WATER AND SANITATION FOR HEALTH PROJECT

Operated by
CDM and Associates

Sponsored by the U S Agency for International Development

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The WASH Project is managed by Camp Dresser & McKee International Inc. Principal cooperating institutions and subcontractors are: Associates in Rural Development, Inc.; International Science and Technology Institute, Inc.; Research Triangle Institute; Training Resources Group; University of North Carolina at Chapel Hill.

CARE/BOLIVIA WATER SUPPLY AND SMALL SCALE IRRIGATION PROGRAM : A FINAL EVALUATION OF THE USAID-FINANCED PROJECT

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APRIL 1986

Prepared for
the USAID Mission to Bolivia
WASH Activity No. 168

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Prepared for the USAID Mission to Bolivia
under WASH Activity No. 168

by

J. Ellis Turner
Jerri Kay Romm

April 1986

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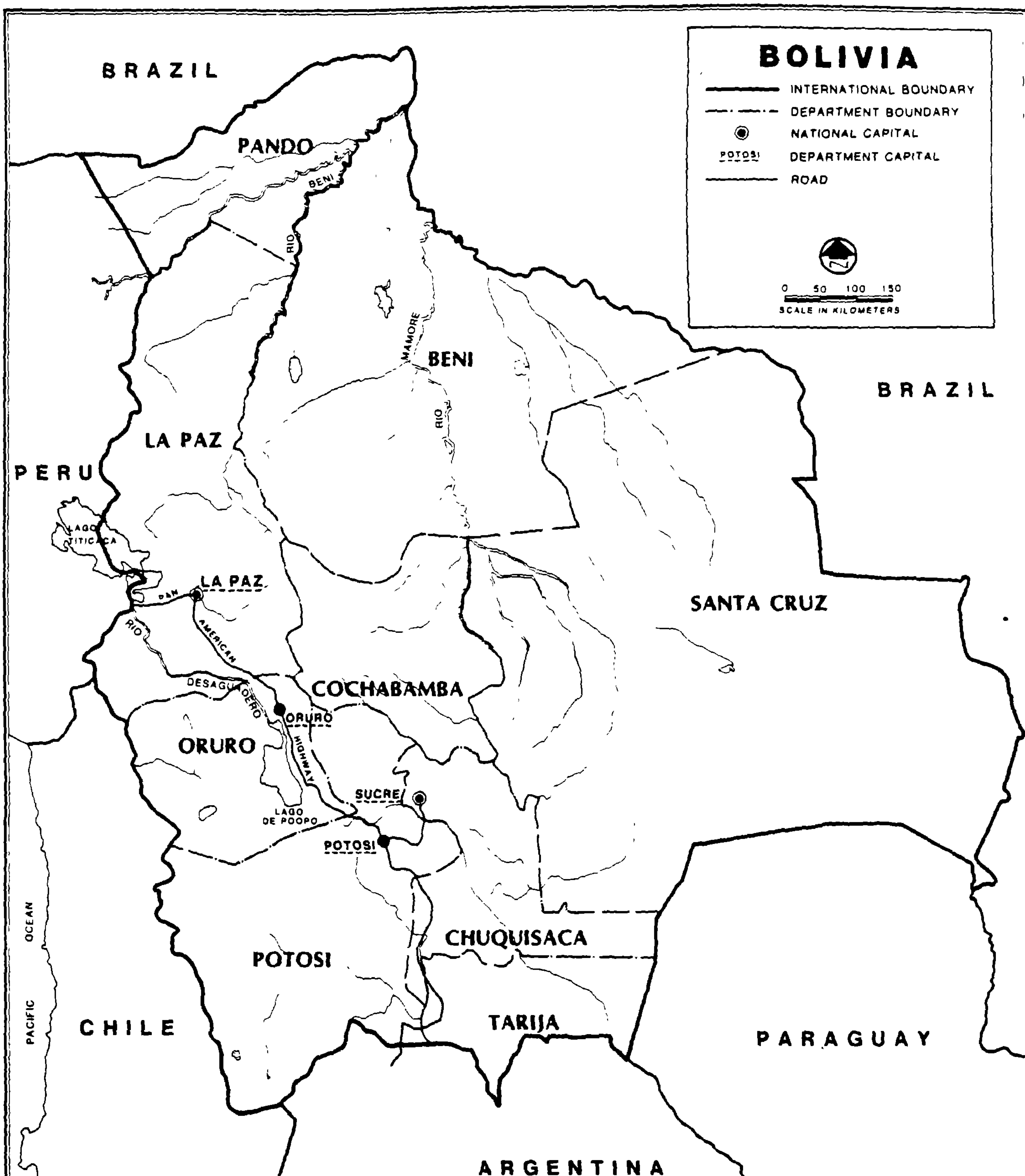

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ACRONYMS

USAID	United States Agency for International Development
CARE	U.S. Based Private Voluntary Organization
DDC	Departmental Development Corporation
DSA	Departimento de Sanimiento Ambiental
FOMO	Servicio Nacional de Fomacion de Mano de Obra
PAHO	Pan American Health Organization
S&T/H	AID Office of Health, Bureau of Science and Technology
UNICEF	United Nations Childrens Fund
WASH	Water and Sanitation for Health Project
WHO	World Health Organization

ACKNOWLEDGEMENTS

This final evaluation of the CARE potable water and small scale irrigation program in Bolivia was prepared by the team of J. Ellis Turner and Jerri Kay Romm under the direction of WASH Activity Manager, Fred Rosensweig.

The WASH team wishes to express its appreciation for the excellent cooperation it received from Gerard R. Bowers, USAID Mission Health Officer, and Raphael Indaburu, USAID project manager in the Division of Health and Human Resources, and for the enthusiastic assistance and support from CARE, especially Ron Burkard, Director of CARE/Bolivia, Art Flanagan, Assistant Director of CARE/Bolivia, Alfredo Leon, General Manager of CARE/Bolivia, and Dr. Mary Ruth Horner of CARE/New York.

EXECUTIVE SUMMARY

This report constitutes a final evaluation of a CARE potable water, sanitation, and small-scale irrigation program in Bolivia. The program was financed by the U.S. Agency for International Development (USAID) under the Bolivia Disaster Recovery Project (No. 511-0581). Funds in the amount of US $1,750,000 were provided to CARE by USAID for the construction, rehabilitation, and expansion of potable water/sanitation systems and irrigation facilities in response to recent (1983) drought conditions. Because of the emergency created by the El Niño drought of 1982 and 1983, the project was launched by USAID primarily as an attempt to provide water to communities and secondarily as a long-term health intervention.

Under the original USAID/CARE cooperative agreement, CARE was to provide projects in 110 communities -- 80 water systems and 30 small scale irrigation systems. Sanitation systems were called for but no target number was specified. All of the projects were to be completed by October 14, 1985.

In mid-1985, the USAID mission in La Paz requested the assistance of the Water and Sanitation for Health Project (WASH) to perform the final project evaluation of the CARE program. A proposed scope of work was forwarded to WASH by the La Paz mission. The request for assistance was approved by the USAID Office of Health and Activity Implementation Plan No. 168 was issued in July 1985.

To evaluate the program performance, a WASH evaluation team visited 15 projects (17 communities) in the Departments of La Paz, Oruro, Potosi, and Chuquisaca. The evaluation was conducted between September 23 and October 12, 1985.

The following is a summary of the major conclusions and recommendations of the WASH evaluation team. Detailed discussions of the team's conclusions and recommendations are presented in Chapters 12 and 13 of this report.

1. According to CARE data, 126 projects have been undertaken, 17 of which are for irrigation. At the time of the evaluation, work was complete in 84 percent of the communities and was expected to be finished by the end of November 1985. Although CARE did not complete all of its projects by the program deadline (October 14, 1985) and did not complete the required number of irrigation systems (30), the WASH consultants believe that CARE's construction progress was remarkable -- especially considering the lack of full counterpart support and the economic crisis that existed in Bolivia at the time. In addition, CARE constructed 16 more water systems than what was originally required. However, no sanitation systems were constructed by CARE.

2. Although CARE was very successful in implementing the water systems, a high price has been paid for stressing the resources of CARE and its project counterpart, the Departmental Development Corporations (DDCs) to complete the projects on time. The WASH evaluation team found consistent and significant problems in the following areas: project conception (coverage and level of service); design and construction; training (including health education and community management); and operation and

maintenance practices. These problems diminish the potential benefits to the communities and affect the medium to long-term survival of the water systems. The WASH consultants believe that with appropriate modifications and assistance, the problems with existing projects can be corrected and CARE's future programs can be very successful.

3. Based on its findings during the evaluation, the WASH team developed a list of recommendations to improve existing and proposed projects, and identified areas of the water supply and sanitation sector that should be supported. The recommendations (see Chapter 13) are divided into two categories: those referring to the design and implementation of the CARE project and those referring to programs for future USAID funding. The WASH team believes, however, that the highest priority should be given to correcting and rehabilitating the projects that were constructed under the Disaster Recovery Project.

Chapter 1

BACKGROUND

1.1 Introduction

This report constitutes the final evaluation of a CARE potable water, sanitation, and small-scale irrigation program in Bolivia. The program was financed by the U.S. Agency for International Development (USAID) under the Bolivia Disaster Recovery Project (No. 511-0581). Funds in the amount of US $1,750,000 were provided by USAID for the construction, rehabilitation, and expansion of potable water systems, sanitation systems and irrigation facilities during the period October 14, 1983, to October 14, 1985. The goal of the USAID program was to assist Bolivia in responding to recent (1983) drought conditions by increasing water supply and food production in drought-affected areas.

In January 1985 a joint CARE/USAID mid-term evaluation of the project was conducted to measure the general progress of the project and to recommend changes to achieve the project goals.

1.2 CARE, the Executing Agency

CARE is a private voluntary organization that has been active in water system construction in Bolivia for the past seven years (including the two years of the present program). To date CARE has constructed over 300 water systems in Bolivia in rural areas -- generally in communities having fewer than 2,000 persons. These projects included two USAID-funded projects: Contract No. 511-04790-70160N for rural water supply in Chuquisaca (1977 to 1978); and Contract No. 511-0495-90042 to develop water systems in the Department of La Paz (1980 to 1983).

Because of the success of its past efforts, CARE was selected by USAID/Bolivia to implement the water supply, sanitation, and irrigation portion of the Disaster Recovery Project in Bolivia. CARE has also been selected by USAID to receive Child Survival Funds and is being considered for additional funding to construct more rural water supply systems and irrigation systems throughout Bolivia.

1.3 Program Purpose and Objectives

As defined in the cooperative agreement between USAID and CARE for the USAID Disaster Recovery Project, the purpose of the CARE program was to construct, rehabilitate, and expand existing potable water/sanitation systems and irrigation facilities to provide for increased water supply and food production in drought-affected regions of Bolivia. The program was also intended to decrease the impact and risks of future dry weather conditions.

Because of the emergency created by the El Niño drought of 1982-1983, the project was launched by USAID primarily as an attempt to provide water to communities and secondarily as a long-term health intervention. The cooperative agreement between USAID and CARE outlined the following criteria for the program:

- Projects were to be located within the drought-affected areas of La Paz, Oruro, Potosi and Chuquisaca.

- The communities to be served were to have populations of fewer than 2,000 people, and the irrigation projects were generally to encompass fewer than 200 hectares.

- Projects were to be located in populated areas which have a justifiable need for the investment, even under normal rainfall conditions.

- Approximately 80 potable water and sanitation system projects were to be constructed, along with approximately 30 additional potable water projects that included irrigation or were solely irrigation projects (a total of 110 systems.)

- All projects were to be designed and constructed within the two-year life of the program.

- To be included in the program a community had to show strong interest and commitment, such as the willingness to provide voluntary labor and materials and to pay for maintenance and operation costs, and it had to form a local group or organization to oversee and ensure continued community support.

- Each community project was to be demonstrably feasible, based on technical, financial, social, and administrative evaluation criteria to be jointly agreed upon by USAID and CARE.

- Irrigation projects were to be selected using the following criteria. They were supposed to:

  - involve the improvement/expansion of an existing infrastructure;
  - require minimum (less sophisticated) engineering and operation requirements;
  - require less continual attention to operation, management, and maintenance; and
  - present minimal need for elaborate environmental analyses.

- Whenever possible, both the potable water systems and small-scale irrigation facilities were to be constructed as gravity systems to reduce operating costs and maintenance requirements.

- In potable water projects, preference was to be given to the installation of house connections to reduce maintenance requirements.

- After construction of each potable water project, CARE was to train operators in system maintenance programs. Training would be provided in cooperation with the Servicio Nacional de Formacion de Mano de Obra (FOMO).

- Each community was to set up a water user committee for both potable water and irrigation projects and charge fees to finance the materials and labor used in system maintenance.

- CARE would work with the assistance of its national counterpart, the Departmental Development Corporations (DDCs), in community promotion, engineering surveys, designs and plans, and construction supervision. In irrigation projects, the DDCs would also provide communities with ongoing assistance in water management and agronomy. CARE and the DDCs would make periodic site visits to check on operation and maintenance.

- In selecting communities for the program, CARE was to ensure that the engineering and implementation demands did not exceed the existing or augmented technical, organizational, and financial capacity of the DDCs or FOMO.

Note that in October 1984, CARE realized that certain budgetary line items had been over-budgeted and determined that the surplus funds could be used to construct an additional 15 systems for a total of 125 water/irrigation systems. The financial plan was amended to allow for the importation of additional materials and the change in the scope of work was approved by USAID.

1.4 WASH Involvement

In mid-1985 the USAID mission in La Paz, Bolivia, requested the assistance of the Water and Sanitation for Health Project (WASH) to perform the final project evaluation of this CARE program. A proposed scope of work (Appendix A) was forwarded to WASH by the La Paz mission. The request for assistance was approved by the AID Office of Health (S&T/H) and Activity Implementation Plan No. 168 was issued in July 1985.

Following the approval of the mission request, WASH staff identified a two-member evaluation team (consisting of a sanitary engineer and a sociologist) and forwarded their names to USAID/Bolivia for approval in August 1985. The approval was given and the two-person WASH team carried out the project evaluation in Bolivia between September 23, 1985, and October 12, 1985.

Chapter 2

EVALUATION

2.1 Purpose of the Evaluation

The purpose of any project evaluation is the measurement of project status to determine progress towards defined project goals and objectives. For the CARE potable water and small scale irrigation project in Bolivia, the cooperative agreement between USAID and CARE established the objectives for the project. These objectives are discussed in Chapter 1 of this report. The cooperative agreement also required that mid-term and final evaluations be conducted. The purpose of the mid-term (after the first year) evaluation was to measure the general progress of the program, identify implementation problems, and provide suggestions for resolving these problems. The final evaluation was intended to determine if the general objectives of the program had been met.

The evaluation requested by USAID (see Appendix A for the scope of work) was more comprehensive than that outlined in the cooperative agreement. The scope of work reflects the desire of both USAID and CARE to improve CARE's program approach to ensure the long-term viability and effectiveness of the systems that are being constructed. The evaluation is supposed to provide conclusions and recommendations that can be useful to USAID and CARE in establishing future programs in water supply, sanitation, irrigation and training. Because of these requirements, this evaluation provides not only an assessment of CARE's progress in achieving its program goals, but also recommendations for ways to improve.

- CARE's program development (project planning),
- CARE's design and construction supervision capabilities,
- the operation and maintenance capabilities of rural communities, and
- the beneficial impact of a water system on the health of the community.

2.2 Scope of Work

To address the objectives of the evaluation outlined above, the WASH team evaluated the scope of work, developed a detailed work plan, and prepared a proposed report outline before arriving in Bolivia. The work plan was based on a three-week evaluation period and included about ten days of field time for community and institutional visits, and one week to prepare a report before leaving Bolivia.

Upon arrival in La Paz on September 23, 1985, the WASH team reviewed the scope of work, the proposed report outline, and the work plan with Gerard R. Bowers, the USAID mission health officer, and Raphael Indaburu, the USAID project manager in the Division of Health and Human Resources (responsible to the health officer). At that time the health officer, at the request of the WASH team, asked S&T/H to modify the team's scope of work to provide more field time for visiting communities. Both the mission and the WASH team believed that more field time would be required to visit a representative sample of the communities in the CARE program. The health officer also requested that the WASH team present only its preliminary conclusions and recommendations while in Bolivia. The final evaluation report would be completed once the team returned to the United States. A draft report would be sent to the mission for review by December 1, 1985.

With the concurrence of the WASH team, the mission requested that S&T/H in Washington approve the change in scope of work and provide additional funds to complete the report in writing in the United States. The approval was given by S&T/H and confirmed by a telex to the mission.

The WASH team also discussed the same items listed above with Mr. Art Flanagan, assistant director for CARE/Bolivia. The change in the scope of work was accepted by CARE and arrangements were made by CARE to provide transportation to the communities and institutions to be visited.

2.3 Evaluation Procedures

To gather information for the program evaluation and to address the additional information requests of USAID and CARE (outlined in the scope of work), the WASH team developed the following survey forms.

Form	Where Used
CARE Regional Office Survey Form	CARE regional office in each department
DDC Survey Form	Each DDC
Design Data Survey Form (for each community)	In the CARE regional office or DDC office -- whichever had major responsibility for the community project
Rural Water and Sanitation Survey	In each community visited
Community Survey Form	In each community visited
O&M Assessment of Community Water Supply System	In each community visited

Copies of these forms are contained in Appendix B of this report.

The forms were used in each of the places listed above to ensure continuity of the survey from one department or from one community to another. Note that the Rural Water and Sanitation Survey and the Community Survey Form were developed by the team sociologist and the team sanitary engineer, respectively. The purpose of the dual survey form was to provide a cross check on the information gathered at the community level and to address similar questions from different perspectives (i.e., the social or cultural aspect vs. a technical aspect).

In addition to the interviews and surveys that were done at the CARE regional offices and the DDC offices, the WASH consultants also visited the FOMO training center in El Alto (outside of La Paz) and interviewed the regional

FOMO director in each department. WASH also visited the CARE regional material warehouses in Potosi and Chuquisaca.

The general procedure followed by the WASH consultants was to meet with the institutions and communities in each department in the following order: 1) CARE regional office, 2) DDC, 3) FOMO, and finally 4) the communities.

This procedure gave the WASH team the opportunity to become more familiar with the personnel of each organization and to collect back-up community information before visiting the communities in that department. The team was also able to use these office interviews and the field trips not only to gather information but also to discuss the conceptual and practical aspects of, and provide alternatives to, CARE's approach to low cost water supply and sanitation programs.

To select a representative sample (at least 10 percent) of the 126 communities in the CARE program, the WASH consultants compiled data (with the assistance of CARE/Bolivia) on each of the communities. The WASH team also requested that CARE prepare location maps and estimated travel times to each of the communities. From the information that was obtained, the WASH team selected the following communities to visit:

Department		Community
La Paz	(1)	Suañaca/(2) Jachasivi (combined water system)
	(3)	Cairoma
	(4)	Bajaderia
Oruro	(5)	Pongo
	(6)	Huerta Pampa
	(7)	Copacabana
Potosi	(8)	La Lava
	(9)	Chilcani
	(10)	Huary-Huary
	(11)	Quivi-Quivi
	(12)	Tecoya
Chuquisaca	(13)	Carvajal
	(14)	Siguayo
	(15)	San Antonio De Chaupillajta
	(16)	Vila Vila (17) Vila Vila Norte (combined water system)

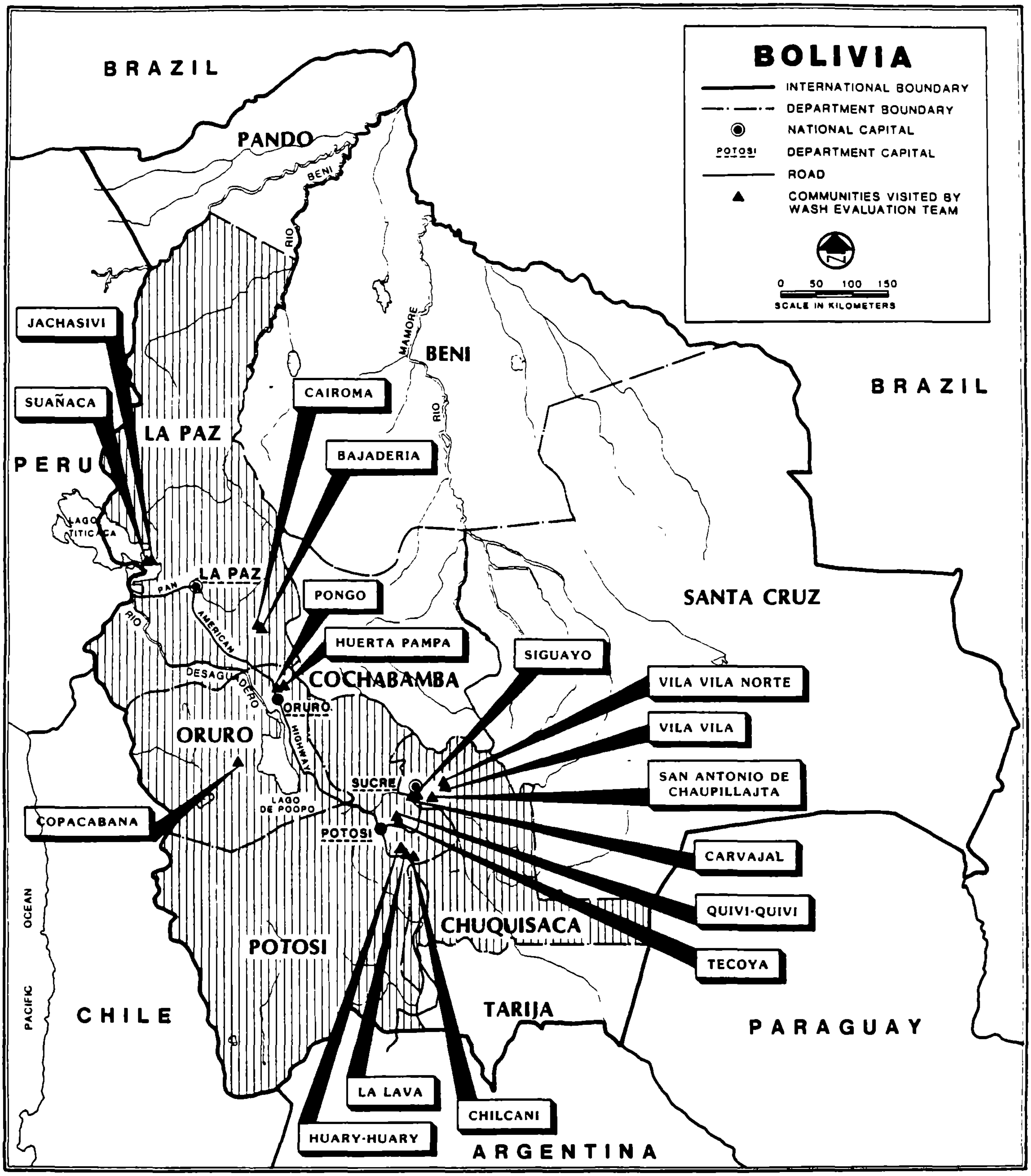
The locations of the communities visited by the WASH team are shown in Figure 1.

The communities were selected on the basis of the type of water system (i.e., gravity or pumped) and the travel time from the CARE regional office. (The principal characteristics of each system are given in Chapter 5, Table 2.) Generally the communities were reached within two to three hours from the CARE regional office. Two communities were within one hour, and two communities were six to eight hours away. All travel to the departments and to the communities was by four-wheel-drive vehicle.

Alfredo Leon, the general manager of CARE/Bolivia, accompanied the WASH team throughout the evaluation (except for several community visits). As mentioned

FIGURE 1.

LOCATION MAP
CARE PROJECT EVALUATION
BOLIVIA



earlier, CARE and/or DDC personnel from the regional offices were also present during the community visits. However, to ensure that responses would not be affected by the presence of CARE or DDC staff, they were excluded from all of the community interviews which were conducted by the WASH consultants.

Upon completion of the field visits, the WASH consultants prepared a preliminary list of conclusions and recommendations. These were discussed in a meeting with Ron Burkard, director of CARE/Bolivia, Art Flanagan, assistant director of CARE/Bolivia, Alfredo Leon, general manager of CARE/Bolivia, and Raphael Indaburu, USAID project manager. In a separate meeting WASH discussed its preliminary conclusions and recommendations with Gerard R. Bowers, health officer, USAID. A typed copy of the conclusions and recommendations was left with the mission. Upon the consultants' return to the United States, a copy was also forwarded to Dr. Mary Ruth Horner of CARE/New York.

2.4 Report Organization

This report is organized in the following manner. First, CARE's program implementation plan is discussed in Chapter 3. Next, the WASH team's findings in each of the major areas of the evaluation (i.e., project development, system design and construction, etc.) are discussed in a separate chapter. The recommendations are listed at the end of each of these chapters. Finally, the major conclusions of the evaluation team are presented in Chapter 12 and the major recommendations in Chapter 13. The major recommendations are divided into two categories: project design and implementation and ways to support existing and future project performance.

Because CARE tended to focus on the water supply component, the sanitation component of the project was neglected and irrigation was treated as a water supply project. For this reason, distinctions are generally not made between water systems and irrigation projects in this report.

Chapter 3

CARE'S IMPLEMENTATION PLAN

3.1 Introduction

In order to implement the original 110 projects proposed for the CARE program, CARE signed agreements for counterpart assistance with the Development Corporations (DDCs) in each of the four departments where projects were being constructed (La Paz, Oruro, Potosi, and Chuquisaca). The DDCs were selected as counterpart agencies because of their decentralized organization -- they receive a percentage of the taxable income in each department -- and because they had available experienced staff to assist in community organization, water system design, and construction supervision. Because of the projected workload for the CARE projects, the DDCs agreed to hire additional personnel.

As outlined in the agreements between CARE and the DDCs, CARE would have project responsibilities in the following areas:

- community surveys and selection and project promotion (including organizing water committees),
- design review and selection of standards,
- overall project management and coordination, and
- technical assistance (to the ddcs or the communities).

The DDCs would have responsibility for these areas:

- assisting in project promotion,
- collecting water samples for analysis,
- field surveys,
- water, sanitation, and irrigation system design,
- teaching construction techniques to communities,
- construction supervision, and
- transporting construction materials from the closest South American port (for materials purchased in the United States) or from La Paz to central warehouses and community construction sites.

The following sections of this chapter discuss in detail CARE's implementation plan for each of the major phases of a community project.

3.2 Project Development

CARE's usual process for project development includes a proposal which identifies the need for the project and describes in general terms the project objectives and how they will be met. The Disaster Recovery Project, due to time constraints, did not go through the proposal preparation phase. However, in every other way the assumptions and procedures used to develop the USAID/CARE agreement mirrored CARE's normal process.

