

SUMMARY REPORT OF THE
INTEGRATED CHOLERA CONTROL
AND PREVENTION PROGRAM
FOR MACHALA, ECUADOR

PN-ABP-970

WASH Field Report No. 427
September 1993

**WATER AND
SANITATION for
HEALTH
PROJECT**

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INTEGRATED CHOLERA CONTROL
AND PREVENTION PROGRAM
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Prepared under WASH Task No. 450

by

John Paul Chudy

Septmeber 1993

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Machala Latrine Design Workshop, Trip Report under Task 461. Prepared by Mercedes Torres Barriero, Enrique Gil-Bellorin, and John Gavin.

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Ing. John Gavin
Lica. Elsa de Mena
Lic. Jorge Infante
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ACRONYMS

A.I.D.	Agency for International Development
ASCAM	Asociación de Consultores Sanitarios y Ambientales (Association of Sanitary and Environmental Consultants)
EMAP-Q	Empresa de Agua Potable-Quito (Quito Water Utility)
FIM	Municipal Investment Fund
FISE	Fondo de Inversión Social Emergente (Fund for Social Investment)
GDP	Gross Domestic Product
HEALTHCOM	A.I.D. Communications for Health Project
HDI	Human Development Index
IEOS	Instituto Ecuatoriano de Obras Sanitarias (Ecuadorian Institute of Sanitary Works)
l/s	liters per second
LAC	Latin America and Caribbean (bureau of AID)
mg/l	milligrams per liter
MOH	Ministry of Health
O&M	operations and maintenance
PAHO	Pan American Health Organization
PCO	Provincial Council of El Oro
PDM	Municipal Development Program
PREDESUR	Programa para el Desarrollo del Sure (Program for the Development of the South)
RHUDO	Regional Housing and Urban Development Office
S/.	sucres
SIC	Special Investment Contribution
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WASH	Water and Sanitation for Health Project

EXECUTIVE SUMMARY

In December 1992 WASH carried out a rapid assessment of drinking water quality in the cities of Guayaquil, Esmeraldas, and Machala, in Ecuador. The assessment was requested by USAID/Ecuador, who on behalf of the Ministry of Health, wanted to ascertain the threat of cholera in coastal areas as posed by the quality of water consumed. A team of three consultants sorted through the cholera transmission factors of water quality, hygiene practices, and institutional issues in the three cities and made observations and recommendations with respect to each. The report serves as a baseline of cholera transmission in these coastal cities.

A decision was arrived at that follow-up activities should be integrated and be directed at the city of Machala only. Four activities were identified for implementation: a workshop to build local skills in cholera prevention and control, a prefeasibility study for the development of a water management plan, a workshop to review technical options available for improving community sanitation in peri-urban areas, and technical assistance to the municipal water and sanitation departments on cost recovery and financial management. The four tasks were implemented between March 11, 1993, and July 9, 1993.

This report is a summary of the four activities. It relates each activity to the observations made during the 1992 rapid assessment, summarizes the implementation of each activity, and assesses the immediate post-implementation impact. This report also presents an assessment of lessons learned and actions for the future.

Major Outcomes

The two workshops, both directed at peri-urban areas, produced a combined action plan for improving the control and prevention of cholera in Machala. The plan included the four action areas from the first workshop: epidemiological surveillance, household disinfection, hygiene education, and action plan coordination. A fifth action area of latrinization was added at the second workshop.

The action plan coordination committee designed a pilot project for household disinfection using chlorine (liquid bleach), which is directed at 20 barrios of Machala and costs about US\$47,000. The committee also designed a pilot project for latrinization in one barrio, which costs about US\$13,000. Funding for the household disinfection pilot project has not been found, but funding for the latrine pilot may be available from the newly created Fondo de Inversion Social Emergente (FISE—Fund for Social Investment) program.

The two technical assistance activities in the plan are directed at improving the quality and quantity of water delivered through the municipal network and produced important steps toward that end. The prefeasibility study updated and enhanced a network expansion plan developed for Machala in 1987 by Asociación de Consultores Sanitarios y Ambientales (ASCAM—Association of Sanitary and Environmental Consultants), and proposed the

construction of new and replacement water distribution systems including addition of water meters in households, construction of additional storage capacity, development of four new wells, and construction of a well-water treatment facility at a total cost of US\$17.8 million. The municipality has already used the prefeasibility study as part of its support documentation for a loan application to the Banco del Estado (State Bank) to initiate construction.

The technical assistance in financial management and cost recovery helped the municipality develop a framework and schedule for creating a new municipal utility for water and sewage. Training and institutional development work needed to make the new entity function properly could be modeled after Quito's potable water utility that recently restructured its financial management and administrative systems. The cost recovery work produced preliminary rates and terms for repaying a US\$17.8 million loan under Municipal Development Program (PDM) terms. For meter installation (24 months), a special improvement contribution (36 months), and ongoing operations and maintenance (O&M), the monthly tariff for a low-income household was estimated at US\$11.45.

A leak detection study was identified as a necessary follow up to the prefeasibility study, and as a necessary first step in creating trust in the community that the municipality is serious about improving water delivery service. Also identified as necessary follow-up activities were capacity building in the new utility and implementation of an in-depth tariff study. USAID/Ecuador, through the Regional Housing and Urban Development Office (RHUDO), has expressed interest in supporting these activities.

Lessons Learned

- The integrated program was effective in improving Machala's readiness to control and prevent the spread of cholera.
- Interagency workshops promoted cooperation.
- The integrated program helped direct the focus of local agencies involved in water and sanitation activities toward peri-urban areas for the first time.
- Household disinfection of drinking water is an appropriate and relatively low-cost intervention for marginal urban areas provided that a full promotion package can be organized and implemented.
- Cholera workshops and technical assistance should be implemented only when resources enabling project-level follow-on activities are available.

Actions for the Future

Consideration should be given to conducting a follow-up assessment a year from now to see how much of the technical assistance provided under the integrated cholera control and prevention program has been institutionalized or sustained in some meaningful fashion.

Chapter 1

INTRODUCTION

1.1 Background

Cholera reappeared in South America in early 1991 following a 100-year absence. The disease broke out almost simultaneously in several coastal cities of Peru and Ecuador. By the end of 1991, 391,750 cases had been reported in Latin America with 4,002 resulting in death. In 1992, the U.S. Agency for International Development (USAID) mission in Ecuador requested that the Water and Sanitation for Health Project (WASH) conduct a rapid assessment of the threat from cholera in terms of the quality of water being consumed by people in the coastal cities of Ecuador. The USAID/Ecuador request was prompted by a plea from the Ministry of Health (MOH) for chlorine that could be distributed in coastal cities. In consultation with WASH, USAID/Ecuador suggested to MOH that the distribution of chlorine alone could not affect the prevention and control of cholera. Other direct and indirect factors may also be involved, and to combat the disease, these have to be understood and dealt with along with water quality.

Once assured of the value of a multidisciplinary approach to assessing the threat of cholera, MOH asked that the assessment proceed. WASH sent a team of three consultants in December 1992 to carry out the assignment. Employing WASH's *Cholera Prevention and Control: Guidelines for Assessing the Options in Water Supply, Sanitation and Hygiene Education*, the team sorted through the factors associated with cholera transmission in three coastal cities: Guayaquil, Esmeraldas, and Machala. The team made observations and recommendations with respect to water quality, hygiene education, and institutional issues. Recommendations were both site specific and general for the entire coastal region, suggesting follow-up actions that could be undertaken on a local, regional, or national level.

Following the team's in-country work and debriefings at USAID, and later at A.I.D./Washington, a consensus was formed indicating that any follow-up activities would achieve greater impact if they were focused on one local area rather than regionally or nationally. Moreover, given the WASH project's completion date of September 1993, a local focus would minimize logistics, ensuring a more efficient use of time and resources. Of the three cities visited, Machala was selected as the focus for several reasons. First, local authorities, including municipal government, provincial health officials, and the provincial office of USAID's counterpart in the water and sanitation sector (IEOS—Ecuadorian Institute of Sanitary Works), all expressed keen interest in working together to address cholera transmission issues. Second, the relatively robust economy suggested resources that could be tapped for investment in erecting barriers to disease transmission. Third, the region has experienced a high incidence of cholera, and was the point of entry for the original outbreak in 1991.

Building on the findings from the rapid assessment, four specific activities that form an integrated cholera control and prevention program were identified for implementation in Machala. These included a workshop to build local skills in cholera prevention and control, a prefeasibility study for the development of a water management plan for the city of Machala, a workshop to review technical options available for improving excreta disposal in peri-urban areas, and technical assistance to the municipal water and sanitation departments on cost recovery and financial management. The four tasks were implemented between March 11, 1993, and July 9, 1993. An additional strategy and preparation task was developed to lay the groundwork for the four individual tasks and to prepare a concise summary report of the tasks following their implementation.

1.2 Purpose

The purpose of this report is to do the following:

- Review and summarize the four tasks;
- Compare the state of readiness to prevent and control the spread of cholera in Machala following the implementation of the integrated program with that observed in the rapid assessment carried out in 1992;
- Provide overall observations on the effectiveness of the integrated program to prevent and control the spread of cholera in Machala;
- Present lessons learned as a result of the rapid assessment and the follow-up integrated cholera control and prevention program.

1.3 Organization of Report

The report is organized into seven chapters. Following the introduction, Chapter 2 summarizes the integrated cholera control and prevention program for Machala and presents descriptive information on Machala. Chapters 3 and 4 summarize the experience of the two workshop tasks organized under the program, the cholera prevention and control workshop and the sanitation options workshop. Chapters 5 and 6 review the two technical assistance tasks presented under the program, the prefeasibility study for a water plan and the financial management and cost recovery improvement task. Chapter 7 presents conclusions drawn from the overall experience, compares the progress made against the baseline of the rapid assessment carried out in December 1992, presents lessons learned, and discusses actions for the future.

Chapter 2

AN INTEGRATED CHOLERA CONTROL AND PREVENTION PROGRAM FOR MACHALA

2.1 A Baseline: The 1992 Water Quality Assessment

The WASH December 1992 Water Quality Assessment looked at both direct and indirect factors affecting cholera. Direct factors include water quality and quantity, excreta disposal, and health practices; indirect factors include community participation, institutional development, financial planning, and the legal and regulatory environment.

The assessment team's findings provide a baseline against which to measure the effectiveness of follow-up activities to control and prevent the spread of cholera. The following are specific findings that suggested Machala was unprepared to control and prevent cholera and therefore would benefit from a concentrated focus:

- The incidence of cholera in 1992 in El Oro Province and the city of Machala was similar to that in 1991, i.e., about 5,300 cases. Some cantons that did not report any cases in 1991 began reporting in 1992, which means that the number of cases was stable for the province as a whole but that the problem was spreading over a much larger geographical area.
- Water demand exceeds current supply capabilities in terms of treatment, storage, and distribution. Only about 78,300 of Machala's 145,000 people receive water through the distribution network. Another 52,200 are served by tankers. The remaining 14,500 take water from wells or streams.
- Chlorine residual above 0.5 milligrams per liter (mg/l) was present in less than 15 percent of the samples analyzed. The absence of free chlorine residual was worse in 55-gallon drums and cisterns served by tankers and in cisterns fed by the water distribution network in areas of low pressure.
- The coliform bacteria levels of the raw water entering the La Lucha water treatment plant were very high.
- There is a lack of knowledge about excreta disposal compounded by technical problems. A high water table is thought to present a problem for latrine construction.
- The population at risk of contacting cholera from poor water quality is estimated to be higher than 60 percent. High risk areas include Puerto Bolivar, all areas served by tankers, and areas in the network with low or negative water pressure.
- A government mass media anti-cholera campaign was not based on the local knowledge, attitudes, and practices of the population at risk. Therefore, although the

information is disseminated, it does not lead to changes in dangerous hygiene practices.

- Machala's population has been growing at the rate of 3.6 percent over the last 10 years, the highest of any urban area in the country. The attraction for migrants is the economic activity. Unemployment is under 5 percent. Nonetheless, cost recovery for water supply service is insufficient to meet needs, suggesting potential resources remain untapped.

