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WATER QUALITY IN THE MONASAVU RESERVOIR AND WAILOA RIVER IN 1994

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by

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WATER QUALITY IN THE MONASAVU RESERVOIR, THE FIVE WEIR SITES AND THE WAILOA RIVER IN 1994

1. INTRODUCTION

The Monasavu dam has been monitored twice yearly since 1985 by the Institute of Applied Sciences, USP with funding provided by the Fiji Electricity Authority (FEA). Initially the water quality of the dam and the Wailoa river above the Power Station and at the Tailrace (discharge site) were the main areas studied but in 1990, the FEA requested the IAS to include the five weir sites at Wainisavulevu, Wainabua, Wainikasou and Nabilabila in the monitoring programme. The biological study of the main fauna of the dam, the Wailoa river and the weir sites has also been carried out in conjunction with the water chemistry assessment, but to a lesser extent (one study per year). However in the 1994 monitoring programme, the biological study was not carried out because the biologist in charge was not available during the visit to Monasavu.

2. BACKGROUND

Over the years, results of water chemistry analyses have indicated a gradual improvement in the quality of the water at the reservoir, as evident from the results of nutrient levels and the metals iron and manganese(Morrison et al., 1990; Gangaiya, 1991; Lloyd et al., 1993; Tamata et al., 1995). Generally speaking, the water quality has been good in the dam as well as in the Wailoa river and the five weir sites. The pH, temperature and dissolved oxygen concentrations at all these sites have been within the acceptable range for freshwater lakes and the creeks (Wetzel, 1975).

However, the seasonal trends in water temperature and dissolved oxygen variation with depth at the reservoir remain clear, i.e. during the winter months (July), the water body in the dam is relatively homothermic and as a consequence, DO levels remain fairly constant throughout the water body (except at station 1 which is the deepest part of the dam). In contrast, during the summer months, there is definite stratification with the surface waters being much warmer than the water at depth. This in turn creates a clear variation in DO levels in the water body, with the surface water being saturated with dissolved oxygen while the bottom waters remain anoxic (dissolved oxygen levels being near zero). Whilst these conditions do affect the status of the metals iron and manganese (as has been observed in previous monitoring visits, Tamata et al., 1995), the 1994 results showed low levels of iron and manganese throughout the water column for all three stations. In fact with the exception of the bottom of station 1, the other values are below detection limit (see Tables 2 and 3 below).

3. THE MONITORING PROGRAMME

3.1 Organisation

As has been the practice since 1986 (Naidu and Brodie, 1987; Naidu et al., 1989; Morrison et al.,1990; Gangaiya, 1991; Lloyd et al., 1993), the monitoring of the

Monasavu dam and the Wailoa river was carried out twice yearly to cover the winter season (July) and the summer season (November - April). In 1994, the winter visit was carried out on the 18th and 19th July and the summer visit was carried out on January 10th and 11th, 1995. The summer visit was deferred from December 1994 to January 1995 due to staff commitments.

The July sampling was relatively problem-free but the summer visit in January 1995 was again hampered by very heavy rainfall as did happen during the sampling visit in January 1994 (Tamata et al., 1995). Once again the DO meter did not work after the first station had been assessed (station 3) as a result of water leaking into the meter. Therefore no temperature/dissolved oxygen profiles could be measured for stations 1 and 2 (see Table 3). However, water samples were collected from the three depths (surface, mid-depth and bottom) for the three stations in the reservoir and analysed in the laboratory at IAS for the same parameters that were normally assessed.

Apart from the dam and the Wailoa river, the five weir sites at Wainisavulevu, Wainikasou North and South, Nabilabila and Wainabua were also monitored as has been the case since the request was made by the FEA in 1990.

3.2 Parameters measured and Sampling Sites

The parameters assessed were the same as those assessed in previous monitoring visits.

Reservoir

At the reservoir, water samples were collected from the surface, mid-depth and the bottom at the three stations shown in Fig. 1. The samples were analysed in the laboratory using standard methods (APHA, 1990) for nutrients (nitrates, phosphates, total nitrogen, total sulphur, ammonia), the metals iron and manganese and chlorophylls. Only at station 3 was the depth/temperature/ dissolved oxygen profile assessed. Water depth and clarity was also measured on site.

Clarity was measured using a white secchi disc which is lowered into the water until it just disappears from sight. The water temperature and dissolved oxygen profiles were measured at 1 m depth intervals using a YSI Model 51B Dissolved Oxygen meter (calibrated on site for altitude set at 2,500 feet).

The pH of the samples were measured using the ORION model 250A pH meter.

Wailoa Power Station

At the Wailoa Power Station, the three sampling sites are shown in Fig. 2 below, i.e. at the Wailoa river before the power station, below the tailrace (discharge site into the river), and at Laselevu village further downstream. The water temperature, dissolved oxygen and pH were measured on site and water samples were collected and analysed in the laboratory for the nutrients, chlorophylls, total and dissolved iron and manganese.

The aim of the monitoring at the Wailoa river is to investigate if the power station (and the hydroelectric scheme) was having an impact on the quality of the Wailoa river and the villages downstream from the power station.

The Weir sites

At the weir sites, pH, water temperature and dissolved oxygen were also measured on site as above. The total dissolved solids, total suspended solids, total and dissolved iron and manganese were analysed in the laboratory at the IAS using standard methods (APHA, 1990). The aim of the monitoring at the weir sites was to establish if the logging in the catchment area was having an impact on the quality of the water in the creeks feeding the dam.