CARE's water and sanitation program in Bolivia is centered around the provision of water supplies as a way to mobilize communities in support of other activities. CARE selects the communities from a list of those which have submitted requests either to the DDCs or to CARE. For purposes of requesting donor funding, CARE does not use pre-feasibility studies of proposed systems, but instead generates project construction cost estimates for "model" gravity, well and spring, and pumped systems serving communities of 400 people. The models are based on previous projects. The donor funds available and the average cost of model systems determine the number of water systems to be constructed under the project. Materials are purchased based on material requirement assumptions for these models.

CARE then sends promoters to villages on the solicitation list which meet the basic selection criteria of location, size, and need for water. Communities which organize a water committee, contribute up to 30 percent of the project cost in labor and local materials, and place deposits for patio connections are selected. Also considered in selection is the housing configuration and the proximity of the community to others selected. Those that are not selected are dropped and substitutes are found from the same list.

CARE or the DDCs help to organize a water committee, then usually collect general social and technical information and discuss the conditions of work organization and distribution of responsibilities. If the community agrees to the conditions, a contract is signed and work commences.

CARE/Bolivia provides service only through patio connections. It does not provide public taps. Households purchase the materials for connections from CARE. Those who do not contribute labor, even if they have purchased the connections, are not entitled to be part of the water system. The community is not consulted in the selection of the level of service to be provided. (This issue is discussed in more detail in Chapters 4 and 5.)

CARE/Bolivia has not planned a sanitation program as part of its water projects nor developed any selection criteria for standards or level of service to be provided. Communities are not asked if they would like to have a sanitation program.

3.3 System Design and Construction

3.3.1 Design

CARE's original implementation plan delegates all phases of the design of the water, sanitation, and irrigation systems to the DDCs. The design phase of each water system includes the measurement and selection of water supply sources, population and water demand projections, field topographical surveys, intake and water system design, and the selection of materials. CARE plans to review and approve the design criteria for each project and the project design, thus exercising a measure of quality control during the design phase. Where necessary, CARE provides technical assistance to the DDCs.

A similar process was planned for the design phase of the irrigation projects in the program. No implementation plan was ever adopted for the sanitation part of the program.

3.3.2 Construction

Construction of all community projects was planned in accordance with CARE's traditional self-help philosophy. Under the self-help program, CARE furnishes the basic construction materials (pipe, valves, cement, etc.) and the community supplies the project labor and locally available materials (unskilled labor, sand, gravel, etc.). The value of the community's contribution is required to be at least 30 percent of the total project cost. The community is also required to purchase and install pipe, faucets, and other accessories that are necessary for the patio connection to each house.

3.3.3 Construction Training and Supervision

Both the training of communities in construction techniques and the supervision of the construction are the responsibility of the DDCs. The implementation plan called for the presence of a field supervisor throughout the construction period. Periodic inspections of the work in progress were planned for the community promotor (either a CARE or DDC person) and a field engineer.

3.4 System Operation and Maintenance

Under CARE's implementation plan, and in accordance with CARE's philosophy, responsibility for the operation and maintenance of its water system is given to each community. As part of the project agreement with CARE, the community agrees to accept this responsibility, to establish a water committee, and, to collect fees for the operation and repair of its water system. An operations and maintenance training program (discussed in the next section) for two community members is to be established by CARE, assisted by the DDCs.

3.5 Training

To provide the knowledge necessary for a community to operate and maintain its water system, CARE is to establish an agreement with FOMO (Servicio Nacional de Formacion de Mano de Obra) to train two persons from each of the 125 project communities. The training is to be provided in La Paz for the communities in La Paz and Oruro, in Potosi for the communities in Potosi, and in Sucre for the communities in Chuquisaca.

FOMO is a national organization which receives its funds from a tax on industry in Bolivia. Traditionally FOMO has provided training in vocational skills such as plumbing, carpentry, and masonry -- as opposed to specific skills for the operation and maintenance of rural water supply systems. For the purposes of the CARE program, FOMO, CARE, and the DDCs are to collaborate in designing a training program for rural water system caretakers.

Although the cooperative agreement between USAID and CARE required that the DDCs provide irrigation project assistance to the communities in water management and agronomy, no specific implementation plan for this type of training program was developed. Also, no training programs were developed for the sanitation component of the CARE program.

3.6 Health Education

CARE has not included a health education component as a complementary input to its water supply projects. In order to address this deficiency, CARE is beginning implementation of a Child Survival Program which will focus specifically on health education. Although this program is designed for communities that have or will have CARE water projects, it will not include them all.

3.7 Administration and Management

CARE administers its programs on a decentralized basis with an emphasis on departmental responsibility for project planning and organization. Agencies such as the DDCs and FOMO, selected by CARE to provide technical support and training, also operate on a decentralized basis. The initial planning, setting of objectives, and overall coordination occurs in La Paz. Within the national project objectives each department office reaches agreements and signs separate contracts with the appropriate DDC, FOMO office, and communities on the allocation of responsibilities for work within the department. (Section 3.1 discusses the types of services to be provided by each).

CARE purchases all imported and most local materials at one time and in advance of the selection of community projects to ensure their availability when required. Stocks of materials are maintained in the regional warehouses in each department. The DDCs are responsible for transporting materials to the site. Construction does not begin until a community has assembled all necessary local materials.

CARE coordinates with the DDCs and FOMO closely to ensure that work is initiated and the FOMO courses are designed to meet project needs. Coordination and follow-up is informal and continuous. Some initial survey and evaluation procedures exist but are not rigorously followed.

CARE has full management responsibility to ensure that designs are reviewed, materials are disbursed, and construction quality is adequate. However, there is no formal system to receive and analyze information to improve project execution and operation. During the design and construction of systems, CARE manages the project and removes constraints by reassigning its own resources or identifying others to fill gaps left by its government counterparts.

CARE turns the responsibility for the management of the systems over to the water committee on completion of the construction. There is no formal process to evaluate completed systems' operation or to follow up on maintenance.

3.8 Implementation Constraints

In reality, CARE's implementation plan was severely hampered by the economic crisis of 1984 and 1985. During this time, inflation in Bolivia reportedly reached a peak rate of 10,000 percent per year and the value of the Bolivian peso declined from about 200 to about 1,000,000 pesos to the dollar. Government strikes were common as workers became more and more dissatisfied with the high rate of inflation and the decline in the standard of living.

CARE estimated that DDC personnel were out on strike between 30 and 50 percent of the time in 1984 and early 1985. The high rate of inflation also reduced the amount of government funds available to support the personnel and transportation requirements of the CARE/DDC agreements.

As a result of the economic crisis, CARE elected to increase its staff to supplement the decreased capabilities of the DDCs. CARE also elected to increase the number of communities in the program when it found that more construction funds were available because of over-budgeting. Instead CARE should have reduced the number of communities that could be served under the program -- to match the available manpower resources. USAID approved CARE's request to increase the number of communities in the program from 110 to 125 in October 1984.

3.9 Recommendations

The following are recommendations about how to improve the effectiveness of CARE's program implementation plan.

1. CARE lacked a clear plan to implement the small-scale irrigation program. Future irrigation programs should include steps to establish the potential for a positive return to the farmers: training for CARE and counterpart personnel; design criteria; baseline data surveys (types of crops and yields); training and assistance for communities in water management, agronomy, and operation and maintenance; and, follow-up assistance and project impact surveys.

2. The WASH consultants believe that in the face of decreased counterpart capabilities, CARE should have requested an extension of the time to complete the project or a decreased workload to achieve a higher level of supervision and project quality control. Future agreements should permit an on-going assessment of counterpart capabilities and provide a mechanism to adjust contractual requirements.

Chapter 4

PROJECT DEVELOPMENT

4.1 Introduction

CARE has demonstrated an exceptional capacity to meet the construction objectives of the rural water supply component. The keys to its success are a staff which is highly motivated to the achievement of targets; a systematic process of community selection which requires serious prior commitment by participating communities to organize and contribute labor and materials; the skill to help mobilize these resources; and the ability to work around physical, political and economic constraints. The level of organization involved to gear up, formalize interagency relationships, select communities and obtain agreements, initiate training programs, and schedule and complete construction was remarkable by standards found in the developing world. The communities themselves were a strong reason for the completion of projects. They were highly motivated and willing to organize and learn and commit scarce financial resources. These two characteristics, a motivated implementing agency able to mobilize self-help programs and strong villages willing to commit resources to change conditions are often lacking when great technical skills are present in development efforts. They could be the basis for model projects.

Unfortunately, the cost of achieving the numerical targets was a loss of quality, immediate effectiveness and longer term performance. Problems started at the project development stage. The use of models based on past projects affected the selection and effectiveness of new ones. The lack of feasibility studies left gaps in knowledge affecting project performance, coverage, future operation and maintenance and benefits.

The problems found in the CARE projects are not unique and CARE is above average in implementation. But if the people are not getting water or they are not utilizing it to improve conditions, the criteria for success have not been met. This is a particularly serious matter when one considers the resources the community itself has invested and will continue to invest to make the system work.

4.2 Project Proposal

Water project planning involves identifying the need for the project and preparing a proposal for how it can be financed and implemented. The proposal should include a description of the major activities to achieve the objectives; an implementation plan, including resource needs and a schedule of activities; an assessment of technical, economic, social, financial, and institutional feasibility, and the identification of risks and constraints. When projects are financed on the basis of such a proposal, the donor accepts the objectives and the feasibility of the plan to achieve them.

This evaluation of CARE's planning process in the project just being completed should allow the successes and difficulties identified in the evaluation to be tied back into the preparation of the next project proposal. With the benefit of this feedback, modifications can be incorporated and project effectiveness increased.

Apparently due to the rapid dispersal of donor funds under the drought recovery program, no actual proposal was developed for the project. The goals and method of implementation were identified within the cooperative agreement between USAID and CARE. However, the approach laid out within this agreement and followed during implementation was identical to previous and subsequent proposals. Thus, it was possible to evaluate what constitutes the standard CARE procedure.

4.2.1 Project Identification

CARE identified the need for the project based on a list of 300 written requests for water supply received by CARE and the DDCs. Some requests had also been received for sanitation projects.

4.2.2 Objectives, Components, and Costs

Based on previous water supply project experience CARE developed a plan to design and construct 80 water and 30 irrigation systems (this was subsequently modified to 95 and 30 for water and irrigation, respectively). The water systems were to be combined with sanitation. The designs and construction costs for the actual systems were not included since actual communities were to be chosen from the selection list during the program implementation period. In this project no breakdown of costs was presented in CARE's plan. Estimates for financing and CARE personnel requirements were based on model systems for several types of CARE projects: gravity, well and spring, and pumped supplies -- all sized to serve a population of 400.

No designs or costs have ever been generated by CARE/Bolivia in proposing sanitation systems. CARE/Bolivia has no previous experience in this area and has not developed a method to handle it.

The use of model designs and costs by CARE and USAID in a proposal for project funding can be acceptable in a project like this with many sub-projects: it would be unrealistic to expect actual preliminary designs for over a hundred systems. The procedure works well when the implementing agency (CARE) has a proven track record for designing good systems. Having confidence in the agency's procedures and results, the donor releases funds to continue as before. It was such a track record that CARE presented as the major argument to receive funds.

A better procedure, however, would have been to request a design for a representative sample of the systems to be constructed, to review the design, visit a few CARE projects already constructed, and then permit these systems to provide the basis for a full proposal with associated cost estimates. If serious problems were found, the proposal could have been funded with realistic modifications and with the proviso that groups of designs be reviewed and a few constructed systems be evaluated before the release of additional funds. As it was, USAID did not have an engineer to evaluate the proposal and there was pressure to implement quickly. Therefore, CARE's track record was accepted and CARE went ahead and purchased materials and equipment based on updated costs of typical system facilities for villages of 400, without having visited or selected the actual sites.

4.2.3 Complementary Programs

Normally a proposal for a water supply and sanitation project will be evaluated for complementary programs such as health education to ensure that benefits are realized. USAID did not ask that this program be so evaluated. Assistance in water management and agronomy for irrigation was mentioned in the proposal but no specifics were given.

4.2.4 Implementation and Manpower Requirements

The cooperative agreement laid out a precise schedule for completion of the systems. This subsequently created a strong "target" orientation for tangible systems (water and irrigation) while intangible targets like sanitation were ignored. When the DDCs were unable to fulfill their role, CARE engineers filled the gap, with a subsequent lapse in management and quality control.

4.2.5 Feasibility

No feasibility studies were prepared by CARE, although the cooperative agreement states that care and USAID should establish feasibility criteria and see that it is met. Feasibility studies would have determined community preferences, ability to pay the annual costs of system maintenance, and the adequacy of the water source to meet proposed service standards.

4.2.6 Constraints and Risks

CARE did not identify project constraints and consistently presented a positive view of its experience and potential. A realistic assessment of constraints within the proposal would have permitted care to identify and incorporate ways to remove the constraint or, for that matter, study it. Technical assistance, more trucks, costs for studies could have been built in as part of the project. The period of implementation could have been expanded. By taking an optimistic approach care trapped itself into having to sacrifice quality -- not a budget item -- to measure up to what it said it could do. (Otherwise the next time it might be faced with a smaller program.)

Even if CARE/Bolivia had been inclined to implement the sanitation component or carry out feasibility studies it could not have done so and still have met the numerical targets for water systems. Under realistic conditions there was no way all the project objectives could be achieved. The same approach is inclined against doing some basic feasibility studies since they would increase the implementation time and decrease the number of systems within the period.

4.3 Community Selection Criteria and Size of Communities

4.3.1 Community Selection Criteria

Community selection criteria were clearly defined and were applied with consistency and fairness. By selecting communities which were compact and by grouping communities for design and construction, CARE attempted to utilize its resources efficiently. However, it is probable that funds could have been allocated to achieve much greater coverage (more people served) if consideration had been given to ranking communities by the cost of service per person.

CARE perceives community self-help as a precondition to successful projects. The way CARE uses the self-help criterion to select communities is the most important aspect of CARE's success in implementation. CARE staff adhered strictly to the guidelines of serving only communities and households prepared to make financial and manpower commitments in advance of project initiation. By incorporating this requirement into the pre-construction phase, CARE ensured that only the most motivated communities proceeded to construction. About 20 to 30 percent of the communities initially offered the opportunity to participate were eliminated and others substituted.

4.3.2 Size of Selected Communities

Although the contract permitted the selection of communities with populations as high as 2,000, 50 percent of those served had fewer than 300 people and 80 percent fewer than 500. CARE engineers gave two reasons for this. First, CARE looks at the total system cost and compares it to the model system costs used to develop its proposal, (the model was based on a community of 400 people). Thus, the use of the models to estimate costs favors selection of small communities so as to stay within the parameters of the model design and costs.

Second, smaller communities are poorer, more vulnerable, and more in need of project assistance to build local infrastructure and deter migration. However, in actuality the ability of the poorest communities to meet the financial and manpower requirements for CARE project selection argues against their participation. An effort to include more villages of a larger size would have permitted a significantly higher number of equally needy people to receive water due to the economies of scale involved.

4.4 Community Participation and Community Surveys

CARE promotional activities to involve the communities were highly successful. During the first site visit CARE promoters explained the need for the community to organize a water committee which would be responsible for mobilizing local materials, organizing construction teams, and subsequent project operation and maintenance. The evaluation team found the communities to be impressively motivated, even after the system was constructed.

However, while CARE centers its program around community self-reliance for the construction and operation phases, it fails to involve the community in the basic planning decisions, such as the choice of technology or of service to be provided. Both within CARE's formal process of committee organization, and the informal dialogue between the promoters and the community, the flow is essentially uni-directional. CARE/Bolivia staff predetermine what will or will not work before it arrives in the communities.

With the exception of asking people in the community what the best water source is, the promoter is primarily concerned with explaining to the community what its responsibilities will be if it chooses to accept technical and material assistance for the services chosen by CARE. At no point is the community made aware that alternatives exist. While this standardized approach facilitates implementation, it results in a number of problems which then plague the system and the community and affect operations and utilization. These are discussed in Chapter 5.

The CARE process calls for a socioeconomic community survey in the initial stages of project design. The surveys provide an adequate general baseline but include little or no information on community preferences or water utilization or sanitation practices from which a project could be designed or an evaluation of future impacts measured. The surveys vary from department to department and are not consistently applied so they do not provide a basis for analyzing socioeconomic, geographic or other factors useful in future project investment decisions. The information, when gathered, is not analyzed except for use in the design calculations.

4.5 Community Service Area Selection

A serious source of concern expressed in one-half of the villages visited in the evaluation was the decision by CARE or the DDCs to exclude parts of the community from service. Even when communities were reticent to discuss other system problems, they were vocal on this issue. The subject was often raised by those who already had water. A review of a list of all 125 systems in the project revealed the need for system expansion on a large scale.

The area to be served by a project should be selected on the basis of the location of houses, density, the cost of developing the source, and, primarily, the cost of each increment of the distribution system. CARE's approach is to fully develop the source but distribute only to densely developed adjacent areas, leaving expansion to the community itself. In areas where houses were clearly dispersed or located in a group at a distance, the rationale was both clear and accepted. However, there were cases where the decision appeared arbitrary, distribution halting at one house in a row of others. Sometimes an excluded section of the community could have been served at a small incremental cost of extending the line and increasing the number benefited at a very low cost per person. The reason given to both the community and WASH was that a certain amount of pipe was allocated for each community, and an extension would have exceeded the allocation. CARE engineers have been investigating ways to serve outlying areas of dispersed development with public taps.

CARE's approach to service-area definition has had several impacts:

- Given the high demand for water some people have left their traditional settlement pattern and have built a new house within the service area. This makes it easier for them to receive other services and is a social impact which CARE supports.

- The increased density of communities where open air defecation is the rule has increased the potential for disease transmission.

- A strong division has been created within communities between people who have access to the new water supply and those that do not. In addition, there are a number of instances where people who contributed the required labor to construct the system were excluded from access to the water system.

4.6 Level of Service and Community Coverage

As a matter of policy CARE provides only patio connections, which must be purchased by the households. As a pre-condition for participation, households must place a deposit for the connections in advance. The community is not consulted about the level of service to be provided. CARE bases its approach on the belief that it is not possible to collect fees or ensure maintenance on public taps.

The percentage of population served in the project communities varied from 30 to 100 percent and currently averages 65-70 percent. In most communities some households within the service area are excluded from the system because families have not purchased connections. It is CARE's view that everyone can afford the connections and those who do not become a part of the system simply lack confidence that it will come to fruition. CARE does not, however, collect information on ability to pay for the patio connections before setting the level of service. It applies the same standard to all communities, although some are poorer than others. The evaluation team found that some families are renters whose landlords did not buy connections. It is also reasonable to assume that some segment of the population cannot afford improved service.

The results of this policy are listed below.

- Instead of providing at least basic access to water to everyone in drought-prone areas and then giving the improved service to those prepared to pay for it, CARE excludes part of the population from access to any piped water.

- Some people are actually worse off than they were before the project. CARE captures the complete and best pre-project source of water for the system; those outside the system are forced to use sources of lesser quality and convenience.

- In some cases people have contributed labor and then found themselves unable to buy into the system. In other cases, some people have the money to buy the connections from CARE shortly after the project has been completed, but they find that CARE has allocated the connections to another community.

- People with piped water were found to be more likely to defecate near rivers which were no longer their water source; those downstream without water are subject to the effects of contamination.

- The use of contaminated water by part of the community leaves open the path for disease transmission to those with piped water.

- Health clinics were found to be without piped water because there was no money to purchase the connection and a public tap was not provided.

- CARE loses the opportunity to influence and educate the segment of the population that does not have access to the water system.

4.6.1 Service Standard

The projects are designed to provide from 60 to 150 liters per person. Consumption estimates were not based on demand and the adequacy of the source to supply it. As a result, in about half of the sites visited the source was not adequate to provide water on a 24-hour basis. People were unable to increase their water use and carried out activities at alternative sources or stored water in unsanitary containers. It was the view of CARE staff that providing some water was better than providing no water. However, from the communities' point of view, they contributed valuable resources but ended up with a less than adequate system. If there is a question about the adequacy of supply the community could be given the choice of receiving less water, perhaps through public taps. If the source is marginal, it would be reasonable, as a policy, to drop that community and use the resources where they would have better effect.

4.6.2 Technical, Financial, Social, and Administrative Feasibility

CARE did not carry out feasibility studies referenced in the AID/CARE contract. The implicit planning assumptions for feasibility were as follows:

- Technical: the existence of a source which could be developed;
- Financial: the commitment of a portion of the community to provide materials and labor and to purchase connections;
- Social: the commitment of the community to fulfill the terms of the project, organize a water committee, and accept future system responsibility;
- Administrative: the ability of CARE, the DDCs, and the communities to implement the project.

4.7 Recommendations

1. Project objectives should emphasize the long-term viability of the system.

2. Project objectives should encourage greater flexibility to allocate resources to serve the greatest number of people within small rural communities. In future contracts a range could replace a specific number

of communities or the number of communities could be decreased to encourage rational design and overall quality.

3. In the absence of pre-feasibility studies as the basis for proposed project costs, the physical contingency cost category should be increased to 20 percent to permit the purchase of sufficient materials to cover implementation of larger distribution networks, as needed.

4. Pre-feasibility studies should be included as a category in future budgets and schedules to improve project planning.

5. The CARE system model used to project proposal costs should be modified to reflect service to a larger average population.

6. The cost per person should replace the cost of the total system as a yardstick for selection.

7. CARE should be prepared to offer a basic level of water service via public taps to those unable to purchase patio connections, sizing the system to allow phased improvement of service levels over time if the source permits.

8. Promoters should inform the community of alternative technologies and standards of service as well as the expected operation and maintenance costs of each and permit the community to make the selection.

9. Public taps should be provided for all school and health posts.

10. CARE engineers should receive training and provide assistance in the rehabilitation of wells and the use of handpumps to provide safer water in dispersed areas.

Chapter 5

SYSTEM DESIGN AND CONSTRUCTION

5.1 Program Status

In addition to the information gathered in the community visits, the WASH team obtained information from CARE/Bolivia on the major characteristics of each of the projects (for 126 communities) constructed under the CARE program. This information is presented in Appendix C of this report. A summary of the project data that is relevant to the program status is presented in Table 1 and discussed in the following paragraphs.

5.1.1 CARE Data

Based on the socioeconomic surveys that were done in each community, CARE estimates the total population of all of the communities in the program to be 51,475. Of this number CARE estimates that 42,173 persons will be served by the water and irrigation systems in the program. This represents an 82 percent coverage of the communities' populace. Of the number of people served, about 40,535 persons are served by the 117 water systems in the program, and 1,965 persons will receive only irrigation water from the 17 CARE irrigation projects. A distribution of these projects by department is shown in Table 1.

As of the time of the evaluation, about 84 percent of the projects in the program had been completed. The percent completed varied from a low of 71 percent in Oruro to a high of nearly 100 percent in La Paz. CARE expects that all projects will be completed by the end of November 1985. As noted previously, no sanitation projects were constructed under the CARE program.

5.1.2 WASH Data

To assess the current status of the CARE projects, the WASH team obtained information on the number of families in the community and the number of family connections that have been made to the water system from each community that was visited. These data (labeled "current") are compared with CARE estimates (labeled "projected") in column 4 of Table 2. Note that CARE projects coverage will range from 50 to 100 per cent with a weighted average of 80 percent for the 17 communities visited. For all of the 126 communities, CARE estimated a projected coverage of 82 percent, reaching about 42,200 persons.

The WASH consultants found the percent coverage in the communities visited to be between 30 and 100 percent. The weighted average was between 65 and 70 percent. Using the average for all of the 126 communities, WASH estimates that the current coverage of the systems is 33,000 to 35,000 persons.

The WASH consultants conclude that CARE expects to reach all of the persons within the water system service areas that were established (82 percent of the total population). However, for reasons discussed in this chapter and the

Table 1

Summary of Project Data Provided by CARE/Bolivia

Department	Number of Community Projects	Number Supervised by CARE	Number Supervised by Corporation	Percent Completed	Number of Water System Projects	Number of Irrigation Projects	Number of Sanitation Projects	Estimated Population in Project Communities	Estimated Population Served by Project
La Paz	33	24	9 (CORDEPAZ)	100	33	0	0	13,192	11,107
Oruro	31	10	21 (CORDEOR)	71	25	7	0	18,166	14,863
Potosi	27	15	12 (CORDEPO)	89	27	1	0	9,536	7,805
Chuquisaca	35	63	18 (CORDECH)*	77	32	9	0	10,581	8,398
TOTAL	126	63	60	84	117	17	0	51,475	42,173

*Three other communities supervised by ELAPAS, DSA, or Plan de Padrinos

Table 2

Summary of Principal Design Features and Observations for Communities Visited by WASH

Department	Community	Estimated Current Population	Percent of Community Served by Water System: Projected[1]	Current[2]	Type of Source	Type of System	Water Use: Domestic	Irrigation	24-Hour Water Supply: CARE	WASH	Initial Water Quality Testing: Phys./Chem.	Bact.	Intake Protection Needed	Major Rehabilitation Needed	Comments
La Paz	(1) Suanaca/ (2) Jachasivi	778	91	84	Infiltration Gallery	Gravity	Yes	No	Yes	No	No[3]	No	No	Yes	Supply is not adequate, additional source/intake needed, expand distribution system
	(3) Cairoma	528	100	62	3 springs[4]	Gravity	Yes	No	Yes	No	Yes	No	Yes[5]	Yes	Supply is not adequate, additional source/intake needed, expand distribution system
	(4) Bajaderia	333	100	60	Spring	Gravity	Yes	No	Yes	No	Yes	No	Yes[5]	Yes	Supply is not adequate, additional source/intake needed
Oruro	(5) Pongo	270	100	77	Spring	Gravity	Yes	No	Yes	Yes	No	No	Yes[5]	No	
	(6) Hureta Pampa	240	65	30	Spring	Gravity	Yes	No	Yes	Yes	No	No	Yes[5]	No	
	(7) Copacabana	340	100	60	Infiltration Gallery	Gravity	Yes	No	Yes	Yes	No[3]	No	Yes	Yes	Intake is on river bed, protection from high flows and river bank mudslides is needed. Install additional shut-off valves in the distribution system
Potosi	(8) La Lava	450	78	85	Spring	Gravity	Yes	No	Yes	No	Yes	No	Yes	Yes	Supply is not adequate, additional source/intake needed, expand distribution system
	(9) Chilcani	620	50	50	Spring	Gravity	Yes	No	No	No	Yes	No	-	Yes	Supply is not adequate, additional source/intake needed
	(10) Huary-Huary	330	80[6]	64	Spring	Gravity	Yes	No	Yes	Yes	No	No	No	No	
	(11) Quivi-Quivi	400	90	55	Spring	Gravity	Yes	No	Yes	No	No	No	-	Yes	Supply is not adequate, additional source/intake needed
	(12) Tecoya	180	80[6]	-	Spring	Gravity	Yes	No	No	No	Yes	No	-	Yes	Supply is not adequate, additional source/intake needed
Chuquisaca	(13) Carvajal	300	100	67	Infiltration Gallery	2 Pumps	Yes	No	Yes	Yes[7]	No	No	Yes	No	
	(14) Siguayo	246	100	100	Infiltration Gallery	Gravity	Yes	No	Yes	No	No	No	No	Yes	Supply is not adequate, additional source/intake needed
	(15) San Antonio de Chaupillajta	-	-	-	River	Gravity	No	Yes	Yes	No	No	-	No[8]	Yes	Supply is intermittent and not reliable during dry season, additional source/intake needed. PVC bridge crossing is not structurally sound and should be replaced
	(16) VilaVila/ (17) Vila Vila Norte	600	71	74	Spring	Pump	Yes	No	Yes	Yes[7]	No	No	Yes[9]	No.	

