LAND-BASED POLLUTANTS INVENTORY FOR THE SOUTH PACIFIC REGION

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TABLE OF CONTENT

PART I

LIST OF TABLES

LIST OF FIGURES

PART I

1.0 INTRODUCTION

Land-based sources of marine pollution have long been recognized as a major problem throughout the world. The United Nations Conference on the Environment (UNCED) Agenda 21 includes agreements on the prevention of land based sources of marine pollution. The coastal areas of the world are among the most intensely used which has resulted in the physical degradation as well as the pollution of coastal and near shore areas. With the exception of Papua New Guinea, all land in the Pacific Islands Region lies within the standard definitions of the coastal zone. Hence, land-based marine pollution is especially critical to this region.

In earlier times the waste produced on land was primarily degradable and easily absorbed by the sheer vastness of the sea. Recently, changing land use patterns, increasing populations, industrialization, and land-based pollutants threaten the marine environment.

Studies over the last several years have documented increased degradation of the marine environment in the South Pacific Region (Brodie and Morrison, 1984; Baines and Morrison, 1990: Naidu et al, 1990). Sediment, freshwater, nutrients, and increasing quantities of organic and inorganic chemicals are degrading the coastal environment. Agriculture, industry, domestic sanitation, and commercial activities all contribute substances, or pollutants, to the marine environment.

Marine water quality degradation affects public health, ecosystems, and the economy (UNEP, 1991).

The following serve as examples of the impacts on public health that have been studied and reported in innumerable studies throughout the world:

- bathers (skin rashes and diseases, infectious diseases, gastroenteritis, ear and eye infections),
- consumption of microbial contaminated aquatic organisms, particularly filter feeders (infectious diseases, gastroenteritis),
- consumption of toxic substances (organ-specific and systemic effects depending on the substance).

The following studies identify some examples of the impacts on ecological systems:

- TBT in Suva Harbour. (Morrison, 1992)
- Eutrophication in Port Vila Lagoons. (Naidu et al., 1991)

Impacts to the economy can be demonstrated with the following examples:

- Reduction in tourism as a result of poor environmental conditions,

- Destruction or misallocation of marine resources (e.g., lack of reef fish to support subsistence fishing).

Many of the region's countries and territories have or are in the process of preparing environmental management plans (Stewart, personal communication 1992). These plans address a wide range of issues, including threats to the marine environment and strategies designed to properly manage marine resources.

The major sources of land-based pollution vary from country to country, depending on the nature and intensity of specific activities. (UNEP, 1991). The objective and purpose of this study is to inventory land-based sources of marine pollution in the South Pacific region and identify the differences and similarities of land-based sources for the region's countries and territories. It also briefly examines the current waste management strategies and makes recommendations for improvements, including actions to improve quantification of waste flows.

2.0 STUDY METHODS

The conduct of this survey and the study of land-based pollution sources was primarily based on the procedures published by the World Health Organization (WHO), entitled, Rapid Assessment of Sources of Air, Water, and Land Pollution (WHO, 1982) and the follow-up publication entitled, Management and Control of the Environment (WHO, 1989). Although this procedure includes the discharge of all (total) wastes, this study focuses on wastes discharged into the marine environment. While almost all activities in an insular environment affect the marine water, not all activities could be incorporated into this study. The selection of significant activities is discussed in greater detail in appropriate sections. The WHO procedure involves the following steps:

- Identification of significant pollution generating activities,
- Collection of appropriate data on the production or output data for the identified activities,
- Utilization of applicable waste or pollution factors found included in the WHO procedure for the various activities based upon their UN classification of Industries and Services Code (United Nations, 1968) to calculate pollution and waste loads.

Some modifications and additional methods were incorporated into the study where this procedure was not appropriate or could not be utilized due to the lack of data. In addition to the tasks included in the WHO procedure, this study conducted other activities to inventory land-based pollutant sources. These activities included the following tasks:

- review of existing studies on pollutant sources in the region,
- review of existing studies on marine water quality to determine areas with degraded water quality and identify possible causes for the degradation,
- identify and use any other available quantitative data on pollutant loadings,
- incorporate river inputs from concurrent SPREP-POL project.

These tasks, conducted simultaneously with the first two steps in the WHO procedure, provide both quantitative and qualitative data. Quantitative data from sources or methods other than the WHO method are labeled as such in the appropriate sections of this report.

After calculation of the waste loads from individual facilities and activities the data was summarized to obtain an overall estimate for the total waste loads. The principal sources for each of the major pollutants are identified. This information along with a review of existing waste management practices provided the basis for recommendations to reduce pollutant loadings.

The most important part of this procedure is the acquisition and use of reasonable production figures. This, unfortunately, is the information that is most lacking in the Pacific region. As such it was very difficult to apply this procedure at each location or facility. For activities with no production data qualitative information and/or gross estimates are provided.

The following sections provide a more detailed description of the methods used in completing each of the steps identified above.

2.1 Identification of Significant Pollution Generating Activities and Collection of Appropriate Data on Production and/or Output of the Activities

The study concentrated on permanent activities and waste sources most likely to enter the marine environment. Previous studies have identified construction activities, including dredge and fill activities, as major contributors to the reef and marine water quality degradation (Fuavao et al. 1990; Baines and Morrison, 1990, Morrison, 1990). These activities have long-term impacts but are not considered in this study because they are not truly permanent activities. The study primarily addresses liquid and solid wastes discharged into the marine environment, including wetlands. Discharges to rivers and storm drains discharging to the marine environment were also included. Exceptions to the inclusion of discharges to rivers were made for wastes not expected to impact marine waters. Most notable of these are inland discharges in Papua New Guinea and sewage discharges sufficiently inland to allow natural degradation of wastes to occur. Professional judgement was necessary to determine which sources to exclude or include. In some cases, pollutant loads from land treatment of wastewater reaching the marine waters were estimated using knowledge of the typical treatment efficiency. Standard values for transmittal of these pollutants to the marine environment were used. Section 3.0 presents these assumptions and working tables used to calculate pollutant loadings.

Previous studies have also indicated that on a worldwide basis air contaminant inputs to the marine environment make up a significant contribution to marine pollutant loadings (GESAMP, 1990a, 1990b). Regional studies have found air contributions to be minimal for the South Pacific Region (Morrison, 1992a). This in conjunction with the limited data available to calculate air emissions led to the exclusion of air emissions from this inventory. This study noted major air emission sources.

The identification of significant pollution sources and the collection of production and output data for these sources was obtained by one or more of three principal methods:

1. Bibliographic/Library Searches

Searches were made of the collections at the University of the South Pacific (USP) Library, Institute of Applied Science Library, Institute of Natural Resources (INR), School of Applied Science Library, SPREP Library, East-West Center Library, and the University of Hawaii's Hamilton Library (Government Documents and Pacific Islands Collections). In addition the consultant examined files of the U.S. EPA for National Pollution Discharge Elimination System permits for the present and former

American Flag Territories (Palau, Republic of the Marshall Islands (RMI), Federated States of Micronesia (FSM), Guam, Commonwealth of the Northern Marianas Islands (CMNI), and American Samoa). Included under bibliographic/library searches are interviews with regional professionals familiar with the environmental and waste management issues of the region and/or their respective sub-region.

2. Site Visits

The consultant, Ms. Nancy S. Convard, visited Fiji, Western Samoa, Tonga, Solomon Islands, Vanuatu, and American Samoa. She also met with representatives of Palau, FSM, RMI, and CMNI in Kauai, Hawaii. These visits included interviews with a number of government officials, manufacturing facility managers, agriculture facility personnel, and others knowledgeable about environmental issues in the region. The visits also allowed for field trips to potential waste generating activities and observation of waste management practices.

The SPREP Focal Point, or his representative, arranged meetings with appropriate government officials in each country. In most countries the consultant met with, or obtained data from, the following departments:

- Ministry of Natural Resources,
- Ministry of Industry,
- National Development and Planning Offices,
- Ministry of Health,
- Ministry of Agriculture,
- Local Health Departments,
- Department of the Environment,
- Water and Water Pollution Control Authorities,
- Meteorological Service,
- National Statistics Office.

A list of the individuals contacted is included in Appendix A.

3. Summary Data Sheets/Surveys

Utilizing information obtained from bibliographic/library searches and interviews with knowledgeable regional professionals, the consultant prepared draft summary data sheets for each country. Summary data sheets for each country not visited were sent via facsimile and/or regular mail to SPREP Focal Points for review. The Focal Points were asked to assess the accuracy of information on the summary sheets and provide any missing data. If no response was received the data was assumed to be correct for the purposes of this report. The summary data sheets are included in

Appendix C. Summary data sheets for visited countries along with a country-specific draft report will be forwarded to all countries concurrent with the draft report submittal to SPREP.

2.2 Utilize Applicable Waste or Pollution Factors to Calculate Pollution and Waste Loads

The WHO procedure, Management and Control of the Environment (WHO, 1989) provides factors for industrial production and output on the basis of their U.N Classification of Industries and Services Code (U.N. 1968). In some cases the factors allow for different production processes and wastewater treatment processes that may be provided the effluent. Waste load factors vary from plant to plant and are significant in some places. The WHO methods are used when possible to provide average values. This method produces accurate estimates of total plant loading from several similar plants although individual plant loading estimates may not be accurate. In the Pacific Island Region there are few locales in which more than one facility produces the same product. The predicted waste loads are still the best estimate available at this time. Figure 2.1 is an example of the worksheets used for the calculation of waste loads.

Table 2.1 presents a list of industries, their Standard Industrial Code (SIC) numbers, and the availability of waste loading factors, as included in the WHO procedure. The table also indicates if these industries are found in the region. Actual flow and effluent data were used whenever possible, particularly in municipal wastewater facilities in present and former U.S. territories.

For many of the facilities in the region, no production data is available. Production data is only available for the larger facilities. The data for the larger facilities is usually provided in terms of monetary value rather than units produced. In these cases the calculation of waste loads was not possible. Working tables that list all industries and their identification for each country were prepared. These tables facilitate the rapid calculations of waste loads should production data become available.

In some cases, actual flow and effluent quality data were available. In these cases actual data rather than calculated data were used.

When data was not available, import data for certain chemicals was used. Although not precise, the knowledge that waste loads are between some minimal level, e.g., zero kilograms (kg); and the imported quantity, is a better approximation than no approximation at all.

Figure 2.1

SAMPLE WORKING TABLE FOR THE CALCULATION OF POLLUTANT LOADINGS

Area: COOK ISLANDS Year Prepared: 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3units	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			Comments
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3113	Canning and Preserving of Fruits and Vege-tables	Fac (1)				0		0		0		0		0			0			0	
	Dried Fruit	tonnes		Yes	12.4	0	1.9	0		0		0		0			0			0	
	Pineapple	tonnes		Yes	10.3	0	2.7	0		0		0		0			0			0	
Treatment	Settling or Floatation				0.3	0	0.75	0		0		0		0			0			0	If Used
3131	Distillery, Rect-ifying, and Blending Spirits	Fac (1)				0		0		0		0		0			0			0	
	Grain Distillery	tn anhyd. alcohol		Yes	216	0	257	0		0		0		0			0			0	
		tonnes grain		Yes	3.2	0	2.8	0		0		0		0			0			0	
Treatment	Aerated Lagoon				0.043	0	0.077	0		0		0		0			0			0	If Used
3210	Manufacture of Textiles	Fac (3)		?		0		0		0		0		0			0			0	
3420	Printing and Publishing and Allied Indust.	Fac (1)		?		0		0.		0		0		0			0			0	No WHO Data for Water
4101	Electricity Light (2) and Power			?		0		0		0		0		0			0			0	

Assumptions: 1) Fruit canning operations included drying fruit.
2) Distillery is grain distillery

(1) - Feedlots represent livestock populaitons - waste loading factors require adjustment.

(2) - Industries listed in classification code are assumed to occur in the Cook Islands.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Small Fishing Operations
Ship Building and Repairing
Petroleum Storage

Table 2.1

List of Industries and Classification Code and Reference to Air, Water and Solid Waste Working Tables Found in Management and Control of the Environment (WHO, 1986).

In Region			Air	Water	Solid Waste
	0000	Miscellaneous processes	*		
Y	1110	Agricultural and Livestock Production	*	*	*
	1210	Forestry	*		
	2100	Coal Mining	*		*
	2200	Crude petroleum and natural gas production	*		
	2301	Iron ore mining			*
	2302	Non-ferous ore mining	*		*
	2901	Stone quarrying, clay and sand pits	*		*
	2902	Chemical and fertilizer mineral mining	*		*
	2909	Mining and quarry not elsewhere classified			*
	3111	Slaughtering, preparing and preserving meat	*	*	*
Y	3112	Manufacturing of dairy products		*	
Y	3113	Canning and preserving of fruits and vegetables		*	*
Y	3114	Canning, preserving and processing of fish, crustacea and similar foods	*	*	*
Y	3115	Manufacture of vegetable and animal oils and fats		*	*
	3116	Grain mill products	*	*	
	3117	Manufacture of bakery products		*	
Y	3118	Sugar factories and refineries		*	*
Y	3121	Manufacture of food products not elsewhere classified	*	*	*
	3122	Alfalfa dehydrating	*		
Y	3131	Distilling, rectifying and blending spirits		*	*
	3132	Wine industries		*	*
Y	3133	Malt liquors and malt beer	*	*	*
Y	3134	Soft drinks		*	
Y	3210	Manufacture of textiles		*	
	3211	Spinning, weaving and finishing textiles	*		*
	3214	Carpet and rug manufacturing			*
	3231	Tanneries and leather finishing		*	*
	3411	Manufacture of pulp, paper and paperboard	*	*	*
	3420	Printing and publishing and allied industries	*		
	3511	Manufacture of basic industrial chemicals except fertilizer	*	*	*
Y	3512	Manufacture fertilizers and pesticides	*	*	
	3513	Manufacture of synthetic resins, plastic materials and man-made fibers, except glass	*	*	
	3521	Manufacture of paints, varnishes and lacquers	*	*	*
	3522	Manufacture of drugs and medicines		*	*
Y	3523	Manufacture of soap and cleaning preparations	*	*	
	3529	Manufacture of chemical products not elsewhere classified	*	*	
	3530	Petroleum refineries	*	*	*
	3540	Manufacture of miscellaneous products of petroleum and coal	*	*	*
	3551	Tire and tube industries		*	*
	3620	Manufacture of glass and glass products	*	*	
	3691	Manufacture of structural clay products	*		
Y	3692	Manufacture of cement, lime and plaster	*	*	*
	3699	Manufacture of non-metallic mineral products not elsewhere classified	*		
	3710	Iron and steel basic industries	*	*	*

Table 2.1 (continued)

	3720	Non-ferrous metal basic industries	*	*	*
	3819	Manufacture of fabricated metal products, machinery and equipment not elsewhere classified		*	*
	3841	Ship building and repairing			*
Y	4101	Electricity, light and power	*	*	*
	6100	Wholesale trade	*		
	6200	Retail trade	*		
Y	7112	Land transport	*		
Y	7121	Water transport	*		
Y	7131	Air transport	*		
	7192	Storage and warehousing	*		
Y	9200	Sanitary and similar services	*	*	*
Y	9520	Laundries, laundry services, cleaning and dyeing plants	*		

Note:

(1) An asterisk in the appropriate column signifies that the relevant industrial activity is listed in an appropriate working table (Annexes II, II, an VI) according to it's Standard Industrial Code number.

(2) A Y in the "In Region" column indicates that the industry occurs in the region.

(3) Note that this table represents industries, and available working tables. For example cement manufacturing will result in solid waste and wastewater generation as well as air emissions.

3.0 DOMESTIC CONTRIBUTIONS

The domestic contribution to marine pollution encompasses sanitary wastewater and solid wastes. Residential sources also contribute to non-point source pollution which is discussed in Section 4.0. Domestic wastes remain the greatest contributors to marine pollution in the South Pacific Region. Wastewater contributions are greater than that of solid wastes, however, both are a serious threat to marine water quality.

3.1 Domestic Wastewater

The discharge of domestic wastes remains the largest contributor, in terms of quantity of contaminants to the marine environment in the Pacific Region. However, it should be noted that total quantity of contaminants does not necessarily reflect deleterious impact. This same concept applies to the comparison of waste loads from different areas and countries. Hence, loading to marine areas must be assessed with the local conditions in mind. The loadings in conjunction with local water quality studies, epidemiological studies, and other related studies provide a more accurate assessment of the significance of the domestic wastewater contribution to the marine environment.

The discharge of domestic wastewater in the South Pacific Region poses serious public health and ecological risks to the region. A study of South Pacific Lagoon water quality found that chemical and microbial contamination due to sewage disposal is the principal marine pollution problem (Naidu et al., 1991). Few countries or territories are completely free of this traditional environmental problem, although the risk varies from locale to locale.

The following are wastewater management systems that typify those found in the region. Areas such as Suva (Fiji) and Koror (Palau), have areas served by secondary treatment plants that limit the potential negative impacts. These countries have areas with poorly operated septic tanks and over-the-water latrines. Tonga has no sewerage systems but some areas are adequately served by individual systems (septic tanks, cesspools, or latrines) with minimal potential for contaminating groundwater or near shore waters; yet, some individual systems are inadequate and have the potential for contaminating both types of water sources. Some of Kiribati's population is served by a reticulated wastewater system. However, the location of this outfall and the number of inadequate individual systems leaves Kiribati with serious water quality problems in the Tarawa Lagoon.

Domestic wastewater, or sewage, is managed in various ways. Facilities range from the non-existent in some rural areas, to squatter settlements in urban areas, to advanced wastewater treatment plants in some larger cities. Ascertaining the proportion of the population adequately served by sanitation facilities is difficult. Obtaining and maintaining accurate and consistent data is a problem. With the inception of the International Drinking Water Supply and Sanitation Decade (IDWSSD), the WHO assumed responsibility for monitoring the progress of individual countries' efforts to improve the coverage of water and sanitation. Several of the difficulties encountered by the WHO are shared by this study (Guo, 1991):

(1) The number of involved agencies: Many agencies share responsibility for water and sanitation.

(2) Isolation of communities: It is often difficult to monitor progress in rural and isolated areas. For this reason improvements in coverage or failed sanitation projects are not often documented and results in inaccurate coverage figures.

(3) Definition of criteria: This is a critical problem for the study due to divergent national staff opinions.

For the purpose of this study, which is quantifying the pollutant loadings, the definitions for the criteria are particularly significant because by definition, adequate does not indicate the actual type of facility. For example an over-the-water latrine could be considered adequate, although its pollutant contribution is much more than an inland septic system or a latrine. The public health and ecological implications of over-the-water latrines are also greater. Therefore the level of coverage information available from WHO and other IDWSSD related reports (World Water, 1984) primarily provide only a basis from which to make educated assumptions about the types of facilities found in the individual countries. Table 3.1 presents recent coverage information for sanitation in Pacific Island countries. In addition to IDWSSD information, the following sources were used to estimate the population served by different types of sanitation facilities.

(i) Country representatives information gathered during visits
(ii) Country statistical reports
(iii) U.S. EPA permit files
(iv) Relevant sanitation and environment reports
(v) Knowledge and experience of the author

Estimates suggest that the greatest numbers of persons are served by latrines and septic tanks. The appropriateness and the effectiveness of these systems varies with locale. While many areas are adequately served, there are still a number of areas where the lack of adequate sanitation facilities have been identified as the sources of public health and or water quality problems (Guo, 1991; Naidu et al., 1991; Brodie et al., 1990 ; Sinclair-Knight, 1991).

Table 3.1

Decade progress - Pacific Island Countries

	URBAN				RURAL			
	WATER SUPPLY		SANITATION		WATER SUPPLY		SANITATION	
	1980	1990	1980	1990	1980	1990	1980	1990
COOK ISLANDS	99	99	99	99	63	99	60	99
FIJI	94	96	85	91	66	69	60	65
FEDERATED STATES OF MICRONESIA	95	88	99	99	9	38	7	46
FRENCH POLYNESIA	90	99	95	98	N.A.	N.A.	43	95
KIRIBATI	56	99	87	99	25	63	80	49
PALAU	98	99	80	95	47	97	31	99
PAPUA NEW GUINEA	55	94	48	57	10	20	3	13
REPUBLIC OF MARSHALL ISLANDS	81	99	89	99	31	45	11	45
SOLOMON ISLANDS	91	83	82	73	20	58	10	3
TONGA	86	92	97	88	70	99	94	78
VANUATU	96	90	90	86	24	70	23	34
WESTERN SAMOA	89	99	83	99	94	77	83	92
AVERAGE	86	95	86	90	42	67	42	60

SOURCE: GUO, 1991

NOTE: Figures in table are percentages of population served by safe drinking water and adequate sanitation.

The primary pollution constituents of concern for domestic wastewater are biochemical oxygen demand (BOD), suspended solids, nutrients (consisting of nitrogen and phosphorus). High oxygen demanding wastes can use oxygen needed by the aquatic life; solids settle and smother corals. High concentrations of suspended solids increase the visible turbidity, inhibiting photosynthesis. Nitrogen and phosphorus are limiting nutrients and cause eutrophic conditions in excessive levels. Pathogenic organisms present serious public health considerations. However, neither pathogenic organisms nor their indicator organisms are considered in this report. The other constituents serve as a reasonable indication of the magnitude of sewage being discharged into the marine environment. Where large quantities are discharged to a given area it would be reasonable to assume that high microbial counts, including pathogenic organisms, would also be found. Due to the variability associated with different facility types and locations, pollutant loading generalizations are difficult to make. Hence, generalizations regarding the pollutant quantity that reaches marine areas, and the effects pollutants have on the receiving water are also difficult to make.

The intent of this study is to quantify the sources. Little attempt was made to study the effects of the pollutants on the marine environments. Other studies now underway in the SPREP-POL program are studying these issues as have other previously completed studies. Continuing research in this area is need to interpret and improve the loading data obtained in this study.

Wastewater Reuse

Re-use of treated wastewater and sludge may be a potential option for some of the islands. Re-use provides the benefit of conserving valuable freshwater resources and may also provide additional treatment to the wastewater before it reaches the marine environment. Wastewater should be treated to at least the primary level, sedimentation and preferably disinfection before re-use. Wastewater treated to the primary level is most suitable for forage grasses, crops that are processed or cooked prior to consumption, and landscape irrigation. Sludge can serve as fertilizer. Survival of pathogenic organisms as well as uptake and effect of chemicals in the wastewater must be considered. Certain chemicals that may be found in wastewater can be harmful to agriculture (Shuval, 1977).

In Hawaii, research on the use of primary treated wastewater for irrigation of sugar cane demonstrated negligible potential for adverse health impacts. Groundwater located at depths of approximately six to 12 meters also showed no significant degradation in quality as a result of wastewater reuse (Lau, 1989).

The re-use of wastewater and sludge for edible crops needs to be carefully evaluated as improper applications can create serious public health concerns. Properly implemented non potable water reuse does not entail significant health risks (EPA, 1992). In the United States the use of wastewater for crops eaten raw is not common. Presently wastewater is applied to fiber, feed, and processed grain. Sewage farms in Paris apply raw wastewater to crops eaten cooked which are approved for public consumption by the Ministry of Health, with no reported health problems (EPA, 1981). Waiting periods of several days to one week have been recommended between applications of wastewater and grazing or harvesting of crops (EPA, 1981).

3.1.1 Issues Affecting Determination of Pollution Loadings

The methods section of this report (Section 2.0) describes the use of the WHO method for rapid assessment of sources of pollution. It provides loadings predicted from wastewater with treatment, without treatment and typical pollutant reduction factors for processes (see Table 3.2). Reductions in pollutant loadings when septic tanks are used are based on typical values used in wastewater engineering (Metcalf and Eddy, 1979). Below average treatment efficiencies are used for the septic tanks because the septic tanks are usually poorly designed and operated. Using this method, reasonable estimates for the pollutant loadings entering the environment from domestic sanitation facilities were obtained. Reasonable estimates for the pollutants entering the marine environment are much more difficult to generate.

For sewered areas, the pollutant loadings to the marine environment are, quite obviously, easily calculated since the effluent generally discharges directly to the marine environment. In only two cases (Baza Gardens [Guam] and Ralwaza [Fiji]) where sewered outfalls empty into inland rivers or streams, total quantities of pollutant loadings were used because of the relatively short distance to the marine environment from the point of source. Some self-purification occurs in streams before the waste flow reaches the ocean, however, the reduction is minimal. Obviously, self-purification does not occur when over-the-water latrines are used.

Table 3.2

Treatment Reductions for Different Facility Types

Facility Type	BOD	Suspended Solids	Nitrogen	Phosphorous
Sewer with primary sedimentation	0.67	0.4	0.925	0.9
Sewer with bacteriological treatment	0.2	0.2	0.86	0.4
Septic Tanks*	0.20	0.8	0.95	0.95

* Metcalf and Eddy, Water and Wastewater Engineering, 1979

Difficulty in determining the pollutant loading from individual land-based sanitation facilities is the most significant factor affecting the accuracy of estimates of pollutant loading to the marine environment from domestic wastewater. There is no easily applied rapid assessment technique to make this determination, yet studies have demonstrated that subsurface pollutant flow from individual sanitation facilities are major contributors to water quality problems in a number of lagoons in the South Pacific region (Naidu et al., 1991; Sinclair Knight, 1991). Lagoons in Vanuatu, Tonga, Kiribati, and Fiji are among the coastal waters clearly affected by nutrient loadings from individual sewage systems. These sources cannot be ignored and must be considered, yet it is clear that less than 100 percent of the waste reaches the marine environment. This study makes gross estimates based on some standard engineering assumptions about treatment efficiencies. These assumptions are described below of the reduction of the major pollutants from the effluent of these systems.

Typical values for additional treatment of pollutants as they percolate through the ground after discharge from septic tanks above groundwater are assumed as follows (Metcalf and Eddy, 1979): BOD is reduced an additional 25 to 30 percent and nutrients are reduced an additional five to 30 percent. Suspended solids are typically completely removed. Therefore, it is assumed that 70 percent of waste flows from individual systems reach the marine environment.

A study of similar flows in Vanuatu (Sinclair-Knight, 1991) used a higher value of 85 percent. The geology of Vanuatu is such that rapid flows may be expected because of the fractured nature of the bedrock. Fiji and the Solomon Islands also have also been identified as islands with high groundwater flow. Lower flows would be expected under different geologic conditions such as those in Tonga, where sand and gravel conditions would likely result in increased reduction in the pollutant loadings prior to the flows reaching the marine environment. In order to maintain consistency, the 70 percent reduction value was used for all areas as a reasonable estimate of average conditions. Again, this value is limited; however, for the purpose of this study it does allow for an assessment of the magnitude of the importance of these sources. [The author is concurrently conducting related research to develop a rapid method of estimating predicted pollutant loadings transported from individual sanitary facilities.]

The pollutant loadings entering septic tanks and latrines and the treatment efficiencies of these facilities are likely to be different. The study assumed them to be the same for the following reasons: (1) the lack of standard values for latrines and (2) to some extent the reduced load entering the latrines compared to septic tanks may balance reasonably well against the reduced treatment efficiency. A distinction between the facility types was made which facilitates the incorporation of standard values, if obtained in the future, and the resultant loading recalculation.

3.1.2 Results and Conclusions

This study confirms that domestic wastewater remains the major contributor of many important pollution constituents, including BOD, solids, nitrogen, and phosphorus. Table 3.2

summarizes the estimated pollution loadings from domestic wastewater in the South Pacific Region. The study estimated that 16.7×10^3 tonnes of BOD, 11.3×10^3 tonnes of suspended solids, 8.4×10^3 tonnes of nitrogen, and 1.1×10^3 tonnes of phosphorus enter the South Pacific Ocean from domestic wastewater sources. The quantity of pollutants is, as expected, closely related to population size. The type of facility also is a major factor in determining the pollutant loading. It is essential to reiterate that the population using any given facility type is an estimate only. The accuracy of this estimate varies from area to area, and is dependent upon the quality of data that was available. The error in the estimation is, however, unlikely to affect the overall interpretation of the major sources of domestic, land-based sources of pollution.

Tables B.1 through B.22 in Appendix B present this study's estimates of populations served by different type of wastewater facilities and the resulting pollutant loadings from these facilities. The major pollutants considered are nitrogen, phosphorus, BOD, and suspended solids.

The quantities are only estimates, yet they provide some insight into the current domestic waste management strategies. They are particularly useful when used in conjunction with water quality studies. The estimates, and a review of the methods used to obtain them, clearly demonstrate areas for improved waste management to reduce the pollutant loadings from these sources.

There are a number of areas which have reticulated sewer systems (RMI, Solomon Islands, Kiribati, and Nauru) but provide no treatment. In addition to the systems designed without treatment facilities, some treatment systems are functioning poorly and do not achieve the level of treatment for which the plant was designed. In Pohnpei (FSM) for example, the existing wastewater treatment system was designed to meet secondary treatment standards. However, the effluent quality is similar to that of systems with no treatment. The Ralwaza plant in Suva (Fiji) is similarly ineffective. When these sewer systems have their outfalls in near shore areas, the public health and ecological implications are great. Water quality studies in Pohnpei and Fiji confirm that the pollutant loadings from these systems have a deleterious effect on the local water quality. In Pohnpei, as in Suva, there are other contributing sources, such as over-the-water latrines and poorly functioning septic tanks. Other sources not withstanding, it is clear that water quality improvements could be obtained with the upgrading of these plants.

The environmental impact of sewered areas with primary or secondary treatment is minimized by locating the outfall 1) outside the reef, 2) in areas with higher circulation rates, and 3) preferably below the thermocline. While no facility in the region meets all these criteria, several plants do provide effective treatment and discharge into somewhat deeper waters and/or areas with adequate circulation. Palau's wastewater treatment plant, for example, achieves secondary treatment and discharges effluent at a depth of about twenty meters in a channel with strong currents. Water quality problems are minimal in that segment of the coastal waters. New Caledonia, Solomon Islands, and FSM are countries with existing piped collection systems that would benefit from outfalls moved or extended to deeper waters.

The treatment effectiveness for the removal of nutrients from domestic wastewater of primary and secondary treatment plants is low, less that 15 percent for nitrogen and less than 60 percent for phosphorus. Expensive, even by developed world standards, tertiary treatment is necessary to effectively remove nutrients. This is important in understanding the importance of outfall locations as well as treatment levels. Treatment may be effective for protection of public health but not the environmental health of sensitive lagoon areas. These nutrients accumulate and result in eutrophication of the lagoons (Naidu et al., 1991). Water reuse is an option for wastewater treatment and disposal that serves to reduce nutrient discharge to the marine areas as well as provide nutrients to agricultural areas. Water reuse is discussed below and in Section 3.1.

The contribution of wastes from over-the-water latrines is probably understated in this report due to the lack of information on the number of over-the-water latrines. Their contribution is significant because of its nearness to shore and the potential public health impacts. Over-the-water latrines are ubiquitous in the Pacific Region. However, the distinction between over the-water-latrines is often not made in surveys and other data sources. The distinction is obviously important as it results in direct pollutant loading of the marine environment. Also the direct deposition of human waste does not allow for the natural die-off and treatment obtained through land-based disposal.

Individual systems can be an adequate form of domestic wastewater treatment and disposal. When properly designed and constructed for the population using the facility, they provide a very effective form of sanitation. Care must be taken to place them away from drinking water supplies and areas subject to flooding. Locating such systems in areas with moderate or low population densities minimizes the potential for subsurface overload and the potential for absorption and natural treatment and reduces the transport of large quantities of pollutants to the marine environment. Individual systems including basic latrines to well-designed septic systems require that soils are adequately permeable to absorb leachate from the facility. Adequate land area to provide for absorption and treatment is also necessary. Land area requirements for septic tanks typically range from approximately two to four square metres per bedroom (one to two persons) depending on the percolation rates for the soil (Clark et al., 1977).

Many of the Pacific Island countries would benefit from wastewater reuse projects. On review, wastewater reuse seems particularly applicable to islands that have agroforestry, sugar, and cattle industries. Thus, wastewater use appears to have particular potential in Fiji, Vanuatu, FSM, and the Solomon Islands. Other countries with commercial agriculture activities may also benefit from water reuse projects but may require greater improvements to their existing collection and treatment systems prior to implementation. As with direct discharge of wastewater plant effluent, the siting and operations of areas re-using wastewater requires careful planning to avoid adverse environmental

Table 3.3
SUMMARY TABLE FOR WASTE LOADS FROM DOMESTIC WASTEWATER

Country	Pollutant Constituent (tonnes/yr)			
	BOD	SS	N	P
American Samoa	217.41	259.47	89.48	7.99
Cook Islands	831.02	15.28	53.27	6.46
Federated States of Micronesia	1,010.93	1,314.26	53.27	6.46
Fiji	3,270.31	1,390.78	2,043.26	240.98
French Polynesia	1,251.51	0.00	812.32	98.46
Guam	2,565.44	1,013.54	781.70	80.27
Kiribati	409.07	405.96	174.57	21.16
Nauru	102.13	160.84	26.54	3.22
New Caledonia	948.27	1,344.30	410.17	49.10
Niue	9.78	0.00	6.35	0.77
Northern Mariana Islands	99.36	155.07	110.60	6.27
Palau	73.29	73.33	38.63	3.78
Papua New Guinea	5,665.54	2,424.70	3,106.91	374.49
Pitcairn	0.24	0.00	0.61	0.02
Republic of Marshall Islands	419.05	579.70	150.54	18.11
Solomon Islands	2,136.96	1,762.56	979.15	139.21
Tokelau	12.42	28.80	55.94	0.72
Tonga	563.82	161.62	344.72	43.28
Tuvalu	36.48	16.92	23.00	2.79
Vanuatu	817.74	560.04	457.01	58.35
Wallis Futuna	64.57	0.00	41.91	5.08
Western Samoa	1,170.04	584.53	739.50	83.04
TOTAL	21,675.38	12,251.70	10,499.45	1,250.01

impacts. It is important to avoid runoff of the irrigation wastewater to near shore areas. Nevertheless, wastewater reuse is an option that should be carefully considered for use in the Pacific Region.

To reduce pollutant contributions to the marine environment from domestic wastewater sources it is important to consider improved treatment options and methods for reducing the potential for effluent to reach marine areas. Obviously, treatment options are constrained by costs and must be balanced with the benefits of improved public health and water quality.

3.2 Pollutant Loadings from Solid Waste

Solid waste generation in the South Pacific Region is increasing at a rapid rate. As urbanization increases and the local economies are transformed from the traditional subsistence economies to cash economies there is an increased use of non-biodegradable materials and products. In the traditional economy wastes largely consisted of leftover or discarded organic wastes that degraded rapidly or were easily burned. In the insular environment with little excess land available to use as disposal sites, much of this solid waste is disposed directly into the marine environment. Others are located in coastal areas. This disposal occurs in the form of controlled dumping and littering. The dumping occurs, with few exceptions, in wetlands, e.g., mangrove swamps, and reef flats.

Domestic and industrial solid wastes are usually co-disposed in the Pacific region. Hence, no attempt is made to segregate the waste into hazardous and non-hazardous materials. Industrial and commercial solid wastes often include process waste, solvents, cleaners, construction debris, metals, acids, petroleum products, etc. Household waste may also contain hazardous wastes from cleaners, pesticides, used oils, and infections wastes. Leachate generated from solid waste landfills may contain a number of toxic chemicals and infectious agents. The leachate can adversely upset the ecosystems and may be injurious or fatal to a number of aquatic species. Fish and shellfish may bioaccumulate such toxins. Persons consuming these fish and shellfish are at risk for cancer and a variety of chemical-induced diseases and organ failures.

Health, ecological, and economic risks from improper solid waste disposal practices are important concerns. Much of the region has, or desires, tourism as a major economic component. Poorly managed solid waste disposal resulting in water quality degradation or unsightly conditions adversely affects the potential to attract visitors and maintain repeat visitors. The region has earned substantial foreign exchange due to its image as a unspoiled, tropical vacation destination.

Because solid waste is dumped directly into the marine environment, rapid calculation of solid waste loadings can be assessed by estimating the solid waste production in respective countries. In the United States, generation rates of one to 3.5 kg/person/day are used to estimate solid waste production (Lindberg, 1986). In the South Pacific Region data on the per capita generation rate is not known. WHO studies have estimated the per capita generation rate for the capital towns of the region to be in the range of 0.35 and 0.45 kg/person/day and noted that this is increasing every year (H. Ogawa, 1992).

The WHO method that this study generally follows estimates per capita generation in developing countries to be 250 kg/yr or 0.69 kg/person/year. In Vanuatu, planning for a solid waste landfill, indicated a slightly higher generation rate of 75 tonnes per week for a population of about 19,000 persons, or about 0.7 kilograms/person/day. In the Solomons, a rate of 0.5 kg/person/day was suggested by a South Pacific Commission study (Ogawa, 1992). This study applied a value of one kg./person/day. The higher rate is used to account for wastes generated from commercial activities and to account for wastes that do not get disposed at controlled community sites, e.g., litter, home burning or burying. This provides an indication of the magnitude of this source, although much refinement could be made in a detailed study. Table 3.4 presents these estimates.

Another concern associated with solid waste disposal sites is the use of rodenticides and insecticides to control pests and flies around the dumping area. Pest control benefits are offset by the effects of toxic chemicals that flow into the marine environment and may bioaccumulate in aquatic organisms, including edible fish and shellfish (Suva Harbour Study, 1992).

