

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

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NICARAGUA INSTITUTE OF MUNICIPALITY
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THE REPUBLIC OF NICARAGUA

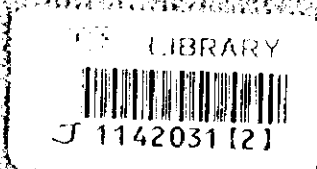
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**THE STUDY ON
THE IMPROVEMENT OF
URBAN SANITATION ENVIRONMENT
OF
PRINCIPAL CITIES
IN
THE REPUBLIC OF NICARAGUA
(LEON, CHINANDEGA, AND GRANADA)**

**FINAL REPORT
VOLUME III**

MAIN REPORT FOR THE FEASIBILITY STUDY

JANUARY 1998



KOKUSAI KOGYO CO., LTD.

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PREFACE

In response to the request from the Government of the Republic of Nicaragua, the Government of Japan decided to conduct the Study on the Improvement of Urban Sanitation Environment of Principal Cities in the Republic of Nicaragua and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Nicaragua a study team headed by Mr. Susumu Shimura, KOKUSAI KOGYO CO., LTD., four times between July 1996 to November 1997.

The team held discussions with the officials concerned of the Government of Nicaragua, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Nicaragua for their close cooperation extended to the team.

January, 1998



Kimio Fujita
President
Japan International Cooperation Agency

January 1998

Mr. Kimio Fujita
President
Japan International Cooperation Agency

Dear Mr. Fujita

Letter of Transmittal

We are pleased to submit the report on the Study on the Improvement of Urban Sanitation Environment of Principal Cities in the Republic of Nicaragua.

The Study consists of: the Basic Study on the USE (Urban Sanitation Environment) for the three major cities in Nicaragua (Leon, Chinandega and Granada); formulation of the USE M/P (Master Plan) until the year 2010 for Granada and the USE Conceptual M/Ps for Leon and Chinandega; and the F/S (Feasibility Study) on the first priority projects.

The Basic Study on the USE identified the current state of the USE in the three cities which was evaluated. Based on the results of the Basic Study, Granada City was selected as the first priority city.

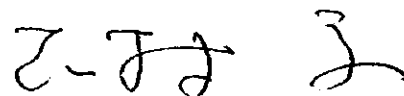
An USE M/P, which includes various sectors, such as water supply, domestic waste water management, municipal SWM (Solid Waste Management), etc., was formulated for Granada City. USE Conceptual M/Ps were compiled for Leon and Chinandega respectively in order to encourage the two cities to formulate M/Ps and subsequently carry out F/Ss on the priority projects by themselves.

The feasibility study was conducted on the first priority projects in the USE M/P for Granada, i.e. the Municipal SWM System Improvement Project and the Model Community Integrated USE Improvement Project. Both projects were evaluated from financial, economic, technical, social and environmental aspects. The results inferred the projects would be feasible in every aspect.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, the Ministry of Health and Welfare and the Ministry of Construction. Also in the Republic of Nicaragua, we also wish to express our deep gratitude to the INIFOM, MCE, INAA, MINSAs, MARENA, INETER, Granada Municipality, Leon Municipality, Chinandega Municipality, the Embassy of Japan and the JICA office in the Republic of Nicaragua.

Finally, we hope that this report will help improve and enhance the USE of Granada, Leon and Chinandega.

Yours Sincerely,



Susumu Shimura
Team Leader
The Study on the Improvement of Urban
Sanitation Environment of Principal Cities
in the Republic of Nicaragua

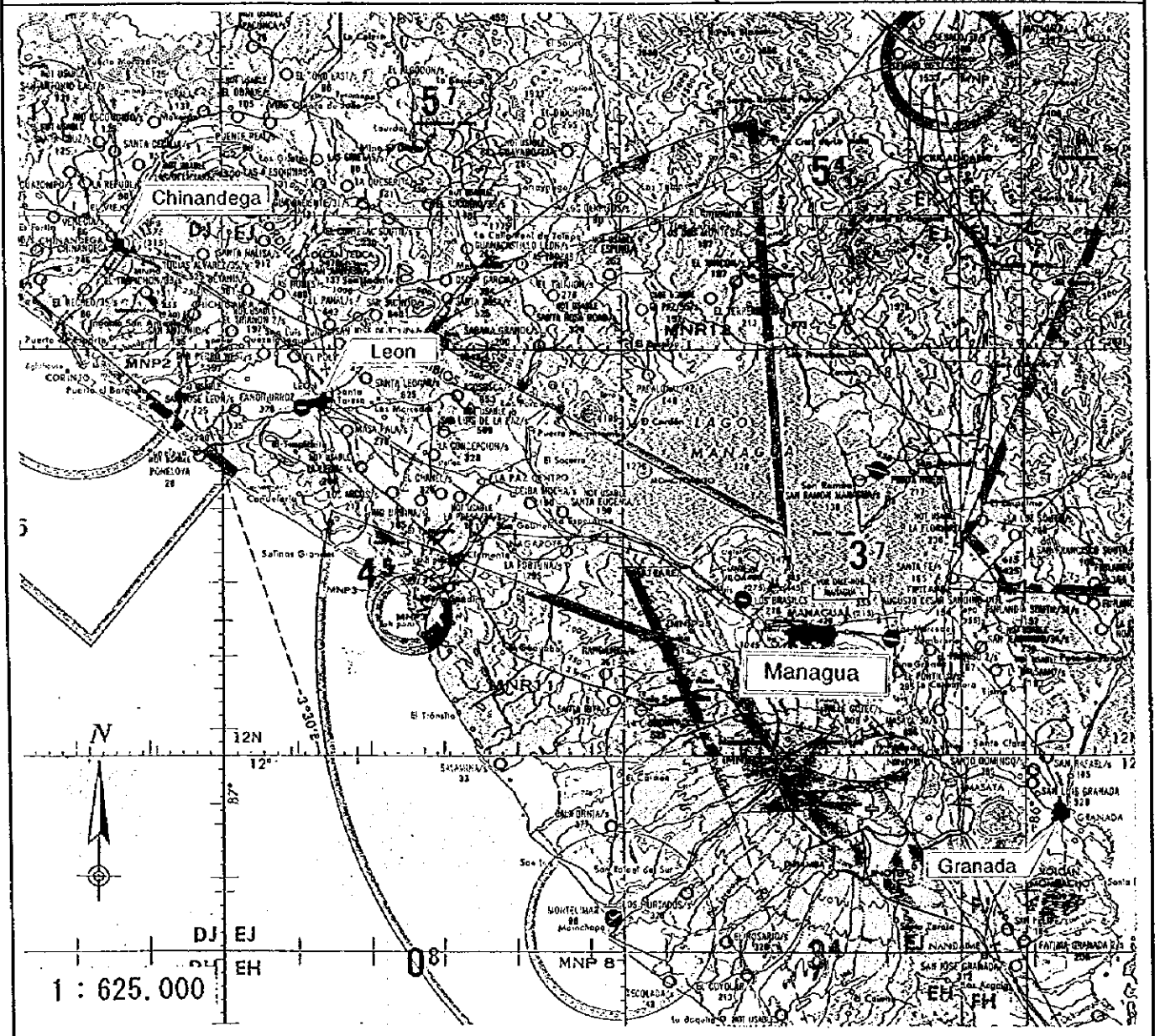
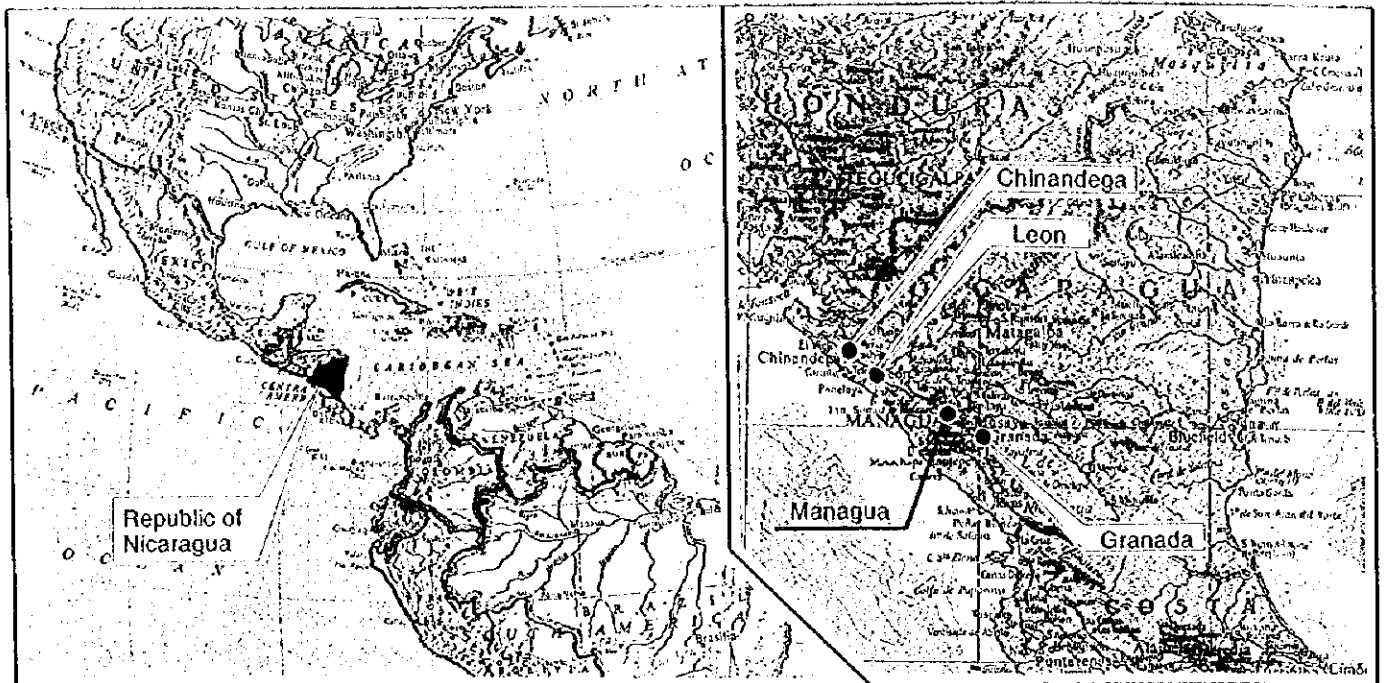
**The Study on the Improvement of Urban Sanitation Environment
of Principal Cities in the Republic of Nicaragua
(Leon, Chinandega, and Granada)**

