

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

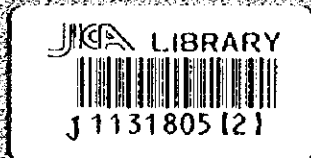
MUNICIPAL WATER SUPPLY PUBLIC CORPORATION(EMPAGUA)  
THE REPUBLIC OF GUATEMALA

THE STUDY  
ON  
THE IMPROVEMENT  
OF  
WASTEWATER MANAGEMENT  
IN  
THE GUATEMALA METROPOLITAN AREA

FINAL REPORT

VOLUME III  
SUPPORTING REPORT(I)

AUGUST 1996



NIHON SUIDO CONSULTANTS CO.,LTD.  
PACIFIC CONSULTANTS INTERNATIONAL

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## ABBREVIATIONS

### ABBREVIATIONS OF ORGANIZATION / SIGLAS DE ORGANIZACION

AID	=	Agency for International Development Agencia Internacional para el desarrollo
ANAM	=	National Association of Municipalities Asociacion Nacional de Municipalidades
BANVI	=	National Housing Bank Banco Nacional de Vivienda
BANGUAT	=	Central Bank of Guatemala Banco de Guatemala
BCIE	=	Central American Economic Integration Bank Banco Centroamericano de Integracion Economica
CIDA	=	Canadian International Development Agency Agencia Canadiense de Desarrollo Internacional
CACIF	=	Coordinator Committee of Agricultural, Industrial and Financial Associations Comite Coordinador de Asociaciones Agricolas, Industriales y Financieras
CAPRE	=	Regional Coordinating Committee of Drinking Water and Sanitation of Central America, Panama and Dominican Republic Comite Coordinador Regional de Instituciones de Agua Potable y Saneamiento de Centroamerica, Panama y Republica Dominicana
CIEN	=	National Economic Research Center Centro de Investigaciones Economicas Nacionales
CNPE	=	National Council of Economic Planning Consejo Nacional de Planificacion Economica
CONAMA	=	National Environmental Commission Comision Nacional del Medio Ambiente
CONAP	=	National Council of Protected Area Consejo Nacional de Areas Protegidas
COPECAS	=	Permanent Committee of Coordination of Water and Sanitation Comite Permanente de Coordinacion de Agua y Saneamiento
EDOM	=	Study of Metropolitan Orderliness Estudio de Ordenamiento Metropolitana
DGSS	=	General Bureau of Health Services Direccion General de Servicios de Salud
DST	=	Environmental Sanitation Department Division de Saneamiento del Medio
EMPAGUA	=	Guatemala Municipal Water Supply Corporation Empresa Municipal de Agua de la Ciudad de Guatemala
ERIS	=	Regional School of Sanitary Engineering Escuela Regional de Ingenieria Sanitaria
FAO	=	Food and Agricultural Organization Organizacion de Comidas y Agricultura
GOG	=	Government of Guatemala Gobierno de Guatemala
GOJ	=	Government of Japan Gobierno de Japon
GTZ	=	German Cooperation Agency Sociedad Alemana de Cooperacion
IBRD	=	See "WB" Vease "WB"
IDA	=	International Development Association Asociacion Internacional de Desarrollo
IDB	=	Inter-American Development Bank Banco Interamericano de Desarrollo
IGM	=	Military Geographic Institute Instituto Geografico Militar

IGSS	=	Guatemalan Institute of Social Security Instituto Guatemala de Seguridad Social
INAFOR	=	National Institute of Forestation Instituto Nacional de Forestacion
INDE	=	National Institute of Electrification Instituto Nacional de Electrificacion
INE	=	National Institute of Statistics Instituto Nacional de Estadistica
INFOM	=	National Institute of Municipal Development Instituto Nacional de Fomento Municipal
INSIVUMEH	=	National Institute of Seismology, Vulcanology, Meteorology and Hydrology Instituto Nacional de Sismologia, Vulcanologia, Meteorologia e Hidrologia
INTECAP	=	Technical Institute of Training and Productivity Instituto Tecnico de Capacitacion y Productividad
JICA	=	Japan International Cooperation Agency Agencia de Cooperacion Internacional del Japon
MCTyOP	=	Ministry of Communications, Transportation and Public Works Ministerio de Comunicacion, Transportacion y Obras Publicas
MINFIN	=	Ministry of Public Finance Ministerio de Finanzas Publicas
MSPyAS	=	Ministry of Public Health and Social Assistance Ministerio de Salud Publica y Asistencia Social
MUNI	=	Municipality of Guatemala Municipalidad de Guatemala
OECF	=	Overseas Economic Cooperation Fund of Japan Fondo Japonese de Cooperacion Economica Ultramar
PAHO	=	Panamerican Health Organization Organizacion Panamericana de Salud
PLAMABAG	=	Guatemala City Water Supply Master Plan Plan Maestro de Abastecimiento de Agua a la Ciudad de Guatemala
SEGEPLAN	=	General Secretariat of Economic Planning Secretaria General de Planificacion Economica
SRH	=	Secretariat of Hydraulic Resources Secretaria de Recursos Hidraulicos
UEA	=	Emergency Water Unit Unidad de Emergencia de Agua
UENIA	=	Study Unit of New Water Introduction Unidad de Estudios de Nuevas Introducciones de Agua
UN	=	United Nations Organicacion de Naciones Unidas
UNDP	=	United Nations Development Program Programa de Naciones Unidas para el Desarrollo
UNEHIVAGUA	=	Executant Unit of Hydrological Study of Guatemalan Valley Unidad Ejecutora del Estudio Hidrologico del Valle de Guatemala
UNEPAR	=	Executant Unit of Rural Aqueduct Program Unidad Ejecutora del Programa de Acueductos Rurales
UNESCO	=	United Nations Educational Scientific and Cultural Organization Organizacion Educacional, Cientifica y Cultural de Naciones Unidas
UNICEF	=	United Nations International Children's Emergency Fund Fondo de Naciones Unidas para la Infancia
USAC	=	University of San Carlos of Guatemala Universidad San Carlos de Guatemala
USAID	=	United States Agency for International Development Agencia Internacional de Desarrollo de Estados Unidos
WB	=	World Bank Banco Mundial
WHO	=	World Health Organization Organizacion Mundial de Salud

## ABBREVIATIONS OF TERMS USED IN THIS REPORT

B/C	-	Benefit Cost Ratio
BOD	-	Biochemical Oxygen Demand
CCTV	-	Closed Circuit Television
COD	-	Chemical Oxygen Demand
DSR	-	Debt Service Ratio
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
FIRR	-	Financial Internal Rate of Return
GDP	-	Gross Domestic Product
GDE	-	Gross Domestic Expenditure
GFCF	-	Gross Fixed Capital Formation
HWL	-	High Water Level
IC	-	Intermediate Clarifier
IEE	-	Initial Environmental Examination
NPV	-	Net Present Value
O/M	-	Operation and Management
PDWF	-	Peak Dry Weather Flow
PST	-	Primary Sedimentation Tank
RCP	-	Reinforced Concrete Pipe
SCF	-	Standard Conversion Factor
SDB	-	Sludge Drying Bed
SDT	-	Sludge Digester Tank
SGC	-	Screen • Grit Chamber
TF	-	Trickling Filter
TOR	-	Terms of Reference
VA	-	Value Added
VAT	-	Value Added Tax
WWTP	-	Wastewater Treatment Plant

## ABBREVIATIONS OF MEASURES

1	Length		
	mm	=	millimeter
	cm	=	centimeter
	m	=	meter
	km	=	kilometer
	"	=	inch
2	Area		
	m <sup>2</sup> , sq.m	=	square meter
	ha	=	hectare
	km <sup>2</sup> , sq.km	=	square kilometer
3	Volume		
	cc	=	cubic centimeter
	lit, l, L	=	liter
	lcd	=	liter per capita per day
	m <sup>3</sup> , cu.m	=	cubic meter
	Gal, Gallon (US)	=	3.785 liter
4	Weight		
	mg	=	milligram
	g	=	gram
	kg	=	kilogram
	t	=	ton
5	Time		
	s, sec	=	second
	min	=	minute
	h, hr	=	hour
	d	=	day
	yr	=	year
6	Money		
	Q	=	Quetzales (unit of Guatemalan currency)
	US\$, \$	=	US Dollar
	¥	=	Japanese Yen
7	Electric Measures		
	A	=	ampere
	V	=	volt
	kV	=	kilovolt
	kW	=	kilowatt

kWh	=	kilowatt hour
kVA	=	kilovolt ampere
Hz	=	hertz

8 Other Measures

mS	=	milli Siemens
$\mu$ mho	=	micromho = conductivity
ppb	=	parts per billion
ppm	=	parts per million
MPN	=	most probable number
‰	=	per thousand
%	=	percent
PS	=	0.736 kW
°	=	degree
'	=	minute
"	=	second
°C	=	degree centigrade

9 Derived Measures Based on the Same Symbols

cm/sec	=	centimeter per second
m/s, m/sec	=	meter per second
cm <sup>3</sup> /min	=	cubic centimeter per minute
m <sup>3</sup> /sec, cu.m/sec	=	cubic meter per second
m <sup>3</sup> /s, cu.m/s	=	cubic meter per second
m <sup>3</sup> /min, cu.m/min	=	cubic meter per minute
m <sup>3</sup> /h, cu.m/h	=	cubic meter per hour
m <sup>3</sup> /day, cu.m/day	=	cubic meter per day
m <sup>3</sup> /d, cu.m/d	=	cubic meter per day
lpcd	=	liter per capita per day
m <sup>3</sup> /m <sup>2</sup> /day	=	cubic meter per square meter per day
m <sup>3</sup> /sec/km <sup>2</sup>	=	specific discharge
kg/day	=	pollutant load
ton/m <sup>2</sup>	=	ton per square meter
kg/day/km <sup>2</sup>	=	unit areal pollutant load
kg/(ha • mm)	=	areal pollutant load per unit rainfall
mg/kg	=	milligram per kilogram
mS/cm	=	milli Siemens per centimeter
mg/L	=	milligram per litre
g/cm <sup>3</sup>	=	gram per cubic centimeter
GPM	=	Gallon per minute

## EXCHANGE RATES USED IN THIS STUDY

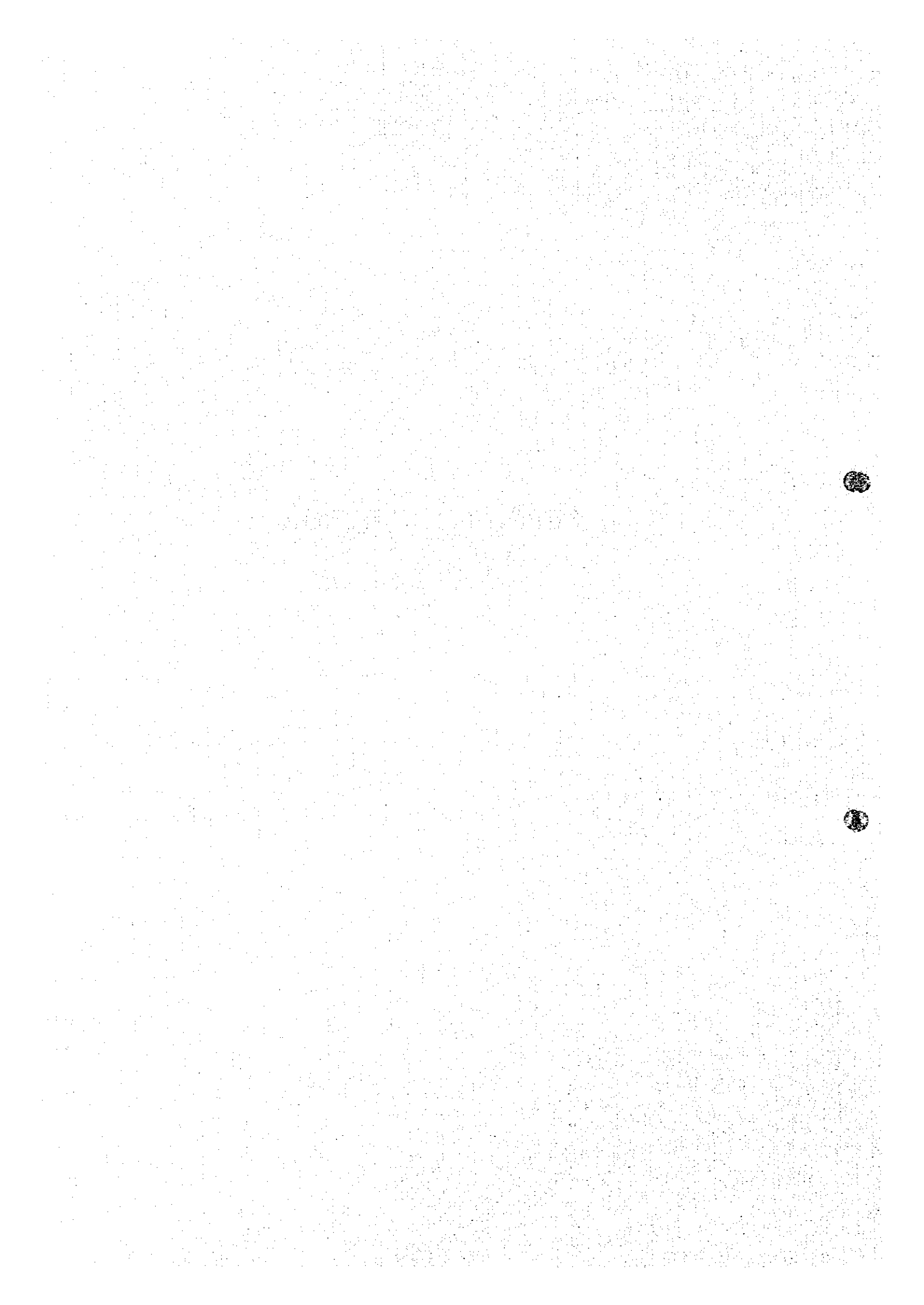
### 1. Selection of Priority Regions (Master Plan)

1 US\$ = Q 5.71 = Yen 100.75 (average of May '95~April '94)

### 2. First Stage Project

1 US\$ = Q 5.88 = Yen 99.12 (average of July '95~December '94)

**SUPPORTING REPORT A**  
**POPULATION**





**SUPPORTING REPORT A  
POPULATION  
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## A POPULATION

### A1 Objectives

The objectives of the population study are to develop accurate projections of future population trends, land usage and urban development for the Study Area for the purpose of sewerage and sanitation master planning. The Study covers Guatemala City, Chinautla, Mixco, Villa Nueva, San Miguel Petapa, Santa Catarina Pinula, Villa Canales and San Pedro Ayampuc.

The population projection of this study will be used as the basis for estimating the wastewater flows for sewerage/sanitation master planning in the year 2015, development of sewerage and sanitation system in Priority Regions and First Stage Project.

### A2 Past and Present Population

The importance of Guatemala City and its environs as the capital and commercial center of the Republic of Guatemala has grown. In recent years, with tourism and industry developing, the growth of the Guatemala Metropolitan area has been much more rapid than other areas of the country. Besides the natural growth of the town, there has been a very significant migration of people from the country areas into Guatemala Metropolitan Area. The development of industries and commerce has also been significant in the growth of the area.

According to the latest census in 1994, as shown in Table A-1, the population of the Republic of Guatemala is about 8.3 million, of which the Department of Guatemala and Guatemala City are about 1.8 million and 0.82 million, respectively.

Table A - 1 Population and Annual Growth Rate based on Census Data

Area	1981 *1)		1994 *2)		Annual Growth Rate (%)
	Population	Share (%)	Population	Share (%)	
Republic of Guatemala	6,054,227	--	8,322,051	--	2.9
Guatemala Department	1,311,192	100.0	1,812,411	100.0	2.9
Guatemala City	754,243	57.5	822,587	45.40	0.7
Mixco	197,741	15.1	304,954	16.83	4.2
Villa Nueva	71,069	5.4	191,985	10.59	13.1
Villa Canales	39,309	3.0	62,284	3.44	4.5
Santa Catarina Pinula	17,387	1.3	38,609	2.13	9.4
Chinautla	41,682	3.2	63,431	3.50	4.0
Other Municipalities	189,761	14.5	328,561	18.13	5.6

Source: \*1) INE, 1985, Censos nacionales de 1981, \*2) INE, 1995, Censos nacionales de 1994  
Note: The census data has some omissions.

From a comparison of the census data of 1981 and 1994, the population of the Department of Guatemala increased from 1.31 to 1.81 million during thirteen years at an annual growth rate of 2.9%, which coincides with that of the Republic of Guatemala.

Guatemala City's population of 0.82 million as of 1994 accounted for 45% of the Guatemala Department population, but its share decreased and its growth rate of 0.7% was lower than those of surrounding municipalities and also lower than those of the Department of Guatemala and Republic of Guatemala. While, the municipalities of Villa Nueva and Santa Catarina Pinula showed a particularly sharp increase at average annual rates of 13% and 9%, respectively.

### **A3 Future Population**

#### **A3.1 General**

In order to develop the Sewerage/Sanitation Master Plan for the year 2015, the extent and character of land use and population distribution shall be examined on the basis of the latest Future Population Projection and Future Land Use Plan.

An intensive study by the Municipality of Guatemala was underway during the period of preparation of Sewerage/Sanitation Master Plan to analyze the past and present land use patterns and project the population and its distribution in the Guatemala Metropolitan Area. In the study, past trends of population, distribution, and growth are being analyzed and the conditions will be projected up to the year 2010. Future population and land use patterns will be developed and presented for appropriate time intervals to the year 2010. Commercial, industrial, housing and other development forecasts will also be developed in the study from the evaluation of pertinent parameters influencing specific types of such growth. The study was expected to be completed by the end of October 1995. Therefore, the result of the study on future population projection and land use plan could not be applied at the phase of developing the Sewerage/Sanitation Master Plan for the year 2015.

Under these circumstances, to determine the future population in the study area, such projections of future population that were available.

### A3.2 Population Projection Procedure

The Future Population is projected as follows.

- Step 1 : Review of available Population Projections
- Step 2 : Projection of Future Population in the Study Area (2015)
- Step 3 : Calculation of Planned Population in each Region for Sewerage/Sanitation Master Plan

### A3.3 Population Projections

There are three different Population Projections; (1) IDB M/P 1976, (2) Sectorial Analysis of Drinking Water and Sanitation, and (3) Population Projection in Urban and Rural for Region and Department, 1980 - 2000 (SEGEPLAN). Among these projections, (3) Urban and Rural Population Projection Regions and Departments of Guatemala, 1980 - 2000 is most reliable and authorized, the projection was selected for projecting the Future Population in the Study Area for Sewerage/Sanitation Plan up to the target year of 2015.

According to the projection, the future population in the Department of Guatemala is as shown in Table A-2.

**Table A-2 Projected Future Population in the Department of Guatemala**

Year	Projected Population
1980	1,459,368
1985	1,696,229
1990	1,962,719
1995	2,246,170
2000	2,538,039

Source : SEGEPLAN

### A3.4 Projection of Future Population in the Study Area

Based on the "Urban and Rural Population Projection in Regions and Departments of Guatemala, 1980 - 2000", Population by Municipality during year 1990 to 1995 is estimated as shown in Table A-3.

