WASH

WATER AND SANITATION FOR HEALTH PROJECT

Operated by
CDM and Associates

Sponsored by the U.S. Agency
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REPORT ON TECHNICAL ASSISTANCE TO THE VILLAGE-LEVEL WATER AND SANITATION PROJECT, CARE/BELIZE

WASH FIELD REPORT NO. 193

JULY 1986

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Prepared for
the USAID Mission to Belize
WASH Activity No. 225

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by

J. Ellis Turner

July 1986

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LIST OF ACRONYMS

MOA	Ministry of Agriculture
MOH	Ministry of Health
PAHO	Pan American Health Organization
PHI	Public Health Inspector
RWS	Rudimentary Water Systems
VLWS	Village-level water supply
WASA	Water and Sanitation Authority
WHO	World Health Organization

Chapter 1

BACKGROUND

1.1 History of the Village-Level Water and Sanitation Project

The CARE Village-Level Water and Sanitation (VLWS) Project, which is jointly funded by CARE and USAID, is a three-year effort focusing on approximately 1,600 households in the districts of Corozal and Orange Walk in northern Belize. The VLWS Project was initiated in July 1984 and will enter its third year in July 1986.

The water supply component of the project will include the installation of up to 160 India Mark II handpumps (one per ten families by WHO/PAHO standards) on either new or rehabilitated wells. The project will also include the installation of supply sources and distribution systems (rudimentary water systems -- RWS)) in two villages. The construction of rudimentary water systems was not included in the original project document but was added to the project in January 1986. The sanitation component of the project includes the construction and/or rehabilitation of up to 1,600 latrines (one per family.) The overall project places a strong emphasis on health education for all age groups and includes both formal, school-based programs and nonformal, community-based education.

1.2 WASH Involvement and Scope of Work

During 1986, the Water and Sanitation for Health (WASH) Project and CARE developed and delivered a water supply and sanitation workshop for CARE personnel from ten Latin American and Caribbean countries. The workshop was held in Trujillo, Peru, during April 1986. Part of the activity was the provision of one week of technical assistance to selected CARE missions, following the workshop in Peru. Mr. J. Ellis Turner, one of the workshop trainers and the Associate Director for Engineering for the WASH Project, was asked to provide one week of consulting time to the CARE/Belize Mission. The scope of work for his assignment was the following:

- Visit the San Antonio Rudimentary Water Systems project site.
- Make recommendations in relation to preliminary studies of the San Antonio RWS project site; review and discuss recommendations with counterpart (Ministry of Health.)
- Develop operations and maintenance activities for the design selected for San Antonio by its water and sanitation committee and by the community.
- Develop policies for an agreement between CARE and the community for the San Antonio project.
- Review plans for rehabilitating other Rudimentary Water Systems constructed under previous CARE and Government of Belize projects.

- Assist in preparing a plan for internal project monitoring.
- Prepare the final report and recommendations.

The consulting assignment was carried out by Mr. Turner from Wednesday, April 16, 1986 to Thursday, April 24, 1986. Initial meetings were held with CARE, the Belize Ministry of Health (MOH), and USAID personnel. A meeting was also held with Messrs. Fred Smith and Sylburn Arthurs of the MOH to discuss Mr. Turner's preliminary findings. Final debriefings and the presentations of Mr. Turner's conclusions and recommendations were held with both USAID and CARE personnel. A list of contacts for the assignment are presented in Appendix B of this report.

Chapter 2

EXISTING CONDITIONS AND FINDINGS FROM FIELD VISITS

2.1 Introduction

During the assignment, the consultant visited the communities of San Antonio, Douglas, Nuevo San Juan, Buena Vista, San Pablo, San Victor, San Luis, and Santa Marta. The consultant's general findings during these visits are presented in the following sections of this chapter. Conclusions and recommendations are presented in Chapter 3.

2.2 Water Supply Practices

2.2.1 Sources

Rainwater Catchment. One of the mostly widely used sources of drinking water supply in rural Belize is rainwater catchment. The use of rainwater systems has certain advantages -- especially the low maintenance cost. Where rainwater catchment systems exist, owners should be encouraged to upgrade their systems and provide periodic cleaning and maintenance. Where there are pipe community water systems too, the rainwater systems can provide a cheaper source of good water and can also provide a back-up source in the event of a piped water system breakdown. Where there are neither piped systems nor existing rain catchment systems, the rainwater collection system should be considered as a desirable alternative.

Rainwater is collected from galvanized roofs through a series of gutters and drains to a ground storage tank. The ground storage tanks are usually constructed of galvanized metal. Some of the tanks are constructed of wood and resemble large barrels constructed of wood staves. The use of ferrocement as a storage tank construction material is virtually unknown in Belize.

Rainwater is preferred to groundwater because of its low mineral hardness that produces a superior taste to the usually hard groundwater. It is also preferred to groundwater for cooking beans, which do not soften when cooked in hard water.