2.2 Overview of Activities

The four specific activities that make up the integrated cholera control and prevention program for Machala were selected as short-term measures that could best assist local health professionals and municipal authorities to address the problems the Water Quality Assessment team identified. The following discussion summarizes each of the activities in the program.

1. *Cholera Control and Prevention Workshop*: A two-week interagency workshop developed a cholera strategy for the urban area of Machala (and El Oro Province) emphasizing two interventions: a behavior-based communications program incorporating epidemiology, community participation, and evaluation and a household disinfection program.

2. *Prefeasibility Study to Develop a Water Management Plan*: Two weeks of technical assistance to conduct a prefeasibility study for the Municipal Water Department, and developed a water management plan directed at immediately improving the efficiency of water distribution in the city of Machala. The work evaluated all current data regarding potable water quality and quantity, developed an inventory of existing supplies and estimated needs for Machala and nearby towns in El Oro Province, evaluated short-term alternative water management scenarios and financing requirements including cost recovery options, and made recommendations for next steps compatible with available financing and water management scenarios.

3. *Interagency Latrine Design Workshop*: A two-week workshop reviewed technical options and appropriate designs for improving excreta disposal in marginal urban areas. The workshop was patterned after WASH's new latrine training manual, "Approaches to Improved Excreta Disposal Management in the Community." It addressed the steps necessary to collect information about a community's excreta disposal behaviors; analyzed these behaviors with respect to health risks, especially cholera; and identified appropriate excreta disposal approaches and appropriate technical designs.

4. *Financial Forecasting and Financial Management Improvement*: Four weeks of technical assistance sought ways to improve billing, cost accounting, and financial management of the water and sanitation departments in the city of Machala. The task was directed at improving financial management and cost recovery for the water and sanitation departments of the municipality of Machala.

The four activities were programmed to take place in succeeding order beginning with the cholera control and prevention workshop in April and ending with the technical assistance on cost recovery and financial management in July. The details of each of the activities with respect to the consultants and dates of implementation are presented in the following table.

Table 1
Cholera Control and Prevention Program

Integrated Cholera Control and Prevention Program for Machala, Ecuador		
TASK	CONSULTANTS	DATES
Cholera Control and Prevention Workshop	J.I. Matta (HEALTHCOM) Enrique Gil(WASH) Mercedes Torres (WASH)	April 19-30, 1993
Prefeasibility Study for Water Plan	Elio Arniella (WASH)	May 3-14, 1993
Interagency Latrine Design Workshop	John Gavin (WASH) Enrique Gil (WASH) Mercedes Torres (WASH)	May 17-28, 1993
Cost Recovery and Financial Management	Jorge Infante (WASH) Elsa de Mena (WASH)	June 14-July 9, 1993

A WASH consultant visited Machala in March 1993 prior to the implementation of the four activities. The purpose of the preparatory visit was to lay the groundwork for the four activities. The consultant's principal objective was to achieve a consensus among the municipal government, the provincial directorate of MOH, and the provincial office of IEOS on the four activities and the responsibilities of each agency in assisting in implementing them. This work also involved developing participant lists, reserving site facilities for the two workshops, and identifying counterpart professionals with whom the technical assistance consultants would work during their visits.

2.3 Study Area Description

In 1990, Ecuador had a population of 10.3 million, a nominal per capita gross domestic product (GDP) of US\$1,056, an adjusted purchasing power parity per capita GDP of US\$3,012, and a GDP growth rate of 2.3 percent, well above the 0.4 percent average for developing countries in the Western Hemisphere (World Development Report 1992, Human Development Report 1992). The country ranked 77 out of 166 countries on the United Nations Development Programme's (UNDP) Human Development Index (HDI) with a score of 0.641 (Canada was highest with an HDI of 0.982). The HDI combines longevity, knowledge, and income.

The study area that concerns the integrated cholera control and prevention program encompasses the province of El Oro, the canton of Machala (county-like administrative unit), and the city of Machala proper on the country's southwestern coast. The El Oro Province has an area of 5,850 square kilometers, and the 1990 population was 412,572. Machala is the third largest city in Ecuador and the largest city in El Oro Province. The 1990 population recorded by the census for the canton of Machala was 157,572 (with the actual city population being about 144,000). The topography is generally flat with a tropical climate. The rainy season occurs during the winter months of December through April. The largest body of water in El Oro Province is the Jubones River, which discharges into the Pacific Ocean near Puerto Bolivar. One large tributary of the Jubones River is the Casacay River. An alluvial plane runs along the Jubones River. In the urban area of Machala, the soils are predominantly clay.

The water distribution system that currently serves the city of Machala also serves the peri-urban areas of the city within the canton of Machala as well as Puerto Bolivar, which has a population of about 40,000. Tanker trucks, which are filled at the city's La Lucha treatment plant, are used to distribute water to the canton of Machala. Some of the water that feeds into Machala's distribution system comes from the Regional Water Treatment Plant, which also serves the towns of Pasaje and El Guabo. These towns have respective populations of 51,406 and 28,058. The regional water system will eventually serve all of Machala. When fully on line in 1994, the regional system will provide water to the following communities listed here with current populations:

Machala	144,000
Puerto Bolivar	40,000
Pasaje	51,406
El Guabo	28,058
Total	263,464

The economic activity of Machala is built around agriculture (banana plantations), shrimp farming, silviculture (forestry), and mining. The light industry and construction are other sources of employment. Figure 1 provides a general map of Machala, nearby cities, and hydrological features.

A more thorough review of each activity begins in the next chapter with a discussion of the two workshops.

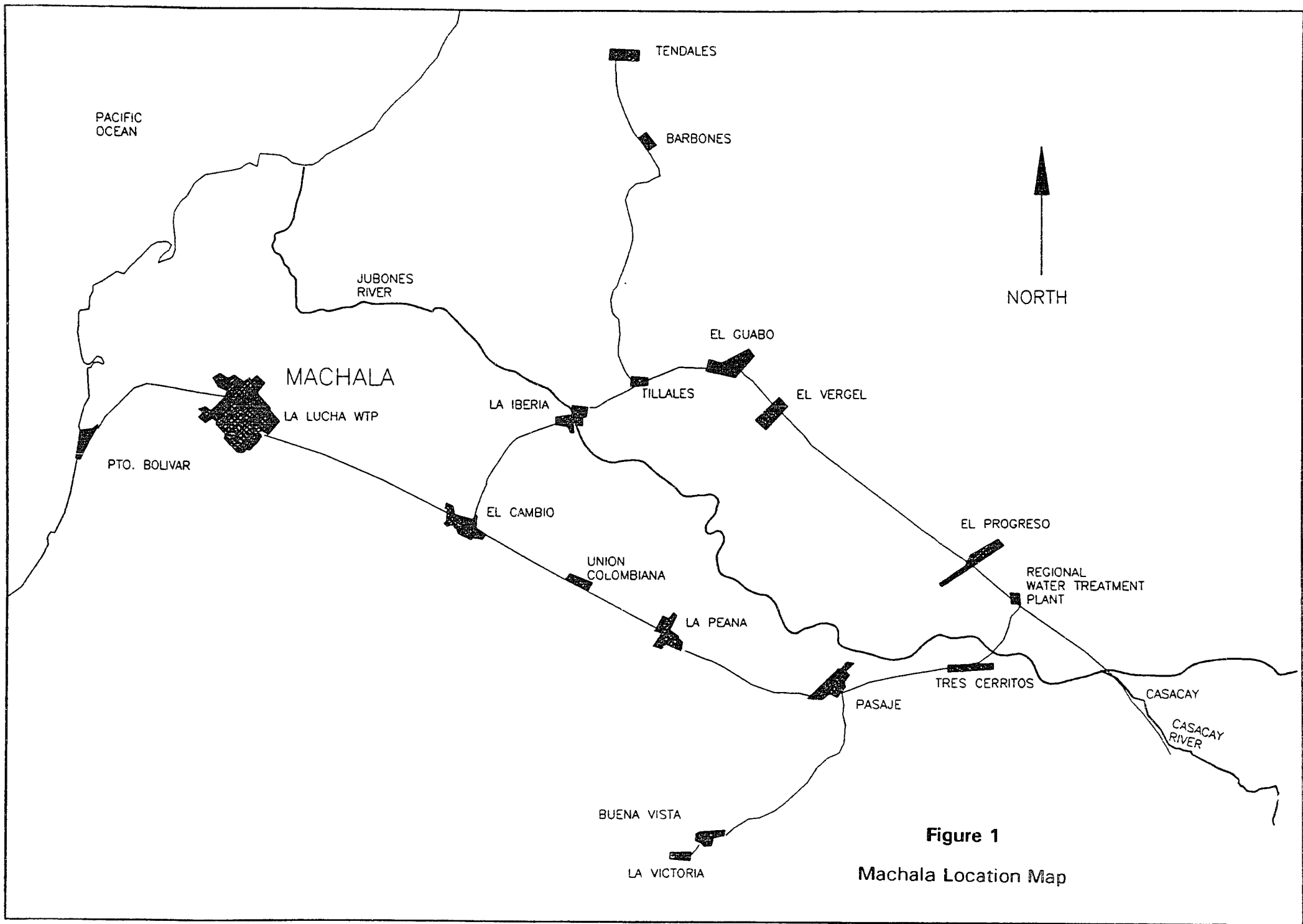


Figure 1
Machala Location Map

Chapter 3

THE CHOLERA CONTROL AND PREVENTION WORKSHOP

3.1 Baseline

This workshop was developed to respond to findings and short-term recommendations put forth by the Water Quality Assessment team in December 1992. Principal findings included the following:

- The quality of water received through municipal systems, from water vendors (tanker trucks), or from nearby streams and rivers was more often than not contaminated.
- Overnight storage of water in 55-gallon tanks or cisterns results in loss of chlorine residual, and containers used to collect water from storage tanks and cisterns may contaminate the remaining water. The team concluded that the population in the study area at risk for contacting cholera by ingesting contaminated water exceeds 60 percent.
- The government has launched a mass media anti-cholera campaign, but it is not based on the knowledge, attitudes, and practices of the population at risk. As a result, the information is received but does not lead to changes in dangerous hygiene practices.

The following are short-term recommendations made to remedy the effects of these findings:

- Implement a household water disinfection program to reduce the risk of vulnerable groups to cholera.
- Strengthen epidemiological surveillance so that cholera planning and decision-making are based on risk of vulnerable populations, geographic area, and time of year, and are linked to the development of a communications plan for hygiene education.
- Train health educators and inspectors in community studies, data analysis, use of epidemiological information, community participation, and education methodologies.

3.2 The Workshop

The workshop addressed the above recommendations through a two-week program that developed and implemented two components: a research-based communications program incorporating epidemiology, community participation, and evaluation and a household disinfection program.

The workshop was presented April 19-30, 1993, in Machala, at the hotel "Pearl of the Pacific." It was preceded by a one-week team planning session. Dr. Mercedes Torres, a WASH consultant, acted as facilitator; Dr. Enrique Gil, also a WASH consultant, was the

health specialist on the team; and a HEALTHCOM consultant, Jose Ignacio Matta, provided the communications specialist skills.

3.2.1 Workshop Participants

The 30 workshop participants came from the following agencies:

MOH Provincial Directorate (El Or Province)

3 chiefs of department

14 sanitary inspectors

1 health educator

Municipality of Machala

1 secretary

1 president, Federation of Barrios

1 director of environmental education

1 coordinator, Association of Barrios

IEOS

2 sanitary promoters

1 supervisor of promotion

5 engineers

3.2.2 Workshop Purpose and Goals

The purpose of the workshop was to develop a plan of activities for epidemiological surveillance, hygiene education, and household water disinfection based on data collected in peri-urban areas during the workshop.

The workshop's principal goals were as follows:

- Apply basic elements of epidemiology to the planning and evaluation of health actions;
- Reinforce knowledge about the storage, distribution, preparation, use, and measurement of and risks with use of chlorine for the disinfection of water in the home;
- Learn the process for developing behavior-based health education programs through communication;

- Identify the variables, the population, and the objectives in the planning of data collection in the field;
- Develop basic skills needed for collecting and analyzing data from peri-urban areas;
- Prepare and field test data collection instruments, collect and analyze data;
- Apply newly acquired skills to the development of an action plan addressing behavior-based communication and household water disinfection;
- Apply newly acquired skills to the design of education materials for use in the implementation of a household disinfection program.