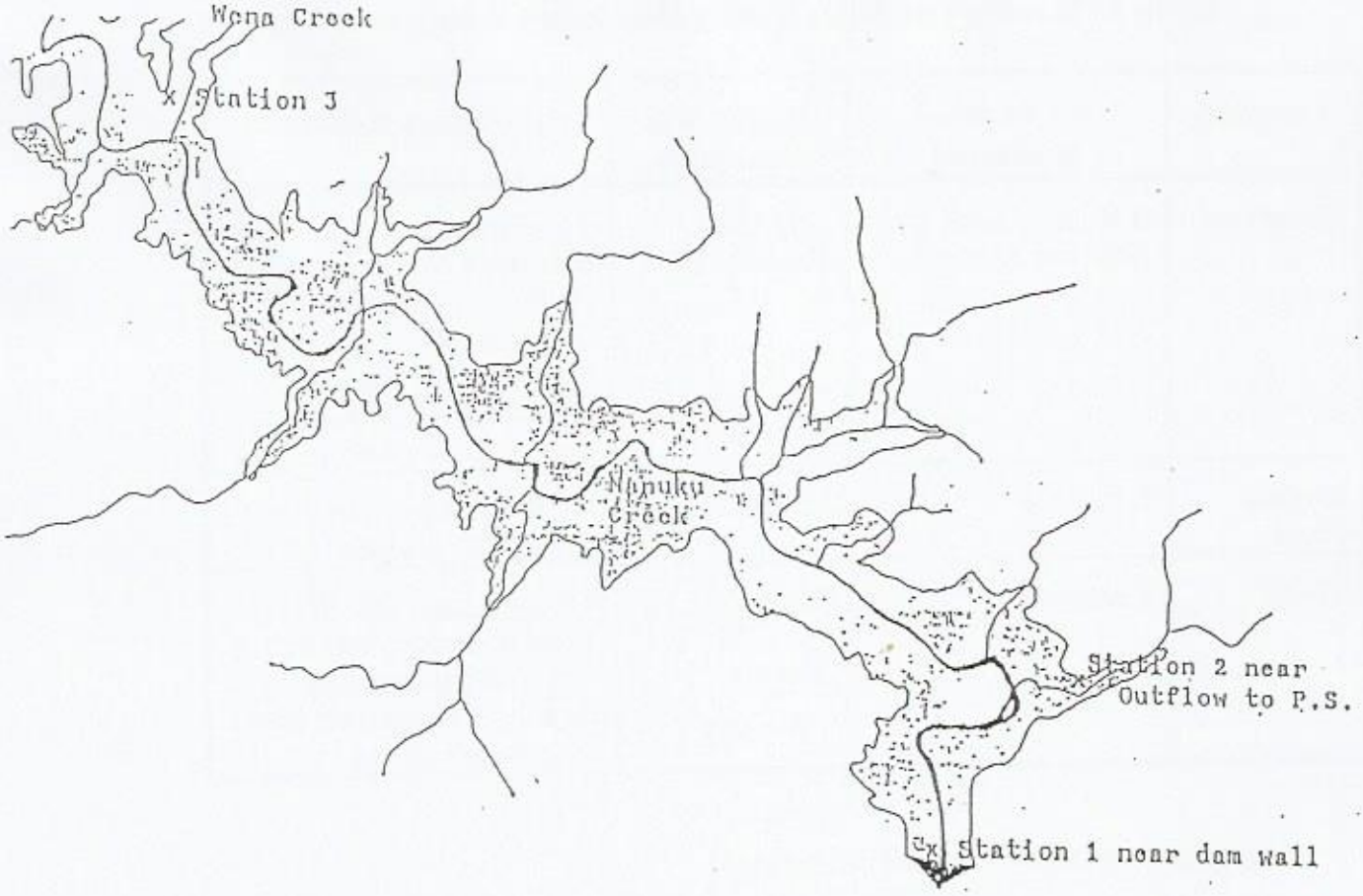

FIGURE 1 : Location of the sampling stations in the Monasavu Reservoir

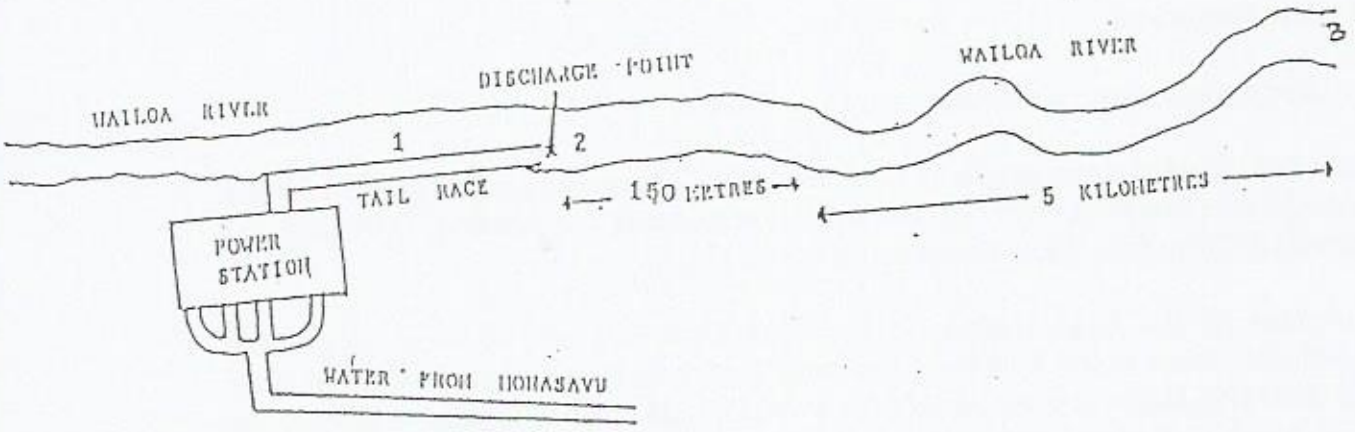

FIGURE 2 : Sampling sites along the Wailoa River

Site 1 : 100 m above Power Station discharge
Site 2 : Tailrace
Site 3 : Wailoa at Laselevu village

Table 1 : Summary of Water Quality Monitoring Programme

Location	No. of Sites Monitored	Monitoring Sequence	Parameters measured
Reservoir	3 stations each at 3 different depths	July 1994 January 1995	Temperature and dissolved oxygen profiles, clarity, pH, alkalinity, Chlorophylls (a,b,c), nutrients (nitrogen, phosphorus and sulphur), iron and manganese.
Wailoa River	3 stations	As above	As above except for the Temp./DO profiles
Weirs	5 stations	As above	Temperature, DO, pH, Total and dissolved iron and manganese, total dissolved solids and total suspended solids.

