APPENDIX F

PROJECT EVALUATION

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1. Economic and Social Evaluation

1.1 Reduction of Water-Borne Disease

1.1.1 Estimation of Economic Costs of Water-Borne Diseases

The economic costs of a water-borne disease case would be comprised of two (2) factors. One, which is the most obvious, is the medical cost to be required to cure the case. Another is the opportunity cost of time spent by a hospitalized patient.

The formulas for the estimation of average economic costs per case are shown in Table F.1.1.

The costs of a water-borne disease case can be typically represented by the first factor, i.e. medical cost.

Data and information on the medical cost per case for each type of water-borne diseases were collected by visiting hospitals concerned.

They were tabulated as shown in Table F.1.2. The weighted average of medical cost per case was calculated at Rp. 129,839 at 1991 prices.

When a person in the study area is afflicted with a water-borne disease and hospitalized for a certain period, he cannot work during the period. It is a loss to the economy of the study area. Such a loss is calculated at Rp. 9,873 on average per case.

These two (2) costs add up to Rp. 139,712. This is the average economic costs per water-borne disease case.

As the number of water-borne disease cases in the study area was 27,263 in 1990, the total economic costs of water-borne diseases work out at Rp. 3,809 million.

1.1.2 Reduction of Water-Borne Disease

It is known that the incidence of water-borne diseases is positively related to the unsanitary conditions of surface and groundwater, nutritional conditions and educational level of people, etc.

It is observed from the color, smell and chemical levels of river water that most of the rivers crisscrossing the study area are polluted due to domestic and industrial discharges.

It can be reasoned that a high incidence of water-borne diseases in the study area is inseparably connected with this polluted state of water courses.

It follows from the above that the introduction of sewerage and the resultant purification of river water will greatly contribute to the reduction of water-borne diseases and related economic costs in the study area.

The overall introduction of water supply will also lead to the reduction of such diseases because it will reduce the necessity and opportunities to use untreated water. Further, an efficient garbage collection measure will mitigate the pollution of river water along with sewerage.

1.2 Increase of Tourism Income

1.2.1 Results of Questionnaire for Tourists

The JICA Study Team conducted the sampling questionnaire survey towards the tourists in the Sanur, Kuta and Nusa Dua areas. The questions asked were about important tourism attractions, expression of the importance of the "clean, clear and beautiful seas and rivers" as percentage of the total tourism attractions, conditions of the seas and the rivers and the desire to visit Bali again in case the conditions of the seas and the rivers get worse than now. The number of samples totaled 173. (Refer to Table F.1.3.)

47.4% of the respondents were Australians, 12.7% British, 12.7% Dutch, 7.5% Germans and 19.7% people of other nationalities. The average age of the respondents was 35.5 years. 61.8% were male and 38.2% female. As regard the marriage status 50.3% were single and 49.7% married. 95.4% of the interviewees came here on holiday, 1.2% on business, 0.6% on official

mission and 2.8% for family union. For 45.1% of them this was the first visit, for 29.5% the 2nd visit, for 8.7% the 3rd visit, for 5.8% the 4th visit, for 3.5% the 5th visit and for the remaining 7.4% the 6th visit or more.

Firstly, sampled tourists were asked to choose the ones which they consider more important out of the 14 major attractions of Bali. Those attractions are as follows :

Smiling and Friendly People; Accommodations (Hotels, Cottages, etc.); Clean, Clear and Beautiful Seas and Rivers; Green and Peaceful Rural Scenery with Paddy Fields, Groves of Coconut Trees, Tropical Flowers, etc.; Mild Temperature; Bali Dances; Souvenir (Paintings, Garments, Puppet Masks, Wooden Sculptures, etc.); Temples and Other Religious Objects; Food (Seafood, Bali Food, etc.); Fruit (Mangosteen, Durian, Mango, etc.); Night Life; Marine Sports (Diving, Surfing, Parasailing, etc.); Northern Mountainous Areas (e.g. Kintamani); and Wedding and Funeral Ceremonies.

Survey results revealed that 86.7% considered Smiling and Friendly People more important, 59.5% chose Accommodations, 55.5% Clean, Clear and Beautiful Seas and Rivers, 54.9% Green and Peaceful Rural Scenery, 46.2% Mild Temperature, 44.5% Bali Dances, 42.8% Souvenir, 32.9% Temples, 31.2% Food, 26.6% Fruit, 26.0% Night Life, 24.3% Marine Sports, 17.9% Northern Mountainous Areas and 11.6% Wedding and Funeral Ceremonies.

Clean, Clear and Beautiful Seas and Rivers gained 55.5 points and was placed third. However, when one looks deep into the matter, it becomes clear that the 14 attractions are mutually connected. Besides, they are interconnected not in an additional fashion, but in a multiplying fashion.

That is to say, supposing the water of the seas and the rivers deteriorates more and turns dark or black all over, then all the other attractions will be more or less affected. Such attractions as Accommodations, Green and Peaceful Rural Scenery, Souvenir, Food, Night Life and Marine Sports will be directly and heavily affected. Even such attractions as Smiling and Friendly People, Mild Temperature and Bali Dances which appear irrelevant to the seas and the rivers will lose their original lusters and meanings.

In other words, the worsening of water quality of the seas and the rivers in the Study Area will deal crushing and fatal damage to the tourism in the area.

Secondly, tourists were asked to express the importance of Clean, Clear and Beautiful Seas and Rivers as percentage of the total tourism attractions. The results are that they consider the attraction of Clean, Clear and Beautiful Seas and Rivers accounts for 70.6% of the entire attractions of Bali.

Thirdly, tourists were asked about the existing conditions of the seas and the rivers. It was found that 44.5% of them, which is the highest percentage consider the conditions of the seas "not so clean and clear in some locations". Also, 44.5% of them, which is also the highest percentage consider the conditions of the rivers "not so clean and clear in some locations".

Although regarding the conditions of the seas 43.9% of tourists interviewed, which is the second highest percentage consider "clean, clear and in good conditions", regarding the conditions of the rivers only 8.7% of them consider in the same way. Furthermore, they notice garbage, dying corals, excessive weeds under the water and filthy, stinking water.

As the last question tourists were asked if they wanted to visit Bali again as tourists, supposing the conditions of the seas and the rivers got worse than now in the coming years. The results are that 67.6% of them replied "No", and 32.4% "Yes".

1.2.2 Estimation of Tourism Benefits

As is shown in Table A.5.8, estimated tourists' expenditures in the Study Area totaled Rp. 610,321 million in 1990. In the target year of 2010 they are projected to reach Rp. 2,390,500 million increasing at the average annual rate of 7.1% from 1990 to 2010.

Tourists spend money for accommodations (38.4%), souvenir (22.5%), eating (20.5%), tour (6.5%), show (4.3%), public transportation (3.1%), guides (2.2%) and others (2.5%).

It is estimated that the gross profit ratio of the commercial businesses catering for tourists is on average 30%. That is to say, tourism income or the direct contribution of tourism to the economy of the Study Area is estimated at Rp. 183,096 million in 1990. The GRDP of the Study Area in the same year is estimated at Rp. 815,484 million as shown in Table A.4.1. It means that the direct contribution of tourism to the economy of the Study Area as percentage of the GRDP was 22.5% in 1990. The direct contribution of tourism to the per capita GRDP of the Study Area is calculated to have amounted to Rp. 383,498 in 1990.

Tourists' spending provides stimuli to the overall economy of the Study Area. When one takes such multiplier effects into account, contribution of tourism to the economy of the Study Area will be much higher. As the economy develops and matures, direct contribution of tourism as percentage of the economy may decline, but its overall contribution will get higher because of greater multiplier effects.

In 2010 the direct contribution of tourism to the economy of the Study Area is projected to reach Rp. 717,150 million, while the economy of the Study Area is forecast to grow to Rp. 3,463,310 million in the same year. It means the direct contribution of tourism to the economy of the Study Area as percentage of the economy will be 20.7% in 2010. The direct contribution of tourism to the per capita GRDP of the Study Area is estimated to grow to Rp. 1,011,067.

The above-mentioned tourism income or direct contribution of tourism to the economy of the Study Area will be realized only if the conditions of the seas and the rivers in the area do not deteriorate more in the future. In other words, it will be realized in the "with" situation.

In the "without" situation, according to the results of the sampling questionnaire survey for the tourists, the number of tourists visiting Bali is expected to drastically decline in the coming years. It is assumed based on the results of the survey that in the target year of 2010 tourism income in the "without" situation will be 32.4% of tourism income expected under the "with" situation.

The "with" situation (or case) means the situation (or case) where it is assumed that the project will be implemented. On the other hand, the

"without" situation (or case) means the situation (or case) where it is assumed that the project will not be implemented.

It is assumed that sewerage services under the first phase project will partially start in 1998 and be in full operation from 2000 onward and that sewerage services will be extended under the second phase project to cover the required areas in 2010.

Also, it is assumed that the ratio of tourism income in the "without" situation to tourism income in the theoretical "with" situation in the interim years from 1990 to 2010 will decline following a simple equation, i.e. tracing a straight line.

The theoretical "with" situation means an imaginary situation where it is assumed that sewerage services were already partially started in 1991.

Based on the above assumptions tourism benefits were calculated. Tourism benefits are defined as the difference in tourism income between the "without" and "with" situations. The results are shown in Table F.1.4.

As the table shows tourism benefits will be Rp. 143,316 million in 2000, climb sharply every year and reach Rp. 484,793 million in 2010.

It is to be noted that the above tourism benefits will not accrue to the wastewater disposal project alone, but will be realized only by the combined support of all the related fields such as road, water supply, drainage, telecommunications, electricity and garbage disposal projects.

1.3 Others

As already analyzed, a further deterioration of water quality in the seas and the rivers will deal irrevocably serious damages to the tourism and the economy of the Study Area. Also, the number of cases of water-borne diseases will increase, forcing unwanted losses to the economy of the Study Area.

In addition to these damages and losses, negative impacts of the worsening of sea and river water will be strongly felt in the now thriving fisheries of the Study Area.

As already described, the values of fish production excluding catching in the outer seas in Badung came to Rp. 15,570 million in 1989. Also, the number of families engaged in fisheries full or part time was 2,972 in Badung in the same year.

