INTERIM PROJECT REPORT

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Interim Report on
Water Quality Investigation
DEGRAY RESERVOIR
Arkansas

By

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ABSTRACT

INTERIM REPORT ON WATER QUALITY INVESTIGATION

DEGRAY RESERVOIR

ARKANSAS

Impoundment of the Caddo River near Arkadelphia, Arkansas began in August, 1969. Detailed patterns of the dissolved oxygen distribution in this reservoir are presented for the period September, 1969 through April, 1971. Although the reservoir had not reached normal pool elevation, thermal stratification accompanied by severe hypolimnic oxygen depletion has been observed. The dissolved oxygen data show that an under flow occurs in the fall of the year and carries dissolved oxygen into the hypolimnic zone. The gradients of dissolved oxygen concentration observed during the winter indicate that the reservoir does not undergo complete mixing.

A short summary of the results of trace elements and other water quality parameters is also included.

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Key Words - impoundments#/trace metals#/water quality/
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Gary Fiser

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Mike Hurst

Ramona Rice

Introduction:

The DeGray Dam has been constructed on the Caddo River approximately 7 miles north of Arkadelphia, Arkansas. This multi-purpose project will provide flood control, power generation, recreation, watersupply, and water quality control. At normal pool elevation the impoundment will have an area of 13,400 acres. There are three unique features to this project: 1) a multi-level intake structure for temperature and water quality control, 2) a small regulating dam located below the main structure to provide regulation of the down-stream power wake, and 3) a pumpback facility allowing an average pumpback of 2,000 c.f.s. during periods of low power consumption. The regulating dam will also provide a pool for this pump back facility.

The impoundment of DeGray Reservoir was begun on August 8, 1969. By May 11, 1970 the elevation of the pool was at 119 M (msl) giving a maximum depth of approximately 55 M near the dam. On May 12, 1970 the gates were opened to lower the pool for tree topping. By mid-June the elevation of the pool was at 113 M (msl) and remained at this level through mid-October. During this period, the bottom of the release gates were set at elevation 113 M so that inflow approximately equaled outflow. In late October the elevation of the reservoir was increased to approximately 114 M and remained roughly at that level until the gates were closed on December 31, 1970. No discharges have been made through April 1971. The elevation of the pool on April 30, 1971 was 119 M (msl).

The regulating dam located downstream from the main structure, is nearing completion but, as yet, has impounded no sizable pool.

A study of the water quality in DeGray Reservoir has been conducted since its impoundment in August, 1969. Selected water quality parameters have been determined in samples taken from various depths and locations within the reservoir. The parameters which have been followed are given below:

dissolved oxygen
temperature
pH
chloride
fluoride
phosphate (ortho)
nitrate
C.O.D.
calcium
magnesium
sodium
potassium
alkalinity
sulfate
iron
manganese
copper
cobalt
nickel
lead
zinc
cadmium
silver

This interim report presents a summary of the dissolved oxygen data and representative temperature data for DeGray Reservoir for the period September, 1969 through April, 1971. A brief summary of the results of other water quality parameters

is also presented. A relevant literature survey and detailed interpretation of the results of this study will be presented in the project completion report.

Sampling stations:

The location of sampling stations on DeGray Reservoir are shown in Figure No. 1. Water samples are taken from various depths at Stations No. 1, 7, 10, 12, 13, and 17. Dissolved oxygen and temperature profiles are measured at these and other stations as needed to give a complete picture of the reservoir.

Temperature:

Table No. 1 presents the temperature data for Station No. 1 for the period 9/26/70 through 5/15/71. During the period of stratification the hypolimnic temperatures are around 7 to 8 degrees Centigrade. Maximum epilimnic temperatures are around 28 degrees. During the months of January and February there is a slight temperature gradient in the reservoir.

Dissolved Oxygen:

The dissolved oxygen data is presented in Figures 2 through 25. Dissolved oxygen was measured at selected stations shown in Figure 1, using a Yellow Springs dissolved oxygen meter. The determinations were made at 2 meter intervals. In Figures 2 through 25, the reservoir is idealized as a triangle with the vertical line on the left of each figure representing the dam, the horizontal line representing the surface of the water and the diagonal line representing the drop of the river through the reservoir area. Since each station is located over the river channel, the data was recorded at the appropriate location within the triangle and the isoconcentration lines were drawn. Although the drop of the river through the reservoir area is not uniform as depicted in this graphical representation, the pattern developed by the isoconcentration lines clearly show the dissolved oxygen distribution within the different regions of the reservoir.

Shortly after beginning of impoundment, the reservoir developed a pattern of very low dissolved oxygen in the downstream section of the impoundment, gradually increasing in an upstream direction. This is shown in the profile for 9/26/69. Stocking of some fish in the downstream section of the reservoir by the Game and Fish Commisssion during this period resulted in considerable stress and a large mortality. Subsequently stocking operations were moved upstream. It is likely that the low dissolved oxygen reflects oxygen consumption by newly flooded organic materials. During this period of reservoir

filling the ratio of organic debris to total volume of the reservoir would be relatively large.

As shown in the dissolved oxygen profile taken on 10/18/69 the cooler fall rains underflow the reservoir bringing fresh oxygen into the lower region of the impoundment. It is interesting to note the small pocket of low dissolved oxygen which was formed near the center of the graph. By 11/8/69 the underflow had proceeded all of the way to the dam and there had been considerable increase in elevation of the pool. The cooler temperatures were causing oxygenation of the surface water while the underflow seems to be oxygenating the lower strata. The pocket of low dissolved oxygen near the center of the graph was maintained.

Although the dissolved oxygen levels were observed to be higher on 12/13/69, the pattern of high dissolved oxygen on bottom, originating from the underflow, was still present. The pocket of low dissolved oxygen was still present indicating that complete mixing of the reservoir had not occurred.

On 1/17/70 the dissolved oxygen distribution suggests that considerable mixing had occurred but that there was an increasing oxygen demand in the lower regions of the impoundment. By 3/21/70 the more classical picture of dissolved oxygen began to develop showing values of saturation in the upper 14 meters and a declining oxygen concentration in the lower region.

The elevation of the reservoir increased from 114 M to almost 120 M between 3/21/70 and 5/2/70. The large quantity

of water which entered the reservoir during this time is probably responsible for the rather complex pattern of dissolved oxygen distribution observed on 5/2/70. The water below 100 M elevation appears to be undisturbed by the inflow since a declining dissolved oxygen concentration is observed. A pocket of zero dissolved oxygen has developed near bottom in the central portion of the impoundment.

On 6/15/70 the dissolved oxygen distribution shows the classical clinograde distribution with values near saturation on the surface and a sharply declining concentration in the thermocline region. A pocket of higher dissolved oxygen is maintained under this sharp drop in the lower regions of the impoundment. It should also be noted that the reservoir was lowered during this period for the purpose of tree topping. Releases were made from the upper elevation (approximately 114 M). The release of water from the upper elevation is probably responsible for the relatively thin layer of oxygenated water on the reservoir during this period.

The reason for the minimum in the dissolved oxygen profile at elevation 107 M in the lower portion of the reservoir is not clear. Such a minimum could be produced by the interflow of water carrying a heavy burden of organics from spring runoff. The mechanism of the development of this minimum is being investigated further.

The dissolved oxygen distribution during the period from 7/7/70 through 10/10/70 is characterized by a relatively thin

layer of oxygenated water on the surface and an oxygen depleted zone immediately below this layer. The pocket of slightly higher dissolved oxygen below elevation 105 M was observed to gradually dissipate over this period. On 7/23/70 and again on 10/10/70 a disturbance in the even layering of the dissolved oxygen distribution was observed in the upper end of the reservoir. Such disturbances could be produced by an underflow of cooler runoff water flowing into or slightly below the thermocline causing a lifting up of some of the oxygen depleted water into the epilimnic zone. Mixing of oxygen depleted water by interflows or underflows of cooler runoff water conceivably could produce a zone of low oxygen which could be of biological significance.

On 11/7/70 the dissolved oxygen profile showed a distinct underflow in the upper end of the reservoir. The rains experienced immediately prior to this period were considerably cooler and would be expected to underflow deeper into the thermocline. By 12/2/70 the underflow has caused oxygenation of the hypolimnic water in the upper portion of the reservoir and by 12/16/70 dissolved oxygen concentrations indicative of fresh water is detectable throughout the upper half of the reservoir.

The dissolved oxygen profile observed on 1/12/71 shows that the fresh water has completely underflowed the reservoir, oxygenating the hypolimnic water throughout the reservoir. It is obvious that mixing has not taken place in the downstream section of the impoundment since a pocket of zero dissolved

oxygen can still be detected near the dam. This intermediate pocket of oxygen depleted water is still detected on 1/30/71 even through the concentrations of dissolved oxygen have increased. By 2/20/71 dissolved oxygen concentration has increased to 7 ppm and above throughout the reservoir. Although there is a definite gradient from the lower end of the impoundment toward the upstream section, the dissolved oxygen distribution reflects as near a homogeneous state as has ever been observed in this reservoir.

The dissolved oxygen measurements observed on 3/20/71 indicate that the reservoir is beginning stratification with oxygen depletion beginning in the lower regions. As the oxygen depletion process continues, the higher oxygen demand seems to be in the central portion of the reservoir. The first stations to show a zero dissolved oxygen zone were near mid reservoir. This is shown in the profiles taken on 4/24/71 and 5/18/71.

Other Water Quality Parameters:

The various water quality parameters which have been determined in the study of DeGray Reservoir are shown in Table No. 2 along with the results of analyses of samples taken on March 20, 1971.

During the summer of 1970 a large build up of iron and manganese was observed in the anoxic portion of the reservoir. There were indications that other trace metals were also affected by the strong reducing conditions present in the lower portion of the reservoir during this period. Cadmium has been observed to increase in the extreme lower portion of the hypolimnic zone prior to the detection of hydrogen sulfide.

A statistical evaluation of trace metal data show a trend of decreasing concentration since impoundment. Additional data will be necessary to confirm this trend.

Water quality data indicate that there were interflows within the reservoir during the early spring of 1971. Rainfall during the spring of 1971 has been below average. These density currents are apt to be more pronounced during periods of heavy runoff.

DeGray Reservoir
Temperature (°C)
Station No. 1

Depth (M)	1969 9/26	10/18	11/8	12/13	1/17	3/21	5/2	5/18	6/15	7/7	7/23	8/13
0	26.0	21.2	16.7	10.3	6.9	9.6	19.2	25.0	28.0	28.6	26.2	28.9
2	24.3	20.8	16.1	10.1	6.9	9.0	19.2	25.0	27.2	28.6	26.0	28.7
4	24.1	20.8	16.1	10.0	6.6	9.0	19.0	24.0	23.0	24.1	25.2	28.4
6	24.0	20.7	15.5	9.9	6.3	9.1	19.0	18.2	16.1	15.7	16.3	17.4
8	24.0	20.7	15.0	9.7	6.2	9.1	16.3	16.9	12.1	11.7	12.3	12.9
10	24.0	20.7	14.9	9.7	6.2	9.2	14.0	15.0	10.0	9.8	10.2	10.5
12	23.9	20.5	14.0	9.7	6.2	9.2	11.0	13.0	9.0	8.9	9.2	9.5
14		20.2	13.6	9.6	6.2	7.9	10.2	10.4	8.0	8.0	8.3	8.6
16		20.2	13.5	9.0	6.2	6.9	10.0	9.8	7.5	7.7	7.8	7.9
18				8.5	6.2	6.4	8.9	9.0	7.0	7.1	7.3	7.4
20				8.1	6.1	6.3	7.8	8.0	6.9	7.0	7.0	7.2
22				8.0	6.1	6.1	7.1	7.3	6.9	6.9	7.0	7.1
24				7.6	6.0	6.0	6.9	7.0	6.8	6.8	7.0	7.0
26				7.5	6.0	5.8	6.8	6.9	6.7	6.7	6.9	6.9
28				7.5	6.0		6.7	6.6	6.5	6.7	6.8	6.9
30							6.5	6.6	6.5	6.7	6.8	6.9
32							6.3	6.3	6.5	6.7	6.8	6.9
34							6.2	6.1	6.4	6.6	6.8	6.9
36							6.2	6.1	6.4	6.6	6.8	7.0
38							6.1	6.1	6.4	6.9	7.0	7.2
40							6.1	6.1	6.9	7.1	7.1	7.2
42							6.1	6.1	7.0	7.2	7.1	7.3
44							6.1	6.1	7.0	7.3	7.2	7.4
46							6.1	6.1	7.0			7.4
48							6.1	6.1	7.0			
50							6.1	6.1	7.0			

Temperature (°C)
Station No.1
(continued)

Depth (M)	1970 (cont.) 8/21	9/19	10/10	11/7	12/2	12/16	1971 1/12	1/30	2/20	3/20	4/24	5/18
0	28.6	27.8	19.8	14.1	13.0	9.9	8.6	8.3	9.3	9.0	19.8	21.0
2	28.6	26.6	19.7	14.3	12.5	9.9	8.2	7.9	8.0	9.0	16.7	20.5
4	27.8	26.3	19.7	14.3	11.4	9.9	8.1	7.8	7.6	9.0	16.2	19.1
6	17.0	19.2	19.7	14.4	11.1	9.9	7.8	7.7	7.3	9.0	16.1	14.2
8	12.3	12.3	13.9	14.2	10.7	9.9	7.5	7.5	7.2	9.0	15.0	11.9
10	10.2	10.2	10.3	13.7	10.3	9.9	7.5	7.4	7.0	9.0	11.2	10.5
12	9.0	9.1	9.5	9.9	10.1	9.9	7.5	7.3	6.9	9.0	10.8	9.8
14	8.1	8.2	8.5	8.9	10.0	9.9	7.5	7.3	6.8	9.0	9.2	8.9
16	7.5	7.8	7.9	8.2	8.6	9.2	7.5	7.2	6.6	9.0	8.7	8.4
18	7.1	7.5	7.6	7.9	8.0	9.0	7.4	7.2	6.6	9.0	8.0	8.0
20	7.1	7.3	7.4	7.7	7.9	8.1	7.3	7.2	6.5	9.0	7.8	7.8
22	7.0	7.2	7.2	7.5	7.8	8.0	7.3	7.2	6.5	9.0	7.5	7.4
24	7.0	7.2	7.2	7.3	7.8	7.9	7.3	7.2	6.3	9.0	7.4	7.2
26	7.0	7.1	7.1	7.2	7.6	7.8	7.3	7.2	6.3	8.0	7.2	7.2
28	6.9	7.1	7.1	7.2	7.5	7.8	7.3	7.1	6.3	7.2	7.0	7.2
30	6.9	7.0	7.1	7.2	7.4	7.5	7.2	7.0	6.3	7.0	7.0	7.1
32	6.9	7.0	7.1	7.2	7.4	7.5	7.2	6.8	6.3	7.0	7.0	7.0
34	6.9	7.3	7.1	7.2	7.4	7.4	7.2	6.8	6.2	6.9	7.0	7.0
36	7.1	7.3	7.3	7.5	7.4	7.4	7.2	6.8	6.2	6.8	7.0	7.0
38	7.1	7.3	7.4	7.7	7.6	7.6	7.2	6.8	6.2	6.8	7.0	7.0
40	7.1	7.2	7.5	7.7	7.8	7.8	7.1	6.8	6.2	6.8	7.0	7.0
42	7.4	7.4	7.5	7.8	7.8	7.8	7.1	6.7	6.2	6.7	7.0	7.0
44	7.4	7.6	7.5	7.8	7.8	7.8	7.0	6.7	6.2	6.7	7.0	7.0
46				7.8		7.8	7.0	6.7	6.2	6.7	7.0	7.0
48							7.0	6.7		6.7	7.0	
50										6.8	7.0	

