	6.6
Max.	416.5	48.5	39200	11.0
Min.	98.2	9.8	6400	3.3
PILE 6				
Med.	275.7	30.7	510	7.8
Max.	635.0	79.9	8535	16.0
Min.	129.3	13.3	82	4.2
PILE 7				
Med.	233.9	25.6	30.0	6.8
Max.	462.4	54.5	70.0	12.0
Min.	173.4	18.4	20.0	5.3

*Log 96hr LC50 = 1.37 + 1.20 Log TOC R^2=.957
+Log 48hr LC50 = 0.301 + 1.33 Log TOC R^2=.925

Table AVIII-2

ACUTE TOXICITY OF NICKEL, 1979 (µg/l)

	F. Minnows*	Daphnia+	Ni	Hardness
PILE 1				
Med.	83561	12013	321	677
Max.	218912	203039	820	1694
Min.	22318	4920	102	192
PILE 2				
Med.	73824	11047	342	601
Max.	172524	19613	760	1350
Min.	8824	2628	40	80
PILE 3				
Med.	66144	10256	752	542
Max.	183320	20434	2840	1430
Min.	24117	5185	220	207
PILE 4				
Med.	59738	9574	321	492
Max.	88429	12482	14600	714
Min.	21102	4737	89	183
PILE 5				
Med.	154790	18226	116000	1218
Max.	393885	34274	406000	2963
Min.	76317	11298	46000	621
PILE 6				
Med.	156181	18336	6110	1228
Max.	379940	33449	26600	2863
Min.	31218	6173	27	265
PILE 7				
Med.	220496	23152	30	1705
Max.	447903	37386	60	3349
Min.	98682	13443	20	793

*Log 96hr LC50 = 1.95 + 1.05 log hardness R^2 = 0.707

+Log 48hr LC50 = 2.07 + 0.71 Log hardness R^2 = 0.705

Table AVIII-3

CEU Values for Piles, 1979 (μg/l)

CEU = 1 * Cu + .1* Ni + 1* Co + .1* Zn

Piles	Med.	Max.	Min.
1	84.7	217.0	39.2
2	173.7	253.0	60.0
3	211.4	671.0	76.0
4	89.6	300.0	29.9
5	57439.0	203900.0	15426.0
6	1609.9	13499.0	137.0
7	55.2	241.0	32.0

Table AVIII-4

Percentage of Cu, Ni, Co, Zn for CEU values

Pile	Med. CEU	%Cu	%Ni	%Co	%Zn
1	84.7	35	38	24	3
2	173.7	65	20	12	3
3	211.4	39	36	21	4
4	89.6	30	36	26	8
5	57439.0	64	20	15	1
6	1609.9	32	38	28	2

Table AVIII-5

Toxicity of Cu and Ni mixtures*

Pile	F. Minnows	Daphnia
1	0.1	1.0
2	0.03	1.8
3	0.4	4.1
4	0.2	2.2
5	166.2	1522.7
6	1.9	16.9

*Med. values of mix. $= \frac{\text{measured med. conc. Cu}}{\text{predicted LC50 for Cu}} + \frac{\text{measured med. conc. Ni}}{\text{predicted LC50 for Ni}}$

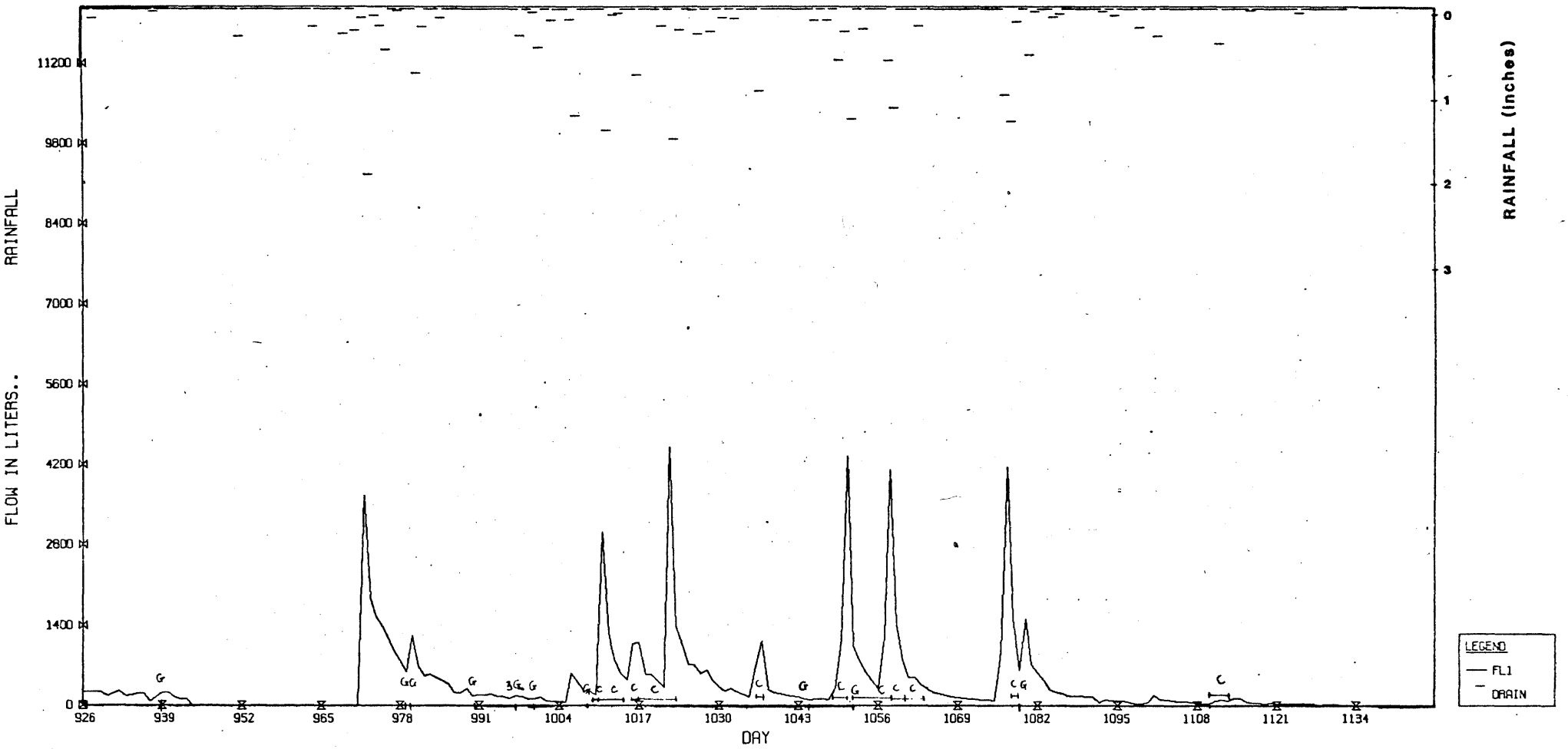
Appendix IX

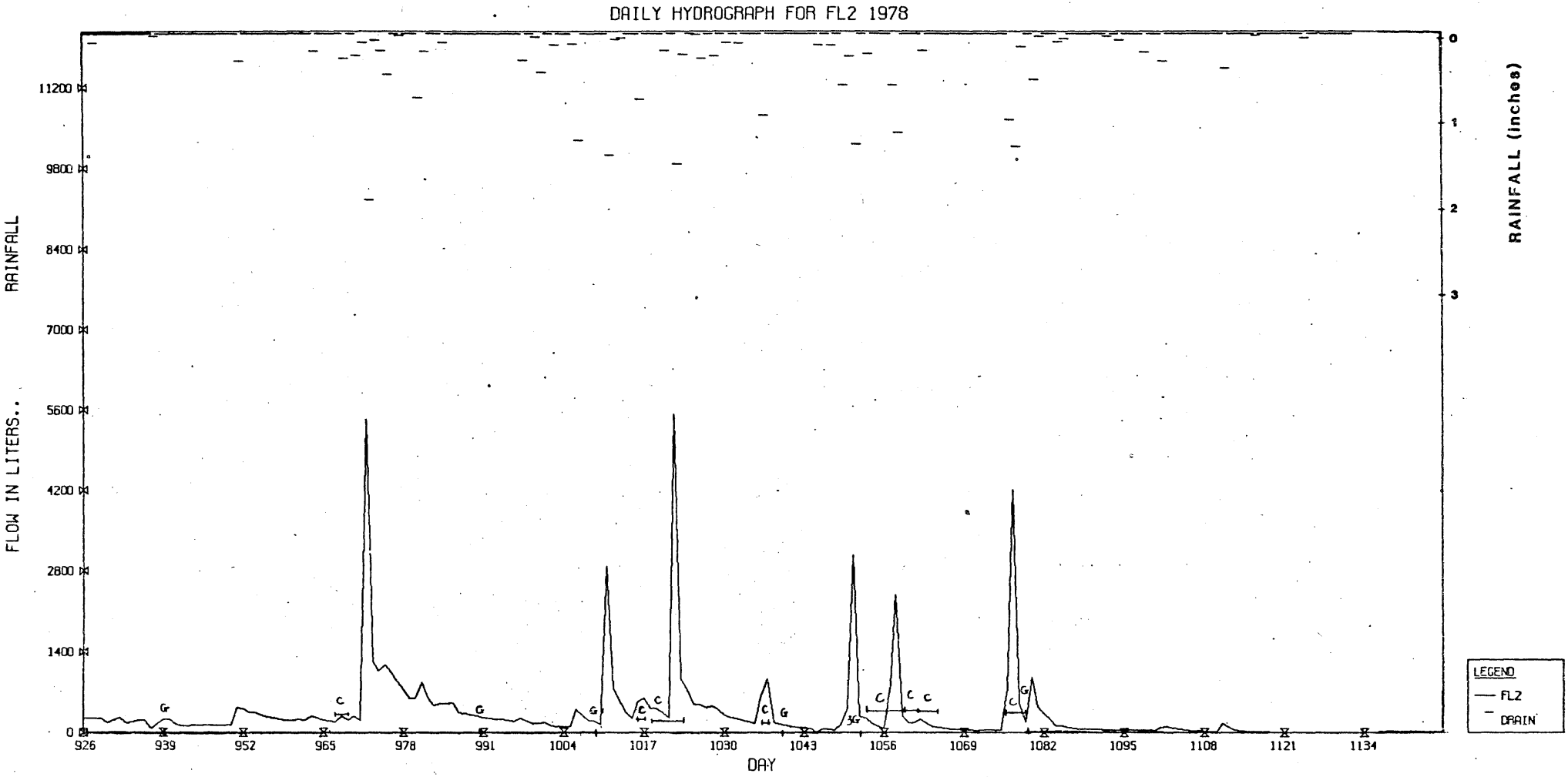
Sampling Scheme 1978; 1979:
Hydrographs with sample overlays

Composite samples are collected over fixed periods of time and integrate over flow conditions. Grab samples are collected at a fixed point in time and represent the water quality only at that specific time and flow condition. In 1978, both composite and grab samples were collected. These samples are plotted on Figures AIX-1 to AIX-6. In 1979 only composite samples were collected (Figures AIX-7 to 12). In 1979 the samples cover more of the hydrograph than in 1978.