Prawn culture in brackish water occupies a predominant position in the values of fish production with the share of 96.2%.

Supposing the share of the Study Area in the values of fish production and the number of fishery families is 97% and 70% of the whole Badung respectively, then the values of fish production and the number of fishery families in the Study Area in the same year work out at Rp. 15,103 million and 2,080 families, respectively. Supposing the gross profit ratio of fisheries is 30%, the contribution of the fisheries to the economy of the Study Area works out at Rp. 4,531 million in 1989.

Leaving the conditions of the seas and the rivers to deteriorate in the coming years, this important segment of the economy of the Study Area will sustain irreparable damages.

Furthermore, the so-called salt farming is practiced in Denpasar Selatan using sea water, the values of salt produced this way coming to Rp. 116 million in 1991. This unique industry is destined to completely phase out if the conditions of the seas are left as they are.

2. Financial Evaluation

2.1 People's Willingness to Pay

2.1.1 People's Willingness to Pay in 1991

The JICA Study Team carried out the sampling questionnaire survey in October, 1991 to know how much a household, business or industry is on average willing to pay for sewerage services in the event sewerage system is constructed in the Study Area.

Note: "Willingness to pay" means the amount which, or the extent to which the beneficiaries are willing to pay (for sewerage services).

The number of samples was 750 for households and 30 each for hotels, restaurants, shops/banks and factories.

It was found out as a result of the survey that the willingness to pay in general goes up as household income or corporate sales increase. Further, it was found that the ratio of willingness to pay to income/sales also goes up in parallel with the increase of income/sales.

Based on the above findings correlational/regressional analysis was performed regarding the relationships between household income / corporate sales and willingness to pay. The results are shown in Table F.2.1.

Households were classified into high, middle and low income classes. Hotels were classified into 4 to 5 star hotels, 1 to 3 star hotels and others. Restaurants were divided into large ones and medium/small ones. Shops were divided into large, medium and small ones. Banks were not classified. Factories were classified into large/medium and small ones.

As a result of the survey, the average monthly income/sales in 1991 for each of the households, businesses and factories classified in the above way were clarified as shown in Table F.2.2. Using these income/sales and equations in Table F.2.1, monthly willingness to pay and the ratio of willingness to pay to income/sales for each of the classified households and establishments were calculated.

The results are shown in Table F.2.2. As it shows, the monthly amount of sewerage service charge the high income class household is willing to pay on average is calculated at Rp. 10,205, corresponding to 0.978% of its monthly income. Likewise, the monthly willingness to pay of the middle and low income class households is on average Rp. 1,614 or 0.504% of monthly income and Rp. 836 or 0.398% of monthly income, respectively. The average monthly willingness to pay of the household across the three income classes works out at Rp. 1,480 or 0.516% of its monthly income.

The average monthly willingness to pay of the 4 or 5 star hotel is calculated at Rp. 4,808,750, corresponding to 0.489% of its monthly sales. Likewise, the average monthly willingness to pay of the 1 to 3 star hotel and the other

accommodation is Rp. 281,948 or 0.443% of monthly sales and Rp. 32,757 or 0.252% of monthly sales, respectively.

The large restaurant is on average willing to pay Rp. 40,992 per month, corresponding to 0.372% of its monthly sales, while the medium/small restaurant is on average willing to pay Rp. 2,924 per month or 0.107% of its monthly sales.

The large shop's average monthly willingness to pay amounts to Rp. 352,059, accounting for 0.164% of its monthly sales. Similarly, the medium and small shop's monthly willingness to pay is Rp. 6,557 or 0.132% of monthly sales and Rp. 1,193 or 0.071% of monthly sales, respectively. The average monthly willingness to pay of the bank works out at Rp. 29,522, accounting for 0.156% of its monthly sales.

The large or medium factory is on average willing to pay Rp. 21,309 per month, corresponding to 0.133% of its monthly production, while the small factory is on average willing to pay Rp. 1,246 per month or 0.050% of its monthly production.

From the monthly willingness to pay per household or establishment and the number of households or establishments in the proposed sewerage service areas, the total willingness to pay per year for the households or establishments can be worked out.

As Table F.2.3 shows the total willingness to pay per year in 1990 comes to Rp. 1,914 million. Out of it, households and hotels account for 39.1% and 28.4% respectively, adding up to 67.5% or more than two thirds of the total amount. Shops, banks, restaurants and factories account for 8.5%, 5.0%, 1.4% and 0.9%, respectively. Others include private and government offices other than banks, educational, medical and religious institutions, combinedly accounting for 16.7%.

2.1.2 People's Willingness to Pay in 2010

When income of a household or sales of an establishment increases, the amount of willingness to pay of the household or establishment will also go up as already mentioned.

It is estimated that in 2010 the average income/sales of a household/establishment will be more than in 1990, and along with it the amount of willingness to pay per household/establishment will be more than in 1990.

However, the JICA study team adopted the amount of willingness to pay per household/establishment in 1991 for estimating the total amount of willingness to pay in 2010 so that the estimate will be as conservative as possible.

The estimated number of households, hotels and restaurants in 2010 shown in Table F.2.4 is based on official projections. The number of shops, banks and factories in 2010 was estimated based on the growth of population and tourists between 1990 and 2010.

As Table F.2.4 shows the total amount of willingness to pay per year in 2010 comes to Rp. 4,460 million, which is 2.33 times greater than in 1990. Out of it, households and hotels account for 46.0% and 20.3% respectively, adding up to 66.3% or approximately two thirds of the total amount. Shops, banks, factories and restaurants account for 8.1%, 6.9%, 1.1% and 0.9%, respectively. Others account for 16.7%.

The amount of Rp. 4,460 million is much greater than the estimated annual operation and maintenance cost of Rp. 2,670 million.

2.2 Estimated Allocable Budget of Government

2.2.1 Analysis of Development Budget for Badung in 1991/1992

There are three governments compiling and using development budget for the Regency of Badung. The first is the Regencial Government (or the Second Stage Government) of Badung. The second is the Provincial Government (or the First Stage Government) of Bali. The third is the Central Government of Indonesia.

According to the report on the development budget for Badung in 1991/1992, the total development budget for Badung in the same year adds up to Rp. 154,005 million. The GRDP of Badung for the same year is estimated

at Rp. 1,223,183 million. So, the development budget for Badung corresponds to 12.6% of the GRDP of the Regency in 1991/1992.

Out of Rp. 154,005 million, Rp. 15,015 million or 9.7% is to be borne by the Regencial Government of Badung, Rp. 27,963 million or 18.2% by the Provincial Government of Bali and Rp. 111,027 million or 72.1% by the Central Government of Indonesia. (Refer to Table F.2.5.)

Usually, the development budget financed by the central government derives from foreign loans or grants, and development budget shouldered by the governments of Badung and Bali comes from the local resources.

Also, out of Rp. 154,005 million, Rp. 110,412 million or 71.7% is related to the development/improvement of infrastructure such as irrigation facility, road, bridges, water supply, drainage facility, transport and housing, and related fields. Out of Rp. 110,412 million, Rp. 6,748 million or 6.1% is to come from the regencial government, Rp. 11,398 million or 10.3% from the provincial government and Rp. 92,266 million or 83.6% from the central government.

Summing up, out of Rp. 154,005 million, which is the total amount of development budget for Badung in 1991/1992, Rp. 110,412 million or 71.7% is allocated for the development of infrastructure and related fields, of which Rp. 92,266 million or 83.6% is to be financed via the central government by foreign resources and Rp. 18,146 million or 16.4% is to be financed by local resources.

Supposing the wastewater disposal project now under study were being implemented, the budget for the project would be incorporated in that Rp. 110,412 million. Also, supposing the budget for the project were being financed by both foreign and local funds, the standard ratio of resources would be around 84% for foreign portion and around 16% for local portion.

The ratio of the population of the study area to that of Badung was 72.0% in 1990. Supposing this ratio can be applied in estimating development budget, the infrastructure-related development budget for the study area in 1991 works out at Rp. 79,497 million.

2.2.2 Development Budget for Badung in Repelita V

According to the development budget for the Regency of Badung during the 5th Five Year Plan period of 1989/1990 to 1993/1994, the cumulative amount of the development budget for the five years comes to Rp. 140,763 million plus the amount which is scheduled, but not immediately known. (Refer to Table F.2.6.)

Out of Rp. 140,763 million, Rp. 72,447 million or 51.4% is to be financed by the Regencial Government of Badung, Rp. 12,464 million or 8.9% by the Provincial Government of Bali and Rp. 55,852 million or 39.7% by the Central Government of Indonesia.

Also, out of Rp. 140,763 million, Rp. 81,812 million or 58.1% is to be spent for the development of infrastructure and related fields.

It is surmised that the budgetary amount which is scheduled, but not immediately known is comparatively small for the regencial government, greater for the provincial government and the greatest for the central government. Therefore, the above figures and ratios do not reflect the true picture and are misleading as such.

It is to be noted as a reference that the development budget for Badung occupied 62.3% of the development budget for the whole Province of Bali in 1986/1987.

2.2.3 Estimation of Allocable Budget in Future

Based on the data and information in the preceding sections and the projected GRDP of Badung, the development budget to be allocable for the development/improvement of infrastructure and related fields in the future was projected for the study area. The results are shown in Tables F.2.7.

As it shows, the allocable budget concerned for the study area will grow from Rp. 73,670 million in 1990 to Rp. 312,871 million in 2010 at the average annual rate of 7.5%. Supposing the project starts in 1994 the cumulative allocable budget will reach Rp. 3,245,607 million during the 17 years from 1994 to 2010.

The construction cost of the project during the same period is estimated at Rp. 253,600 million. This amount occupies 7.81% of the allocable budget.

