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WASH WORKING REPORT

BELIZE: REDESIGN AND TECHNICAL ASSISTANCE FOR THE IPTBH PROJECT

Prepared for USAID/Belize
under WASH Activity No. 358

by

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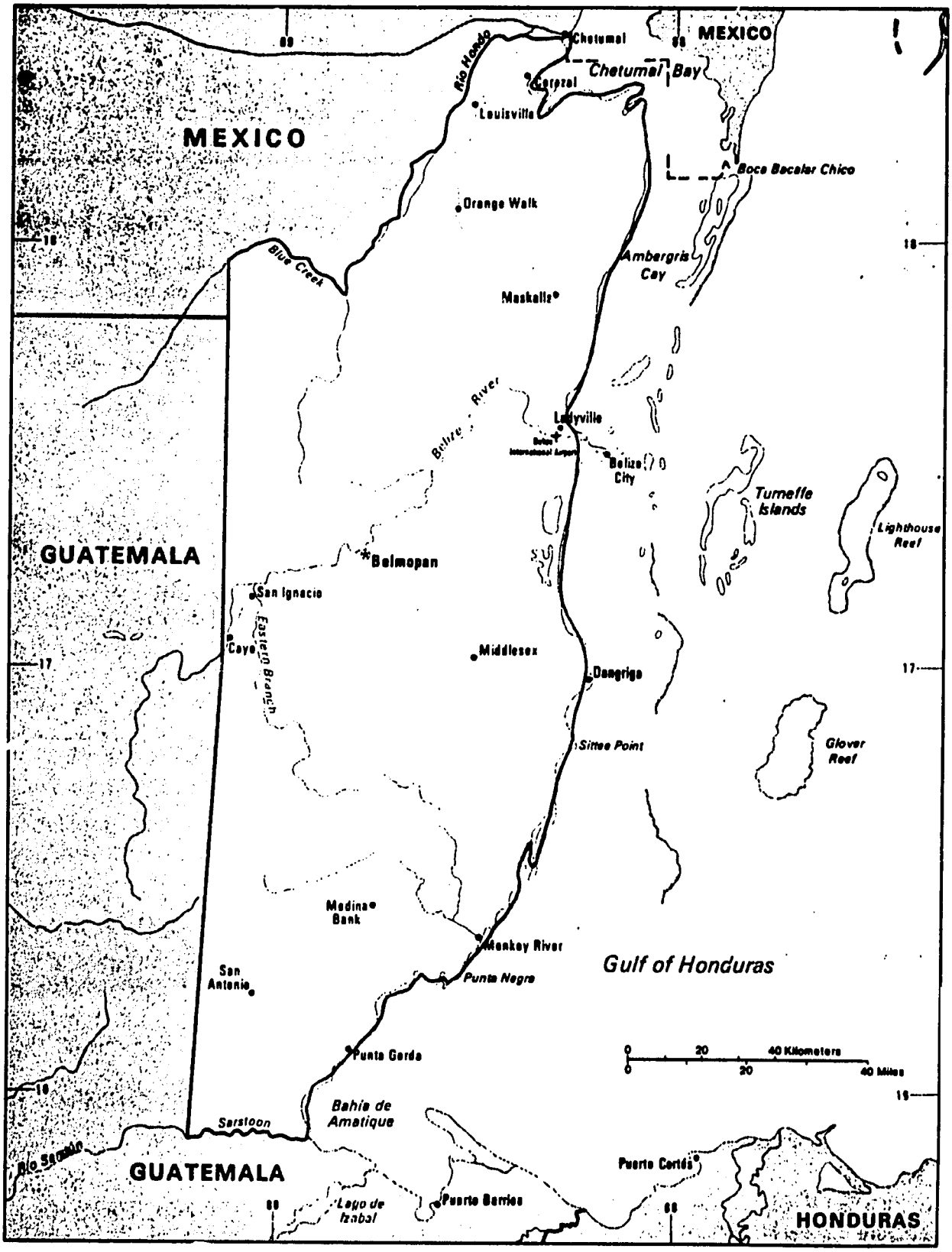
Belize



Boundary representation is not necessarily authoritative.