4. WATER CHEMISTRY AT MONASAVU

4.1 Results

The data on water chemistry for the reservoir, weirs and Wailoa river for the winter and summer monitoring are given in Tables 2 and 3 respectively. The data on depth/temperature/dissolved oxygen for the three stations in the dam are given in Tables 4 - 7.

4.2 Interpretation of results

4.2.1 The Reservoir

(a) Temperature and dissolved oxygen profiles:

In the 1994 monitoring programme, stations 1 and 2 temperature/DO profiles for the summer period (January) were not assessed due to meter malfunction. Only station 3 temperature/DO profile could be measured (see Fig. 6).

The profiles for the three stations in July (see Figs. 3, 4 and 5) show very stable temperatures down to the bottom of the reservoir. Likewise dissolved oxygen (DO) values were also stable and remained high around 6 mg/l down to depths of 30 m in the case of stations 1 and 2 and to the bottom (17 m) in the case of station 3. Such temperature and DO profiles have been characteristic of the July (winter) results (Gangaiya, 1991; Lloyd et al., 1993; Tamata et al., 1995).

A comparison of the two profiles measured in July and January for station 3 (see Figs. 5 and 6) again showed the seasonal variation that has been observed during the previous monitoring (Lloyd et al., 1993; Tamata et al., 1995). In winter, homothermal conditions persist with negligible temperature difference between the surface waters and the bottom of the reservoir and relatively high DO levels for depths down to about 30 m. In summer the water is stratified and the temperature difference between the surface and the bottom of the reservoir is greater and the DO values decrease steadily with depth.

in winter the temperature difference for station 3 between the surface and the bottom was only 1.3 °C but in summer the temperature difference was 3 °C. The dissolved oxygen level was relatively high, 5.8 mg/L at 16 m depth in July but in summer, the DO was <5 mg/l from 8 m down to the bottom (see Table 7).

TABLE 2 - WATER QUALITY RESULTS FOR MONASAVU DAM AND WAILOA RIVER - JULY 1994

	Station 1 Surface	Station 1 Mid	Station 1 Bottom	Station 2 Surface	Station 2 Mid	Station 2 Bottom	Station 3 Surface	Station 3 Mid	Station 3 Bottom	Wailoa Above P.S.	Wailoa Tailrace	Wailoa at Laselevu
Lab No.	94/1143	94/1144	94/1145	94/1146	94/1147	94/1148	94/1149	94/1150	94/1151	94/1157	94/1158	94/1159
Total alkalinity (mg/l CaCO3)	14	14	17	15	29	9	16	14	16	16	33	26
Clarity (m)	2.8			2.6			2.1					
pH on site	6.74	6.81	6.41	6.64	6.54	6.62	6.94	6.92	6.94	7.80	6.95	6.84
Total N (mg/l)	NSL	2.51	4.01	0.87	0.15	1.19	0.69	2.14	1.14	1.16	1.07	<0.1
Total S (mg/l)	NSL	6.0	6.4	6.2	6.3	7.5	7.0	7.4	7.3	7.3	7.5	7.5
NO3 (NO3 ug/l)	16.5	82.3	124.1	2.8	93.7	122.3	0.1	44.1	52.5	230.3	131.8	188.8
NH3 (ug/l)	<12.2	<12.2	984	15.0	<12.2	21.2	25.2	18.7	21.4	16.1	<12.2	<12.2
Chlorophyll ug/m3 a	NSL	1.5	1.8	2.2	1.7	1.9	3.0	2.4	2.1	1.0	0.12	1.7
Dissolved Mn (mg/l)	<0.1	<0.1	1.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Mn (mg/l)	<0.1	<0.1	1.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Fe (mg/l)	<0.3	<0.3	1.0	<0.3	<0.3	<0.3	<0.3	<0.3	0.3	<0.3	<0.3	<0.3
Total Fe (mg/l)	<0.3	<0.3	2.8	<0.3	<0.3	0.8	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Temperature (deg C)	19.8	19.3	18.8	19.0	19.3	19.3	20.8	19.6	19.5	20.8	20.2	20.7
Dissolved O2 (mg/l)	7.88	6.20	0.60	8.04	6.20	5.20	8.12	6.20	5.38	7.80	7.65	7.50
Depth (m)	0	29	59	0	18	37	0	8	17			
Dissolved PO4 (ug/l)	<73	112	105	<73	<73	73	<73	130	130	81	182	<73

NB : NSL - Not enough sample left

TABLE 2 (Contd.)

Lab No.	Wainabua	Nabilabila	Wainisavulevu	Wainakasou Sth	Wainakasou Nth
	94/1152	94/1153	94/1154	94/1155	94/1156
Total dissolved solids (mg/l)	45	55	53	18	35
Total suspended solids (mg/l)	124	120	32	99	86
Total iron (mg/l)	<0.3	<0.3	<0.3	<0.3	<0.3
Dissolved iron (mg/l)	<0.3	<0.3	<0.3	<0.3	<0.3
Total manganese (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved manganese (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1
pH	6.77	6.37	6.42	6.74	6.84
Temperature (deg C)	16.3	16.9	17.8	17.4	17.2
Dissolved oxygen (mg/l)	8.44	8.08	8.54	9.04	9.10