These are gross estimates that do not predict leachate production from the landfills. Again, leachate from the landfill is a serious concern. Leachate production could be estimated if the size of the landfills was known and the amount of rainfall for the given area was known. It could then be assumed that some portion of the rainfall results in leachate production. In Vanuatu, it has been assumed that 40 percent of total rainfall results in leachate production. This type of analysis may be considered in future research involving the pollutant contribution to the marine environment of solid wastes.

A number of South Pacific countries face a significant littering problem. Dumping spoils, e.g., littering, frequently enter marine waters. Litter is difficult to quantify, however, studies in Fiji have attempted to quantitatively describe the problem by determining the litter coverage (liter per square meter) on shorelines in Fiji. Littering has since been made illegal, resulting in an observable decline in litter. Enactment and enforcement of anti-littering legislation should be considered in all Pacific Island countries. The improvement seen in Fiji as a result of such action points to the value of such action.

The contribution of litter to pollution of the marine environment is also demonstrated by the collection of solid waste from Pago Pago Harbor in American Samoa. The government has enlisted a contractor to periodically pick up the floating rubbish in the harbour. The contractor reports collecting some 2000 pounds or 0.9 tonnes per month (Weigman, 1992).

Standard engineering practices generally rule out the siting of solid waste landfills in wet areas because of the potential for leachate generation and direct contamination of both ground and surface waters. In island states, however, there are some advantages to utilization of solid waste to reclaim land or raise land elevations to reduce flooding potential. This has been practiced throughout the region. The Marshall Islands are considering a resort development on such fill material. Given the limited land situation, the use of solid waste as reclamation material may not be completely unreasonable if a sufficient effort is made to restrict hazardous material from the landfill, the landfill is located so as to avoid critical ecological areas, and facilities are properly operated and maintained in order to minimize the generation of toxic and provide a structurally suitable land area. Carefully managed land reclamation with solid waste has not been the practice in the region.

Pollution prevention has gained recognition as the key component of waste management strategies. Pollution prevention minimizes the amount of waste that must be "managed" in the first place. Thus, pollution prevention activities are recommended wherever possible.

Recycling is an option that is beginning to be practiced in some countries. Though recycling is not pollution prevention, it does reduce the waste volumes entering the environment at controlled or uncontrolled sites. Recycling efforts are hampered by the lack of a local market for recyclable materials and economies of scale to ship these materials to the potential buyers. These economies of scale might be overcome through sub-regional cooperation. Recycling should be encouraged in all Pacific Island countries. Regional assistance to initiate recycling programs is appropriate and encouraged.

Larger urban areas such as Suva (Fiji), Noumea (New Caledonia), Port Vila (Vanuatu), Pago Pago (American Samoa), Agana (Guam) would benefit from collection of batteries and waste oil. Batteries can be recycled and waste oil can be mixed with new fuels and burned in appropriate boilers. Waste oil can also be burned directly as inexpensive fuel in cement kilns. Thus, if appropriate arrangements can be made, waste oil recycling would be particularly applicable in Fiji and New Caledonia. Air pollution control measures may be required at these facilities.

Composting of organic wastes is also a means of reducing solid waste volumes that is applicable to all Pacific Island countries. Composting is of particular value in rural areas where the composted waste serves as a valuable soil additive.

Improved raw materials handling and improved production processes are necessary for reducing the volumes of pollution generation. Some examples of such improvements include maintenance improvements, good housekeeping, controlled materials inventories, equipment modernization, and in-process recycling.

The limitations of disposal and treatment options for solid waste in the Pacific region point to pollution prevention strategies as the most appropriate way to mitigate the contributions of solid waste to marine environmental concerns. This, in conjunction with the segregation and proper disposal of household and industrial solid wastes, would be a much improved solid waste management strategy.

Table 3.4
SUMMARY TABLE FOR SOLID WASTE LOADS

COUNTRY	POPULATION	ANNUAL GENERATION (Tonnes/year)
American Samoa	32,760	11,957
Cook Islands	18,000	6,570
Federated States of Micronesia	102,134	37,279
Fiji	756,559	276,144
French Polynesia	102,535	37,425
Guam	138,093	50,404
Kiribati	72,298	26,389
Nauru	8,042	2,935
New Caledonia	165,000	60,225
Niue	2,500	913
Northern Marianas Islands	39,000	14,235
Palau	15,122	5,520
Papua New Guinea	3,650,000	1,332,250
Pitcairn	52	19
Republic of Marshall Islands	46,188	16,859
Solomon Islands	328,695	119,974
Tokelau	1,800	657
Tonga	97,000	35,405
Tuvalu	9,043	3,301
Vanuatu	167,137	61,005
Wallis and Futuna	12,391	4,523
Western Samoa	165,000	60,225
TOTAL	5,929,349	2,164,212

4.0 NON-POINT SOURCES OF POLLUTION

Non-point sources of pollution (NPS) are extremely difficult to identify and quantify, yet numerous studies have identified them as an important contributor to marine and fresh water quality degradation (Carpenter et al, 1992; USEPA, 1991; Vermon Public Advisory Committee; 1991). This study did not specifically consider non-point sources as a distinct category. Named as a prominent issue in other studies, it may be appropriate to consider NPS as a specific issue in this study also.

Non-point sources of pollution originate from residential, commercial, industrial, agricultural, and construction areas. The type of pollutants that are associated with these different sources are summarized in Table 4.1.

Table 4.1

Non-Point Pollution Sources and Typical Constituents

SOURCE	TYPICAL CONSTITUENTS
Urban	oil and grease, nutrients, organic chemicals, toxic metals, pathogens
Agricultural	nutrients, pesticides, sediments
Industrial	petroleum products, metals, organic compounds
Residential	household pesticides, nutrients, used oils, pathogens
Construction	sediment, oil and grease

It is very difficult to quantify the contribution to marine pollutant loadings without detailed hydrologic and water quality monitoring. The WHO methods provide some typical loadings that were developed for United States and European countries using the average concentration of pollutants in urban runoff and pollutant loadings per square kilometer for agricultural and urban runoff. Because the applicability of these loadings to the Pacific region is uncertain and the data on urban and agricultural areas is unavailable, this analysis was not conducted for this study. However, it may be considered in future studies, particularly if research on some typical areas in the Pacific can be conducted to produce region specific loading factors.

A recent study conducted in Vanuatu addressed the issues of urban and rural runoff in the Port Vila (Vanuatu) region, estimating 5,540 kilograms of nitrogen and 540 kilograms of phosphorus are contributed to the Port Vila Bay system from such runoff (Sinclair-Knight, 1991).

Sediment loadings in the region originate from a variety of sources including agriculture and construction activities. The pollutant constituents of concern in agricultural runoff are described in the following section of this report. In addition, a concurrent study is evaluating the river inputs to the marine environment which, by nature, includes sediment loading.

5.0 AGRICULTURAL CONTRIBUTIONS

The agricultural economy plays a significant role in almost all countries and territories of the region, with the possible exception of Nauru, Guam, and the CNMI. Much of the agricultural activity in the region is associated with the subsistence economy, but there is a major commercial component as well. The sugar industry in Fiji and the coffee industry in Papua New Guinea are notable examples. As shown in Table 3.4 the pollutant constituents of concern that result from agricultural areas are nutrients, pesticides, and sediments.

5.1 Erosion and Sedimentation

Intensive agriculture, particularly on the steep slopes of many of the regions high islands, has contributed greatly to the increased sediment loads deposited into the region's marine environment. Increased cultivation of pepper and sakau plants with shallow root systems, in Pohnpei (FSM) has increased the erosion in Pohnpei (Len Newell, personal communication). In Fiji, a study was conducted which indicated losses of soil due to erosion in the sugar industry to be approximately 77 tonnes/hectare/year (Sugrim, 1988).

5.2 Nutrients and Pesticides

The improper use and storage of pesticides and fertilizers in the South Pacific region has been a continuing concern to the region's environmental and public health professionals, despite the efforts of concerned agencies. Poor use and storage techniques may be due to the fact that, relative to other parts of the world, pesticide and fertilizer use in the South Pacific region is small. Mowbray (1988) provided a thorough review of pesticide use in the South Pacific. The relatively minor use of these chemicals may be attributed more to financial constraints than to a concern for the environment. The costs of agrochemicals provides an opportunity for agricultural professionals to encourage more environmentally sound pest management practices such as integrated pest management. While the use of fertilizers and pesticides is small compared to other regions there is a need for improved management of their storage, use, and disposal. Localized environmental areas of concern have occurred (Chester, 1984, Mowbray, 1988).

Pesticides are also used for insect and rodent control. In malaria areas such as the Solomons and Vanuatu, DDT is sprayed by the government health departments in an attempt to control the mosquito population. The residues from these spraying operations can be washed into nearby drains and eventually into the marine environment after rains. Household and commercial use of these chemicals is also practiced in many areas, particularly urban areas. Since pesticide use is normally associated with agricultural practices and the estimate is made from total consumption, the estimated pollutant loading from all pesticide use is included in this section.

Rapid assessment techniques for calculating the contribution agricultural chemicals make to the marine environment have yet to be developed. The WHO method includes mixed agricultural loading factors for nitrogen, phosphorous, and suspended solids based on three U.S. areas. The method relies on knowledge of the land area under agriculture and the number of days of rainfall. Such information for the Pacific region was not available to this study and the applicability of the factors given the dramatic differences in crops, fertilizer and pesticide application is questionable, both method and quantity. Therefore, this approach not taken. It has been reported, that from a review of several case studies, some five percent of all applied agricultural chemicals reach surface waters (Unger, 1977). In the case of most of the Pacific islands, surface waters can be assumed to be the same as marine waters for the purposes of this study. The validity of this assumption is suspect for Papua New Guinea, however, for consistency the assumption will be used.

Table 5.1 presents the available data for fertilizer and pesticide use in the South Pacific Region. Data from several countries and territories was unavailable. In some cases, the data is out-dated. Some of the data were obtained from Stone (1990) who calculated quantities from monetary totals. The original sources for the Stone data are not known. The use of agricultural chemicals in the region does not appear to be changing dramatically, thus the data serve as reasonable estimates of pesticide use. Table 5.2 shows the estimated loadings for each chemical type based on the assumption that five percent of the chemicals will reach the marine environment.

The estimates demonstrate the relative minimal contribution of pesticide and fertilizer use to the pollutant loadings of the South Pacific Region. Their use should be continually monitored to avoid the serious environmental impacts that can occur even with small quantities. Increased record keeping as to the quantities of chemicals in use and the location of their use is essential to determining the actual potential for environmental contamination. The cases that have occurred involving pesticide use confirm the need for such monitoring. Continued education programs on the proper transport, storage, use, and disposal of pesticides and fertilizers will also reduce the chance for unnecessary environmental problems as the result of their use. Should improper and/or excessive use of these chemicals occur, there is great potential for contamination of water supplies and loss of marine resources.

Table 5.1
AGRICULTURAL CHEMICAL USE

Country	FERTILIZERS					PESTICIDES									
	Nitrogen Based (tonnes)	Phosphates (tonnes)	Potassic (tonnes)	Other (tonnes)	Total (tonnes)	Insecticides (tonnes)	Weedicides (tonnes)	Fungicides (tonnes)	Herbicides (tonnes)	Rodentcides (tonnes)	Mineral oils (liters)	Fumigants (tonnes)	Molluscides (tonnes)	Other (tonnes)	Total (tonnes)
American Samoa															
CNMI															
Cook Islands (1)						3.65		2.44	2.44						8.53
Federated States of Micronesia					0.00										
Fiji (2)	12.00	23.00	18.00		53.00	283.00		24.00	198.00	198.00					703.00
French Polynesia															
Guam (3)						4.90		0.60	2.10					0.10	7.70
Kiribati (4)					0.06										
Nauru															
New Caledonia															
Niue (5)								1.20	1.00			0.10			2.30
Northern Marianas Islands															
Palau															
Papua New Guinea					20.55	143.00		2.10	467.00					6.00	618.10
Pitcairn (6)						16.90									16.90
Republic of Marshall Islands															
Solomon Islands (7)		2238.00	160.00		2398.00	283.00		5.00	205.00					4.00	497.00
Tokelau														0.06	0.06
Tonga (8)	430.04	0.24			430.28	0.98	0.20	10.71		0.08			0.85		12.82
Tuvalu		2.00	5.00	17.00	24.00	1.00				1.00				2.00	4.00
Vanuatu (9)					120.00	1.00		0.30	10.00					30.00	41.30
Wallis and Futuna															
Western Samoa (10)	150.00	150.00	150.00		450.00	0.625 (11)		0.087 (12)	(13)	0.83	250.00	1.00			252.52 (14)
TOTAL	592.04	2413.24	333.00	17.00	3495.89	738.06 (11)	0.20	46.44 (12)	885.54 (13)	199.91	250.00	1.10	0.85	42.16	2164.25 (14)

Note:

1 Data from Mowbray (1988)
2 United Nations (1989) for fertilizers; Mowbray (1988) for pesticides
3 Data from Mowbray (1988)
4 Data from Stone (1990)
5 Data from United Nations (1990)
6 Pitcairn High Commisioner (1992)
7 Pesticide data from Mowbray (1988); fertilizer data from Stone (1990)
8 Data from Foliaki (1991)
9 Data from Allan Sands Vanuatu Agriculture Store (1992)
10 Data from Mowbray (1988) and Taylor (1991)
11 + 0.39 kilolitres
12 + 0.585 kilolitres
13 + 43.56 kilolitres
14 + 44.535 kilolitres

Table 5.2

AGRICULTURAL CHEMICAL POLLUTANT LOADING TO MARINE ENVIRONMENT

	FERTILIZERS					PESTICIDES									
Country	Nitrogen Based (tonnes)	Phosphates (tonnes)	Potassic (tonnes)	Other (tonnes)	Total (tonnes)	Insecticides (tonnes)	Weedicides (tonnes)	Fungicides (tonnes)	Herbicides (tonnes)	Rodentcides (tonnes)	Mineral oils (liters)	Fumigants (tonnes)	Molluscides (tonnes)	Other (tonnes)	Total (tonnes)
American Samoa															
CNMI															
Cook Islands						0.18		0.12	0.12						0.43
Federated States of Micronesia															
Fiji	0.60	1.15	0.90		2.65	14.15		1.20	9.90	9.90					35.15
French Polynesia															
Guam						0.25		0.03	0.11					0.01	0.39
Kiribati					0.0031										
Nauru															
New Caledonia															
Niue								0.06	0.05			0.01			0.12
Northern Marianas Islands															
Palau															
Papua New Guinea					1.03	7.15		0.11	23.35					0.30	30.91
Pitcairn						0.85									0.85
Republic of Marshall Islands															
Solomon Islands		111.90	8.00		119.90	14.15		0.25	10.25					0.20	24.85
Tokelau														0.003	0.00
Tonga	21.50	0.01			21.51	0.05	0.01	0.54		0.004			0.04		0.64
Tuvalu		0.10	0.25	0.85	1.20	0.05				0.05				0.10	0.20
Vanuatu					6.00	0.05		0.02	0.50					1.50	2.07
Wallis and Futuna															
Western Samoa	7.50	7.50	7.50		22.50	0.03 (1)		0.04 (2)	(3)	0.04	12.50	0.05			12.66 (4)
TOTAL	29.60	120.66	16.65	0.85	174.79	36.91 (1)	0.01	2.34 (2)	44.28 (3)	10.00	12.50	0.06	0.04	2.11	108.25 (4)

Notes:

All quantities are formulation quantities

1 + 0.02 kilolitres

2 + 0.029 kilolitres

3 + 2.18 kilolitres

4 + 2.23 kilolitres

6.0 INDUSTRIAL WASTEWATER

The contribution by industrial complexes to the local economies of the South Pacific Region is currently small but continues to grow. Growing industrial activity in the region provides the potential for economic expansion and increased environmental impacts. Most of the counties and territories of the countries in the region can be classified as having small, or non-existent industrial bases. The most industrialized countries of the region, with the exception of mining operations, still have only small to medium industrial bases in worldwide terms. Still, the limited industry has resulted in environmental contamination in a number of areas. These cases of environmental contamination pale, almost to invisibility, compared to the environmental disasters found in parts of Eastern Europe and Southeast Asia. But for a region with limited resources and an economic dependence, through tourism, on its image as an unspoiled tropical paradise, the cases that have occurred serve as warnings to better monitor and manage industrial wastes in the region.

Mining operations in New Caledonia and Papua New Guinea are currently not of large-scale, even in world-wide terms. They are, however, a large and growing industry in the region. There are many untapped mineral resources in the region that will likely result in the continued growth of this industry. A number of areas are under consideration for development, including Namosi (Fiji), Gold Ridge (Solomon Islands), and Lihir (Papua New Guinea) (Lum et al. , 1991). Due to the scale and environmental significance of this industry, it is discussed separately in Section 7.0.

The WHO method requires production data to rapidly assess the pollutant loading from industry. Production data were available on a limited basis; hence, discussion in the report is a qualitative assessment of the expected types and potential impacts of pollutants. Quantitative data, where available, is used to generate regional assessments. In the concluding section of this report, recommendations are provided that may improve the use of the rapid assessment method for this region.

The industries found in the region are shown in Table 6.1. The table is somewhat aggressive as it includes activities in the region that are not truly industries, but services. For example, almost all countries are shown as having health services and pharmaceutical production. However, in reality this may simply be interpreted as health services in the form of a hospital or clinic. The table does, however, provide insight into the industrial activity of the region.

For each country, the author has prepared computer-based spreadsheets containing the industries present and the WHO loading factors to calculate estimated waste loads. This allows for easy updating and efficient assessment of pollutant loadings in future studies.

A description of the industrial economies of the region is provided below and is followed by a summary of the pollutant loadings that could be calculated with available production data. These pollutant loadings are summarized by country, process, and priority pollutants.

Table 6.1

Industries Represented in the Region

AS	CNMI	CI	FSM	F	FP	G	K	RMI	NA	NC	NI	P	PNG	PI	SI	TK	TN	TU	V	WF	WS	
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	Agricultural Services and Chemicals
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Health Svcs. and Pharm. Storage or Prod.
X	X		X	X	X	X	X	X		X		X	X		X		X		X		X	Other Chemicals Storage Manufacture & Use
X		X		X	X	X	X	X	X	X		X	X	X	X		X		X	X	X	Fuel or Oil Storage
				X									X		X		X		X			Wood Treatment
X		X								X			X		X						X	Wood Products Manufacture
X		X		X						X			X		X						X	Furniture and Fixtures Manufacture
							X															Paper Production
										X			X						X			Metal Mining
				X													X					Metal Fabrication
		X	X	X		X																Machinery & Transport Equipment Mfg.
X				X	X	X	X														X	Electric/Electronic Equip. Mfg, Maint., & Use
				X					X	X		X	X									Minerals Mining
				X						X		X	X		X	X						Minerals Processing
X			X	X	X	X			X	X		X	X		X	X	X		X		X	Paint & Allied Prod. Storg, Mfg. and Use
X	X		X	X	X	X	X			X		X	X				X	X			X	Boat Building
			X	X	X	X	X		X	X		X	X				X		X			Printing and Publishing
																						Plastic Production
				X						X												Cement Production, Construction
			X	X	X	X				X		X					X		X			Food Processing
		X	X	X	X		X	X		X	X	X	X(a)		X(a)		X	X	X	X	X	Coconut/Palm Products Processing
				X						X			X			X			X		X	Brewery
				X									X			X						Sugar Refining

Notes:

AS = American Samoa
CNMI = Commonwealth Northern Mariana Islands
CI = Cook Island
FSM = Federated States Micronesia
F = Fiji
FP = French Polynesia
G = Guam
K = Kiribati
RMI = Republic of Mariana Islands
NA = Nauru
NC = New Caledonia
NI = Niue
P = Palau
PNG = Papua New Guinea
PI = Pitcairn
SI = Solomon Islands
TK = Tokelau
TN = Tonga
V = Vanuatu
WF = Wallis and Futuna
WS = Western Samoa

a = Palm Oil

6.1 Countries With Small Industrial Bases

Countries in the region that can be considered to have almost no industrial base include Pitcairn, Tokelau, and Wallis and Futuna. Countries such as the Cook Islands, Kiribati, Niue, Tuvalu, FSM, RMI, CNMI, Palau, and French Polynesia all have very small industrial bases. There are only a few industries represented in these countries. These industries are primarily involved in the processing of coconuts, fish and fruit. CNMI also has a fairly significant garment factory base. Yap, in the FSM, also has a small garment factory employing some 350 persons, though many of these are foreigners.

Wastes from these industries typically include solid wastes and small quantities of wastewater. Note that higher wastewater flows can be expected where bottling and cleaning with water occurs. The pollutants that reach the marine environment, either through direct discharge or leachate from landfilled solid waste, include BOD, nitrogen, phosphorus, and solids. Oil and grease pollution may result from the storage of fuels and lubricating oils associated with these processes. Except for the additional solid waste, little environmental impact occurs from these activities.

In countries with small industrial bases there are also printing shops, laundries, boat building, and other small commercial activities that utilize solvents and other hazardous chemicals. These wastes are usually disposed in domestic wastewater drains or pits in the ground. These chemicals degrade very slowly and there is a potential for accumulation, even if the annual generation is small.

6.2 Countries With Small to Medium Industrial Bases

In addition to the industries mentioned in Section 6.1, countries with medium or small industrial bases have larger manufacturing facilities of a more diverse nature and/or larger facilities for other industries such as breweries and fish canning plants. The countries in the region that can be classified as having small to medium industrial bases include Guam, Solomon Islands, Tonga, Vanuatu, and Western Samoa.

The increased number of smaller industries together with wastes discharged from the larger manufacturing facilities results in increased volume of wastewater discharged. This requires increased monitoring and record keeping to determine the impact and potential impact of these activities. A wide range of wastes can be anticipated with the industries found in these countries. As with smaller industrial bases, BOD, solids, nutrients, solvents, and cleaning agents are found, but usually in much higher concentrations and total loadings.

The small-scale manufacture of food and beverages results in solid waste, and wastewaters containing BOD, solids, and nutrient loadings. Coconut processing is often limited to solid waste. In many countries, the wastes are disposed on land in septic tanks or dry wells. Printing and photography shops in the region commonly dispose of their wastes using land-based facilities or public drains. Depending on the geology and hydrogeologic conditions of the islands, the quantity of pollutants reaching the marine water will vary from zero to nearly 100 percent. For facilities discharging to land-based facilities, as in the case of Tonga, the potential for contamination of groundwaters and surface waters is reduced. The degree of reduction is not known for these specific areas. In some areas these wastes are discharged directly into storm drains. In these cases the potential for the pollutants reaching the marine environment is much greater. As an example, Western Samoa and Tonga both have discharges from printing shops and small manufacturing shops.

Solid waste generation from the growing numbers of dry process manufacturing facilities, e.g., garment factories, and wire assembling plants, in the region has not been identified as a significant contributor to the solid waste problems in the region. The type of industries in the region and the lack of production data preclude the calculation of a definitive contribution. Domestic per capita solid waste generation rates were adjusted upward to account for the commercial and manufacturing contributions. As mentioned in Section 3.0, solid waste management needs to be improved throughout the region to prevent environmental problems. Wastes from manufacturing and industrial processes should be examined for hazardous material content prior to permitting their disposal in community landfills.

Several countries also have small to medium sized abattoirs and meat processing facilities. Slaughtering and meat processing activities range from household activities to small all-manual slaughter houses to the larger more modern facilities, such as those found in Vanuatu. The small abattoir in Apia (Western Samoa) processes about 500 head of beef annually. Using the WHO method, the following waste loads were estimated: BOD five kg, nitrogen 0.45 kg; phosphorus 0.025 kg; and suspended solids four kg. Most of this waste is discharged through a pipe into the ocean. This compares with the modern facility at Port Vila (Fiji) where wastes are discharged to settling tanks and aeration ponds. It is unlikely that surface flows from the facility reach the ocean. However, the contents of the ponds may leach to groundwater which could result in the contents reaching marine waters. For simple slaughterhouses with no treatment facilities, the release of pathogenic microorganisms is of greater concern than the BOD, nitrogen, and phosphorus loadings, particularly if these facilities are located near human bathing areas or drinking water supplies.

Breweries have been established in Western Samoa, Vanuatu, Tonga, Fiji, Papua New Guinea, and New Caledonia. A brewery is planned for the Solomon Islands. Breweries in Western Samoa, Tonga, and Vanuatu are smaller than breweries in Fiji and New Caledonia. Beer production and the associated bottle washing produces large volumes of wastewater. The ratio of wastewater to beer produced is approximately 8 to 10:1. The principle constituents of the wastewater are BOD, suspended solids, dissolved solids, chemical oxygen demand (COD). The wastewater is heated to 25°C above ambient temperatures. The facilities observed in Western Samoa, Tonga, and Vanuatu used settling tanks or septic tank systems as treatment prior to discharge. These systems appeared to be undersized and not providing adequate treatment. The plants in Western Samoa and Fiji discharge to the nearby bays. The plant in Vanuatu discharges to a wetland area while the plant in Tonga discharges in a land treatment facility some distance from the shoreline. The environmental impact of these discharges will depend on the receiving water; but the high levels of BOD and suspended solids as well as the heated water could become significant. The methods of treatment currently in-place would be appropriate if sized correctly. In addition, outfalls should be located at depths greater than the thermocline and away from ecologically sensitive areas. Sedimentation of reef areas is of particular concern. The waste loads predicted from these brewery operations are summarized in Table 6.2.

Fish canning and fish processing is the only other large-scale industry that is present in these countries. American Samoa, Fiji, and the Solomon Islands all have tuna canning operations that each process several hundred tonnes of tuna per day. The wastewater from these operations varies in terms of nutrient loading, BOD, pathogens, and solids. Pollution problems have been associated with each of these facilities, particularly in American Samoa.

Table 6.2

Process Contribution to Regional Pollutant Loadings

PROCESS	BOD (mt/yr)	SS (mt/yr)	N (mt/yr)	P (mt/yr)	OIL/GREASE (mt/yr)
Beer Manufacturing	184.60	77.85	0	0	0
Fish Canning	26.77	194.75	297.93	167.30	0
Sugar Refining	477.25	225.38	0	0	0
Edible Oils	833.00	1554.00	0	80.00	1,426.80

The facilities in American Samoa are now closely monitored by the American Samoa EPA to minimize negative environmental impacts. In addition to wastewater flows, the American Samoa canneries have been authorized to [deep] ocean dump sludges from the tuna canning process. Serious pollution problems were reported with the Tulagi fish canning operation in the Solomon Islands (Leary, 1991). The plant in Tulagi has reportedly closed but the plant in Noru remains in operation. This plant was designed with secondary treatment for wastewater effluent, which if designed and operated properly can minimize pollution effects. Conflicting anecdotal reports were received regarding the degree of pollution produced by the plant. Table 6.2 provides the estimated waste loads for the tuna canning operations in the region.

6.3 Medium Industrial Base Countries

Fiji, Papua New Guinea, and New Caledonia are the only three countries in the region with medium-sized industrial bases in the South Pacific Region. Nauru may be considered to have a medium sized industrial base, but this base is limited to phosphate mining. The industrial complex in Papua New Guinea is primarily copper and gold mining. The industrial complex in Fiji and New Caledonia are similar with a variety of manufacturing and industrial activities ranging in size from small family-owned operations to large exporting facilities.

A recent study of Suva Harbor pollutant sources (Cripps, 1992) provides a thorough review of the industrial pollutants entering the harbor directly or through its tributary drains and streams. The study focuses on the types of industries and the identification of the known and probable pollutant constituents. It provides an important insight into the importance of the small industries contribution to marine pollution problems, particularly the potential cumulative effect of heavy metals, solvents, and other hazardous materials from these operations. The presence of several contaminants is being increasingly documented. Unfortunately, with respect to the presence of contaminants and concentration levels in waste flows, limited data on wastewater quantities were available. Also, very limited production data were available for use with this study. It is important to note that of the 39 industrial facilities surveyed in the Cripp study, 29 discharged directly into the port waters or tributaries.

Table 6.3 provides a representative sampling of the industries and their associated wastes that were identified by Cripps (1992) for Suva and Lautoka (Fiji). This table can also serve to demonstrate the industrial scheme in New Caledonia and major urban centers of Papua New Guinea, where the available data is much more limited.

Liquid waste flow data were available for a limited number of the facilities. A report on the current state of hazardous waste management in Fiji also provided data for waste flows from some industries (Maata, 1992). Waste and analysis data were used to estimate pollutant loadings from these industries. The calculations for battery manufacturing utilized flow data for all industries of that type from Maata (1992) and effluent analysis data for a single facility from Cripps (1992). If data for more than one facility or more than one outfall for several facilities was given, the data were averaged. As such it is not certain if flow characteristics were the same for each survey, hence, estimated pollutant loadings must be interpreted with caution. Table 6.4 presents these calculations. These are gross estimates and it is expected that the actual figures are much higher since many industries and facilities were not included in the surveys.

Industrial pollutant loadings from these data were much lower than would be anticipated for these types of facilities. For example, if the WHO method was used for the edible oil factory and corn oil production considered, the predicted BOD loading would be 0.3 tonnes per year for corn oil, or 0.13 tonnes less than that predicted by direct calculation for all oils. This assumes that the raw corn oil used is roughly equivalent to product volume. If raw oil use for all oil types produced at the plant, or 20 metric tonnes per day, is assumed to equal production some 96.9 tonnes of BOD is predicted. Thus, it seems likely that the liquid waste flows for these flows were inaccurately reported by the facilities.

Table 6.3

Sampling of Industries in Two Fiji Urban Areas

INDUSTRY	CONSTITUENTS
Battery manufacturers	lead, cadmium, zinc, antimony, oil/grease SS, TDS, N, P, acids
Paint factories	lead, oil/grease,
Fuel storage facilities	oil/grease, SS
Photo developing	acids, oil/grease, silver
Printing	solvents, acids, oil/grease
Food manufacturing	BOD, SS, TDS, oil/grease
Cement Plant	SS, TDS
Wire manufacturing	lead, zinc, tin
Manufacture of cleaning products	oils/grease, acids, alkalis
Metal Fabricating Shops	oils/grease, solvents
Electro Plating (Metal) Shops	lead, tin, zinc, chromium, cadmium
Auto Repair Shops	oils/grease, solvents, SS
Marinas	TBT, solvents, solids
Concrete mixing	SS, TDS
Brewery	BOD, SS, TDS, oil/grease
Edible Oil	BOD, SS, TDS, oil/grease, emulsified oil
Sugar refining	SS, TDS, nutrients

If the WHO method is applied to the edible oils factory in Suva with the assumption that raw oil inputs are roughly equivalent to production and that oils other than corn oil are classified as general oils, the following pollutant loadings are predicted. For corn oil, BOD of 0.289 tonnes/yr and suspended solids of 0.3 tonnes/yr. For other oils, BOD loading is predicted as 95.6 tonnes/yr, suspended solids as 94.5 tonnes/yr, and oils as 107.9 tonnes/yr. If the entire production was attributed to corn oil these loadings would be much more in line with those calculated with flow data. Obviously, there is a large discrepancy. This stresses the need for accurate production and/or wastewater flow data.

Table 6.4

REPRESENTATIVE INDUSTRIAL POLLUTANT LOADINGS FROM SUVA, FIJI

PARAMETER	INDUSTRY						
	BATTERY MANUFACT.	PAINT MANUFACT.	EDIBLE OILS	FOOD MANUFACT.	BULK FUEL STORAGE	CLEANING PRODUCTS	TOTAL
FLOW (M^3/day)	0.346	7.000	4.000	2.000	1.000	0.200	
B.O.D (mg/l)	N/A	N/A	1400.000	N/A	4.800	1140.000	
tonne/yr	0.000	0.000	0.177	0.000	0.001	0.144	0.32
S.S (mg/l)	9.000	48.000	650.000	2637.000	55.500	290.000	
tonne/yr	0.001	0.006	0.082	0.333	0.007	0.037	0.47
TDS (mg/l)	173.000	621.000	1090.000	780.000	201.000	2425.000	
tonne/yr	0.022	0.078	0.138	0.099	0.025	0.306	0.67
NITRATES (mg/l)	0.680	N.D.	N/A	0.210	11.000	7.250	
tonne/yr	0.000	0.000	0.000	0.000	0.001	0.001	0.00
PHOSPHATES (mg/l)	29.000	N.D.	N/A	7250.000	N.D.	1.000	
tonne/yr	0.004	0.000	0.000	0.916	0.000	0.000	0.92
OILS/GREASE (mg/l)	240.000	290.000	490.000	480.000	255.000	215.000	
tonne/yr	0.030	0.037	0.062	0.061	0.032	0.027	0.25
ZINC (mg/l)	N/A	3.000	N/A	N/A	N/A	N/A	
tonne/yr	0.000	0.001	N/A	N/A	N/A	N/A	0.00
LEAD (mg/l)	9.000	104.000	N/A	N/A	N/A	N/A	
tonne/yr	0.001	0.038	N/A	N/A	N/A	N/A	0.04

6.4 Current State of Industrial Waste Management

These industries clearly have the potential to cause serious environmental impacts. Indeed, such environmental problems are evident in countries having these types of industries. Several studies have documented the introduction of organic chemicals, heavy metals, and toxics into Suva Harbour that are clearly of industrial origin (Cripps, 1992; Morrison, 1991; Morrison, 1992; Naidu et al. 1991). Similar pollution has been observed in marine waters near other regional urban centers (Morrison, 1990; Gangaiya and Green, 1991).

The waste streams from most industrial facilities have little or no treatment. The most common type of treatment provided for almost all facility types is simple sedimentation. Where oils and greases are anticipated, oil-water separators are provided. As evidenced by the author's visits to a number of facilities in the region and the reports of others (Cripps, 1992; Gangaiya and Green, 1991; Morrison, 1990; Maata, 1992; Chester, 1984; Stone, 1990), most of these so-called treatment facilities are grossly undersized and provide inadequate treatment In some cases secondary treatment was originally provided, but is no longer adequately maintained.

Regulation, even where legislated, of these waste discharges has been largely ignored. Fiji's Ports Authority recently moved to improve the regulation of wastewater discharge into the harbours of Fiji. These regulations were enacted in 1990 but no enforcement program has been initiated. In U.S. territories the discharges are regulated under the National Pollutant Discharge Elimination System (NPDES), among other regulations, which specifies by permit conditions allowable pollutant concentrations and loadings for each facility. The NPDES permits also require monitoring of receiving water quality.

6.5 Results and Conclusions

The intent of this study was to calculate pollutant loadings using the WHO rapid assessment method (WHO, 1990). However, the method was extremely difficult to implement in the region due to the lack of production data. A few facilities in Fiji had both wastewater flow volume and pollutant concentration information. In these cases, waste loadings were directly calculated (see Section 6.3). Although limited production data were available, working tables for industrial wastewater for each of the countries studied were created and are included in Appendix C. These tables include all identified industries for the region and any available production data. If production data were available, these tables show calculated pollutant loadings. This section summarizes the results obtained from the working tables and the directly calculated pollutant loadings that were possible for a few industries in Fiji.

The purpose of the land-based pollutant inventory is to identify the type and sources of the major pollutants entering the marine waters of the South Pacific. The quantitative results of the industrial portion of this study reflect only a small portion of the actual wastes produced. It does however, point to some of the areas of concern and the growing significance of industrial pollutants in the land-based pollutants waste management scheme.

Table 6.5 summarizes the available quantitative information on industrial pollutant loadings reaching marine waters, excluding mining wastes. The information is structured so that the pollutant loadings are identified by the process from which they originated and the country that they are located in. As was cautioned previously, care must be taken not to place too much importance on quantities of waste without considering the location of the discharge outfalls and the potential health and environmental impact of the pollutants. Indeed, many of the more hazardous and toxic wastes such as solvents and heavy metals associated with the medium scale industrial bases of Fiji, New Caledonia and Papua New Guinea, are not well represented in the summary table. For example, the summary does not include most of industrial pollutant sources identified by Cripps (1992) for Suva Harbor due to the lack of production data and/or WHO method loading factors. Table 6.6 summarizes the pollutant loadings for each country.

It can be seen from Table 6.2 and Table 6.5, however, that the fish canneries, sugar refineries, breweries, and edible oil production are major sources of several pollutant constituents, including BOD, suspended solids, nitrogen, phosphorus, and oils and grease.

Fish canneries, as previously mentioned, exist in several countries and are planed for several others. Presently they contribute pollution in the following quantities: BOD (26.77 tonnes), nitrogen (297.93 tonnes), phosphorus (167.3 tonnes), and suspended solids (194.75 tonnes). Canneries may be an appropriate industry for the region given its pelagic resources. Care must be taken, however, to plan for and implement adequate waste treatment. Pollutants can upset the coral reef environment including, perhaps, reef fisheries and ultimately the pelagic fisheries upon which the canneries rely. Many countries with canneries or plans for canneries also wish to promote tourism. Obviously, ill-managed or heavy polluting cannery operations are not compatible with the development of a successful visitor industry.

Breweries are also increasing in prominence in the industrial sector of the region. This industry can be relatively innocuous and simple treatment technologies provide adequate treatment, if adequately sized. Siting effluent discharges in non-sensitive areas with good circulation, and preferably below thermocline levels, minimizes environmental problems. Sediments, BOD, and heated water are again the primary constituents of concern for this industry. Presently, breweries are the source of 337 tonnes of BOD and 427 tonnes of suspended solids.

Sugar milling is a critical part of the industrial base of Fiji. The suspended solids and BOD loadings to the marine environment, however, are quite high; visual observations in Lautoka confirmed this. Presently, sugar milling is the source of 264 tonnes of BOD and 125 tonnes of suspended solids/yr.

