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Impact of residential development on Laucala Bay and Suva Harbour

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IMPACT OF RESIDENTIAL DEVELOPMENT ON LAUCALA BAY AND SUVA HARBOUR

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A. INTRODUCTION

This is a preliminary report of a long term environmental study of Laucala Bay and Suva Harbour. It is presented as a background paper to the discussion of Biogas as a potential energy resource. In this context, the presentation and discussion is not comprehensive to the general title. Most of the results refer to the period September 1977 to January 1978, with comparative figures being available from 1976 and 1975.

B. METHOD

Water samples were collected from a large number of sites in Laucala Bay and Suva Harbour. In general, samples were collected twice weekly at up to twelve points at any one time. Environmental parameters which changed rapidly on removal from the bulk water were analysed immediately, other parameters within twelve hours. The methods used are those outlined in "Standard Methods for the Examination of Water and Waste Water". (American Public Health Association) and "A Practical Handbook of Seawater Analysis (J.DOH. Strickland and T.R. Parsons, 1972).

The range of values is presented in Tables I-IV. In most cases the data represents a range of tidal conditions. Within the sampling period, the variation of weather conditions associated with samples from any one site is limited. The range of values presented in the Tables are representative only of conditions over the sampling period and not the maximum range possible.

C. DISCUSSION

The major impact of residential development upon natural water systems is through the increased sediment and nutrient imput. The increased sediment loading arises from removal of vegetation covering and disturbance of the top soil. In general, it is very severe in the initial development stage, decreasing as the land is re-compacted. The effect of sediment is to physically cover biological organisms and to change the physical nature of the strata. Further stress is placed on biological communities by the variation of light penetration due to increased sedimentation. Certain types of sediments can also cause gross changes of chemical species in the water system. Sulphur containing mineral sediments generally lead to increased acidity in natural water systems.

Within the very limited study of suspended sediments in Laucala Bay and Suva Harbour, the major imput would appear to be associated with flood conditions of the major rivers. Increased sediment concentration from residential development does not appear to be significant.

The major long term impact of residential development is from increased nutrient imput from the disposal of human sewage. In a stable ecological system, the mutual interaction between the activities of producer and consumer organisms, between photosynthesis and respiration, will ensure the concentration of oxygen and nutrients in the water remains constant. Productivity in a natural water system is primarily dependent upon that of the algal micro-organisms. The requirements for growth are a supply of carbon, nitrogen and phosphorus in the appropriate ratio of 106 + 16 + 1 and energy. In surface waters, energy is rarely a limiting factor, so that a small increase in nutrient imput results in an increase in photosynthetic production. This in turn is followed by an increase in heterotrophic respiration which returns the organic cell material to carbon dioxide. While the overall chemical balance of the water system is maintained, the total productivity will increase and the relative abundance of species will vary.

Large increases in nutrient concentrations will result in a large increase in photosynthetic production. In theory, the resultant large increase in heterotrophic respiration will maintain the chemical balance in the water system. However, the greatly increased productivity will introduce changes in relative species abundance. A much more significant factor is that the highly productive system is unstable. Small physical variations reduce the viability of the high concentration of algal biomass. Subsequent microbial degradation of this biomass introduces gross chemical changes in the water system. The most significant is the almost total removal of dissolved oxygen required for the survival of higher organisms. These organisms cannot respond to rapid fluctuations and disappear from the system. The ecology is dominated by algal "blooms" and organisms which survive the subsequent anaerobic conditions.

Concentrations of dissolved nitrogen and phosphorus measured in this study are 10 - 1000 fold less than those determined in eutrophic lakes in the United States. Eutrophic conditions are unlikely to develop in the outher areas of Laucala Bay or Suva Harbour in the immediate future. It may be noted that optimum dissolved nitrogen concentrations for the growth of selected alga species have been measured as 1-2 micro-moles per litre. In most of Laucala Bay and Suva Harbour, dissolved nitrate and phosphate are limiting factors to primary production and increased sewage input will increase primary production.

The other role of natural water systems for the disposal of human sewage is to reduce the concentration of pathogenic bacteria to insignificant levels. Determination of pathogenic bacteria requires specialized medical microbiological laboratory. Bacteria of the Bacillus coli group are normal inhabitants of the intestinal tract of warm-blooded animals. Under normal conditions they do not multiply outside of the animal body. The presence of such bacteria in water may accordingly be considered evidence that the water has been polluted with the intestinal discharge of a higher animal. The number of such bacteria present is a fair index of the degree of this pollution. As almost all disease vectors which are commonly transmitted through water supplies (such as cholera and typhoid) are discharged from the intestines of infected persons, the presence of coliform bacteria is used universally as a measure of the potential presence of pathogenic bacteria.

Generally accepted health standards for drinking water are a coliform determination of less than one per 100 ml. The test however is a statistical one and an alternate presentation is that less than 10% of 10 ml samples should yield a positive test for coliform bacteria. Whereas it may be argued that some coliform bacteria may not be of fecal orginal, the present standard is readily achieved in a soundly operated modern water supply system.