International boundary
National capital
Road
International airport

ACRONYMS

AID	Agency for International Development (U.S.)
AID/W	Agency for International Development/Washington D.C. (office)
BIM	Belize Institute of Management
CARE	Cooperative for American Relief Everywhere
CD	Community Development
CIDA	Canadian International Development Agency
EHS	Environmental Health Service (Ministry of Health)
GDO	General Development Officer
GOB	Government of Belize
HE	Health Education
IPTBH	Improved Productivity Through Better Health (project)
Log Frame	Logistical Framework (of a project)
LOP	Life of Project
MOH	Ministry of Health
MOW	Ministry of Public Works
MNR	Ministry of Natural Resources
MSS	Ministry of Social Services
PAHO	Pan American Health Organization
PCV	Peace Corps Volunteer
PID	Project Identification Document
PIO/C	Project Implementation Order/Commodity
PP	Project Paper
PRAGMA/MCD	The PRAGMA Corporation/Medical Care Development
PS	Permanent Secretary
PVC	Polyvinyl Chloride (pipe)
RWS	Rudimentary Water System
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development (Mission)
VIP	Ventilated Improved Pit (latrine)
WASA	Water and Severage Authority
WASH	Water and Sanitation for Health (project)
WS/S	Water Supply/Sanitation

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This activity was carried out by Joseph Haritani (team leader), an independent consultant, and Ralph E. Preble of CDM, Boston, Massachusetts, under the direction of WASH activity manager J. Ellis Turner.

This assessment could not have been conducted without the full cooperation and assistance of the agencies involved in the execution of the IPTBH project. These agencies are the Ministry of Natural Resources; the Ministry of Health; USAID/Belize; and the technical assistance contractor, PRAGMA/MCD. The WASH team wishes to thank the staff of each of these entities for their willingness to assist us in our work. We are especially grateful to Mr. Neboysha Brashich, AID Representative, for providing his full support and the services of his staff.

Special thanks go to Messrs. Roland Rivers and Ivan Tingling of WASA and Messrs. Harry Phillipeaux and Ray Robertson of PRAGMA/MCD who accompanied us on our field visits. We also wish to thank Mr. Dennis Conroy, Acting General Development Officer, USAID/Belize for providing his assistance and insights gained from his many years of service with AID. And to the many other persons who assisted us, we express our sincere gratitude.

EXECUTIVE SUMMARY

This assessment was requested by USAID/Belize through the office of S&T/Health in AID/Washington, D.C. The purpose of the assessment was to investigate specific technical issues dealing with the rural water supply and sanitation component of USAID's Improved Productivity Through Better Health (IPTBH) project, to determine the adequacy of project design, and to prepare alternative plans for attaining project goals.

In response to this request, WASH fielded a two-person team consisting of a well-drilling engineer specialist (Ralph E. Preble) and a sanitary engineer (Joseph Haritani). The team met in the WASH office for document review, briefings, and work planning, and traveled to Belize, arriving there on June 27, 1987. The team remained in-country until July 14, 1987, when it returned to the U.S.

During its stay in Belize, the team met with the staffs of the three key Agencies involved in implementing the project, visited field work sites and villages; interviewed field staff; and inspected drilling equipment, warehouses, and project interventions (VIP latrines).

Based on the information gathered through this process, the team prepared an initial draft report which was used as the basis of briefings for the AID Representative and the Acting General Development Officer. A final draft report was prepared by the team after its return to the U.S.

This report briefly describes the project status in terms of its achievements, shortfalls and constraints. It then presents the team's findings as they relate to the specific tasks set forth in the scope of work. Additional findings on other project-related topics are also presented. These are followed by recommendations on actions to be initiated by the USAID/Belize Mission. The team then presents two project redesign alternatives for the mission to consider in reaching its own conclusions and deciding on its line of action. Alternative A should be considered only as a stopgap measure to provide USAID and the GOB time to work out the project extension details of Alternative B and to secure necessary additional funding. Finally, a suggested schedule for urgent USAID actions is provided.

The main findings and recommendations were (in accordance with the tasks specified in the scope of work):

<u>Task (a)</u>: Compare cost/benefits of 100-foot wells with 250- to 300-foot wells.

<u>Finding</u>: There is insufficient data in Belize to justify the implied assumption that usable aquifers exist at these ranges of depths. The depths to which wells need to be drilled cannot be predetermined.

<u>Recommendation</u>: Within reason, drill until a suitable aquifer is reached.

Task (b): Assess the comparabilities of existing drilling rigs.

Finding: The drilling rigs, when properly repaired/rehabilitated, are capable of drilling wells to the maximum depths suggested in Task (a) and beyond. Based on past experience, they cannot complete the number of wells targeted in the original plan.

Recommendation: Repair/Rehabilitate the 20W and the two 22W cable tool rigs. Purchase a rotary rig similar to the MNR's Canterra 211.