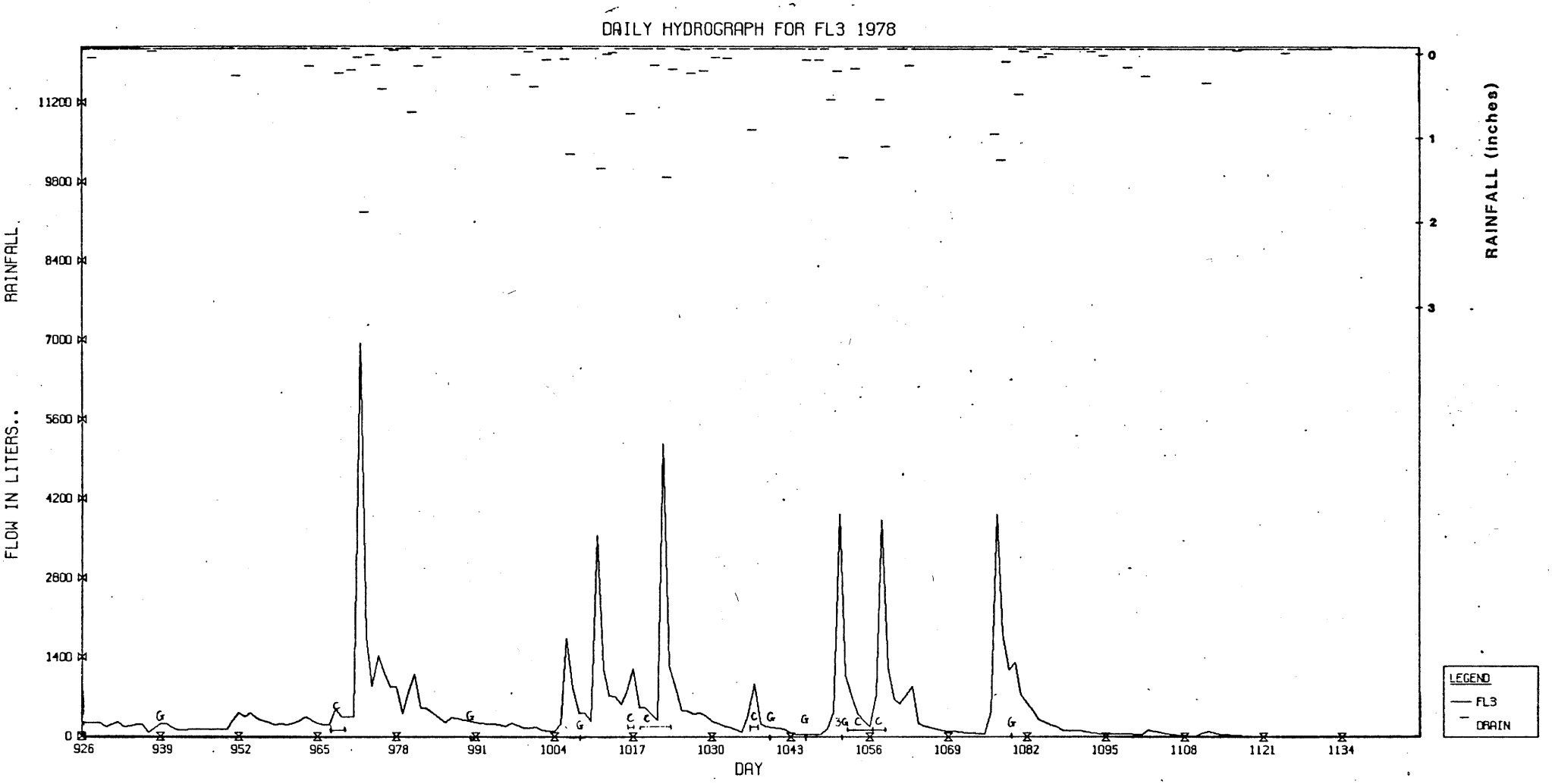
C = composite sample
G = grab sample

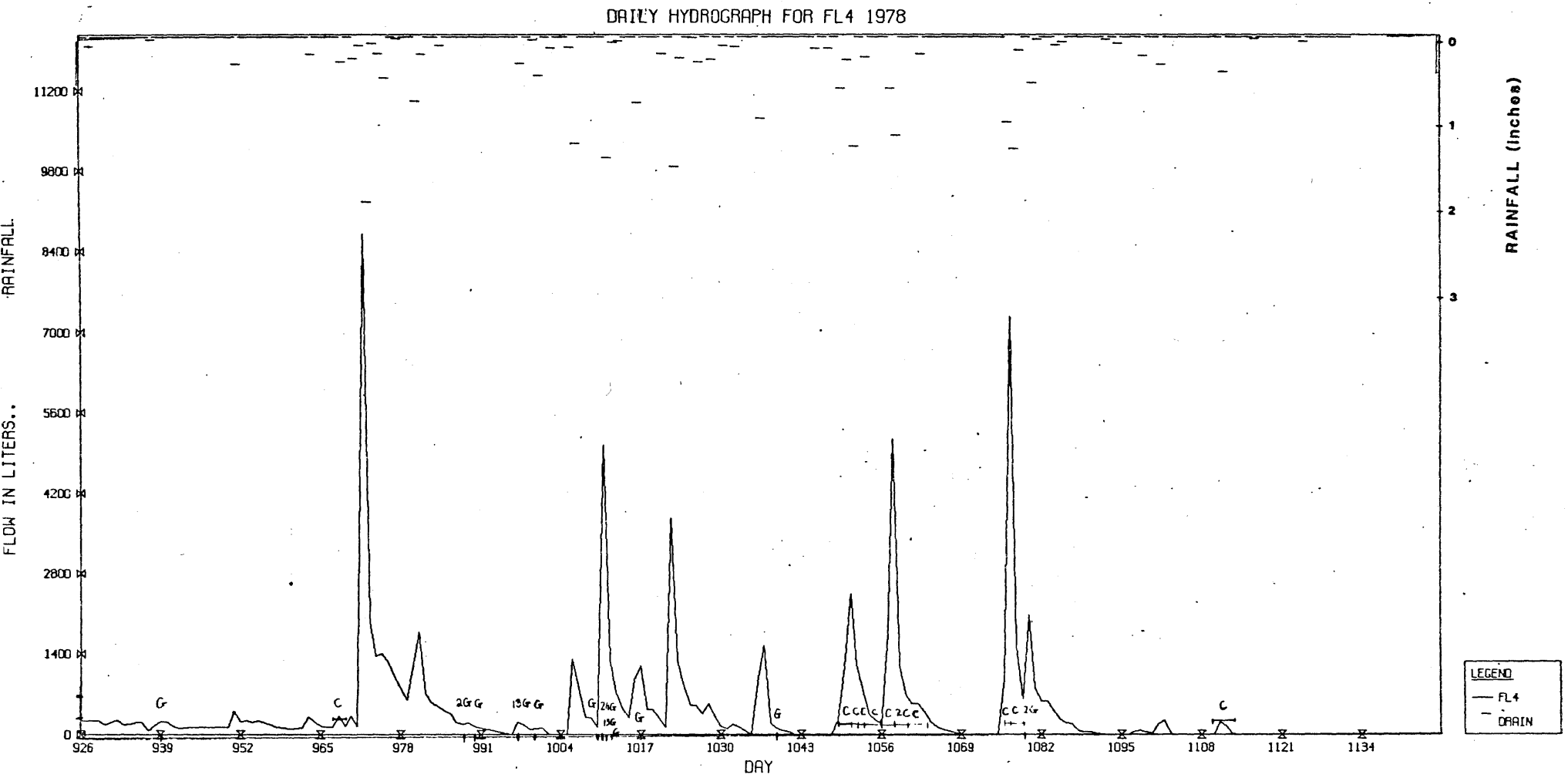
DAILY HYDROGRAPH FOR FL1 1978



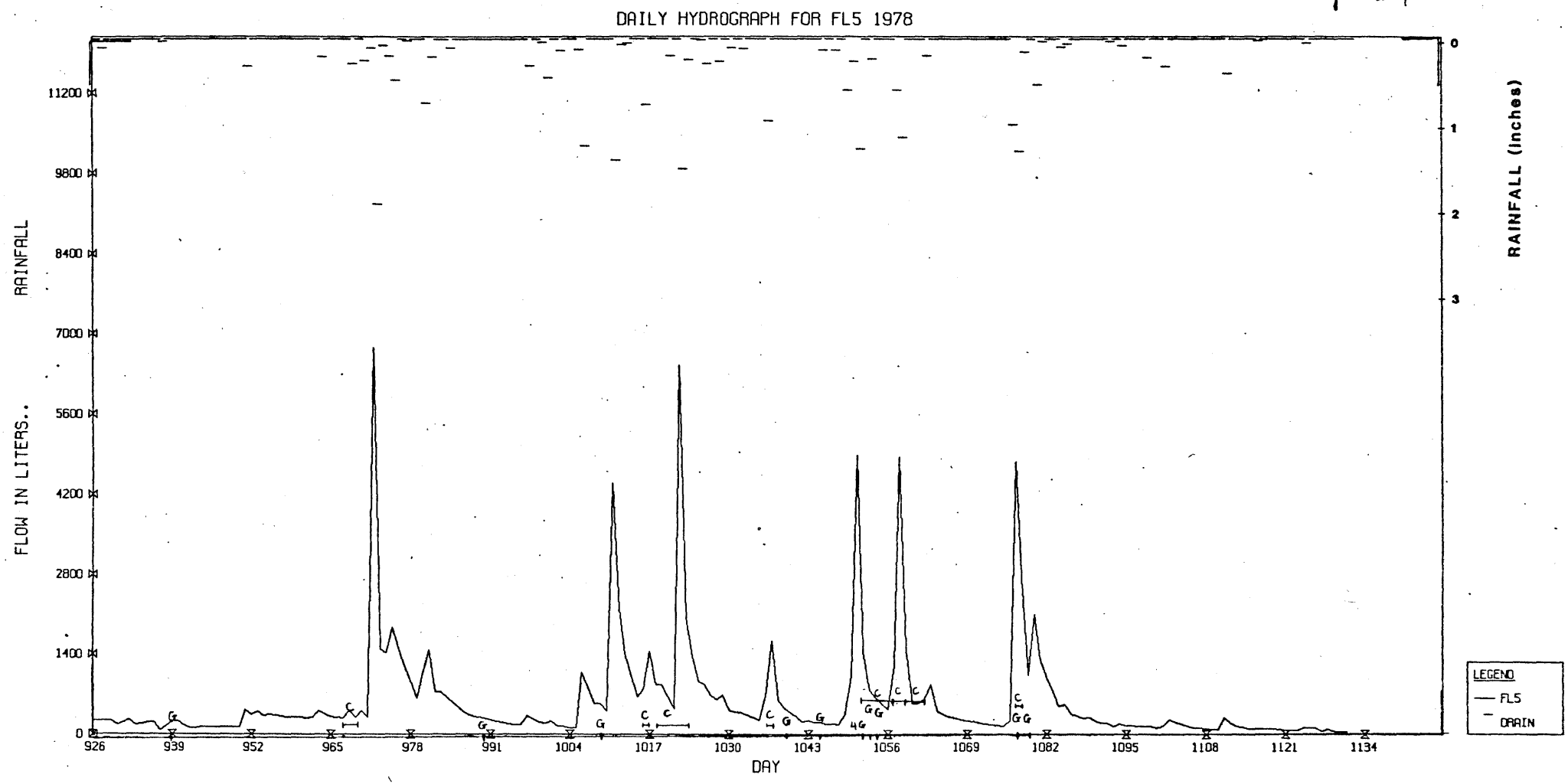

DAILY HYDROGRAPH FOR FL2 1978
RAINFALL
FLOW IN LITERS..
RAINFALL (inches)
11200
9800
8400
7000
5600
4200
2800
1400
0
0
1
2
3
926
939
952
965
978
991
1004
1017
1030
1043
1056
1069
1082
1095
1108
1121
1134
DAY
LEGEND
FL2
DRAIN