List of Volumes

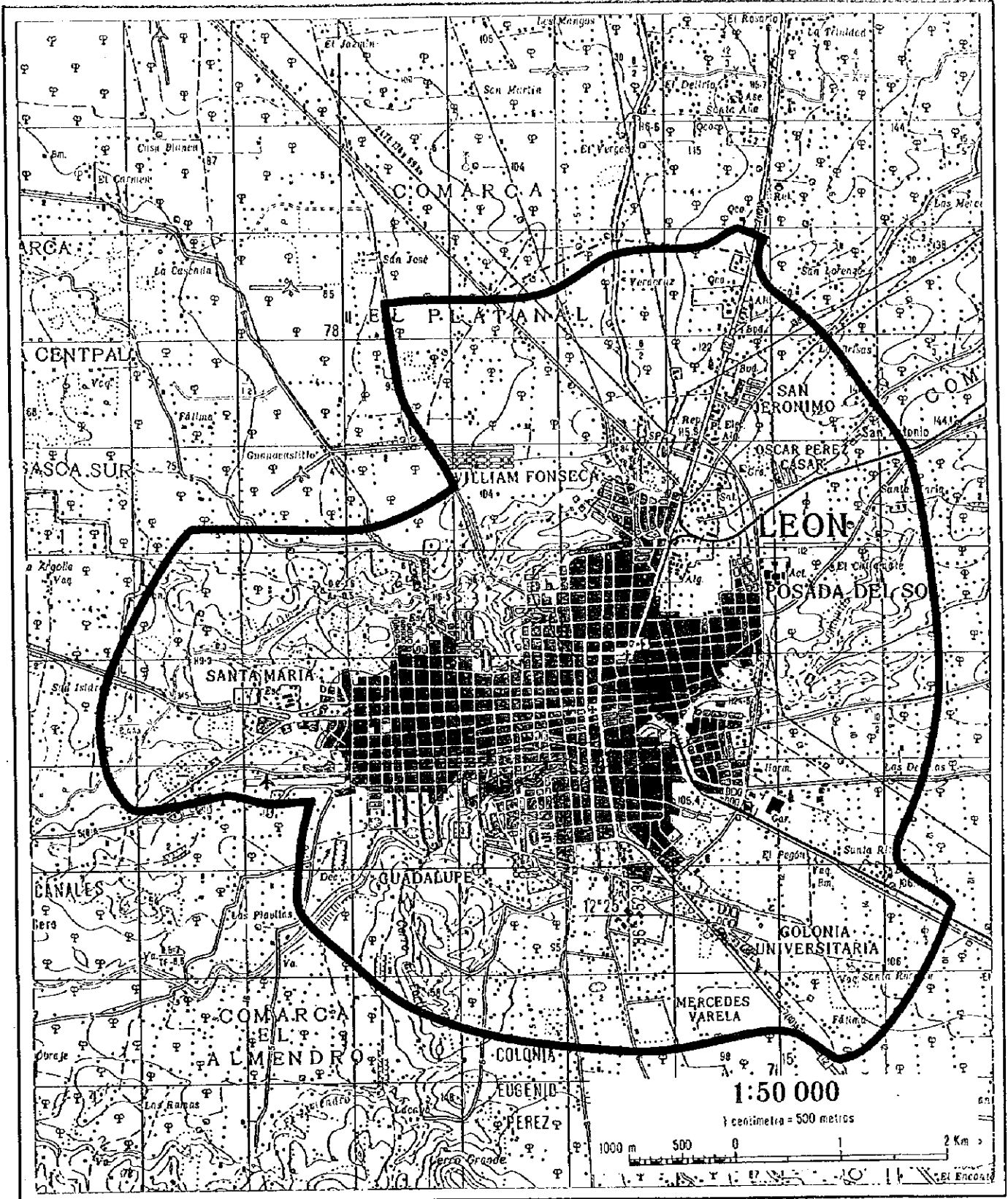
- Volume I Executive Summary
- Volume I(S) Executive Summary (Spanish Version)
- Volume II Main Report for the M/P and Conceptual M/Ps
- Volume II(S) Main Report for the M/P and Conceptual M/Ps (Spanish Version)
- Volume III Main Report for the Feasibility Study
- Volume III(S) Main Report for the Feasibility Study (Spanish Version)
- Volume IV Annex
- Volume V Data Book

This is the Main Report for the Feasibility Study.

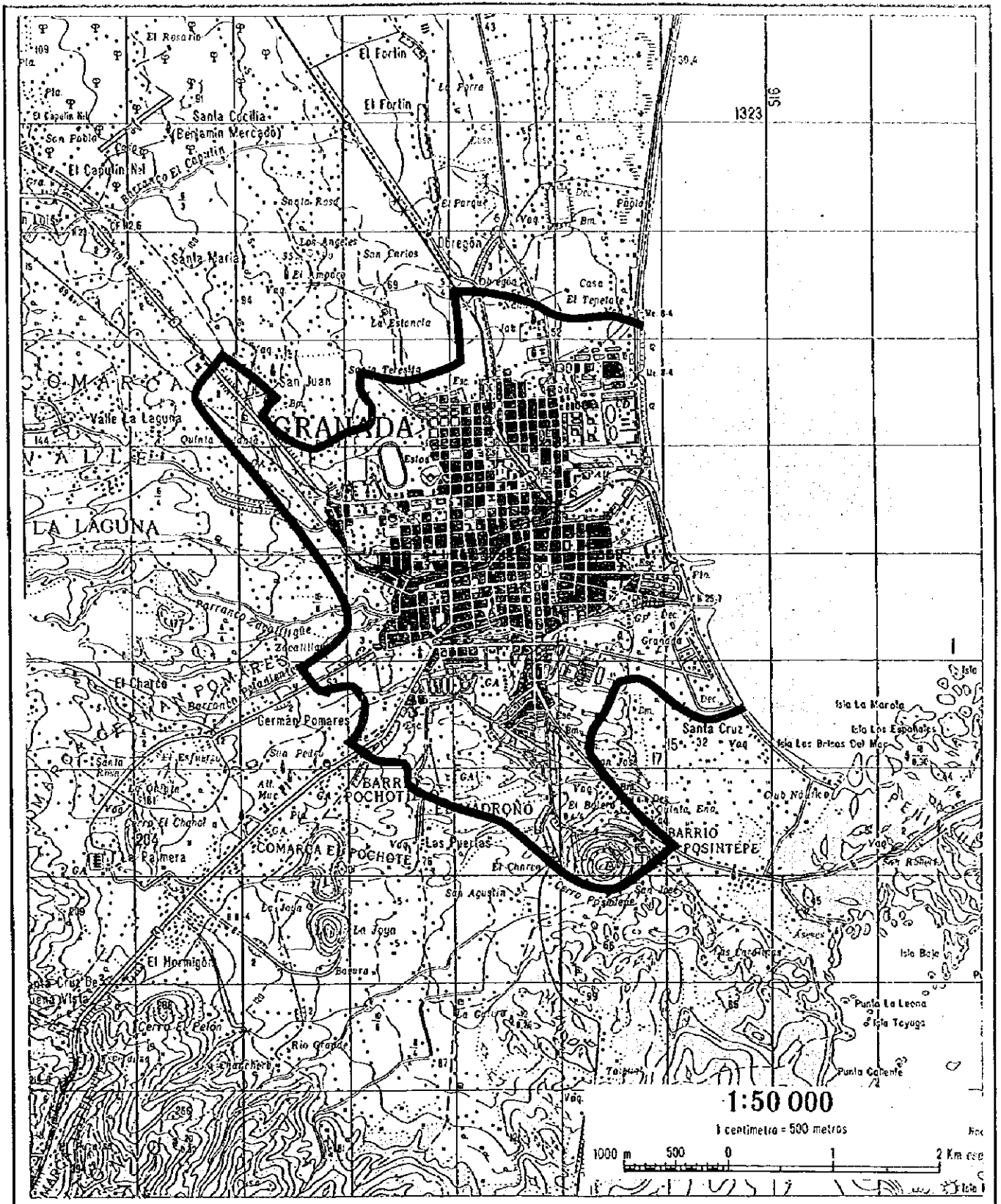
In this report, the project cost is estimated using the September 1997 price and at an exchange rate of 1US\$ = 120.00 Japanese Yen = 9.60 Cordoba.



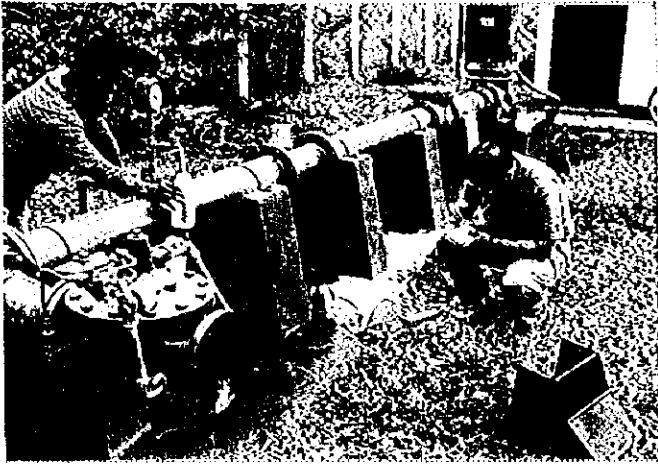
Map 1: The Location Map of the Study Area



Map 2 : The Location Map of the Study Area (Leon)



Map 4 : The Location Map of the Study Area (Granada)



Water Quality Survey

Sampling in a well used for water supply in Granada.



Water Quality Survey

Checking waste water from the present sewage plant.



Water Quality Survey

The present situation of the Chiquito river in Leon.



Water Pollution Loading Survey

A manhole which is a sampling point for the survey.



Waste Amount and Composition Survey
Sampling for the waste composition survey.



Waste Amount and Composition Survey
The physical composition analysis.



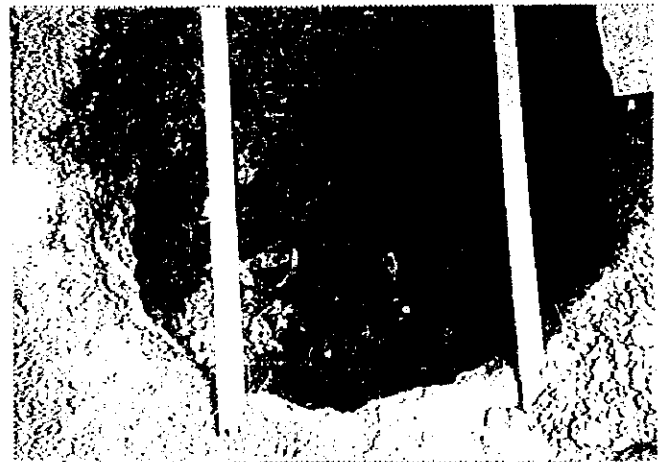
Industrial/Medical Waste Survey
A flour milling factory. Industrial waste survey is carried out through interviews and field surveys to factories.



Industrial/Medical Waste Survey
Inside of a soap factory in Granada.



Industrial/Medical Waste Survey
Discharged medical waste is collected and disposed of in the final disposal site together with municipal solid waste without separating.



Industrial/Medical Waste Survey
Infectious/hazardous waste is burned off and buried inside a hospital yard.

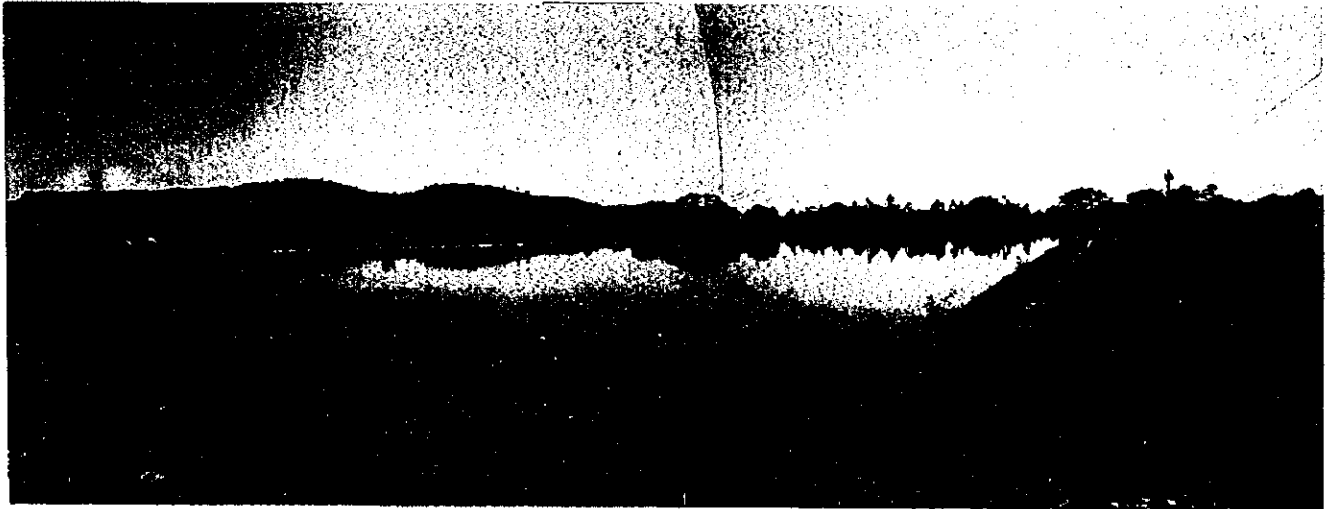
Plate 3 : Present Situation of the Urban Sanitation Environment (I) Leon



The municipal final disposal site in Leon located on top of a hill spreads not only soil and groundwater contamination in its down stream but also air polluted and scenic damages on the landscape.



Rio Chiquito is polluted with industrial waste water of tannery, soap/detergent factories.