3.2.3 Workshop Design and Methodology

The workshop was designed to help the participants meet the eight workshop objectives. The 10 units of the workshop were designed around an experiential learning approach intended to engage participants directly in the subject matter. Learning was participatory and hands-on. The original two-component focus of the workshop was modified so that greater emphasis was placed on household disinfection when it was learned that both the provincial directorate of MOH and the provincial office of IEOS had been distributing chlorine materials for use in household water disinfection independent of each other's knowledge, and that each agency was providing different preparation instructions. It was therefore decided that engaging participants in the establishment of a common protocol for chlorine distribution would be a very effective and relevant use of workshop time. It also became apparent during the one-week planning period that there would not be enough time in two weeks to permit participants to both learn communications techniques and apply them by gathering data and developing and disseminating health messages through radio, television, or newspapers. The modification allowed for the development of an action plan that addressed household disinfection using the behavior-based communications techniques that were being presented. Development of the action plan allowed participants to address cholera prevention and control issues beyond household disinfection.

A workshop report presenting a complete discussion of the preparation and implementation experience was prepared in Spanish. The schedule of the workshop is presented in Table 2.

Table 2

Cholera Prevention and Control Workshop Schedule

Day 1	Day 2	Day 3	Day 4	Day 5
<ol style="list-style-type: none"> 1. Introduction and orientation 2. Epidemiology of cholera (Storyboard: epidemiology, transmission, and prevention) 	<ol style="list-style-type: none"> 1. Epidemiology of cholera (Storyboard: transmission and prevention) 2. Household disinfection of water by chlorine 3. Process of communication education: why investigate 	<ol style="list-style-type: none"> 1. Process of educational communication 2. Determination of variables, population, and objectives 3. Investigation techniques (Observation) 	<ol style="list-style-type: none"> 1. Investigation techniques (Interviews) (Focus groups) <ul style="list-style-type: none"> ■ Exercises ■ Analysis of exercises 	<ol style="list-style-type: none"> 1. Investigation techniques 2. Data collection and analysis

Day 6	Day 7	Day 8	Day 9	Day 10
<ol style="list-style-type: none"> 1. Data collection and analysis <ul style="list-style-type: none"> ■ Field testing instruments ■ Evaluation of field test 	<ol style="list-style-type: none"> 1. Data collection and analysis <ul style="list-style-type: none"> ■ Field work in marginal urban areas 	<ol style="list-style-type: none"> 1. Data collection and analysis <ul style="list-style-type: none"> ■ Consolidation and analysis of data ■ Analysis of results 	<ol style="list-style-type: none"> 1. Formulation of action plan for household disinfection 2. Presentation of action plan to authorities 	<ol style="list-style-type: none"> 1. Preparation of communications materials 2. Personal plans and evaluation of workshop

3.2.4 Data Collection and Analysis

Once participants were introduced to the epidemiology of cholera, the elements of household disinfection using chlorine, and the basic techniques of data collection during the first week of the workshop, they were then engaged in actual data collection in peri-urban areas. Participants designed and field tested data collection instruments and then worked in groups and in pairs to collect data by observation, direct interviews, and focus groups. The data collection and analysis exercises were built around the issues of water supply, water storage, and water disinfection using chlorine in households in the peri-urban areas.

A total of 98 mothers were interviewed, 48 of whom were later observed for their knowledge and understanding of how to disinfect water in the household (24 used the tablets distributed by MOH, and 24 used the granular calcium hypochlorite distributed by IEOS). In addition, 36 fathers were interviewed, and four focus groups with 10 people each were convened. Participants collected data from a total of 220 people. The data collection was conducted in four peri-urban barrios of Machala: Rayito de Luz, Ciro Ceratto, Los Algarrobos, and Rodolfo Cruz Chero.

These data provided a snapshot of conditions in the peri-urban areas of Machala. They also revealed a consciousness among peri-urban dwellers about the relationship between water and health. Most importantly, the data revealed how participants learned first hand how peri-urban dwellers perceive their water quality and what they are able to do about it. Following is a summary of responses obtained by the participants:

Water Supply

- The majority of households do not know the origin of the water they receive, whether it be from public standpipes or a tanker. The quality of water from public standpipes is uncertain given the current status of the La Lucha treatment plant. Likewise, tankers claim to get their water from the treatment plant, but may be getting it from somewhere else.
- Sixty-four percent of homes visited get their water from a public standpipe, and 37 percent get their water from tankers.
- Thirty-one percent of mothers spend more than one hour a day collecting water, while 59 percent spend less than one hour.
- Seventy percent of mothers must hand carry water to their homes (from standpipes or from tankers); 24 percent use hoses from standpipes and share them with their neighbors (common in Rayito de Luz).
- Fifty-nine percent refill their barrels or cisterns every two days, and 29 percent refill between three and eight days.
- Fifty-four percent collect rainwater, and 47 percent use the rainwater for drinking (27 percent believe it is safe and drink it without any treatment).

- Families that share water from public standpipes must respect an established access timetable. People consider the public network to be unsafe because of breaks in the line that can cause contamination. Those that must buy from tankers consider the water to be of poor quality because it has a bad taste and bad smell, and they also complain of abusive chauffeurs who they view as “despots.”

The people provided the following suggestions for improving water supply in peri-urban areas:

- Improve the network so that it reaches these areas.
- Increase the number of tankers and ensure that they fill at the treatment plant and do not use doubtful sources of water.
- Improve the quality of the streets so that tankers can reach homes more easily and regularly.

Water Storage

- Twenty-three percent report using less than one gallon of water in the house for drinking; 64 percent consume more than one gallon (usually between one and two gallons).
- Fifty-two percent of mothers interviewed use a barrel for storage, 13 percent have a cistern, and 33 percent use buckets. All three methods are exposed to contamination from extraction; for example, by using a dipper or bucket.
- Eighty-nine percent report regularly washing the utensils with which they extract water from the storage tank, cistern, or bucket; 12 percent report washing their tank daily; and 57 percent report doing so once a week. Detergent and a brush are used for cleaning the tank in 84 percent of the cases.

Household Water Disinfection

- Ninety percent of respondents boil their water, but were confused as to how long to let the water boil. The correct answer is two minutes from when it begins to boil, not two or more minutes from the time it is put on the flame, as some reported.
- Seventy-four percent of mothers reported hearing about the use of chlorine for disinfecting water. Some may be confusing this with the malaria control activity in which a larvacide is applied to water storage tanks to control the hatching of mosquitoes. If this idea is true, more field work and an educational campaign may be required.
- Twenty-four percent of those interviewed reported actually using chlorine to disinfect water in their homes. However, many of these people continue boiling water because they do not have confidence in the use of chlorine and do not know the correct dosage.

- Seventy-five percent of those interviewed believe that the use of chlorine will make water safe, but 42 cite lack of knowledge in applying it as a barrier to using it in their home. Another 20 percent give the bad taste it leaves as a reason for not using it.
- People cited the advantages of chlorine are that it makes water safe and is cheaper than boiling water.
- Disadvantages given include the lack of knowledge about proper dosage and application, doubts about health effects if improperly used, and the bad smell and bad taste (that probably comes from improper dosage).
- People do not know where to obtain chlorine.

Observed Capacity of Residents to Apply Chlorine

- Forty-seven percent use the incorrect dosage.
- The lack of measuring utensils makes chlorine application in the proper dosage difficult to achieve.
- The application rates of chlorine suggested by IEOS and MOH have no direct relation to the average quantity of water being consumed in peri-urban homes. Suggested stock solution amounts lead to waste as it exceeds the amount needed in most homes. Moreover, the instructions from MOH and IEOS are different and lead to confusion among users. Obviously, a uniform set of instructions would be better.

Data collection from the four peri-urban neighborhoods and the subsequent analysis gave the participants a base for developing an action plan to address water quality.

3.2.5 The Action Plan

The participants' final activity in the workshop was to develop an action plan. The action plan focused primarily on the important role of a water disinfection program at the household level and the need to unify the two different approaches of MOH and IEOS.

The action plan addresses four areas: epidemiological surveillance, household water disinfection using chlorine, hygiene education, and coordination of the plan. (See Appendix A for details of the action plan.)

The general objective of the action plan is to reduce mortality and morbidity caused by cholera and other diarrheal diseases by improving the quality of water consumed by the population in marginal urban areas of Machala. The participants developed specific objectives for each action area.

Of the three principal institutions involved in Machala—IEOS, MOH/provincial directorate, and the municipality—IEOS was identified as the coordinating agency for the action plan. Each institution in turn identified internal departments responsible to the coordinator.

IMPROVED COMMUNITY SANITATION WORKSHOP

4.1 The Baseline

The Water Quality Assessment conducted in December 1992 identified a number of problems associated with poor sanitation in the city of Machala. Currently, collection sewers serve only 50 percent of the population. This wastewater, none of which is treated, is discharged into nearby estuaries or directly into the Pacific Ocean. In areas not served by the sewer system, the minority of residents who do have an excreta disposal system use substandard septic tanks and latrines that are in most cases in direct contact with the water table. In some of the more water-logged marginal urban areas where residents elevate their homes on stilts, human excreta is discharged directly into the water.

Generally, there are no systems for properly disposing of excreta in homes in marginal urban areas. Even in those homes with a flush toilet, the water valve is often closed to save water, and therefore, fecal material accumulates. Fecal matter is frequently observed in residential yards as well as in the streets. Associated with these observations is the notable lack of hygiene education based on the knowledge, attitudes, and practices of the populations at risk.

The following are short-term recommendations made to remedy these findings:

- Develop and present an interagency workshop to review the full range of technical alternatives available for on-site excreta disposal.
- Incorporate community participation into cholera control activities, but follow clearly defined guidelines that ensure the sustainability of the strategy.
- Train health workers in information-gathering techniques at the community level. Topics should include data collection and analysis; approaches for community participation; use of epidemiological information; and the preparation, implementation, and evaluation of hygiene educational strategies and campaigns.

4.2 The Workshop

The workshop addressed these observations and recommendations by presenting a systematic approach to improving community sanitation, which consisted of identifying problems, determining appropriate interventions, and monitoring and evaluating the project.

The two-week workshop was presented May 17-28, 1993, in Machala, at the hotel "Pearl of the Pacific." It was preceded by a one-week team planning session. Three WASH consultants comprised the team. Dr. Mercedes Torres acted as facilitator, Dr. Enrique Gil was the health specialist on the team, and Mr. John Gavin provided the sanitary engineering skills.

4.2.1 Workshop Participants

The 20 workshop participants came from the following institutions:

Promotion for the Development of the South (PREDESUR)	5 (4 engineers, 1 promoter)
Municipality of Machala	1 (engineer, Sewage Department)
Municipality of Santa Rosa	2 (1 topographer, 1 supervisor)
Provincial Council El Oro Province	2 (1 engineer, 1 promoter)
IEOS/El Oro	3 (2 assistants, 1 draftsman)
MOH/El Oro	4 (4 sanitary inspectors)
IEOS/Quito	3 (1 engineer, 2 trainers)

4.2.2 Workshop Purpose and Goals

The purpose of the workshop was to integrate the fundamental technical elements and develop the skills necessary to plan, implement, and evaluate a program for improved community sanitation.

The workshop's principal goals were to do the following:

- Describe the appropriate approaches for developing a program for improving community sanitation;
- Identify the excreta disposal behaviors in the community and their affect on health;
- Collect information to assist in the development of a sanitation improvement strategy;
- Analyze critical factors in determining the selection of an appropriate system for the elimination of excreta;
- Describe the design principles required for the various types of systems;
- Identify possible problems with operation and maintenance of latrines;
- Formulate techniques that are feasible to apply in hygiene education;

- Review the elements that are essential for proper supervision, monitoring, and evaluation of sanitation interventions;
- Develop an action plan for improving community sanitation in Machala.