C= composite sample
G= grab sample

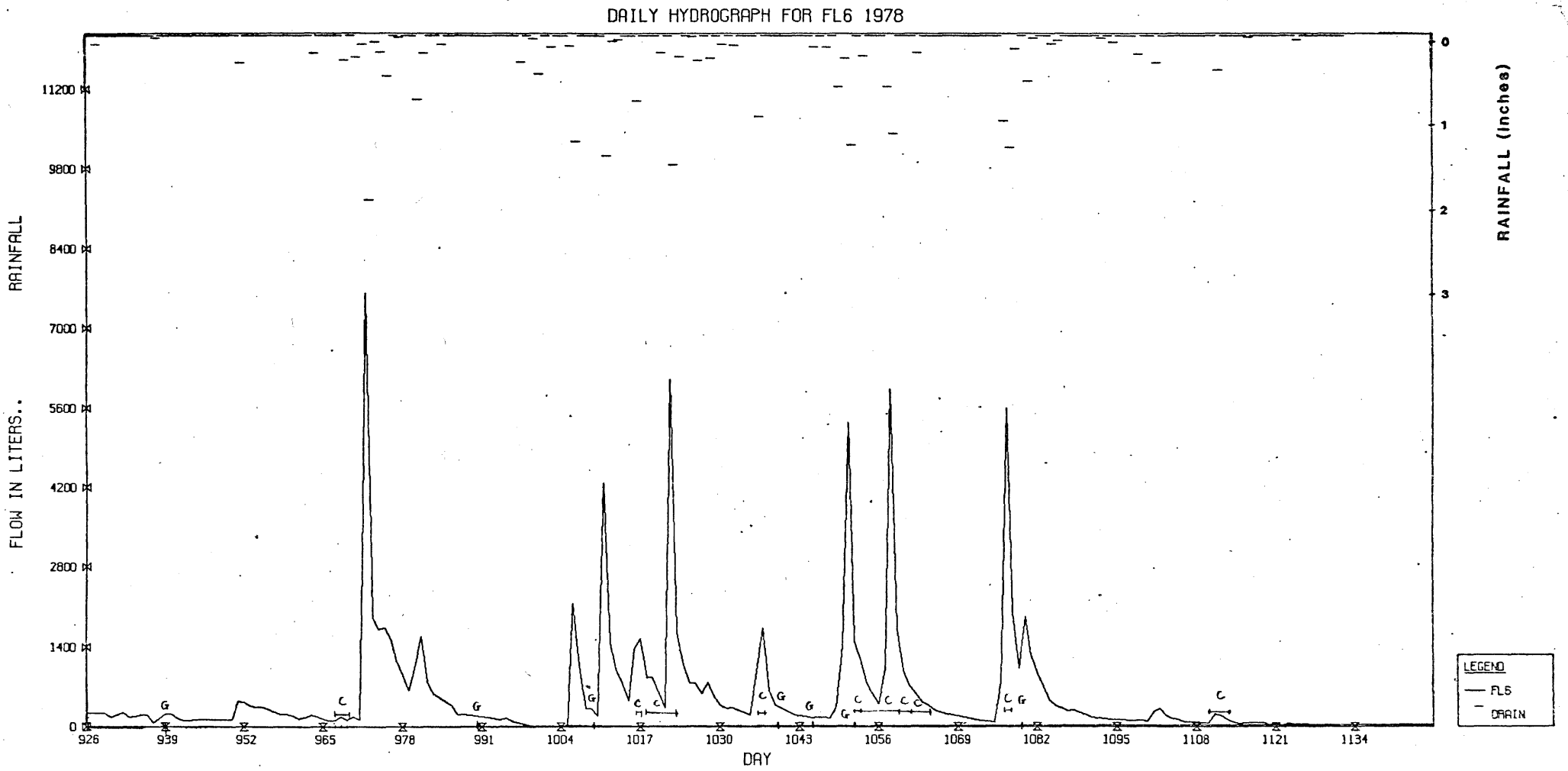


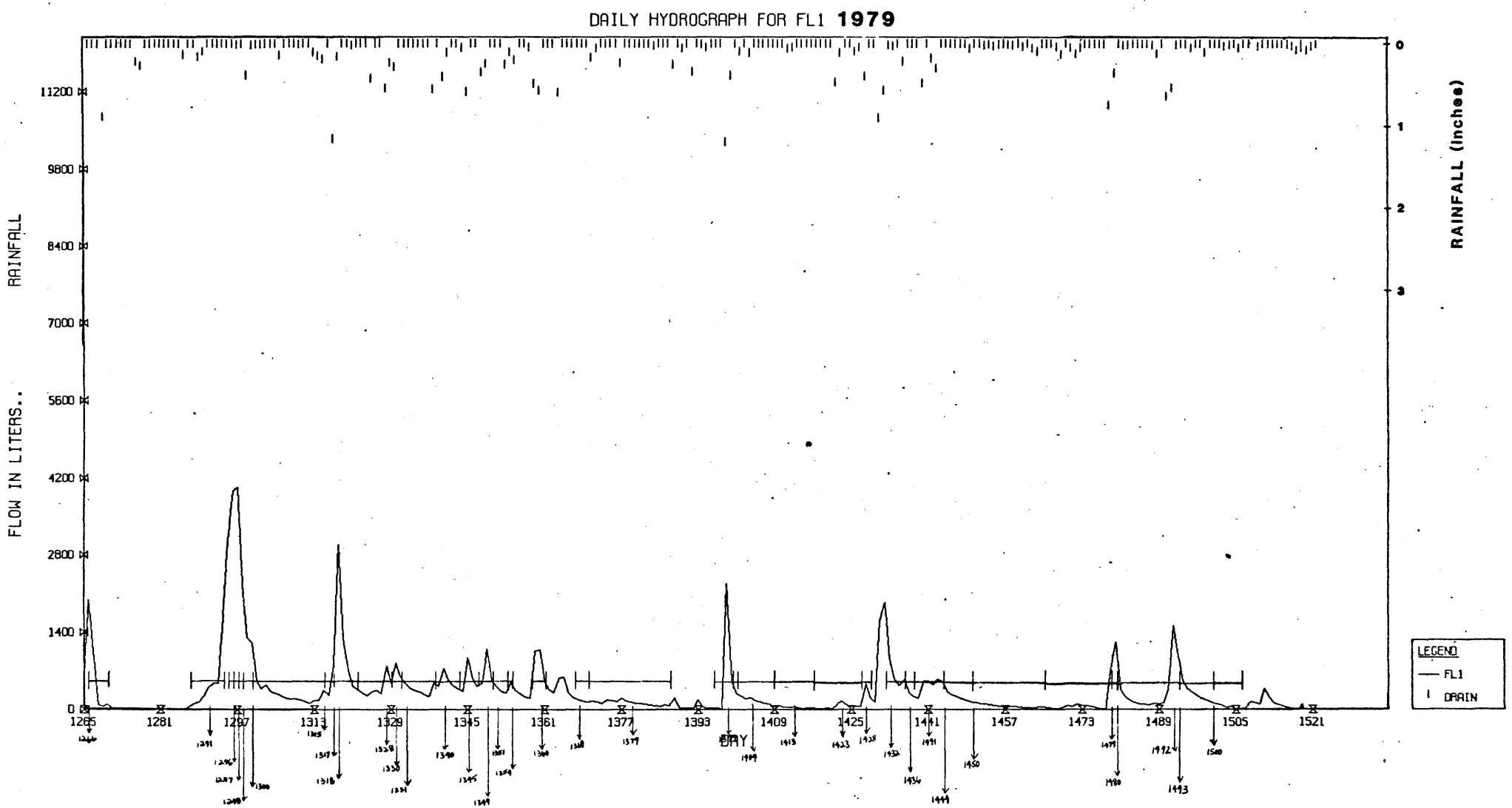

DAILY HYDROGRAPH FOR FL4 1978
RAINFALL
FLOW IN LITERS..
11200
9800
8400
7000
5600
4200
2800
1400
0
926
939
952
965
978
991
1004
1017
1030
1043
1056
1069
1082
1095
1108
1121
1134
DAY
0
1
2
3
RAINFALL (inches)
LEGEND
FL4
DRAIN