Table No. 2

Station No. 1

Depth (M)	Temp. (°C)	D.O. (ppm)	pH	Alk. ($ppmCaCO_3$)	C.O.D. (ppm)
0	9.0	10.7	6.9	27.1	12
5	9.0	10.2	6.9	30.8	5
10	9.0	10.3	6.8	30.0	14
15	9.0	10.2	6.8	29.6	13
20	9.0	10.1	6.7	29.9	9
30	7.0	7.6	6.7	29.0	6
40	6.8	6.2	6.6	29.5	9
50	6.8	3.3	6.6	29.1	11

(ppm)	Na	K	Ca	Mg	Cl	F	NO_3	PO_4
0	1.9	1.6	9.6	2.0	1.5	0.04	1.1	0.10
5	1.9	1.6	7.5	2.0	1.3	0.06	1.1	0.09
10	1.9	1.6	8.3	1.9	1.5	0.04	1.0	0.10
15	1.9	1.7	7.8	1.9	1.3	0.06	0.9	0.11
20	1.9	1.6	8.2	1.9	2.0	0.04	1.4	0.12
30	1.9	1.6	7.4	2.0	1.8	0.05	1.3	0.11
40	1.9	1.6	9.1	2.0	1.8	0.05	1.8	0.09
50	1.9	1.6	8.5	2.0	1.5	0.08	1.3	0.13

Filtered

(ppb)	Fe	Mn	Cu	Ni	Co	Pb	Zn	Ag	Cd
0	170	49	6	0	0	10	24	1	1
5	96	27	2	0	3	9	6	1	1
10	58	19	3	0	2	11	6	1	1
15	109	29	2	0	2	12	9	1	1
20	116	40	6	0	3	10	23	0	0
30	192	64	17	4	2	10	43	1	1
40	212	74	5	0	2	14	74	1	1
50	238	90	0	0	3	13	10	1	1

Particulate

(ppb)	Fe	Mn	Cu	Ni	Co	Pb	Zn	Ag	Cd
0	50	27	6	1	0	5	16	0	4
5	30	13	0	0	2	0	5	0	0
10	37	19	1	0	0	1	9	0	1
15	41	17	0	0	0	0	2	9	2
20	51	14	1	2	0	10	6	2	3
30	48	23	11	2	3	1	3	3	6
40	82	29	0	0	0	3	7	2	2
50	670	58	0	0	0	6	5	2	2

Station No. 7

Temp. (°C)	D.O. (ppm)	pH	Alk. ($ppmCaCO_3$)	C.O.D. (ppm)
9.0	10.2	6.9	30.0	9
8.9	10.0	6.9	28.7	17
8.8	9.8	6.9	27.6	11
7.3	8.0	6.8	27.7	10
6.9	6.6	6.8	25.1	12
6.7	6.0	6.7	31.3	5

(ppm)	Na	K	Ca	Mg	Cl	F	NO_3	PO_4
2.0	1.4	8.6	1.9	1.5	0.05	1.0	0.13
2.0	1.3	8.3	1.8	2.0	0.04	1.1	0.13
2.0	1.4	8.6	1.8	2.0	0.04	0.9	0.08
1.8	1.6	9.6	1.9	1.8	0.03	1.5	0.11
1.9	1.6	8.8	2.0	1.5	0.07	1.3	0.10
1.9	1.5	11.4	2.0	2.0	0.05	1.2	0.09

Filtered

(ppb)	Fe	Mn	Cu	Ni	Co	Pb	Zn	Ag	Cd
	95	33	9	2	0	12	7	0	0
	79	23	6	0	2	16	4	1	0
	73	20	5	0	2	11	10	0	0
	98	35	6	0	1	9	9	1	0
	176	59	31	0	2	7	21	1	1
	119	47	1	0	1	11	5	1	1

Particulate

(ppb)	Fe	Mn	Cu	Ni	Co	Pb	Zn	Ag	Cd
	34	11	0	0	0	3	0	3	0
	40	16	0	0	0	3	0	4	5
	40	15	0	0	4	2	0	0	1
	54	22	0	0	0	4	2	0	3
	90	21	5	3	2	10	6	18	3
	48	20	0	2	2	5	0	0	3

Table No. 2 (continued)

Station No. 10

Depth (M)	Temp. (°C)	D.O. (ppm)	pH	Alk. (ppm $CaCO_3$)	C.O.D. (ppm)
0	10.0	10.-	7.0	24.5	6
5	9.7	9.9	6.9	26.3	10
10	8.0	8.6	6.9	26.5	2
15	7.0	7.1	6.9	29.5	14
20	7.0	7.0	6.8	29.1	15
30					
40					
50					

(ppm)	Na	K	Ca	Mg	Cl	F	NO_3	PO_4
0	2.2	1.1	11.0	1.6	1.8	0.05	0.5	0.10
5	2.1	0.9	6.9	1.6	1.8	0.03	0.3	0.10
10	2.0	1.2	12.0	1.8	1.5	0.04	0.5	0.08
15	2.0	1.3	8.9	1.9	1.5	0.07	0.9	0.10
20	2.0	1.3	9.1	1.9	1.3	0.05	1.0	0.03
30								
40								
50								

Filtered

(ppb)	Fe	Mn	Cu	Ni	Co	Pb	Zn	Ag	Cd
0	10	0	1	6	3	9	13	1	0
5	14	1	0	0	2	7	0	0	0
10	59	25	5	0	2	11	7	0	0
15	70	36	7	0	1	12	7	1	1
20	83	41	6	0	1	37	10	0	1
30									
40									
50									

Particulate

(ppb)	Fe	Mn	Cu	Ni	Co	Pb	Zn	Ag	Cd
0	90	13	0	0	2	4	0	0	2
5	90	13	0	0	1	4	0	0	3
10	54	13	0	0	3	0	0	0	3
15	52	12	0	0	2	4	4	3	1
20	47	16	1	0	1	0	10	3	5
30									
40									
50									

Station No. 12

Temp. (°C)	D.O. (ppm)	pH	Alk. (ppm $CaCO_3$)	C.O.D. (ppm)
10.8	10.4	7.0	25.4	8
9.9	9.[illegible]	6.9	25.1	6
8.6	8.1	6.9	25.9	8

(ppm)	Na	K	Ca	Mg	Cl	F	NO_3	PO_4
	2.2	0.9	13.3	1.6	1.8	0.04	1.1	0.[illegible]
	2.1	0.8	7.4	1.6	1.8	0.04	0.8	0.[illegible]
	2.0	0.9	23.8	1.6	1.8	0.09	0.5	0.1[illegible]

Filtered

(ppb)	Fe	Mn	Cu	Ni	Co	Pb	Zn	Ag	Cd
	10	2	1	0	1	9	4	1	1
	35	17	11	0	0	11	6	0	0
	18	7	0	0	0	12	0	2	0

Particulate

(ppb)	Fe	Mn	Cu	Ni	Co	Pb	Zn	Ag	Cd
	102	7	0	4	4	0	0	4	1
	118	11	1	0	0	1	0	6	1
	170	22	0	0	1	0	0	4	2

Figure No. 1

Map of DeGray Reservoir showing sampling stations

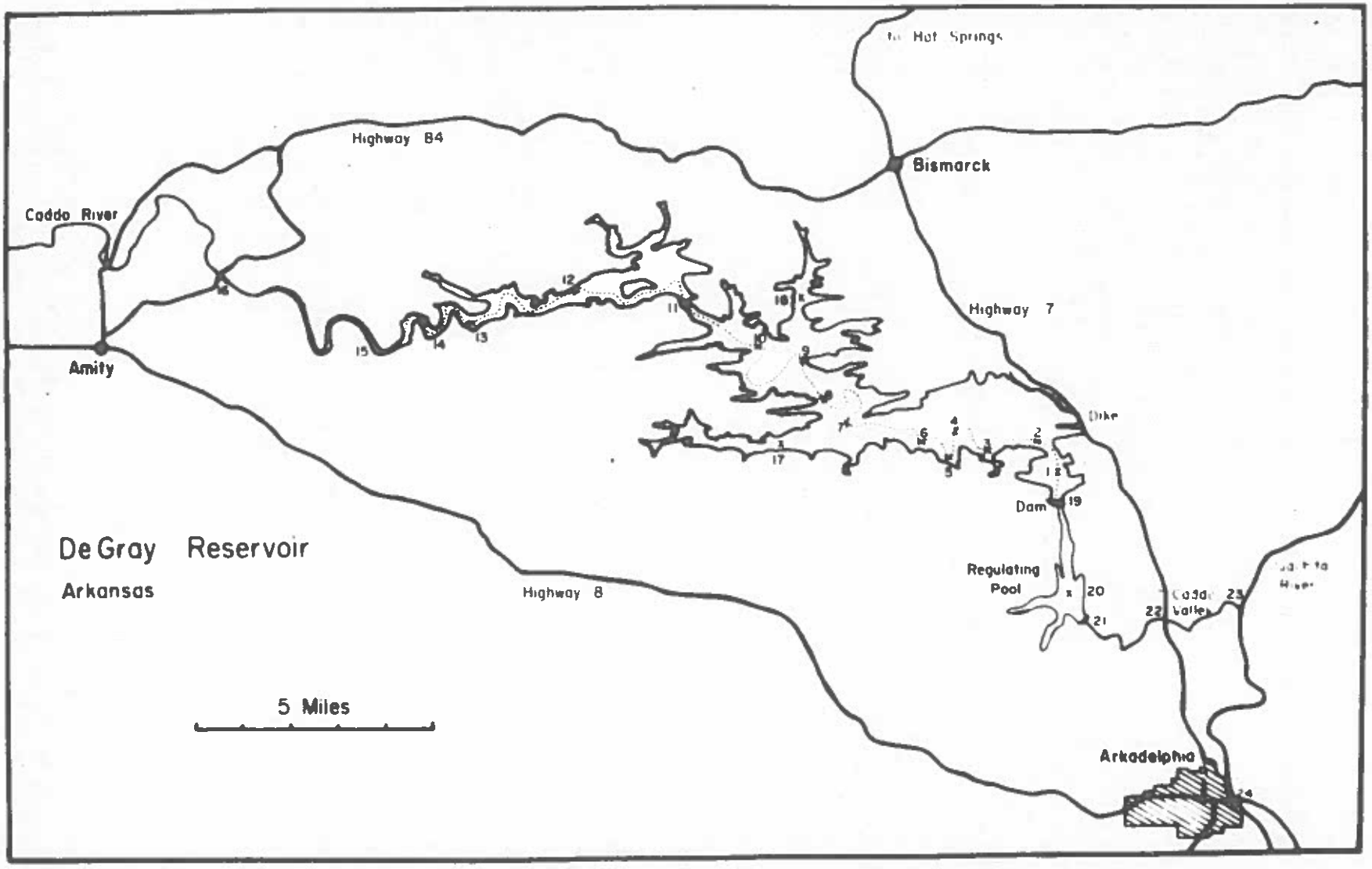
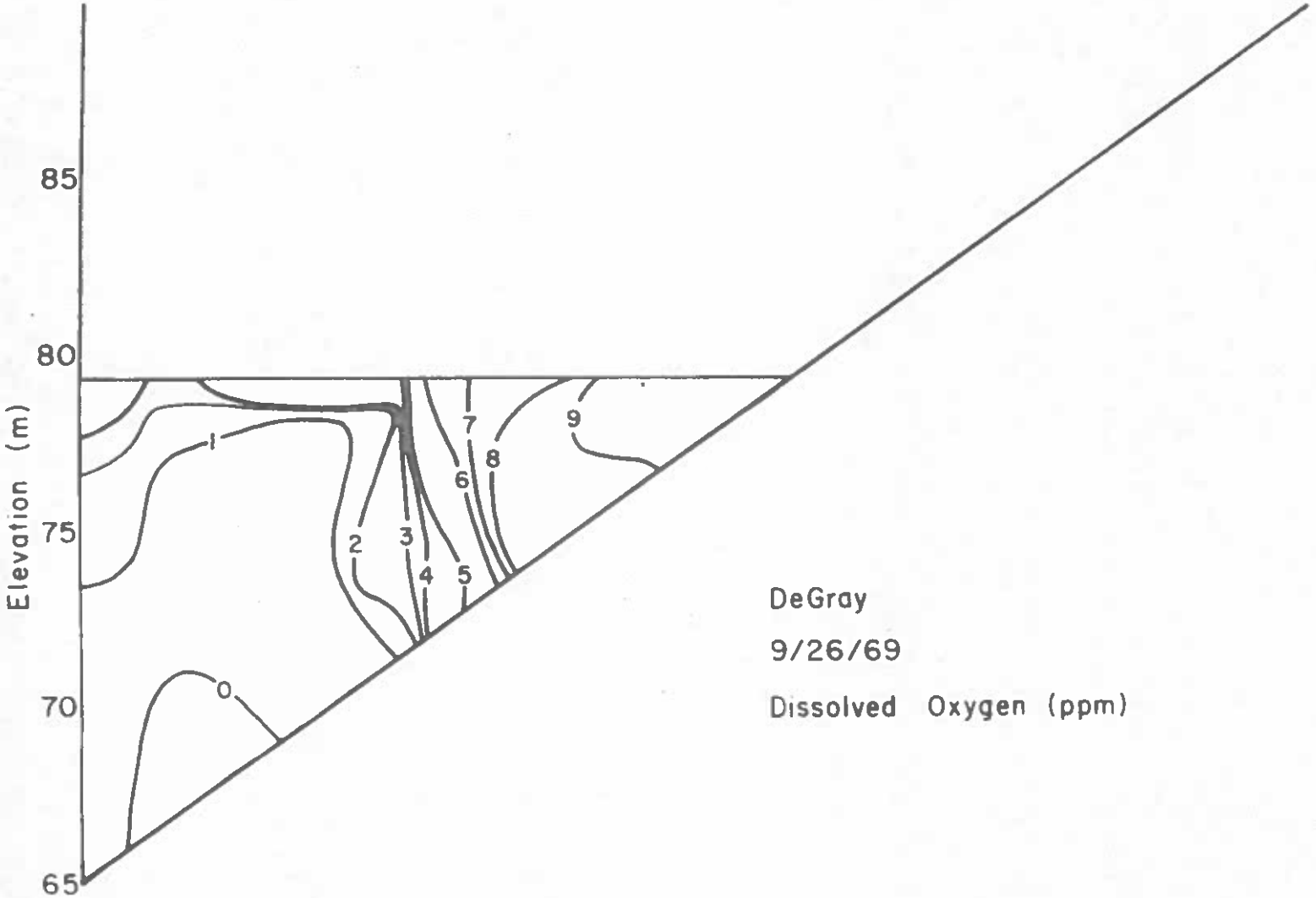
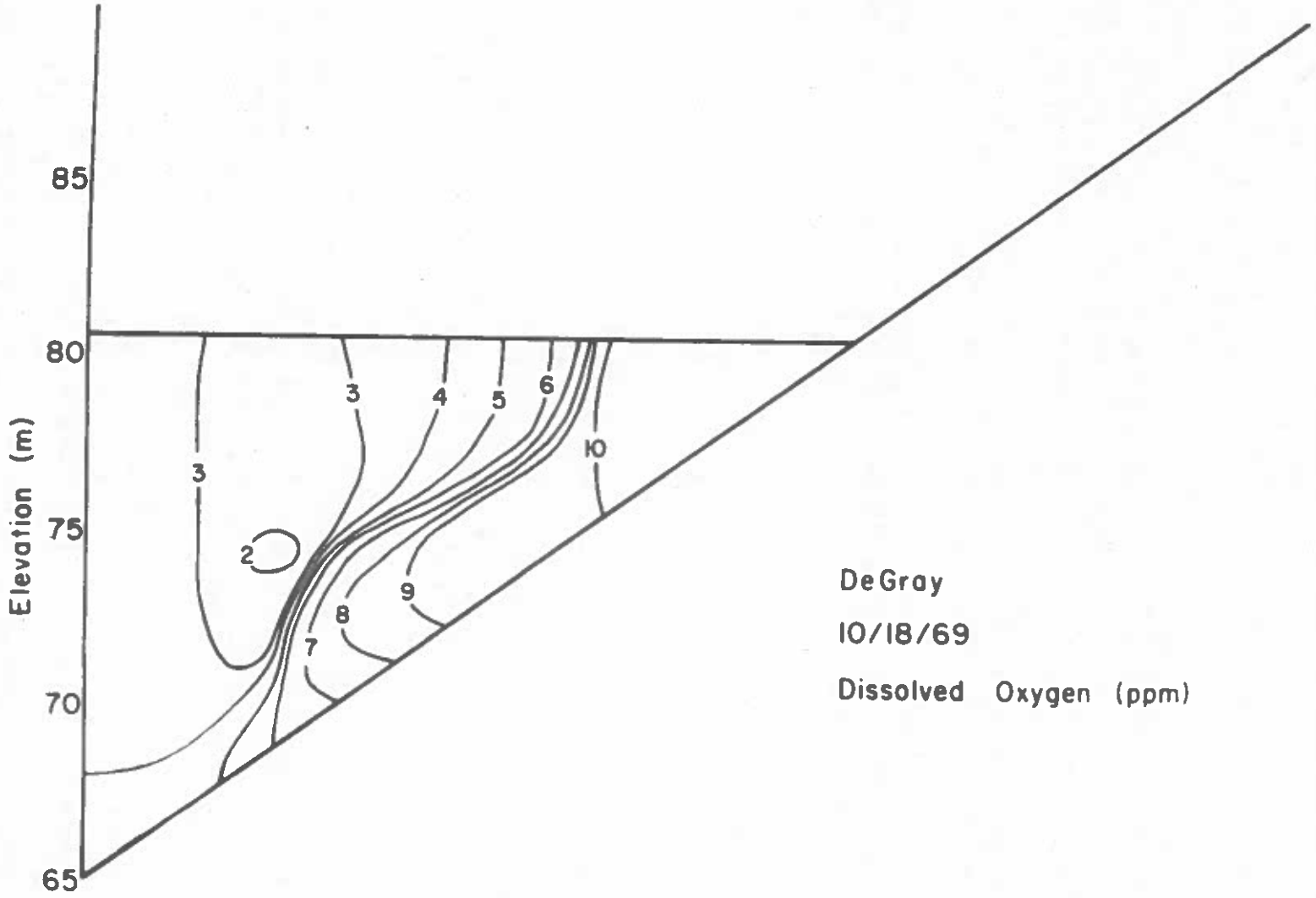