Table F.1.1 Formulas for Estimation of Average Economic Costs per Water-Borne Disease Case

1. Average Medical Cost per Case

$$UMC = \sum_{j} (CR(j)*UMC(j)) \; / \; \sum_{j} CR(j)$$

where, UMC : Average medical cost per case
CR(j) : Contraction rate for disease j
UMC(j) : Medical cost per case for disease j

2. Average Economic Loss by Not Working per Case

$$ELN = \sum_{j} (CR(j)*UBD(j)*LP*WD) \; / \; \sum_{j} CR(j)$$

where, ELN : Average economic loss by not working per case
UBD(j) : No. of days in bed per case for disease j
LP : Labor force participation rate
WD : Wages/salaries per worker per day

3. Average Economic Costs per Case

$$UEE = UMC + ELN$$

where, UEE : Average economic costs per water-borne disease case

Source : JICA

Table F.1.2 Medical Cost per Patient

(Unit : Rp. at 1991 prices)

Name of Diseases	Outside Hospital			In Hospital			Total per patient
	Medication Period (days)	Unit Cost (Rp./day)	Cost	Medication Period (days)	Unit Cost (Rp./day)	Cost	
1 Malaria	2	2,200	4,400	15	22,000	330,000	334,400
2 Diarrhea	1	2,200	2,200	4	22,000	88,000	90,200
3 Cholera	1	2,200	2,200	4	22,000	88,000	90,200
4 Tuberculosis	4	2,200	8,800	13	22,000	286,000	294,800
5 DHF	1	2,200	2,200	7	22,000	154,000	156,200
6 Typhoid	2	2,200	4,400	10	22,000	220,000	224,400
7 Dysentery	0	2,200	0	7	22,000	154,000	154,000
8 Diphtheria	2	2,200	4,400	16	22,000	352,000	356,400
9 Measles	2	2,200	4,400	5	22,000	110,000	114,400
10 Hepatitis A	5	2,200	11,000	14	22,000	308,000	319,000
11 Hepatitis B	0	2,200	0	17	22,000	374,000	374,000

Source : JICA

Table F.1.3 (1) Results of Questionnaire for Tourists

I. Indentity of Respondents

1. Nationality

Australia	= 47.4%	Britain	= 12.7%	Holland	= 12.7%
Germany	= 7.5%	Others	= 19.7%		

2. Age = 35.5 years

3. Sex Male = 61.8% Female = 38.2%

4. Marriage Status Single = 50.3% Married = 49.7%

5. Purpose of Visit

Holiday	= 95.4%	Business	= 1.2%	Official	= 0.6%
Family Union	= 2.8%				

6. Times of Visits

1st visit	= 45.1%	2nd visit	= 29.5%		
3rd visit	= 8.7%	4th visit	= 5.8%		
5th visit	= 3.5%	More than 5 times	= 7.4%		

II. Answers to Questions

1. Important Tourism Attractions

1)	Smiling and friendly people	= 86.7%
2)	Accommodations (hotels, cottages, etc.)	= 59.5%
3)	Clean, clear and beautiful seas and rivers	= 55.5%
4)	Green and peaceful rural scenery with paddy fields, groves of coconut trees, tropical flowers, etc.	= 54.9%
5)	Mild temperature	= 46.2%
6)	Bali dances	= 44.5%
7)	Souvenir (paintings, garments, puppet masks, wooden sculptures, etc.)	= 42.8%
8)	Temples and other religious objects	= 32.9%
9)	Food (seafood, Bali food, etc.)	= 31.2%
10)	Fruit (mangosteen, durian, mango, etc.)	= 26.6%
11)	Night life	= 26.0%
12)	Marine sports (diving, surfing, parasailing, etc.)	= 24.3%
13)	Northern mountainous areas (e.g.Kintamani)	= 17.9%
14)	Wedding and funeral ceremonies	= 11.6%

Note = A percentage denotes the ratio of respondents who considered a particular tourism attraction item more important.

Table F.1.3 (2) Results of Questionnaire for Tourists

2. Expression of the Importance of the "Clean, Clear and Beautiful Seas and Rivers" as Percentage of the Total Tourism Attractions = 70.6%

3. Conditions of the Seas and the Rivers

1) Conditions of the Seas

(1) Not so clean and clear in some locations	= 44.5%
(2) Clean, clear and in good conditions	= 43.9%
(3) Garbages are noticeable.	= 30.1%
(4) Corals in some locations are dying.	= 13.3%
(5) Excessive seaweeds are noticeable.	= 4.6%
(6) Filthy and stinking	= 1.7%

2) Conditions of the Rivers

(1) Not so clean and clear in some locations	= 44.5%
(2) Garbages are noticeable.	= 37.0%
(3) Filthy and stinking	= 19.7%
(4) Clean, clear and in good conditions	= 8.7%
(5) Lots of weeds are noticeable under the water.	= 7.5%

Note : A percentage denotes the ratio of respondents who were affirmative regarding a particular condition item.

4. "Suppose the conditions of the seas and the rivers get worse than now in the coming years, do you want to visit Bali again as a tourist ?"

Yes = 32.4% No = 67.6%

Note : No. of samples was 173.

Source : JICA

Table F.1.4 Estimation of Benefits

(Unit: Rp. million)

Year	Tourism Income			Tourism Benefits
	Theoretical "With" Case	"With" Case	"Without" Case	
	A1	A2	B	C = A2 - B
1990	183,096	183,096	183,096	0
1991	203,658	196,774	196,774	0
1992	225,878	210,608	210,608	0
1993	248,697	223,479	223,479	0
1994	272,098	235,311	235,311	0
1995	296,067	246,032	246,032	0
1996	320,591	255,575	255,575	0
1997	345,657	263,875	263,875	0
1998	371,256	304,331	270,868	33,463
1999	397,377	359,083	276,495	82,588
2000	424,012	424,012	280,696	143,316
2001	451,153	451,153	283,414	167,739
2002	478,792	478,792	284,594	194,198
2003	506,923	506,923	284,181	222,742
2004	535,541	535,541	282,123	253,418
2005	564,636	564,636	278,366	286,270
2006	594,209	594,209	272,861	321,348
2007	624,250	624,250	265,556	358,694
2008	654,757	654,757	256,403	398,354
2009	685,725	685,725	245,352	440,373
2010	717,150	717,150	232,357	484,793

Source: JICA

Table F.2.1 Results of Regression Analysis of Relationships Between Household Income / Corporate Sales and Willingness to Pay

(Unit : Rp.)

Item	Regression Equations
Household	log y = -12.39747 + 1.560739 log x where, y = Willingness to pay per month per household for sewerage services x = Monthly household income per household Correl. Coef. = 0.410383 T-Value = 3.052211
Hotel	y = -31,264 + 0.004924719 x where, y = Willingness to pay per month per hotel for sewerage services x = Monthly sales per hotel Correl. Coef. = 0.986823 T-Value = 20.227870
Restaurant	y = -9,576 + 0.004587086 x where, y = Willingness to pay per month per restaurant for sewerage services x = Monthly sales per restaurant Correl. Coef. = 0.748740 T-Value = 5.051515
Shop/Bank	y = -1,589+ 0.001644075 x where, y = Willingness to pay per month per shop/bank for sewerage services x = Monthly sales per shop/bank Correl. Coef. = 0.95299 T-Value = 11.768350
Factory	y = -2,448 + 0.0014823051 x where, y = Willingness to pay per month per factory for sewerage services x = Monthly sales per factory Correl. Coef. = 0.998808 T-Value = 183.994700

Note : Results of the sampling questionnaire survey. The number of samples was 750 for houscholds and 30 each for hotels, restaurants, shops/banks and factories.

Source : JICA

Table F.2.2 Willingness to Pay per Month of Households and Establishments in 1991

(Unit : Rp.)

Items	Classification	Willingness to Pay	Monthly Income/Sales	Ratio (%)
		A	B	C = A/B x 100
Household	High Class	10,205	1,043,000	0.978
	Middle Class	1,614	320,000	0.504
	Low Class	836	210,000	0.398
	Average	1,480	287,000	0.516
Hotel	4 to 5 Stars	4,808,750	982,800,000	0.489
	1 to 3 Stars	281,948	63,600,000	0.443
	Others	32,757	13,000,000	0.252
Restaurant	Large	40,992	11,024,000	0.372
	Med./Small	2,924	2,725,000	0.107
Shop	Large	325,059	215,105,000	0.151
	Medium	6,557	4,956,000	0.132
	Small	1,193	1,692,000	0.071
Bank		29,522	18,923,000	0.156
Factory	Large/Med.	21,309	16,027,000	0.133
	Small	1,246	2,492,000	0.050

Note : Results of the sampling questionnaire survey. The amount of the willingness to pay was calculated using regression equations shown in Table G.2.1.

Source : JICA

Table F.2.3 Total Willingness to Pay per Year in 1990

(Unit: Rp. million)

Item	Classification	Willingness to Pay per Month per Household/Estab.	No. of Households /Establishments	Total Willingness to Pay per Year
		A	B	C = AxBx12/E6
Household	High Class	10,205	1,192	146.0
	Middle Class	1,614	20,634	399.6
	Low Class	836	20,278	203.4
	Sub-Total		42,104	749.0
Hotel	4 to 5 Stars	4,808,750	6	346.2
	1 to 3 Stars	281,948	20	67.7
	Others	32,757	328	128.9
	Sub-Total		354	542.8
Restaurant	Large	40,992	37	18.2
	Med./Small	2,924	264	9.3
	Sub-Total		301	27.5
Shop	Large	352,059	16	67.6
	Medium	6,557	765	60.2
	Small	1,193	2,492	35.7
	Sub-Total		3,273	163.5
Bank		29,522	270	95.7
Factory	Large/Med.	21,309	54	13.8
	Small	1,246	177	2.6
	Sub-Total		231	16.4
Others				319.0
Total				1,913.9

Note: No. of Households/Establishments = No. of households/establishments in the proposed sewerage service areas

Sources:
1) Badung dalam Angka 1988 to 1990
2) Statistical Yearbook of Bali 1990
3) JICA

Table F.2.4 Total Willingness to Pay per Year in 2010

(Unit: Rp. million)