Although rainwater is preferred and large storage tanks are used, the amount of rainwater is limited by the duration of the rainy season. As a result, rainwater is used sparingly over a period of months and is used mostly for drinking and cooking. Other sources of water such as streams and rivers or wells provide water for bathing, washing clothes, and other domestic uses. Even in the City of Belize, which has a treated water supply (from a freshwater river) and household water connections, many residents use rainwater cisterns in preference to the city water supply. Most of the rainwater catchment systems were installed before the municipal water system was built but are still being used because of the high cost of municipal water. In some communities, large masonry ground-storage tanks with catchment roofs have been installed and are operated by the community.

The principal disadvantages in the use of rainwater systems in Belize are the:

- Lack of a design which would permit the bypass of the first flush of water once rainfall begins (The first flush carries dirt and bird droppings into the storage tank.)

- Deterioration of bacteriological water quality over time

- Availability of stored water if left uncovered as a breeding ground for mosquitoes. (Malaria is prevalent, especially in northern Belize.)

An attempt has been made to prevent mosquitoes from entering the storage tanks by installing wire screening over the inlets to the tanks, and water quality is improved somewhat by the periodic (once-a-year) cleaning of the tanks. In some cases, however, the wire screening is not present or the screening is not fine enough to keep mosquitoes out. Modifications to the design of the catchment systems and more extensive user training will be required to ensure that rainwater catchment systems will provide an acceptable drinking water quality.

Hand-dug Wells. Next to rainwater catchment systems, hand-dug wells are the most prevalent source of water supply. Because of the heavy reliance on rainwater for drinking water, however, these wells are often used as drinking water supplies only when stored rainwater is exhausted. Unfortunately, this often coincides with the driest part of the year when groundwater levels are dropping and some of the shallow hand-dug wells go dry.

For the most part, hand-dug wells are protected by a headwall of either concrete or masonry construction. Occasionally, old truck tires are stacked around a well to protect it. The headwalls serve several functions. First, they prevent children and animals from falling into the wells. Second, when well constructed, they keep surface drainage from entering and contaminating the well (tires are unable to provide this protection.) Third, they provide a place to mount a pulley or beam that can be used to lower a bucket into the center of the well. In general, the headwalls appear to be well constructed, but covers and drainage pads around the headwall base should be installed to provide better protection. In all cases, the use of a bucket to retrieve water is a potential source of contamination. Occasionally, electric or small gasoline or diesel pumps have been installed for the user's convenience and to prevent contamination of the well from the rope and bucket.

Hand-drilled Wells. Hand-drilled wells are rarely, if ever, used in Belize. They do have the advantage of permitting greater community participation in well drilling and eliminating reliance on expensive and scarce well-drilling rigs. Under certain conditions (fairly homogeneous soils without rocks and boulders), hand-drilled wells could be used effectively in Belize.

Drilled Wells. Most drilled wells in Belize have been installed by cable tool-drilling equipment. Currently, for use in the MOH's rural water supply program, there are only three operational cable tool rigs in the country, and most of these need extensive rehabilitation. One new rotary drilling rig exists that was recently provided to the Ministry of Health under the UNICEF water supply program. Because it is currently being used in the UNICEF program, this rig is unavailable for well installation in either the central districts or in the northern districts of Corozal and Orange Walk.

Traditionally, drilled wells in Belize have been either four or six inches in diameter and have been installed with steel casing before PVC was available. Because of the rapid corrosion of the steel and its effect on water quality (especially taste), most of the new wells are being installed with PVC casing. Where the groundwater is naturally high in iron and manganese, the change to PVC well casings will not appreciably affect the water quality.

In the rural areas of northern Belize, many of the wells have been fitted with handpumps mounted on small concrete pads. Occasionally, wells have been fitted with small centrifugal pumps (electric or diesel), submersible pumps, or jet pumps.

In most well installations, well development (by backwashing and/or surging) is not practiced. Well pumping (to measure the groundwater drawdown and determine well yield) was generally not practiced in the past but is now being used more frequently. The methods of well logging, well development, and well testing, however, do not appear to be used consistently from one installation to another.

With the recent use of PVC as a well-casing material, well screens are also made of PVC. Unfortunately, the screens are being made in the field by cutting slots in the PVC casing with a hacksaw. Because of the way the slots are cut, the slots do not correspond to the grain size of the material in the aquifer. Often times bottom plates are not installed in wells. The result is poor well yield and/or the progressive filling of the well with fine material that is entering the well through the wide slots or from the bottom of the well.

Well-siting Criteria. At present, no water resource studies or groundwater maps exist that could be used to determine the potential locations of wells. Reportedly, some exploratory well drilling has been undertaken by oil companies, but the logs of these drilling operations are unavailable. As a result, well drilling is on a trial-and-error basis, and well siting in a given community is based on local experience. Well sites that could take advantage of favorable geologic conditions (that is, near river or stream beds) are often ignored, and wells are often not deep enough to hit water of acceptable quality or to avoid dry spells (from falling groundwater tables). The use of casing and grouting to exclude layers of inferior water quality is generally not practiced.