**Table A-3 Population Estimates by Municipalities, 1990-1995**

No.	Area	Year					
		1990	1991	1992	1993	1994	1995
	Department of Guatemala	1,962,954	2,018,180	2,074,463	2,131,356	2,188,653	2,246,170
1	Guatemala	1,076,725	1,095,677	1,114,432	1,132,730	1,150,452	1,167,495
2	Santa Catarina Pinula	26,295	27,185	28,090	29,002	29,919	30,836
3	San Jose Pinula	18,933	19,186	19,434	19,673	19,900	20,113
4	San Jose del Golfo	4,254	4,286	4,317	4,345	4,371	4,394
5	Palencia	29,956	30,532	31,105	31,665	32,211	32,739
6	Chinaulta	59,130	60,715	62,309	63,897	65,473	67,027
7	San Pedro Ayampuc	14,795	14,985	15,172	15,351	15,521	15,681
8	Mixco	346,445	363,928	382,080	400,827	420,130	439,950
9	San Pedro Sacatepequez	16,739	17,049	17,356	17,657	17,949	18,230
10	San Juan Sacatepequez	63,465	64,429	65,378	66,297	67,179	68,019
11	San Raymundo	14,970	15,280	15,588	15,891	16,187	16,474
12	Chuarrancho	9,779	9,901	10,020	10,134	10,241	10,342
13	Frajanes	15,608	16,136	16,673	17,214	17,757	18,301
14	Amatitlan	45,510	46,607	47,706	48,795	49,869	50,922
15	Villa Nueva	140,888	150,012	159,642	169,764	180,375	191,474
16	Villa Canales	54,005	55,264	56,523	57,770	58,996	60,197
17	San Miguel Petapa	25,457	27,008	28,638	30,344	32,123	33,976
18	Total of Municipalities related to Study Area	1,743,740	1,794,774	1,846,886	1,899,685	1,952,989	2,006,636
	Ratio of Population of Municipalities of Study Area and Department of Guatemala, %	88.8	88.9	89.0	89.1	89.2	89.3

Note : Municipalities of the Study Area are Santa Catarina Pinula, Chinaulta, San Pedro Ayampuc, Mixco, Villa Nueva, Villa Canales and San Miguel Petapa.

Source : INE, 1995

**Table A-4 Annual Growth Rates, Major Municipalities**

Area	Average Annual Increase of Population	Annual Growth Rate (%)
Department of Guatemala	56,600	2.7
Total of Municipalities related to Study Area	52,600	2.8
Guatemala	18,200	1.6
Mixco	18,700	4.9
Villa Nueva	10,100	6.3

From the Estimated Population by Municipalities, annual percentage growth rates were calculated for the Department of Guatemala, All Municipalities in the Study area, Guatemala City, and each Municipality, as shown in Table A-4.

In order to coincide with the projected figure of 2,538,039 for the Department of Guatemala at year 2000 in the "Population Projection in Urban and Rural for Region and Department, 1980 - 2000", and the calculated figure based on annual growth rate, an appropriate figure of annual growth rate was set to be 2.5%. The future population of the Department of Guatemala can be estimated with the same annual growth rate of 2.5 % to be 3,670,000 in the year of 2015.

The annual growth rates are set up to the year 2015, as shown in Table A-5, to estimate the future population of the Department of Guatemala and the related Municipalities. The results of this projection are presented in Table A-6 up to the year of 2015, and schematically shown in Fig. A-1 and A-2.

The future population of 1,542,000 in Guatemala City has been distributed to each zone based on the trend of population density. Table A-7 shows the results and that the planned population in the Study Area will be 1,533,000.

The future population in other municipalities in the Study Area is calculated on the basis of area ratio of area in the Study Area against the administrative area, taking into consideration population density. The results are shown in Table A-8.

**Table A-5 Growth Rates Used For Population Projection**

Municipality	Growth Rate (%)					
	1990	1995	2000	2005	2010	2015
Department of Guatemala	2.7	2.5	2.5	2.5	2.5	2.5
Local Government Area	2.8	2.6	2.6	2.6	2.6	2.6
Guatemala City	1.6	2.4	1.4	1.4	1.4	1.4
Mixco	4.9	4.2	3.5	3.0	2.5	2.5
Villa Nueva	6.3	4.9	4.9	4.4	3.8	3.8
San Miguel Petapa	5.9	6.0	6.0	5.0	5.0	5.0
Villa Canales	2.2	3.5	5.0	6.5	7.2	7.2
Santa Catarina Pinula	2.8	3.0	3.5	4.0	4.0	4.0
Chinautla	2.5	2.8	3.2	4.3	6.1	6.1
San Pedro Ayampuc	1.2	1.2	1.2	1.2	1.2	1.2

Source: Study Team

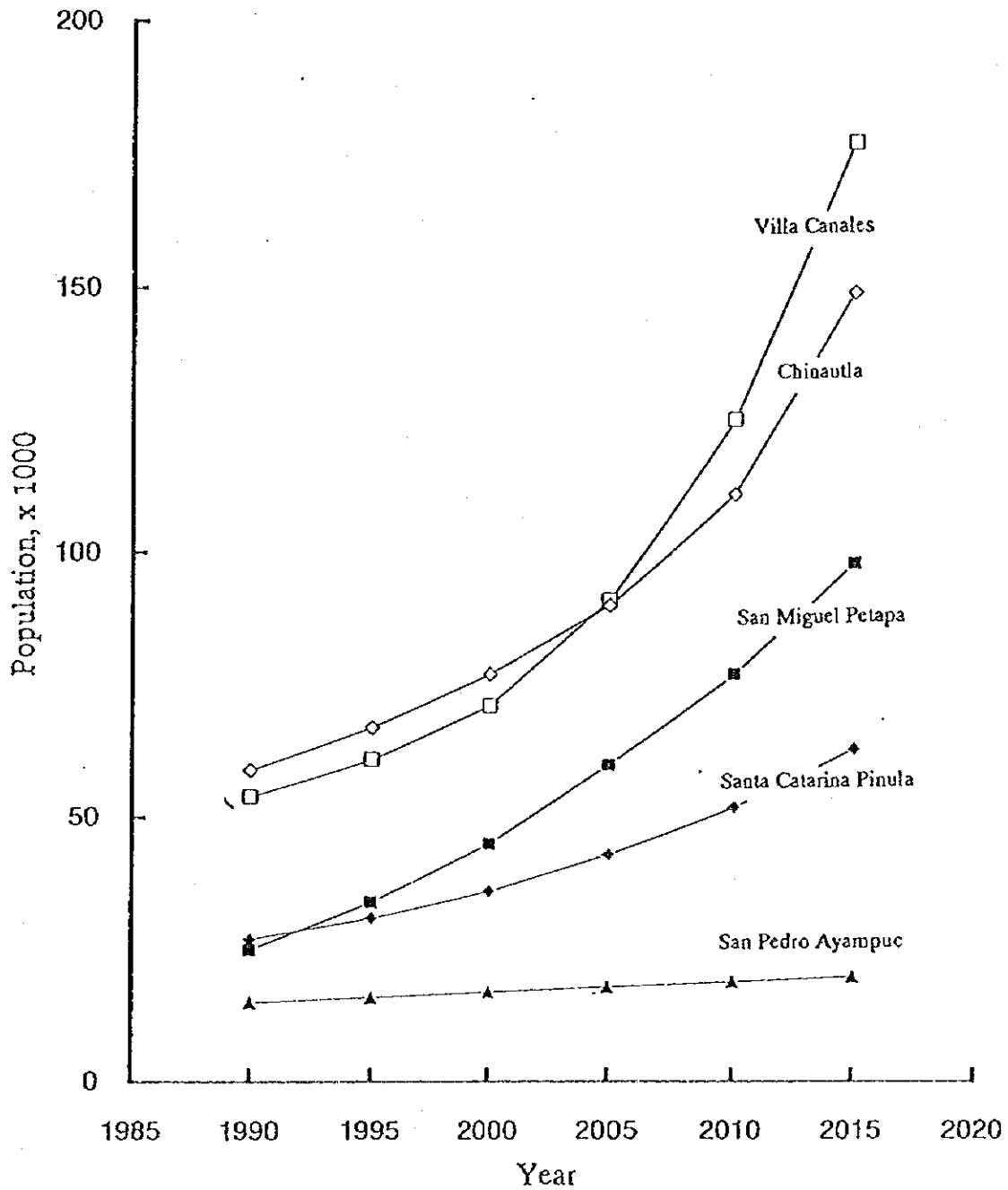
**Table A-6 Population Projection by Municipality, Year 2015**

Municipality	Year					
	1990	1995	2000	2005	2010	2015
Department of Guatemala	1,962,953	2,246,170	2,540,000	2,870,000	3,250,000	3,670,000
Related Municipalities to Study Area	1,743,740	2,006,636	2,281,000	2,594,000	2,949,000	3,353,000
Guatemala City	1,076,725	1,167,495	1,252,000	1,342,000	1,438,000	1,542,000
Mixco	346,445	469,957	540,000	641,000	743,000	841,000
Villa Nueva	140,888	191,474	243,000	309,000	384,000	463,000
San Miguel Petapa	25,457	33,976	45,000	60,000	77,000	98,000
Villa Canales	54,005	60,197	71,000	91,000	125,000	177,000
Santa Catarina Pinula	26,795	30,836	36,000	43,000	52,000	63,000
Chinautla	59,130	67,027	77,000	90,000	111,000	149,000
San Pedro Ayampuc	14,795	15,681	17,000	18,000	19,000	20,000
Other Municipalities in the Department	219,213	239,534	259,000	276,000	301,000	317,000

Source: Study Team



Fig. A - 1



THE REPUBLIC OF GUATEMALA  
 GUATEMALA MUNICIPAL WATER  
 SUPPLY PUBLIC CORPORATION  
 (EMPAGUA)

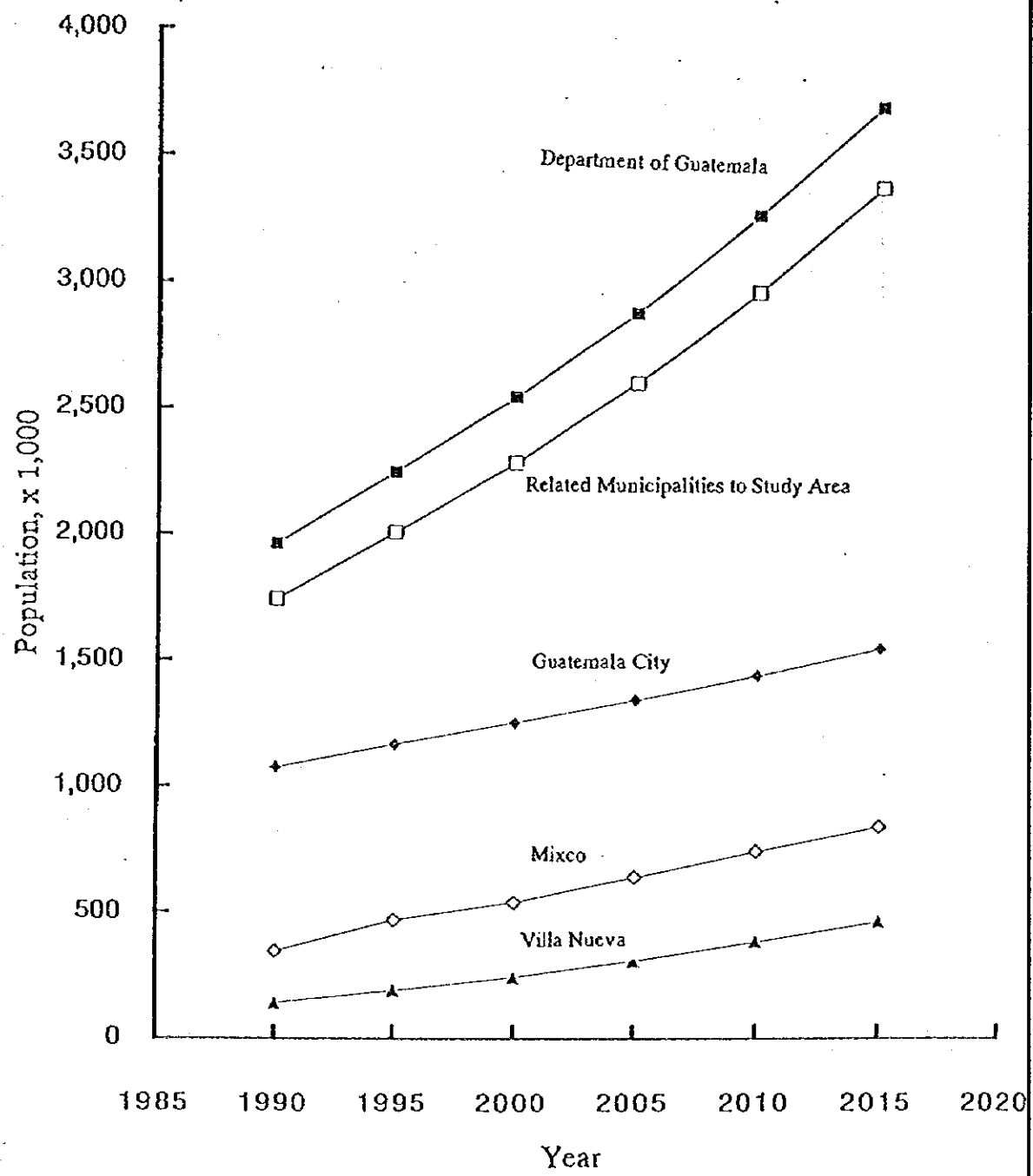
THE STUDY ON  
 THE IMPROVEMENT OF WASTEWATER  
 MANAGEMENT IN THE GUATEMALA  
 METROPOLITAN AREA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Population Projection by  
 Municipality, Year 2015

Fig. A-2



THE REPUBLIC OF GUATEMALA  GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)	THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA	TITLE  Population Projection by Municipality, Year 2015
	JAPAN INTERNATIONAL COOPERATION AGENCY	

Table A-7 Population Density in Guatemala Municipality by Zone up to 2015

Zone No.	Area (ha)	Population							Population Density (capita/ha)				
		1981 *2)	1985 *3)	1990 *3)	1995 *4)	2015	1981	1985	1990	1995	2015		
1	617.6	57,328	85,212	78,787	79,000	79,000	93	138	128	128	128		
2	490.7	20,229	22,794	21,075	21,000	21,000	41	46	43	43	43		
3	246.2	46,914	60,176	55,660	56,000	56,000	191	244	226	227	227		
4	105.8	4,200	5,454	5,044	5,000	5,000	40	52	48	47	47		
5	423.1	74,043	97,435	94,086	94,000	94,000	175	230	222	222	222		
6	527.8	74,011	86,101	82,356	82,000	82,000	140	163	156	155	155		
7	1,003.9	113,417	139,883	153,594	170,000	215,000	113	139	153	169	214		
8	127.8	20,394	27,404	26,630	27,000	27,000	160	214	208	211	211		
9	235.1	4,867	7,678	7,098	7,000	7,000	21	33	30	30	30		
10	491.8	14,802	24,259	24,115	24,000	24,000	30	49	49	49	49		
11	605.8	49,728	54,166	51,609	52,000	52,000	82	89	85	86	86		
12	958.7	43,309	75,117	80,301	86,000	113,000	45	78	84	90	118		
13	642.6	23,161	25,484	26,503	28,000	37,000	36	40	41	44	58		
14	581.0	16,744	18,478	18,231	18,000	23,000	29	32	31	31	40		
15	524.8	13,753	14,888	15,311	16,000	20,000	26	28	29	30	38		
16	1,699.1	5,393	6,694	7,406	8,000	42,000	3	4	4	5	25		
17		8,635	10,353	10,999	12,000	39,000							
18	2,166.5	93,781	120,058	191,112	223,000	460,000	43	55	88	103	212		
19	104.0	28,530	32,110	31,730	32,000	32,000	274	309	305	308	308		
Sub Total	11,552.3	713,239	913,744	981,647	1,040,000	1,428,000	62	79	85	90	124		
22	381.0	30,804	51,687	84,169	86,000	95,000	81	136	221	226	249		
24		5,504	5,903	6,542	8,000	10,000							
Total *1)		749,547	971,334	1,072,358	1,134,000	1,533,000							
25		4,696	4,873	5,366	6,000	9,000							
Grand Total		754,243	976,207	1,077,724	1,140,000	1,542,000							

Note: \*1) Figures show the zones related to the Study Area

\*2) Figures as of 1981 are Census Data

\*3) Figures as of 1985 and 1990 are originated from SEGEPLAN

\*4) Figures as of Year 2015 Grand Total originated from INE, 1995

Source: City Planning Department of Guatemala Municipality and JICA Study Team

**Table A-8 Planned Population by Municipalities related to the Study Area, Year 2015**

Municipality	Population in the Department of Guatemala		Population in the Study Area	
	Present Population (A)	Planned Population (B)	Present Population (C)	Planned Population (D)
	1994	2015	1994	2015
Guatemala City	822,587	1,542,000	818,287	1,533,000
Mixco	304,954	841,000	304,954	816,000
Villa Nueva	191,985	463,000	52,000	125,600
San Miguel Petapa	41,482	98,000	16,000	37,000
Villa Canales	62,284	177,000	34,000	96,000
Santa Catarina Pinula	38,609	63,000	37,000	58,400
Chinautla	63,431	149,000	32,000	47,000
San Pedro Ayampuc	20,260	20,000	-	2,000
<b>Total of Municipalities related to Study Area</b>	<b>1,545,592</b>	<b>3,353,000</b>	<b>1,294,241</b>	<b>2,715,000</b>
<b>Other Municipalities in the Department of Guatemala</b>	<b>266,819</b>	<b>317,000</b>		
<b>Grand Total (Municipalities in the Department of Guatemala)</b>	<b>1,812,411</b>	<b>3,670,000</b>		<b>2,715,000</b>

Source: Study Team

### **A3.5 Planned Population in Each Region for Sewerage/Sanitation M/P**

The Planned population of each of the Regions defined in Section 8.2 of the main report, are summarized in Table A-9.

Planned Population of each Region has been determined as followings:

- (1) The future population of each zone in Guatemala City is allocated to the related Region within which it is located.
  
- (2) The future population for municipalities of Mixco and Santa Catarina Pinula, which cover more than one Region, has been distributed to the related Regions based on the area ratio where part of the municipality falls outside the study Area the proportion of the population calculated by area ratio as being outside the Area is not included in any of the Regions.

Table A-9 Planned Population served by Sewerage/Sanitation system in each Region

Municipality	Regions										Remarks
	Central	North 1	North 2	South 1	South 2	South 3	East 1	East 2	Total		
Guatemala	781,000	32,000			66,000	123,000	521,000	10,000	1,533,000	Without Zone 25	
Mixco	58,000	360,000	138,000	280,000					816,000		
Villa Nueva					125,600				125,600		
San Miguel Petapa						37,000			37,000		
Villa Canales						96,000			96,000		
Santa Catarina Pinula						28,400		30,000	58,400		
Chinautla	47,000								47,000		
Total	866,000	392,000	138,000	280,000	191,600	284,400	521,000	40,000	2,713,000		
Remarks			Sanitation Only				Zone 16,17,18	Sanitation Only			
Population Density ( person/ha )	133	170	166	167	86	117	129				

## **A4 Population to be connected to sewerage/sanitation system in Priority Regions**

### **A4.1 General**

After construction of sewerage/sanitation systems, people will have an access to discharge wastewater through the system.