Task (c): Compare the costs/benefits of handpumps with rudimentary water systems.

Finding: Handpump systems installed on shallower (100 foot) wells are cheaper per capita served than rudimentary water systems. Handpump systems installed on deeper (200 foot) wells are just as expensive as rudimentary water systems. The advantage of handpump systems is their low recurrent (O&M) cost which is about one-fifth that of RWS. The disadvantage is that they are not as convenient and do not provide as much volume of water as an RWS.

Recommendation: Within the limit of their pumping lift capacity (approx. 120 feet), install Mark II handpumps. When people show that they can effectively manage them, install RWS as the preferred choice whenever they are feasible. Rainwater catchment systems should be considered as an alternative in zones of high and frequent rainfall where the RWS and handpump systems are not feasible.

Task (d): Review/revise equipment and commodity lists.

Finding: The procurement lists do not provide enough detailed information to allow suppliers to provide the correct items ordered.

Recommendation: Have the procurement lists reviewed/revised by qualified specialists such as drilling manufacturers' representatives. To the extent that time permitted, some of the procurement lists have been reviewed and revised by the WASH team.

Task (e): Review the planning, management and implementation of programs in this sector.

Finding: The implementing agency, WASA, is totally new and inexperienced in this rural sector. It has appointed a few experienced and dedicated staff to run the program.

Recommendation: There is an urgent need for USAID to fill the technical assistance gap in well-drilling expertise. USAID should provide WASA with additional technical assistance in public administration, drilling, and training. USAID should also continue to strongly urge WASA to fill its vacant positions.

Task (f): Advise on the potential for the project to achieve its physical targets.

Finding: The only way to achieve the physical targets within the original time frame is to have a U.S. drilling contractor to drill wells. This would defeat the developmental goals of the project.

Recommendation: Extend project life by three years and provide additional funding for increased technical assistance in public administration, drilling, and training and purchase another rotary drilling rig.

Project Design Alternatives

Alternative A: Retain original project timeframe and budget. Reduce physical targets and purchase of related equipment and commodities. Apply savings to the purchase of a new rotary drilling rig accompanied by a long-term driller/trainer. Selection of this alternative would significantly increase the drilling capabilities of WASA but neither the physical nor the institutional goals of the project will be achieved.

Alternative B: Extend the project timeframe by three years and add $2.8 million to the budget. Purchase a new rotary drilling rig accompanied by a long-term driller/trainer. Extend TA services of present water supply and sanitation advisor by two years and HE/CD advisor by two and one-half years. Add public administration advisor for 4 person-years and a training advisor for one person-year consisting of short term assignments over the life of the project.

With regard to Alternative B, extending the project, explore utilizing CARE's TA resources and potential cost savings by delegating responsibility for some of the project communities to CARE (through a new and separate contract).

Chapter 1

INTRODUCTION

1.1 Country Setting

Population: The estimated population of Belize in 1984 was 161,500. Some 45,000 live in Belize City, the commercial capital and largest city in the nation. The main ethnic groups are Creole and Garifuna (Caribs), both of African descent. They make up roughly 40% of the population.

Another 40% of the people are of Latin and Mayan Indian lineage. The rest of the population is made up of Europeans, Americans, Arabs and Asians. There is a Mennonite community of several thousand people. As a result of the insurgency in El Salvador, some 2000 Salvadorans have resettled in Belize.

The capital of the country, Belmopan, was built after the former capital, Belize City, suffered extensive damage from Hurricane Hattie in 1961. The main population centers and their 1980 population are listed below:

Belmopan (new Capital)	3,700
Belize City (old Capital)	43,500
Orange Walk Town	8,400
Dangriga	6,700
Corozal Town	8,400
San Ignacio and Santa Elena	6,300
Benque Viejo del Carmen	2,600
Punta Gorda	2,700

Geography (Figure 1): Belize (formerly British Honduras) lies on the eastern or Caribbean coast of Central America, bordered on the north and part of the west by Mexico, and on the remainder of the west and the south by Guatemala. The coastal waters are shallow and are sheltered by coral reefs dotted with islets (cayes) extending almost the entire length of the country. There is a low coastal plain, much of it covered with mangrove swamp. The land rises gradually as you travel west towards the interior. The Maya Mountains and the Cockscombs form the backbone of the southern half of the country. The highest point is Victoria Peak (1,122 meters) in the Cockscombs. The Cayo District in the west includes the Mountain Pine Ridge ranging from 3055 to 914 meters above sea level. The northern districts contain large areas of low tableland. There are many rivers. Some are navigable for short distances by shallow-draught vessels. A large part of the mainland is forest. The area of the mainland and cayes is 22,962 kilometers (slightly larger than the state of Massachusetts). The greatest distance from north to south is 280 kilometers and its greatest width is 109 kilometers.

