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WATER QUALITY IN THE QAWA RIVER DURING THE SUGAR CANE CRUSHING SEASON OF 1995

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by

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STATUS OF WATER QUALITY IN THE QAWA RIVER

DURING THE SUGARCANE CRUSHING SEASON OF 1995

1. INTRODUCTION AND BACKGROUND

The Qawa River in Labasa has been the centre of much concern and controversy because of the foul smell and the uncharacteristic colour of the river water. This becomes worse during periods of dry weather when the FSC mill is in operation. The Qawa River is considered to be very dirty and smelly and devoid of fish resources. The problem is worst for the residents of Natokamu, a settlement located on the Qawa River bank about 1.8 km upstream from the Fiji Sugar Corporation Mill. The stench and the unusual colour of the Qawa river is not new and has been there for long. According to District Officer Macuata, the pollution of the Qawa River is no secret and people have had to live with the problem for years.

The problem has been discussed at various village meetings, tikina meetings and at the provincial level during meetings of the Macuata Province (pers. comm., Roko Tui Macuata, August, 1995). The complaints have come from the villagers of Natokamu, and Boubale and Urata, about 6 km upstream from the Sugar mill.

The Qawa river was brought to public attention when it was highlighted in Parliament by the Indian Member for Labasa, Honourable M. Chinnkannu on 22 February 1995 (Daily Hansard Report, 22 February 1995). The government through the Department of Environment attempted an assessment of the problem based on information gathered from Fiji Sugar Mill's own records. However, the first real attempt to take measurements and readings of environmental pollution indicators was undertaken by the Institute of Applied Sciences (IAS) of the University of the South Pacific. TDS values are expected to be high where salinity is high because of the presence of sodium chloride salts and ammonia elevation in the water could indicate deoxidising conditions in the water. The financial support for the research carried out by the IAS was provided by the USP through the Research Committee of the university.

The Physical Setting

The Qawa River is a relatively small river by Fiji standards. The average width of the river is about 50 metres but in several places it is much narrower. From the only bathymetric data available for the river (Hydrographic office, 1959), the average depth for the section from the main bridge, to the river mouth is 2 to 3 m. The deepest sections are only a little over 5 m. The Qawa river is certainly narrower and shallower than the Labasa river which runs almost parallel to it on the other side of the Labasa town.

The dominating feature of the Qawa and Labasa rivers is the extensive area of lush mangrove bordering the rivers from the estuary approximately 6 km upstream where the rivers meet at the Cawa-i-Ra settlement. The mangrove and associated ecosystems may be providing valuable filtering process for much of the waste being carried downstream. Furthermore, the area may be providing good breeding ground for the juvenile fish and aquatic life forms in the area.

However, an interesting contrast appears when comparing the Qawa and Labasa rivers. The Qawa River is commonly dirty grey-green in colour with a characteristic strong odour. The Qawa River is depleted of *salala* (*Rastcelliger branchysoma*) and other estuarine and brackish water fish resources which was once abundant in the river and mangals. The Labasa River however is abundant with these resources.

2. WATER QUALITY ASSESSMENT OF THE QAWA RIVER

A team of two scientists from the Institute of Applied Sciences at the USP visited Labasa on August 21 and 22 1995 to carry out water quality testing of the Qawa river. Further relevant data were collected by interviewing a variety of information sources. The detailed work program is set out below.

Detailed work program by the IAS at Labasa on 21 and 22 August, 1995

Day 1 - Monday 21 August

9.00 - 11.00 am : met with the District Administration Officials at the Katonivere House. Interviewed the District Officer Macuata, Mr Gordon Leewai and other District Administration Officials (Roko Tui Macuata Maikali Rabaro and Emosi Cagi, Factory Manager, FSC).

11.30 - 1.00 pm : met with the Fiji Sugar Corporation Management at the mill. Shown the plans for improved effluent treatment ponds. Spoke with the Chemist at the mill regarding regular testing by the mill staff of the effluent in the ponds.

2.30 - 3.00 pm : Toured the settlements and villages along the Qawa River, interviewing them whenever possible about their experiences of pollution in the river.

3.15 pm : Interviewed the Senior Fisheries Officer Mr Indar Raj. Information received at the Fisheries Office revealed complaints from the community on fish kills, depletion of fish stock etc. Made arrangements whereby the Fisheries Officer was to inform the IAS and collect samples of water and dead fish if another such problem occurs in Labasa.

3.30 pm - 5 pm : The entire navigable length of the river was assessed for sampling sites

Day 2 - Tuesday 22 August

8.30 - 10.30 am : Water quality testing and sample collection at low and receding tide. Sampling was started upstream at Boubale/Urata (Site 1) then proceeded downstream to site 2 at the Natokamu settlement, site 3 at the FSC mill site and finally at the river mouth (site 4).

11.00 - 1.00 pm : Water samples were stored in ice for transport to the water laboratory at the IAS, Suva.

2.00 - 4.00 pm : Water quality testing and sample collection at high and rising tide. This time sampling started from site 4 at the entrance to the river and moving upstream with the tide. The last site sampled, site 1 at Boubale/Urata was sampled at 3.45 pm.

6.00 pm : Samples received at the IAS laboratory.