Population to be connected to the systems proposed for Priority Regions, namely Central and South 3 Regions will be described. The systems would be constructed with three stages of construction program, as described in Chapter 11 of the Main Report.

The estimated population connected to the system will be used for estimation of inflow to sewerage system and sanitation system.

### **A4.2 Population to be Connected**

The estimation are described separately for the following cases:

- (1) Sewerage System in Central Region
- (2) Sanitation System both in Central and South 3 Regions
- (3) Sewerage System in South 3 Region

#### **1) Sewerage System in Central Region**

Connection Ratio is used for the estimation of population be connected to the system, since most of planned area is covered by existing sewerage system. The connection ratio is expressed as the ratio of population connected to wastewater collection facilities against planned population in a target area, i.e., the value of 0.50 means that 50 % of people in the target area connected to the sewerage system.

In Central Region, existing sewerage area covers about seventy five (75) % of planned area at present. Since it is planned that the planned area by sewerage system will be fully connected to the system by 2015, the connection ratio is gradually increased every year set out at 0.75 at present (1995) to 1.00 in year 2015, as shown in Table A-10.

**Table A - 10 Population to be Connected to Sewerage System  
in Central Region**

Year	Planned Population	Connection Ratio	Population to be connected
1994			
1995	595,700	(0.75)	
1996	603,500	(0.76)	
1997	611,300	(0.77)	
1998	619,100	(0.78)	
1999	626,900	(0.79)	
2000	634,700	(0.80)	
2001	642,500	(0.81)	
2002	650,300	0.82	533,200
2003	658,100	0.83	546,200
2004	665,900	0.84	559,400
2005	673,700	0.85	572,600
2006	681,500	0.86	586,100
2007	689,300	0.87	599,700
2008	697,100	0.88	613,400
2009	704,900	0.89	627,400
2010	712,700	0.90	641,400
2011	720,500	0.92	662,900
2012	728,300	0.94	684,600
2013	736,100	0.96	706,700
2014	743,900	0.98	729,000
2015	751,800	1.00	751,800
2016	751,800	1.00	751,800
2017	751,800	1.00	751,800
2018	751,800	1.00	751,800



Thus, the estimated population be connected to the system is projected to increase from 533,200 in the year 2002 after the commencement of the proposed first stage project to 751,800 in the year 2015.

## 2) Sanitation System both in Central and South 3 Regions

The population be connected to the sanitation system proposed in the Priority Regions is estimated on the basis of overall connection ratio described below.

The overall connection ratio is set out as the product of ratio of reticulation sewers (collectors) completed in each stage and respective connection ratio.

The reticulation sewers construction ratio are set out as shown in Table A - 11 for each stage in construction development program described in Chapter 11 of Main Report.

**Table A - 11 Reticulation Construction Volume Ratio**

Stage	Central Region	South 3 Region
First Stage (3 years)	0.10, 0.10, 0.10	0.50
Second Stage (5 years)	0.06,0.06,0.06,0.07, 0.07	0.50
Third Stage (5 years)	0.07,0.07,0.07,0.07, 0.08	-

The respective connection ratio is set , assumed that the connection will be completed within seven (7) years with gradual increase as shown in Table A - 12.

**Table A - 12 Respective Connection Ratio**

Years after Commencement	Respective Connection Rate
1	0.1
2	0.2
3	0.4
4	0.6
5	0.8
6	0.9
7	1.0

The overall connection ratios are estimated as shown in Table A - 13 and Table A - 14 for Central Region and South 3 Region, respectively.

Table A-13 Overall Connection Ratio for the Sanitation System in Central Region

Year	First Stage			Second Stage					Third Stage					Overall Connection Ratio
	1	2	3	1	2	3	4	5	1	2	3	4	5	
2000	0.011													0.01
2001	0.022	0.010												0.03
2002	0.044	0.020	0.011											0.08
2003	0.066	0.040	0.022	0.006										0.13
2004	0.088	0.060	0.044	0.012	0.006									0.21
2005	0.099	0.080	0.066	0.024	0.012	0.006								0.29
2006	0.110	0.090	0.088	0.036	0.024	0.012	0.007							0.37
2007	0.110	0.100	0.099	0.048	0.036	0.024	0.014	0.007						0.44
2008	0.110	0.100	0.110	0.054	0.048	0.036	0.028	0.014	0.007					0.51
2009	0.110	0.100	0.110	0.060	0.054	0.048	0.042	0.028	0.014	0.007				0.57
2010	0.110	0.100	0.110	0.060	0.060	0.054	0.056	0.042	0.028	0.014	0.007			0.64
2011	0.110	0.100	0.110	0.060	0.060	0.060	0.063	0.056	0.042	0.028	0.014	0.007		0.71
2012	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.063	0.056	0.042	0.028	0.014	0.008	0.78
2013	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.063	0.056	0.042	0.028	0.016	0.85
2014	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.070	0.063	0.056	0.042	0.032	0.90
2015	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.070	0.070	0.063	0.056	0.048	0.95
2016	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.070	0.070	0.070	0.063	0.064	0.98
2017	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.070	0.070	0.070	0.070	0.072	0.99
2018	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.070	0.070	0.070	0.070	0.080	1.00
2019	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.070	0.070	0.070	0.070	0.080	1.00
2020	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.070	0.070	0.070	0.070	0.080	1.00
2021	0.110	0.100	0.110	0.060	0.060	0.060	0.070	0.070	0.070	0.070	0.070	0.070	0.080	1.00

**Table A-14 Overall Connection Ratio for the Sanitation System  
in South 3 Region**

Year	First Stage		Overall Connection Ratio
	1	2	
2000	0.050		0.050
2001	0.100	0.050	0.150
2002	0.200	0.100	0.300
2003	0.300	0.200	0.500
2004	0.400	0.300	0.700
2005	0.450	0.400	0.850
2006	0.500	0.450	0.950
2007	0.500	0.500	1.000
2008	0.500	0.500	1.000
2009	0.500	0.500	1.000
2010	0.500	0.500	1.000
2011	0.500	0.500	1.000
2012	0.500	0.500	1.000
2013	0.500	0.500	1.000
2014	0.500	0.500	1.000
2015	0.500	0.500	1.000
2016	0.500	0.500	1.000
2017	0.500	0.500	1.000
2018	0.500	0.500	1.000
2019	0.500	0.500	1.000
2020	0.500	0.500	1.000
2021	0.500	0.500	1.000

The population to be connected to the proposed sanitation system up to the year 2015, is calculated by multiplying the planned population with the overall connection ratios.

The results are shown in Table A - 15. In Central Region, connected population of 8,800 in the year 2002 will be increased to 109,600 in the year 2018, and in South 3 Region, it is 840 in the year 2002 which will be increased to 2,900 in the year 2007.

### 3) Sewerage System in South 3 Region

Since most of the proposed sewerage system for South 3 Region will be newly developed, served area development by the sewers construction and planned population are taken into consideration to estimate the population to be connected.

The served area development by construction of main collectors and collectors are as shown in Table A - 16. This development corresponds to the construction development programs described in Chapter 11 of Main Report.

It is assumed that connection to the constructed main collectors and collectors will be completed within five years after the completion of construction. These are summarized in Table A - 16, in terms of served area by construction for each stage construction.

The Table shows that in the case of the First Stage Project, the connection will be completed by the year 2006, while in succeeding stages the connection will be completed by the year 2011 for the Second Stage Project and by the year 2016 for the Third Stage Project.

The area to be connected to sewerage system is estimated as shown in Table A - 16. Taking into consideration of the connected area and the planned population in the area, population to be connected to the sewerage system for each stage is estimated and summarized in Table A - 16.

### A4.3 Planned Wastewater Generation and Inflow to Wastewater Treatment System

Planned wastewater generation and inflow to the proposed wastewater treatment systems are estimated. Estimated inflow in terms of daily maximum is used for the plan of increasing treatment capacity of wastewater treatment plants both in Central and South 3 Regions, and in term of daily average is used for the estimation of annual revenue accruing from sewage service charge.

**Table A -15 Population to be Connected to the Sanitation System**

Year	Central Region			South 3 Region		
	planned Population	Overall Connec. Ratio	population to be connected	planned Population	Overall Connec. Ratio	population to be connected
1995	109,600			2,400		
1996	109,600			2,500		
1997	109,600			2,500		
1998	109,600			2,600		
1999	109,600			2,600		
2000	109,600			2,700		
2001	109,600			2,700		
2002	109,600	0.08	8,800	2,800	0.30	840
2003	109,600	0.13	14,200	2,800	0.50	1,400
2004	109,600	0.21	23,000	2,900	0.70	2,030
2005	109,600	0.29	31,800	2,900	0.85	2,470
2006	109,600	0.37	40,600	2,900	0.95	2,760
2007	109,600	0.44	48,200	2,900	1.00	2,900
2008	109,600	0.51	55,900	2,900	1.00	2,900
2009	109,600	0.57	62,500	2,900	1.00	2,900
2010	109,600	0.64	70,100	2,900	1.00	2,900
2011	109,600	0.71	77,800	2,900	1.00	2,900
2012	109,600	0.78	85,500	2,900	1.00	2,900
2013	109,600	0.85	93,200	2,900	1.00	2,900
2014	109,600	0.90	98,600	2,900	1.00	2,900
2015	109,600	0.95	104,100	2,900	1.00	2,900
2016	109,600	0.98	107,400	2,900	1.00	2,900
2017	109,600	0.99	108,500	2,900	1.00	2,900
2018	109,600	1.00	109,600	2,900	1.00	2,900

Table A - 16 Area Connected to Sewerage System in South 3 Region

Year	Stage	Served Area by Construction (ha)			Area to be connected to Sewerage System *1						Population to be connected to Sewerage System							
		Existing	Collectors		Cum. Total	First Stage		Second Stage		Third Stage		First Stage	Second Stage	Third Stage	Total			
			Main	Collectors		Annual	Cum.	Annual	Cum.	Annual	Cum.							
1999	First Stage	293	170	92	555													
2000	First Stage		78	93	726													
2001	First Stage		77	93	896													
2002	Second Stage			105	1,001	87	87								380	53,200	0	53,200
2003	Second Stage			105	1,106	87	174	21	21						488	56,700	1,200	57,900
2004	Second Stage			105	1,211	87	261	42	63						617	69,100	3,700	72,800
2005	Second Stage			105	1,316	86	347	63	126						766	81,800	7,800	89,600
2006	Second Stage			104	1,420	86	433	84	210						936	95,700	13,800	109,500
2007	Third Stage			188	1,608			105	315						1,041	98,700	21,800	120,500
2008	Third Stage			188	1,796			84	399	37	37				1,162	101,800	29,100	133,300
2009	Third Stage			188	1,984			63	462	74	111				1,299	105,100	35,600	148,400
2010	Third Stage			188	2,172			42	504	112	223				1,453	108,500	41,100	165,600
2011	Third Stage			188	2,360			20	524	150	373				1,625	112,400	45,200	185,900
2012										188	561				1,811	116,600	47,900	209,300
2013										151	712				1,962	121,000	50,700	231,700
2014										114	826				2,076	125,700	53,800	253,100
2015										76	902				2,152	130,600	57,000	272,600
2016										38	940				2,190	130,600	57,000	276,100
2017																		
2018																		
2019																		

Note \*1 : Served Area (170 ha) by construction of main collectors is excluding from the area connected, because wastewater for the area is already accounted for as commercial wastewater.

## 1) Planned Wastewater Generation

The planned domestic wastewater generation for sewerage/sanitation systems is calculated by multiplying planned population with the daily unit wastewater generation as shown in Table A - 17 and Table A - 18 for Central Region and South 3 Region respectively.

Since the projected wastewater generation for sewerage system is the sum of domestic and industrial wastewater and ground water infiltration, the projected wastewater generation is as shown in Table A - 17 and Table A - 18 for Central Region and South 3 Region respectively.

## 2) Inflow to Wastewater Treatment System

Inflow to the wastewater treatment plants for sewerage system proposed in Central and South 3 Regions is the sum of domestic and industrial wastewater and ground water infiltration. While for that to community wastewater treatment plant for sanitation system proposed in both in Central and South 3 Regions is only domestic wastewater without ground water infiltration, because that sewers will be constructed at shallow depth, that is, above the ground water elevation, so that the effect of ground water would be negligible.

The domestic wastewater inflow to the treatment systems are estimated with the production of the population connected to the proposed sewerage/sanitation system and unit wastewater generation.

The estimated wastewater inflow to the wastewater treatment systems are shown in Table A - 19 and A - 20 for Central Region and South 3 Region respectively.

Table A - 17 Wastewater Generation in Central Region

Year	Planned Population			Unit Wastewater Generation (pcpd)			Projected Wastewater Generation										
	Sewerage	Sanitation	Total	Sewerage	Sanitation	Total	Domestic Wastewater			Sewerage System							
							Daily Ave.	Daily Max.	Daily Ave.	Sanitation	Industrial	Ground	Total				
	Daily Ave.	Daily Max.	Daily Ave.	Daily Max.	Daily Ave.	Daily Max.	Daily Ave.	Daily Max.	Daily Ave.	Water	Water	Daily Ave.	Daily Max.				
1994				268	295	150											
1995	595,700	109,600	705,300	269	296	151	160,200	176,300	16,500	4,700	8,940	173,840	189,940				
1996	603,500	109,600	713,100	270	297	151	162,900	179,200	16,500	4,700	9,050	176,650	192,950				
1997	611,300	109,600	720,900	271	298	152	165,700	182,200	16,700	4,700	9,170	179,570	196,070				
1998	619,100	109,600	728,700	273	300	153	169,000	185,700	16,800	4,700	9,290	182,990	199,690				
1999	626,900	109,600	736,500	274	301	153	171,800	188,700	16,800	4,700	9,400	185,900	202,800				
2000	634,700	109,600	744,300	275	303	154	174,500	192,300	16,900	4,700	9,520	188,720	206,520				
2001	642,500	109,600	752,100	276	304	155	177,300	195,300	17,000	4,700	9,640	191,640	209,640				
2002	650,300	109,600	759,900	277	305	155	180,100	198,300	17,000	4,700	9,750	194,550	212,750				
2003	658,100	109,600	767,700	278	306	156	183,000	201,400	17,100	4,700	9,870	197,570	215,970				
2004	665,900	109,600	775,500	279	307	157	185,800	204,400	17,200	4,700	9,990	200,490	219,090				
2005	673,700	109,600	783,300	280	308	158	188,600	207,500	17,300	4,700	10,110	203,410	222,310				
2006	681,500	109,600	791,100	282	310	158	192,200	211,300	17,300	4,700	10,220	207,120	226,220				
2007	689,300	109,600	798,900	284	312	159	195,800	215,100	17,400	4,700	10,340	210,840	230,140				
2008	697,100	109,600	806,700	286	315	160	199,400	219,600	17,500	4,700	10,460	214,560	234,760				
2009	704,900	109,600	814,500	288	317	160	203,000	223,500	17,500	4,700	10,570	218,270	238,770				
2010	712,700	109,600	822,300	290	319	161	206,700	227,400	17,600	4,700	10,690	222,090	242,790				
2011	720,500	109,600	830,100	291	320	162	209,700	230,600	17,800	4,700	10,810	225,210	246,110				
2012	728,300	109,600	837,900	292	321	162	212,700	233,800	17,800	4,700	10,920	228,320	249,420				
2013	736,100	109,600	845,700	293	322	163	215,700	237,000	17,900	4,700	11,040	231,440	252,740				
2014	743,900	109,600	853,500	295	324	164	219,500	241,000	18,000	4,700	11,160	235,360	256,860				
2015	751,800	109,600	861,400	295	325	165	221,800	244,300	18,100	4,700	11,280	237,780	260,280				
2016	751,800	109,600	861,400	295	325	165	221,800	244,300	18,100	4,700	11,280	237,780	260,280				
2017	751,800	109,600	861,400	295	325	165	221,800	244,300	18,100	4,700	11,280	237,780	260,280				
2018	751,800	109,600	861,400	295	325	165	221,800	244,300	18,100	4,700	11,280	237,780	260,280				



Table A - 18 Wastewater Generation in South 3 Region

Year	Planned Population		Unit Wastewater Generation (pcpd)		Projected Wastewater Generation (m <sup>3</sup> /d)							
	Sewerage Sanitation	Total	Sewerage Daily Ave. Daily Max.	Sanitation Daily Ave. Daily Max.	Domestic Wastewater		Sewerage System					
					Sewerage Daily Ave. Daily Max.	Sanitation Daily Ave. Daily Max.	Industrial Wastewater	Ground Water	Total Daily Ave. Daily Max.			
1994	131,600	2,400	134,000	200	220	26,320	28,950	360	2,230	1,320	29,870	32,500
1995	138,500	2,400	140,900	201	221	27,840	30,610	360	2,230	1,390	31,460	34,230
1996	141,700	2,500	144,200	202	222	28,620	31,460	380	2,230	1,420	32,270	35,110
1997	152,200	2,500	154,700	203	223	30,900	33,940	380	2,230	1,520	34,650	37,690
1998	159,000	2,600	161,600	204	224	32,440	35,620	400	2,230	1,590	36,260	39,440
1999	165,900	2,600	168,500	205	225	34,010	37,330	400	2,230	1,660	37,900	41,220
2000	172,700	2,700	175,400	206	226	35,580	39,030	420	2,230	1,730	39,540	42,990
2001	179,600	2,700	182,300	207	227	37,180	40,770	420	2,230	1,800	41,210	44,800
2002	186,400	2,800	189,200	208	228	38,770	42,500	430	2,230	1,860	42,860	46,590
2003	193,300	2,800	196,100	209	229	40,400	44,270	440	2,230	1,930	44,560	48,430
2004	200,100	2,900	203,000	210	230	42,020	46,020	460	2,230	2,000	46,250	50,250
2005	207,000	2,900	209,900	211	231	43,680	47,820	460	2,230	2,070	47,980	52,120
2006	213,900	2,900	216,800	212	232	45,350	49,620	460	2,230	2,140	49,720	53,990
2007	220,800	2,900	223,700	213	233	47,030	51,450	460	2,230	2,210	51,470	55,890
2008	227,700	2,900	230,600	214	234	48,730	53,280	460	2,230	2,280	53,240	57,790
2009	234,600	2,900	237,500	215	235	50,440	55,130	460	2,230	2,350	55,020	59,710
2010	241,500	2,900	244,400	216	236	52,160	56,990	470	2,230	2,420	56,810	61,640
2011	248,400	2,900	251,300	217	237	53,900	58,870	470	2,230	2,480	58,610	63,580
2012	255,300	2,900	258,200	218	238	55,660	60,760	470	2,230	2,550	60,440	65,540
2013	262,200	2,900	265,100	219	239	57,420	62,670	470	2,230	2,620	62,270	67,520
2014	269,100	2,900	272,000	220	240	59,200	64,580	480	2,230	2,690	64,120	69,500
2015	276,100	2,900	279,000	220	240	60,740	66,260	480	2,230	2,760	65,730	71,250
2016	276,100	2,900	279,000	220	240	60,740	66,260	480	2,230	2,760	65,730	71,250
2017	276,100	2,900	279,000	220	240	60,740	66,260	480	2,230	2,760	65,730	71,250
2018	276,100	2,900	279,000	220	240	60,740	66,260	480	2,230	2,760	65,730	71,250
2019	276,100	2,900	279,000	220	240	60,740	66,260	480	2,230	2,760	65,730	71,250

