L.2.7 Industrial Solid Waste Management

L.2.7.1 Major Findings of the Industrial Waste Survey

a. Major Findings of the Industrial Waste Survey

Industrial solid waste (ISW) generated amount in Leon is estimated about 7,400 ton/year, which is the largest generation of ISW among the 3 cities. The industries in CIIU3116 (processing dry seeds from leguminous and the likes) is the main source of ISW generation in Leon, which counts for about 80% of ISW generation in Leon. The ISW of these industries (i.e., CIIU3116) mainly consists of organic compounds, and therefore it is less possible that hazardous ISW be included therein. Meanwhile the industries with high potentiality of generating hazardous waste in Leon is CIIU3231 (leather tanning), whose ISW counts for about 6% of the total ISW generation in Leon.

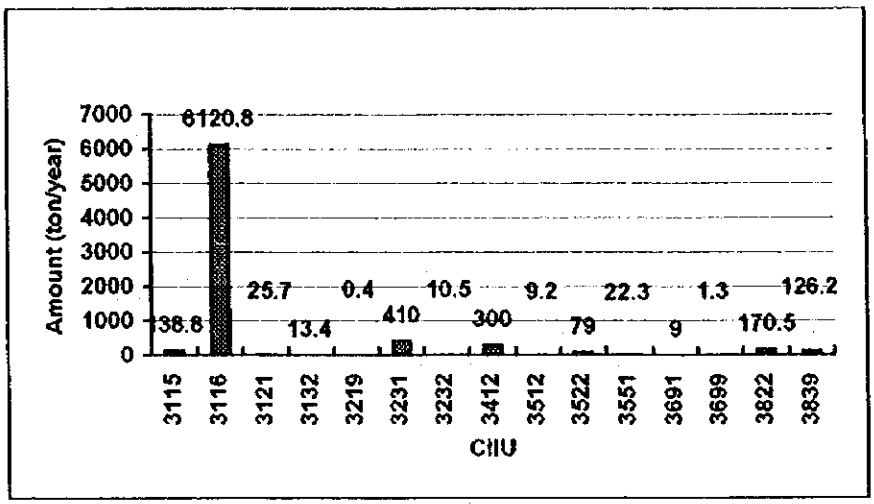


Figure L-44: Solid Waste Generation Amount

The great majority of the ISW generated from industries in Leon are disposed of at the municipal SW dumping site without control and in a disordered manner.

However, under such circumstances, legislation for treatment and/or disposal of ISW is not established at this moment, which is urgently needed and awaited.

L.2.7.2 Industrial Solid Waste Management

L.2.7.2.1General Recommendations

a. Technical System

a.1 General Aspect

In the same principle for the IWWM, cost of safe treatment/disposal of ISW should be born by the industries by all means based on the "polluter pays principle (PPP)", since the ISW is generated and disposed of as a result of industrial production activities.

On the other hand, from a technological management viewpoint, the following will be listed as the key solutions for the problems:

- Reduction of ISW generation amount and reduction of its generated pollution load by means of production processes (including raw/auxiliary materials) conversions; and
- Establishment of appropriate treatment/disposal technologies.

In practice among others, the disorderly mixed dumping of ISW and domestic SW in the present landfill should be immediately prohibited.

In this context, legislation on appropriate management of ISW should be established in order for authorities to take administrative measures (e.g., manifest system) and be empowered in doing so. On the other hand, an integrated system to bind both industries and authorities in facilitating the appropriate ISW management should be sought and established.

a.2 Industrial Waste Management System

The treatment/disposal of ISW generated by the company's activities should be undertaken and its cost covered by the company which profits from its activities. On the other hand, the authorities should arrange necessary administrative measures including legislation/rules in order for ISW to be properly treated, and carry out necessary monitoring/supervision as well as instruct the companies to make sure that they observe these legislation and rules. The following items are recommended to be put into practice urgently for the effective monitoring and guidance.

- Introduction of a manifest system
- Classification of industrial solid waste
- Hazardous solid waste management
- Treatment and disposal system of industrial solid waste.

a.2.1 Manifest System

A manifest system needs to be introduced so that the authorities know where the ISW are generated and the routes which the ISW are transported from the generation sources and where and how it is finally disposed of according to the type of IW.

By introducing the following manifest system (see Figure L-45), the process of solid waste from its generation to final disposal can be understood by waste generators and competent authorities. Moreover, whether or not the ISW is properly treated/disposed of in accordance with its characteristics can be monitored.

- The generator of ISW issues the manifest sheet comprising 6 carbon copies((A) to (F)) which indicates type of solid waste, its volume, and the date of discharge, etc.
- The generator keeps one copy (A) of the manifest sheet and submit one copy (B) to the competent authorities.
- Four copies from (C) to (F) should be handed to the ISW transporter together with the ISW and the transporter should keep one (C) of these copies.

- Copies from (D) to (F) should be handed to the agent of the ISW final disposal site together with the ISW.
- The agent of the ISW final disposal site should keep one (D) of these copies and return (E) of the manifest sheet to the waste generator and (F) to the competent authorities.
- Competent authorities and the waste generator shall collate the manifest sheet they received from the agent of the ISW final disposal site with the manifest sheet they have been keeping and confirm whether the ISW was treated/disposed of properly or not.

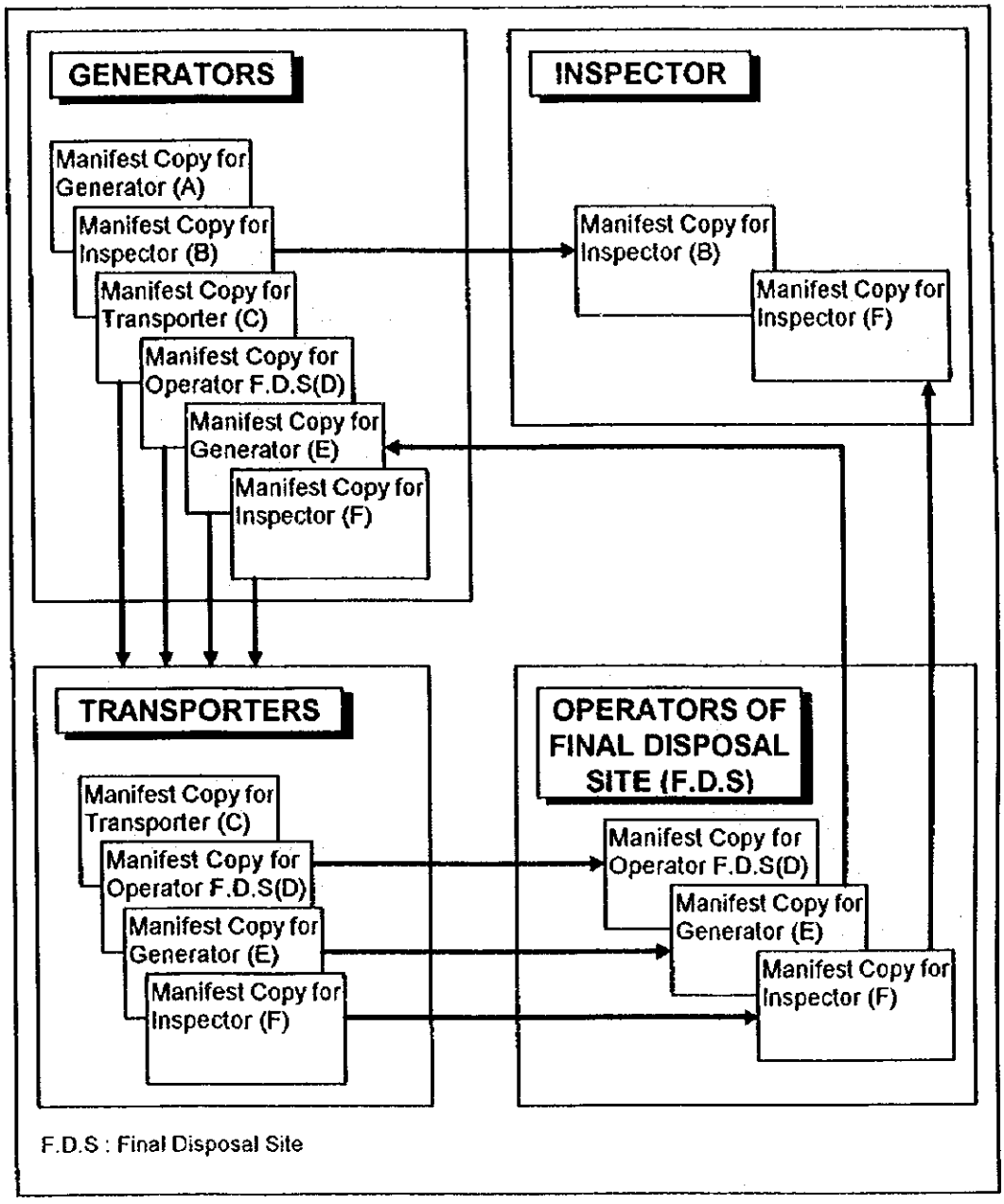


Figure L-45: Concept of Manifest System

a.2.2 Definition of the Waste

ISW types are diverse and its characteristics, such as its hazardousness, also differ. In order to manage various ISWs, it is indispensable to define the types and characteristics of the solid wastes and manage them based on the definition.

The definition of ISW is basically classified into either hazardous or non-hazardous waste which is then divided into liquid, solid, and semisolid.

The following are the definitions determining the kind of solid wastes that are hazardous.

- Definition given in the Basel Convention
- Definition given by the European Union (EU)
- Definition given in the domestic laws in developed countries such as RCRA (Resource Conservation and Recovery Act) of the U.S.

However, expensive analysis facilities and high analytical skills are indispensable in order to identify and manage hazardous and non-hazardous solid wastes based on the definition used in these developed countries. In view of the present conditions in Nicaragua from the technological and economic perspectives, it is judged that it is unrealistic to manage ISW using these definitions because it lacks prevalence in adequate analyses facilities and skills.

Therefore, the following method is recommended to classify and manage ISW until technological base is established and administrative measures are economically arranged.

- Roughly judge whether solid waste is hazardous or non-hazardous from the outward appearance (liquid, solid, or semisolid) and its generation process (type of business of waste generators)

To put it more concretely,

- Make a list of industrial classification according to high, middle, and low potential of generating hazardous waste referring to cases from developed countries.
- Make a list of ISW classification according to either high or low potential of being hazardous wastes from the outward appearance referring to cases from developed countries.

The possibility of wastes being hazardous or non-hazardous is judged from the ISW classification and industrial classification of waste generators referring these lists. Secondly, ISW, which is judged as a highly potential hazardous waste, is treated and managed as hazardous wastes unless the waste generator (polluter) proves that the wastes they generated to be non-hazardous at their own cost of laboratory analysis.

a.2.3 List of Potential Hazardous Waste

The study team classified ISW into 24 categories and carried out a survey on the amount of waste generation etc. for the factory survey referring to the present condition in Nicaragua and some cases of other countries.

The characteristics of hazardous solid waste are defined as follows here.

- Ignitable
- Corrosive
- Reactive
- Toxic (Acute, Non-acute)

Table L-67 shows the assumption made on the respective characteristic of hazardousness for each of 24 ISW categories referring to the past cases, which was employed in the Team's factory survey.

It is necessary to note that this hazardousness assumption (i.e., Table L-135) was made referring to past cases. This judgment chart shall be used for the ISW management for the time being and if some inconvenience emerges, the respective hazardousness assumption should be re-examined in order to meet the actual condition in Nicaragua.

Table L-135: Relations of 24 Industrial Waste Classification and Hazardous Waste

No.	Type of Waste	Liquid or Not	Hazardous Waste					Non-hazardous Waste	
			Ignitable	Corrosive	Reactive	Toxic		Non-inert	Inert
						Acute	Non-acute		
1	Ash, combustion residue	No	No	Possible	Possible	Possible	Possible	Possible	Possible
2	Dust	No	Possible	Possible	Possible	Possible	Possible	Possible	Possible
3	Slag from melting	No	No	Possible	Possible	Possible	Possible	Possible	Possible
4	Sludge	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
5	Asbestos	No	No	No	No	No	Possible	No	No *2
6	Acid	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
7	Alkalis	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
8	Oily waste	Possible	Possible	No	Possible	Possible	Possible	Possible	No
9	Chemical residue	Possible	Possible	Possible	Possible	Possible	Possible	Possible	No
10	Waste from food production	Possible	No	No	No	No	No	Possible	No
11	Waste similar to domestic waste	No	No	No	No	No	No	Possible	No
12	Animal manure	No	No	No	No	No	No	Possible	No
13	Carcasses	No	No	No	No	No	No	Possible	No
14	Glass and ceramics	No	No	No	No	No	No	Possible *1	Possible
15	Metal and scrap	No	No	No	No	No	No	Possible *1	Possible
16	Paper and cardboard	No	No	No	No	No	No	Possible *1	No
17	Plastic	No	No	No	No	No	No	Possible	Possible
18	Rubber	No	No	No	No	No	No	Possible	Possible
19	Textile	No	No	No	No	No	No	Possible	Possible
20	Leather	No	No	No	No	No	No	Possible	Possible
21	Wood	No	No	No	No	No	No	Possible	No
22	Construction and demolition waste	No	No	No	No	No	No	Possible	Possible
23	Water	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
24	Others	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible

*1: Considering a possibility used as containers contaminated with non-inert
*2: Asbestos without treatment is considered as hazardous waste

a.2.4 Industrial Category of Potentially Hazardous Waste Generators

Table L-136 shows industrial category (using the CIIU code) of potentially hazardous waste generators, based on past cases.

This table also needs to be reexamined in the future, in order to meet the actual condition in Nicaragua.

Table L-136: Potentiality of Hazardous Waste Generation Industrial Category

Potentiality	CIIU Code	Industrial Category
Highly potential Industries	351	Manufacture of industrial chemical products
	352	Manufacture of other chemical products
	354	Oil and coal products
	356	Other non-classified plastic products
	371	Iron and steel industries
	372	Basic metal industries
	381	Manufacture of metal products except machinery & equipment
Potential Industries	3211	Textile processing and materials manufacturing
	3231	Leather tanning and finishing
	3232	Fur dressing, dyeing and other fur and skin articles
	3319	Other non-classified wooden products
	341	Paper, printing and publishing industries
	3420	Printing, photoengraving, publishing and the likes
	355	Manufacture of rubber products
	362	Glass and glass products
	3699	Other non-metallic mineral products
	382	Manufacture of machinery except electrical
	383	Manufacture of electrical machinery
	384	Manufacture of transport equipment
	385	Manufacture of science, measuring, controlling equipment (inc. lens)
	390	Other manufacturing industries
	625	Gasoline filling stand
	952	Laundries and dry cleaners
Less Potential Industries	311	Food manufacturing
	312	Other food manufacturing
	313	Beverage industries
	314	Cigarettes, cigars and tobacco
	3212-3219	Textile industries
	322	Garment industries
	3233	Leather products (exe. footwear)
	324	Leather footwear
	3311-3315	Wood and cork industry
	332	Furniture, fixture and the likes
	361	Potters and ceramic products
	3691-3696	Manufacture of non-metallic mineral products

Regarding the authorities' management of ISW, hazardous wastes generating industries should be mainly monitored and supervised, referring to Table L-68 for the time being, and at the same time, whether or not the proper treatment and disposal is done for respective ISW category should be monitored by utilizing Table L-67.

a.3 Industrial Waste Reduction

Most of the ISW are the scraps and residues of raw materials incorporated in the manufacturing process and if it is treated or disposed of at the "end-of-pipe", the cost of treatment/disposal becomes very large.

Therefore, as the first step of ISW management by industries, it is rational to use up raw materials as much as possible in the manufacturing process than treating or disposing of ISW at the "end-of-pipe". In other words, Cleaner Production Technology (CP Technology) should be introduced, which keeps the generation amount of waste to a minimum through: improvement and/or conversion of the manufacturing process; raw materials conversion to what improves material efficiency in products.

The introduction of CP Technology brings about the following beneficial impacts to the industries.

- Increase profits by improving material efficiency in products.
- Reduce ISW treatment/disposal cost by reducing the ISW amount generated.

It can be concluded that the introduction of CP Technology is not only a great advantage but also reduces environmental impact by ISW.

Therefore, the reduction of ISW amount by rationalization of manufacturing process should be carried out before the "end-of-pipe" treatment is implemented.

Figure L-31 illustrates the example of the reduction of COD discharge amount when CP Technology was applied to pulp and paper industry in Japan.

Moreover, as significant amount of ISW consists of left-over of raw materials from manufacturing products, it is necessary to set up a mechanism which facilitates the exchange of information on solid waste among companies so that the wastes generated from company A can be used as a raw materials by company B if this mechanism functions.