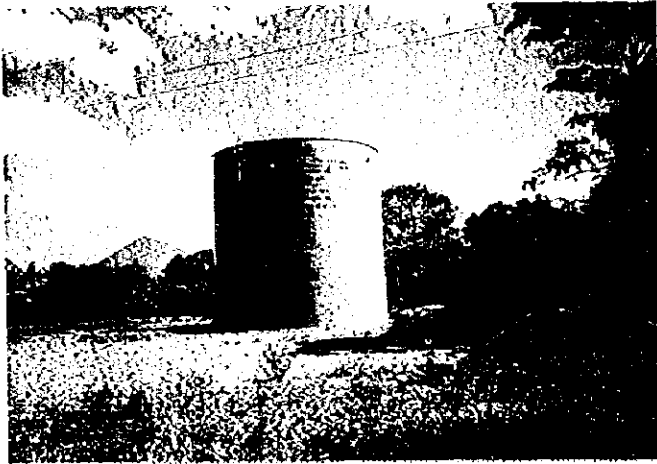


El Cocal Sewage Treatment Plant.



The final disposal site receives industrial waste without control.

Plate 4 : Present Situation of the Urban Sanitation Environment (2) Chinandega



They use groundwater for service water. The groundwater pumped up is delivered to water tanks in the city to supply water to residents.



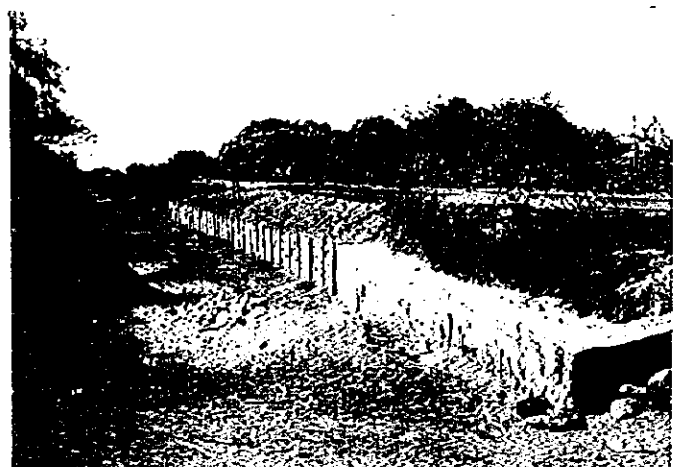
A scene of waste collection service.



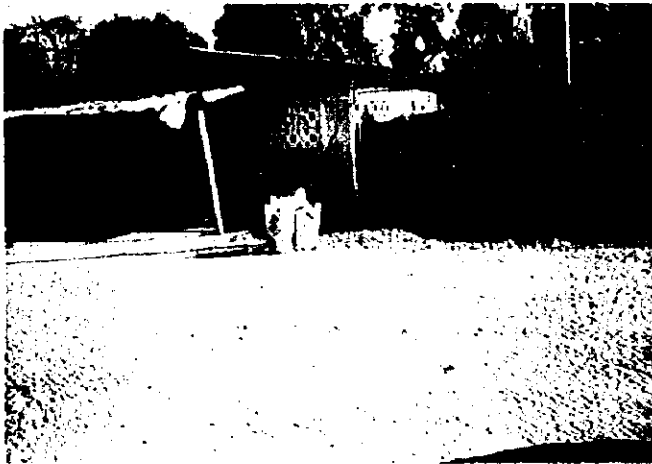
The municipal final disposal site located along the Rio Acome continuously pollutes the river and its downstream lands, (although some people uses the river water for washing and bathing).



Swage Treatment Plant.



Damages of road bank repaired. This is due to lack of a macro-drainage management.



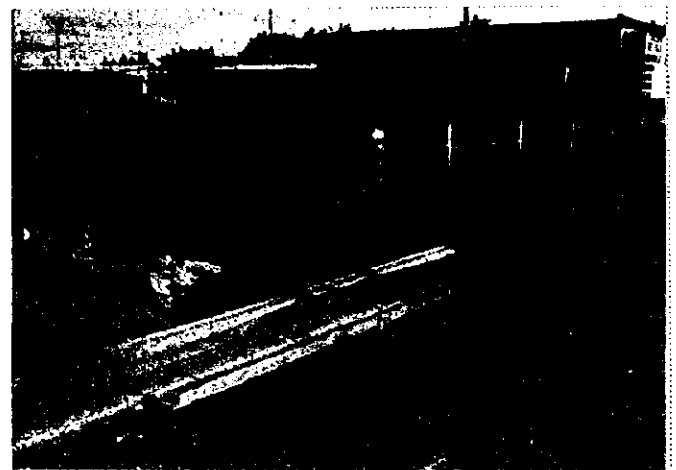
Plastic bags are used as a discharge container for waste collection services. They reuse the plastic bags repeatedly.



Illegal dumping on the road side is seen here and there in suburb. Wastes discharged illegally shut the drain in rainy season



Waste dumped in the municipal final disposal site along the crater pollutes groundwater. It is anticipated that INAA's wells in its downstream become contaminated.



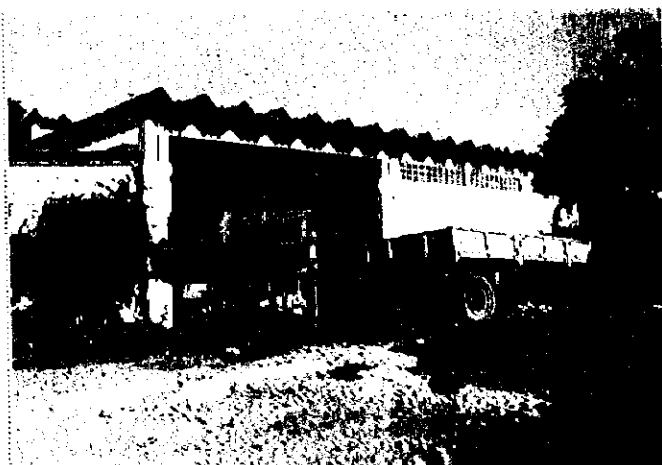
Damage of rain water drainage system.



Arroyo Zacateligue is contaminated with illegal dumps of solid waste and discharge of domestic/industrial waste water.



Unsanitary conditions are created with stagnant domestic waste water and uncollected (or illegally duped) waste in urban fringe areas.



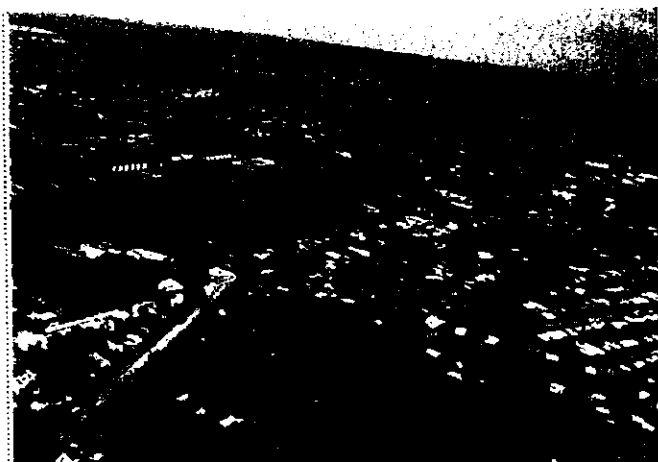
An appearance of the present workshop. This building was constructed originally as a market



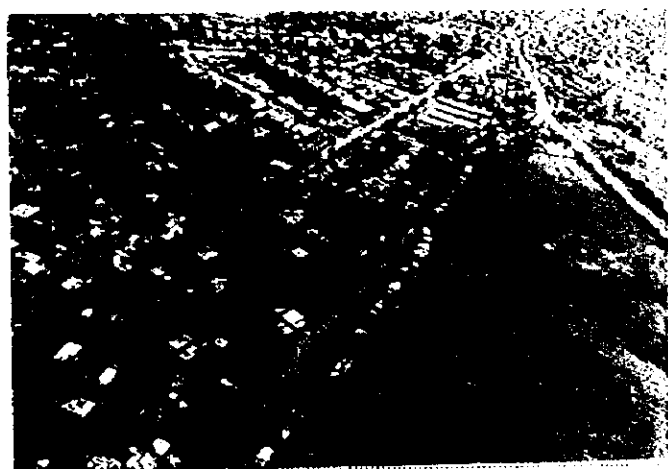
There is scarcely any spare parts and maintenance equipment inside of the workshop.



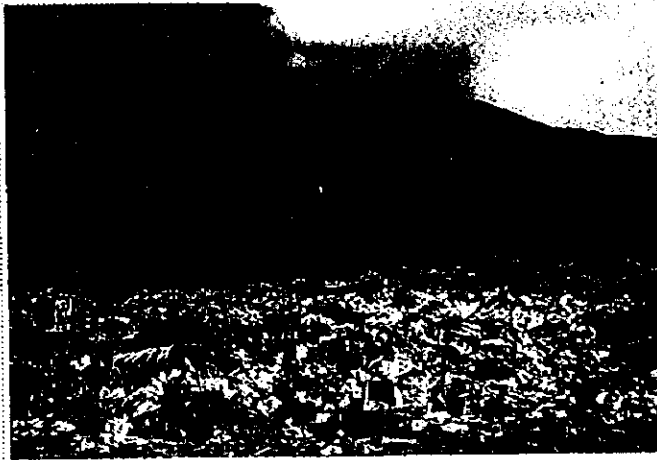
The SJV (San Jose de la Viuda) candidate site for a new municipal solid waste disposal site.



Model area C-1 (right side) and C-3 (left side).



Model area C-2.



La Joya dump site before the project: full of tons of waste and ill odors.



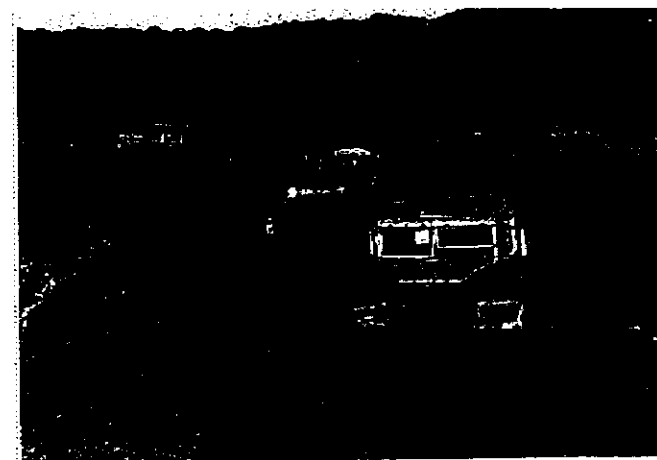
Odor check by the Team



Waste accumulation completed.



Operation Completed (an amazing view from the sky). No one could deny its neat renewal and environmental improvement.



Final covering in action.



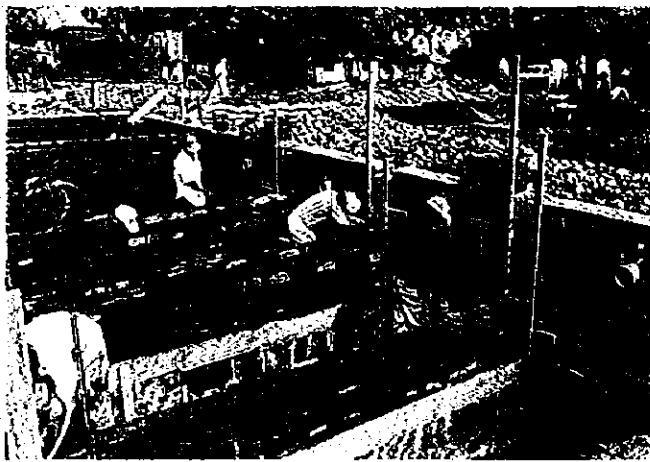
An inauguration ceremony was held on August 30, 1997 with honored guests including the minister of INAA, the Japanese ambassador to Nicaragua, the mayor and so on.