(1) Estimated by CARE
(2) Based on information gathered by WASH team
(3) A physical-chemical water analysis was done after the water system was constructed
(4) One spring intake was designed and constructed by the community
(5) Protection includes restricting animal access and providing drainage around the intake structure
(6) Information not available; used average for all 126 communities
(7) Water supply may be limited by community's inability to pay for pumping cost
(8) Irrigation system
(9) Abandoned well should be sealed shut; extend source protection (existing wall) by providing fencing and drainage upstream of the intake area

Note: None of the communities visited uses chlorination previous chapter, the WASH consultants believe that the actual coverage will be less -- somewhere between 35,000 and 42,200 persons.

5.1.3 DDC Performance

According to CARE's implementation plan and the agreements signed between CARE and the DDCs, the DDCs were to take on most of the responsibility for project implementation (aside from project promotion). In actuality, the DDCs were not able to complete the projected workload. As Table 1 shows, of the 126 communities, only 60 (less than half) were supervised by the DDCs. CARE increased its effort in the program and supervised 63 of the community projects. Another three projects were supervised by other agencies (two by DSA). Clearly, the program was successful because of CARE's ability and willingness to take on the additional workload.

A summary of the CARE and DDC resources that were available in each department is presented in Table 3.

5.2 Water and Irrigation System Design

During the evaluation, the WASH team reviewed the following major areas in the design of the community water systems in the 17 communities selected:

- source selection and measurement,
- source protection,
- water system service area and level of service, and
- design features, chlorination, breaktanks.

The principal design features and the WASH team's observations for each of the water systems visited are summarized in Table 2 and discussed below. More detailed engineering observations for each of the communities visited are listed in Appendix D of this report.

5.2.1 Source Selection and Measurement

Type of Source. In general, CARE and the DDCs selected for each community the water supply source that was most likely to be the highest quality available. Where possible, springs were used, followed by (in order of priority) infiltration galleries, wells and surface waters. Also, in all cases, CARE and the DDCs favored the construction of gravity-supply systems versus pumped systems to minimize the cost and complexity of system operation and maintenance. Of all of the communities in the CARE program, fewer than 5 percent were designed with pumped systems. This percentage is much lower than the average for other water supply sector agencies in Bolivia. They report 20 to 30 percent with pumped systems. It is to CARE's credit that the number of pumping installations has been limited.

Water Quality. In principle, water quality testing is done for new water supplies to ensure that the water meets acceptable standards for physical-chemical parameters (i.e., pH, total dissolved solids, hardness, lead, etc.) and bacteriological standards (as measured by the number of total coliform or

Table 3

Summary of CARE and DDC Personnel
Resources for Each Department

PERSONNEL CLASSIFICATION	LA PAZ CARE	LA PAZ CORDEPAZ	ORURO CARE	ORURO CORDEOR	POTOSI CARE	POTOSI CORDEPO	CHUQUISACA CARE	CHUQUISACA CODECH
Engineer	1	2	1	5	1	2	1	2
Technical Assistant	1	3	1	-	-	2	1	2
Surveyor	-	2	-	2	-	3	-	2
Social Promoter/Coordinator	1	2	-	2	1	-	1	-
Field Supervisor/Worker	2	7	1	4	-	5	1	4
Drivers	2	4	1	2	1	2	2	2
Warehouse Attendants	1	-	1	-	1	-	-	-
TOTAL[1]	8	20	5	15	4	14	8	11

Total CARE Personnel: 25
Total DDC Personnel : 60

[1]Does not include accounting or secretarial support.

fecal coliform bacteria). Although the selection of certain types of sources (i.e., a spring versus a river) will generally tend to diminish the likelihood of source contamination, without water quality testing there is no way to be sure that the supply is acceptable and to rule out the need for chlorination.

Samples for physical-chemical tests are easy to take and the sample (five to ten liters) can be stored in a plastic or glass container. If the sample is preserved (to prevent bacterial growth) and kept cool, it may be delivered for analysis up to five days after it is taken.

Bacteriological samples are more difficult to take. The sample container must be sterilized and kept from contamination. The sample must be kept cool and delivered to a laboratory for analysis within 24 hours. Good planning and care of the samples are required to obtain accurate results of physical-chemical and bacteriological tests.

In their discussions with the WASH consultants, CARE and DDC personnel in all four departments acknowledged the importance of water quality testing and stated that such tests were generally included in all water supply evaluations. However, of the 15 water systems visited by the WASH team, none of the water supply sources had been tested bacteriologically before the water system was constructed. Only three of the sources had had physical-chemical tests, and these lacked analyses for arsenic and lead, two elements which can cause adverse health effects. These elements tend to be more prevalent in mining areas -- even in groundwater. Therefore, since two project departments, Potosi and Oruro are mining areas, tests for lead and arsenic should be included in all source analyses.

Because of the importance of water quality testing, the WASH team believes that CARE and DDC personnel should have made a stronger effort to get these tests done. Toward the end of the program, CARE did obtain Hach DREL5 field test kits (for physical-chemical analyses) but these received only limited use.

<u>Source Management</u>. In addition to water quality considerations, one of the most important factors in selecting a water supply source is to establish that there is a sufficient quantity of water to meet the existing and projected water demands of the community.

When there is not an adequate supply of water to meet the communities' needs, a number of adverse situations occur.

- At times the system will be only partially full (not under pressure) and will be subject to contamination from infiltration and back siphonage.

- There will not be enough water to promote good sanitation habits (hand washing, bathing, etc.).

- The community, which contributed a significant amount of labor and money connections) to the project, may become disenchanted and either fail to maintain the system and/or refuse to participate in future projects.

In discussions with the WASH team, CARE and DDC engineers indicated that nearly all water systems were designed to meet standard per capita allocations of water (see Section 5.3.4) and to provide water 24 hours a day. However, the WASH team found that many of the water systems could not meet the design objective, which varied from 60 to 120 liters per capita per day (lpcd), on a seasonal or sometimes even on a daily basis. Some water systems were periodically without water altogether. Of the 15 water systems visited, 9 (53 percent) did not have a 24-hour water supply.

WASH attributes this problem to the manner in which source-flow measurements are taken. Flows from rivers, springs, and stream underflow (for infiltration galleries) is measured only once prior to the design of the water system. This measurement is not necessarily taken during the dry season (the time of lowest flow).

Because the measurements are not adjusted for time of year, type of source, or recent rainfall history, they are subject to large errors when represented as average annual flows and used as the basis of source design. Therefore, the water system may not have an adequate supply of water throughout the year. In Jachasivi and Suanaca (Department of La Paz), for example, the source-flow for the combined community system was measured as 6 liters per second (lps) during the project design stage. Later in the year (July through August 1985), after the water system was in operation, the community began to experience water shortages, particularly in the higher areas of the water system. The source was remeasured in September 1985 and was found to have less than half the original flow.

This source was also described by the CARE engineers as a spring. However, the WASH team determined during its visit to the site that the source was actually stream underflow (water flowing under a river bed) and the intake structure was not optimally located to capture the largest flow available at the site. It is also important to note that during the year the quantity of stream underflow often varies more widely than the flow from a spring source (because of underground storage). This should be considered when determining the average flow that is available to supply the water system.

A similar situation was found in the community of Siguayo (Department of Chuquisaca). This community had relocated to take advantage of the new water system to be built by CARE and to build a new style of housing (under a Foster Parents Program) to reduce the incidence of Chagas disease. Reportedly the community had an adequate supply of water to meet its needs 24 hours a day.

The WASH evaluation team visited the intake site for Siguayo's water system (an infiltration gallery) and found only a trickle of water entering the intake. The community reported that during the months of July and August of 1985 they had had no water. It was clear that the amount of flow under the river bed had diminished markedly after the measurements for design had been taken. Similar situations had occurred in a number of other communities visited by the WASH team.

5.2.2 Source Protection

In addition to water quality testing of a source when the water system is being designed, there should also be ongoing testing of a water system to ensure that the water continues to be potable. Bacteriological tests are especially important. Although periodic testing of the water system is desirable, the WASH consultants recognize that in rural Bolivia this is not yet feasible. Therefore, because there is no ongoing monitoring of water systems the protection of the source is critical. Source protection can be accomplished by a variety of methods, including the following:

- minimizing the use of the watershed for raising livestock (compatible with the level of water treatment to be provided),
- preventing any animal or human defecations within a 30 to 50 meter distance of a river or spring intake,
- providing drainage ditches upstream of a spring intake to intercept and divert surface runoff, and
- constructing intake structures so that seasonal flooding will not inundate and contaminate the intake.

One example of the problem with intake protection was the community of Copacabana (Department of Oruro). There the intake was constructed in the river bed. A retaining wall about 0.5 meters in height was constructed to divert river flows away from the intake. However, high river flows could easily overflow this wall and inundate the intake. Under this condition surface water would enter and contaminate the community's water system.

As noted in Table 2, 8 of the 15 water systems that were visited needed some type of intake protection (other than watershed management). Because none of these systems has chlorination, each is currently susceptible to contamination. Measures should be taken to construct the fences, drainage ditches, and flood protection structures that are necessary to ensure the potability of these supplies. In all cases, more attention should be given to overall watershed management to increase source protection.

5.2.3 Water System Service Area and Level of Service

Service Area. As stated in Chapter 4, a model was developed by CARE to represent the average cost of water system construction in a community. CARE also used the model cost and amount of materials (length of pipe, quantity of valves, etc.) as guidelines for the cost and quantities of materials to be used in each community. In some instances, the use of these guidelines led CARE (in order to reduce costs) to restrict the service area to the central part of the community. In addition to the impacts discussed in Chapter 4, this practice

- left a number of people in the community without access to the water system (public standposts are discouraged by CARE) and

- increased the length of service line pipe that some individuals needed to buy to connect to the system. In some cases this cost to individuals is prohibitive and they cannot get water service even though they participated in the community self-help project.

The WASH consultants recognize that there are many cases where some individuals' houses are too far away to be economically connected to the water system. However, in these instances, a public standpost should be provided so that these persons can obtain water (by bucket or other container) from a potable water supply. Providing public standposts will also allow the CARE program to reach a higher number of people at little additional cost.

Level of Service. Typically, deciding on the level of service for a community water distribution system will mean providing one or more of the following:

- public standposts,
- patio (yard) connections, or
- house connections (for indoor plumbing).

The level of service that is chosen will depend on

- the amount of water available to the community,
- the ability of the community to afford the materials that are required, and
- the willingness of the community to effectively use the water that is provided (training may also have to be provided to the community).

The impacts of CARE's policy are discussed in Chapter 4.

5.2.4 System Design Features

Design Criteria. The water system design criteria used by CARE and the DDCs were generally in accordance with the Normas Bolivianas de Vivienda y Urbanizacion -- the standards set by the country of Bolivia.

The following is a summary of the criteria that were used, with comments, where appropriate, on the use of the criteria:

- Per Capita Consumption. In almost all cases, CARE attempts to provide a minimum of 60 lpcd and a maximum of up to 125 lpcd. The target amount varies with the location of the community (lower amounts provided in the colder altiplano region) and the amount of water available from potential sources. The minimum amount of 60 lpcd is adequate to support good sanitation habits (bathing, handwashing, etc.) in the community; however, because some supplies were overestimated, that minimum is not available in some communities.

- Population Projections. Future water demand for each community water system is based on per capita consumption and the projected population growth. Current population figures are obtained from a census conducted by CARE. Projections for the future are based on estimated growth rates provided for each province by the government of Bolivia. Generally CARE and the DDCs used a design period of 20 years (acceptable to WASH) to project the future population of each community. However, in the Department of Potosi a design period of 30 years was used in a number of cases. That results in over-design of the water system.

- Average Day Water Demand. This is based on the average annual water demand which is obtained by multiplying the per capita consumption times the projected population.

- Maximum Day Water Demand. The maximum day water demand is the basis for the water supply design. The water supply source (either pumped or gravity) must be able to meet the projected demand during the hours that water is used in the community. The maximum day demand is obtained by multiplying the average day demand times the maximum day factor. CARE selected maximum day factors from the range recommended in the Normas de Vivienda y Urbanizacion. The WASH consultants found that use of the maximum day factor was inconsistent and in some cases misapplied.

- Peak Hour Water Demand. The peak hour water demand is the basis for design of the distribution system piping and sometimes the basis for distribution storage design (CARE used another procedure, discussed below). The peak hour factor is obtained by multiplying the average day demand by the peak hour factor. CARE selected peak hour factors from the range recommended in the Normas de Vivienda y Urbanizacion. The WASH consultants found the use of the peak hour factors to be acceptable for hydraulic design.

- Storage Requirements. Distribution system storage is provided to meet the fluctuations in the community's water demand during the course of the day. The standards recommend that storage be sized to provide from 20 to 30 percent of the maximum day demand. CARE and the DDCs generally used 25 percent of the maximum day demand as their criteria. This is adequate for gravity systems (with a constant flow from the source) but it is not adequate for pumped systems. Where pumps are present, the size of the distribution system storage should be based on the water system demand, the capacity of the pump, and the frequency of daily pumping. WASH found the storage in both Carvajal and Vila Vila (both pumped systems) to be undersized. In both cases, the storage was designed for a gravity system using a factor of 15 percent -- probably too low a factor even for gravity systems. As a result, these communities have to operate their pumps four or five times a day (instead of twice) to meet the community's needs.

- Source Requirement. Because of the way in which sources are measured, many of the supplies in the CARE communities cannot meet the community's water demand at all times. However, this problem is due not only to the source measurement, but also to the way CARE and the DDCs determine the amount of flow needed. The source should be able to meet the community's daily water demand during the demand period (about 12 hours per day). The WASH consultants found a number of cases where the source determination was based on 24 hours. As a result, the actual amount of flow available to the community was overestimated.

- Hydraulic Design. Typically the transmission system (from the source to storage) is designed to meet the maximum day demand and the distribution system is designed to meet the peak hour demand. The demands are based on the population projection for the next 20 years. The WASH team reviewed the hydraulic design procedures for the systems built by CARE and the DDCs. The hydraulic analyses were based on the use of the Hardy-Cross method using a reasonable distribution of demands throughout the system. The WASH team found these procedures to be acceptable.

System Design. A water system should be designed to be easy to operate and maintain, and, where possible, pumps should be avoided in favor of gravity flow systems.

In general WASH found the CARE and DDC water systems to be well designed to meet these objectives (with the exceptions noted previously). However, in the course of the evaluation the WASH team did find some items that should be corrected (and considered in future designs) to ensure the longevity of these water systems. These are listed in the recommendations at the end of the chapter. Note that at the time of the evaluation most of the water systems were only two to six months old.

5.3 Sanitation System Design

CARE has a long-standing commitment to the improvement of health. As part of the project it was required to provide sanitation, although no details were given in the contract as to how this was to be done. A review of other proposals by CARE that include funds for sanitation as part of rural water supply programs found them to be similarly lacking in details except that latrines had been substituted for sanitation.

The transmission of many of the most prevalent diseases in Bolivia occurs through the fecal-oral route. Thus, the safe disposal of human and animal wastes and improved personal hygiene could essentially eliminate these diseases. The existence of a piped water system is an important first step in introducing improved personal hygiene in water-scarce areas. Use of a good source of supply, or treatment of a contaminated supply can prevent direct transmission if users are educated in personal hygiene and understand how to prevent contamination between the tap and actual use. Control of excreta (both animal and human) prevents it from entering the water supply in the first place -- thus reducing the incidence of waterborne diseases.

The four departments of Bolivia in which the CARE project operated are areas of uncontrolled, random excreta disposal practices. Although the overall population density is low, animal and human excreta are a source of contamination in rivers and other water sources. In some areas population density is increasing dramatically as people move to be close to schools or other services. Without attention to water use and sanitation practices and the safe disposal of wastes, a piped water system represents only one opportunity to affect disease transmission; in conjunction with one or both of the other components a very effective program of disease prevention can be created.

Discussions with CARE departmental engineers revealed that no sanitation component had been initiated with project funds. The reason given was that the rural people preferred open air defecation and did not want latrines. Examples were given of latrines constructed by other programs which were improperly maintained or used for other purposes. Those who plan and implement CARE projects equated sanitation with latrines and showed a lack of knowledge of potential types of intervention to improve sanitation and waste disposal practices. There is no indication that CARE ever intended to carry out a sanitation component and it is unclear why sanitation was included as an objective. Some community water survey forms included a question on the presence of latrines and described general sanitary conditions.

There were a few latrines in almost all the villages visited by the WASH team. Most of these had been constructed by the people themselves; one village was served under a program by the Department of Environmental Sanitation (DSA). Some were clean, others (particularly those sponsored by DSA) were exceptionally dirty, and some were in disuse or had been put to another purpose. In discussions with water committee members and the community at large it was found that, without exception, the CARE promoters had not asked if the community would be interested in having either a latrine program or education on how to use the water system to help improve health conditions. In all communities but two, those people without latrines defecated in the open. When asked, water committee members and others indicated an interest in material assistance so they could construct latrines. The preference was for household rather than public units. People stated that latrines were desirable because they were better for health and there was some indication among community leaders of knowledge on the subject. Respondents were primarily individuals who had broader experience than the rest of the community. One community had formally requested a latrine program from CARE and had been waiting for a response for two years.

General conditions in the villages and of the people did not clearly indicate that the existence of piped water had affected personal hygiene. However, no consistent comparison was made between villages with and without water. Most people did not know that they should wash their hands after defecation or before food preparation.

One impact of the project was the failure to provide drainage for wastewater. Since the connections were in the yard the water collected at the base of the tap creating unsanitary conditions where animals and children had access.

5.4 Materials and Methods of Construction

In general, WASH found the materials used by CARE and the methods of construction to be acceptable. Typically, CARE uses slip-joint PVC for pipe greater than 1 1/2 inches in diameter, and solvent welded PVC for pipe 1 1/2 inches in diameter and smaller. Most PVC pipe used by CARE is imported -- locally made pipe is available but costs from three to four times as much as imported pipe. PVC pipe is specified as Schedule 40, SDR 21, and meeting ASTM 2241. The latest (1985) shipment of PVC pipe was supplied by National Pipe of Vestal, New York.

For pump discharge and suction piping, CARE uses imported galvanized steel pipe. This pipe is also sometimes used where additional pipe protection is required (i.e., suspended river crossings and shallow quebrada crossings).

Shut-off valves that are used in valve chambers to isolate sections of the distribution system and as curb stops for service connections, are all imported, bronze-bodied, globe valves. According to CARE good quality valves are not available locally. The latest (1985) shipment of valves was supplied by NIBCO of Elkhart, Indiana.

The WASH team also reviewed the construction criteria for depth of pipe burial, pipe bedding material, and service connections. These were found to be acceptable.

Although the materials and methods of construction were found to be generally acceptable, the WASH team noted a number of areas where improvements are needed. These areas are listed below in the recommendations at the end of the chapter.

5.5 Construction Management

One of the most notable aspects of the CARE potable water and small scale irrigation program was the speed with which the projects in the 126 communities were constructed. Typically, it took only two to three months for a community to construct its water or irrigation system. This success can be attributed to

- good scheduling;
- the nearly constant pressure of a CARE or DDC employee at the site during the construction phase;
- the high level of community motivation that CARE generated during the project promotion phase; and
- decentralized (on a departmental level) storage and control of construction materials.

CARE's success in project construction is even more remarkable given the reduced level of DDC participation in the program. Note also that much of the time the DDCs could not fulfill their commitment to deliver construction materials to the project site. Generally, the communities made arrangements themselves to either collect and transport or have the materials delivered from the regional warehouses to the project sites. CARE also generally did a good job of obtaining and distributing construction materials.

Imported materials were delivered by truck from Chile to the warehouse in La Paz. From there, materials were distributed to the regional warehouses. At each regional warehouse, material disbursements were signed by CARE (when disbursed) by the DDC (when transported) and by the community (when received). No major problems were reported in the acquisition and disbursement of materials. A few relatively minor problems are noted below.

Although the construction of the water and irrigation systems was a successful program, the WASH team made the following observations concerning construction management.

1. Field Supervision. Although a representative (generally a plumber or masonry worker) of either CARE or the DDCs was present during most of the construction period in each community, WASH noted the following construction problems.

   - In a number of instances (when open excavations were present) pipes were buried only .30 to .50 meters instead of the standard 1 meter depth. These shallow pipes may be subject to freezing or damage from vehicle traffic.

   - In several instances service lines had been installed using vertical connections instead of horizontal ones. The connections should be horizontal to prevent damage from traffic loads.

   - In many instances valves were installed without unions or in valve pits without adequate clearance to be removed (without cutting the pipe). These cases are in addition to examples in which these items were not considered during design.

   - In many cases valve pits were allowed to fill with water, causing premature rusting of the pipes.

   - There was no indication that PVC pipe had been stored at construction sites out of the direct sun -- where it is subject to deterioration.

   - There was no indication that water systems had been chlorinated and thoroughly flushed after construction. As many water service connections as possible should be made to the water system before the final chlorination and flushing take place. This procedure will help reduce the number of water system shutdowns that are later required for service line installations.

   - In Bajaderia (Department of La Paz) the community lacked a sufficient supply of glue for pipe jointing (a single one-pint can was provided). As a result, after only a few months of operation, the community has had more than 40 water system leaks.

   - In Carvajal a pump suction pipe and in San Antonio de Chaupillajta (Department of Chuquisaca) a pipe line were poorly installed. The pipes were structurally unsound (supported on sticks) and subject to failure at any time. The failure of these pipes would cause the unnecessary shutdown of the entire water system.

   WASH believes that additional training of field construction supervisors is needed to ensure that they recognize the importance of adhering to project plans and construction details and understand when field modifications are appropriate.

2. Materials Storage. The WASH team visited two of the four regional warehouses. The team's findings are listed below.

   a. Chuquisaca (in Sucre)

      - The warehouse and materials yard were well organized and materials were kept in excellent condition.

      - Inventory control appeared to be easily accomplished because of the organization.

      - Only two areas of improvement were noted: to keep the chlorine storage room well ventilated; and, to keep all PVC pipe protected from exposure to direct sunlight.

   b. Potosi

      - The warehouse and materials lacked any system of organization. Pipe materials were strewn about an abandoned building--which at least provided security.

      - Inventory control is only possible through a great effort and pipe materials are subject to damage because of the way they are stocked.

3. Materials for Service Connections. The only materials supply problem discovered by WASH was in the availability of faucets, standposts, and service pipe for the installation of individual patio connections. In theory, these items were to be purchased from CARE by the homeowner from CARE while the water system was being constructed. The cost of the connection was also supposed to cover all of the service line pipe.

   In practice, these materials were not always available. In addition, the amount of pipe needed to make a service connection was often more than CARE would provide. As a result system coverage is less than it would have been had materials been available and some homeowners are dissatisfied because they contributed to the construction program but cannot yet get water service

5.6 Economic and Financial Considerations

Financial and technical resources at the community, national, and international levels are insufficient to meet the basic needs for water and sanitation in Bolivia. Since it is impossible to meet the needs of over three million rural people without access to these basic services, it is critical that available resources be allocated to achieve the greatest effect when measured against the desired objective. In other words, failing to consider the relative cost of service to similar communities or selecting one technical alternative and not another has a social impact.

Cost considerations are particularly important in the CARE project in two areas: coverage (the number of people who will benefit) and system viability (the long-term operation of the system to provide benefits). Economic and financial factors should be considered when water systems are designed so that both quantity and quality objectives can be met.

A cost analysis is relevant to the CARE project in the following ways:

- comparative cost of materials and technologies,
- capital versus operation and maintenance costs,
- economies of scale -- service to two small communities versus one large one,
- incremental cost of service-area expansion,
- level of service,
- the ability and willingness to pay,
- the cost of operation and maintenance, and
- the cost of related activities.

Decisions made by CARE in planning the rural water systems and results observed in the field show the effect of these factors.

CARE does not specifically look at cost considerations as part of its selection of communities. However, some decisions are influenced by cost, and CARE engineers try to make each project component cost effective. CARE also gives priority to communities which have a compact development pattern to reduce the cost of distribution. A number of cost factors are discussed below, the the results of CARE decisions related to them is examined.

1. <u>Comparative cost of materials and technologies</u>: Unless cost is considered projects can be designed which are more costly than necessary, and money is diverted away from use in the construction of other systems. The WASH consultants found that CARE engineers consciously tried to design using inexpensive materials and equipment which would perform as required. In some cases false economies were achieved and decisions affected the operation of the system. In the choice of technical alternatives, CARE has a definite policy of selecting gravity systems when possible. Although the construction cost is not always the lowest, the costs of operation and maintenance are lower than pumped projects and fewer skills are needed.

2. <u>Capital versus operation and maintenance costs</u>: Although CARE considers the difference in costs between gravity and pumped projects, it is not consistent in its approach. For example, in the choice between an electric pump and a diesel pump, if a transformer is required for installation of the electric pump, a diesel pump is chosen even though the costs of its operation are much higher. In principle the high capital and low operating costs of the electric pump should be compared against the low capital cost and high operating cost of the diesel pump to see which has the lower economic cost over the life of the project. But on rural water projects where the capital cost is supplied as a grant and the operation and maintenance costs must be generated by the community, the best practice is to choose the alternative which places the least annual cost burden on the

community. Otherwise the project will not be maintained and the benefits of the investment will be lost.

An example of this was seen in Carvajal which had a diesel pump and was collecting money to run it. The community limited the number of hours it ran the pump, trying to save money on fuel and hoping to extend the life of the equipment. (See item 6 below). The result was a system operated in a way which limited the supply of water and its benefits.