4.2.3 Workshop Design and Methodology

The workshop was designed around 10 units to help the participants meet the workshop objectives. An experiential learning approach was used to engage participants directly in the subject matter. Learning was participatory and hands-on. Because one day of the original 10-day schedule was a national holiday, the 10-unit program had to be scheduled for implementation over nine days.

The methodology employed the three-part model proposed in the WASH community sanitation training guide (Technical Report No. 83). The model is a process whereby the participants are directly involved in identifying problems, selecting an appropriate intervention for the isolation of excreta, and monitoring and evaluating the project.

A workshop report presenting a complete discussion of the preparation and implementation experience was prepared in Spanish. The schedule of the workshop is presented in Table 3.

Table 3

Improved Community Sanitation Workshop Schedule

Day 1	Day 2	Day 3	Day 4	Day 5
<ol style="list-style-type: none"> 1. Introduction and orientation 2. Participant experience and knowledge level 3. Focus for improving community sanitation 4. Analysis of excreta disposal behaviors in the community 	<ol style="list-style-type: none"> 1. Analysis of excreta disposal behaviors in the community and limits associated with peri-urban areas <ul style="list-style-type: none"> ■ Identify high-risk behaviors 2. Skills for collecting data on excreta disposal behaviors 	<ol style="list-style-type: none"> 1. Development and application of data collection instruments <ul style="list-style-type: none"> ■ Develop ■ Field Test ■ Collect data 	<ol style="list-style-type: none"> 1. Data analysis and definition of interventions 2. Concepts of systems used for the elimination of excreta <ul style="list-style-type: none"> ■ Types of basic systems for the elimination of excreta 	<ol style="list-style-type: none"> 1. Factors that affect selection of a system for the elimination of excreta 2. Field work: data collection
Day 6	Day 7	Day 8	Day 9	Day 10
Holiday	<ol style="list-style-type: none"> 1. Institutional perspectives on the problem of sanitation and the design of technical alternatives 	<ol style="list-style-type: none"> 1. Supervision of construction 2. Operation and maintenance 	<ol style="list-style-type: none"> 1. Methods of sanitation education 2. Monitoring and evaluation 	<ol style="list-style-type: none"> 1. Elaborate an action plan for improved sanitation in two peri-urban barrios 3. Evaluate workshop

4.2.4 Data Collection and Analysis

Participants took two field trips to the peri-urban communities of La Garzota and Rayito de Luz to collect data. Accurate populations of each community were unknown at the time of the visits, but the number of houses was indicated as 41 in La Garzota and 500 in Rayito de Luz. Twenty of the houses in La Garzota were visited, and 30 houses were visited in Rayito de Luz. The participants developed questionnaires for use during the field trips. In the first trip, participants collected information about knowledge, attitudes, and practices regarding excreta disposal and current systems used. They also collected information about the physical and geological features of the area. On the second visit, participants collected information about financial, material, and human resources potentially available in the communities to implement sanitation projects as well as sanitation technology preferences of community residents.

Participants then analyzed these data and devised a problem definition for each barrio. Following is a summary of these findings and problem definitions for both barrios beginning with La Garzota.

Data summary for La Garzota:

- Most frequent responses when asked what is the importance of having or constructing a latrine
 - Better hygiene
 - Fewer insects and flies
 - More convenience
- Most frequent responses when asked why people get diarrhea, cholera, or parasites
 - Using contaminated water (water not boiled)
 - Eating food from street vendors or food improperly prepared at home
 - Not practicing personal hygiene and cleanliness
 - Eating unwashed fruit
 - Eating too many sweets
 - Going barefoot
- Fecal matter from adults is considered more dangerous than from children.
- Most frequent responses regarding beliefs about how to prevent diarrhea, cholera, and parasites
 - Boil water
 - Properly handle food
 - Practice hygiene

- Wash hands
- Do not go barefoot
- Mothers say that following defecation, they wash their hands with soap and water, but children do not.
- The majority of households do not have sanitary facilities; therefore, people do their necessities in
 - Chamber pots and later empty them in the patio, street, or nearby bushes
 - Open air
 - Relative's latrine
 - Newspaper and then throw in the patio or nearby bush
- Most frequent reason for not constructing a latrine
 - The soil is flooded (too near the canal)
- In those cases where people have a latrine, all are dry pit latrines constructed in the patio, and most are flooded. People use used motor oil, diesel fuel, or lime to clean latrines. Children under five years of age do not use the latrine because it is dangerous (might fall in), so they use a chamber pot instead.
- Advantages noted for having a latrine
 - More cleanliness in the patio in summer (the dry season)
 - Closer to the house
 - More privacy
- Disadvantages noted
 - Flood in the rainy season
 - Attract flies and insects
 - Dangerous for small children
 - Are incomplete if latrines are simple
- Problems during construction
 - Flooding
 - Sides cave in
- Observations of latrines that were not flooded
 - Most were not clean

- Dirty toilet paper was found in the area of latrine
- Most did not have a seat or platform
- Principal construction materials
 - Cane (bamboo) walls
 - No doors (or with a curtain at best)
 - Most without roof
 - Most without a seat or platform
- Residents were able to identify leaders from the Barrio Directive, sports clubs, and women's groups and could site when and why the Barrio Directive meets (Mondays and Fridays to discuss water, sewage, and light).
- Physical characteristics of La Garzota
 - Flat topography
 - Clay soil
 - Lot size is greater than 10 m²
 - Water table 1.3 m on average
 - Soil is impermeable in 70 percent of the barrio
 - People use a canal that borders the barrio to bathe and wash clothes
 - There is no water distribution system apart from three private standpipes connected to the city distribution system, the owners of which make water available to nearby neighbors. Water otherwise is distributed by tanker truck.

The participants found, in their summary analysis of La Garzota, that 80 percent of homes do not have a latrine or sanitary facility. Moreover, filtration from a nearby canal bordering the barrio affects soil conditions, and in the rainy season there is usually general flooding. There is also a lack of understanding about the relationship between disease transmission and the lack of proper excreta disposal systems.

The following are some appropriate interventions:

- Provide hygiene education;
- Offer construction techniques of excreta disposal systems appropriate for the physical limitations encountered;
- Regulate operations and maintenance (O&M);
- Control the flow of the canal (by petitioning the municipality);

- Consolidate community organization so that it can manage a latrine building program.

Data summary for Rayito de Luz:

- Most frequent responses when asked what is the importance of having or constructing a latrine
 - Better hygiene
 - Prevents disease
 - More convenience
- Most frequent responses when asked why people get diarrhea, cholera, or parasites
 - Eating contaminated food
 - Drinking contaminated water
 - Not adopting personal hygiene and cleanliness
 - Eating too many sweets
- Fecal matter from adults is considered more dangerous than from children.
- Most frequent responses regarding beliefs about how to prevent diarrhea, cholera, and parasites
 - Boil water
 - Properly handle food
 - Practice hygiene
- Mothers say that following defecation, they wash their hands with soap and water, but children do not unless they are with them.
- Of those households interviewed, the majority have sanitary facilities used by the entire family with the exception of children under five years. These children use chamber pots, which are later emptied in the patio, street, or nearby bushes.
- Most frequent problem people have with their latrine is that it floods in the rainy season and overflows. Those who have not built an improved latrine cite the lack of economic resources and the flood-prone conditions of the barrio.
- People use chlorine, soap, used motor oil, diesel fuel, or lime to clean their latrines. Used toilet paper is burned.
- Advantages noted for having a latrine
 - Disease prevention
 - More privacy

- More convenience
- Better hygiene
- Disadvantages noted
 - Flood in the rainy season
 - Have to change location as pits fill up
- Problems during construction
 - Flooding
 - Lack of economic resources
- Most latrines are a simple, dry pit type, with about 38 percent in unhygienic conditions, such as dirty toilet paper around the latrine site and, in some cases, fecal material in the patio area.
- Principal construction materials
 - Cane (bamboo) walls
 - Many without roof; those with are made of metal sheeting
 - Most without a seat or platform
- Residents were able to identify leaders from the Barrio Directive, sports clubs, and women's groups and could site when and why the Barrio Directive meets (as needed, and lately to discuss sewage collection). Most of the population supports community activities with labor, in meetings and/or economically.
- Physical characteristics of Rayito de Luz:
 - Flat topography
 - Clay soil
 - Lot size is greater than 10 m²
 - Water table 1.3 m on average
 - Soil is permeable
 - Canal del Macho borders the barrio that people use to bathe and wash clothes
 - There is water distribution system through PVC tubing 24 hours a day, with standpipes installed on the corner of each block (homes connect hoses to the standpipes to fill their cisterns).

The participants found in their summary analysis of Rayito de Luz that approximately 50 percent of the homes have latrines, but most are not adequately maintained, and some do not

function properly because of problems caused by flooding or improper construction techniques. Participants also felt that Rayito de Luz respondents had a weak understanding of the cause-effect relationship among excreta, the use of latrines, and disease.

The following are some appropriate interventions for Rayito de Luz

- Improve latrines
- Construct latrines appropriate to the setting (could be toilets with septic tanks)
- Regulate O&M
- Provide hygiene education

4.2.5 The Action Plan

The 10 workshop units were designed so that participants could identify problems in peri-urban areas by collecting information from barrio residents. Information regarding knowledge, attitudes, and practices relating to excreta disposal were complemented by information on the physical conditions and resources of the barrio. Participants then reviewed technical options available for excreta disposal, and by matching the information with data collected from the barrios, made appropriate selections with community members for solving the excreta disposal problem. A final step was to draft an action plan for implementing a program to construct excreta disposal systems in the barrios. The plan is called latrinization.

The action plan exercise for this workshop led to the development of one action area that was integrated into the action plan developed in the earlier cholera control and prevention workshop. Thus, there now is one action plan for the peri-urban areas of Machala that has five action areas, four from the earlier workshop and one from this workshop. The action areas include the following:

- | | |
|-----------------------------------|------------------------------|
| ■ Epidemiological surveillance | Developed in first workshop |
| ■ Household disinfection of water | " |
| ■ Hygiene education | " |
| ■ Coordination of the plan | " |
| ■ Latrinization | Developed in second workshop |

The overall objective of the action plan is to reduce the incidence of mortality and morbidity from cholera and other diarrheal diseases by improving the quality of water the population in marginal urban areas of Machala consumes. The addition of this action area strengthens the action plan by addressing the issue of proper excreta disposal, which contributes directly to improving the quality of water consumed. It also dovetails the action plan effectively regarding hygiene education and epidemiological surveillance.

The objectives of the latrinization action area are to construct an appropriate excreta disposal system in the barrio of La Garzota, to improve hygiene conditions at both family and community level, and to reduce the risk of contracting cholera and other diarrheal diseases. (See Appendix B for a detailed breakout of the latrinization action area.)

Chapter 5

PREFEASIBILITY STUDY FOR A WATER PLAN FOR MACHALA

5.1 The Baseline

The 1992 Water Quality Assessment found that in Machala water quality and quantity were factors that increased the risk of cholera among residents. Water demand exceeded supply, with only 90 percent of the population having access to service, of which 60 percent was being served by the municipal distribution system and 40 percent by tanker trucks. Of those receiving water from the municipal system, only 75 percent had 24-hour service. Intermittent service was exacerbated by breaks in the system and illegal hookups. The assessment concluded that if the quantity of treated water delivered through the distribution system was increased, more high-quality water would reach more people, thus reducing the number of people at risk.

The quality of water consumed was inconsistent. Six of 21 water samples tested for bacteriological quality had fecal coliform counts between 6 and 7,200 colonies, and a seventh sample had 14,000 fecal coliform colonies. Water delivered through the municipal system was generally found to have chlorine residual and to be free of fecal coliform counts. By contrast, consumers in peri-urban areas who received water by tanker truck and stored it in 55-gallon drums or cisterns had low chlorine residual levels, and fecal coliform were detected at some of these sites. Generally, the manipulation of water in 55-gallon drums or cisterns leads to loss of chlorine residual and increases the opportunity for recontamination.

Principal assessment recommendations for addressing water quantity and quality issues included the following:

- Provide regional water quality laboratories with basic equipment, reagents, and trained personnel for monitoring and controlling water quality throughout the region.
- Develop a master plan and preliminary design for water supply, treatment, storage, and distribution that will set the goal of supplying potable water to the design population 24 hours a day.