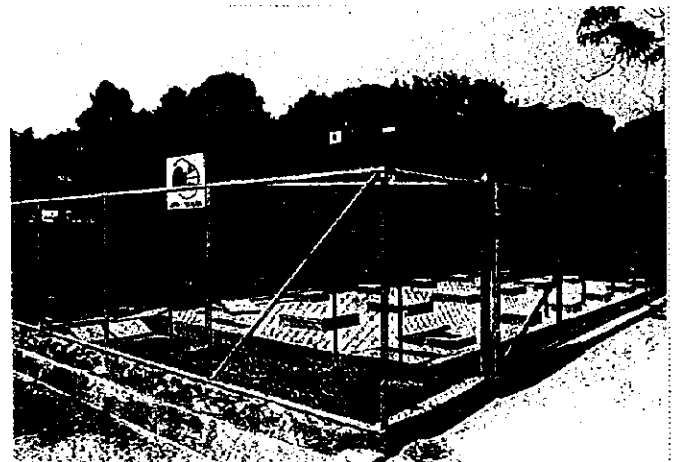
Very early stage of the facility construction in Adelita II.



Treatment facility from the sky. Process of the construction and location of a septic tank and filler trenches are easily understood.



Brick work of a 'septic tank'.



The treatment facility construction completed.

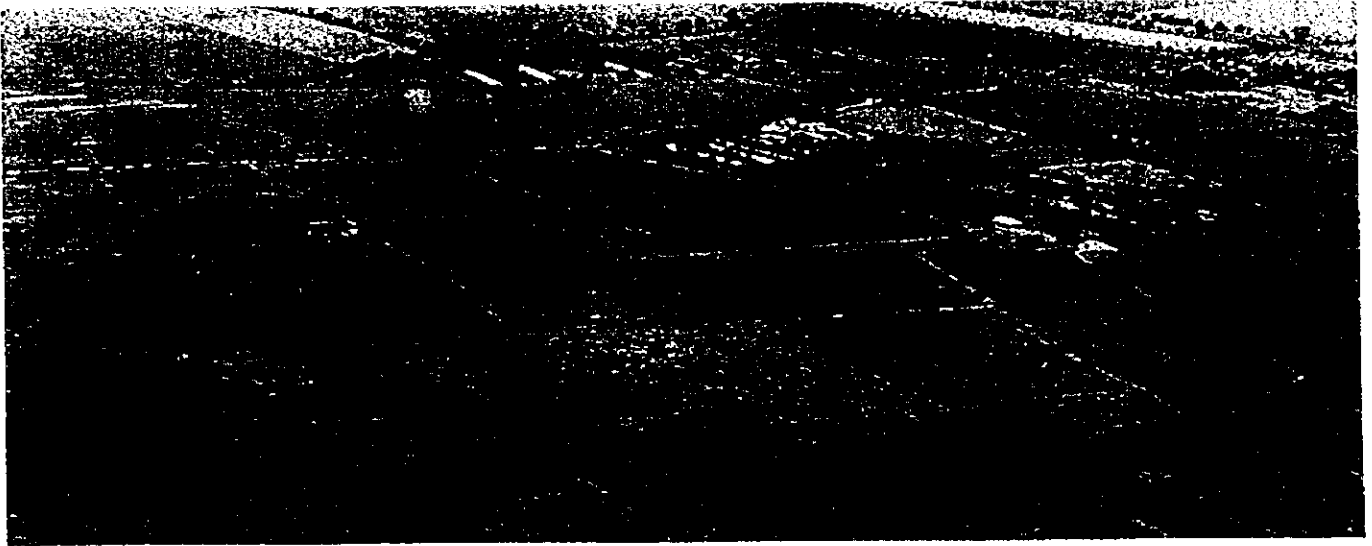


Construction created new job opportunities with positive impact on the communal economy (right-hand side: newly emerged 'mini shop').

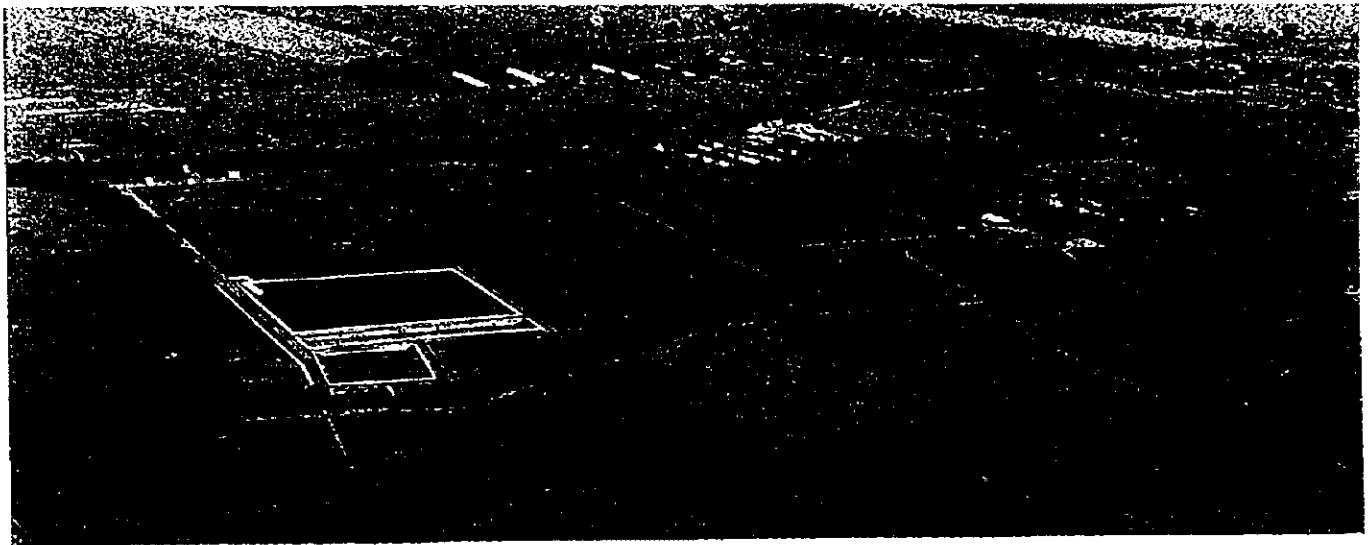


An inauguration ceremony was held on August 30, 1997 with honored guests including the minister of INAA, the Japanese ambassador to Nicaragua, the mayor and so on.

Plate 10 : Present and Future Landscape of SJV New Disposal Site



San Jose de la Viuda (SJV) Present Landscape



San Jose de la Viuda (SJV) Landscape Expected in 2001



San Jose de la Viuda (SJV) Landscape Expected in 2005



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List of Abbreviations

ACEM	:	Malaria Control and Eradication Area
ADES	:	Agency of Social Economic Development (Agencia de Desarrollo Económico Social)
AFD	:	Administration and Finance Department
ALMA	:	Municipal Government of Managua (Alcaldía de Managua)
AMUNIC	:	Nicaraguan Institute of Engineers and Architects
ARI	:	Average Recurrence Interval
AT	:	Ambient Temperature
ATP	:	Ability to Pay
BAVINIC	:	Housing Bank of Nicaragua (Banco de la Vivienda de Nicaragua)
BCN	:	Nicaraguan Central Bank (Banco Central de Nicaragua)
BDT	:	Transport Bulletin (Boletín de Transporte)
BID	:	Interamerican Development Bank (Banco Interamericano de Desarrollo)
BIV	:	Vehicle Inactivity Bulletin (Boletín de Inactividad de Vehículos)
BOD	:	Biochemical Oxygen Demand (5 day)
BORS	:	Landfill Operation Bulletin (Boletín de Operación de Relleno Sanitario)
BPP	:	Beneficiary Pays Principle
CDP	:	Personnel Distribution Board (Cuadro de Distribución de Personal)
CEM	:	Materials Entrance Control (Control de Entrada de Materiales)
CEPRODEL	:	Local Development Promotion Center (NGO) (Centro de Promoción del Desarrollo Local (ONG))
CHISPA	:	Centro de Crédito de Capacitación Humanística Integral Sistemática de la Pequeña Empresa
CIRA	:	Investigation Center on Aquatic Resources
CL	:	Controlled Landfill
CNA	:	National Environmental Agency
CNRH	:	National Commission of Water Resources
COD	:	Chemical Oxygen Demand
CONAVIAH	:	National Commission of Housing and Human Settlements (Comisión Nacional de Vivienda y Asentamientos Humanos)
DC	:	the Development Committee
DENACAL	:	Departamento Nacional de Acueductos y Alcantarillados
DO	:	Dissolved Oxygen
DSW	:	Domestic Solid Waste
DW	:	Domestic Waste
DWW	:	Domestic Wastewater
DWWCTS	:	Domestic Wastewater Collective Treatment System
DWWM	:	Domestic Wastewater Management
EAP	:	Economically Active Population
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
ENACAL	:	Empresa Nicaragüense de Acueductos y Alcantarillados Sanitarios
ENEL	:	Nicaraguan Electric Company (Compañía Nicaragüense de Electricidad)
ENITEL	:	Nicaraguan Telecommunication Company
EPD	:	Environmental Protection Department
EU	:	European Union
EUDOPF	:	Physical Program for Urban Development

F/S	:	Feasibility Study
FIDEG	:	International Foundation for Global Economic Challenge (Fundación Internacional para el Desafío Económico Global)
FINCA	:	International Community Assistance Board
FIRR	:	Financial Internal Rate of Return
FISE	:	Emergency Social Investment Fund (Fondo de Inversión Social de Emergencia)
FPC	:	First Priority City
GDP	:	Gross Domestic Product
GRDP	:	Gross Regional Domestic Product
HSW	:	Health Services Solid Waste
HW	:	Hazardous Waste
IDS	:	Inundation Damage Survey
IL	:	Inert Landfill
IMWS	:	Industrial /Medical Waste Management Survey
INAA	:	Nicaragua Institute of Waterworks and Sewerage (Instituto Nicaragüense de Acueductos y Alcantarillados)
INATEC	:	Instituto Nacional Tecnológico
INE	:	Nicaraguan Institute of Energy (Instituto Nicaragüense de Energía)
INEC	:	National Institute of Statistics and Census (Instituto Nacional de Estadísticas y Censos)
INETER	:	Nicaraguan Institute of Territorial Studies (Instituto Nicaragüense de Estudios Territoriales)
INIFOM	:	Nicaraguan Institute of Municipal Development (Instituto Nicaragüense de Fomento Municipal)
INSSBI	:	Institution of Nicaraguan Social Security and Welfare
IRENA	:	Nicaraguan Natural Resources and Environmental Institute
ISW	:	Industrial Solid Waste
ISWM	:	Industrial Solid Waste Management
IW	:	Industrial Waste
IWM	:	Industrial Waste Management
IWS	:	Industrial Waste Survey
IWW	:	Industrial Wastewater
IWWM	:	Industrial Wastewater Management
JICA	:	Japan International Cooperation Agency
JUVED	:	Neighborhood Development Board
M.G.	:	Municipal Government
M/M	:	Minutes of Meeting
M/P	:	Master Plan
MAG	:	Ministry of Agriculture and Livestock (Ministerio de Agricultura y Ganadería)
MARENA	:	Ministry of Environment and Natural Resources (Ministerio del Ambiente y Recursos Naturales)
MAS	:	Ministry of Welfare (Ministerio de Acción Social)
MCE	:	Ministry of Foreign Cooperation (Ministerio de Cooperación Externa)
MCT	:	Ministry of Construction and Transport (Ministerio de Construcción y Transporte)
MDO	:	Modulo de Operación (Workshop)
MED	:	Ministry of Education (Ministerio de Educación)