3. Economies of scale: CARE has tended to select smaller communities or parts of communities in order to minimize the total costs of service. However, the larger the source works, transmission, storage and distribution works, the lower the cost of serving each additional person. This is demonstrated in the example below for a Latin American project similar to this one. Its purpose was to serve 90 villages with 50 to 100 lpcd based on the development of a gravity system fed from streams and springs and using house connections.

Village Size	Cost (US $)
100 - 200	137
201 - 400	93
401 - 600	79
601 - 1,000	58
1,001 - 2,000	43

In addition to the savings shown for increased populations, the demands for promotion, transport, design, and administration would be reduced if, for example, one larger community of 600 was served in place of two communities of 300 each. Furthermore, the operation and maintenance cost per household would be lower, providing the greatest benefit to the lowest income group while broadening the financial base to ensure system viability.

4. Incremental cost of service area expansion: In some cases CARE engineers did not extend service to all of the community because the length of distribution pipe exceeded what was the estimated average for all systems. It is possible that an analysis of the incremental cost of the distribution pipe needed to include another five or fifteen houses is quite low, particularly since the other parts of the system have already been designed by CARE to accommodate this type of future expansion when the source is adequate. While it is true that the community could also extend the system itself, as envisioned by CARE, the technical skill is clearly lacking to accomplish this correctly. Cases where it had been attempted proved this. The number of systems which needed expansion was so significant that extending service in even one-fourth of them would have been equivalent to building a new system in a new community, but the extensions would have cost much less.

5. Level of service: Patio connections cost more than public taps because patio-connection systems must be designed to meet a higher demand. They also have a higher cost of distribution which is paid for by the household. CARE has selected this level of service for the communities

because it is easier to collect fees and control the condition of taps belonging to households.

While the community is expected to contribute the equivalent of about 30 percent of the project construction cost and all of the operation and maintenance costs, CARE does not provide an opportunity for the community to make a choice between alternatives with different costs. For example, given the choice between a combined system with public taps and patio connections, some households might prefer to initially use a public tap, sharing the cost of the tap with four or five other families and improving their condition in increments suited to their future ability to pay. If different levels of service were provided, the community could decide whether the added convenience of a patio connection was worth the necessary diversion of capital from another use such as the purchase of tools for system maintenance or seeds to plant as part of a CARE irrigation project.

6. Ability and willingness to pay: CARE does not try to evaluate the ability or willingness to pay of the community, assuming that all can afford to contribute the funds and purchase the connections. Since an average of 30 to 35 percent of the households are not served by the water systems, it is evident that a significant percentage either lack the ability or willingness to pay for the service. A major challenge of social programs designed to meet basic needs is to provide the service for a price high enough to create a commitment and sustain the system but low enough to get people to use it so that benefits can be derived. By isolating the households that do not initially join the system the opportunity is lost to influence and help them.

7. Cost of operation and maintenance: The ability to pay the costs of operation and maintenance is essential to the continued viability of the system. In planning the CARE projects, neither the ability to pay nor the costs to be covered were determined. These amounts should be matched in much the same way as engineers would match the available water supply with the expected water demand before designing the system. If the monthly costs of system maintenance and the ability of the community to meet them had been estimated, it is probable that the community with the diesel pump alternative would have been given the electric pump instead. The communities made a serious commitment to collect funds and operate and maintain the systems, but in most cases it was made with no awareness of the costs involved. Knowledge at the planning stage that there is a gap between system requirements and the ability to meet them does not mean that a project cannot be built. Instead the design, the service level can be re-evaluated or ways to increase the income of the community can be found. Once a system is designed and constructed it is difficult to make adjustments.

8. Cost of related activities: It is CARE policy to use the water supply system as the first step in other community development activities such as irrigated agriculture. CARE intends to implement such programs in the communities covered by the project under discussion here. In each of these intended programs CARE expects that the communities will contribute labor and materials and will pay monthly charges to maintain the service. In irrigation projects other costs will also devolve to the farmer as

necessary inputs (seeds, equipment) to increase agriculture production. Will the communities with water systems be in a position to absorb additional costs of investment and operation and maintenance of the new irrigation system? Will this affect their ability to maintain the water system? Without an assessment of household income and of the combined costs of CARE projects, the financial feasibility and long-term viability of each project remains in doubt.

5.7 Recommendations

Program Status

1. Of the 126 communities in the program only 60 (less than half) were supervised by the DDCs. Future projects should base an estimate of the DDC's capability on the actual resources and number of successful projects supervised by each DDC. Capabilities vary from department to department.

Water and Irrigation System Design

1. Inadequate attention was given to the analysis of water quality during the design stage. Analyses should include physical-chemical tests and bacteriological tests. Physical-chemical tests can be performed using available laboratory facilities (in each department) or field test kits (CARE now has these kits). Bacteriological testing is more difficult and should be done at a local laboratory. Some training and funding support may be required to enable the existing labs to do the number of bacteriological tests that would be required.

2. About half of the communities that were visited did not have enough water to meet the communities' water supply needs because of the manner in which water supply source measurements were taken and because of errors in design decisions. Better training and supervision of the CARE and DDC engineers is needed to correct existing deficiencies and to avoid similar problems in other projects.

   Within the guidance of the staff hydrologist or a consultant hydrologist CARE should develop guidelines that will allow:

   - correct identification of spring versus river infiltration supplies,
   - a plan for taking source measurements during drier seasons, and
   - development of a hydrologic method that will permit adjustment of flow measurements for time of year, type of source, recent rainfall history, and a factor of safety.

3. A number of system design features should be corrected and considered in future designs:

   - Break Pressure Tanks. Increase volume to decrease the frequency of overflows; install overflow outlet and pipe to discharge overflows; and install regulating valves (manual) on inlet pipe.

- Storage Tanks. Provide reinforcing in the bottom slab of all concrete storage tanks. Although these tanks can be designed (under good soil conditions) without reinforcing, it is not recommended because of the lack of control over construction quality (construction is by the community).

- Pump Selection. Review pump selection procedures. The 5 lps pumps for Carvajal and Vila Vila (Department of Chuquisaca) are too large and require an excessive number of daily uses. Pumps should be better matched to the community's water demand and storage tank size. Also review the recurrent costs of electric versus gasoline- or diesel-driven pump motors. Where electricity is available, the electric motor may be less expensive for the community to operate. Disadvantages of electric pumps are a higher installation cost for CARE and more difficulty for the community to estimate its daily pumping cost.

- System Valves. Provide enough valves in the water distribution system for repair or service connections. Two or three valves is not enough -- even though this limits valve maintenance. Also provide a means (at low spots) to flush the water system.

- Splash Tanks. Provide details of splash tanks (to be constructed by individuals) at the base of each standpost. The cement for these tanks should also be provided as a part of the CARE contribution.

- Structure Openings. All concrete structures (intakes, storage tanks, etc.) should have concrete or metal lids that are light enough to be moved by, at most, two or three persons. Lids are to be secured by a chain and lock.

- Valve Chambers. Valve chambers should have drainage so that leakage or other water drains from the chamber. Many of the chambers seen by WASH were full of water and valves were already starting to rust.

- Valve Removal. Provide unions at all valves so that they can be removed for repair without cutting the pipe. Also allow sufficient room on the side of and below a valve to permit maintenance or removal.

- Curb Stop Boxes. Valves (curb stops) are provided at each service connection. Provide a detail to be used by individuals to construct a box (small chamber) to protect these valves.

- Thrust Protection. No evidence was seen of any consideration of thrust protection for pipes. CARE and the DDCs should review their standard practice and ensure that steps are taken to prevent pipe movement once it is installed.

4. Corrections to and rehabilitation of existing water system design problems should be completed. Specific steps are as follows:

- review water supply measurements and demand calculations for each water system-to determine adequacy of supply,

- develop additional water supply sources (where required and where available) to meet projected demands,

- work with communities to optimize daily pumping schedules (where storage is undersized and/or pumps are over sized, consideration should be given to either adding additional storage or to reducing the pump capacity),

- make corrections to existing systems to provide adequate source protection, valve protection, and valve pit drainage, and an adequate number of valves in the system to facilitate shut downs and repairs, and

- provide communities with a sample sketch and cement to construct splash tanks at each standpost.

The design of future intake structures should include a V-notch or rectangular weir for use in flow measurements. The community water system caretaker would be responsible for taking measurements (height of water above the weir) once a month. This data would provide a continuous record of the monthly fluctuations in source flow at little additional project cost. The data would also be useful in designing systems with similar source and watershed characteristics.

Sanitation System Design

1. CARE staff should be educated in the relationship of water supply, waste disposal and human health to better appreciate the need for complementary inputs for water system effectiveness.

2. CARE engineers should receive training in the design of low cost sanitation alternatives. The training should focus on factors which influence the acceptability of sanitation systems by users: an appropriate design, proper location, etc. Examples of "traditional" cultures who have changed from open field defecation to acceptance of other methods should be included.

3. CARE should have the assistance of a social scientist to design and conduct surveys for water supply and sanitation projects.

4. A pilot project for the implementation of a low-cost sanitation program should be designed with technical assistance from social scientists and engineers with expertise in the field. Consideration should be given to implementing it first through the water committee members in representative communities in each of the four departments. Rehabilitation of existing latrines should be undertaken where possible, if an appropriate design can be identified.

5. Designs for drainage tanks and assistance in construction (if needed) should be provided to communities which have CARE water systems.*

*CARE department engineers have agreed to implement.

6. Pre-design studies for future water projects and in health education programs should include surveys of defecation habits and should place greater emphasis on diarrheal prevention through control and handling of excreta.

7. Where an adequate source of water exists, water systems should consider the potential for water-using sanitation facilities (pour flush) and should design for the higher demand.

Materials and Methods of Construction

1. A number of improvements in materials and methods of construction should be made and considered in the future.

   - Valve Protection and Support. A number of cases were found where schedule 40 PVC pipe was threaded and connected to shut-off valves. Schedule 40 PVC does not have sufficient wall thickness to be threaded (leakage was common) or to support valves. Where threaded connections are to be made, schedule 80 PVC or galvanized pipe should be used. Shut-off valves that are located on service lines should be placed in concrete boxes for protection. No bronze bodied globe valves should be direct buried.

     Where bronze bodied gate valves are used with galvanized pipe, there is a possibility of creating a corrosion cell (because of the dissimilar metals). Therefore, insulating tape or an anti-corrosive paint (available and in use in Bolivia) should be used on the pipe threads to prevent corrosion.

   - Suspended Pipe. All suspended pipe (i.e., for stream or river crossings) should be galvanized steel pipe. PVC pipe is not acceptable. In San Antonio de Chaupillajta (Department of Chuquisaca) unsupported 6-inch diameter PVC irrigation pipe was used to span a river crossing. It was not structurally sound, and the exposed PVC pipe is subject to degradation by the sunlight.

   - Shallow Quebrada Crossings. Where possible, pipe that is crossing areas subject to scouring should be buried at least 1 meter deep. In areas of high velocity erosion (steep channels) additional rip-rap protection and cement may also be required.

   - Wall Penetrations. Where pipes pass through water tank or valve chamber walls that are subject to leakage, water stops should be installed between the pipe and the wall. In discussions with CARE engineers in La Paz it was determined that water stops are generally not available. However, the use of rubber gasketed, steel service clamps would be an acceptable alternative.

   - Drainage. Drainage ditches and/or buried drains should be provided where required, to prevent the accumulation of water around structures, particularly valve chambers -- which may leak and cause rusting of the valves and piping.

- Ventilation Pipe. All vent pipes on storage tanks should be galvanized steel instead of PVC. Vent openings should be screened to prevent the entry of insects.

- Overflow Pipes. All overflow pipes on storage tanks should be galvanized steel where exposed. The pipe should be extended far enough from the structure to prevent the accumulation of water in the valve chamber.

Construction Management

1. In the communities that were visited, a number of problems were noted that are related to construction supervision. Field construction supervisors should receive additional training to ensure that they recognize the importance of adhering to project plans and construction details and understand when field modifications are appropriate.

Economic and Financial Considerations

1. When more than one alternative exists to provide water (source, distribution, level of service) CARE should evaluate the costs of the alternatives compared with the number of people who will benefit.

2. Different levels of service and their associated costs should be considered and presented to the community for discussion to determine the willingness of the community to pay more to receive the additional benefits.

3. CARE should try to assess the ability of users to pay, and should develop operation and maintenance cost estimates to evaluate the potential of the community to sustain them.

4. When there is a choice between a low capital cost and a low operation and maintenance cost, the alternative with the lower operation and maintenance cost should generally be chosen.

5. CARE engineers should avoid trying to design systems which meet "model" project criteria. Instead a combination of cost effective designs, constructed, will form the basis for the next set of "model" projects and more realistic cost proposals.

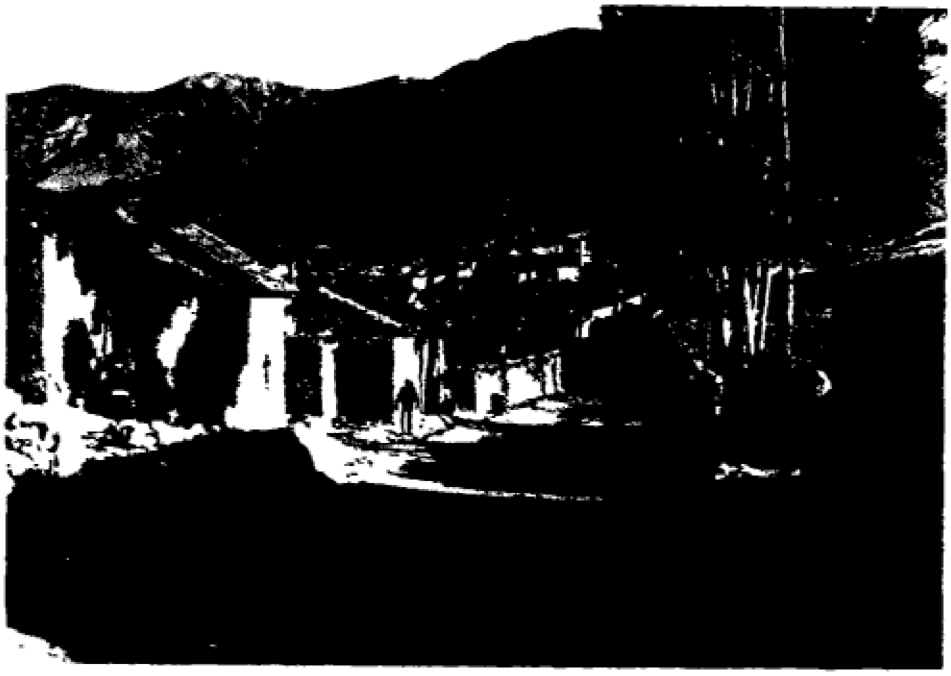


Photo 1. Typical CARE community - Vila Vila, Chuquisaca

Photo 2. Community meeting in school house, Carvajal, Chuquisaca

Photo 3. Typical water distribution system storage tank.

Photo 4. Well and unstable suction pipe, Carvajal, Chuquisaca.

Photo 5. Broken pipe that is too shallow.

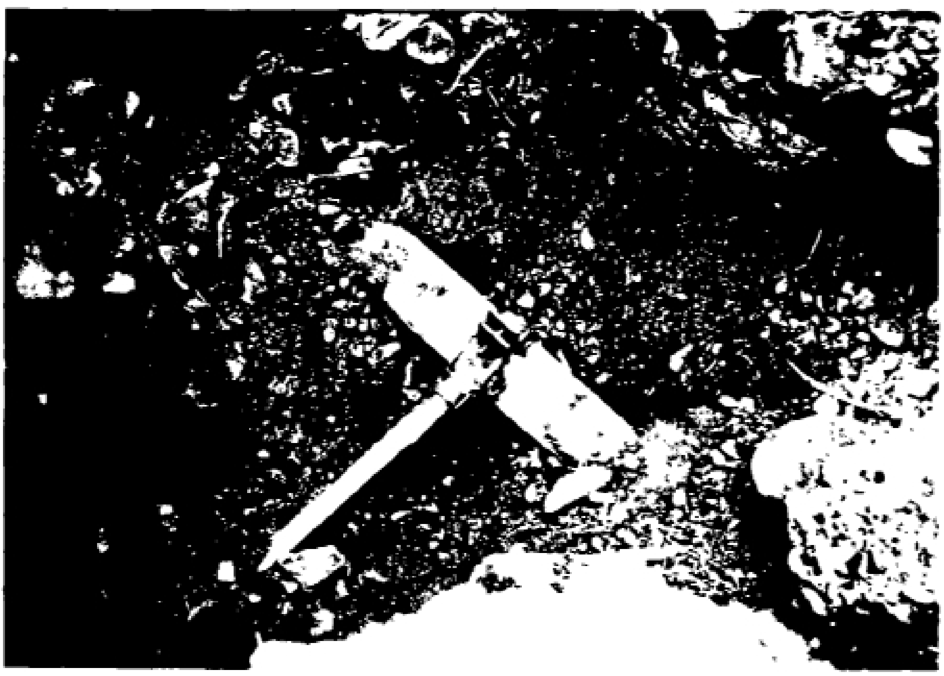


Photo 6. Standard water service connection.

Photo 7. Intake structure subject to flooding and mud-slides, Copacabana, Oruro

Photo 8. Spring intake subject to surface contamination, Pongo, Oruro.

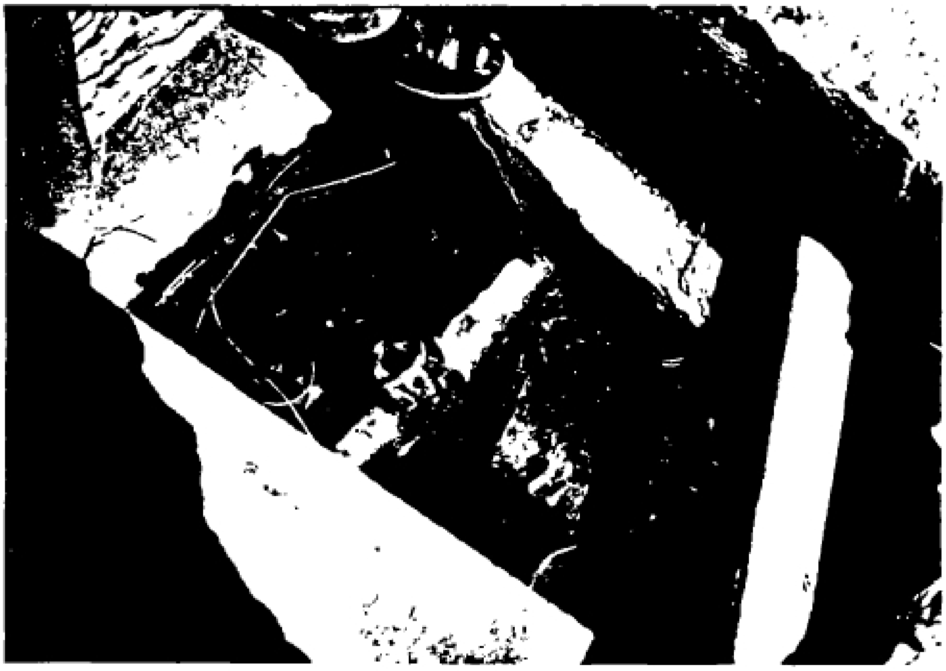


Photo 9. Flooded chamber with valve removed, Copacabana, Oruro.

Photo 10. Flooded valve chamber, Vila Vila, Chuquisaca.

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Photo 11. Pipe folded to reduce leakage, Copacabana, Oruro.

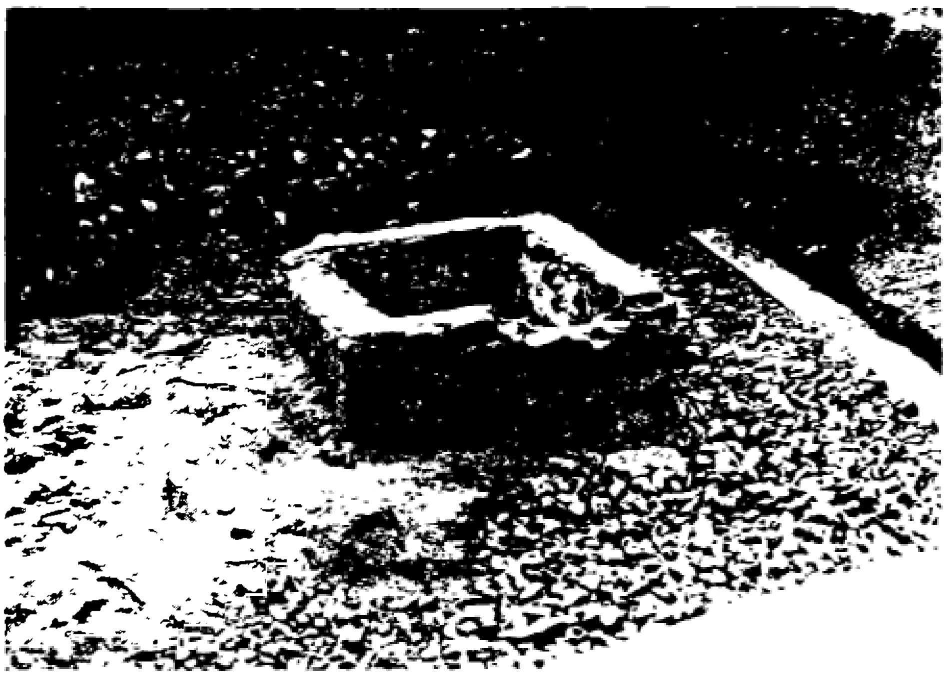

Photo 12. Abandoned well next to spring intake, Vila Vila, Chuquisaca.

Photo 13. Typical standpost without splash tank or drainage.

Photo 14. Well constructed splash tank and drainage.

Photo 15. Pump installation, Carvajal, Chuquisaca.

Photo 16. Unstable PVC pipe crossing, San Antonio de Chaupilljata, Chuquisaca.

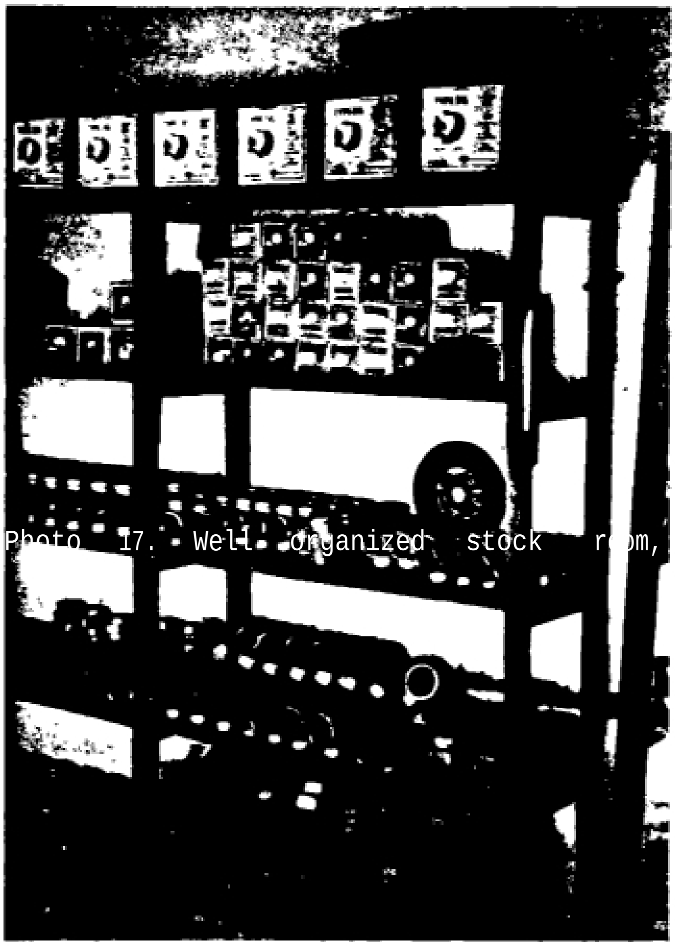

Photo 17. Well organized stock room, Sucre, Chuquisaca.

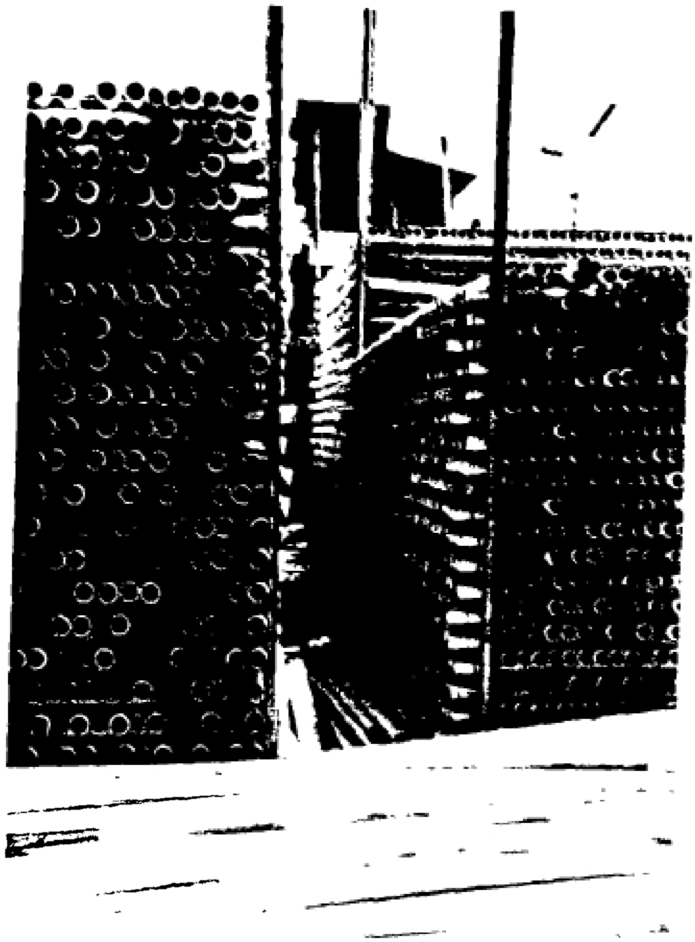

Photo 18. Well organized PVC pipe but exposed to sun, Sucre, Chuquisaca.

Photo 19. Headwall of infiltration gallery
Suanaca/Jachisivi, La Paz

Chapter 6

SYSTEM OPERATION AND MAINTENANCE

6.1 Introduction

Operation and maintenance programs are the most difficult and important component of rural water projects. Such projects traditionally are difficult for governments to serve: they are dispersed and small, and they serve populations in terrain to which there is no easy access. They also have less chance of generating any revenue from service charges. Yet a water system which does not function provides no benefit.