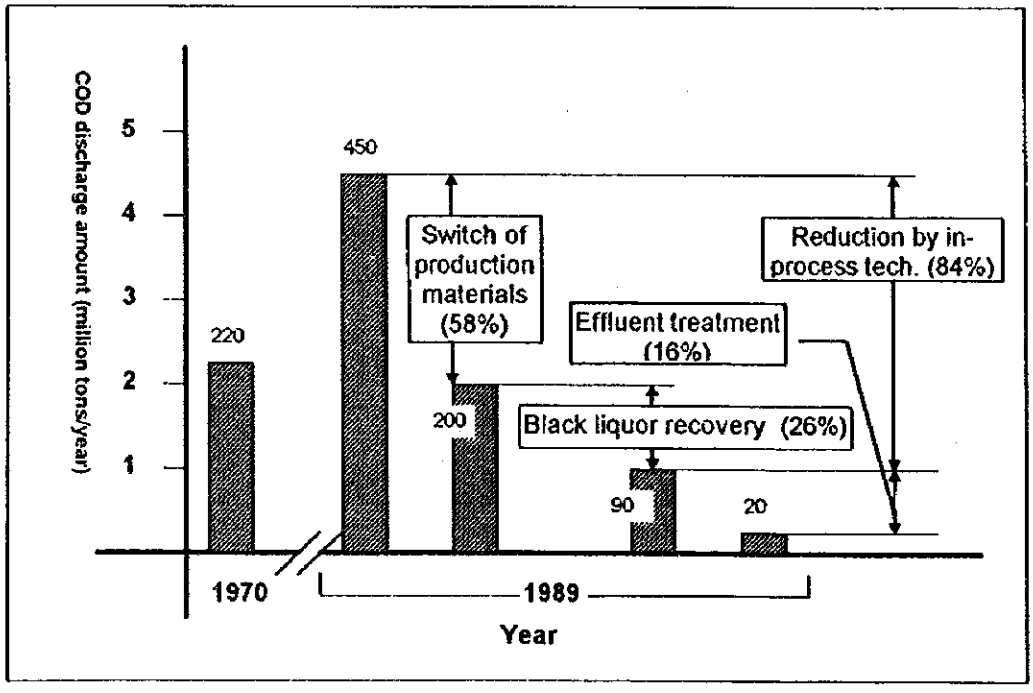


Figure L-46: Reduction of COD Discharge from Pulp and Paper Industry in Japan [8]

[8] Source : J. Nakanishi, "Technological Measures to Eliminate Pollution in the Last Tow decade in Japan"

a.4 Industrial Waste Treatment/Disposal by Third Party

The demand for the treatment/disposal of ISW is predicted to increase in the future. This is attributed to the increase of ISW generation amount in correlation to the economic growth in Nicaragua, and strengthening legislation which restricts discharge of ISW, and international trend of environmental protection such as ISO14000.

Therefore, the authorities needs to encourage creation of safe and reliable ISW treatment/disposal sectors in Nicaragua based on the market principle, in parallel with the economic growth and strengthening of legislation on ISW.

a.5 Outline of Industrial Waste Treatment / Disposal Method

a.5.1 Industrial Waste Treatment/Disposal Flow

In order for ISW to be properly treated/disposed of, it is vital to understand the characteristics of ISW, and select the most appropriate treatment/disposal method which best suits its characteristics. Figure L-47 shows the process of implementing appropriate treatment/disposal for ISW in general.

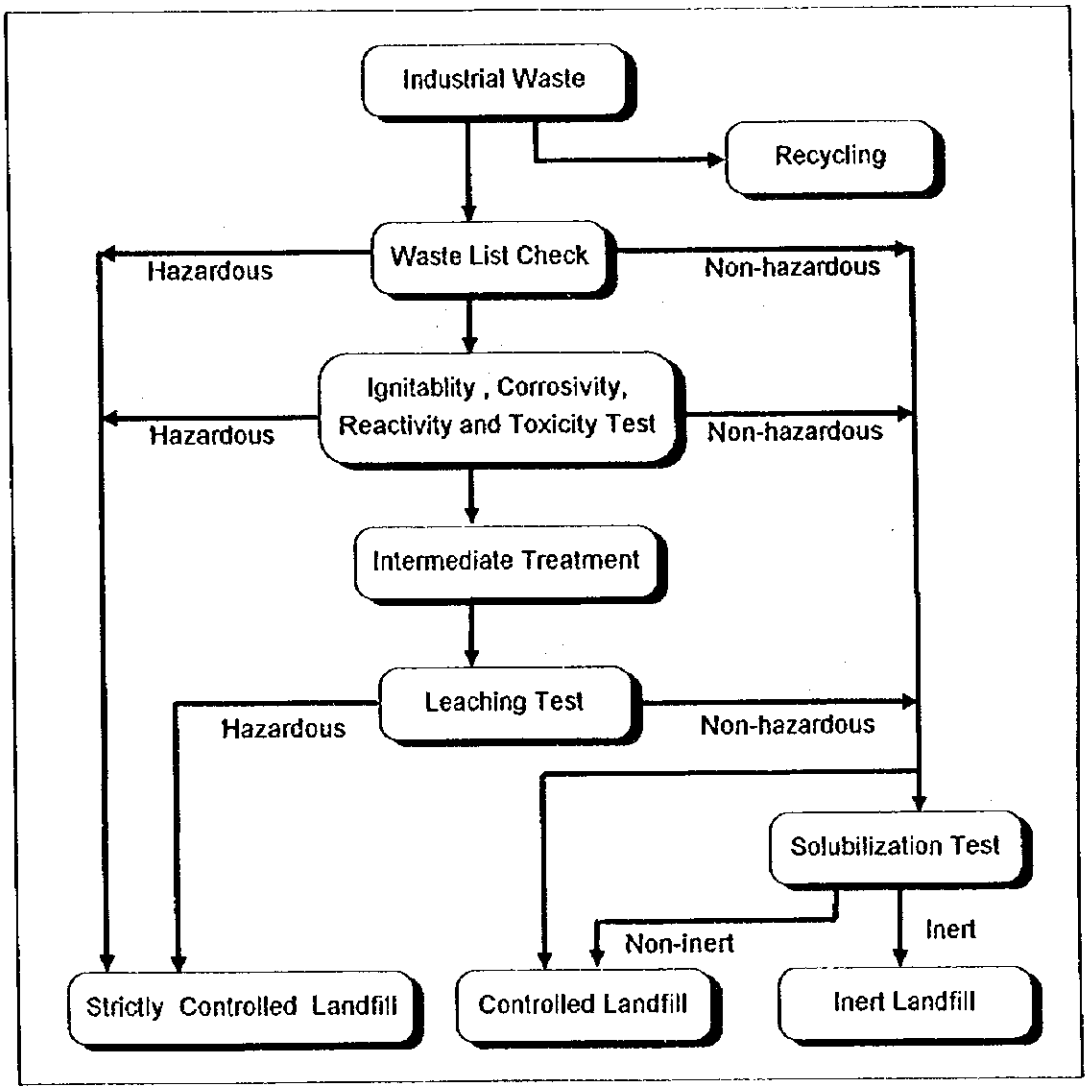


Figure L-47: Industrial Waste Treatment/Disposal Flow

a.5.2 Industrial Waste Treatment / Disposal Method

The industrial waste treatment/disposal method is diversified as the types and characteristics of ISW are diverse. It is, therefore, indispensable to understand the characteristics of the solid waste and select treatment/disposal method most suitable for its characteristics.

However, as the intermediate treatment facility requires considerable expenses in its construction, maintenance & operation, the following treatment should be practiced for the time being considering the present economic condition in Nicaragua.

- Simple intermediate treatment (such as neutralization), and
- Treatment/disposal by utilizing existing production facility. (As a concrete example, a large amount of fossil fuel is used in the calcination process of cement. In this process, if hazardous wastes such as waste oils, solvents and tires etc. are incinerated with fuel in a small appropriate ratio, it works not only as cement production but also as ISW disposal.)

Therefore, landfill disposal shall be adopted as a main ISW treatment/disposal method for the time being. In this case, it is essential that ISW should be disposed of at a landfill appropriately structured depending upon the characteristics of the solid wastes to be disposed.

To put it concretely, the following three types of final disposal sites need to be established.

- Strictly Controlled Landfill (SCL) where substances which are hazardous and difficult to handle are disposed of.
- Controlled Landfill (CL) where wastes which are not hazardous but require leachate control (mainly organic wastes) are disposed of.
- Inert Landfill (IL) where non-hazardous inert wastes such as earth and sand etc. which do not require leachate control are disposed of.

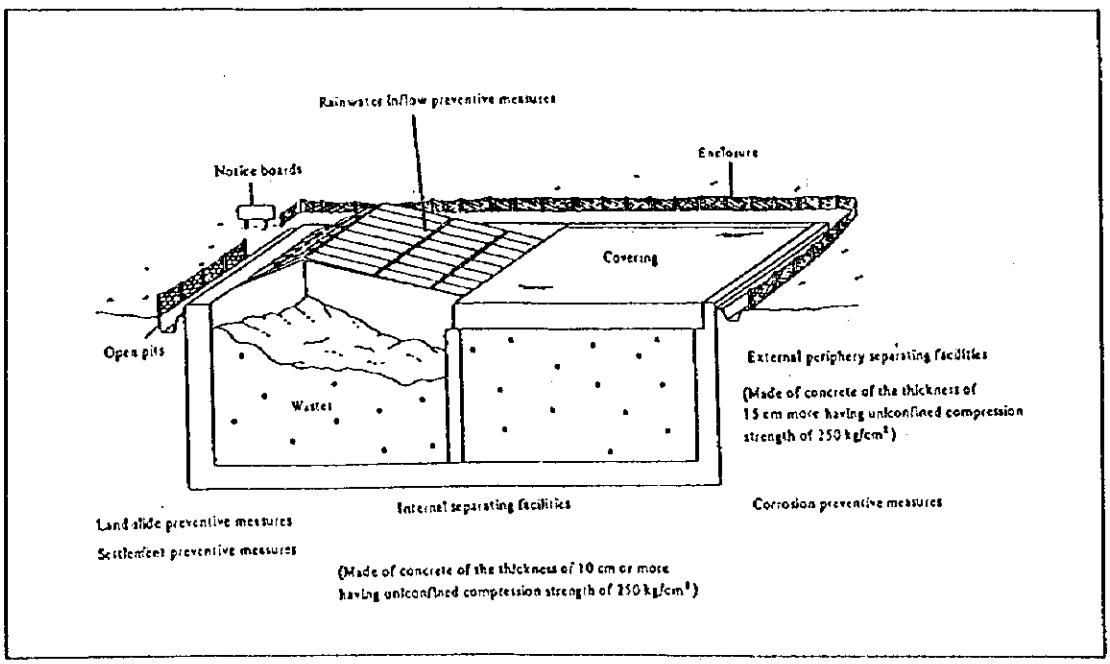


Figure L-48: Structure of Strictly Controlled Landfill

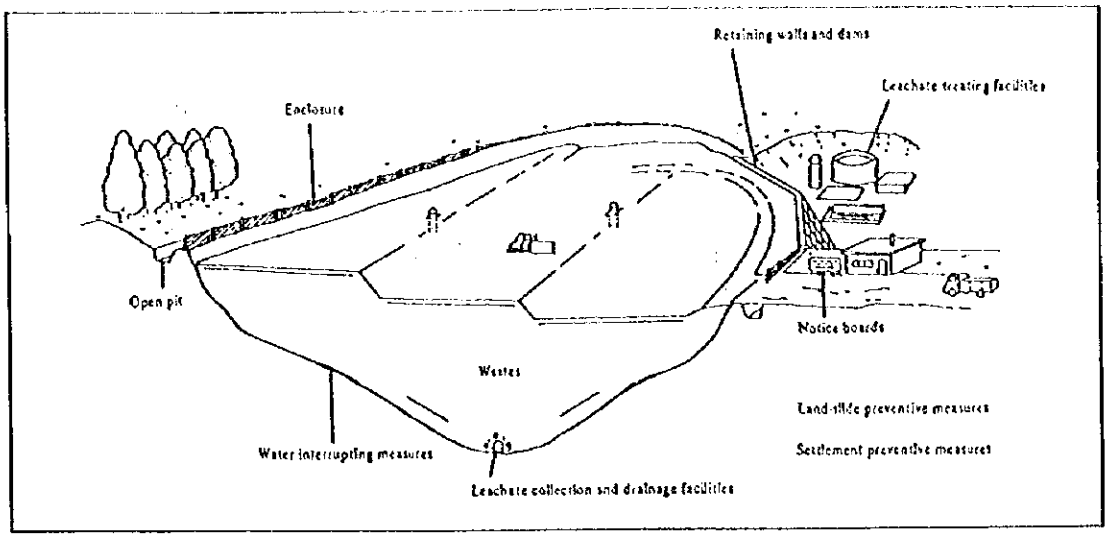


Figure L-49: Structure of Controlled Landfill

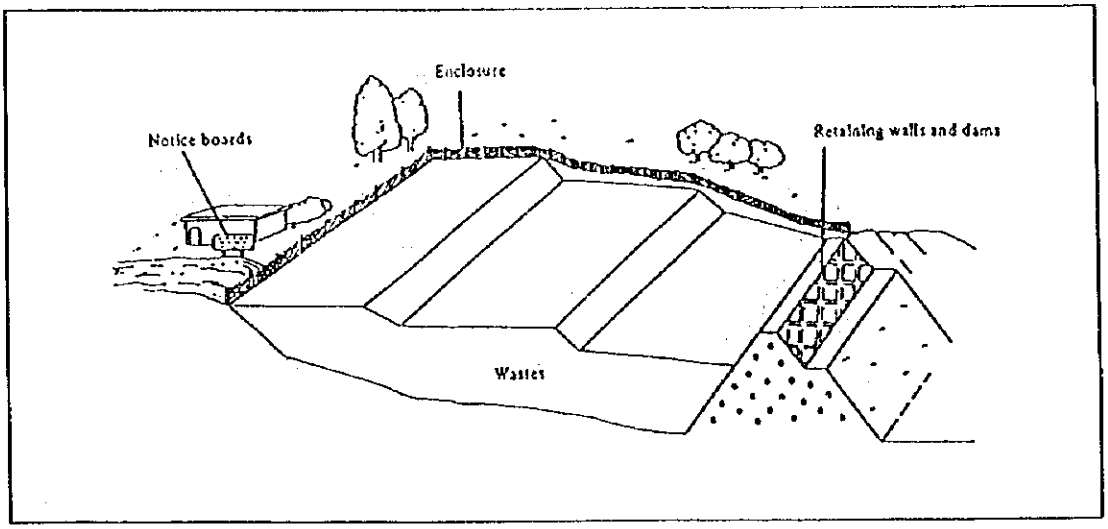


Figure L-50: Structure of Inert Landfill

b. Institutional System

b.1 Roles of Public Sector

MARENA is the competent authority for the management of industrial solid waste (ISW) and industrial wastewater (IWW) by the Law No. 217-96 and Decree 33-95. MARENA should establish the regulations related to ISW and IWW, as well as restrictions for its disposal and the operational limits of the municipality. It should also expedite easily understandable instructions to facilitate technical information to the IW generators, professionals, university students, and those interested in about IW and the IW management services that can be provided for industries in Nicaragua. On the other hand, MARENA should help and encourage industries in finding accessible financial resources or grant to support their projects of IW treatment/disposal and/or "cleaner production".

The competence to inspect and penalize the IW management belongs to MARENA and MINSA. INAA is also competent whenever they receive wastewater. The municipality can establish legal and technical norms restricted to the municipality which can not be more tolerant than the national norms (see Annex N).

The Annex N shows "Instructions and/or Regulations (as well as Tables with Strategies and Intersectorial Integration)" which is recommended for MARENA, and complementarily for MCT, MINSA and the municipality. Furthermore, the Regulation on agro-toxic materials, in its final phase, will be very important to the municipality.

b.2 Polluter Pays Principle (PPP) and Authorities' Management

The IW are qualitative and quantitative dependent of the type of industry, industrial process, of the raw materials, source of energy, and the management of the generator establishments, especially the training and discipline of the personnel, also the equipment maintenance and the working environment.

The IW is strictly industries' responsibility. Since the costs of IW management are included in the products price, the company that generates non-hazardous IW and/or less IW, they could achieve lower production cost. In addition, the "environmentally friendly products" are commonly an important marketing element with respect to customers consciousness.

It is an premise universally accepted premise: **"The generator is responsible for the waste generated by him or her"**, i.e., he or she is responsible for the management of the waste and its effects on the environment and public health, with all the costs to be born therewith. These costs constitute an incentive to minimize waste, in other words, it encourages a "clean production" which is the objective of a competitive and environmentally-conscious industries.

In general, the largest part of ISW results from the industrial effluents, therefore, the management on ISW and IWW should consider all the IW in total.

The consulting and operational services related to IWM constitute an attractive economic activity, once the market has reached certain level. In this context, the public authorities could create the situation that makes such economic activity (ISWM by private sectors) viable, which solves the problems involved with industrial contamination and pollution when the regulations for the IW management is established and its requirements are enforced obviously in a stepwise manner in a feasible time frame. The municipal/national government should not invest more than necessary for the studies, cadastres, regulation, technical information, inspection, monitoring and sanction to the transgressor when it is related to IW.