Typical water-quality problems throughout the northern districts include: high hardness, high salinity, iron and manganese (sometimes from well casing corrosion), and hydrogen sulfide. Because water treatment in rural areas is either too expensive or infeasible, the types of water-quality problems mentioned above are best avoided by better well location criteria (to take advantage of groundwater flow under streams and rivers) and improved drilling practices (use of grouting and casing to black out poor quality aquifers).

2.2.2 Water Systems

Types of Systems. Few of the rural communities in the districts of Orange Walk and Corozal have water distribution systems. Some systems were installed in past MOH or CARE projects, but, for a variety of reasons, many of the systems are not functioning. The most common forms of community water systems (other than rainwater catchment) are handpumps and hand-dug wells (discussed previously). Because of the flat terrain in northern Belize, gravity-fed water distribution systems are virtually nonexistent. Even where springs or artesian wells can be found, pumping to an elevated storage tank is usually required for a community distribution system.

The existing hand-dug wells have been installed mostly by individuals, while the handpumps (and wells) have been installed primarily under MOH programs. An attempt was made to locate the handpumps in areas that were accessible to the most people, but in many cases they are still not within easy walking distance.

Most of the handpumps that have been installed in the rural areas were made by Dempster. Reportedly, these handpumps have not held up well under the high rate of use at community water supply wells (as opposed to the farm use for which they were designed) and many are not functioning or have been abandoned. Further, the drop pipes that were installed with the Dempster pump were galvanized steel that easily corroded. Coupled with the corrosion of the steel casing the resulting poor water quality (an iron taste) has discouraged the use and maintenance of the Dempster.

Another problem with handpump installations of the past was the base pad; many of the pads were too thin and later cracked (allowing infiltration and contamination of the well) or were too small to adequately protect the well. Poor drainage compounded the problem by creating muddy pools at the base of the handpump, thereby creating an additional health hazard.

In addition to the Dempster, a number of other handpumps have been tried without much success. Most recently, however, Consallen and India Mark II pumps have been introduced and appear to be functioning well.

In an attempt to remedy the problem of stocking spare parts and repairing a number of different types of handpumps and because of its durability, the MOH has decided to standardize around the India Mark II Handpump. As a result, all three of the major VLWS water supply programs (USAID, UNICEF, and CARE) will use India Mark II pumps where handpumps are installed. In the northern districts, the few India Mark II handpumps that have been installed have been located on large concrete drainage pads that are pitched to drain to a soakaway channel and pit. Although the pitch could be increased to facilitate drainage, the addition of this type of pad has greatly improved the sanitary conditions around and protection of the well source.

Because of the cost of construction, few rural water supply distribution systems have been installed in Orange Walk and Corozal. In those that were constructed, the storage tank has generally been elevated and made of concrete. Some of the elevated storage tanks were made of galvanized steel (donated by CARE or UNICEF), and these appear to have held up much better than the concrete tanks.

Water Quality and Treatment. At present, no agency exists that can handle the quantity of sample analyses that will be required for the rural water supplies in Belize (for selection of sources and for continuing analyses once a water supply is installed). When a water-quality analysis is required the physical/ chemical analysis is done by the Health Department and the bacteriological tests are done by the Water and Sanitation Authority (WASA) in Belize City. Turnaround for sample analysis is from three days to three weeks. Because of the limited facilities available and the distance to the lab, water-quality analysis is sporadic.

Some of the Public Health Inspectors (PHIs) in the field have water-quality testing kits. These, however, lack replacement chemicals and are generally unused. To respond to the increasing rural water supply needs for water quality analyses, an AID-funded program has been started to establish a national water quality laboratory -- mostly for rural water supplies -- located in the Public Health Building in Belize City. Although the program is approximately one year behind schedule, equipment for the lab has been ordered, and training of lab technicians is being scheduled.

As mentioned, water treatment for surface supplies, or for the removal of hardness, salinity, iron, manganese, or hydrogen sulfide, is generally too expensive and complicated for use in rural water systems. In some cases, disinfection through chlorination has been used in rural systems. The disinfection system consists of a pulse feeder which uses either liquid or powdered sodium hypochlorite in solution.

Although chlorination should ideally be installed on all water systems to provide a chlorine residual within the system (and protect against contamination), because of the cost to the community and the difficulty of providing adequate O&M, the use of chlorination at present, in rural water systems, should be considered only where it is necessary to treat the source water and where the community has the demonstrated capability to pay for and maintain a chlorination system.

2.2.3 Organizations Responsible for Water Supply

Within Belize, three agencies are responsible for water supply and well-drilling activities. These agencies and their areas of responsibility are:

- Ministry of Health (MOH), rural areas
- Water and Sanitation Authority (WASA), urban areas
- Ministry of Agriculture (MOA), farm use

The MOH is the agency responsible for planning and installing rural water supplies. It is managed on the district level by the public health inspector (PHI), who also has responsibilities for a number of other sanitation activities.