This prefeasibility study was designed as a first step toward responding to these observations. Conducted May 3-14, 1993, the study went beyond the December 1992 assessment and evaluated in greater depth the current balance in Machala's water distribution system, assessed present and future needs, and developed and evaluated alternatives for meeting the needs in terms of quantity and quality (see Field Report No. 400).

5.2 Assessment of Existing Water Systems

The prefeasibility study found that current water demand for Machala and Puerto Bolivar is 503 liters per second (l/s). Existing sources produce 491 l/s, of which 280 l/s is produced by four wells, 120 l/s is provided from the La Lucha treatment plant, and 91 l/s comes from the regional water treatment plant. However, because of losses in the Machala distribution system of 294 l/s due to leaks and illegal hookups, the distribution system has a current deficit of 306 l/s.

When the regional water treatment plant is fully operational in early 1994, it will produce 1000 l/s. However, the current condition of the distribution system in Machala will not be able to fully accommodate the additional production. Even after the regional plant is functioning at full capacity, the deficit in Machala will be about 116 l/s, and it will gradually rise to 750 l/s by 2015. Water losses are responsible for the deficit. It is therefore essential that the existing network be restored and that new distribution lines be installed.

To assess water quality, bacteriological and physical/chemical water quality parameters were monitored in the regional and the municipal systems. All physical/chemical parameters were found to be within World Health Organization norms. Bacteriological characteristics of the surface water sources for Machala, Pasaje, and the regional treatment plant had fecal coliform counts ranging from 46 to 2,300 number/100 ml. The chlorinated finished water from the La Lucha plant had no fecal coliform bacteria count, notwithstanding the fact that the raw water entering the plant had in excess of 14,000 fecal coliform count.

5.3 Proposed Options and Evaluation

Based on water quantity and quality requirements for Machala, the prefeasibility study identified the following list of system improvements necessary to meet current and future demand:

- Install 120 km of new distribution network in Machala and Puerto Bolivar by 1996 and add 21,600 m³ of storage capacity;
- Repair existing water distribution network;
- Disallow and remove illegal connections by 1996 and pass and enforce additional legislation prohibiting illegal connections;
- Establish a goal for reducing system losses to less than 20 percent by 1999;
- Install water meters to 50 percent of the users by 1996 and to 85 percent by 1999.
- Install three to four new wells with 200 l/s capacity by 1994;
- Design and build by 1996 a new 500 l/s water treatment plant for removal of iron and manganese and disinfection of water from wells;

- Add additional water supply capacity of 250 l/s by 2005 and double this capacity by 2010.

5.4 Implementation Issues

The following proposed actions require immediate attention:

- Repair and install a water distribution network for Machala and Puerto Bolivar.
- Design and install four new wells.
- Locate pressure filter treatment plant at or near the La Lucha plant. (The plant will remove iron and manganese from the well water, reduce particulates, and chlorinate the water. This treated water will be mixed with the water from the regional treatment plant in the distribution system.)
- Decide on additional capacity needed for 2005 and 2010 by 2000.

The cost estimates for designing and constructing the proposed water system improvements for Machala and Puerto Bolivar are as follows:

Water distribution network	\$12.0 million
Storage tanks	1.8 million
Four new wells	1.1 million
Pressure/filtration plant	2.9 million
Total	\$17.8 million

Total annual O&M costs will be US\$1.3 million, and total annualized capital costs will be US\$1.6 million at 6 percent annual interest. (Annual O&M and amortization costs per capita were estimated under the fourth activity of the integrated program, the Finance Management and Cost Recovery technical assistance, and are discussed in Chapter 6).

Financing options include a number of possibilities, but the most likely would be through the Banco del Estado. The availability of credit to the city of Machala, however, will depend on its creditworthiness. The creation of a new basic water and sanitation utility in Machala that would operate autonomously from the municipality is being proposed as a first step toward improving financial management capacity. This new entity is further discussed in Chapter 6.

FINANCIAL MANAGEMENT AND COST RECOVERY IMPROVEMENT

6.1 The Baseline

The December 1992 assessment ranked financial management concerns among the more important factors needing attention in Machala. The assessment team observed that, until these concerns are addressed, the residents of Machala will continue to be at risk for cholera. As a result, the team recommended pursuing new approaches to financing and managing public utilities. Some of their specific observations included the following:

- In Machala, the municipal water service is of poor quality. About 60 percent of the city's 145,000 residents are reported to receive water through the distribution network, but service interruptions, illegal connections, and breaks in the system suggest that only 25 percent of the population may actually be receiving water from the network. The rest receive water from tankers, or are not served at all.
- The high population growth rate indicates that Machala could double in size in the next 15 years, adding pressure to demand for water and sanitation services and requirements. The threat to public health, especially from cholera, will also increase if provision of these services does not catch up to population growth.
- In 1989, investment in all infrastructure, including water and sanitation, accounted for only 9 percent of the municipality's budget, while recurrent costs accounted for 82 percent. In 1992, recurrent costs were expected to exceed 90 percent of the budget.
- More than 50 percent of the municipality's general revenues come from transfers from the central government.
- Machala's high population growth rate and high level of economic activity suggest that there are financial resources available that may be untapped.

This task was a first step toward improving cost recovery and financial management for the Water and Sanitation Departments of the municipality of Machala. The following were objectives of the task:

- Evaluate actual and potential levels for cost recovery to meet O&M and investment costs, and work with the municipality to implement recommendations to increase cost recovery.
- Evaluate the municipality's internal financial management for budget accounting, cost accounting, and general accounting; recommend actions for improving efficiency and autonomy; and work with the municipality to implement the recommendations.

- Provide complementary financial planning, cost estimates, and cost recovery assessments for the prefeasibility study for a water management plan implemented as a separate task.

6.2 Assessment of Financial Management and Cost Recovery

A two-person team visited Machala between June 28, 1993, and July 9, 1993, to conduct an in-depth review of the Municipal Water Department in Machala with respect to financial management. The team also assessed cost recovery both in terms of actual performance and untapped potential. The team found a number of weaknesses that will require specific attention if the municipality is to improve its financial management and increase its cost recovery to levels sufficient to support improving the distribution system. Highlights of some of the specific problems are presented below by area of emphasis.

6.2.1 Water and Sewage Systems

An understanding of the problems facing Machala's Water Department starts with the observation that only 25 to 45 percent of the population actually receives water through household connections to the network. The rest is lost or is unaccounted for through illegal hookups. In addition, there is no meter system for measuring consumption.

The sewage system is in equally bad shape. Annual flooding in different parts of the city create opportunities for contamination of the water distribution network, which is riddled with breaks and illegal hookups. Moreover, the system's coverage is deficient, and what sewage is collected is deposited raw into the nearby Pacific Ocean.

6.2.2 Cost Recovery

Tariffs cover neither the costs of O&M nor investment. The municipality, through transfers from the central government, subsidizes about 75 percent of the cost of water. The charges per cubic meter are absurdly low at S/. 24 per cubic meter compared to S/. 250 per cubic meter paid by rural systems functioning in El Oro Province. Charges do not reflect real costs.

Water bills, which almost no one pays, are issued once a year only. The municipality does not have an effective method of billing and following up on unpaid bills. Bills for 1993 have yet to be issued. Moreover, the list of users is not up to date. There is no charge for sewage beyond an initial installation fee.

The only people who pay for water are those who buy it from tanker trucks. Tanker owners buy water from the municipality's La Lucha treatment plant for about S/. 143 per cubic meter (about US\$0.07) and sell it to peri-urban customers for S/. 4,000 per cubic meter (about US\$2.00).

6.2.3 Financial Management

Financial management, like cost recovery, suffers from a number of problems that will need to be improved if greater efficiency is to be achieved. Following are a few examples of the more serious deficiencies facing the Finance Department.

The sections of the Municipal Finance Department do not exhibit financial management characteristics, which makes it difficult to discern actions that would identify finance policy, planning, evaluation, and procedures improvement. There is no budget section in the department. Budgeting takes place within the accounting section, but the process lacks an adequate approach to planning, budgeting, and cost accounting.

Accounting methods conform to the standards of the Controller General of Ecuador under which transactions are treated on a cash debit/credit basis. Any analysis of costs for planning or decision-making purposes is not timely or complete. Rapid and adequate information on cost processes is not available. Also lacking is any initiative for changing the budgeting and accounting system toward one that a municipality that attends to multiple services such as water, sewage, and solid waste collection requires.

The treasurer's section maintains no control of cash flow, nor does it analyze liquidity that would facilitate decision-making. The computer section has been placed in the Finance Department, there are terminals in the accounting section, and a line runs to the Water Department but there is no terminal. Nonetheless, the accounting section carries out all of its functions manually. There is a fear of using the computer terminal because continual system breakdowns may lead to loss of data.

The department has initiated computerization of the appraisal and registry section, but a general lack of confidence in the system has every worker manually maintaining a parallel system. In general, the use of computers is at an incipient stage, and there is no technical support in the municipality for computerization.

Finally, there is little collaboration among personnel of the various sections of the Finance Department of the municipality. The lack of job security, or perhaps concern that information might reach the Controller General's office and reflect back on someone in the municipality, contributes to this cautious attitude among sections of the department.

6.2.4 Improving Finance Management

The municipality's image in the community has deteriorated in recent years because of its poor performance in providing public services, especially water and sanitation. The filth and poor state of repair of the municipal building and other facilities also contribute to the poor image, as does the generally poor treatment extended to employees. Refurbishing this image is essential if an overall improvement in financial management is to be achieved. A total change of image is necessary and can best be achieved by abolishing the existing water and sewage departments, moving the administration of water and sanitation out of the municipal building, and creating a new municipal utility for water and sanitation in Machala.

6.3 Investment Requirements for Water Distribution System

The total estimated cost for construction of the proposed water system improvement in Machala is US\$17.8 million, or approximately S/. 32,238.4 million. The construction costs include purchase and installation of meters (30,000 units for Machala), as well as the physical improvement of the distribution mains, storage capacity, new wells, and pressure and filtration plant. As specified in the scope of work for the prefeasibility study reviewed in Chapter 5, part of the work under this task was to analyze cost recovery potential for those investments.

Financing for these investments is available through the Municipal Development Program, which is administered by the Banco del Estado, with credits extended through the Interamerican Development Bank and the World Bank and national counterpart funds through the Municipal Investment Fund (FIM). The terms of lending through the FIM allow for 80 percent reimbursement with 20 percent being provided as grant. Interest would not be paid during the construction period, but would be absorbed as grant under the terms of FIM. Interest payments would begin when the system is completed.

6.3.1 Cost of Water Meters and Recovery

The cost of water meters and recovery are as follows:

30,000 meters @ US\$70/unit	=	\$2,100,000
10 percent Engineering and Administration	=	210,000
15 percent Contingencies	=	315,000
Total	=	\$2,625,000

At an exchange rate of S/. 1,925, US\$2,625,000 = S/. 5,053,125,000. The unit cost would be S/. 168,437.50, less 20 percent subsidized through FIM; the charge to the consumer, including installation, is estimated at S/. 134,750.00, or US\$70.

Under a financing period of 24 months and with interest payments of 36 percent, the consumer would pay a monthly fee toward purchase of the meter of S/. 7,960.00 (or about US\$4.13).

6.3.2 Improvements to Water Distribution System

Less the cost of water meters, the total cost for improving the water distribution system is estimated to be S/. 27,185 million. Of this amount, it is estimated that 80 percent can be recovered with 20 percent being subsidized under the terms of the FIM. At the 80 percent recovery rate, the full amount to be recovered is S/. 21,748,250,000. Assuming 60,000 customers by 2004, the S/. 21.748 million price tag would mean each customer would pay an average of S/. 362,470 toward improving the system. It is estimated that the full financing period would be 36 months, and interest paid during this period (after completion of

construction) would be 36 percent. This would yield an average monthly payment of S/. 16,600 (or about US\$8.60).

A further breakdown of the payment schedule by socioeconomic category is presented in Table 4.