MEDE	:	Ministry of Economy and Development (Ministerio de Economía y Desarrollo)
MG	:	Municipal Government
MGC	:	Municipal Government of Chinandega (Alcaldía de Chinandega)
MGG	:	Municipal Government of Granada (Alcaldía de Granada)
MGL	:	Municipal Government of Leon (Alcaldía de Leon)
MINSA	:	Ministry of Health (Ministerio de Salud)
MITRAB	:	Ministry of Labor (Ministerio del Trabajo)
MITUR	:	Ministry of Tourism (Ministerio de Turismo)
MSD	:	Municipal Services Department
MSW	:	Municipal Solid Waste
MSWM	:	Municipal Solid Waste Management
MTP	:	Municipal Tributary Plan
MWS	:	Medical Waste Survey
NHW	:	Non-Hazardous Waste
NIW	:	Non-infectious Waste
OPS	:	Pan American Health Organization (Organización Panamericana de la Salud)
OS	:	Service Order (Orden de Servicio)
PEA	:	Economic Active Population
PECM	:	Special Program for Model Community Integrated Urban Sanitation Environment Project
POS	:	Public Opinion Survey
PPP	:	Polluter Pays Principle
PSW	:	Public Solid Waste
RAAN	:	North Atlantic Autonomous Region
RAAS	:	South Atlantic Autonomous Region
RCRA	:	Resource Conservation and Recovery Act
RPD	:	Research and Projects Department
RW	:	Rain Water
S/W	:	Scope of Work
SCL	:	Strictly Controlled Landfill
SILAIS	:	Local System of Integral Attention and Health (Sistemas Locales de Atención Integrada)
SILVAH	:	Local Information System on Housing and Human Settlements (Sistema de Información Local de Vivienda y Asentamientos Humanos)
SISCAT	:	Cadastral System
SJV	:	San Jose de la Vuelta
SPD	:	the Social Promotion Department
SPDMG	:	the Social Promotion Department of the Municipality in Granada
SS	:	Suspended Solid
ST	:	Sample Temperature
STP	:	Sewage Treatment Plant
SW	:	Solid Waste
SWD	:	Solid Waste Disposal
SWM	:	Solid Waste Management
SWR	:	Solid Waste Recovery
TELCOR	:	Nicaraguan Institute of Post and Telecommunications (Instituto Nicaragüense de Telecomunicaciones y Correos)

UEMB	:	Bureau of Urban Environmental Maintenance
UFA	:	Urban Fringe Area
UFW	:	Unaccounted for Water
UNICEF	:	United Nations Children's Fund
UROC	:	Unidades de Rehidratación Oral Comunitaria
USE	:	Urban Sanitation Environment
WACS	:	Waste Amount and Composition Survey
WID	:	Women in Development
WPLS	:	Water Pollution Loading Survey
WS	:	Water Supply
WTP	:	Willingness to Pay
WW	:	Wastewater

Definitions

Concession Contract	A contract system in which the contractor entrusted with refuse collection and haulage in a given area, and granted the right to collect RCC from its beneficiaries.
Contracting out	A contract system in which the client make payment to the contractor in return for performing refuse collection and haulage.
Concessionaire	The contractor that works in the concession contract.
Level of Sanitary Landfill	Study Team classified sanitary landfills into the following four levels.
Level 1:	Controlled tipping (casual soil covering)
Level 2:	Sanitary landfill with dike and daily soil covering (without an impermeable liner)
Level 3:	Sanitary landfill with leachate circulation (impermeable liner, leachate collection and circulation facility)
Level 4:	Sanitary landfill with leachate treatment (impermeable liner, leachate collection, and leachate treatment facility)
Micro-drainage	Drainage channel or river, whose basin is small and located within the municipal boundary.
Macro-drainage	Drainage channel or river, whose basin and/or catchment area is large and stretches over plural municipalities.

CHAPTER 1

Introduction

1 Introduction

The Study consists of the following three phases: (Refer to Figure 1-1 for details)

Phase I: Basic Study (from July 1996 to December 1996)

Phase II: Formulation of a Master Plan (M/P) (from January 1997 to May 1997)

Phase III: Feasibility Study (F/S) on the First Priority Projects (from June 1997 to February 1998)

Phase I: The Basic Study was carried out in the three major cities in Nicaragua, namely, Leon, Chinandega and Granada. Granada City was selected as a priority city based on the result of the Basic Study.

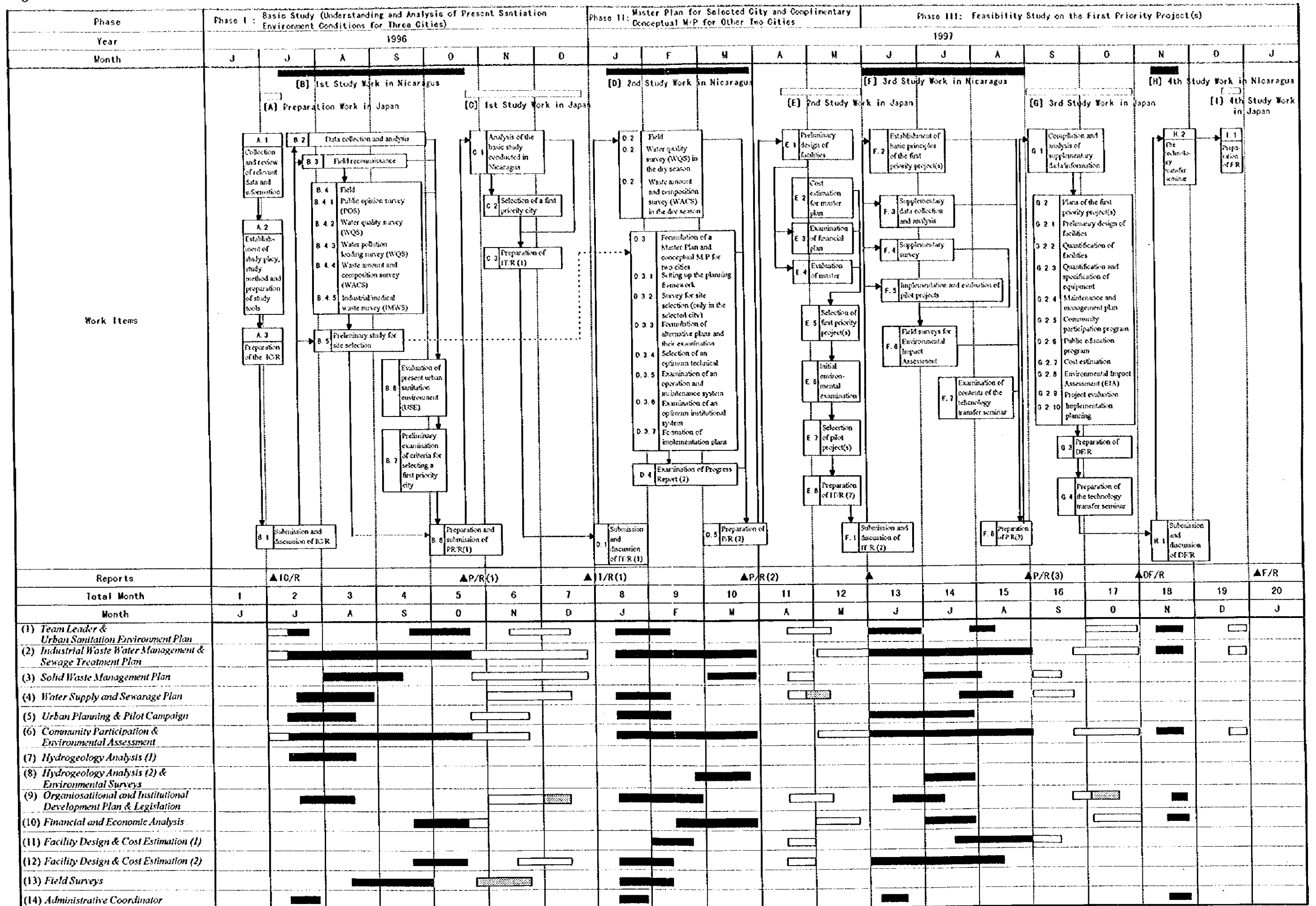
Phase II: In Urban Sanitation Environment Master Plan (USE M/P) was formulated for Granada City, the priority city, and Urban Sanitation Environment Conceptual Master Plans (USE Conceptual M/Ps) were formulated for Leon and Chinandega respectively. The results from Phase I and Phase II are summarized in Volume II: Main Report for the Master Plans.

Phase III: The following surveys were carried out.

1. Examination of the technical system suggested in the M/P, and the implementation of the pilot projects to obtain basic data for the preliminary design of the F/S.
2. Implementation of the F/S on the first priority projects selected from the USE M/P for Granada City.

This report presents the result of Phase III: Feasibility Study on the First Priority Projects.

Figure 1-1: Flow of the Study



CHAPTER 2

Pilot Projects

2 Pilot Projects

2.1.1 Objectives

The systems related to the USE in Granada City are extremely weak except for the water supply sector. The improvement of the USE in Granada City is indispensable for the conservation of water quality of Lake Nicaragua, a very important future water supply source not only for Granada City but also for Managua and its surroundings. However, improvements could hardly be perceived in spite of the various efforts made. Taking these conditions into account, it is assumed that many difficulties will arise in order to implement the plan suggested in M/P.

Consequently, pilot projects were carried out in this Study in order to examine potential problems and its countermeasures for planning and implementing priority projects subject to the F/S. The objectives of the pilot projects are outlined below:

1. To examine the applicability of the technical system proposed in the M/P.
2. To obtain basic data for the preliminary design of the F/S.
3. To enhance the public awareness and cooperation on USE improvement.
4. To demonstrate feasible level of cooperation between national, municipal and non-governmental entities in working together for an USE improvement project.
5. To demonstrate various improvement measures to the persons concerned with USE and the public.

2.1.2 The Implementation of Pilot Projects

a. Plan of the Pilot Projects

Based on the objectives above, the following projects were proposed as pilot projects (Refer to Figure 2-1).

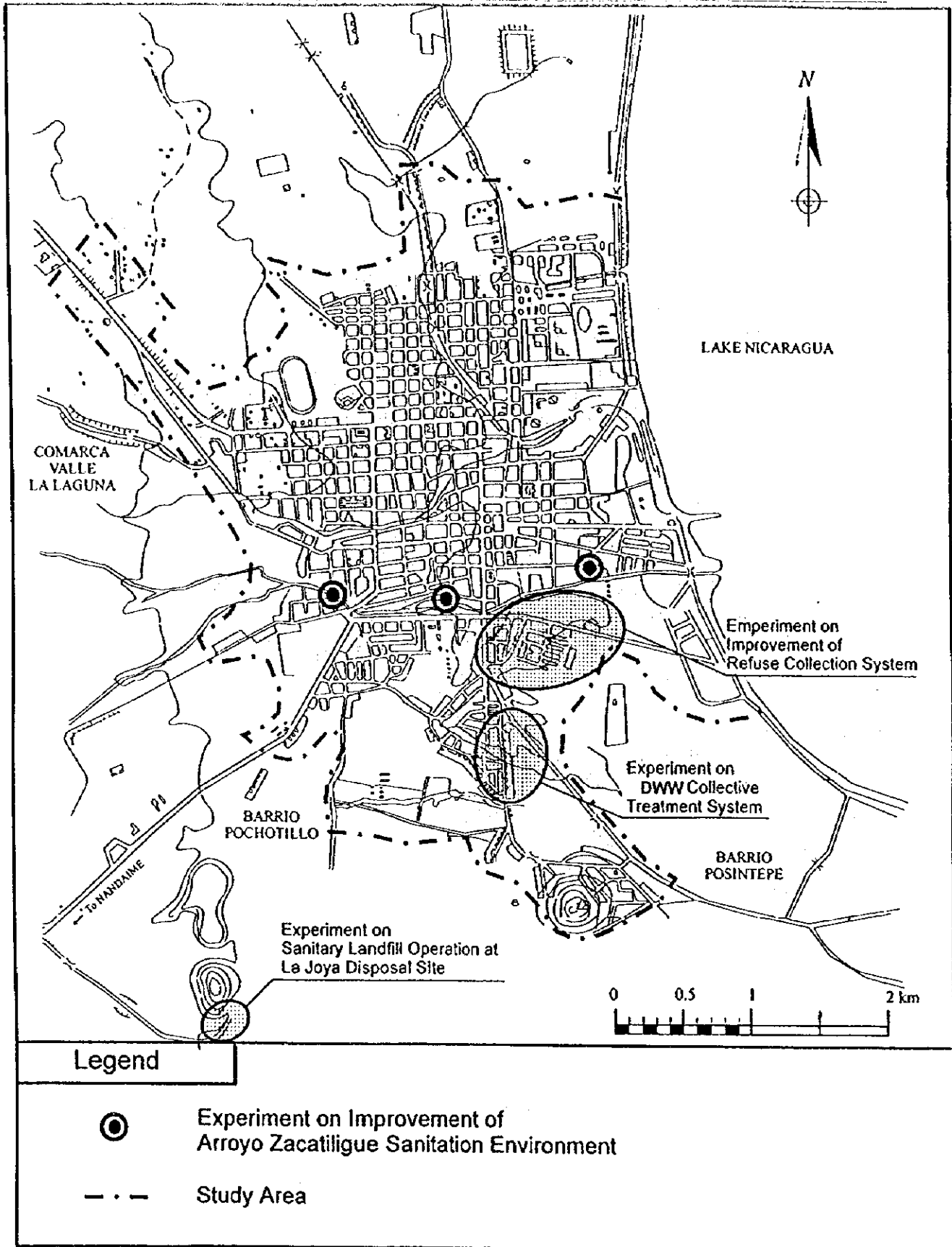


Figure 2-1: Location of Pilot Projects

a.1 Beautify Granada Campaign

In order to examine the methodologies to enhance public awareness and cooperation on USE improvement, a series of public campaigns on USE improvement were carried out. Public campaigns promoted in closer ties with other projects listed below (a.2 to a.5) as much as possible. The effectiveness of the public education program proposed in the M/P was examined through these campaigns. Furthermore, data required for the F/S of the priority projects were also collected along with the implementation of campaigns.