Hot Springs
Highway 84
Bismarck
Caddo River
Highway 7
Amity
Dike
Dam
De Gray Reservoir
Arkansas
Regulating Pool
Highway 8
5 Miles
Arkadelphia

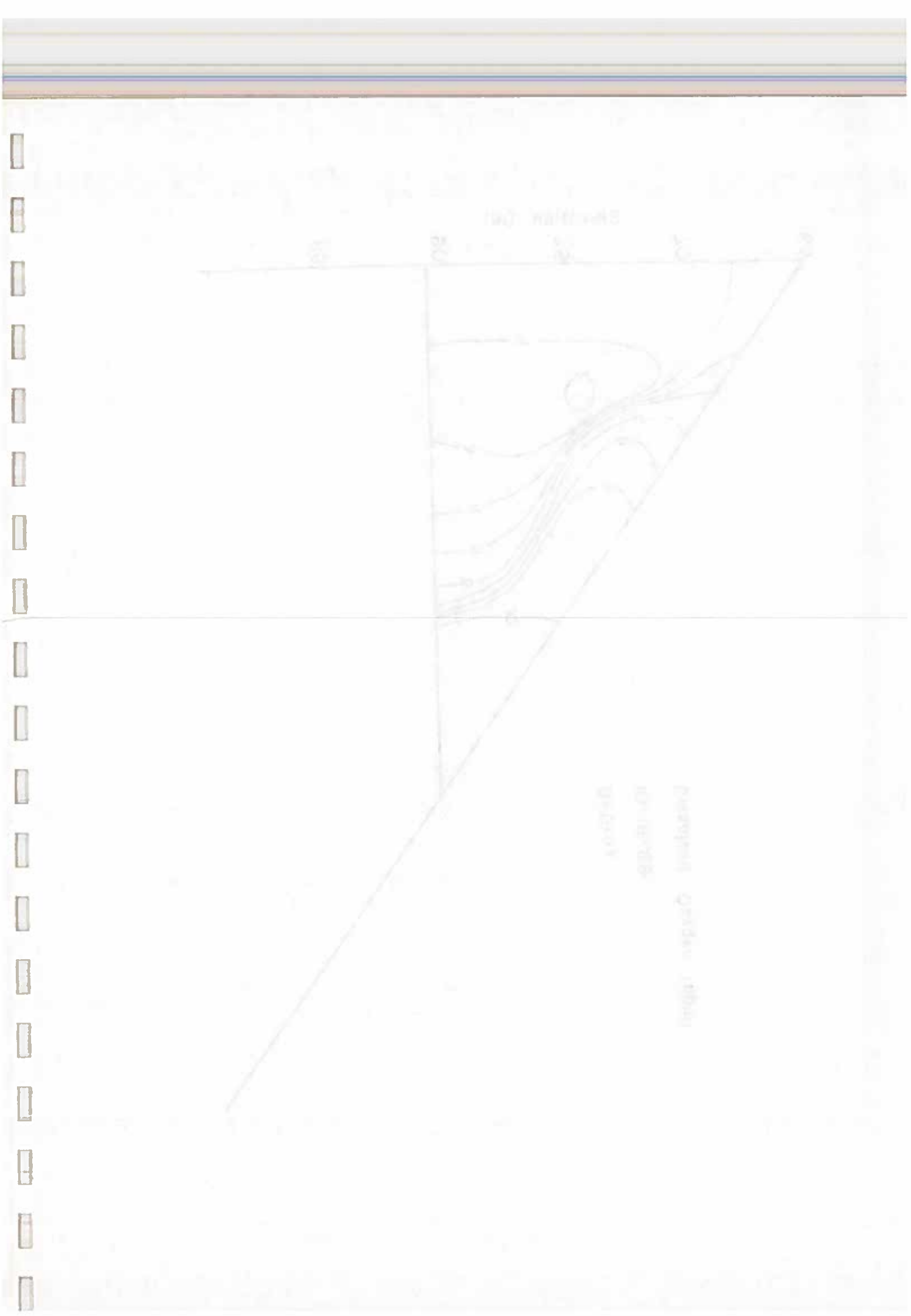
Figure 2 through 25

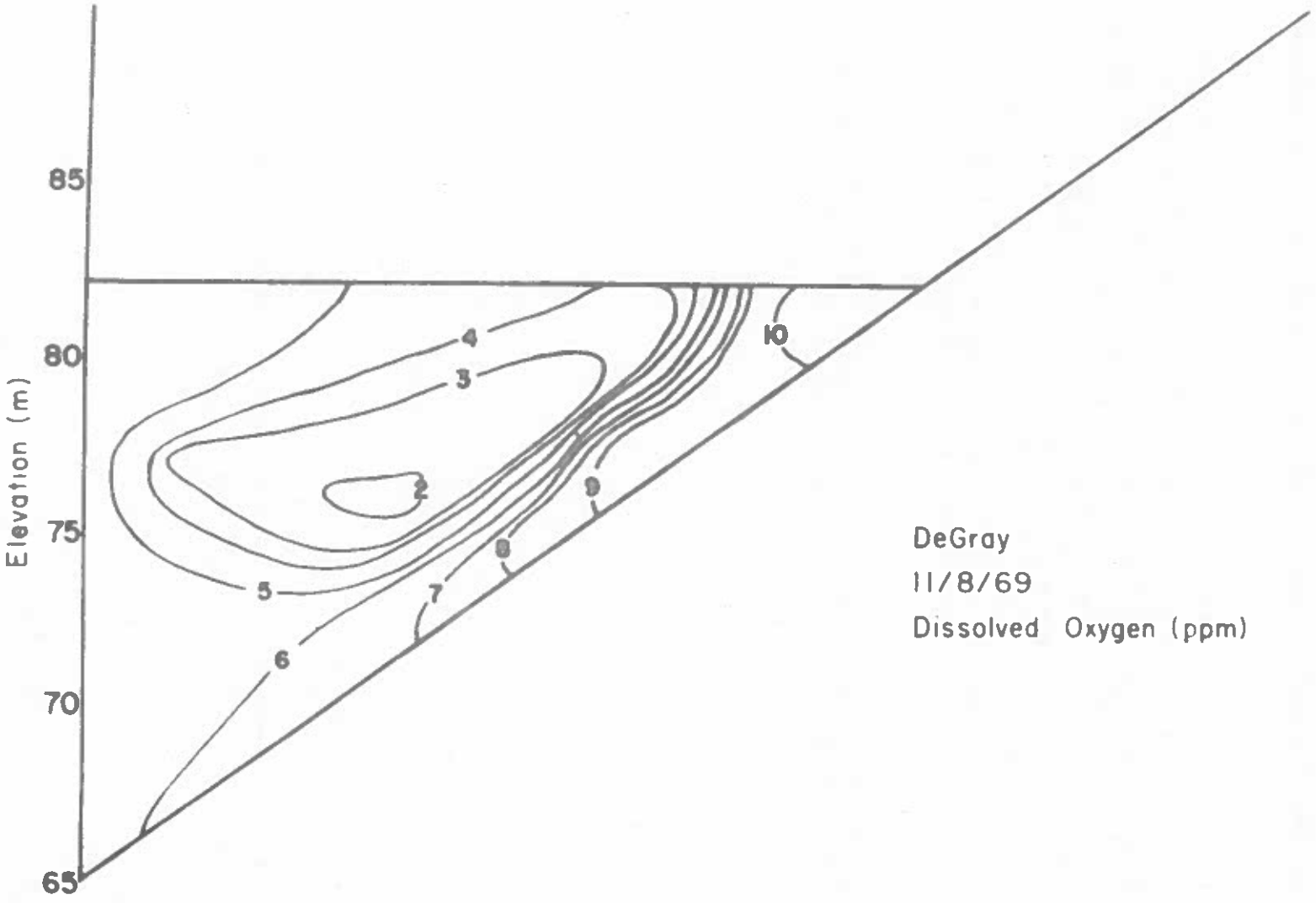
Dissolved Oxygen (ppm) profiles of DeGray Reservoir

Figure No.	Date
2	9/26/69
3	10/18/69
4	11/8/69
5	12/13/69
6	1/17/70
7	3/21/70
8	5/2/70
9	6/15/70
10	7/7/70
11	7/23/70
12	8/13/70
13	8/21/70
14	9/19/70
15	10/10/70
16	11/7/70
17	12/2/70
18	12/16/70
19	1/12/71
20	1/30/71
21	2/20/71
22	3/20/71
23	4/24/71
24	5/18/71

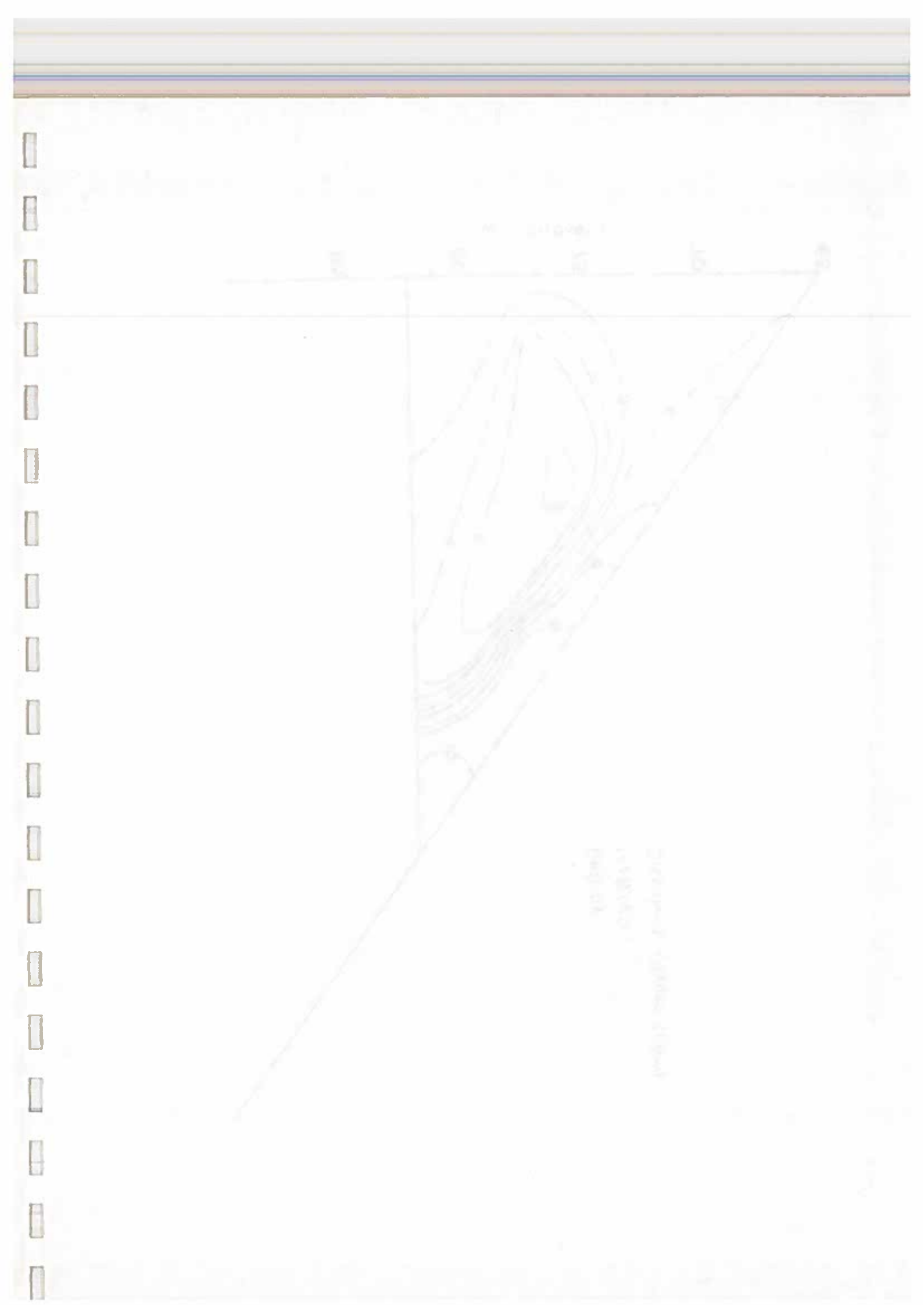

85
80
75
70
65
Elevation (m)
0
1
2
3
4
5
6
7
8
9
DeGray
9/26/69
Dissolved Oxygen (ppm)