The elements of a successful operation and maintenance program are

- an appropriate design, both in terms of simplicity and cost;
- adequate construction quality;
- a high priority for the water on the part of the community;
- a sense of responsibility within the community to maintain the system;
- trained operators and maintenance staff;
- a population which is generally familiar with the needs of the system;
- a community set of tools, materials, and spare parts;
- the ability of the community to collect enough money on a regular basis to care for the system;
- a regional support system when major repairs are necessary; and
- adequate transportation for regional technicians and community operators.

Previous sections of this report have discussed design, construction quality, and community motivation. This chapter discusses the current operational status of the water systems and the factors that indicate whether or not the systems can be expected to continue functioning over the years.

6.2 Operational Status

In general, the community water systems that were visited during the evaluation had been in operation for no more than of 18 months and an average of about 2 to 4 months. Systems that are so new should be in good condition. When they are not, the problem may be due to errors in design, selection of material, construction practices, or the system maintenance procedures. The following section discusses only those problems that are related to system maintenance. The other elements were discussed in Chapter 5.

6.2.1 Water Quantity and Quality

As discussed in Chapter 5, many of the water systems that were visited (about half) had water shortages. However, most of the problems were due to errors in source measurement procedures or to design errors. The only two cases of water shortages that were also related to operation and maintenance practices were in Carvajal and Vila Vila (Department of Chuquisaca) -- both have pump systems. In both communities, design problems were compounded by a lack of understanding of pump operation. With a better understanding of the system, and a clear set of procedures, the magnitude of the water shortages in these communities could be reduced.

No water quality analyses, particularly bacteriological tests, were carried out during the design stage for most of the water systems that were visited, there are no baseline records for a comparison of present or future water quality. In addition, there are no plans to institute periodic water quality testing of the systems.

To the extent possible, the communities have attempted to maintain good water quality by periodic cleaning of the intakes and storage tanks. In most communities this was done every few months or more frequently.

To maintain the quality of water in the distribution system, the lines should be flushed every six months to a year. In addition, when repairs are made to the system, it should be flushed and chlorinated. The evaluation team saw no evidence that the communities were familiar with these procedures. They are also inhibited by the lack of an adequate number of shut off and flushing valves in most systems (as previously discussed).

No systems were visited that used chlorination as a treatment process. Therefore, no evaluation of community chlorination practices was made.

6.2.2 System Reliability

One indicator of system reliability is the number of leaks that have occurred and the speed with which they are repaired. WASH found that there is not an excessive amount of leakage in the water systems. However, most of the systems have one or more leaks that have not been repaired for many months. WASH believes that although the system caretakers have received training, they are not well versed in the repair of systems that are under pressure. Training should include hands on experience in realistic pipe repair procedures.

6.2.3 System Logistics and Practices

Since few of the communities visited had vehicles of any kind, it is time-consuming to inspect the intake (often one to two kilometers away), transmission system, and storage tanks and difficult to transport repair materials. However, communities do their best to inspect their systems at least once a month.

Inspection of the water system components is hampered in some cases by heavy hatch covers. They should be designed to be lifted by two or at most three persons. Several that were seen by the evaluation team required more than three persons to lift and one required six people. Heavy access hatches discourage periodic inspections.

Although, most of the communities in the program have had one or two members trained by FOMO, almost without exception the communities visited by the WASH consultants had neither the tools nor the materials to make water system repairs. WASH believes that the lack of materials and supplies is due principally to the lack of a clear plan for the communities to follow including practical guidelines for setting and collecting fees (discussed in the next section). The communities do not know what should be purchased for emergency repairs, what supplies and materials should be kept in inventory, or where the purchases should be made. When repair materials are needed, the communities (most don't have vehicles) try to collect some money from the system members and send the caretakers to look for transportation to the nearest urban center.

The lack of a plan is even more critical for communities that have pump systems. The pumps are imported from Brazil and through Santa Cruz. No replacement parts or pumps are available except by order through Santa Cruz. Without planning for repair and replacement parts it is certain that these communities will suffer through periods without water as repairs care being made.

There are currently no preventive maintenance schedules for valves and pumps. Pumps are field repaired on an "as needed" basis. Valves are not exercised periodically. When they have to be replaced, it will be time consuming and difficult if there are no unions or where working space is not adequate.

There are currently no maintenance logs or records for any of the equipment in the water system.

Even though the systems are newly constructed, few of them still have copies of the drawings which show the locations of pipes and valves in the system. In addition, none of the communities keep any records of the leaks that are found in the water system. Updated, accurate maps and good records are vital to good system operation.

6.2.4 System Sanitation

Lack of a 24-hour water supply in some communities poses a hazard because of the possibility of contamination entering the water system. In these cases, the community should be especially careful not to locate latrines or animal pens near the water system piping. Hoses that are connected to a spigot and left in a tank or pool of water are also a hazard. When the water system is emptying, backsiphonage can draw contaminated water through the hose and into the system. The communities should be made aware of these hazards.

As discussed in Chapter 5, the protection of the water supply source is critical, especially when no disinfection system is used. The evaluation team found that most communities are unaware of the need to protect their sources. As a result, animal defecation on and near intake chambers was common. The communities should be made aware of the need to provide source protection.

Additional community education is also needed to promote good sanitation practices around patio connection standposts. This includes encouraging homeowners to construct and maintain splash tanks at the foot of each standpost and to keep areas around the standposts clean and free of animal and human defecation.

6.3 Organizational Infrastructure

Often times, especially in systems that have been recently constructed, a visual inspection does not provide a good indication of the long-term effect of certain operation and maintenance practices on the community system. Better indicators are the institutional capabilities and practices that have been established. These are discussed in the following sections.

CARE's strategy for operation and maintenance is based on the principle that without community commitment and self-reliance the system cannot succeed. The evaluation showed this approach to be well-founded but incomplete.

Prior to its selection, the community must organize a water committee which will be responsible for operation and maintenance. The community must also agree to collect fees and send two individuals to receive training in operation and maintenance from FOMO, a national organization which provides vocational training. The community selection process is completely effective in ensuring that there is a high priority for water; future users must make a major investment and thus feel a sense of ownership and responsibility.

Only those who contribute both labor and financial resources are permitted to become members of the water system. CARE's policy of putting in only patio connections is intended to ensure better maintenance. Community organization of construction teams and the actual construction is meant to encourage the feeling of pride in ownership. In addition, to promote self reliance and responsibility for the system, CARE leaves no tools or materials behind after construction. When construction is finished, CARE leaves. There is no handing over period.

It was the conclusion of the evaluation team that CARE's program to identify, select, and mobilize the resources of motivated communities was extremely successful. The communities were committed to fulfilling their responsibilities. However, CARE's program was unrealistic in its expectation that communities could carry out operations and maintenance responsibilities with the scant knowledge and resources left at their disposal.

6.3.1 Water Committees

The evaluation team found functioning water committees in all but one of the villages it visited. In all of the communities the members of the committee had been elected in a meeting by the members of the system. In most cases those voting included both men and women heads of households; in some it meant only the male heads of households. The committee usually consisted of a president, secretary, treasurer, and two others. Some included a vice president. Women did not serve as officers in any of the committees, but once the question was raised the idea appeared to have support from the men.

Although the evaluation took place during the dry season when many people were away, the water committee meetings were well attended by those present. It was evident that even with the system constructed, the committees and the water system still generated community involvement. In almost all cases the water project had been the first self-help project carried out by the community.

During the committee meetings a number of problems surfaced which demonstrated the strengths and weaknesses of the operation and maintenance component of the CARE project. Many of the problems could be traced back to system planning, design or the supervision and quality of the construction. Even before some systems had been inaugurated it was already apparent that they would not produce water on a 24-hour basis. Members of the community were not able to obtain water when they needed it. Where errors were made in design or construction by engineers and technicians, the committee was left with a system with problems which made it inherently difficult to operate and maintain.

Another serious issue was the lack of access to the system by people who had contributed labor for construction. Told by CARE that it was the community's responsibility to expand the system, the committee either did not know where to turn or in a few cases proceeded to improvise. The very fact that the meetings were being held, the committee's understanding of the problems, and their seriousness in trying to deal with them represents the strength of the CARE program and should not be underestimated. On the other hand, the people and the committees have a lot invested in making the system work. It is important that they be given the essential tools for success.

The weaknesses in the operation and maintenance organization were found in the failure of the committees to handle simple maintenance problems and a lack of understanding of who was responsible when something went wrong. The fact that none of the communities had tools for repairs made responsibility even for minor repairs unclear. The committee members had received no training in management or in specific roles like treasurer. No system had been set up for fee collection or the procurement of spare parts. There was no systematic basis for performing management functions, no clear procedures of how to get help for major problems, and no transport. None of the committees had received health education training, although members of the committees voiced a need for training. Since many of the committees are elected annually the need for continuous training was expected to arise.

6.3.2 Staffing

In order to carry out operation and maintenance, CARE required that each community designate two people, able to read and write, to attend a training course. With the exception of the Department of Oruro, most communities had designated these system caretakers and nearly all those designated had been to the course or were awaiting the next one. In several situations one or both of the operators had sought work elsewhere and were no longer present in the community. For the most part, however, these were temporary migrations to Santa Cruz for the sugar harvest or to the mines in Potosi to supplement annual income during the dry season. The committees were considering ways to keep the system caretakers in the village by not sending young men for training. Other problems encountered by the system caretakers centered on the lack of tools and materials.

Because of the CARE self-help orientation, no staff has been assigned by CARE or the Development Corporations to provide technical assistance in operation and maintenance. CARE has intended that its water promoters be used to supervise operation and maintenance but, while the promoters were found to be good social organizers and hard workers, the evidence during the evaluation was that they were not trained to recognize even the most evident technical problems.

6.3.3 Financing Operation and Maintenance: Household Fees

A key factor in the long-term operation of rural water systems is the availability of spare parts, supplies, and materials to meet annual maintenance requirements. Two potential sources of funds for these items are the government operating budget or fees collected from those who receive the service. These sources can also be combined, with the community contributing what it can and the government subsidizing the rest. It is, however, difficult for rural water systems to compete effectively for government funds, particularly when the number of systems is increasing annually. If community systems in remote areas can be effectively maintained locally, they are more likely to continue functioning over the long term.

Because the ability of most rural communities in Bolivia to pay monthly fees is limited, it is important to design systems with operation and maintenance costs that households can cover. Several decisions at the design stage can influence what the fees will be. The first will be the type of water source development. It is preferable to select the system with lower operation and maintenance costs if there are two alternatives which will produce the desired benefits. The fees should also reflect the benefits and the costs of supply if two or more levels of service are provided. Those with a higher level of service or additional facilities (such as a shower) will use more water and thus be responsible for increased system capacity and therefore should be expected to pay more. Another decision concerns the number of households served by the system. The more households in the system the greater the base will be over which to spread the costs. Since the costs do not increase proportionately, the cost per household will decline.

The costs of fuel or electricity and lubricants for pumps, materials and spare parts, chemicals for treatment, labor (if operators are paid), and transport must be covered.

To be selected communities must promise to institute the collection of fees for operation and maintenance. As soon as the projects are completed, the systems are handed over to the communities who become the owners and operators. CARE engineers and promoters discuss the need to collect fees with the water committees and suggest that a meeting of the members of the system be called to decide how this will be done. In at least one department CARE engineers initially recommended the amount of money which should be collected monthly to cover annual needs. The amount was based on the amortized cost of the system. However, it soon became apparent to CARE that the communities were unable to generate the funds required. Therefore CARE ceased evaluating the operation and maintenance financial requirements and told the committees to collect whatever they could. Another problem reported by CARE in estimating the financial requirements was the instability of the value of the Bolivian peso. The engineers felt that because of inflation it was meaningless to try to estimate future costs.

During the evaluation, it was found that CARE had clearly conveyed the importance of fee collection to all the communities. However, only one-third were actually collecting a fee. These were in the Department of Chuquisaca -- with the exception of one community in the Department of Potosi. The amounts collected varied widely and were based on the joint decision of the member households on what they could afford. Where communities had yet to begin collection, all expressed the intention of doing so and were aware of the commitment they had made. Whether they collected fees or not, none of the communities had purchased a set of tools for use in repairs. The only project-related purchase with monies collected was a wrench in one community.

The primary reason given for not using the collected funds for buying tools was that the people found that they did not have enough money for the tools and that the devaluation of currency had made what they collected insufficient. One community used the funds to buy sugar and laundry soap. CARE and the communities were giving some thought to how the money could be invested as a hedge against loss in value. The lack of goals and the lack of materials, knowledge, and sufficient money to obtain them created the inertia to permit small repair problems to build up and become large ones. In the communities where money had been collected it was clear that people were discouraged over how little it would buy.

Since individual households were able to purchase connections, but the combined households apparently could not afford to purchase a set of tools, it must be concluded that they could pay more but are unwilling or unaware of how much to collect or their resources have been stretched to the limit by the financial requirements to purchase patio connections.

6.3.4 Major Repairs/Departmental Support

Critical to the continued success of project operation is a back-up support system for the community. Periodically, major or extraordinary repairs can be expected which are beyond the skill of village operators. Under the existing project, no procedures were developed to handle these situations, CARE left the committees responsible for their resolution. While reference is made in the contract to periodic visits by CARE and the DDCs to check on operation and maintenance, there is no institutional arrangement or governmental unit to provide this support. Visits to communities left no doubt that there were problems which would arise and no procedure which the committees could follow to obtain assistance.

In recognition of a similar countrywide gap, donors and agencies involved in rural water systems intend to initiate such a support system through the Department of Environmental Sanitation.

6.4 Recommendations

Operational Status

1. CARE should develop written preventive maintenance schedules for each of its communities. These would include maintenance for valves and pumps,

scheduling of cleaning and disinfection of tanks and intakes, and water system flushing.

2. CARE should also instruct communities in procedures for flushing and chlorinating water systems after repairs are made.

3. CARE should work with each community to develop a pumping schedule and procedures to minimize pumping costs and maximize the water supply yield.

4. CARE should take a stronger role in encouraging the community to purchase tools, spare parts, and repair materials.

5. CARE should ensure that physical/chemical water quality analyses and bacteriological tests are done at least once for every water system. While this is hardly sufficient to ensure ongoing water quality, it will at least assure the community that its water system is producing a potable water.

6. Water system caretakers, even those who have received FOMO training, do not have adequate "hands-on" experience to make repairs when the water systems are operating and under pressure. This type of training should be included under future training programs. The community should be required to purchase a set of tools before the operators are trained.

7. To assist the communities in future O&M tasks and to provide a base record for the community's use (i.e., for system expansion), a copy of the water system maps should be left with the communities. They should also be encouraged to keep a running log of repairs and to mark all leaks and repairs on the system maps.

8. Where the water supply is not available 24 hours a day in a community, CARE should instruct the community in the hazards of contamination through infiltration and back-siphonage. The community should be instructed to keep all latrines and animal pens at least ten meters away from distribution system pipes.

9. Additional training for the communities is also needed to encourage them to install splash tanks at patio connections and standposts, and to keep the standpost areas clean.

Infrastructure

Water Committees

1. CARE may wish to experiment with a brief handing-over period during which systemic problems can be identified and CARE will assist in their evaluation, management, and the cost of solving them. During this period responsibility for routine maintenance should remain in community hands.

2. Water committee members should receive training in their various roles. A procedure for handing over the knowledge of the system and of committee responsibilities should be instituted for newly elected members.

3. CARE should work with the water committees to devise a simple written report procedure.

4. The water committee should be provided with a written list of expected materials and equipment needs over the life of the project.

5. A clear procedure on how to handle major repairs should be developed and should include a departmental support system

<u>Staffing</u>

6. Women could be trained in operation and maintenance since they remain in the communities. Initially they could be trained as assistants working with the regular caretakers.

7. CARE should develop a simple diagnostic manual with FOMO and the operators which can be referred to when something goes wrong. This could be used by the caretaker or others in his absence.

8. A plan should be developed for staffing a departmental support unit to provide technical back-up for major repairs. An engineer should be included to assist in system expansion and rehabilitation.

<u>Financing Operation and Maintenance: Household Fees</u>

9. When the system is designed an estimate should be made of expected annual operation and maintenance costs per installed connection (total annual cost per household). The estimate should be based on the flow of replacement parts and supplies which will be consumed depending on the system facilities, length of pipe, materials and equipment.

10. Prior to signing the contract with the community, households committed to purchasing connections should be assessed for their ability to pay the estimated fee. CARE should consider collecting the monthly fee during construction as a condition for community selection. If the cost to maintain the system significantly exceeds the combined household ability to pay, CARE should reassess the project design, investigate the feasibility of increasing the financial base through a two-tier fee structure and two levels of service, or abandon the project.

11. The community should be required to purchase operation and maintenance tools before construction starts.

12. The water committee should receive training in collection, accounting, and the use of maintenance and inventory reporting so it will know when to schedule purchases.

13. When the project is handed over to the community, the committee should be provided with a written schedule of expected material and equipment needs (by year) over the life of the project. The cost of the items should be shown in constant prices with a schedule for annual price checks and appropriate fee increases.

14. Maintenance problems caused by improper design and inadequate construction supervision should not be repaired with community funds but should be the responsibility of the CARE program.

15. CARE should not begin other projects in communities with water systems unless

    - the community has been collecting enough funds to cover water system operation and maintenance,
    - an analysis of the ability to pay for both the monthly charges of water and the intended new charges is carried out by an economist, and
    - water system funds collected are placed in an account separate from other CARE projects.

<u>Major Repairs/Departmental Support</u>

16. Departmental operation and maintenance support units should be establish to supply technical assistance on major repairs, engineering assistance on the rehabilitation and extension of systems, and water quality monitoring.

17. Staff for the units should include an engineer and technicians. The number of technicians should increase and be proportionate to the increase in number and the location of the project communities in the department. Financial support to the units should include transport.

18. The units should maintain a store of specialized tools and materials not on hand in the communities.

19. The role of the units should only be trouble-shooting and specialized technical assistance. They should not be used as a substitute for routine maintenance.

20. The units should be supported by the government budget and service charges to the communities. Financial or material support from CARE is not recommended, although coordination of technical staff activities should be encouraged. External aid from USAID should be directed to the government agency for the purpose of institution-building.

21. The units should have a copy of all the system plans in the department.

Chapter 7

TRAINING

7.1 Introduction

Training can be provided to a wide variety of persons in order to enhance the planning, execution, and impacts of a project. They include

- managers,
- technical personnel (design and construction),
- social promoters/coordinators,
- community water committees and individuals,
- water system caretakers, and
- regional organization and maintenance support groups

In this CARE water supply and small scale irrigation program, only two types of training were required by the CARE/USAID cooperative agreement: training of water system caretakers (operators) and instruction to communities in water management and irrigation systems.

Training of the water system caretakers was implemented essentially as planned by CARE -- except in the Department of Oruro where management and coordination problems left most of the communities without caretaker training. Table 4 summarizes the number of trainees from each department that attended FOMO courses.

Instruction to the communities in water management and irrigation systems was not well planned. There are no course materials available and the training was not sufficient to enable communities and individual farmers to address the complex problems that accompany irrigation projects.

CARE also provided some informal training (by the social promoters) to the water committees.

These training programs are discussed in the following sections of this report.

7.2 Construction

The FOMO courses were based on vocational training programs offered by FOMO. A list of the course topics is shown in Table 5. Although these programs offered some of the basic skills that are required for water system construction, the evaluation team found two basic problems with the courses, scheduling and emphasis.

7.2.1 Course Scheduling

Training of the system caretakers involves mostly construction methods and some operation and maintenance practices. However, the training takes place after the construction is complete. Therefore, the community does not get the

Table 4

Summary of Persons Attending FOMO Training Courses in Each Department

Department	Number of Communities in Program	Maximum Number of Persons To Be Trained (1)	Number of Communities That Received Training	Number of Persons Trained
La Paz	33	66	33	60
Oruro	31	62	N.A. (2)	N.A. (2)
Potosi	27	54	24	39
Chuquisaca	35	70	30	57
Total	126	252	87 (2)	156 (2)

(1) Based on 2 persons per community

(2) Few persons in the Oruro communities received training. However, the actual number was not provided by CARE.

Table 5

List of Topics Covered in FOMO's O&M Training Course

- Operation and maintenance of intakes, tanks, distribution system
- Repairs and cleaning
- Use and handling of galvanized iron and PVC pipes
- Use and handling of plumbing tools
- Operation and maintenance of pumps and motors
- Household water connections
- Principles of cooperatives
- Basic accounting
- Health and nutrition
- Planning of community development

benefits of training during the construction process, and the trainees do not get to practice the skills that they have learned.

Although training before construction for the initial communities in the program may not have been possible (because of the implementation schedule), training for the later communities should have been scheduled prior to or during the construction phase to obtain the benefits mentioned above.

7.2.2 Course Emphasis

The course that was given by FOMO was modified from FOMO's basic vocational course after discussions with and revisions by CARE and the DDCs. However, the courses were still oriented mainly toward vocational skills and not enough emphasis was placed on the construction techniques and repair practices that are needed for rural water supply systems. No sanitation system construction training was given.

The emphasis on vocational training had an unpredictable consequence. Communities found that a number of their system caretakers, after receiving training, left the community to seek employment using their newly acquired vocational skills. In these cases, the caretaker's decision to leave was also influenced by the lack of pay for his duties. Also young, single caretakers were more apt to leave than older, married men with firmer ties to the community.

7.3 Operation and Maintenance

The training provided by FOMO emphasized construction rather than operation and maintenance. Some of the skills for installing valves, cutting and replacing pipe, and basic pump considerations were taught -- but without stressing the difference (through experience) between making repairs on new construction and making repairs on a water system that is leaking and under pressure. As a result, the WASH evaluators found that most of the water systems had long-term leakage (although not yet severe) that was partly due to the community's inability to repair it.

7.4 Water Committees

Water committee training was not provided on a formal basis. Some of the issues that are pertinent to water committee functions (such as record keeping, fee collection, community cooperation) were discussed in the FOMO training courses. However, because the training was not participatory but was in the form of lectures and because many of the caretakers are not members of or leaders of the water committee, little of this type of information was put to practical use.

The reader is referred to Section 6.3.1 for additional discussions of the water committee functions and training needs.

7.5 Health Workers

CARE did not provide any health workers or community health education in conjunction with this project. A few lectures on health and nutrition were given to system operators sent to attend the FOMO course.

CARE intends to use health promoters and village health volunteers in its Child Survival program carried out in selected villages with CARE water supplies.

7.6 Recommendations

Construction

1. Training of system caretakers should be scheduled to take place before or at least during the construction phase of the project. Each trainee should be required to bring the tools that are purchased by the community to the training course. This will enable the trainee to become more familiar with and less reluctant to use his tools.

2. Training courses should be less vocational and more oriented to the needs of a rural water system. Courses should include maintenance assessment (materials and spare parts), preventive maintenance, record-keeping, pump maintenance, and practical repairs.

Operation and Maintenance

1. Training should include hands-on experience in the repair of water systems that are leaking under pressure. This will familiarize the operator with real conditions that he is likely to encounter.

Water Committees

1. Water committees receive only limited assistance and training from CARE. In addition to those needs discussed in Section 6.3.1, water committees should receive:

   - training in management and in specific functions such as simple accounting and operation and maintenance reporting procedures,

   - assistance in establishing a procedure for handing over management knowledge and records to newly elected committee members,

   - training in watershed management, irrigation practices, and agronomy, and

   - health education (see Chapter 8).

Health Workers

2. CARE should increase the beneficial impact of the water system construction program by promoting health education in its upcoming Child Survival Program. Note that CARE has proposed to do this. However, CARE must be sure to

   - place emphasis on changing sanitation and hygiene practices which, at present result in the transmission of disease,

   - use skilled health professionals to train child survival health promoters (who in turn will train village health volunteers),

   - provide training in basic water system operation and maintenance evaluation procedures for health volunteers (if such volunteers are used to increase operation and maintenance effectiveness)

   - take account of the effect compensating village health workers might have on village water operators, who are at present not compensated.

Chapter 8

HEALTH EDUCATION

8.1 Community Health Education

There were no complementary program components, such as health education, in this water supply project. Lack of knowledge by users of the consequences of water utilization habits and sanitation practices greatly limits the magnitude of any health-related benefits a community could derive from its new water system.

None of the communities visited in the evaluation had been asked by the CARE water promoters if they were interested in health education. Many placed a high value on health care, almost always citing a health post as the highest priority for development. Women in the communities did not indicate an understanding of the relationship between water use, sanitation, hygiene, and health. They were clearly unaware of the value of the water system in reducing disease. They were also unaware of how to keep their water uncontaminated.

CARE intends to begin health education programs through its Child Survival Program. The initial focus of this program is oral rehydration treatment, with support for vaccination, family gardens to improve nutrition, and water use education.

There is a serious danger that, amidst these more medically oriented solutions, the enormous value of an effective program of personal hygiene and safe waste disposal in the prevention of diseases like typhoid, or dehydration caused by diarrhea, will be forgotten, just as it was in the water supply project.

8.2 Recommendations

1. It is strongly recommended that future and existing water project communities incorporate water use and health education classes for men and women. This health education program should establish the relationship between water use and sanitation practices and human health. It should include water use for personal hygiene, sanitary waste disposal, the use and abuse of latrines, bathing of children, the handling of food, washing dishes, utensils and clothes, the use of soap, the handling of children's fecal matter.

2. Particularly where part of the population remains unserved or the system does not meet a 24-hour demand, people should be taught the proper storage and transport of water.

3. CARE plans to implement its Child Survival Program in communities where water supplies have been constructed. Communities should be chosen where the water quality of the system has been tested and found to be safe; the system is functioning on a 24-hour basis; water system operation and maintenance funds are being collected; and the community is in possession of tools.

4. The health education program should not be restricted to those households which have purchased a patio connection but should attempt to reach all members of the community.

5. The health education program should be preceded by a survey of household water and sanitation practices.

Chapter 9

PROJECT UTILIZATION

9.1 Community and Household Water Use

Project utilization refers to the number of people who are using the water systems and the amount of water being used. In order for the project to be well utilized, it must be functioning reasonably well and the people must have the desire and understanding to want to use the product it produces.

Within two to three months of the contracted schedule CARE will have completed 126 water systems, of which 109 are for potable water and the rest for irrigation. The estimated population within the communities served by the drinking water systems is 51,300. The evaluation results indicate that coverage is currently between 65 and 70 percent of the total population (51,300) with 30-35,000 people using the systems.

The number of people using the facilities in individual communities visited in the evaluation (a 15 percent sample) varied from 30 to 100 percent depending on the community. The degree of coverage was limited by

- the service area boundary drawn by the design engineers, reflecting the distribution network for patio connections;
- the number of people within the service area who did not join the system by purchasing patio connections and were provided with no alternate service;
- the number of people within the service area who joined the system but were not receiving water because the facilities could not provide it or distribution materials were lacking to complete the network.