TABLE 3 – WATER QUALITY RESULTS FOR MONASAVU DAM AND WAILOA RIVER – JANUARY 1995

	Station 1 Surface	Station 1 Mid	Station 1 Bottom	Station 2 Surface	Station 2 Mid	Station 2 Bottom	Station 3 Surface	Station 3 Mid	Station 3 Bottom	Wailoa Tailrace	Wailoa at Laselevu	Wailoa above P.S
Lab No.	95/36	95/37	95/38	95/39	95/40	95/41	95/42	95/43	95/44	95/45	95/46	95/47
Total alkalinity (mg/l CaCO3)	16	17	30	16	15	22	21	17	19	17	26	29
Clarity (m)	Not measured											
pH (lab)	6.3	6.4	6.2	6.7	6.8	6.7	6.9	6.9	6.3	7.8	7.7	N.D.
Total N (mg/l)	1.52	1.36	2.40	1.17	1.47	3.57	1.75	2.10	2.03	1.70	1.71	5.14
Total P (ug/l)	22.9	9.6	110.4	41.8	30.4	388	17.7	17.7	47.9	57.3	66.5	57.4
Total S (mg/l)	0.36	0.25	1.90	0.32	0.28	3.72	0.30	0.28	1.05	2.13	0.34	0.40
NO3 (ug/l)	30.9	125.7	11.5	6.1	66.6	290.1	61.1	31.5	21.7	159.2	91.8	117.7
NH3 (ug/l)	<12.6	12.6	777	<12.6	19.1	296	<12.6	<12.6	140	67.3	<12.6	<12.6
Chlorophyll ug/L a	49.3	3.73	3.99	34.5	27.6	5.45	50.9	26.6	11.9	2.91	2.64	1.82
b												
c												
Dissolved Mn (mg/l)	<0.2	<0.2	0.94	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total Mn (mg/l)	<0.2	<0.2	1.0	<0.2	<0.2	<0.2	<0.2	<0.2	0.25	<0.2	<0.2	<0.2
Dissolved Fe (mg/l)	<0.3	<0.3	3.23	<0.3	<0.3	<0.3	<0.3	<0.3	1.28	<0.3	<0.3	<0.3
Total Fe (mg/l)	<0.3	<0.3	4.06	<0.3	<0.3	0.69	<0.3	<0.3	2.08	<0.3	<0.3	<0.3
Temperature (deg C)	) Not done due to meter						24	22	21	24	25	24
Dissolved O2 (mg/l)	) malfunction						8	5	0	6	6	7
Depth (m)	0	29	59	0	17	34	0	11	21			
Dissolved PO4 (ug/l)	31.1	12.8	167.1	37.0	5.24	42.4	18.7	7.6	34 7	14.8	76.4	122.9

TABLE 3 (Contd.)

Monasavu Water Samples (Weirs)

Lab No.	Wainabua 95/49	Nabilabila 95/48	Wainisavulevu 95/50	Wainakasou St 95/52	Wainakasou Nt 95/51
Total dissolved solids (mg/l)	580	70	380	760	64
Total suspended solids (mg/l)	10	4	7	2	7
Total iron (mg/l)	<0.3	<0.3	<0.3	<0.3	<0.3
Dissolved iron (mg/l)	<0.3	<0.3	<0.3	<0.3	<0.3
Total manganese (mg/l)	<0.2	<0.2	<0.2	<0.2	<0.2
Dissolved manganese (mg/l)	<0.2	<0.2	<0.2	<0.2	<0.2
pH	7.75	7.53	7.88	7.87	7.86
Temperature (deg C)	21	20	20	20	20
Dissolved oxygen (mg/l)	6.4	6.2	6.9	6.6	6.4

TABLE 4 - WINTER RESULTS

DATA FOR MONASAVU DAM - STATION 1, JULY 1994.

DEPTH (m)	TEMP. (°C)	D.O. (mg/L)	DEPTH (m)	TEMP. (°C)	D.O. (mg/L)
0	19.8	7.88	14	19.4	6.40
1	19.8	7.76	16	19.4	6.32
2	19.8	7.50	18	19.4	6.32
3	19.6	7.42	20	19.3	6.22
4	19.6	7.38	25	19.3	6.22
5	19.5	7.12	30	19.3	6.20
6	19.5	7.06	35	19.3	5.06
7	19.5	7.10	40	19.3	3.90
8	19.5	7.08	45	19.2	2.95
9	19.4	6.96	50	19.2	3.10
10	19.4	6.80	55	19.1	0.40
12	19.4	6.44	59	18.8	0.60