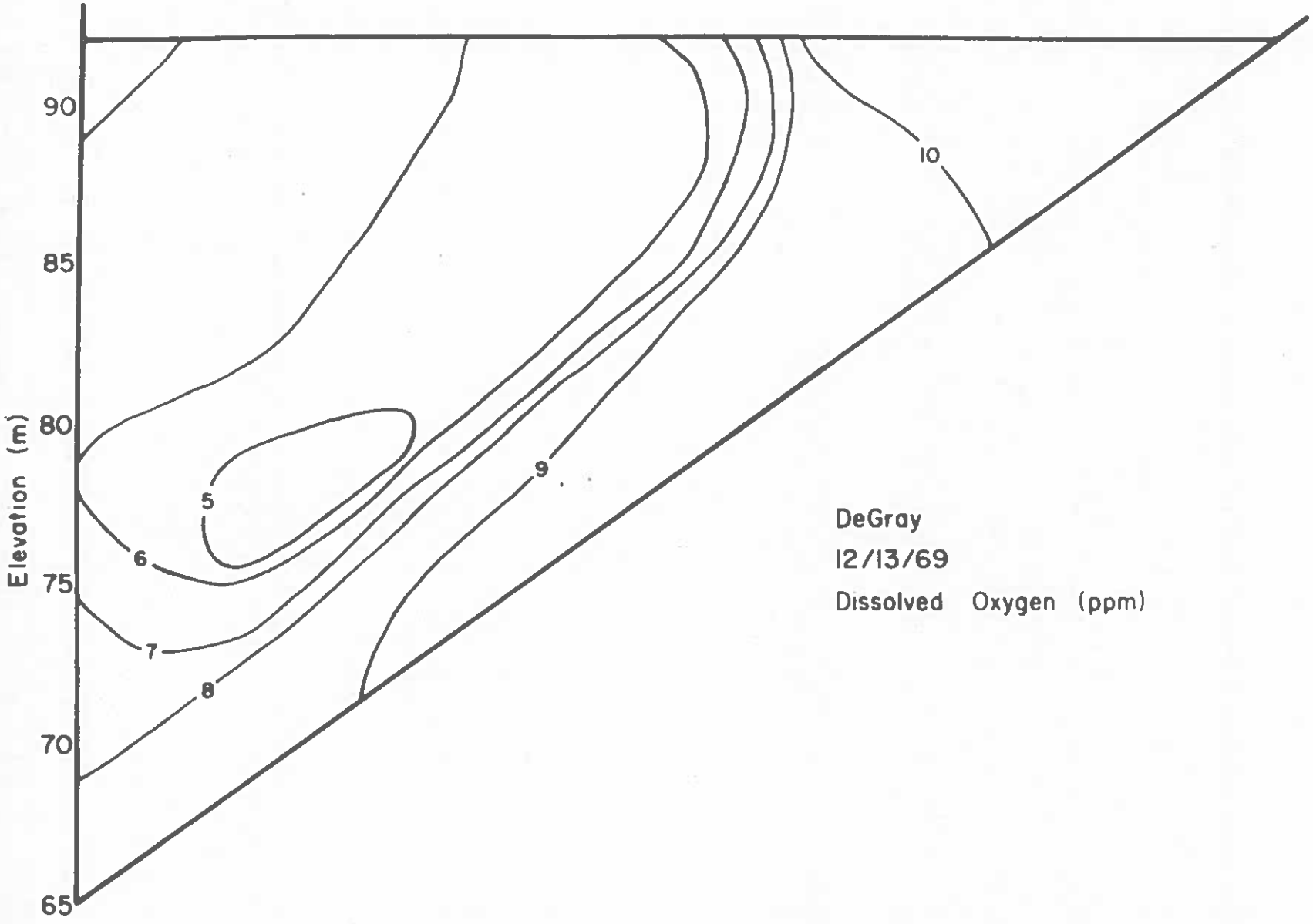

85
80
75
70
65
Elevation (m)
3
2
3
4
5
6
10
9
8
7
DeGray
10/18/69
Dissolved Oxygen (ppm)

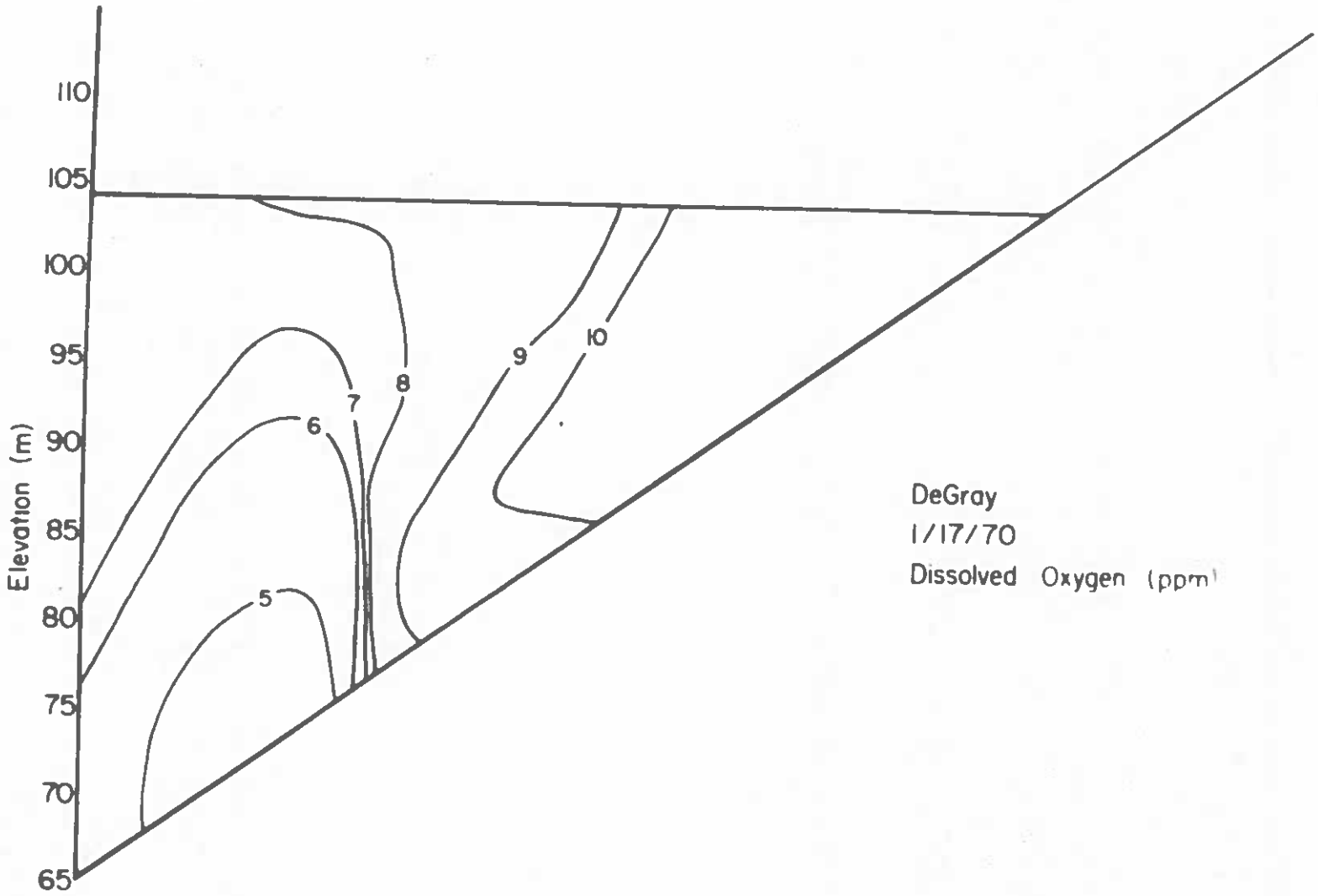


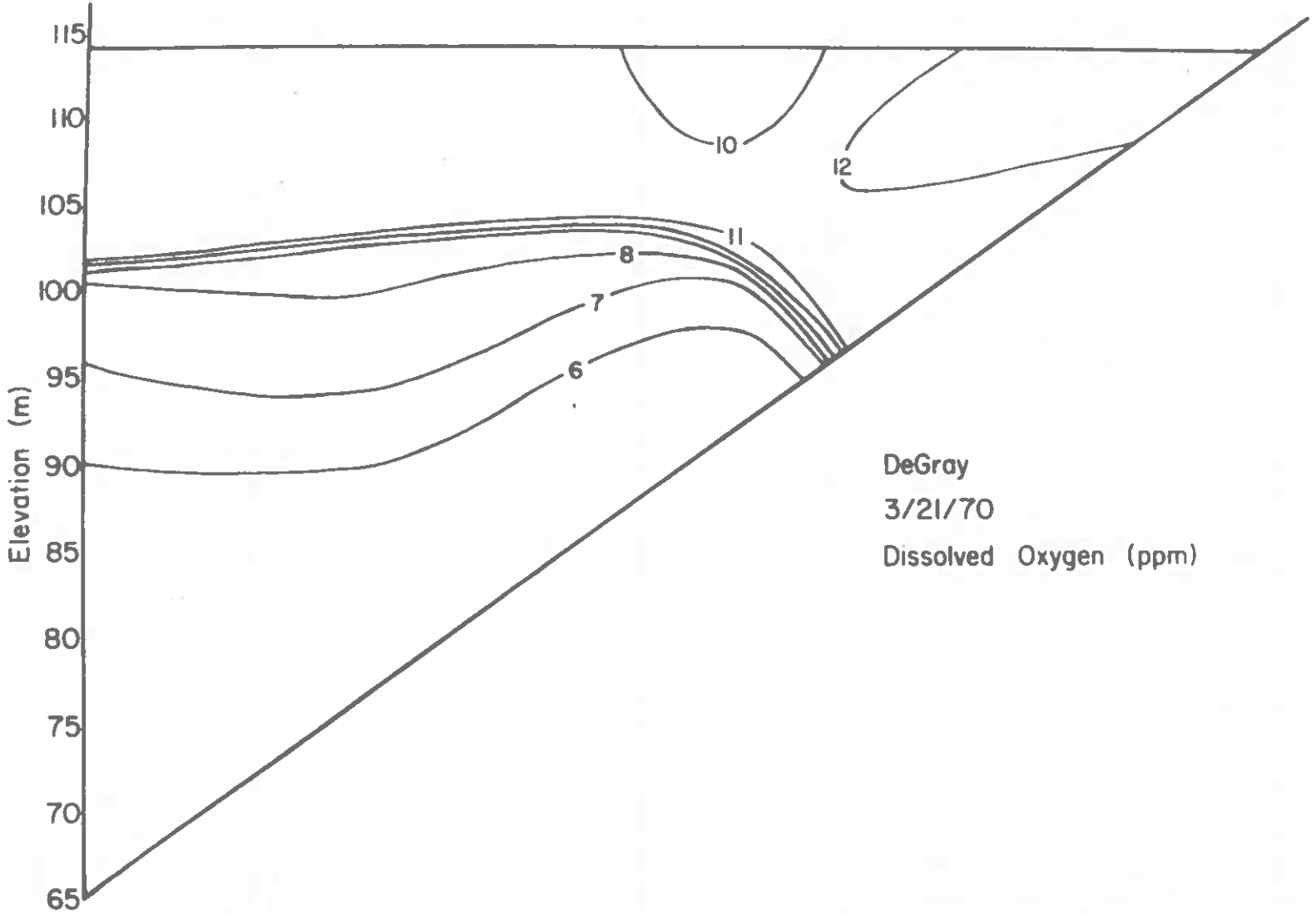


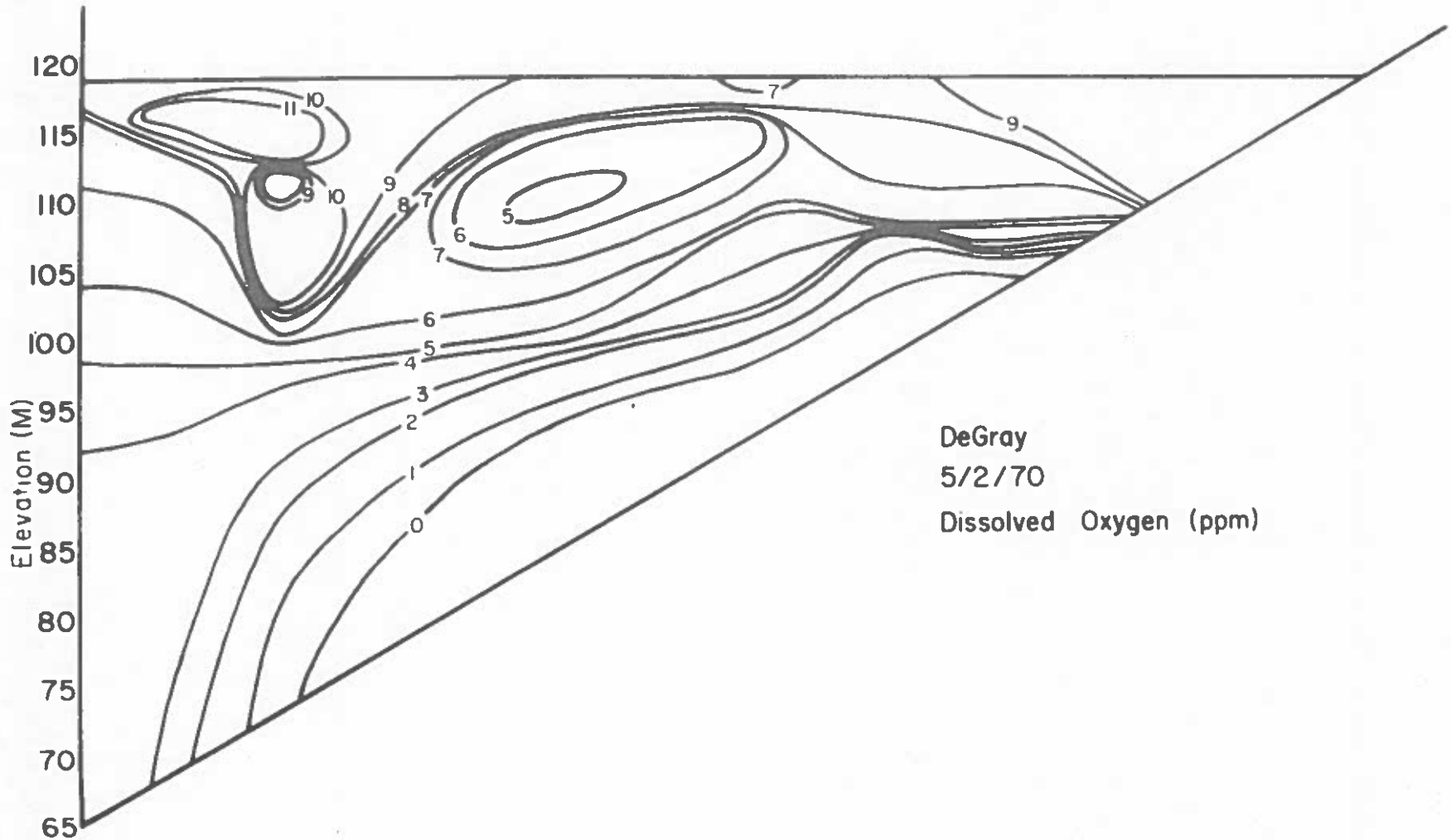
DeGray
11/8/69
Dissolved Oxygen (ppm)