Table 6.5

SUMMARY TABLE OF AVAILABLE DATA FOR LIQUID INDUSTRIAL WASTES ENTERING MARINE WATERS

COUNTRY	PROCESS	B.O.D. t/yr	S.S. t/yr	OIL t/yr	N t/yr	P t/yr	OTHER t/yr	OTHER t/yr
American Samoa	Fish canning	4.53	179.18	64.71	255	167.3		
CNMI	no data							
Cook Islands	no data							
Federated States of Micronesia	no data							
Fiji	Beer Production	12.9	18.7					
	Fish Canning	8.18	6.35	4.52	25.63			
	Sugar Milling	263.81	124.58					
	Food Production		0.333	0.061		0.91		
	Brewery	129.7	187.1					
	Edible Oils	95.9	94.8	107.9				
	Soap Manufacturing	0.14	0.04	0.03	0.001			
	Paint Manufacture			0.04		Pb	0.04	
	Battery Manufacture	0.001	0.006	0.03				
	Bulk Fuel Storage	0.001	0.007	0.032				
	TOTAL	510.632	431.916	112.613	25.631	0.91	0.04	0
French Polynesia	no data							
Guam	no data							
Kiribati	no data							
Nauru	no data							
New Caledonia	Beer Production	37.4	6.1					
Niue	Slaughter House	0	0	0	0	0		
Palau	no data							
Papua New Guinea	Edible Oil	246.6	974.6	765.3				
	Brewery	48.9	8					
	Sugar Milling	213.44	100.8					
	TOTAL	508.94	1083.4	765.3	0	0		
Pitcairn Islands	no data							
Republic of Marshall Islands	no data							
Solomon Islands	Slaughter House	9	1.12	1.04	1.4	0.1		
	Fish Processing	14.1	9.09	6.185	17.3			
	Edible Oil	490.5	484.6	553.6				
	Food Manufacture							
	Soft Drinks							
	TOTAL	513.6	494.81	560.825	18.7	0.1	0	0
Tokelau	no data							
Tonga	Fish Canning	0	0	0	0	0	0	
Tuvalu	no data							
Vanuatu	Beer Production	211.7	34.63					
	Soft Drinks Prod.	126	88.2					
	Slaughterhouse	152.69	101.99	98.03	117.21	42.72		
	Milk Production	57.7	16.6					
	Fish Processing	0	0	0	0	0		
	TOTAL	548.09	241.42	98.03	117.21	42.72	0	0
Wallis and Futuna	no data							
Western Samoa (1,2)	Soft Drinks							
	Slaughterhouse							
	Beer Production	63.7	10.42					
	TOTAL	63.7	10.42	0	0	0	0	0
TOTAL		2,186.9	2,447.2	1,601.5	416.5	211.0	0.04	0.0

Table 6.6

SUMMARY TABLE FOR WASTE LOADS FROM INDUSTRIAL WASTEWATER

Country	Pollutant Constituents							
	BOD (mt/yr)	SS (mt/yr)	Oil/ Grease (mt/yr)	N (mt/yr)	P (mt/yr)	LEAD (mt/yr)	ZINC (mt/yr)	OTHER (mt/yr)
American Samoa	4.53	179.18	64.71	255	167.3	0	0	0
CNMI	0	0	0	0	0	0	0	0
Cook Island	0	0	0	0	0	0	0	0
Federated States of Micronesia	0	0	0	0	0	0	0	0
Fiji	510.63	431.92	112.61	25.63	0.91	0.04	0	0
French Polynesia	0	0	0	0	0	0	0	0
Guam	0	0	0	0	0	0	0	0
Kiribati	0	0	0	0	0	0	0	0
Nauru	0	0	0	0	0	0	0	0
New Caledonia	37.4	6.1	0	0	0	0	0	0
Niue	0	0	0	0	0	0	0	0
Palau	0	0	0	0	0	0	0	0
Papua New Guinea	508.94	1083.4	765.3	0	0	0	0	0
Pitcairn Island	0	0	0	0	0	0	0	0
Republic of Marshall Islands	0	0	0	0	0	0	0	0
Solomon Islands	513.6	494.81	560.8	18.7	0.1	0	0	0
Tokelau	0	0	0	0	0	0	0	0
Tonga	0	0	0	0	0	0	0	0
Tuvalu	0	0	0	0	0	0	0	0
Vanuatu	548.09	241.42	98.03	117.21	42.72	0	0	0
Wallis and Fatuna	0	0	0	0	0	0	0	0
Western Samoa	63.7	10.42	0	0	0	0	0	0
TOTAL	2186.89	2447.25	1601.45	416.54	211.03	0.04	0	0

Note: 0 = no data

Edible oils production also contributes to two of the industrial economies of the region. Waste loadings from this industry are high. Annual contributions of BOD from this industry are 96 tonnes; suspended solids: 95 tonnes; and oils 108 tonnes. In these calculations no treatment was assumed for the facilities. Treatment could reduce these loadings substantially.

It is also interesting to look at the pollutant constituents and the contributing sources. Figure 6.1 shows industrial sources of the major pollutant constituents including, BOD, suspended solids, nitrogen, and phosphorus. The information in this figure suggests that fish canneries are the major contributors to all pollutant constituents except suspended solids in which case sugar milling is the major contributor. Breweries are also significant contributors to BOD and suspended solids.

A lack of data on waste flows from smaller industries makes definitive analysis in this area difficult to perform. The lack of actual pollutant loading data, however, does not negate the importance of these industries to the degradation of water quality around many of the region's urban centres. The previous sections discussed the availability of numerous studies that clearly indicate that marine waters of the region are receiving and accumulating industrial wastes.

6.6 Recommendations

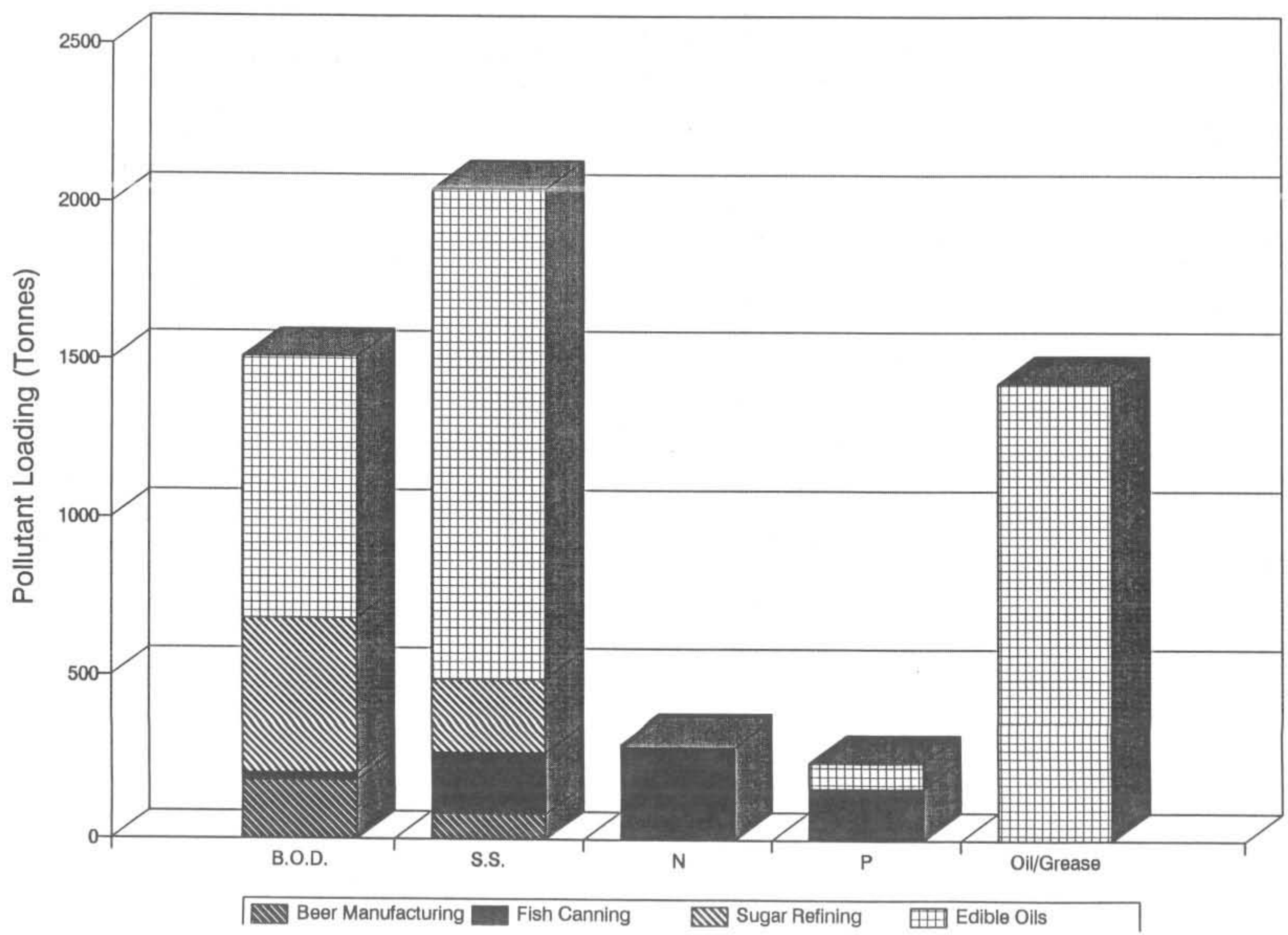
There is clearly a need for improved industrial waste management in the region. Monitoring efforts need to be increased to identify the types of industries present, define the pollutant constituents that they discharge, and quantify wastes. Lack of data leaves the responsible government agencies with limited information on which to prioritize their pollution control, and more importantly, pollution prevention efforts. The lack of information also hinders responsible operators of industrial facilities who prefer to operate in an environmentally responsible manner.

The lack of such data makes it difficult to make specific waste management recommendations. Thus, this report makes an urgent recommendation for the improvement of data collection wherever possible and to use and build upon existing regulations to monitor the discharge of industrial wastes. It also encourages the implementation of pollution prevention concepts wherever possible. This can be done with simple surveys in which industries are required to submit production rates, raw material use, and any known data on waste quantities generated. Raw material use should include quantities as well as types of materials. These surveys can be conducted by environmental departments or as part of regular statistics gathering and industrial licensing activities that are conducted in most countries.

The lack of quantitative production data has been noted throughout the report. In a number of cases, production data in terms of monetary value were available for the primary industries as well as industrial production. Without information on unit prices this information was of little value. The statistical offices of the region's governments usually conduct industrial surveys that could be used to collect production data in terms of units produced. It is possible that this data is collected in a raw

Figure 6.1

POLLUTANTS AND THEIR CONTRIBUTING INDUSTRIAL SOURCES



form, but never reduced to a usable form. In Fiji, for example, the industrial data form specifically includes this type of information, but the database apparently is not set up to process the information. The reluctance of manufacturers to produce output data is understood to be related to competitiveness and potential tax responsibilities. However, this should not preclude government officials from attempting to obtain reasonably accurate production data. Use of existing systems to collect the data necessary for these rapid assessment systems is essential if these types of methods are to be effective. All Pacific Islands countries should include collection of this data in future statistical data collection activities and compile the data into a usable form.

In the long-term, industrial waste permit systems should be implemented in the region wherever possible. Permit systems are an effective method for legislating industrial waste monitoring efforts. The permit system need not only be interpreted as a command and control approach, but also as a means of monitoring the effectiveness of different treatment methods. The systems serve not only to justify requiring increased treatment efficiency, but also to justify reduced treatment requirements. This will depended on the facility type, its location, and its in-house waste reduction efforts. Waste reduction, or pollution prevention, can easily be incorporated into the permit systems. The permit systems provide the government with a mechanism for monitoring the industrial waste output, and for working with the industries to reduce the deleterious impacts of the industry on the environment. Permit systems are applicable to the countries with current and growing industrial economies. Fiji has legislation in-place that can be implemented with an effective permit system. This is recommended. Papua New Guinea, New Caledonia, Solomon Islands, and Vanuatu would also immediately benefit from a permit system.

Pollution prevention has been demonstrated to result in cost savings for a number of U.S. industries. It may be particularly beneficial to a region where raw materials may be costly and difficult to obtain.

Surveys of industrial facilities and their waste production and waste management practices must be continued. These surveys should be conducted in a non-confrontational manner. That is, efforts can be made to demonstrate to facility operators that surveys can benefit them. The human and financial resources to conduct these surveys is limited in many areas of the region. This limitation can be overcome in part by the use of university students. Students from regional institutions such as the University of the South Pacific and the University of Papua New Guinea would be particularly appropriate. However, universities in Australia, New Zealand, Canada, and the United States often have programs that require students to conduct practicums, or field study. Many of these students are highly qualified, capable, and interested in carrying out waste management surveys. Technical assistance and training in this area can be combined into representative case studies. The case studies would involve the conduct of surveys at representative facilities in the region as part of sub-regional workshops. The survey is primarily conducted by a professional trained in this field who is accompanied by workshop attendees. The training workshop should also include review of guidance manuals for other industries found in the region. A series of workshops would allow effective coverage of a number of industries.

These surveys do not require promulgation of legislation or regulations. Indeed these surveys can aid in the development of such legal aspects. The surveys will identify the needs and constraints of industry as well as the urgent environmental protection issues.

These surveys should be immediately considered in the countries with medium-scale industrial bases, that is, Fiji, Papua New Guinea, and New Caledonia. Guam, Solomon Islands, Tonga, Vanuatu, and Western Samoa have somewhat smaller industrial economic sectors, however, they also would benefit from the implementation of these surveys.

7.0 MINING CONTRIBUTION TO MARINE POLLUTANT LOADINGS

Presently, mining activity in the region is limited to a few countries, namely, Papua New Guinea, New Caledonia, Fiji, and Nauru. Four materials are mined in the Pacific region; these are phosphate, nickel, copper, and gold. Phosphate mining primarily occurs in Nauru, with some phosphate mining in French Polynesia. Nickel is only mined in New Caledonia. Both copper and gold are mined in Papua New Guinea and gold is also mined on a small to medium scale in Fiji, Solomon Islands, and Vanuatu. With prospecting occurring in a number of areas, mining may not be limited to these few countries in the future.

Mining is an extremely intrusive and disruptive activity and has major deleterious impacts on the environment. Many studies have reviewed the environmental impacts of mining in the region, particularly those in Papua New Guinea (Carpenter and Maragos, 1989; Brodie et al. 1990; Hughes, 1989). None of the mining activities have been without negative environmental impact, though the phosphate mining operation discharges little waste to the marine environment. (Morrison, 1992a).

Hughes (1990) has described the direct effects of the Misima mine (PNG) on the marine environment. There is daily discharge of approximately 20,000 tonnes of soft waste rock and 15,000 tonnes of tailings per day. The tailings are washed to recover 75 percent of the process chemicals and then mixed with sea water and discharged at a depth of 75 to 100 meters on the outer edge of the coral reef.

Environmental problems as the result of New Caledonia's nickel mining occur inland and to the marine environment. The nickel is strip mined and over 500 million tonnes of overlying material have been stripped to access the ore. The waste is discharged into valleys, rivers, and streams. The amount of the waste which reaches the marine waters from the stream has not been quantified, however the bays to which the rivers flow are coloured by the red-brown sediment. Production in terms of total nickel content was 34,800 tonnes in 1984.

In addition to the active mines, prospecting is currently being conducted in the Solomon Islands and Vanuatu. Mining in Gold Ridge (Solomon Islands) and Namosi (Fiji) is expected to move forward.

Table 7.1 presents the known quantitative information on mining waste discharged to the marine environment.

Table 7.1

Summary Table for Waste Loads From Mining to the Marine Environment

Country/Mine	Non-Hazardous Solid Waste (10^3 tonnes/year)	Hazardous Solid Waste (10^3 tonnes/year)	Total Waste (10^3 tonnes/year)
Papua New Guinea Misima (1)	6,240	4,680	10,920
Papua New Guinea Bougainville (1)		46,800	46,800
New Caledonia Noumea (2)	unknown	unknown	unknown
Total	6,240	51,480	57,720

Notes: (1) Calculated from daily production assuming six day workweek, 52 weeks per year.

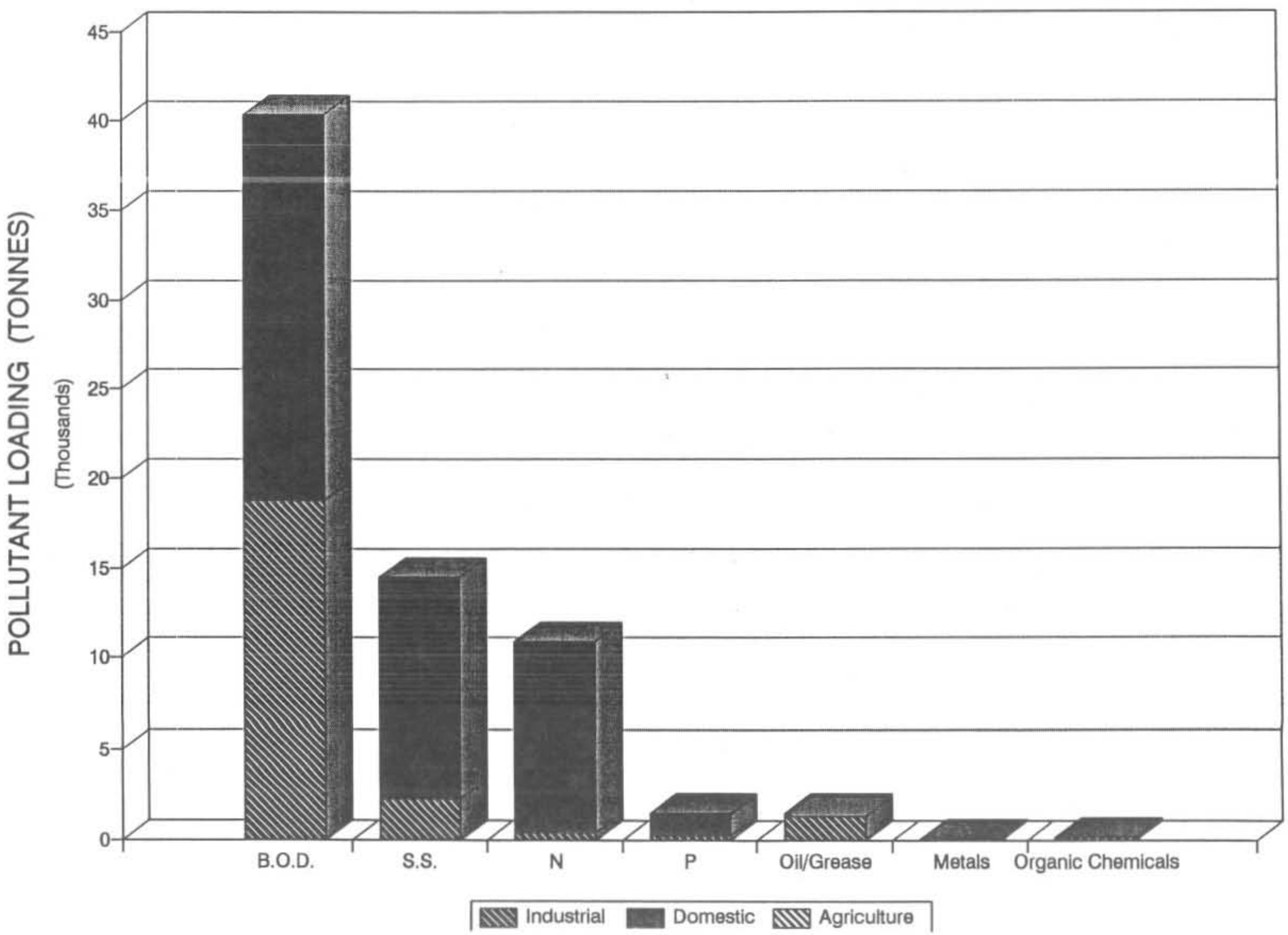
(2) If quantity of total ore processed is available for final report, this will be estimated.

The direct economic value of these mining operations to the host countries is considerable. The direct and indirect costs can also be great. Bartelemus (1992) reviewed the economic valuation of some activities which affect the environment in Papua New Guinea. Few of the operations have undergone comprehensive environmental management planning that could minimize the environmental damage, including the social and cultural effects. These costs are very high in many cases. The analysis of the economic gain from mining in the South Pacific Region must consider all the costs and benefits and determine the availability and feasibility of adequate environmental control measures. If a tradeoff between financial gain and environmental losses is made, environmental planning can minimize the losses and allow decision makers to make better informed decisions. Thus, all new mining operations should undertake a comprehensive environmental impact study to determine both impacts and potential mitigative measures.

The growth of the mining industry in Papua New Guinea, Fiji, and the Solomon Islands provides an opportunity for these countries to begin to take a proactive approach to environmentally sensitive mining. New mining operations should be designed with appropriate operations and effluent standards. Cooperative efforts to develop mining operations and effluent environmental procedures suitable for the Pacific Island region may help to minimize costs associated with a particular mining project. For example, the development of environmental guidelines for the proposed Namosi project, could serve as a case study for other mining projects. in the region.

Figure 7.1

REGIONAL POLLUTANT LOADING
BY SOURCE CONTRIBUTION



8.0 COMPARISON OF CONTRIBUTIONS OF LAND-BASED SOURCES OF POLLUTION

This study has reviewed the major land-based sources of pollution entering the marine environment in the South Pacific Region. Pollutant loadings for the major pollutant constituents identified for the waste processes were quantified. The major source areas considered were domestic wastewater, industrial wastewater, agricultural chemical runoff, and mining. The study also included total solid waste generation, but did not consider its chemical composition (the final report will also include sediment loadings estimated from a concurrent study). Also not considered were coastal reclamation projects, construction, and accidental spills.

The sources of land-based pollutants in the region are growing in number and complexity. Domestic wastes are managed in a number of different ways and the effluent is discharged to the environment through a variety of pathways. Industrial wastes include a variety of organic and inorganic chemicals and heavy metals as well as the so-called traditional pollutant constituents of BOD, suspended solids, and nutrients, represented by total nitrogen and total phosphorus. These industrial wastes are often discharged to the marine environment with little or no treatment. Agricultural activities contribute sediments, nutrients, and organic pesticides to the marine environment. Non-point sources of pollution were not quantified in this study, however, the study recognizes the contribution of non-point sources as potentially critical contributors to marine water quality issues.

The WHO method that was selected for the study is based on the use of loading factors for per capita and production levels for domestic waste and industries respectively. The method considers all wastes and not just those entering the marine environment. Hence, this study makes a number of assumptions regarding the potential for pollutants to reach marine waters. This was primarily done for domestic wastes. It was assumed that industrial wastes entered the marine environment unless otherwise indicated in the reference. Because production data were unavailable for most industrial sources the contributions from industrial sources is probably greatly underestimated.

The study, even with the number of assumptions that were required and the known and unknown inaccuracies, yields some information on the relative contributions of the major sources of pollution to the marine environment. As can be seen in Figure 7.1, domestic contributions for the major pollutants remain the dominant source of marine pollution. Industrial contributions, largely composed of the major industries in the region, fish canning, sugar milling, breweries, and food production do provide a significant contribution as well. Mining wastes produce by far the greatest pollution loads for a single given activity, particularly in terms of solids. The environmental effects of mining activities are well documented (Hughes, 1990).

9.0 REGIONAL SUMMARY AND CONCLUSIONS

The study clearly showed the need for continued improvement in waste monitoring activities and improved record keeping on the types and sources of pollutants. Appropriate waste management practices need to be based on accurate and up-to-date information. The WHO method provides a rapid assessment method that could be very appropriate for this region pending monitoring and data collection. At present, however, there is insufficient production data to get a complete and detailed quantification of industrial pollutant loading to the environment. As a first pass it has provided a reasonably complete overview and quantifies what many professionals have concluded from water and environmental quality studies.

The continued dominance of the domestic contribution indicates it is necessary to apply increased effort in resolving issues of sanitation and waste disposal. The discharge of untreated sewage to near shore areas is still too common in the region. Partially treated wastes are also discharged in near shore waters. While some treatment with discharge to near shore water is better than none, the location of the outfall can also play a major role in minimizing the public health and ecological dangers.

While domestic waste remains a serious problem, industrial waste loadings to the marine environment are increasing not only in quantity but toxicity. Previously conducted water quality and marine environmental studies have clearly demonstrated the presence of metal, organic chemicals, and other toxics in the marine environment. Though this study was unable to quantify industrial wastes in some cases, it does identify a number of industries that generate wastes that are harmful or potentially harmful to the marine environment. The effects of industrial discharges need to be more urgently addressed in the more industrialized countries of the region: Fiji, New Caledonia, and Papua New Guinea. Countries with growing industrial activity such as Vanuatu, American Samoa, and others are in a position to take proactive action toward preventing environmental degradation from industrial waste discharges.

Agricultural sources of pollutants other than sediments are minor compared to the other sources. Except for the potential of accidental spills and accidents, the environmental impact of agrochemicals is negligible. Erosion as a result of improper or inappropriate cultivation practices contributes substantial quantities of sediment to the marine environment.

The most critical finding of this study is the need for increased monitoring and data collection on the various contributing sources, particularly industrial sources, in order to concurrently develop improved waste management plans. Of critical importance is the need to train local officials in the use of rapid assessment methods and simple control strategies. The gap that will continue to exist without established and ongoing monitoring programs can be bridged through the use of rapid assessment methods. The WHO method, if improved to include more of the industries found in the region, can be valuable if data is made available in a usable form. The collection of such data needs to be made a part of the ongoing statistical data collection process.

Data on the waste loadings to the marine environment is of little value unless steps are then taken to utilize this data to prevent or minimize such wastes. Long-term environmental, communal, health, and economic well being require close attention to land-based sources of pollution in the region.

PART II

AMERICAN SAMOA

American Samoa is the only territory of the United States located south of the equator. It consists of five principle islands and two atolls in the Samoa Group. Its main island is Tutuila, which is the government centre and the centre of most commercial activity. Most of the population of 32,760 lives on Tutuila, and most of these live in the Utelei town area.

The total land area of American Samoa is 197 square kilometres (km^2). Tutuila is 147 (km^2). Pago Pago Harbour nearly bisects the island and provides a large and very safe anchorage. This harbour was of great interest to the early European traders and whalers and eventually the American military.

Public service and tuna canneries are the largest employers. Commercial and industrial activity is mainly of a retail and service nature. There are a number of automotive, electrical, and machinery shops, as well as a soft drink bottler and sandal factory.

Domestic Wastewater

The majority of the population is served by a piped sewer system which provides secondary treatment. The sewer system, including the treatment plant are regulated by the U.S. Clean Water Act that requires permitting and setting of effluent standards for any facility discharging to navigable waters. As such the wastewater treatment plants in American Samoa generally provide reasonable treatment of domestic waste waters. Annual pollutant loadings from these plants is estimated from permit monitoring reports as follows: BOD 145 tonnes and suspended solids 276 tonnes. Nitrogen and phosphorous loading are estimated using flow data from the permit reports and World Health Organization (WHO) loading factors (translated to concentrations). Nitrogen loading from the plants is estimated to be 44 tonnes per year and phosphorous is estimated to be 2.4 tonnes per year. The rest of the population uses septic tanks and latrines. Total loading from domestic sources in American Samoa is therefore estimated to be 217 tonnes of BOD; 259 tonnes of suspended solids; 90 tonnes of nitrogen, and eight tonnes of phosphorous.

Industrial Wastewater

The only significant industry is the tuna cannery operations. These facilities have in the past been identified as the sources of significant pollution in Pago Pago Harbor. The American Samoa and U.S. Environmental Protection Agencies (EPA) have pressured the two facilities to upgrade their treatment facilities and comply with the effluent standards required by their permits.

As a result the marine pollution problems due to the tuna canning operation have subsided somewhat. The two facilities have been granted an ocean dumping permit for sludges resulting from the tuna canning operations. The selected ocean dumping site presumably is in an area of adequate circulation and poses minimal ecological and public health risks.

Production data for the two facilities is confidential; however, permits are based on production of 291 tonnes (320 U.S. tons) and 454 tonnes (500 tons) per day. Since wastewater flow, including contaminant concentration data, was available from the permit monitoring reports, annual pollutant loadings were calculated directly. These calculations yielded annual pollutant loadings from the two canneries to be 4.53 tonnes of BOD (for one plant only); 179 tonnes of suspended solids; 254 tonnes of nitrogen; and, 1,810 tonnes of phosphorous. These loadings are much less, approximately two and three times less, than that predicted by the WHO method. Without accurate production data, it is uncertain whether production is the source of the difference or if the loading factors are totally applicable to these plants.

There are also two bulk fuel storage facilities with permits allowing for the discharge of stormwater wastes. Actual pollutant loadings are difficult to predict because of the intermittent nature of the discharges.

High concentrations of lead were found in some fish harvested from Pago Pago Harbour (Weigman, 1992). Other toxics have also been identified in the bottom sediments of the harbor. The sources of these contaminants have not yet been identified.

Solid Waste

No information was available at the time of the report on solid waste disposal issues.

Litter floating on Pago Pago Harbor is routinely collected by a contractor to the ASEPA. The collected trash is estimated to be about 0.9 tonnes per month (Weigman, 1992). This is indicative of the significance of urban runoff problems as well as solid waste disposal problems.

Agricultural Runoff

Agriculture in American Samoa is limited to subsistence agriculture. No data was available on pesticide and fertilizer imports.

Summary

The American Samoa EPA has an established monitoring system for the regulation and management of domestic and industrial wastes. This system generally functions well and provides an adequate means of monitoring marine pollution sources.

The tuna canneries and urban runoff are significant contributors to marine pollution. Domestic wastewater is managed well in most areas and marine pollution minimized through the use of secondary treatment facilities.

COMMONWEALTH OF NORTHERN MARIANA ISLANDS

The Commonwealth of Northern Mariana Islands (CMNI) consists of three main islands; Saipan, Rota and Tinian, located 5,635 km west-southwest of Honolulu in the North Pacific Ocean, about three-quarters of the way between Hawaii and the Philippines. The combined total land area of the CNMI is approximately 477 km2 with 1,482 km of coastline. The population was estimated to be around 39,000 in 1990 with 80 percent of the Commonwealths population located on Saipan (Hazardous Waste Storage and Disposal in the South Pacific). The population growth rate is estimated to be 10.2 percent in this decade (Duenas & Associates, Inc., April, 1992).

The CNMI has a tropical marine climate with little seasonal temperature variation. The dry season is from December to July and the rainy season is from July to October. The southern islands are of carbonate origins with level terraces and fringing coral reefs. The northern islands are volcanic in origin with Mt. Tagpochu on Saipan having the highest elevation of 471 meters. Mt. Pagan, CNMI's one active volcano, last erupted in October 1988. Natural resources are arable land and fish.

CNMI's economy is based upon five broad industries and the resulting secondary supporting industries. Of the five broad industries (the Federal Government, garment factories, transhipment, construction, and the visitor industry) the visitor industry is the most dynamic (Duenas & Associates, Inc., April 1992).

Land-based pollution sources center around domestic waste. Pollution of marine areas around the Sadog Tase and Agingan Wastewater Treatment Plants is likely to increase if the Section 301(h) NPDES Waivers are approved. It is likely that there is localized pollution from the discharge and waste handling activities of individual factories and manufacturers.

There is one U.S. EPA Priority Superfund Site located in Saipan. This site consists of a temporary shelter for approximately 1,400 gallons of PCB transformer fluid with PCB concentrations of up to 25,000 parts per million (Hazardous Waste Storage and Disposal in the South Pacific).

The results of two hazardous waste surveys, conducted in 1977-78 and 1980, indicated that limited amounts of hazardous wastes were generated in the CNMI and these wastes posed a significant threat to the small island environments. Large quantities of hazardous wastes which included asphaltic oil, calcium hypochlorite, pesticides, and chlorextol were being stored in Saipan. The Division of Environmental Quality of the Commonwealth reported that approximately one tonne of agricultural pesticides had been disposed and stored in the region (Hazardous Waste Storage and Disposal in the South Pacific).

No comments on the draft report were received thus the following information has not been confirmed by representatives of the CMNI.

Domestic Wastewater

A large majority of the CNMI population is connected to the public sewer systems. The CNMI has two wastewater treatment plants (WWTP); the Agingan WWTP, located on the southwest section of the island of Saipan and the Sadog Tase WWTP, located approximately 150 feet north of the Agingan WWTP. The Agingan plant services an estimated population of 25,872; the Sadog Tase plant services approximately 12,896 (Duenas & Associates, Inc., April, 1992).

Currently the Commonwealth Utilities Corporation (CUC) is in violation of it's extended NPDES permit for the Agingan effluent. The CUC has contracted to build a new WWTP which will improve the Agingan discharge to secondary effluent quality by February 1993. The CUC has applied for 301(h) waivers for both Agingan and Sadog Tase which will allow the discharge of primary treated effluent at each outfall while the plants are upgraded (Duenas & Associates, Inc., April 1992).

Commercial and Industrial Wastewater

There are less than ten manufacturing businesses in the CNMI. The garment industries account for approximately half of these businesses; the other half consists of wood, fiberglass, beef jerky, and miscellaneous manufacturers. Other small industries include garment assemblers, printers, photo processors, dry cleaners, and auto repair shops. There are three bulk fuel storage facilities in the CNMI; one located on each of the three islands.

Solid Waste

A new sanitary solid waste landfill is under construction in CMNI that should result in adequate solid waste disposal for the majority of the population.

Agricultural Runoff (Pesticides And Fertilizers)

No information on pesticide and fertilizer imports was available at the time of this study. It is not expected that pollutant contributions from this sector are significant.

Summary

The CMNI Department of Environmental Quality has an established monitoring system for the regulation and management of domestic and industrial wastes. This system generally functions well and provides for an adequate means of monitoring marine pollution sources. Domestic wastewater is managed well in most areas and marine pollution minimized through the use of secondary treatment facilities. Continued enforcement of discharge permits will serve to limit most adverse effects from point sources of pollution.

Non-point sources of pollution likely contribute significant pollutant loadings to marine waters. Continued efforts including public educational programs, implementation of stormwater controls, and enforcement of anti-littering provisions is recommended.

COOK ISLANDS

The Cook Islands are located between 156^{o} and 167^{o} west longitude and between 8^{o} and 23^{o} south latitude and consist of 15 islands spread throughout an area of two million square kilometres. The total land area of the Cook Islands is 236 km^2; Raratonga (65 km^2) and Mangaia (51 km^2) are the two largest islands with the individual areas of the remaining 13 islands no greater than 30 km^2. Six of the islands, the Southern Group, Mangaia, Atiu, Mitiaro, Mauke, and Aitutaki comprise 88 percent of the 18,000 people living in the Cook Islands. Fifty-three percent of the population is centered on the main island of Raratonga which also contains the capital, Avarau. The population density is 76.9 people per square kilometre. The population growth rate is declining due to out-migration to New Zealand.

The Cook Islands lie within the hurricane zone with the wet season extending from December to March. The mean annual temperature and rainfall on Raratonga are 23.6^{o} C, and 2,134 mm, respectively. The islands are comprised of both low lying coral atolls and cays and majestic volcanic islands rising to more than 650 metres on Raratonga.

The economy of the Cook Islands is agriculture-based with some light manufacturing in Raratonga. The government employs about 80 percent of the wage earners with the remainder employed in service and retail activities, and the light manufacturing sector.

No response was received on the draft summary table, thus information is that obtained from the literature.

Domestic Wastewater

Limited information on sewage disposal was available for the Cook Islands. Data was obtained from the International Water Supply and Sanitation Decade Directory, 3rd Edition (1983). This indicated good coverage of adequate sanitation, but did not provide specific data on facility types and/or populations using them. Thus, for the purposes of this study it was assumed that Raratonga was served by septic tanks and all other areas served by latrines. No over-the-water latrines were included though it is likely that some percentage of the population still uses this type of facility.

The Cook Islands have not been specifically cited as having marine pollution problems resulting from domestic waste disposal (Brodie et al. 1990). Since marine and fresh water quality are especially critical to an insular environment, however, domestic waste disposal should always be properly managed and monitored.

Commercial and Industrial Wastewater

Manufacturing is limited to fruit processing, clothing assembly, assembly of electronic parts and a small distillery. Although the Cook Islands are reported to have no major industrial facilities and no industries generating hazardous wastes, the presence of industries such as agriculture, fruit canning, health care, printing and publishing, and transportation, makes it likely that small quantities of hazardous wastes may be present in the islands (PBHWRC, 1989). The Secretary of Health reported that there have been no environmental impacts or health effects from any hazardous wastes stored or disposed in the region (UNEP, 1984).

Solid Waste

The present solid waste disposal site for the Cook Islands is located inland and thus is not a threat to marine water quality (Morrison, 1992).

Agricultural Runoff (Pesticides and Fertilizers)

Data from Mowbray (1988) indicates that pesticides are used in The Cook Islands at the rate of approximately 8.5 tonnes per year. Although this level of pesticide usage is high in the region for countries of this size it is still low on a world scale. No pollution problems have been described as a result of pesticide usage. If the assumption that five percent of all applied chemicals reach the marine water is used then 0.43 tonnes of pesticides, in terms of formulation quantities not actual chemical contamination, may reach marine waters. Given the application rates normally used in the region this is probably an overestimate of pesticide loadings.