Table 4
Payment Schedule by Socioeconomic Category

Income Group	Percent of Total	Customers by Group	Monthly Payment (sucres)	Total with Interest x 36 Months (sucres)
Low	30	18,000	8,250	5,346,000,000
Middle	55	33,000	18,900	22,453,200,000
High, Commercial Industrial	15	9,000	24,900	8,067,600,000
Total	100	60,000	16,600 (avg)	35,866,800,000

The payment for the construction would be called the Special Improvement Contribution (SIC). In the 36-month finance period, S/. 35,866 million would be recovered through the SIC. The average SIC monthly bill of S/. 16,600 is equivalent to three bottles of beer, three packs of cigarettes, and three liters of Coca Cola. Construction would begin in 1994 or 1995, and the SIC would be collected beginning in January 1994. Construction would be completed during 1997.

6.3.3 Annual Costs for Operation, Maintenance, and Depreciation

Estimates were made based on actual costs and were projected out 10 years for actual water consumption to meet O&M and depreciation costs. The most expensive year would be 1998, the first full year with the new system fully operational. The average payment in 1998 would be S/. 9,989. For low income customers, the estimated monthly bill based on 20 m³ of consumption would be S/. 5,790, or about US\$3.00.

6.3.4 Summary of Cost Recovery

The total monthly payment for a user from the low income group based on actual prices would be as follows:

Meter charge (over 24 months)	S/. 7,960	\$ 4.15
SIC (over 36 months)	S/. 8,250	\$ 4.30
Water tariff (20m ³ monthly)	<u>S/. 5,790</u>	<u>\$ 3.00</u>
Total	S/. 22,000	\$11.45

This amount represents about 12 percent of the minimum average salary of S/. 173,667 per month.

6.4 Action Plan for Improving Finance Management and Cost Recovery

A calendar of actions has been suggested for improving the finance management and cost recovery in Machala. The first activity involves moving the responsibility for water and sanitation administration out of the municipality and creating a new municipal utility that would be autonomous from the municipality's Finance Department. This action would begin immediately, i.e, July/August 1993. A full calendar of events is presented in Appendix C.

Chapter 7

OBSERVATIONS AND CONCLUSIONS

7.1 Introduction

In a wrap-up visit to Machala from July 27 to July 30, 1993, a WASH consultant made a number of observations regarding the immediate impact of the four activities. Following is a discussion of each activity including relevant observations.

7.2 Cholera Control and Prevention Workshop

Six of the 30 participants were interviewed regarding their impression and reactions to the workshop. Interviews were supplemented by visits to the barrios of Rayito de Luz and La Garzota. Interviewees included the following:

- Provincial Directorate of MOH
 - Rafael Montealegre, chief, Department of Health Education
 - Maria del Carmen Santillán, chief, Promotion and Protection
 - Luis Tuárez, health inspector, Velasco Ibarra
 - Angel Villavicencio, health inspector, Rayito de Luz
- Municipality of Machala
 - Richard Cartuche, president, Eastern Barrios Federation
- IEOS El Oro
 - Jorge Cordero, promoter

All six participants said the workshop was excellent in its pedagogical approach as well as its content. The participatory methodology was a first-time experience for virtually all of the participants. Another innovation was the experience of collecting data in the peri-urban areas and then using the analysis to develop appropriate intervention strategies. In this workshop, participants used analysis results to develop an action plan (see Appendix A).

The centerpiece of the action plan is the design and implementation of a household water disinfection program using chlorine. The plan's other components include epidemiological surveillance, hygiene education, and action plan coordination. Of the three institutions involved in the workshop—IEOS, the provincial directorate of MOH, and the municipality—IEOS was selected to coordinate the plan. Each institution has monthly internal meetings to discuss the action plan. Interagency meetings also should be held monthly, but have not been since the plan's inception in April 1993.

Participation and support from the municipality turned out to be weak. Apart from the participation of two barrio federation presidents, the municipality's presence was represented only by a secretary from the Department of Social and Cultural Promotion. There was no participation from such technical offices as planning and projects, potable water, and sewage. There has been little participation from the municipality in implementing the action plan.

The original two-component focus of the workshop was modified to converge on household disinfection when it was learned that both MOH and IEOS were distributing chlorine materials using different instructions and lacking extension work at the community level (see 3.2.3). Participants realized the importance of addressing cholera transmission via water through information provided in the workshop and through data they collected from the barrios on water supply, water storage, and household water disinfection. For example, participants discovered firsthand that most households doubt the quality of water they receive, especially when bought from tankers who may be loading water from dirty streams, and that most store their water in open barrels and buckets, which leads to recontamination. The urgency of mounting a campaign to inform people about disinfection and proper storage and handling became preeminent among workshop topics (see 3.2.4).

Household Disinfection Pilot Project

The action area developed in the workshop for this activity (see Appendix A) suggested that existing resources could be used for implementing most of the program. The only exception would be the need to mount a pilot project for the local manufacture and promotion of a storage container that meets Pan American Health Organization (PAHO) standards. In practice, however, existing resources are proving insufficient. The budget of the provincial directorate of MOH for education and promotion is very limited and is usually earmarked. For example, UNICEF provides funds for cholera-related education activities, but limits use to the painting of murals that convey good health practices to avoid or prevent the spread of cholera. (While the creation of murals no doubt generates employment for painters, it is of questionable utility with respect to targeting health messages at high-risk groups). Similarly, the funds required to print posters and flyers as well as to prepare and disseminate radio spots providing instructions on water disinfection using chlorine are not available in either IEOS or MOH.

Equally difficult has been the search for a container. A jerry can with one mouth is currently available in the market and retails for about US\$3.50. The participants' field work found this model unacceptable. The most frequent users of the drinking water source in the home are children. Small children cannot use a jerry can that requires tipping to one side to extract water. By contrast, a model with a spigot allows small children easy access.

A container that fully meets the PAHO standards, i.e., a 20-liter plastic jerry can of high density polyethylene equipped with a spigot and an easy-to-fill mouth too small to insert hands or utensils can be specially manufactured in Guayaquil at a unit price of about US\$7.50. However, in order to get the manufacturer to produce the desired model, lots of 1,000 or more need to be ordered. The household disinfection program can become a vehicle for creating a market for such a container if attention can be drawn to its use.

As a result of these difficulties, the coordination committee for the action plan developed a pilot program for household disinfection using chlorine. The pilot program requires outside funding to enable IEOS and the provincial health directorate to move forward. As a first step, the pilot program calls for the elaboration and implementation of a surveillance form to collect information on cholera and diarrheal diseases in the barrios of Machala. It also calls for the manufacture and distribution of 4,280 water storage containers (the container may be sold rather than given to project beneficiaries); the training of health workers and community members in household disinfection techniques; the development of hygiene education materials, including posters, flyers, and radio spots; and the production of video tape materials.

The pilot program promotes the use of liquid bleach (5.25 percent sodium hypochlorite) for disinfecting water. This material is readily available in markets throughout the Machala area and is widely used for laundry. At least seven brand names are available, many of which already provide instructions on their packaging about application for disinfection of drinking water. Tests run by IEOS El Oro promoters demonstrated that these seven products consistently provide a safe chlorine residual (about 1 mg/l) when applied at the rate of 15 drops per 20 liters of water. The products are also cheap, S/. 200 for a 4-ounce packet, which is enough to disinfect more than 3,100 liters of water. This translates into about US\$.10 at the current rate of exchange. To measure chlorine residual, the pilot program proposes to purchase and distribute to community volunteers about 800 comparators. A Peruvian model is locally available for about US\$1.00 per unit.

The budget for the pilot plan is presented below in US dollars.

Epidemiology forms and data collection	\$ 1,500
Comparators (to measure chlorine residual)	800
Containers, polyethylene (4,300 units)	32,100
Hygiene education, materials, radio, video	7,000
Administration	3,550
Miscellaneous	<u>1,800</u>
Total	\$46,750

The pilot plan will focus on 20 barrios in the Machala area that, according to existing data, are most at risk of cholera incidence. The 20 barrios have 4,280 households. Implementation would span six months and was originally scheduled to run July-December 1993. As of this writing, the coordinating committee for the action plan has been unsuccessful in securing financing for the pilot project.

One objective of the pilot project is to make the resources available to manufacture the container. It is expected that the hygiene education program built around the container would create a market so that the manufacturer would continue to produce it beyond the pilot project. The intense extension effort in which MOH and IEOS personnel would direct attention at the selected barrios, train people, present demonstrations, and provide support through

radio, video, and printed materials would draw public attention to household disinfection using chlorine among residents of the targeted barrios as well as to people beyond these barrios.

The process and content of the workshop provided participants with some tools with which to improve their ability to prevent and control the spread of cholera. The pilot project is an effort to cement this impact. However, as health workers return to their normal work routines, the new skills, which represent additional activities, will not be put to use in most cases. For example, a typical health inspector's schedule already requires multiple visits to as many as 2,000 households a year to give child immunizations, perform health inspections, follow up on citations, and vaccinate dogs. The one-on-one or small group demonstrations that are essential for this program become additive rather than alternative to the current workload.

The household disinfection program represents an effort to use limited resources to mount a secondary barrier to disease transmission. If needed resources are found, the pilot program will secure the impact gained in the workshop.

7.3 Improved Community Sanitation Workshop

Ten of the 22 participants in this workshop were interviewed during the wrap-up visit to Machala, July 27-30, 1993. Interviewees were as follows:

- **PREDESUR**

- Pedro Vera, promoter
 - Jorge Murillo, construction supervisor
 - Marcelo Siguenza, construction supervisor
 - Felipe Matamoros, construction supervisor
 - Fausto Carrion, design and construction

- **IEOS/El Oro**

- Edi Dávila, draftsman
 - Oscar Loayza, assistant engineer
 - Néstor Ochoa, assistant engineer

- **Provincial Directorate of the Ministry of Health**

- Luis Tuárez, health inspector, Velasco Ibarra
 - Angel Villavicencio, health inspector, Rayito de Luz

As with the first workshop, both the presentation and the content were highly regarded by the participants. Participants developed an action plan that was integrated into the plan from the first workshop. A pilot project was designed within that action plan for the implementation of a sanitation program in the barrio of La Garzota.

The pilot plan evolved out of the workshop's three-step approach of clarifying problems, identifying appropriate interventions, and monitoring and evaluating the project. Prevailing

practices in the community, existing environmental conditions, community preferences, and available resources suggested that the appropriate intervention was a compost latrine. Piped sewage was thought to be the answer, but constraints on resources and institutional capacity were beyond what is available for the foreseeable future. This workshop involved finding substantive community resources to solve the problem. As a result, the process raised awareness of appropriate interventions.

One of the challenges facing technicians in the Machala area is a long-held belief that the high water table precludes latrines because of easy flooding. A pilot project in a low-lying area could demonstrate that the problem can be addressed effectively with an affordable technology.

Latrinization Pilot Project

The pilot plan to be implemented in La Garzota is small. The barrio has only 60 homes. At an estimated cost of US\$205 per unit, the total pilot plan will cost about US\$12,300. When the plan was originally designed in the workshop, it was expected that IEOS would be able to finance the effort. However, available funds in IEOS are targeted at rural areas, and therefore could not be redirected to La Garzota. Meanwhile, Ecuador is about to launch a Fund for Social Investment (FISE) program. IEOS/El Oro has submitted a proposal to FISE for latrinization in the province at large and included in that request the pilot plan for La Garzota.

Consideration of the request is expected by September 1993. If approval is granted, IEOS/El Oro would manage the funds. Construction design and supervision would be provided by PREDESUR.

7.4 Prefeasibility Study for Water Supply

The purpose of this task was to help develop a water management plan at the prefeasibility level for Machala by evaluating options available for improving the city's water supply and selecting the best conceptual design. A WASH consultant carried out the assessment May 3-14, 1993. Details of the assessment are provided in WASH Field Report No. 400.

Water demand for Machala and Puerto Bolivar in 1993 is 503 l/s. Demand will rise to 660 l/s by 2000 and to 1,148 l/s by 2015. The present distribution system is experiencing losses of approximately 60 percent.