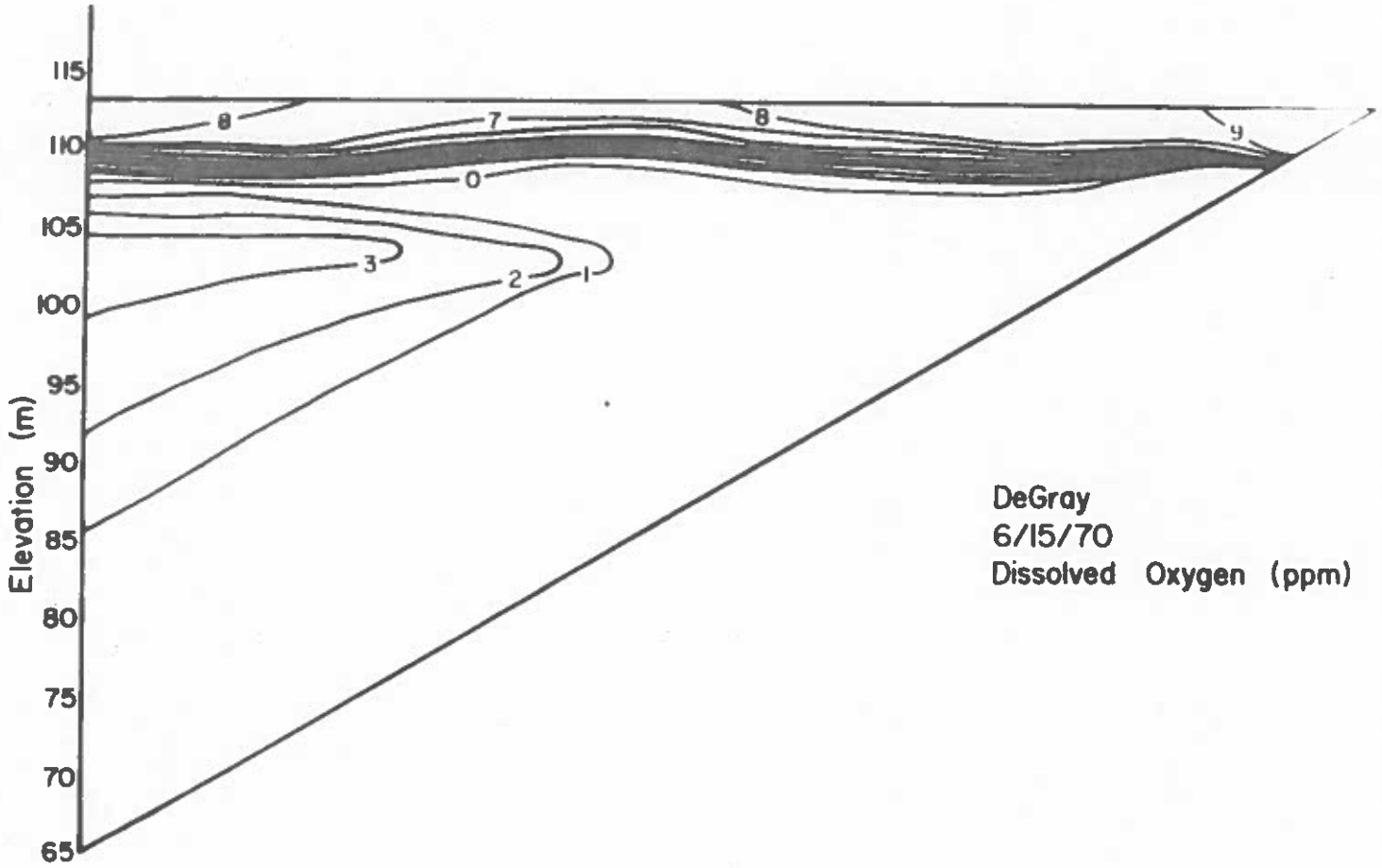


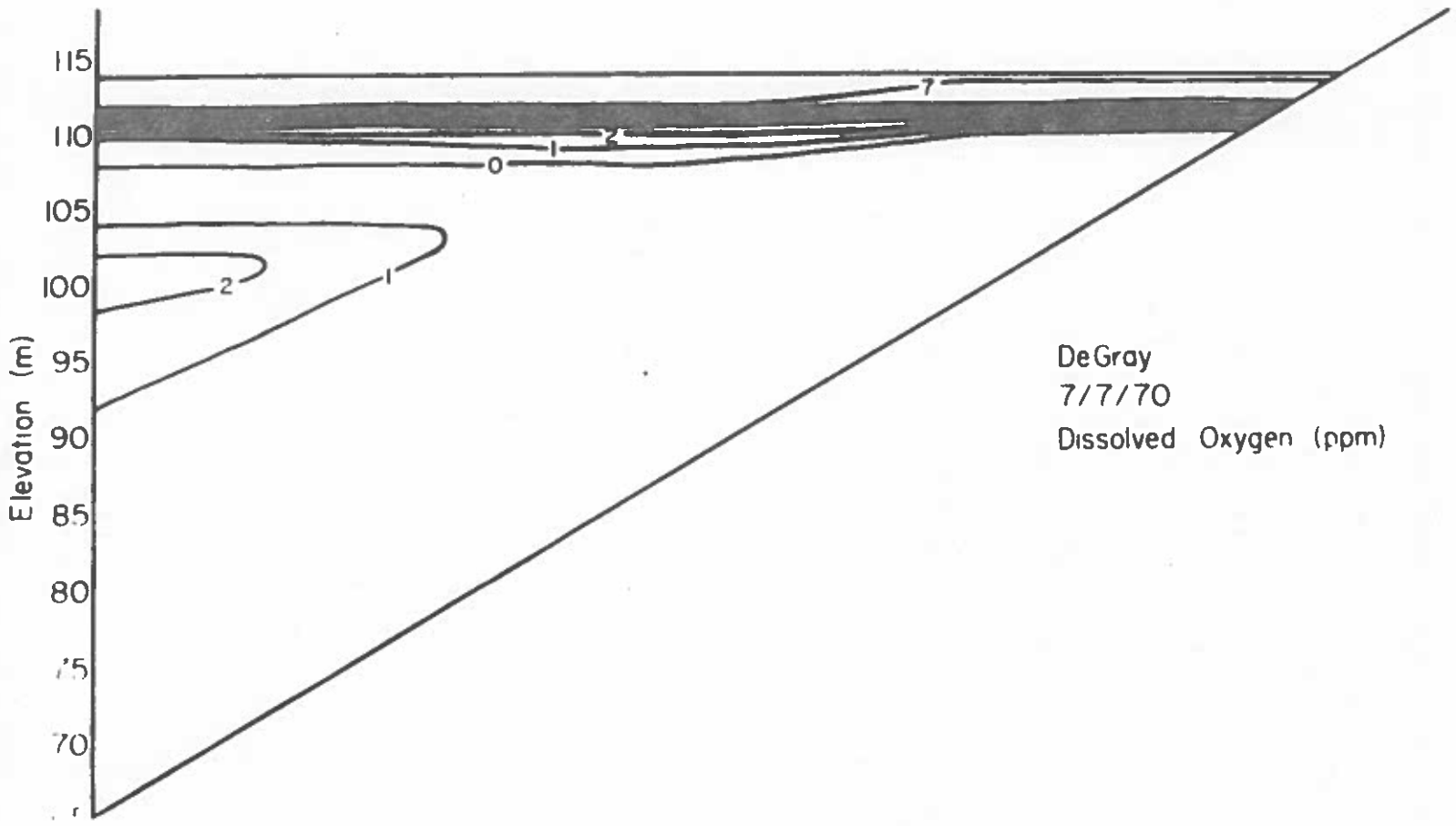

90
85
80
75
70
65
Elevation (m)
5
6
7
8
9
10
DeGray
12/13/69
Dissolved Oxygen (ppm)

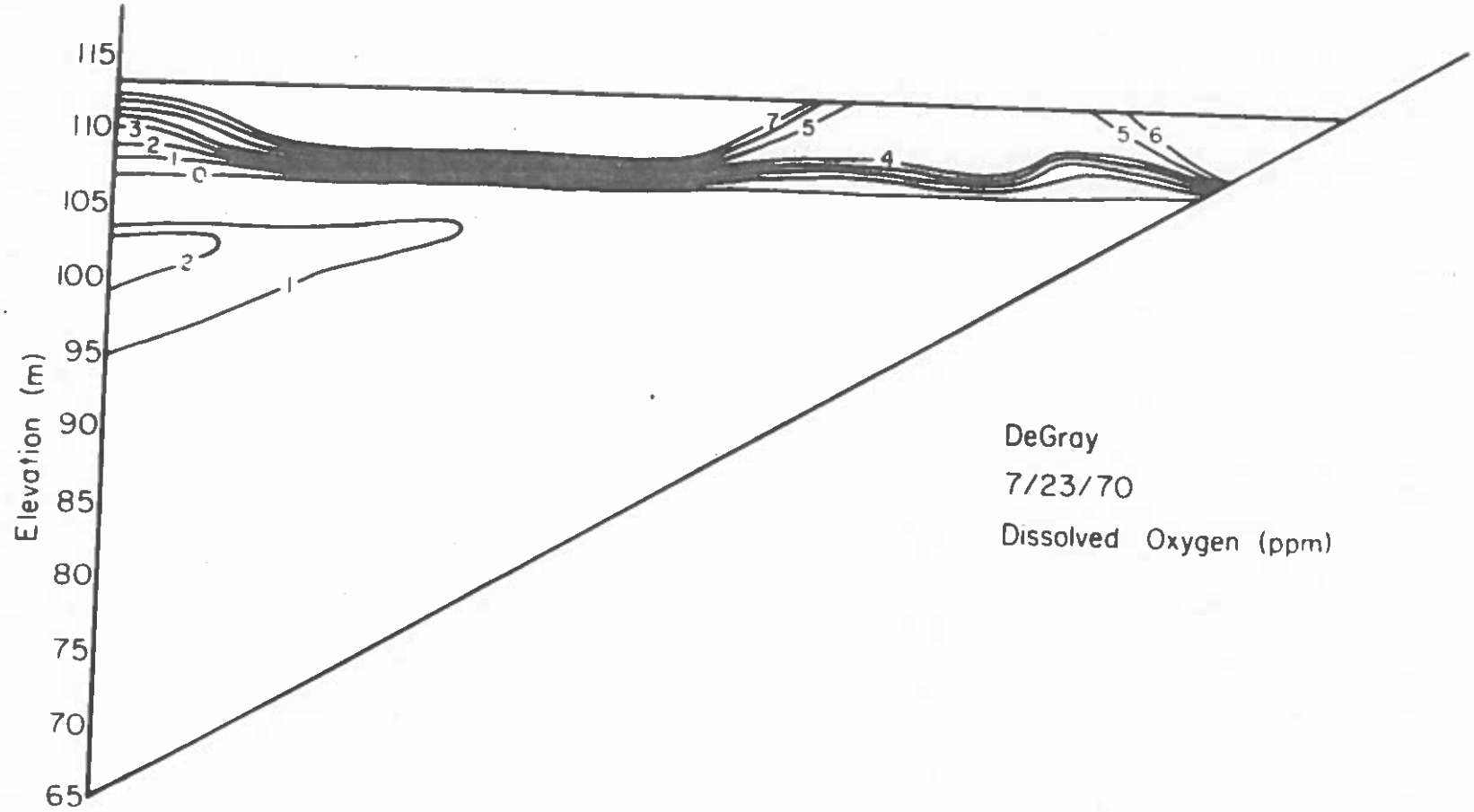

110
105
100
95
90
85
80
75
70
65
Elevation (m)
5
6
7
8
9
10
DeGray
1/17/70
Dissolved Oxygen (ppm)

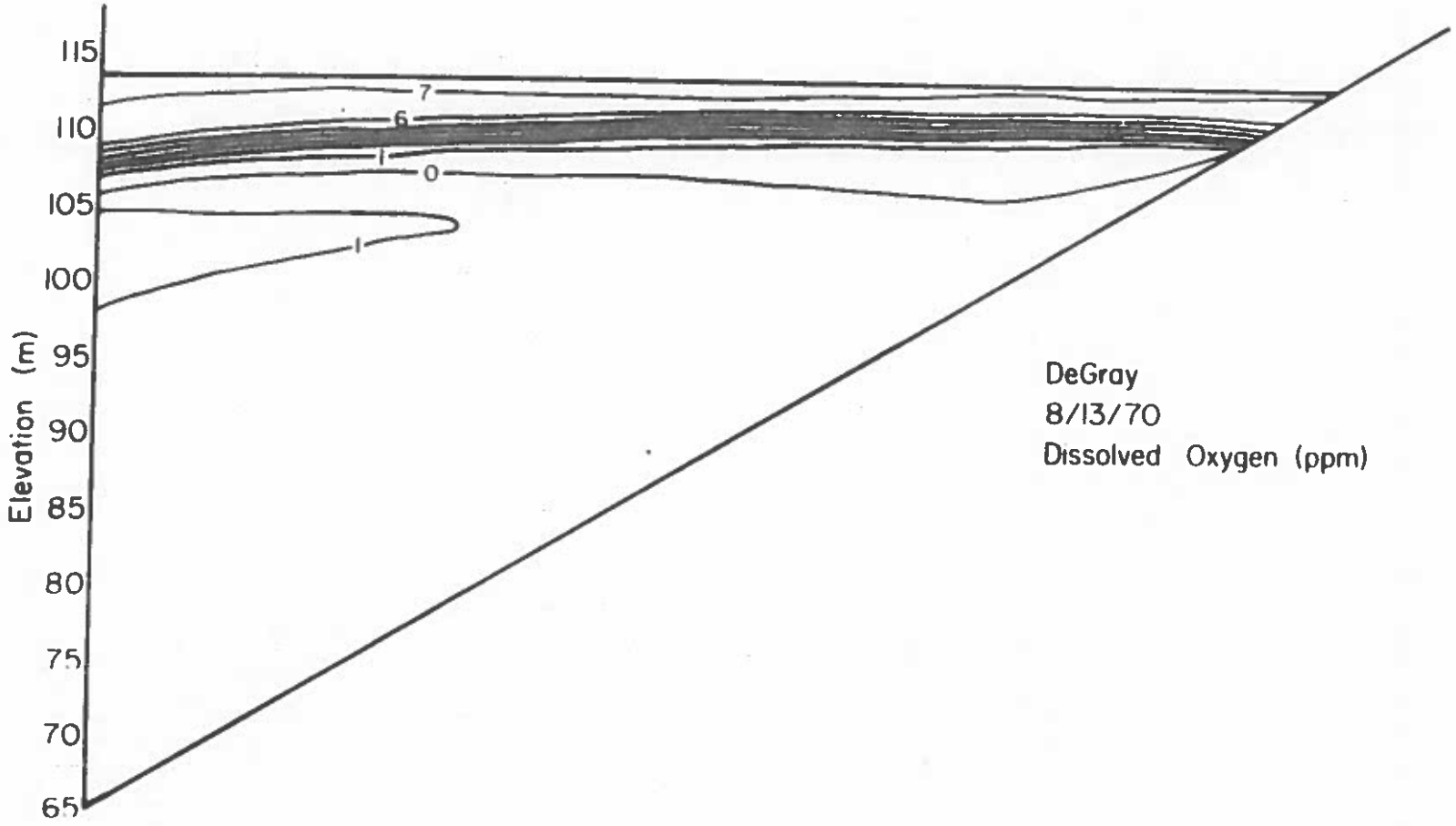

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
10
12
11
8
7
6
DeGray
3/21/70
Dissolved Oxygen (ppm)