Erosion problems are also associated with agricultural practices in the Cook Islands as in other areas of the region. Poorly planned plantation-scale pineapple cultivation has resulted in considerable soil loss to coastal swamps and the sea producing some coastal water pollution.

Summary

The lack of production data for the light manufacturing, particularly the distillery and food processing facilities, does not allow for a accurate assessment of the contribution of this sector to marine pollution. However, it is expected that marine pollution loading from the manufacturing sector is low. This is for two reasons, the processes are probably dry, and the production number are probably low.

Information on the sanitary facilities in the Cooks Islands is somewhat speculative. Though marine pollution may not be significant at this time domestic waste water is still probably the larger contributor of pollutants to the marine environment.

THE FEDERATED STATES OF MICRONESIA

The Federated States of Micronesia (FSM) is located approximately 5,150 kilometers west-southwest of Honolulu in the North Pacific Ocean. The FSM is composed of four major island groups totaling 607 islands with a total land area of 702 square kilometers and 6,112 kilometers of coastline. There are four states, Pohnpei, Yap, Kosrae, and Chuuk. There are approximately 102,000 people residing in the FSM with a population growth rate of 2.8 percent.

The natural resources in the FSM consist of forests, marine products, and deep-seabased minerals. The geology of the island varies from high mountain island of volcanic nature to low, coral atolls.

The environmental issues the FSM faces include provision of a safe drinking water supply, solid waste disposal, and the disposal of domestic and commercial waste water. Currently safe drinking water is often not available to much of the population. There is coastal degradation and resource depletion, particularly in the reef and the nearshore area.

The use of the explosive/chlorine fishing, the loss of reef area from filling and dredging, and the degradation of water quality and reef habitats from pollution sources has led to the significant depletion of reef fish stocks and shellfish in certain coastal areas. Specific pollution sources impacting the coastal water quality in the FSM are runoff and associated sedimentation, discharge of sewage, siltation from dredging activities, sunken vessels, fish canneries, domestic waste management, increased fishing pressures from rising populations and new technologies, and increasing non-traditional land use and conservation practices associated with coastal fishing.

Fresh water quality is threatened by accelerated rates of erosion caused by poor agricultural and development practices which degrade the forests of all the states. There is also potential for soil and water contamination to occur from the improper use of pesticides.

Domestic Wastewater

Domestic wastewater facilities in both rural and urban areas of the FSM are poor in all states. The situation is particularly poor in urban areas of Pohnpei and Chuuk. The urban areas were provided with wastewater treatment facilities during the time these newly independent countries were territories of the United States. Lack of trained personnel and funding of operations and maintenance has resulted in the failure of the plants. The wastewater treatment plants, though designed as secondary treatment plants, in Chuuk and Pohnpei do little to treat the sewage flows. The effluent is essentially raw sewage. Wastewater treatment plants in Kosrae and Yap serve small populations, but are believed to still provide reasonable treatment. The pollutant loading calculations assumed secondary treatment, however it is not certain that they attain this level of pollutant removal.

The prevalence of water-related diseases and water quality monitoring data indicate that the sewage pollutant loading to the environment is very high. A recent waste quality monitoring study (as part of a workshop) was unable to find a clean, uncontaminated site in the Kolonia, Pohnpei area.

In urban areas not served by sewers, and rural areas most persons are served by latrines. There are some septic tanks, but most are of poor design and construction. Over-the-water latrines are found in many low-lying areas.

Sewage disposal facilities, the estimated population using each type, the resultant pollutant loadings are presented in Table B.4. Former U.S.EPA discharge permits were used to obtain flow data and estimate populations served (using 150 US gallons per capita per day). Fairly recent (1988) U.S. EPA permits indicated plants in Yap and Kosrae operating reasonably; therefore BOD and suspended solids data was used and nitrogen and phosphorous were calculated using the WHO method.

Total pollutant loadings for the FSM from domestic waste disposal is estimated to be 1,010 tonnes of BOD; 1,314 tonnes of suspended solids; 434 tonnes of nitrogen; and 50 tonnes of phosphorous.

Solid Waste

Solid waste disposal is poorly managed throughout the FSM. Most disposal sites are located in mangrove areas and litter is common. The Pohnpei dump is located adjacent to the fish processing plant, airport, and a hotel.

Industrial Wastewater

Industry in the FSM is very limited. Fish processing, cleaning and dressing only, occurs in a small facility in Pohnpei. Other states have sold storage facilities, but no significant processing facilities. Canneries are planned for all states.

Other commercial activities that may contribute to marine pollution, but for which no data is available include, laundries, auto shops, ship repair, and printers.

Agriculture Runoff

No data on agrochemical use was available. Erosion as the result of poor agricultural practices, especially on the steep slopes of Pohnpei, is likely to result in loss of valuable topsoil and downstream sedimentation.

Summary

Domestic waste disposal is indisputably the major contributor to marine pollution in the FSM. The pollution is visibly evident in the urban areas and is validated by sporadic water quality data. Improved waste management in this area is essential to the improvement o marine environmental quality in the FSM.

Regulations exist for the control of land-based sources but have not been enforced due to a lack of an adequate number of trained personnel and the will of the government. This lack of trained personnel also hinders efforts of the public works department. There is little funding for operation and maintenance of sewage disposal (and water) infrastructure.

The improvement of this sector will require a large financial investment, however, if improvements are to be made it must receive priority for the limited financial resources of the government.

FIJI

Fiji is located 2,500 kilometres north of New Zealand in the South Pacific, and is composed of 332 islands (approximately 110 are inhabited) with a total land area of 18,274 km^2 and 1,129 kilometres of coastline. There are four major islands which include Viti Levu, Vanua Levu, Taveuni, and Levuka; the two largest islands, Viti Levu and Vanua Levu, have areas of 6,418 and 3,419 $miles^2$ respectively. In 1989 the Fijian population was estimated to be approximately 756,559 of which 61 percent lived in rural areas. The population density is 39.7 persons km^2. Suva, the capital city of Fiji, has an estimated population of 157,980 and the urban growth rate is 3.4 percent. The overall population growth rate for Fiji is 2.1 percent. The majority of the Fijian population is found in the lowlands which consist of flatter land in the coastal areas and near large deltas.

Approximately 19 percent of the land in Fiji is very good and 10.5 percent is still arable (Fiji's State of Environment Report in Nair, personal communication, 1992). The majority (43 -45 percent) of land in Fiji is forest and three percent is pasture. Natural resources consist of timber, fish, copra, gold, and copper (Fiji's State of Environment Report in Nair, personal communication, 1992).

Except for a few islands underlain by limestone, the islands of Fiji consist of volcanic mountains, the highest of which are found on the two largest islands. Viti Levu has a central plateau but most of the land is composed of steep slopes with elevations ranging between 150 and 1,300 metres. Most of Vanua Levu consists of generally flat-topped mountains cut by deep, narrow valleys.

The height of the land on both the larger islands has a profound effect upon the tropical marine climate. Slight seasonal temperature variation occurs with yearly maximum and minimum temperatures of about 32 and 16 degrees Centigrade (°C) respectively. The cool season extends from May to October. The southeast trades are the dominant winds which control the pattern of rainfall. Fiji is subject to hurricanes from November to April (Fiji's State of Environment Report in Nair, personal communication, 1992).

Surface water is the major source of water and is used to supply all the large communities and most of the villages, a majority of which are situated on the tributaries of main rivers. Surface water can be, and is readily, polluted by village and cattle effluent. Groundwater, particularly deep groundwater, is less easily contaminated from surface pollution sources. Shallow groundwaters, however, are easily contaminated by surface pollution sources such as latrines, septic systems, and sullage.

The Fijian economy is primarily agriculturally based and has a large subsistence sector. Sugar is a major export product; its processing accounting for a third of the industrial output. The industrial sector is among the largest in the region. Only New Caledonia and Papua New Guinea have similarly large industrial sectors. Large by regional standards these are of only small to medium scale on a worldwide scale.

Industrial, agricultural, and domestic activities are the major sources of marine pollution in Fiji. These activities include mining, shipyards, slipways, moorages, sugar mills, timber mills, cement factory, litter refuse disposal sites, sewage, pesticides and herbicides, tourist developments, and changing land-use practices. Environmental problems in Fiji also arise from highly erosive rainfall in areas impacted by deforestation and agriculture. Suva Harbour is described as highly contaminated (Cripps, 1992; Morrison, 1992).

Marine pollution may have major impacts on the local fishery in Fiji by destroying or modifying coastal habitats making them less suitable for commercial species by killing or reducing survivorship of individuals. Not only does marine pollution impact the coastal ecosystems; local studies show that it is also affecting the health and welfare of the people inhabiting the coastal regions.

Domestic Wastewater

According to the WHO, urban areas of Fiji are reasonably well-served by adequate sanitation facilities. As discussed in Section 3.1, there is no standard definition of adequate sanitation and the WHO relies on the interpretation and the reports of the individual countries. Ninety one percent of the urban population in 1990 was considered to have adequate coverage. The rural coverage was determined to be even better, 99 percent coverage (Guo, 1991). Cripps (1992) reports much lower levels of coverage. That study reported urban coverage of 61 percent and just 12 percent coverage for the rural populations. Clearly, the definition of adequate sanitation must be clearly defined to explain the different determinations and its affect on assessing the pollution potential of sanitary facilities. Regardless of the level of coverage accepted, sanitation problems exist and numerous marine pollution problems are associated with domestic sewage.

Urban areas are served by both sewered and individual wastewater disposal/treatment systems. Sewered areas, with the exception of the Raiwaqa plant in Suva, treatment of waste from sewered areas is adequate for the protection of public health. High levels of treatment, ie., tertiary treatment, is necessary to remove nutrients. Thus, minimization of risks to marine ecosystems is dependent on the proper location of the outfall.

Urban areas not served by sewers are often the older areas of the towns and thus also have inadequate septic tanks, cesspools, and latrines. These individual facilities are known to be undersized and often discharge overflows and or leachate directly to marine areas or streams and storm drains. Septic systems in the Suva region are also hampered by the local geology, which includes a soapstone called Suva Marl (Nair, personal communication, 1992). The soapstone does not allow for adequate perocolation and absorbtion of the septic tank effluent.

Sanitary facilities and the resultant pollutant loads calculated by the WHO methods are included in Table B.5.

Solid Waste

Bronders (1991b) conducted an extensive survey of solid waste disposal sites in Fiji. He concluded that all dumps, except the one located at Tavua, were badly maintained and most are located in environmentally sensitive areas. Eleven of the 21 sites surveyed were located in mangrove or other coastal areas. Smoke, smell, insects, water pollution, and loss of natural beauty were the environmental problems noted by Bronders. The need for improved solid waste management was highlighted. Table 1 summarizes his results.

The Bronders study is comprehensive and points out the need for additional studies to determine the quantities of waste generated and disposed at different facilities, and the potential for leachate discharge to marine waters. The direct discharge of wastes to coastal areas inevitably results in pollution of the marine environments. The pollutants of concern will vary from facility to facility, but nutrients, BOD, and toxics such as heavy metals and pesticides can be expected in some quantity at most facilities. It is likely that insecticides and rodenticides, where used to control pests (which occurs at several Fiji dumps), will leach into surrounding waters.

Industrial Wastewater

The industrial contribution to marine pollutant loadings in Fiji is comprehensively described by Cripps (1992). Cripps study focused on Suva Harbour, but also included general information applicable to the whole of Fiji with additional specific data on Lautoka. Section 5.0 in Part I of this report utilized Fiji as an example for the other medium-sized industrial economies in the region. That discussion will not be repeated here, rather a brief summary is provided. The reader is referred to Part I of this report for additional discussion of the issues and to the Cripps report for details of that industrial survey.

Cripps identified a number of industries contributing to the pollutant loading of Fiji's marine waters. The industries survey by Cripps are listed in Table 6.4 of Part I of the report, and includes, battery manufacture, food production, cleaning products manufacturing, electroplating, auto repair shops, beer production, sugar milling, and others.

Analyses of samples collected from nine out of 39 industry effluents in Fiji significantly exceeded levels permissible for effluent discharge into port waters. Constituents analysed for included, BOD, solids, lead, zinc, nutrients, pH, and oil and grease. Effluents from the Carlton Brewery, Fiji Foods, CASCO Steel, manufacturers of cleaning agents, petroleum product storage terminals, a photoprocessing company, paint factories, food processors, printing shops, electroplating industries, service stations, and Lami dump all contribute to Suva Harbour pollution (Cripps, 1992).

An additional industrial survey showed that the major generators of hazardous waste in Fiji were the battery and paint factories (Maata, 1992).

Vatuwaqa River Mouth is considered to be the most polluted site in Fiji for contamination of shellfish populations and the Nabukaulou Creek is also considered to be one of the most polluted sites in Fiji (Cripps, 1992). This is the result of the numerous small industries discharging wastes into the area as well as the numerous malfunctioning septic tanks, which also discharge into the rivers/creeks.

The effects of tributyl tin (TBT) in marine paints are evident in Suva Harbour. TBT levels in Suva Harbour are higher than any reported for other harbours (Cripps, 1992). TBT is a toxin that has been shown to cause imposex (a development of male sexulal organs on genetically female animals) in neogastropods (young mollusks, including oysters). This effect has been observed in Suva Harbour in recent studies in several neogastropod species including, Morula sp., Thais mancinella sp., Murex sp.(Morrison and Seeto, 1992).

The industrial activities and the resultant pollutant loadings that could be calculated for Fiji are found in Table C.5. The calculations indicate, as expected, that the sugar industry, tuna cannery, edible oil production, and the brewery are significant contributors, from the industrial sector of BOD, suspended solids, and, depending on the industry, nitrogen, phosphorous and oils. The loading of metals seems insignificant; however, the actual pollutant loading to the marine environment of these contaminants is probably much higher. The actual pollutant loaading is beleived to be higher because it is known that several industries and other non-point sources were not included in the survey.

Table 1 below summarises only those industries for which data was available and pollutant loadings could be calculated, using information from Cripps survey.

At present few regulations exist for the control and monitoring of pollutants entering the marine environments. In 1990, the Ports Authority of Fiji established strict regulations for port waters that included standards for types and quantities of wastes that may be discharged. The regulations apply only to port waters. Fiji has five major ports; Labasa, Lautoka, Levuka, Savusavu, and Suva. These ports, excluding Labasa, are under the Authority's jurisdiction. The regulations have yet to be enforced, and as is seen by the above description of analysis results, there is little voluntary compliance.

Agricultural Runoff

Morrison (1990) discussed the environmental impacts of agriculture in Fiji. The paper discusses issues of soil erosion, land degradation, deforestation, sedimentation, pesticides, and water resources. Soil erosion and land degradation are noted as significant problems. The topic has been reviewed at length by several researchers and estimates for erosion from different agricultural activities have been made. The Sugar Cane Farming News, (Sugar Cane Farming News, 1988) reviewed these and provided the following from a previous study. Soil erosion from sugar cane plots ranges from 69 to 77 tonnes/hectare/year; erosion from pineapple plots is approximately 71 tonnes/hectare/year; and erosion from pine seedlings is up to 4877 tonnes/hectare/year.

Summary

Fiji provides an example of the marine pollution problems associated with a medium-scale industrial economy that still maintains a strong agricultural component and large urban and rural populations. The dangers of ignoring industrial wastes while the toxic chemicals accumulate in the marine environment and then the flora and fauna consumed by the community is clear. It demonstrates that huge industrial complexes are not necessary to have serious toxic pollution problems. While domestic waste disposal remains a problem, the industrial contribution to marine pollution also grows.

Waste management needs to be provided for each sector of the economy and the population. Pollution control can be expensive and the more complex the industry, often the more complex the treatment system required. For this reason, the emerging waste management strategies should incorporate pollution prevention, or waste reduction strategies, in order to reduce the costs of treatment.

The recently enacted legislation that provided for improved monitoring of wastewater discharges to the harbors of the country should be expanded to cover all surface waters. The implementing regulations should include a permit system with enforcement provisions. As is discussed with the recommendations in the main body of this report, the permitting processes need not be confrontational. It should provide a means for the responsible government agency to interact with the industry to establish a database of information of wastewater generation and associated impacts. It provides valuable information for improving production processes in a manner that results in pollution prevention rather than simply utilizing end-of-the-pipe solutions, or even worse, significant water quality degradation. Wastewater generating facilities should be provided with information regarding the new regulations and their responsibilities under them.

Informational seminars and conferences including both government and industry representatives may be appropriate to improve industries understanding of the impact their activities have on the environment. It also provides and opportunity for joint solving of waste management problems.

An improved database of waste generation can also be established by utilizing information currently provided annually to the industrial statistics office. The information that is collected on production volumes is only recorded in monetary terms rather than quantities, though the industrial survey raw data includes this information. This information, if included on the computerized database would allow for improved rapid assessment of industrial waste generation using the WHO method employed by this study.

Industrial waste management can also be partially addressed through the use of recycling opportunities. For example, the large quantities of waste oil that is generated can be mixed with new oil for burning in a number of types of boilers. Waste oil can also be burned by the cement manufacturing plant since high temperatures similar to waste incinerators are reached by cement kilns. Some air pollution problems have been noted at the existing plant in Fiji (Morrison, personal communication, 1992), so additional air pollution controls may be necessary to allow the use of waste oil. Nevertheless, the costs of these controls may be offset by the low costs of this alternative fuel. Other recycling opportunities exist with batteries, solvents, aluminum, and other metal wastes.

Government operated wastewater treatment plants in Fiji function efficiently with the exception of the Raiwaqa Plant. Pollution problems associated with the effluents from these plants are likely the result of depths and circulation patterns of the receiving water. The outfalls should be located in areas of good circulation and preferably below the thermocline. Siting and permitting of individual wastewater treatment should require percolation tests. These tests should demonstrate adequate percolation rates for the area prior to allowing new construction of any type.

Fiji is now in a position to develop comprehensive waste management programs. Some solid efforts in this regard have been initiated. Qualified individuals are found in the government and private sector that can work toward an improved database and improved monitoring as well as address pollution prevention and waste treatment issues. Use of expertise at the University of the South Pacific should also be considered. Proactive attention to new industries through environmental impacts and development of effluent standards will aid in the prevention of future environmental problems while progress is made in remediating existing problems.

TABLE 1 SOLID WASTE MANAGEMENT IN FIJI

PLACE	POPULATION (Estimated)	DUMP PRESENT (1)	AREA		LAND SURFACE		REMARKS (Treatment, Pollution, Technical Problems and Maintenance)
			TYPE	LOCATION	TOTAL	IN USE	
CITIES							
Lautoka	30,000	Yes	Mangrove	next to river and urban area	15	3	Burning, levelling, compaction,insecticide, no pollution recorded, maintenance access difficult
Suva	75,000	Yes	Mangrove	next to river and urban area	5	all	Burning, levelling, compaction, insecticide, dump is full, pollution of sea, river and air
TOWNS							
Ba	8,000	Yes	Forest	1km urban area, .5 km village	5	1	Burning, levelling, no pollution reported
Labasa	16,000	Yes	Mangrove	close to river	5	1	Levelling, waste covering, road upgrading, insecticide, no pollution report except fly nuisance
Lami	not given	No (4)	n.a.	n.a.	n.a.	n.a.	Use of Suva City dump (located in Lami) complaints concerning bad maintenance of the site
Levuka (2)	8,200	Yes	Mangrove	next to sea	0.6	0.2	Levelling, compaction, villages have private pits, smell and air pollution, lack of cover soil
Nadi	16,000	Yes	Mangrove/Shore	next to sea	1	all	Compaction,levelling,no pollution reported,sea pollution suspected,shallow watertable,dump full
Nausori	5,000	Yes	Forest/Swamp	next to river	1	1	Levelling, insecticide, river pollution and smell, lack of cover material, cover problem river side
Savusavu	4,000	Yes	Mangrove	close to sea	2.5	0.5	Levelling, insecticide, no pollution reported
Sigatoka	2,700	Yes	Sand Dunes	close to sea	1	0.2	Levelling, back filling, burning,insecticide, no pollution reported(smoke);asked to abandon site
RURAL AREAS							
Ba	60,000	No (4)	n.a.	n.a.	n.a.	n.a.	Individual households are burning and burying waste, some villages have communal pits
Labasa	10,000	No (4)	n.a.	n.a.	n.a.	n.a.	Use of Ba town dump
Lautoka	not given	No (4)	n.a.	n.a.	n.a.	n.a.	Use of Lautoka city dump
Nadi	60,000	No (4)	n.a.	n.a.	n.a.	n.a	Use of Nadi town dump
Nausori	60,000	No	n.a.	n.a.	n.a.	n.a.	Private individual pits encouraged, some villages have communal system
Navua	25,000	Yes	Mangrove	100 meters from the sea	1	0.2	Levelling when funds and machinery are available, smell and fly nuisance are reported
Rakiraki	5,000	Yes	Mangrove	near sea	2	0.2	Levelling, compaction and use of insecticide
Sigatoka	44,250	No (4)	n.a.	n.a.	n.a.	n.a.	Use of Sigatoka Town dump, rural area: burning and burying
Taveuni	7,000	No	n.a.	n.a.	n.a.	n.a.	Dumping happens in communal and individual pits
Tavua	33,000	Yes	depression		2	1	Levelling, no treatment of waste, no pollution reported
Suva	70,000	No (4)	n.a.	n.a.	n.a.	n.a.	Use of Suva City dump

source: Bronders, 1991

notes:
n.a. = not applicable; (1) = is a dump present; owned or leased by authority; (2) = data obtained from the Rural Local Authority
(3) = population of the total island of Ovalau; (4) = dump of the ne town or city is used; (5) = Native Land T ;
(6) = owned by Vatukoula Gold Mine; (7) = approximated surface in hectares; (8) = charge included in the city or town rate

FRENCH POLYNESIA

French Polynesia, an overseas territory of France, consists of five main island groups that include over 130 islands. The total land area encompasses approximately 4,000 square kilometers in a marine area of four million square kilometers. They are located at between approximately seven to 29 degrees south latitude and 131 to 156 degrees west longitude. The capital is Papeete, which is located on Tahiti. The population of the territory as of the 1985 census is 172,080.

The economy of French Polynesia includes a tourism and limited light manufacturing as well as large agricultural and subsistence sector. There are two breweries in the territory and several plants producing soft drinks (Douglas, 1989). No production information was available for these plants. Also, no additional information was provided on other industries or manufacturing activities in the region.

Though no quantitative information is available on industrial waste, domestic waste is probably the largest land-based contributor to marine pollution. The pollutant loadings were calculated based on populations obtained from Douglas (1989) using the standard loading assumptions and it was assumed that the populations used septic tanks and latrines. These calculations are presented in Table B.6.

GUAM

Guam is located in the western North Pacific Ocean, and is the largest, southernmost island in the Mariana Islands archipelago. The land area of Guam totals 541 square kilometers with 125.5 kilometers of coastline. Eleven percent of the land is cultivated, 15 percent is pasture, and 18 percent is forest. As of July 1989, the population of Guam was 138,093 with a population growth rate of 2.8 percent. Sixty percent of the population lives in the rural areas and the population density is 661 persons per square mile. Fishing and tourism are Guam's major resources.

The island of Guam is volcanic in origin and is surrounded by coral reefs. The relatively flat northern limestone plateau is the source of most of the fresh water in Guam. The northern part of the island has steep coastal cliffs and narrow coastal plains, t here are mountains in the south, and low-rising hills in the center of the island.

Environmental issues in Guam include the marine water quality, sold waste disposal, rapid development, erosion, and pesticide use. Industrial pollution is limited in the tourist-based economy, however, there are a number of small manufacturing facilities. Approximately one-third of Guam (212 square miles) is occupied by military installations.

No response was received in a request for information to quantify land-based pollution sources in Guam. Recent hurricanes may have contributed to this.

Domestic Wastewater

Domestic wastewater disposal is well managed in Guam. Wastewater disposal in Guam is subject to U.S. Environmental Protection Agency and Guam EPA (GEPA) water quality regulations which require the monitoring and permitting of all wastewater discharges. Much of Guam is sewered with secondary treatment provided in most locations. The larger plant Agana provides only primary treatment (assumed from discharge monitoring report).

The study only calculated pollutant loading for sewered areas as the population served by these areas, 151,040 approached the population of the last census. Military populations are included in the served population and not necessarily the residential population, thus, many residents are served by individual facilities. The discharge from the treatment plants accounts for far greater loads, making the contributions from the individual facilities insignificant.

For treatment plants actual loading as reported on U.S. EPA discharge permits were used. Population was calculated based on a per capita flow of 125 US gallons per day. Nitrogen and phosphorous loadings were then calculated using the WHO method. Baza Gardens included, however, discharges to a stream so some self-purification may occur before flows reach marine waters.

The sewerage facilities, populations served and resultant pollutant loadings are presented in Table B.7. Total pollutant loading to the marine environment from sewerage was estimated as 2,565 tonnes of B.O.D.; 1,013 tonnes of suspended solids; 78 tonnes of nitrogen; and 80 tonnes of phosphorous.

Solid Waste

Solid waste disposal on Guam is of concern because of the limited availability of suitable land. The major disposal site is at Ordot Landfill. This landfill has been in use for over 40 years, mostly as an open dump. Surface water from the site drains into the Pago River and discharges into Pago Bay, causing concern about direct human contact with the wastes and possible contamination of marine life.

Industrial Wastes

Industrial activity in Guam is of small to medium scale. There are a number of small manufacturing plants, commercial printers, garment manufacturing, auto repair shops, and laundries, etc. Guam is subject to the U.S. EPA and it's own pollutant discharge permit system. The only permits for Guam are for the municipal wastewater plants and bulk fuel storage plants indicating all other liquid wastes are discharged into the domestic system. Thus, pollutant loadings from these activities are accounted for in the municipal discharge calculations.

The Guam Environmental Protection Agency (GEPA) reports that the types and amounts of hazardous wastes generated and stored on Guam each year are the following: 1) flammables and combustibles - 40.5 tonnes, 2) poisons - 13.9 tonnes, 3) corrosives - 97.8 tonnes, 4) etiologic agents - 18.25 tonnes, 5) oxidizers - 0.25 tonnes; and 6) other regulated materials - 1.35 tonnes (Branch, 1984).

Summary

Marine pollution problems in Guam do exist. Major point sources of pollution are from domestic wastewater facilities, however, these plants provide reasonable treatment. Though not assessed in this study, non-point sources of pollution are probably a large contributor of pollutant loading to the marine environment. The lack of significant point sources and the existence of water quality problems suggest non-point sources as significant contributors.

Additional data is necessary to quantify industrial sources and identify their potential sources of marine pollution.

KIRIBATI

Kiribati is composed of 33 islands that are divided into three island groups; the Gilbert (contains 93 percent of the population), Phoenix, and Line Islands. Of a total land area of 810.5 km^2, Christmas Island is the largest island with a total area of 388.4 km^2. Kiribati has 1,143 kilometers of coastline and a total marine area of 3.55 million square kilometers.

The 1990 census reported the population of Kiribati to be 72,298 of which 47,144 (65%) people live in rural areas and 25,154 people (35%) live in the 15.8 square kilometers of urban area. Twenty of the 33 islands are inhabited. The growth rate is 2.24 percent and the population density of Kiribati is 89 people per square kilometer. South Tarawa, the capital, contains 34.8 percent of the total population.

Natural resources on Kiribati consist of copra and pelagic fishing. Approximately three percent of Kiribati is forest land. Banaba or Ocean Island was one of the three great phosphate rock islands in the Pacific, but has been almost completely denuded of phosphate.

The economy is primarily based in subsistence agriculture with a small commercial and service sector. Employment opportunities, primarily in government service and small private commerce, center on islands of Bairiki, Betio, and Bikenibeu.

Sanitary sewage disposal and solid waste disposal are critical environmental issues in Kiribati. Lagoonal water quality shows heavy contamination from human waste. The southern lagoonal area of Tarawa shows increased nutrient levels and bacteriological quality has generally not improved. No specific information on solid waste management was provided to allow specific recommendations for this area.

Industrial wastewater and other sources of marine pollution are insignificant.

Domestic Wastewater

Numerous studies have traced the poor lagoonal water quality to inadequate domestic wastewater disposal (Johannes et al, 1979; Naidu et al, 1991). A serious cholera outbreak occurred in 1977 and diarrhoea is endemic. The high population density in the atoll setting has overwhelmed the ability of the shallow soils to absorb the waste discharged to them. In addition, much of the population still uses the beach as their "sanitary facility". A sewerage system was constructed in 1983 to serve a population of about 9,000 persons. It was hoped that this would improve the water quality situation, however, Naidu et al (1991) found no improvement over the 1978 situation. This is probably due to the fact the population continues to grow and are reluctance to use the toilet blocks that were constructed.

The importance and critical nature of dramatic improvements to domestic wastewater disposal in Kiribati is evident without the actual quantification of the pollutant loadings. The calculated loading for the different areas and facility types, presented in Table B.8, however, do highlight the high loadings. It was assumed that in those areas where no piped sewerage system is used that more than twenty percent of the population used the beach.

Loadings predicted were 409 tonnes of BOD, 405 tonnes of suspended solids; 174 tonnes of nitrogen, and 21 tonnes of phosphorous. The situation in Kiribati also points out that the method does not predict pathogenic microorganism loadings, the primary concern for public health. The loadings do demonstrate the magnitude of sewage disposal.

Summary

It is apparent that issues of domestic waste remain an urgent concern in Kiribati. Continued efforts to develop culturally acceptable sanitation facilities need to be encouraged and assisted. The sewerage system should be maintained and the outfall upgraded or relocated so that discharge is located in areas of adequate circulation and away from poulation areas.

NAURU

Nauru is a single raised coral island with a circumference of 19 kilometers. Phosphate bearing rock covers approximately three-fifths of the island. This high-grade phosphate is the basis of the country's economy. The remaining commerce supports the mining activities and administration of the island. There are no rivers.

The mining wastes are controlled and remain on land and limited so no discharge occurs to the marine waters (Morrison, 1992). Hence, the only significant source of marine pollution is domestic waste from the population of approximately 8,000. The waste water is collected in a piped sewerage system, but no waste treatment is provided. The calculated pollutant loadings to the marine population from this population are as follows: BOD, 102 tonnes; suspended solids, 160 tonnes; nitrogen, 26.5 tonnes; and phosphorous 3.2 tonnes. The data are found in Table B.9.

While important environmental issues are present in Nauru, major marine water quality problems have not been identified. Local water quality impacts probably exist in connection with domestic wastewater disposal.

No response to the draft report was received from Nauru. Thus the above information has not been confirmed by country representatives.

NEW CALEDONIA

New Caledonia consists of one large and several small islands including the Loyalty and Huron groups. The group is located between 19 and 23 degrees south latitude and 163 and 168 degrees east longitude. The main island is called La Grande Tenre on which the capital, Noumea, is located. The island group is a French overseas territory.

The population of New Caledonia is 164,226 with approximately 69,564 persons residing in the capital Noumea. Other smaller urban areas include Thio, Bourail, and Kone, with their total population of approximately 31,992. The remainder of the population is found in rural areas.

New Caledonia is mineral rich. The main island has approximately 40 percent of the world's nickel deposits and 20 percent of the world's oxidized ore deposits. The economy is based on mining this mineral wealth. The open-cut mining of the nickel far overshadows the agricultural and small manufacturing segments of the territory. The manufacturing and industrial sector is primarily based in Ducus (Douglas, 1989).

Environmental issues in New Caledonia also centre around the mining industry. Over 500 million tonnes of ore has been extracted in less than 100 years (Dupon, 1986). To get to this ore millions of tonnes of overlying material was removed. This waste material was dumped down slopes, into valleys, where it entered the rivers and streams. The strip mining and dumping of the waste has resulted in massive loss of vegetation and sedimentation of rivers and bays. No fewer than 40 valleys and streams, and the bays to which they flow have been significantly modified. The rivers and bays are polluted with a red-brown sediment (Dupon, 1986).

Discharge of untreated sewage into lagoon waters has also been noted as an important problem. This is particularly the case in areas around Noumea.

No response was received on the draft summary, therefore most of the comments are quite general and calculations are made based on assumptions from available material.

Domestic Wastewater

The type of community and individual wastewater facilities used, and by what population, was estimated using the International Water Supply and Sanitation Decade Directory, (World Water, 1988) and an assumed population of 164,226 (1983 census population of 145,368 adjusted with growth rate of 1.8 percent) . The calculations assumed that planned coverage was achieved and that planned improvements took place. As such, it was assumed that 90 percent of the urban population is sewered and remaining 10 % is served by septic tanks. It was also assumed that 52% of the rural population with adequate sanitation have latrines, and that the remainder have over-water latrines.

Solid Waste

No information was obtained on specific solid waste problems in the territory. It may be assumed that the issues are the same as throughout the region. Based on the per capita generation rate of one kilogram per day, New Caledonia's solid waste generation is estimated as 60,225 tonnes. This per capita generation may be slightly low for Noumea and other urban areas because of the industrial sector and tourist contribution.

Industrial Wastewater

Again no specific data appropriate for applying the WHO method was received. Data from other sources, (Douglas, 1989) allowed the calculation of brewery waste loads. Brewery waste contribution is estimated to be 4,240 tonnes of BOD and 37,402 tonnes of suspended solids. This analysis assumed that at least primary treatment (sedimentation) was provided for the effluent.

Other industries were identified, and in some case production data available, but not for industries included in the WHO method. Examples of these are the cement works (50,154 tonnes/year); sheet iron manufacturing (3,147 tonnes), and paper goods manufacturing (including 100,000 boxes of tissue, 3.6 million rolls of toilet paper).

Agricultural Runoff

The agricultural economy is overshadowed by the mining industry. No fertilizer or pesticide import data was available to estimate usage quantities. Due to the great impact of the mining industry, agricultural runoff is not considered a significant contributor to marine pollution.

Summary

The limited available data does not allow a comprehensive evaluation of the pollutant loading to the marine environment. The mining industry is clearly the single most significant activity affecting both the marine and terrestrial environment. Given that the remaining industrial sector is similar to Fiji, similar pollution problems should be expected. These would include heavy metal pollution from battery and paint manufacturers, nutrient and BOD loadings from food processing and food production, and oils and grease from a variety of industries, including bulk fuel storage areas, repair shops, and power plants. Solvents and organic chemicals from printers and photo shops may also be of concern if the wastes from these activities are not properly disposed.

In that the industrial base of New Caledonia is similar to that of Fiji, with the notable exception of the influence of the mining industry, waste management issues in New Caledonia are also likely to be similar. Waste management needs to be provided for each sector of the economy and the population. Pollution control can be expensive and the more complex the industry, often the more complex the treatment system required. For this reason, the emerging waste management strategies should incorporate pollution prevention, or waste reduction strategies, in order to reduce the costs of treatment.

Waste management regulations include a permit system with enforcement provisions. As is discussed with the recommendations in the main body of this report, the permitting processes need not be confrontational. It should provide a means for the responsible government agency to interact with the industry to establish a database of information of wastewater generation and associated impacts. It provides valuable information for improving production processes in a manner that results in pollution prevention rather than simply utilizing end-of-the pipe solutions, or even worse, significant water quality degradation. Wastewater generating facilities should be provided with information regarding the new regulations and their responsibilities under them. Informational seminars and conferences including both government and industry representatives may be appropriate to improve industries understanding of the impact their activities have on the environment. It also provides and opportunity for joint solving of waste management problems.

Industrial waste management can also be partially addressed through the use of recycling opportunities. For example, the large quantities of waste oil that are generated can be mixed with new oil for burning in a number of types of boilers. Other recycling opportunities exist with batteries, solvents, aluminum, and other metal wastes.

Additional data for New Caledonia is critical to further assessing the present situation and planning for improved waste management strategies

NIUE

Niue is an uplifted coral island with a total land area of approximately 258 square kilometres, located at about 19 degrees south latitude and 169 degrees west longitude. The population is just over 2,500 and out-migration occurs at a high rate. The soil is worn resulting in relatively low feritility. There is no surface water, but deep groundwater occurs and serves as the country's water supply source. No significant coastal water quality problems have been noted. It has been reported that deep groundwater has high nitrate content (SPREP IGM documents, 1990).

There are few natural resources. The economy is based on agriculture with a shift towards tourism development and small cottage industries such as joineries, a beer refinery and auto shops. No data was available on the production of fruit juices.

Land -based sources of marine pollution are dominated by domestic waste,. Though the water use andwastewater production for the fruit juice manufacturing is not known, it is believed to be very small compared to domestic wastes.

There is a small harbour into which paints, solids, oil, and grease from boat operation and maintenance may enter the harbour waters.

Soil erosion is severe in the many places where errant bulldozer is used for clearing. Pesticide use is estimated to be the same as pesticide imports which is approximately 2.5 tonnes per year (UN/ESCAP, 1989). Lot of unused and outdated pesticides lying around near town water catchment (Tulega, 1992).

Domestic sewage pollutant loadings calculations are presented in Table B.11. The calculation assumes all individual facilities. There is a small visitor population about 1500 per year. The visitor population is for the entire year and therefore considered insignificant and not included. Total BOD loading was calculated to be 9.8 tonnes; suspended solids: no discharge nitrogen 6.4 tonnes ;and phosphorous 1.7 tonnes.

Summary

Niue land-based pollutants are dominated by domestic wastes and non-point sources that are primarily associated with slash and burn agriculture practices.

Non-point sources of pollution can be reduced through education and intrioduction of improved management practices to reduce exposed soils and runoff during agricultural activities. The potential effects of effluents from individual systems can reduced through proper siting and design.