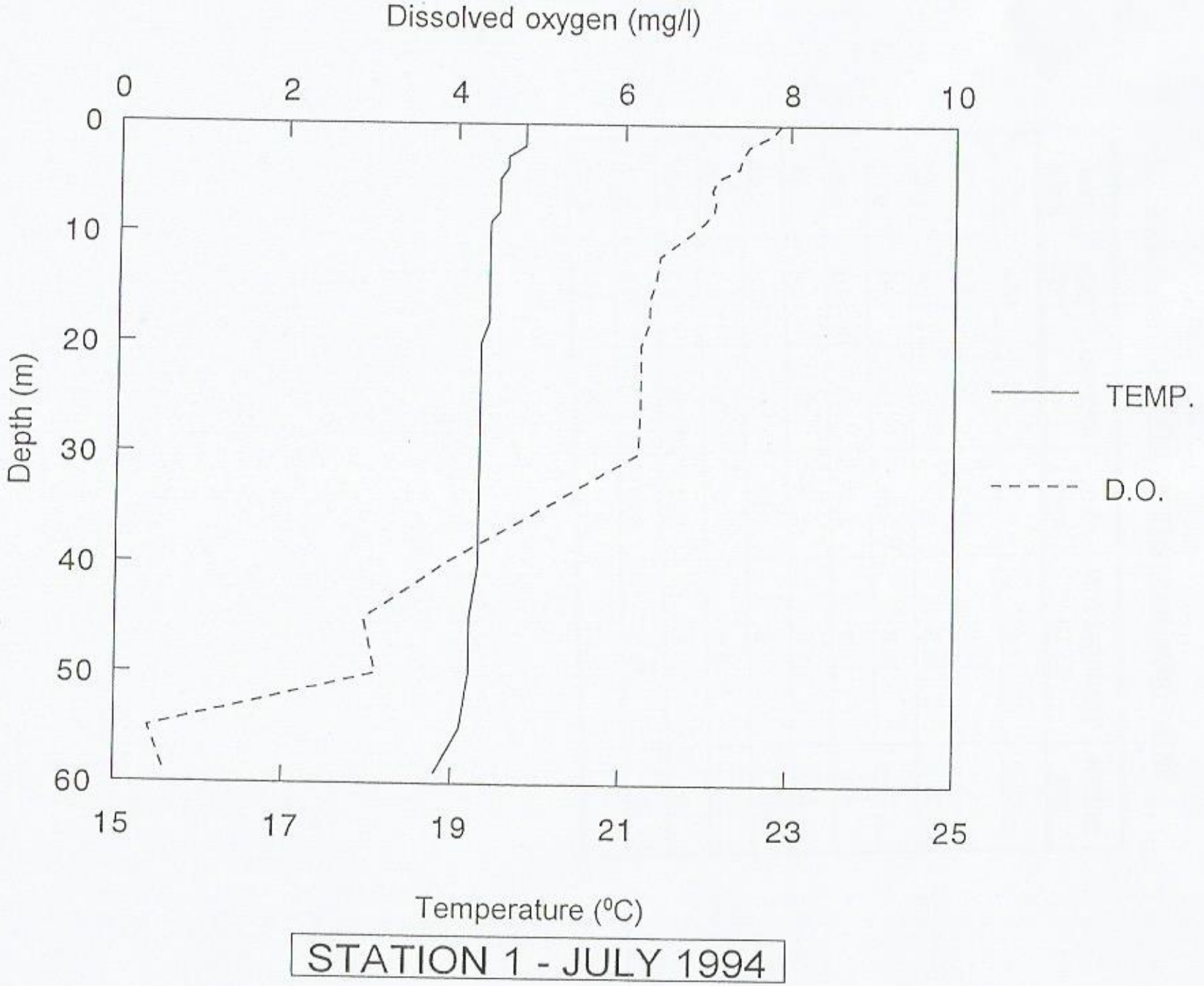

FIGURE 3 – TEMPERATURE/DO PROFILE FOR STATION 1 – JULY 1994

TABLE 5 - WINTER RESULTS

DATA FOR MONASAVU DAM STATION 2, JULY, 1994

DEPTH (m)	TEMPERATURE (°C)	D.O. (mg/L)	DEPTH (m)	TEMP. (°C)	D.O. (mg/L)
0	19.0	8.04	10	19.4	6.78
1	18.9	8.04	12	19.4	6.76
2	18.9	8.10	14	19.4	6.42
3	18.8	7.92	16	19.4	6.28
4	18.8	7.76	18	19.3	6.20
5	18.8	7.80	20	19.3	6.20
6	18.8	7.80	25	19.3	5.98
7	19.6	7.78	30	19.2	6.18
8	19.6	7.22	35	19.3	6.48
9	19.6	6.92	37	19.3	5.20
			40	19.3	3.42

FIGURE 4 - TEMPERATURE/DO PROFILE FOR STATION 2 - JULY 1994

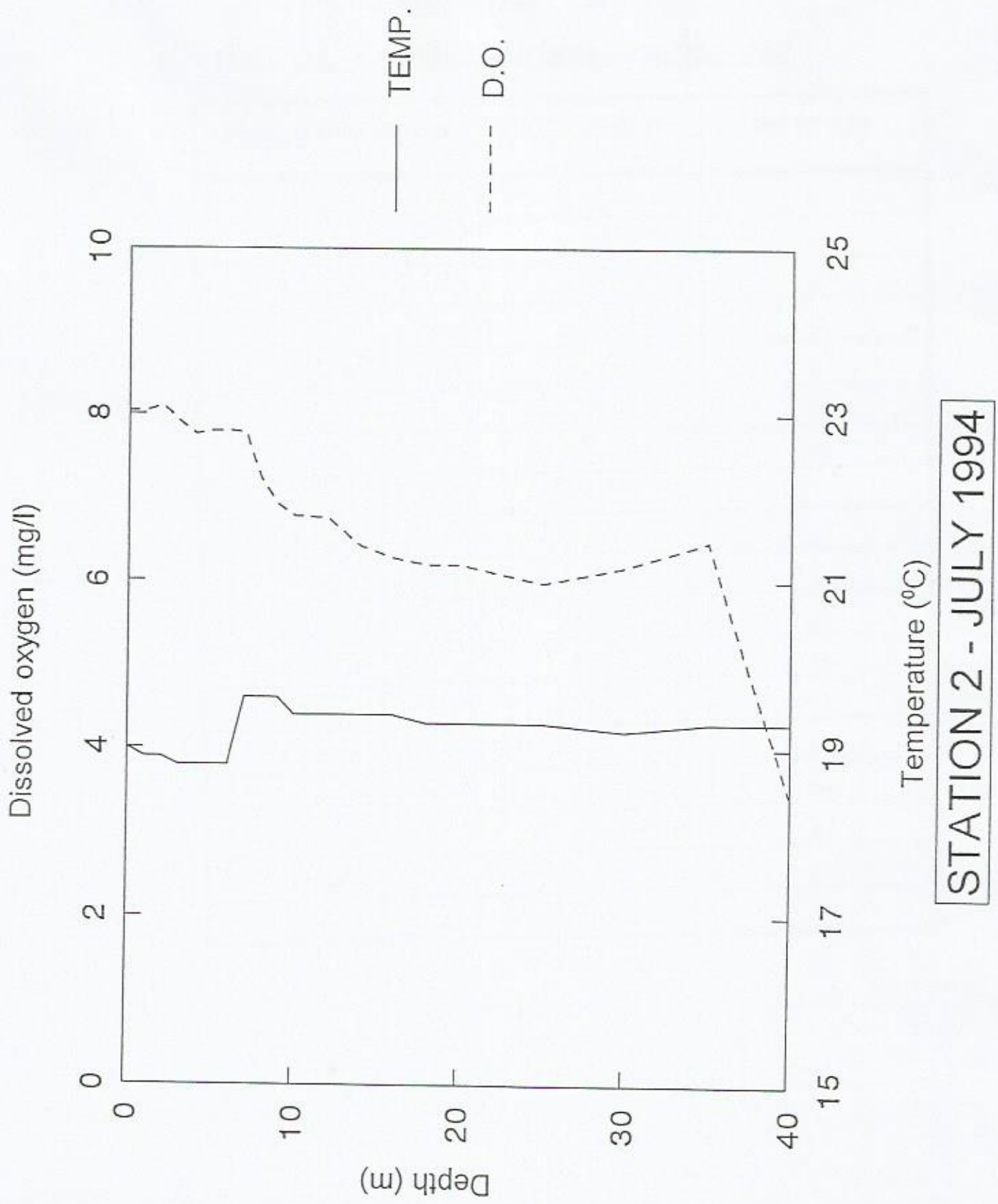

TABLE 6 - WINTER RESULTS

DATA FOR MONASAVU DAM STATION 3 - JULY, 1994

DEPTH (m)	TEMPERATURE (°C)	DISSOLVED O_2 (mg/L)
0	20.8	8.12
1	20.8	8.14
2	20.6	8.20
3	19.9	7.80
4	19.8	7.38
5	19.8	6.40
6	19.6	5.92
7	19.6	6.00
8	19.6	6.20
9	19.5	6.40
10	19.5	6.20
11	19.5	6.20
12	19.5	6.28
13	19.5	6.00
14	19.5	5.82
15	19.6	5.90
16	19.6	5.88
17	19.5	5.38