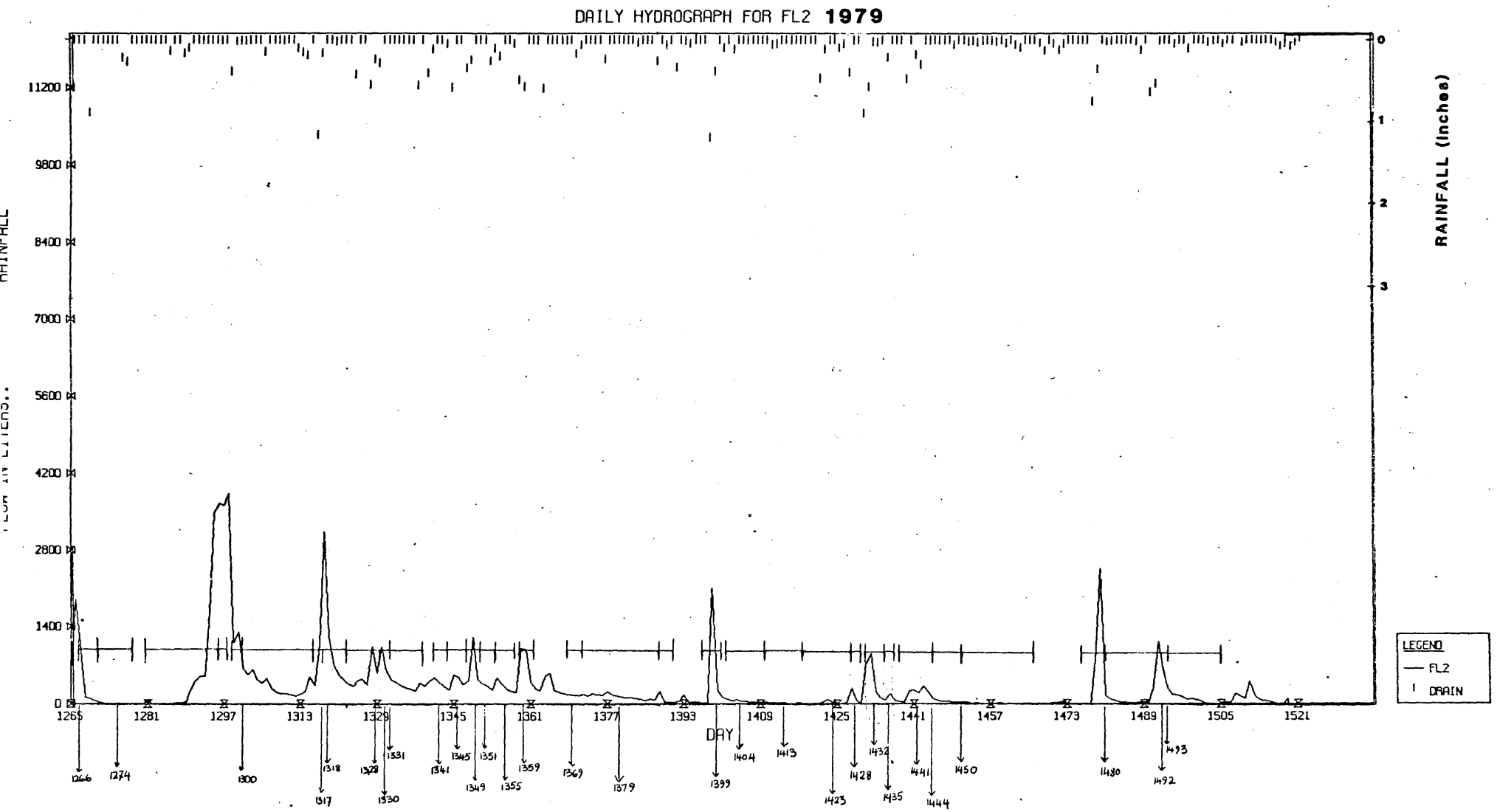
C = composite sample
G = grab sample

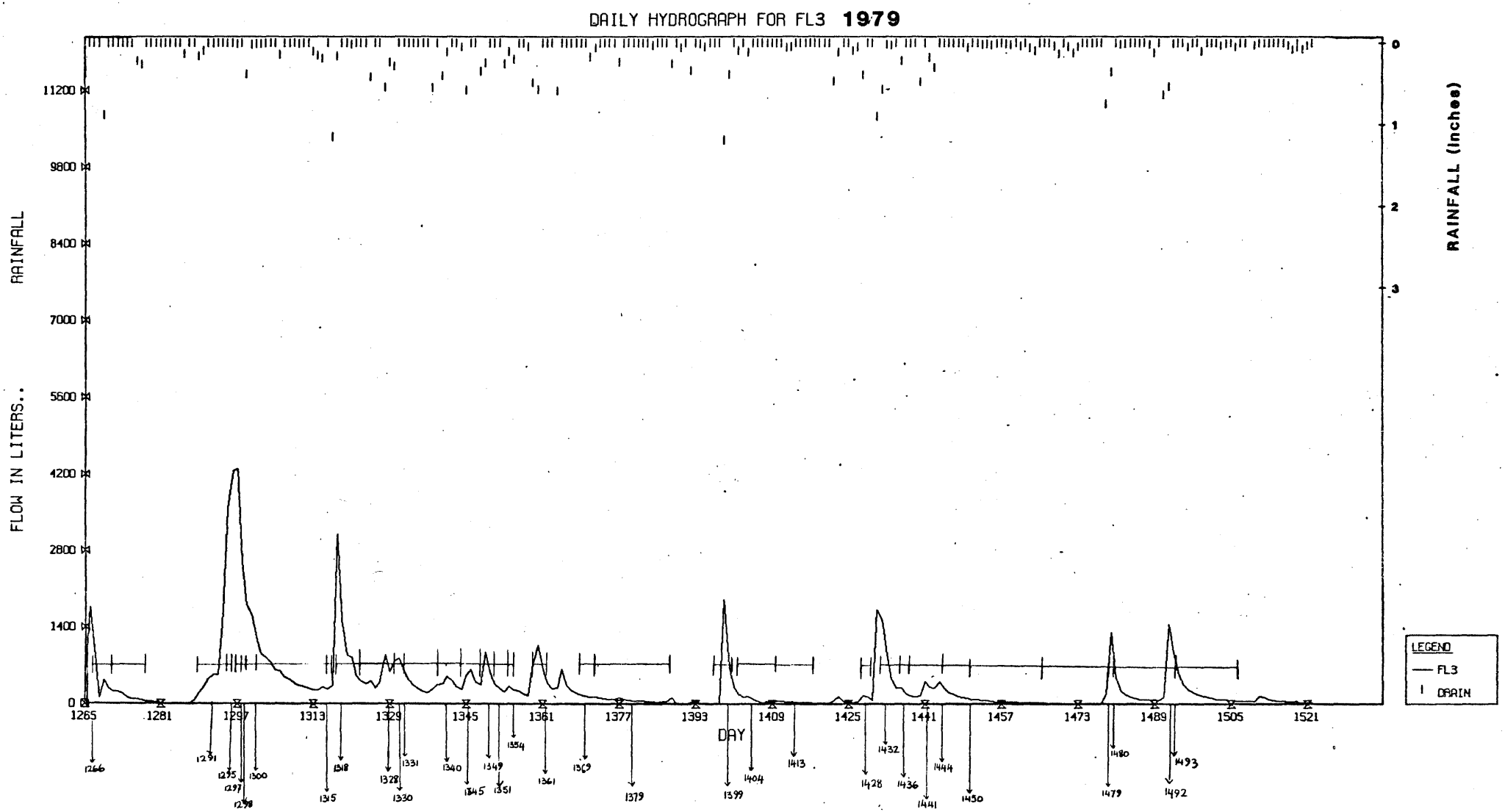


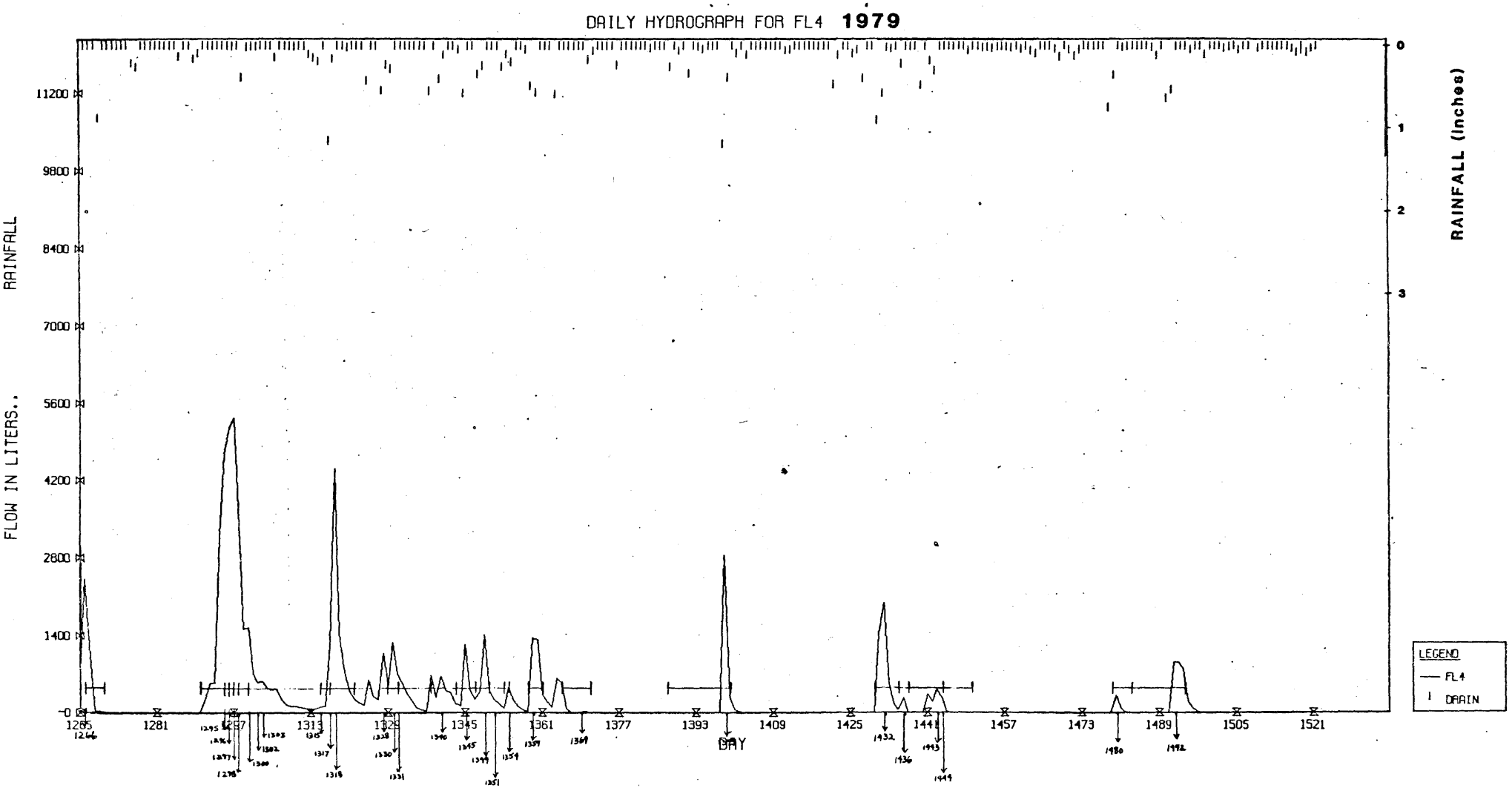
C = composite sample
G = grab sample

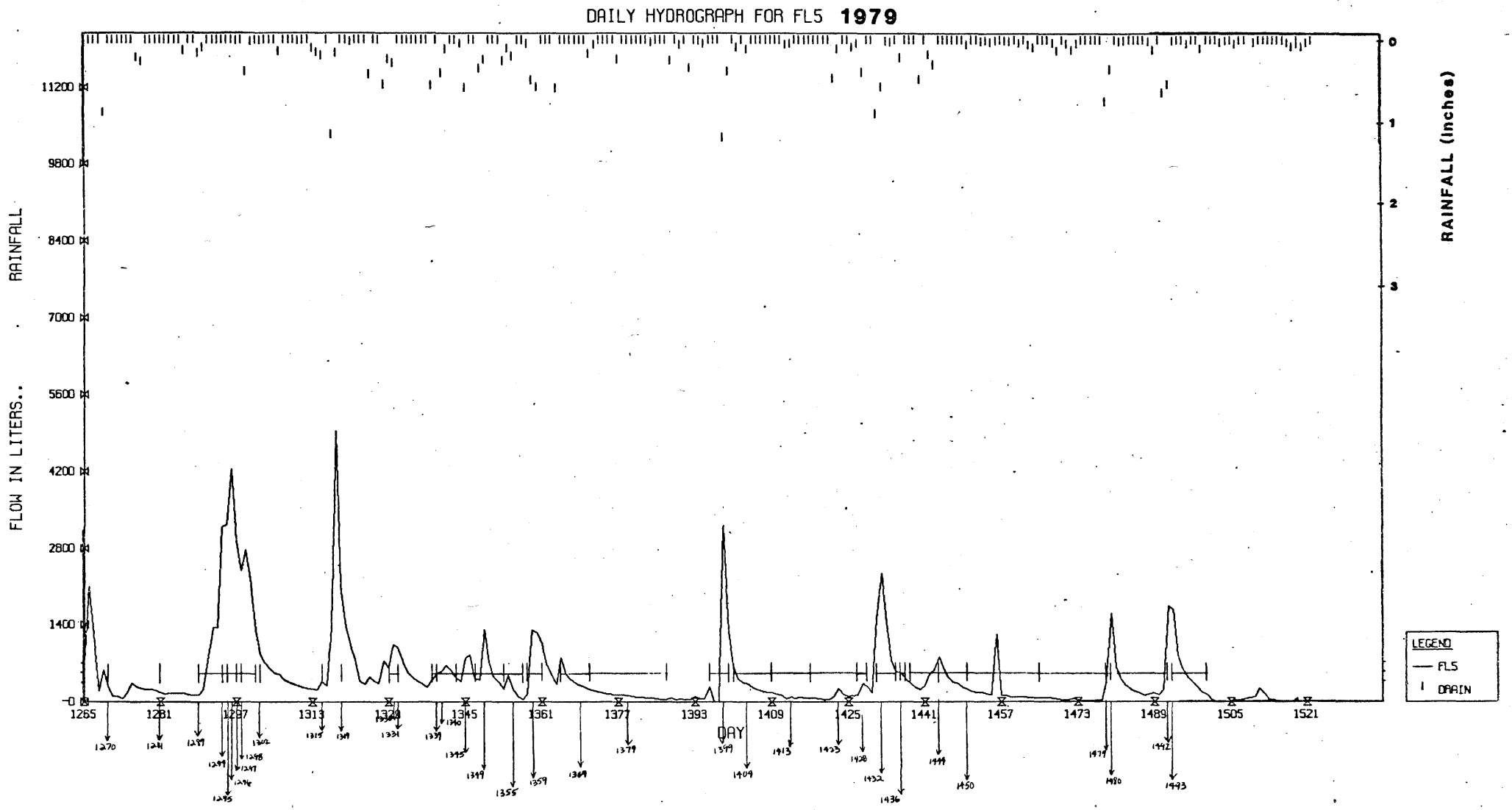


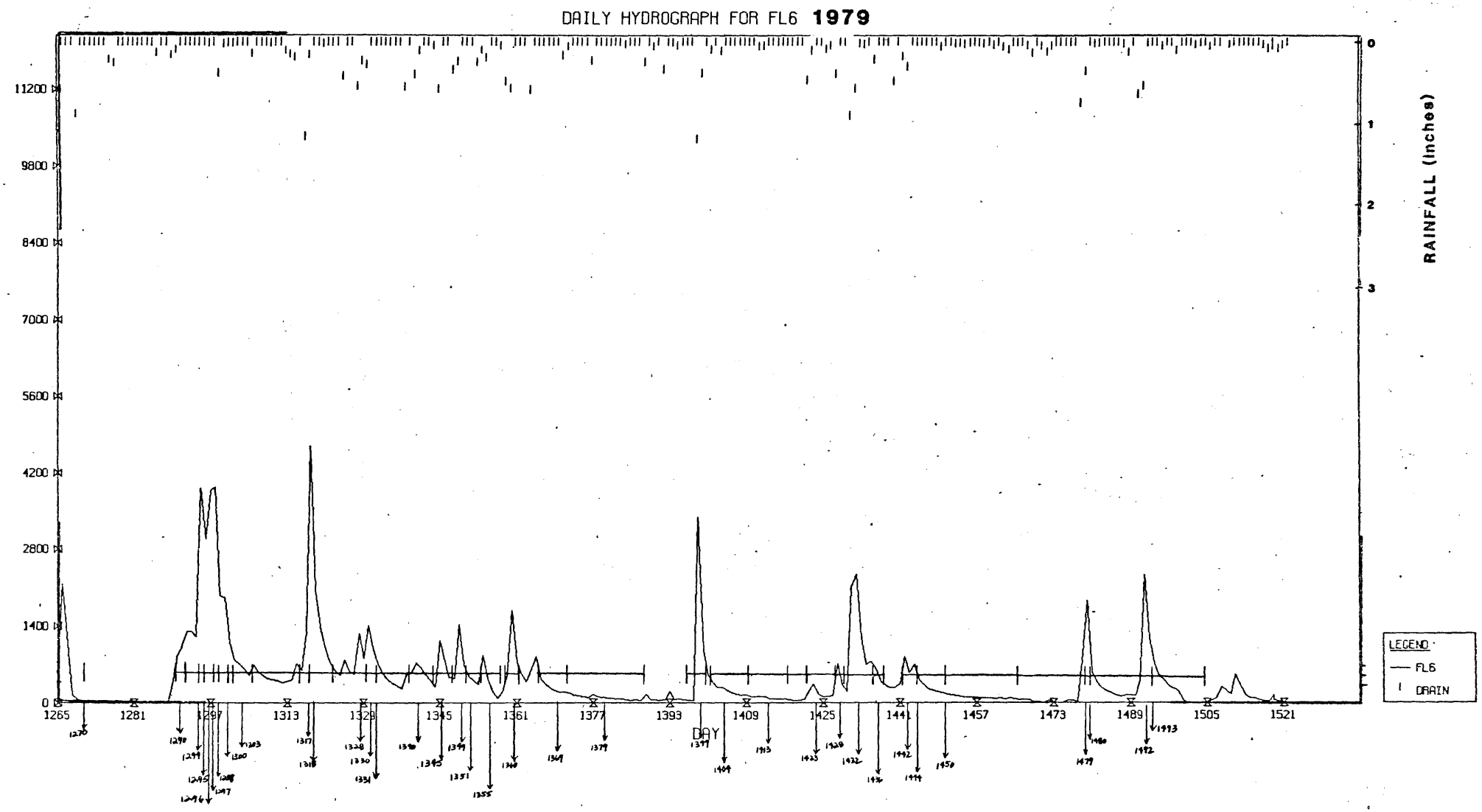

DAILY HYDROGRAPH FOR FL1 1979
RAINFALL
FLOW IN LITERS..
RAINFALL (Inches)
11200
9800
8400
7000
5600
4200
2800
1400
0
0
1
2
3
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
LEGEND
FL1
DRAIN


DAILY HYDROGRAPH FOR FL2 1979
RAINFALL (Inches)
FLOW IN CUBIC FEET PER SECOND
RAINFALL
11200
9800
8400
7000
5600
4200
2800
1400
0
0
1
2
3
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
1266
1274
1300
1317
1318
1328
1330
1331
1341
1345
1349
1351
1355
1359
1369
1379
1399
1404
1413
1423
1428
1432
1435
1441
1444
1450
1480
1492
1493
LEGEND
FL2
DRAIN


DAILY HYDROGRAPH FOR FL3 1979
RAINFALL
FLOW IN LITERS..
RAINFALL (Inches)
11200
9800
8400
7000
5600
4200
2800
1400
0
0
1
2
3
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
1266
1291
1295
1297
1298
1300
1315
1318
1328
1330
1331
1340
1345
1349
1351
1354
1361
1369
1379
1399
1404
1413
1428
1432
1436
1441
1444
1450
1479
1480
1492
1493
LEGEND
FL3
DRAIN


DAILY HYDROGRAPH FOR FL4 1979
RAINFALL
FLOW IN LITERS..
RAINFALL (Inches)
11200
9800
8400
7000
5600
4200
2800
1400
-0
0
1
2
3
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
LEGEND
FL4
DRAIN


DAILY HYDROGRAPH FOR FL5 1979
FLOW IN LITERS..
RAINFALL
RAINFALL (Inches)
11200
9800
8400
7000
5600
4200
2800
1400
0
0
1
2
3
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
LEGEND
FL5
DRAIN


DAILY HYDROGRAPH FOR FL6 1979
11200
9800
8400
7000
5600
4200
2800
1400
0
1265
1281
1297
1313
1329
1345
1361
1377
1393
1409
1425
1441
1457
1473
1489
1505
1521
DAY
0
1
2
3
RAINFALL (inches)
LEGEND
FL6
DRAIN

Appendix X

Julian Date Conversions

1978 Julian Dates

	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
1	883	914	944	975	1005	1036	1067	1097	2028
2	4	915	945	6	6	7	8	8	9
3	885	6	6	7	7	8	9	9	2030
4	6	7	7	8	8	9	1070	2000	1
5	7	8	8	9	9	1040	1	1	2
6	8	9	9	980	1010	1	2	2	3
7	9	920	950	1	1	2	3	3	4
8	890	1	1	2	2	3	4	4	5
9	1	2	2	3	3	4	1075	5	6
10	2	3	3	4	4	1045	6	6	7
11	3	4	4	985	1015	6	7	7	8
12	4	925	955	6	6	7	8	8	
13	895	6	6	7	7	8	9	9	
14	6	7	7	8	8	9	1080	2010	
15	7	8	8	9	9	1050	1	1	
16	8	9	9	990	1020	1	2	2	
17	9	930	960	1	1	2	3	3	
18	900	1	1	2	2	3	4	4	
19	1	2	2	3	3	4	1085	5	
20	2	3	3	4	4	1055	6	6	
21	3	4	4	995	1025	6	7	7	
22	4	935	965	6	6	7	8	8	
23	805	6	6	7	7	8	9	9	
24	6	7	7	8	8	9	1090	2020	
25	7	8	8	9	9	1060	1	1	
26	8	9	9	1000	1030	1	2	2	
27	9	940	970	1	1	2	3	3	
28	910	1	1	2	2	3	4	4	
29	1	2	2	3	3	4	1095	5	
30	2	3	3	4	4	1065	6	6	
31	3	---	4	---	1035	6	---	7	

1979 Julian Dates

	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
1		1279	1309	1340	1370	1401	1432	1462	1493
2		1280	1310	1341	1	2	3	3	4
3		1281	1311	1342	2	3	4	4	1495
4		1282	1312	1343	3	4	1435	1465	6
5		1283	1313	1344	4	1405	6	6	7
6		1294	1314	1345	1375	6	7	7	8
7		1285	1315	1346	6	7	8	8	9
8		1286	1316	1347	7	8	9	9	1500
9		1287	1317	1348	8	9	1440	1470	
10		1288	1318	1349	9	1410	1	1	
11		1289	1319	1350	1380	1	2	2	
12		1290	1320	1351	1	2	3	3	
13		1291	1321	1352	2	3	4	4	
14	1261	1292	1322	1353	3	4	1445	1475	
15	1262	1293	1323	1354	4	1415	6	6	
16	1263	1294	1324	1355	1385	6	7	7	
17	1264	1295	1325	1356	6	7	8	8	
18	1265	1296	1326	1357	7	8	9	9	
19	1266	1297	1327	1358	8	9	1450	1480	
20	1267	1298	1328	1359	9	1420	1	1	
21	1268	1299	1329	1360	1390	1	2	2	
22	1269	1300	1330	1361	1	2	3	3	
23	2170	1301	1331	1362	2	3	4	4	
24	1271	1302	1332	1363	3	4	1455	1485	
25	1272	1303	1333	1364	4	1425	6	6	
26	1273	1304	1334	1365	1395	6	7	7	
27	1274	1305	1335	6	6	7	8	8	
28	1275	1306	1336	7	7	8	9	9	
29	1276	1307	1337	8	8	9	1460	1490	
30	1277	1308	1338	1369	9	1430	1	1	
31	1278		1339		1400	1431		1492	

Appendix XI

1979 Rainfall Data

RAINFALL EVENTS: April through October, 1979

Month	Total # of Events	# of Events ≥0.3 inches	Total Rain	Rain Provided by Events ≥0.3 inches	
				in.	%
April	9	1	.97	.38	39.2
May	12	4	3.38	2.66	69.5
June	13	6	3.98	2.98	74.9
July	11	3	2.77	1.91	70.0
August	10	3	2.32	1.76	75.9
September	15	3	2.00	1.35	67.5
October	16	4	2.98	2.26	75.8
Total	86	24	18.85	13.30	70.6

Note: Rainfall ≥ 0.01 inches is an Event.