Whereas coliform standards for drinking water are generally accepted, those for water associated with shellfishing, swimming, food production, and irrigation are not. The use of coliform bacteria as a water quality criteria in these cases is open to debate. The United States Public Health Service Manual of Recommended Pracitce for Shellfish defines approved waters as those having an average coliform most probable number of less than 70 per 100 ml. Prohibited waters are those having coliform MPM greater than 700 per 100 ml.

Most illness connected with swimming is polluted waters are associated with eye, ear, nose and throat ailments. The use of coliform bacteria as a quality criteria is thus further open to question. However, various authorities in the United States have recommended average values not to exceed 1000 per 100 ml, with values above 1000 per 100 ml indicating the water is unsuitable for bathing purposes. Similarly, mean values for coliform bacteria of less than 5000 per 100 ml are recommended for water used in irrigation, although individual values may exceed this limit.

From Tables I and II it may be seen that most waters of Laucala Bay and Suva Harbour meet recommended coliform recreation standards. However, onshore areas generally in vicinity of the entry of rivers and creeks are not within the standards accepted by some authorities.

CONCLUSION

Residential development does not appear to be contributing a significant pollution factor to outer waters of Laucala Bay and Suva Harbour. All natural water courses surveyed as part of this study show significant microbiological and nutrient contamination, probably from septic tank run-off. The results of this study will suggest that total septic tank run-off is a more significant factor as a contribution to total microbiological and nutrient pollution than the concentrated sewage discharge points. It may be noted that coliform bacteria and nutrient concentrations are as great above the Raiwaqa sewage outlet on the Vatuwaqa River as those downstream at the Fletcher Road Bridge, whereas average values in Nubukalou Creek were in excess of both of these points.

TABLE I

COLIFORM BACTERIA COUNT

Most Probable Number (MPN) per 100 ml

LAUCALA BAY	MPN / 100 ml
Outer reef front	0 - 1
Inner reef front	0 - 10
Middle waters	0 - 100
Within 50 m shore	10 - 5000
50 m Kinoya effluent outlet	10 - 1000
Vatuwaqa River mouth	1000 - 100,000
Vatuwaqa River - above	
Raiwaqa effluent outlet	100,000 - 1,000,000
Muanivatu drainage outlet	greater than 1,000,000

TABLE II

COLIFORM BACTERIA COUNT

Most Probable Number (MPN) per 100 ml

SUVA HARBOUR	MPN / 100 ml
Outer reef front	0 - 1
Inner reef front	0 - 30
Middle waters	10 - 1000
Stinson Parade Landing	150 - 1000
50 m sewage discharge	1000 - 12,000
Nubukalou Creek-mouth	10,000 - 100,000
Nubukalou Creek - Greig Street footbridge	10,000 - 1,000,000
Lami River - mouth	1000 - 10,000
Navesi River mouth	100 - 800
Tamavua River - mouth	2,000 - 12,000

TABLE III

NUTRIENTS

NITRATE, TOTAL AMMONIA AND PHOSPHATE (SOLUBLE INORGANIC)

LAUCALA BAY	NITRATE	TOTAL AMMONIA	PHOSPHATE
	micromoles	per litre	
Outer reef front	0.05-0.1	0 - 0.1	0 - 0.05
Inner reef front	0.05-0.2	0 - 0.2	0 - 1.0
Middle waters	0.1 -0.3	0 - 0.5	0.05 - 0.2
Within 50 m shore	0.1-1.0	0.1 - 2.1	0.05 - 0.3
50 m from Kinoya effluent outlet	0.2-5.0	0.1 - 0.9	0.1 - 1.0
Vatuwaqa River - mouth	1.0-35.0	6 - 45	0.3 - 3.3
Vatuwaqa River - above Raiwaqa effluent outlet	40-57	36 - 50	2.1 - 3.4
Muanivatu drainage outlet	25	700	90

TABLE IV

NUTRIENTS

NITRATE, TOTAL AMMONIA AND PHOSPHATE (SOLUBLE INORGANIC)

SUVA HARBOUR	NITRATE	TOTAL AMMONIA	PHOSPHATE
	micromoles	per litre	
Outer reef front	0.1 - 0.2	0 - 0.1	0 - 0.5
Inner reef front	0.1 - 0.2	0 - 0.2	0 - 0.1
Middle waters	0.1 - 0.2	0.1 - 1.3	0.05 - 0.2
Stinson Parade Landing	0.3 - 5.0	0.1 - 1.2	0.05 - 0.2
50 m from sewage discharge	0.1 - 0.5	0.3 - 0.9	0.15 - 0.3
Nubukalou Creek - mouth	8 - 20	5 - 12	1.7 - 2.5
Nubukalou Creek - Greig Street footbridge	90 - 150	34 - 85	4 - 11
Lami River - mouth	0.1 - 2.0	0.6 - 2.0	0.1 - 0.4
Navesi River - mouth	0.2 - 0.7	0.2 - 0.7	0.1 - 0.2
Tamavua River - mouth	0.2 - 0.9	0.5 - 1.9	0.1 - 0.3