a.2 Experiment on Improvement of Refuse Collection System

In order to examine appropriate and reliable SW collection system for the areas where presently such services are insufficient or not provided (e.g., Eddy Ruiz III), an experiment on improvement of refuse collection system was carried out. Applicability of systems proposed in the M/P were examined through this experiment and data necessary for preliminary designs of the priority projects were collected.

a.3 Experiment on Improvement of Arroyo Zacatiligue Sanitation Environment

Illegal dumping along creeks (arroyos) in Granada deteriorates the sanitation environment of the city and the lake. The experiment on removal of illegally dumped waste took place at Arroyo Zacatiligue (as a model arroyo). Collection services were provided (using waste collection bays) in order to prevent illegal dumping along the creek. The systems proposed in M/P were examined to ascertain practicability through this experiment and data necessary for preliminary designs of the priority projects were collected.

a.4 Experiment on Sanitary Landfill Operation at La Joya Disposal Site

The experiment on sanitary landfill operations was carried out at La Joya disposal site in order to obtain data necessary for the priority "New Municipal SW Disposal Site Development Project". (Refer to Figure 2-2)

a.5 Experiment on DWW Treatment System

A model area (Reparto Adelita) was selected for this experiment from the areas where sewer services will not be provided by the year 2010. A domestic wastewater collective treatment system was installed in the area in order to collect data necessary for examining the most appropriate technical system to be employed in the priority project (i.e., Model Community Integrated USE Improvement Project); also a community participation system that is necessary for the operation and maintenance of the collective system was studied (Refer to Figure 2-3).

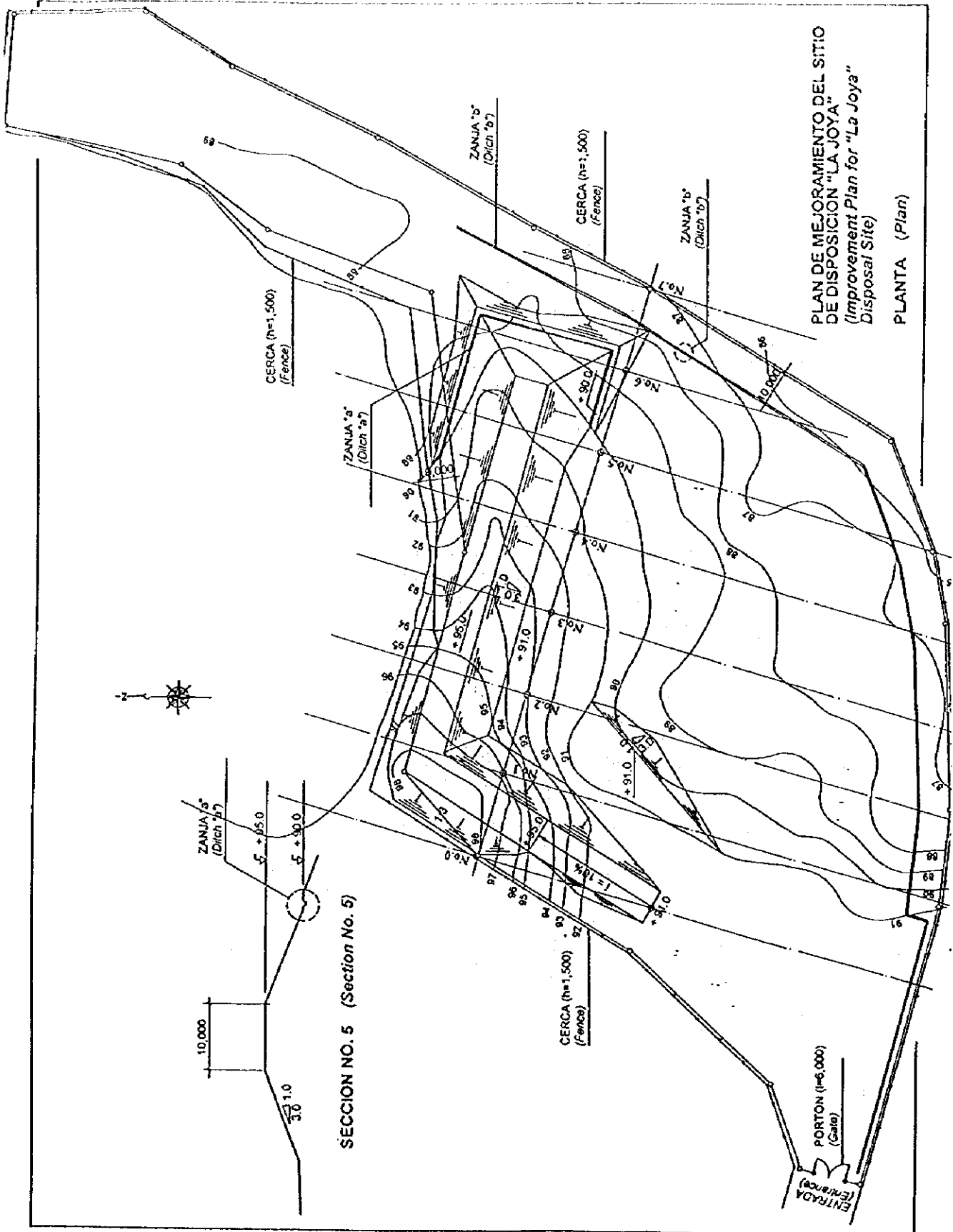


Figure 2-2: Experiment on Sanitary Landfill Operation at La Joya Disposal Site

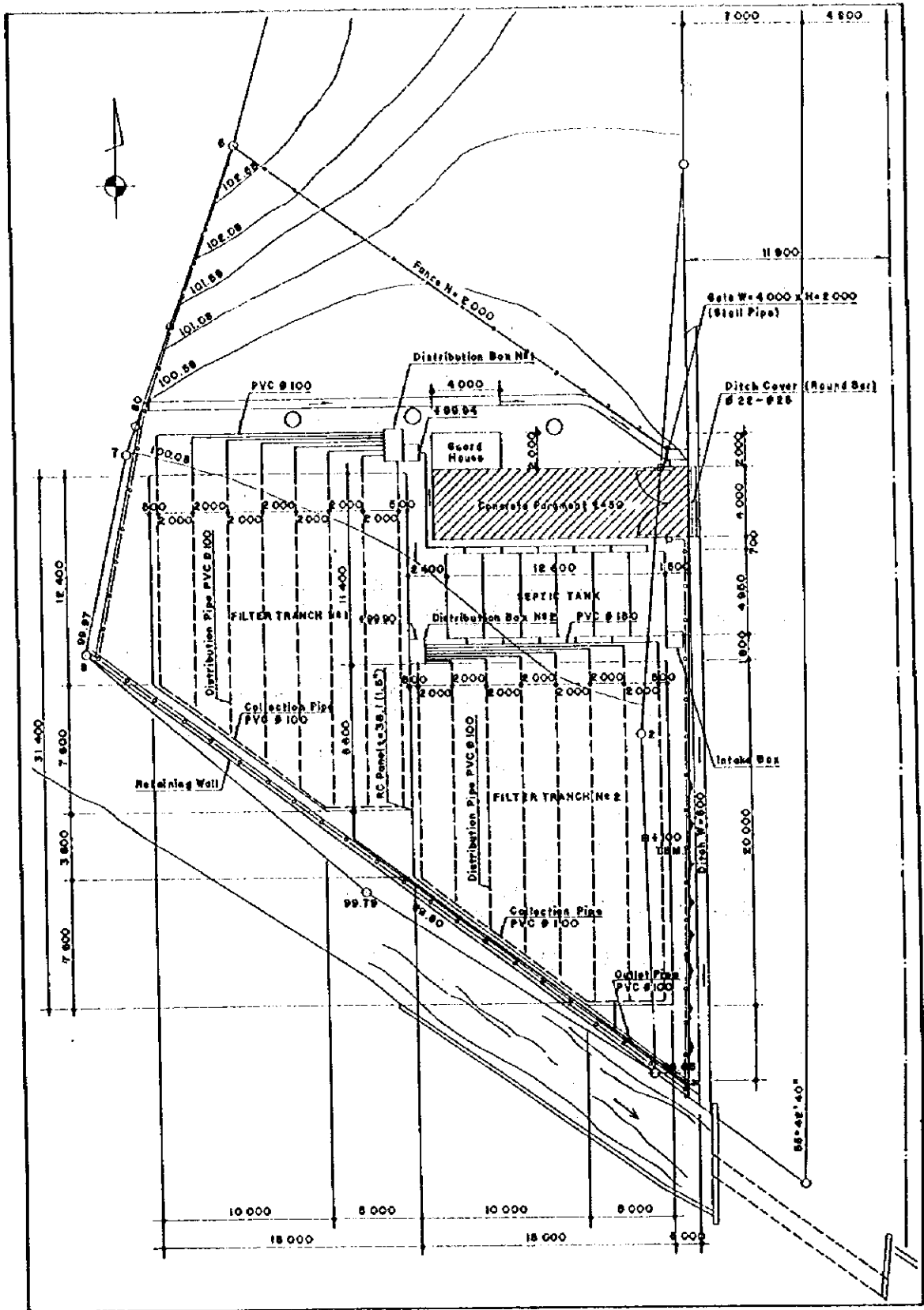


Figure 2-3: Experiment on Domestic Waste Water Collective Treatment System

b. Responsibilities of Each Related Institution in the Pilot Projects

Pilot projects require tangible results within a short period of three months obtaining necessary data to implement F/S. Therefore, active participation/burden sharing and leadership by the Nicaraguan side is indispensable. In this context, the Study Team planned to implement pilot projects based on the role assignment summarized in the table below: leading roles were taken by the Nicaraguan side and supporting roles by the Study Team.

Table 2-1: Responsibilities of Each Related Institution in the Pilot Projects

Pilot Project	Nicaraguan Side	Team
1. Beautify Granada Campaign	<ol style="list-style-type: none"> 1. Planning and design of signboards, posters, stickers, seminar/workshops. 2. To provide a car with loudspeakers and to implement the public campaign activities. 3. To implement seminars and workshops on sanitary education. 	<ol style="list-style-type: none"> 1. To support the planning and design of the campaign to be prepared by the Nicaraguan side. 2. To provide signboards, posters, and stickers. 3. To support the arrangement of seminars and workshops on sanitary education. 4. To conduct questionnaire surveys before and after the experiments.
2. Experiment on Improvement of Refuse Collection System (Eddy Ruiz III)	<ol style="list-style-type: none"> 1. To provide a car with loudspeaker and to implement the public campaign activities. 2. To request community participation a placing waste at designated locations. 3. To provide regular waste collection services for the area. 4. To bear the cost for operation and maintenance of the tipper lorry provided for the experiment (including fuel). 	<ol style="list-style-type: none"> 1. To prepare a plan of Eddy Ruiz III refuse collection improvement. 2. To provide a waste collection vehicle and waste containers. 3. To construct waste collection bays. 4. To conduct questionnaire surveys before and after the experiments.
3. Experiment on Improvement of Arroyo Zacateligue Sanitation Environment	<ol style="list-style-type: none"> 1. To provide a car with loudspeakers and to implement the public campaign activities. 2. To request community cooperation for placing waste at designated locations instead of discarding waste illegally. 3. To enforce monitoring and restriction to prevent illegal dumping. 4. To provide regular waste collection services for the area. 	<ol style="list-style-type: none"> 1. To prepare "illegal dumping areas improvement" and "refuse collection improvement" plans. 2. To provide a waste collection vehicle (co-use with Eddy Ruiz III) and waste containers. 3. To remove illegally dumped wastes and to construct waste collection bays. 4. To conduct questionnaire surveys before and after the experiments.
4. Experiment on Sanitary Landfill Operation at La Joya Disposal Site	<ol style="list-style-type: none"> 1. To commence public campaign regarding the sanitary landfill experiment. 2. To control the entry of vehicles and waste disposal at the site. 3. To continue sanitary landfill operation after the improvement (i.e., after September 1997). 	<ol style="list-style-type: none"> 1. To implement urgent improvement works for the present La Joya disposal site and environmental protection measures. 2. To prepare a manual for sanitary landfill operations. 3. To conduct questionnaire surveys before and after the experiments.