1979 Rainfall Data

AMAX

Date of Rainfall	Days Since Last Rainfall	Total Amount	Duration Hours	Intensity	Comments
4-8	?	.13	---		Not on strip chart recorded by AMAX.
4-11	3	.16	---		Not on strip chart recorded by AMAX.
4-12	1	.09	5		Storm from East.
4-19	7	.01	---		Recorder not operating properly when checked.
4-21	2	.38	---	$\frac{.38}{???}$	Recorder out of order.
4-22	1	.02	---		Recorder out of order.
4-23	1	.01	1		
4-24	1	.01	---		Recorder ReCalibrated.
4-28	4 20/24	.14	2		
5-2	4	.01	?		Duration Not recorded Time???
5-5	3	.10	2.5		
5-6	1 0.5/24	.15	8		
5-7	14/24	.19	14		
5-9	1 6/24	1.15	18	$\frac{1.15}{15}$=.077	Rainfall steady.
5-10	0	.16	14		Rainfall steady.
5-13	3	.02	?		Time ??
5-17	4	.42	1	$\frac{.42}{0.5}$= 0.84	Downpour.
5-18	?	?	?	Only a Drizzle During this span of time.	Clock stopped during this time interval.
5-19	?	?	?		
5-20	?	.54	?		
5-21	?	.23	?		
5-22	1	.28	8	$\frac{.28}{7}$=.04	Steady.
5-29	6 23/24	.55	9	$\frac{.55}{5}$=0.11	
6-1	1 16/24	.40	1	$\frac{.40}{1.5}$=.27	Heavy rainfall, clock slow.
6-2	22/24	.11	1		Clock slow.
6-5	3	.05	---		No time record.
6-6	1	.58	2	$\frac{.58}{2}$=.29	Steady hard rainfall.
6-9	2 22/24	.35	9	$\frac{.35}{9}$=.039	

1979 Rainfall Data (at AMAX) con't.

Date of Rainfall	Days since Last Rainfall	Total Amount	Duration Hours	Intensity	Comments	
6-10	1	.24	6			
6-14	4 17/24	.25	1			
6-15	2/24	.10	2.5			
6-16	1 10.5/24	.20	2			
6-19	-	.05	9		1500-2400	
6-20	0	.29	2	$\frac{.29}{1} = .29$	2400-0200	Total Rain 1.11"
	14/24	.20	8		1600-2400	
		.49 total	10 total		2400-0600	
6-21	0	.57	6	$\frac{.57}{2} = .285$		
6-25	4 15.5/24	.59	1.5	$\frac{.59}{2} = .295$		
7-2	6 18.5/24	.17	2			
7-3	14.5/24	.06	0.5			
7-8	5 0.5/24	.24	5			
7-15	7	.03	---		No time record.	
7-19	4	.25	---		No time record.	
7-21	2	.06	---		Very light Rain @ 0800 and @ 2200 No time record.	
7-23	2	.34	5	$\frac{.34}{4} = .085$		
7-25	2	.01			No time record.	
7-26	1	.05			Rain at 1300 - No record of time - Duration.	
7-30	3 16/24	1.55	5	$\frac{1.55}{3} = .52$	Hard rainfall.	
7-31	1	.38	---	$\frac{.38}{3}$ Chart indicates no rainfall.	No time record.	
8-2	2	.09	0.5			
8-4	1 7/24	.11	0.5			
8-12	8 20.5/24	.06	?			
8-13	1	.05	0.5			
8-22	8 15/24	.47	13	$\frac{.47}{12} = .039$	Steady rain.	
8-23	6/24	.11	4		Light rain.	
8-26	3	.09	3		Light rain.	
8-27	12/24	.05	6		Very light rain.	

1979 Rainfall Data (at AMAX) con't.

Date of Rainfall	Days since Last Rainfall	Total Amount	Duration Hours	Intensity	Comments
8-28	1 2/24	.39	4	$\frac{.39}{2} = .195$	
8-31	2 19.75/24	.90	0.5	$\frac{.90}{1} = .90$	
9-1	18/24 and 11.5/24	.57	3 and 0.75	$\frac{.47}{4} = .143$	0300-0600 1730-1815
9-2	22.5/24	.02	---		Very gentle Intermittent Rain.
9-3	12/24	.03	11		
9-5	1 10/24	.22	0.5		
9.9	4 16.5/24	.48	2	$\frac{.48}{1.5} = .320$	Downpour
9-11	2 1/24	.18	11.5		.05 fell from 2400-1100 .13 fell from 1100-1130.
9-12	1 8.5/24	.30	1	$\frac{.30}{1.5} = .200$	
9-19	6 22/24	.06	2		Slight, gradual rainfall 1900-2100.
9-22	3	.02	---		Sprinkles.
9-23	1	.01	---		Sprinkles.
9-24	1	.03	---		Sprinkles.
9-25	1	.01			Sprinkles.
9-27	2	.01			Very light
9-28	1	.02			sprinkles
9-30	2	.04	1		hardly noticeable.
10-2	1 22.5/24	.06	2		
10-3	17.5/24	.09	5.5		
10-7	3 23.5/24	.04	4		Very gradual rain.
10-8	13/24 and 7.5/24	.13	2.5 and 1.0		
10-10	1 17/24	.05	7.0		
10-11	1/24 and 10/24	.12	3 and 0.5		
10-12	1	.02	---		Snow flurries.
10-13	1	.02	---		Snow flurries.
10-18	5 and 4/24	.75	2 and 4	$\frac{.75}{10} = .075$	1400-1600 2000-2400 Hard stea rainf
10-19	0	.36	3	$\frac{.36}{5} = .072$	2400-0300
10-21	2	.02	---		Trace.

1979 Rainfall Data (at AMAX) con't.

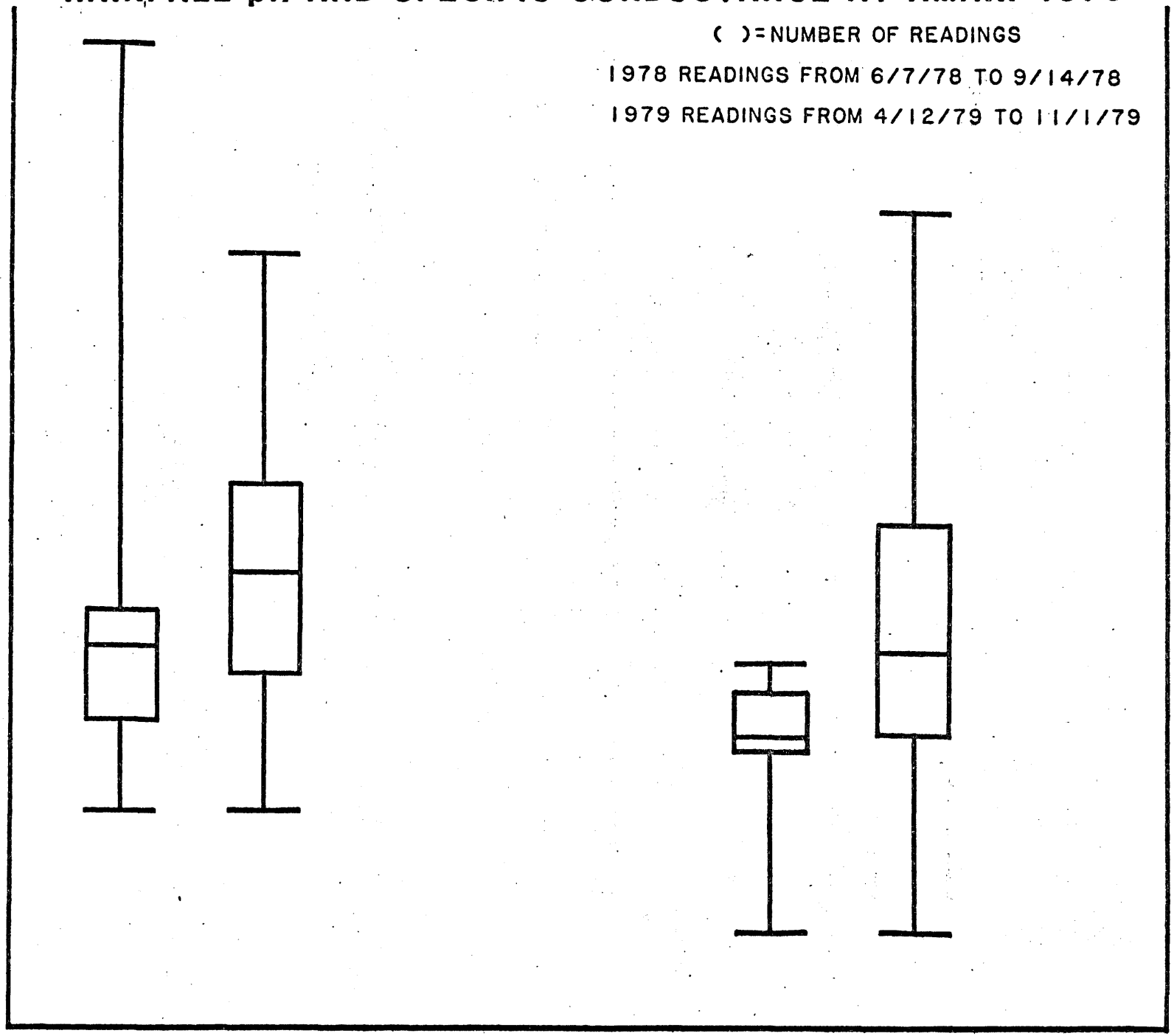
of Rainfall	Days since Last Rainfall	Total Amount	Duration Hours	Intensity	Comments
10-22	1	.01	---		Trace.
10-27	5	.10	---		Fell as snow at 0600, Melted by 1200.
10-29	2	.02	---		Trace
10-31	2	.64	---	$\frac{.64}{5} = .128$	

RAINFALL pH AND SPECIFIC CONDUCTANCE AT AMAX: 1979

( )=NUMBER OF READINGS

1978 READINGS FROM 6/7/78 TO 9/14/78

1979 READINGS FROM 4/12/79 TO 11/1/79



Table

Date Julian	Date Calender	Rainfall Amt. (in)	Overall Intensity (in/hr)	Peak[1] Intensity (in/hr)	Peak Amt. (in)	Peak Duration (hrs)	Days Since Last Rain	Amt. Rain Preceeding (in)	Days since[2] Last runoff peak
1317	5-9	1.15	.077	.12	.7	6	1 1/4	.19	20
1345	6-6	.58	.29	- same -		2	1	.05	5
1348	6-9	.35	}.039	.04	.59	14	3	.58	4
1349	6-10	.23							
1359	6-20	.49	}.29	.38	.75	2	1/2	.05	6
1360	6-21	.57							
1364	6-25	.59	.30	.30	.59	2	4 2/3	.57	4
1399	7-30	1.55	.52	.85	.85	1	3 2/3	.05	7
1422	8-22	.47	.039	.06	.25	4	8 2/3	.05	23
1431	8-31	.90	.90	.90	.90	1	2 4/5	.39	~3
1432	9-1	.57	.143	.17	.50	3.0	3/4	.90	~1
1440	9-9	.48	.32	.50	.25	½	4 2/3	.22	4
1479	10-18	.75	}.074	.16	.65	4	5	.02	36
1480	10-19	.36							
1492	10-31	.64	.128	.18	.45	2.5	2	.02	12

[1] peak intensity; amount must be $\geq$ ½ total rainfall

[2] .3" or over

Appendix XII

Tailings Plot

In November 1978, a small tailings pond (~20' x 30' x 1½-2'), denoted FL 7, was constructed at AMAX as part of the leaching study. It was built similar to the other leach piles; tailings on top of impervious hypalon and a perforated 6 inch PVC pipe built on the downslope end. Leachate collects in this pipe and moves out through a flow weighted composite sampler before reaching the main sump. All leach piles froze in November, 1978 and no longer discharged water until spring, 1979.

The fine texture of tailings material (>62% passing 200 mesh) enables it to absorb large quantities of water and hold it under tension. During April and May when FL 1-6 were flowing readily, only small, intermittent flows were recorded for FL 7. In June, several FL 7 composite samples were collected, but July and August were dry months and virtually no flow occurred from the tailings.

The possibility of fine material washing into and clogging the piping and/or compositing system prompted the DNR and AMAX to dig up the outflow pipe for inspection (Aug. 14). It was decided to turn the pipe around to a more suitable position with the perforations facing downward. This was done on Aug. 31 after flushing the pipe of water and wrapping a nylon mesh screen over the holes to discourage fines in the pipe.* The flow meter was also cleaned and the system appeared in good working order by Sept. 1.

Two composite samples were collected after rains in early September. (The pile usually quit flowing within 2 days after a rain event). Relatively low specific conductance, pH, and alkalinity readings on these samples raised the suspicion that rain water was collecting around the standpipe and moving out of the pile almost immediately or filtering

*A soaking test was done on this material to define any contamination. -J. Sturgess.

through a relatively shallow layer of tails before entering the perforated outflow pipe. The somewhat mounded profile of the pond might also encourage such flow routes, rather than the desired slow seepage of precipitation through a large area of the basin before discharge. In an attempt to change this pattern, on Sept. 10, tailings were mounded around the standpipe to discourage water from running off rapidly. Water quality samples taken after that date show slightly elevated pH, specific conductance and alkalinity but are still lower than the first few samples obtained early in the field season. For a more realistic picture of a tailings basin, further excavation of the entire pile should be done to alter the mound shape to that more like a pond.

FL-7 exhibits another deviation from the hydrology of an actual tailings pond--depth. The mini-pond is no greater than 2-3 ft. deep. Over long dry spells, evaporation throughthe surface together with drainage from the bottom can draw moisture out of its entire depth. An actual tailings pond is generally much deeper than this. Radiation and evaporation affect only the upper foot or so and water has more of a tendency to move laterally than infiltrate down below the basin. In such a situation, the moisture profile increases with depth to a point at or near saturation, depending on texture and permeability of tails. One hypothesis is that little or no oxidation and leaching should occur in this near saturated zone due to lack of oxygen.

A timeline (Figure AXII-1) shows the sequence of major events concerning the AMAX tailings pond. Water quality results on leachate samples from FL 7 are listed in Appendix IV.

---

*Metal Extraction by DPTA chelate. ** Soaking test - nylon mesh result

1979 Field Season FL-7 Tailings Pile-General Events

April

17 Tailings pile unfrozen

May 27 Relay recorder hooked up to FL-1

June

8 Composite Sample

13 C*

25 C

July

August

7 Unclogged flow meter

14 Dug out pipe-maintenance

Sept. 31 Pile reassembled after cleaning nylon mesh overhole

4 C.

10 C-Banked Standpipe
13 C
19 C

Oct.

22 C

Nov.