3. SITE LOCATION AND DESCRIPTION

Site 1	Boubale/Urata, 6 km up from FSC mill, boat difficulty during low tide, furthest point sampled
Site 2	Natokamu settlement, 1.8 km up from FSC mill site
Site 3	FSC mill site, pipes discharging cooling water into river
Site 4	River mouth, about 8.75 km downstream from FSC mill

Site No.	Time	pH	Clarity (m)	Diss. Oxygen (mg/L) (0 m)	Diss. Oxygen (mg/l) (5 m)	Temp. (°C) (0 m)	Temp. (°C) (5 m)	Salinity (ppt) (0 m)	Salinity (ppt) (5m)
1 - Bulileka/Urata	8.45 am	7.07 (0m)	0.2 (to bottom)	7.4	8.0 (0.2m)	25	25 (0.2m)	2	2
2 - Settlement	9.30 am	6.77 (0m) 6.96 (1m)	0.5	3.2	1.8 (2m) 10.0 (5m)	26.5	28.5	12	27
3 - FSC Mill Site	10.00 am	6.82 (0m) 6.86 (1m)	0.9	3.0	8.0 (5m)	30	30.5	20	20
4 - Estuary	10.25 am	8.01 (0m) 8.02 (1m)	1	8.0	10.0	26	26	18	28

TABLE 1. Analysis of Qawa River at Low Tide.

Sample Lab No.	Site 1 Low 95/1252	Site 2 Low 95/1253	Site 3 Low 95/1254	Site 4 Low 95/1255	Site 1 High 95/1256	Site 2 High 95/1257	Site 3 High 95/1258	Site 4 High 95/1259	Mill Discharge 95/1260
Alkalinity (mg CaCO3/L)	59.4	78.9	101.2	116.1	79.8	93.0	131.5	124.6	
Nitrate (N-NO3 µg/L)	65.1	<34	34	<34	<34	<34	<34	<34	<34
Ammonia (N-NH3 µg/L)	194	76	123	86	94	72	134	73	421
Orthosphosphate (µg/L)	24.2	<20	<20	<20	<20	<20	<20	<20	<20
Phosphorus, total (µg/L)	37.8	<20	<20	<20	<20	<20	<20	<20	<20
Iron (mg/L)	0.43	<0.3	<0.3	<0.3	0.46	<0.3	<0.3	<0.3	<0.3
Manganese (mg/L)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Copper (µg/L)	2.2	<2	<2	<2	<2	<2	2.1	5.0	4.4
Lead (µg/L)	<5	<5	5.4	<5	<5	<5	6.4	6.1	5.4
Zinc (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (µg/L)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total coliforms (/100 mL)	31,000	112,000	175,000	1,660	20,000	77,000	50,000	1,210	
Faecal coliforms (/100 mL)	6,500	1,960	4,600	34	1,640	2,700	18,000	3	
BOD (mg/L)	2.8	7.8	12.5	<2	3.9	6	11.5	2	38
Total dissolved solids (mg/L)	1,624	12,049	20,305	34,719	8,903	15,988	25,509	35,802	
Total suspended solids (mg/L)	7	42	83	16	16	12	50	148	

TABLE 3. Laboratory Analysis of Qawa River.

Site No.	Time	pH	Clarity (m)	Temp. (°C) (0 m)	Diss. Oxygen (mg/l) (5 m)	Salinity (ppt) (0 m)
1 - Bulileka/Urata	3.50 pm	6.72 (0m) 6.70 (1m)	0.5 (to bottom)	27.0 (0m) 27.0 (0.5m)	2.8 (0m) 1.8 (0.5m)	10 (0m) 10 (0.5m)
2 - Settlement	3.25 pm	6.72 (0m) 6.74 1m)	0.7	29.0 (0m) 29.0 (5m)	1.6 (0m) 10.6 (5m)	20 (0m) 27 (5m)
3 - FSC Mill Site	3.10 pm	6.93 (0m) 6.84 (1m)	0.8	31.0 (0m) 28.0 (5m)	2.2 (0m) 13.6 (5m)	22 (0m) 23 (5m)
4 - Estuary	2.40 pm	8.05 (0m) 8.18 (5M)	1	27.0 (0m) 27.5 (5m)	9.2 (0m) 14.0 (5m)	33 (0m) 33 (5m)

TABLE 2. Analysis of Qawa River at High Tide.

a) On-site, low tide results

Lowest tide was at 10.00 am. Sampling started at 8.45 am at Boubale/Urata, the most upstream site designated site 1. The last site (site 4) at the river mouth was sampled at 10.25 am.

pH, clarity, temperature

pH ranged from 6.77 to 8.02 with no significant difference between depths or sites.

Clarity of the water did not have much significance because the tide was low and the river was relatively shallow. Site 4 at the estuary had a higher clarity value than the other sites. The highest clarity of 1 m was recorded for site 4.

Water temperature varied between 25 and 30.5°C. The water near the FSC mill (site 2) was relatively warmer (30 - 30.5°C) than the other sites (**Fig. 1**). This was due to the cooling water being discharged from the mill into the river.

Salinity, dissolved oxygen

For open oceans in Fiji, salinity values usually range from 30-39 parts per thousand (ppt) with the average salinity of around 35 ppt. For Qawa River during ebb tide, salinity ranged from 2 ppt at site 1 and increasing downstream to 28 ppt (highest) for site 4 at 5m depth.

Surface water salinity (freshwater layer) was generally lower than salinity at 5m depth except near the FSC mill site where salinity remained at 20 ppt on the surface and at depth. With the ebbing tide, there appeared to be definite stratification with the fresh water overlaying more saline water from about 5m depth (**Fig. 2**).