PALAU

The Republic of Palau is an archipelago of some 200 islands, six of which are permanently inhabited. The main islands are Koror (actually several islands connected by causeways), Babelthaup, Kayangel, and Angaur. Palau is composed of 16 states. The capital of Koror is the main population center with approximately 10,000 of the country's population of 15,122. The rock islands of Palau and its barrier reef are recognized for their uniqueness and great biodiversity.

Principle environmental issues in Palau include the destruction of coastal resources from construction of roads, harbors, and dredging. Erosion and sedimentation of reef areas is a key environmental issue. Nearly all of Palau's solid waste landfills are located in wetlands or mangrove swamps. Koror's dump at Malakal has surpassed its capacity and a new site is needed.

Water and sanitation issues remain a priority for Palau. While the level of sewer coverage in Palau is high, much improvement in the rural areas is particularly needed.

Domestic Wastewater

Domestic wastewater disposal and sewage management in the Koror area is generally adequate. About 40 percent of the population is served by the sewer system, which provides secondary treatment. The treatment plant is meeting its permitted effluent guidelines even though its flow of 1.2 million gallons per day is greater than its design flow of 1.0 million gallons. The plant discharges approximately 36 tonnes of BOD, 70 tonnes of suspended solids, 14.5 tonnes of nitrogen, and 0.8 tonnes of phosphorous. The sewer outfall is located in the harbor channel where a strong current results in good mixing of the effluent with the ocean water. The remaining population of Koror are served with septic tanks and latrines. In low lying mangrove areas, over-the-water latrines are often used. Septic tanks and latrines in these areas are often inadequate and overflows occur. As a result, marine water quality is poor in these areas.

In rural areas, the majority of the population uses latrines, though there is an increasing number of septic tanks, particularly in Peleliu and Airai. Marine water quality problems in the rural areas are limited and where they occur are associated with poor sanitation facilities. Total estimated pollutant loading from domestic sewage to the marine environment per year in Palau is 73.3 tonnes of BOD, 73.3 tonnes of suspended solids, 38.6 tonnes of nitrogen and 3.7 tonnes of phosphorous.

Industrial Wastewater

Industry in Palau is very limited. Palau, as a United Nations Trust Territory administered by the United States is subject to its National Pollutant Discharge Elimination System (NPDES). Presently the only facilities with NPDES permits are the wastewater treatment plant and bulk fuel storage areas. There is also a small fish processing facility that conducts only cleaning and dressing of tuna. Oil and grease runoff and solid waste from this activity enter the harbor from this facility. No production data or waste flow information is available for the plant. The plant has applied for a NPDES permit.

Other activities including, auto repair, laundries, boat repair, and lime production result in minimal localized pollution problems. Small oil spills have occurred a number of times over the last several years.

Solid Waste

The Palau Environmental Quality Protection Board (PEQPB) implemented a program requiring states to establish solid waste management plans. Several states have formulated the plans that establish community facilities or provide standards for individual facilities. The community facilities are still usually located in low lying wetlands, however the PEQPB and the states have attempted to identify less sensitive sites. Solid waste generation in Palau based on a per capita generation rate of 1 kilogram per day is 5,520 tonnes per year.

Waste Management Strategies

Palau has an established permit system for all major pollutant discharges, including solid waste, domestic wastewater, industrial wastewaters, and earthmoving activities. This permit system, when enforced, provides an effective mechanism for monitoring and mitigating environmental impacts due to the respective activity. The permit system also provides valuable quantitative information that is often not available in the South Pacific region. The information can be used to plan for future developments, design and implement waste reduction strategies, and improved treatment processes if necessary.

Palau also has a requirement for environmental impact assessment study for many types of projects. Unfortunately this process is often initiated after planning and design is completed, which often negates its value as a planning tool.

Summary

The sources of much of Palau land-based pollution remains domestic sewage and domestic solid waste. Sediment laden runoff is also of concern; however, no quantitative information is available.

The institutional infrastructure for Palau's environmental management system and waste management system is well established with the PEQPB. Continued monitoring and enforcement is necessary for the systems to achieve their mission. Continued training for local staff is necessary as the local issues become more complex.

PAPUA NEW GUINEA

Papua New Guinea is the largest of the South Pacific island countries (465,000 square kilometres), excluding Australia. Its main land area is the eastern half of the island New Guinea, and also includes New Britain, New Ireland, and many other smaller off-shore islands. It extends from the equator to 12 degrees south latitude and from 141 to 160 degrees east longitude. It is the only country in the region where the entire land area can not be considered in, or affecting, the coastal region. The interior is rugged mountainous terrain with a massive cordillera over 2,500 kilometres long. Much of the interior is impenetrable jungle. There are considerable mangrove areas on the coastline.

Much of the population of 3,650,000 live in the rural highlands. The rural population is approximately 2,600,000. The urban population of approximately 390,000 is found primarily in the capital of Port Moresby, and provincial centers of Lae, Madang, Wewak, Goroka, Rabaul, Mt. Hagen, and other smaller provinces.

Papua New Guinea's industrial base is perhaps the largest in the region, and is definitively the largest when mining is included. Besides the mining industry, large industrial activities include palm oil production, tea manufacturing, coffee processing, cocoa, and sugar manufacturing. Other industrial activities, primarily for domestic consumption are similar to those found in Fiji and New Caledonia. Again these include beer production, soft drink production, paint factories, food processing facilities, soft drink manufacturing, printers, etc.

Environmental issues in Papua New Guina are largely associated with the mining activities, some of the smaller industries, and domestic wastes. Environmental impacts from agricultural are assumed to be local since only about seven percent of the land is under commercial cultivation. Environmental impacts from agriculture are principally the result of soil erosion and other effects of the forest clearing for cultivation (Bartelemus, 1992). Many studies have examined the environmental impacts of mining (Hughes, 1989; Hughes, 1990; Brodie et al, 1990; Bartelemus, 1992). Environmental impacts of other activities are not as well studied but coastal pollution from canning and bottling plants and soap manufacturing has been reported (Bartelemus, 1992).

Domestic waste disposal, including sewage and solid waste, is generally inadequate and threatens marine and inland water quality.

No response was received to this study's request for specific industrial production and domestic waste disposal information. The discussion is therefore based upon data from literature reviews and interviews with those knowledgeable of the country.

Domestic Wastewater

The coverage for adequate sanitation is limited in Papua New Guinea to between 20 and 41 percent (World Water, 1984, 1988). Coastal degradation from sewage disposal is evident around urban areas. Outfalls for many of the piped sewerage systems are typically too short to keep the effluents offshore (Bartelemus, 1992). In Papua New Guinea it is not appropriate to consider the entire population's domestic waste as contributors to marine pollution loadings. For the reason the study estimated coastal population and there anticipated waste loads only. This study estimated the coastal population by incorporating the entire population of coastal urban areas and the entire populations of the Gulf District and Milne Bay.

Population data was obtained from a computer atlas (P.C. Globe v.2.1) for individual urban areas. This data compared favourably with overall population data from last the last census when adjusted for growth. For determining facility types and calculating waste loads the study utilized adequate sanitation coverage from International Water Supply and Sanitation Decade Directory, 1988. This included 41% coverage with sewage for urban areas; only three percent of the population is served by adequate sanitation in rural areas. The remaining population in urban areas was described as served by household systems which were assumed to be septic tanks (60%), latrines (37%) and three percent of the population was assumed to be served by over-the-water latrines. Table B.13 presents the calculations and total estimated pollutant loadings. The calculated pollutant loadings per year are as follows: BOD is 5.655 million tonnes; suspended solids is 2.424 million tonnes; nitrogen is 3,106 tonnes; and phosphorous is 374 tonnes.

Solid Waste

Controlled and uncontrolled solid waste disposal usually occurs in the coastal environment. No quantitative information and very limited qualitative information was available to the study. The problems can be assumed to be the same as throughout the region, and perhaps of a greater scale because of the greater populations.

Agriculture Wastes

Prior to 1972 and the start of the mining industry, agriculture was Papua New Guinea's most important industry (Douglas, 1989). Commercial scale agriculture includes copra, palm oil, coffee, rubber, timber, tea, pyrethrum (plant extract used in insecticides), and some sugar. Subsistence agriculture and small-scale agriculture for local consumption includes a variety of vegetables, cattle raising, dairying, fruit, and some rice production.

The agriculture industry is found throughout Papua New Guinea from the coastal areas to the highlands as appropriate for the given crops. No information was provided on agriculture practices to determine significant sources of land-based pollutants to the marine environment. Mowbray (Mowbray, 1988) reported pesticide use quantities and some pesticide use information. A total of 143 tonnes of insecticides, 2.1 tonnes fungicides and 467 tonnes of herbicides, were reported used in 1987. Poor use and disposal practices for pesticides and pesticide containers are apparently common. Pesticide control legislation has been implemented. At the time of the Mowbray report pesticides regulations and guidelines were drafted.

Palm oil processing, a significant generator of wastewater, is discussed below in the discussion of industrial wastewater.

Industrial Wastewater

As discussed above the industrial sector of Papua New Guinea, except for its much larger mining sector, is similar to that of Fiji. Little production data was available, thus pollutant loadings could only be calculated for the palm oil, beer, slaughterhouse, and sugar refining industries. Numerous industries are present and do contribute substantial pollutant loadings to the marine environment. Environmental problems as the result of some of these industries, e.g., soft drink manufacturing and soap manufacturing have been identified. Environmental problems associated with the industries found in Papua New Guinea are likely to be similar to those found for Fiji.

The identified industries and the predicted pollutant loadings for those industries with production data are presented in Table C.13.

Beer and palm oil production were found to be large contributors of BOD and suspended solids. Palm oil production also results in large quantities of oil wastes. Pollutant loading from beer was calculated to be 48,951 tonnes of BOD and 8,000 tonnes of suspended solids per year. For Palm oil, BOD loadings were calculated to be 246 tonnes; suspended solids were 974 tonnes, and oils were 765 tonnes per year. The sugar milling industry also contributed 213 tonnes of BOD and 100 tonnes of suspended solids per year.

These calculations assumed primary treatment for the beer and sugar industries and dissolved air flotation for the palm oil industry. Dissolved air flotation reduces BOD by about 92 percent, solids 68 percent, and oils by 78 percent. It is unlikely that the facility provides this level of treatment and higher pollutant loadings should be anticipated. Primary treatment of sugar milling wastes reduces BOD by 77 percent and solids by about 95 percent. Most milling in the region provide some minimal treatment but they probably do not achieve these levels. For breweries the waste reduction is greatest for suspended solids, which are reduced by 63 percent with sedimentation. BOD is reduced by only 16 percent with this kind of treatment.

There are regulations to limit the discharge of waste to coastal areas. These regulations, however, are not enforced and there is a lack of voluntary compliance.

Mining

Mining, as discussed above, is the activity with the greatest environmental impacts in Papua New Guinea. This issue was also discussed in Section 6.0 of Part I of this report. That discussion will not be repeated here except to provide a summary of the quantitative data.

Both the Misima and the now-closed Bougainville mines have directly impacted the marine environment. Bougainville's mine tailings and contaminated mine wastes flow into the Jaba River and eventually to Empress Augusta Bay. The Ok Tedi copper and gold mine discharges its wastes into the Fly River which ultimately enters marine waters. Severe environmental impacts associated with the Ok Tedi mine have been discussed in a number of published reports. The Ok Tedi mine discharges approximately 80,000 tonnes of mine tailings into the river per day (Hughes, 1989). Cyanide, used in gold extraction process, is found in the tailings in high concentrations.

The Misima mine's impact on the marine environment is quite direct. There is daily discharge of approximately 20,000 tonnes of soft waste rock and 15,000 tonnes of tailings per day. The tailings are washed to recover 75 percent of the process chemicals and then mixed with seawater and discharges at a depth of 75 to 100 metres on the outer edge of the coral reef. Table 1 summarizes the wastes from mining that reach the marine environment.

Summary

Mining clearly has major negative effects on the environment. In the case of mining, control measures can be very costly and the economic benefits have been considered great enough nationally to allow the environmental degradation. It is beyond the scope of this study to address that issue, but in order to reduce the pollutant loadings to the environment and the resultant short- and long-term damages, tailings storage and treatment facilities must be constructed.

Other industries and domestic wastes also clearly are not adequately controlled and result in severe coastal pollution problems. These industries and the domestic activities of the population are also economically important, but there are also costs associated with the lack of pollution control measures for these activities. Costs include increased diseases associated with sewage contamination, increased chemical contamination of the marine water and the edible resources consumed by human beings, and ecological degradation. In none of these areas is waste management sufficient to minimize the pollutant loadings and thus minimize the risks to public health and the marine environment. The limited information available to this study indicates that waste management does not really exist except as attempts to transport the wastes away from the immediate area of the activity. Further information is necessary to fully substantiate this and more importantly, develop appropriate waste management strategies.

Table 1

Summary Table for Waste Loads From Mining to the Marine Environment

Country/Mine	Non-Hazardous Solid Waste (10^3 tonnes/year)	Hazardous Solid Waste (10^3 tonnes/year)	Total Waste (10^3 tonnes/year)
Papua New Guinea Misima (1)	6,240	4,680	10,920
Papua New Guinea Bougainville(1)		46,800	46,800
TOTAL	6,240	51,480	57,720

Notes: (1) Calculated from daily production assuming 6 day work week, 52 weeks per year.

Source: Hughes, 1989

PITCAIRN

Pitcairn is a small British Dependent Territory. The Dependent Territory consists of three small islands, but the population resides on the island of Pitcairn itself. The island is three kilometers long and 1.5 kilometers wide and lies at 25 degrees south latitude and 130 degrees west longitude. The population is just 62.

Pitcairn has a subsistence economy and therefore nearly all marine waste is derived from domestic activities. Ten people are served by septic tanks and the remainder of the population uses latrines. Pollutant loading from this population was calculated as 0.2 tonnes of BOD, 0.15 tonnes of nitrogen, and 0.019 tonnes of phosphorus per year. Given the low population density the loadings to the marine environment may not even occur since the facilities are located inland and there is ample soil capacity to absorb the wastes.

No specific marine water quality problems were cited in comments received from Pitcairn representatives.

REPUBLIC OF THE MARSHALL ISLANDS

The Republic of the Marshall Islands (RMI) is an island group consisting of 30 atolls and 1,152 islands. The major atolls are Kwajalein, Rongelap, Enewetak, and Maloelap. The RMI is located in the North Pacific Ocean, approximately 800 km southwest of Honolulu (approximately two-thirds of the way between Hawaii and Papua New Guinea) and has a total land area of 181.2 square kilometers with 370.4 kilometers of coastline. In July 1989, the population of the RMI was reported to be 46,188 with a population growth rate of 4.2 percent. The urban and rural population densities are 19,336 and 626 people per square hectometer respectively.

Approximately 60 percent of the land in the RMI is cultivated. The RMI's major natural resources are marine products. Deep-seabed mining is not economically viable at this time. The islands are raised coral islands with low elevations.

The United States formerly used both Bikini and Eniwetak for nuclear testing. Kwajalein is a U.S. military base and was used as missile-test range.

The most serious environmental problems in the RMI are caused by overpopulation and poorly-planned development. The environmental quality of the urban area is impacted by increased demand on land and water resources due to over-exploitation of food resources, over use of water supplies, and contamination of marine and fresh water. Additionally, domestic waste water and solid waste disposal also pose a serious threat to the RMI environment.

Human and animal wastes and increased concentrations of nitrogen have been identified in extremely high concentrations in lagoon waters near densely populated areas. Coastal shoreline waters have also been found to be contaminated by human and animal wastes. Contamination of groundwater by benjos and pit privies have impacted the quality and use of groundwater.

No response to the draft summary table was received. It is assumed, therefore, that the presented data is correct and that no other data is available.

Domestic waste disposal in Majuro/Ebye, including sewage and solid waste, is the major contributor to marine pollution. Industry is not present in the RMI, with the exception of some laundries and small print shops. A tuna cannery is planned for Majuro. Domestic wastewater disposal is achieved by a combination of piped sewerage and individual systems in urban areas and all individual facilities in rural areas. The piped sewerage is untreated but discharges to the ocean side of atoll. The negative environmental and public health effects of these discharges, even though the outfalls are not at great depth, are less than the cumulative discharge of the individual facilities that discharge on the lagoon side. In addition to the individual land facilities, many persons still use the beaches below the high water mark.

Total pollutant loading from the sewage facilities are as follows: BOD 419 tonnes; suspended solids: 579 tonnes; nitrogen 150 tonnes; and phosphorous: 18 tonnes.

All solid waste in the RMI is disposed of in the marine environment, either in very low lying areas or reef flats. This is true both for controlled facilities and litter, which is prevalent in both Majuro and Ebeye.

The RMI has through it's Environmental Protection Authority, a strong regulatory framework for the management and control of land-based pollution. It provides for environmental assessments, permitting, and monitoring of all major activities. The need for major capital improvements and trained personnel to operate an maintain them are necessary before such a framework can be effective in managing domestic waste disposal.

Finally, enforcement of environmental regulations is necessary, without adequate enforcement of the legislative and regulatory framework, improvement in waste management will be difficult to achieve.

SOLOMON ISLANDS

The Solomon Islands lie in the southwest Pacific between the latitudes of 5 degrees south and 12 degrees south and 152 degrees and 170 degrees east latitude. The islands run between Papua New Guinea and Vanuatu. The country consists of a double chain of six major islands, some 30 smaller islands and approximately 962 atolls and cays. The total land area is approximately 28,369 kilometers and the marine area (Exclusive Economic Zone) of 1.34 million square kilometers. Many of the islands are of relatively recently volcanic origin and the Solomon Islands are a part of the Pacific "Ring of Fire". Rivers and streams are numerous on all major islands.

The population of the Solomon Islands is approximately 330,000 with most of the population living in the rural areas. There is an increasing trend to move to the capital of Honiara located on Guadalcanal. Outside of Honiara, other urban areas are quite small with populations less than 2,000. Urban environmental issues such as solid waste disposal, littering, and sewage problems do occur in these areas.

The economy is primarily based in agriculture and industrial activity primarily produces for the domestic market. The exceptions are the tuna canning operation in Noro and the Palm oil facility on Guadalcanal. Environmental issues in the Solomon Islands include population growth, over harvesting of coastal and marine populations, land degradation, improper logging activities, waste disposal, and threats to terrestrial flora and fauna. Mining is a potential environmental concern.

Domestic Wastewater

Domestic wastewater disposal in the Solomon Islands is generally inadequate. Field inspection during site visit revealed urban sewerage in Honiara is very poor. Septic tanks and latrines leach into soils of low porosity and then to rivers, streams, and marine waters. Also, about 75 percent of Honiara's population's domestic wastewater (effluent from individual systems and some direct discharges) enters into a piped collection system which discharges to about 14 outfalls along Honiara's shore. The outfalls are on the beach or extend just a few meters into the water. The resultant bacterial in these areas is very high (Wallis, 1989; Lolemai, 1991). The situation in Gizo and Auki is reported to be very similar (Wallis, 1989). Squatter settlements use latrines, many of which are located over rivers and marine waters. The degree of coverage in urban areas was reported to be 73 percent.

Some of the raw sewage outfalls are located in areas with considerable reef fishing and bathing activities. One outfall discharges into the fishing grounds of an established fishing village which sells the fish to Honiara residents. Adequate sanitation is provided to just 3 percent of the rural population (Guo, 1991) The study assumed that the populations in provinces other than Guadalcanal and the Western Province to use 10 percent septic tanks, 10 percent latrines and 10 percent over-the-water latrines. This assumption was made due to the lack of any other information about the degree of coverage. It is likely that many households have no facilities. These assumptions may not be precise but they provide some insight into the domestic wastewater contribution to marine pollutant loadings. Table B.16 presents the sanitary facility types found in the Solomon Islands and the assumed serviced population for each type. The data is broken down by province. Estimates for pollutant loadings resulting from these facilities is also provided. The total domestic wastewater contribution for the Solomon Islands is estimated at 2,136 thousand tonnes of B.O.D., 1,176 thousand tonnes of suspended solids, 979 tonnes of nitrogen, and 139 tonnes of phosphorous.

Solid Waste

Solid waste disposal in the country is poorly managed. There is no sanitary landfill. The Honiara dump is located in a low lying area adjacent to a river delta and the beach at Ranadi. This waste spreads into the beach area and is washed into the ocean in flood conditions. The effect of littering and other indiscriminate waste disposal is evidenced by the sediment and solid waste delta seen at the mouth of one river in Honiara. The mouth is closed by the accumulation of sediment and trash. In addition to the direct solid waste loading, leachates from the inadequate solid waste disposal sites threaten groundwater supplies and marine water.

Industrial Wastewater

While industrial activity in the Solomon Islands is limited, environmental problems occuras the result of this activity (Leary, 1990). Industrial activity at Tulagi, including the now closed fish cannery, and ship building facility, ship and vehicle repair activities resulted in obvious marine pollution problems. The past and present activity at Tulagi is not quantified in any available data. Industrial activity is now centered at the Ranadi industrial area in Honiara and the fish cannery at Noru.

The fish cannery at Noru processes approximately 8,250 tonnes of canned fish and 2,750 tonnes of fish meal. Anecdotal reports state that the cannery wastes discharge directly to the mangrove and marine areas causing serious environmental problems. The plant is designed witha secondary treatment system. A secondary treatment system for cannery wastes should resultin pollutant reductions of 95 percent. If the treatment system at Noro provides such treatment, the pollutant loadings to the marine environment per year are: B.O.D.: 5.53 tonnes, suspended solids: 4.29 tonnes, nitrogen: 17.35 tonnes, and oils: 3.05 tonnes. If the plant is not functioning these loading become: B.O.D.: 110.6 tonnes, suspended solids: 85.8 tonnes, nitrogen: 17.35 tonnes, and oils: 61 tonnes per year. This conflict demonstrates the importance of adequate treatment to the management of industrial waste.

The palm oil factory on Guadalcanal also discharges wastewater with major pollutant constituents of B.O.D., solids, and oils. The palm oil production of 19,700 tonnes results, with no treatment provided, in a waste production of 490.53 tonnes of B.O.D., 484.62 tonnes of suspended solids, and 555.57 tonnes of oils per year. The discharge plume is visible from the shoreline adjacent to the outfall. Ranadi, on the outskirts of Honiara, is the location of a number of small manufacturing plants. Metal fabrication, paint manufacturing, soft drink manufacturing, and biscuit manufacturing are among the industries located there. A brewery is also planned for Ranadi. No production data was available for any of these facilities. Some of the facilities discharge to septic tanks and most into drainage ditches.

Industrial facilities in the country contribute to the marine pollution loadings, particularly in Noru and Ranadi. Past industrial activity in Tulagi has left behind a polluted harbor. The industrial wasteflows in the Solomon Islands are not well controlled or monitored. The consequences of the lack of control and monitoring demonstrate the need for improvements in this area.

In addition to the direct pollution loading that can result from the existing industrial activities, the fresh water supplies in Honiara are limited. The planned brewery will further stress these supplies.

Agriculture Runoff

Pesticide use and disposal was reported as a concern in the Solomon Islands Environmental Management Strategy (Leary, 1991). The use of fertilizers and pesticides in the country, based on import data, is relatively high for the region. Fertilizer imports are approximately 2,398 tonnes (Stone, 1990), mostly for the oil palm industry and a little for cocoa, and pesticide imports are approximately 493 tonnes per year. This volume of agrochemical imports is second only to Papua New Guinea among the countries with available data. If the assumption is made that 5 percent of these chemicals reach the marine environment, the resultant loading is 119.9 tonnes of fertilizers and 25 tonnes of pesticide. These are formulation quantities not active ingredient quantities. The actual chemical loading to the marine loading is therefore much less, perhaps by a factor of 5 or more.

Sediment laden runoff is also reported as a serious problem due to soil erosion as theresult of agricultural and forestry activities. This loading is probably significant, but is not considered in this report. It is hoped that a concurrent river loading study may provide some quantitative insight into this problem.

Summary

Domestic wastes remain the principle source of pollutant loadings to the marine environment in the Solomon Islands. Numerous public health and environmental health problems are evident as a result of the poor disposal of sewage and solid wastes in the country. The deleterious effects of a small industrial sector on the marine environment are clearly demonstrated here. The industrial sector is small and the relative industrial contribution to pollutant is also small relative to that of the domestic sector, yet the degradation in Tulagi, and apparently, Noru, is clear. This reiterates the cautions stated in the Part 1 of this report regarding the need to examine not only the pollutant loadings but the receiving water conditions as well. The lack of adequate sewage disposal and the associated problem of a limited water supply, subject to contamination from the lack of adequate sewage disposal, requires urgent action. Environmental problems from industrial activity, though clearly requiring attention pose a less urgent threat to the public health. Present pollutant loadings from industrial activities should be monitored to confirm the quantities discharged and to improve treatment facilities where available. New industries should be required to install adequate treatment facilities on site.

TOKELAU

Tokelau consist of three atolls (Fakaofo, Nukunonu, and Atafu) with 127 atoll islets located 400 miles north of Western Samoa. The islands are built up of coral and sand fragments, generally resting on old reef of coral-limerock. Because of the high permeability of the unconsolidated material there is virtually no runoff.

Tokelau has is a subsistence economy with limited commercial activity and little industry e.g., handicraft, cooked toddy and fish. The source of marine pollution is therefore primarily from domestic waste (99.7%), the rest are from fisheries (0.2%) and shops (0.1%). Since fifity percent of the population of 1,600 uses over-the-water latrines (or shoreline use without facilities), all of this waste directly enters the marine waters. The remaining fifty percent of the population utilizes septic tanks. The calculated annual pollutant loads from this population are therefore very simple. BOD loadings are 12 tonnes; suspended solids 28.8 tonnes; nitrogen: 5.9 tonnes and phosphorous; .72 tonnes. This data are also presented in Table B.17.

Based on the information provided by SPREP (Tulega, 1992), 75 % of solid waste generated is decomposable type of waste that usually composted around trees or given to pigs. The remaining 25 % including tires, plastic containers, bottles, outboard motor engine parts, batteries, and corrugated iron roof. Some recycled wastes including as aluminum cans, bottles and batteries are shipped to Apia, Western Samoa.

The most critical issue regarding land-based sources of pollutants to the marine environment is therefore the use of over-the-water latrines and the shoreline without the use of facilities. Continued efforts to provide improved on-land facilities and public education to modify social and cultural habits in this regard is necessary.

TONGA

Tonga is located in the southwestern Pacific Ocean and is comprised of more than 50 islands, divided into four main groups with a total land area of 747 square kilometers. Thirty-six of the islands are inhabited. Most of the islands are coralline, and the few volcanic islands are most notably in the Ha'apai group. The population of Tonga is approximately 97,000.

Tonga is primarily an agriculture-based economy with little industry and a growing tourism sector. The limited industrial sector consists of small manufacturing activities, vehicle and equipment servicing, food processing, beverage production, and garment making. At present, waste management for both the domestic and industrial sectors is primarily the responsibility of the producer.

The key environmental issues for Tonga primarily occur on Tongatapu, the location the capital, Nuku'alofa. Groundwater in the Nuku'alofa area is contaminated from the outflow of septic tanks and latrines. This has resulted in the microbial contamination of some water supplies. The disposal of solid wastes in the coastal area is of concern, particularly at the present site, Pupoa which is adequate in size and located relatively the shoreline. A new site has been identified. This site is also located in a wetland area. The proposed area appears to be a dying wetland area, probably as the result of filling activities.

The great majority of waste generated in Tonga is discharged on land into septic systems, simple pits, or other land facilities. There is limited direct discharge of wastes to the marine environment. Wastes known to be discharged directly into marine waters include: stormwater drainage from central Nuku'alofa, food wastes condemned by the Ministry of Health, and solid wastes (littering) of individual households and persons. The present public dump site in Nuko'alofa is approximately 200 meters from the coastline in a wetland area.

There is only a limited capacity for monitoring and controlling of land-based pollution in Tonga. The environmental office is minimally staffed. The potential for environmental degradation is not considered in a number of government development criteria. Additional hydrogeological information is required to assess the fate and transport of wastes discharged to land.

Domestic Waste

With the exception of systems at the small industries center, the hospital and a boarding school, there is no reticulated sewage system in the country. All domestic wastewater is disposed of in individual disposal systems which range from mechanical flush septic systems to pit latrines. The collection systems at the hospital and boarding school discharge to septic systems. While some of these facilities are located in wetlands and other coastal areas, the number of facilities in coastal versus non-coastal cannot be quantified with the information available to this study. Also, this study has insufficient hydrogeological data to quantify flow through to the marine water. Therefore, it is difficult to accurately quantify the domestic sewage entering the marine waters in Tonga. Nevertheless, the study does provide a reasonable estimate of total waste production and a rough approximation of the pollutant loading to the marine environment. The 30 percent reduction from the total pollutant loading to the marine pollutant loading applied throughout the study may be reasonable accurate for areas very near the shore, but is probably quite high for central island area. The nutritious condition in Fanga'uta lagoon identified by Naidu et al. (1990) has not been substantially affected by human activities. Thus the pollutant transport factors applied throughout this study may overestimate loadings in Tonga. Nevertheless for consistency, these same factors are used. The domestic wastewater facility types and the predicted pollutant loadings are detailed in Table B.18. Total pollutant loadings from domestic wastewater in Tonga is estimated to be 563 tonnes of BOD, 161 tonnes of suspended solids, 344 tonnes of nitrogen and 43 tonnes of phosphorous.

Industrial Waste

In Tonga, the medium size industrial base is the result of a number of small manufacturing centers which utilize imported materials, e.g., the knitwear industry. Coconut processing remains a large industry. The wastes from these industries are mostly in the form of solid waste. The processing of foods and beverages such as biscuits, milk, fruit drinks, and other soft drinks may contribute to BOD., solids and nutrient loadings. These wastes are discharged to septic tanks and dry wells. All of the wastes have the potential of adversely affecting groundwater quality and eventually reaching marine waters. As with domestic wastes the actually loading that reaches the marine environment is difficult to predict. No attempt was made to make such a prediction.

Agricultural Chemicals

Agriculture chemical use in Tonga is increasing but still of relatively small scale. The government recently established a licensing system for pesticides that if implemented and enforced may help reduce concern about the possible contamination of groundwater supplies. Presently, the greatest environmental concern with pesticide use is spills that may occur as the result of improper storage or transport. In 1991, Tonga imported some 431 tonnes of fertilizers and just 15 tonnes of various pesticides.

Summary

In Tonga, there are a minimal number of direct discharges of pollutant from land to the marine water. The discharge of pollutants appears to more directly affect ground water than marine waters. This would eventually affect the marine environment, but the magnitude and type of affect is not easily predicted. Even with this uncertainty as to the affect of land discharges of pollutants, the lack of an adequate program for the monitoring and control of pollution, the potential for significant environmental problems is always present.

In order to improve the waste management strategies in Tonga it is necessary to carry out more extensive monitoring program for ground water quality. The pollutants associated with the established industries should be targeted as priority pollutants for analysis. Once this is established further efforts should address the potential fate and transport of the identified pollutants.

VANUATU

The Republic of Vanuatu is an archipelago comprised of some 80 islands scattered over a distance of 900 kilometers from north to south and lies west of Fiji and north of New Caledonia. Most of the islands are mountainous and are relatively young geologically. There is an abundance of rainfall, averaging about 2200 millimeters per year, but there are few perennial streams. This is probably the result of their small size and rugged topography. Eighty percent of the 142,944 population live in rural areas.

The economy is primarily agricultural based and beef, copra, and fish remain the primary exports. Industrial scale logging also occurs as well as a small industrial sector that is found in Port Vila. A brewery, soft drink manufacturer, canned meat manufacturer, biscuit factory, and a number of manufacturers and commercial operations also contribute to the economy.

In Vanuatu, environmental issues include marine degradation and erosion and sedimentation that primarily affects the rural population, and sewage contaminated lagoons in the urban area of Port Vila. Industrial contribution to marine environmental problems is still quite small.

Domestic Wastewater

Domestic wastewater, or sewage, disposal in Vanuatu is one of the more serious environmental concerns in Vanuatu, particularly in urban areas. In 1990, the level of coverage with adequate sanitation in Vanuatu as 86 percent for urban areas and 34 percent in rural. The prevalence of water-related diseases in the country suggests that the public health and environment is affected by the level of coverage and type of sanitation facilities provided.

Studies identify poorly functioning sanitary facilities together with rapid groundwater flow as the causes of the microbial and nutrient pollution in the lagoons around Port Vila (Sinclair-Knight, 1991; Royds Garden, 1990). The uncontrolled flow of nutrient and bacterial contamination combined with the poor natural flushing in these lagoons results in decreased oxygen concentrations, high turbidity, and contaminated marine food resources.

Table B.20 shows the pollutant loadings to the marine environment. These calculations utilized facility data from the previous studies (Sinclair-Knight, 1991; Royds Garden,1990); however, WHO method loading rates were applied. It is interesting to note that the previous studies used a pollutant transport rate of 85 percent rather than the 70 percent used by this study. The method predicted total annual pollutant loadings from domestic waste as 817.8 tonnes of BOD, 560 tonnes of suspended solids, 457 tonnes of nitrogen, and 58.4 tonnes of phosphorous.

Industrial Wastewater

Vanuatu's industrial sector is relatively small but is approaching medium-scale on a regional level. With the exception of the beef, fish freezing, and timber industries, the manufacturing industry is almost exclusively for local consumption. Industries for the domestic market include, soft drink manufacturing, printing, small cement works, brewery, soap manufacturing, garment manufacturing, baked goods, milk production, boat building. Table C.20 lists the industries included in the WHO method and the resultant pollutant load calculation for these industries where production data was available.

Waste management in the industrial sector is minimal. The exception to this is the abattoir at Port Vila (Santo abattoir was not visited). The Port Vila abattoir provides secondary treatment for its wastes in anaerobic lagoons. The facility itself is kept very clean. This is necessary to meet international food sanitation requirements. The brewery and soft drink manufacturing facilities utilized septic tanks for their waste effluents. Simple treatment through septic tanks or settling tanks can be effective for these kinds of waste, however, the septic tanks at these facilities appeared to be undersized. Overflow and seepage was observed at both facilities. Overflow from the area enters allow marshy area with eventual discharge into the nearby bay.

Numerous small wastewater producing activities such as laundries, printers, restaurants, and photo shops discharge their wastes to overflowing septic tanks or directly to storm drains. Quantification of this waste was not possible. As with the domestic waste flows, better designed septic tanks and individual systems would reduce the pollutant loadings from these sources.

The industrial contribution to the marine pollutant loading appears to be relatively small. The present marine water quality problems around Port Vila, however, warrant reductions wherever possible. Few studies have been conducted for other than nutrient and sediment pollution in the marine areas of Port Vila.

Solid Waste

Solid waste disposal, as elsewhere throughout the region, is poor in the urban centers of Vanuatu. The Port Vila dump at Fres Wata is of particular concern as it is located over a water supply. Also, in Port Vila, debris from a hurricane was allowed to be dumped directly into the harbor area. Presumably this filled area could then be used to extend the public works yard area. The high organic content of this largely green waste contributes to the nutrient loading of the harbor. (Sinclair-Knight, 1991).

Agricultural Runoff

Agrochemical use in Vanuatu is small considering the large agricultural sector. Only some tonnes of fertilizers and approximately tonnes of pesticides are imported each year. (Stone, 1992). Agrochemical use is not encouraged by the Agriculture Department nor its Plantation Project, which encourages integrated pest management procedures, using the right crops and grasses together to minimize weeds. The study estimates that less than 6 tonnes of fertilizers (nitrogen and phosphorus) and less than 1 tonne of pesticides per year enter the marine environment. The heavy use of DDT and other mosquito-control pesticides that are sprayed as part of a malaria prevention program may contribute greater quantities of pesticides to the environment than agriculture. This was not calculated, but might be considered for future study.

Summary

Domestic wastes, sewage and solid wastes are the major contributors to marine pollutants. This is illustrated in Figure 1 below. As in other countries of the region, industrial contributions appear to be growing but large loadings from this sector have not been identified. Waste management practices should continue to be improved in both sectors. Simple management practices in the present industrial sector are probably sufficient, if properly designed. It is also critical that data on industrial activity be collected and analysed routinely to monitor the importance of this sector to environmental quality.

WALLIS AND FUTUNA

Wallis and Futuna has a population of approximately 9,500. The total land area of the country is 26 square kilometers. Funafuti, the capital, is made up of 30 islets and is 20.8 kilometers by 16 kilometers.

The economy is subsistence based with only a few retail shops to support the local populations. As such the land-based contribution is limited to domestic waste. No information was available on the types of facilities and populations using them. It was assumed that all persons use latrines. All calculations were based on land-based latrines. It is expected, however, that there is a great use of over -the-water latrines and direct disposal to the beach. Therefore, the calculated annual pollutant loadings of BOD 36 tonnes; suspended solids 16 tonnes; 23 tonnes of nitrogen and 2.8 tonnes of phosphorous, are probably low. These data are also presented in Table B.21.

WESTERN SAMOA

Western Samoa consists of two major islands and several smaller islands including a total land area of approximately 2,934 km^2. The main islands are Upolu and Savaii. Western Samoa has a population of around 165,000 with over seventy percent of the population living on Upolu. Apia, with a population of approximately 33,000, is the capital and urban center. It has no official status a municipality and is made up of a number of traditional villages.