The evaluation of the water supply, storage, and distribution system for the Machala-Puerto Bolivar area was based in part on design estimates conducted in 1987 by the Asociación de Consultores Sanitarios y Ambientales [Association of Sanitary and Environmental Consultants (ASCAM)] plus 15 percent extra piping for new development areas and repairs to the existing system. The water balance and distribution components of a design for current and future needs include construction and implementation of the following:

- 24,700 lineal meters of ductile iron;

- 140,900 lineal meters of polyvinyl chloride water distribution pipes;
- 30,000 new water meters;
- 10,000 new home connections;
- 30 water hydrants;
- 30 isolating/controlling valves.

The construction cost estimate for the water distribution system is about US\$12 million. When construction of additional storage capacity, development of up to four new wells, and construction of a treatment plant for the new wells are added, the total reaches US\$17.8 million.

Consultants on the finance management task used the US\$17.8 million figure and the breakdown of components to devise an approach for cost recovery. This task also provided the municipality of Machala with a document that updated the 1987 ASCAM study and could be used to begin discussions with the Banco del Estado for financing. Negotiations were initiated in March 1993 and were advanced with the submission of this report in July 1993.

Leak Detection Follow-on Activity

The first step in implementing the proposed construction program is to locate leaks and illegal hookups and either repair them or convert them to paying connections. Presently, Machala reports that about 60 percent of its water is unaccountable. Improving service through a leak detection program will demonstrate the municipality's good will toward the public. The municipality hopes to initiate a leak detection program in September or October 1993. USAID/Ecuador, through the Regional Housing and Urban Development Office (RHUDO), might be able to extend support to this effort.

7.5 Financial Management and Cost Recovery Improvement

Two consultants conducted this task in Machala between June 28 and July 9, 1993. The team assessed cost recovery potential in Machala and looked into improving the overall financial management of the current Department of Water within the municipality. An overview of the work was presented in Chapter 6. Full details are available in WASH Field Report No. 422.

The cost recovery analysis included developing a monthly payment schedule for repayment of the capital investment proposed under the prefeasibility study. Also developed in this consultancy was a cost recovery schedule for water meter installation and purchase by users and a cost recovery schedule for O&M.

The financial management component of the consultancy identified a number of weaknesses within the current water department. One is a bad public image resulting from years of poor service, poor understanding among employees about financial management and administration, and weak and sometimes duplicated financial procedures. All the accounting

is done manually, despite the presence of some computer equipment. Improving efficiency requires a total restructuring of the department.

Recommendations from the assessment called for a number of improvements that, if implemented, would enhance the efficiency of the municipal water service. The following are some of the more important recommendations:

- Create a new municipal utility for water and sewage that would be located outside of the municipal building;
- Mount a campaign to improve the image of the municipality by training employees in interpersonal relations, motivation, and customer service, as well as in professional and technical areas;
- Install a modern information system and train staff in its use;
- Improve technical standards in the area of finance through administration and finance courses and practical training in other similar institutions, such as the Quito Water Utility (EMAP-Q, which has undergone a reorganization along the lines being prescribed for Machala);
- Contract an outside service to keep the building clean.

A schedule of events for implementing these recommendations as well for implementing the cost recovery charges is provided in Appendix C.

The observations and recommendations from this task were well received by the municipality. The consultancy helped officials focus on the specifics of improving cost recovery and financial management in Machala. For example, the municipality has been interested for some time in forming a new, autonomous utility. This assessment provided a clear explanation of what would be involved in creating the new entity. Similarly, the task identified what is implied in the cost recovery challenge of borrowing up to US\$17 million to improve and expand the water distribution network. Finally, the task helped the municipality think through the process of how to begin the work of improving the water distribution system and how the facets of construction, cost recovery, and financial management have to be integrated if the effort is to succeed.

Formation of a Municipal Water and Sewage Utility

Concurrent with the follow-on leak detection work identified above, the municipality will be initiating the formation of a new water and sewage utility for Machala. Formation of the new entity will conform to the activities presented by the WASH assessment team and will be similar to the institutional development work provided to EMAP-Q and financed by RHUDO over the past several years. This follow-on work, which is scheduled to begin in August and September of 1993, will essentially be an adaptation of the accounting and administrative systems developed for EMAP-Q. The work proposes that technical assistance and training be carried out through a series of activities, some of which could be funded by USAID through

RHUDO. The new utility, housed in office space separate from the municipality and with fully trained staff, would begin official operations in August 1994.

7.6 Lessons Learned

The following paragraphs present some of the lessons learned.

- The integrated program was effective in terms of the mix of activities in improving Machala's readiness to control and prevent the spread of cholera. The program directed two activities at the marginal urban population presently not served by the municipal water distribution network and two activities at the formal urban sector now being served by the network. The activities were complementary in that the work directed at the formal sector is expediting long-held intentions to improve and expand the water distribution network to eventually include the 150 marginal barrios surrounding Machala; the two workshops directed at the marginal areas improved the skills of health workers, promoters, and engineers in hygiene education, household disinfection of water, and improved sanitation; and the combination of the four activities attracted considerable attention to the issue of cholera (and diarrheal diseases in general) across the spectrum of institutions involved in delivering services to urban and peri-urban dwellers (for example, the municipality, IEOS, MOH, PREDESUR, Provincial Council, and the Federation of Barrios).
- Interagency workshops promoted cooperation. An important accomplishment of the workshops was getting the various agencies to work together, some for the first time. IEOS and MOH have worked together in the past, but not on a common problem such as cholera. Other groups, such as PREDESUR, the Provincial Council, and the Federation of Barrios, have heretofore not collaborated among themselves, nor directly with MOH and IEOS.
- The integrated program helped direct focus of local agencies to peri-urban areas. For most of the agencies involved in the two workshops, especially IEOS, MOH and PREDESUR, water and sanitation activities have traditionally been directed at rural communities. The integrated program, and especially the two workshops, brought into focus for these agencies the serious water quality and sanitation problems people in peri-urban areas face.
- Cholera workshops and technical assistance should be implemented only when resources enabling follow-on activities on a project level are available. (This is not meant to imply that USAID should supply these funds, but that at the assessment stage it should be determined if any follow-on resources are available. If not, the workshop or technical assistance should be reconsidered).

Notwithstanding the appropriateness of the two workshops, impact would be enhanced if resources were available for follow-on projects in which the new skills and methods could be directly applied. Funding for the household disinfection pilot project is

uncertain, and even if secured, remains small. Funding for the latrine pilot project, meanwhile, is more certain, but is also very limited. The two technical assistance tasks, by contrast, are poised to have greater impact given the municipality's efforts to secure credit from the Banco del Estado to proceed with construction and the concurrent development of a new water and sewage utility.

- Household disinfection of drinking water is an appropriate and relatively low-cost intervention as a secondary barrier to cholera transmission in marginal urban areas, provided a full promotion package can be organized and implemented.

The main element of the program is chlorine. In Ecuador, liquid bleach is readily available and people require little training in its use. Where liquid bleach is not available, mixed oxidant gases for on-site disinfection machines can be considered. A 90-liter unit called the "Clorid," which is assembled in Cuenca, Ecuador, was observed in Machala (owned and operated by IEOS). It produces a fresh 90-liter batch of 15 percent available chlorine every day and has done so for two years without a breakdown. The 90-liter unit costs about US\$500. A project to finance the purchase of one of these units for an area where liquid bleach is not readily available could be considered. Unit capacities vary and begin at 30 liters. A smaller unit would be adequate for most peri-urban areas. A shopkeeper, entrepreneur, or local public health center could sell the chlorine. These machines require electricity to function, but most peri-urban areas have electricity. The next element of the package is its promotion. Promoters need training, time, and access to educational materials. Also helpful to the discussion would be a regional meeting (hemisphere level) where donors, government representatives, private voluntary organizations, and non-governmental organizations could exchange opinions and experiences on household disinfection.

7.7 Activity Mix of the Integrated Program

The selection of activities in the integrated program was the correct mix, given the circumstances in Machala. If the opportunity to design an integrated technical assistance package presented itself again, the same mix of activities would be recommended. The overall cholera control and prevention problem facing Machala challenges both the formal sector that has a piped water distribution system and sewerage system, as well as the informal peri-urban sector that relies on uncertain quality and quantity of water supply and lacks sanitation facilities. The four activities addressed both challenges.

The two technical assistance activities directed at the municipality were not only appropriate but also very timely. With the election of a new mayor in early 1992, the city of Machala began expressing interest in moving forward to improve the city's water distribution system. The A.I.D.-funded water quality assessment carried out by WASH in December 1992, followed by these two technical assistance activities, catalyzed the municipality's interest into action. The pre-feasibility study provided the municipality with needed information and a budget estimate to apply to the Banco del Estado for financing to renovate and extend the

water distribution system. The financial management technical assistance presented the municipality with a strategy for cost recovery for both the capital costs and the operations and maintenance costs of a renovated and improved water distribution system. It also provided an approach for creating a new municipal water and sanitation utility.

The two workshops were the most appropriate activities for the peri-urban areas of Machala. Indeed, the December 1992 assessment demonstrated that these two workshops also would have been the most appropriate follow-up interventions for the peri-urban areas of Guayaquil and Esmeraldas which were also visited during the assessment. The informal sectors of these cities were confronted by the same water and sanitation problems encountered in Machala.

The package of activities would be directly applicable to most urban areas of equal size, where the risk of cholera is high. Some variation could be expected on technical assistance directed to the formal urban sectors depending on the kinds of problems an assessment would uncover. If the formal sector had good coverage on water supply and sanitation and adequate cost recovery, the package would be different. However, the two workshops would be highly appropriate for most peri-urban areas. It should be pointed out, however, that the actual mix of activities to be undertaken in any situation should be based on an assessment using WASH's guidelines for assessing the options in water, sanitation, and hygiene practices.

7.8 Impact on Reducing Cholera

This integrated program itself has had a limited effect on reducing cholera in Machala in the short run. Apart from the direct impact the various activities had on participants in the workshops or on the outputs of the technical assistance work, there was no way to measure any direct effect on the incidence of cholera or other diarrheal diseases through this follow-up assessment. The impact on disease may also be limited over the longer term if the skills obtained in the workshops are not utilized. For example, skills and approaches learned in the latrine workshop are likely to have little or no impact if latrine programs are not designed and funded in the marginal urban areas of Machala. The skills obtained in the cholera workshop, especially those relating to household disinfection and hygiene education, are likely to have little impact if no projects are undertaken as well. As a result of this experience, the development community should keep in mind that stand-alone technical assistance tasks are likely to have little direct impact on reducing cholera. On the other hand, technical assistance activities, especially training, may have significant direct impact on reducing disease if they linked to follow-on projects or programs in which the new skills, techniques, and approaches can be implemented.

7.9 Actions for the Future

A follow-up assessment in one year should be considered to see how much of the technical assistance provided under the integrated package has been institutionalized or sustained in some meaningful fashion. For example, how much activity has taken place within the two pilot projects would indicate the level of institutional commitment to the action plan. The level of pilot project activity would also indicate the coordinating committee's success in working together and in finding resources.

Similarly, a review of the municipality's progress toward rehabilitating and expanding the water distribution network would indicate the value of the technical assistance provided under the integrated program. Progress made in lowering the amount of unaccounted for water (through the proposed leak detection program) and in the formation and capacity building of the proposed new municipal water and sewage utility would be good indicators of follow-through on these activities.

Appendix A

ACTION PLAN FOR HOUSEHOLD DISINFECTION USING CHLORINE IN MARGINAL URBAN AREAS OF MACHALA

Epidemiological Surveillance

Objectives:

1. Determine the mortality rate and incidence of morbidity caused by cholera and other diarrheal diseases in marginal urban areas of Machala
2. Establish a reliable information system among the different units in the health sector in Machala.

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Collect data about diarrheal diseases in form EPI 2, and monthly diarrhea form.	MOH centers and subcenters	Ongoing, permanent
Tabulate and analyze data in terms of time, place, and individuals.	MOH centers and subcenters; Director, MOH Provincial	Ongoing, permanent
Elaborate on indicators—number of cases, incidence of morbidity and mortality—for programming actions.	MOH centers and subcenters; Director, MOH Provincial	Monthly
Investigate cases of unusual increments in incidence of diarrhea. Identify risk factors: time, place, individuals.	Health and Epidemiology Team/MOH	As needed
Perform evaluation	Chief of Area and Director MOH Provincial	Trimesterly

Household Disinfection

Objectives:

1. Achieve a consensus among institutions about the use of chlorine for household water disinfection.
2. Establish one set of instructions—a unified approach—about preparation and application of chlorine.
3. Establish a system for effective, safe storage and supply and distribution of chlorine.
4. Identify activities complementary to water disinfection to help improve health in peri-urban areas.