2 C

14 C

20 Freeze up

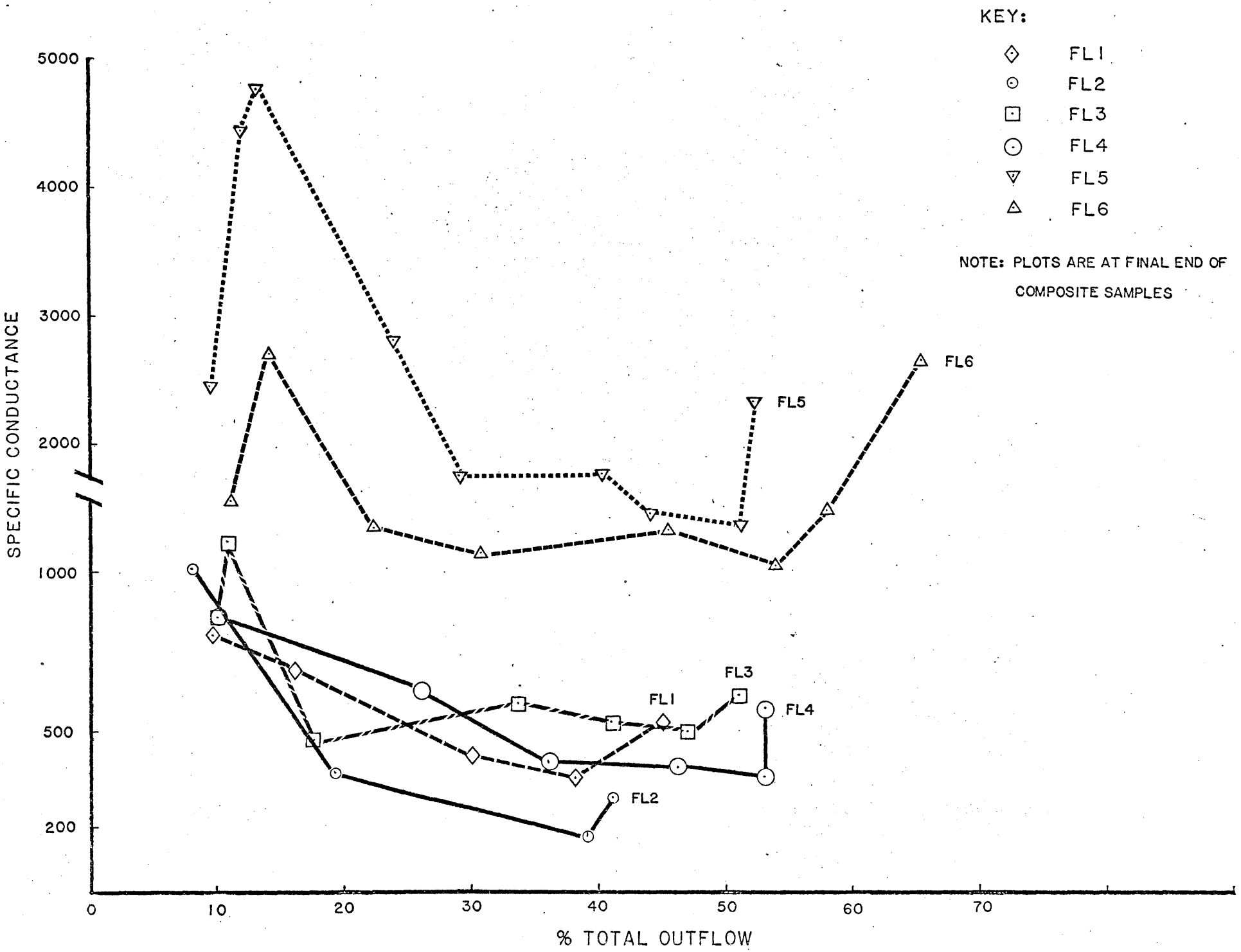
*C = composite sample

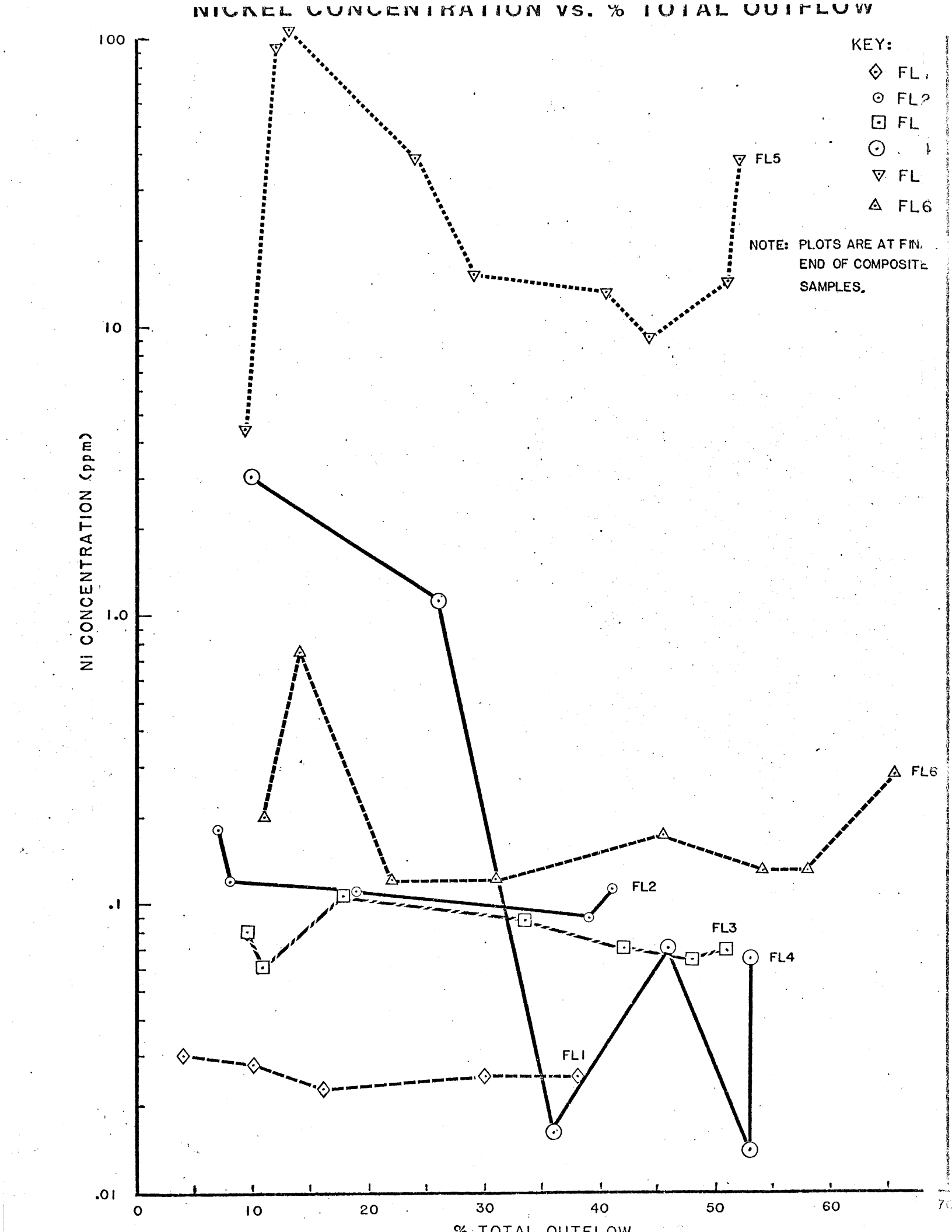
Appendix XIII

Spring Runoff

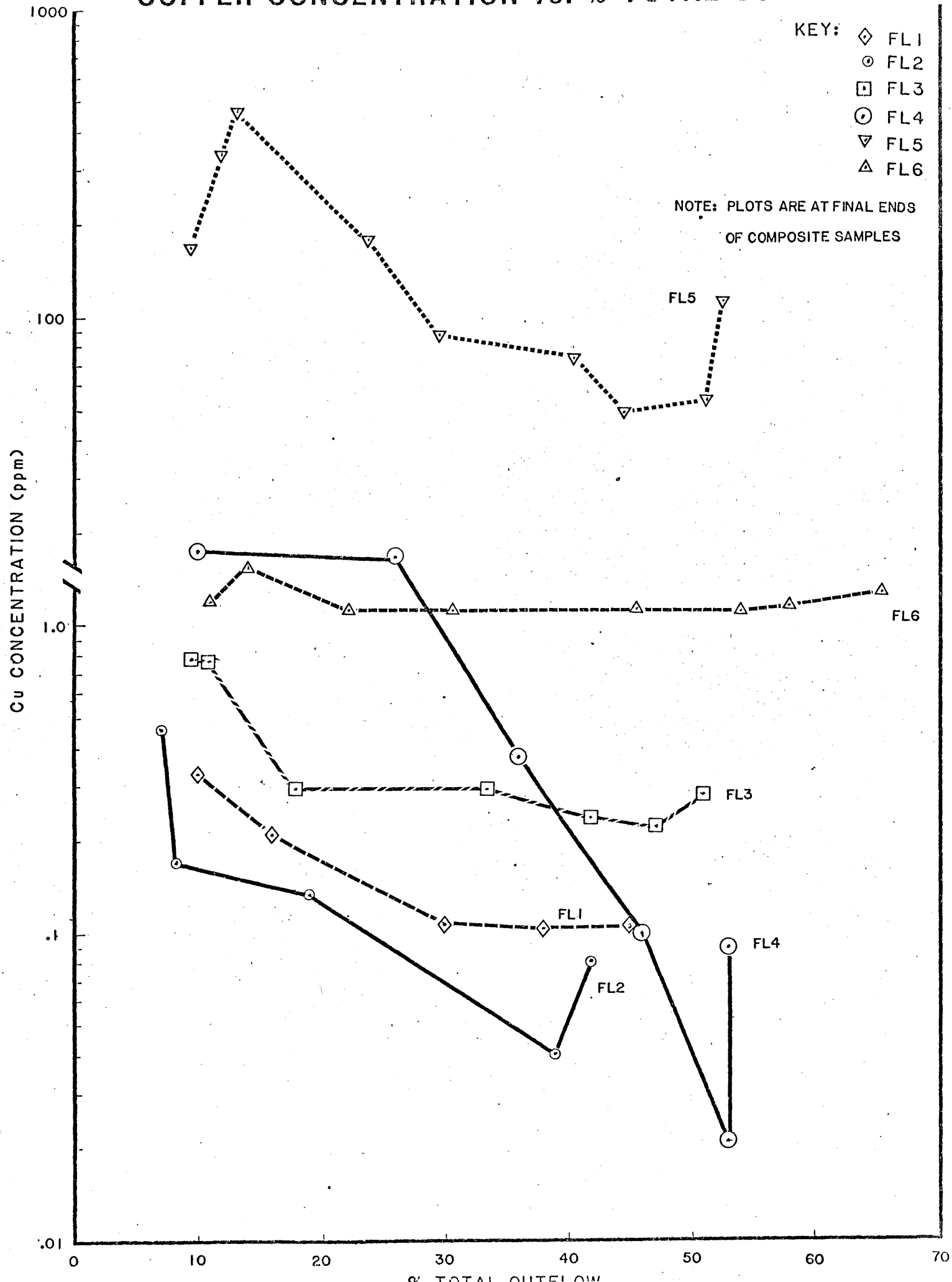
Concentration vs. Percent Runoff

SPECIFIC CONDUCTANCE vs. % TOTAL OUTFLOW




NICKEL CONCENTRATION VS. % TOTAL OUTFLOW
KEY:
FL1
FL2
FL3
FL4
FL5
FL6
NOTE: PLOTS ARE AT FIN. END OF COMPOSITE SAMPLES.
Ni CONCENTRATION (ppm)
100
10
1.0
.1
.01
0
10
20
30
40
50
60
% TOTAL OUTFLOW
FL5
FL6
FL2
FL3
FL4
FL1

COPPER CONCENTRATION vs. % TOTAL OUTFLOW



Appendix XIV

Chloride and Nitrate as a Function of Total Rainfall on the Pile

Chloride and nitrate concentrations were plotted for each pile as a function of the cumulative rainfall that had fallen on the pile. By plotting against cumulative rainfall, the data is normalized for the different dates of construction of the piles. (Figure AXIV-1 and 2).

In general, the concentrations decrease as the amount of rainfall increases. This trend supports the hypothesis that the chloride and nitrate are residual elements left on the rock during stockpiling and are being continually rinsed.

Chloride and nitrate concentrations in FL 6 have generally declined, but at a much slower rate than the other piles. Chloride concentration for FL-5 has declined to levels comparable to FL-4 but nitrate concentrations remain at levels much higher. The anomalous behavior of FL 5 and 6 is not understood at this time.

An estimate of the retained water has been made for each pile (Table AXIV-1). The average value for piles 1-4 is .42% by weight.

A weighted chloride concentration was determined by weighting the monthly main settling basin concentration by the amount of rock stockpiled during that month. The concentration was determined for piles 1-4 and assumed to represent 5 and 6.

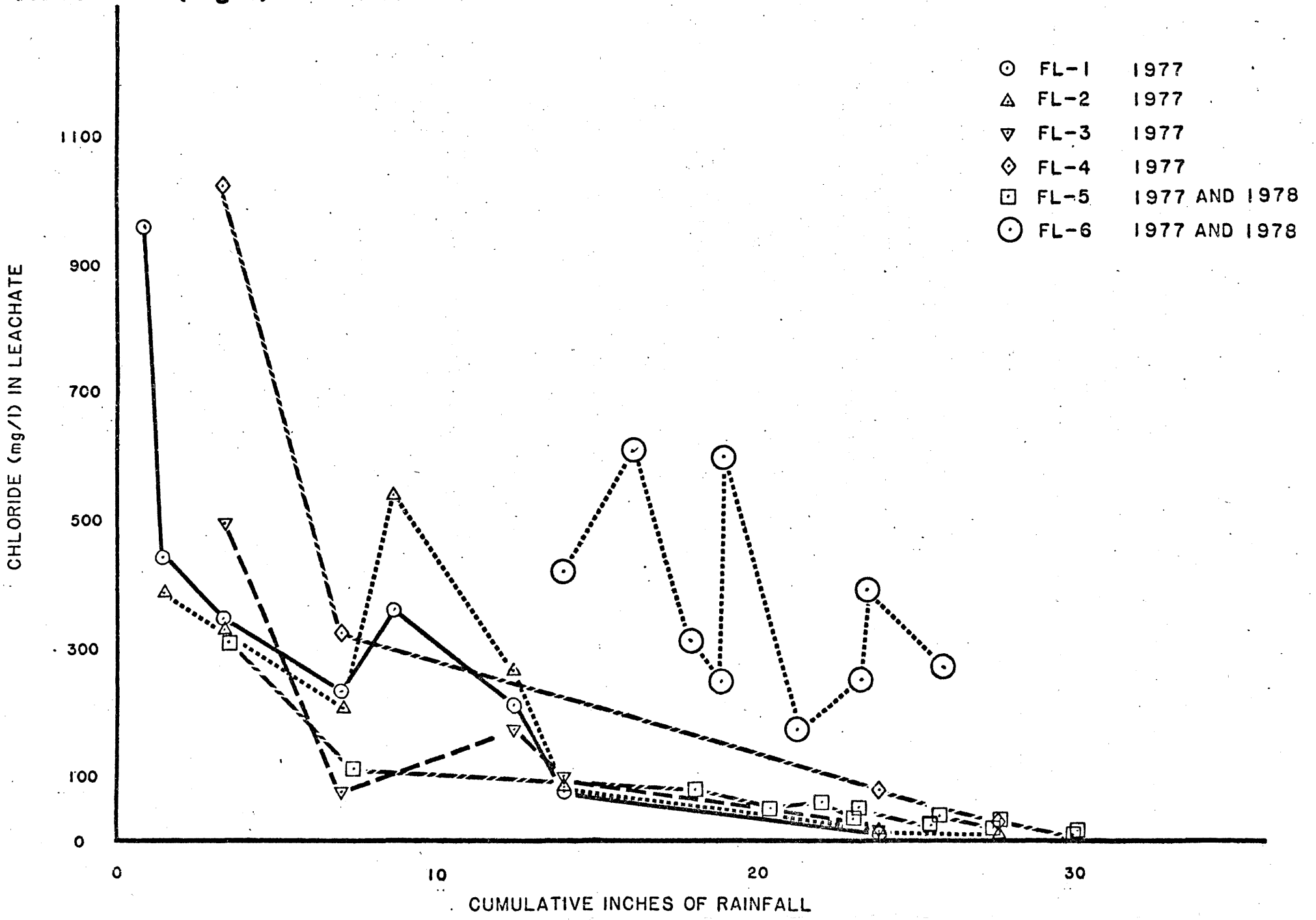
$$C1 = \frac{\text{Tons stockpiled 12/76}}{\text{Total Tons}}(9300) + \frac{1713}{6808}(9100) + \frac{631}{6808}(9100) + \frac{2075}{6808}(1900) + \frac{1659}{6808}(1750)$$

Chloride conc. main basin.