Those not included in the system continued to use traditional sources other than those developed by the project.

Of the people within the service area who had joined the system and received their connections, 100 percent used the facilities, subject to service interruptions and inadequate flows.

9.1.1 Water Consumption

The water systems are designed for 60 to 150 lpcd consumption levels. CARE does not expect actual use to reach these levels for a few years. No educational program was incorporated into the project to encourage people to use more water. No estimates were made during the planning stage of the level of pre-project water use. It is also difficult to measure post-project use since taps are in the patio and water is taken directly from them in a variety of containers at all times of day.

According to community interviews held during the evaluation, about one-half of the people served have increased their use of water as a result of the project. The constraint for the remainder was the rationing of water or the regulation of system operation as a result of inadequate flows. The people in areas of inadequate supplies either restrict use, store water in containers, or supplement project water by using pre-project sources. In the last case it is possible that total water consumption has increased by combining project and non-project supplies.

9.1.2 Types of Water Usage

Project water is being used for drinking, bathing, cooking, and, where sufficient supply exists, for washing clothes. Of the communities visited in the evaluation, 20 percent used some water for irrigating small gardens. The cold weather of the altiplano was the reason for not bathing with greater frequency in some communities. All communities were anxious to receive household showers and laundry facilities and additional water for irrigation.

9.2 Household Sanitation Practices

Although sanitation was to be provided in communities receiving water supplies, no program was initiated and no coverage resulted.

Two indirect effects of the new water supplies occurred due to technical problems with the system.

- Wastewater and drainage: No design for drainage was included for the patio connections. As a result, the wastewater collects under the tap. No cases were found where the wastewater was being reused for other planned purposes. It did create unsanitary conditions close to the house and was used by animals and children.

- Water storage: Where systems did not provide 24-hour service, people supplemented their water from local sources and/or stored project water in unsanitary containers.

9.3 Recommendations

1. About one-half of the people served use more water than before the project. The remainder are limited by constraints in operating the system so that it delivers adequate supplies. People would use more if restrictions did not exist. Remedial work should be done on those systems which do not function to produce adequate supplies on a 24-hour basis.

2. An education program should be implemented in all communities with water systems to encourage greater water use and hygiene and to prevent contamination through water storage.

3. Taps should be supplied to schools and clinics, and consideration should be given to the installation of public taps to serve groups of houses with no service.

4. In future projects a water use study should be undertaken to measure pre- and post-project consumption. Representative households or communities should be selected and meters installed.

5. Consideration should be given to the installation of household water using facilities such as showers and wash basins.

Chapter 10

ADMINISTRATION AND MANAGEMENT

10.1 Introduction

The primary objectives of project administration and management are to

- set project goals and objectives,
- establish schedules and project milestones,
- establish a system to provide information on project implementation and performance,
- monitor project implementation against milestones,
- evaluate the quality of project implementation, and
- make necessary changes to ensure that the project objectives are met.

In the CARE water supply and small scale irrigation program, the principal goals and objectives program were established in the cooperative agreement between CARE and USAID. These were discussed in Chapter 1. Additional program objectives were established by CARE.

To meet the program objectives, CARE developed a general implementation plan, a basic management information system, and a coordination policy. Using these plans and systems, CARE had varying degrees of success in achieving the project administration and management objectives listed above. The CARE project implementation plan is discussed in Chapter 3 of this report, the management information system and coordination policies are discussed in this chapter. Also included in this chapter are discussions of CARE's purchasing and disbursement policies and its inventory systems -- these were critical elements in CARE's successful construction management program.

10.2 Management Information System

The collection and evaluation of information on project implementation and performance is necessary to improve present performance and to plan for future projects. Information should be developed on implementation problems, on the effectiveness of activities, and on actual system performance. It can be used to set realistic objectives and design criteria, improve designs, modify the materials used, monitor operations, and plan for new programs and system expansion.

CARE's primary emphasis has been on collecting information and monitoring progress to construct a targeted number of water systems as rapidly as possible. Monitoring the quality of design and construction has been minimal, to some extent affected by an overoptimistic estimation of the DDCs' implementation capacity and an over-extended CARE staff. Inadequate site investigation, design review, and construction supervision will affect the immediate and future performance of installed systems. However. there is no evidence that CARE will consider past experience in new plans and scale back future efforts to permit better quality control. For example, findings in the mid-term evaluation were not used to alter subsequent activities. In fact, the findings of a previous final evaluation of another USAID-financed CARE rural water system project in Bolivia (8-81; project number 511-0479) were ignored by both USAID and CARE in planning and implementing this project. Findings included an over-concentration on construction, weakness of the health component, the tendency to overestimate project costs, and the need for a sanitation program.

CARE has developed forms and reporting procedures for social and technical investigations and progress reports. CARE departmental engineers understand the usefulness of the information and maintain files on each water system constructed. However, the forms are not standardized from department to department, the information is sporadically collected, there is no procedure to inventory project operations, and information gathered is not used for evaluation purposes nor as a planning tool.

Most of the understanding gained by departmental staff during the project results in thoughtful discussion and efforts locally to improve specified aspects of projects. Adjustments to overall schedules are made and construction targets modified. But the lack of a basic monitoring and evaluation process, and the failure to incorporate feedback in the planning process for subsequent projects, make it impossible for these problems to be handled within the larger context where solutions are likely to be found. The reports which reach La Paz tend to cover only water system construction progress and not other project objectives such as sanitation and irrigation.

The following are examples of information which CARE needs to develop to improve project performance.

- Baseline (feasibility) community information necessary to design a viable program -- including water source (quantity and quality), water use (types, quantities, pre- and post-project), sanitation practices, health statistics, ability and willingness to pay for service. With this information it is possible to design systems and activities which fit resources and needs together (treatment for contaminated source, low cost sanitation designs). It is also possible to measure project impacts. Without this information it becomes difficult to design the project with confidence or to assess why things fail to go as planned.

- Implementation monitoring necessary to control the work, plot progress and costs, identify constraints, such as the availability or quality of materials, logistics, supervision, adequacy of design. With this information it is possible to make future schedules more realistic, purchase pipe for additional distribution systems, change storage procedures for PVC pipe, provide training for construction supervision, and modify models used for proposal cost estimating to reflect recent experience.

- Performance monitoring and evaluation necessary to understand the operational status of projects and activities and to find out what the benefits are, what improvements should be made in the existing projects, and how the next plan should be changed to incorporate knowledge.

At present, when CARE goes into a community it works on the basis of assumptions, rather than facts, about the source of water, the habits and preferences of the people, their ability to maintain the system, and how much water they use. On completion of the system, CARE knows little more about these aspects which affect the benefits and viability of the project than it did in the beginning. In fact, even though CARE has now constructed more than 300 rural water systems, it has not changed any of its original assumptions about costs, communities, or institutional capacity to reflect the experience. A simple, effective data collection, monitoring, and evaluation program would continuously improve the basis for assumptions. It would allow CARE to revise its proposals and overall plans using actual experience from the field to determine what changes are needed best to achieve objectives.

10.3 Coordination

Coordination between CARE and other agencies was excellent. The project was administered by the central office of CARE in La Paz and was managed by CARE's general manager. This office provided coordination between the departments to meet overall objectives. However, project implementation was effectively decentralized. The four CARE departmental offices were responsible for their respective programs and for coordination with cooperating agencies within the departments. Cooperating agencies in the program, the DDCs and FOMO, also operate on a decentralized basis. CARE's approach to coordination combines formal agreements and specified responsibilities with informal operating procedures.

Because the CARE departmental offices are accorded a great deal of autonomy, coordination at this level has been effective in the initial definition and agreement on procedures, inputs, responsibilities, and contractual commitments of departmental and community counterparts. Serious difficulties have arisen at various times due to the inability of some of the DDCs to meet their project commitments, particularly in the transport of materials and the contribution of staff. The informal and continuous nature of the coordination between CARE and the DDCs has permitted CARE to find ways to work around the constraints imposed on water project design and construction. In some cases problems were resolved by CARE engineers initiating coordination between other agencies such as DSA and DDC.

Coordination with FOMO appears to have been good, with CARE providing direction on the training needs and FOMO and CARE bringing together individuals from other agencies to supplement the coursework.

The central office and the departmental offices worked together to transfer needed materials and skills from one area to another to remove bottlenecks.

Coordination with the communities was effective in maintaining work schedules and generating community inputs.

On the whole, continuous communication between the major parties in the project was central to CARE's success in the completion of water systems.

The CARE program would have been more effective if it had been possible to develop relations with additional agencies to achieve the broader program objectives of sanitation and irrigation. When the DDCs did not fulfill their responsibilities for latrine construction and irrigation management, CARE, lacking experience in both areas, was unable to use its own staff to meet project objectives.

10.4 Purchasing and Disbursements

The timely purchase of construction materials and the disbursement of these materials to the regional warehouses and construction sites were critical to the completion of the construction program on time.

The WASH evaluators found that purchasing and disbursement plans were followed as CARE intended -- the only exceptions were in the purchase of patio connection materials and in the disbursement of materials to communities.

10.4.1 Purchase of Patio Connection Materials

An adequate quantity of faucets and pipe materials for standposts has not been available to the communities. As a result, communities have not been able to complete connections to the water systems. This has created dissatisfaction within some communities because homeowners who contributed to the project cannot take advantage of the water supply that is available.

10.4.2 Disbursement of Materials to Communities

Under the original implementation plan, the responsibility for disbursement of materials to the communities was the responsibility of the DDCs. However, because of limited availability of transportation vehicles, often the DDCs could not meet this responsibility. In these cases, the communities themselves arranged for the transport of materials from the regional warehouse. In general, the WASH consultants found that this delayed the completion of the project, but the delay was not significant.

10.5 Inventories

The WASH team visited two of the four warehouses in the four departments of the program. Specific observations are discussed in Section 5.6. In general, the WASH consultants found that the inventory practices varied widely -- from good organization and control to poor organization and lack of systematic materials checks. However, in all cases WASH found good security practices and no indication of materials misuse at the regional or community level.

10.6 Recommendations

Management Information

1. CARE should develop a simple management information system covering:

- basic technical and social data and analysis for planning, design, and evaluation needs;
- information on quality and availability of materials and related logistics;
- construction monitoring information -- scheduling, costs, work supervision and progress, final inspection;
- operation and maintenance -- status of completed systems and simple procedures and forms developed for community operator and committee members;
- financial and accounting information -- updated materials requirements and costs for planning purposes, inventory control, and simple accounting of fee collection for community management of systems; and
- institutional and administrative information for identification of constraints in counterpart and internal absorptive capacity.

2. Forms should be standardized to permit use of information for evaluation of impacts and as a basis for future investments.

3. The management systems should be simple and suitable for CARE's existing framework for implementation. Monitoring and evaluation should be built into each project phase with mechanisms (including the mid-term evaluation) for incorporating evaluation results to improve project effectiveness.

Coordination

1. In the future CARE should attempt to identify and coordinate with agencies which could collaborate in health education, sanitation design, and in agricultural extension and irrigation management programs.

2. CARE should identify and plan for potential constraints in the future, decreasing the objectives to fit the counterpart capacity to produce or developing mechanisms to overcome the constraints.

Purchasing and Disbursements

1. In future programs CARE should arrange to keep a larger inventory of patio connection materials. In addition, CARE should arrange to provide these materials to the communities for an established period of time (i.e., until two months from the system construction completion date) after which time communities would be obligated to purchase these materials in local markets.

Inventories

1. In future projects CARE should establish consistent inventory practices for storage and accounting of materials. CARE should also include periodic inspections of regional warehouses in its management plan.

Chapter 11

PROJECT BENEFITS AND IMPACTS

11.1 Introduction

Project impacts can be both intended and unintended. The main purpose of an evaluation is to establish the benefits from the project investment and to determine what can be done to increase them in the future. Benefits are optimized when the systems have been constructed, are functioning well, and the output is utilized effectively by a high percentage of the population.

The specific objectives of the CARE project were to enhance long-term water supply in drought-prone areas and provide sanitation. Implicit in these objectives were the goals of CARE's integrated approach for rural communities in Bolivia: to use water supply to bring about changes in health and social and economic conditions in Bolivia. Water supply is to be the initial community development block upon which other social and economic development activities are to build, such as the Child Survival and irrigation programs.

11.2 Health Aspects

Water supply and sanitation are key elements of preventive medicine. There is evidence that improved sanitation is, in the long run, more effective and less expensive than vaccination in the control of diseases such as typhoid and cholera. A recent program in Bangladesh resulted in a definite decline in diarrheal disease after a six-month intensive education program of hand washing after contact with feces. While many waterborne diseases cannot be controlled without safe water, the provision of safe water alone is not sufficient for their control since all can also be transmitted by fecal material reaching the mouth in other ways. Thus, water supply, personal hygiene and sanitation practices, and safe excreta disposal by the community are interconnected elements of improved health. Safe water will prevent direct disease transmission only if the user has been educated so as not to use a contaminated container.

Consequently, to maximize health benefits of a water supply it is necessary to increase the quantity of water, improve the quality of water, ensure correct operation of the system and prevent contamination of the source and facilities, and provide complementary activities such as sanitation and health education.

11.2.1 Quantity

The CARE project has provided the first step in several which are necessary to achieve health benefits. In perhaps 50 percent of the communities, reasonably functioning facilities have increased the quantity of water available. By providing yard connections, access has been improved and usage potentially increased. The construction of irrigation systems should result in improved nutrition by making fresh vegetables available in arid and semi-arid regions.

11.2.2 Quality

Since the water quality is untested, it is not possible to know if water quality has been improved. Generally the water source developed was the same one previously utilized by the community. However, development itself may have resulted in some increased protection, and there is less potential for contamination on transmission for those receiving water through patio connections.

11.2.3 Operation and Protection

Inadequate source development and facilities have resulted in secondary complications in the water supply systems of about one-half of the communities. In some cases the source is not properly protected. In others it is not possible to provide 24-hour service and this opens the way for possible contamination. During times when water is regulated, flows are low, or water is unavailable, people use sources such as rivers or unprotected wells or they store water in unsanitary containers from one day to the next.

Lack of drainage around the taps in the yard creates unsanitary conditions in virtually all the communities.

11.2.4 Complementary Activities

No complementary activities were provided such as hygiene education or sanitation.

11.2.5 Unintended Health Impacts

In many cases, where the entire source has been developed for the project, people who are not included in the system may be worse off because they may be using less desirable sources than before. Also errors in design and in judging the adequacy of water sources have contributed to a continuation of unsanitary conditions.

An unintended health benefit resulted when one entire community relocated to receive service and CARE collaborated with Plan de Padrinos in the construction of new houses with metal roofs which provided protection against Chagas disease.

11.3 Social Impacts

11.3.1 Convenience and Perception of Quality

The individuals receiving the water felt that there were substantial benefits related both to easy access and to what they perceived as clean water.

11.3.2 Community Organization and Self Help

For most communities this was their first attempt at self-help activity. The water project demonstrated that they could organize themselves to achieve a goal and they are now prepared to take on other projects.

11.3.3 Increased Demand for Other Services

The communities with water supplies are actively demanding other services. It is likely that these demands already existed before, since to get the water project itself the communities had to request it. However, demand for water-using facilities, such as showers, is clearly related to the distribution of water supply through patio connections.

11.3.4 Nuclearization and Community Relocation

CARE's policy to first serve compact communities has encouraged entire towns to change their houses and individual families to move into villages. It is difficult to assess the nature of this impact in the long term. Indians of the Altiplano have traditionally moved around the country during the year to obtain work and in recent years to be closer to services. While movement in response to the CARE project represents some dislocation and a change in settlement patterns, it may, in the short run, forestall a more dramatic change. The move will make other services available to previously dispersed households.

11.3.5 Role of Women

Discussions in the communities did not indicate that the role of women had in any way been altered. No women were on water committees nor had any been sent for training on system operation.

11.3.6 Unintended Social Impacts

Renters, people who could not afford patio connections, and people who did not buy into the system because they were absent from the community or chose not to have been deprived of their water rights to a primary source. The exclusion of segments of the community due to their physical location has created serious tension in the community and a strong desire to extend the system. The creation of higher density communities can make open air defecation a more serious health hazard than before.

11.4 Economic Impacts

Numerous economic benefits may result from water supply projects: food may be produced in small gardens with irrigation; people may be able to take up a new activity because they no longer have to spend time collecting water; a disaster such as a famine or epidemic may be diverted, people's productivity may increase because they are ill fewer days; and the health sector may spend less because the incidence of certain diseases is decreased.

Although the information available to the evaluation team did not permit the quantification of benefits, a number of potential benefits may have been derived from the project. Vegetables have been grown with excess water in the arid and semi-arid Altiplano. In the dry season, food produced with project water gives the project an increased economic impact. This may be occurring in up to 20 percent of the communities. The irrigation projects produced a lower benefit than intended since fewer were constructed than proposed. In addition, since no prior studies were done to evaluate the benefit to the farmers, it is possible that the cost of producing their crops may have exceeded the benefit from what they produced. It may have been better for them to work in the sugar harvest in Santa Cruz or the mines in Potosi in the dry season and buy food with their earnings. Although the time previously spent collecting water was low (2 to 3 hours per day) compared to other parts of the world, it does appear that the women were released to spend more time in income-producing activities, primarily weaving and small gardens. The project was intended as drought recovery and as such the presence of some supplies which are adequate through the dry season may save some costs of drought relief in the future.

It is unlikely that there are any significant benefits yet associated with reduced illness. Although half of the communities report using more water than before, none have received training in the need for increased water use and its relation to improved health.

11.4 Recommendations

1. Remedial action (rehabilitation) should be taken so that all systems produce adequate supplies; are adequately protected, and provide additional water for gardens. Alternate sources should be improved.

2. A study should be conducted to evaluate the longer term impacts of water projects and to help select communities where the impact from investment will be the greatest. The study should include pre- and post-project baseline data on health, water use and sanitation, time spent in water collection, and time saved and spent in income-producing or other activities.

3. A study should be conducted to measure the economic benefits of time saved from water collection by measuring the income produced from time spent in alternative activities. Given the entreprenurial tradition of Quichua and Aymara women, Bolivia would be an ideal country in which to undertake this study because of the high potential for income producing activities.

Chapter 12

CONCLUSIONS

12.1 General Project Summary

Under the USAID/CARE Cooperative Agreement, CARE was to provide projects in 125 communities -- 95 water systems and 30 small scale irrigation systems. Sanitation systems were called for but no target number was specified. All of the projects were to be completed by October 14, 1985.

According to CARE data, 126 projects have been undertaken, 17 of which are for irrigation. At the time of the evaluation, work was complete in 84 percent of the communities and was expected to be finished by the end of November 1985. Work has been slowest in Oruro, with 71 percent completion. No sanitation activities were undertaken in the program.

CARE estimates that the total population in the 126 communities covered by the project is 51,475. Of this number, about 42,200 (82 percent) will be served by the systems that are being built. CARE believes that this level of coverage (42,200 persons) will be achieved within several months of the end of the construction program.

In general, the WASH team found that for the quantity of water systems constructed, CARE has demonstrated a remarkable ability to mobilize communities and implement projects within budget and on schedule. CARE has achieved this success in spite of strikes and lack of government counterpart support. To accomplish this required a highly dedicated staff, effective administration, efficient purchasing and distribution of materials, and motivated communities. Compared to government institutions operating in Bolivia, CARE's success is even more noteworthy -- typically, in the four departments in the program, government agencies can be expected to install only about 15 to 20 water systems per year (compared with CARE's 126 systems in two years).

However, the quality of the systems implemented in the CARE program demonstrates that a high price has been paid for putting the resources of CARE and the DDCs under stress to complete the projects on time. The WASH team found consistent and significant problems in the following areas: project conception (coverage and level of service); design and construction; training (including health education and community management); and operation and maintenance practices. These problems diminish the potential benefits to the communities and affect the medium to long-term survival of the water systems. However, WASH believes that with appropriate modifications and assistance, CARE has the capacity to launch very successful programs.

The WASH team's general findings and conclusions are discussed in the following section.

12.2 Findings and Conclusions

1. The most notable aspect of the CARE potable water systems and small scale irrigation program was the speed with which the projects in each of the 126 communities were implemented. Besides the types of benefits normally associated with water system projects, their rapid completion had three major impacts on the communities: it reinforced the high level of community motivation that CARE generated during the project promotion phase; it set the stage for additional projects to be implemented (i.e., the Child Survival Program and possible, sanitation projects); and it generated a momentum that carried over to other communities to participate in the program.

2. CARE's success in the program was due in large part to its focus on what it does best -- water systems. CARE avoided getting involved in sanitation projects and treated irrigation projects almost like domestic water supply projects. CARE staff did not provide the level of water management and agronomy assistance that was required under the USAID cooperative agreement. Additional training of CARE staff is needed in both low-cost sanitation system design and construction and irrigation system design and operation, before sanitation and irrigation projects are implemented.

3. CARE's use of a target number of communities, rather than a target number of people, and its method of estimating proposed project costs, diminished the number of people who could be served. Costs were estimated and materials were purchased on the basis of average system costs prior to field investigations of actual sites. This, in combination with the need to produce 125 systems, limited the total cost that could be allocated to each community. Small communities with low total project costs, and few people served had equal merit with larger ones. The communities selected had populations less than 400 on an average, even though economies of scale are possible in larger systems. It would have been possible to benefit a significantly higher population if the cost per person served had been used as a yardstick rather than the total system cost.

4. The highly motivated communities are a real benefit to CARE's project implementation. However, because of the high cost that has been extracted from the communities, a failure of a community's water system (because of design or construction errors, or poor operation and maintenance practices) will undercut the community's self confidence and/or willingness to participate in future programs. Design and construction errors must be corrected, and correct operation and maintenance practices must be supported.

5. The following are problems noted by WASH that can and should be corrected to ensure the continued operation of the systems that have been built.

   Water Service Areas. Within a number of communities, CARE has tended to exclude non-dispersed sectors of the community which would require materials which exceeded average needs, even if they could have been incorporated into the system at a minimal incremental cost. This has created a strong division within communities and has generated a demand for immediate system expansion.

Level of Service. CARE has chosen to provide only one level of service: patio connections. It does not provide the basic level of public taps. Patio connections must be purchased as a condition of community selection. Those people who do not purchase this improved service are excluded from access to any piped water even if they have worked on constructing the project. Since the best pre-project water source is captured for the water system, some of the population is actually worse off as a result of the project, because they have been forced to sources of lesser quality and convenience. The use of contaminated water by part of the community leaves open the door for continued disease transmission to those with potable water.

Water System Design. Flows at potential sources are measured only once before the water system is designed. The measurements are not adjusted for time of year, type of source, or recent rainfall history. The use of this measurement as the average flow rate (basis of design) can lead to over-design of the water system and an erroneously high expectation of the amount of water available to the community. In about 50 percent of cases visited, the source proved inadequate to provide 24-hour service.

Additional design problems are detailed in Chapter 5. These include:

- source protection,
- incorrect sizing of pump systems and storage,
- lack of reinforcing in water tank base slabs,
- lack of adequate number of shut-off valves in the water distribution system,
- lack of unions near valves for maintenance and repair, and
- lack of drainage in valve chambers.

Water Quality. Only 3 of the 15 water systems visited by the WASH consultants had physical chemical analysis of the water source before the system was constructed. None of the systems had bacteriological tests. In order to ensure the potability of the community water supply, such tests must be performed when a water source is being selected. The tests should also include analyses for lead and arsenic -- which were generally omitted.

6. Materials and methods of construction used in the project were generally found to be acceptable with the following exceptions:

   - Imported, schedule 40, PVC pipe should not be threaded. The pipe wall is too thin to be threaded and will leak at threaded connections.

   - Galvanized iron pipe should be used (instead of PVC) in all quebrada crossings (buried or suspended) to decrease the possibility that the pipe will be damaged.

- Locally made water stops should be installed on all pipes that penetrate the concrete walls of a water storage tank to prevent leakage.

7. PVC pipe was found to be stored in open air areas in both the CARE warehouses and on construction sites. PVC pipe should be covered or stored in a shaded area to prevent damage by exposure to direct sunlight.

8. Generally, construction supervision was found to be adequate in that a field supervisor was present in the community during most of the construction period. However, the lack of correct supervision led to the following problems:

   - pipes installed at insufficient depth and without adequate bedding,

   - substitution of materials in the field for recommended (standard design) materials,

   - omission of valves, unions, and other details during construction,

   - lack of supervision and/or materials in installing PVC pipe with glued joints,

   - installation of vertical pipe taps for house services rather than horizontal taps, (vertical taps are more easily damaged), and

   - Lack of drainage around and in valve chambers.

9. A number of communities experienced difficulties in obtaining faucets, risers, and service pipe to make individual service connections. CARE should ensure that these materials are available to the community for at least a two-month period after the water system construction is completed.

10. About one-half of the communities had sent two people to be trained for operation and maintenance in FOMO. In several cases the trainees had subsequently left the communities to seek work elsewhere.

11. Training provided by FOMO is mostly adequate but does have the following deficiencies:

    - Training almost never occurs before the construction of the water system. This should be changed so that community personnel can use their new knowledge during the construction of their system and also teach others.

    - Training by FOMO is more oriented to occupational training rather than rural water system construction and operation.

12. All but one of the communities visited had a formal functioning water committee. However, none of the committees had a systematic basis for performing management functions to respond to community water system requirements.

13. One third of the communities had begun to collect fees for the system. None had used the funds for the purchase of necessary tools and materials.

14. Water committee training is essentially verbal, informal, and inconsistent. CARE should provide the committees with simple written report procedures. Since committees are elected annually, continuous training and simple records are necessary to provide continuity.

15. CARE did not provide health education to the communities served. Some education was provided to trainees sent to the FOMO course. All communities visited by the WASH consultants expressed a strong desire to learn how to use the water system to prevent the spread of disease. Responses to questions indicated clearly that the absence of this knowledge was a serious constraint on the beneficial effect of the project. The teaching of the relationship of safe water and sanitation to health is absolutely essential to realizing project benefits. Such a program should be undertaken in all communities where CARE has placed a system.

16. In one half of the communities visited by the WASH consultants, water use had apparently increased as a result of the project. However, in several communities the failure of the system to provide an adequate supply on a daily and monthly basis forced people to restrict use, store water (often in unsanitary containers), and supplement piped water with water from unsafe sources. It is critical that communities be educated in the value of safe water and household practices required to prevent contamination. The communities, without exception, were anxious to obtain other water-related facilities such as showers and laundry sites. A few of the communities used water for vegetable gardens, but most felt that the supply was inadequate for more than personal use. Currently the most important ways to increase water project benefits are to ensure an adequate, unregulated supply and to educate communities in enhanced utilization.