Table A - 19 Inflow Rate to Wastewater Treatment Systems in Central Region

Year	Estimated Domestic Inflow Rate to Wastewater Treatment Systems (m3/d)				Inflow Rate to Wastewater Treatment Systems (m3/d)								
	Population be connected		Inflow Rate to WT Systems (m3/d)		Industrial Wastewater	Sewerage System		Sanitation System	Sanitation System				
	Sewerage	Sanitation	Sewerage	Sanitation		Ground Water	Total		Daily Max.	Daily Ave.			
							Daily Ave.				Daily Max.		
2001													
2002	533,200	8,800	147,700	162,600	1,360	4,700	8,000	160,400	175,300			1,360	
2003	546,200	14,200	151,900	167,200	2,220	4,700	8,190	164,790	180,090			2,220	
2004	559,400	23,000	156,100	171,700	3,610	4,700	8,390	169,190	184,790			3,610	
2005	572,600	31,800	160,300	176,400	5,020	4,700	8,590	173,590	189,690			5,020	
2006	586,100	40,600	165,300	181,700	6,400	4,700	8,790	178,790	195,190			6,400	
2007	599,700	48,200	170,300	187,100	7,660	4,700	9,000	184,000	200,800			7,660	
2008	613,400	55,900	175,500	193,200	8,930	4,700	9,200	189,400	207,100			8,930	
2009	627,400	62,500	180,700	198,900	9,980	4,700	9,410	194,810	213,010			9,980	
2010	641,400	70,100	186,000	204,700	11,260	4,700	9,620	200,320	219,020			11,260	
2011	662,900	77,800	192,900	212,200	12,640	4,700	9,940	207,540	226,840			12,640	
2012	684,600	85,500	199,900	219,800	13,880	4,700	10,270	214,870	234,770			13,880	
2013	706,700	93,200	207,100	227,500	15,220	4,700	10,600	222,400	242,800			15,220	
2014	729,000	98,600	215,100	236,200	16,200	4,700	10,940	230,740	251,840			16,200	
2015	751,800	104,100	221,800	244,300	17,200	4,700	11,280	237,780	260,280			17,200	
2016	751,800	107,400	221,800	244,300	17,740	4,700	11,280	237,780	260,280			17,740	
2017	751,800	108,500	221,800	244,300	17,920	4,700	11,280	237,780	260,280			17,920	
2018	751,800	109,600	221,800	244,300	18,100	4,700	11,280	237,780	260,280			18,100	

**Table A - 20 Inflow Rate to Wastewater Treatment Systems in South 3 Region**

Year	Estimated Domestic Inflow Rate to Wastewater Treatment Systems				Inflow Rate Wastewater Treatment System (m3/d)						
	Population be connected	Sanitation	Inflow Rate to WWT Systems (m3/d)		Industrial Wastewater	Sewerage System		Sanitation System			
			Sewerage	Sanitation		Ground	Total				
			Daily Ave.	Daily Max.		Water	Daily Ave.	Daily Max.	Daily Ave.		
2001											
2002	53,200	840	11,070	12,130	130	2,230	530	13,830	14,890	130	
2003	57,900	1,400	12,100	13,260	220	2,230	580	14,910	16,070	220	
2004	72,800	2,030	15,290	16,740	320	2,230	730	18,250	19,700	320	
2005	89,600	2,470	18,910	20,700	390	2,230	900	22,040	23,830	390	
2006	109,500	2,760	23,210	25,400	440	2,230	1,100	26,540	28,730	440	
2007	120,500	2,900	25,670	28,080	460	2,230	1,210	29,110	31,520	460	
2008	133,300	2,900	28,530	31,190	460	2,230	1,330	32,090	34,750	460	
2009	148,400	2,900	31,910	34,870	460	2,230	1,480	35,620	38,580	460	
2010	165,600	2,900	35,770	39,080	470	2,230	1,660	39,660	42,970	470	
2011	185,900	2,900	40,340	44,060	470	2,230	1,860	44,430	48,150	470	
2012	209,300	2,900	45,630	49,810	470	2,230	2,090	49,950	54,130	470	
2013	231,700	2,900	50,740	55,380	470	2,230	2,320	55,290	59,930	470	
2014	253,100	2,900	55,680	60,740	480	2,230	2,530	60,440	65,500	480	
2015	272,600	2,900	59,970	65,420	480	2,230	2,730	64,930	70,380	480	
2016	276,100	2,900	60,740	66,260	480	2,230	2,760	65,730	71,250	480	
2017	276,100	2,900	60,740	66,260	480	2,230	2,760	65,730	71,250	480	
2018	276,100	2,900	60,740	66,260	480	2,230	2,760	65,730	71,250	480	
2019	276,100	2,900	60,740	66,260	480	2,230	2,760	65,730	71,250	480	

## **A5 Population Connected to Sewerage/Sanitation System Proposed for the First Stage Project**

### **A5.1 General**

In the same manner explained in the previous section, the population be connected to the systems in First Stage Project is estimated.

The estimated population is used for estimation of inflow rate to wastewater treatment systems and of annual revenue to manage the projects accruing from sewage service charge, which is based on the daily average inflow to wastewater treatment system.

### **A5.2 Population to be Connected**

As described in Chapter 12 and Chapter 13 of Main Report, the proposed sewerage/sanitation systems for the First Stage Project are as follows:

**- Alternative Study (Chapter 12)**

Both sewerage and sanitation systems will be constructed within three years in Central Region or South 3 Region

**- Selected Alternative : South 3 Region (Chapter 13)**

Only sewerage system be constructed.

Main collectors and wastewater treatment facilities be constructed within three years

Collectors (reticulation sewers) be constructed within five years

Therefore, the population be connected to the systems will be described separately as follows:

**1) In case of Alternative Study**

The estimated population be connected to the sewerage/sanitation systems is shown in Table A - 21 and A - 22 for Central Region and South 3 Region respectively.

**2) In case of Selected Alternative**

The estimated population sewerage system only for South 3 Region is shown in Table A - 23.

### **A5.3 Inflow Rate to Wastewater Treatment System**

Similar to the method described in the previous section, inflow to wastewater treatment systems are estimated separately as follows:

These estimates are obtained by the same manner, as described in section A4.3.

In case of Alternative Study, for Chapter 12 of Main Report, those estimates are shown in Table A - 21 and Table A - 22 for Central Region and South 3 Region respectively.

While in case of Selected Alternative : South 3 Region only sewerage system construction, for Chapter 13 of Main Report, those estimates are shown in Table A - 23.

Table A - 21 Population be Connected and Inflow Rate to Wastewater Treatment Systems in Central Region

Year	Estimated Domestic Inflow Rate to Wastewater Treatment Systems				Inflow Rate to Wastewater Treatment Systems (m3/d)						
	Connection Ratio Sewerage/Sanitation	Population be connected Sewerage	Sanitation	Inflow Rate to WT Systems (m3/d)		Sewerage System		Sanitation System			
				Daily Ave.	Daily Max.	Ground Water	Total				
2001											
2002	0.82	533,200	6,800	147,700	162,600	1,050	4,700	8,000	160,400	175,300	1,050
2003	0.83	546,200	13,600	151,800	167,100	2,120	4,700	8,190	164,690	179,990	2,120
2004	0.84	559,400	20,300	156,100	171,700	3,190	4,700	8,390	169,190	184,790	3,190
2005	0.85	572,600	27,100	160,300	176,400	4,280	4,700	8,590	173,590	189,690	4,280
2006	1.00	572,600	33,900	161,500	177,500	5,360	4,700	8,590	174,790	190,790	5,360
2007	1.00	572,600	33,900	162,600	178,700	5,390	4,700	8,590	175,890	191,990	5,390
2008	1.00	572,600	33,900	163,800	180,400	5,420	4,700	8,590	177,090	193,690	5,420
2009	1.00	572,600	33,900	164,900	181,500	5,420	4,700	8,590	178,190	194,790	5,420
2010	1.00	572,600	33,900	166,100	182,700	5,460	4,700	8,590	179,390	195,990	5,460
2011	1.00	572,600	33,900	166,600	183,200	5,490	4,700	8,590	179,890	196,490	5,490
2012	1.00	572,600	33,900	167,200	183,800	5,490	4,700	8,590	180,490	197,090	5,490
2013	1.00	572,600	33,900	167,800	184,400	5,530	4,700	8,590	181,090	197,690	5,530
2014	1.00	572,600	33,900	168,900	185,500	5,560	4,700	8,590	182,190	198,790	5,560
2015	1.00	572,600	33,900	168,900	186,100	5,590	4,700	8,590	182,190	199,390	5,590
2016	1.00	572,600	33,900	168,900	186,100	5,590	4,700	8,590	182,190	199,390	5,590
2017	1.00	572,600	33,900	168,900	186,100	5,590	4,700	8,590	182,190	199,390	5,590
2018	1.00	572,600	33,900	168,900	186,100	5,590	4,700	8,590	182,190	199,390	5,590

Table A - 22 Population be Connected and Inflow Rate to Wastewater Treatment System in South 3 Region

Year	Estimated Domestic Inflow Rate to Wastewater Treatment Systems				Inflow Rate to Wastewater Treatment Systems (m3/d)				Sanitation System		
	Connection Ratio Sanitation	Population be connected		Inflow Rate to WWT Systems (m3/d)		Industrial Wastewater	Ground Water	Sewerage System		Sanitation System	
		Sewerage	Sanitation	Daily Ave.	Daily Max.			Daily Ave.	Daily Max.		
											Total
2001											
2002	0.30	53,200	840	11,070	12,130	130	2,230	530	13,830	14,890	130
2003	0.50	56,700	1,400	11,850	12,980	220	2,230	570	14,650	15,780	220
2004	0.70	69,100	2,030	14,510	15,890	320	2,230	690	17,430	18,810	320
2005	0.85	81,800	2,470	17,260	18,900	390	2,230	820	20,310	21,950	390
2006	1.00	95,700	2,900	20,290	22,200	460	2,230	960	23,480	25,390	460
2007	1.00	98,700	2,900	21,020	23,000	460	2,230	990	24,240	26,220	460
2008	1.00	101,800	2,900	21,790	23,820	460	2,230	1,020	25,040	27,070	460
2009	1.00	105,100	2,900	22,600	24,700	460	2,230	1,050	25,880	27,980	460
2010	1.00	108,500	2,900	23,440	25,610	470	2,230	1,090	26,760	28,930	470
2011	1.00	112,400	2,900	24,390	26,640	470	2,230	1,120	27,740	29,990	470
2012	1.00	116,600	2,900	25,420	27,750	470	2,230	1,170	28,820	31,150	470
2013	1.00	121,000	2,900	26,500	28,920	470	2,230	1,210	29,940	32,360	470
2014	1.00	125,700	2,900	27,650	30,170	480	2,230	1,260	31,140	33,660	480
2015	1.00	130,600	2,900	28,730	31,340	480	2,230	1,310	32,270	34,880	480
2016	1.00	130,600	2,900	28,730	31,340	480	2,230	1,310	32,270	34,880	480
2017	1.00	130,600	2,900	28,730	31,340	480	2,230	1,310	32,270	34,880	480
2018	1.00	130,600	2,900	28,730	31,340	480	2,230	1,310	32,270	34,880	480
2019	1.00	130,600	2,900	28,730	31,340	480	2,230	1,310	32,270	34,880	480

**Table A - 23 Inflow to WWTP in South 3 Region**  
 (Sewerage only to be constructed within 5 years)

Year	Inflow Rate to Wastewater Treatment Plant (m3/d)						
	Estimated Population be connected	Domestic Wastewater Inflow Rate (m3/d)		Industrial Wastewater	Ground Water	Total Inflow Rate	
		Daily Ave.	Daily Max.			Daily Ave.	Daily Max.
2001							
2002	50,700	10,550	11,560	2,230	510	13,290	14,300
2003	53,400	11,160	12,230	2,230	530	13,920	14,990
2004	65,300	13,710	15,020	2,230	650	16,590	17,900
2005	78,100	16,480	18,040	2,230	780	19,490	21,050
2006	92,200	19,550	21,390	2,230	920	22,700	24,540
2007	97,500	20,770	22,720	2,230	980	23,980	25,930
2008	101,800	21,790	23,820	2,230	1,020	25,040	27,070
2009	105,100	22,600	24,700	2,230	1,050	25,880	27,980
2010	108,500	23,440	25,610	2,230	1,090	26,760	28,930
2011	112,400	24,390	26,640	2,230	1,120	27,740	29,990
2012	116,600	25,420	27,750	2,230	1,170	28,820	31,150
2013	121,000	26,500	28,920	2,230	1,210	29,940	32,360
2014	125,700	27,650	30,170	2,230	1,260	31,140	33,660
2015	130,600	28,730	31,340	2,230	1,310	32,270	34,880
2016	130,600	28,730	31,340	2,230	1,310	32,270	34,880
2017	130,600	28,730	31,340	2,230	1,310	32,270	34,880
2018	130,600	28,730	31,340	2,230	1,310	32,270	34,880
2019	130,600	28,730	31,340	2,230	1,310	32,270	34,880



**SUPPORTING REPORT B**  
**WATER SUPPLY SOURCES AND EFFECT OF**  
**WASTEWATER DISCHARGES**



**SUPPORTING REPORT B**  
**WATER SUPPLY SOURCES AND EFFECT OF WASTEWATER**  
**DISCHARGES**  
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## B WATER SUPPLY SOURCES AND EFFECT OF WASTEWATER DISCHARGES

### B1 INTRODUCTION

The purpose of this supporting report is to briefly describe the water supply sources used in the Guatemala Metropolitan Area and to emphasize the effect of untreated wastewater discharges on them. These information is used for prioritizing Regions as described in Chapter 9 of the Main Report.

### B2 WATER SUPPLY SOURCES

Table B-1 shows water supply systems, raw water sources, production capacity and the year of commencement of operation. Total production capacity is 4,600 L/s and consists of approximately 36% surface water and 64% ground water.

**Table B-1 Water Supply Sources of Guatemala Metropolitan Area**

Water Supply System	Source	Production Capacity, L/s	Percentage of Total	Year
Lo De Coy	Xaya and Pixcaya Rivers	950	20.7	1978
Santa Luisa	Teocinte, La Piedrona, Acatan and Canalitos Rivers	280	6.1	1938 1952
El Cambray	Pinula and Las Minas Rivers	130	2.8	1942 1970
Las Ilusiones	Bijague and Los Ocotes Rivers	240	5.2	1972
La Brigada	El Milagro, Las Limas, Pancocha, Pansalic, La Brigada and El Sifon	50	1.1	1945 1965
Ojo de Agua	Ground Water	830	18.0	1961 1963 1969
Ground Water Wells of EMPAGUA	Ground Water	520	11.3	-
Sub-Total		3,000	65.2	-
MARISCAL	Ground Water	350	7.6	-
Ground Water Wells of Other Municipalities	Ground Water	1,250	27.2	-
<b>TOTAL</b>		<b>4,600</b>	<b>100</b>	<b>-</b>

Source : EMPAGUA

Fig. B-1 shows the location of surface water intakes (and present intake rate) affected by the Study Area. Catchment areas for La Brigada and El Cambray (intakes at Hincapic and

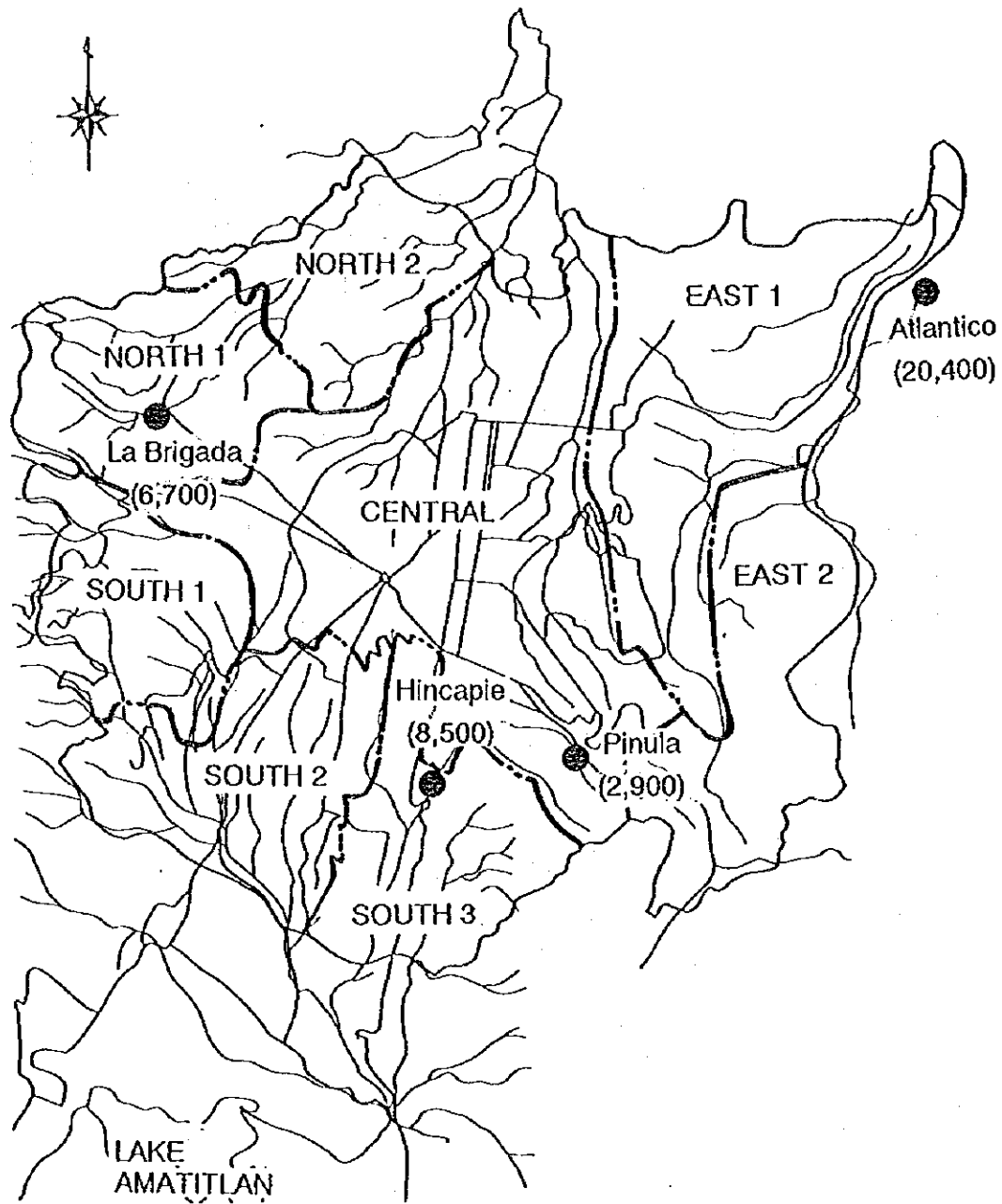
Pinula) fall in Regions North 1 and South 3 respectively. The intake for Las Ilusiones Water Treatment Plant is at Atlantico and the catchment area falls in Regions East 1 and East 2.