The islands are mountainous and volcanic in origin. These high islands also have a flat to gently sloping coastal plain. Rainfall varies 2,200 mm in northwesterly parts of the main island to over 6,000 mm in the highlands of Savaii. The hydrogeologic properties of the island are highly variable. Systemic collection of hydrological data only began in 1971 (UN DTEC, 1983). There is significant spatial and temporal variations in the elevation and characteristics of the groundwater table. These variations make it difficult to predict rainfall-run-off regimes (UN DTEC, 1983).

Employment is generally based around a subsistence economy. Apia also has a more urban economy with government employment and a number of small industries and manufacturers. Land-based pollution sources in the rural areas centre around land clearing activities, agriculture, and domestic waste. Land-clearing likely has the greatest effect. Transport of pollutants from domestic wastes from land-based individual systems (eg. latrines) can be somewhat mitigated by the low population densities. However, problems may occur where populations are concentrated in small coastal areas. Pollution of marine areas around Apia results from ongoing discharge of urban waste from a variety of sources. Urban waste sources include domestic waste, sewage, small industry wastewaters, and larger facilities such as breweries and bottling plants.

Identified land-based pollution sources in Western Samoa are discussed below. As with the regional study, only on-going activities are included. Land clearing for construction and agricultural activities while significant are not specifically included. It is expected that a reasonable estimate of the magnitude of this source will be provided through the river inputs component of this study.

The relative contribution and importance of these various sources are discussed after the discussion of the specific sources.

Domestic Wastewater

The Apia area is the only urban area of Western Samoa and the greatest volumes of domestic waste are discharged from this area. There are limited details regarding the location and type of sanitary facilities and determination of the pollutant loadings potentially reaching marine waters from rural areas is difficult to calculate. In most rural areas it may be assumed that the assimilative capacity of receiving soils and waters will minimize environmental problems. However, since the population in rural areas is concentrated in coastal areas, and ifacilities are concentrated near the shoreline, localized pollution problems may occur.

There is no existing public sewerage system in Apia and the majority of the population is served by on-site facilities. Small individual sewerage treatment systems are in-place at the hospital, hotels, brewery, and some commercial facilities. Residential facilities are served by simple on-site facilities.

Residential facilities include four main types, septic tanks, water-seal latrines, pit latrines, and primitive latrines without pits (usually located at drains and streams). The types of facilities and the estimated population using each type are shown in Table B.22. Septic tanks and associated soakage facilities are rarely properly designedand usually consist of single compartment tanks which are not adjusted for number of persons connected. Soakage pits, if used are also not sized for population using the facility and inlet and outlet piping to the facilities are often incorrectly placed. Treatment efficiencies of properly designed septic tanks is on the order of 30 percent. As such, the groundwater in the Apia region is highly contaminated from the septic tanks and other individual facilities. The septic tanks function without visible problems because of the high percolation rates in most areas. In areas with high percolation rates, groundwater movement is likely to result in the pollution of near-shore waters. According to SPREP, no serious attempt has been made to determine and identify water tables amd water lenses throughout the country (Tulega, 1992).

In low lying areas in Apia, such as Fugalei and Saleufi, poor percolation rates in conjunction with poor drainage results in wastewater ponding and flowing on the surface. Much of this polluted surface water makes its way to the nearshore waters.

In order to estimate the loading from domestic wastewater to marine areas, some broad assumptions must be made regarding the composition of the wastewater, treatment efficiencies, and potential for the wastewater to reach the marine waters. The composition of wastewaters follows that used throughout the study and described in Section 3.1 of the main body of this report.

The only institution served with a sewerage system plant is the hospital; all other institutions are served by septic tank or latrine systems. The hospital system consists of an imhoff tank and trickling filter. The plant dates from the first half of this century and presently provides absolutely minimal treatment. Replacement of the plant is now underway and should be completed before this report is issued. Discharge from the plant enters the Mulivai stream. Much of the wastewater reaches the near-shore area with little self-purification occurring. Wastewater flows from this facility are based upon an assumed average patient population.

The Tusitala Hotel and Vailima Brewery operate small sewage treatment systems. The Tusitala Hotel utilizes an oxidation ditch and the brewery a sedimentation tank. Mechanical difficulties result in poor to no treatment of the wastewaters. The brewery's sedimentation tank is overloaded and the wastewater overflow discharges directly to Vaiusu Bay. The Aggie Grey Hotel utilizes a septic tank and soakage field system; there have been no problems reported at the facility.

Industrial Wastewater

There are only approximately 75 manufacturing businesses in Western Samoa. In 1986, the food and beverage industries accounted for 36 percent of these businesses. Wood and paper industries were 31 percent of the total which was approximately 73 businesses (UNIDO, 1989, pg 131). The veneer industry has reported no production since 1987 and production in the timber industry declined 40 percent between 1986 and 1989. There has also been two new developments that effect the composition of manufacturing industries in Western Samoa. These are the establisment of a second brewery and a wire harness plant. Thus, the food and beverage industries account for a greater share of the manufacturing in Apia and a much larger share in the assembly sector. Other smaller industries include, paint manufacturing, printers, photo shops, cigarette manufacturing, shoes and industrial gas production.

These smaller facilities are significant to the study of land-based pollution sources of marine pollution. Some of these industries have "wet processes" which involve the use of chemicals and other toxic materials. Printers, for example, utilize solvent, acids and alkalis, silver, and inks that are discharged directly into drains withour treatment. Another example of relatively small facility with potentially significant wastewater flows is the abbotoir. Wastewater from the abbotoir flows directly to the ocean with no treatment. Due to the lack of community sewerage system, these discharges enter at the coastline. Other small industries have "dry processes". Waste from these industries contribute to the required capacity of community solid waste disposal sites. In an uncontrolled or poorly sited landfill this may contribute to marine pollution problems through changes to leachate quantity and composition. Metal wastes, battery disposal, and dye or solvent contaminated materials may contribute heavy metals, acids, alkalais, and solvents to leachate. These industries also contribute to wastewater flows through the sanitation facilities for employees.

Petroleum and lubricant products are distributed from two locations in Wester Samoa, Mobil and British Petroleum. Bulk fuels such as aviation fuels, gasoline, and diesel are pumped from the tankers to land via a submarine pipeline. This pipeline must be cleared of seawater before each shipment prior to the pumping of fuels to shore storage tanks. The seawater is contaminated with oils and other petroluem products. The contaminated water is treated in an oil water separator prior to discharge to the marine environment. The separation process is not complete and some oil remains in the effluent discharged to the ocean. Total discharge is estimated at 70 tonnes every month (Perval report through Tulega, personal communication, 1992).

Limited information on the production rates and information on waste water flows form the industries is available (see regional report for discussion on industrial statistics and data needs). As noted in the regional discussion, the quantification of pollution sources is thus very difficult. This is particularly true for the smaller industries where production rates are generally not maintained, e.g., printers. Table C.21 provides a summary of the major industries identified and information on production and waste volumes, if known.

Solid Waste

Solid waste contributes to land-based pollution through the direct discharge of the waste to the marine environment, litter waste carried to nearshore waters with runoff, and leachate production. It is difficult to quantify the amount of solid waste reaching the marine environment through any of these means. Therefore, the contributions must be discussed in more qualitative terms.

The current dump at Vaitola is being closed by the government. This dump is located in a mangrove area. There is no operation or maintenance of the facility and this facility is considered a significant pollution source. A new tipping site at an inland location has been identified and should be operational prior to issuance of this report. This site should should have much lower impact on near-shore waters. The leachate flow to the groundwater and on to the nearshore waters will depend on the local soil conditions and hydrogeological conditions which have not been determined. No estimates of waste volumes were available for this report.

Agricultural Runoff (Pesticides And Fertilizers)

As in the regional repor,t the risks from pesticide use appear to rest primarily with occupational health rather than environmental damage or risk to the general public health. Fertilizer use in Western Samoa is very limited. Only 22 percent of all farm holdings reported using fertilizers in 1989 (W.Samoa, Agriculture Department, 1990). Pesticide use was greater, with some 59 percent of the holdings using pesticides. This level of use is not very high by world standards.

Lacking detailed information regarding location of use, application rates, and other information for modeling concentrations in runoff, agricultural chemical loadings on the marine environment were estimated using a percentage of the quantity of applied chemicals. The volume of chemicals applied is assumed to be the same as the volumes imported. Official totals for the amount of pesticides imported was not available, however, one report indicated pesticide imports totalling 252 tonnes and 44500 litres (Taylor, 1991). This report also indicated that excess pesticides are poured into ditches and on the ground near streams. However, the relatively high costs of pesticides and the low average income likely minimizes the amount of excess pesticides that are disposed of in this manner.

Summary

The land-based pollution sources survey in Western Samoa provides a foundation for analysis of waste management and marine pollution control strategies. Though the information is qualitative in nature, it provides a description of the magnitude of a number of sources and their relative importance.

Domestic wastewater, as expected, remains the primary contributor of wastes to the marine environment. Industrial and manufacturing contributions, while small in quantity are of concern because of the chemical and toxic nature of the waste. The cumulative effect of these discharged chemicals is unknown. No testing has been conducted in regards to quantification of waste flows nor in regards to determining contaminant concentrations in streams and near-shore waters. Pesticide and fertilizer contributions are slight.

Domestic wastewater contributions to the pollutant loading of the marine waters of Western Samoa should be addressed. A sewerage collection system is necessary for significant improvement around Apia. Primary treatment should be provided, if feasible. If this is not feasible, the discharge outfall should be sited and design so that effluent is discharged below the thermocline in areas of good circulation. Major business such as the brewery, wire assembly plant, and large hotels should be required to improve their individual systems.

In residential areas that cannot be sewered, designs and location for new facilities should be approved prior to construction to determine the appropriateness of the system and the capability of soils at the site to accept the wastes. This should apply to rural areas as well as Apia.

As a start to managing industrial wastes, it is encouraged that the local industries be required to submit annual reports to the environment department that include information on the industry process, raw materials used, waste generated, water use, and waste generation. Government officials should work with industry representatives to determine appropriate management practices based on the collected data. A permit program may be established to ensure compliance with these procedures. To the extent possible the use of hazardous materials should be limited through materials substitution, recycling, and good housekeeping or maintenance procedures. For example, silver recovery is possible, and profitable from x-ray films and photographic processing. Solvents used in paint production, dry cleaning, and printing industries can be recycled and used in the same facility. The discharge of chemical wastes into storm drains should be prohibited since these often lead directly to the ocean or other surface waters.

The two large facilities for petroleum products should be monitored to determine the amount of petroleum products that pass through, or bypass completely, the oil water separator. If the oil water systems are determined to be ineffective, the companies should be required to upgrade the system as necessary. The current practice of waste oil reuse should be monitored to determine if sny improper disposal is occuring or if the reuse might result in the dishcarge of oil to surface waters.

The new solid waste landfill (dump) should be monitored to determine types and quantities of wastes disposed. This information can be used to determine life of the facility, potential characteristics of leachate, and management practices that may be rewuired at the facility. Daily, or as often as practical, cover should provided.

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APPENDIX A
LIST OF INDIVIDUALS CONTACTED

APPENDIX A
PERSONS CONTACTED

The following is a list of individuals contacted in regards to the Land-Based Pollutants Inventory. Those individuals with an asterisk adjacent to their name were contacted via mail or facsimile communication only. Much gratitude is extended to all who provided information for this study. This list, unfortunately, may be incomplete and to those individuals who are not named but assisted in the study please accept the author's apologies and gratitude for your assistance.

REGIONAL LEVEL

Dr. John Morrison, Ph.D.	Wollongong University, BHP Professor of Environmental Science
Mr. Laisiasa Tulega	Environmental Contaminants Officer, SPREP
Mr. Len Newell	Pacific Forester, U.S. Forest Service
Mr. Michael Lee	U.S. Environmental Protection Agency, Office of Pacific Island and Native American Programs
Mr. Chalapan Kaluwin, Ph.D.	Specialiste des changements climatiques

COUNTRY LEVEL

American Samoa

Mr. Pati Fai'ai	Executive Director, American Samoa EPA SPREP Focal Point
Ms. Sheila Weigman	Technical Advisor, American Samoa Environmental Protection Agency
Mr. Richard D. Hansen, D.C.	Soil Conservation Service, U.S. Department of Agriculture
Mr. Tuvalu T. Teleni, S.C.	Soil Conservation Service, U.S. Department of Agriculture
Mr. Dan Ma'ileoi, S.C.T.	Soil Conservation Service, U.S. Department of Agriculture

Commonwealth of Northern Mariana Islands

Planning and Budget Affairs Officer* Office of the Governor, SPREP Focal Point

Cook Islands

Mr. Teariki Rongo*	Director of Conservation, Ministry of Internal Affairs and Conservation, SPREP Focal Point

The Federated States of Micronesia

The Secretary*	Department of External Affairs, FSM National Government, SPREP Focal Point
Mr. Nachsa Siren*	Environmental Health Coordinator, Ministry of Health

Fiji

Mr. John Teiwa	Permanent Secretary for Housing and Development, SPREP Focal Point
Mr. Dick Watling	Environmental Management Strategy Project
Mr. Jamir Khan	Lautoka Town Clerk
Mr. David Chandra	Chief Health Officer
Mr. Tui Cavuilatu	Agriculture Department
Mr. Jan Bronders, Ph.D.	Mineral Resources Department
Mr. Iliasa ~~Senmoli~~ Semiloli	Ports Authority
Mr. ~~Alii~~ M. H. Ali	Lautoka Rural Authority
Mr. David Green, Ph.D.	Director, Institute of Natural Resources University of the South Pacific
Dr. John Skoda	UNDP Fiji
Mr. David Narayan	Lautoka Senior Health Inspector
Mr. Jay S. Gawander	Senior Research Scientist, Fiji Sugarcane Research Centre
~~Mr. Bernard Telei~~	~~Senior Environmental Officer, Ministry of Natural~~ Resources — Solomons
Mr. Uraia Lesu	Chief Health Inspector, Ministry of Health
Mr. Percy Wijenayake	Senior Engineer Sewerage, Public Works Department

French Polynesia

Monsieur Pierre Dehors*	Ministere de la qualite de la vie, et de la culture, de l'environment et des transports terrestres, SPREP Focal Point
Mr. Allen Sands	Director, Vanuatu Agricultural Supplies Limited

Guam

Mr. Fred Castro*	Administrator, Guam Environmental Protection Agency, SPREP Focal Point

Kiribati

Ms. Tererei Abete*	For the Secretary for Environmental and Natural Resource Department, SPREP Focal Point

Nauru

*Secretary for Foreign AffairsDepartment of External Affairs,SPREP Focal Point

New Caledonia

Monsieur le deleque du gouvernement*	Haut-Commissaire Del la Republique en Nouvelle-Caledonie, SPREP Focal Point

Niue

SPREP Focal Point	Secretary to Government, Administrative Department, Government of Niue

Palau

Mr. Demei Otobed	Chief of the Division of Conservation and Entomology, SPREP Focal Point
Mr. Lucio Abraham	Assistant Executive Officer, PEQPB

Papua New Guinea

Mr. Iamo Ila	Secretary, Department of Environment and Conservation
Mr. Kirpal Singh*	Professor, Chemistry Department, University of Papua New Guinea

Pitcairn

Mr. Iain C. Orr*	Deputy High Commissioner
Ms. Barbara Proctor*	Second Secretary (Chancery)

Republic of Marshall Islands

Mr. Kasuo Helgenburg*	General Manger, RMI Environmental Protection Authority

Solomon Islands

Mr. Henry Isa	Principle Environment Officer, Ministry of Natural Resources, SPREP Focal Point
Mr. Levi M. Laka	Honiara Municipality
Mr. Victor Ngele	Minister of Natural Resources
Mr. Mostyn Habu	Permanent Secretary to The Minister of Natural Resources
Mr. John Wooden	School of Natural Resources, College of Education
Mr. Allan Fiku	Statistics Officer
Mr. Tom Lolemai	Chief Health Inspector
Mr. Figuery	Principal Health Inspector
Mr. Russell Abrams	WHO Consultant
Mr. Milton Sibisopere	Public Relations Officer, Solomon Taiyo

Tokelau

Mr. Suia Pelasio*	Environment Officer, Office for Tokelau Affairs
Mr. Foua Toloa*	Director of Agriculture and Fisheries, SPREP Focal Point

Tonga

Mr. Sione Latuila Tongilava*	Secretary for Lands, Survey, and Natural Resources, SPREP Focal Point
Mrs. Netatua Prescott Fifita	Ecologist and Environmentalist, Ministry of lands Survey, and Natural Resources
Mr. Pocea Havea	Section Head, Meteorological Office
Mr. Malin Takai	Ministry of Public Works
Mr. Filipe Koloi	Water Board
Ms. Elona Amanak	Ministry of Agriculture
(name uncertain)	Government Printing Office
Mr. Paul Karalus	Manager, Private Farm Supply Shop
Mr. Penisimani L. Latu	Manager Small Industries Park

Tuvalu

Mr. Alefaio Semese	Environmental Officer
Secretary to the Government	Office of the Prime Minister, SPREP Focal Point

Vanuatu

Mr. Ernest Bani	Principal Environment Officer, Environment Unit Ministry of Home Affairs, SPREP Focal Point
Mr. Stuart Hardfield	National Government Planning Office
Mr. Benuel Tarilongi	Quarantine Officer, Agriculture Department

Ms. Catherine MacCaan	Livestock Officer, Agriculture Department
Mr. David McFarlane	Manager, Pasture Improvement Project
Mr. Cedric Mortimer	Director, Hydrogeology Department
Ms. Kathy Fry	Foundation for The Peoples of the South Pacific
Mr. Seth Kaurua	Foundation for The Peoples of the South Pacific
Mr. Philippe Metois	Clown Fish Foundation
Ms. Marilyn Temakon	Department of Industries
Mr. Michael Vari	Senior Environmental Health Inspector, Environmental Health
Mr. Tony Ata	Environmental Health Officer, Port Vila Municipality
Mr. David Blaike	Senior Planning Advisor, National Government Planning Office
Captain Hemmish Norris	Ports Authority

Wallis and Futuna

Monsieur le Prefet	Administrateur superieur du Territorie, Mata 'Utu

Western Samoa

Mr. Fiu Mataese Elisara Laulu	Director, Department of Lands and Survey and Environment, SPREP Focal Point
Ms. Malama Hadley	Personal Assistant to Director
Mr. Frank Fong	Economic Analysis Planning Unit
Mr. Dick Carpenter	Manager, Apia Bottling
(name uncertain)	Managing Director, Public Works Department
Mr. Roger Hazaelman	Senior Project Officer, Department of the Treasury
Mr. Mutatanaga Amansa	Trade and Commerce Department
Mr. Paafolo Taafuli	Department of Statistics
Mr. Albert Peters	Chief of Crops, Department of Agriculture
Mr. Tapeni S. Tenari	Health Inspector
Mr. Kevin Doig	G.K. Co. Consultants
Mr. Trevor Gregory	General Manager, Hellaby Samoa
Mr. Roger Cornforth	Environment Planning Advisor, Division of Environment and Conservation
Mr. Samuelu Sesega	Principal Environmental Officer, Department of Lands Surveys & Environment

APPENDIX B
WORKING TABLES FOR
DOMESTIC WASTEWATER

Table B.1 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area AMERICAN SAMOA Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Utulei		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	9,520	Sewered: Secondary	pers.	12.7	72,096	20	92,503	3.3	27,018	0.4	1,523
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Tafuna		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	6,000	Sewered: Secondary	pers.	12.7	72,900	20	127,767	3.3	17,028	0.4	960
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Rural		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	13,740	Septic tanks	pers.	6.9	75,845	16	153,888	3.3	43,075	0.4	5,221
	3,500	Latrines	pers.	6.9	19,320	16	39,200	3.3	10,972	0.4	1,330
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	72,096	92,503	27,018	1,523
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	72,096	92,503	27,018	1,523
	0	0	0	0
	0	0	0	0
	72,900	127,767	17,028	960
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	72,900	127,767	17,028	960
	0	0	0	0
	0	0	0	0
	0	0	0	0
	53,091	0	34,460	4,177
	19,320	39,200	10,972	1,330
TOTAL	72,411	39,200	45,432	5,507
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
COUNTRY TOTAL	217,407	259,470	89,478	7,990

Table B.2 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area COMMONWEALTH OF THE NORTHERN MARIANAS ISLANDS Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Sadog Tase		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Central Syste		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	12,896	Sewered: Secondary	pers.	12.7	32,756	20	51,584	3.3	36,599	0.4	2,063
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Agingan Pt.		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Southern Syst		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	25,872	Sewered: Secondary	pers.	12.7	65,715	20	103,488	3.3	73,425	0.4	4,140
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Other Areas		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	230	Septic tanks	pers.	6.9	1,270	16	2,576	3.3	721	0.4	87
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	32,756	51,584	36,599	2,063
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	32,756	51,584	36,599	2,063
	0	0	0	0
	0	0	0	0
	65,715	103,488	73,425	4,140
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	65,715	103,488	73,425	4,140
	0	0	0	0
	0	0	0	0
	0	0	0	0
	889	0	577	70
	0	0	0	0
	0	0	0	0
TOTAL	889	0	577	70
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	99,359	155,072	110,600	6,273

Table B.3 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area COOK ISLANDS Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Raratonga		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	9,580	Septic tanks	pers.	6.9	52,882	16	107,296	3.3	30,033	0.4	3,640
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Aitutaki		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
	2,335	Latrines	pers.	6.9	12,889	16	26,152	3.3	7,320	0.4	887
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Mangaia		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
	1,364	Latrines	pers.	6.9	7,529	16	15,277	3.3	4,276	0.4	518
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Other Island		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
	4,771	Latrines	pers.	6.9	26,336	16	53,435	3.3	14,957	0.4	1,813
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Tourists		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	515	Septic tanks	pers.	6.9	2,843	16	5,768	3.3	1,615	0.4	196
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	37,017	0	24,027	2,912
	0	0	0	0
	0	0	0	0
TOTAL	37,017	0	24,027	2,912
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	9,022	0	5,856	710
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	7,529	15,277	4,276	518
	0	0	0	0
TOTAL	7,529	15,277	4,276	518
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	18,435	0	11,966	1,450
	0	0	0	0
TOTAL	18,435	0	11,966	1,450
	0	0	0	0
	0	0	0	0
	0	0	0	0
	1,990	0	1,292	157
	0	0	0	0
	0	0	0	0
TOTAL	1,990	0	1,292	157
COUNTRY TOTAL	64,972	15,277	41,560	5,038

Table B.4 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area FEDERATED STATES OF MICRONESIA Year Prepared 1992 Page 1 of 2

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Pohnpei	14,120	Sewered: no treatment	pers.	12.7	179,324	20	282,400	3.3	46,596	0.4	5,648
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	3,165	Septic tanks	pers.	6.9	17,471	16	35,448	3.3	9,922	0.4	1,203
	15,825	Latrines	pers.	6.9	87,354	16	177,240	3.3	49,611	0.4	6,014
	2,110	over water latrine	pers.	6.9	14,559	16	33,760	3.3	6,963	0.4	844
Yap		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	1,100	Sewered: Secondary	pers.	12.7	14,765	20	11,799	3.3	3,122	0.4	176
	1,523	Septic tanks	pers.	6.9	8,407	16	17,058	3.3	4,775	0.4	579
	7,617	Latrines	pers.	6.9	42,046	16	85,310	3.3	23,879	0.4	2,894
	1,015	over water latrine	pers.	6.9	7,004	16	16,240	3.3	3,350	0.4	406
Chuuk	9,000	Sewered: no treatment	pers.	12.7	114,300	20	180,000	3.3	29,700	0.4	3,600
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	6,232	Septic tanks	pers.	6.9	34,401	16	69,798	3.3	19,537	0.4	2,368
	31,161	Latrines	pers.	6.9	172,009	16	349,003	3.3	97,690	0.4	11,841
	5,461	over water latrine	pers.	6.9	37,681	16	87,376	3.3	18,021	0.4	2,184
Kosrae		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	1,100	Sewered: Secondary	pers.	12.7	22,231	20	16,590	3.3	3,122	0.4	176
	1,002	Septic tanks	pers.	6.9	5,531	16	11,222	3.3	3,141	0.4	381
	5,013	Latrines	pers.	6.9	27,672	16	56,146	3.3	15,716	0.4	1,905
	668	over water latrine	pers.	6.9	4,609	16	10,688	3.3	2,204	0.4	267
Tourists	7,518	Sewered: no treatment	pers.	12.7	95,479	20	150,360	3.3	24,809	0.4	3,007
Pohnpei		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	179,324	282,400	46,596	5,648
	0	0	0	0
	0	0	0	0
	12,230	0	7,938	962
	61,148	0	39,689	4,811
	14,559	33,760	6,963	844
TOTAL	267,260	316,160	101,186	12,265
	0	0	0	0
	0	0	0	0
	14,765	11,799	3,122	176
	5,885	0	382	463
	29,432	0	19,103	2,316
	7,004	16,240	3,350	406
TOTAL	57,085	28,039	25,957	3,361
	114,300	180,000	29,700	3,600
	0	0	0	0
	0	0	0	0
	24,080	0	15,630	1,895
	172,009	349,003	97,690	11,841
	195,466	208,039	71,287	8,855
TOTAL	505,855	737,042	214,306	26,191
	0	0	0	0
	0	0	0	0
	22,231	16,590	3,122	176
	3,872	0	2,513	305
	19,370	0	12,573	1,524
	4,609	10,688	2,204	267
TOTAL	50,082	27,278	20,412	2,272
	95,479	150,360	24,809	3,007
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	95,479	150,360	24,809	3,007

Table B.4 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area FEDERATED STATES OF MICRONESIA Year Prepared 1992 Page 2 of 2

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Tourists		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Yap		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	3,901	Sewered: Secondary	pers.	12.7	9,909	20	15,604	3.3	11,071	0.4	624
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Tourists		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Chuuk		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	6,923	Sewered: Secondary	pers.	12.7	17,584	20	27,692	3.3	19,647	0.4	1,108
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Tourists		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Kosrae		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	1,763	Sewered: Secondary	pers.	12.7	0	20	7,052	3.3	5,003	0.4	282
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	9,909	15,604	11,071	624
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	9,909	15,604	11,071	624
	0	0	0	0
	0	0	0	0
	17,584	27,692	19,647	1,108
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	17,584	27,692	19,647	1,108
	0	0	0	0
	0	0	0	0
	0	0	4,003	226
	0	0	0	0
	0	0	0	0
	17,584	27,692	23,650	1,333
TOTAL	17,584	27,692	27,653	1,559
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	1,010,930	1,314,263	433,970	49,762

Table B.5 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area FIJI Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Suva City		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
(Raiwaqa plant)	15,000	Sewered: primary	pers.	12.7	127,635	20	120,000	3.3	45,788	0.4	5,400
(Kinoya plant)	50,000	Sewered: Secondary	pers.	12.7	127,000	20	200,000	3.3	141,900	0.4	8,000
	44,700	Septic tanks	pers.	6.9	246,744	16	500,640	3.3	140,135	0.4	16,986
	1,368	Latrines	pers.	6.9	7,551	16	15,322	3.3	4,289	0.4	520
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Lami		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	14,100	Septic tanks	pers.	6.9	77,832	16	157,920	3.3	44,203	0.4	5,358
	2,607	Latrines	pers.	6.9	14,391	16	29,198	3.3	8,173	0.4	991
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Suva		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
(other)		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	26,100	Septic tanks	pers.	6.9	144,072	16	292,320	3.3	81,823	0.4	9,918
	4,105	Latrines	pers.	6.9	22,660	16	45,976	3.3	12,869	0.4	1,560
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Nadi		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	9,000	Sewered: Secondary	pers.	12.7	22,860	20	36,000	3.3	25,542	0.4	1,440
	3,732	Septic tanks	pers.	6.9	20,601	16	41,798	3.3	11,700	0.4	1,418
	2,488	Latrines	pers.	6.9	13,734	16	27,866	3.3	7,800	0.4	945
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Ba		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	6,500	Septic tanks	pers.	6.9	35,880	16	72,800	3.3	20,377	0.4	2,470
	3,760	Latrines	pers.	6.9	20,755	16	42,112	3.3	11,788	0.4	1,429
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	127,635	120,000	45,788	5,400
	127,000	200,000	141,900	8,000
	172,721	0	112,108	13,589
	5,286	0	3,431	416
	0	0	0	0
TOTAL	432,642	320,000	303,226	27,405
	0	0	0	0
	0	0	0	0
	0	0	0	0
	54,482	0	3,536	4,286
	10,073	0	6,538	793
	0	0	0	0
TOTAL	64,556	0	10,075	5,079
	0	0	0	0
	0	0	0	0
	0	0	0	0
	100,850	0	65,459	7,934
	22,660	45,976	12,869	1,560
	165,406	0	75,533	13,013
TOTAL	288,916	45,976	153,861	22,508
	0	0	0	0
	0	0	0	0
	22,860	36,000	25,542	1,440
	14,420	0	9,360	1,135
	9,614	0	6,240	756
	0	0	0	0
TOTAL	46,894	36,000	41,142	3,331
	0	0	0	0
	0	0	0	0
	0	0	0	0
	25,116	0	16,302	1,976
	14,529	0	9,430	1,143
	0	0	0	0
TOTAL	39,645	0	25,732	3,119

Table B.5 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area FIJI Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Lautoka		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	24,500	Sewered: Secondary	pers.	12.7	62,230	20	98,000	3.3	69,531	0.4	3,920
	8,734	Septic tanks	pers.	6.9	48,212	16	97,821	3.3	27,381	0.4	3,319
	5,822	Latrines	pers.	6.9	32,137	16	65,206	3.3	18,252	0.4	2,212
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Labasa		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	5,000	Sewered: Secondary	pers.	12.7	12,700	20	20,000	3.3	14,190	0.4	800
	6,922	Septic tanks	pers.	6.9	38,209	16	77,526	3.3	21,700	0.4	2,630
	4,614	Latrines	pers.	6.9	25,469	16	51,677	3.3	14,465	0.4	1,753
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Sigatoka		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	500	Sewered: Secondary	pers.	12.7	0	20	2,000	3.3	1,419	0.4	80
	2,538	Septic tanks	pers.	6.9	14,010	16	28,426	3.3	7,957	0.4	964
	1,692	Latrines	pers.	6.9	9,340	16	18,950	3.3	5,304	0.4	643
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Tavua		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Levuku		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	1,336	Sewered: primary	pers.	12.7	11,368	20	10,688	3.3	4,078	0.4	481
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
	890	Latrines	pers.	6.9	4,913	16	9,968	3.3	2,790	0.4	338
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

	LOADING TO MARINE ENVIRONMENT			
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	62,230	98,000	69,531	3,920
	33,748	0	21,905	2,655
	22,496	0	14,602	1,770
	0	0	0	0
TOTAL	118,474	98,000	106,037	8,345
	0	0	0	0
	0	0	0	0
	12,700	20,000	14,190	800
	26,747	0	1,736	2,104
	17,828	0	11,572	1,403
	0	0	0	0
TOTAL	57,275	20,000	27,498	4,307
	0	0	0	0
	0	0	0	0
	0	0	1,135	64
	9,807	0	6,365	772
	9,340	18,950	5,304	643
	67,082	20,000	34,998	5,142
TOTAL	86,229	38,950	47,803	6,621
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	11,368	10,688	4,078	481
	0	0	0	0
	0	0	0	0
	3,439	0	2,232	271
	0	0	0	0
TOTAL	14,807	10,688	6,310	752

Table B.5 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area Fiji Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Savusavu		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	1,723	Septic tanks	pers.	6.9	9,511	16	19,298	3.3	5,402	0.4	655
	1,148	Latrines	pers.	6.9	6,337	16	12,858	3.3	3,599	0.4	436
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Other Viti Levu		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
(schools,		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
industry, etc.)	3,700	Sewered: Secondary	pers.	12.7	9,398	20	14,800	3.3	10,501	0.4	592
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Other Rural Fiji		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	60,477	Septic tanks	pers.	6.9	333,833	16	677,342	3.3	189,595	0.4	22,981
	393,104	Latrines	pers.	6.9	2,169,934	16	4,402,765	3.3	1,232,381	0.4	149,380
	50,398	over water latrine	pers.	6.9	347,746	16	806,368	3.3	166,313	0.4	20,159

	LOADING TO MARINE ENVIRONMENT			
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	6,658	0	4,321	524
	4,436	0	2,879	349
	0	0	0	0
TOTAL	11,094	0	7,200	873
	0	0	0	0
	0	0	0	0
	9,398	14,800	10,501	592
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	9,398	14,800	10,501	592
	0	0	0	0
	0	0	0	0
	0	0	0	0
	233,683	0	151,676	18,385
	1,518,954	0	985,905	119,504
	347,746	806,368	166,313	20,159
TOTAL	2,100,383	806,368	1,303,895	158,048

COUNTRY TOTAL	3,270,312	1,390,782	2,043,281	240,978

Table B.6 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area FRENCH POLYNESIA Year Prepared 1992 Page 1 of 2

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Papeete		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Mahina		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Papara		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Mataiea		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Afareaitu		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

Table B.6 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area FRENCH POLYNESIA Year Prepared 1992 Page 2 of 2

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Teahupoo		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
COUNTRY TOTAL	0	0	0	0

Table B.7 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area GUAM Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
PUAG Comm.		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	880	Sewered: Secondary	pers.	12.7	6,232	20	2,423	3.3	2,497	0.4	141
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Navy PWC		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Apra Harbor		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
	33,680	Sewered: Secondary	pers.	12.7	189,435	20	241,265	3.3	95,584	0.4	5,389
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Agana		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	76,160	Sewered: primary	pers.	12.7	878,974	20	64,095	3.3	232,478	0.4	27,418
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Baza Gardens		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
(stream dis.)	4,800	Sewered: primary	pers.	12.7	37,412	20	28,297	3.3	14,652	0.4	1,728
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Agat		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	14,080	Sewered: primary	pers.	12.7	144,407	20	92,013	3.3	42,979	0.4	5,069
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	6,232	2,423	2,497	141
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	6,232	2,423	2,497	141
	0	0	0	0
	0	0	0	0
	189,435	241,265	95,584	5,389
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	189,435	241,265	95,584	5,389
	0	0	0	0
	878,974	64,095	232,478	27,418
	0	0	0	0
	0	0	0	0
	0	0	0	0
	1,068,409	305,360	328,062	32,806
TOTAL	1,947,383	369,455	560,541	60,224
	0	0	0	0
	37,412	28,297	14,652	1,728
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	37,412	28,297	14,652	1,728
	0	0	0	0
	144,407	92,013	42,979	5,069
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	144,407	92,013	42,979	5,069

Table B.7 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area GUAM Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Northern Distric		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	21,440	Sewered: primary	pers.	12.7	240,568	20	280,089	3.3	65,446	0.4	7,718
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	240,568	280,089	65,446	7,718
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	240,568	280,089	65,446	7,718
COUNTRY TOTAL	2,565,437	1,013,542	781,699	80,269

Table B.8 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area KIRIBATI Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
S. Tarawa	16,000	Sewered: no treatment	pers.	13	203,200	20	320,000	3	52,800	0	6,400
		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
	7,159	Latrines	pers.	7	39,518	16	80,181	3	22,443	0	2,720
	2,000	over water latrine	pers.	7	13,800	16	32,000	3	6,600	0	800
Other Gilberts		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
	33,662	Latrines	pers.	7	185,814	16	377,014	3	105,530	0	12,792
	8,415	over water latrine	pers.	7	58,064	16	134,640	3	27,770	0	3,366
Line &		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0
Phoenix		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
	4,048	Latrines	pers.	7	22,345	16	45,338	3	12,690	0	1,538
	1,012	over water latrine	pers.	7	6,983	16	16,192	3	3,340	0	405
Tourists	2,031	Sewered: no treatment	pers.	13	25,794	20	40,620	3	6,702	0	812
		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
		Latrines	pers.	7	0	16	0	3	0	0	0
		over water latrine	pers.	7	0	16	0	3	0	0	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	203,200	320,000	52,800	6,400
	0	0	0	0
	0	0	0	0
	0	0	0	0
	27,662	0	17,955	2,176
	13,800	32,000	6,600	800
TOTAL	230,862	320,000	70,755	8,576
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	130,070	0	84,424	10,233
	58,064	134,640	27,770	3,366
TOTAL	130,070	0	84,424	10,233
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	22,345	45,338	12,690	1,538
	130,070	0	84,424	10,233
TOTAL	22,345	45,338	12,690	1,538
	25,794	40,620	6,702	812
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	25,794	40,620	6,702	812

COUNTRY TOTAL	409,071	405,958	174,572	21,160

Table B.9 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area NAURU Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Nauru	8,042	Sewered: no treatment	pers.	12.7	102,133	20	160,840	3.3	26,539	0.4	3,217
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Tourists		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	102,133	160,840	26,539	3,217
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	102,133	160,840	26,539	3,217
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	102,133	160,840	26,539	3,217