17. Management of the project suffered, particularly in the area of design and construction quality control, both within CARE and on the part of CARE as the manager of the DDC activities. Inadequate site investigation, design supervision and review, construction work, and evaluation of completed works and lack of systematic, basic management information feedback at all levels seriously affect the immediate and future performance of the systems installed. It is recommended that CARE undertake fewer systems and slow the rate of implementation to permit greater attention to the quality of each one. Fewer systems of larger size would permit as many or more beneficiaries to be served while reducing stress on CARE resources. The overall time for implementation need not increase since there will be fewer residual problems.

18. Coordination with other agencies during the project was excellent. Although other institutions were committed to fulfilling major areas of project responsibility, CARE provided the resources to fill the gap when these commitments were not met (most of the time). In addition, CARE personnel provided training of counterpart personnel and attempted to encourage counterpart participation to the extent possible. In future

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project proposals, however, a more realistic assessment of the corporations' absorptive capacity should be made, and if necessary resources should be increased either to the corporations or to CARE.

Chapter 13

RECOMMENDATIONS

13.1 Introduction

Based on its findings during the evaluation, the WASH team developed the following recommendations to improve existing and proposed projects and identified areas of the water supply and sanitation sector that should be supported. The recommendations are divided into two categories: those that refer to CARE project design and implementation and those that refer to programs for future USAID funding. The WASH team believes, however, that the highest priority should be given to correcting and rehabilitating the projects that were constructed under the Disaster Recovery Project.

13.2 Recommendations for CARE's Project Design and Implementation

1. Project objectives should permit greater flexibility to allow resources to be allocated within the community selection process to serve the greatest number of people. In future contracts, a range could replace a definite number of communities. Project objectives should emphasize the effective performance and long-term viability of water systems, not the number constructed. New funding should be based on an evaluation of the number of water systems constructed under prior agreements which are found to be performing adequately.

2. In the absence of pre-feasibility studies as the basis for a proposed project budget, the physical contingency cost category should be increased to 20 percent to permit the purchase of sufficient materials to cover implementation of larger distribution systems, as needed.

3. Pre-feasibility studies should be included as a category in future budgets and schedules to improve project planning.

4. The CARE system model used in proposals to project costs should be modified to reflect service to a larger average population. Cost per person should be considered in community selection.

5. CARE should take a less rigid approach and be prepared to provide a dual service level, sizing the system to permit phased improvement of service levels over time by the community. At a minimum, it should provide a basic level for everyone, with patio connections for those who can afford them. Public standpipes should be provided for those who are too poor to afford private connections and those who are too far from the water service to have a connection. A system which combines two levels of service also provides the basis for a two-tier fee collection system, increasing the funds available for operation and maintenance.

6. At present CARE does not consult the community on the proposed design. It should inform the community of the opportunity for alternative levels of service and permit the community to decide.

7. In water system design CARE should make the following improvements:

- Review water system designs to correct or modify systems with inadequate water supply and/or errors in pump or storage design.
- Involve a hydrologist in the selection of and estimation of flow for a potential water source.
- Develop procedures for taking a flow measurement and adjusting it to obtain an estimated annual average flow rate. The procedures should include analyses of similar types of sources with recorded flows, rainfall history, and a factor of safety.
- Include a weir or flow measuring structure in future projects so that water system operators can measure and record the flow rate on a monthly basis.
- Install reinforcing in the base slab of all new water storage tanks.
- Provide an adequate number of shut off valves in the water distribution system.
- Install unions and select pipe materials to make maintenance easier.
- Provide drainage in all valve chambers to keep them dry.

8. Source protection was needed in one half of the projects visited by the WASH team. CARE should construct fences around an upstream (30-50 meters) of spring intakes and construct drainage ditches around springs to protect the intake from surface runoff.

9. Additional training should be provided to those involved in the supervision of water system construction. The training is needed to promote a greater awareness of the importance of following designs and of quality control.

10. All water systems should have physical-chemical and bacteriological tests done when the water supply is selected. Where possible, CARE could use field test kits for physical-chemical tests. However, these kits have to be periodically calibrated at a qualified lab. Bacteriological tests must be done at a qualified lab.

11. A greater emphasis should be placed on teaching financial and management skills (including fee collection and record keeping) to the water committee members. It is recommended that the basis for training be expanded in the community to ensure the presence of necessary skills. This should include training women.

12. Since the collection of tariffs is essential to continued system operation it is recommended that CARE do the following:

- At the time of design make an estimate of expected annual operation and maintenance costs per household to be served (based on the system facilities, length of pipe, materials, and equipment) and assess the ability of the community to pay these costs as part of the selection procedure. No project design should be considered if the community lacks the resources to ensure its reasonable operation.

- Provide the community with a written list of expected material and equipment needs over the life of the project, so that the water committee will have a basis for assessing how much should be collected from each household monthly.

13. CARE should select technical alternatives which carry lower operation and maintenance cost to the community even if the capital cost is higher.

14. No operation and maintenance support system has been set up to assist in major repairs and rehabilitation which communities are not prepared to handle. Such a support system should be set up on a departmental level.

15. None of the communities visited by the WASH consultants had any tools for the repair of water systems. WASH recommends that CARE make available, and that all communities be required to purchase, a tool kit for the repair of their systems prior to system construction.

16. While training by FOMO is generally adequate in teaching basic skills, there should be more emphasis on the types of construction and repairs encountered in rural water systems and on repairing systems under realistic conditions.

17. No sanitation education or facilities (i.e., latrines) were offered or provided in the project. All of the communities visited requested assistance in the construction of latrines. With the exception of two communities, people relied for the most part on open field defecation:

    - A sanitation program is important and should be developed through careful analysis. The willingness of a community to construct and use a sanitation system, the selection of the type of system, and the location of the facilities within a community are all factors which will influence the success of such a program.

    - The sanitation program should have heavy social science and community input and should be initiated on a pilot project basis to test results.

    - CARE engineers should be trained in aspects of low-cost sanitation.

18. Of the communities visited by WASH, almost none had splash tanks or drainage installed at the faucet (usually located in the yard). The lack of these facilities leads to the accumulation of water around the faucet area and can be a source of contamination for the user. These facilities and adequate insulation should be installed at each faucet.

19. Because of the need to improve project utilization, health education should be undertaken in all communities where CARE has constructed a water system.

20. A management information system should be established.

    - A simple system of data collection, analysis, use, and storage should be set up and used to monitor and improve planning and design, implementation, operation, and the assessment of impacts. Types of information should include technical and social data for planning, materials and logistics, construction monitoring, system operation and maintenance, financial and accounting, and institutional and administrative.

    - Surveys and procedures should be standardized to produce baseline information and facilitate cross-departmental and other comparisons.

    - Procedures for monitoring, evaluation, and feedback should be defined. Findings should be incorporated as modifications to existing and new projects to improve performance.

13.3 Recommendations on Programs for Future USAID Funding

In the evaluation of the CARE water supply and small scale irrigation program, the WASH team found a number of areas where supplemental and/or additional USAID projects could improve the performance of existing and future water supply, irrigation, and sanitation projects in Bolivia. These areas and recommended programs are described in the following sections.

13.3.1 High Priority (listed in order of priority)

1. Corrections to Existing Projects: As indicated in Chapters 4, 5, and 6, there are a number of problems that were found in the 17 communities that were visited by the WASH consultants. However, WASH believes that similar problems exist in the remaining 109 projects. These should be corrected. Of particular concern are major source modifications to permit an adequate 24-hour water supply (where resources are available), source protection, corrections of critical design and construction errors, providing service (public standposts) to people excluded from the piped system, providing system expansion to serve groups of houses that can be included at low incremental costs, and the development of written operation and maintenance procedures. Without corrections, the long-term survival of these projects will be jeopardized. Corrections to these projects would involve a four step process:

    - Review critical project elements and develop a checklist to evaluate these elements for each community; develop written operation and maintenance procedures and schedules for each community to follow.

- Visit each community to discuss operation and maintenance procedures and evaluate the need for system rehabilitation.

- Review the project evaluations and develop a scope of work and cost item estimates for the rehabilitation efforts.

- Complete rehabilitation program. Additional efforts should also be made to encourage communities to collect fees and purchase tools and repair materials.

2. Operation and Maintenance Programs. Critical to the long-term functioning of the community water supply projects are community-based and regional-support operation and maintenance programs. The WASH consultants believe that additional community operation and maintenance training is needed. Regional support is non-existent and should be developed.

The WASH consultants understand that USAID, in conjunction with UNICEF (the United Nations Children's Fund), the World Health Organization (WHO), the Pan-American Health Organization (PAHO), and DSA, is developing an operation and maintenance training program for field supervisors and a program for community water system operators. These programs are scheduled to begin in the department of Cochabamba. The WASH consultants recommend that these and future operator training programs include:

- extensive training in leak repair (using actual systems -- at the workshop -- that are under pressure and leaking badly) and

- provisions for communities to purchase a standard set of tools for the operators to bring to the workshop and to be used later in the community (tools could be purchased through a revolving loan account and repaid).

The WASH consultants also recommend that USAID expand this program to other departments and support similar types of training programs in conjunction with future water supply, irrigation, or sanitation projects.

At the present time there are no regional operation and maintenance support programs. However, WASH understands that USAID, UNICEF, WHO, and PAHO have jointly agreed to support DSA as the national agency responsible for rural water supplies. Plans are being developed to staff and support DSA to undertake this responsibility. The WASH consultants recommend that consideration be given to providing a regional technical engineer, as part of the DSA staff, who can

- provide technical support and advice to communities in solving operation and maintenance problems and
- assist communities in planning for water system expansion (either distribution system piping or sources).

The funding agencies for the regional O&M operation and maintenance support program should provide a regional storehouse of materials that could be purchased by the communities. These would include pipe, valves, faucets, repair clamps, service taps, some special fittings, and possibly pump parts. The purpose of the regional supply house would be to

- provide quality control of the materials being used in water system construction,
- lower the cost of materials to the community, and
- provide a clear plan for communities to know where to purchase materials.

3. Benefit Enhancement: Establishing a reliable potable water supply system is only one step in eliminating the transmission of waterborne diseases and diseases due to poor sanitation practices. To increase the impact of the water system, a program to promote water utilization and to improve health and sanitation practices (i.e., bathing, handwashing, and defecation practices) is needed.

   A pilot health education program is being developed by the firm of Lowder-McCann, supported by USAID, for a number of communities in Cochabamba. USAID should support the development of health education training programs for all communities that have constructed water supply systems with USAID funds.

   The program should include: training of trainers for water utilization and health and sanitation practices; a program to promote these practices in the communities; provisions to teach communities how to make and use health promotion materials locally; and provisions to use community water committees to lead the health promotion activities. The proposed CARE Child Survival Program provides a mechanism for achieving some of these objectives.

4. Water Quality Testing. Because of the lack of adequate water quality testing on most of the communities in the current program, USAID should develop a plan (through CARE) to ensure that at least one physical/chemical analysis and one bacteriological test is done for each of the 126 communities. This effort could be implemented along with the program to correct existing project deficiencies (see item 1 above). If indicated by the results of the bacteriological tests, a water supply chlorination system should be installed.

13.3.2 Lower Priority (listed in order of priority)

1. Engineering and Construction Supervision Training. To avoid the engineering design and construction problems that were noted in the evaluation, regional (department level) CARE and DDC (or DSA) engineers should be trained to review and re-evaluate project design criteria (especially for source, storage, and pumping system design) and to establish acceptable and consistent construction practices. Design criteria and construction practices should also be developed for sanitation projects.

   Those engineers that receive training should, in turn, instruct and supervise junior engineers during project design and implementation. The training program should be funded along with the project which provides construction funds (see below).

   During the evaluation, the WASH consultants found that CARE and the DDCs had little experience in the design and implementation of irrigation projects. For future projects, training (similar to that described above) should be provided for CARE and DDC engineers. Training should include irrigation system design criteria, hydraulics, construction practices, operation and maintenance, agronomy, and watershed management.

2. Additional Community Water Supply Projects. At the time of the evaluation, CARE had a backlog of 300 community requests for water supply projects just in the Department of La Paz (there are nine departments in Bolivia). There is still a tremendous need for water supply projects throughout Bolivia. Therefore USAID should continue to fund water supply construction programs, incorporating the recommendations that are discussed in this report. Note, however, that existing systems (Disaster Recovery Project) should be corrected before additional projects are undertaken.

3. Sanitation Programs. During the evaluation the WASH team found a strong desire on the part of most communities to construct sanitation facilities. USAID should consider implementing sanitation facilities construction projects, in conjunction with the health education program described above.

4. Water Supply Projects for Dispersed Houses. Most of the water supply efforts in Bolivia have been directed to urban areas and more recently to smaller rural communities. Still unserved are the many dispersed houses throughout Bolivia. Although it would not be feasible to serve these houses with conventional water distribution systems and patio connections, groups of houses could be served by central standposts (watering points).

   USAID should consider funding projects to serve these areas. Part of the project development would be the development of project design criteria and the selection of appropriate technologies from available alternative water supply systems (i.e., conventional pumps, handpumps, windpumps, and solar pumps). These technologies may also be applicable to the large community systems. Selection of an appropriate technology and a pilot implementation program are recommended.

5. Water Quality Support. To improve the quality of physical/chemical and bacteriological testing and to ensure that laboratories are available for ongoing analyses of rural water systems (either new or existing), USAID should consider upgrading existing laboratories. At least one lab in each department should be upgraded. To implement this program, the following steps are required:

   - evaluate existing labs (university and health department labs) to determine which ones can be used and what upgrading is required,
   - select regional support labs,
   - develop a program to provide new or supplemental lab equipment,
   - provide training to lab personnel, and
   - integrate the use of lab support with DSA, USAID, and other agency water supply programs.

APPENDIX A

Proposed Scope of Work for Evaluation of
CARE's Potable Water and Small-Scale
Irrigation Program
USAID-1985

SCOPE OF WORK

Background

On October 14, 1983 CARE signed a cooperative agreement with USAID for $1,750,000 (U.S.) in order to construct 110 potable water systems and/or small scale irrigation facilities by the project completion date of October 12, 1985. The agreement was amended to 125 systems in October 1984. In January, 1985 a joint CARE/USAID community dialogue evaluation of the project was conducted to measure general project progress and to identify program trends.

The results of the evaluation were generally very positive. CARE is interested in continuing to work in potable water projects and will also begin implementation of a child survival project in August in some of the beneficiary communities of the potable water project. The mission foresees the results of this evaluation as a tool for planning both future water projects and for the child survival project.

The objective of the evaluation is to make recommendations that will ensure long-term viability of this project in terms of functioning water systems, water committees, high quality potable water, etc. as well as to set guidelines for future water projects. Technical, social, cultural and institutional factors will be assessed in certain project areas to determine positive and negative health and development impacts.

Responsibilities

A. Technical

1. Evaluate the engineering integrity of the water systems in terms of:

   A. Design and construction,
   B. Quantity of available water per community member,
   C. Sustained operation and maintenance,
   D. System expansion constraints.

2. Recommend methods to guarantee water quality control and sustained operation and maintenance.

3. Analyze how many systems will require expansion as well as the geological, climatological, social and cultural constraints.

4. Assess the communities' access to needed tools, construction materials, and equipment for maintenance efforts.

5. Recommend methods to dispose of waste water.

B. Social

1. Determine the levels of services presently available at existing potable water systems.

2. Investigate the different ways in which services can be improved and/or incorporated into the operation and maintenance of water systems.

3. Evaluate the impact of the maintenance training courses conducted by FOMO, a water systems training organization (social and technical).

4. Evaluate the long-term effectiveness of the maintenance systems and water committees and make suggestions for improvement.

5. Analyze cultural and social factors affecting optimal water usage by beneficiaries and recommend follow-up activities.

6. Analyze residual water usage.

7. Analyze the role of women in water committees and in follow-on health activities.

8. Assess attitudinal changes caused by the water systems in terms of positive and/or negative community impact.

9. Assess the level of community understanding between potable water and sanitary feces disposal.

C. Institutional

1. Collect sufficient information to support or modify the operational strategy used by the project in terms of community selection, allocation of resources, selection of technologies and fittings of design, etc.

2. Analyze personnel policies based on a network of supervision and administration, emphasizing review of field work and reporting of problems arising in the field to decision levels.

3. Assess the implementation role and participation of the departmental development corporations and their compliance to agreements with CARE.

D. Reporting

1. Consultants will be required to prepare written reports in English on completion of their assignments. USAID/Bolivia and CARE will review draft reports with consultants prior to their departure from Bolivia. Draft reports will be left with USAID/Bolivia. The consultants will finalize their report within 15 days of their return to the U.S.

<u>Timing</u>

The field work requested herein should be completed during the period September 23 - October 11, 1985.

APPENDIX B

Survey Forms

CARE - REGIONAL OFFICE SURVEY FORM
(note respondent on the form)

DATE: ______________

SURVEY BY: ______________

1. Discuss the selection criteria for selecting communities for the CARE/AID water/sanitation/irrigation program? Is the project cost or cost per person a factor?

2. Is there an initial survey which is done before the final selections are made? (Obtain copy).

3. Is the procedure different when there is not a drought? for other programs?

4. How many communities (and persons) in your area lack water and sanitation? What area is covered by your office?

5. Under the AID/CARE project, who was responsible for the following project components? Why?

   - Selection of the community for the program
   - Project design
   - Project coordination with the community
   - Supervision of construction
   - Training
   - Operation and Maintenance

6. What is CARE's organization/staffing in this region? How often is the office visited by the main office?

7. How was the project cost estimated?

8. How was it determined what the community should pay?

9. Are O&M costs included in the amount the community pays? In the overall project cost?

10. Are there records on the estimated cost of the system? Are there records on the final cost of the system?

11. Are actual costs used to estimate project costs in subsequent projects?

12. What is the average length of time for the following? Are schedules kept and monitored? (copies)

    - Community Selection
    - From Selection to Construction
    - Construction

13. Are agreements signed between CARE and each community? What are the responsibilities?

14. What is CARE's opinion of the regional DDC? (capabilities, staff, management?) (water/sanitation)

15. What is CARE's opinion of the regional DSA? (capabilities, staff, management)? (water/sanitation)?

16. What is CARE's opinion of the regional FOMO? (capabilities, staff, management) and water, sanitation, irrigation?

17. Are there any other agencies or PVO's in the region that can provide the services that are needed in water/sanitation/irrigation projects?

18. In the design of a community project, how is the level of service for water/sanitation/irrigation decided?

19. Who selects the design criteria for the project?

20. Did CARE review or discuss design criteria for projects with DDC before the AID/CARE project began?

21. Is there a system for reporting problems during design, construction, training to CARE? What actions are taken?

22. How many times does CARE visit a community during a project?

23. Did CARE review FOMO's training program before training began? Is there follow-up supervision and program modification?

24. How are project materials ordered in a project? Where are they stored, and how controlled?

25. How long does it take to deliver materials to a site once they are ordered?

26. List the following costs?

- Cost of fuel
  - gasoline
  - oil
  - electricity
- Cost of pipe - 1"0
  - 2"0
- Cost of valves - 1"0
  - 2"0
- Cost of cement
- Cost of pumps
- Average daily rate of a skilled laborer
- Average daily rate of a non-skilled laborer
- Average daily rate of an agricultural worker
- Average daily rate of a field supervisor (Technico)

- Average Transportation costs

27. What provisions are made for long-term operation and maintenance of a community system? (materials, regional support, training)

DDC SURVEY FORM
(note respondent)

ORGANIZATION ____________________ DATE ____________

RESPONDENT ____________________ SURVEY BY ____________

1. Describe the organizational structure of your agency? Staffing?

2. What are your agency's capabilities?

3. How is your agency funded? Do you receive funds from AID/CARE?

4. What assistance have you provided in the AID/CARE Project? Staffing - capabilities?

5. What design standards do you use for water supply, sanitation and irrigation projects? Does it vary with the project? Have these been reviewed by CARE?

6. Does your agency provide technical assistance, materials or O&M training to communities that have completed projects? Which ones? How often?

7. Does your agency work with the MOH and DSA in any projects?

8. Do you provide health education or agricultural extension training to communities?

9. Do you work with community water committees to provide assistance in setting fees, planning system O&M programs?

DESIGN/DATA SURVEY FORM
(note respondent on the form)

DATE ____________________ COMMUNITY ______________

SURVEY BY ________________ DESIGN BY ______________

1. Are there survey forms for the community to develop basis project data? (obtain copy). How far is it to the community from ___________, travel time?

2. Were water samples taken of the source water before the project was designed? (obtain copy) Was a reconnaissance of the watershed done? Is treatment required? Acceptable?

3. What are the projected water demands for the community and the basis of projection? (include domestic, commercial, irrigation demands). Is there an allowance for leakage?

4. What is the source(s) of water that is selected for the community water supply? Why? Are there additional supplies available?

5. What is the safe yield of the water supply? Have measurements been taken (When? Where? How?)

6. Is there an intake system? What type of transmission system was selected? (pumped, gravity) (what type?)

7. Are there pumps used in the water distribution system? Where?

8. What were the design criteria used for the project (average water use, maximum day demand, storage requirements, velocities, pressures, depth of pipes?)

9. How many people are served by the project now? What types of connections are there, why?

10. Is there a defined service area for the project? Any constraints on expansion?

11. Maps of the area? System(s)?

12. Is there periodic inspection and water sampling of the system?

13. Provide a list of the types and quantities of materials used in the project and the reason for selecting these materials?

14. Is there electricity available in the community?

15. Was there a sanitation component to the project? If so, what method of sanitation was selected, why?

16. What method of sanitation is preferred by the community?

17. What was the estimated cost of the project? How much did the project cost?

RURAL WATER AND SANITATION SURVEY FORM

COMMUNITY: ____________________

DATE: ____________________

INTERVIEW: ____________________

I. WATER USE (B-1, B-5)

A. Baseline - Prior Use

1. How many houses are in the community?

2. How many people are in each house?

3. Before the project, where did you get your water?

4. How long did it take to get there?

5. How many trips did it take each day?

6. What container did you use to carry the water? (Show) (Estimate capacity).

7. Did you store the water in your house? How?

8. What did you use the water for?
   - drinking-cooking
   - washing food and utensils
   - bathing
   - washing clothes
   - other

9. How many times a week did you bathe? Wash clothes?

10. Could you get water all year round?

11. Who went to get the water?

B. Level of Service/Use (B-1, B-5, B-8)

1. Why did you want the new project?

2. Do you get all of your water from the project now? (all hours, dry season)

3. If there is not enough, where do you go?

4. Do you use more water now? How much (estimate containers, compare to design)

5. What do you use the water for now? What has changed from before? Amount, quality, reliability.

   - drinking and cooking
   - bathing
   - laundry
   - animals
   - plants

6. Do you bathe and wash clothes more times a week now? *Do you wash hands after defecating?

7. Do you store your water the same way as before? Do you cover the water?

8. Do you give animals water? Where?

9. Can children reach the water faucet?

10. Are there any problems with the water?

C. Demand (A-3)

11. (If there is not enough water) how would you use more?

12. Are more people moving into the village or away from it each year?

13. How many new houses are added to the village each year?

II. <u>IMPROVED SERVICE</u> (B-2)

1. When there is not enough water, what do you do?

2. Would you like to have a place to wash clothes on the patio? Other service?

3. Does water collect around the bottom of the faucet on the ground?

III. <u>ATTITUDE CHANGES</u> (B-8)

1. Do you think more water brings health to your family? Is it good for health to be clean?

2. (If there is chlorination) do you object to the smell? Do you think it makes the water safer?

3. Do you think the old water was bad for your health? Why?

4. Since the community has constructed the water system, do you have more confidence to do other things to improve life?

5. What changes would you like in the village?

IV. WASTEWATER (A-5, B-6)

1. What do you do with the wastewater?
   [ ] throw in street [ ] patio
   [ ] on ground away from house
   [ ] in drainage ditch
   [ ] use on garden, other
   [ ] for animals

V. SANITATION AND HEALTH (B-9)

1. What are the places you defecate during the date? [ ] latrine, [ ] the ground, [ ] other? Where at night? [ ] latrine, [ ] behind the house

2. What do you like or dislike about using this place? Is privacy important? Do you think this is the best way?

3. Where do the children defecate? Where do you put it?

4. Do you think this place for defecation is good for health?

5. Are there any latrines in the village? What type? Who has them? Who built them?

6. Did CARE or anyone offer to build latrines as part of the water project? Were any built? Is there one for the school?

7. How many families use the latrines? Who cleans it? Who digs the new hole? What are the problems?

   - smell
   - difficulties for young children
   - emptying
   - flies

8. Has anyone come to talk to you about improving the method of human waste disposal?

9. Would the village like to have latrines? Would the women? Why? Why not? Should men and women have separate ones? Should they be close or far away from house?

10. What sicknesses do people have in the village? diarrhea, etc.

11. Observation [cleanliness of people, face, hands, hair, clothes clean: status of homes, cleanliness, no animals inside]

12. Food preparation: Do you wash your hands after defecation? Before food preparation, wash food to be eaten, use soap for washing dishes? hands? clothes?

13. Has CARE or anyone provided a program of how to use water to improve health in the community? Would you be interested in learning this?

VI. <u>WOMEN AND HEALTH</u> (B-7, B-9)

1. Are any women on the committee? Would it be acceptable to have a woman? Could women learn to operate the water system? Would they like to?

2. What women's groups (organized) exist in the village?

3. Would women like to receive information about how to use water and improve methods of waste disposal to improve the family's health?

4. Would the local ________ help to offer a course to train women?

VII. <u>O&M - WATER COMMITTEES</u> (B-4, C-1)

1. How was the water committee organized? Who is on it? Is it a position of importance?

2. Did the committee receive training on how to manage the system? Did it receive training on health education?

3. What are your functions?

4. What do you do to take care of the system? Training? Tools? Collect funds?

5. Does the operator give you a report on how everything is? How often? Is it written? Did CARE help make a form to be filled out about repairs, problems? (show)

6. Does the committee collect money for the operation and maintenance of the system? When did they begin to collect it? How often? Who collects its?

6a. For what reason do you need to collect money?

7. How much does the committee collect from each family? How did it decide how much?

8. What is the average income each month for a family?

9. Did CARE advise how much money to collect?

10. How many families pay? Don't pay?

11. Do you keep a record? of money collected? of repairs and costs? (show me)

12. What will the committee do if a major repair is needed? Who will you go to for help? Why? Do you have a procedure?

13. What will you do when the system needs to be expanded?

14. Was the community consulted about the design of the water system? Was it asked if it wanted latrines?

15. How did the community contribute to the construction of the system? Money? Labor? Materials?

16. What role did the committee play in the construction?

17. Does the community feel it is its responsibility to operate and maintain the system?

18. How did the community organize to carry out this work or new projects?

VIII. OPERATOR TRAINING

1. How were the people chosen to receive training?

2. Were they chosen before, during, or after construction of the system?

3. Can the operators read and write?

4. Did the operators feel they learned a new skill from the training? Will the operators remain in the community?

5. Does the comittee think the training was enough? Is there

something they do not understand that more training would help?