Dissolved oxygen (DO) concentrations were very high at site 1 (7-8 mg/L) but decreased significantly at Natokamu settlement and near the sugar mill (**Fig. 3**). The surface DO values for these two sites were 3.2 and 3.0 mg/L respectively. The recommended dissolved oxygen (DO) levels for a healthy aquatic life in receiving waters are >6 mg/L but often values >4 mg/L are considered acceptable (CCREM, 1987). The surface waters near the mill at Natokamu settlement do not satisfy the requirements for healthy aquatic life. Further downstream at the estuary, surface DO concentrations again improved significantly to 8.0 mg/L. The DO at 5m depth for all sites remained high (saturation levels) between 8 to 10 mg/L.

b) On-site high tide results

Highest tide was at 4.08 pm. Sampling started at 2.40 pm at the river mouth (site 4) and continued upstream where site 1 was sampled at 3.50 pm.

pH, clarity, temperature

pH was similar to low tide results, ranging from 6.70 to 8.18. As in the earlier sampling, the estuary recorded the higher pH (8.05 and 8.18). The other three sites had very similar pH (6.70 - 6.93) regardless of depth of the water.

Clarity was also similar to the low tide results, the range being 0.5 m at site 1 to 1 m near the river mouth.

Water temperatures varied from 27.0 to 31.0°C. The surface water at the mill site was again slightly warmer at 31.0°C than the other sites. Otherwise temperature distribution was fairly even throughout the water column.

Salinity, dissolved oxygen

As expected, salinity increased for most parts of the river during sampling as sea water flowed into the river. The exceptions were the mill site and at Natokamu settlement at 5m depth where salinity remained constant. Salinity values varied from 10 ppt at site 1 to 33 ppt at site 4. For site 3 near the mill, salinity was 22 ppt (surface) and 23 ppt (5m depth), values which were not much different from the 20 ppt recorded during low tide. At Natokamu (site 2), 1.8 km upstream from the mill, salinity at 5m depth was the same during low and high tides. From these observation, it appears that the fresh water discharge from the mill is keeping the salinities constant at sites 2 and 3 throughout the tidal cycle.

Against the CCREM guidelines, the only site with acceptable DO concentrations was site 4 at the estuary where DO was 9.2 mg/L for the surface and 14.0 mg/L at 5m depth. The surface DO concentrations for the other three upstream sites were below life-sustaining levels : 2.8 mg/L for site 1, 1.6 mg/L for site 2 and 2.2 mg/L for the mill site. At 5m depth, DO levels had increased to saturation concentrations : 10.6 mg/L for site 2, and 13.6 mg/L for site 3 (mill site). Site 1 was still quite shallow (0.5m) at the time of sampling and no difference was observed in the DO levels.

c) Laboratory analysis results

Table 3 shows all the results of the laboratory analysis for both high tide and low tide samples.

i) Physical characteristics : Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and Alkalinity

Generally, the total dissolved solids (TDS) concentrations increased for all sites during incoming tide and as one moved towards the river mouth and the sea from site 1 to site 4. During low tide, TDS values varied from 1,624 (site 1) to 34,719 mg/L (site 4) and during high tide, TDS ranged from 8,903 (site 1) to 35,802 mg/L (site 4).

Total suspended solids (TSS) was highest (148 mg/L) for the estuary during flow tide. The only other high values were recorded for the mill site, 83 mg/L during low tide and 50 mg/L during high tide.

Alkalinity values varied from 59.4 mg $CaCO_3$/L (site 1, low tide) to 131.5 mg $CaCO_3$/L (site 3, high tide).

ii) Organic constituents : Biochemical Oxygen Demand (BOD)

The biological oxygen demand (BOD) values are higher for the mill site and nearby settlement (sites 2 and 3) than at the other two sites at Urata/Boubale and at the river mouth (**Fig.** 4). The BOD concentrations at Urata/Boubale upstream remained low at 2.8 mg/L (low tide) and 3.9 mg/L (high tide). Similarly near the river mouth, BOD concentrations were <2 mg/L at low tide and 2 mg/L at high tide. On the other hand BOD at sites 2 and 3 varied from 6 mg/L (Natokamu, high tide) to 12.5 mg/L (FSC mill site, low tide). The same distribution of BOD is observed during low and high tides. Interestingly, the wastewater (mostly cooling water) being discharged from the mill directly into the river has a significantly higher BOD of 38 mg/L than the receiving water. The increased BOD could be attributed to traces of sugar in the wastewater.

iii) Nutrients : Nitrates, Orthophosphates

The concentrations of nitrates and orthophosphates were all low during sampling at low tide and high tide. The mill cooling water was no different. With the exception of site 1 (Urata) at low tide, all the values of nitrates and phosphates were below detection limit for the IAS laboratory i.e. <34 ug/L N/NO_3 and <20 ug/L PO_4 respectively.

iv) Inorganic non-metallic constituents : Ammonia (NH_3) and Total Phosphorus (P)

The concentration of ammonia was similar for all sites, (72-94 ug/L N-NH3) except for site 1 during low tide (194 ug/L N-NH3) and for site 3 near the mill (123 and 134 ug/L N-NH3). The mill wastewater flowing from the pipe into the river had significantly higher ammonia concentration of 421 ug/L N-NH3.

Total phosphorus concentrations were low for all sites including the mill cooling water being discharged directly into the river.

v) Metals

With the exception of lead, all the other metals (iron, manganese, copper, zinc and cadmium) were generally very close to or below detection limits of the instrumentation at the IAS laboratory. Lead levels for the FSC mill wastewater and receiving water (site 3) were around 5 - 6 ug/L.

vi) Total coliform, faecal coliform

Total coliform counts were all high ranging from 1,210 colonies/100 mL at the river mouth at high tide, to 175,000 colonies/100 mL for the mill site at low tide. For each site, the total coliform concentrations decreased as the tide rose e.g. at the mill site, the total coliform counts decreased from 175,000 to 50,000 colonies/100 mL (Fig. 5). The sea water may have reduced coliform numbers by increasing dieoff from osmotic shock and ingestion by other organisms.