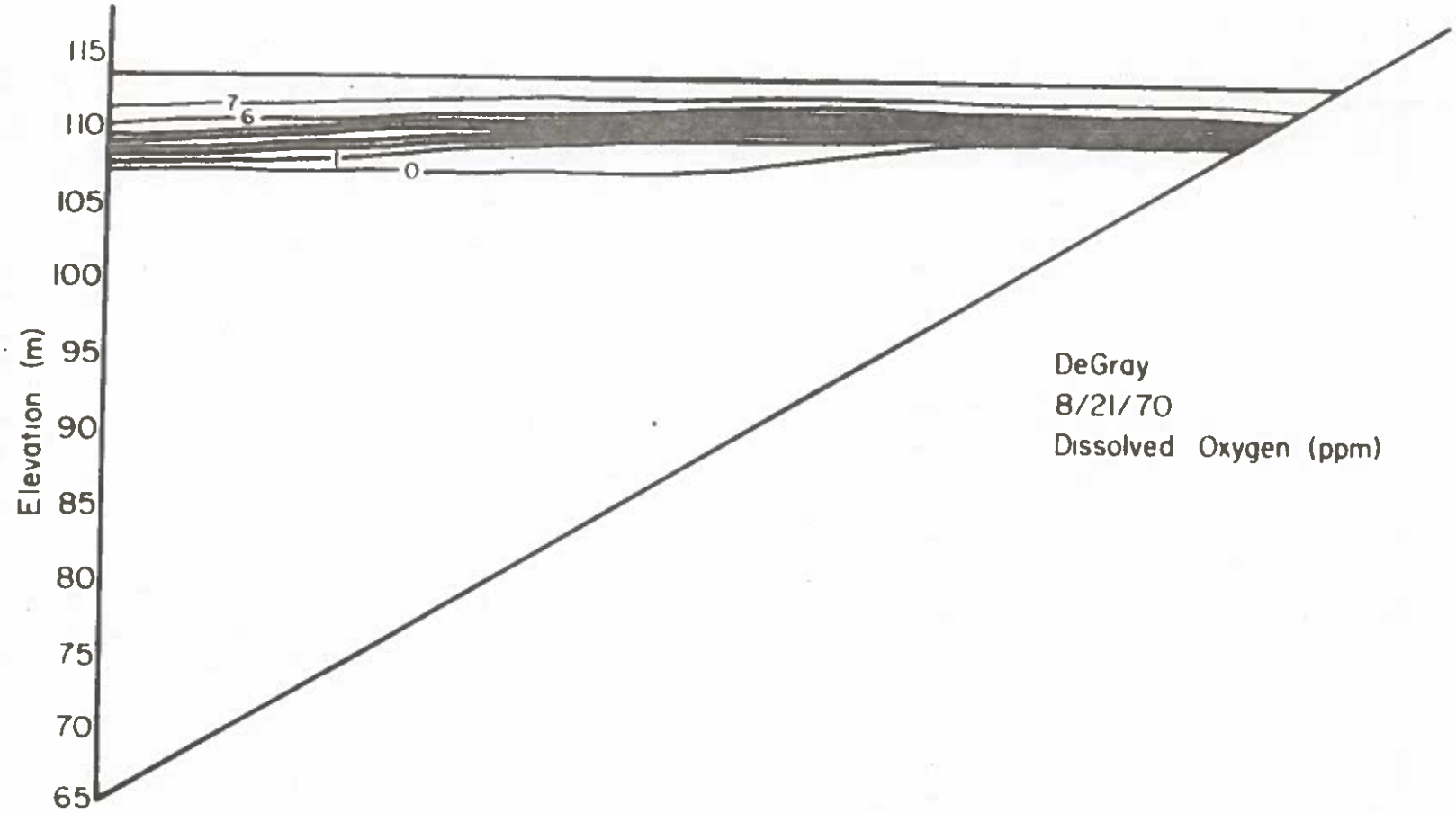

120
115
110
105
100
95
90
85
80
75
70
65
Elevation (M)
11
10
9
10
9
8
7
7
6
5
6
7
9
6
5
4
3
2
1
0
DeGray
5/2/70
Dissolved Oxygen (ppm)

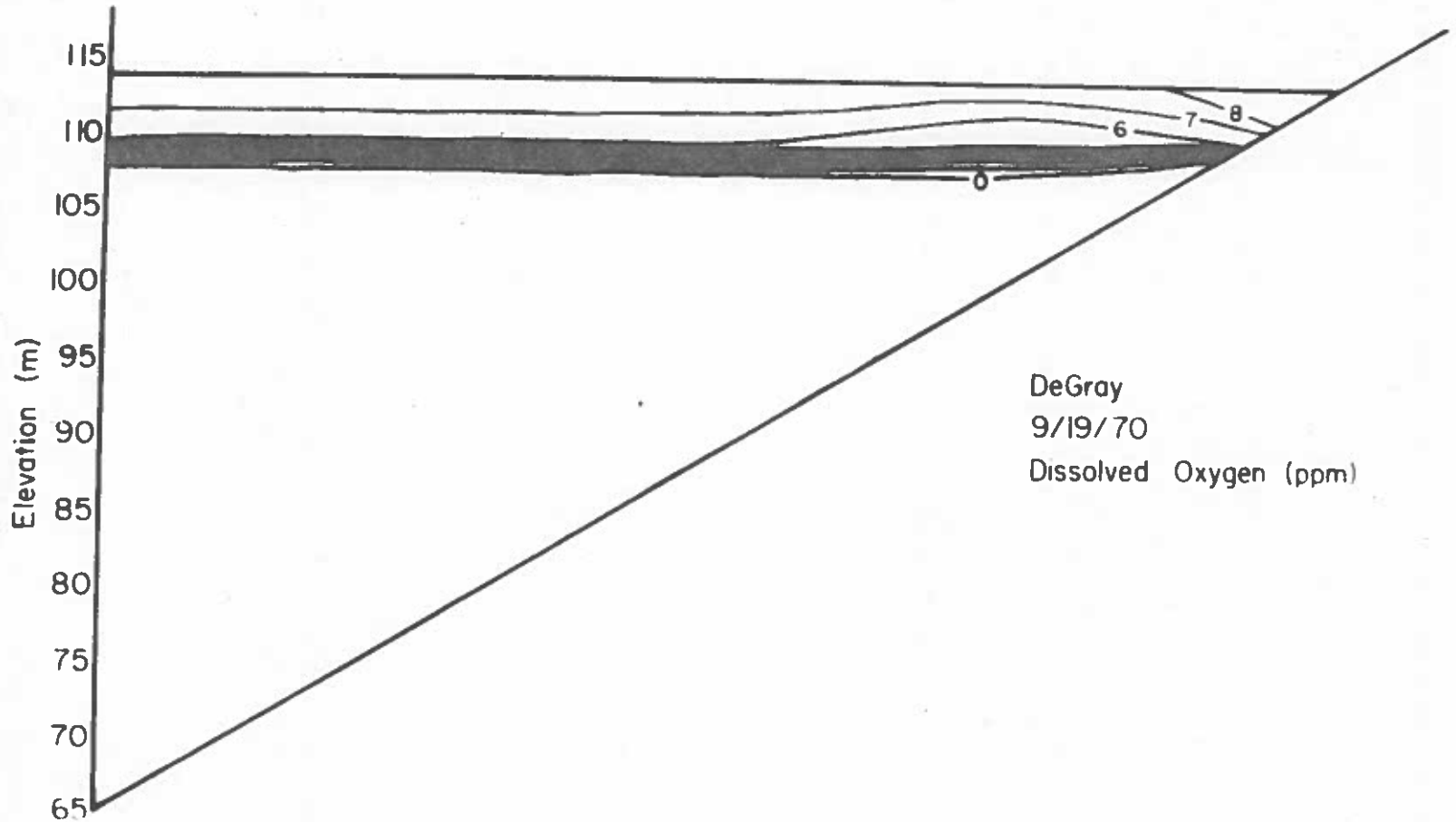

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
8
7
8
9
0
3
2
1
DeGray
6/15/70
Dissolved Oxygen (ppm)

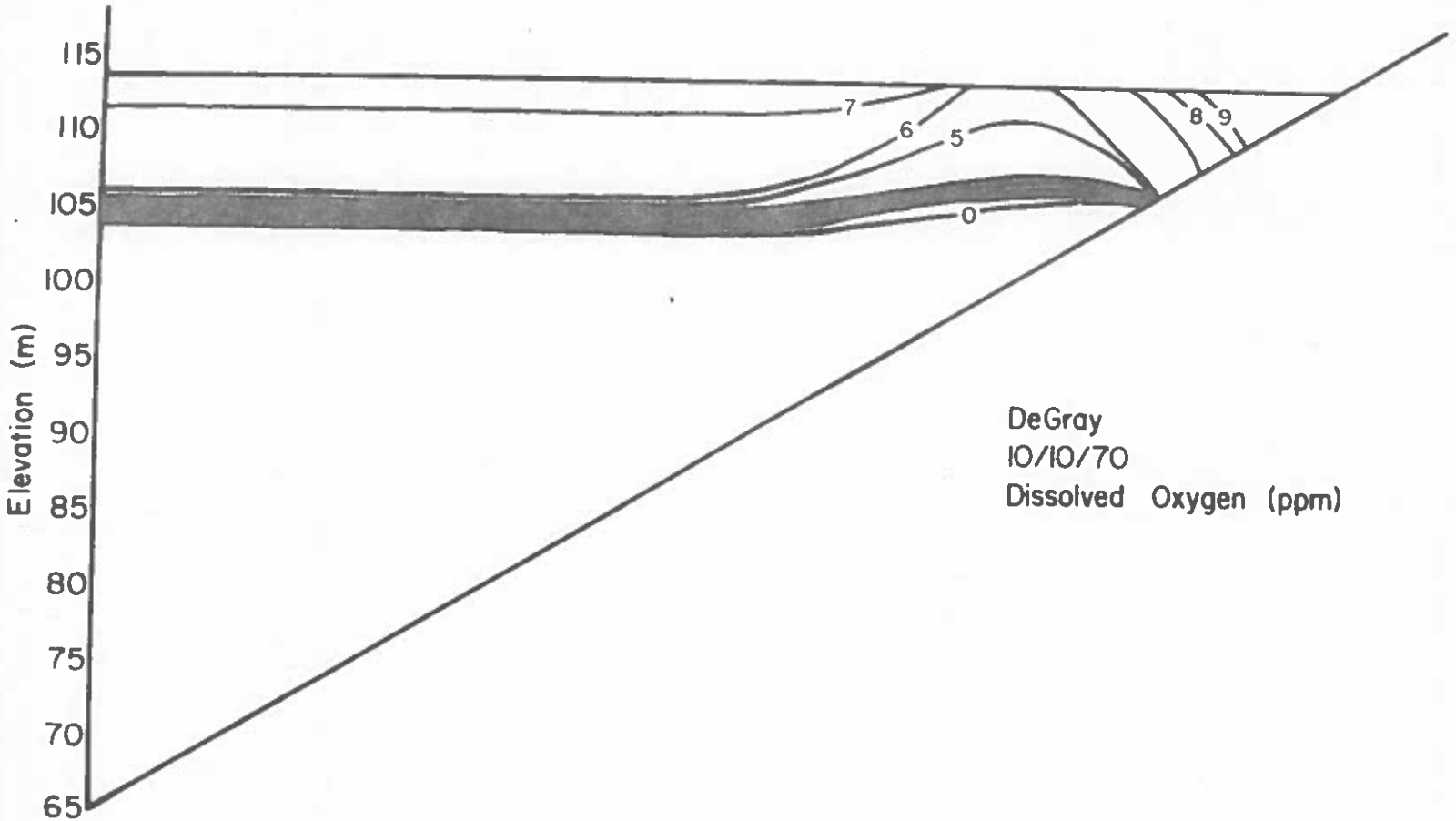

115
110
105
100
95
90
85
80
75
70
Elevation (m)
7
4
1
0
2
1
DeGray
7/7/70
Dissolved Oxygen (ppm)

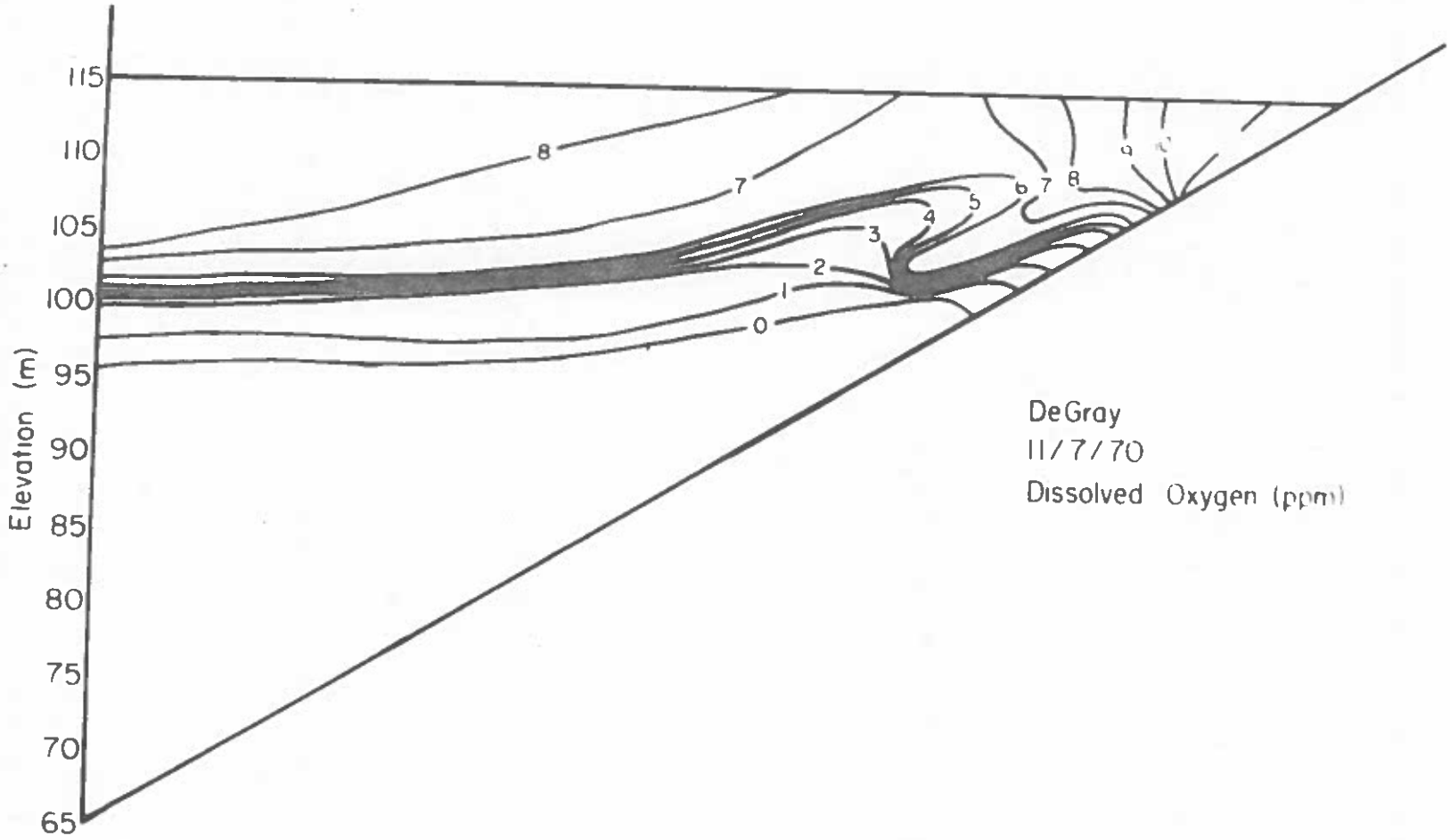

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
3
2
1
0
7
5
4
5
6
2
1
DeGray
7/23/70
Dissolved Oxygen (ppm)