At present, the well-drilling capabilities of the MOH and the other agencies are limited and consist of the following equipment:

- MOH - 1 rotary drilling rig
  - 2 operational cable tool rigs
  - 2 cable tool rigs out of service

- WASA - 1 operational cable tool rig
  - 2 cable tool rigs out of service

- MOA - unknown, but generally unavailable for rural water supply development

The MOH, which is responsible for providing the well-drilling equipment for all three of the VLWS programs, has only one rotary rig and two operational cable tool rigs. The rotary rig (provided under the UNICEF project) has been committed to the Toledo District and will be unavailable for drilling activities in other districts during 1986. In an attempt to provide additional drilling capacity, equipment from the other agencies (WASA and MOA) is sometimes used. In addition, the USAID-funded water project in central Belize has funds for rehabilitating most of MOH's well-drilling equipment and purchasing a new cable tool rig. Although these efforts will increase the availability of welldrilling equipment for rural water supply efforts, the limited number of rigs may delay the completion of the proposed programs.

2.2.4 Operation and Maintenance Responsibilities

Because of the history of problems with handpump maintenance, the MOH has adopted a policy of standardizing the handpump in Belize. All new handpumps that are to be installed are to be the India Mark II type. This policy will help to ensure better maintenance of the handpumps by standardizing spare parts, repair procedures, and training materials.

In the past, organization and maintenance of handpumps and wells were the sole responsibility of the PHI. Neither communities nor individuals in the community could not repair a pump. As a result, broken pumps were not operational for weeks at a time. To remedy this situation, the MOH has established handpump maintenance crews that will be responsible for repairing the below-ground portion of handpumps. The communities will be responsible for the above-ground portion.

Although the MOH policy represents a significant improvement and will help to ensure continuous handpump operation, too few crews exist to cover the number of handpumps in the country. For instance, only one crew is available to cover the districts of Orange Walk, Corozal, rural Belize, and San Ignacio. MOH planned to have two crews for this area but the second crew has not yet been established. In Orange Walk and Corozal, there are 210 Dempster handpumps (that require frequent maintenance) plus the new India Mark II handpumps that are being installed.

Another problem is the availability of spare parts. Currently, spare parts are available mostly through the Ministry of Works, which has the funds to buy and stock them. To make the regional maintenance crews more effective, staff of the Ministry of Works should be purchasing and stocking the materials that they need to maintain the handpumps in their jurisdiction.

In general, the Village Councils have the responsibility for the maintenance of community water systems, including pumped systems. However, many of these systems have been poorly maintained and, in a number of cases, are not functioning. One reason for the poor maintenance record is the lack of a fee collection system in communities. Although this has not been particularly successful in the past, communities appear to be willing to collect fees for new RWS systems, but not for handpump systems. Most people view handpumps as a low level of service that should be paid for by the government.

2.2.5 Design and Construction Standards

At present in Belize, there are no published national or regional design or construction standards for water supply systems.

2.3 Sanitation Practices

In the rural areas of northern Belize, the presence of pit latrines is common. For the most part, however, the older latrines are poorly constructed, allow the entrance and breeding of flies and mosquitoes, and produce foul odors. As a result, the use of the pit latrine is discouraged. In an attempt to improve the quality and rate of usage of latrines, the Ventilated Improved Pit (VIP) latrine and compost latrines have been introduced in rural Belize by CARE. CARE is in the process of putting together a booklet containing plans and information for constructing the VIP latrine. In northern Belize where CARE is working, the VIP latrine appears to have been accepted.

Chapter 3

CONCLUSIONS AND RECOMMENDATIONS

3.1 Introduction

The following sections of this report describe the major conclusions and recommendations of the WASH consultant. In addition to these conclusions and recommendations, the consultant reviewed CARE's water system design procedures and discussed with CARE personnel a number of modifications to the procedures.

3.2 CARE's Village-Level Water and Sanitation Project

CARE's community promotion activities and project implementation activities got off to a slow start but are now proceeding smoothly. Much of CARE's effort has concentrated on promoting community organization and full participation in the VLWS program and in health education. This approach is especially evident in San Antonio and Buena Vista where the sanitation program is advancing and the communities are successfully initiating their own changes in latrine pit design to accommodate local conditions.

Although much effort to date has been expended on various aspects of the VLWS program, CARE has adopted standard procedures (including design criteria and construction standards) for the VLWS Project. The WASH consultant recommends, therefore, that CARE consolidate the work that has been completed and adopt the following standard procedures, as soon as possible:

- A standard form of agreement among the VLWS community, CARE, and the MOH
- Design criteria
- Construction standards
- Community training programs
- Written and illustrated community operation guidelines
- An internal project monitoring plan.

Each of these procedures is described in detail in Appendix A of this report.

The current low number of water quality samples that can be processed and the turn around for sample analysis will limit the effectiveness of water testing during the well exploration program.

To be able to test the physical/chemical and bacteriological quality of proposed water supply sources, CARE should take the following steps:

- Work with the MOH and USAID to try to expedite the start-up of the national water quality lab. According to Dr. Bill Boughton of Project Hope, some of the basic laboratory services (that is, bacteriological analyses) that will be needed in the VLWS project could be set up within approximately two to three months.

- Work with the MOH and USAID to review the condition of Hach field water quality test kits that MOH now has but is not using.