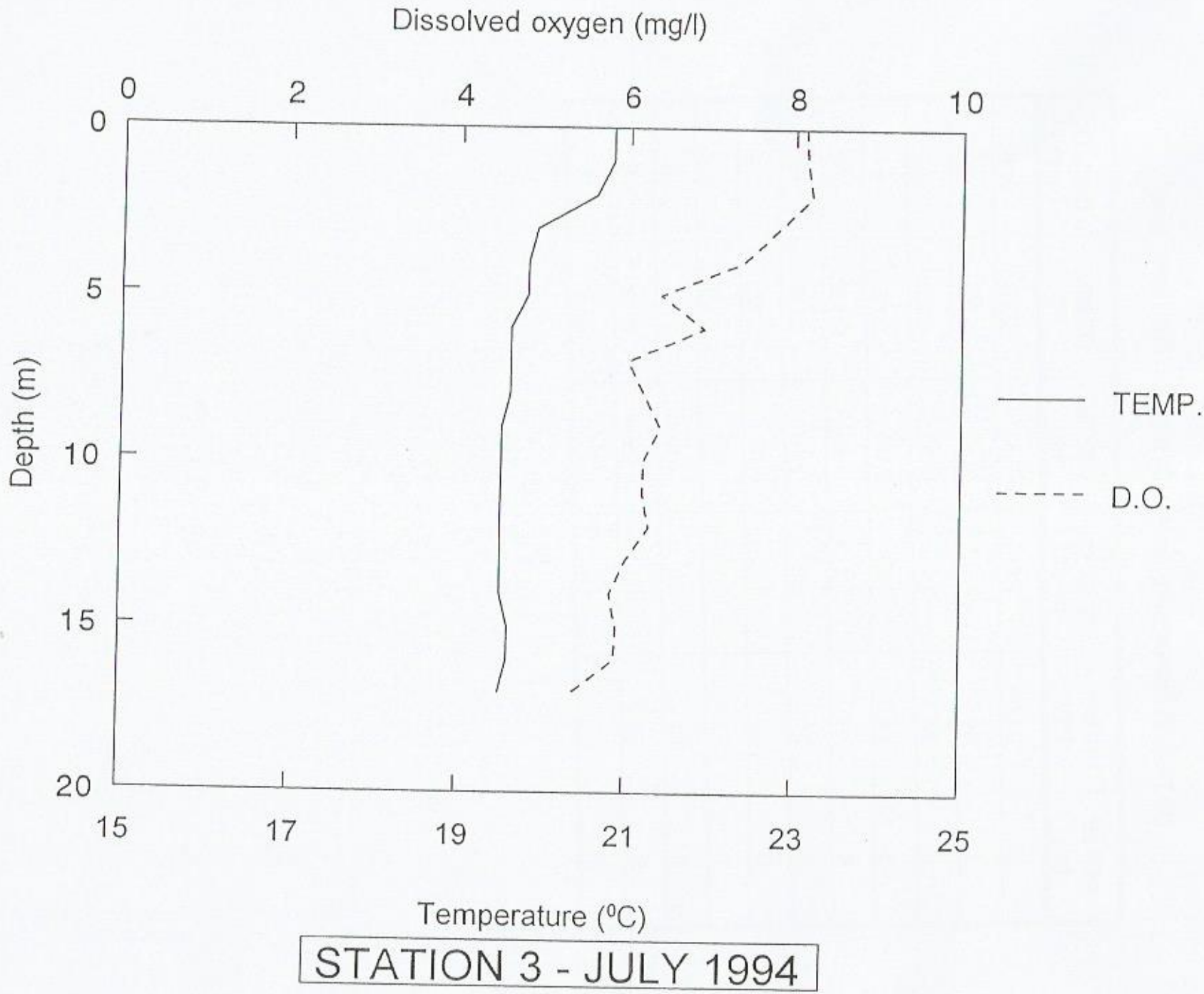

FIGURE 5 – TEMPERATURE/DO PROFILE FOR STATION 3 – JULY 1994

TABLE - 7 - SUMMER RESULTS

DATA FOR MONASAVU DAM STATION 3 - JANUARY, 1995

DEPTH (m)	TEMP. (°C)	DISS. O_2 (mg/L)	DEPTH (m)	TEMP. (°C)	DISS. O_2 (mg/L)
0	24.0	7.6	11	22.0	4.8
1	24.0	7.7	12	21.5	4.6
2	24.0	7.7	13	21.5	4.2
3	24.0	7.6	14	21.5	3.4
4	24.0	7.2	15	21.5	2.5
5	24.0	6.0	16	21.5	1.5
6	23.5	5.8	17	21.5	0.8
7	23.0	6.1	18	21.0	0.2
8	23.0	4.9	19	21.0	0
9	22.0	4.4	20	21.0	0
10	22.0	4.9	21	21.0	0