L.2.8 Medical Waste Management

L.2.8.1 Future Medical Solid Waste/Wastewater Amount

a. Forecast for Major Medical Institutions

The future medical solid waste generation in the major institutions is estimated as shown in Table L-69. The growth rate of medical solid waste generation is assumed to be the same as the population growth rate of the city (i.e., medical solid waste generation ratio per capita remains the same for future). The values in 1996 are estimated on the analogy

of the data in Granada and Chinandega from the questionnaire survey carried out in February by the Study Team, which is why the institutions did not give the reliable data.. The growth rate is assumed that it will increase in proportion to the population growth rate as shown in Table L-70. The water supply value in 1996 is obtained from the record of INAA. Wastewater generation is estimated to be 80% of water consumption in the forecast.

Table L-137: Forecast of Generation Ratio of Medical Solid Waste Management in the Medical Institutions With Beds for Inpatients(Hospital Class) in Leon

Unit : kg/day

		1996	2000	2005	2010
Growth Rate of Inpatients Beds		1.000	1.351	1.570	1.807
Risky Waste*1 (kg/day)	Risk Waste *2	80.7	109.1	126.7	145.8
	Hazardous Waste *3	4.8	6.5	7.5	8.7
	Special Waste *4	0.05	0.07	0.08	0.10
	Subtotal	85.6	115.7	134.3	154.6
Common	Common Waste (kg/day) *5	74.7	101.0	117.3	135.0
Grand Total		160.3	216.6	251.6	289.6

Note : *1 Study team's prepared category.
*2 Waste with infection (sharps, blood, blood sustained and etc.), infected waste from laboratories, waste from infectious disease patients and wastewater etc.
*3 Chemical waste (medicines, drugs, etc.), radioactive waste etc.
*4 Ash from incinerator, sludge etc.
*5 Office waste, kitchen waste, packing waste, bulky waste, garden waste, domestic wastewater and etc.

Table L-138: Forecast of Medical Wastewater Generation Amount in Medical Institutions

Item	1996	2000	2005	2010
Population	135,796	183,519	213,165	245,421
Growth Rate of Population	1.000	1.351	1.570	1.807
Water Supply by INAA (ton/day)	220.3	297.7	345.9	398.1
Wastewater (ton/day)	176.2	238.2	276.7	318.5

b. Forecast for Minor Medical Institutions

In the minor medical institutions without beds for inpatients(C/S,P/M class), medical solid waste amount is estimated as shown in Table L-139, assuming that it will increase in proportion to the growth rate of population. The value in 1996 is estimated on the analogy of the questionnaire survey to the institutions in Granada and Chinandega by the Study Team in February 1997. Medical wastewater is estimated assuming it will increase in proportion to the growth rate to the population. The values of water supply in 1996 are obtained from the record of INAA.

Table L-139: Forecast of Generation ratio of Medical Solid Waste Management in the Medical Institutions without Beds for Inpatients(C/S, P/M and Laboratory Class) in Leon

Medical institution		1996 C/S[1]	1996 P/M[2]	1996 Lab[3]	1996 Total	2000 C/S[1]	2000 P/M[2]	2000 Lab[3]	2000 Total	2005 C/S[1]	2005 P/M[2]	2005 Lab[3]	2005 Total	2010 C/S[1]	2010 P/M[2]	2010 Lab[3]	2010 Total
Growth Rate					1.000				1.351				1.570				1.807
Outpatients/day/ institution		172	104	0	276	240	145	0	285	270	163	0	433	311	188	00	499
Outpatients/day		688	1248	0	1936	930	1,687	0	2,617	1,080	1,956	0	3,036	1,244	2,256	0	3,500
Risky	Risk	68.4	0.2	0	68.6	92.4	0.3	0	92.7	107.4	0.3	0	107.7	123.6	0.4	0	124.0
	Hazardous	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Special	1.3	0.2	0	1.5	1.8	0.3	0	2.1	2.0	0.3	0	2.3	2.3	0.4	0	2.7
	Subtotal	69.7	0.4	0	70.1	94.2	0.6	0	94.8	109.4	0.6	0	110.0	125.9	0.8	0	126.7
Common		64.4	0	0	64.4	87.0	0	0	87.0	101.1	0	0	101.1	116.4	0	0	116.4
Grand Total		134.1	0.4	0	134.5	181.2	0.6	0	181.8	210.5	0.6	0	211.1	242.3	0.8	0	243.1

Note [1] C/S : Centro de Salud(Health Center) [2] P/M : Puesto de Salud or Puesto de Medico
[3] Labo: Laboratory [4] Values based on Questionnaire Survey

Table L-140: Forecast of Generation of Medical Wastewater Management in the Medical Institutions without inpatient beds(C/S, P/M, Laboratory class) in Leon

Unit : kg/day

Item		1996				2000				2005				2010			
Growth Rate		1.000				1.351				1.570				1.807			
Basic Data	Population	135,796				183,519				213,165				245,421			
	Institution Type	C/S	P/M	Lab	Total	C/S	P/M	Lab	Total	C/S	P/M	Lab	Total	C/S	P/M	Lab	Total
	Outpatient/day	688	1,248	0	1,936	930	1,687	0	2,617	1,080	1,956	0	3,036	1,244	2,256	0	3,500
Water (ton/day)	Water Supply	1.8	0.9	0	2.7	2.4	1.2	0	3.6	2.8	1.4	0	4.2	3.3	1.6	0	4.9
	Wastewater Generation	1.4	0.7	0	2.1	1.9	0.9	0	2.8	2.2	1.1	0	3.3	2.6	1.3	0	3.9

L.2.8.2 Major Findings of the Medical Waste Survey

a. Present Situation of Medical Institutions in Leon

a.1 Distribution of Medical Institutions in Leon

There are 19 medical institutions in Peon, among which, 4 institutions provides inpatient beds, on the other hand, remaining 15 institutions do not.

Table L-141: Distribution of Medical Institutions in Leon

Item			Ownership		Total
Category	Inpatient Beds	Type	Public	Private	
Major	With	Hospital	1(1)	2(2)	3(3)
Minor	Without	C/S	4(2)	0	4(2)
Minor	Without	P/S, P/M	12(0)	0	12(0)
Minor	Without	Laboratory	0	0	0
Total			16(1)	3(3)	19(5)

Note: Values in ( ) show the institutions conducted questionnaire survey.

a.2 Questionnaire Survey to the Typical Medical Institutions in Leon

In order to understand the medical waste conditions in Leon, questionnaire surveys were conducted to the 6 typical medical institutions shown in Table L-141 in September 1996 and February 1997 as follows:

(1) Questionnaire Survey in September 1996

focusing on the general information on medical waste management

(2) Questionnaire Survey in February 1997

focusing on the amount of medical waste amount and medical wastewater

b. Medical Solid Waste

b.1 Separation at Generation Source and Internal Collection and Haulage

Although 80 % of the medical institutions separate medical waste at generation source, cleansing workers mix them with non-infectious waste during internal collection and haulage as shown in Table L-142. As a result, 100% of the medical institutions store the mixed medical waste at collection point. As a result, the table indicates the necessity of following things:

- Periodical education to the medical workers including cleansing services
- Establishment of the treatment system for medical infectious wastes

Table L-142: Medical Waste Separation at generation Source and Internal Collection and Haulage in Leon

Institution Type		Separation at Generation Source	Internal Collection and Haulage		Total
			Separated	Mixed	
Public	Hospital	1(syringe needle only) 1(pathological waste only)	0	2	2
	C/S	1(laboratory only)	0	2	2
	P/M.P/S	0	0	0	0
Private	Clinic etc.	1(laboratory only)	0	1	1
Total		4	0	5	5
Share(%)		80.0	0	100.0	100.0

b.2 Internal Treatment

No internal treatment is carried out in Chinandega.

b.3 Storage Place before External Collection Service

Regarding storage places, the institutions provides the security of storage without fence and without lock mostly as shown in Table L-143, although the storage place should be restricted from people's entrance strictly.

Table L-143: Security of Storage place before collection at 5 typical medical institutions in Leon

Institution Type		Answer			No Answer	Total
Condition		With Fence With Lock	With Fence Without Lock	Without Fence Without Lock		
Public	Hospital	0	0	1	1	2
	C/S	0	0	2	0	2
	P/M,P/S	0	0	0	0	0
Private	Clinic etc.	0	0	0	1	1
Total		0	0	3	2	5
Share(%)		0	0	60.0	40.0	100.0

b.4 External Collection Service

All of the medical institutions rely on the public collection service for the disposal of medical wastes.

b.5 Final Disposal Site

The Municipal final disposal site is used for medical waste disposal.

b.6 Recycling

Recycling in the medical institutions is not conducted in Leon.

b.7 Incineration

Medical solid waste is incinerated in primitive manners by 40% of medical institutions. Remaining 60% of medical institutions dispose of medical wastes without incineration as shown in Table L-144.

Table L-144: Incineration Method in Leon

Category of Medical Institution		With Incineration		Without Incineration	Total
		Primitive Open Air Incineration			
		Inside Premise	Outside Premise		
Public	Hospital	1*1	1*2	0	2
	C/S	0	0	2*3	2
	Others	0	0	0	0
Private		0	0	1	1
Total		1	1	3	5
Share(%)		20.0	20.0	60.0	100

Note: C/S Centro de Salud
*1 Syringe needle only
*2 Pathological wastes only
*3 Out of operation so far due to smoke problems in 1 C/S with a furnace

c. Medical Wastewater

c.1 Present Conditions

Medical wastewater is disposed of by either discharge into sewer without treatment as shown in Table L-145.

Table L-145: Present Medical Wastewater Management in Leon

Unit: number

Treatment		Without Discharge into			With Septic Tank to River	Total
		Sewer	Partial Sewer Partial Soak Pit	Soak Pit		
Public	Hospital	2	0	0	0	2
	C/S	1	1	0	0	2
	Others	0	0	0	0	0
Private	Clinic etc.	1	0	0	0	1
Total		4	1	0	0	5
Share (%)		80.0	20.0	0	0	100.0

c.2 Inspection by medical institutions

Decree No.33-95 provides that medical institutions have an obligation to inspect the quality of wastewater. However, no institutions have been carrying out the designated inspections.

L.2.8.3 General Recommendations for the Improvement of Medical Waste Management

a. Technical System

a.1 Comprehensive View Points

a.1.1 Examination on Marketability of Participation of Private Sectors for Medical Waste Management

MINSA should examine the marketability of participation of private sector on the medical waste management.

a.1.2 Examination of Regional Treatment

Since the volume of medical waste generated from the institutions in Leon, possibility of regional treatment should be examined as one of alternatives.

a.2 Medical Solid Waste

Medical waste management should be focused mainly on prevention of the secondary infection caused by the medical waste. From this point of view, the followings are recommended.

a.2.1 Separation of Infectious Waste

Segregation of infectious waste at generation source intensified. Importance of infectious waste separation should be educated to cleansing workers, otherwise medical workers' effort will be in vain to segregate the waste at generation source, which has been carried out at present.

a.2.2 Internal Treatment

In principle, medical waste is to be treated in the institutions, however, taking into account the small quantity of generation of medical waste in each institution, regional treatment plan should be included as one of alternatives.

a.3 Medical Wastewater

a.3.1 Segregation of Infectious Wastewater at Generation Source

In order to reduce the volume of infectious wastewater, it should be segregated at generation source.

a.3.2 Pretreatment before Discharge

Infectious wastewater should be pretreated at generation source for the prevention of water pollution.

b. Institutional System

MINSA is the regulating authority (Decree No. 393-88). It is recommended to establish immediate instructions, which should be improved to "Code of Practice" for Medical Waste in the near future.

These norms should emphasize the management inside the generator establishments where waste will be classified and separated for a safe collection and disposal. Medical workers and cleaning workers must be oriented and trained for this purpose.

Hazardous medical waste should be defined and regulated by MARENA (Law No. 217-96). Meanwhile, MINSA should establish temporary instructions as the superior Ministry dealing with medical activities, mainly with regard to infectious waste.

The Municipality will operate, without monopolize them and at a reasonable price, the collection services and disposal of non-hazardous waste, proved in accordance with competent instructions.

The Annex N presents recommendations for the regulating acts and intersectorial actions.

The Main Report for F/S of Volume III includes (item 4.3.2) the proposed Regulation on SWM for Granada, that might be the same for the other municipalities.

L.3 USE Conceptual M/P for Chinandega

L.3.1 Planning Frameworks for and USE M/P

L.3.1.1 Goals, Targets and Strategy

a. Goals

The principal goal of the Conceptual Master Plan for Chinandega is to improve the Urban Sanitation Environment (USE) of the Chinandega City till the target year 2010 where people and major economic activities of the Region II are centered.

Through the improvement of USE in Chinandega City, **the Plan aims to:**

- **promote the Citizens' Well-being;**
- **support Sustainable Development of the City; and**
- **contribute to the Growth of the Regional Economies.**

The goals in practice of the Master Plan are as follows:

1. Improvement of public health in the city;
2. Reduction of health hazards in and around the city;
3. Protection of natural resources and environment (e.g., underground water resources and ecology);
4. Encouragement of citizens' environmental consciousness;
5. Increased provision of USE services (i.e., water supply, sewer, SW collection, etc.) in affordable and appropriate levels;
6. Establishment of self-sustainable management systems on USE services;
7. Establishment of a Beneficiary-Pay-Principles (BPP) under which services recipients pay for the USE services;
8. Development and promotion of community participation in USE systems;
9. Employment of satisfactory measures for protection of environment/human health in the operation and maintenance of USE facilities;
10. Prevention of pollution by industrial wastewater and solid waste;

11. Establishment of appropriate legislation, regulations and guidelines on USE through modifications and revisions of the existing ones; and

12. Establishment of a coordination mechanism for the city with national institutions for USE management.

b. Targets

Target years are set up as follows:

Master Plan: Year 2010

Feasibility Study: Year 2005

In order to achieve the principal goals, target figures in 3 major sectors comprising USE are set up as indicated in the Table below.

Table L-146: Target Figures of Technical System in Chinandega

	Present(1995/96)	F/S(2005)	M/P(2010)
Water Supply Coverage	74.0%	85%	85%
Domestic Wastewater Treatment			
Sewer coverage	33.6%	49%	65%
On-site system coverage	4.0%	8%	12%
Latrine only system	51.8%	37%	23%
No system rate	10.6%	5%	0%
Waste Collection Coverage			
Collection rate of all waste	81.6%	90%	100%
Collection rate of household waste	51.0%	88%	100%

c. Strategies

Strategic actions to reach the goals and targets should, in practice, be deployed in a stepwise manner toward the target year 2010. Therefore, it is recommended herewith to divide the period to the target year 2010 into 3 phases.