Evidently, several of these kits are in the MOH/Belize office, and at least one kit is in each PHI district office. If these kits are suitable for testing of pH, hardness, hydrogen sulfide, chlorides, and nitrate then they should be refurbished (new batteries, if necessary, and chemical supplies) for use in the field during well drilling and testing of sources.

- If the foregoing arrangements cannot be made in time to provide water quality testing during the VLWS drilling program, then CARE should purchase field kits to conduct both bacteriological and physical/chemical tests.

For the community of San Antonio (Orange Walk), several water supply options appear to be feasible:

1. Development of a RWS using the existing artesian well (with the largest flow) as the course and construction of an elevated storage tank and distribution system

2. Development of a RWS using a proposed well near the river and construction of an elevated storage tank and distribution system

3. Development of a handpump to serve the village.

At present, neither a solar-driven pump system nor a hydraulic ram pump appear to be feasible methods of pumping water to a proposed Rudimentary Water System. In the distribution system options discussed above, an existing steel storage tank, which is stored at the MOH warehouse, could be used in San Antonio, thereby reducing the overall project cost.

On the basis of the alternatives available, the consultant recommends that the first option -- using the artesian well and constructing an RWS -- and the third option -- a handpump program -- be developed for presentation to the community. The capping of the existing artesian well (for a RWS) will be a difficult operation because of the continuous flow of water from the well. The capping operation will require the use of two pumps (one on the well to be capped and the other on the remaining well) to drawn down the water level inside the pump casing. Once the water level is down, quick-setting cement should be poured around the existing well casing to seal off the escape of groundwater and to form the foundation of the well intake structure.

Currently, CARE is preparing a preliminary design and cost estimates for the first alternative. CARE should also prepare costs (including both construction and O&M costs) for the handpump alternative. Once the alternatives are presented to the community and an alternative is selected, CARE should complete its final agreement with the community and begin final design work.

It is also worthwhile to note that a drainage problem exists in San Antonio because of the overflow from the artesian wells. If either or both of the artesian wells are not used, then they should be capped or drainage pipe should be installed to direct the drainage to the river. One option to consider would be to use the overflow to supply a community laundry or bathing facility that could be constructed near the river.

For the community of Douglas, the principal problem in providing a new water supply is the presence of hydrogen sulfide in the water. After visiting the site, the consultant believes that the hydrogen sulfide problem is localized and that drilling closer to the Rio Honda could yield an adequate quantity and quality of water to supply the village. In the event that a hydrogen sulfide-free source could not be found, the water could be aerated to remove it. According to Mr. Fred Smith of MOH, this type of treatment has been successfully used in San Pedro Town.

If a well is located in the river flood plain, the well house and pump should be constructed at an elevation that is sufficiently high to avoid being submerged when the river floods. Once a new supply is located, the existing water storage tank and distribution system (with some rehabilitation and leak repair) could be used.

The nearby village of Nuevo San Juan, which is located near the traditional supply source for Douglas (but was abandoned because of the long distance and cost of pumping) could be developed along with a distribution system and storage tank, to provide a RWS for that village. A second alternative is to provide a handpump program for Nuevo San Juan. Water quality in the area appears to be acceptable.

The consultant also visited the communities of Buena Vista, San Pablo, San Victor, San Luis, and Santa Marta. Handpump programs are proposed for all of these communities, with the possible exception of San Pablo, which once had a water system (distribution system, storage tank and wind driven pump) that is now abandoned.

In San Pablo, the consultant inspected the storage tank and well. The concrete storage tank, which is in an advanced state of deterioration, is unsafe for use and should be torn down. The well has gone dry and has been abandoned. In addition, the distribution system has been torn up by road construction. Therefore, if an RWS is to be considered for San Pablo, a completely new source, tank, and distribution system would have to be constructed. San Pablo, however, could be considered for a handpump program.

The remaining communities of Buena Vista, San Victor, San Luis, and Santa Marta all appear to have acceptable water quality and good potential well sites, although Santa Marta has some areas with high concentrations of hydrogen sulfide and salinity. Because of the low density of housing in these areas (except in Buena Vista), an RWS does not appear to be feasible, and handpump installation is recommended. Buena Vista, which stretches along the main road, could be considered for either a handpump program or an RWS.

On the basis of conversations with CARE, MOH, and UNICEF personnel, it appears that much of the well development in Belize is limited by poor water quality. In coastal areas, salt water intrusion is a major factor which cannot be avoided. In inland areas, the presence of high hardness, saline water, hydrogen sulfide, and iron or manganese often prevent the use of a potential well. With the exception of hydrogen sulfide, the cost and complexity of treating water to remove these elements make treatment in rural areas impractical.