Table B.10 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area NEW CALEDONIA Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Noumea		Sewered: no treatment	pers.	12.7	0	20	0	3	0	0.4	0
	63,503	Sewered: primary	pers.	12.7	540,347	20	508,024	3	193,843	0.4	22,861
		Sewered: Secondary	pers.	12.7	0	20	0	3	0	0.4	0
	6,011	Septic tanks	pers.	6.9	33,181	16	67,323	3	18,844	0.4	2,284
		Latrines	pers.	6.9	0	16	0	3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3	0	0.4	0
Other Urban		Sewered: no treatment	pers.	12.7	0	20	0	3	0	0.4	0
	29,153	Sewered: primary	pers.	12.7	248,063	20	233,224	3	88,990	0.4	10,495
		Sewered: Secondary	pers.	12.7	0	20	0	3	0	0.4	0
	2,839	Septic tanks	pers.	6.9	15,671	16	31,797	3	8,900	0.4	1,079
		Latrines	pers.	6.9	0	16	0	3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3	0	0.4	0
Rural		Sewered: no treatment	pers.	12.7	0	20	0	3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3	0	0.4	0
	34,848	Latrines	pers.	6.9	192,361	16	390,298	3	109,248	0.4	13,242
	27,872	over water latrine	pers.	6.9	192,317	16	445,952	3	91,978	0.4	11,149
		Sewered: no treatment	pers.	12.7	0	20	0	3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	540,347	508,024	193,843	22,861
	0	0	0	0
	23,227	0	15,076	1,827
	0	0	0	0
	0	0	0	0
TOTAL	563,574	508,024	208,918	24,688
	0	0	0	0
	248,063	233,224	88,990	10,495
	0	0	0	0
	10,970	0	712	863
	0	0	0	0
	0	0	0	0
TOTAL	259,033	233,224	89,702	11,358
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	192,361	390,298	109,248	13,242
	192,317	445,952	91,978	11,149
TOTAL	384,678	836,250	201,226	24,391
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
COUNTRY TOTAL	948,272	1,344,295	410,166	49,100

Table B.11 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area NIUE Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P		LOADING TO MARINE ENVIRONMENT				
													BOD	SS	N	P
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.		kg	kg	kg	kg
Niue		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
	844	Septic tanks	pers.	6.9	4,659	16	9,453	3.3	2,646	0.4	321		3,261	7,562	2,117	257
	1,688	Latrines	pers.	6.9	9,318	16	18,906	3.3	5,292	0.4	641		6,522	0	4,234	513
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	9,784	7,562	6,350	770
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	0	0	0	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	0	0	0	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	0	0	0	0

COUNTRY TOTAL	9,784	7,562	6,350	770

Table B.12 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area Palau Year Prepared 1992 Page 1 of 2

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Koror	0	Sewered: no treatment	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: primary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	5,460	Sewered: Secondary	pers.	-	36,135	-	70,080	3.3	15,495	0.4	874
	4,823	Septic tanks	pers.	6.9	26,623	16.0	54,018	3.3	15,120	0.4	1,833
	0	Latrines	pers.	6.9	0	16.0	0	3.3	0	0.4	0
	105	Over Water latrines	pers.	6.9	725	16.0	1,680	3.3	347	0.4	42
Peleliu	0	Sewered: no treatment	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: primary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: Secondary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	119	Septic tanks	pers.	6.9	657	16.0	1,333	3.3	373	0.4	45
	217	Latrines	pers.	6.9	1,198	16.0	2,430	3.3	680	0.4	82
	0	Over water latrine	pers	6.9	0	16.0	0	3.3	0	0.4	0
Kayangel	0	Sewered: no treatment	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: primary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: Secondary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	28	Septic tanks	pers.	6.9	155	16.0	314	3.3	88	0.4	11
	196	Latrines	pers.	6.9	1,082	16.0	2,195	3.3	614	0.4	74
	0	over water latrine	pers	6.9	0	16.0	0	3.3	0	0.4	0
Airai	0	Sewered: no treatment	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: primary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: Secondary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	315	Septic tanks	pers.	6.9	1,739	16.0	3,528	3.3	988	0.4	120
	193	Latrines	pers.	6.9	1,065	16.0	2,162	3.3	605	0.4	73
	0	Over water latrine	pers	6.9	0	16.0	0	3.3	0	0.4	0
Babaelthaup	0	Sewered: no treatment	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: primary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: Secondary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	42	Septic tanks	pers.	6.9	232	16.0	470	3.3	132	0.4	16
	3,115	Latrines	pers.	6.9	17,195	16.0	34,888	3.3	9,766	0.4	1,184
	98	Over water latrines	pes	6.9	676	16.0	1,568	3.3	323	0.4	39

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	36,135	70,080	15,495	874
	18,636	0	12,096	1,466
	0	0	0	0
	725	1,680	347	34
TOTAL	55,496	71,760	27,938	2,373
	0	0	0	0
	0	0	0	0
	0	0	0	0
	460	0	30	36
	838	0	544	66
	0	0	0	0
TOTAL	1,298	0	574	102
	0	0	0	0
	0	0	0	0
	0	0	0	0
	108	0	70	9
	757	0	492	60
	0	0	0	0
TOTAL	866	0	562	68
	0	0	0	0
	0	0	0	0
	0	0	0	0
	1,217	0	790	96
	746	0	484	59
	0	0	0	0
TOTAL	1,963	0	1,274	154
	0	0	0	0
	0	0	0	0
	0	0	0	0
	162	0	105	13
	12,036	0	7,812	947
	676	1,568	323	39
TOTAL	12,875	1,568	8,241	999

Table B.12 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area: Palau Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Angaur	0	Sewered: no treatment	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: primary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	0	Sewered: Secondary	pers.	12.7	0	20.0	0	3.3	0	0.4	0
	28	Septic tanks	pers.	6.9	155	16.0	314	3.3	88	0.4	11
	259	Latrines	pers.	6.9	1,430	16.0	2,901	3.3	812	0.4	98
	0	Over Water latrines	pers.	6.9	0	16.0	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20.0	0	3.3	0.0	0.4	0
		Sewered: primary	pers.	12.7	0	20.0	0	3.3	0.0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20.0	0	3.3	0.0	0.4	0
		Septic tanks	pers.	6.9	0	16.0	0	3.3	0.0	0.4	0
		Latrines	pers.	6.9	0	16.0	0	3.3	0.0	0.4	0
				6.9	0	16.0	0	3.3	0.0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	77	0	4	9
	715	0	41	79
	0	0	0	0
TOTAL	792	0	45	87
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
TOTAL FOR AREA	73,289	73,328	38,634	3,784

Table B.13 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area Papua New Guinea Year Prepared 1992 Page 1 of 2

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Port Moresb		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	63,320	Sewered: primary	pers.	12.7	538,790	20	506,560	3.3	193,284	0.4	22,795
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	53,208	Septic tanks	pers.	6.9	293,708	16	595,930	3.3	166,807	0.4	20,219
	32,811	Latrines	pers.	6.9	181,117	16	367,483	3.3	102,862	0.4	12,468
	2,660	over water latrine	pers.	6.9	18,354	16	42,560	3.3	8,778	0.4	1,064
Lae		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	32,800	Sewered: primary	pers.	12.7	279,095	20	262,400	3.3	100,122	0.4	11,808
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Madang		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	32,800	Sewered: primary	pers.	12.7	279,095	20	262,400	3.3	100,122	0.4	11,808
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	28,320	Septic tanks	pers.	6.9	156,326	16	317,184	3.3	88,783	0.4	10,762
	28,320	Latrines	pers.	6.9	156,326	16	317,184	3.3	88,783	0.4	10,762
	1,416	over water latrine	pers.	6.9	9,770	16	22,656	3.3	4,673	0.4	566
Wewak		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	9,430	Sewered: primary	pers.	12.7	80,240	20	75,440	3.3	28,785	0.4	3,395
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	8,142	Septic tanks	pers.	6.9	44,944	16	91,190	3.3	25,525	0.4	3,094
	5,021	Latrines	pers.	6.9	27,716	16	56,235	3.3	15,741	0.4	1,908
	407	over water latrine	pers.	6.9	2,808	16	6,512	3.3	1,343	0.4	163
Rabaul		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
	6,560	Sewered: primary	pers.	12.7	55,819	20	52,480	3.3	20,024	0.4	2,362
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	5,652	Septic tanks	pers.	6.9	31,199	16	63,302	3.3	17,719	0.4	2,148
	3,485	Latrines	pers.	6.9	19,237	16	39,032	3.3	10,925	0.4	1,324
	283	over water latrine	pers.	6.9	1,953	16	4,528	3.3	934	0.4	113

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	538,790	506,560	193,284	22,795
	0	0	0	0
	205,596	0	133,446	16,175
	126,782	0	82,290	9,975
	18,354	42,560	8,778	1,064
TOTAL	889,521	549,120	417,798	50,009
	0	0	0	0
	279,095	262,400	100,122	11,808
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	279,095	262,400	100,122	11,808
	0	0	0	0
	279,095	262,400	100,122	11,808
	0	0	0	0
	109,428	0	71,027	8,609
	156,326	317,184	88,783	10,762
	667,619	524,800	271,271	32,225
TOTAL	1,212,469	1,104,384	531,202	63,404
	0	0	0	0
	80,240	75,440	28,785	3,395
	0	0	0	0
	31,461	0	20,420	2,475
	19,401	0	12,593	1,526
	2,808	6,512	1,343	163
TOTAL	133,910	81,952	63,141	7,559
	0	0	0	0
	55,819	52,480	20,024	2,362
	0	0	0	0
	21,839	0	14,175	1,718
	13,466	0	8,740	1,059
	1,953	4,528	934	113
TOTAL	93,077	57,008	43,874	5,252

Table B.13 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area PAPUA NEW GUINEA Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Other		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Coastal Pop.		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	462,312	Septic tanks	pers.	6.9	2,551,962	16	5,177,894	3.3	1,449,348	0.4	175,679
	285,092	Latrines	pers.	6.9	1,573,708	16	3,193,030	3.3	893,763	0.4	108,335
	23,116	over water latrine	pers.	6.9	159,500	16	369,856	3.3	76,283	0.4	9,246
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	1,786,374	0	1,159,478	140,543
	1,101,595	0	715,011	86,668
	159,500	369,856	76,283	9,246
TOTAL	3,047,469	369,856	1,950,772	236,457
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	5,655,542	2,424,720	3,106,909	374,490

Table B.14 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area PITCAIRN Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Pitcairn		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	10	Septic tanks	pers.	6.9	55	16	112	3.3	31	0.4	4
	52	Latrines	pers.	6.9	287	16	582	3.3	163	0.4	20
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	39	0	25	3
	201	0	130	16
	0	0	0	0
TOTAL	240	0	155	19
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	240	0	155	19

Table B.15 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area REPUBLIC OF THE MARSHALL ISLANDS Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P		LOADING TO MARINE ENVIRONMENT				
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.		BOD kg	SS kg	N kg	P kg
Majuro	14,649	Sewered: no treatment	pers.	12.7	186,042	20	292,980	3.3	48,342	0.4	5,860		186,042	292,980	48,342	5,860
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
	3,761	Latrines	pers.	6.9	20,761	16	42,123	3.3	11,791	0.4	1,429		14,533	0	9,433	1,143
	1,253	over water latrine	pers.	6.9	8,646	16	20,048	3.3	4,135	0.4	501		8,646	20,048	4,135	501
												TOTAL	209,221	313,028	61,909	7,504
Kwajalein		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
(Ebeye)	8,323	Sewered: primary	pers.	12.7	70,820	20	66,584	3.3	25,406	0.4	2,996		70,820	66,584	25,406	2,996
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	70,820	66,584	25,406	2,996
Total Rural		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
	11,545	Latrines	pers.	6.9	63,728	16	129,304	3.3	36,194	0.4	4,387		63,728	129,304	36,194	4,387
	3,848	over water latrine	pers.	6.9	26,551	16	61,568	3.3	12,698	0.4	1,539		70,820	66,584	25,406	2,996
												TOTAL	134,549	195,888	61,600	7,383
Kwajalein		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
(Army Facilit		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
	5,000	Sewered: Secondary	pers.	12.7	4,313	20	2,820	3.3	14,190	0.4	800		4,313	2,820	14,190	800
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	4,313	2,820	14,190	800
Roi Namur		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
	520	Sewered: primary	pers.	12.7	4,425	20	4,160	3.3	1,587	0.4	187		4,425	4,160	1,587	187
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	4,425	4,160	1,587	187
												COUNTRY TOTAL	419,049	579,695	150,537	18,106

Table B.16 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area SOLOMON ISLANDS Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Honiara	25,000	Sewered: no treatment	pers.	12.7	317,500	20	500,000	3.3	82,500	0.4	10,000
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	6,225	Septic tanks	pers.	6.9	34,362	16	69,720	3.3	19,515	0.4	2,366
	6,226	Latrines	pers.	6.9	34,368	16	69,731	3.3	19,519	0.4	2,366
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Other		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Guadalcanal		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	6,074	Septic tanks	pers.	6.9	33,528	16	68,029	3.3	19,042	0.4	2,308
	48,596	Latrines	pers.	6.9	268,250	16	544,275	3.3	152,348	0.4	18,466
	6,074	over water latrine	pers.	6.9	41,911	16	97,184	3.3	20,044	0.4	2,430
Western	525	Sewered: no treatment	pers.	12.7	6,668	20	10,500	3.3	1,733	0.4	210
Province		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	25,685	Septic tanks	pers.	6.9	141,781	16	287,672	3.3	80,522	0.4	9,760
	32,140	Latrines	pers.	6.9	177,413	16	359,968	3.3	100,759	0.4	12,213
	6,421	over water latrine	pers.	6.9	44,305	16	102,736	3.3	21,189	0.4	2,568
Isabel		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	1,621	Septic tanks	pers.	6.9	8,948	16	18,155	3.3	5,082	0.4	616
	13,323	Latrines	pers.	6.9	73,543	16	149,218	3.3	41,768	0.4	5,063
	1,620	over water latrine	pers.	6.9	11,178	16	25,920	3.3	5,346	0.4	648
Central		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	2,100	Septic tanks	pers.	6.9	11,592	16	23,520	3.3	6,583	0.4	798
	16,797	Latrines	pers.	6.9	92,719	16	188,126	3.3	52,659	0.4	6,383
	2,100	over water latrine	pers.	6.9	14,490	16	33,600	3.3	6,930	0.4	840

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	317,500	500,000	82,500	10,000
	0	0	0	0
	0	0	0	0
	24,053	0	15,612	1,892
	24,057	0	15,615	1,893
	0	0	0	0
TOTAL	365,611	500,000	113,727	13,785
	0	0	0	0
	0	0	0	0
	0	0	0	0
	23,470	0	1,523	1,846
	187,775	0	121,879	14,773
	41,911	97,184	20,044	2,430
TOTAL	253,155	97,184	143,446	19,049
	6,668	10,500	1,733	210
	0	0	0	0
	0	0	0	0
	141,781	287,672	80,522	9,760
	124,189	0	80,607	9,771
	44,305	102,736	21,189	2,568
TOTAL	316,943	400,908	184,051	22,309
	0	0	0	0
	0	0	0	0
	0	0	0	0
	6,264	0	4,065	493
	51,480	0	33,414	4,050
	11,178	25,920	5,346	648
TOTAL	68,922	25,920	42,826	5,191
	0	0	0	0
	0	0	0	0
	0	0	0	0
	8,114	0	5,267	638
	64,904	0	42,127	5,106
	14,490	33,600	6,930	840
TOTAL	87,508	33,600	54,324	6,585

Table B.16 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area SOLOMON ISLANDS Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P			LOADING TO MARINE ENVIRONMENT BOD	SS	N	P
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.		kg	kg	kg	kg
Malaita	500	Sewered: no treatment	pers.	12.7	6,350	20	10,000	3.3	1,650	0.4	200		6,350	10,000	1,650	200
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
	34,471	Septic tanks	pers.	6.9	190,280	16	386,075	3.3	108,067	0.4	13,099		133,196	0	8,645	10,479
	42,995	Latrines	pers.	6.9	237,332	16	481,544	3.3	134,789	0.4	16,338		166,133	0	107,831	13,070
	8,524	over water latrine	pers.	6.9	58,816	16	136,384	3.3	28,129	0.4	3,410		58,816	136,384	28,129	3,410
												TOTAL	364,494	146,384	146,256	27,159
Makira		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
	3,874	Septic tanks	pers.	6.9	21,384	16	43,389	3.3	12,145	0.4	1,472		14,969	0	9,716	1,178
	17,482	Latrines	pers.	6.9	96,501	16	195,798	3.3	54,806	0.4	6,643		96,501	195,798	54,806	6,643
	3,874	over water latrine	pers.	6.9	26,731	16	61,984	3.3	12,784	0.4	1,550		379,463	146,384	155,972	28,337
												TOTAL	490,933	342,182	220,494	36,158
Temotu		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
	1,649	Septic tanks	pers.	6.9	9,102	16	18,469	3.3	5,170	0.4	627		6,372	0	4,136	501
	13,197	Latrines	pers.	6.9	72,847	16	147,806	3.3	41,373	0.4	5,015		50,993	0	33,098	4,012
	1,649	over water latrine	pers.	6.9	11,378	16	26,384	3.3	5,442	0.4	660		11,378	26,384	5,442	660
												TOTAL	68,743	26,384	42,675	5,173
Tourists	9,500	Sewered: no treatment	pers.	12.7	120,650	20	190,000	3.3	31,350	0.4	3,800		120,650	190,000	31,350	3,800
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	120,650	190,000	31,350	3,800
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0		0	0	0	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0		0	0	0	0
												TOTAL	0	0	0	0

COUNTRY TOTAL	2,136,959	1,762,562	979,150	139,209

Table B.17 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area TOKELAU Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Tokelau		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	400	Septic tanks	pers.	6.9	2,208	16	4,480	3.3	1,254	0.4	152
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
	800	over water latrine	pers.	6.9	4,416	16	8,960	3.3	2,508	0.4	304
	400	Others	pers.	6.9	2,208	16	4,480	3.3	1,254	0.4	152
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	13.0	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	1,546	0	1,003	122
	0	0	0	0
	3,091	0	2,006	243
	1,546	0	1,003	122
TOTAL	4,637	0	3,010	365
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	4,637	0	3,010	365

Table B.18 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area TONGA Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Tongatapu		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	26,897	Septic tanks	pers.	6.9	148,471	16	301,246	3.3	84,322	0.4	10,221
	6,621	Latrines	pers.	6.9	36,548	16	74,155	3.3	20,757	0.4	2,516
	501	over water latrine	pers.	6.9	3,453	16	8,008	3.3	1,652	0.4	200
Vava'u		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	2,730	Septic tanks	pers.	6.9	15,070	16	30,576	3.3	8,559	0.4	1,037
	13,620	Latrines	pers.	6.9	75,182	16	152,544	3.3	42,699	0.4	5,176
	138	over water latrine	pers.	6.9	952	16	2,208	3.3	455	0.4	55
Ha'apai		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	1,000	Septic tanks	pers.	6.9	5,522	16	11,204	3.3	3,136	0.4	380
	13,640	Latrines	pers.	6.9	75,291	16	152,764	3.3	42,760	0.4	5,183
	494	over water latrine	pers.	6.9	3,409	16	7,906	3.3	1,631	0.4	198
Eua		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	554	Septic tanks	pers.	6.9	3,060	16	6,209	3.3	1,738	0.4	211
	3,774	Latrines	pers.	6.9	20,835	16	42,273	3.3	11,833	0.4	1,434
	106	over water latrine	pers.	6.9	734	16	1,702	3.3	351	0.4	43
Niuas		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	296	Septic tanks	pers.	6.9	1,636	16	3,320	3.3	929	0.4	113
	1,915	Latrines	pers.	6.9	10,572	16	21,450	3.3	6,004	0.4	728
	171	over water latrine	pers.	6.9	1,180	16	2,736	3.3	564	0.4	68

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	103,930	0	67,458	8,177
	25,584	0	16,605	2,013
	3,453	8,008	1,652	200
TOTAL	129,514	0	84,063	10,189
	0	0	0	0
	0	0	0	0
	0	0	0	0
	10,549	0	685	830
	52,628	0	34,159	4,140
	952	2,208	455	55
TOTAL	64,129	2,208	35,299	5,026
	0	0	0	0
	0	0	0	0
	0	0	0	0
	5,522	0	2,509	304
	75,291	152,764	42,760	5,183
	69,651	2,208	37,808	5,330
TOTAL	150,464	154,972	83,077	10,817
	0	0	0	0
	0	0	0	0
	0	0	0	0
	2,142	0	1,390	169
	14,584	0	9,466	1,147
	734	1,702	351	43
TOTAL	17,461	1,702	11,208	1,359
	0	0	0	0
	0	0	0	0
	0	0	0	0
	1,145	0	743	90
	7,400	0	4,803	582
	1,180	2,736	564	68
TOTAL	9,726	2,736	6,111	741

Table B.18 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area TONGA Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Tourists		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	31,584	Septic tanks	pers.	6.9	174,344	16	353,741	3.3	99,016	0.4	12,002
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
Other	18242	Latrines	pers.	6.9	100,694	16	204,306	3.3	57,187	0.4	6,932
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	122,041	0	79,213	9,602
	0	0	0	0
	0	0	0	0
TOTAL	122,041	0	79,213	9,602
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	70,486	0	45,750	5,545
	0	0	0	0
TOTAL	70,486	0	45,750	5,545
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	563,818	161,618	344,721	43,278

Table B.19 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area TUVALU Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Funafuti		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
	3,839	Latrines	pers.	7	21,191	16	42,997	3	12,035	0	1,459
		over water latrine	pers.	7	0	16	0	3	0	0	0
Vaitupu		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
	1,202	Latrines	pers.	7	6,635	16	13,462	3	3,768	0	457
		over water latrine	pers.	7	0	16	0	3	0	0	0
Niutao		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
	749	Latrines	pers.	7	4,134	16	8,389	3	2,348	0	285
		over water latrine	pers.	7	0	16	0	3	0	0	0
Nanumea		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
	824	Latrines	pers.	7	4,548	16	9,229	3	2,583	0	313
		over water latrine	pers.	7	0	16	0	3	0	0	0
Nanumago		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0
	644	Latrines	pers.	7	3,555	16	7,213	3	2,019	0	245
		over water latrine	pers.	7	0	16	0	3	0	0	0

	LOADING TO MARINE ENVIRONMENT			
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	14,834	0	9,628	1,167
	0	0	0	0
TOTAL	14,834	0	9,628	1,167
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	4,645	0	3,015	365
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	4,134	8,389	2,348	285
	0	0	0	0
TOTAL	4,134	8,389	2,348	285
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	3,184	0	2,067	250
	0	0	0	0
TOTAL	3,184	0	2,067	250
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	2,488	0	1,615	196
	0	0	0	0
TOTAL	2,488	0	1,615	196

Table B.19 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area Tuvalu Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P		LOADING TO MARINE ENVIRONMENT	BOD	SS	N	P
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.		kg	kg	kg	kg
Nukufetau		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
	751	Latrines	pers.	7	4,146	16	8,411	3	2,354	0	285		2,902	0	1,884	228
		over water latrine	pers.	7	0	16	0	3	0	0	0		0	0	0	0
												TOTAL	2,902	0	1,884	228
Nui		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
	606	Latrines	pers.	7	3,345	16	6,787	3	1,900	0	230		2,342	0	1,520	184
		over water latrine	pers.	7	0	16	0	3	0	0	0		0	0	0	0
												TOTAL	0	0	0	0
Nakulaelae		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
	353	Latrines	pers.	7	1,949	16	3,954	3	1,107	0	134		1,949	3,954	1,107	134
		over water latrine	pers.	7	0	16	0	3	0	0	0		0	0	0	0
												TOTAL	1,949	3,954	1,107	134
Niulakita		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
	75	Latrines	pers.	7	414	16	840	3	235	0	29		290	0	188	23
		over water latrine	pers.	7	0	16	0	3	0	0	0		0	0	0	0
												TOTAL	290	0	188	23
Tourists	N.S.	Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
		Latrines	pers.	7	0	16	0	3	0	0	0		0	0	0	0
		over water latrine	pers.	7	0	16	0	3	0	0	0		0	0	0	0
												TOTAL	0	0	0	0
	9,043											COUNTRY TOTAL	34,425	12,342	21,851	2,649

Table B.20 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area VANUATU Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Port Vila											
Erikor Lagoon		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Catchment		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	6,400	Septic tanks	pers.	6.9	35,328	16	71,680	3.3	20,064	0.4	2,432
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Port Vila Harbor		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Catchment		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	5,400	Septic tanks	pers.	6.9	29,808	16	60,480	3.3	16,929	0.4	2,052
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Fatumaru Bay		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Catchment		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	8,100	Septic tanks	pers.	6.9	44,712	16	90,720	3.3	25,393	0.4	3,078
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Santo/Malo Bay		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Catchment		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	8,700	Septic tanks	pers.	6.9	48,024	16	97,440	3.3	27,274	0.4	3,306
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Rural Efate	4,657	Sewered: no treatment	pers.	12.7	59,144	20	93,140	3.3	15,368	0.4	1,863
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

	LOADING TO MARINE ENVIRONMENT			
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	24,730	0	16,051	1,946
	0	0	0	0
	0	0	0	0
TOTAL	24,730	0	16,051	1,946
	0	0	0	0
	0	0	0	0
	0	0	0	0
	20,866	0	1,354	1,642
	0	0	0	0
	0	0	0	0
TOTAL	20,866	0	1,354	1,642
	0	0	0	0
	0	0	0	0
	0	0	0	0
	31,298	0	20,315	2,462
	0	0	0	0
	52,164	0	21,669	4,104
TOTAL	83,462	0	41,984	6,566
	0	0	0	0
	0	0	0	0
	0	0	0	0
	33,617	0	21,820	2,645
	0	0	0	0
	0	0	0	0
TOTAL	33,617	0	21,820	2,645
	59,144	93,140	15,368	1,863
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	59,144	93,140	15,368	1,863

Table B.20 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area VANUATU Year Prepared 1992 Page 2 of 3

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Santo/Malo		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	8,435	Septic tanks	pers.	6.9	46,561	16	94,472	3.3	26,444	0.4	3,205
	19,341	Latrines	pers.	6.9	106,762	16	216,619	3.3	60,634	0.4	7,350
	4,670	over water latrine	pers.	6.9	32,223	16	74,720	3.3	15,411	0.4	1,868
Tafea		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Tanna +		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
Erromango		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
	21,292	Latrines	pers.	6.9	117,532	16	238,470	3.3	66,750	0.4	8,091
	3,757	over water latrine	pers.	6.9	25,923	16	60,112	3.3	12,398	0.4	1,503
Malakula		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
	17,995	Latrines	pers.	6.9	99,332	16	201,544	3.3	56,414	0.4	6,838
	3,175	over water latrine	pers.	6.9	21,908	16	50,800	3.3	10,478	0.4	1,270
Tourists		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	1,715	Septic tanks	pers.	6.9	9,467	16	19,208	3.3	5,377	0.4	652
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	32,593	0	21,155	2,564
	74,734	0	48,507	5,880
	32,223	74,720	15,411	1,868
TOTAL	139,549	74,720	85,073	10,312
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	117,532	238,470	66,750	8,091
	25,923	60,112	12,398	1,503
TOTAL	143,455	298,582	79,149	9,594
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	69,533	0	45,131	5,470
	21,908	50,800	10,478	1,270
TOTAL	91,440	50,800	55,609	6,740
	0	0	0	0
	0	0	0	0
	0	0	0	0
	6,627	0	4,301	521
	0	0	0	0
	0	0	0	0
TOTAL	6,627	0	4,301	521

Table B.20 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area VANUATU Year Prepared 1992

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Other		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
	50,825	Latrines	pers.	6.9	280,554	16	569,240	3.3	159,336	0.4	19,314
	2,675	over water latrine	pers.	6.9	18,458	16	42,800	3.3	8,828	0.4	1,070

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	196,388	0	127,469	15,451
	18,458	42,800	8,828	1,070
TOTAL	214,845	42,800	136,297	16,521

COUNTRY TOTAL	817,735	560,042	457,006	58,350

Table B.21 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area WALLIS AND FUTUNA Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P		LOADING TO MARINE ENVIRONMENT				
													BOD	SS	N	P
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.		kg	kg	kg	kg
Wallis		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
	8,072	Latrines	pers.	7	44,557	16	90,406	3	25,306	0	3,067		31,190	0	20,245	2,454
		over water latrine	pers.	7	0	16	0	3	0	0	0		0	0	0	0
												TOTAL	31,190	0	20,245	2,454
Futuna		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
	4,319	Latrines	pers.	7	23,841	16	48,373	3	13,540	0	1,641		16,689	0	10,832	1,313
		over water latrine	pers.	7	0	16	0	3	0	0	0		0	0	0	0
												TOTAL	16,689	0	10,832	1,313
		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
		Latrines	pers.	7	0	16	0	3	0	0	0		0	0	0	0
		over water latrine	pers.	7	0	16	0	3	0	0	0		16,689	0	10,832	1,313
												TOTAL	16,689	0	10,832	1,313
		Sewered: no treatment	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: primary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Sewered: Secondary	pers.	13	0	20	0	3	0	0	0		0	0	0	0
		Septic tanks	pers.	7	0	16	0	3	0	0	0		0	0	0	0
		Latrines	pers.	7	0	16	0	3	0	0	0		0	0	0	0
		over water latrine	pers.	7	0	16	0	3	0	0	0		0	0	0	0
												TOTAL	0	0	0	0

COUNTRY TOTAL	64,567	0	41,909	5,080

Table B.22 WORKING TABLE FOR THE CALCULATION OF WASTE LOADS FROM DOMESTIC WASTEWATER

Area WESTERN SAMOA Year Prepared 1992 Page 1 of 1

LOCATION	POP.	TYPE	UNITS	BOD		SS		N		P	
				kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.	kg/unit	Effl.
Apia		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Residential		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	16,430	Septic tanks	pers.	6.9	90,694	16	184,016	3.3	51,508	0.4	6,243
	15,444	Latrines	pers.	6.9	85,251	16	172,973	3.3	48,417	0.4	5,869
	986	over water latrine	pers.	6.9	6,803	16	15,776	3.3	3,254	0.4	394
Apia		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
Commercial	500	Sewered: primary	pers.	12.7	4,255	20	4,000	3.3	1,526	0.4	180
(incl. tourists		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	276	Septic tanks	pers.	6.9	1,524	16	3,091	3.3	865	0.4	105
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
Sawaii		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
	4,900	Septic tanks	pers.	6.9	27,048	16	54,880	3.3	15,361	0.4	1,862
	44,100	Latrines	pers.	6.9	243,432	16	493,920	3.3	138,254	0.4	16,758
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0
		Sewered: no treatment	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: primary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Sewered: Secondary	pers.	12.7	0	20	0	3.3	0	0.4	0
		Septic tanks	pers.	6.9	0	16	0	3.3	0	0.4	0
		Latrines	pers.	6.9	0	16	0	3.3	0	0.4	0
		over water latrine	pers.	6.9	0	16	0	3.3	0	0.4	0

LOADING TO MARINE ENVIRONMENT				
	BOD	SS	N	P
	kg	kg	kg	kg
	0	0	0	0
	0	0	0	0
	0	0	0	0
	63,486	0	41,206	4,995
	59,676	0	38,734	4,695
	6,803	15,776	3,254	394
TOTAL	123,161	0	79,940	9,690
	0	0	0	0
	4,255	4,000	1,526	180
	0	0	0	0
	1,066	0	69	84
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	18,934	0	12,289	1,490
	243,432	493,920	138,254	16,758
	18,934	0	12,289	1,490
TOTAL	262,366	493,920	150,543	18,248
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
	0	0	0	0
TOTAL	0	0	0	0

COUNTRY TOTAL	385,527	493,920	230,483	27,937

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

General Notes

1. Per capita contributions from populations serviced by sewers and septic systems are from the WHO Rapid Assessment of Sources of Air, Water , and Land Pollution, WHO 1982; and its follow-up publication Management and Control of the Environment. Reductions in loading based upon different treatment in sewered areas provided also those found in WHO manual. All latrine types were assumed to have similar per capita contributions and reduction in treatment (except that over -ocean facilities provide no treatment, as septic systems. The contributed loadings for latrines may be a bit lower but their treatment efficiency is less, therefore this assumption is valid for rapid assessment purposes.

2 Treatment reductions for different facility types are as follows.

Facility Type	BOD	Suspended Solids	Nitrogen	Phosphorous
Sewer with primary sedimentation	0.67	0.4	0.925	0.9
Sewer with bacteriological treatment	0.2	0.2	0.86	0.4
Septic Tanks*	0.20	0.8	0.95	0.95

* Metcalf and Eddy, Water and Wastewater Engineering.

3. Loadings to the marine environment were roughly estimated as 100% for sewer discharges and over-ocean latrines; 70% of effluent from septic systems for BOD, Nitrogen, and Phosphorous; and all suspended solids removed from effluent of septic tanks prior to reaching marine waters;

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

American Samoa

1. It was assumed that all rural areas of Tutuila were served by latrines.

2. It was assumed that outer island populations were served by latrines.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Federated States of Micronesia

1. Former U.S. EPA discharge permits were used to obtain flow data and estimate populations served (using 150 gallons per capita per day).

2. Fairly recent U.S. EPA permits indicated plants operating reasonably; therefore BOD and SS data used and Nitrogen and Phosphorous calculated from WHO method.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Fiji

1. Data obtained from 1989 Public Works Department Statistics and "Seepage Management in the Suva Region: Study of Options and Selection of Long-term Strategy", Ministry of Public Works, 1985.

2. The 1985 study gave numbers of septic tanks; it was assumed that 7 persons are served by each tank.

3. Nandi: Used 1986 population connected to sewer and remaining population served by septic tanks (60%) and latrines (40%).

Ba: Reported to have 6, 500 persons served by septic tanks (1989 statistics); Assumed latrines served the remaining population.

Lautoka; Labasa; Savu Savu: Assumed some percentage of septic tanks and latrines.

Levuku: Population uses septic tanks that enter a clarifier (Public Works Department, 1992 [personal communication]. This is equivalent to primary treatment.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

French Polynesia

1. No data available. Assumed served by 50% latrines and 50% septic tanks. City by City population data from P.C. Globe v2.0. This compared favorably to census data adjusted for growth rate.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Guam

1. For treatment plants actual loading as reported on U.S. EPA discharge permits were used. Population was calculated based on a per capita flow of 125 gallons per day. Nitrogen and Phosphorous loadings were then calculated using the WHO method.

2. Treatment levels not indicated, assumed primary treatment based on effluent quality. Northern District effluent quality appeared to even less than that expected of primary treatment.

3. Baza Gardens included, however, this discharges to a stream so some self-purification may occur before flows reach marine waters.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

New Caledonia

1. Utilized International Water Supply and Sanitation Decade Directory, 1984 and assumed population of 164, 173 (Pacific Island Yearbook) and that planned improvements took place. As such assumed 90% of urban population is sewered and remaining 10 % served by septic tank. Assumed 52% of rural population with adequate sanitation have latrines, and that the remainder have over-water latrines.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Papua New Guinea

1. Population data from P.C. Globe v.2.1 for individual areas; again compared favorably with overall population data from last census adjusted for growth.

2. Utilized adequate sanitation coverage from International Water Supply and Sanitation Decade Directory, 1984. This included 41% coverage with sewage for urban areas; only 3% of population served by adequate sanitation in rural areas. The remaining population in urban area were described as served by household systems which were assumed to be ,septic tanks (60%) , latrines (37%) and 3% of the population was assumed to be served by over-water latrines.

3. Other coastal population was estimated from summing remaining populations for major urban areas, (Capital District, Lae, Madang) and adding populations of the Gulf District and Milne Bay .

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Republic of the Marshall Islands

1. Populations for specific areas were calculated from population densities and land areas provided in the 1991 National Population Policy, Office of Planning and Statistics, RMI.

2. Assumed that the DUD area comprised the sewered population and that 75 % of the remaining population used latrines and 25% used over the water latrines.

3. For treatment plants in Kwajalein and Ebeye actual loading as reported on U.S. EPA discharge permits were used. Population was calculated based on a per capita flow of 125 gallons per day. Nitrogen and Phosphorous loadings were then calculated using the WHO method.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Solomon Islands

1. Populations were obtained from Solomon Islands Environmental Management Plan, 1991.

2. Honiara and Gizo status from Wallis (1989) . According to this and Chief Sanitarian's report to SPC workshop (Lolemai, 1992).

3. Because of Wallis (1989) report on Gizo, 100% of septic tank effluent assumed to reach marine areas. Gizo assumed to be served by septic tanks (40%), latrines (50%), and over-water latrines (10%).

4. For all Isabel and all smaller provinces served by septic tanks (10%), latrines (80%) and 10% over-water latrines.

5. Auki has an outfall.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Tonga

1. Data from National Environmental Management Strategy

2. Assumed a mechanical flush facilities were connected to septic tanks.

3. Assumed manual, pit, and not stated were connected to latrines.

4. Assumed "no" or "other " were served by over-water latrines.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Vanuatu

1. Sinclair (1991) used to determine populations and facility types, however pollutant loading calculations were made using the WHO method.

2. Population growth rate of 7% in urban areas and 2.4% in rural areas was used to adjust census data of 1986.

3. International Water Supply and Sanitation Decade Directory, 1984, indicated 85% coverage for adequate sanitation. Remaining area assumed to use over-water latrines.