Table L-147: Strategies for the Realization of USE Master Plan

Classification Phase	Technical Aspects	Institutional Aspects
Phase 1 **(1998 - 2000) Preparation for Priority Projects Implementation**	**Common Aspects** • An USE M/P should be urgently formulated and F/S on priority projects should be conducted along with the M/P. **Water Supply System** • The water supply system should be consolidated to maintain target coverage of 85% for the increasing population. **Domestic Wastewater System** • In order to execute the priority projects (F/S projects), the required funds shall be secured and the detailed design of the projects shall be conducted. • As for sewer area, connection to sewer should be promoted and system improvement necessary for maintaining the present sewer coverage (33.6%) should be provided. • As for the non-sewer area, F/S for introducing on-site DWW treatment system should be carried out, referring PECM (Special Program for Model Community Integrated USE Improvement Project) in Granada. In order to prepare for such projects, public education program should be deployed to encourage citizens' environmental consciousness. **Stormwater Management** • Technical guidelines necessary for storm water management should be prepared. • Basic investigation (e.g., topographic survey) for inundation prone area should be conducted for planning the improvement and recruiting necessary funds. • Rain drainage in urban fringe areas (UFA) should be improved, referring PECM in Granada. **Municipal SWM** • A site for a future municipal SW final disposal site should be selected from some candidate sites. Its preliminary design and the environmental impact assessment (EIA) should be carried out. • In order to execute the priority projects (F/S	**Common Aspects** • Regulations of wastewater discharge into sewer/public water body should be legally and practically enforced. • The municipality should provide norms and guidelines regarding USE to the citizens, from which citizens should easily understand appropriate sanitary practices and civil procedures. • Urban development plan of the city (at least including the land use regulations) should be prepared. Meanwhile, a cadastre for real property and public services should be established. **Domestic Wastewater System** • Guidelines for appropriate on-site DWWM should be elaborated. • INAA, MINSA and the municipality should, referring PECM in Granada, coordinate to establish a steering committee for PECM in Chinandega necessary for introducing on-site DWW treatment system and to seek foreign and domestic grants for such projects. **Stormwater Management** • Authoritative competency for storm water management (planning, maintenance and repair) should be reviewed respectively for macro- and micro- drainage. • INAA, MINSA and the municipality should, referring PECM in Granada, coordinate to establish a steering committee for PECM in Chinandega necessary for improving rain drainage in UFA and to seek foreign and domestic grants for such projects. **Municipal SWM** • Regulations on urban cleansing should be established to clarify municipality's powers (including placing penalties) and duties as well as citizen's rights and duties. • The municipality should improve collection of municipal taxes and

	projects), the required funds shall be secured and the detailed design of the projects shall be conducted. Then, construction of the facilities and procurement of vehicles and equipment shall be done. • Technically satisfactory level of sanitary landfill operation should be maintained in the present landfill until its closure, in order to reduce the pollution impacts to the environment. Meanwhile, illegal dumping should be reduced through improved collection services. **Industrial Waste Management** • Based on the "polluter pays principle", industries should be instructed to implement appropriate on-site management of their solid/liquid wastes and residual water. **Medical Waste Management** • Appropriate on-site management (e.g., separation of hazardous/infectious medical waste from other waste) in institutions should be promoted.	charges for the services. **Industrial Waste Management** • Waste classification suited for Nicaraguan authorities' present IWM should be established. Management of hazardous waste should be prioritized. • Inventory of factories and their waste generation should be made for identifying ISW and IWW. • With regard to ISWM and IWWM, authorities should be empowered to conduct administrative measures such as monitoring, supervision and guidance. **Medical Waste Management** • Classification of medical waste should be established. Code of practice for respective medical waste categories should be formulated.
Phase 2 **(2001 - 2005) Priority Projects Implementation**	**Water Supply System** • The water supply system should be consolidated to maintain target coverage of 85% for the increasing population. **Domestic Wastewater System** • Facilities and equipment provided in Phase-1 should be operated and maintained appropriately. • In order to prepare for M/P projects, designs and funds recruitment for the projects should be prepared. Then, facilities construction should be implemented. • Sewer provision should be improved to attain the target coverage of 49%. • In the non-sewer area citizens' participation in the "model communities integrated USE improvement" projects should be substantiated in order to sustain the projects in affordable and appropriate levels. Meanwhile coverage rate of on-site system should be raised to 8%. **Stormwater Management** • Drainage should be improved in accordance with Flood Damage Area	**Common Aspects** • The norms and guidelines regarding USE provided by the municipality should be demonstrated through public education programs in order for the citizens to practice appropriate sanitation measures and civil procedures. • The urban development plan should be put in practice to guide and to restrict the land use, in order to maintain a preferable urban environment (e.g., protect potable water sources of the city, regulate industrial activities and NIMBY facilities in designated areas). • The cadastre of real property and public services, perhaps applying crossed subsidies; should be utilized for establishing the management system on USE services and also promoting a Beneficiary-Pay Principles for the services. **Domestic Wastewater System** • PECM steering committee should further seek foreign and domestic grants for constructing on-site DWW

	Improvement Plan. • Integrated Arroyo Management Plan (comprising: land use regulation; catchment conservation with reforestation; and drainage channel improvement) should be formulated. • Rain drainage in UFA should be further improved through PECM. **Municipal SWM** • Facilities and vehicles acquired in Phase-1 should be appropriately operated and maintained. • Technically satisfactory level of sanitary landfill operation should be maintained in the new landfill. Meanwhile, illegal dumping should be further reduced through improved collection services. **Industrial Waste Management** • On-site ISWM and IWWM should be further strengthened. • Treatment/disposal by private sectors, mainly for hazardous waste, should be implemented. **Medical Waste Management** • Appropriate on-site management (e.g., separation of hazardous/infectious medical waste from other waste) in institutions should be obligated. • Treatment/disposal of hazardous/infectious medical waste should be implemented by private sectors.	treatment projects. **Stormwater Management** • Respective institutional system (e.g. funds, design guidelines) for macro- and micro-drainage should be established. • PECM steering committee should further seek foreign and domestic grants for constructing rain drainage facilities. **Municipal SWM** • Authorities should encourage recycling activities by waste generators and private recyclers. However, the administrative support should be such a manner with least financial burden on authorities. **Industrial Waste Management** • Legislative framework to obligate appropriate IWM (e.g., manifest system) should be established. • With regard to ISWM and IWWM, authorities should practice administrative measures (e.g., monitoring, supervision and guidance) and apply penalties (if necessary) against illegal measures by industries. • Formulation of commercial mechanism for appropriate treatment/disposal should be promoted. **Medical Waste Management** • Code of Practice on medical waste management should be enforced.
Phase 3 **(2006 - 2010) M/P Projects Implementation**	**Water Supply System** • The water supply system should be consolidated to maintain target coverage of 85% for the increasing population. **Domestic Wastewater System** • The M/P projects should be reexamined and implemented, with reference to the outcome of the priority projects (F/S projects). • As for sewer area, the off-site system should be consolidated to maintain target coverage of 65% of the population. • As for no sewer area, the on-site system should be consolidated to maintain target	**Common Aspects** • Public education programs related with the norms and guidelines regarding USE provided by the municipality should be deployed widely. • The urban development plan should be put in practice to restrict the land use, in order to maintain a preferable urban environment. Meanwhile the plan should serve for planning USE services corresponding to the urban expansion and the population increase therein.

	coverage of 12% of the population. • As for area served with "model communities integrated USE improvement" projects, self-help of communities should be employed in operation and maintenance of the facilities. **Stormwater Management** • Reforestation, drainage improvement works, etc. should be implemented in accordance with Integrated Arroyo Management Plan. • Rain drainage facilities in UFA should be further constructed through PECM. **Municipal SWM** • The M/P projects should be reexamined and implemented, with reference to the outcome of the priority projects (F/S projects). • Satisfactory municipal SWM both technically and environmentally should be continued. In maintaining 100% waste collection rate, illegal dumping should be eradicated. **Industrial Waste Management** • Industries should take initiatives for introducing "waste minimization and cleaner production" technologies for their production. **Medical Waste Management** Appropriate collection, treatment and disposal should be practiced for all medical waste (including hazardous and infectious ones).	**Domestic Wastewater System** • PECM steering committee should raise funds for constructing on-site DWW treatment projects, from water and wastewater charges collected. **Stormwater Management** • PECM steering committee should raise funds for constructing rain drainage facilities, from automobile taxes etc. **Municipal SWM** • Introduction of separate collection system should be examined in order to promote waste minimization and resource recovery from waste. **Industrial Waste Management** • Authorities should promote introduction of "cleaner production" mainly for factories that generate hazardous waste. **Medical Waste Management** • Appropriate control, treatment and disposal of medical waste should be enforced in line with the Code of Practice for Medical Waste Management.

d. Strategic Management

d.1 General Directions in the Management

d.1.1 The Municipality as the Citizens Main Support

The municipality should manage and coordinate all the services and public needs for the USE in the municipal territory. In order to reach this goal, the municipality should be able to:

- Provide norms and directives to the population with respect to the location, sanitary structures and civil procedures to live and work under satisfactory environmental and sanitary conditions;
- Provide services of their own competence, and coordinate and promote other institutions' services for the citizens.

The main rational measures by the municipality should be:

- An urban development plan or, at least, zoning and regulations for urban land use;
- A regulation for construction/extension/rehabilitation of residential and non-residential buildings and/or other installations;
- A cadastre for real property and public services to be offered for the citizens;
- Regulations for the municipality responsible services such as waste collection and disposal, public areas cleaning and micro-drainage.

d.1.2 Legal Improvement

The Constitution of the Republic establishes the principle of Municipal Autonomy, which is explicit in the Law of Municipalities No. 40-88, article 2, 6, 7, 9 and 10 (which refers sanitary and environmental issues). This municipal competence is also declared in the Environmental Law No. 217-96, article 16 and 129.

Municipal Ordinance (MO) are the documents dictated by the Municipal Council after accepting the Mayor's request (Law No. 40-88, article 28 and 34), which will empower the municipal government to administrative measures and necessary sanctions for the municipal government in order to execute municipality's functions and demand citizens burden sharing.

d.1.3 Organizational Improvement

The Annex A presents organizational structures and respective functions recommended to the municipality, which are compatible with the needs to develop a Master Plan. It recommends a transition from the actual organization to the proposed one, to be assisted by an expert in organization, improvement methodologies and human resource training.

d.1.4 Municipal Personnel Training

The training should be done stepwise in order to obtain results (i.e., operational instruction; training; and professional formation) immediately. Furthermore such training should be selective in accordance with the necessity of reaching the targets.

It is recommended that it should be programmed and evaluated by an expert, with a priority on training of:

- Department chiefs;

- all the personnel of the sections very linked to what proposed in the M/P (e.g., assistance to the cadastre on real property);
- chiefs of the sections and sectors in "Waste Collection and Public Cleaning" and "Vehicles and Equipment";
- chiefs of "Administration" and "Finances" sections; and
- chiefs of "Fee Collection" and "Audit" sectors.

It is very important that the directors and chiefs be selected according to their formation and personal aptitudes which should make a perfect match to their attributions in their operational branches and divisions.

d.1.5 Coordination with the National Entities that Provides Public Services in the Municipal Territory

The municipality should coordinate and offer to the citizen **instructions** (concerning services of municipal competence and other entities' competence), in the pursue to make the instructions simple and to have a quick access to services. In such a way the citizens will have the opportunity to obtain the required information in just one place.

The **instructions** should be simple, specific and prompt documents (i.e., which should be an easy-to-understand translation of the regulations, technical and administrative norms). It should be presented in words, drawings and other basic forms that makes them easier to understand for the common citizens. They do not require legislative approval to be emitted, but they should be prepared by the entity that offers such services.

The municipality should try to coordinate with the national entities in order to develop intersectorial projects, in such a manner the municipality could always remain expected to request better services by the institutions. Along with MINSA, the municipality should intensify its pro-active mobilization of the communities involved in the sanitation projects. In agreement with MCT, the municipality should begin joint works to clean and protect the dry ditches and streams (arroyos). The municipality at the same time should prevent the illegal disposal of solid waste in such places. On the other hand, INAA and MINSA should control the liquid waste disposal. The municipality should correspond to MARENA to classify the urban ditches and to define responsibilities for their maintenance and protection. Meanwhile, MARENA should supply the instructions regarding industrial waste and "infectious" medical waste to the municipality (and also to those interested in).

The Municipal Council and INIFOM should unite together in order to support the municipality's plans firmly and to request cooperation from national entities. Assistance by INIFOM is considered as a fundamental requirement for the success of the Master Plan, specially in view of institutional improvement and municipal personnel training.

d.1.6 New Services by INAA

With regard to on-site sewage treatment/disposal systems, INAA (through an agreement with the municipality) should extend its services, including the construction and operation/maintenance of the on-site collective systems, as well as the removal of sludge from individual/collective septic tanks.

d.2 Management on Constructions and Urban Development

d.2.1 Residential Constructions

The municipality should establish the Permission System which comprises: permission for construction; and permission for the use of constructed residences (which should include the real property cadastre, so that it proceeds to receive all the public services available in the micro-region, and the services should be paid for).

Issues of the construction permits will indicate the services demand in the future (in the medium term). Meanwhile issues of permits for use of constructed residences will indicate the immediate demand of the services and the potential incomes corresponding to that.

The municipality should supply, to those interested to construct, the Instructions and orientations, in order for that the constructions fulfill the sanitary requirements and others requirements without bearing needless costs. Meanwhile the municipality should maintain the design submitted in files. Once the construction works are concluded, the municipality should inspect whether it is constructed as proposed in the design, and then the use permission is granted. This should be informed immediately to the other public services suppliers. The immediate transmission of such information should be through the data processing network among the municipality and the services suppliers in order for that those service suppliers should also fulfill their duties and rights.

The permission process should be simple and at a low cost in order to make it feasible. Some models of low-cost housing should be designed, pre-approved and permitted by the municipality. Furthermore such low-cost housing should be offered by the municipality to low income citizens, however, the inspection and register in cadastre should not be exempted once the work has finished.

Similar procedures should also be applied to: renovations of existing residence for other use purposes; and reforms with extension of constructed one.

The municipality, by the Municipal Ordinance, should also establish the obligation of connection to the sewer (of off-site or on-site system) from all residential buildings where such sewer exists in the adjacent street or neighboring property.

d.2.2 Non-Residential Constructions

For buildings of non-residential use, the pre-approved designs and permits (as mentioned above) should not be applicable. The construction permission for non-residential building should establish the obligation to observe the Decree 33-95, in order to permit to connect them to the existing sewer system.

d.3 Management of Wastewater in Non-Sewer Areas

The municipality should establish, by Municipal Ordinance, the obligatory nature of citizens to make an appropriate disposal of their wastewater. For such purpose, viable alternatives and a reasonable assistance will be offered, before applying sanctions as they are established in the Ordinance.

In the micro-regions where sewer system would not be feasible, on-site treatment (preferably a collective system) should be adopted. However for the time being, it

should be tolerated with the more primitive solutions of current practices, but with an appropriate sanitary control.

The municipality should coordinate a Special Program for Model Community Integrated USE Improvement Project (PECM) to be developed by INAA and MINSA, with initial funds from a Rotating Fund which will be maintained and will support the continuity of PECM through the payments of the services for the system construction, connection to the houses, operation and maintenance of the system. These payments will be facilitated and could be reduced through the beneficiary citizens' burden sharing by participation, which should be stimulated by a community mobilization.

The municipality should also establish the obligatory nature and tolerance for those who operate commercial and industrial establishments. To the existing industrial establishments, it will be demanded to certify that they have complied with the ordinance of article 72 of the Decree 33-95 and the Gradual Decontamination Plan accepted by MARENA or INAA.

d.4 Urban Cleaning Management

The municipality, by Municipal Ordinance, should regulate whatever regarding the Urban Cleaning (e.g., the waste collection as an result of the citizen behavior, provision of norms for the cleaning services, etc.). One clear issue is that the feasible level of the cleaning service is defined by the citizens' behavior and the financial capacity of the society to sustain it. The cleaning is shared by the Municipality and the citizen, but the latter should support the cleaning service and should operate one part in order to reduce the costs incurred therein.

Meanwhile, the municipality should establish a tariff plan (that should be socially viable) so that everybody pays for the service a compatible amount of money according to their income. It is recommended that the total amount collected should not be less than 50% of the costs; as it is established in the Municipal Tax Plan (Decree No. 455-89, article 40). It is desired that the percentage be gradually increased up to 100% according to the stepwise improvement in providing *regular and frequent* services.

The urban cleaning services should be previously planned in a "permanent" nature or in the long term, or they should be programmed for the short term. On such basis, the services should be controlled and then their results and costs be evaluated.

The "privatization" of the services, in other words, the contract or cession to a third party, will not be prudent whenever the municipality does not have structure nor capable personnel to make or hire the planning of services. Only when the municipality has such structure and capable personnel, parameters for control are established and the control of results and costs are effectively executed.

L.3.1.2 Forecast of Future USE Services Demand

a. Projected Service Area

During the discussion of the Inception Report (IC/R), the Nicaraguan side requested to expand the boundary of the Study Area (1995). The Team agrees to expand the present Study Area up to the urban limits by the target year 2010, provided that the counterpart supplies the Team with relevant information, e.g., boundary, population estimates, for the projection of the outcome of the USE improvement plan in 2010.

Based on the above discussion, the counterpart from the Municipal Government of Chinandega (MGC) presented a map showing the boundary for urban expansion in Chinandega. Using the digital planimeter and based on the map, the coverage of the urban expansion program for 2010 was calculated at 16.10 km^2 by the Team. This area shall be defined as the project service area in Chinandega for the selected years 1995, 2000, 2005 and 2010.

Accordingly, the main objective of this section is to provide relevant fundamental data for future USE service demands to forecast urban growth, water supply, domestic wastewater, municipal and medical solid wastes conditions within the projected service area.

b. Population Forecast

The population estimates established in the Interim Report (1) shall be used to forecast USE service demands and to formulate the conceptual M/P for Chinandega. The study shall use the 1995 population census data of INEC, the latest INAA population projection, and shall consider the future expansion of urbanized areas in Chinandega.

Accordingly, the population of the projected service area for 2010, the target year for the conceptual M/P, is estimated at approximately 153 thousand. The average annual population growth rate in the projected service area for the period 1995-2010 is estimated at about 3.0%.

The following table shows the population forecast by selected years (1995, 2000, 2005 and 2010).

Table L-148: Population Forecast

Year	1995	2000	2005	2010
Urban (Service Area)	97,387	115,393	133,753	153,444
Rural	19,650	20,683	21,770	22,915
City Total	117,037	136,076	155,523	176,359
Service Area (km^2)	16.10			

Source: 1995 statistical census data of INEC
2000, 2005 and 2010, projected urban population provided by INAA
2000, 2005 and 2010, projected rural population estimated by Team

c. Water Supply

Future water supply demand for the Study is forecast in compliance with the INAA's Pre-feasibility study[9] and based on the following conditions. The results are shown in Table L-149 and Figure L-51.

- Water supply coverage in years 2000, 2005 and 2010 are 85% of total population in the urban areas in respective year;
- Water consumption ratio is 160 l/person/day;
- Water supply ratio for areas without water supply system is 30 l/person/day; and

[9] Estudio de Priorizacion de Inversiones en el Sector de Agua Potable y Alcantaillado Sanitario Marzo 1996, INAA, ITS, Lotti, Lamsa

- Commercial, institutional, and industrial water use are 8%, 8% and 2% of the water consumption of served population, respectively.