Item	Classification	Willingness to Pay per Month per Household/Estab.	No. of Households /Establishments	Total Willingness to Pay per Year
		A	B	C = AxBx12/E6
Household	High Class	10,205	10,253	1,255.6
	Middle Class	1,614	31,811	616.1
	Low Class	836	17,827	178.8
	Sub-Total		59,891	2,050.5
Hotel	4 to 5 Stars	4,808,750	11	634.8
	1 to 3 Stars	281,948	37	125.2
	Others	32,757	373	146.6
	Sub-Total		421	906.6
Restaurant	Large	40,992	53	26.1
	Med./Small	2,924	377	13.2
	Sub-Total		430	39.3
Shop	Large	352,059	36	152.1
	Medium	6,557	1,671	131.5
	Small	1,193	5,442	77.9
	Sub-Total		7,149	361.5
Bank		29,522	871	308.6
Factory	Large/Med.	21,309	173	44.2
	Small	1,246	390	5.8
	Sub-Total		563	50.0
Others				743.3
Total				4,459.8

Note: No. of Households/Establishments = No. of households/establishments in the proposed sewerage service areas

Sources:
1) Badung dalam Angka 1988 to 1990
2) Statistical Yearbook of Bali 1990
3) Indikator Ekonomi Badung 1990
4) Pendapatan Regional, Kabupaten Daerah Tingkat II Badung 1983-1987
5) JICA

Table F.2.5(1) Development Budget for Badung 1991/1992

I. Projects Directly Managed by Regencial Government of Badung, Second Stage Government 1991/1992.

A. Projects from Second Stage Government Budget 1991/1992

a. Main Projects

No.	Projects	Costs (Rp.)	Remarks
1.	Agricultural Germ Improvement	19,543,000	
2.	Temple Maintenance	17,863,000	
3.	Agriculture Improvement	17,750,000	
4.	Production Improvement of Plantation	30,000,000	
5.	Irrigation Management Improvement	15,000,000	
6.	Livestock Improvement	20,500,000	
7.	Production Improvement of Fishery	10,000,000	
8.	Irrigation Establishment Improvement*	27,000,000	
9.	Office Maintenance	27,500,000	
10.	Guidance & Counseling of Industry	15,000,000	
11.	Roads Lighting Maintenance*	30,000,000	
12.	Roads & Trotoars Maintenance*	50,000,000	
13.	Painting for Trotoars & Traffic Regulation	30,000,000	
14.	Roads & Bridges Rehabilitation & Construction*	998,580,000	
15.	Development Tax Regulation	1,289,500,000	
16.	Tourism Management Improvement	35,000,000	
17.	Cooperative Improvement	242,500,000	
18.	Health & Safety Service	3,000,000	
19.	Realocation	5,000,000	
20.	Arranging for Development Plan	10,800,000	
21.	Project Monitoring	26,250,000	
22.	Rural Area Development	573,412,000	
23.	Land/Building Compensation	58,732,000	
24.	Religion Improvement	134,500,000	
25.	Education & Sport Improvement	339,000,000	
26.	Arts and Culture Improvement	95,000,000	
27.	Health Improvement	107,256,000	
28.	Water Supply Improvement*	70,613,000	
29.	Socio-Economic Improvement	126,252,000	

Note: Projects with the asterisk are for the development/improvement of infrastructures and related fields.

Table F.2.5(2) Development Budget for Badung 1991/1992

(continued)

No.	Projects	Costs (Rp.)	Remarks
30.	Land Consolidation	100,000,000	
31.	Law & Politics Improvement	342,448,000	
32.	Modernisation for Government Statistics	363,180,000	
33.	Improvement of Government Organisation & Operations	2,101,001,000	
	Sub - Total	7,295,180,000	

b. Additional Projects

No.	Projects	Costs (Rp.)	Remarks
1.	Temple Maintenance	12,500,000	
2.	Plantation Improvement	16,240,000	
3.	Livestock Improvement	5,000,000	
4.	Fishery Improvement	16,810,000	
5.	Roads and Trotoars Maintenance and Construction*	4,487,799,000	
6.	Tourism Management Improvement	80,960,000	
7.	Roads, Trotoars and Drainages Construction*	1,082,328,750	
8.	Rural Area Development	417,668,175	
9.	Religion Improvement	43,900,000	
10.	Education and Arts Improvement	239,726,325	
11.	Health Improvement	46,500,000	
12.	Socio-Economic Improvement	41,777,500	
13.	Law & Politics Improvement	76,485,000	
14.	Improvement of Government Organisation & Operations	1,178,864,500	
	Sub - Total	7,719,809,250	

Note: Projects with the asterisk are for the development/improvement of infrastructures and related fields.

Table F.2.5(3) Development Budget for Badung 1991/1992

B. Projects from Central Government Budget 1991/1992

No.	Projects	Costs (Rp.)	Remarks
1.	Municipality Development*	2,027,006,000	For Planning, Roads, Irrigations
2.	School Development	1,215,089,000	
3.	Health Facility Development	487,277,000	
4.	Regencial Road Development*	5,509,808,000	
5.	Rural Area Development	295,160,000	
6.	Greening & Reforestation	102,587,000	
Sub - Total		9,636,270,000	
Total of I		24,651,259,250	

II. Projects Monitored by Regencial Government of Badung, Second Stage Government 1991/1992

A. Projects for Province of Bali, First Stage Government

No.	Projects	Costs (Rp.)	Remarks
1.	Agriculture & Watering Improvement*	2,295,000,000	
2.	Industry Improvement	500,000,000	
3.	Mining & Energy Improvement	100,000,000	
4.	Transportation and Tourism Improvement*	3,903,317,000	
5.	Trade and Cooperatives Improvement	350,000,000	
6.	Employees Realocation Improvement	350,000,000	
7.	Religion Improvement	880,000,000	
8.	Lower Area Development	618,000,000	
9.	City Development*	2,032,358,000	
10.	Rural Development	338,000,000	
11.	Agrarian Improvement	79,000,000	
12.	Basic Education Improvement	364,000,000	
13.	Middle Education Improvement	92,000,000	

Note: Projects with the asterisk are for the development/improvement of infrastructures and related fields.

Table F.2.5(4) Development Budget for Badung 1991/1992

(continued)

No.	Projects	Costs (Rp.)	Remarks
14.	High Education Improvement	90,000,000	
15.	Sport Improvement	695,060,000	
16.	Public Service Improvement	213,000,000	
17.	Arts and Culture Improvement	230,000,000	
18.	Literature Library and Language Improvement	180,000,000	
19.	Customs & Institutional Improvement	205,000,000	
20.	Culture Inventory	185,000,000	
21.	Helath & Socio-Economic Improvement	3,376,300,000	
22.	Public Housing & Settlement Improvement*	2,600,000,000	
23.	Law Improvement	200,000,000	
24.	Safety and Orderliness Improvement	600,000,000	
25.	Information, Social Commuincation and Press Improvement	460,000,000	
26.	Knowledge, Technology and Observation Improvement	855,000,000	
27.	Government Apparatus Improvement	3,586,204,000	
28.	Trade Improvement	280,000,000	
29.	Natural Resources & Environments Improvement*	568,000,000	
30.	Subsidy for Lower Area Development	1,759,630,000	
	Sub - Total	27,962,869,000	

Note: Projects with the asterisk are for the development/improvement of infrastructures and related fields.

Table F.2.5(5) Development Budget for Badung 1991/1992

B. Sectoral Projects from Central Government Budget for Badung 1991/1992

No.	Projects	Costs (Rp.)	Remarks
1.	Agricultural & Watering Improvment*	1,267,458,875	
2.	Industrial Improvement	4,235,994,000	
3.	Transportation & Tourism Improvement*	66,089,346,372	
4.	Trade and Cooperatives Improvement	135,269,200	
5.	Employees Relocation Improvement	324,144,550	
6.	Religion Improvement	227,429,000	
7.	Education for Younger Generation	10,366,380,950	
8.	Health & Socio-Economic Improvment*	16,013,509,975	Include water supply
9.	Public Prosperity	121,762,460	
10.	Public Housing & Settlement*	1,288,023,600	
11.	Law Improvement	3,500,000	
12.	Information, Social Communications and Press Improvement	429,097,000	
13.	Government Apparatus Improvement	818,296,500 + PM	
14.	Natural Resources & Environments Improvement*	71,483,000	
15.	Knowledge, Technology and Observation Improvement	-	
16.	Public Safety and Orederliness Improvement	-	
	Sub - Total	101,391,290,860	
	Total of II	129,354,159,860	
	Grand Total of I & II	154,005,419,110	

Note: Projects with the asterisk are for the development/improvement of infrastructures and related fields.

Source : Laporan Bupati Kepala Daerah Tk.II Badung
Kepada Gubernur Kepala Daerah Tk.I Bali

Table F.2.6(1) Development Budget for Badung in Repelita V

I. Budget of Second Stage Government for Badung (1989/1990 - 1993/1994)

No.	Programs	Costs (Rp.)
1.	Agriculture & Irrigation Improvement*	1,574,683,000 + PM
2.	Industry Improvement	40,904,000 + PM
3.	Mining & Energy Improvement	1,272,913,000 + PM
4.	Transportation & Tourism Improvement *	44,451,374,000 + PM
5.	Trades & Cooperatives Improvement	266,793,000 + PM
6.	Relocation & Employees Improvement	1,351,377,000 + PM
7.	Territory Development	7,220,521,000 + PM
8.	Religion Improvement	685,939,000 + PM
9.	Education for Younger Generation	1,992,674,000 + PM
10.	Health & Socio-Economic Improvement	1,030,389,000 + PM
11.	Housing and Settlement Improvement*	392,613,000 + PM
12.	Law Improvement	183,153,000 + PM
13.	Safety & Tranquillity Improvement*	918,250,000 + PM
14.	Information, Press & Social Communications Improvement	327,478,000 + PM
15.	Knowledge, Technology and Observation Improvement	1,105,292,000 + PM
16.	Government Apparatus Improvement	6,992,354,000 + PM
17.	Business Improvement	838,615,000 + PM
18.	Natural Resources & Environments Improvement*	1,801,426,000 + PM
Total		72,446,748,000 + PM

Note: 1) Projects with the asterisk are for the development/improvement of infrastructures and related fields.
2) "PM" means budget the exact amount of which is not known.