Fig. B-2 shows the distribution of ground water wells managed by EMPAGUA by Region. Table B-2 shows the number of wells and total capacity of wells in each Region (Note that some of the wells managed by EMPAGUA are located outside Guatemala City in other municipalities). Region North 1 has the most number of wells followed by Central Region. However, withdrawal capacity is highest in Region South 3 at 1,142 L/s where Ojo de Agua wells are located. Central Region which has only 20 wells has a slightly higher withdrawal capacity at 548 L/s than Region North 1 which has a capacity of 540 L/s.

**Table B-2 Number of Ground Water Wells Managed by EMPAGUA (Including Those Located Outside Guatemala City in Other Municipalities) and Withdrawal Capacity by Region**

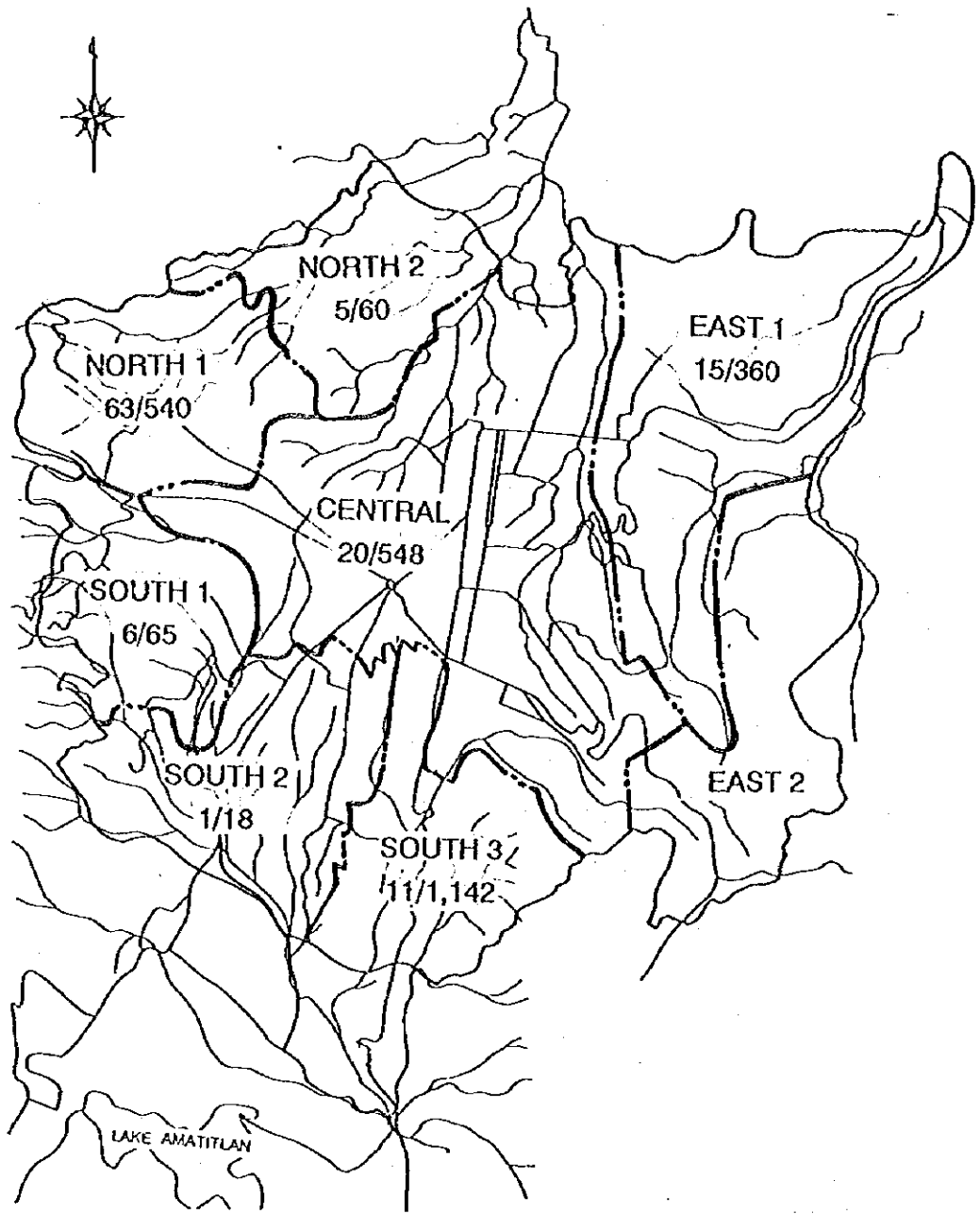
Region	Number of Wells	Withdrawal Capacity, L/s
Central	20	548
North 1	63	540
North 2	5	60
East 1	15	360
East 2	0	0
South 1	6	65
South 2	1	18
South 3	11	1,142
<b>TOTAL</b>	<b>121</b>	<b>2,733</b>

Source : EMPAGUA & Study Team



Location of Intake (Intake capacity, m<sup>3</sup>/day)

<p>THE REPUBLIC OF GUATEMALA</p> <p>GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)</p>	<p>THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA</p> <p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>TITLE</p> <p>Surface Water Supply Intakes</p>
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Number of wells / Withdrawal Capacity (L/s)

<p>THE REPUBLIC OF GUATEMALA</p> <p>GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)</p>	<p>THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA</p> <p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>TITLE</p> <p>Distribution of Ground Water Wells Managed by EMPAGUA</p>
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Table B-3 Location of Deep-wells Managed by EMPAGUA (121 Wells)

No.	Well	Location	Counter #	Withdrawal Capacity		Region	Number of Wells /Region	Total Withdrawal Capacity, L/s
				GPM	L/s			
1	Arcos I	Boulevard Liberacion y 6 Av. Z.9	1263458-5	400	25.23	Central		
2	Arcos II	Boulevard Liberacion y 6 Av. Z.9	1312948-5	200	12.62	Central		
3	Americas	Av. Las Americas y 2 calle Z.13	1266474-9	180	11.36	Central		
4	Reforma	Av Reforma entre 11 y 12 calle Z.9	1306488-2	100	6.31	Central		
5	Ciudad Vieja II	Zona 10 entre 2 av. y 7 calle	1244705-8	100	6.31	Central		
6	Calz. Jose Milla	Calzada Jose Milla y 23 Av. zona 6	1445840-1	300	18.93	Central		
7	Puente Belice	18 calle y 11 av Col. Atlantida Z.18	1442758-6	200	12.62	Central		
8	San Antonio	Barrio San Antonio 24 av y 17calle Z.6	1442757-3	180	11.36	Central		
9	Proyecto 4-3-I	Col. Proy4-3 Z.6 atras Merc. Candelaria	1412203-2	200	12.62	Central		
10	Proyecto 4-3-II	Col. Proy4-3 Z.6 atras Merc. Candelaria	1442756-0	1000	63.08	Central		
11	Proyecto 4-10	Proy.4-10 Z.6,19av final y 23 calle	1445837-7	1000	63.08	Central		
12	Jocotales II	Zona 6 entre 21 calle "e" y 23 av.	1445839-2	1000	63.08	Central		
13	Primera y Tercera	Zona 1 entre 1 av. y 3 calle	-	200	12.62	Central		
14	Santo Domingo	Atrio Santo Domingo Zona 1	1244694-1	500	31.54	Central		
15	Diagonal VI	Zona 10 Diag. VI y 10 av	1244704-3	400	25.23	Central		
16	TP2-II	Fca. El Incienso TP2-II Zona 7	-	800	50.47	Central		
17	Centro America	Av. C.A y 18 calle Zona 1	-	1180	74.44	Central		
18	El Bosque	8 av. A 11-25 Zona 3 El Gallito	P	200	12.62	Central		
19	Visia Hermosa III			200	12.62	Central		
20	TP-2-1			350	22.08	Central	20	(8,690 GPM) 548
21	Maestro	Zona 15 entre 18 av. y 2 calle	1288577-5	200	12.62	East 1		
22	Santa Luisa	Fca. Sta. Luisa, 300ms de Acatan	1326280-4	100	6.31	East 1		
23	Juana de Arco	Col. Juana de Arco Zona 18	1288938-1	140	8.83	East 1		
24	Canalitos Jica	Aldea Canalitos Zona 17	1628586-7	800	50.47	East 1		
25	Lourdes	Col. Lourdes Z. 17 (Predio Municipal)	1558147-9	280	17.66	East 1		
26	San Rafael	Zone 18	P	40	2.52	East 1		
27	Maya I	Manzana 7 Lote 965 Col. Maya Z. 18	1646540-8	550	34.70	East 1		
28	Neuro	Hosp. Neurosiquiatrico Zona 18	P	200	12.62	East 1		
29	Maya II	Col. Maya Z.18, 8 av. Final	P	150	9.46	East 1		
30	Barrio Colombia	17 av. y 115 calle Zona 18	P	800	50.47	East 1		
31	Nuevo II	Hosp. Neurosiquiatrico Zona 18	P	800	50.47	East 1		
32	Preventiva	Final Preventivas de Mujeres Zona 18	P	800	50.47	East 1		

Table B-3 Location of Deep-wells Managed by EMPAGUA (121 Wells)

No.	Well	Location	Counter #	Withdrawal Capacity		Region	Number of Wells /Region	Total Withdrawal Capacity, L/s
				GPM	L/s			
33	Pinares del Incivisa	Zona 18		500	31.54	East 1	15	(5,710 GPM) 360
34	Concepcion las Lomas			150	9.46	East 1		
35	San Gaspar			200	12.62	East 1		
36	Brigada I	Calzada San Juan y 47 Av. Zona 7	-	118	7.44	North 1		
37	Filtros Brigada I	Calzada San Juan y 47 Av. Zona 7	1244698-2	400	25.23	North 1		
38	Filtros Brigada II	Calzada San Juan y 47 Av. Zona 7	1244698-2	400	25.23	North 1		
39	Belen III	Calzada San Juan y 47 Av. Zona 7	-	400	25.23	North 1		
40	Florida	Col. Florida Z.19, 11 av. y 17 calle	1244701-5	180	11.36	North 1		
41	Brigada III			200	12.62	North 1		
42	Brigada VI			180	11.36	North 1		
43	#1	Lomas de Portugal		40	2.52	North 1		
44	#2	Lomas de Portugal		80	5.05	North 1		
45	#3	Lomas de Portugal		20	1.26	North 1		
46	#4	Lomas de Portugal		130	8.20	North 1		
47	#1	Molino de las Flores		140	8.83	North 1		
48	#2	Molino de las Flores		140	8.83	North 1		
49	#1	El Paraiso 1 y 2		120	7.57	North 1		
50	#1	Santa Rita 1 y 2		70	4.42	North 1		
51	#2	Santa Rita 1 y 3		80	5.05	North 1		
52	#1	Urbanización Gonzales		100	6.31	North 1		
53	#1	Kajaval		50	3.15	North 1		
54	#1	Santa Monica		120	7.57	North 1		
55	#1	Nimajay		100	6.31	North 1		
56	#2	Nimajay		110	6.94	North 1		
57	#1	Nueva Monserrat		150	9.46	North 1		
58	#2	Nueva Monserrat		200	12.62	North 1		
59	#3	Nueva Monserrat		90	5.68	North 1		
60	#4	Nueva Monserrat		20	1.26	North 1		
61	#5	Nueva Monserrat		280	17.66	North 1		
62	#1	San Francisco		100	6.31	North 1		
63	#2	San Francisco		40	2.52	North 1		
64	#3	San Francisco		120	7.57	North 1		

Table B-3 Location of Deep-wells Managed by EMPAGUA (121 Wells)

No.	Well	Location	Counter #	Withdrawal Capacity		Region	Number of Wells /Region	Total Withdrawal Capacity, L/s
				GPM	L/s			
65	#4	San Francisco		60	3.79	North 1		
66	#5	San Francisco		160	10.09	North 1		
67	#6	San Francisco		170	10.72	North 1		
68	#7	San Francisco		100	6.31	North 1		
69	#1	Monte Verde		100	6.31	North 1		
70	#2	Monte Verde		70	4.42	North 1		
71	#3	Monte Verde		50	3.15	North 1		
72	#1	El Rosario		26	1.64	North 1		
73	#1	Belen		190	11.99	North 1		
74	#2	Belen		220	13.88	North 1		
75	#1	Villa Verde		110	6.94	North 1		
76	#1	San Ignacio		190	11.99	North 1		
77	#2	San Ignacio		150	9.46	North 1		
78	#1	Belencito		150	9.46	North 1		
79	#1	Pablo VI		100	6.31	North 1		
80	#1	La Brigada		150	9.46	North 1		
81	#2	La Brigada		100	6.31	North 1		
82	#1	Aldea de la Coy		190	11.99	North 1		
83	#1	Jardines de San Juan		220	13.88	North 1		
84	#2	Jardines de San Juan		90	5.68	North 1		
85	#1	Las Brisas		40	2.52	North 1		
86	#1	San Jose Los Pinos		60	3.79	North 1		
87	#2	San Jose Los Pinos		130	8.20	North 1		
88	#3	San Jose Los Pinos		250	15.77	North 1		
89	#1	Valle del Sol		130	8.20	North 1		
90	#2	Santa Marta		170	10.72	North 1		
91	#3	Santa Marta		120	7.57	North 1		
92	#4	Santa Marta		220	13.88	North 1		
93	#7	Santa Marta		120	7.57	North 1		
94	#1	Monserat		130	8.20	North 1		
95	#2	Monserat		60	3.79	North 1		
96	#3	Monserat		75	4.73	North 1		

Table B-3 Location of Deep-wells Managed by EMPAGUA (121 Wells)

No.	Well	Location	Counter #	Withdrawal Capacity		Region	Number of Wells /Region	Total Withdrawal Capacity, L/s
				GPM	L/s			
97	#4	Montserrat		80	5.05	North 1	63	(8,559 GPM)
98	#5	Montserrat		200	12.62	North 1		
99	31	La Esperanza		30	1.89	North 2		
100	#1	El Milagro		216	13.63	North 2	5	(946 GPM)
101	#2	El Milagro		300	18.93	North 2		
102	#3	El Milagro		150	9.46	North 2		
103	#4	El Milagro		250	15.77	North 2		
104	#1	Villa de Mixco		150	9.46	South 1		
105	#2	Villa de Mixco		130	8.20	South 1	6	(1,035 GPM)
106	#3	Villa de Mixco		270	17.03	South 1		
107	#4	Villa de Mixco		100	6.31	South 1		
108	#5	Villa de Mixco		200	12.62	South 1		
109	#1	El Satelite		185	11.67	South 1		
110	Villa Lobos II	8 av. 21-70 Zona 12 Villa Lobos I	P	280	17.66	South 2	1	18
111	Diamante I	Final Av. Petapa Z-12 Fca. El Frutal	-	828	52.23	South 3	11	(280 GPM)
112	Diamante III	Final Av. Petapa Z-12 Fca. El Frutal	-	576	36.34	South 3		
113	Diamante VII	Final Av. Petapa Z-12 Fca. El Frutal	-	729	45.99	South 3		
114	Ojo de Agua I	Final Av. Petapa Z-12 Fca. El Frutal	-	2038	128.56	South 3		
115	Ojo de Agua II	Final Av. Petapa Z-12 Fca. El Frutal	-	2080	131.21	South 3		
116	Ojo de Agua III	Final Av. Petapa Z-12 Fca. El Frutal	-	1325	83.59	South 3		
117	Ojo de Agua IV	Final Av. Petapa Z-12 Fca. El Frutal	-	5075	320.15	South 3		
118	Hincapie I	Planta de Bombeo Hincapie	-	500	31.54	South 3		
119	Ojo de Agua V	Planta Ojo de Agua	-	1500	94.63	South 3		
120	Hincapie II	Estacion de Bombeo Hincapie	-	450	28.39	South 3		
121	Ojo de Agua VI	Planta Ojo de Agua	-	3000	189.25	South 3		
<b>Total Withdrawal Capacity</b>				<b>43,321</b>	<b>GPM</b>			
				<b>2,733</b>	<b>L/s</b>			

Source : EMPAGUA

Table B-4 shows the summary of the existing water supply sources by region. South 3 Region has the highest existing capacity at 1,240 L/s followed by North 1 Region at 617.5 L/s.

**Table B-4 Summary of Existing Capacity of Water Supply Sources by Region**

Region	Existing Capacity, L/s		Total Capacity, L/s
	Ground Water	Surface Water	
Central	548	34	582
North 1	540	77.5	617.5
North 2	60		60
East 1	360	236**	596**
East 2	0		0
South 1	65		65
South 2	18		18
South 3	1,142	98	1,240
Total	2,733	445.5	3,178.5

Note : \*\* Catchment area falls in both East 1 and East 2 Regions.

Source : EMPAGUA and Study Team

### B2.1 Abandoned Sources

Table B - 4 shows the wells abandoned by EMPAGUA. Only one of them was abandoned due to poor water quality. Others were abandoned due to structural problems, appearance of fines etc.