Faecal coliform counts were also very high ranging from 1,960 to 18,000 colonies/100 mL for all sites except for site 4 at the river mouth. At site 4, faecal coliform counts were very low at 34 colonies/100 mL during low tide, and 2 colonies/100 mL during high tide.

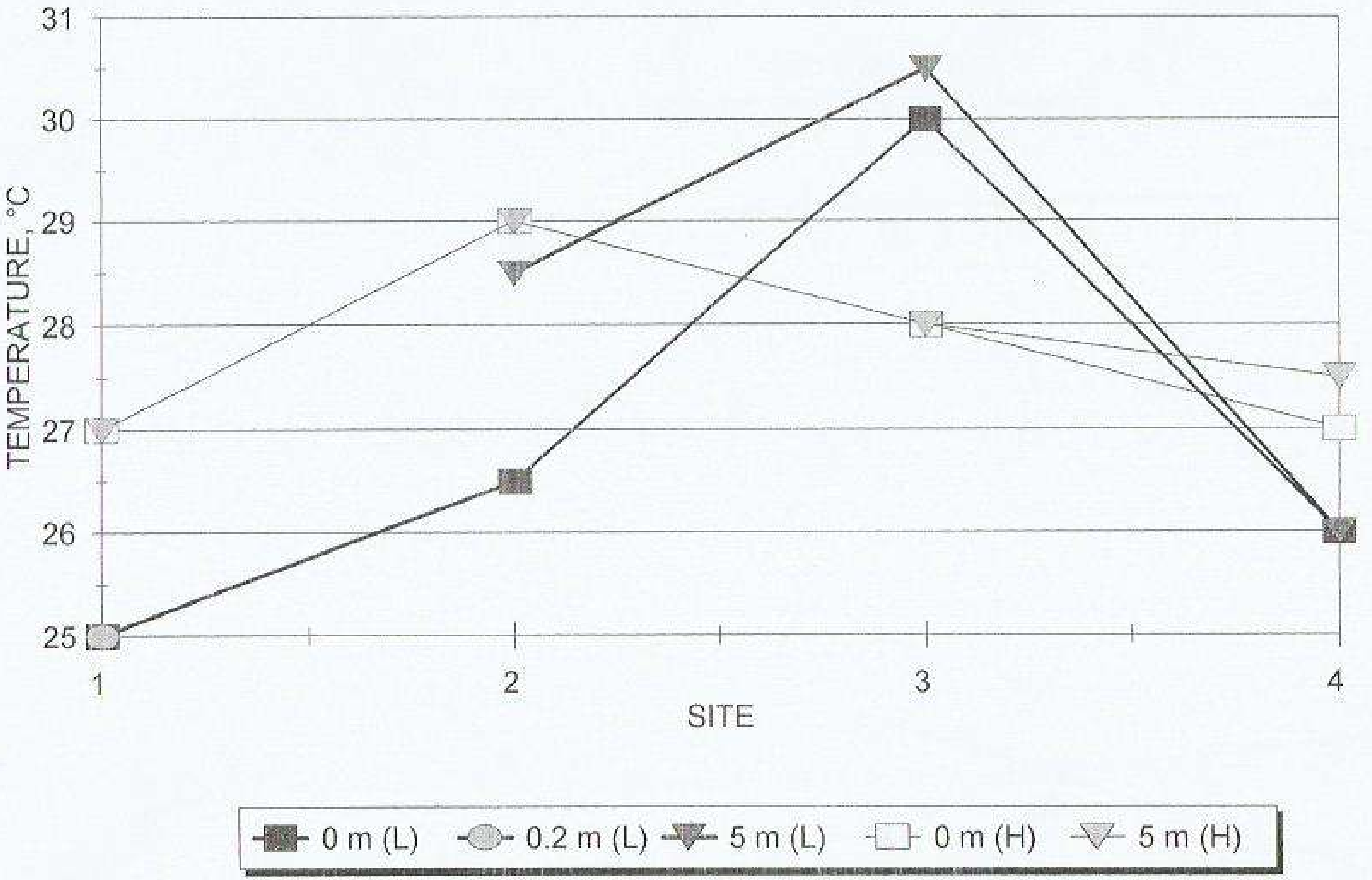

Figure 1. Temp. Along Qawa River
22nd August, 1995

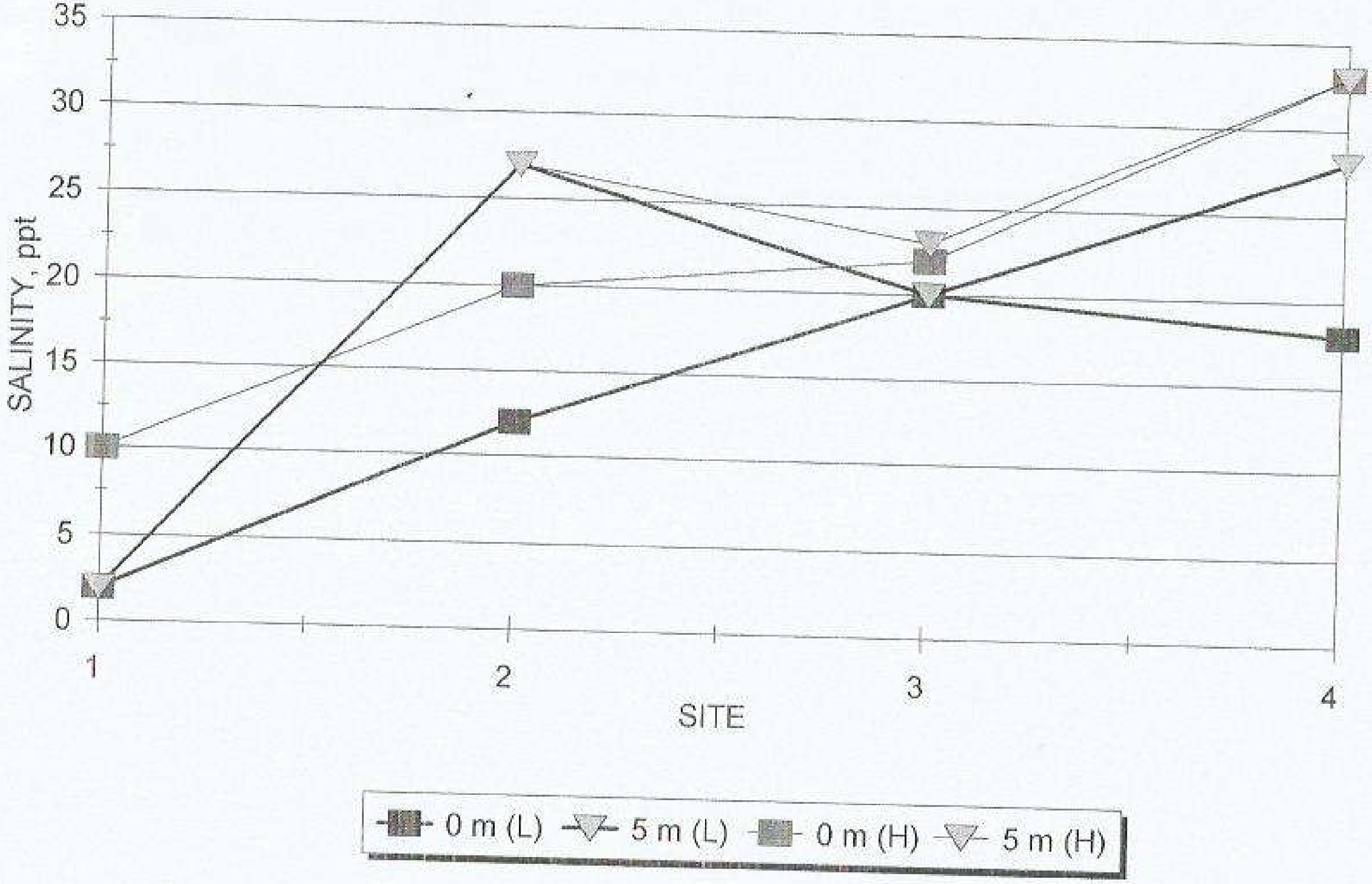

Figure 2. Salinity Along Qawa River
22nd August, 1995

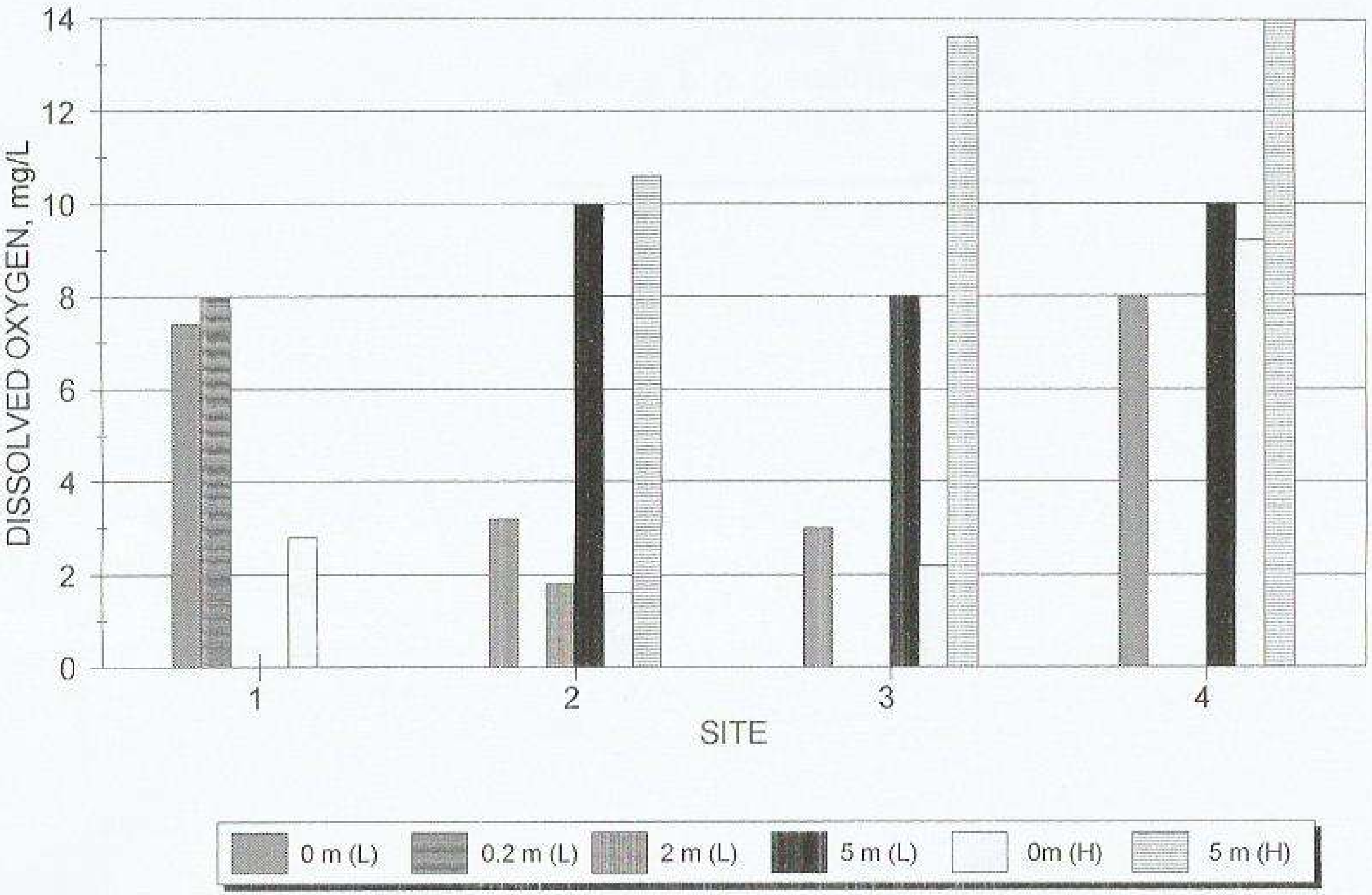

Figure 3. D . O. Along Qawa River
22nd August, 1995

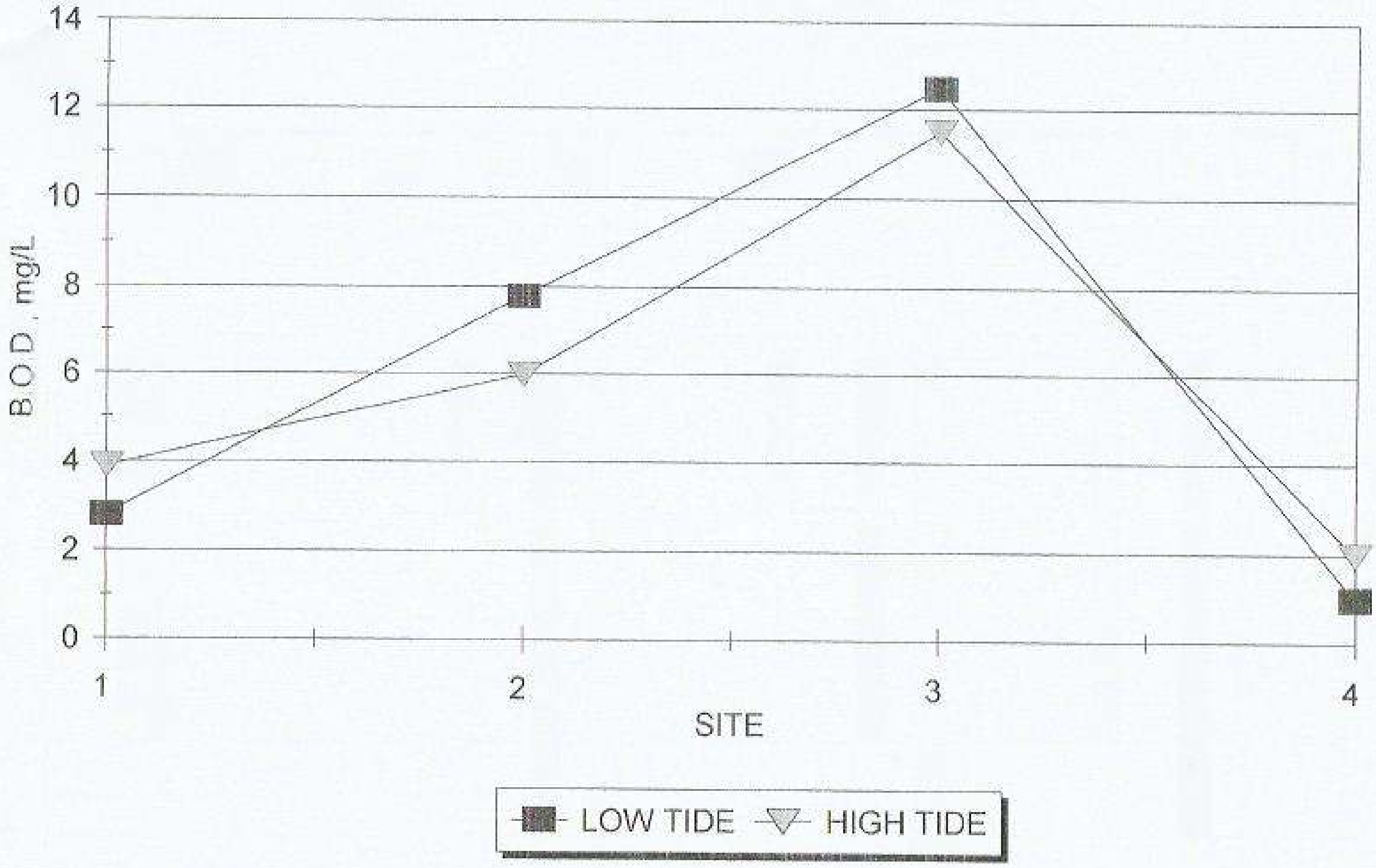

Figure 4. B. O. D. Along Qawa River
22nd August, 1995

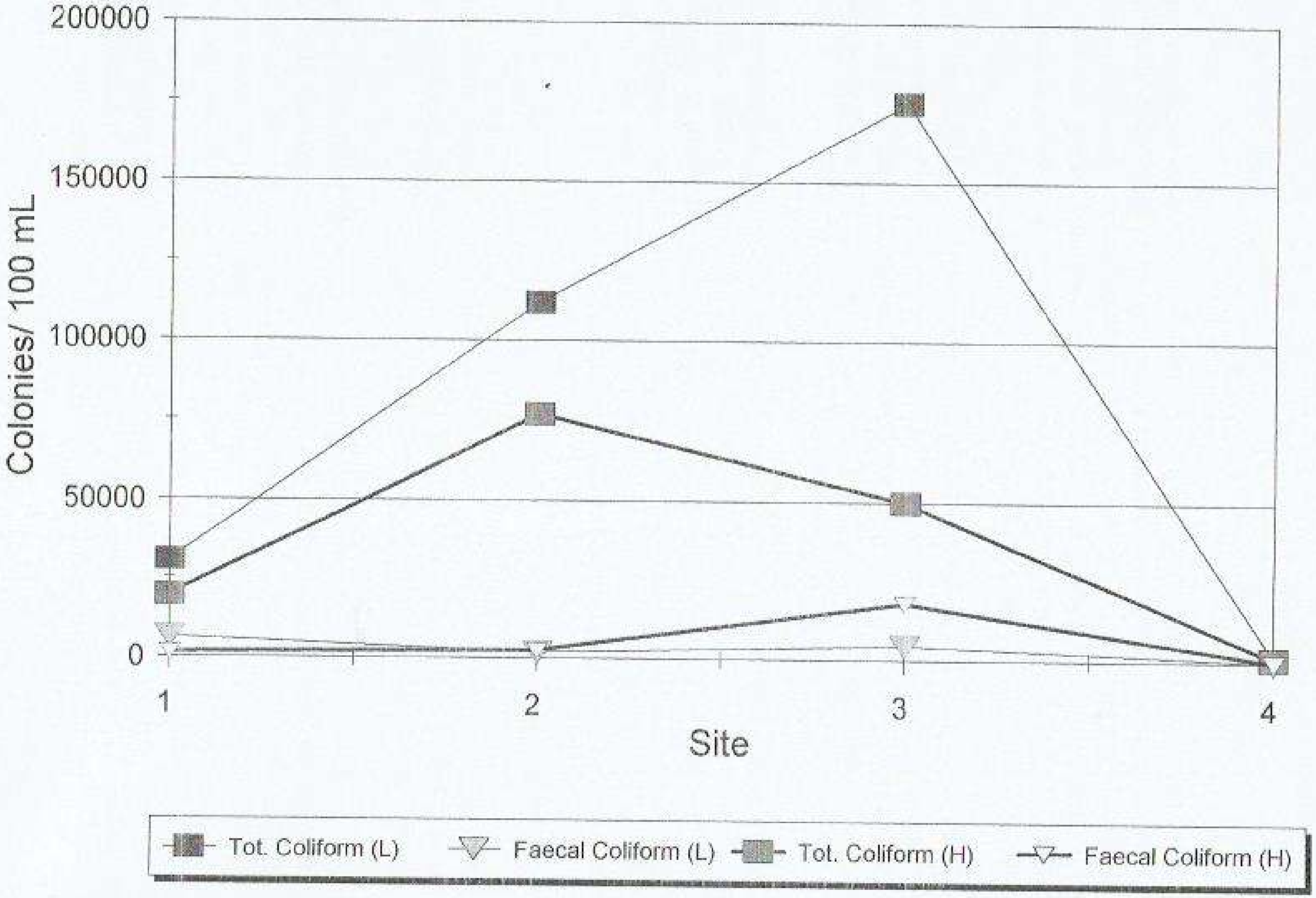

Fig.5.Tot.Col. and FC along Qawa River
22nd August, 1995

6. DISCUSSION

pH, clarity and water temperature

pH values measured for the Qawa river in the range 6 - 8 were as expected for any river. The higher pH of 8 at the estuary may be due to presence