Table F.2.6(2) Development Budget for Badung in Repelita V

II. Budget of First Stage Government for Badung (1989/1990 - 1993/1994)

No.	Programs	Costs (Rp.)
1.	Agriculture & Irrigation Improvement*	874,104,000 + PM
2.	Industry Improvement	71,704,000 + PM
3.	Mining & Energy Improvement	15,263,000 + PM
4.	Transportation & Tourism Improvement*	1,560,464,000 + PM
5.	Trade & Cooperatives Improvement	28,999,000 + PM
6.	Relocation & Employees Improvement	24,426,000 + PM
7.	Territory Development	2,704,516,000 + PM
8.	Religion Improvement	1,521,471,000 + PM
9.	Education for Younger Generation	1,375,980,000 + PM
10.	Health & Socio-Economic Improvement	2,619,448,000 + PM
11.	Housing & Settlement Improvement*	PM
12.	Law Improvement	PM
13.	Safety & Tranquility Improvement*	255,095,000 + PM
14.	Information, Press & Social Communications Improvement	305,255,000 + PM
15.	Knowledge, Technology and Observation Improvement	349,517,000 + PM
16.	Government Apparatus Improvement	349,517,000 + PM
17.	Business Improvement	418,200,000 + PM
18.	Natural Resources & Environments Improvement*	20,012,000 + PM
Total		12,463,941,000 + PM

Note: 1) Projects with the asterisk are for the development/improvement of infrastructures and related fields.

2) "PM" means budget the exact amount of which is not known.

Table F.2.6(3) Development Budget for Badung in Repelita V

III. Budget of Central Government for Badung (1989/1990 - 1993/1994)

No.	Programs	Costs (Rp.)
1.	Agriculture & Irrigation Improvement*	722,355,000 + PM
2.	Industry Improvement	26,405,000 + PM
3.	Mining & Energy Improvement	PM
4.	Transportation & Tourism Improvement*	26,926,544,000 + PM
5.	Trade & Cooperatives Improvement	124,446,000 + PM
6.	Relocation & Employees Improvement	45,789,000 + PM
7.	Territory Development	2,308,778,000 + PM
8.	Religion Improvement	92,034,000 + PM
9.	Education for Younger Generation	17,012,286,000 + PM
10.	Health & Socio-Economic Improvement	6,040,856,000 + PM
11.	Housing & Settlement Improvement*	1,272,541,000 + PM
12.	Law Improvement	PM
13.	Safety & Tranquillity Improvement*	918,250,000 + PM
14.	Information, Press & Social Communications Improvement	72,034,000 + PM
15.	Knowledge, Technology and Observation Improvement	83,054,000 + PM
16.	Government Apparatus Improvement	83,054,000 + PM
17.	Business Improvement	PM
18.	Natural Resources & Environments Improvement*	124,135,000 + PM
Total		55,852,561,000 + PM

Note: 1) Projects with the asterisk are for the development/improvement of infrastructures and related fields.
2) "PM" means budget the exact amount of which is not known.

Source : Rencana Pembangunan Lima Tahun Kelima Daerah Kabupaten Daerah Tingkat II Badung (1989/1990 - 1993/1994)

Table F.2.7 Estimation of Budget Allocable for Development of Infrastructure and Related Fields for Study Area

(Unit: Rp. million at 1990 prices)

Year	Badung			Study Area
	GRDP	Total Development Budget	Development Budget for Infrastructures and Related Fields	Development Budget for Infrastructures and Related Fields
	A	B = A x 12.6%	C = B x 71.7%	D = C x 72.0%
1990	1,132,577	142,705	102,319	73,670
1991	1,223,183	154,005	110,412	79,497
1992	1,321,038	166,451	119,345	85,928
1993	1,426,721	179,767	128,893	92,803
1994	1,540,859	194,148	139,204	100,227
1995	1,664,127	209,680	150,341	108,246
1996	1,797,257	226,454	162,368	116,905
1997	1,941,038	244,571	175,357	126,257
1998	2,096,321	264,136	189,386	136,358
1999	2,264,027	285,267	204,537	147,266
2000	2,445,149	308,089	220,900	159,048
2001	2,616,309	329,655	236,363	170,181
2002	2,799,451	352,731	252,908	182,094
2003	2,995,412	377,422	270,612	194,841
2004	3,205,091	403,841	289,554	208,479
2005	3,429,448	432,110	309,823	223,073
2006	3,669,509	462,358	331,511	238,688
2007	3,926,375	494,723	354,717	255,396
2008	4,201,221	529,354	379,547	273,274
2009	4,495,306	566,409	406,115	292,403
2010	4,809,978	606,057	434,543	312,871

Source: JICA

APPENDIX G

SUPPLEMENTARY STUDY

1. Introduction

1.1 Background

Bali Island is an internationally famous tourism spot which is attracting many foreign tourists every year. Therefore it is of major importance for the Government of Indonesia (GOI) in terms of earning foreign currencies as well as informing the unique culture of the Island to the outside world. The Island is also one of the most important tourism spots for Indonesian people.

In the last two decades there have about been a considerable number of tourism developments in different sizes in the Island. The largest one is Nusa Dua which has been developed by BTDC (Bali Tourism Development Corporation) since about 20 years ago. On the other land there are many small-sized developments along the seashore lines, where only several cottages and few restaurants are surrounded by a few houses of local residents.

The more the number of tourists is increasing in the Island, the faster the environment is deteriorating. The Government of Indonesia is seriously concerned with the environmental issue and requested the Japanese Government to provide it with technical assistance of wastewater management in tourism resort areas of Bali Island.

Upon the request of GOI the JICA Study Team have been working since fall of 1991 for Master Plan (M/P) and Feasibility Study (F/S) of wastewater management in Denpasar. They will be completed by end of 1992.

In Bali Island there are three major tourism areas : Kuta, Nusa Dua and Sanur. The fourth one is Jimbaran which is rapidly developing. See the locations in Fig. G.5.1.

There are also small-size resort areas in process or planning of development, which are located out of M/P.

The local government officials may not be familiar with the methods to monitor and inspect those tourism developments for protecting the environment from wastewater disposal.

The Guidelines will provide them with background information and technical suggestions of the methods and facilities for environmental protection in tourism resort areas of Bali Island.

The primary responsibility of tourism development rests on Ministry of Tourism, Post and Telecommunication (Parpostel). But officials of the Ministry may not be familiar in dealing with environmental issues. So Cipta Karya of PU, will coordinate with the Ministry of Tourism, Post and Telecommunication for environmental protection from tourism developments by monitoring and inspecting the related facilities. The inter governmental coordinations are quite important to ensure a sound tourism development.

The Guidelines will deal with mainly technical aspects for environmental protection of tourism areas.

The GOI is hoping that Bali Island will develop its tourism in good harmony with natural and environmental conservation so that the Island will attract more and more people form outside and inside of the country.

1.2 Purpose of the Guidelines

The purpose of the guidelines is to provide the local government officials responsible of wastewater management in coastal resort areas of Bali Island, with the know-how to monitor tourism developments and inspect the tourism developers. Otherwise the resort developments would take place disorderly and out of control, which could result in environmental deterioration and reduction of tourists.

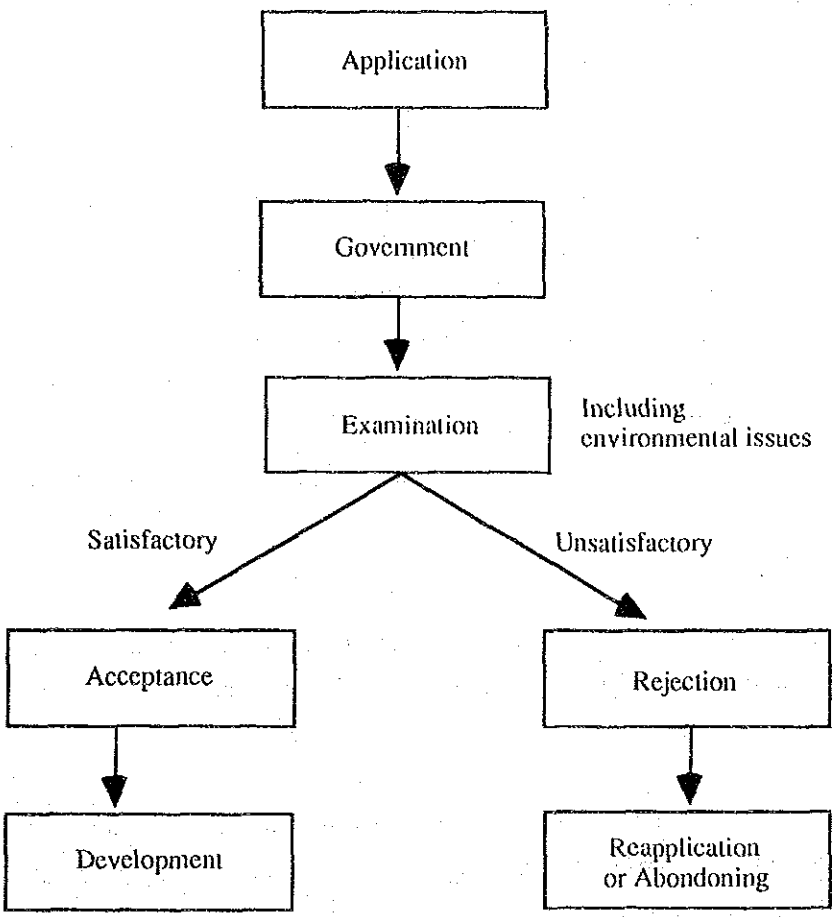
1.3 Users of the Guidelines

When a new tourism development is planned by public, private or third sectors, the application will be filled by them and sent for approval to Ministry of Tourism, Post and Telecommunication (Parpostel).

The Ministry of Tourism, Post and Telecommunication examines the application of tourism development. It will issue the permission of

development, after all the requirements have been proved to be satisfactory, including environmental requirements. Some of the items may need to be modified to satisfy the requirement. The permission procedures are as follows:

Prosedure of Tourism Development Permission



The Guidelines are not considered to explain the detailed administrative procedures of tourism development. Only the subjects related to environmental protection in tourism areas are described in the Guidelines.