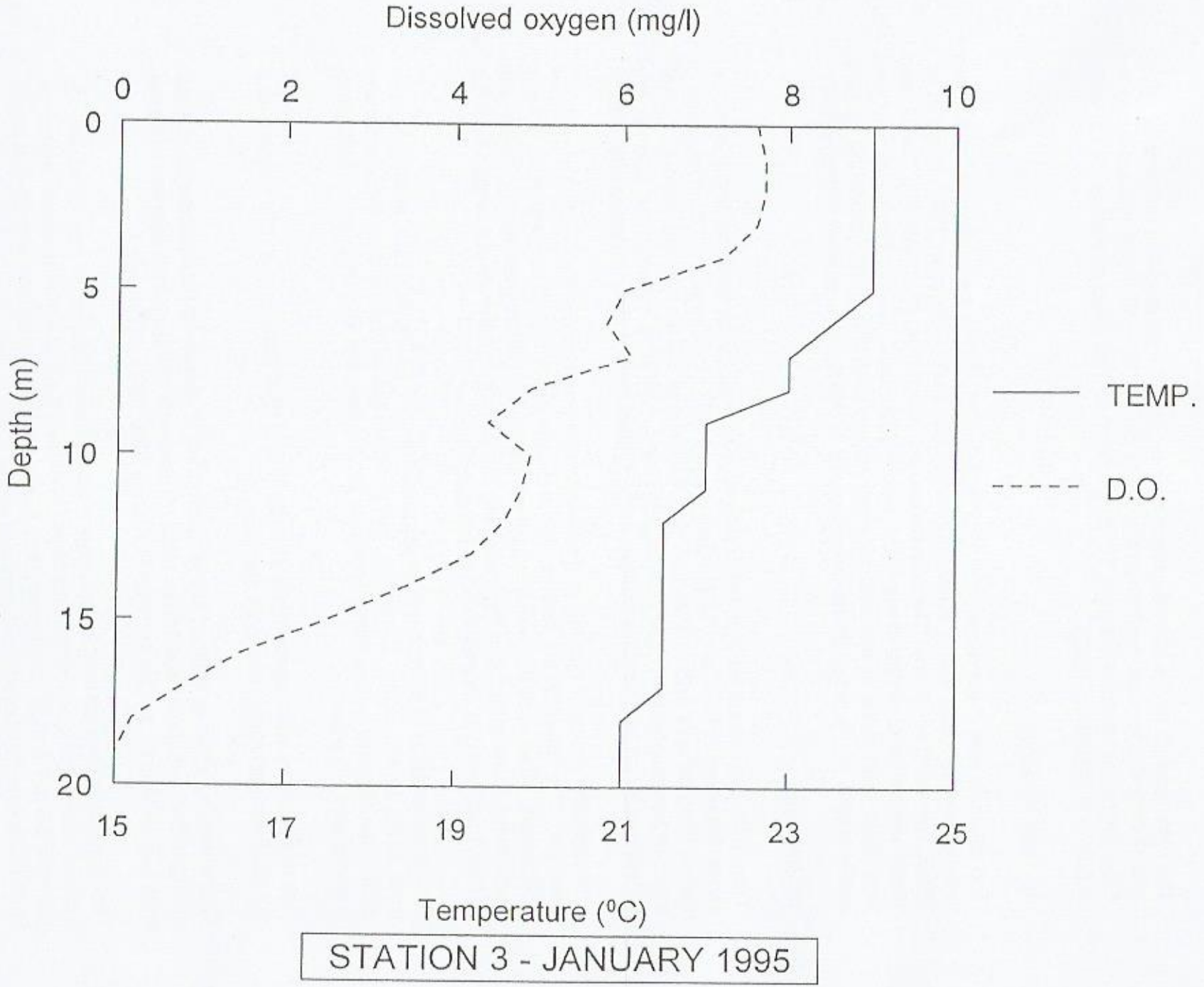

FIGURE 6 - TEMPERATURE/DO PROFILE FOR STATION 3 - JANUARY 1995

(b) pH

The pH values for all the sites during the winter sampling was in the range 6.37 - 7.80 and during the summer visit, the range was 6.2 - 7.88. All these values are in the expected range for dams (Wetzel, 1975) and also for recreational waters for Fiji which is 5.0 - 9.0 (NEMP 6, 1992).

(c) Total Alkalinity

The alkalinity was in the range 9.0 - 33.0 mg/L $CaCO_3$ during the winter period and this was generally lower than values obtained in the past (Gangaiya, 1991; Lloyd et al., 1993; Tamata et al., 1995). The summer values varied from 15 to 30 mg/L $CaCO_3$ and these values were similar to previous results (Gangaiya, 1991). There has not been any major difference in the total alkalinity values over the years, indicating that the water quality in the reservoir has remained fairly stable for a number of years now.

(d) Nutrients

Total nitrogen values for both the winter and summer visits were basically similar to those obtained in 1991 and 1992 (Gangaiya, 1991; Lloyd et al., 1993). The range of values in winter was 0.15 to 4.01 mg/L and the summer values varied from 1.17 to 3.57 mg/L in the reservoir. There was no significant difference between the summer and winter results and no obvious pattern in the distribution of the substance with depth.

The concentrations of nitrates in the winter visit varied from 0.1 to 124.1 ug/l in the reservoir. The values in the Wailoa river were generally higher ranging from 131.8 to 230.3 ug/l. Also noted in winter was the increase in concentrations of nitrates with depth at the three stations in the reservoir. In summer, nitrate values ranged from 6.1 to 290.1 ug/l with no distinct trend in the distribution.

The concentrations of ammonia in winter ranged from <12.2 to 984 ug/L and in summer from <12.6 to 777 ug/L. Generally, the concentrations of ammonia increased with depth, the highest values being recorded for the deepest site (station 1 - bottom) in summer and in winter.

Due to problems with the methods of determining total phosphorus, this nutrient was not analysed for during the 1994 sampling.

There was no obvious pattern in the distribution of dissolved phosphates at all sites during both the summer and winter visits. The range of PO_4 in the reservoir in winter was <73 - 130 ug/L, and in summer the range was 5.24 - 167.1 ug/L.

The concentrations of total sulphur were again lower in summer than in winter. In summer total sulphur concentrations varied from 0.25 to 3.72 while in winter the range was from 6.0 to 7.5 mg/l. In summer, total sulphur seemed to be concentrated at depth while there was no such pattern noted in winter.

(e) Chlorophyll

Only chlorophyll *a* was determined during the 1994 monitoring of the reservoir. During the winter visit chlorophyll *a* concentrations were generally low ranging from 1.5 to 3.0

ug/l but in summer, the values were relatively higher ranging from 3.73 to 50.9 ug/l. Also noted in summer was the concentration of chlorophyll in the surface waters (corresponding to presence of algae and phytoplankton) and decreasing with depth.