Table L-149: Forecast of Future Water Supply Demand

		1995	2000	2005	2010
Urban Population		97,387	115,393	133,753	153,444
Service Coverage (%)		74	85	85	85
Served Population		72,077	98,084	113,690	130,427
No Served Population		25,310	17,309	20,063	23,427
Daily Consumption (m^3/day)	Served Population	-	15,693	18,190	20,868
	No Served population	-	519	602	690
	Commercial	-	1,255	1,455	1,669
	Institutional	-	1,255	1,455	1,669
	Industries	-	314	364	417
	Total	10,021	19,036	22,066	25,313

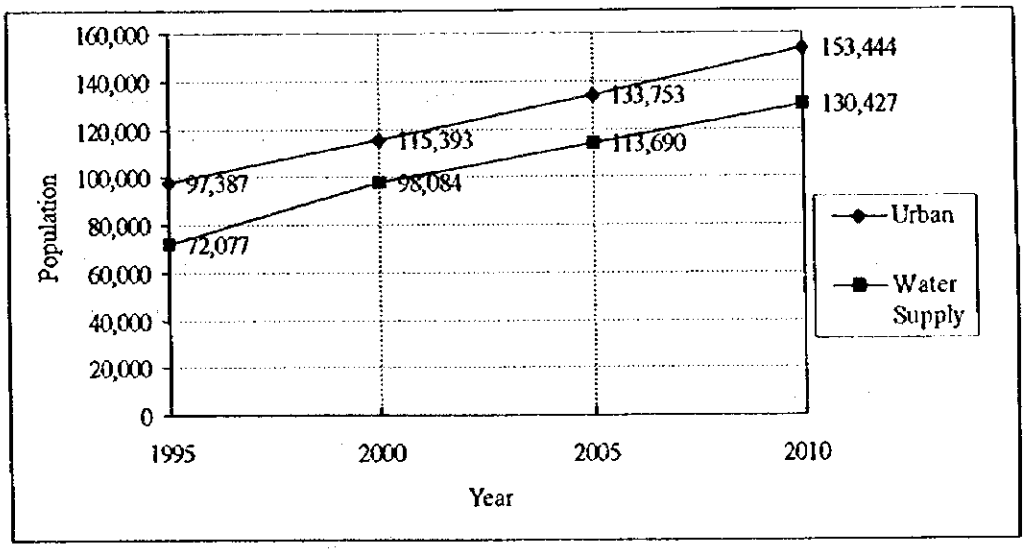


Figure L-51: Forecast of Future Water Supply Population

d. Domestic Wastewater

d.1 Definition of DWWM System

Domestic wastewater mainly comprises from night soil and DWW generated from households. Systems for DWWM in Chinandega comprise:

- system of joint treatment/disposal for night soil and DWW e.g., sewer system and septic tank;
- system of night soil only disposal through infiltration e.g., latrine; and
- no system.

Table L-150 shows prevalence of the respective systems in the city.

Table L-150: Present Domestic Wastewater Treatment / Disposal System

Unit: population

	Sewer System	Septic Tank	Latrine and/or Soak System	No System
Nightsoil + Sullage	32,752 (33.6%)	3,895 (4.0%)	-	10,323 (10.6%)
Nightsoil	-		50,417 (51.8 %)	-

In view of the present system, definitions of respective DWWM systems listed below are clarified as follows:

Sewer System:

Nightsoil and DWW generated through citizens' household activities are collected in a large scale through sewers and treated at off-site (i.e., sewage treatment plant).

On-site System:

Nightsoil and DWW generated through citizens' household activities are collected in a small scale (only one to a couple of decade households) through channels (open or closed) and treated locally in the vicinity of generation sources (e.g., septic tank, community collective system, etc.).

Soak System:

Nightsoil and DWW (or only nightsoil) generated through citizens' household activities are individually disposed in a wet system through infiltration locally in the vicinity of generation sources.

Latrine System:

Only nightsoil generated through citizens' household activities are individually disposed in a dry system through infiltration locally in the vicinity of generation sources.

No System:

There is no system to treat nor dispose nightsoil/DWW generated through citizens' household activities.

d.2 Forecast of Future DWWM Service Demand

As indicated in Table L-6, present sewer coverage in Chinandega ranges about 34% of the urban population, and septic tank (i.e., on-site system) coverage is minimal. Latrine, which avoids treatment and directly disposes the nightsoil for infiltration and therefore being potentially an underground water contamination source, covers about 52% of the total urban population today. In recent years, many of newly constructed soak pit receives only nightsoil in a wet system in order to prolong its service life, and therefore DWW are discharged to roadside and/or rivers without any treatment. Consequently it accelerates deterioration of USE in the city.

In view of the present situation of USE, followings are raised as target figures:

- coverage of nightsoil disposal systems in water supply areas and no water supply areas in the target year 2010; and
- DWW treatment systems (sewer and/or on-site systems) coverage is 90% in water supply areas in the target year 2010.

Future USE service demand is estimated for the years 2005 and 2010 based on the following conditions, which is shown in Table L-149and Figure L-51.

- Water supply coverage is 85% (i.e., 130,427 persons) of total urban population in the year 2010; and
- Sewer coverage is 65% of the total urban population in the year 2010.

The population covered by the on-site domestic wastewater treatment system from 1995 to 2000 are the residents from the high income bracket who install septic tanks at their own expenses. Supposing that, as a result of the increase in off-site sewerage system, these domestic wastewater treated in the septic tank is discharged into off-site sewerage system, the service population of the on-site treatment system (i.e., septic tank only) will be zero in 2005.

Table L-151: Forecast of Future DWWM Service Demand

		1996	2000	2005	2010
Urban Population		97,387	115,393	133,753	153,444
Water Served Population		72,077	98,084	113,690	130,427
Sewer System Area					
Served Area (km^2)		7.5			
Served Population		32,752	38,772	65,940	99,739
Service Coverage (%)		33.6	33.6	49.3	65
Treatment Amount (daily average, m^3/day)		6,591 (*Inflow volume)	6,165	12,277	15,818
Non Sewer System Area					
On-site System (Night Soil + Sullage Treatment)	Population	3,895	4,616	10,699	18,413
	Service Coverage (%)	4.0	4.0	8.0	12.0
Latrine System (Night Soil Disposal System)	Population	50,417	59,774	50,025	35,292
	Service Coverage (%)	51.8	51.8	37.4	23.0
No System	Population	10,323	12,232	7,089	0
	Service Coverage (%)	10.6	10.6	5.3	0

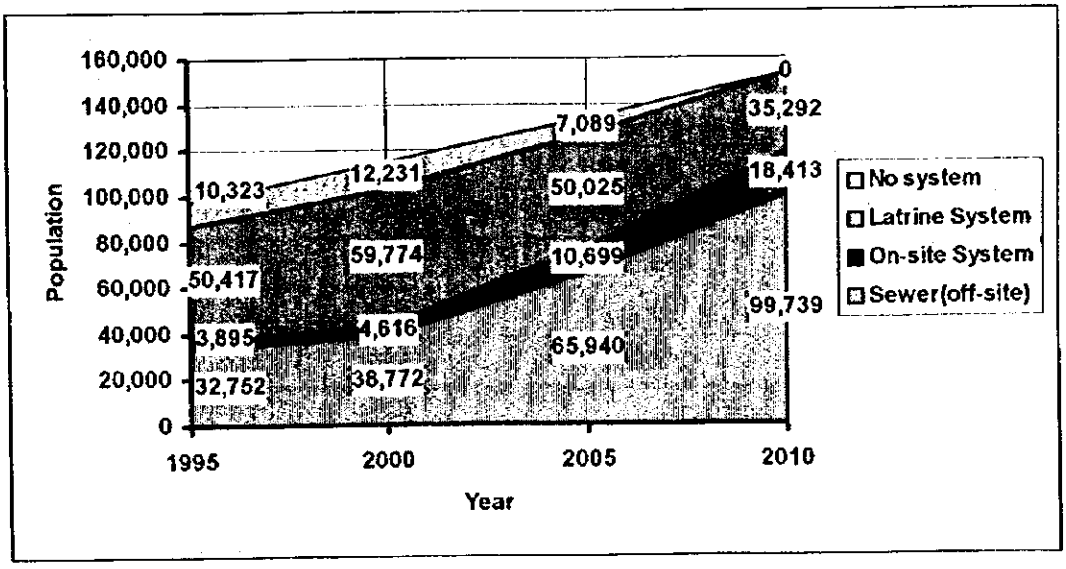


Figure L-52: Forecast of Future DWWM Service Demand

e. Municipal Solid Waste

The future demand on Municipal Solid Waste Management is almost determined by the future population. The demand on collecting and disposing waste will rapidly increase with the steep increase of population in urbanized cities in developing countries. This can be applied to Chinandega City.

The items concerning to the future demand on the MSWM in Chinandega are shown in the following table.

Table L-152: Future Demand on MSW in Chinandega

	1996	2000	2005	2010
Population in the study area	100,748	115,393	133,753	153,444
Waste generation amount (ton/day)	76.2	92.2	114.7	141.4
Waste discharge amount (ton/day)	48.4	60.4	78.0	99.7
Waste collection amount (ton/day)	39.5	49.3	70.2	99.7
Final disposal amount (ton/day)	40.5	50.3	71.8	101.4
Coverage rate (to waste amount) (%)	81.6	82	90	100
Coverage rate (to population) (%)	51.0	51	88	100
Served population	51,382	58,851	118,088	153,444
Non served population	49,366	56,542	15,665	0
Length of sweeping served road (km)	45	45	45	45

f. Medical Solid Waste

f.1 Medical Solid Waste

The estimation of the future medical solid waste generation in Chinandega is summarized in Table L-153, which is obtained through extrapolation of the Team's survey as summarized in Table L-185 and Table L-187.

Table L-153: Future Medical Solid Waste Generation Amount in the Medical Institutions(Whole institutions) in Chinandega

	Item	1996	2000	2005	2010
Basic data	Population in the Study Area	100,988	115, 393	133,753	153,444
	Growth Rate of Inpatient Beds	1.000	1.143	1.324	1.519
	Number of Beds for Inpatients	327	374	433	497
Risky Waste*1 (kg/day)	Risk *2	36.9	42.1	48.8	56.0
	Hazardous*3	3.0	3.4	4.0	4.6
	Special *4	0.03	0.03	0.04	0.05
	Subtotal	39.9	45.5	52.8	60.7
Common	Common*5	56.2	64.1	74.4	85.4
Grand Total		96.1	109.6	127.2	146.1

Note : *1 Study team's prepared category.
*2 Waste with infection (sharps, blood, blood sustained and etc.), infected waste from laboratories, waste from infectious disease patients and wastewater etc.
*3 Chemical waste (medicines, drugs, etc.), radioactive waste etc.
*4 Ash from incinerator, sludge etc.
*5 Office waste, kitchen waste, packing waste, bulky waste, garden waste, domestic wastewater and etc.

f.2 Medical Wastewater in the whole Institutions in Chinandega

The estimation of the future medical wastewater generation amount is summarized in Table L-154, which is obtained through extrapolation of the Team's survey as summarized in Table L-186 and Table L-188.

Table L-154: Future Medical Wastewater Generation Amount in the Medical Institutions(Whole institutions) in Chinandega

Category	Item	1996	2000	2005	2010
Population	Growth rate of Population	1.000	1.143	1.324	1.519
	Population in the Study Area	100,988	115,393	133,753	153,444
Water (ton/day)	Water Consumption	207.6	237.2	274.9	315.4
	Wastewater Generation	166.1	189.8	219.9	252.3

L.3.1.3 Economic and Financial Conditions in the Region

a. Economic and Financial Conditions in the Region

- The Gross Regional Domestic Product (GRDP) of Granada in 1995 was calculated based on the data of INSSBI on the number of people insured (adjusted by regional ratio of participation) and the average salary by industry and region. After 2001, it is assumed to grow in proportion to the national Gross Domestic Product (GDP
- The municipal budget of Granada is assumed to increase in proportion to the GRDP growth.
- The family income in 1995 is calculated based on the data of the Ministry of Labor (MITRAB) on the number of employees by income. After 2010, this is estimated to increase in proportion to per capita GRDP multiplied by average family size, which is assumed to slightly increase from 5.751 in 1995 to 5.74 after 2000.
- In proportion to the overall budget of the INAA financial plan, the budget of INAA Region II (Chinandega) is assumed to remain as it was in 1995.

The major economic and financial indicators are summarized in the following table.

Table L-155: Major Economic and Financial Indicators

		1995	2000	2005	2010
GRDP	C$ million	657.0	866.5	1,105.9	1,322.6
No. of Households		16,934	20,103	23,302	26,732
Family income	C$/year	14,772	16,410*	18,069	18,979
INAA Region II	C$1,000	13,765	16,597	18,873	21,631
Municipal Budget	C$1,000	14,604	19,260	24,581	29,620

Note *: Because the increase in the number of households from 1995 to 2000 is estimated to be slightly higher than the growth in GRDP, the family income in 2000 is forecast to slightly decrease.

L.3.2 Water Supply Management

L.3.2.1.1 Future Water Use

Daily average water supply (excluding UFW) in Chinandega is estimated: about 22,100m^3/day by the year 2005; and about 25,300m^3/day by the year 2010.

On the other hand, INAA has a plan to improve the efficiency rate from the present 72% to 75% both in years 2005 and 2010. Referring to these figures, particulars of future water use are calculated based on the INAA's planning figures (e.g., coefficient of daily peak, coefficient of hourly peak, etc.) as shown in Table L-156.

Table L-156: Future Water Use

		1996	2000	2005	2010	Remarks
a.	Daily consumption demand (m^3/day)	10,021	19,036	22,066	25,313	
b.	Efficiency rate (%)	72	75	75	75	INAA' s Pre F/S
c.	Daily average flow (m^3/day)	13,918	25,381	29,421	33,751	a./b.
d.	Coefficient of daily peak	NA	1.5	1.5	1.5	INAA' s Pre F/S
e.	Daily peak consumption flow (m^3/day)	NA	28,554	33,099	37,970	a. x d.
f.	Daily peak flow (m^3/day)	NA	34,899	40,454	46,408	e.+(c.-a.)
g.	Coefficient of hourly peak	NA	2.5	2.5	2.5	INAA' s Pre F/S
h.	Hourly peak consumption flow (l/sec)	NA	551	638	732	a. x g.
i.	Hourly peak flow (l/sec)	NA	624	724	830	h.+(c.-a.)

Note : NA : not available

L.3.2.2 Selection of an Optimum Technical System

a. Water Resources

8 wells serving for present water supply in Chinandega have, in total, maximum pumping capacity of 391 l/sec (33,782m^3/day). Meanwhile, present average pumping amount ranges 195.5 litter/sec (16,891m^3/day), which corresponds about 50% of the pumping capacity and satisfies present daily consumption of 13,918 m^3/day.

Potable water supply sources could be classified into: underground water (deep water, shallow water); surface water; riverbed water; etc. in general. Present potable water source in Chinandega comes exclusively from deep wells. Since the underground water is comparatively in good quality and it only requires chlorination for potable use, which is much more economical than what requires conventional water purification facilities. Furthermore, in view of the topography and geology there, it is highly possible that available underground water near the city is abundant.

Meanwhile, INAA's pre-F/S plans that water supply sources in Chinandega in year 2010 should be deep wells. In view of economical advantages, and topographic and geological conditions therein, it should be judged that the plan with deep wells is optimum and recommendable. Therefore the Study, in formulating the M/P, follows the INAA's plan of water sources relying on the underground water.

It is planned in the INAA's pre-F/S that 2 numbers of new deep well (pumping capacity: 80 litter/sec/well) should be installed by the year 2005 and 3 number of new deep well should be installed by the year 2010, to satisfy the demand in the year 2010, as shown in Table L-157. The Study follows this concept in formulating the M/P.

Table L-157: Existing and Future Wells Capacity and Installation Plan

Unit : litter/sec.

Year	1995	2000	2005	2010
Calvario	80	80	reserve	reserve
La Pila	92	92	92	92
La Mora	109	109	109	109
Los Angeles	82	82	82	82
12 September	12	12	12	abandon
El Jiron	16	16	16	abandon
Future 1	-	80	80	80
Future 2	-	-	80	80
Future 3	-	-	-	80
Future 4	-	-	-	80
Future 5	-	-	-	80
Total	391	471	471	683
Daily average flow	161	294	341	391
Daily average flow/Total	41.1	62	77.0	57.3
Daily peak flow	-	403	468.2	537.2
Daily peak flow/Total	-	85.6	99.4	78.6

Source : INAA's pre-F/S

b. Water Purification System

Present potable water source is all from deep wells. Since the underground water is comparatively of good quality and it only requires chlorination for potable use. Since future water sources will rely on underground water, water purification systems (other than chlorination) is not required.

c. Transmission and Distribution System

Present transmission system employs direct transmission from the wells to the distribution net. In certain area, storage tanks are connected on a distribution net. Although this type of transmission and distribution system has problems of unstable and/or insufficient pressure and water supply quantity in some areas in the distribution net, it has an advantage in expanding distribution net with lesser costs. It is observed that INAA will continue to abide by this prevalent system of transmission and distribution. Namely, INAA's pre-F/S adopts this transmission and distribution system in the future water supply plan for Chinandega.