Although these elements are present throughout Belize, they are often present in only certain aquifer layers and are often underlain by good quality aquifers. Current well-drilling practice, however, does not enable the drillers to seal out the poor quality aquifers and develop the good ones. As a result, many drilled wells cannot be used. Additional problems include the lack of bottom plates on wells, the lack of proper well-development practices (surging and backflushing), the use of slotted pipe (cut by hacksaw) instead of well screens, and inconsistent well-capping procedures, thereby increasing the possibility of contaminating wells. To improve these practices and to increase the quantity and quality of groundwater resources available in Belize, the consultant recommends:

- CARE consider and seek funding for (possibly through AID) a workshop for drillers and field inspectors that would concentrate on:

  - selected well-drilling procedures using cable tool equipment
  - well-screen selection
  - well development
  - well sealing (sanitary protection).

  The course should involve both classroom instruction and hands-on training. The course would be developed in three stages. The first stage involves a visit by a well-drilling expert and a trainer. The purpose of the visit would be to develop the content of the workshop and to review local practices, materials, and equipment. Drilling procedures would be developed that could be used consistently throughout Belize. The trainer's role would be to establish the training format, resources needed, and time required to deliver the workshop. The second stage is to develop the workshop. The third stage is delivery of the workshop by the drilling expert and trainer.

- Instituting procedures for stocking, selecting, and installing well screens instead of slotted pipe. The use of correctly sized well screens and bottom plates on wells should eliminate many of the problems of wells filling in.

- Developing standard details for well construction and logging procedures that can be used from site to site.

In addition to the health education activities that have been developed for the VLWS program to date and appear to be going well, some additional health-related activities should be implemented:

- Because people will continue to use rainwater catchment systems for drinking water, some effort should be made to encourage people to clean their storage tanks more often and to install and use first flush bypass pipes or sediment traps (this is to be included in a booklet now being formulated by CARE.)

- Once a RWS or handpump program has been completed, the use of hand-dug wells should be discouraged. These wells should be abandoned, filled, and capped, or at least covered and protected, to prevent contamination or creation of mosquito-breeding areas.

The consultant visited the latrine construction programs in San Antonio, Buena Vista, and San Victor. In general, the latrines (which are the VIP type and some compost), are well designed and constructed. Following, however, are observations and recommendations for improving the latrine program:

- CARE or community representatives should provide a greater presence during the construction phase of the program, to ensure that construction details (like vent pipes on the outside of the building, and size of the facility) are followed, that the shelters are sealed (generally with solid wood or plaster), and that the height of raised latrines is kept to a minimum.

- Reduce the size of the compost latrines to lower the cost and high profile of the facility.

- Reduce the slab thickness from 2 1/2 to 2 inches, and use 1/4" round rebar, thereby reducing the cost and weight of the slabs.

- Consider using metal forms for the slabs and constructing the slabs in two sections -- to reduce weight and make them easier to move in the future. Harry Phillipeaux of PRAGMA has developed a metal form system that could serve as a model.

- Use cheaper nonpressure PVC or ABS pipe for the vent pipe rather than the pressure-rated pipe.

- Use polystyrene beads in the latrine pits to cover the water surface (where there is a high groundwater table) to eliminate breeding sites for mosquitoes.

Generally, the India Mark II Handpump is designed for a minimum depth of 25 meters (approximately 80 feet). Where available groundwater does not require such a deep well, however, the depth of the well could be shallower. In such a case, CARE should consider modifying the Mark II handpump so that it could be used in as shallow a depth as 50 feet. The modification would require an increase in the pump rod thickness from 1/2 inch to 5/8 inch or the addition of weights to the rod. This type of modification is required to ensure that the pump rod and cylinder have sufficient weight to return to their pumping position on the pump upstroke.

Because of the importance of sustaining O&M of the VLWS systems once they are constructed, CARE should consider working with MOH and AID to try to increase the number of pump maintenance crews that will be available. Currently, only one crew is working in the two northern districts.

At present, CARE should be working with USAID and MOH to establish the dates and objectives of a project mid-term evaluation. A number of possible resources exist for the evaluation (including outside contractors or a joint CARE/MOH/AID team). If the services of the WASH Project are to be requested for the evaluation, then this request should be made as soon as possible so that assistance may be considered in WASH's upcoming annual plan.

APPENDIX A

Recommended Standard Procedures

Recommended Standard Procedures

In order to facilitate the planning, design, and implementation of its projects in Orange Walk and Corozal, CARE should consolidate the significant amount of work that has been done to date and develop a set of standard procedures -- including design criteria and construction standards. In general, the procedures should include the following:

- a standard form of agreement between the VLWS community, CARE and the MOH
- design criteria
- construction standards
- community training programs
- written and/or illustrated community operation guidelines
- an internal project monitoring plan.

A number of the policies and criteria that should be used have already been developed by the National Coordinating Committee on Water Supply and Sanitation. Any additional procedures or changes should be developed as soon as possible and discussed with the MOH and USAID so that any disagreement or conflicts can be resolved. These procedures should also be discussed and reviewed by the National Coordinating Committee on Water Supply and Sanitation. With agreed upon procedures and standards, the design and implementation of the upcoming VLWS projects will proceed much faster than they have to date.

The following section lists those items that should be included in each of the categories listed above and should serve as a checklist for CARE to use in its program implementation.