**Table B-5 Location of Deep-wells Abandoned (EMPAGUA)**

No	Well	Location	Counter #	Withdrawal Capacity		Region	Reason for Abandoning
				GPM	L/s		
1	J. A. Salazar II	Col. Los Proceros Z. 10 y 14 av	1309257-6	-	-	Central	Appearance of fines
2	Proyecto 4-4	Proy 4-4 Z.6, 16 av y 18 calle	1445834-9	-	-	Central	Collapse of structure
3	Navidad	Z.6, 19 av. entre 2 calle A y B	1296041-0	-	-	Central	Transformation of well
4	Jard. de la Asuncion	Boulevard Cipresales y 15 "c" Jardines	1445836-4	450	28.39	Central	Unacceptable water quality
5	Colon	Parque Colon, Z.1	1244695-4	-	-	Central	
6	Castellana	Av. La Castellana, 8 Calle, 0-10, Z.9	1306486-7	-	-	Central	
7	Diamante 5	Final Av. Petapa Z.12F Calle El Frutal	-	-	-	South 3	Equipment fault
8	# 2	El Satelite	-	-	-	South 1	
9	# 1	Santa Marta	-	-	-		

Source : EMPAGUA

## **B3 WATER QUALITY OF WATER SUPPLY SOURCES**

### **B3.1 Raw Water Quality of Surface Water**

As shown in Fig. B-2 there are four raw water intakes affected by the Study Area. They are:

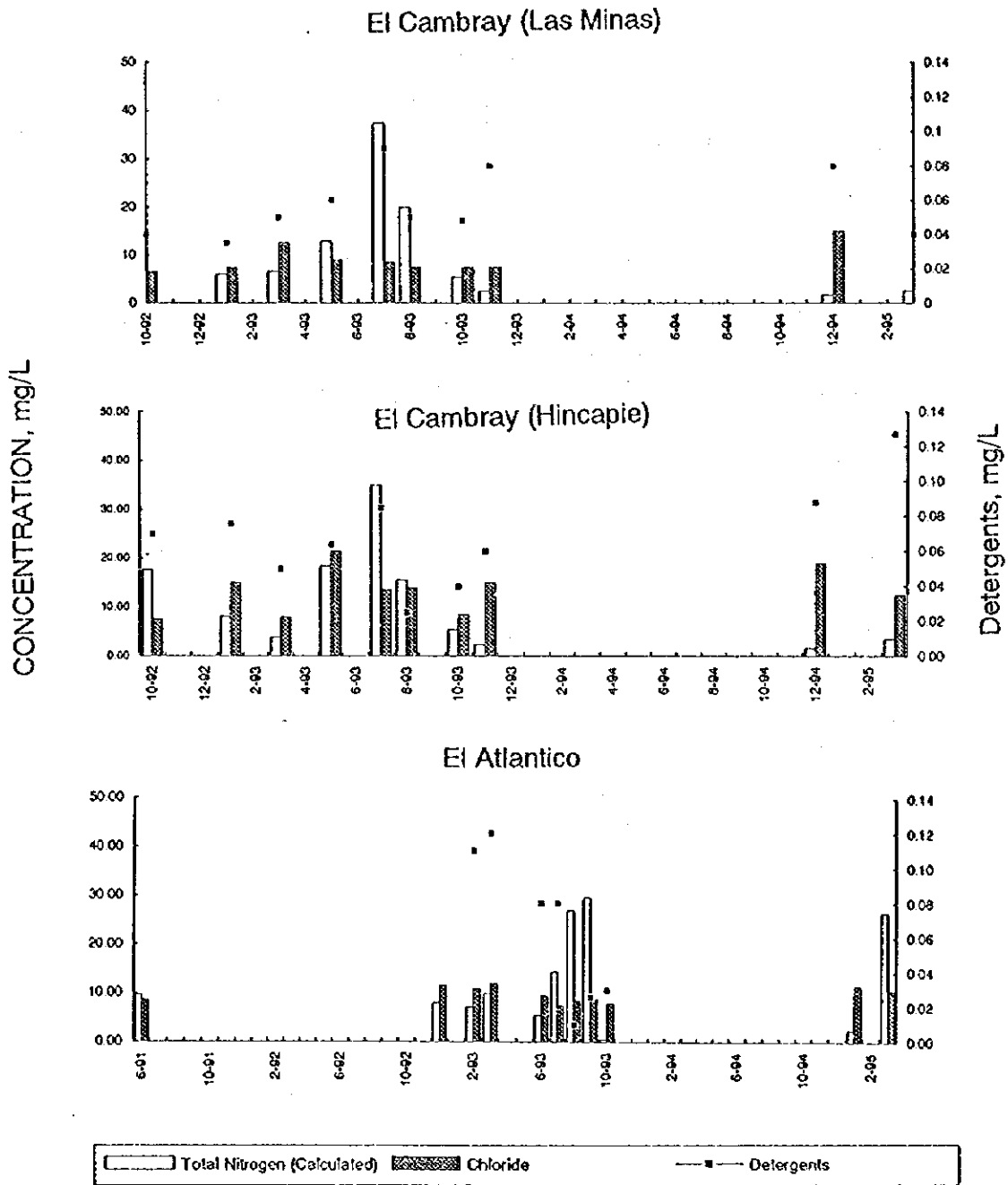
- Las Minas for El Cambray Water Supply System
- Hincapie for El Cambray Water Supply System
- El Atlantico for Las Ilusiones Water Supply System
- La Brigada for La Brigada Water Supply System

Tables B - 6, B - 7, B - 8 and B - 9 show the available results of raw water quality variation during 1991~1995 and Fig. B - 3 shows the variation of total nitrogen (calculated), chloride ion and detergent concentrations. From the tables it is obvious that all of the raw water sources are subject to extreme fecal pollution. Total nitrogen levels, mainly consisting of nitrate, are also high in the range 1.64 ~ 37.5 mg/L. Detergents are also always present.

### **B3.2 Groundwater Quality**

Table B-10 shows the water quality of wells in sector diamante and sector anexo of Ojo de Agua for the years 1993, 1994 and 1995. From Table B-10, it can be deduced that the water quality of the following wells are deteriorating with bacterial and nutrient pollution. They are, Pozo Diamante 1, Pozo diamante 2, Pozo diamante 3, Pozo diamante 5, Pozo diamante 7 and Pozo anexo 1, Pozo anexo 2 and Pozo anexo 3. These wells are located close to River Villalobos and are recharged by the river water. Water quality of river water is similar to raw sewage and it progressively pollutes the groundwater.

Fig. B-3



THE REPUBLIC OF GUATEMALA

GUATEMALA MUNICIPAL WATER  
SUPPLY PUBLIC CORPORATION  
(EMPAGUA)

THE STUDY ON  
THE IMPROVEMENT OF WASTEWATER  
MANAGEMENT IN THE GUATEMALA  
METROPOLITAN AREA

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Variation of Raw Water  
Quality of El Cambray and  
El Atlantico



Table B - 6 Variation of Raw Water Quality of Water Supply Sources (El Cambay, Las Minas)

Water Treatment Plant	Date	Organic Nitrogen mg N/L	Ammonium Nitrogen mg N/L	Nitrite Nitrogen, mg N/L	Nitrate Nitrogen, mg/L	Chloride, mg/L	Detergents, mg/L	Total Coliforms, MPN/100mL	Fecal Coliforms, MPN/100mL	Total Nitrogen (Calculated) mg/L
El Cambay (Las Minas)	09-10-92	0.024	0.048	0.066	19.80	6.5	0.04	>11E+04	>24E+05	19.94
El Cambay (Las Minas)	29-01-93	0.036	0.018	0.003	5.94	7.5	0.035	46E+03	46E+03	6.00
El Cambay (Las Minas)	19-03-93	0.112	0.049	0.016	6.38	12.5	0.05	>24E+05	>24E+05	6.56
El Cambay (Las Minas)	21-05-93	0.058	0.03	0.007	12.80	9.0	0.06	>24E+05	>24E+05	12.89
El Cambay (Las Minas)	02-07-93	0.065	0.037	0.010	37.40	8.5	0.09	>24E+05	>24E+05	37.51
El Cambay (Las Minas)	20-08-93	0.044	0.022	0.003	19.80	7.5	0.05	>24E+05	>24E+05	19.87
El Cambay (Las Minas)	08-10-93	0.038	0.024	0.003	5.28	7.5	0.048	>24E+05	>24E+05	5.35
El Cambay (Las Minas)	26-11-93	0.038	0.018	0.003	2.42	7.5	0.08	>24E+05	>24E+05	2.48
El Cambay (Las Minas)	09-12-94	0.045	0.017	0.033	1.54	15.0	0.08	>24E+04	>24E+04	1.64
El Cambay (Las Minas)	10-03-95	0.050	0.022	0.066	2.42	7.00	0.04	>24E+04	>24E+04	2.56

Source : EMPAGUA

Table B - 7 Variation of Raw Water Quality of Water Supply Sources (El Cambay, Hincapie)

Water Treatment Plant	Date	Organic Nitrogen mg N/L	Ammonium Nitrogen mg N/L	Nitrite Nitrogen, mg N/L	Nitrate Nitrogen, mg/L	Chloride, mg/L	Detergents, mg/L	Total Coliforms, MPN/100mL	Fecal Coliforms, MPN/100mL	Total Nitrogen (Calculated) mg/L
El Cambay (Hincapie)	09-10-92	0.023	0.077	0.007	17.60	7.5	0.07	>24E+04	>24E+05	17.71
El Cambay (Hincapie)	29-01-93	0.106	0.049	0.012	7.92	15.0	0.076	46E+03	46E+03	8.09
El Cambay (Hincapie)	19-03-93	0.046	0.03	0.003	3.74	8.0	0.05	>24E+05	>24E+05	3.82
El Cambay (Hincapie)	21-05-93	0.105	0.052	0.010	18.26	21.5	0.064	>24E+05	>24E+05	18.43
El Cambay (Hincapie)	02-07-93	0.063	0.034	0.010	34.90	13.5	0.085	>24E+05	>24E+05	35.01
El Cambay (Hincapie)	20-08-93	0.062	0.037	0.010	15.40	14.0	0.025	>24E+05	>24E+05	15.51
El Cambay (Hincapie)	08-10-93	0.037	0.023	0.003	5.28	8.5	0.04	>24E+05	>24E+05	5.34
El Cambay (Hincapie)	26-11-93	0.115	0.044	0.012	2.20	15.0	0.06	>24E+05	>24E+05	2.37
El Cambay (Hincapie)	09-12-94	0.058	0.025	0.015	1.54	19.00	0.088	>24E+04	>24E+04	1.64
El Cambay (Hincapie)	10-03-95	0.125	0.043	0.012	3.30	12.50	0.127	>24E+04	>24E+04	3.48

Source : EMPAGUA

Table B - 8 Variation of Raw Water Quality of Water Supply Sources (El Atlantico)

Water Treatment Plant	Date	Organic Nitrogen mg N/L	Ammonium Nitrogen mg N/L	Nitrite Nitrogen mg N/L	Nitrate Nitrogen mg/L	Chloride mg/L	Detergents mg/L	Total Coliforms, MPN/100mL	Fecal Coliforms, MPN/100mL	Total Nitrogen (Calculated) mg/L
El Atlantico (River)	14-06-91	0.135	0.057	0.020	9.46	8.5	-			9.67
El Atlantico (River)	11-12-92	0.160	0.067	0.990	6.85	11.50	0.2			8.07
El Atlantico (River)	05-02-93	0.108	0.054	0.016	7.04	11.0	0.11	>24E+05	>24E+05	7.22
El Atlantico (River)	26-03-93	0.137	0.052	0.150	9.68	12.0	0.12	>24E+05	>24E+05	10.02
El Atlantico (River)	04-06-93	0.122	0.055	0.018	5.28	9.5	0.08	11E+05	11E+05	5.48
El Atlantico (River)	09-07-93	0.048	0.027	0.010	14.4	7.5	0.08	>24E+05	>24E+05	14.48
El Atlantico (River)	27-08-93	0.047	0.027	0.003	27	8.5	0.01	>24E+05	>24E+05	27.08
El Atlantico (River)	03-09-93	0.045	0.028	0.007	29.62	9.0	0.026	>24E+05	>24E+05	29.70
El Atlantico (River)	22-10-93	0.047	0.028	0.007	0.46	8.0	0.03	>24E+05	>24E+05	0.54
El Atlantico (River)	20-01-95	0.108	0.04	0.010	2.20	11.5	-	24E+11	24E+11	2.36
El Atlantico (Succion)	20-01-95	0.110	0.042	0.012	2.20	10.5	-	24E+11	24E+11	2.36
El Atlantico (River)	21-03-95	0.172	0.055	0.396	26.00	10.0	0.21	>24E+04	>24E+04	26.62

Source : EMPAGUA

Table B - 9 Variation of Raw Water Quality of Water Supply Sources (La Brigada and Others)

Water Treatment Plant	Date	Organic Nitrogen mg N/L	Ammonium Nitrogen mg N/L	Nitrite Nitrogen mg N/L	Nitrate Nitrogen mg/L	Chloride mg/L	Detergents mg/L	Total Coliforms, MPN/mL	Fecal Coliforms, MPN/100mL	Total Nitrogen (Calculated) mg/L
La Brigada	10-09-93	0.028	0.013	0.000	20.48	11.0	0.057	>24E+04	>24E+04	20.52
La Brigada	12-11-93	0.025	0.013	0.000	4.84	10.0	0.095	>93E+00	>15E+00	4.88
La Brigada	24-03-95	0.125	0.043	0.010	29.00	10.0	0.41	>24E+03	>24E+03	29.18
Las Ilusiones	20-01-95	0.107	0.038	0.010	0.20	11.0	-	24E+11	24E+11	0.36
Santa Luisa	02-12-94	0.147	0.050	0.012	1.98	15.0	0.09	>24E+03	>24E+03	2.19
Santa Luisa	03-03-95	0.137	0.048	0.360	12.42	8.5	0.16	>24E+04	>24E+04	12.97
Santa Luisa	05-05-95	0.122	0.030	0.015	22.00	8.5	0.70	>24E+04	>24E+04	22.17
Lo de Coy	27-01-95	0.110	0.042	0.010	2.20	9.0	0.24	>24E+04	>24E+04	2.36
Lo de Coy	21-04-95	0.104	0.039	0.010	19.98	9.0	0.11	>24E+03	>24E+03	20.13

Source : EMPAGUA

Table B - 10 Variation of Raw Water Quality of Ground Water (Ojo de Agua)

Water Treatment Plant	Date	Organic Nitrogen mg N/L	Ammonium Nitrogen mg N/L	Nitrite Nitrogen, mg N/L	Nitrate Nitrogen, mg/L	Chloride, mg/L	Total Coliforms, MPN/100mL	Fecal Coliforms, MPN/100mL	Total Nitrogen (Calculated) mg/L
Pozo anexo 1	08-01-93	0.027	0.013	0.000	4.62	10.0	<3	<3	4.66
Pozo anexo 3	08-01-93	0.022	0.012	0.000	3.08	8.5	<3	<3	3.11
Pozo anexo 4	08-01-93	0.021	0.012	0.000	4.84	11.0	<3	<3	4.87
Pozo anexo 5	08-01-93	0.025	0.013	0.000	4.84	10.0	<3	<3	4.88
Pozo diamante 1	08-01-93	0.045	0.021	0.007	0.88	11.5	7	4	0.95
Pozo diamante 3	08-01-93	0.024	0.013	0.000	1.54	8.0	<3	<3	1.58
Pozo diamante 7	08-01-93	0.060	0.027	0.010	1.10	9.0	<3	<3	1.20
Pozo anexo 1	16-07-96	0.025	0.013	0.000	2.20	10.0	<3	<3	2.24
Pozo anexo 2	16-07-96	0.021	0.012	0.000	2.20	12.5	<3	<3	2.23
Pozo anexo 3	16-07-96	0.022	0.012	0.000	1.76	11.0	<3	<3	1.79
Pozo anexo 4	16-07-96	0.026	0.013	0.000	2.20	12.5	<3	<3	2.24
Pozo anexo 5	16-07-96	0.055	0.028	0.003	2.20	13.0	<3	<3	2.29
Pozo diamante 1	16-07-96	0.027	0.013	0.000	1.32	14.0	23	23	1.36
Pozo diamante 3	16-07-96	0.057	0.037	0.010	1.10	13.0	<3	<3	1.20
Pozo diamante 7	16-07-96	0.022	0.012	0.000	1.10	12.5	<2.2	<2.2	1.13
Pozo anexo 1	17-09-96	0.027	0.013	0.000	1.10	9.5	<3	<3	1.14
Pozo anexo 3	17-09-96	0.021	0.012	0.000	1.54	10.0	<3	<3	1.57
Pozo anexo 4	17-09-96	0.026	0.013	0.000	1.32	10.0	<3	<3	1.48
Pozo anexo 5	17-09-96	0.022	0.012	0.000	1.32	11.5	<3	<3	1.35
Pozo diamante 7	17-09-96	0.112	0.049	0.010	0.66	10.0	<3	<3	0.83
Pozo anexo 2	24-02-95	0.022	0.010	0.000	0.88	7.5	<3	<3	0.91
Pozo anexo 3	24-02-95	0.021	0.010	0.000	0.88	8.5	<3	<3	0.91
Pozo anexo 4	24-02-95	0.028	0.011	0.000	0.88	8.5	<3	<3	0.92
Pozo anexo 5	24-02-94	0.027	0.011	0.000	1.10	7.0	<3	<3	1.14
Pozo diamante 3	24-02-94	0.022	0.010	0.000	1.10	10.5	<3	<3	1.13
Pozo diamante 5	24-02-95	0.162	0.055	0.366	9.68	10.0	<3	<3	10.26
Pozo diamante 7	24-02-95	0.158	0.053	0.825	7.48	10.0	240	43	8.52
Pozo anexo 1	15-12-95	0.021	0.01	0.000	8.80	7.5	210	<3	8.83
Pozo anexo 2	15-12-95	0.022	0.01	0.000	11.00	15.0	270	<3	11.03
Pozo anexo 3	15-12-95	0.022	0.01	0.000	4.40	11.0	160	<3	4.43
Pozo anexo 5	15-12-95	0.025	0.011	0.000	8.80	9.0	310	<3	8.84
Pozo anexo 6	15-12-95	0.021	0.01	0.000	8.80	10.0	250	<3	8.83
Pozo diamante 2	15-12-95	0.145	0.053	0.120	4.40	11.0	uncountable	1,100	4.72

Source : EMPAGUA

**SUPPORTING REPORT C**  
**LAWS, REGULATIONS AND STANDARDS ON**  
**WATER POLLUTION CONTROL**

**SUPPORTING REPORT C**  
**LAWS, REGULATIONS AND STANDARDS ON WATER POLLUTION**  
**CONTROL**  
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## **C LAWS, REGULATIONS AND STANDARDS ON WATER POLLUTION CONTROL**

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### **C1 INTRODUCTION**

In Chapter 4, Section 4.4 of the Main Report, main laws and regulations are discussed, and in this supporting report details of other regulations can be found. They are :

- Instructions and Procedures for Environmental Impact Assessment
- Law on Creation of Lake Amatitlan Authority and Conservation of Lake Amatitlan (Government Agreement No. 204-93)

Further, main articles of the law on Protection and Improvement of the Environment and Regulation on Minimum Requirements and Maximum Permissible Pollution Values for Wastewater Discharges.

### **C2 INSTRUCTIONS AND PROCEDURES FOR THE ENVIRONMENTAL IMPACT ASSESSMENT**

Article 8 of Decree 68-86 of the Law for the preservation of the environment requires that studies on environmental impact for new activities be approved by CONAMA. New activities or projects are categorized into three types based depending on the level of impact. The individual or organization executing the project is required to get the Terms of Reference for the project approved by CONAMA, and the environmental impact assessment must be carried out by consultants selected by SEGEPLAN. Finally, the environmental assessment shall be approved by CONAMA prior to implimentation of projects where major environmental impact is to be realized.

### **C3 CREATION OF LAKE AMATITLAN AUTHORITY AND CONSERVATION OF LAKE AMATITLAN (GOVERNMENT AGREEMENT NO. 204-93)**

This government agreement redefines the original government agreement No. 489-85 and authorizes the Authority to plan, coordinate and execute all the works that will help to rehabilitate the Lake Amatitlan's ecosystem. Lake Amatitlan Authority is pursuing the industries within the catchment of Lake Amatitlan to reduce pollutant loads and is also conducting studies to protect the lake.