(6808) (1/77) (2/77) (3/77) (4/77)

$$= 5136 \text{ mg/l}$$

CHLORIDE (mg/l) IN LEACHATE vs. CUMULATIVE RAINFALL (Inches) 1977-1978



NITRATES (mg/l) vs. CUMULATIVE RAINFALL (Inches) 1977-1978

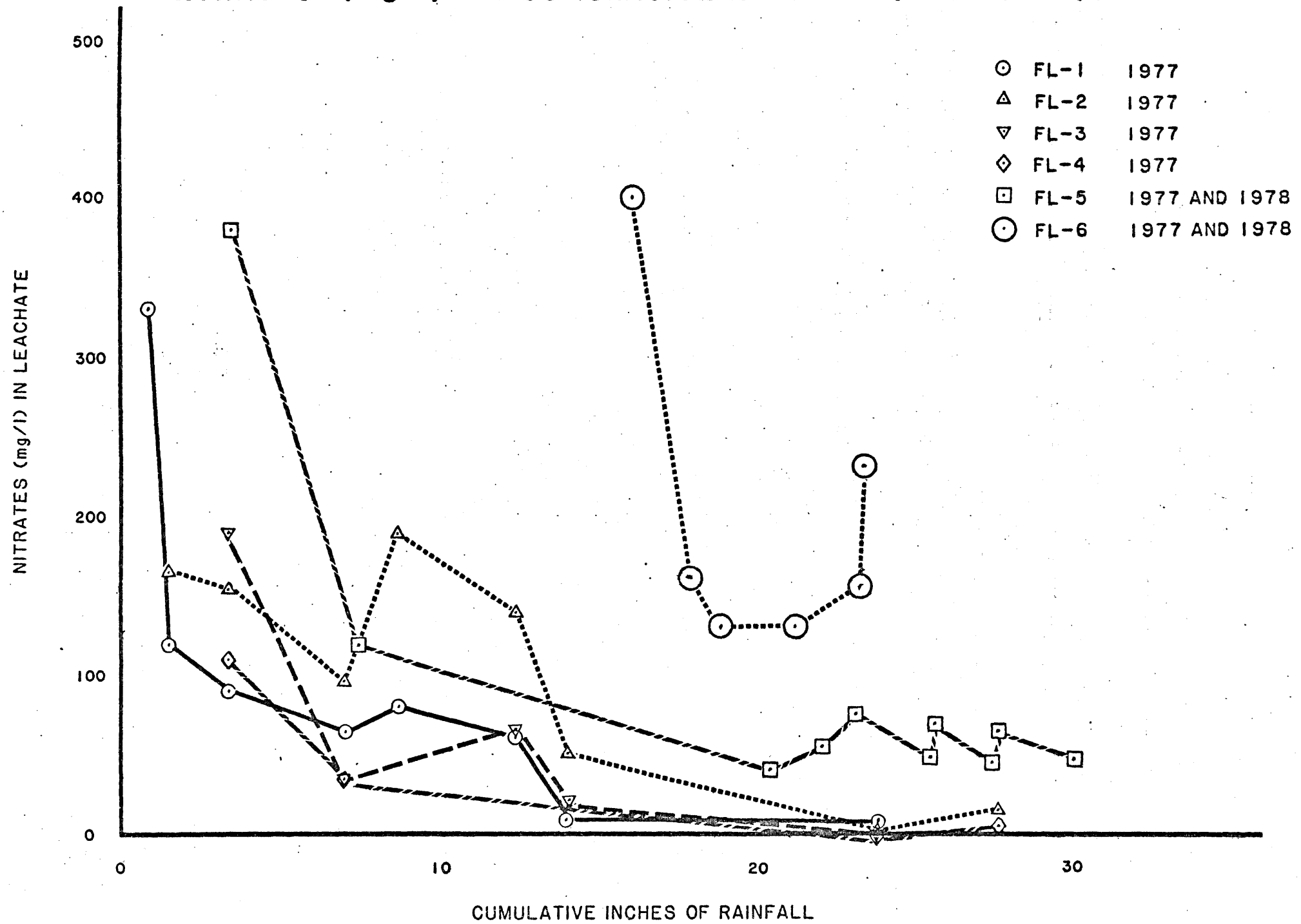


Table AXIV-1 RETAINED WATER

Pile	Total mass of chloride out of pile	Total mass[1] of chloride into pile(kg)	Net= wash off (kg)	Mass of[2] retained water (kg)	% Retained water
1	35.4	.8	34.6	6737	.42
2	31.8	1.0	30.8	5997	.37
3	23.5	.9	22.6	4400	.27
4	44.8	.9	43.9	8548	.53
5	12.3	.7	11.6	2259	.10
6	51.6	.6	51.0	9930	.63
					$\bar{x}$ =.39
					s =.19

$$\text{Mass of retained water} = \frac{\text{wash off mass (kg)}\ 10^6 \text{mg/kg}}{\text{estimated concentration in residual water(mg/l)}} \times \frac{10^3 \text{ mg/l}}{10^3 \text{ gm/kg}}$$

$$\%\ \text{retained water} = \frac{\text{mass of water}}{\text{mass of stockpile}} \times 100\ \%$$

[1]Total mass of chloride into pile = rainfall concentration x total rainfall x collecting area of stockpile.

(rainfall concentration ~1.5 mg/l; estimated from bulk precipitation samples, RCNS ( )).

[2]Estimated concentration of chloride in residual water.

Appendix XV

Quality Assurance

Quality Assurance Program

I. Marked Duplicates--Precision

15% of all water quality samples were masked duplicates. Data on the duplicates are listed in Table AXV-1. The results are summarized in Table AXV-2. Percent differencies between duplicates has been calculated for each parameter. Medians range from 0 to 8.7%. In general, results are satisfactory.

II. Standards/Spiked Samples--Accuracy

Metal standards and natural water samples spiked with known concentrations of metals are used for developing accuracy control charts. These aid in monitoring accuracy of analyses by recovery efficiencies. Such a program has been started for this project but more data must be generated before construction of accuracy control charts is possible. What information there is so far has been listed in Table AXV-3.

III. Interlaboratory Analyses

Results for the two interlaboratory sample collections taken this field season are shown in Table AXV-4. Discrepancy appears greatest in the first set with Fe and Co. The second set is satisfactory.

IV. Blanks

2% of all water samples were distilled deionized water blanks. The blanks were analyzed to determine the quality of laboratory water and show evidence of possible contamination from sample containers and filter units. Table AXV-5 summarizes the results. Only one sample showed evidence of contamination.

Table AXV-1 Quality Assurance - Range of % Error

Ca	Mg	Na	K	Cu	Ni	Fe	Mn	Co	Zn	SO_4	Cl	DOC	pH	Spec. Cond.	Alk
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	2.2	0	0	0	0	0
0	0	.1	0	0	0	0	0	0	0	3.0	0	1.1	0	0	3.0
.26	0	.24	0	0	0	0	0	0	0	3.8	0	1.5	0	.3	3.3
.3	0	.3	0	0	0	0	0	0	0	3.9	0	5.6	0	.34	3.7
.3	0	.4	.56	0	1.7	0	0	0	0	4.2	0	7.0	0	.56	3.8
.38	0	.5	.56	0	2.4	0	0	0	0	4.2	0	8.2	0	.8	6.1
.48	.3	.7	.8	.1	2.6	0	0	0	0	4.8	0	9.2	0	.81	6.1
.50	.4	.8	1.1	.57	2.7	0	0	0	0	6.3	0	9.5	0	.9	9.1
.61	.41	1.4	1.1	.6	2.7	0	0	0	0	6.7	11.7	12.7	0	1.8	15.4
.65	.52	1.9	1.1	1.9	3.9	.4	0	0	0	<11.4	18	24.0	.7	2.4	
.7	.6	2.1	1.2	2.3	4.1	2.4	0	.14	0	16.3	40	26.5	1.4	3.9	
.8	.7	3.3	1.2	2.7	4.1	8.0	.4	.95	0	22.6	126	41.9	1.5	4.1	
.82	1.2	3.5	1.3	4.3	4.2	10.	.6	3.2	0	41.3	>133	72.3	2.8	4.2	
1.2	1.4	3.8	1.3	5.1	4.4	18.2	.8	4.5	0				4.2	5.2	
1.2	1.6	4.0	1.5	7.6	7.2	28.5	.88	5.4	0				8.1	5.3	
1.5	1.8	4.4	2.0	9.1	8.0	30.5	2.1	13.5	.5				9.0	5.5	
1.6	2.7	6.1	2.1	12.6	10.1	40	2.4	14.3	.51						
3.1	2.8	6.1	2.2	16.4	13.3	40	15.4	36.4	.9						
3.6	3.1	8.0	3.2	27.5	13.8	66.7	20	43.7	1.5						
4.0	4.2	9.5	6.1	28.6	43.	66.7	186	61.5	5.1						
8.2	5.4	47	10.5	47.3	46.6	133	194	80.7	9.5						
Median															
.675	.56	2.0	1.15	2.1	4.0	.2	0	.07	0	4.8	0	8.7	0	.9	3.75
Mean															
1.37	1.23	4.73	1.72	7.58	8.13	20.2	19.2	12.0	.82	9.62	23.5	15.7	1.63	2.12	5.05

Table AXV-2

QUALITY ASSURANCE SUMMARY

-Duplicate Samples

$$\% \text{ error } \frac{X_1 - X_2}{\frac{(X_1 + X_2)}{2}} \times 100$$

Parameter	No. of Samples	Median	Max.	Min.
Ca	22	.675	8.2	0
Mg	22	.56	5.4	0
Na	22	2.0	47	0
K	22	1.15	10.5	0
Cu	22	2.1	47.3	0
Ni	22	4.0	46.6	0
Fe	22	.2	133	0
Mn	22	0	194	0
Co	22	.07	80.7	0
Zn	22	0	9.5	0
SO_4	14	4.5	41.3	0
Cl	14	0	>133	0
DOC	14	8.7	72.3	0
pH	17	0	9.0	0
Spec. Cond.	17	.9	5.5	0
Alk	10	3.75	15.4	0

Table AXV-3

Spiked Samples - Quality Assurance Accuracy

			Mg/l Cu	Ni		
FL6	#465	without spike:	4.2	14.3		
		standard spike:	5.0	5.0	(theorectical)	
		expected :	4.6	9.7		
	#466	found :	4.6	9.4		

			Mg/l Cu	Ni	Co	Zn	
FL	#498	without spike:	4.4	15.5	1.09	.63	
		standard spike:	2.0	10.0	2.0	1.0	(theoretical)
		expected :	3.2	12.8	1.5	.8	
	#502	found :	3.2	12.9	1.6	.8	

			Mg/l Cu	Ni	Co	Zn	
FL	#494 #500 $\bar{x}$	without spike:	.2	.36	.02	.04	
		standard spike:	1.0	5.0	1.0	.5	(theoretical)
		expected :	.6	2.7	.5	.3	
	#501	found :	.53	2.75	.38	.15	

Table AXV-4

Interlaboratory Quality Assurance

	June 8 FL 7			September 4 FL 4		
	DNR	SERCO		DNR	SERCO	
Sample #	363	365	% Difference	443	447	% Difference
Cu	.037	.028	27.7	.03	.031	3.2
Ni	.13	.100	26.1	.47	.44	6.6
Fe	.02	<.05				
Mn	.07	.12	55			
Co	.009	.002	127	.03	.026	14.3
Zn	.01	.007	10.5	.10	.100	0

Table AXV-5

Blanks - Quality Assurance

Parameter	(mg/l) High	(mg/l) Low	Median	Mean	σ
Co	<.01	<.01	<.01	<.01	0
Cu	<.01	.002	<.01	.01	.002
Ni	.044	<.01	<.01	.014	.009
Zn	<.01	<.01	<.01	<.01	0
Ca	<.02	<.01	<.01	.01	.005
Fe	<.02	<.01	<.01	.01	.005
K	<.01	<.01	<.01	<.01	0
Mg	<.01	<.01	<.01	<.01	0
Mn	<.02	<.01	<.01	<.01	.005
Na	.03	<.01	<.01	.01	.006

14 Samples

IV. Quality Assurance - Contamination Tests

A. Pump contamination Test

Purpose: To determine whether any contamination resulted from leachate contact with aluminum plated impeller housing on FL 5's replacement pump before it was coated with a silicon rubber compound.

Procedure: 1. Collected a leachate sample directly from PVC pipe coming onto 5 gallon sump from FL 5 and processed it for analysis. (#388)

2. Immediately collected another sample of leachate after allowing it to go through the sump and pump with uncoated metal plate: Processed it for analysis. (#389)

Results: No contamination occurred. Lab results for this test are listed in Table AXV-6.

Comments: The metal plate on all pumps have been sealed with a silicon rubber compound even though this test shows no contamination results from contact.

B. Filter Unit Washing Test

Purpose: To observe any contamination from filter unit after washing the unit according to a modified rinse procedure.

Procedure: Contaminated a clean unit with FL5 water, washed the unit according to new procedure and than ran some distilled, deionized water through it for analysis.