of alkaline materials derived from the sea such as calcium carbonates and bicarbonates. This pattern is supported by the distribution of alkalinity values along the river, the higher alkalinity values being near the sea and decreasing with distance from the estuary.

Generally, clarity is low for the landward sites but improves nearer the sea. The activities along the banks of the river such as sugar cane farming, grazing of cows and goats and clearing of land in the catchment areas contribute significantly to the sediment load in the river thus lowering the clarity of the river water to less than a meter in most places.

The water continually being discharged into the river from the sugar mill is several degrees warmer than the receiving water. The warm water affects aquatic life forms directly and indirectly through its effect on solubility of gases. Gases including oxygen which is essential for life in the water are less soluble in hot water. The higher water temperatures around the sugar mill could be responsible in part for the depleted DO concentrations at the site.

Salinity, dissolved oxygen

The relatively constant salinity values for sites 2 and 3 indicated that the volume of cooling fresh water being added from the mill is sufficient to keep the salinities constant at these sites throughout the tidal cycle.

The distribution of salinity values during low and high tides indicated that while there appeared to be definite stratification (fresh water/saline water) during outgoing tide, this layer disappears as tide flows in, pushing the low DO surface waters (laden with organic material) as far upstream as Boubale and Urata (site 1) and possibly even further inland along the other river (Namoli river) which branches off the Qawa River. From this observation it is clear that during dry periods when fresh water flow is low, the pollutants (high BOD material) is carried back upstream by the incoming tide. This explains why the discoloured water and stench can be observed for several kilometres upstream from the sugar mill.

The very low DO levels observed for the surface waters around the sugar mill throughout the tidal cycle indicated that the mill could well be responsible for pollution of the Qawa River. The observed DO levels were below that normally required for aquatic life (CCREM, 19874; Clark, 1986). Further measurements during the period when the mill is not functioning will enable a more accurate evaluation of the effect of mill discharge on the acquatic life. From the observed low DO in the upper parts of the river during high tide, it can be assumed that the tide actually carries this pollution upstream for several kilometres. Whether this happens all the time can only be confirmed if measurements are also done during the non-funtioning period for the sugar mill.