#### **C4 OBSERVATIONS**

- At present there is no comprehensive law and enforcing authority for water pollution control.
- Even though the Law on the Protection of the Environment requires an environmental impact assessment, monitoring after the project is lacking.
- At present, enforcement action is taken only if complaints are made.



## ANNEX CA

### EXCERPTS FROM "REGULATIONS ON THE MINIMUM REQUIREMENTS AND MAXIMUM PERMISSIBLE POLLUTION VALUES FOR WASTEWATER DISCHARGE (Regulation No. 60-89)"

#### CHAPTER I

##### Article 1

The main objective of this regulation is to establish the permissible pollution values that will apply to the discharge of wastewater to surface water, groundwater, and sea water bodies. Before the discharge of wastewater the water body, (ground water, sea water, surface) should be monitored by the CONAMA, in order to establish whether the wastewater exceeds the permissible values.

##### Article 2

There are two types of wastewater to be considered.

- 1) Direct discharge  
That is water that goes directly to a water body.
- 2) Indirect discharge  
The water discharged from entities which are connected to the public sewerage system.

The maximum permissible pollution values will be applied to both discharge categories.

##### Article 9

The maximum permissible pollution values established in Article 8, do not apply to water from industries or water with less than 3 kilograms per day of BODs load.

##### Article 17

According to the articles 7,8,10,11,12 and 15 proper monitoring, analysis and supervision of the parameters established should be carried out 3 to 5 times a year. This should be done following the standards set by the Guatemalan Standards Committee (COGUANOR). If they lack the relevant standard, they should use the ones set by the Central American Standards Committee or the American Public Health Association (APHA), the American Water Works Association, (AWWA), or the Water Pollution Control Federation of USA.

**Article 19**

All municipalities in the country and the industries classified here, should construct their treatment plants, within a two year period after this regulations has been established.

**Article 20**

If Article 19 cannot be executed due to strong or justified causes, or other reasons, the municipalities, industries, or similar entities listed here, should at least either provide a sedimentation tank, where the wastewater should remain for at least 2 hours before discharge, or a similar method should be applied. Therefore, wastewater will be discharged after the settleable sludge has been properly removed, and the water quality is within the maximum limits of acceptable pollution established on Tables I, II, III, IV, V and VI of this regulation.

## ANNEX CB

### EXCERPTS FROM "LAW FOR THE PROTECTION AND IMPROVEMENT OF THE ENVIRONMENT" (DECREE 68-86)

This is a Law made by CONAMA and approved by the Congress.

The National Commission for the Environment is composed of one coordinator and a group of technical advisors.

A internal regulation will be established for the technical and administrative commission for CONAMA.

#### Article 8

Reformed by the Decree # 1-931 of the Congress for projects, industry or any other activity that by its characteristics can produce deterioration of either replenishable or non replenishable natural resources in the environment, or introduce significant modifications or visible changes to the cultural resources of the nation, would be required to conduct a study and evaluation prior to its development, which must be carried out by personnel from the appropriate specialized technical subjects and approved by CONAMA. The employee required to order the environmental impact study, will be personally responsible for fairule to acheive of the necessary duties, and those who do not perform the study shall be liable to a fine of Q.5000.00 to Q.100,000.00.

In the event that the requirements are not accomplished within a six month term after being fined the business will be closed.

#### Article 15

The government will work out the necessary dispositions and the corresponding rules, for water for human use and other activities for which its use is necessary. These duties will be to:

- A) Evaluate water resources and the possibilities of further exploiting them meanwhile periodically monitoring its physical, chemical and biological composition.
- B) Execute control over the exploiting and use of water while not causing damage to the environment.

- C) Supervise in the long term the systems of discharge of wastewater or contaminated water such that it meets hygienic norms, sanitation norms and set requirements.
- D) Technically determine cases in which waste and garbage can be allowed for disposal.
- E) Promote integrated rational management of water supply sources.
- F) Promote and support research and analysis of inland, coastal and oceanic waters.
- G) Promote the rational use and control of all water sources from contamination to ensure that the safety of biological cycles and the normal development of species.
- H) Maintain the capacity to regulate water quality amicably in national and international waters.
- I) Carry out surveillance for the conservation of flora especially forests, for the maintenance of equilibrium of the hydrological system and promoting the immediate reforestation of drainage basins.
- J) Prevent, control and determine the level of contamination of rivers, lakes and seas of Guatemala.
- K) Investigate, prevent and control any source of water contamination.

## ANNEX CC

### EXCERPTS FROM "CREATION OF LAKE AMATITLAN AUTHORITY AND CONSERVATION OF LAKE AMATITLAN" (Government Agreement No. 204-93)

According to governmental agreement No. 489-485 issued by the Chief of Staff on June 12th 1985, the Organization for the Conservation and Rescue of Lake Amatitlan was established. This organization's nature, legal capacity, and functions, were not properly established in that agreement, therefore it is necessary to issue a legal disposition in order to redefine all those aspects and obtain the support, projection that such organization requires.

#### Article 1

##### Establishment

The Organization for the conservation and protection of Lake Amatitlan was established as an organization of great importance. Its main objective is to organize, coordinate and execute the different actions carried out by private or public companies which will contribute in any way to the preservation of the lake and its basins.

#### Article 2

##### Members of the Organization

"The Organization for the Conservation and Protection of Lake Amatitlan" will have the following members:

As President : The Governor of the Department of Guatemala

##### Members

The Commanding Officer of the southern region of Guatemala

one member from the Ministry of Public Health and Social Assistance

one member from the Ministry of Agriculture,

one member from the Ministry of Public Affairs

one member from the Municipality of Guatemala being represented by the maximum authority of EMPAGUA

The Mayor of the Municipality of Amatitlan

one member from the Secretariat of Hydraulic Resources of the Presidency of the Republic

one member from National Environmental Commission

one member from the Lake's committee

one member from each Guatemalan Rotary Club.

Each member should appoint a substitute so that they will be represented all the time. Among the members an Executive Coordinator should be appointed, His main task will be to direct the organization in charge of the rescue and protection of Lake Amatitlan and its basin.

### **Article 3**

#### **Hierarchy**

Due to the great importance of this organization, it shall be directly responsible to the President. The organization shall hire all administrative personnel that they might need, as long as procedures and standards established by the law are followed. All institutions, municipalities, and government institutions within Lake Amatitlan's territory must cooperate in every way and support the Organization.

### **Article 7**

#### **Financial resources**

The Organization for the Protection and Rescue of Lake Amatitlan, will manage the resources assigned by the Government. The organization shall accept grants, technical and financial assistance from local donors or international donors. All this shall be done in order to achieve its objectives within a legal frame.

**SUPPORTING REPORT D**  
**PUBLIC ATTITUDE SURVEY**

**SUPPORTING REPORT D  
PUBLIC ATTITUDE SURVEY  
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## D PUBLIC ATTITUDE SURVEY

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### D1 INTRODUCTION

The public attitude survey was conducted as follows:

- Survey period:** May of 1995
- Interviewers:** 6 persons experienced in various social surveys who worked for a local sub-contractor.
- Survey Area:** Since population data of the study area was not available prior to the survey, in order to get the appropriate sample distribution, the number of EMPAGUA's customers was used for reference, thereby the survey was mostly done in 20 zones of Guatemala City where EMPAGUA provides a service. The sample distribution is shown in D2 and D3.
- Number of Samples:** 201 households were actually surveyed.
- Sample Selection:** According to the income levels defined by the Guatemala Municipality, interviewers visited households which apparently corresponded to various income categories.
- Questionnaire:** The Study Team, in collaboration with EMPAGUA, prepared the Spanish Questionnaire (D4).
- EMPAGUA's Support:** In order to carry out the survey as smoothly as possible, the covering letter to interviewees was provided by EMPAGUA (D8).

## D-2 Sample Distribution by Zone

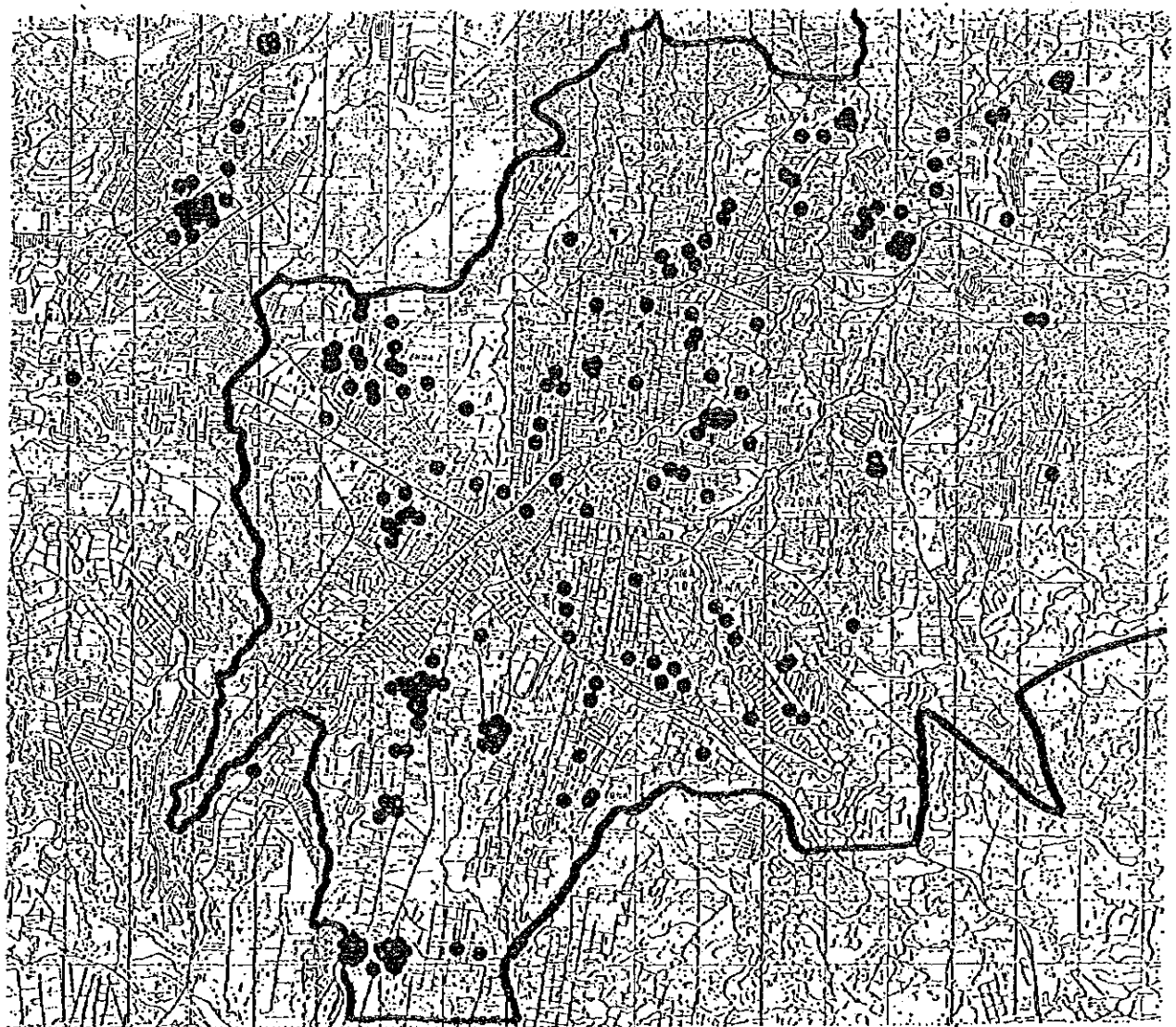
ZONE NO.	INCOME LEVEL *1	NUMBER OF SAMPLES (PLANNED) *2					NUMBER OF SAMPLES (ACTUAL)				
		HIGH	MIDDLE	LOW	TOTAL	%	HIGH *3	MIDDLE *3	LOW *3	TOTAL	%
1	MIDDLE		10		10	5%	3	5	2	10	5%
2	MIDDLE		3		3	2%		3		3	2%
3	LOW			6	6	3%			6	6	3%
4	LOW			1	1	1%			1	1	1%
5	LOW			11	11	6%		1	10	11	6%
6	LOW			15	15	8%		3	12	15	8%
7	MIDDLE		21		21	11%		12	9	21	11%
8	LOW			2	2	1%			2	2	1%
9	HIGH	4			4	2%	4			4	2%
10	HIGH	8			8	4%	3	4		7	4%
11	MIDDLE		10		10	5%	1	8	1	10	5%
12	MIDDLE		20		20	10%	6	7	9	22	11%
13	HIGH	10			10	5%	6	4		10	5%
14	HIGH	7			7	4%	6	1		7	4%
15	HIGH	8			8	4%	8			8	4%
16	HIGH	3			3	2%	3			3	2%
17	LOW			4	4	2%			4	4	2%
18	LOW			19	19	10%	1	5	13	19	10%
19	LOW			19	19	10%		1	18	19	10%
21	LOW			19	19	10%	1	5	13	19	10%
<b>TOTAL</b>		40	64	96	200	100%	42	59	100	201	101%



\*1 Classification of zones used by Metropolitan Development Unit of Guatemala City is applied.

\*2 Distribution of samples by zone is proportional to the number of EMPAGUA's customers in each zone. For zones where EMPAGUA offers limited service, the number of samples is assumed to be the same as similarly populated zone.

\*3 The number of high, middle and low income samples actually surveyed was determined according to the response of those interviewed in the survey. The levels are Q.5001 or more per month for high income, Q.2001 through Q.5000 for middle income, and Q.0 through Q.2000 for low income.

Fig. D 3



-  Guatemala City boundary
-  Location of surveyed households

<p>THE REPUBLIC OF GUATEMALA</p> <p>GUATEMALA MUNICIPAL WATER SUPPLY PUBLIC CORPORATION (EMPAGUA)</p>	<p>THE STUDY ON THE IMPROVEMENT OF WASTEWATER MANAGEMENT IN THE GUATEMALA METROPOLITAN AREA</p> <p>JAPAN INTERNATIONAL COOPERATION AGENCY</p>	<p>TITLE</p> <p>Sample Distribution Map</p>
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# PLAN MAESTRO DE ALCANTARILLADO Y DRENAJES DE LA CIUDAD DE GUATEMALA

## ENCUESTA DE AGUA Y ALCANTARILLADO

Como usted podría saber, el Japón es uno de los países más avanzados en el mejoramiento de las condiciones de vida de los habitantes en las ciudades. La Agencia de Cooperación Internacional del Japón está realizando la presente encuesta, para colaborar con EMPAGUA en el mejoramiento de las condiciones de saneamiento de la Ciudad de Guatemala y el consiguiente beneficio en el medio ambiente para los habitantes. Su casa ha sido seleccionada al azar para que represente a la comunidad de su zona en esta encuesta, por lo que no se preguntarán nombres sino únicamente datos y opiniones generales.

**1. Datos de la vivienda:**

- a. Ubicación de la vivienda
  - a.1 Zona ..... ( )
  - a.2 Barrio/Colonia .....
- b. Tipo de vivienda
  - b.1 Covacha ..... ( )
  - b.2 Palomar ..... ( )
  - b.3 Popular ..... ( )
  - b.4 Residencial ..... ( )
  - b.5 Acomodada ..... ( )
- c. Calidad de ocupante
  - c.1 Vivienda Propia ..... ( )
  - c.2 Vivienda Alquilada ..... ( )

2. Edad del jefe de casa (años): ..... ( )

**3. ¿Cuál es la ocupación que genera el mayor ingreso en su casa?**

- a. Dueño de Negocio ..... ( )
- b. Dueño de negocio pequeño no registrado ..... ( )
- c. Trabajo por su cuenta ..... ( )
- d. Empleado en una Compañía registrada ..... ( )
- e. Empleado Público ..... ( )
- f. Empleado Doméstico ..... ( )
- g. Otro (especifique) .....

4. Número de personas que habitan la vivienda ..... ( )

**5. Ingreso mensual familiar (estimativo)**

- a. Q. 0 a 500 ..... ( )
- b. Q. 501 a 1000 ..... ( )
- c. Q. 1001 a 1500 ..... ( )
- d. Q. 1501 a 2000 ..... ( )
- e. Q. 2001 a 2500 ..... ( )
- f. Q. 2501 a 3000 ..... ( )
- g. Q. 3001 a 3500 ..... ( )
- h. Q. 3501 a 4000 ..... ( )
- i. Q. 4001 a 4500 ..... ( )
- j. Q. 4501 a 5000 ..... ( )
- k. Q. 5001 a más ..... ( )

**6. Servicio sanitario de la vivienda**

- a. Disposición de excretas
  - a.1 A flor de tierra . . . . . ( )
  - a.2 Letrina de pozo ciego . . . . . ( )
  - a.3 Excusado . . . . . ( )
  - a.4 Inodoro . . . . . ( )
- b. Disposición de las aguas servidas
  - b.1 Pozo ciego . . . . . ( )
  - b.2 Fosa séptica y pozo de absorción . . . . . ( )
  - b.3 Fosa séptica . . . . . ( )
  - b.4 Alcantarillado público . . . . . ( )
  - b.5 Aguas negras a flor de tierra . . . . . ( )

**7. Indique la fuente o fuentes de agua utilizadas en su vivienda**

- a. Servicio municipal domiciliario . . . . . ( )
- b. Servicio municipal por pila o chorro público . . . . . ( )
- c. Servicio con sistema privado de agua . . . . . ( )
- d. Ojo de agua, nacimiento o manantial . . . . . ( )
- e. Pozo o aljibe exclusivo de la vivienda . . . . . ( )
- f. Camión o tanque aguatero . . . . . ( )
- g. Agua de lluvia . . . . . ( )
- h. Agua envasada . . . . . ( )

**8. Consumo mensual estimado de agua en la vivienda en metros cúbicos**

- a. 0 a 10 m<sup>3</sup> . . . . . ( )
- b. 11 a 20 m<sup>3</sup> . . . . . ( )
- c. 21 a 30 m<sup>3</sup> . . . . . ( )
- d. 31 a 40 m<sup>3</sup> . . . . . ( )
- e. 41 a 50 m<sup>3</sup> . . . . . ( )
- f. 51 a 70 m<sup>3</sup> . . . . . ( )
- g. 71 a 90 m<sup>3</sup> . . . . . ( )
- h. 91 a 120 m<sup>3</sup> . . . . . ( )
- i. 121 a 150 m<sup>3</sup> . . . . . ( )
- j. 151 a más m<sup>3</sup> . . . . . ( )

**9. Indique el gasto mensual aproximado por consumo de agua en su vivienda**

- a. Q. 0 a 10 . . . . . ( )
- b. Q. 11 a 20 . . . . . ( )
- c. Q. 21 a 30 . . . . . ( )
- d. Q. 31 a 40 . . . . . ( )
- e. Q. 41 a 50 . . . . . ( )
- f. Q. 51 a 60 . . . . . ( )
- g. Q. 61 a 70 . . . . . ( )
- h. Q. 71 a 80 . . . . . ( )
- i. Q. 81 a 90 . . . . . ( )
- j. Q. 91 a 100 . . . . . ( )
- k. Q. 101 a más . . . . . ( )

**10. Record de Enfermedades**

Indicar la información que se pide sobre enfermedades que hubieren afectado a algún o algunos habitantes de la vivienda, durante los últimos cinco años.