6. Does anyone from CARE or the DDC come to visit to see if everything is O.K.? How often? Would it be a good idea?

7. Would you like more training? What will you do if both operators leave the village?

COMMUNITY SURVEY FORM
(note respondent for each question)

COMMUNITY: ____________________ DATE: ____________________

SURVEY BY: ____________________

1. How many people are in the community? How many have water, sanitation?

2. What are the numbers of types of water services, latrines?

3. What facilities were installed in the CARE project? (water supply, sanitation, irrigation)

4. Does the water supply project meet the communities needs? (quantity, quality, accessibility, availability)

5. What uses of water are there? (domestic, animals, irrigation, commercial)

6. Is there treatment of the water, what type?

7. Would the community accept chlorination?

8. If sanitation facilities were installed, do they meet the communities needs (what type, where)? What is the preferred system?

9. If irrigation facilities were installed, do they meet the communities needs (what type, where)?

10. What were the water supply, sanitation and irrigation practices before the project? For those still not in the project?

11. Do the systems allow for expansion? What are the restrictions (supply, elevation, topography)?

12. Are there water samples taken periodically (what type, where, by whom)?

13. Was an initial community survey done (when, by whom)?

14. Was construction supervised (when, by whom)?

15. Was construction training provided (for whom, when, by whom)? Was it adequate?

16. Was O&M training provided (for whom, when, by whom)? Was it adequate?

17. Is there an agreement between CARE and the community? What are the responsibilities of each?

18. Who is responsible for the overall management of the project in the community? How were they selected?

19. Was training provided to this group (when, by whom)? Was it adequate?

20. Was Community Health Education provided (for whom, when, by whom)? Was it adequate?

21. Have there been uses of the water system that were not originally planned? (gardens, animal use, washing)

GENERAL COMMENTS BY OBSERVER

- Water system design (adequacy of source, source protection, treatment)

- Level of service
- Reliability
- Transmission and storage
- Sanitation practices (including areas around standpipes)
- Sanitation system design
- Water quality
- Overall O&M practices

OPERATIONS & MAINTENANCE ASSESSMENT OF COMMUNITY WATER SUPPLY SYSTEM

SURVEY FORM
(note respondent for each question)

COMMUNITY: ______________

DATE: ______________

SURVEY BY: ______________

I. INSTITUTIONAL

A. COMMUNITY LEVEL

1. Is active community participation included in the project?

2. Has the community participated in successful self-help projects?

3. Does a community group exist that can assume responsibility for maintenance? What is their level of training? When?

4. Has a determination been made of community members willingness to participate?

5. Has a written agreement outlining the responsibility of the community in the project been made between the government and community?

B. CENTRAL/REGIONAL GOVERNMENT LEVEL

6. Does the central regional/government have a history of effective response to O&M problems?

7. Has a commitment been made by the government to actively support O&M?

8. Does a distinct agency or authority have responsibility for water supply projects?

9. Is there an O&M section or department within the agency?

II. SYSTEM MAINTENANCE

10. Does the project include provision to select community members as system caretakers?

11. Has the community caretaker been provided with maintenance tools and material as part of the project?

12. Has a preventive maintenance (PM) program been developed for the caretaker and regional maintenance team?

13. Has the government made a provision to handle major maintenance items?

14. Are the responsibilities for specific maintenance tasks between government agencies and the community clearly defined?

III. RECORD KEEPING

15. Is the caretaker required to maintain records of PM done and materials used?

16. Is the regional maintenance group required to maintain records on work done?

17. Is the regional O&M agency required to submit regular repair reports to the water supply agency?

IV. SPARE PARTS/SUPPLIES

18. Are supplies of spare parts and materials available at the community level? Regional Level?

19. Is there a system for control of inventory at the community level? Regional level?

20. Is the government's tendering process capable of obtaining spare parts and supplies in a timely manner?

21. If needed, are spare pumps provided for the project?

V. LOGISTICS

22. Is reliable transportation available for locally based caretakers and regional maintenance workers?

23. Are there practical plans for the caretaker to notify the regional teams of the need for pump maintenance?

24. Are government facilities available to repair maintenance vehicles?

25. Are regional workshops available for major (pump) repairs?

26. Is the workshop outfitted with the tools and equipment that are needed?

VI. TRAINING

27. Does project include training for system maintenance for both caretakers and regional crews?

28. Are training materials developed to suit the level of the trainees?

29. Has the responsible ministry in the government made provision for ongoing training for maintenance workers?

<u>ADDITIONAL O&M QUESTIONS</u> (TO CARETAKER)

1. Since the system has been built, how many interruptions in service have there been? How long? (Leaks, breaks, freezing)

2. Where are materials and equipment stored? Was PVC pipe covered to prevent damage?

3. Are there any metered records?

4. Is there a leakage control program?

5. If pumps are needed for future expansion is there electricity available?

6. What are the problems that you have with the system?

7. Do you feel that you have received adequate training?

APPENDIX C

Project Characteristics for Each of the 125 Communities in the CARE Program

DEPT	NAME OF COMMUNITY	POPULATION ACTUAL	POPULATION PROJECTED	RURAL/ URBAN	GRAVITY PUMPED	DOMESTIC SYSTEM (PERSONS SERVED)	NO OF CONN S	DESIGN WATER ALLOTMENT (lpcd)	HOURS OF WATER SERVICE	IRRIGATION SYSTEM (AREA SERVED)	SOURCE TYPE	SOURCE FLOW (lps)	DATE PROJECT COMPLETED	NO OF PERSONS AT FOMO TRAINING
	Chita	200	271	Rural	Gravity	165[4]	70	70	24	None	Spring	0.80	JUN 85	1
	Quehua	260	352	Rural	Gravity	215[4]	50	70	12	None	Spring	1.00	NOV 85[5]	2
	Vila-Vila	530	742	Rural	Gravity	455	91	80	12	None	Spring	0.55	NOV 85	2
	Chacala	319	432	Rural	Gravity	300	60	80	24	None	Spring	1.70	JUN 85	2
	S. Antonio	236	320	Rural	Gravity	200	50	80	24	None	Spring	0.50	SEP 85	2
	Carquella	220	298	Rural	Gravity	220	44	80	24	None	Spring	0.70	NOV 85[5]	2
	Tica-Tica	250	339	Rural	Gravity	235[4]	47	70	24	None	Spring	5.00	NOV 85[5]	2
	T. Pampa	253	354	Rural	Gravity	210[4]	45	60	24	None	Spring	0.24	NOV 85	
	Huanaque	270	366	Rural	Gravity	225[4]	40	80	24	None	Spring	1.30	NOV 85	2
	Pelcoya	215	291	Rural	Gravity	175	40	80	24	None	Spring	1.50	NOV 85	2
	S. Agencha	275	373	Rural	Gravity	250	50	90	24	None	Spring	1.00	NOV 85	
	Nuqui	210	294	Rural	Gravity	200	50	120	24	None	Spring	1.50	NOV 85	1
	Chilcany	620	868	Rural	Gravity	290	58	60	12	None	Spring	0.20	JUN 85	2
	Quivi Quivi	400	560	Rural	Gravity	360	90	80	24	None	Spring	0.45	JUN 85	
	Subtotal	9536	13218			7805								39
Choquisaca	Siguayo	246	336	Rural	Gravity	246	41	100	24	None	River	1.20	JAN 84	2
	Tinteros	216	280	Rural	Gravity	216	36	100	12	None	Spring	0.49	JAN 84	2
	Carvajal	300	388	Rural	Pumped	300	50	95	12	None	Inf Gal	2.00	DEC 83	2
	San Antonia de Chaupillajta	216[6]	216[6]	Rural	Gravity	216[6]	0	0	24	16	Inf Gal	5.00	JUN 84	2 2
	Alcantari	240	310	Rural	Pumped	240	40	100	12	None	Inf Gal	0.24	JAN 84	2
	San Pedro Claver	66[6]	66[6]	Urban	Pumped	66[6]	0	0	6	6	Well	0.20	FEB 83	2
	Azari	1250	1724	Rural	Pumped	700	140	100	12	None	Suc Sys	2.00	FEB 83	2
	Cachimayu	330	450	Rural	Gravity	330	55	100	24	None	Spring	0.67	DEC 84	2
	Tuero Chico	180	233	Rural	Gravity	180	30	48	24	None	Inf Gal	0.10	FEB 84	2
	Sapse	240	311	Rural	Gravity	240	40	100	24	None	Inf Gal	1.00	FEB 84	2
	Tambo Ackachila	300	409	Rural	Gravity	300	50	100	24	None	Inf Gal	0.86	DEC 83	2
	Peras Pampa	120	164	Rural	Gravity	120	20	100	24	None	Inf Gal	0.27	DEC 83	2
	Uyoni	336	425	Rural	Gravity	324	54	100	24	None	Inf Gal	0.70	JUN 84	2
	Tipaca	786	1065	Rural	Pumped	786	113	50	12	None	Inf Gal	0.55	MAR 83	2
	San Jose de Molles	372	496	Rural	Gravity	204	34	100	24	None	Inf Gal	0.75	JUN 84	2
	Miska	300	409	Rural	Gravity	275	55	100	24	None	Inf Gal	1.17	AUG 84	2
	San Juan	420	560	Rural	Pumped	325	65	60	12	None	Well	0.90	SEP 84	
	Normal Serrano	120[6]	120[6]	Rural	Gravity	120[6]	0	0	24	5	Inf Gal	4.00	SEP 84	2
	Chuno Pampa	218	303	Rural	Gravity	218	37	100	24	None	Inf Gal	0.40	JAN 85	2
	Molle Mayo	220	285	Rural	Gravity	220	35	120	24	None	Inf Gal	0.50	FEB 85	2
	Vila Vila	438	695	Rural	Pumped	264	25	65	12	None	Spring	0.80	JUN 85	
	Vila Vila Norte	162	210	Rural	Pumped	162	9	65	12	None	Spring	0.80	JUN 85	
	Tarcani Baja	330	427	Rural	Gravity	330	15	100	24	None	Spring	0.50	JUN 85	
	Kochis	426	347	Rural	Pumped	426	65	50	12	None	Inf Gal	0.70	JUN 85	2
	Tajahausi	400	513	Rural	Pumped	230	45	60	12	None	Well	1.00	MAY 85	2
	Surima	350	633	Rural	Gravity	200	40	150	24	4	Well	3.40	NOV 85[5]	2
	La Culata	65	117	Rural	Gravity	65	14	150	24	None	Well	3.40	NOV 85[5]	1
	Kacha Kacha	280	359	Rural	Gravity	215	43	80	24	None	Well	0.34	NOV 85[5]	2
	Bella Vista	90	115	Rural	Gravity	75	15	80	24	None	Well	0.34	NOV 85[5]	1
	Limabamba	600	1275	Rural	Gravity	120	24	120	24	1.5	Well	2.50	NOV 85[5]	2
	Choquimayu	240	320	Rural	Gravity	175	37	100	24	1	Spring	1.00	NOV 85[5]	2
	Otorongo	174	226	Rural	Gravity	100	20	150	24	1	Inf Gal	3.00	NOV 85[5]	1
	El Campanrio	110	143	Rural	Gravity	100	20	120	24	None	Inf Gal	0.25	JUL 85	2
	El Tapial	250	380	Rural	Gravity	170	34	100	24	None	Inf Gal	6.00	SEP 85	
	Corso	190	246	Rural	Gravity	140	28	150	24	None	Inf Gal	1.00	NOV 85[5]	2
	Subtotal	10581	14756			8398								57
Oruro	Avaroq	450	599	Rural	Gravity	400	100	81	24	None	Spring	0.38	JUN 84	N.A.
	Copacabana	340	455	Rural	Gravity	340	84	60	24	None	Spring	0.12	JUL 84	N.A.
	Lajma	500	660	Rural	Pumped	350	70	60	12	None	Well	5.00	N.A.	N.A.
	Wichaj Lupe	430	572	Rural	Gravity	420	105	60	24	0.5	Spring	0.16	JUN 84	N.A.
	Pasto De Lobos	223	297	Rural	Gravity	205	22	80	24	None	Spring	1.20	OCT 84	N.A.
	Callohalca	244	323	Rural	Gravity	244	27	80	24	None	Spring	0.70	OCT 84	N.A.
	Puqvi	505	670	Rural	Gravity	216	36	60	24	None	Inf Gal	0.85	OCT 84	N.A.
	Alaroco	320	425	Rural	Gravity	140	N.A.	N.A.	12	10	Spring	0.54	FEB 85	N.A.
	Todos Santos	350	466	Rural	Gravity	336	56	80	24	None	Spring	0.50	JAN 85	N.A.
	Negrillos	395	526	Rural	Gravity	240	N.A.	N.A.	12	20	Spring	1.60	JUN 85	N.A.
	Pongo	270	360	Rural	Gravity	270	46	60	24	None	Spring	0.40	JUL 85	N.A.
	Huerta Pampa	240	320	Rural	Gravity	156	26	60	24	None	Spring	0.20	JUL 85	N.A.
	Torko	228	298	Rural	Gravity	228	30	100	24	None	Spring	1.00	JUL 85	N.A.
	Carangas	430	573	Rural	Gravity	300	55	80	24	None	Spring	0.79	JUN 85	N.A.
	La Rivera	360	480	Rural	Gravity	360	29	80	24	None	Spring	0.37	AUG 85	N.A.
	Julo	306	420	Rural	Pumped	306	51	80	12	None	Spring	3.00	AUG 85	N.A.
	Surumi	300	400	Rural	Gravity	250[4]	N.A.	60	24	None	Inf Gal	1.30	OCT 85	N.A.
	Totoral	1000	1602	Rural	Gravity	835[4]	N.A.	60	24	None	Inf Gal	1.30	OCT 85	N.A.
	Pisiga Sucre	200	270	Rural	Pumped	165[4]	N.A.	60	12	None	Well	1.79	OCT 85	N.A.
	Pisiga Bolivar	200	270	Rural	Pumped	165[4]	N.A.	60	12	None	Well	1.79	OCT 85	N.A.
	Leque Palca	216	288	Rural	Gravity	200	40	80	24	None	Well	1.50	OCT 85	N.A.
	Leque Lequene	180	240	Rural	Gravity	180	N.A.	N.A.	N.A.	25	River	15.00	OCT 85	N.A.
	Quelcata	1200	1600	Rural	Pumped	852	142	60	12	None	Spring	4.00	JUL 85	N.A.
	Sevaruyo	1800	2400	Rural	Pumped	1495[4]	N.A.	60	12	None	Spring	3.00	NOV 85	N.A.
	Corque	879	1183	Rural	Gravity	730[4]	N.A.	80	24	None	Spring	3.50	NOV 85	N.A.
	Poopo	2800	3707	Rural	Gravity	2325[4]	N.A.	60	24	None	River	15.00	NOV 85	N.A.
	Belen de Hvachacalla	300	400	Rural	Gravity	250[4]	N.A.	N.A.	24	40	River	3.20	OCT 85	N.A.
	Aqua Cruz	200	266	Rural	Gravity	165[4]	N.A.	N.A.	24	15	Spring	N.A.	NOV 85	N.A.
	Pampa Aullagas	1800	2378	Rural	Pumped	1495[4]	N.A.	60	12	None	Spring	1.00	NOV 85	N.A.
	Huayna Pasto Chico	300	396	Rural	Gravity	250[4]	N.A.	N.A.	24	50	River	10.00	NOV 85	N.A.
	Santiago de Andamarca	1200	1585	Rural	Gravity	995[4]	150	80	24	None	River	3.00	OCT 85	N.A.
	Subtotal	18166	24429			14863								0
													Grand Total	156

NOTES

N.A. = Not Available
Inf Gal = Infiltration Gallery
Suc Sys = Sucre System

(1) Figures shown are from design of system and do not reflect actual amount of water available per person per day
(2) lpcd = liters per capita per day.
(3) Flow (lps) = liters per second. Figures shown are for flow measurement before system construction and do not reflect the average flow or the amount of water that is actually available. Flows also reflect the amount for the entire system -- which may be several communities combined.
(4) Data not available, program wide average of 83 percent used to estimate population served.
(5) Projected completion date
(6) Estimate based on 6 persons per family.

APPENDIX D

Engineering Observations for the Communities
Visited by the WASH Evaluation Team

Summary of Engineering Field Observations
for Communities Visited by the WASH Evaluation Team

During the evaluation, the WASH team visited 15 projects (17 communities) in the CARE program. In a community, the WASH team observed selected parts of the water or irrigation system. The team's observations are listed below. Note that because the WASH team's scope of work did not include a comprehensive analysis of each system, there may be some additional items that should be corrected but are not listed below.

General for all communities:

- install splash tank and drainage around standposts
- put reinforcing in the base slab of all new water storage tanks
- install boxes to cover and protect shut-off valves at house connections
- use water stops on pipes that penetrate concrete walls of intakes and storage tanks - to prevent leakage

1. Suanaca, Jachasivi - La Paz
   a. Access hatches to both storage tank and valve chambers are too heavy--should be light enough for 2 to 3 persons to move.

   b. Extend overflow drain from storage tank past the valve chamber to prevent flooding of chamber.

   c. Valve chamber should have unions to remove valves - and more working space around/below valve.

   d. Install drainage pipe for valve chamber to eliminate standing water.

   e. The water source was reported to be a spring but is actually a river infiltration system and is not optimally located to capture this source. The community reports that it does not have an adequate 24-hour supply of water. CARE should investigate additional sources or the expansion of the existing source to increase the supply.

   f. Investigate and encourage communities to repair two water system leaks that have been present for months.

2. Cairoma - La Paz

   a. Provide fences and ditches around intakes to prevent contamination from runoff. Fill in open excavations around structures.

   b. Intakes need some remedial concrete repair work - especially chamber covers.

c. Extend drainage and overflow pipes away from valve chamber.

d. Community installed its own intake--but at an elevation that is lower than the existing ones. CARE should work with community to obtain additional supplies and to install isolation valves to improve hydraulics of distribution system where new intake was constructed.

e. Community has experienced a number of water main breaks because of high pressure. CARE should install additional valves and instruct community in correct procedures for filling water system - breaks are probably due to high pressure from filling water system. Having a 24-hour supply will also help.

3. Bajaderia - La Paz

a. Town does not have an adequate water supply but sufficient flow exists at the spring site. Problem is that only one of four springs was captured. Intake should be expanded to capture additional flows. This should provide enough water for domestic needs and for family farm plots - which are badly needed. Existing spring should be fenced and fill placed over spring to prevent surface contamination.

b. Valves in valve chamber are rusting and there is no way to drain water from this structure. Valve chamber should be made deeper and drainage installed to keep it dry. Valve on storage tank overflow pipe should be removed to allow free overflow of tank.

c. Install bird/insect screening on storage tank vent pipe.

d. Repair broken PVC transmission pipe on upstream side of storage tank.

e. Storage tank should have been located at a higher elevation to serve a larger area (more people).

f. There have been an excessively large number of leaks in the water distribution system. Reportedly, this is due to the lack of adequate supply of pipe glue during construction. CARE should investigate this problem to determine the exact cause of the leakage.

g. There are a number of houses in the vicinity of the community plaza where water service connections are not installed either because the houses are rented or the families are too poor to afford connections. Currently these people are using a poorly constructed, open well for water supply. At a minimum, one public standpost should be installed in this area to provide access to the new potable supply.

4. Pongo - Oruro

a. System appears to be well constructed except for drainage around standposts.

b. Provide fencing and drainage ditches around the spring intake to protect it from surface contamination.

5. Huerta Pampa - Oruro

a. System appears to be well constructed except for drainage around standposts.

b. Provide fencing and drainage ditches around the spring intake to protect it from surface contamination.

6. Copacabana - Oruro

a. Spring intake is located in a dry river bed. During rainy season river level can overtop short retaining wall and flood intake structure -- introducing contaminated water into the water system. Also, there are stagnant water pools in the river bed next to the intake structure. Intake structure was filled with rocks which were reportedly used for filtration. WASH team recommended that the river bed (only 2-3 meters wide) be channelized and the height of the retaining wall increased to prevent flooding of the intake. Channelizing the river bed would also remove the low spots where stagnant water accumulates. A retaining wall should be constructed to support the river bank next to the intake -- to keep it from collapsing on the intake structure. The WASH team also instructed the community to remove the rocks from the intake chamber--these serve no useful purpose and impede cleaning and maintenance. The team left a list of written instructions for the community to follow.

b. The valve chamber next to the intake is full of water and the valve is rusting. The valve mechanism has been removed. A drain line should be installed on the chamber to remove excess water and the valve should be replaced (with unions included).

c. Additional shut-off valves should be installed in the system to allow shut-down of sections for repair. Currently the valve on the downstream side of the storage tank is the only valve that can be closed and shuts down the entire system.

d. There are several leaks in the water system that have gone unrepaired for at least several months -- one for eight months. This leak is on the end of a pipeline section. Because the community does not have repair materials, they have not fixed the leak. They have attempted to reduce the amount of leakage by folding the pipe and weighting down the folded section with rocks.

e. Several pipe sections were uncovered for inspection. The depth of pipe was too shallow (.30 meters vs. the design depth of 1.0 meter). Also, small rocks were included inthe backfill material. These conditions may be contributing to periodic pipe breaks.

7. La Lava - Potosi

a. Excavation on the upstream side of the spring intake was left open, contained stagnant water; and could be contaminated by animals. This area should be filled and fencing and drainage ditches installed to prevent contamination from surface runoff.

b. The area on the other side of the river that runs through the community contains a number of houses that are not served by the water system. The water system should be expanded to include these houses.

c. The valve chamber was constructed next to an irrigation channel which is leaking and flooding the chamber. The chamber should be relocated to a drier area.

8. Chilcani - Potosi

a. The people in the community report that they do not have enough water to supply their needs. CARE should investigate additional sources to increase the supply.

9. Huary Huary - Potosi

a. The water supply system for this community was constructed in particularly difficult mountainous terrain. The system appears to be well constructed and maintained -- with the exception of the break pressure tanks which are too small and do not have overflow pipes. Therefore, the tank sometimes fills and overflows over the sides of the tank. An overflow pipe should be installed to carry excess flow away from the structure and a valve should be installed on the tank inlet pipe that can be manually throttled to control the rate of flow into the tank.

10. Quivi Quivi - Potosi

a. The general design and construction of this system was very good. However, the community reported that it did not have adequate 24-hour water supply. CARE should investigate additional sources to increase the supply.

b. The community reported a number of pipe breaks. This may be caused by the high pressures that are generated when the system is filled -- after a water shortage period. If this is the case, CARE should instruct the community in correct filling procedures. An increase in the supply would also help to alleviate this problem.

11. Tecoya - Potosi

a. The community does not have an adequate 24-hour water supply. CARE should investigate additional sources to increase the supply.

12. Carvajal - Chuquisaca

a. The source of supply is an infiltration gallery located in a river bed. During periods of high river flow, the river level can overtop the intake chamber and water can enter the chamber. The suction pipe from the pump to the chamber is in the air and supported by sticks.

It can be easily destroyed by vandals and /or floods. The community also reports that it does not have an adequate 24-hour water supply.

b. CARE should determine if the source is inadequate or if the community is limiting its pumping (its supply) to reduce its monthly maintenance costs. It also appears that the community does not fully understand the correct operation of a pumped storage system. CARE should review the community's procedure and leave written instructions with the community.

c. Because of the danger of contamination, and the instability of the suction pipe, the intake to the intake chamber should be sealed shut and the intake pipe should be buried and covered with rip rap.

d. The review of the storage tank size for Carvajal showed that it is too small for the community's pumped system. The storage should be enlarged or the pump sizes should be decreased to better match the pump capacity to demand -- decreasing the size of storage that is needed. There are two pumps in this system.

13. Siguayo - Chuquisaca

a. There is a major problem with the water supply for this community, which has relocated to take advantage of the new supply and a housing program. The community reports that it does not have an adequate 24-hour supply during much of the year and had no water during June, July, and August of 1985. CARE should investigate additional sources of water to increase the community's supply.

14. San Antonio de Chaupillayta - Chuquisaca

a. This community was the only full fledged irrigation project visited by the WASH team. A previous project by CARE had installed a community water system. WASH found that the irrigation system did not have an adequate supply. During the visit (the planting season) no water was available from the irrigation system.

b. To cross a river bed (with the irrigation canal), CARE installed three parallel runs of 6-inch diameter PVC pipe. However, the pipe is unsupported along its length and fixed in concrete at the ends. As a result the pipe is sagging, especially at the bell joint in the middle of the crossing and is structurally unsound. In addition, the PVC pipe is exposed to direct sunlight and will deteriorate.

c. CARE should investigate additional sources of water (a spring or infiltration gallery instead of river water) for the irrigation system. The PVC river crossing should be replaced by well supported, galvanized steel pipe.

d. Although the water system was not constructed under the current AID project, WASH noted that a principal quebrada crossing (by a PVC water pipe) was supported in the air by sticks. This quebrada crossing should be changed to galvanized pipe and buried -- to avoid pipe collapse and shut down of the water system.

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15. Vila Vila/Vila Vila Norte - Chicquisaca

a. The source of supply is a spring that was formerly tapped by a shallow, hand-dug well (upstream of where the spring surfaces). The new source is a spring intake and storage chamber. Water is pumped from the chamber to the distribution system. The old well is still present and although isolated by a wall, presents a possible source of contamination. The community reported that its 24-hour water supply was not adequate.

b. CARE should determine if the source is inadequate or if the community is limiting its pumping (its supply) to reduce its monthly maintenance costs. It also appears that the community does not fully understand the correct operation of a pumped storage system. CARE should review the community's procedure and leave written instructions with the community.

c. The review of the storage tank size for Vila Vila showed that it is too small for the community's pumped system. The storage should be enlarged or the pump size should be decreased to better match the pump capacity to demand -- decreasing the size of storage that is needed.

d. The old well should be covered and sealed shut to prevent possible contamination of the water supply.

e. The area upstream of the spring should be fenced and drainage ditches installed to prevent runoff from a cow pasture from contaminating the source.

f. Drainage piping should be installed around the storage tank and valve chamber to prevent groundwater from entering the valve chamber --already full of water and rusting.

g. Public standposts should be installed to allow access to the water system by persons who used to obtain water from the old well (now inaccessible) and who have not yet installed water service connections.

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