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Develop one set of instructions for chlorination	IEOS, MOH	May 1993
Agree on a way to present information on disinfection and chlorine dosage.	IEOS, MOH	May 1993
Establish a system for adequate storage of chlorine stocks.	IEOS, MOH (warehousemen)	May 1993 (and on a permanent basis)
Periodically test for available chlorine in warehouse stocks of chlorine	IEOS, MOH	Biannually
Resupply chlorine to health subcenters according to the population coverage.	IEOS, MOH	Trimesterly
Establish a distribution system at the community level.	MOH subcenters	Trimesterly
Distribute a three month supply of chlorine to each home.	Distribution unit (to be identified in each community), MOH subcenters	Ongoing

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Monitor how chlorine is prepared and used in the home.	Health inspectors	Monthly
Periodically measure chlorine residual in homes using the "chlorotest" unit.	Health inspectors and promoters, and community leaders	Monthly
COMPLEMENTARY ACTIVITIES		
Legal control of tankers.	Municipality	Ongoing
Sanitary inspection of street vendors.	Municipality, MOH	Ongoing
Sanitary inspection of markets.	Municipality, MOH	Ongoing
Provide all institutions in the water and sanitation sector with norms about the proper use of chlorine for disinfecting water.	IEOS, MOH	June 1993
Investigate the availability of a water storage container that meets PAHO standards and design a pilot project for its local manufacture and promotion.	IEOS	May 1993

Hygiene Education

Objectives:

1. Create confidence among residents of marginal urban areas about the advantages of disinfecting water for use in the home with chlorine.
2. Train mothers in the proper preparation and application of chlorine.
3. Raise consciousness among residents about the problem of water and sanitation and the need for communities to organize themselves around efforts to find solutions.

4. Raise consciousness about the importance of communities coordinating with institutions such as the municipality, IEOS, and MOH to improve the delivery of vital services and improve the environment.

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Produce a radio spot to instruct mothers about proper boiling of water.	IEOS, MOH, community	May 17-30, 1993
Produce two radio spots to promote the proper use of chlorine among the general population.	IEOS, MOH	June 1-15, 1993
Distribute posters in peri-urban barrios to promote the proper use of chlorine.	MOH/Education, MOH promoters, IEOS	June 17-August 30, 1993
Prepare and distribute guidelines for the correct use of chlorine to disinfect water in the home.	IEOS, MOH	June 15-30, 1993
Produce two radio spots that tell people where they can obtain chlorine (and that generate demand at the same time).	IEOS, MOH	After July 1, 1993, then ongoing for six months.
COMMUNITY WORK		
Demonstrate chlorination to mothers' clubs and other women's organizations.	MOH inspectors	July-October 1993
Train community leaders or representatives of chlorine distribution units in chlorination techniques.	MOH inspectors, IEOS promoters	July-October 1993
Create a system for distribution of chlorine in communities.	Director, MOH Provincial; community leaders	July-October 1993
Conduct household disinfection instruction for high school students.	MOH Inspectors	October-December 1993

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Deliver educational talks to community organizations to promote the use of chlorine for disinfection of water in the household.	MOH inspectors, IEOS promoters, community leaders	October-December 1993
<i>Institutional Strengthening</i>		
Conduct workshops for inspectors and institutional personnel in unified approach to household disinfection using chlorine.	MOH, IEOS	June 1993
<i>Monitoring and Evaluation</i>		
Formulate an evaluation and monitoring plan regarding acceptance of household disinfection and the use of chlorine.	MOH, IEOS, municipality, Federation of Barrios	November 1-30, 1993
<i>Possible Indicators</i>		
<ul style="list-style-type: none"> ■ Knowledge and confidence demonstrated by the population in marginal urban areas. ■ Number of homes adopting method. ■ Number of homes applying chlorine properly. ■ Measure of chlorine residual. ■ Change (reduction) in incidence of diarrheal diseases. 		
Execute monitoring and evaluation actions.	Director, MOH Provincial; IEOS; community leaders	January 1994

ACTIVITY	RESPONSIBLE ENTITY	TIMING
COMPLEMENTARY AND FUTURE ACTIVITIES		
Execute a study in marginal urban areas on knowledge, attitudes, and practices related to latrine use, hygiene, and waste disposal.	Director, MOH Provincial; IEOS, municipality	Depends on latrine (sanitation improvement) activities
Formulate a communications and education program	Director, MOH Provincial; IEOS, municipality	Depends on latrine (sanitation improvement) activities
Progressively execute communication and education program covering cholera and acute diarrheal diseases.	Director, MOH Provincial; IEOS; municipality; community	

Coordination of the Action Plan

Objectives:

1. Identify one institution to be responsible for the coordination of the action plan.
2. Achieve interagency integration in order to optimize human and financial resources.
3. Find out which government and nongovernmental institutions are working in the sector and if their activities are related to the action plan.
4. Achieve the active participation of the community in the planning, implementation, and evaluation of the activities in the action plan.
5. Define the role of each organization participating in the action plan.
6. Evaluate the process and impact of the action plan.
7. Secure the necessary financial and material resources for the development and implementation of the action plan.

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Conduct interagency meeting to identify the coordinator agency.	Representatives of agencies that participated in the workshop	April 29, 1993
Determine which departments within each institution will be responsible for different activities.	Mayor's office; Director, MOH Provincial; IEOS	April 29, 1993
Conduct internal meetings in each institution for monitoring the activities of the plan.	Departments in each institution	Monthly
Conduct interagency meetings to consolidate and analyze monitoring data from each institution (involve barrio representatives).	Coordinator agency	Trimesterly
Take inventory of the institutions working in community development and water and sanitation in Machala.	Municipality: Richard Cartuche Fernando Maldonado IEOS: Jorge Cordero Manual Guaman	May 1993
Hold meetings with barrio leaders to distribute the action plan.	Coordinator agency	May 1993
Hold meetings with inventoried institutions to define areas of action of each one.	Coordinator agency	June 1993
Manage resources needed to finance the activities in the plan.	Coordinator agency, participating institutions	As necessary
Analyze impact of the activities on health.	Involved institutions, Federation of Barrios	Biannually

*IEOS was selected

Appendix B

LATRINIZATION ACTION AREA

Problem Clarification

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Collect information: knowledge, attitudes, and practices (KAP); physical and social data	MOH, assisted by Department of Promotion, Provincial Council, and PREDESUR	Completed
Census of La Garzota and Rayito de Luz	MOH	June 1993
Analyze and apply information	MOH	Completed

Hygiene Education

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Develop an education plan that has the following elements: <ul style="list-style-type: none">■ Group goal■ Key messages based on KAP■ Identified channel for diffusion	MOH	June 1993
Integrate the sanitation messages into the hygiene education component of the action plan developed under the Cholera Control and Prevention Workshop.	MOH	June 1993
Select appropriate technology.	PREDESUR, Provincial Council of El Oro (PCO)	Completed

ACTIVITY	RESPONSIBLE ENTITY	TIMING
Elaborate pilot project designs: <ul style="list-style-type: none"> ■ Plans ■ Technical specifications ■ Chronogram of work 	PREDESUR, PCO	Completed
Plan budget: <ul style="list-style-type: none"> ■ Analysis of unit prices and total cost of the work. 	PREDESUR, PCO	Completed
<ul style="list-style-type: none"> ■ Approval of the budget and designs by institution directors. 	IEOS	Completed
Acquire materials: <ul style="list-style-type: none"> ■ Gravel/stones ■ Cement, steel rods, bricks ■ Timber planks ■ Pipe ■ Sanitary engineers 	Municipality, IEOS	June 1993
Distribute materials to communities: <ul style="list-style-type: none"> ■ Manual labor 	PREDESUR, PCO	July 1993
Implement and supervise: <ul style="list-style-type: none"> ■ Site selection ■ Layout ■ Adequate provision of materials ■ Based on designs 	PREDESUR, PCO	
Establish contact with community leaders for the pilot project.	PREDESUR, PCO, MOH	Completed
Present technical alternatives to community leaders and final selection with their input. Modify designs with community leader input.	Workshop participants, second field visit	May 1993

ACTIVITY	RESPONSIBLE ENTITY	TIMING
<p>Develop daily schedules to accomplish:</p> <ul style="list-style-type: none"> ■ Work groups in communities ■ Commitments and responsibilities for implementing the work ■ Operation and maintenance ■ Hygiene education 	PREDESUR, PCO, assisted by MOH, IEOS	8 days
<p>Develop guidelines to specify correct use and functioning of latrines and their maintenance.</p>	IEOS promoters	July 1993
<p>Develop a poster for families that lists what they should do to properly maintain a composting latrine:</p> <ul style="list-style-type: none"> ■ Use only one chamber ■ Deposit no liquids ■ After each use deposit lime or ashes ■ When full, transfer to the second chamber ■ Make household visits to observe and record operation and maintenance activities. 	MOH	Monthly
<p>Make visits to households to assess KAP regarding excreta disposal and use of the sanitary facility, operation and maintenance, and use of the facility.</p>	MOH	Monthly
<p>Design a form that includes all the necessary monitoring information.</p>	IEOS, MOH	July 1993

ACTIVITY	RESPONSIBLE ENTITY	TIMING
<p>Make visits to the communities to monitor activities of each component (hygiene education, community participation, construction, and operation and maintenance).</p>	<p>MOH, IEOS</p>	<p>Monthly, biannually</p>
<p>Evaluate the impact of the program with respect to the objectives laid down in the workshop and the process involved in the activities of each component; make recommendations for future projects.</p>	<p>IEOS</p>	<p>Annually</p>

Appendix C

ACTION PLAN FOR IMPROVING FINANCIAL MANAGEMENT, COST RECOVERY, AND CREATION OF A MUNICIPAL WATER AND SANITATION UTILITY FOR MACHALA

A calendar of activities for improving the management of water and sanitation in Machala has been developed and is presented below.

ACTIVITY	RESPONSIBLE ENTITY	TIMING
1. Prepare ordinance to create a new utility.	Mayor/Municipality	July-August 1993
2. Obtain approval of the ordinance by the Municipal Council.	Mayor/Municipality	September-October 1993
3. Identify site for construction of office space for new utility.	Mayor	September-October 1993
4. Obtain technical assistance to design utility office.	Municipal Planning and Projects Department	November 1993-January 1994
5. Construct utility office.	Municipal Planning and Projects Department	November 1993-June 1994
6. Obtain financing for water system improvements.	Municipality	January-February 1994
7. Obtain technical assistance to determine type of water meters to use.	Municipal Planning and Projects Department	January-March 1994
8. Obtain technical assistance for water tariffs study.	Potable Water Department	October-November 1993

ACTIVITY	RESPONSIBLE ENTITY	TIMING
9. Obtain technical assistance to assess and implement institutional development and finance administration.	Mayor	January 1994-December 1995
10. Obtain technical assistance for design and implementation of finance administration systems.	Mayor	January-June 1994
11. List users, networks, and connections.	Potable Water Department	January-March 1994
12. Clean up the users portfolio and actions to begin charging.	Financial Department	March-June 1994
13. Develop and implement water project feasibility study and ordinance for establishing a special improvement contribution.	Mayor	August 1993-October 1994
14. Begin operation of the new municipal utility begins.	Mayor	August 1994
15. Obtain technical assistance for detection, control, and repair of leaks.	Mayor	October-December 1993
16. Undertake a study to determine the real costs of house connections.	Potable Water Department	September-October 1993
17. Study the cost of sewage system installation.	Sewage Section	September-October 1993

ACTIVITY	RESPONSIBLE ENTITY	TIMING
18. Obtain technical assistance to determine service costs for sewage system and to fix the tariff.	Sewage Section	January-February 1994
19. Implement financial administration.	Mayor	May-August 1994
20. Send out updated water bills for 1993.	Finance Department	August-October 1993