Result: No contamination. New rinse procedure is adequate. See Table AXV-6.

V. Quality Assurance - Stability Test.

Purpose: To observe composite sample stability over a period comparable to that of low flow collection. Composites

Table AXV-6

QUALITY ASSURANCE - LAB RESULTS FROM VARIOUS TESTS

	Blank	New filter unit wash test	Contamination Test		Stability Test Samples					
			FL 5		- FL 4 -			- FL 5 -		
Sample #.	521	413	388	389	300	302	314	301	303	313
pH	5.8				6.9	7.1	7.3	3.3	3.4	3.3
Alkalinity	1.6				39	21	18			
Spec. Cond.	4.1				981	1071	1075	2332	2453	2498
Calcium	<.02	<.02	309.8	309.6	193	193	176.0	286	283	262.8
Magnesium	<.01	<.01	103.6	103.6	17.2	17.2	16.2	89.2	90	88.8
Sodium	<.01	<.01	13.6	13.4	52	.49	44.4	130	131	143.8
Potassium	<.01	<.01	77.6	77.4	24.6	25.0	26.0	11.2	11.6	11.2
Copper	<.01	<.01	36.0	34.0	.032	.033	.022	37	37	35.0
Nickel	<.02	<.02	100	101	.246	.246	.28	111	109	94.4
Iron	<.02	<.02	5.26	5.23	<.02	<.02	<.02	7.07	3.90	2.12
Manganese	<.02	<.02	9.20	9.00	.18	.18	.16	9.49	9.45	9.82
Cobalt	<.01	<.01	6.64	6.62	.024	.024	.020	7.55	7.40	7.2
Zinc	<.01	<.01	3.89	3.89	.07	.07	.07	3.76	3.71	3.39
Sulfate										
Chloride										
DOC										
Comments	Distilled deionized water put through clean filter unit.	Test on modified filter washing procedure.	Pump contamination test. See notes in Q.A. section.		Filtered and acidified immediately upon collection	24 hrs. after sample was collected	13 days after initial collection	Filtered & acidified immediately upon collection	24 hrs. after sample was collected	13 days after initial collection
Date	11/14	7/26	6/20/79		4/24 1430	4/25	5/7	4/24 1430	4/25	5/7

*See Quality Assurance Section

<=below detection limits

are stored up to 2 weeks without being preserved.

Procedure: A composite sample was collected from FL 4 and from FL 5 on April 24th and a portion of each was processed immediately (filtered and preserved with HNO_3). The unprocessed sample was allowed to sit at room temperature in the lab for 24 hours. At that time (April 25th) another portion was processed for analysis. The remaining composite was refrigerated for 12 more days. On May 7th a sample was again processed for analysis.

Results: Most parameters appear quite stable over a two week period. Some changes were noticed however, and they are as follows:

a. pH rise in FL 4 leachate - 6.9 to 7.3

b. Rise in specific conductance reading for both FL 4 and FL 5 $\sim$ 100-150 µmho increase over entire storage period.

c. Decreased alkalinity in FL 4 - 39 to 18 mg/l as $CaCO_3$.

d. Decrease in copper concentration in 13 day sample.
-2% decrease in FL 5 (37 mg/l to 35 mg/l)
-49% decrease in FL 4 (.032 mg/l to .022 mg/l)

f. Large decrease in iron concentration in FL 5.
$\sim$5mg/l or 71% decrease
(no change in FL 4 sample)

Parameters not mentioned above either did not significantly change over the test period or showed a conflicting trend between piles. See TableAXV-6for water quality analysis.

Conclusions: There are no major problems associated with storage of composite samples and measurements of water quality.

However, it should be kept in mind when viewing lab results from low flow composites, of the tendencies toward change listed above. It is possible that dilution from ongoing, more current collection of low flow leachate will negate these changes to some degree. Further tests should be run in attempt to firm up these findings and answer other questions about composite stability.

Appendix XVI

Column Design:

Simulation of Field Conditions

The initial column experiments were designed to simulate certain field conditions. One possible use of an adsorbent would be to incorporate it within the stockpile. The material must have a permeability that will allow the runoff to flow through it rather than across the surface (Table AXVI-1)

The test material must also have sufficient removal capacity to treat stockpile runoff for the entire life of the operation (Table AXVI-2).

Table AXVI-1 PERMEABILITY ESTIMATES

It is difficult to calculate travel time for unsaturated flow conditions. The assumption is made that permeability will control the rate of movement. (This is strictly true only for saturated flow conditions). The second assumption is that the infiltration rate will be greater than or equal to the permeability.

$$\text{rate of water movement} = \frac{\text{Permeability (cm/sec) x 3600 sec/hr.}}{\text{2.54 cm/in.}}$$

permeability (cm/sec)	Infiltration (in/hr)
10^{-3}	1.4
10^{-4}	.14

1977 data from Erie's Dunka pit indicated that stockpile runoff peaks were observed for rainfall intensities in the range .10-.97 in/hr. If rainfall intensity is greater than the infiltration rate of the adsorbent material water will runoff across the surface of the adsorbent and very little metal removal will occur. Therefore, the infiltration rate should be 1 in/hr. or greater, which gives a permeability estimate of 10^{-3} cm/sec.

Table AXVI-2 CALCULATION OF THE TOTAL AMOUNT OF LEACHATE SOLUTION REQUIRING TREATMENT

For natural watersheds

Average precipitation	(in)	28.57
Average evaporation	(in)	16.3
Net		12.27

For stockpiles

Estimated evaporative loss (based on 1976-77 field data collected at Erie Mining Company's Dunka pit) is 70%

net runoff = .3 (28.57) = 8.57 in/yr.

for 25 yr life for a mine

total runoff = 25 (8.57 in) = 214 in

total volume

column diameter = 2 in

$$\text{volume} = \frac{214 \text{ in} \times \pi \times (1 \text{ in})^2 \times (2.54 \text{ cm/in})^3}{1000 \text{ cm}^3/\text{liter}}$$

$$= 11 \text{ liters}$$

Appendix XVII

Water Quality Data:
Removal Experiments

Table. Raw column data, peat and FLL.

	pH					Cu (ppb)					Ni (ppb)					Zn (ppb)					Co (ppb)					Cumuluative Volume (ml)				
Col.#	5	6	7	8	Mean	5	6	7	8	Mean	5	6	7	8	Mean	5	6	7	8	Mean	5	6	7	8	Mean	5	6	7	8	Mean
Time hrs.																														
4.7	6.2	6.3	6.5	6.5	6.4	60	60	60	60	60	470	470	470	470	470	40	40	40	40	40										
22	5.1	5.3	5.3	5.3	5.2																									
29	4.8	4.9	4.8	4.8	4.8																									
47	4.7	4.8	4.8	4.8	4.8	200	200	200	190	197.5	260	310	320	270	290	70	70	80	80	75	37	42	44	41	41	2447	2180	2100	2045	2193
53	4.7	4.7	4.7	4.7	4.7	170	160	170	150	162.5	200	230	260	220	227.5	50	50	60	60	55	30	36	35	33	33.5	2765	2455	2350	2310	2470
72.5	4.6	4.7	4.7	4.6	4.7																									
78	4.6	4.6	4.6	4.5	4.6																									
98	4.4	4.5	4.5	4.4	4.5	150	150	150	140	147.5	210	220	220	220	217.5	20	70	43	74	51.8	22	24	22	24	23	4905	4495	4430	4495	4581
103.5	4.4	4.5	4.4	4.4	4.4	150	140	150	140	145	200	240	220	210	217.5	11	10	10	13	11	19	18	18	21	19	5195	4855	4695	4770	4879
118.5	4.4	4.4	4.4	4.4	4.4	140	140	150	140	142.5	240	240	210	240	232.5	12	12	13	21	14.5	13	14	14	15	14	5935	5505	5355	5470	5566
124	4.4	4.5	4.4	4.4	4.4	130	130	130	120	127.5	190	220	200	220	207.5	9	9	9	7	8.5	9	11	11	11	10.5	6225	5755	5625	5755	5840
142	4.3	4.4	4.3	4.3	4.3	130	130	130	120	127.5	210	230	210	230	220	4	7	3	6	5	15	16	16	17	16	7125	6535	6615	6715	6748
148	4.3	4.4	4.3	4.4	4.4	120	120	120	120	120	200	230	190	210	207.5	4	4	3	6	4.3	13	15	15	16	14.8	7460	6800	6995	7035	7073
166.5	4.4	4.5	4.4	4.4	4.4																									
172.5	4.4	4.4	4.3	4.4	4.4																									
190	4.3	4.4	4.4	4.4	4.4	58	91	57	89	73.8	200	230	180	220	207.5	3	7	2	8	5	12	15	10	16	13.3	9650	8495	9090	9255	9123
216	4.4	4.5	4.4	4.5	4.5	49	56	38	57	50	190	180	170	180	180	2	4	1	4	2.8	13	10	8	10	10.3	10860	9665	10150	9965	10160
237.5				4.4	4.4																									

Table Raw column data, FL 5 and peat

Col#	pH				Copper (mg/l)				Nickel(mg/l)				Zinc (mg/l)				Cobalt(mg/l)				Cumulative Volume (ml)			
Time Hrs.)	9	10	12	Mean	9	10	12	Mean	9	10	12	Mean	9	10	12	Mean	9	10	12	Mean	9	1n	n	Mean
0	3.8	3.8	3.8	3.8	11.5	11.5	11.5	11.5	64	64	64	64	2.30	2.30	2.30	2.30	4.36	4.36	4.36	4.36				
4.7																								
22																								
29																								
47	4.8	4.7	4.7	4.7	.21	.22	.17	0.2	.44	18	.47	6.3	.22	1.07	.21	0.5	.24	2.62	.27	1.0	2065	3300	2040	2468
53	4.7	4.7	4.5	4.6	.22	.21	.18	0.2	1.65	30	1.90	11.2	.31	1.40	.33	.68	.84	3.21	.93	1.7	2280	3350	2365	2665
72.5																								
78																								
98	4.5	4.4	4.4	4.4	.25	.26	.24	.25	43.0	60.0	48	50.3	1.82	2.45	1.92	2.0	4.38	4.74	4.35	4.5	3920	4895	4325	4380
103.5	4.4	4.3	4.4	4.4	.26	.24	.24	.25	55.0	66.0	55	58.7	2.20	2.66	2.13	2.3	4.70	4.88	4.28	4.6	4250	5145	4640	4678
118.5	4.3	4.3	4.4	4.3	.23	.24	.22	.23	65.0	72	58	65.0	2.54	2.93	2.35	2.6	4.67	4.94	4.20	4.6	5480	5915	5690	5695
124	4.3	4.2	3.8	4.1	.26	.24	.21	.24	63.0	75	58	65.3	2.39	2.98	2.25	2.5	4.18	4.93	3.82	4.3	5650	6230	5960	5947
142	4.4	4.1	4.3	4.3	.23	.26	.20	.23	63.0	66	54	61	2.51	2.67	2.19	2.5	4.42	4.64	3.84	4.4	6070	7140	6990	6733
148	4.2	4.1	4.2	4.2	.21	.27	.25	.24	58.0	62	51	57	2.33	2.49	2.09	2.3	4.09	4.30	3.62	4.0	6985	7465	8540	7663
166.5	4.2	4.0	4.1	4.1	.27		.37	.32	51.0		46	48.5	2.08		1.86	2.0	3.64		3.34	3.5	8145	9285	10,740	9390
172.5	4.0	3.9		4.0	.27			.27	51.0			51.0	2.11			2.10	3.68			3.7	10,245	10,285		10,265
190																								
216																								
237.5																								

Table Raw column data, tailings and FL 1

	pH					Cu(ppb)					Ni(ppb)					Zn(ppb)					Co(ppb)					Cumulative Volume(ml)				
Col.#	1	2	3	4	Mean	1	2	3	4	Mean	1	2	3	4	Mean	1	2	3	4	Mean	1	2	3	4	Mean	1	2	3	4	Mean
Time (Hrs)																														
0					7.6					60.0					470					40	260				40					
4.7	5.8	5.5	5.5	5.6	5.6																									
22	6.1	6.4	6.6	6.6	6.4																									
29	6.6	7.0	7.0	7.0	6.9																									
47	6.8	7.0	7.1	7.1	7.0	32	22	25	22	25.3	100	90	80	110	95	2	4	3	1	2.5	9	7	7	9	8	2170	2360	2600	2415	2386
53	7.0	7.1	7.2	7.2	7.1	25	19	19	19	20.5	100	80	80	90	87.5	8	1	1	1	3.5	9	8	7	8	8	2445	2660	3970	2735	2953
72.5	7.1	7.2	7.2	7.3	7.2																									
78	7.2	7.3	7.3	7.4	7.3																									
98	7.1	7.3	7.3	7.3	7.3	25	22	21	19	21.8	110	130	150	140	132.5	1	1	5	2	2.8	8	9	9	8	8.5	4235	4665	5390	4295	4804
103.5	7.2	7.3	7.4	7.3	7.3	22	20	21	19	20.5	150	160	190	180	170	1	1	1	4	0.8+	6	6	9	6	6.8	4580	5125	5740	5240	5171
118.5	7.3	7.3	7.3	7.3	7.3	22	19	21	19	20.3	190	200	240	220	212.5	1	1	1	1	0.8+	6	5	5	5	5.3	5320	6175	6550	6000	6011
124	7.2	7.2	7.3	7.3	7.3	19	57	18	17	27.8	200	290	260	230	245	1	1	1	1	0.8+	5	7	4	4	5	5610	6565	6885	6295	6339
142	7.3	7.3	7.3	7.3	7.3	23	20	20	19	20.5	220	250	240	210	230	1	1	1	1	0.9+	6	7	7	6	6.5	6370	7565	7960	7280	7294
148	7.1	7.3	7.3	7.3	7.3	20	18	20	19	19.3	250	230	270	260	252.5	1	1	1	1	0.9	7	6	7	6	6.5	6950	7705	8240	7570	7616
166.5	7.3	7.5	7.4	7.4	7.4																									
172.5	6.9	7.2	7.2	7.4	7.2																									
190	7.3	7.3	7.3	7.4	7.3	19	16	8	13	14	280	280	290	280	282.5	1	1	6	1	2.2	9	8	9	8	8.3	9120	9415	9915	8935	9346
216	7.0	7.3	7.3	7.2	7.2	17	14	13	14	14.5	770	270	270	280	397.5	16	1	8	1	6.4	38	9	8	7	15.5	10600	10835	11135	10735	10826

+ = value of .8 assigned to <1