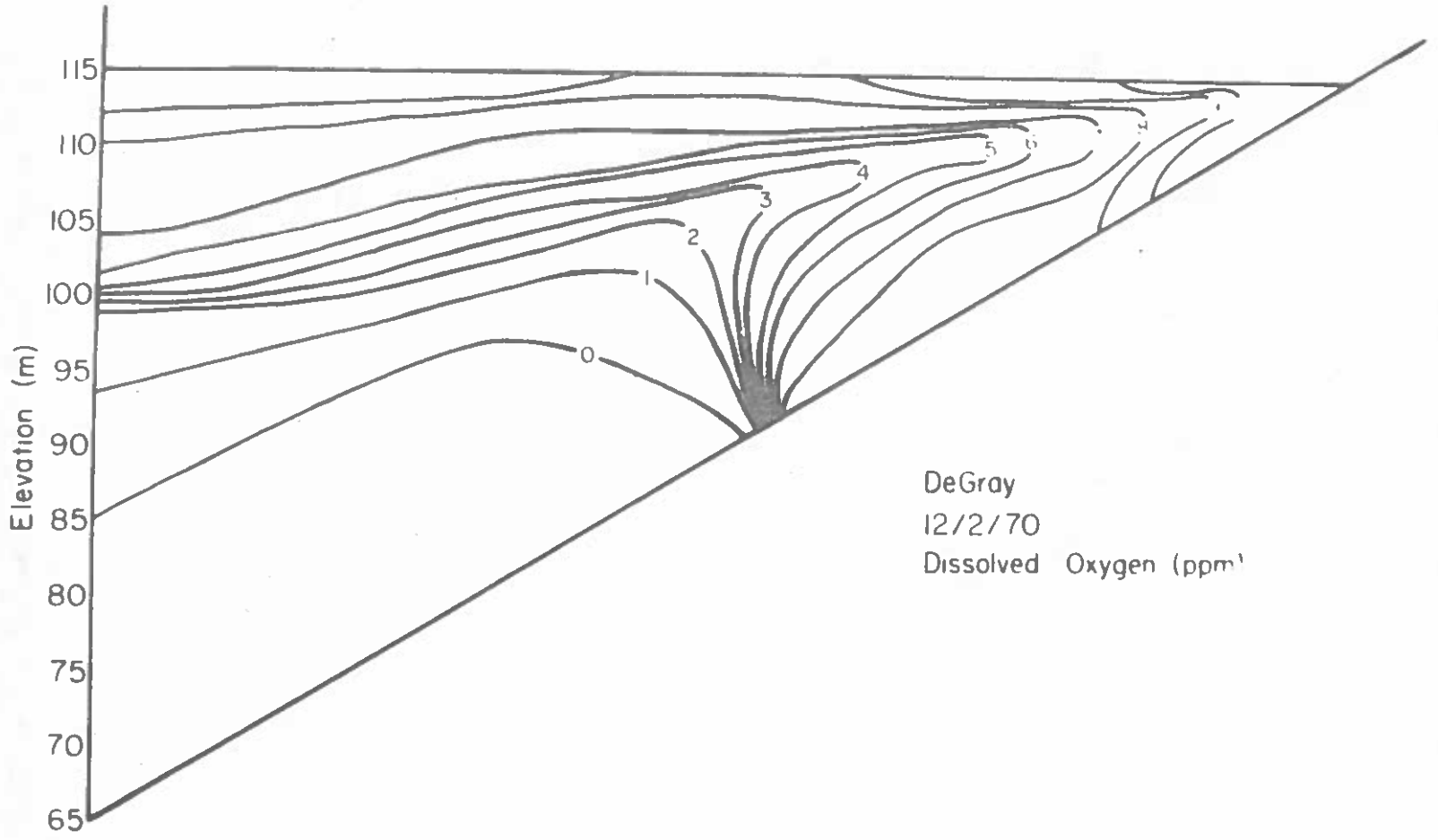

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
7
6
1
0
1
DeGray
8/13/70
Dissolved Oxygen (ppm)

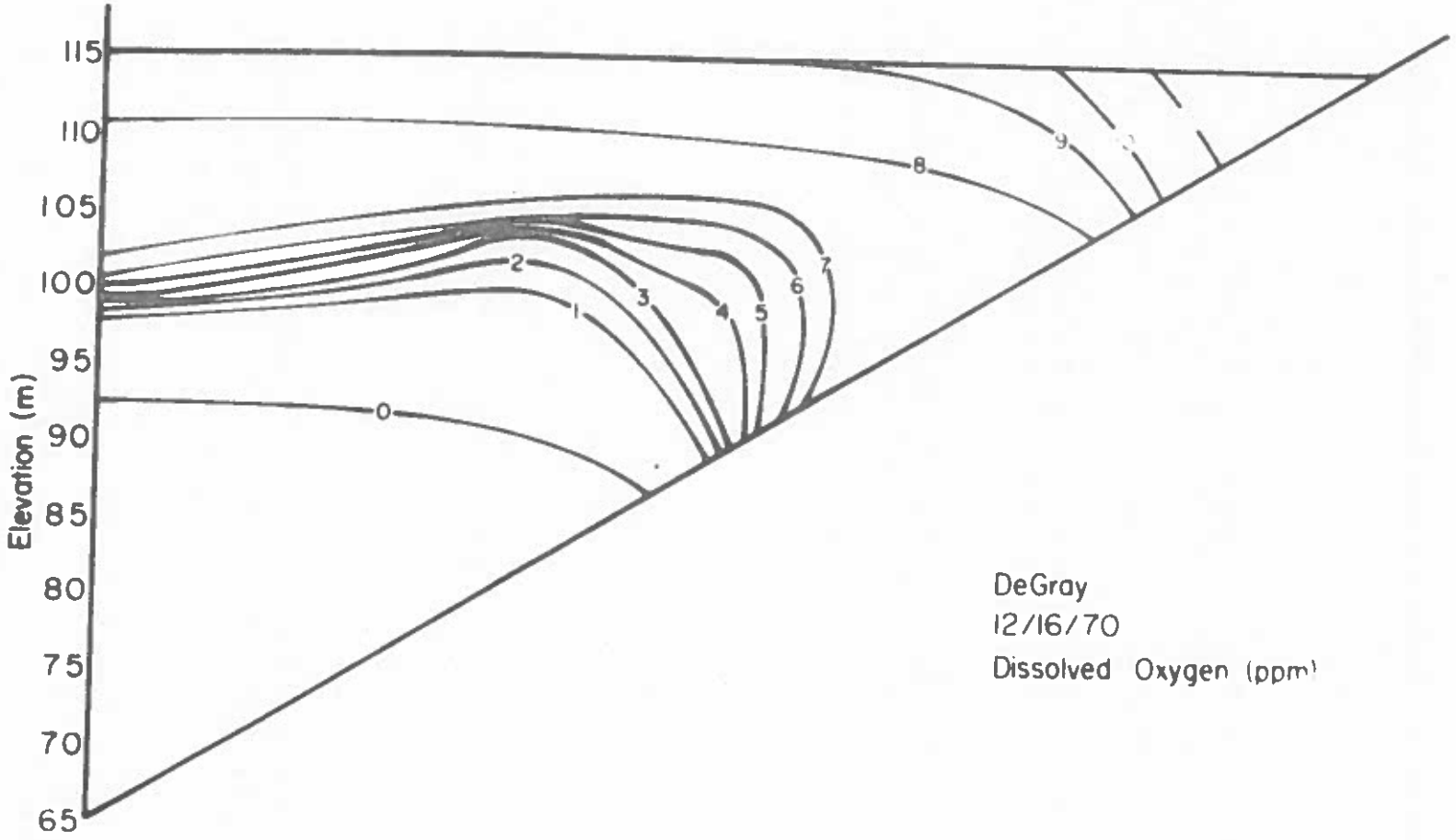

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
7
6
1
0
DeGray
8/21/70
Dissolved Oxygen (ppm)

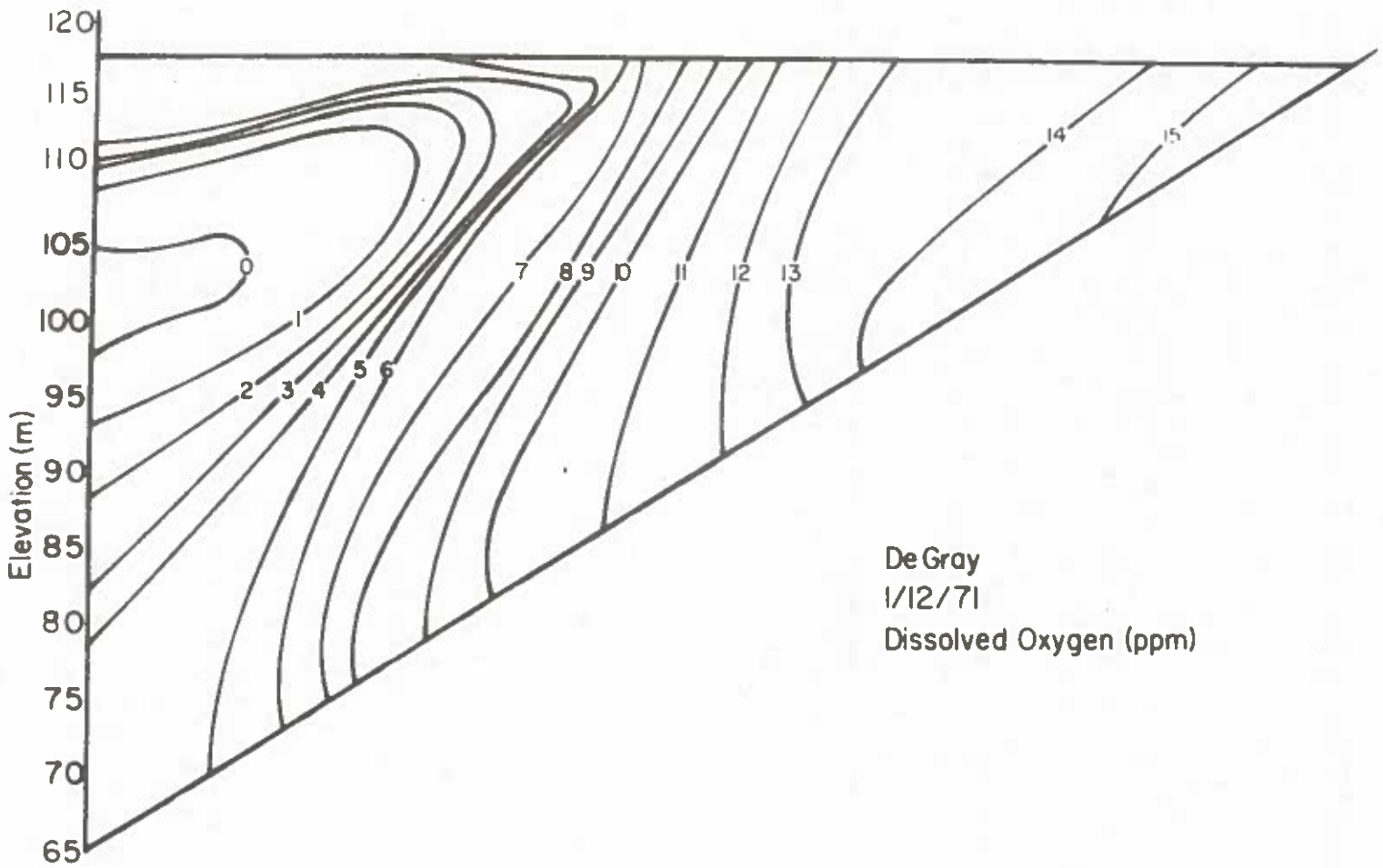

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
8
7
6
5
DeGray
9/19/70
Dissolved Oxygen (ppm)

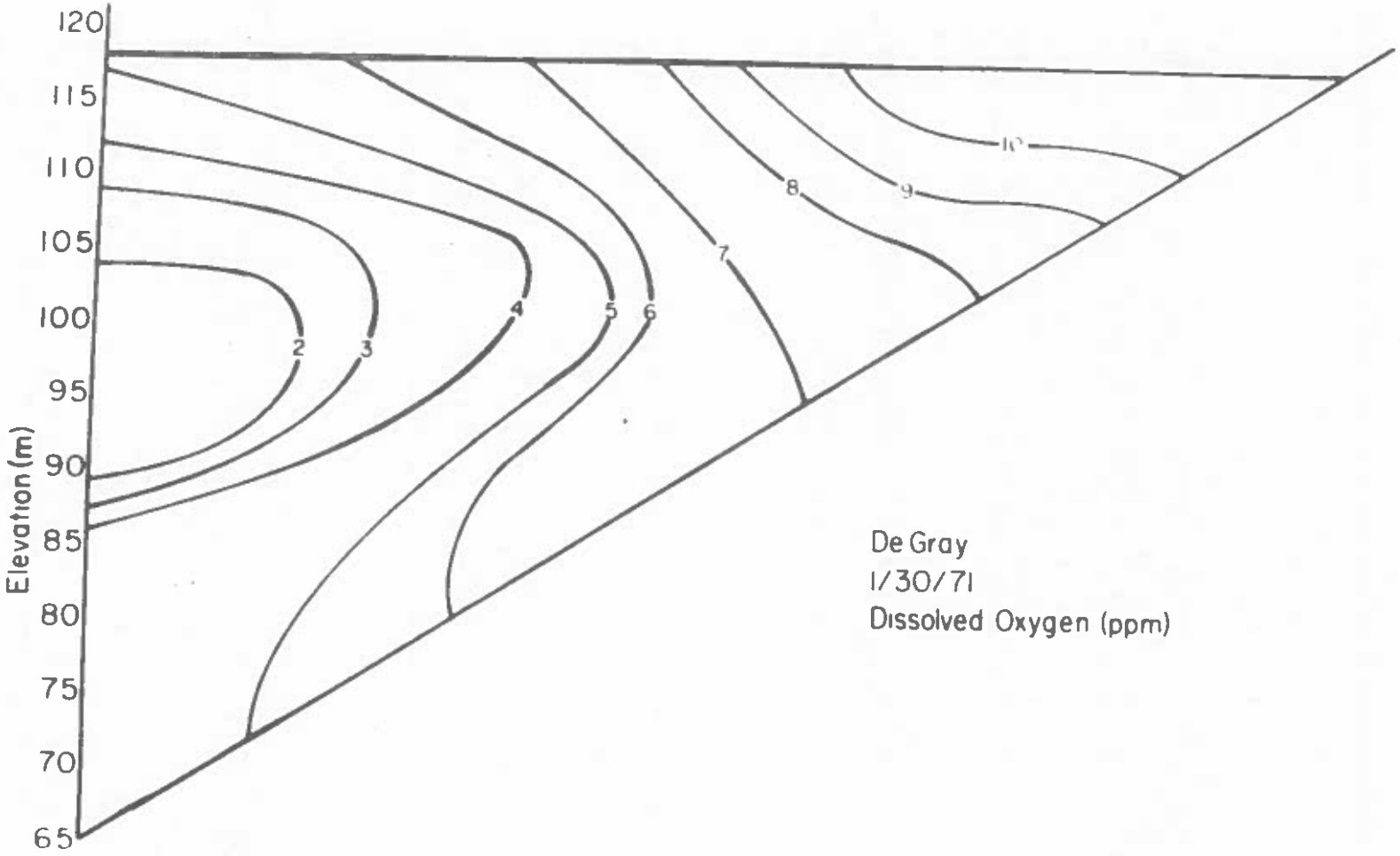

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
7
6
5
8
9
0
DeGray
10/10/70
Dissolved Oxygen (ppm)