To make a project with totally independent conduction from the wells to the distribution reservoirs, conveniently located, it would make that the current conductor and main distributor pipelines would be transformed into the reservoirs supply pipeline. These pipelines would have dimensions corresponding to the maximum daily consumption because the maximum hourly consumption will be absorbed by the reservoirs. Given that the coefficient of maximum hourly flow is $k2=1.67$, it will increment proportionally the efficiency of pipelines which with the same diameter will be able to cover a lager number of persons who will be served by the reservoirs.

It is also clear that given the current situation, the conductor and main distributor pipelines are functioning as distributors which conduct flows corresponding to the daily maximum consumption ($k1=1.5$) and hourly maximum consumption ($k2=1.67$). This results in smaller pressures found in the farthest sectors of the network and the farthest highest points of the network which in some cases are found, in fact, at a very large distance from the source.

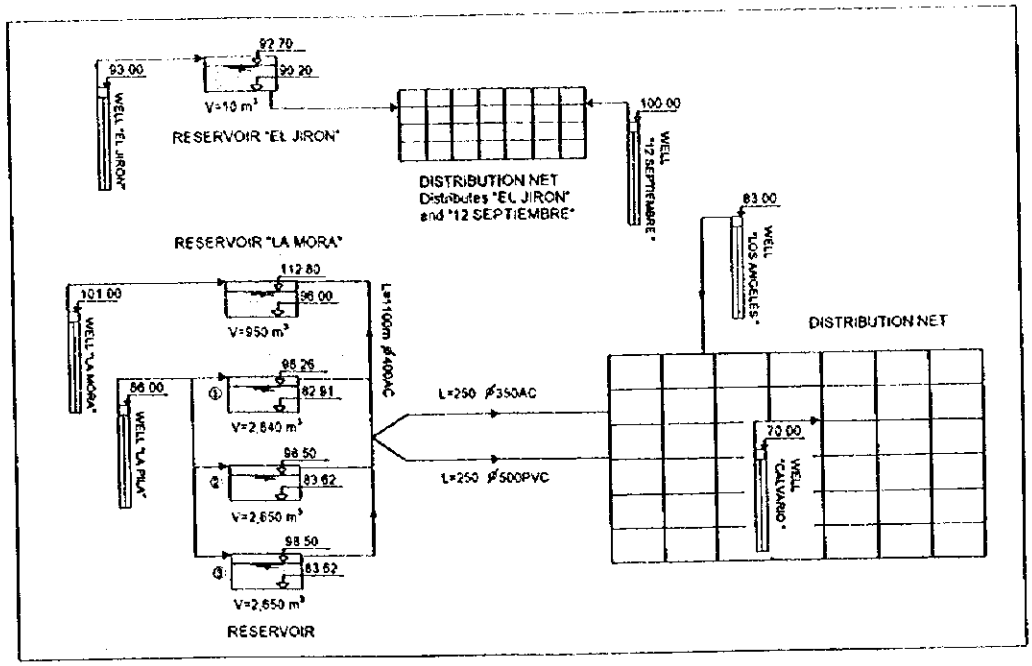
With an independent reservoir conduction and distribution, the piezometric heads which will be established in the influence area, will provide adequate permanent pressures in all the area. Certainly, chronic cases of water shortage that were dealt through special maneuvers and stepwise scheduling supply will be corrected.

It is evident, once the reservoirs have been installed, the distribution loops which nowadays are supplied directly by conductors and main distributor pipelines (that result in high pressures) will be supplied directly by the reservoirs. This is an efficient measure to control losses due to exaggerated pressures.

It should be observed that direct distribution from the wells to the network is not capable to provide large enough flows to cover cumulatively K1 and K2 coefficients. Furthermore, it can be observed that wells projected in the future (Table L-157) are not enough to supply totally the network; it is necessary a complement from the reservoirs.

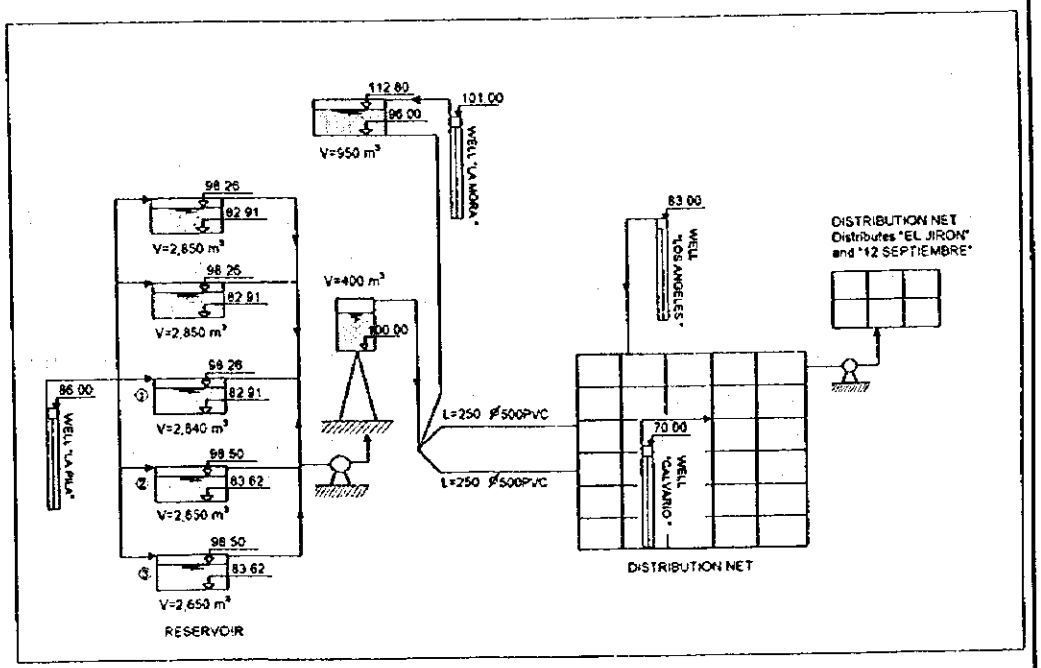
However, in view of the advantages in utilizing existing transmission and distribution systems and reminding the primary target of the water supply coverage increase, the Study, in conformity with INAA's plan, will adopt this system in its formulating M/P. Nevertheless, it is advisable to concentrate efforts on the study of direct transmission system from the wells to the reservoirs, and from these reservoirs to the network system.

Table L-158 and Figure L-53 shows INAA's future improvement plan on transmission and distribution system.



CHINANDEGA
Present Water Supply and Transmission System

Present System



CHINANDEGA
Future Water Supply (2010) and Transmission System

Future System in 2010

Figure L-53: Present and Future Transmission System

Table L-158: Construction Plan of Transmission and Distribution System

		2005	2010
Transmission Line	length (km)	0.8	
	Diameter (mm)	300 and 350 Steel/ 500 PVC	350, 400, 1,250
Distribution Net	length (km)	16	8.2
	Diameter (mm)	100 to 500	150 to 500
Small diameter connection		for 33,000 new consumer	for 47,000 new consumer

d. Storage System

Current storage capacity of the water supply system in Chinandega is 9,100 m^3. INAA's pre-F/S plans to install storage tanks:

- to satisfy the storage demands of the year 2010, by the year 2005; and
- to satisfy the storage demands of the year 2020, by the year 2010.

The outline of the storage system plan is shown in the Table L-159.

Table L-159: Construction Plan of Storage System by INAA's Pre F/S

		1995	2000	2005	2010	2020
Daily average flow (m^3/day)		13,918	25,381	29,421	33,751	47,016
Daily peak flow (m^3/day)		-	34,899	40,454	46,408	64,644
Detention Time (hr)	For average flow	15.7	8.6	12.1	14.6	10.5
	For peak flow	-	6.3	8.8	10.6	7.6
Construction plan		-	-	5,700	5,700	-
Total volume (m^3)		9,100	9,100	14,800	20,500	20,500

Storage capacity is determined, in general, as the quantity of 6 hours to 12 hours of daily peak supply plus the quantity for emergency use (in case of fire). Whereas, INAA determines the minimum storage capacity be 6 hours of daily average supply plus 72m^3 as the emergency provision. Table L-159 shows that the INAA's pre-F/S recommends a more than sufficient storage capacity not only for the daily average supply but for the daily peak supply in 2010 in its plan.

Therefore, the Study's M/P reviews the proposal in INAA's pre-F/S and consequently proposes the following construction plan for the storage system in Chinandega, based on that the Study's proposal assures the storage capacity of about 10 hours of daily average supply. Table L-160 shows the outline of the Study's proposal for the storage construction.

Table L-160: Proposed Storage System Construction Plan

		1995	2000	2005	2010	2020
Daily average flow (m^3/day)		13,918	25,381	29,421	33,751	47,016
Daily peak flow (m^3/day)		-	34,899	40,454	46,408	64,644
Detention Time (hr)	For average flow	15.7	8.6	12.1	14.6	10.5
	For peak flow	-	6.3	8.8	10.6	7.6
Construction plan		-	-	5,700	-	5,700
Total volume (m^3)		9,100	9,100	14,800	14,800	20,500

L.3.2.3 Institutional Requirements

If the National Assembly ratifies Decree No. 27-95, 31-95, and 32-95,INAA will have to share its responsibilities with ENACAL and several changes will be needed. Even INAA maintains all its present attributions, institutional changes might not be required, because INAA is well structured in what it is concerned with water supply to the municipality. In addition, the industrial characteristic of this type of service recommends that it should be operated at a larger extension than the municipality segments because of economic reasons.

Where there exists water supply network, following should be specific and different from the household, commercial, or industrial uses:

- the costs;
- administrative procedures to contract; and
- the technical requirements to be connected to INAA's network.

Meanwhile, the municipality, representing the citizens and protecting their interests, should maintain close ties with INAA, such as to make sure that the water supply service expansion plans (which is already examined with a feasibility study) be fulfilled as scheduled.

Now and in future, a public education program regarding water management (e.g., to save water, to protect the sources, etc.) should be considered by all related institutions and be substantiated.

L.3.3 DWW Management

L.3.3.1 Definition of Area by Method of Treatment/Disposal

Unit cost per person for a DWW treatment project decreases in proportion to the population served by a project increase. This is so called scale merit of project (scale of economy).

In general, sewage treatment projects (i.e., off-site system) are planned and implemented based on this theory. On the other hand in the practical side, since substantially longer time is needed to be spent in the improvement of the sewer systems, effect of investment

hardly appears in case where the sanitation improvement is challenged only with sewer improvement.

Outline of M/P on domestic wastewater management (DWWM) is listed in the table below.

Table L-161: Outline of Master plan on DWWM

Item	Present (1995)	(2000)	(2005)	M/P (2010)
FORECAST ON KEY INDICATORS				
Service projected area	16.1 km^2	16.1 km^2	16.1 km^2	16.1 km^2
Service projected population	97,387	115,393	133,753	153,444
Sewer system area	33.6 %	33.6 %	49 %	65 %
No-sewer area	66.4 %	66.4 %	51 %	35 %
On-site system	4.0 %	4.0 %	8 %	12 %
Soak and/or Latrine system	51.8 %	51.8 %	38 %	23 %
No system	10.6 %	10.6 %	5 %	0 %

Sewer (i.e., off-site treatment) coverage rate in Chinandega is presently about 34 % of the urban population, where INAA's plan has the target of covering 65% of total urban population in the year 2010.

Therefore the Study's M/P on DWWM herewith will deploy planning respectively for:

- sewer projected areas in 2010 (as INAA projected); and
- no-sewer areas in 2010.

Furthermore, "no-sewer areas" in 2010 will comprise:

- the areas where the water supply is provided (about 20% of the urban population); and
- the areas where the water supply is not provided (about 15% of the urban population).

In this context, the M/P deploys planning for:

- the management of nightsoil and DWW for "with water without sewer" areas; and
- the management of nightsoil for "without water" areas.

In practice, since it is estimated that DWWM in "sewer area" will be achieved through the INAA's sewer development plan, the M/P will basically follow the INAA's plan for the "sewer area", and it will be reviewed if necessary. On the other hand, the M/P will independently deploy planning for the DWWM in "no-sewer" areas.

a. Definition of Area

The service projected area is defined as the estimated urban area in the year 2010, which comprises: the water supply areas; and the no water supply areas. Furthermore, the water supply areas should consist of 2 areas: the areas where off-site treatment/disposal

system (i.e., sewer) is rationally suited; and the area where on-site treatment/disposal system is rationally suited.

In practice, off-site system areas in year 2010 will comprise:

- present sewer coverage areas; and
- the areas where the future sewer extensions planned by INAA will be provided by the year 2010.

On the other hand, on-site system areas in the 2010 will comprise:

- the areas where the future sewer system by INAA will not be provided by the year 2010;
- the areas where the future sewer system by INAA will not be provided even after the year 2010; and
- the areas where the future sewer system by INAA by 2010 is planned but its provision will not be easily extended due to topographical constraints, etc.

Meanwhile, the area subject to nightsoil only treatment/disposal system (i.e., latrine system) are the area which are within the service projected areas but where the water is not supplied in 2010.

b. Sewer Service Area by and after 2010

b.1 Sewer Service Area by 2010

According to INAA's pre-F/S, areas subject to "sewer provision by 2010" lie on "urban area in 2010" only. The Study estimates that the areas where sewer provision will be achieved by INAA with relative ease by the year 2010 are subject to off-site system (sewer). Meanwhile the Study plans "on-site system" for the areas where sewer provision will not be easily achieved, as a tentative measure till the sewer provision. When sewer is provided in such areas, on-site system being abandoned, connection to sewer should be realized.

b.2 Sewer Service Area after 2010

The M/P has its target year 2010 and the urban area after 2010 are not defined at this moment. Areas subject to "sewer provision after 2010" lie on "urban area in 2010" and "urban area extension after 2010".

The Study plans on-site system for the areas subject to "sewer provision after 2010" and on "urban area in 2010". The M/P recommends that the on-site system in those areas be abandoned when sewer system are provided there sometime after 2010, and off-site system(sewer) should be utilized. The M/P does not deal with the areas of "urban area extension after 2010".

c. Non-sewer System Area

c.1 Water Supply Area

Considerable amount of domestic wastewater might be generated in such areas due to water supply provision. Therefore, an on-site system to treat and dispose both nightsoil and DWW will be proposed.

c.2 Non Water Supply Area

Amount of domestic wastewater generated might be substantially small in such areas due to no water supply. Therefore, an on-site system to treat and dispose only nightsoil will be proposed.

d. Step-wise Improvement Plan

Actual practices for improving USE with regard to domestic wastewater comprise:

- DWWM by sewer system;
- DWWM by on-site system; and
- Nightsoil management by latrine system in no-water supply areas.

The stepwise improvement plan should promote the USE improvement by combination of the above practices (i.e., an appropriate practice be applied based on respective situation) and in consideration of step by step development in time frame.

In practice, M/P on DWWM by sewer system basically follows the INAA's plan. As for the situation in the areas other than covered by INAA sewer, the more populated area might have more suffered with USE deterioration.

Followings are proposed in view of the situations in non-sewer areas:

- Improvement through on-site system should be carried out "area-wise" in the order of from an area with higher population density to an area with lower density; and
- As population density in no water supply areas are very low, ranking indicator for such areas might not be clearly defined. However, judging from that the areas adjacent to on-site system areas might become more populated in future (than other no water area), "area-wise" improvement with latrine system will be started from the area adjacent to on-site system areas.

L.3.3.2 Future DWW Amount and Quality

a. Sewer System

a.1 Forecast of Future Sewage Amount

INAA estimates the sewer served population in 2010 as 99,739. However, sewer served population in intermediate years are not estimated by INAA. Therefore, Study estimates its increase from the present served population to estimated served population in 2010 be lineal, sewage treatment amount in future based on the estimate are listed in Table L-162.

Table L-162: Forecast of Future Sewage Amount

Year	Urban Population	Sewer Served Population	Sewage Amount (daily average flow, m^3/day)
1995	97,387	32,752	6,591
2000	115,393	38,772	6,165
2005	133,753	77,412	12,277
2010	153,444	99,739	15,818

a.2 Forecast of Future Sewage Quality

a.2.1 Pollution Loading Ratio (PLR)

Sewage quality and quantity are characterized with "pollution loading ratio (PLR)" and "sewage discharge ratio".

WPLS in the Phase I of the Study resulted pollution loading of: BOD 56.5g/person/day; COD 122.3g/person/day; and SS 100.3g/person/day. WPLS resulted average "water consumption ratio" being 232litter/person/day. INAA sets up "sewage discharge ratio" to be 80% of the "water consumption ratio". It derives 185litter/person/day for "sewage discharge ratio".

Table L-163 shows: the sewage quality calculated based on the above data; and INAA's measurement on sewage quality entering the treatment plant.