A.1 Standard Agreement

The purpose of the agreement between the community, CARE, and the MOH is to define the responsibilities of each party in the planning, design, construction, and operation and maintenance of a VLWS project. Although a standard agreement should be prepared -- to ensure that all responsibilities are covered -- the agreement should be modified to suit the circumstances of each VLWS project (community).

The agreement with the community where a project is proposed should take place in two steps. The first step is intended to define overall responsibilities for the project (for instance that the materials would be provided by CARE, that construction labor and system O&M would be provided by the community, and that below ground handpump maintenance would be provided by MOH). The first step should come after a certain amount of community promotion has taken place and will ensure that the community is willing to participate in the project. At this point the possible water supply or sanitation alternatives have not been developed.

The second stage of the agreement with the community comes when alternatives have been developed and the community has an opportunity to see what the level of service will be, what water supply sources will be used, what the O&M costs will be, and what specific responsibilities each party will have during and after the project. Once the community has selected an alternative, the original agreement (step one) is amended to define the project to be built and what each party's responsibilities are.

Some of the items that should be included in the two step agreement are:

- what the project will include (i.e. handpumps, or a RWS) with a list of the major components
- who will pay for each component (i.e. each individual will have to construct his own latrine shelter and house water connection -- and how much this will cost)
- that the community will have to establish a water and sanitation committee and what its major responsibilities should be
- that fees will have to be collected by the community for repairs, operation and maintenance of the system
- what training will be provided to the community
- that a system operations guide (written and illustrated) will be prepared jointly by CARE and the community for use by the community after the system is operating.

With all of the responsibilities for the project spelled out and understood by all parties and with the community having an opportunity to participate in the selection of the design of its system there is a greater possibility of resolving conflicts before the project begins and that the project will be supported by the community once CARE leaves.

A.2 Design Criteria

Since there are no published national or regional design criteria these should be established for both water supply and sanitation projects. The following items should be included in the program and reviewed with MOH:

- provisions for water quality testing of sources -- either field kits or in a lab
- water quality standards to be used
- the amount of water to be supplied for different levels of service (i.e. 30-40 lpcd for handpumps, a minimum of 60 lpcd for RWS, a maximum of 120 lpcd for RWS)
- design life of the projects to be constructed -- either 10 or 20 years

- method of gathering and projecting population figures (statistics -- regional annual growth rates may be available from government records)

- Maximum day factor -- to be used in the design of water supply sources and transmission facilities. Typically this factor varies between 1.5 and 2.5 in developing countries. In the absence of any local data, a factor of 1.8 is recommended.

- Peak hour factor -- to be used in the design of the distribution system piping network. Typically this factor varies between 2.0 and 3.5 in developing countries. In the absence of any local data, a factor of 2.5 is recommended.

- Distribution Storage -- the amount of storage to be provided in a RWS will depend on whether it is a gravity or pumped system and the reliability of the system. The design criteria could be one or two days of storage, a percentage of the maximum day demand, or could be calculated from a mass diagram of supply and demand for a given system.

- Maximum number of people to be served by each handpump. A figure of 60 has been adopted for the VLWS program.

- Minimum water system pressures. In order to keep costs (height) of elevated storage tanks to a minimum, a minimum pressure of 10-15 psi is recommended.

- Criteria for locating handpumps (i.e. maximum distance to the farthest user)

- Standard details for well construction (including drilling methods and supervision, logs, screening and well development), intake works, pipe installation, storage tanks, standpipes, and handpump installations.

- Standard detail for splash tank and drainage to be installed at each standpost. Without a splash tank and drainage, water will accumulate and create a health hazard (breeding ground for mosquitoes, hookworm, etc.)

- Standard details for all sanitation systems. For VIP latrines this would include the size and thickness of the base slab, collar and riser details, vent pipe diameter and material, screening and sealing details. Also included would be the expected life of the pit and the size and depth of the pit. Similar details should be adopted for compost latrines and should also include the size and expected usage period of each chamber. (These details are being included in the booklet CARE is preparing.)

- Treatment considerations -- these should address policies for when chlorination should be used and what type of system should be used, what the target chlorine residual should be (usually .2 to .5 mg/l), and whether other types of treatment (i.e. sedimentation and filtration) should be used. If other treatment systems are to be considered, then design criteria should be adopted.

A.3 Construction Standards

As with design criteria, construction methods, details and operations should be standardized as much as possible early in the project. If necessary they can be modified later in the project based on the availability of local materials and skills.

Typical areas to be covered are:

- all construction materials -- especially pipe materials, type of cement and mix, and use of reinforcing.
- depth of pipe
- provisions for construction supervision
- start-up procedures (including pump operation, water system flushing and disinfection)
- details of service connections and installation -- and motivation of community to install connections during the system construction so that quality of connections can be checked. Training of person in community to supervise service installations that are made at a later date.

A.4 Community Training Programs

Three areas that must be included in both the water supply and sanitation programs are training of the community in construction methods, training of the community in operation and maintenance of its systems, and training of the water and sanitation committee to take on the responsibilities of operating and maintaining its systems.