Pilot Project	Nicaraguan Side	Team
5. Experiment on Domestic Waste Water (DWW) Collective Treatment System	<ol style="list-style-type: none"> 1. To acquire land for the facility (Reparto Adelita II). 2. To obtain permits for the works. 3. To formulate and obtain a consensus from the community for connecting the wastewater to the treatment system and a agreement to operate and maintain the system. 4. Operation/maintenance and monitoring of the experimental system. Results of the monitoring should be presented at the technology transfer seminar in 4th Study Work in Nicaragua. 5. Connection of DWW from houses subject to the experiment. 6. To prepare a plan for community participation in construction, operation and maintenance of the DWW collective treatment system. 	<ol style="list-style-type: none"> 1. To construct sewer pipe lines for the experiment 2. To plan, design and construct the DWW collective treatment system. 3. To examine optimum operation and maintenance measures and to prepare the manual. 4. To support the planning of the "community participation system" for the construction, operation and maintenance of the DWW collective treatment system. 5. To conduct questionnaire surveys before and after the experiments.

c. Implementation of Pilot Projects

The pilot projects below were carried out in close cooperation between the counterpart and the Study Team during the 3rd Study Work in Nicaragua (June to August 1997).

Table 2-2: Contents of Pilot Projects

Pilot Project	M/P's Recommendation for Improvement	Related Projects subject to the F/S	Contents of the Pilot Project
1. Beautify Granada Campaign	<ul style="list-style-type: none"> • Promotion of public awareness and citizens' co-operation • Provision of sanitary education 	<ul style="list-style-type: none"> • New Municipal SW Disposal Site Development Project • Refuse Collection System Improvement Project • Model Community Integrated USE Improvement Project 	<ul style="list-style-type: none"> • Holding a poster contest • Publicity work using signboards, placards, posters, stickers, and loud speakers announcements • Holding seminars and workshops on sanitary education
2. Experiment on Improvement of Refuse Collection System	<ul style="list-style-type: none"> • Expansion of waste collection services by a "point collection system" • Securing citizens' cooperation for the waste collection service 	<ul style="list-style-type: none"> • Refuse Collection System Improvement Project • Model Community Integrated USE Improvement Project 	<ul style="list-style-type: none"> • Constructing 6 waste collection bays and installing 40 waste containers • Extending publicity and providing public education • Providing punctual periodic waste collection services
3. Experiment on Improvement of Arroyo Zacateligue Sanitation Environment	<ul style="list-style-type: none"> • Elimination of illegal dumping • Improvement of waste collection services by a "point collection system" • Securing citizens' co-operation for the waste collection service 	<ul style="list-style-type: none"> • Refuse Collection System Improvement Project 	<ul style="list-style-type: none"> • Removing illegally dumped waste and cleaning the creek • Constructing 4 waste collection bays and installing 20 waste containers • Extending publicity and providing public education • Providing punctual periodic waste collection services

Pilot Project	M/P's Recommendation for Improvement	Related Projects subject to the F/S	Contents of the Pilot Project
4. Experiment on Sanitary Landfill Operation at La Joya Disposal Site	<ul style="list-style-type: none"> Construction of a sanitary landfill disposal site 	<ul style="list-style-type: none"> A New Municipal SW Disposal Site Development Project 	<ul style="list-style-type: none"> Accumulation, shaping and compaction of waste, soil coverage, construction of drainage channels Installation of gas removal pipes and fence Improvement of access road
5. Experiment on Domestic Waste Water Collective Treatment System	<ul style="list-style-type: none"> Installation of domestic wastewater treatment systems for areas projected to have no sewer by 2010 	<ul style="list-style-type: none"> Model Community Integrated USE Improvement Project 	<ul style="list-style-type: none"> Construction, operation and maintenance of domestic wastewater collective treatment system including sewer pipelines and household connections Extending publicity and providing public education

2.1.3 Findings from the Pilot Projects

The following are very important conclusions reached through the pilot projects with regard to the contents of the M/P, and design and implementation of F/S projects.

a. Beautify Granada Campaign

Prior to the campaign, participated in the questionnaire on 147 people for over days from June 16 through 18. As a result, all the respondents agreed that poor sanitation is a problem in Granada. Whereas wastewater (95%) and refuse (89%) were given as the major cause for the sanitary problem, only 19 % of the people replied that water supply is the cause. A large percentage of the public perceive the improvement of USE being inadequate (72%) and everybody agreed that public education is indispensable to gain co-operation for the improvement of USE. Ninety six percent agreed that they will co-operate voluntarily for the improvement.

While the campaign was carried out on July 21 and 22, 151 citizens participated in the same questionnaire surveys. The results showed that 92% of respondents admitted that poor sanitation is a problem in Granada and its major cause was pointed out as wastewater (94%) and refuse (71%). Only 4% pointed out that water supply was the cause. The public perceived the improvement of urban sanitation environment to be inadequate (63%) and responded that public education is indispensable for gaining co-operation for the improvement of the USE. Moreover, 81% knew of the Beautify Granada Campaign and admitted the campaign activities were essential for improvements.

As can be seen from the results of the questionnaire surveys, citizens in Granada perceive that their city has a USE problem and that citizens' active participation is indispensable to improve the present condition. Furthermore, they are also fully aware of the necessity of providing public education through which citizens public awareness is enhanced on the problems regarding sanitation and learn what they should do. In this light, the timing of the recent campaign was good and the majority of the citizens expressed their understanding towards the campaign. This was confirmed by the active participation of more than 100 volunteers for each of the four clean-up activities off the

shore of Lake Nicaragua and Arroyo Zacateligue. In particular, it was very encouraging for the future of Granada that many students participated in these activities.

A special feature of the recent campaign has been the linkage of pilot projects (b.) through (e.) that were designed to actually improve USE. This helped citizens living in the pilot project areas gain firsthand experience on the outcome of the improvement of USE. This could be particularly symbolized by the amount of citizens that participated living around the Zacateligue river. That is to say, with the provision of a regular waste collection service and removal of illegally dumped waste, citizens were inclined to cease dumping into the Zacateligue river. The results of a random questionnaire illustrates that although all respondents agreed that Granada has a problem regarding USE, its number decreased to 92% during the experiment.

Furthermore, as the cooperation from citizens is vital for implementing more concrete improvement projects, campaign activities to gain cooperation through community based organizations smaller than Barrio/Reparto units (i.e., organization per road stretch or block stretch) were carried. Through many meetings held to gain cooperation from citizens living the pilot project area, the importance of activities at the grass root level to enhance public awareness, requiring time and steady efforts, was reconfirmed by Granada Municipality, respective counterpart and the Study Team.

b. Experiment on Improvement of Refuse Collection System

According to the questionnaire surveys carried out in February 1997, of the 20 people that participated, more than half (55%) in Eddy Ruiz were not receiving an adequate waste collection service. This led to the illegal dumping into the rivers by 30% of the citizens there.

However, Granada Municipality started to provide a regular waste collection service from May 1997. As a result of conducting another questionnaire survey that polled 18 citizens prior to the experiment, 94% of the citizens were receiving waste collection service.

With regard to the question on waste collection points, all residents answered they are willing to carry waste to designated collection points within a 25m radius. While the great majority (89%) said they would carry waste to collection points within a distance of 50m, 11% were willing to carry their waste 100m away. The survey also showed that only 1 person (5%) is currently paying the waste collection fee, amounting to less than 2 Cordoba/month. The amount residents are willing to pay for waste collection services averaged 3.4 Cordoba/month.

Taking the previous conditions into account, the Experiment on Improvement of Refuse Collection System in Eddy Ruiz III was conducted with careful consideration to the following items as its main propositions:

1. Whether or not the "point collection system" could be accepted by the residents, although the "point collection system" can curtail the cost of SW collection services, residents' active participation in refuse discharge is indispensable for the system's success.
2. The amount low-income residents in the areas can afford to pay waste collection fee if a regular collection service is provided. (According to the survey, the average monthly expenditure/household is 697 Cordoba)

The "point collection system", that strictly stipulates the rules (place, time and method) on waste discharge, was basically accepted and observed by the residents. However, the extent to which the rule regarding "keep cleanliness of waste collection point" was observed varies widely community by community. This is mainly due to the differences in how and to what extent local community leaders carefully give instructions regarding waste discharge rules to each household which uses the waste collection point. Therefore, in expanding the waste collection service to the "point collection system" in future, residents' co-operation, publicity and public education should be indispensable.

Regarding the type of waste collection point, a "waste collection bay" keeps the waste collection points cleaner than the "waste containers". This is because the residents consider that they do not need to observe rules pertaining to punctuality in waste discharge in the case of the "waste container" system. Furthermore, there was less animal scavenging where the waste discharge time was observed on the whole. Therefore, a "waste collection bay" and a standing notice board will be sufficient for the "waste collection point" system to be proposed.

Considering the observation results of waste generation amount per week for respective waste collection point and cost sharing ability of both Granada City and residents in the community subject to the experiment, it is recommended that cost of waste collection services in such areas should be reduced by decreasing the number of collection times from three to twice a week.

A bell collection system will be effective in letting residents know that the collection vehicles have arrived, in conjunction with a "point collection system" in order to let residents strictly follow and remind them of the waste discharge time.

The questionnaire surveys in which 18 residents participated after the experiment showed that the majority (89%) of the residents were satisfied with the point collection system. Furthermore, all residents replied that waste collection bays were effective in conservation of USE of the community. The amount residents are willing to pay (WTP) for waste collection services remained the same as before the experiment with an average of 3.3 Cordoba/month. Although the percentage of residents willing to pay dropped from 89% to 83%, no significant change could be observed. This is an extremely important fact and the conclusions reached from these facts are as follows:

1. Although residents have will to pay for the waste collection services, the amount they can pay is very limited.
2. Therefore, it is indispensable to take some measures to reduce the financial burden on residents for the waste collection fee by cutting the cost of the collection service in the model district.

c. Experiment on Improvement of Arroyo Zacateligue Sanitation Environment

According to the questionnaire surveys carried out in February 1997 with 60 participants, the majority (70%) in the area within the vicinity of Arroyo Zacateligue were not receiving an adequate waste collection service. This led to illegal dumping into the rivers by 75% of the citizens there.

However, Granada City started to provide regular waste collection services from May 1997. As a result of conducting another questionnaire survey polling 36 citizens prior to the experiment, 81% of the citizens were receiving waste collection service.

With regard to the question on waste collection points, all residents answered they are willing to carry waste to designated collection points within a 25m radius. While the majority (75%) said they would carry waste to collection points within a distance of 50m, 25% were willing to carry their waste 100m away. The survey also showed that only 19% (7 people) currently pay waste collection fees, which only amounts to 3.1 Cordoba/month on an average. The amount residents are willing to pay for waste collection services averaged 3.9 Cordoba/month.

Taking the previous conditions into account, the Experiment on Improvement of Arroyo Zacateligue Sanitation Environment was conducted with the following as its main objectives:

1. The elimination of waste illegally dumped into the river by providing regular waste collection services.
2. The acceptability of the "point collection system" by the residents; although the "point collection system" can curtail the cost of SW collection services, their co-operation in refuse discharge is indispensable for system to succeed.
3. If regular collection services are provided, how much the residents in areas where the income level varies can afford to pay waste collection fee. (According to the survey, the average monthly expenditure/household is C\$1,006.)