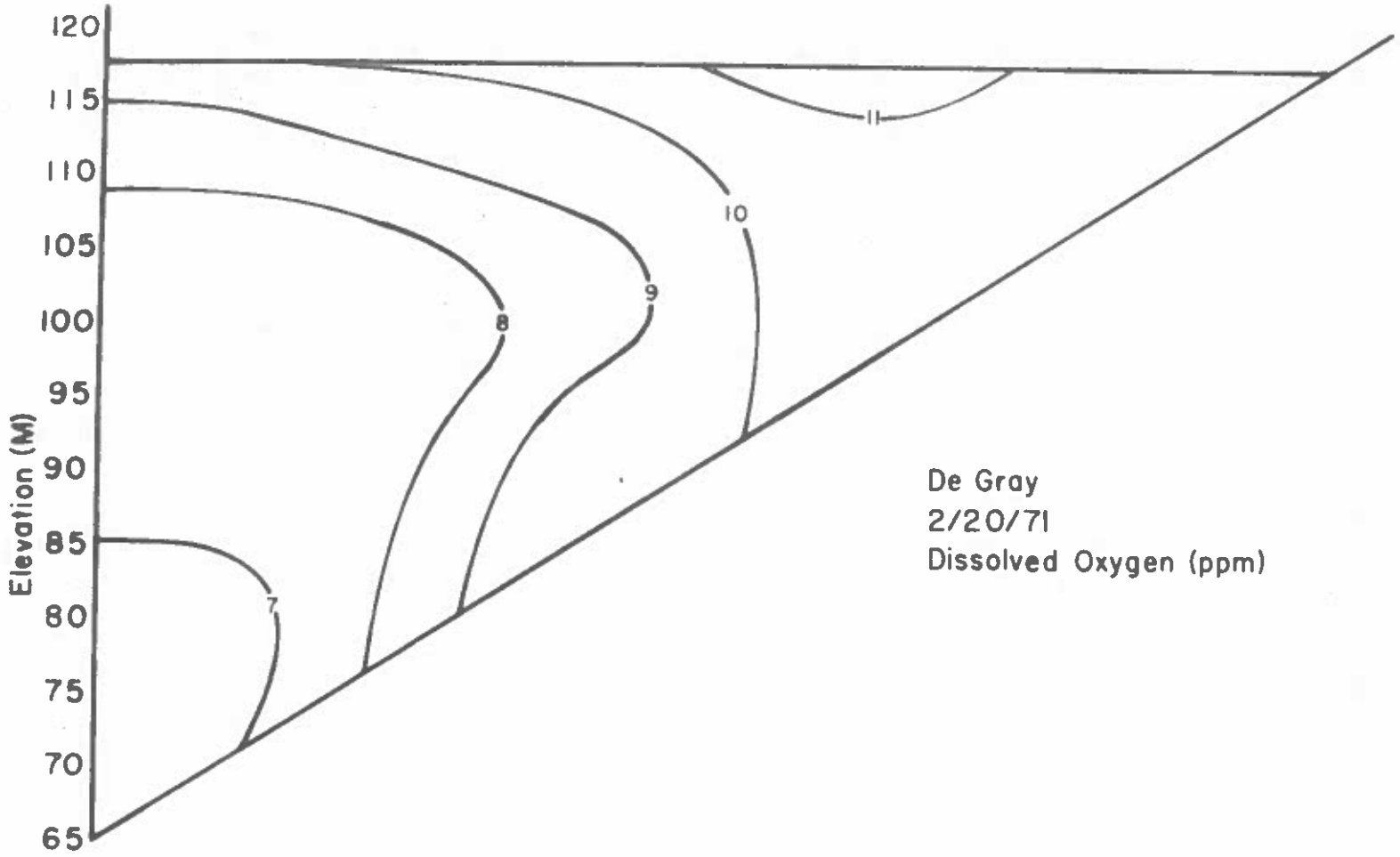

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
8
7
6
5
4
3
2
1
0
DeGray
11/7/70
Dissolved Oxygen (ppm)

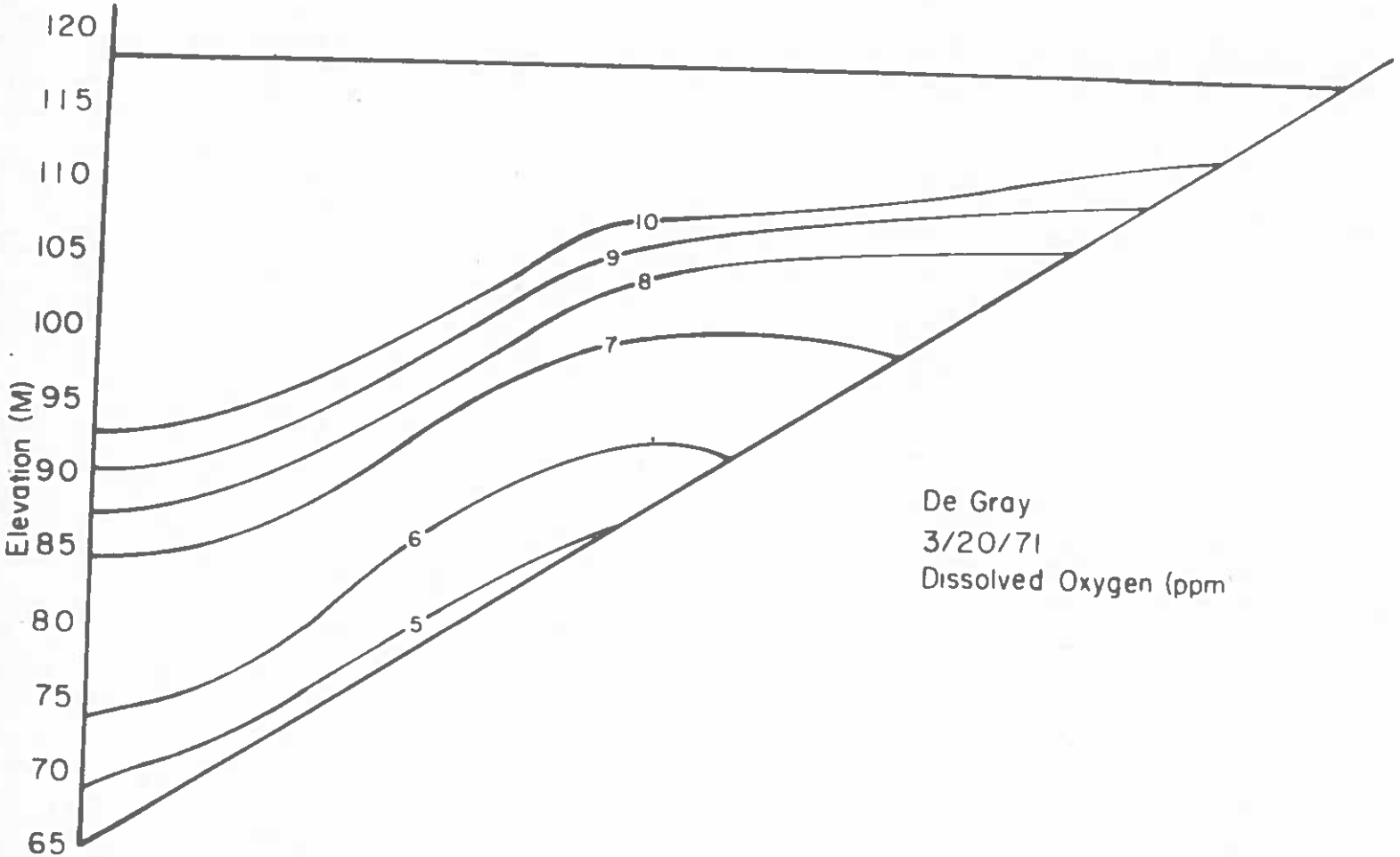

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
0
1
2
3
4
5
DeGray
12/2/70
Dissolved Oxygen (ppm)

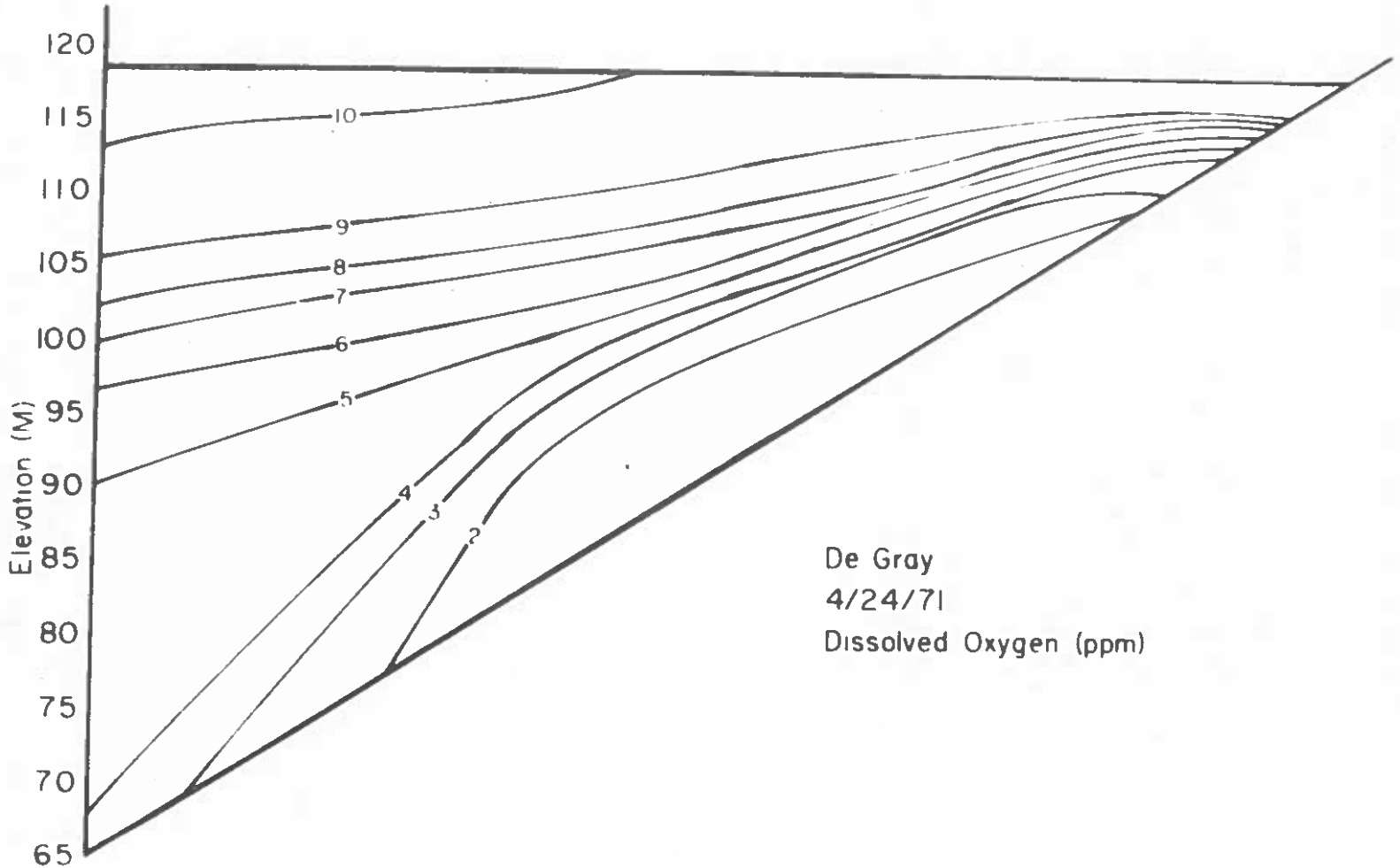

115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
0
1
2
3
4
5
6
7
8
9
DeGray
12/16/70
Dissolved Oxygen (ppm)

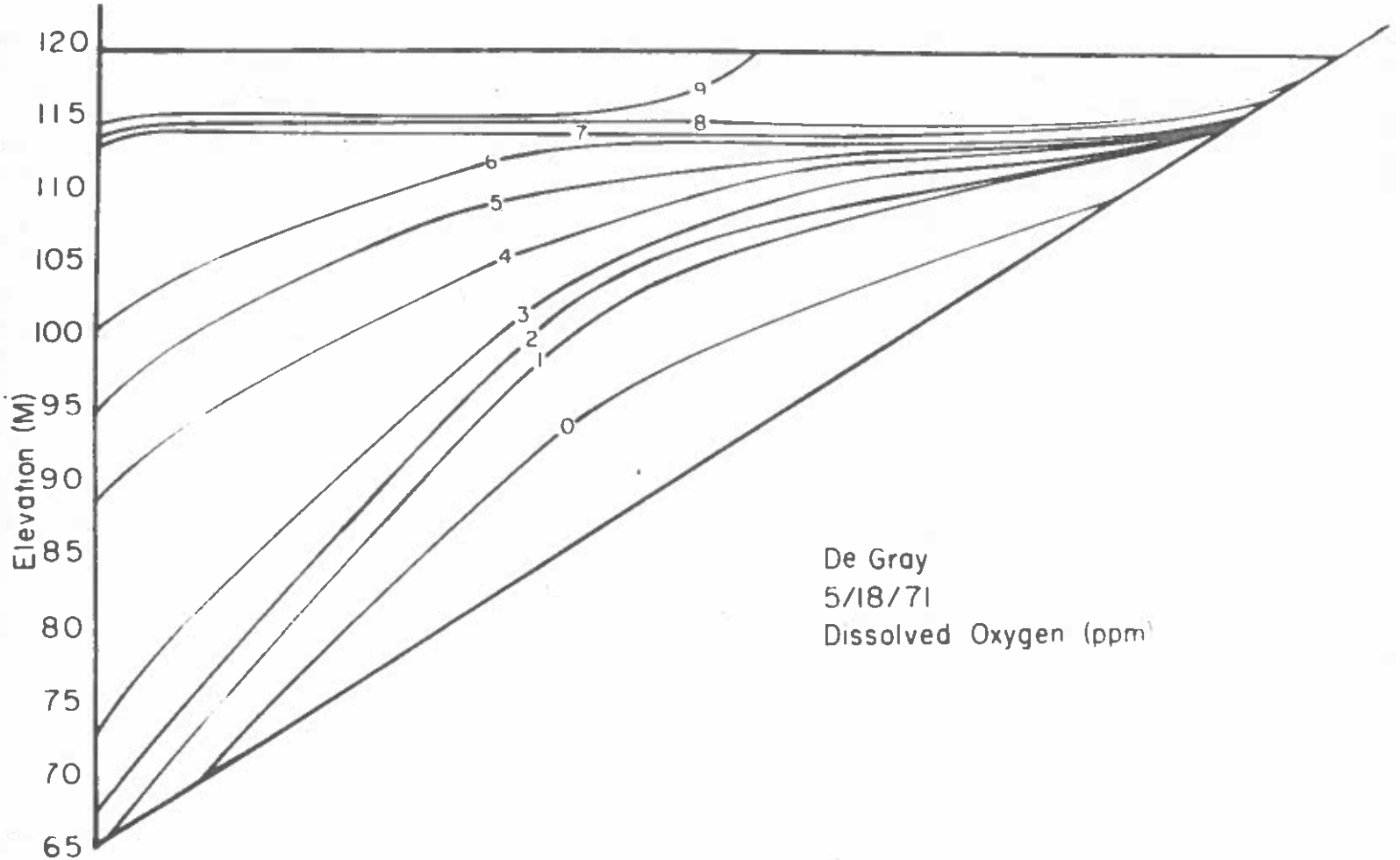

120
115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
De Gray
1/12/71
Dissolved Oxygen (ppm)


120
115
110
105
100
95
90
85
80
75
70
65
Elevation (m)
2
3
4
5
6
7
8
9
10
De Gray
1/30/71
Dissolved Oxygen (ppm)


120
115
110
105
100
95
90
85
80
75
70
65
Elevation (M)
11
10
9
8
7
De Gray
2/20/71
Dissolved Oxygen (ppm)


120
115
110
105
100
95
90
85
80
75
70
65
Elevation (M)
10
9
8
7
6
5
De Gray
3/20/71
Dissolved Oxygen (ppm


120
115
110
105
100
95
90
85
80
75
70
65
Elevation (M)
10
9
8
7
6
5
4
3
2
De Gray
4/24/71
Dissolved Oxygen (ppm)


120
115
110
105
100
95
90
85
80
75
70
65
Elevation (M)
9
8
7
6
5
4
3
2
1
0
De Gray
5/18/71
Dissolved Oxygen (ppm)