In this context the main users of the Guidelines are officials of the Bali Governments in charge with development of the Island. They are concerned with many developments, say agricultural, fishery, forestry, industrial as well as tourism development. The Government is concerned and keen to keep a balanced development among many sectors for Bali Island. The Government should decide the future sound and prosperous

development of the Island, when the different sectors need to be examined and prioritized.

2. Environmental Protection

2.1 Water Quality Standards

Sea Water Quality (Proposal)

The sea water for tourism shall satisfy the following standards :

pH	:	6.5 - 8.3
COD	:	less than 6 mg/l
DO	:	more than 5 mg/l
Fat	:	not detectable
F.C	:	less than 1000 MPN/100 ml

[Explanation]

The seas around Bali Island are used for various purposes such as tourism, fishery and industry as well as aesthetics. If too strict standards are decided, they may create some confusions among the users.

Therefore the Bali Government is now investigating actual situations of sea use so that the most appropriate standards of sea water quality should be established, taking into account the future development of the Island.

Before the Government sets its own standards, the Decree of MENKLH (KEP-02/MENKLH/1988) is referred to (see Table G.2.1).

There are six groups sea water uses as follows:

- Group I for Swimming
- Group II for Mining and Industry
- Group III for Fishery
- Group IV for Sea Park

- Group V for Public and Aesthetics
- Group VI for Cooling.

The Group I requires the most stringent water quality standards. Bali is the center of Indonesian tourism, and needs a stringent environmental protection. However the existing standards are not strict enough to keep the seas clean, compared with some international standards, shown below;

BOD : 10 mg/l
COD : 20 mg/l
SS : 20 mg/l

2.2 Water Quality Requirements

Requirements for Sea Water Quality in Tourism Areas

The sea water in the tourism areas is required to be

- Neutral
- Free of pollution
- Free of oil
- Free of bacteria

[Explanation]

The JICA Study Team suggests the sea water quality standards for Bali Island, compared with international ones (see Table G.2.2).

a. pH

This is an indicator to show whether the water is acid, neutral or alkali. The pH values range from 0 to 14. The figure of 7 indicates that the water is absolutely neutral.

For the purpose of swimming in the sea, the figures of pH should be between 6.5 and 8.3, compared with the international standards.

b. COD (Chemical Oxygen Demand)

This is one of the indicators to show the degree of pollution. It is generally understood that water pollutants, organic or inorganic, require oxygen to get into equilibrium through oxidization. This is a stabilization process. So the degree of oxygen demands suggests how much the water is polluted. The COD is one of them, using dichromates as oxidizing agent. BOD (Biochemical Oxygen Demand) is also the similar indicator to show water pollution.

COD is commonly used for sea water due to its salinity, while BOD is used for fresh water. Looking at the international standards, only Japan has COD as standard for sea water quality.

The COD measured by using permanganates shows a lower figure than the COD by dichromates due to oxidizing conditions. The both have suffixes such as COD_{Cr} and COD_{Mn}. Therefore COD_{Cr} of less than 6 mg/l would be desirable for the standards of sea water quality. The water of less than 6 mg/l COD_{Cr} is almost plain and free from organic pollution.

c. DO (Dissolved Oxygen)

Oxygen is a hardly dissolvable gas into water, compared with other gases like ammonium and chlorine. But it can be dissolved into water in lesser degree, depending upon mainly the water temperature.

DO of 5 mg/l is more than 50% of the oxygen saturation, assuming the sea water temperature to be about 25°C. If DO is maintained above 5 mg/l, the water is aerobic and can accommodate many fresh fauna and flora.

d. Fat (n-Hexan Extracts)

The fats originate from animals, plants and minerals. The presence of any kind of fats is not desirable for swimming and aesthetics. So it is recommended that fat should be undetectable in sea water in tourism areas.

The water analysis uses the figure of normal hexane extracts to indicate the fat concentration.

e. F.C (Fecal Coliform Bacteria)

There exist huge numbers and kinds of bacteria in the water. They are basically harmless general bacteria. Among them there are some bacteria which originate from animal wastes including human ones. They are called fecal coliform (F.C) bacteria, and generally infections harmful for human being.

In the water analysis each fecal coliform bacteria are not identified, but the number of them is used for analysis result. MPN (Most Probable Number) is used to count the number of F.C bacteria.

In the nature it is extremely difficult to keep it completely free from F.C bacteria, and is not necessarily needed to keep sanitary conditions for normal every day life.

However as the number of F.C bacteria increases, the disease danger for human being increases. Therefore the effluent standard of treated wastewater in Japan sets the number of F.C bacteria before discharging from a treatment plant as less than 3,000/ml.

The JICA Study Team recommends that the sea water have F.C bacteria of less than 1,000 MPN/100 ml for swimming in tourism areas.

3. Water Consumption

3.1 Residential Water Consumption

Residential Water Consumption	(l/capita.day)
High Class	330
Middle Class	210
Low Class	160

[Explanation]

In comparison with tourism wastewater the residential wastewater is summarized. It is easily understandable that rich people are using more water than poor people.

The households are defined in the JICA Study as follows :

High class = Luxurious, permanent house. Big size. Has many rooms. Made of good materials. Has one or more cars, a apacious garden and well-tended wall/fences. Occupied by rich people.

Middles class = Ordinary, permanent house. Medium size. Made of ordinary materials. May or may not have a car. May have a small garden. May have mediocre fences. Neither rich nor poor.

Low class = Semi-permanent or temporary house. Small size. Has few rooms, Made of inferior make-shift materials. May have no garden, nor fences. Occupied by poor people.

Based on the JICA Study the existing water consumption per capita of residential use will be summarized as follows :

Residential Per Capita Water Consumption

(l/c.d)

High class	330
Middle class	210
Low class	160

The JICA Study Team concludes that the future water consumption per capita will be the same until year 2010.

3.2 Tourism Water Consumption

Tourism Water Consumption

Hotels (l/room.day)

High class	2,220
Middle class	1,740
Low class	1,260

Restaurants (l/seat/day)

All classes	22

[Explanation]

Generally there are two kinds of water supplies : piped water and well water. There are some people who are using river water or rain water.

Since the whole urban areas of the Study Area are not covered by piped water supply of PDAM, some people are dependent upon wells. There are also some users who have both piped and well supplies. Those are users in hotels and also normal residents.

It is the case that many hotels are using their own wells for main water supply because of costs and water quality. In case of electricity suspension they switch from well water to piped water of PDAM only for temporary use.

Water is supplied and consumed by tourism facilities such as hotels and restaurants. It is obvious that water in hotels is used not only by tourists but also by other people. But assuming that all the hotel users are tourists, all the wastewater from any kinds of hotels are assumed to be tourism wastewater.

Likewise restaurants are used by tourists and non-tourists. However for simplification all the wastewater from restaurants are assumed to be tourism wastewater.

In conclusion it is assumed that the tourism wastewater is generated from hotels and restaurants.

It is true that all rooms are not always occupied. The occupancy rates are different by hotel, season and others. Therefore the occupancy rate is assumed to be two guests per room based on the JICA Study. This makes easier to calculate the unit water consumption and wastewater generation by hotels.

It is easily understandable that richer people stay in higher class hotels, while poorer people stay in lower class hotels. Richer guests are using more water than the others. The classification of hotels is commonly referred to as the star number.

The definition used in the Study is followed:

High class	:	Hotels with stars
Middle class	:	Inns
Low class	:	Home stays

4. Pollution Generation

4.1 Residential Unit Pollution Load

Residential Unit Pollution Load (BOD5 g/capita.day)	
High Class	43,9
Middle Class	31,7
Low Class	26,8

[Explanation]

The residents are using water in many ways such as cooking, washing, toilets and others. For analysis of wastewater management a common way is to separate residential wastewater into two categories:

- Toilet wastewater
- Gray wastewater, excluding toilet wastewater .

Residential unit wastewater is given as follows :

Income	Toilet water (l/c.d)	Gray wastewater (l/c.d)	Total (l/c·d)
High Class	30	268	298
Middles Class	16	169	185
Low Class	16	133	149

Next the ratios of water consumption and wastewater generation are compared for residential use :

Income	Water Consumption (l/c.d)	wastewater Generation (l/c.d)	Ratio (%)
High Class	330	298	90.3
Middles Class	210	185	88.1
Low Class	160	149	93.1
Average	233	211	90.6

The above table indicates that about 91% of consumed water become wastewater generated. This figure conforms well with general understanding of wastewater generation.

Residential Unit Pollution Load of Gray Water
(BOD5 g/capita./day)

High Class	32.7
Middle Class	20.5
Low Class	15.6

[Explanation]

Gray wastewater originates from kitchen, bath room, gardening and others, and indicates more directly a level of living standard than toilet wastewater.

Residential unit pollution load of toilet wastewater is given as below:

Residential Unit Pollution Load of Toilet Wastewater
(BOD5 g/capita.day)

All Classes	11.2

[Explanation]

Unit pollution load of toilet wastewater is the same among all classes, because almost 100% of the population are using any kind of toilets, sewered or septic tanks, and using almost the same volume of water for toilet flushing.

Ratios of Gray Water Pollution Loads to the Total Pollution Loads

	Gray Wastewater (g/c.d)	Toilet Wastewater (g/c.d)	Total (g/c.d)	Gray Wastewater Ratio (%)
High Class	32.7	11.2	43.9	74.5
Middle Class	20.5	11.2.	31.7	64.7
Low Class	15.6	11.2	26.8	58.2

[Explanation]

It is a common practice that almost 100% of the population discharge their toilet wastewater to a minimum level of sanitation such as leaching pits, while they are discharging their gray wastewater into nearest water courses such as ditches, rivers or seas. There are some people who go to rivers for the purpose, because they do not have toilets at home.

They consider that the nuisance level of toilet wastewater would be much higher than that of gray wastewater.

It is common that most of the population consider the gray wastewater to be harmless and less polluted than toilet wastewater. However the above comparison shows the opposite : pollution loads from gray wastewater are more than half of the total pollution loads. And the ratios of gray wastewater to the total increase as the income levels increase.

This suggests that a sanitation system should be required to treat gray wastewater and toilet wastewater so that the environment can be protected within sound level.