The result of questionnaire surveys in which 36 residents participated after the experiments showed that those who replied that they are dumping wastes into the river drastically declined from 75% to 24%. This indicates that illegal dumping by residents living along the river will be prevented if a regular waste collection service is provided. Accordingly, the provision of a regular and reliable waste collection service is vital for the prevent illegal. Active co-operation by citizens in clean-up activities of the lake shore and Zacateligue River proved that public education programs and campaigns for the residents significantly contribute to the elimination of illegal dumping.

The majority (94%) of residents was content to utilize the point collection system. Moreover, ninety seven percent replied that the waste collection bays are effective for the conservation of the community's USE. The amount residents are willing to pay (WTP) for waste collection services remained the same as before the experiment, with an average of C\$ 3.9 /month. Although the percentage of residents willing to pay dropped from 94% to 89%, no significant change could be observed. This reiterates the conclusion regarding the point collection system, the use of waste collection bays, and cost sharing of waste collection fee as observed during the Experiment on Improvement of Refuse Collection System.

d. Experiment on Sanitary Landfill Operation at La Joya Disposal Site

Prior to the experiment, 24 people concerned (the mayor, 5 municipal councilors, 3 journalists, 2 MARENA officials, 13 residents' representatives) were invited to see the pre-experimental conditions in the La Joya disposal site and were asked to answer questionnaires. The results of the questionnaire survey showed the majority (57%) to be unaware of how wastes generated daily in the city are disposed of. With regard to the

conditions in the disposal site, 96% cited the site's offensive odor, 88% stated the site's negative impact on the surrounding environment, air pollution, and is a breeding ground for noxious insects (e.g., flies), 83% pointed out how the waste is scattered, and 54% indicated the site is dusty.

The Experiment on Sanitary Landfill Operation at La Joya Disposal Site as summarized in Table 2-2 resulted in a considerable improvement of the site. To quantitatively evaluate the effects of the improvement works, the same group of people who were asked to participate in the questionnaire survey prior to the experiment were, once again, invited to the disposal site to see its newly improved state. As before, the group was asked to answer questionnaires. The results of this post-experiment questionnaire showed that all participants agreed that the conditions at the disposal site was improved. Furthermore, regarding the respective environmental negative impact, although twenty eight percent pointed out that the issue related to dust remained unsolved, other negative impacts were reduced.

The municipality of Granada should continue the sanitary landfill operation even after the experiment. The municipality's own machinery (a wheel loader and dump trucks) are limited, however, the experiment was able to stockpile some amount of cover soil in the site and sanitary landfill operation with the municipality machinery (a wheel loader and a dump truck) after training to practice for about a week.

e. Experiment on Domestic Waste Water Collective Treatment System

e.1 Construction of the facility

Although the experiment was initially designed to cover about 28 households, it turned out that the facility was to serve a population of about 300 a total of 42 households. Prior to the experiment, a questionnaire survey was issued to 42 of the recipient households in order to ascertain the residents' needs for the domestic wastewater treatment facility. The results show that all respondents (all 40 valid answers) consider domestic wastewater as an environmentally detrimental factor, because, according to 95% of the households, it pollutes the river, it breeds insects e.g., flies (93%) and, it emits offensive odor (90%). The survey also showed that the average monthly household expense amounts to 999 Cordobas.

As the construction works were prolonged due to the reasons outlined below, the outcome of the experiment could not be summarized during the 3rd Study Work in Nicaragua. Consequently, the compilation and reporting of the operation results of these facilities were entrusted to the INAA Region IV.

1. The number of recipient households considerably increased from the initial estimate (the final number is estimated to be more than 42.) Therefore, as the number of areas needing treatment facilities has increased, negotiations for securing sites was time-consuming.
2. Most of the construction works had to be carried out manually because the site's limited space and common local practices of labor-intensive manual works.
3. The contractor was inexperienced in some construction works of the treatment facility.

From the result of the questionnaire surveys after the construction of the facility polling the same 42 households as before, all residents replied that:

1. The USE of the community improved.
2. The domestic wastewater treatment facility was to their satisfaction.
3. They are willing to cooperate with the maintenance and operation of the facility.

Moreover, the majority (67%) of the residents replied that they would like to remodel their toilets into a flush-type at their own cost in the future.

e.2 The result of the facility operation

e.2.1 Pipeline

Technical norms of INAA stipulate that sewer pipes should have a diameter of 150mm and minimum overburden of 1.2m. In order to minimize construction cost, in the pilot project employed a minimum pipe diameter of 100mm and minimum overburden of 0.6m in its design.

Problems related with pipeline reported until October 20, 1997 were mainly related to blockages at certain sections of the pipeline. This is caused by pebbles entering the pipeline during construction. However, it was easily removed with a wire; no damages to the pipe has been reported so far.

e.2.2 Treatment Facility

Although the treatment facility started operation from the end of August, 1997, it was impossible to obtain data on the quality of treated effluent from the filter trench while the Study Team was in Nicaragua. The results of the analysis of intake water quality before the facility construction on September 17, 1997, conducted at a local laboratory, commissioned by the Study Team, and samples taken and analyzed by INAA on the same day, are shown in Table 2-3.

Table 2-3: Result of Water Quality Analysis

Item	Intake				Effluent of Septic Tank		Effluent of Filter Trench		Discharge Limit
	June/1997	Sep/1997 (JICA)	Sep/1997 (INAA)	Reference (WWVE**)	Sep/1997 (JICA)	Sep/1997 (INAA)	Sep/1997 (JICA)	Sep/1997 (INAA)	
BOD (mg/l)	146	369	320	220	207	270	198	260	110
COD (mg/l)	417	632	702	500	453	516	449	477	220
SS (mg/l)	59	289	144	220	17	124	12	106	100
T-KN (mg/l)	3.22	14	-	(T-N,40)	13	-	13	-	-
NH ₄ -N (mg/l)	-	7	-	-	9	-	7	-	-
NO ₂ -N (mg/l)	0.019	0.015	0.12	0	0.011	0.11	0.009	0.07	-
NO ₃ -N (mg/l)	0.71	0.302	3	0	0.093	2.6	0.299	2.7	-
PO ₄ -P (mg/l)	6.74	8	16	4	12	13	11	13	-
T- Coliform (NMP/100ml)	1.11E+05	2.1E+06	-	10E+7 to 10 E+8	4.9E+03	-	8.8E+03	-	-
E- Coliform (NMP/100ml)	5.12E+04	3.1E+04	2.3E+07	-	1.7E+03	-	3.1E+03	1.7E+07	1.0E+04

Note **: Typical composition of untreated domestic wastewater, (Wastewater Engineering THIRD EDITION P109)

According to the results shown in Table 2-3, the BOD removal rate of the septic tank is below the designed removal rates (55%). Suspended solid (SS) removal reported vary widely, i.e., the result of INAA's SS removal rate is 14%, whereas the figure is 94% for JICA's (designed removal rate was 50%). However, judging from the BOD removal rate, microbes in the septic tank have not multiplied sufficiently. It can be judged that the septic tank has not served its original purpose when the water sampling was carried out in September. It was the same with the case of the filter trench. The filter trench effluent quality was almost the same as that of the septic tank. This is due to insufficient increase in microbes, which enhance the purification of wastewater.

In the case of domestic wastewater, although it varies according to the characteristic of influent, it generally takes about half a year for the amount of microbes to increase in these treatment facilities and to provide stable quality of effluent. Therefore, continuous monitoring is required to observed the effect of the facilities.

As stated above, no conclusion can be reached from the analysis result at this moment as to whether this treatment method employed in the pilot project is effective in preventing water pollution caused by domestic wastewater.

e.3 Key Issues

In order to examine and improve the actual applicability of the collective on-site treatment system in future, it is necessary to analyze features of the system found through the operation of the facilities and solve problems if any arise. The following are issues that were clarified, regarding applicability of the system, during the construction of the domestic wastewater system:

1. The site for the treatment system should be where the gravity flow of domestic wastewater can be taken advantage of most (i.e., steep gradients), and should be wide enough for utilizing bacteriological decomposition functions of the facilities (i.e., enough space required).
2. The agreement of the residents regarding construction should be reached prior to the construction of the facilities.
3. Due to time limitations of construction works during the experiment, the pilot project required a construction cost of about 10,630 Cordoba/household (1,456 Cordoba/person). Where construction takes place without time constraints, the construction cost (per household or per person) would be reduced to about 70% of the costs. Nevertheless, construction cost in this range would still be a heavy burden for INAA. Therefore, the critical issue is: how much and in what manner the service recipients could and would shoulder the burden of the construction cost (e.g., a certain portion of internal connection, catch pit construction, and O&M cost to be borne by residents or provision of labor). To cope with this concern, a post-improvement questionnaire survey shall be conducted with recipients. On the other hand, policies and practices for the collective treatment system to be proposed by INAA (as the authority responsible for O&M) should be carefully examined.

e.4 Countermeasures

Table 2-4 summarizes the tasks and its countermeasures on Domestic Wastewater Collection Treatment System Construction.

Table 2-4: Tasks and its Countermeasures

Tasks	Countermeasures
Securing the treatment facility site	Although INAA purchased the site at their own cost in the pilot project, it is necessary to secure a land for the treatment facility to be constructed with less financial burden in order to extend these treatment methods in the future. The following countermeasures can be considered; 1) Utilization of public sites. 2) In case private property is used, free land use/donation in exchange of tax exemption, etc.
Obtaining agreement from the residents (beneficiaries) for construction	Residents' agreement necessary for the construction of facility are: <ul style="list-style-type: none"> • Acceptance of inconveniences caused while the facility is being constructed (e.g., noise, traffic suspension, temporary water cuts). • Participation in operation and maintenance of the facility after the construction. Judging from the results of the pilot project, it is judged that agreement can be reached from the residents if full explanation is given regarding the benefits residents can receive from the facility and obligation residents need to assume for constructing facility.
Sharing construction and Operation & Maintenance costs	Judging from the pilot projects and financial analysis of INAA, it is difficult for INAA to cover all the construction cost of the on-site domestic wastewater treatment systems in the model community with its own funds. Operation and maintenance costs can be fully covered as the amount is minimal. Accordingly, it is vital to examine methods on to securing both domestic and foreign aid for the construction of the systems. In the pilot projects, internal connection to the catch pit of each household and improvement of the drainage system within residences cost C\$540/household (INAA covered the cost this time). This amount is equivalent to approximately 5% of average annual household expenditure (C\$12,000/household) in the pilot project are. Although residents with relatively high income can bear the cost, it is necessary to find means to carry out internal connection by themselves under the supervision of INAA, in case that they can not afford to share the cost.

2.1.4 Continuation of Pilot Projects by the Nicaraguan Side

a. Requests for Continuation of Pilot Projects

At the end of August 1997, the Study Team requested the Nicaraguan side to continue the pilot projects even after the completion of this Study. The following are items that the Nicaraguan side shall carry out continuously in relation to the pilot projects.

Table 2-5: Items to be Continuously Carried out by Nicaraguan Side regarding the Pilot Projects

Pilot Project	Items to be continuously carried out by Nicaraguan side
1. Beautify Granada Campaign	<ul style="list-style-type: none"> • Based on the result of the experiment, development of more effective ways to enhance residents' awareness and gain their cooperation • Since the waste collection vehicle used in the experiments is still capable of continuing its operation, the collection service should be expanded to other similar communities. In this connection, campaigning to enhance residents' awareness and cooperation in waste discharge shall be carried out.
2. Experiment on Improvement of Refuse Collection System	<ul style="list-style-type: none"> • Provision of a regular collection service • Examine possibility of reducing collection frequency from three times to twice a week in order to reduce costs.
3. Experiment on Improvement of Arroyo Zacateligue Sanitation Environment	<ul style="list-style-type: none"> • Expansion of publicity and providing public education • Provision of a regular collection service
4. Experiment on Sanitary Landfill Operation at La Joya Disposal Site	<ul style="list-style-type: none"> • Accumulation of waste dumped and soil coverage • The maintenance of access roads to the La Joya disposal site
5. Experiment on Domestic Waste Water Collective Treatment System	<ul style="list-style-type: none"> • Operation and maintenance of the domestic wastewater collective treatment facility • Expansion publicity and providing public education