4. Tourists may be double counted as Port Vila population numbers were adjusted to include some tourist population.

NOTES FOR POLLUTION LOADINGS FROM DOMESTIC WASTEWATER

Western Samoa

1. Assumed and additional contribution of 500 persons from the hospital

2. Tourists number are not included and may be significant.

APPENDIX C
WORKING TABLES FOR
INDUSTRIAL WASTEWATER

Table C.1 Working table for the calculation of water pollution and waste loads from industrial sources

Area: AMERICAN SAMOA Year Prepared: 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3units	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3114	Canning, Preserving and Processing of Fish, Crustacea and Similar Foods																				
	Tuna	tn prod.		Yes	13.4	0	10.4	0	7.4	0	2.1	0		0			0			0	
	Star Kist (1)	tn prod.	454	Yes				121.94		33.02		149.48409		128							
	Van Camp Seafood (1)	tn prod.	291	Yes		4.53		57.24		31.69		105.52		39.30							
Treatment	Screening & Floatation with Aeration or Aerated lagoon				0.05		0.05		0.05												
3134	Soft Drinks	m3				0		0		0		0		0			0			0	
No Subcategory	(Drink Bottler)					0		0		0		0		0			0			0	
3710	Iron and Steel Basic Industries					0		0		0		0		0			0			0	
No Subcategory	(Roofing Iron Manufacture)			No		0		0		0		0		0			0			0	
3720	Non-Ferrous Metal Basic Industry					0		0		0		0		0			0			0	
No Subcategory	Aluminum Recycling			No		0		0		0		0		0			0			0	
4101 (2)	Electricity Light and Power			Yes		0		0		0		0		0			0			0	

(1) - data from USEPA Discharge Monitoring Report - Production as permitted, not necessarily actual.

(2) - Industries listed in classification code are assumed to occur in American Samoa.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Petroleum Storage

Laundries, Laundry Services, Cleaning and Dyeing Plants

Ship Building and Repairing

Table C.2 Working table for the calculation of water pollution and waste loads from industrial sources

Area: COMMONWEALTH OF NORTHERN MARIANA ISLANDS Year Prepared: 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3units	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl.	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3111	Slaughtering, (3) Preparing, and Preserving Meat	Fac (1)				0		0		0		0		0			0			0	
	Simple Slaughter Houses w/o Blood Rec.	tn LWK	162.87	No	10.00	732.90	8.00	410.43	4.00	213.42	0.70	149.39	0.05	7.47			0.00			0.00	
Treatment	Primary Skimming and Air Floatation				0.450	0.000	0.070	0.000	0.130	0.000		0.000		0.00			0.00			0.00	If Used
3112	Manufacturing of Dairy Products					0		0		0		0		0			0			0	
	Milk Input	tn prod.	601.68	No	0.99	42.29	0.03	0.83		0.00	0.06	1.41	0.01	7.82			0.00			0	
	Milk Processing	tn prod.	601.68	No	5.30	226.41	1.50	41.52		0.00	0.31	7.27	0.07	40.91			0.00			0	
Treatment	Activated Sludge				0.071		0.046				0.039										
3210	Manufacture of Textiles	Fac (3)																			
	Bleaching	tonnes		No	8.00	0.00	5.00	0.00		0.00		0.00		0.00			0.00			0.00	
	Dyeing			No	60.00	0.00	25.00	0.00		0.00		0.00		0.00			0.00			0.00	
	Printing			No	54.00	0.00	12.00	0.00		0.00		0.00		0.00			0.00			0.00	
Treatment	Sedimentation			No	0.60	0.00	0.40	0.00		0.00		0.00		0.00			0.00			0.00	If Used
3420	Printing and * Publishing and Allied Industries	Fac (11)		No		0.00		0.00		0.00		0.00		0.00			0.00			0.00	No Water Data in WHO Doc.

Table C.2 Working table for the calculation of water pollution and waste loads from industrial sources

Area: COMMONWEALTH OF NORTHERN MARIANA ISLANDS Year Prepared: 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3units	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl.	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3513	Manufacture of Synthetic Resins, Plastic Materials, and Man-made Fibers Except Glass	Fac (1)				0.00		0.00		0.00		0.00		0.00			0.00			0.00	
	Acrylic Resin 1)																				
	Uncontrolled	tonnes		No	25.00	0.00	1.10	0.00		0.00		0.00		0.00			0.00			0.00	
	Good Control	tonnes		No	2.75	0.00	1.10	0.00		0.00		0.00		0.00			0.00			0.00	
4101 (2)	Electricity Light and Power					0.00		0.00		0.00		0.00		0.00			0.00			0.00	
	Steam Turbines GWH			No	2.20	0.00	286.00	0.00	0.05	0.00		0.00	0.05	0.00	Cr	0.01	0.00	Cu	0.01	0.00	
															Ni	0.05	0.00	Zn	0.01	0.00	

* Printing and photo processing facilities combined (printing (7); photo processing (4)).

Assumptions - 1) Fiberglass is an acrylic resin.
2) LWK is equal to meat produced

(1) - Feedlots represent livestock populations - waste loading factors require adjustment.
(2) - Industries listed in classification code are assumed to occur in CNMI.
(3) - Numbers calculated using combined beef and pork.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning Plants
Small Fishing Operations
Ship Building and Repairing

Table C.3 Working table for the calculation of water pollution and waste loads from industrial sources

Area: COOK ISLANDS | Year Prepared: 1992

Industrial Classification Codes	Process	Unit	Prod.	Ocean	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			Comments
			per yr. 10^3units	Discharge	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3113	Canning and Preserving of Fruits and Vegetables	Fac (1)				0		0		0		0		0			0			0	
	Dried Fruit	tonnes		Yes	12.4	0	1.9	0		0		0		0			0			0	
	Pineapple	tonnes		Yes	10.3	0	2.7	0		0		0		0			0			0	
Treatment	Settling or Floatation				0.3	0	0.75	0		0		0		0			0			0	If Used
3131	Distillery, Rectifying, and Blending Spirits	Fac (1)				0		0		0		0		0			0			0	
	Grain Distillery	tn anhyd. alcohol		Yes	216	0	257	0		0		0		0			0			0	
		tonnes grain		Yes	3.2	0	2.8	0		0		0		0			0			0	
Treatment	Aerated Lagoon				0.043	0	0.077	0		0		0		0			0			0	If Used
3210	Manufacture of Textiles	Fac (3)		?		0		0		0		0		0			0			0	
3420	Printing and Publishing and Allied Indust.	Fac (1)		?		0		0		0		0		0			0			0	No WHO Data for Water
4101	Electricity Light (2) and Power			?		0		0		0		0		0			0			0	

Assumptions: 1) Fruit canning operations included drying fruit.
2) Distillery is grain distillery

(1) - Feedlots represent livestock populaitons - waste loading factors require adjustment.
(2) - Industries listed in classification code are assumed to occur in the Cook Islands.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

- Laundries, Laundry Services, Cleaning and Dyeing Plants
- Small Fishing Operations
- Ship Building and Repairing
- Petroleum Storage

Table C.4 Working table for the calculation of water pollution and waste loads from industrial sources

Area FEDERATED STATES OF MICRONESIA Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
4101 (2)	Electricity Light and Power			?		0		0		0		0		0			0			0	

(1) - Feedlots represent livestock populations - waste loading factors require adjustment.
(2) Industries listed in classification code are assumed to ocur in the Federated States of Micronesia.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Small Fishing Operations
Ship Building and Repairing
Fish Processing

Table C.5 Working table for the calculation of water pollution and waste loads from industrial sources

Area: FIJI Year Prepared: 1992

Industrial Classification Codes	Process	Unit	Prod.	Ocean	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
			per yr. 10^3unit	Discharge	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3111	Slaughtering, Prepare and Preserve Meat	Fac (2)				0		0		0		0		0			0			0	
	Simple Slaughter Houses w/o Blood	tn LWK	9.696	?	10	43.63	8.00	5.43	4.00	5.04	0.70	6.79	0.05	0.48			0			0	
	Low Processing Packing Houses	tn LWK	4.205	?	8.1	15.33	5.90	1.74	3.00	1.64	0.53	2.23	0.13	0.55			0			0	
	Poultry Proc. w/o Blood Rec.	10E3 birds	5.491	?	17	42.01	12.70	4.88	5.60	4.00		0.00		0.00			0			0	
Treatment	Primary Skimming and Air Floatation				0.45	0	0.07	0	0.13	0		0		0			0			0	If Used
3112	Manufacture of Dairy Products	Fac (3)				0		0		0		0		0			0			0	
	Ice Cream	1 of 3			1.6	0	0.24	0		0		0		0			0			0	
	Butter	tonnes	1.323		33.2	6.81	10.40	13.76		0.00	1.95	2.58	0.42	0.56			0			0	
Treatment	Aerated Lagoon				0.155	0		0		0		0									If Used
3114	Canning, Preserving and Processing of Fish, Crustacea and Similar Foods	Fac (7)				0		0		0		0		0			0			0	
	Tuna	tn produced	12.207	Yes	13.40	8.18	10.40	6.35	7.40	4.52	2.10	25.63		0			0			0	
Treatment	Screening & Floatation with Extended Aeration or with Aerated Lagoon				0.05	0	0.05	0	0.05	0		0		0			0			0	If Used

Table C.5 Working table for the calculation of water pollution and waste loads from industrial sources

Area: FIJI Year Prepared: 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3115	Manufacture of Vegetable and Animal Oils and Fat	Fac (2)				0		0		0		0		0			0			0	
	corn oil	tonnes	0.96	yes	0.3	0.288	0.35	0.336		0											
	general	tonnes	3.84	yes	24.9	95.616	24.6	94.464		0											
	Punja Cooking Oil Factory (General)	tonnes produced		Yes		0		0		0		0		0	Total Coliform	/100 ml	1900000	Faecal Coliform	/100 ml	1500000	One Effluent Sample
Treatment	Dissolved Air Float. with Chems				0.08	0	0.32	0	0.22	0		0		0			0			0	If Used
3116	Grain Mill Products			?		0		0		0		0		0			0			0	
3117	Manufacture of Bakery Products	Fac (4)	0.676	?	0.11	0.07436		0		0	0.004	0.002704		0			0			0	
3118	Sugar Factories and Refineries	Fac (4) tns sugar	395.6	Yes	2.9	263.87	6.30	124.61		0.00		0.00		0.00			0.00			0.00	
	Lautoka	tns sugar	130.1	Yes	2.9	86.78	6.30	40.98		0.00		0.00		0.00			0.00			0.00	
	Rarawai	tns sugar	114	Yes	2.9	76.04	6.30	35.91		0.00		0.00		0.00			0.00			0.00	
	Labasa	tns sugar	118.9	Yes	2.9	79.31	6.30	37.45		0.00		0.00		0.00			0.00			0.00	
	Penang	tns sugar	32.5	Yes	2.9	21.68	6.30	10.24		0.00		0.00		0.00			0.00			0.00	
Treatment	Water Conservation & Activated Sludge				0.23		0.05														If Used
3121	Manufacture of Food Products Not Elsewhere Class.	Fac (160)		?		0		0		0		0		0			0			0	
3131	Distilling, Rectifying, and	Fac (1)				0		0		0		0		0			0			0	
	Blending Spirits			Yes		0		0		0		0		0			0			0	
3133	Malt Liquors and Malt	Fac (1)				0		0		0		0		0			0			0	
	Carlton Brewery Malting and Brewing New Large Plant	cubic metres	14.7	Yes	10.5	129.7	3.90	187.1		0		0		0			0			0	
Treatment	Primary				0.84		0.37														

Table C.5 Working table for the calculation of water pollution and waste loads from industrial sources

Area FIJI Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod.	Ocean	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
			per yr. 10^3unit	Discharge	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3134	Soft Drinks	Fac (21)		No		0		0		0		0		0			0			0	
3210	Manufacture of Textiles	Fac (132)		?		0		0		0		0		0			0			0	
3231	Tanneries and Leather Finishing	Fac (7)		?		0		0		0		0		0			0			0	
3411	Manufacture of Pulp, Paper, and Paper Board	Fac (11)		?		0		0		0		0		0			0			0	
3420	Printing and Publishing and Allied Indust.	Fac (49)		?		0		0		0		0		0			0			0	
3512	Manufacture of Fertilizers and Pesticides	Fac (3)		No		0		0		0		0		0			0			0	
3523	Manufacture of Soap and Cleaning Preparations	Fac (2)				0		0		0		0		0			0			0	
	Soap From Kettle Boiling			Yes		0		0		0		0		0			0			0	
	Punja Soap	tonnes		Yes		280 mg/L		600 mg/L						2.4 mg/L	Total Coliform	/100 ml	50000	Faecal Coliform	/100 ml	10000	One Effluent Sample
3529	Manufacture of Chemical Products Not Elsewhere Classified	Fac (27)		?		0		0		0		0		0			0			0	
3513	Manufacture of Synthetic resins, Plastic Materials and Man Made Fibres, Except Glass	Fac (7)		?		0		0		0		0		0			0			0	
3819	Manufacture of Fabricated Metal Products, Machinery and Equipment Not Elswhere Class.	Fac (117)		?		0		0		0		0		0			0			0	

Table C.5 Working table for the calculation of water pollution and waste loads from industrial sources

Area FIJI Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod.	Ocean	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
			per yr. 10^3unit	Discharge	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3720	Non-Ferrous Metal Basic Industries	Fac (4)		?		0		0		0		0		0			0			0	
4101	Electricity (2) Light and Power	Fac (3)		Yes		0		0		0		0		0			0			0	

Assumptions - 1) Complex Slaughter Houses
2) LWK is equal to meat produced

(1) - Feedlots represent livestock population - waste loading requires adjustment.
(2) - Industries listed in classification code are assumed to occur in Fiji.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

- Laundries, Laundry Services, Cleaning and Dyeing Plants
- Stone Quarrying, Clay and Sand Pits
- Ship Building and Repairing;
- Petroleum Storage
- Forestry
- Non-Ferrous Ore Mining
- Stone Quarrying, Clay and Sand Pits

Table C.6 Working table for the calculation of water pollution and waste loads from industrial sources

Area FRENCH POLYNESIA Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMME
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3133	Malt Liquors																				
	and Malt																				
	Malting and Brewing	m3			10.5	0	3.9	0		0		0		0			0			0	
	Primary				0.84		0.37														

Table C.7 Working table for the calculation of water pollution and waste loads from industrial sources

Area GUAM Year Prepared 1992 Page 1 of 1

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3111	Slaughtering, (3) Preparing, and Preserving Meat	Fac (1) Preparing, Preserving				0	0	0	0	0	0	0	0	0	0		0	0		0	
	Simple Slaughter Houses	tn LWK	0.55	?	10.00	2.49	8.00	1.39	4.00	0.72	0.70	0.51	0.05	0.03			0.00			0.00	
	Poultry Processing w/o Blood Rec.	10 3 bds	0.093182	?	17.00	0.71	12.70	0.63	5.60	0.46		0.00		0.00			0.00			0.00	
Treatment	Primary Skimming and Air Floatation				0.450	0.000	0.070	0.000	0.130	0.000		0.000		0.00			0.00			0.00	If Used
3121	Manufacture of Food Products Not Elsewhere Class.	tonnes		?		0		0		0		0		0			0			0	
3210	Manufacture of Textiles	tonnes		?		0		0		0		0		0			0			0	
3420	Printing and Publishing and Allied Indust.	tonnes		?		0 0		0 0		0 0		0 0		0 0			0 0			0 0	
4101 (2)	Electricity Light and Power			?		0		0		0		0		0			0			0	

(1) - Feedlots represent livestock population - waste loading requires adjustment.
(2) - Industries listed in classification code are assumed to occur in Guam.
(3) - Numbers calculated using combined beef and pork.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

- Laundries, Laundry Services, Cleaning and Dyeing Plants
- Petroleum Storage
- Ship Building and Repairing
- Small Scale Fisheries

Table C.8 Working table for the calculation of water pollution and waste loads from industrial sources

Area KIRIBATI Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD kg per unit	BOD effl. mt	SS kg per unit	SS effl. mt	OIL kg per unit	OIL effl. mt	Total N kg per unit	Total N effl. mt	Total P kg per unit	Total P effl. mt	OTHER Name	OTHER kg per unit	OTHER effl. mt	OTHER Name	OTHER kg per unit	OTHER effl. mt	COMMENTS
1110	Agricultural and																0			0	
	Livestock Prod.					0		0		0		0		0			0			0	
	Swine Feedlot	Head		?	32.8	0	248	0	0	0	7.3	0	2.3	0			0			0	
	Broiler Feedlot	Head		?	146	0	6315	0	0	0	95.3	0	16.4	0			0			0	

(1) - Feedlots represent livestock population - waste loading requires adjustment.

(2) - Industries listed in classification code are assumed to occur in Kiribati.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

- Laundries, Laundry Services, Cleaning Plants
- Small Fishing Operations
- Ship Building and Repairing
- Forestry
- Mining

Table C.9 Working table for the calculation of water pollution and waste loads from industrial sources

Area NAURU Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
4101 (2)	Electricity Light and Power			Yes		0		0		0		0		0			0			0	

(1) - Feedlots represent livestock populations - waste loading requires adjustment.
(2) - Industries listed in classification code are assumed to occur in Nauru.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Small Fishing Operations
Ship Building and Repairing
Non-Ferrous Mining

Table C.10 Working table for the calculation of water pollution and waste loads from industrial sources

Area NEW CALEDONIA Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl.	kg per unit	effl.	kg per unit	effl.	kg per unit	effl.	kg per unit	effl.	Name	kg per unit	effl.	Name	kg per unit	effl.	
3111	Slaughtering, (3) Preparing, and Preserving Meat	Fac (1)		?		0		0		0		0		0			0			0	
	Simple Slaughter Houses w/o Blood Rec.	tn LWK		?	10.00	0.00	8.00	0.00	4.00	0.00	0.70	0.00	0.05	0.00			0.00			0.00	
	Low Processing Packing Houses	tn LWK		?	8.10	0.00	5.90	0.00	3.00	0.00	0.53	0.00	0.13	0.00			0.00			0.00	
Treatment	Primary Skimming and Air Floatation				0.450	0.000	0.070	0.000	0.130	0.000		0.000		0.00			0.00			0.00	If Used
3121 (2)	Manufacture of Food Products Not Else-where Classified			?		0		0		0		0		0			0			0	
3133	Malt Liquors and Malt					0		0		0		0		0			0			0	
	Malting and Brewing New Large Plant	m3 beer	4.2406	Yes	10.5	37.40	3.90	6.12		0		0		0			0			0	
Treatment	Primary Treatment				0.84	0	0.37	0		0		0		0			0			0	

Table C.10 Working table for the calculation of water pollution and waste loads from industrial sources

Area NEW CALEDONIA Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl.	kg per unit	effl.	kg per unit	effl.	kg per unit	effl.	kg per unit	effl.	Name	kg per unit	effl.	Name	kg per unit	effl.	
3710	Iron and Steel Basic Industires					0		0		0		0		0			0			0	
4101 (2)	Electricity Light and Power					0		0		0		0		0			0			0	

(1) - Feedlots represent livestock populations - waste loading requries adjustment.
(2) - Industries listed in classification code are assumed to occur in New Caladonia.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Small Fishing Operations
Ship Building and Repairing
Crude Petroleum and Natural Gas Production
Non-ferrous Ore Mining
Manufacture Cement, Lime and Plaster
Paper Goods, Not Manufacture

Table C.11 Working table for the calculation of water pollution and waste loads from industrial sources

Area NIUE   Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3111	Slaughtering, (3) Preparing, and Preserving Meat	Fac (1)				0		0		0		0		0			0			0	
	Simple Slaughter Houses	tn LWK	24.76		10.00	111.43	8.00	62.40	4.00	32.45	0.70	22.71	0.05	1.14			0.00			0.00	
Treatment	Primary Skimming and Air Floatation				0.450	0.000	0.070	0.000	0.130	0.000		0.000		0.00			0.00			0.00	If Used
3113	Canning and Pres-erving of Fruits and Vegetables	Fac (1)				0		0		0		0		0			0			0	
4101 (2)	Electricity Light and Power					0		0		0		0		0			0			0	

Assumptions: 1) LWK is equal to meat produced.

(1) - Feedlots represent livestock populations - waste loading requires adjustment.
(2) - Industries listed in classification code are assumed to occur in Niue.
(3) - Numbers calculated using combined beef and pork.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Small Fishing Operations
Ship Building and Repairing
Forestry

Table C.12 Working table for the calculation of water pollution and waste loads from industrial sources

Area PALAU Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
4101 (2)	Electricity Light and Power																				

(1) - Feedlots represent livestock population - waste loading requires adjustment.
(2) - Industries listed in classification code are assumed to occur in Palau.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Small Fish Processing Operations
Ship Building and Repairing
Petroleum Storage

Table C.13 Working table for the calculation of water pollution and waste loads from industrial sources

Area PAPUA NEW GUINEA　　　Year Prepared 1992　　　

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3units	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENTS
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3111	Slaughtering, (3) Preparing, and Preserving Meat					0		0		0		0		0			0			0	
	Simple Slaughter Houses	tn LWK	50.00		10.00	225.00	8.00	126.00	4.00	65.52	0.70	45.86	0.05	2.29			0.00			0.00	
Treatment	Primary Skimming and Air Floatation				0.450	0.000	0.070	0.000	0.130	0.000		0.000		0.00			0.00			0.00	If Used
3115	Manufacture of Vegetable and An-imal Oils and Fat Edible Oil					0		0		0		0		0			0			0	
	Palm Oil (General)	tn prod.	123.8	Yes	24.9	246.6096	24.6	974.5536	28.1	765.3316		0		0			0			0	
Treatment	Dissolved Air Floatation with Chems				0.08	0	0.32	0	0.22	0		0		0			0			0	
3118	Sugar Factories And Refineries					0		0		0		0		0			0			0	
	Cane Sugar	tn sugar	320	Yes	2.9	213.44	6.3	100.8		0		0		0			0			0	
Treatment	Water Conservation and Activated Sludge				0.23		0.05														
3121	Manufacture of Food Products Not Elsewhere Class.					0		0		0		0		0			0			0	
3133	Malt Liquors and Malt			Yes		0		0		0		0		0			0			0	
	Malting and Brewing New Large Plant	m3	55.5		10.5	489.51	3.9	80.0865		0		0		0			0			0	
Treatment	Primary				0.84		0.37														

Table C.13 Working table for the calculation of water pollution and waste loads from industrial sources

Area PAPUA NEW GUINEA   Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3units	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3411	Manufacture of Pulp, Paper, and Paperboard					0		0		0		0		0			0			0	
3521	Manufacture of Paints, Varnishes and Lacquers					0		0		0		0		0			0			0	
3819	Manufacture of Fabricated Metal Products, Machinery and Equipment Not Elsewhere Classified					0		0		0		0		0			0			0	
3210	Manufacture of Textiles					0 0		0 0		0 0		0 0		0 0			0 0			0 0	
3521	Manufacture of Paints, Varnishes and Lacquers					0 0 0		0 0 0		0 0 0		0 0 0		0 0 0			0 0 0			0 0 0	
3529	Manufacture of Chemical Products Not Elsewhere Classified																				
4101	Electricity Light and Power					0		0		0		0		0			0			0	

Assumptions: 1) Palm oil numbers are equal to General.
2) LWK is equal to meat produced

(1) - Feedlots represent livestock populations - waste loading requires adjustment.
(2) - Industries listed in classification code are assumed to occur in Papua New Guinea.
(3) - Numbers calculated using combined beef and pork.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

- Laundries, Laundry Services, Cleaning and Dyeing Plants
- Small Fishing Operations
- Ship Building and Repairing
- Forestry
- Petroleum Storage
- Crude Petroleum and Natural Gas Production
- Non-Ferrous Ore Mining - Gold and Copper
- Manufacture of Rubber
- Manufacture of Wood Veneer and Plyboard

Table C.14 Working table for the calculation of water pollution and waste loads from industrial sources

Area PITCAIRN Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMME
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	

Notes: Mainly a Subsistance Economy, No Major Industries

Table C.15 Working table for the calculation of water pollution and waste loads from industrial sources

Area REPUBLIC OF THE MARSHALL ISLANDS Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMMENT
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3420	Printing and Publishing and Allied Indust.					0		0		0		0		0			0			0	
4101 (2)	Electricity Light and Power					0		0		0		0		0			0			0	

(1) - Feedlots represent livestock population - waste loading requires adjustment
(2) - Industries listed in classification code are assumed to occur in RMI.

Additional Industries In Country: Either (a)) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Small Fishing Operations
Ship Building and Repairing

Table C.16 Working table for the calculation of water pollution and waste loads from industrial sources

Area SOLOMON ISLANDS Year Prepared 1992

Industrial Classification Code	Process	Unit	Prod. per yr. 10^3units	Ocean Discharge	BOD kg per unit	BOD effl. mt	SS kg per unit	SS effl. mt	OIL kg per unit	OIL effl. mt	Total N kg per unit	Total N effl. mt	Total P kg per unit	Total P effl. mt	OTHER Name	OTHER kg per unit	OTHER effl. mt	OTHER Name	OTHER kg per unit	OTHER effl. mt	COMMENTS
3111	Slaughtering, Prepare and Pre-serve Meat					0		0		0		0		0			0			0	
	Simple Slaughter Houses	tn prod	2	Yes	10	9	8	1.12	4	1.04	0.7	1.4	0.05	0.1			0			0	
	Poultry Processing w/o Blood Rec.				17	0	12.7	0	5.6	0		0		0							
Treatment	Primary Skimming and Air Float.				0.45		0.07		0.13												
3112	Manufacturing of Dairy Products					0		0		0		0		0			0			0	
	Ice Cream			?	1.6	0	0.24	0		0		0		0			0			0	
Treatment	Activated Sludge				0.071		0.046				0.39										
3114	Canning, Preserv-ing and Proces-ing of Fish, Crustacea and Similar Foods	mt	29.2		13.4	0	10.4	0	7.4	0		0		0			0			0	
	Solomon Taiyo Ltd	Tns Tuna	8.25	Yes	13.4	5.5275	10.4	4.29	7.4	3.0525	2.1	17.325	0	0			0			0	
		Fishmeal	2.75	Yes	62.2	8.5525	34.8	4.785	22.8	3.135	0	0	0	0			0			0	
Treatment	Screening and Floatation with Extended Aeration or with Aerated Lagoon				0.05		0.05		0.05												
3115	Manufacture of Vegetable and An-imal Oils and Fat	Fac (2)				0		0		0		0		0			0			0	
	Edible Oil Ref. Palm Oil	tonnes	19.7	Yes	24.9	490.53	24.6	484.62	28.1	553.57		0		0			0				
Treatment	None																				

Table C.16 Working table for the calculation of water pollution and waste loads from industrial sources

Area SOLOMON ISLANDS Year Prepared 1992

Industrial Classification Code	Process	Unit	Prod. per yr. 10^3units	Ocean Discharge	BOD kg per unit	BOD effl. mt	SS kg per unit	SS effl. mt	OIL kg per unit	OIL effl. mt	Total N kg per unit	Total N effl. mt	Total P kg per unit	Total P effl. mt	OTHER Name	OTHER kg per unit	OTHER effl. mt	OTHER Name	OTHER kg per unit	OTHER effl. mt	COMMENTS
3117	Manufacture of Bakery Products				0.11	0	0.7	0		0	0.004	0		0			0			0	
3121	Manufacture of Food Products Not Elsewhere Classified			Yes		0		0		0		0		0			0			0	
3134	Soft Drinks	Fac (1)			2.1	0	0.7	0		0		0		0			0			0	
	Franchise Plant/ no Syrup Preparation Return Containers			Yes																	
3133	Malt Liquors and Malt	Fac (1)																			
	Malting and Brewing																				
	New Large Plant	m3 beer			10.5	0	3.9	0		0		0		0			0			0	
Treatment	Primary (4)																				
3210	Manufacture of Textiles																				
4101 (2)	Electricity Lights and Power																				

(1) - Feedlots represent livestock populations - waste loading requires adjustment.
(2) - Industries listed in classification code are assumed to occur in the Solomon Islands.
(3) - Numbers calculated using combined beef and pork.
(4) - Not Yet Constructed

Additional Industries In Country: Either (b) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Small Fishing Operations
Ship Building and Repairing
Forestry
Furniture Manufacture
Ship Building and Repair
Non-Ferrous Ore Mining - Gold, Silver,
Battery Manufacture

Table C.17 Working table for the calculation of water pollution and waste loads from industrial sources

Area TOKELAU Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMME
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
1110	Agricultural and Livestock Prod.					0		0		0		0		0			0			0	
	Swine Feedlot	Head			32.8	0	248	0	0	0	7.3	0	2.3	0			0			0	

Notes: Mainly a Subsistance Economy, No Major Industries

Table C.18 Working table for the calculation of water pollution and waste loads from industrial sources

Area TUVALU Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod.	Ocean	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			Comments
			per yr. 10^3unit	Discharge	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3115	Manufacture of Vegetable and Animal Oils and Fat					0		0		0		0		0			0			0	
3121	Manufacture of Food Products Not Elsewhere Class.					0		0		0		0		0			0			0	
3420	Printing and Publishing and Allied Indust.					0		0		0		0		0			0			0	
3525	Manufacture of Soap and Cleaning Preparations					0		0		0		0		0			0			0	

(2) - Industries listed in classification code are assumed to occur in American Samoa.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:
Laundries, Laundry Services, Cleaning and Dyeing Plants

Table C.19 Working table for the calculation of water pollution and waste loads from industrial sources

Area VANUATU Year Prepared 1992

Industrial Classifcation Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD kg per unit	BOD effl. mt	SS kg per unit	SS effl. mt	OIL kg per unit	OIL effl. mt	Total N kg per unit	Total N effl. mt	Total P kg per unit	Total P effl. mt	OTHER Name	OTHER kg per unit	OTHER effl. mt	OTHER Name	OTHER kg per unit	OTHER effl. mt	Comments
3111	Slaughtering, (3) Preparing, and Preserving Meat	Fac (1)				0		0		0		0		0			0			0	
	Simple Slaughter Houses	tn LWK	13.00	No	10.00	58.50	8.00	32.76	4.00	17.04	0.70	11.92	0.05	0.60			0.00			0.00	
	High Processing Packing Houses	tn LWK	13.00		16.10	94.19	10.50	69.23	9.00	80.99	1.30	105.29	0.40	42.12			0.00			0.00	
	Poultry Proc. w/o Blood Rec.	kg lv bd			17	0	12.7	0	5.6	0		0		0			0			0	
Treatment	Primary Skimming and Air Floatation				0.450		0.070		0.130			0.000		0.00			0.00			0.00	If Used
3112	Manufacture of Dairy Products			Yes		0		0		0		0		0			0			0	
	Milk	tn prod.	153.333		5.3	57.699	1.5	0		0	0.31	47.5332	0.068	10.427			0			0	
	Ice Cream	tn prod.			1.6	0	0.24	0		0		0		0			0			0	
Treatment	Activated Sludge				0.071		0.046														
3113	Canning and Preserving Fruits and Vegetables					0		0		0		0		0			0			0	

Table C.19 Working table for the calculation of water pollution and waste loads from industrial sources

Area VANUATU Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			Comments
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3114	Canning, Preserving and Processing of Fish, Crustacea and Similar Foods					0		0		0		0		0			0			0	
	Tuna	tn prod.	107.628	Yes	13.4	72.111	10.4	55.967	7.4	39.8224	2.1	226.019		0			0			0	
	Fishmeal				62.2	0	34.8	0	22.8	0		0		0			0			0	
Treatment	Screening & Floatation with Extended Aeration or Aerated Lagoon				0.05	0	0.05	0	0.05	0		0		0			0			0	
3115	Manufacture of Vegetable and Animal Oils and Fat					0		0		0		0		0			0			0	
3117	Manufacture of Bakery Products					0		0		0		0		0			0			0	
3133	Malt Liquors and Malt	m3	240		10.5	2116.8	3.9	346.32		0		0		0			0			0	
	Primary				0.84		0.37														
3134	Soft Drinks	m3	60		2.1	126	0.7	88.2		0		0		0			0			0	
3210	Manufacture of Textiles					0		0		0		0		0			0			0	
3523	Manufacture of Soap and Cleaning Preparations					0		0		0		0		0			0			0	
3710	Iron and Steel Basic Industries					0		0		0		0		0			0			0	

Table C.19 Working table for the calculation of water pollution and waste loads from industrial sources

Area VANUATU | Year Prepared 1992 |

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^{3}unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			Comments
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3819	Manufacture of Fabricated Metal Products, Machin-ery and Equipment Not Elswhere Classified					0		0		0		0		0			0			0	
4101 (2)	Electricity Light and Power					0		0		0		0		0			0			0	

Assumptions: 1) LWK Processing Packing Houses

(1) - Feedlots represent livestock population - water loading requires adjustment.
(2) - Industries listed in classification code are assumed to occur in Tonga.
(3) - Numbers calculated using combined beef and pork.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

Laundries, Laundry Services, Cleaning and Dyeing Plants
Ship Building and Repairing
Forestry
Grain Production
Non-Ferrous Ore Mining - Gold
Cement Works

Table C.20 Working table for the calculation of water pollution and waste loads from industrial sources

Area WALLIS AND FUTUNA Year Prepared 1992

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			COMME
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	

Notes: Mainly a Subsistance Economy, No Major Industries

Table C.21 Working table for the calculation of water pollution and waste loads from industrial sources

Area WESTERN SAMOA | Year Prepared 1992 |

Industrial Classification Codes	Process	Unit	Prod. per yr. 10^3unit	Ocean Discharge	BOD		SS		OIL		Total N		Total P		OTHER			OTHER			Comments
					kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	kg per unit	effl. mt	Name	kg per unit	effl. mt	Name	kg per unit	effl. mt	
3111	Slaughtering, (3) Preparing, and Preserving Meat	Fac (1)				0		0		0		0		0			0			0	
	Simple Slaughter Houses	tn LWK			10.00	0.00	8.00	0.00	4.00	0.00	0.70	0.00	0.05	0.00			0.00			0.00	
Treatment	Primary Skimming and Air Floatation				0.450	0.000	0.070	0.000	0.130	0.000		0.000		0.00			0.00			0.00	
3113	Canning and Pres-erving of Fruits and Vegetables					0		0		0		0		0			0			0	
3121	Manufacture of Food Producst Not Elsewhere Classified					0		0		0		0		0			0			0	
3133 (2)	Malt Liquors and Malt					0		0		0		0		0			0			0	
	Malting and Brewing New Large Plant	m3 beer	7.2224		10.5	63.702	3.9	10.422		0		0		0			0			0	
Treatment	Primary				0.84	0	0.37	0		0		0		0			0			0	
3210	Manufacture of Textiles					0		0		0		0		0			0			0	
4101 (3)	Electricity Light and Power					0		0		0		0		0			0			0	

(1) - Feedlots represent livestock populations - waste loading requires adjustment.

(2)- Beer production of Vailima plant given as 48,149 hl; increased by 50 % to account for unknown production of Manua plant

(3) - Industries listed in classification code are assumed to occur in Western Samoa.

Additional Industries In Country: Either (a) Not Included in WHO Method Water Pollution Table or (b) Included but does not have water as a matrix:

- Laundries, Laundry Services, Cleaning and Dyeing Plants
- Small Fishing Operations
- Ship Building and Repairing
- Forestry
- Concrete Manufacture
- Industrial and Household Gases
- Manufacture Coconut Cream

APPENDIX D
SAMPLE SUMMARY TABLE

SUMMARY DATA SHEETS

COUNTRY:

Population:
Rural:
Urban:
Population Trends:
Growth rate:
Natural growth rate:
Density:

Resources:

Major Islands (or Groups):

Land Area: km^2
Urban:
Rural:
Cultivated:
Pasture:
Forest:

Marine Area:

I. Geologic/ Geographic Information:

II.Environmental Issues

General:

Coastal and Inland Water Quality:

III. DOMESTIC WASTEWATER DISPOSAL:

LOCATION	FACILITIES(1)	POPULATION	WASTEWATER FLOW(2)	EFFLUENT CHARACTERISTIC(3)						RECEIVING WATER	SOLID WASTE(4)
				BOD	SS	N	P				

Notes: 1) Treatment plant, septic tanks, water-seal latrines, pit latrines, etc 2) If a wastewater treatment plant and flow has been measured, record here. Otherwise it is calculated using typical design assumptions. 3) Measured characteristics record; otherwise used standard design assumptions. Actually measured values identified with an asterisk (*).

GENERAL COMMENTS

IV. DOMESTIC SOLID WASTE

Location*	Facility	Population	Community Type	Waste Volume (1)	Controlled vol(2)	Litter(3)	Other
	community						
	individual						

Notes: 1) This will be calculated using standard design assumptions 2) If there has been waste collection and volumes recorded, or otherwise documented record here.
3) Low, moderate, high; coastline and/or inland. (mostly for countries visited; unless studies have documented this information.
* please note if coastal or inland

GENERAL COMMENTS

V. MAJOR AGRICULTURE

LOCATION	FACILITIES	UNITS	PRODUCTION RATE	COMMENT

Note: *1) This primarily refers to commercial, large-scale agricultural operations. However, other agricultural activities which have been noted for with significant impacts may be included.
2) note in comments or in general notes potential for surface water pollution and groundwater pollution

GENERAL COMMENTS

VI. INDUSTRY

LOCATION	TYPE	FACILITIES	PRODUCTION RATE	WASTEWATER FLOW	EFFLUENT CHARACTERISTIC						RECEIVING WATER	SOLID WASTE
					BOD	SS	N	P	0/G			

GENERAL COMMENTS

IV. SIGNIFICANT AIR EMISSIONS

LOCATION	FACILITY	PRODUCTION RATE		EMISSIONS				

Note: "Significant" means power plants/major industries; transportation inputs are not considered.

GENERAL COMMENTS

V. PESTICIDES

Available Pesticide Use Summary

PESTICIDE	USE	VOLUME IMPORTED	APPLICATION METHOD	AREA APPLIED	DISPOSAL	OTHER

Observed/Documented Cases of Pesticide Pollution :