The following are checklists of items that should be included in these programs. The length of training, materials to be used, training methodology and selection of trainers should all be finalized as soon as possible.

Construction Training

- reading construction plans and understanding the importance of following the design plan
- care and storage of materials -- especially PVC pipe which is damaged by sunlight and should be covered
- formwork, concrete mixing and pouring, and finishing

- trench excavation and pipe bedding
- pipe installation (cutting, jointing, and threading)
- pit excavation and soil shoring methods (for latrines)
- record-keeping

Operation and Maintenance

- preventive maintenance procedures and scheduling
- ordering and storing spare materials and parts for repairs -- knowing where to go for parts and assistance
- hands-on training in emergency repairs. Note that tools for repairs should be purchased by the community or provided by CARE and used during O&M training
- record-keeping
- source protection and water quality sampling (if feasible)

Water Committee Training

- Resolving conflicts
- Promotion of health education
- Fee collection and use of funds
- Water and sanitation system management
- Setting policies and regulations
- Record-keeping
- Where to go for help

Note that all training programs should be designed early in the project and coordinated with government agencies. By planning early CARE can take advantage of all of the resources that are available and ensure that the training curriculum and materials will be ready at the appropriate time in the project cycle.

A.5 Community Operation Guidelines

In addition to the training that a community should receive in the management and O&M of its systems a written and illustrated set of guidelines should be prepared jointly by CARE and the community to serve as a guide once CARE has left. The guidelines should be simple and rely on illustrations and diagrams as much as possible. Instructions and/or data that could be used by the community should be included to cover the following proposed table of contents.

Proposed Table of Contents
Community Operations and Guidelines

Importance of Water and Sanitation
Health Promotion
Purchasing and Inventory
Design Criteria (no. of people to be served, limitations of supply source, expected life of latrine pit, etc.)
Operation of the system
Preventive Maintenance and Repair
Water Committee Functions (collection of fees, etc.)
Policies and Regulations
Record-keeping
Appendices
System Map
Construction Plans
Forms to be Used

A.6 Project Monitoring Plan

In order to ensure that CARE's VLWS project will be planned and implemented as efficiently as possible, the following management and monitoring plan is proposed. Note that the standard community agreement, training plans, design criteria, and construction standards that are referenced below were described in the previous sections of this Appendix.

Management and Monitoring Plan

1. Establish design criteria and construction standards and review with the MOH. Reach agreement between CARE and MOH on criteria and standards to be used in the project.

2. Develop a standard agreement form to be used in a project village. Parties to the agreement include the village, the MOH and CARE. This agreement should also be reviewed and approved by MOH.

3. Establish curricula for construction, O&M, and water and sanitation committee training programs. Responsibilities and resources to be used (personnel and materials) should be determined.

4. Establish who in the project is to be responsible for technical design and at what point and by whom the design is to be reviewed for each village. If MOH or USAID approval of the design is required, this should be factored into the plan.

5. Establish who is to be responsible for construction supervision and how often they will be on site during the construction period.

6. Develop a bar chart of all of the activities needed for each community,

including:

- start-up and promotional activities
- first stage of community agreement
- health education
- preliminary design and preparation of alternatives (including costs)
- selection of preferred alternative by community
- second stage of community agreement
- final design
- ordering materials
- construction training
- construction period
- O&M and W&S committee training
- system start-up (RWS and handpump projects)
- project transition phase (follow-up with community and trouble-shooting)
- project conclusion

Even though CARE's VLWS project has not selected all of the communities for its projects, bar charts of the activities should be developed for all of the possible village projects during years 1 and 2 of the 3 year project. By doing this type of bar chart, the CARE project manager will be able to plan the personnel resources and funds that will be needed.

Based on the bar chart, milestone dates should be established to enable the project manager to monitor key events. The person responsible for each village project should modify the activity bar chart each month based on the month's progress. This should be accompanied by a monthly report which explains the last month's activities and any changes in schedules. Cost expenditures to date should also be included in the monthly report.

APPENDIX B

List of Contacts

List of Contacts

Fred Smith	GOB/MOH Principal Public Health Inspector
Sylburn Arthurs	GOB National Coordinator for Water and Sanitation
Gerald Williams	GOB/MOH Corozal District Public Health Inspector
Neboycha Brashich	USAID/Belize Mission Director
Mary Ellen Tanamly	USAID/Belize Health Projects Officer
Sam Dowding	USAID/Belize Project Officer
Harold Sillcox	CARE/Belize Director
Randolph Pitts	CARE/Belize Executive Secretary
Estilito Loria	CARE/Belize VLWS Project Coordinator
Howard Kolb	CARE/Belize Water and Sanitation Engineer
Doug Clark	CARE/Belize Health Education Specialist
Ravey Smith	CARE/Belize VLWS Corozal District Coordinator
Rafael Novelo	CARE/Belize VLWS Orange Walk District Coordinator
Graham Prokopitz	UNICEF Water and Sanitation Engineer
Bill Boughton	Project Hope advisor (medical and water labs)
Harry Phillipeaux	Pragma Corp. Water and Sanitation Engineer