4.2 Tourism Unit Pollution Load

The JICA Study Team concludes that these figures will remain unchanged until year 2010. But as the peoples income levels increase, the average unit pollution loads will increase accordingly.

Hotel Unit Pollution Load
(BOD5 g/capita./day)

High Classes	75.9
Middle/Low Classes	57.8

[Explanation]

Hotel guests use water for toilet, bathing and others, the same as residential use of water. Therefore the hotel pollution loads are also divided into two categories : gray wastewater and toilet wastewater.

Hotel rooms are occupied by single guests, double guests or more. This is called Occupancy Rate. Based on the JICA Study the occupancy rate was found out to be two guests per room in average, regardless of the hotel classes.

Hotel Wastewater Generation
(l/room.day)

Income Class	Gray Wastewater	Toilet Wastewater	Total Wastewater
High	2,040	60	2,100
Middle/Low	1,468	32	1,500
Average	1,754	46	1,800

[Explanation]

Now the average hotel wastewater generation is calculated by dividing with 2 and compared with the residential wastewater generation as follows :

Classification	Gray Wastewater (l/c.d)	Toilet Wastewater (l/c.d)	Total Wastewater (l/c.d)
Residential Wastewater	190 (100%)	21 (100%)	211 (100%)
Hotel Wastewater	877 (462%)	23 (110%)	900 (427%)

There is commonly no water meter for hotel guests. The room rates are flat, regardless of their water consumption. This is why hotel guests are consuming more water than residents. Residential consumptions are measured by meters.

Large high-class hotels are equipped with other facilities such as restaurants and swimming pools. These facilities can consume a lot of water.

The above comparison shows that wastewater in hotels is generated by more than four times than residential one.

Likewise the unit pollution loads of BOD_5 are compared as follows:

Classification	Gray Wastewater (g/c.d)	Toilet Wastewater (g/c.d)	Total Wastewater (g/c.d)
Residential loads	18.6 (100%)	11.2 (100%)	29.8y (100%)
Hotel loads	34.2 (184%)	11.2 (100%)	45.4 (152%)

This comparison indicates that hotel loads of gray wastewater are by 84% larger than residential loads, while the toilet loads are the same between them. This means that hotel guests are generating the total pollution loads more than 50% per each person.

Case Study 1

A new hotel with 100 rooms is constructed. Impacts of wastewater generated and pollution loads are calculated.

Fulfillment through the year	:	70 %
Occupancy rate	:	2 guests/room

Assuming that the ratios of wastewater and pollution loads by each hotel guest are 4.27 and 1.52 respectively, the result is as follows :

Wastewater

100 rooms x 70 % x 2 guests/room x 4.27 = 598

Pollution Loads

100 rooms x 70 % x 2 guests/room x 1.52 = 213

The impacts of wastewater and pollution loads by the above hotel are 598 and 213 residents respectively.

Restaurant Unit Pollution Load (BOD5 g/seat.day)
5.6

[Explanation]

The JICA Study Team surveyed the pollution loads generated by restaurants. It is a general understanding that normal restaurants are visited by both foreign tourists and local people. However high class restaurants are mainly visited by foreign guests.

It is rather difficult to estimate the restaurant pollution loads per the guest number during the survey. So the JICA Team used the seat number for the purpose.

The above figure was obtained on the JICA Study.

Restaurant Unit Wastewater (l/seat.day)
22

[Explanation]

The restaurants are using water and generating wastewater to serve their guests. The JICA Study Team found out the unit wastewater generated per seat to be 22 l/seat.day in average.

Case Study 2

A new restaurant with 20 seats is constructed. Impacts of wastewater generation and pollution loads are calculated.

Wastewater:

22 l/seat.day x 20 seat = 440 l/day
(equivalent to 2.1 residents)

Pollution Loads:

5.6 g/seat.day x 20 seats = 112 g/day
(equivalent to 3.8 residents)

In comparing both the hotel and restaurant impacts, it is found that the hotel impacts are much larger than the restaurant ones.

Case Study 3

In a small village with 1000 residents a tourism development is planned as follows :

Cottages : 300 rooms in total
Restaurants : 50 seats in total

The tourism impacts of pollution can calculated as follows:

Hotels	:	300	rooms x 2.1	=	630
Restaurants	:	50	seats x 3.8	=	190
			Total		820

1000 residents are registered as the village population. Additional 820 residents are to be included into environmental impacts in planning the tourism development.

5. Wastewater Disposal

5.1 Wastewater Treatment

Wastewater Treatment
All the wastewater generated in tourism areas should be treated by either of the following systems :

- On-site system
- Off-site system

[Explanation]

All the wastewater generated in tourism areas should be treated before discharging into the environment, because the pollution loads are commonly larger than the self purification capacity of the environment. Without treatment the environment will deteriorate sooner or later.

If the tourism areas are connected with a sewered system (off-site system), the wastewater is collected and conveyed by sewers to the treatment plant, commonly operated by a local government. If the operation and maintenance of the treatment plant are conducted carefully, the environment will be safe.

If the sewerage service is not available in the tourism areas, the generated wastewater should be treated in on-site system.

5.2 On-site Treatment System

On-site System

The following systems are available:

(1) Package Plant: Aerobic and Anaerobic
(2) Activated Study Process
(3) Trickling Filter
(4) Extended Aeration System
(5) Oxidation Ditch
(6) Aerated Lagoon
(7) Stabilization Pond

[Explanation]

The package plant can be flexible from small size to relatively large size. However the other systems from (2) to (7) are commonly large size and require special operators. Therefore they are expensive. The aerated lagoon and stabilization pond are relatively easy to operate, but require a large area. For detailed information of these technologies there are a lot of publications for reference.

Hotels are free in selecting the on-site system as long as they can satisfy the effluent standards.

5.3 Tourism Resort Area (TRA)

Tourism Resort Area (TRA)

All the hotels and restaurants within TRA should be registered by the Government.

[Explanation]

The Government should designate such areas to be developed for tourism as Tourism Resort Areas (TRA). (see Table G.5.1)

New tourism developments are basically to be limited within TRA. The above requirement applies a new tourism development within TRA.

All the wastewater, gray wastewater and toilet wastewater, from hotels and restaurants should be treated on on-site or off-site system.

The following hotels and restaurants should be also registered by Cipta Karya with information required for environmental monitoring:

Hotels : High Class
Middle Class
Low Class

Restaurants : With more than 20 seats

Necessary items of information for hotels are as follows:

(1) Owners name
(2) Address
(3) Hotel Class
(4) Room Number
(5) Additional facilities (Restaurant, Pool a.o)
(6) Treatment facility/capacity
(7) Monitoring Records of Effluents
    (a) Water temperature
    (b) pH
    (c) BOD/COD
    (d) SS
    (e) Bacteria
    (f) Others, if needed

Necessary items of information for restaurants are as follows:

(1) Owners name
(2) Address
(3) Seat Number
(4) Treatment facility/capacity

(7) Monitoring Records of Effluent

(a) Water temperature

(b) pH

(c) BOD/COD

(d) SS

(e) F.C. Bacteria

(f) Others, if needed.

5.4 Tourism Facility Monitoring

Tourism Facility Monitoring
The following items should be monitored on a regular basis: (a) Water temperature (b) pH (c) BOD or COD (d) SS (e) Fat (f) F.C. Bacteria

[Explanation]

Samples should be regularly taken by government officials and brought to registered laboratories. At least six parameters should be analyzed.

Sampling frequencies are as follows:

Hotels	High Class	:	every two months
	Middle/low Classes	:	every six months
Restaurants		:	every six months

Based on the analysis results, the Government Officials should calculate the pollution loads generation.

Effluent standards

(a)	Water temperature	:	Normal
(b)	pH	:	5,8 - 8,6
(c)	BOD (mg/l)	:	< 60
(d)	SS (mg/l)	:	< 70
(e)	Fat (mg/l)	:	< 20
(f)	F.C. Bacteria	:	< 3000 MPV/ml

The effluents from treatment facilities of hotels and restaurants should satisfy the above standards.

If some or all the parameters are not satisfactory, the owner of the hotel or restaurant should clarify the reason and explain to government officials immediately. Then new samples should be taken for analysis.

If the second time analysis fails to satisfy the effluent standards, the operation of the facility, eventually the business, should be subject to operation stop after consultation with the Government.

5.5 Sea Water Monitoring

Sea Water Monitoring

(a) Water temperature
(b) pH
(c) COD
(e) Fat
(f) F.C. Bacteria

[Explanation]

The Government should decide the locations of stationary sampling points to monitor the sea environments along the seashore lines of Bali Island.

There will be about 10 stationary sampling stations located about 100 m from the mean seashore line (MSL).

Table G.2.1(1) Water Quality Standards for Sea

No.	Parameter	Unit	Swimming		Mining and Industry		Fishery		Sea Park		Public and Aesthetic		Cooling	
			Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Physical													
1	Color	CU	50	30	50	30	50	30	50	30	50	30	-	-
2	Smell	-	Natural	None	Natural	Natural	Natural*	None*	Natural*	None*	Natural*	None*	-	-
3	Transparency	m	10	30	-	-	3*	5*	10*	30*	Natural	Natural		
4	Turbidity	TU	30	10	-	-	30*	5*	30*	5*	-	-	-	-
5	Suspended Solids	mg/l	23	20	200*	25*	80*	25*	80*	25*	-	-	2500*	1000*
6	Flooting Matters	-	None	None	Natural	Natural	None*	None*	None	None	None*	None*	Natural	Natural
7	Oil Appearance	-	None	None	None	None	None*	None*	None*	None*	None*	None*	None	None
8	Temperature	°C	Natural	26 - 30	Natural*	Natural*	Natural* ± 20	Natural*	-	-	Natural	Natural		
	Chemical													
1	pH	-	6 - 9	6,5 - 8,5	6 - 9*	6,5 - 8,5*	6 - 9*	6,5 - 8,5*	6 - 9*	6,5 - 8,5*	-	-	6 - 9*	6,5 - 8,5*
2	Salinity	‰	Natural ± 10%	Natural	Natural ± 10%	Natural	Natural ± 10%	Natural	Natural ± 10%	Natural	-	-	Natural ± 10%	Natural
3	Disolved Oxigen (DO)	mg/l	5	5	-	-	4*	6*	4*	6*	-	-	-	-