Rainfall: The climate of Belize is characterized by rainfall that is seasonal and varies considerably from one part of the country to another. Precipitation is least in the north (Fig. 2) and gradually increases

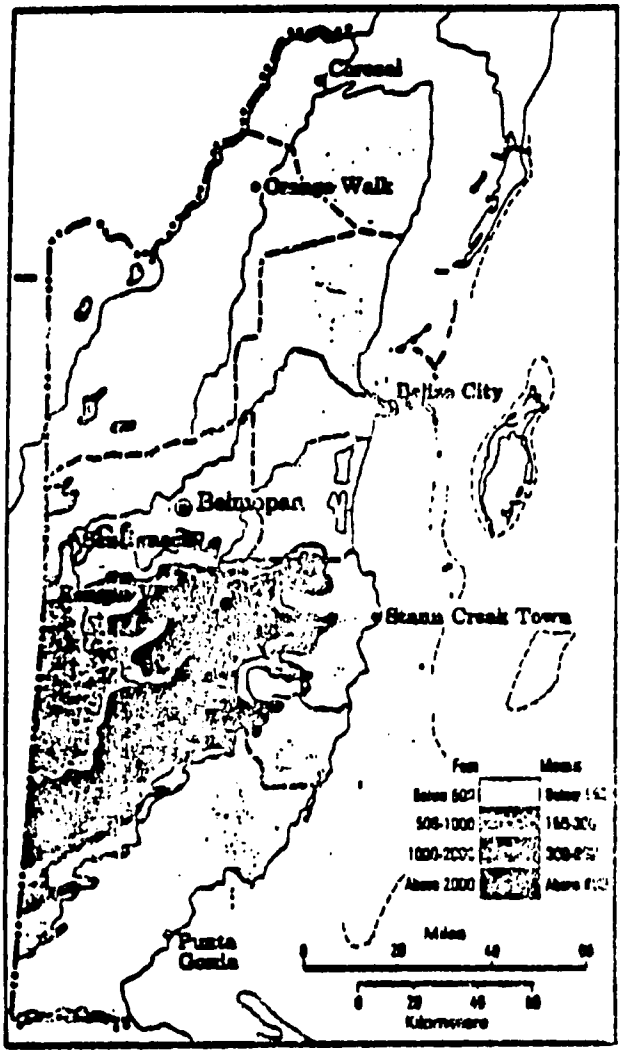

Figure 1. Relief

Source: Floyd. 1972a.