Enfermedad	Número de Pacientes	Periodo de Medicación		Costo del Tratamiento (Q.)
		Hospital	Casa	
Cólera				
Tifoidea				
Leptospirosis				
Paratifoidea				
Hepatitis infecciosa				
Enterovirales				
Disentería				
Gastroenteritis				
Enfermedades de la piel				
Tracoma				
Conjuntivitis				
Amebiasis				
Shigelosis				

\* Periodo en días

**11. Señale en orden de prioridad las razones por las que considera importante, sea realizada la purificación de aguas residuales (aguas negras).**

- a. Para evitar malos olores ..... ( ) [ ]
- b. Para evitar la proliferación de mosquitos, zancudos y otras plagas ..... ( ) [ ]
- c. Para mejorar la producción agrícola ..... ( ) [ ]
- d. Para conservar las fuentes de agua potable ..... ( ) [ ]
- e. Para mantener suficiente agua para uso industrial ..... ( ) [ ]
- f. Para conservar el ecosistema de animales y plantas ... ( ) [ ]
- g. Para aumentar el valor de las propiedades ..... ( ) [ ]
- h. Para no dañar a los habitantes de las poblaciones que reciben los desagües de la ciudad ..... ( ) [ ]
- i. Otro (especificar) \_\_\_\_\_ [ ]
- j. No hay razón de importancia ..... ( ) [ ]

12. La Municipalidad de Guatemala tendrá que realizar fuertes inversiones, para construcción de sistemas de recolección y plantas de tratamiento de aguas residuales. Si usted tuviera que realizar pagos (por su área de vivienda), indique de las siguientes qué cantidad podría pagar mensualmente.

- a. Q. 4 ..... ( )
- b. Q. 8 ..... ( )
- c. Q. 12 ..... ( )
- d. Q. 16 ..... ( )
- e. Q. 20 ..... ( )
- f. Q. 25 ..... ( )
- g. Q. 30 ..... ( )
- h. Q. 35 ..... ( )
- i. Q. 40 ..... ( )
- j. Q. 45 ..... ( )
- k. Q. 50 ..... ( )
- l. Otros (Q. ) ..... ( )

13. Edad de la persona encuestada ..... ( )

14. Sobre el servicio de agua potable

- a. Indique su opinión general del servicio de agua potable
  - a.1 Servicio bueno ..... ( )
  - a.2 Servicio regular ..... ( )
  - a.3 Servicio malo ..... ( )
- b. Indique la regularidad del servicio de agua potable en su sector
  - b.1 Servicio continuo ..... ( )
  - b.2 Servicio diario 1-4 horas ..... ( )
  - b.3 Servicio diario 5-8 horas ..... ( )
  - b.4 Servicio diario 9-24 horas ..... ( )
  - b.5 Servicio cada dos días 1-4 horas ..... ( )
  - b.6 Servicio cada dos días 5-8 horas ..... ( )
  - b.7 Servicio cada dos días 9-24 horas ..... ( )
  - b.8 Servicio cada tres días 1-8 horas ..... ( )
  - b.9 Servicio cada tres días 5-8 horas ..... ( )
  - b.10 Servicio cada tres días 9-24 horas ..... ( )
  - b.11 No sabe el horario del servicio ..... ( )
- c. Opinión sobre la calidad del agua
  - c.1 Es confiable ..... ( )
  - c.2 No es confiable ..... ( )

Observaciones del Encuestador

Pregunta	Observaciones

**D-5 Questionnaire (English Translation)**

**MASTER PLAN OF THE SEWERS AND DRAINS OF  
GUATEMALA CITY**

**WATER AND SEWERS SURVEY**

As you could know, Japan is one of the most advanced countries in the improvement of the life conditions of city habitants. The Japan International Cooperation Agency is carrying out this survey, to cooperate with EMPAGUA in improvement of the sanitary conditions of Guatemala City and to realize the consequent benefit in the environment for the habitants. Your home has been selected to represent your zone community in this survey, so we will not ask names, just data and general opinions.

**1. HOUSING DATA**

- a. Housing Location
  - a.1 Zone ( )
  - a.2 Area / District ( )
  
- b. Housing Type
  - b.1 Humble cottage ( )
  - b.2 Lower grade ( )
  - b.3 Normal ( )
  - b.4 Medium high ( )
  - b.5 High grade ( )
  
- c. Owner
  - c.1 Own Housing ( )
  - c.2 Rent Housing ( )

**2. AGE OF THE HEAD OF THE HOUSE (YEARS) ( )**

**3. WHAT IS THE OCCUPATION THAT GENERATES MOST INCOME TO THE HOUSE?**

- a. Business owner ( )
- b. Owner of unregistered small business ( )
- c. Self employed ( )
- d. Employee of a registered company ( )
- e. Public official ( )
- f. Domestic employee ( )
- g. Other (specify) \_\_\_\_\_ ( )

**4. NUMBER OF PERSONS THAT LIVE AT THE HOUSE ( )**

**5. MONTHLY FAMILY INCOME (ESTIMATION)**

- a. Q. 0 through 500 ( )
- b. Q. 501 through 1000 ( )
- c. Q. 1001 through 1500 ( )
- d. Q. 1501 through 2000 ( )
- e. Q. 2001 through 2500 ( )
- f. Q. 2501 through 3000 ( )
- g. Q. 3001 through 3500 ( )
- h. Q. 3501 through 4000 ( )
- i. Q. 4001 through 4500 ( )
- j. Q. 4501 through 5000 ( )
- k. Q. 5001 or more ( )



**6. SANITARY FACILITIES OF THE HOUSE**

- a. Disposal of Excrements
  - a.1 On the ground ( )
  - a.2 Latrine of Cesspit ( )
  - a.3 Toilet ( )
  - a.4 Lavatory ( )
  
- b. Disposal of supplied water
  - b.1 Cesspit ( )
  - b.2 Septic Tank and Absorption Wells ( )
  - b.3 Septic Tank ( )
  - b.4 Public Sewers ( )
  - b.5 Sewing Water on the ground ( )

**7. INDICATE THE WATER SOURCES USED IN THE HOUSE**

- a. Domestic municipal service ( )
- b. Municipal Service by Public Spout or Basin ( )
- c. Private Water System Service ( )
- d. Spring Water or fountain ( )
- e. Wells, outside of the house ( )
- f. Truck or Water Tank ( )
- g. Rain Water ( )
- h. Bottled Water ( )

**8. ESTIMATED MONTHLY CONSUMPTION OF WATER AT THE HOUSE**

- a. 0 through 10 m3 ( )
- b. 11 through 20 m3 ( )
- c. 21 through 30 m3 ( )
- d. 31 through 40 m3 ( )
- e. 41 through 50 m3 ( )
- f. 51 through 70 m3 ( )
- g. 71 through 90 m3 ( )
- h. 91 through 120 m3 ( )
- i. 121 through 150 m3 ( )
- j. 151 m3 or more ( )

**9. INDICATE MONTHLY COST OF WATER CONSUMED AT HOME**

- a. Q. 0 through 10 ( )
- b. Q. 11 through 20 ( )
- c. Q. 21 through 30 ( )
- d. Q. 31 through 40 ( )
- e. Q. 41 through 50 ( )
- f. Q. 51 through 60 ( )
- g. Q. 61 through 70 ( )
- h. Q. 71 through 80 ( )
- i. Q. 81 through 90 ( )
- j. Q. 91 through 100 ( )
- k. Q. 100 or more ( )

**10. RECORD OF DISEASES**

Indicate information concerning any disease that affected one or more of the household, during the last five years.

Disease	No. of Patients	Period of Medication *		Cost of Treatment (Q.)
		Hospital	House	
Cholera				
Typhoid				
Leptospirosis				
Paratyphoid				
Infective hepatitis				
Enteroviruses				
Bacillary dysentery				
Gastroenteritis				
Skin sepsis and ulcers				
Trachoma				
Conjunctivitis				
Amoebas				
Shigelosis				

\* Days period

**11. INDICATE IN ORDER OF PRIORITY OF THE REASONS WHY YOU CONSIDER IT TO BE IMPORTANT TO CARRY OUT PURIFICATION OF SEWERAGE**

- a. To avoid bad odors ( )
- b. To avoid the proliferation of mosquitos, Germs and other plagues ( )
- c. To improve agricultural production ( )
- d. To maintain drinkable water sources ( )
- e. To maintain sufficient water for the industrial use ( )
- f. To conserve the ecosystem of animals and plants ( )
- g. To increase the value of properties ( )
- h. To avoid the damage to the inhabitants that receive the city drainage ( )
- i. Other (specify) \_\_\_\_\_ ( )
- j. There are no reason of importance ( )

**12. THE GUATEMALAN MUNICIPALITY MUST MAKE LARGE INVESTMENT FOR THE CONSTRUCTION OF COLLECTION SYSTEMS AND PLANTS FOR WASTEWATER TREATMENT. IF YOU MUST MAKE PAYMENTS (FOR YOUR HOUSING AREA), INDICATE WHAT QUANTITY YOU COULD PAY MONTHLY**

- a. Q. 4 ( )
- b. Q. 8 ( )
- c. Q. 12 ( )
- d. Q. 16 ( )
- e. Q. 20 ( )
- f. Q. 25 ( )
- g. Q. 30 ( )
- h. Q. 35 ( )
- i. Q. 40 ( )
- j. Q. 45 ( )
- k. Q. 50 ( )
- l. Q. 0 ( )
- m. Others (Q. ) ( )

**13. ABOUT THE POTABLE WATER SERVICE**

- a. Indicate your general opinion of the potable water service
  - a.1 Good service ( )
  - a.2 Regular service ( )
  - a.3 Bad service ( )
- b. Indicate the availability of the drinkable water service in your sector
  - b.1 Continuous Service ( )
  - b.2 Daily service 1-4 hours ( )
  - b.3 Daily service 5-8 hours ( )
  - b.4 Daily service 9-24 hours ( )
  - b.5 Each two days service 1-4 hours ( )
  - b.6 Each two days service 5-8 hours ( )
  - b.7 Each two days service 9-24 hours ( )
  - b.8 Each three days service 1-4 hours ( )
  - b.9 Each three days service 5-8 hours ( )
  - b.10 Each three days service 9-24 hours ( )
  - b.11 Don't know the service schedule ( )
- c. Opinion about water quality
  - c.1 Reliable ( )
  - c.2 Not reliable ( )

**14. AGE OF THE PERSON SURVEYED** ( )

**OBSERVATIONS OF THE INTERVIEWER**

QUESTION	OBSERVATIONS

D-6 Results of Public Attitude Survey(Classified by Income) 1/3

	LOW INCOME	MIDDLE INCOME	HIGH INCOME	TOTAL
<b>NUMBER OF SAMPLES</b>	100	59	42	201
<b>1. HOUSING DATA</b>				
b. Type of house				
b.1 Humble cottage	22	1		23
b.2 Lower grade	4		1	5
b.3 Normal	61	20	2	83
b.4 Medium high	13	37	28	78
b.5 High grade		1	11	12
c. Proprietorship				
c.1 Own Housing	65	43	36	144
c.2 Rented Housing	35	16	6	57
<b>2. AGE OF HEAD OF HOUSEHOLD</b>	48.2	47.3	51.4	48.6
<b>3. PRINCIPAL EMPLOYMENT</b>				
a. Business Owner	8	5	20	33
b. Owner of Unregistered Small Business	4	2		6
c. Self Employed	26	11	6	43
d. Employee of a registered company	36	23	11	70
e. Public Official	20	19	5	44
f. Domestic Employee	1			1
g. Other	5	1	1	7
<b>4. NUMBER OF HOUSEHOLD MEMBERS</b>	6.0	5.3	5.3	5.6
<b>5. MONTHLY FAMILY INCOME</b>				
a. Q. 0 through 500	11			11
b. Q. 501 through 1000	32			32
c. Q. 1001 through 1500	40			40
d. Q. 1501 through 2000	17			17
e. Q. 2001 through 2500		9		9
f. Q. 2501 through 3000		13		13
g. Q. 3001 through 3500		8		8
h. Q. 3501 through 4000		7		7
i. Q. 4001 through 4500		6		6
j. Q. 4501 through 5000		16		16
k. Q. 5001 or more			42	42
Average income (Q/month)	1065	3555	7000	3036
<b>6. SANITARY SYSTEM</b>				
a. Disposal of Excrement				
a.1 On the ground				
a.2 Latrine or Cesspit	4	1		5
a.3 Simple toilet		1		1
a.4 Lavatory	96	57	42	195
b. Disposal of served water				
b.1 Cesspit	2			2
b.2 Septic Tank and Absorption Wells	1		1	2
b.3 Septic Tank	2	3	2	7
b.4 Public Sewers	92	56	39	187
b.5 Throwing Water on the ground	3			3
<b>7. WATER SOURCES</b>				
a. Domestic municipal service	89	57	40	186
b. Municipal Service by Public Spout or Basin	3			3
c. Private Water System Service	2	1	1	4
d. Spring Water or fountain				
e. Wells, exclusive of the house	4			4
f. Truck or Water Tank	6		2	8
g. Rain Water	1	6	1	8
h. Bottled Water	13	28	29	70

D-6 Results of Public Attitude Survey(Classified by Income) 2/3

	LOW INCOME	MIDDLE INCOME	HIGH INCOME	TOTAL
NUMBER OF SAMPLES	100	59	42	201
<b>8. MONTHLY WATER CONSUMPTION</b>				
a. 0 through 10 m3	28	12	1	41
b. 11 through 20 m3	23	11	4	38
c. 21 through 30 m3	13	18	7	38
d. 31 through 40 m3	2	5	2	9
e. 41 through 50 m3	1	2	5	8
f. 51 through 70 m3	2	2	2	6
g. 71 through 90 m3	1	1	4	6
h. 91 through 120 m3				
i. 121 through 150 m3			1	1
j. 151 m3 or more	3	1		4
Average consumption (m3/month)	23	25	43	27
<b>9. MONTHLY WATER CHARGE</b>				
a. Q. 0 through 10	24	7	1	32
b. Q. 11 through 20	16	13	3	32
c. Q. 21 through 30	23	18	3	44
d. Q. 31 through 40	5	8	7	20
e. Q. 41 through 50	3	6	6	15
f. Q. 51 through 60	2	1	2	5
g. Q. 61 through 70	6		5	11
h. Q. 71 through 80	1		1	2
i. Q. 81 through 90	5		3	8
j. Q. 91 through 100	1		2	3
k. Q. 101 or more	11	4	8	23
Average consumption (Q/month)	39	32	64	42
<b>11. REASON WHY WASTEWATER TREATMENT IS NEEDED (point)*1</b>				
a. To avoid bad odors	129	74	53	256
b. To avoid the proliferation of mosquitoes	137	85	60	282
c. To improve the agricultural production	76	58	29	163
d. To maintain the potable water sources	141	101	37	279
e. To maintain sufficient water for the industrial use	59	45	25	129
f. To keep the ecosystem of animals and plants	64	89	75	228
g. To increase the value of the properties	32	29	20	81
h. To avoid the damage to habitants who receive city drainage	136	122	80	338
i. Other	5	17	7	29
j. There are no reason of importance	6	1		7
<b>12. WILLINGNESS TO PAY (quetzal/month/household)</b>				
	9.3	15.3	19.1	13.3
<b>13. AGE OF INTERVIEWEE</b>				
	40.9	38.8	44.7	41.0
<b>14. SERVICE LEVEL OF POTABLE WATER SUPPLY</b>				
<b>a. General opinion</b>				
a.1 Good service	32	15	4	51
a.2 Normal service	44	30	30	104
a.3 Bad service	24	14	8	46
<b>b. Regularity of water service</b>				
b.1 Continuous Service	20	8	9	37
b.2 Daily service 1-4 hours	14	7	3	24
b.3 Daily service 5-8 hours	22	17	22	61
b.4 Daily service 9-24 hours	19	16	4	39
b.5 Each two days service 1-4 hours	1	1		2
b.6 Each two days service 5-8 hours	1	6	1	8
b.7 Each two days service 9-24 hours	12	2		14
b.8 Each three days service 1-4 hours	1			1
b.9 Each three days service 5-8 hours				
b.10 Each three days service 9-24 hours				
b.11 Unknown service schedule	5	2	3	10
<b>c. Opinion about the water quality</b>				
c.1 Reliable	60	36	20	116
c.2 Not Reliable	40	23	22	85

\*1 In the reasons "a" through "i", points are scored in order of priority, therefore, the higher priority reason get higher points. The total for "j" represents the number of households who selected this reason.

D-6 Results of Public Attitude Survey(Classified by Income) 3/3

		LOW INCOME	MIDDLE INCOME	HIGH INCOME	TOTAL
NUMBER OF SAMPLES		100	59	42	201
<b>10. DISEASE RECORD</b>					
Cholera	Number of patients				
	Hospital treatment (day)				
	House treatment (day)				
	Cost (quetzal)				
Typhoid	Number of patients			1	1
	Hospital treatment (day)				
	House treatment (day)			8	8
	Cost (quetzal) *1			300	300
Leptospirosis	Number of patients				
	Hospital treatment (day)				
	House treatment (day)				
	Cost (quetzal)				
Paratyphoid	Number of patients		1		1
	Hospital treatment (day)		30		30
	House treatment (day)				
	Cost (quetzal) *1		1500		1500
Hepatitis	Number of patients	5	1		6
	Hospital treatment (day)	1			1
	House treatment (day)	164	30		194
	Cost (quetzal) *1	900	400		1300
Enteroviruses	Number of patients	31	3	16	50
	Hospital treatment (day)	1			1
	House treatment (day)	104	8	16	128
	Cost (quetzal) *1	568	750	300	1618
Bacillary dysentery	Number of patients	5		1	6
	Hospital treatment (day)				
	House treatment (day)	21		8	29
	Cost (quetzal) *1	20			20
Gastroenteritis	Number of patients			1	1
	Hospital treatment (day)				
	House treatment (day)			4	4
	Cost (quetzal) *1			300	300
Skin sepsis and ulcers	Number of patients	3			3
	Hospital treatment (day)				
	House treatment (day)	210			210
	Cost (quetzal) *1				
Trachoma	Number of patients				
	Hospital treatment (day)				
	House treatment (day)				
	Cost (quetzal)				
Conjunctivitis	Number of patients	9	2	10	21
	Hospital treatment (day)				
	House treatment (day)	125	4	51	180
	Cost (quetzal) *1	307	60	1170	1537
Amoebas	Number of patients	19	38	16	73
	Hospital treatment (day)	85			85
	House treatment (day)	886	351	87	1324
	Cost (quetzal) *1	2790	3709	1780	8279
Shigellosis	Number of patients	1	2		3
	Hospital treatment (day)				
	House treatment (day)	4	60		64
	Cost (quetzal) *1	3	900		903
Total	Number of patients	73	47	45	165
	Hospital treatment (day)	87	30		117
	House treatment (day)	1514	453	174	2141
	Cost (quetzal) *1	4588	7319	3850	15757

\*1. Some interviewees could not remember the costs.