(f) Total and dissolved iron and manganese

For total iron, the concentrations during both winter and summer sampling were low as has been the trend for some years (Tamata et al., 1995). In winter, seven of the nine samples had <0.3 mg/l total iron. The only samples that recorded some iron were the bottom samples from stations 1 and 2 where low oxygen concentrations may have reduced the iron oxides and hydroxides and release the element back in the water column. In summer the range was <0.3 mg/L to 4.06 mg/L, the high values again associated with the deeper parts of the reservoir.

The concentration of dissolved iron were also generally low during both the winter and summer visits. In winter, all values were <0.3 mg/L except at the bottom of station 1 where the concentration was 1.0 mg/l. In summer, the bottom waters showed some presence of the element while the surface and mid-depth waters all had <0.3 mg/L.

Total manganese concentrations were low, in most cases below detection limit. In the July sampling, eight of the nine samples had <0.1 mg/l while in the January (summer) sampling seven of the nine sample had <0.2 mg/l total manganese. Only the deepest part of the dam at the bottom of station 1 which showed some presence of the element.

The same trend found for total manganese was also found for dissolved manganese. With the exception of the bottom water samples from station 1, all the other samples had dissolved manganese below detection limits.

The low concentrations of the total and dissolved iron and manganese in the dam in general, with the exception of the deeper waters has been the trend for the last ten years since 1985 (Gangaiya, 1986; Naidu & Brodie, 1987; Naidu et al., 1989; Morrison et al., 1990; Gangaiya, 1991; Lloyd et al., 1993; Tamata et al., 1995).

4.2.2 The Wailoa River

The three sites along the Wailoa River (Fig. 2) are compared to see if the Power station was having an impact on the quality of the water. Also by comparing status of iron and manganese at the bottom of station 2 in the dam and the tailrace below the Power station, the possibility of deposition of these metals on the machinery in the power station can be indirectly addressed.

As far as pH, temperature and dissolved oxygen are concerned, there were no significant difference in the values for the three sites along the Wailoa River during both the winter and the summer visits. pH values varied between 6.84 and 7.80, temperatures varied from 20.2 to 20.8 in winter and between 24 and 25 in summer, and DO values were between 6.0 and 7.80 mg/l.

There was no major difference between the pH, temperature and DO between the bottom of station 2 and the tailrace except for a slight increase in DO levels from 5.20 to 7.65 mg/l in winter, indicating that the water was quickly oxygenated at the power

station. Due to meter malfunction, no temperature and DO measurements could be made at station 2 during the summer sampling.

The nutrient levels are generally similar for the three sites along Wailoa River and the reservoir stations. The nitrate levels were higher along the Wailoa River than in the reservoir in winter. As has been the trend so far, the level of ammonia is greatly reduced from when the water leaves the dam (bottom station 2) until it is discharged at the tailrace and this is a consequence of the oxygenation process of the water in the power station. The same process however could create problems as far as the iron and manganese levels are concerned.

There is no cause for concern as far as the status of iron and manganese are concerned. Unlike last year (1993) when some difference was observed in the levels of dissolved iron between the bottom of station 2 and the tailrace, this time (1994) the only variation was in the concentrations of total iron. Total iron decreased from 0.8 to <0.3 mg/l in winter and from 0.69 to <0.3 mg/l in summer between the tunnel entrance in the dam (station 2) and the discharge site at the tailrace in Wailoa river. Dissolved iron and total and dissolved manganese were all below detection limits at the three sites along the Wailoa River as in the surface and mid-depths of the reservoir.

4.2.3 The Weirs

The pH, temperature and dissolved oxygen concentrations were all within acceptable ranges for freshwater creeks during the winter and summer visits.

The total dissolved solids (TDS) concentrations in winter were similar to results obtained during the same time in 1993 (Tamata et al., 1995). The range of TDS values was 18 - 55 mg/l. However in summer, the TDS levels for 1994 were much higher than in 1991 (Gangaiya, 1991); 1992 (Lloyd et al., 1993) and in 1993 (Tamata et al., 1995). The range of TDS in the summer of 1994 was 64 - 760 mg/l. Such high TDS results are unusual for fresh water creeks and may require further assessment. The heavy rain that fell during this period could be causing such high TDS concentrations.

The total suspended solids (TSS) concentrations, unlike the TDS results were low in summer and high in winter. The range of TSS values in summer was 2 - 10 mg/l which was similar to the 1991 results (<1 - 12 mg/l, Gangaiya, 1991). However the range of TSS concentrations in winter was much higher than the 1991 (all <1 mg/l), 1992 and 1993 results. The range of TSS for the winter visit in 1994 was 32 - 124 mg/l. Interestingly, no rainfall was recorded at the Monasavu station on the 17th, 18th and 19th of July, 1994. Also the villagers at Laselevu had noted that the water level in the Wailoa river was very low during the visit (pers. comm. Ed Anderson/villagers). The low water level and dry period may have caused a concentration of suspended material thus the high concentrations of TSS. The results for the two visits do not indicate any substantial increase which could be attributed to logging in the catchment area around Monasavu.

The concentrations of total and dissolved iron were all below detection limit (<0.3 mg/L) in summer and in winter. Such low occurrence of iron at the weir sites have been the trend for many years now (Gangaiya 1991, Lloyd et al., 1993, Tamata et al., 1995).

The concentrations of total and dissolved manganese were also low with all values being below the detection limit of 0.2 mg/L in summer and below 0.1 mg/l in winter.

6. CONCLUSIONS

The water quality in the Monasavu reservoir and the Wailoa river was generally good in that the pH, dissolved oxygen, temperature, the nutrients and the concentrations of total and dissolved iron and manganese were within acceptable ranges for fresh water lakes and rivers. The low levels of total and dissolved iron and manganese in the reservoir, particularly at the bottom of station near the tunnel entrance to the power station minimises any risk of deposition of these metals on the machinery in the power station at Wailoa. Since only one station was profiled for temperature and dissolved oxygen during the summer visit, no useful comparison could be made about the effects of depth on temperature and DO for the two seasons. However for the one station that was profiled, the general trend observed in previous monitoring have persisted i.e. the water body being relatively homothermic in winter and stratified in summer and as a consequence of this seasonal variation, the levels of dissolved oxygen with depth show marked changes in summer and not so much in winter (see Figs. 5 and 6). There has been marked reduction in levels of iron and manganese over the years.

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