Table L-163: Comparison of Sewage Quality

		BOD	COD	SS
By Results of WPLS	PLR (g/person./day)	56.5	122.3	100.3
	Concentration (mg/l)	305	661	542
INAA measured (mg/l)		360 to 480	594 to 840	270 to 329

Table L-164 shows PLR calculated from the INAA measurement on sewage quality, sewage treated amount in 1995 (6,591m^3/day) and the sewer served population (32,752 persons). It also shows some examples of PLR on BOD and SS in other countries as references.

Table L-164: Comparison of Water Pollution Loading Ratio

		BOD	COD	SS
Based on INAA's Data	Concentration (mg/l)	360 to 480	594 to 840	270 to 329
	PLR (g/person/day)	72.4 to 96.6	119.5 to 169.0	54.3 to 66.2
Examples in other Countries	Kampala, Uganda	63	-	-
	San Paulo, Brazil	44	-	-
	India	35	-	-
	USA	76 to 100	-	46 to 91
	Japan	64 to 84	-	13 to 56
	WHO (recommendation)	45	-	-

In comparison of the BOD data, the PLR of BOD in Chinandega based on INAA measurement (72.4 to 96.6 g/person/day) is extremely high. This could be attributable to the measurement frequency. In other words, the error might be attributable to the calculation that analysis results once in a few months are applied as the annual representing figure on BOD. Therefore, the M/P sets up the PLR design indicators as shown in the table below based on the WPLS results. It is estimated that the PLR design indicators set up remain constant to the future in the same value.

Table L-165: Pollution Loading Ratio for M/P

	BOD	COD	SS
Results of WPLS (g/person/day)	56.5	122.3	100.3
PLR Design Indicators (g/person/day)	57	123	101

Meanwhile, INAA designates the design indicator on "sewage discharge ratio" as 160litter/person/day. In this connection, the M/P also employs this value. Sewage quality (i.e., concentration) calculated from this value (sewage discharge ratio) and the PLR design indicators set up as shown in Table L-165 and their round figures as the "sewage quality design indicators" are listed in Table L-166.

Table L-166: Future Sewage Quality

	BOD	COD	SS
PLR Design Indicators (g/person/day)	57	123	101
Concentration (mg/l)	356	769	631
Sewage Quality Design Indicators (mg/l)	360	770	640

b. On-site System

Since sewage quality to be dealt with on-site system is deemed same as what dealt with in the sewer system, the same design indicators (on "sewage discharge ratio", "pollution loading ratio" and "sewage quality") for sewer system are employed as those for on-site system. The table below shows forecast of on-site system treatment amount.

Table L-167: Forecast of On-site System Treatment Amount

Year	Urban Population	On-site System Population	On-site System Treatment Amount (daily average flow, m^3/day)
1996	97,387	3,895	623
2000	115,933	4,616	739
2005	133,753	10,699	1,712
2010	153,444	18,413	2,946

L.3.3.3 Selection of an Optimum Technical System

In this section, technical systems of DWWM is examined to select an optimum technical system which will be proposed in the Master Plan.

a. Criteria for Selection

Taking the current situation and background of SWM in Chinandega city into account, the policies for the selection of a technical system are as follows:

1) Systems and technologies to be adopted should be as simple as possible so that operation and maintenance would be easy and inexpensive;

2) The foreign currency requirements for the purchase, operation and maintenance of systems should be minimized. The use of locally available materials and services should be maximized;

3) The use of labor intensive rather than capital intensive techniques should be used where technically feasible and economically viable; and

4) Technical system proposals have to be consistent with the institutional requirements should be maxim to ensure their efficiency.

b. Examination of an Optimum Technical System

b.1 Sewer (Off-site) System

b.1.1 Collection System

Collection systems for domestic wastewater comprise: the system to collect only sewage ("separate sewer system (SSS)"); and the system to collect both domestic wastewater and pluvial water ("combined sewer system (CSS)").

SSS has the merit to employ smaller dimensions in sewers (than that for CSS), but has the demerit of requiring another sewer system for draining stormwater. Therefore, total cost of installing SSS will be higher than the cost of installing CSS. However, since stormwater intrusion in the case of SSS even when raining is much smaller (than the case of CSS) and therefore sewage flow is constant, SSS is preferable in view of sewage treatment.

CSS collects domestic wastewater and stormwater together when raining, therefore a large peak is created in the flow entering the sewage treatment plant. Treatment capacity of sewage treatment plant is in general designed for sewage flow at no raining conditions. Therefore, peak flows of stormwater and sewage water mixture over the design flow are directly discharged to public watercourses without treatment. It contributes to the pollution on public watercourses.

The present domestic wastewater collection system in Chinandega employs SSS which is preferable for preventing the public watercourses contamination, and at the same time the INAA's plan on future sewer expansion in Chinandega proposes SSS. Therefore the M/P abides by SSS for domestic wastewater collection system in Chinandega.

b.1.2 Treatment System

Treatment systems for domestic wastewater comprise: the system to treat the wastewater employing acceleration of microbiology functions (activated sludge style system); and the system to treat the wastewater employing algae and microbiology functions (facultative lagoon style treatment).

The activated sludge style treatment has the merit of capacity to treat a large quantity of the domestic wastewater to a significantly improved quality requiring a small land area for the facility. On the other hand, costs of its construction, operation and maintenance are extremely large compared with the facultative lagoon style treatment.

The facultative lagoon style treatment has the merit of much smaller costs in its facility construction, operation and maintenance compared with the activated sludge style, although it requires larger land use for lagoons. Consequently it has a much more applicability for the developing countries.

The present domestic wastewater treatment system in Chinandega is facultative lagoon style and INAA's plan on future sewage treatment in Chinandega proposes aerated lagoon treatment through aerators installation in the present facultative lagoon. Therefore, in view of efficient and effective utilization of existing systems and plans, the M/P abides by the INAA's plan on future treatment system.

b.2 Non-sewer (On-site) System

Domestic wastewater mainly consists of nightsoil and DWW. Treatment of domestic wastewater is categorized mainly into three: nightsoil exclusive treatment; DWW exclusive treatment; and nightsoil/DWW composite treatment. Table L-30 summarizes on-site systems and the components of respective on-site system.

The on-site systems comprise: "individual on-site system" and "collective on-site system". The individual on-site system has a treatment at the generation points (i.e., in a premises) and the collective on-site system has its collective treatment/disposal system outside of the plural generation points (i.e., in a separate location).

The conceptual M/P examines the intrinsic situation of the areas subject to on-site system and proposes appropriate system(s) for the situation.

Table L-168: On-site System Components

Type of wastewater	Name of System	Toilet System	Collection System	Typical Treatment and/or Disposal	
				Method	Mechanism
Night soil	On-site Disposal System	- Latrine - VIP latrine - Pour-flush toilet	Non	Soak pit	Soak to ground
	On-site Storage with Off-site Treatment System	- Vault toilet	- Special cart - Special Vehicle	Throw into sewer system	Combine sewerage treatment
				Digestion and gas recovery with tricking filter	An-aerobic decomposition and aerobic decomposition
				Digestion and gas recovery with activated sludge method	Aerobic decomposition and aerobic decomposition
	On-site Treatment System	- Pour flush toilet - Cistern-flush toilet	Non	Septic tank	An-aerobic decomposition
				Simple jokaso	An-aerobic and/or aerobic decomposition
Night soil + Sullage	On-site Disposal System	- Cistern-flush toilet - Pour-flush toilet	Non	Soak pit	Soak to ground
	On-site Treatment System	- Pour flush toilet - Cistern-flush toilet	Non	Septic tank	An-aerobic decomposition
				Combined jokaso	An-aerobic and aerobic decomposition
	On-site Collective System	- Pour flush toilet - Cistern-flush toilet	Pipe line	Septic tank	An-aerobic decomposition
				Combined jokaso	An-aerobic and aerobic decomposition
Sullage	On-site Disposal System	-	Non	Soak pit	Soak to ground
	On-site Treatment System	-	Non	Septic tank	An-aerobic decomposition
				Combined jokaso	An-aerobic and aerobic decomposition
	On-site Collective System	-	Pipe line	Septic tank	An-aerobic decomposition
				Combined jokaso	An-aerobic and aerobic decomposition

b.2.1 Nightsoil Treatment and Disposal System

Nightsoil treatment/disposal systems , being closely related to "toilet systems", comprise the following three types.

Type-1 On-site Disposal System

Latrine (pit latrine), VIP(ventilated improved pit) latrine, Pour-flush toilet with pit are categorized into this type (i.e., Type-1: On-site Disposal System). Main advantageous features of this type are:

- the construction is easy;
- it has an effect on some diseases prevention (since the system prevents breeding of flies and mosquitoes); and
- the operation and maintenance costs are cheap.

On the other hand, the system has a disadvantage that it might probably contaminate the underground water if the groundwater table is comparatively high or the ground is relatively permeable, since nightsoil is infiltrated to the ground without disinfection.

Type-2 On-site Storage with Off-site Treatment System

Vault toilet, which was widely employed in the developing stages in Japan, is categorized into this type. (i.e., Type-2: On-site Storage with Off-site Treatment). It prevents the risks of underground water contamination, which is a disadvantage of Type-1. However, it additionally requires measures of transport/treatment/disposal of the stored nightsoil and comparatively higher cost of facility construction, operation and maintenance will accrue.

Type-3 On-site Treatment System

Pour-flush toilet with septic tank or simple jokaso, Cistern-flush toilet with septic tank or simple jokaso are categorized into this type (i.e., Type-3: On-site Treatment System). Since this type is equipped with treatment function, it prevents risks of groundwater contamination and nuisance of periodical transport of stored nightsoil. On the other hand, costs of facility construction, maintenance and operation is the most expensive among the three types.

"Septic tank" system facilitates anaerobic digestion of nightsoil and DWW retained in a single or plural pits. It substantially achieves separation of solid contents, reduction of E.coli. However, the septic tank system lacks efficiency in removal of organic polluting substances.

"Jokaso" is the system that "septic tank" is followed by a secondary treatment (e.g., "trickling filter", "anaerobic filter" and "activated sludge system"). Hence, it removes organic polluting substances more than the septic tank only system. However, its total cost is considerably high and a comparatively high technology is required in its operation and maintenance activities.

b.2.2 Combined with Nightsoil and Sullage Treatment and Disposal System

Treatment/disposal systems for nightsoil and DWW composite, being closely related to "toilet systems", comprise the following three types.

Type-1 On-site Disposal System

"Pour-flush toilet with soak pit", "Cistern-flush toilet with soak pit" are categorized into this type (i.e., Type-1: On-site Disposal System). Main advantageous features of this type are:

- the construction is relatively easy;
- it has an effect on some diseases prevention (since the system prevents breeding of flies and mosquitoes); and
- the operation and maintenance costs are cheap.

On the other hand, the system has a disadvantage that it might probably contaminate the underground water if the groundwater table is comparatively high or the ground is relatively permeable, since nightsoil and DWW are infiltrated to the ground without disinfection.

Type-2 On-site Treatment System

"Pour-flush toilet with septic tank or combined jokaso" and "Cistern-flush toilet with septic tank or combined jokaso" are categorized into this type (i.e., Type-2: On-site Treatment System). This type is to treat both nightsoil and DWW together in-situ, it prevents risks of groundwater contamination and nuisance of periodical transport of stored nightsoil. On the other hand, the facility construction, maintenance and operation requires considerably high costs. The system of "cistern-flush toilet with **combined** jokaso" is still widely used in Japan today where sewer system is not provided.

However, the initial construction cost for "cistern-flush toilet with **combined** jokaso" is considerably high, as well as that for "cistern-flush toilet with **simple** jokaso". Comparatively high technology is further required in its operation and maintenance activities.

Type-3 On-site Collective System

This type employs the same concepts with Type-2 in its treatment and disposal. Whereas the Type-2 is applied for individual households, the Type-3 is applied for plural households. The Type-3 could have a scale-merit compared to the Type-2. The collective system solution (e.g., cistern-flush toilet with **combined** jokaso **for plural households**) is still widely used in Japan today where sewer system is not provided.

b.2.3 Sullage Treatment and Disposal System

Sullage (only) treatment/disposal systems also employ mostly the same technologies or practices as those for the treatment/disposal systems for nightsoil and DWW composite. The systems comprise the following three types. In case that existing systems of nightsoil treatment/disposal are working satisfactorily, the improvement of USE with "DWW treatment/disposal system" becomes effective.

Type 1 On-site Disposal System

The Type-1 basically takes measures of infiltrating DWW to the ground. Main advantageous features of this type are:

- it has an effect on some diseases prevention (since the system prevents breeding of flies and mosquitoes); and
- the operation and maintenance costs are cheap.

On the other hand, the system has a disadvantage that it might probably contaminate the underground water if the groundwater table is comparatively high or the ground is relatively permeable. However, groundwater contamination only by DWW infiltration might be less significant than nightsoil infiltration.

Type 2 On-site Treatment System

Main features of the Type-2 (DWW only on-site treatment) are mostly same as those of the Type-2 for "nightsoil/DWW composite". This system treats the domestic wastewater where it was generated. It prevents risks of groundwater contamination. On the other hand, the facility construction, maintenance and operation requires considerably high costs. Comparatively high technology is further required in its operation and maintenance activities.

Type 3 On-site Collective System

Type-3 also employs the same concepts of Type-2 in its treatment and disposal. Where the Type-2 is applied for individual households, the Type-3 is applied for plural households. The Type-3 could have a scale-merit compared to the Type-2.

b.2.4 Selection of an Optimum Technical System

In view of the on-site system components described above, Table L-121 shows comparison of applicable technical systems to the M/P.

Team evaluates applicability of respective technical system for the M/P reminding the following 3 items:

- facility construction cost should be relatively low;
- operation and maintenance cost should be ranked in medium or low; and
- soil/groundwater contamination by the system should be none or very less.

Consequently, the systems listed below are concluded to be more applicable.

- "Pour-flush toilet with septic tank" of nightsoil exclusive treatment;
- "Pour-flush toilet with septic tank" of nightsoil/DWW composite treatment; and
- on-site system and on-site collective system of DWW exclusive treatment.

Meanwhile, the on-site collective system could have an advantage of scale merit compared to individual systems. Therefore, the Study recommends to optimize the application of the on-site collective system in Chinandega's USE improvement.

Table L-169: Comparison of Applicable Technical System

Type of Wastewater	Name of System	Toilet and Disposal and/or Treatment System	Construction Cost	Operation Cost	Ease of Construction	Water Requirement	Possibility of Soil Contamination	Applicable for the Project
Night Soil	On-site Disposal System	Latrine with Soak Pit	Low	Very Low	Very easy	Non	Yes	No
		VIP Latrine with Soak Pit	Low	Very Low	Easy	Non	Yes	No
		Pour-flush Toilet with Soak Pit	Medium	Very Low	Requires builder	Water near toilet	Yes	No
	On-site Storage with Off-site Treatment System	Vault Toilet	Medium	High	Requires builder	Non	Non	No
	On-site Disposal System	Pour flush Toilet with Septic Tank	Medium	Medium	Requires builder	Water near toilet	Non	Yes
		Cistern-flush Toilet with Septic Tank	High	Medium	Requires builder	Water pipe to house	Non	No
Night Soil + Sullage	On-site Disposal System	Pour-flush toilet with soak pit	Medium	Low	Requires builder	Water near toilet	Yes	No
		Cistern-flush toilet with soak pit	High	Low	Requires builder	Water pipe to house	Yes	No
	On-site Treatment System	Pour-flush toilet with septic tank	Medium	Medium	Requires builder	Water near toilet	Non	Yes
		Cistern-flush toilet with septic tank	High	Medium	Requires builder	Water pipe to house	Non	No
	On-site Collective System	Pour-flush toilet with septic tank	Medium	Medium	Requires builder	Water near toilet	Non	Yes
		Cistern-flush toilet with septic tank	High	Medium	Requires builder	Water pipe to house	Non	No
Sullage	On-site Disposal System	Soak pit	Low	Very Low	Very easy	Non	Yes	No
	On-site Treatment System	Septic tank	Medium	Medium	Requires builder	-	Non	Yes
	On-site Collective System	Septic tank	Medium	Medium	Requires builder	-	Non	Yes

b.3 Sludge Management

Treatment/disposal of sludge generated from sewage treatment varies depending upon the types of sewage sources and its treatment methods.

INAA has the plan of sewage treatment in Chinandga that the existing "lagoon style" treatment be continuously employed and the lagoons will be in future modified to "aerated lagoons" (i.e., aerators will be installed in the lagoon when in future it becomes necessary.). In general, sludge generated from "lagoon style" treatment is very small in quantity and therefore an independent management of on-site generated sludge can generally be neglected in planning.

Sludge generated from on-site treatment facilities is estimated to be about 0.35m^3/person/year. Table L-32 shows forecast of sludge generation amount from the on-site systems proposed in the Study for the years 2005 and 2010. The forecast of sludge generation from on-site facilities in 2010 be about 6,445m^3/year. Assuming that this amount is extracted from facilities in 240 working days, daily sludge generation in 2010 is estimated to be about 27m^3/day.