Total Dissolved Solids (TDS), Total Suspended Solid (TSS), Alkalinity

The sea is the main source of TDS and TSS. The pattern in the distribution of TDS and TSS are therefore expected for any tidal river, in the absence of any other significant source of TDS and TSS. During high tide the upstream sites are affected as well. The FSC mill does not appear to be an important source of TDS and TSS for the Qawa River except during low tide.

The values for alkalinity correspond to the results obtained for solids. Similarly, alkalinity values increased for each site as tide rose. The seawater provided the major source of the alkaline material, particularly the carbonates and bicarbonates.

Organic constituents : Biochemical Oxygen Demand (BOD)

The typical BOD concentrations for unpolluted river water is <2 mg/L, that of polluted water being between 5 - 10 mg/L and values above 10 mg/L indicating gross pollution (Clark, 1986). Using these guidelines, the only unpolluted sites from this survey are the estuary (site 4) and the most upstream site at Urata/Boubale (site 1). The FSC mill site and Natokamu settlement in between are definitely polluted, and the cooling water discharged from the mill is also grossly polluted, according to the guidelines in Clark (1986).

Nutrients : Nitrates, Orthophosphates

For the Qawa River, the survey showed that the nutrients were all low and were not causing any pollution. However, the single assessment would not give the accurate picture of the situation and only repeat surveys can confirm these findings.

Inorganic non-metallic constituents : Ammonia (NH3), Total Phosphorus (P).

Ammonia level was significantly higher in the mill cooling water than in any of the other receiving water sites, but all the values were within the CCREM recommended concentration for receiving waters which is <730 ug/L (CCREM, 1987).

Total phosphorus concentrations were low for all samples, including the mill cooling water.

Metals

None of the metals showed any real reason for concern for the Qawa River from the one survey carried out. The values were all low, just as was found for the Ba River during the study on impact of the Rarawai sugar mill on the Ba river (Tamata and Lloyd, 1994).

Total coliform, faecal coliform

The very high total and faecal coliform counts at sites 1 - 3 indicated presence of sewage pollution in the Qawa river. This is not surprising since the settlements and residents along the river do not have proper sanitary disposal methods in place. Other sources of coliform bacteria in the river include livestock tied up on the river banks, and birds.

Assessed against the World Health Organisation standards for faecal coliform counts in bathing waters (<350 colonies/100 mL), and the USEPA standard of <200 colonies/100 mL, the only site that satisfies the requirements for bathing or recreational water was site 4 at the river mouth. All the other landward sites did not meet the requirement for bathing or recreational waters. It is reasonable to assume that the FSC mill may not be the only culprit causing the problems for bathers in the Qawa River. The unacceptable faecal coliform levels may well be indicative of other microorganisms that cause the skin diseases, ear and eye infections that people have complained about from bathing in the river.

7. RECOMMENDATIONS

1. That the Qawa River sites be assessed again when the FSC mill is **not** operating, i.e. during the non-crushing season from January to June, 1996. This would enable comparison of results and ascertain whether the FSC mill is polluting the Qawa River.

2. That the Labasa river be sampled and assessed at equivalent points for comparison with the Qawa River. This would help determine theflow regime in the two rivers particularly from the point of contact at Cawa-i-ra and perhaps explain why fish kills have been reported on the Labasa river recently.

3. That an investigation be carried out as to why the Labasa sugar mill has a bagasse management problem (piled up on the river bank) whereas the other sugar mills, for example, the Rarawai mill at Ba does not seem to have the same problem.

4. Direct measurements of the parameters be conducted on all the FSC outflows.

5. Attention should be drawn to the local authority on the influence that human and animal effluent have on the water quality of the river.

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ACKNOWLEDGMENT

The public outrage and concern regarding the deteriorating state of the Qawa River in Labasa prompted us at the Institute of Applied Sciences (IAS) at the University of the South Pacific (USP) to seek financial support to carry out a study of the Qawa River water quality. The study was made possible with the financial support from the University of the South Pacific Research Committee, and this assistance is acknowledged with much gratitude.

During the study, we were very well received and assisted in various ways by the staff of the District Administration at Labasa. The Commissioner Northern, Mr Mataiasi Lomaloma personally instructed the staff under his supervision to assist us in whatever way they could. The District Officer Northern, Mr Gordon Leewai arranged for us to meet the Roko Tui Macuata and other local residents who were directly affected by the pollution in the Qawa River. He also accompanied us to meet with the Fiji Sugar Corporation Management at the sugar mill. Without Mr Leewai's help, our task would have been very difficult.

The Management of the Labasa sugar mill, in particular the Factory Manager Mr Emosi Cagi gave up his time to explain the operation of the mill to us, even though we did not arrange to meet him beforehand. The Fisheries Department officers, in particular Mr Indar Raj were most helpful in explaining the problems with reported fish kills in the area.

Mr Satya Singh of Shell Company arranged for a boat for our use and Mr Freddy Miller also of Shell piloted the boat for us. Their help is gratefully acknowledged here.

Since conducting the study, the media including Fiji TV1, the Fiji Times and the Daily Post have all used our results in their reports on the Qawa River situation. In this way we feel that the main objective of the study has been achieved in that we have provided scientific data on the situation for the public information as well as the authorities. This would not have been possible had the study been commissioned by a client. Research such as these would go a long way in promoting better interaction between the USP and the community. For this, the support of the URC is once again acknowledged with deep appreciation.