Source : KEP-02/MENKLH/1988

Remark : * = Key parameter

Table G.2.1(2) Water Quality Standards for Sea

No.	Parameter	Unit	Swimming		Mining and Industry		Fishery		Sea Park		Public and Aesthetic		Cooling	
			Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
4	BOD5	mg/l	20	10	20*	10*	45*	25*	45*	25*	-	-	-	-
5	COD Dichromate	mg/l	40	20	40	20	80	40	80	40	-	-	-	-
6	Ammonium (NH3-N)	mg/l	4	None	-	-	1*	0.3*	0.3*	0.1*	-	-	-	-
7	Nitrite (NO2)	mg/l	None	None	-	-	None*	None*	None*	None*	-	-	-	-
8	Cyanide (CN)	mg/l	0.20	0.05	0.20	0.05	0.20*	0.05*	0.20*	0.05*	-	-	-	-
9	Hydrogen Sulfur (H2S)	mg/l	-	-	-	-	0.03*	0.01*	0.03*	0.01*	-	-	-	-
10	Oil	mg/l	3	None	2*	None*	5*	None*	5*	None*	5	None	-	-
11	Phenol	mg/l	0.002	None	-	-	0.002*	None*	0.002*	None*	-	-	-	-
12	Pesticides Organic Chlorides	mg/l	0.042	None	0.02	None	0.02*	None*	0.02*	None*	-	-	-	-
13	PCB	mg/l	0.001	None	0.001	None	0.001*	None*	0.001*	None*	-	-	-	-
14	Detergents	mg/l MBAS	0.5	None	1.5	None	1.0*	None*	1.0*	None*	-	-	-	-
15	Mercury (Hg)	mg/l	0.005	0.0001	0.005	0.0001	0.003*	0.0001*	0.006*	0.0001*	-	-	-	-
16	Chromium six valved (Cr6+)	mg/l	0.01	0.00004	0.01	0.00004	0.01*	0.00004*	0.05*	0.00001*	-	-	-	-
17	Arsenic (As)	mg/l	0.05	0.0026	0.05	0.0026	0.01*	0.0026*	0.01*	0.0026*	-	-	-	-

Source : Ibid

Table G.2.1(3) Water Quality Standards for Sea

No.	Parameter	Unit	Swimming		Mining and Industry		Fishery		Sea Park		Public and Aesthetic		Cooling	
			Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit	Permissible Limit	Desirable Limit
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
18	Selenium (Se)	mg/l	0.06	0.00045	0.06	0.00045	0.005*	0.00045*	0.005	0.00045	-	-	-	-
19	Cadmium (Cd)	mg/l	0.01	0.00002	0.01	0.00002	0.01*	0.00002*	0.01*	0.00002*	-	-	-	-
20	Cupper (Cu)	mg/l	1	0.001	1	0.001	0.06*	0.001*	0.06	0.001	-	-	-	-
21	Lead (Pb)	mg/l	0.05	0.00002	0.05	0.00002	0.01	0.00002	0.075	0.00002	-	-	-	-
22	Zinc (Zn)	mg/l	0.15	0.002	0.15	0.002	0.1	0.002	0.1	0.002	-	-	-	-
23	Nikel (Ni)	mg/l	0.1	0.007	0.1	0.007	0.002	0.007	0.1	0.007	-	-	-	-
24	Silver (Ag)	mg/l	0.05	0.0004	0.05	0.0004	0.05	0.0003	0.05	0.0003	-	-	-	-
	Biology													
1	E.Coliform	per 100 ml	1000	None	1000	None	1000	None	1000	None	-	-	-	-
2	Phatogens	per 100 ml	None	None	None	None	None	None	None	None	-	-	-	-
3	Planktons	Member	None	None	None	None	None	None	-	-	-	-	-	-
	Radio Activity													
1	a (Alpha)	pCi/l	1	None	1	None	1	None	1	None	-	-	-	-
2	ß (Betha)	pCi/l	100	None	100	None	100	None	100	None	-	-	-	-
3	Sr-90	pCi/l	1	None	1	None	1	None	1	None	-	-	-	-
4	Ra-226	pCi/l	3	None	3	None	3	None	3	None	-	-	-	-

Source : Ibid

Table G.2.2 Coastal Sea Water Quality Standards of International Beach Resorts

Parameter	Thailand (Phuket)		Philipine		USA (Hawaii)		Japan
	Swimming	Conservation of Coral	Swimming	Conservation of Coral	Swimming	Conservation of Coral	Swimming & Conservation of Natural Life
pH	6.5 ~ 8.3	8.9	6.5 ~ 8.3	-	6.5 ~ 8.3	-	7.8 ~ 8.3
Water Temperature (°C)	23 ~ 33	23 ~ 33	-	-	-	-	-
DO (mg/l)	More than 4	More than 5	More than 5	More than 5	Aerobic	More than 5	More than 7.5
COD KMnO4 (mg/l)	-	-	-	-	-	-	Less than 2
SS (mg/l)	Less than 20	Less than 10	-	-	-	-	-
Cl^- (mg/l)	-	29 ~ 35	-	-	-	-	-
Fecal Coliform (MPN/100 ml)	Less than 1,000	-	-	-	Less than 1,000	-	Less than 1,000
n-Hexan Extracts (mg/l)	N.D	N.D	Less than 2	-	-	-	N.D
Transparency (m)	More than 10	More than 15	-	-	-	-	-

None : N.D means not detectable

Table G.5.1 Tourism Resort Areas (TRA) in Bali Island

	TRA	Location
A	Nusa Dua	Coastal
B	Sanur	"
C	Kuta	"
D	Jimbaran	"
E	Ubud	Inland
F	Kintamani	"
G	Nusa Penida	Coastal/Inland
H	Ujung	Coastal
I	Candi Dasa	"
J	Kali Bukbuk	"
K	Teluk Terima	"
L	Gilimanuk	"
M	Candi Kusuma	"
N	Bedugul	Inland
O	Tanah Lot	Coastal

Note : Coastal TRA are covered by the Guidelines.
Source (SK : No 15/1988)

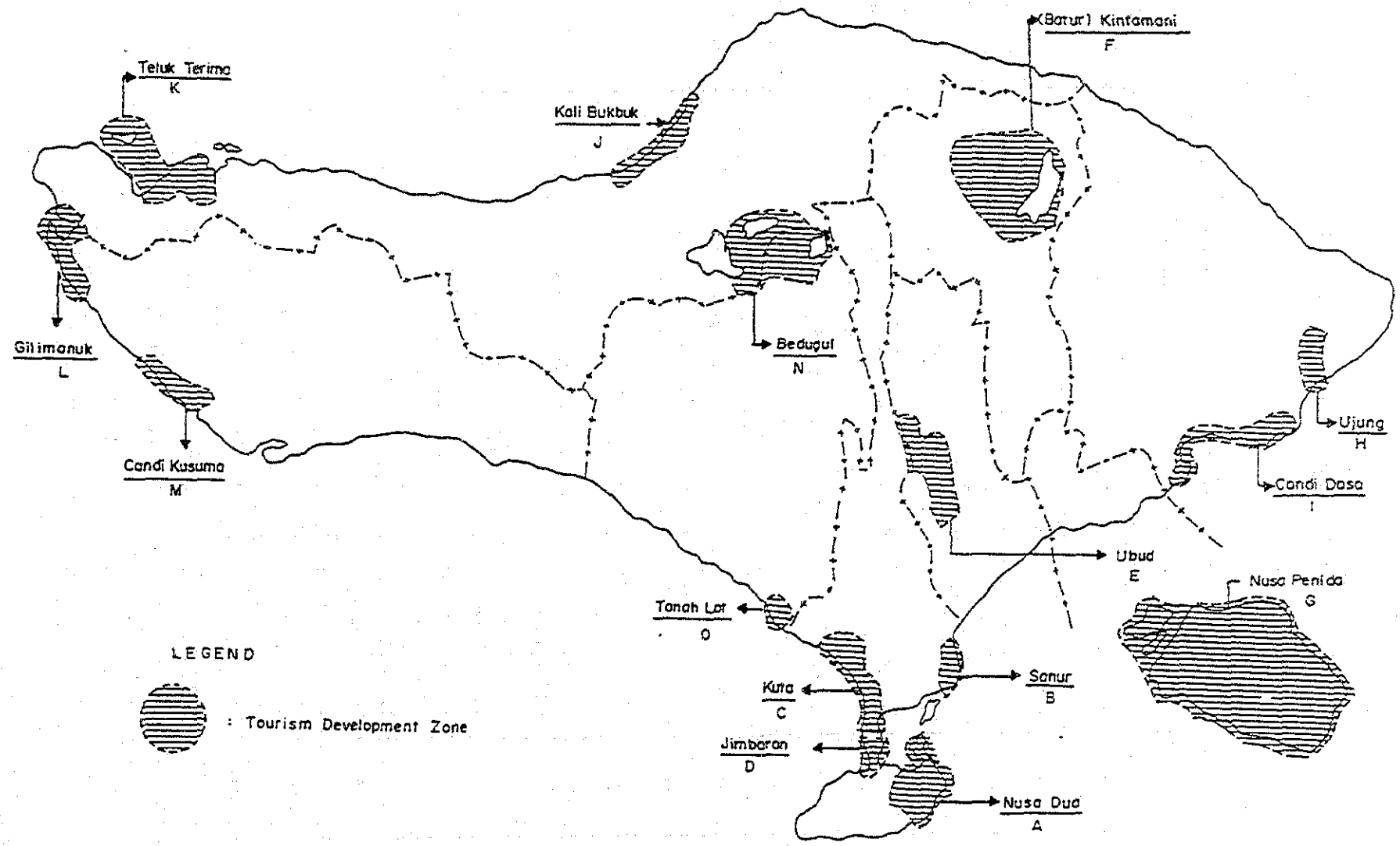


FIG. G.1.1 TOURISM DEVELOPMENT ZONE IN BALI

THE DEVELOPMENT STUDY ON WASTEWATER DISPOSAL FOR DENPASAR