On the other hand, the lagoon sewage treated amount (or influent volume) in 2010 is estimated to be about 15,800m^3/day. If it is assumed that sludge generated from on-site facilities are discharged into the lagoons, it accounts for about 0.2% of the influent volume. Therefore, it could be considered that INAA's off-site system (i.e., the lagoon) has the capability to manage sludge generated from the on-site systems proposed in the Study. The M/P in this regard proposes sludge generated from on-site systems be disposed into the lagoon of off-site system.

Table L-170: Forecast of Sludge Generation Amount from On-site System

	2005	2010
Served Population	10,699	18,413
Sludge Generation Amount (m^3/year)	3,745	6,445

L.3.3.4 Institutional Requirements

a. Connection to the Sewer

Where there exists sewer network, following should be specific and different from the household, commercial, or industrial uses:

- the costs;
- administrative procedures to contract; and
- the technical requirements to be connected to INAA's network.

A Municipal Ordinance should enforce and orient the citizens, using the permits system in order to connect to the sewer network, during their houses are constructed, if it passes by in front of their houses.

INAA jointly with the municipality and MINSA should prepare a program to connect existing houses to the sewer at feasible costs for the householder.

b. Wastewater Management in Non-sewer Area

b.1 Roles of INAA

Where there does not exist a sewage collector in the street, the citizen must provide an adequate treatment and disposal facility for his/her wastewater. Therefore, this facility should be built/installed according to INAA's technical instructions and INAA might recommend or enforce individual or collective systems for it, depending on which system is suited for respective situations. Municipal Ordinance might enforce the appropriate recommendation.

INAA should build and/or operate collective facilities. In any case, INAA should operate sludge collection service for the local treatment (both individual septic or soak systems and collective systems), and should provide inspection/maintenance services for the on-site facilities. The municipality and MINSA should plan and cooperate with INAA to get the most feasible local solutions for domestic wastewater originated in very poor communities where the sanitary and social conditions are determinants.

INAA should provide the citizens, through the municipality, of the requirements referred in the Annex N.

b.2 DWWCTS

The municipality should establish, by Municipal Ordinance, the obligatory nature of citizens to make an appropriate disposal of their wastewater. For such purpose, viable alternatives and a reasonable assistance will be offered, before applying sanctions as they are established in the Ordinance.

In the micro-regions where sewer system would not be feasible, on-site treatment (preferably a collective system) should be adopted. However for the time being, it should be tolerated with the more primitive solutions of current practices, but with an appropriate sanitary control.

The municipality should coordinate a Special Program for Collective Treatment/Disposal of Domestic Wastewater (DWWCTS) to be developed together with INAA and MINSA, with initial funds granted for the investment since the beneficiaries agree to pay for the operation and maintenance of the correspondent facility. The investments and service payments could be reduced through the beneficiary citizens' burden sharing by participation, which should be stimulated by a community mobilization.

c. Institutions other than INAA

c.1 Municipality

The municipality should improve its organizational structure and personnel in order to:

- Provide norms and directives to the population with respect to the location, sanitary structures and civil procedures to live and work under satisfactory environmental and sanitary conditions;
- Provide services of their own competence, and coordinate and promote services of other entities;

- Emit and implement the Municipal Ordinance proposed in the Annex N, referring to the domestic wastewater management;
- Coordinate with MARENA and MCT, having INIFOM and MINSA as supporting institutions, in order to divide the competence on micro and macro drainage, as it is proposed in the Annex N. This is because the drainage system is closely related to damages done by wastewater which are not conducted by a pipe.

c.2 MINSA

MINSA should increase its capacity to mobilize communities and develop programs of sanitary education, observing not only to DWWCTS, but also to objectives and actions with intersectorial integration proposed (see tables in the Annex N).

L.3.4 Industrial Wastewater Management

L.3.4.1 Major Findings of the Industrial Waste Survey

In spite of that 88% of industrial wastewater in 3 cities contain "hazardous substances" to certain extent, most industrial wastewater (99%) are discharged into sewer/watercourses or soaked into underground without treatment. Contribution of industrial wastewater generation by Leon, Chinandega, and Granada count for 10%, 1%, and 89% respectively.

Industrial wastewater generation amount in Chinandega is estimated 11,896 m^3/year. (see Table L-171)

Table L-171: Waste Generation Amount in Chinandega(1996)

Wastewater (ton/year)	Solid Waste (ton/year)	Total (ton/year)
5,526	6,370	11,896

Wastewater generation amount in Chinandega is estimated 5,500m^3/year. Among other, industries in CIIU3114 (fish and other marine foods), and CIIU3115 (animal and vegetable oils) generate the great majority of IWW in Chinandega. Since those IWW from CIIU3114 & 3115 mainly contains organic compounds, oils and fat, it is less possible that hazardous compounds are contaminated therein. Meanwhile the industries with high potentiality of generating hazardous wastewater in Chinandega is CIIU3512 (fertilizer, insecticides and the likes), whose IWW counts for about 1% to total IWW generated in Chinandega.

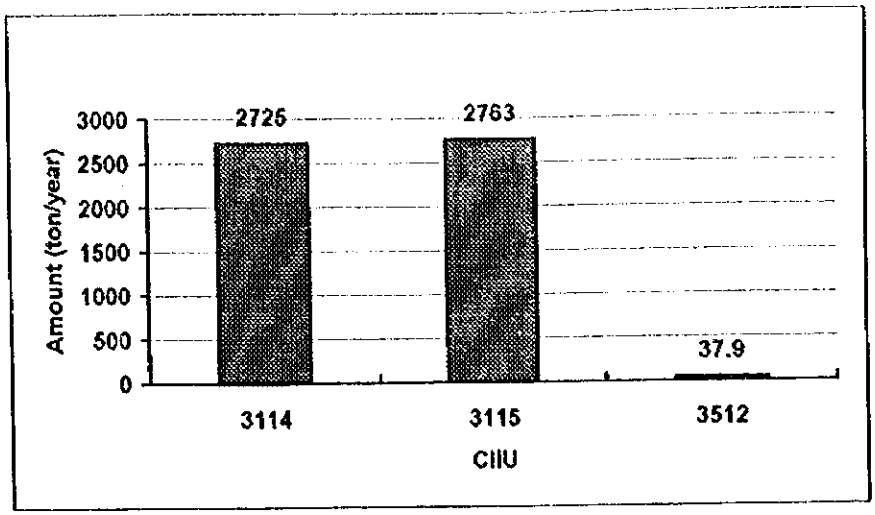


Figure L-54: Wastewater Generation Amount

Since the legislation is newly established, detailed regulations and technical instructions to complement it are not prepared at present. Therefore, current industrial wastewater are mostly discharged without treatment to the environment. Consequently it becomes one of major sources that deteriorate the USE.

L.3.4.2 General Recommendations for the Improvement of the Industrial Wastewater management

a. Technical System

Since the industrial wastewater are generated and discharged as a result of industrial production activities, cost of its safe treatment/disposal should be born by the industries, based on the "polluter pays principle (PPP)".

On the other hand from technological management viewpoint, following will be listed as the key solutions for the problems:

- Reduction of wastewater generation amount and reduction of its generated pollution load by means of production processes (including raw/auxiliary materials) conversions;
- Wastewater treatment by industries themselves in their premises ; and
- Industrial wastewater treatment/disposal by third party (i.e., market mechanism of industrial wastewater treatment/disposal).

In this context, authorities' administrative measures and empowerment in conducting industrial wastewater management are awaited. Since actual application and enforcement of Decree 33-95 will be a key for this management, an integrated mechanism to bind both industries and authorities in facilitating the appropriate industrial wastewater management should be sought and established.

b. Institutional System

b.1 Roles of Organizations Concerned

MARENA is the competent authority for the management of industrial solid waste (ISW) and industrial wastewater (IWW) by the Law No. 217-96 and Decree 33-95.

MARENA should establish the regulations related to ISW and IWW, as well as restrictions for its disposal and the operational limits of the municipality. It should also expedite easily understandable instructions to facilitate technical information to the IW generators, professionals, university students, and those interested in about IW and the IW management services that can be provided for industries in Nicaragua. On the other hand, MARENA should help and encourage industries in finding accessible financial resources or grants to support their projects of IW treatment/disposal and/or "cleaner production".

The municipality, on the other hand, should not collect nor accept ISW in the municipal landfill, until the waste are certified as **"non-hazardous"**. and such certification should be provided by MARENA. MARENA should originate the instructions with which the municipality could guide industries located in the city area. Meanwhile, the competence to inspect and penalize the IW management belongs to MARENA and MINSA. INAA is also competent whenever they receive wastewater. The Municipality can establish legal and technical norms restricted to the municipality which can not be more tolerant than the national norms (see Annex N).

The Annex N shows "Instructions and/or Regulations (as well as Tables with Strategies and Intersectorial Integration)" which is recommended for MARENA, and complementarily for MCT, MINSA and the Municipality.

b.2 Polluter Pays Principle (PPP) and Authorities' Management

The IW are qualitative and quantitative dependent of the type of industry, industrial process, of the raw materials, source of energy, and the management of the generator establishments, especially the training and discipline of the personnel, also the equipment maintenance and the working environment.

The IW is strictly industries' responsibility. Since the costs of IW management are included in the products price, the company that generates non-hazardous IW and/or less IW, they could achieve lower production cost. In addition, the "environmentally friendly products" are commonly an important marketing element with respect to customers consciousness.

It is an premise universally accepted premise: **"The generator is responsible for the waste generated by him or her"**, i.e., he or she is responsible for the management of the waste and its effects on the environment and public health, with all the costs to be born therewith. These costs constitute an incentive to minimize waste, in other words, it encourages a "clean production" which is the objective of a competitive and environmentally-conscious industries.

In general, the largest part of ISW results from the industrial effluents, therefore, the management on ISW and IWW should consider all the IW in total.

The consulting and operational services related to IWM constitute an attractive economic activity, once the market has reached certain level. In this context, the public authorities could create the situation that makes such economic activity (ISWM by private sectors) viable, which solves the problems involved with industrial contamination and pollution when the regulations for the IW management is established and its requirements are enforced obviously in a stepwise manner in a feasible time frame. The municipal/national government should not invest more than necessary for

the studies, cadastres, regulation, technical information, inspection, monitoring and sanction to the transgressor when it is related to IW.

L.3.5 Storm Water Management

The tendency of damage in the inundation prone areas in each city was recognized by the questionnaire survey conducted in the first work in Nicaragua. The result indicated that the damage was a serious problem for the three cities.

It was inferred from the result of the questionnaire survey and the field reconnaissance that inundation causes would be classified into two major types and in detail for minor types as shown in the following table.

Table L-172: Inundation Prone Area Classification

Principal Classification	Detailed Classification	Features
1. Areas with drainage channels (mainly located in the urban area)	1.1 These areas are located at downstream of larger catchment area	1.1 Large amount of water flows into these areas from the hinterland catchment area. These areas usually experience considerable flood damage.
	1.2 These areas are located in a smaller drainage basin, which mostly overlaps with the study area.	1.2 Inundation occurs because the drainage channels in these areas are small or clogged with waste. The damage is comparatively small.
2. Areas without drainage channels (mainly located in the urban fringe)	2.1 Flood plain (i.e., inside river banks)	2.1 Flooding occurs when the water level of the river or stream rises due to heavy rain.
	2.2 others	2.2 These areas are located in lowlying areas and lack of road and roadside drains intensifies the damage.

The result on inundation damage survey is limited only on the basis of interview and field reconnaissance, because there are no base data such as detailed topographical maps, river regime. And to obtain these data in this study is physically impossible as it requires considerable time and resources.

L.3.5.1 Identification of Inundation causation

The following table shows inundation causation in each areas and Figure L-55 shows the inundation prone areas in Chinandega City.

Table L-173: Inundation Causation

No.	Name of Area	Classification	Damage	Causation
1	Buenos Aires, 12 de Septiembre, Abraham Rugama	1.1	Destruction of a road and bridges, inundation of houses, occurrence of epidemic	The water flow which used to go down through the watercourse along the east side of the area comes to the west side of the area due to the destruction of the wall in the upper stream. Because of the small scale of the watercourse along the west side, it often floods. This cause damage to houses, roads and bridges.
2	Miriam Tinoco	2.2	inundation of houses, occurrence of epidemic	The roads in the area used to be low, so that it was heavily damaged when the 'Acome' river flooded. However, the problem was solved, because the roads were risen up and block-paved.
3	Ana Virgen Roble	2.2	ditto	The area was developed without a urban plan. The part along the Acome river in the area is higher than other areas, and there is no drains.
4	David Andino	2.2	ditto	This area is next to the above area. The situation is the same as it.
5	Pablo Sabala	2.1	ditto	The area is located on the Acome riverbed. It is almost the same level as the river.
6	Carlos Fonseca	2.2	ditto	The area expands along the former railroad. The water comes form the upper area along the bank of the railroad.
7	Florida	2.2	ditto	This is low land. It has no drains and no paved roads. The water comes from the northern area.
8	Augusto Cesar Sandino, Rubén Darío, Pedro Joaquín Chamorro	2.2	ditto	The same as above.
9	Resistencia	2.2	ditto	The same as above.
10	José Benito Centeno	2.2	ditto	The same as above.

Almost all the inundation prone areas in Chinandega used to be agricultural land, and were developed without a urban plan. Generally, the inhabitants in the areas are low income people. These areas are low compared with the surrounding areas, the infrastructure such as roads and drains is insufficient. The inundation is caused by the water flow from the surrounding high land through the paved roads.

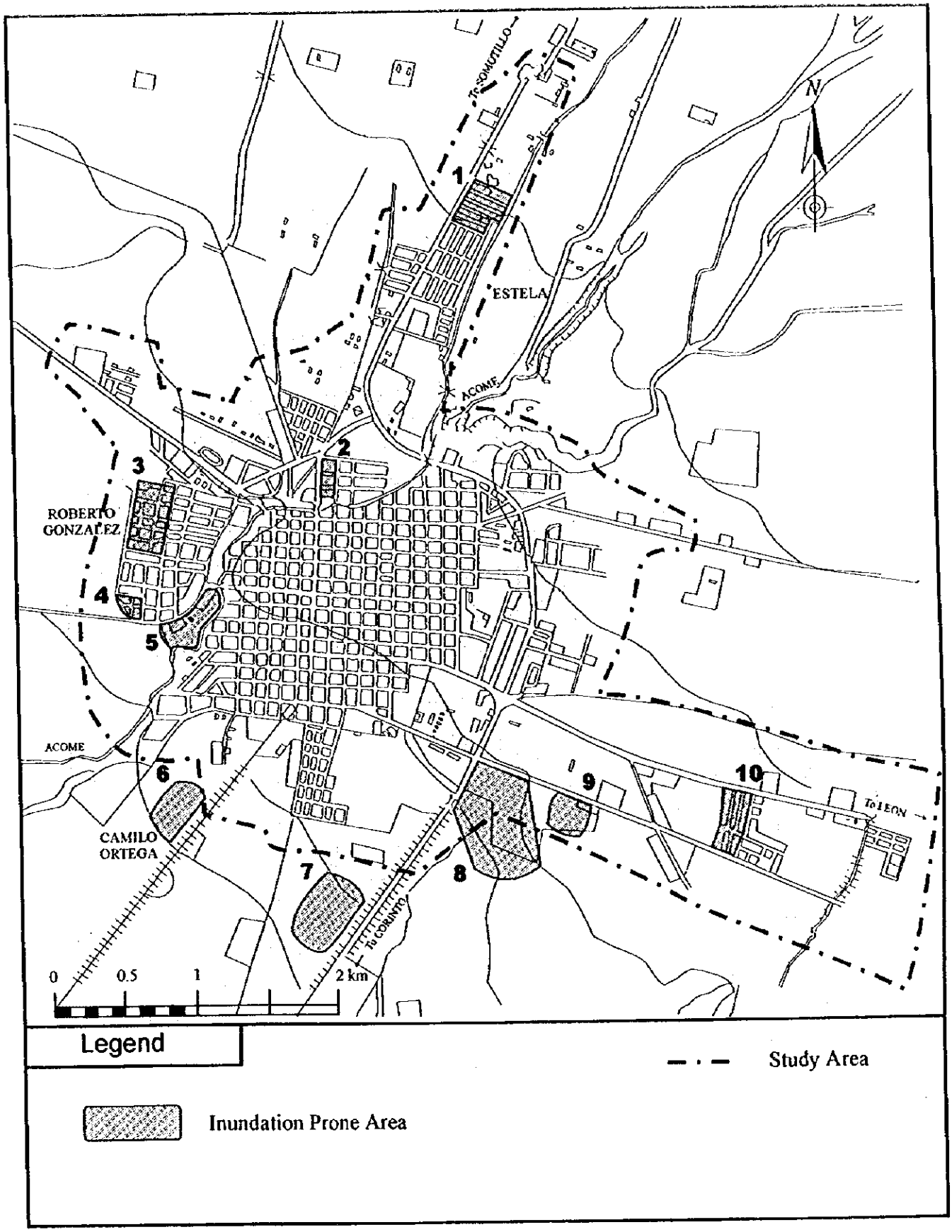


Figure L-55: Inundation Prone Area in Chinandega