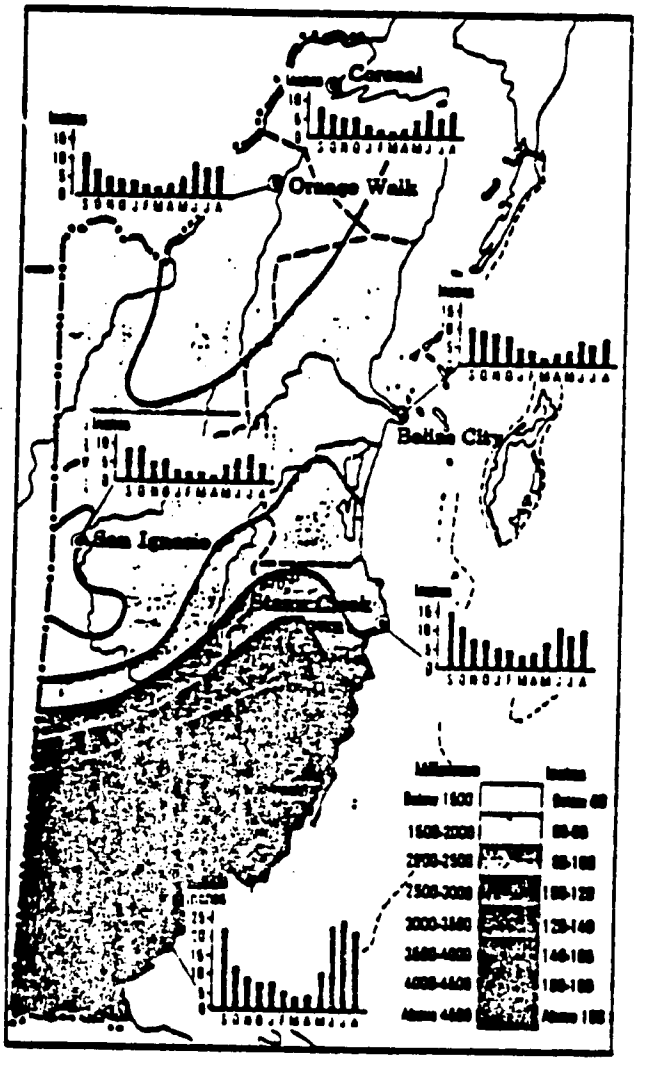

Figure 2. Rainfall

Source: Floyd. 1972a.

southward. As an illustration, Corozal, in the extreme north, has an annual rainfall of 1,300 mm (51 in.); at Orange Walk, a little to the south, it is 1,550 mm (61 in.) and at Belize City, 1,850 mm (73 in.). Inland and in the central portion of the country in the Mountain Pine Ridge at Augustine and at Cayo, the mean annual rainfall is about 1,650 mm (65 in.). Gallon Jug, just north of Mountain Pine Ridge and situated within a region of tall luxuriant forest, receives only about 1,500 mm (59 in.) per year. The southern portions of the Maya Mountains in the extreme south are reported to receive in excess of 4,060 mm (160 in.) annually.

The seasonal distribution of rainfall in Belize (Fig. 2) is marked in the northern half of the country where a Wet/Dry Tropical, or Savanna, climate prevails. The southern sector is much less seasonal, being classified as Wet Tropical.

January through April or May are the "dry months" in the northern localities; the remaining months are "wet" (e.g., greater than 100 mm per month). In the southern regions the dry season is somewhat shorter, occurring primarily during February, March, and April. At Belize City, Gallon Jug, and Augustine, the four driest months receive only about 10 percent of the annual rainfall. At Punta Gorda, in the extreme south, the three driest months receive slightly less than 11 percent of the annual rainfall. There is usually a short "dry" season in August. The averages shown in Figure 2 disguise marked variations in monthly rainfall from year to year, as well as the degree of intensity of precipitation. The number of days with rain also varies considerably from place to place: San Ignacio averages 125; Belize City, 171; Stann Creek, 198; and Punta Gorda in the extreme south, over 200.

Seasonal variations in rainfall are directly influenced by easterly trade winds that blow most strongly from the Caribbean Sea during December to April, the "dry" months. Both the seasonal and daily variability in rainfall have significant bearing on forestry, agriculture, and transportation.

1.2 Project History

The PID (Project Identification Document) was approved on October 12, 1984. This led to the fielding of a project development team (see Appendix A) that prepared the project paper. The project was approved on December 21, 1984 and the project authorization was signed on March 21, 1985. The project agreement between AID and the Government of Belize (GOB) was signed on March 26, 1985.

A contract with PRAGMA/MCD to provide technical assistance through a Management Support Unit consisting of a Project Manager (Chief of Party), Water Supply and Sanitation advisor, a Community Development/Health Education/Training advisor and a Vehicle Maintenance Specialist was negotiated and became effective January 1, 1986.

Prior to finalizing the negotiated contract with PRAGMA/MCD, three of the four proposed technical assistance team members (the Chief of Party, the WS&S advisor and the CD/HE/T advisor) traveled to Belize in September 1985 for the project orientation and for interviews and approval by the GOB and USAID/Belize. These three advisors were approved and arrived in Belize on January 21, 1986.

Almost from the beginning of the project, slippages in project implementation began to occur. The first procurement order which included project vehicles, a well-drilling rig, and spare parts was delayed in submission and in processing. As a result, the arrival of the vehicles and commodities were delayed over a year. The decision to make the technical assistance contract an 8A set-aside, requiring a procedure which is more complex and time-consuming than the usual contracting process, occasioned a seven- to ten-month delay in the arrival of technical assistance team members.

To illustrate the magnitude of the delays, the time lag between scheduled and actual dates of key project events are shown in Table 1 below.

Table 1

Schedule of Key Project Events

Event	Project Paper Date	Actual Date	Delay[1]
Project Agreement signed	2/85	3/85	1 mo.[1]
General Development Officer hired 3/85	3/85	0	
TA Team Chief, HE/CD advisor arrives	5/85	1/86	8
Vehicle Maintenance Specialist arrives	5/85	3/86	10
1st PIO/C submitted	FY 85	1/86	4
WS&S advisor arrives	6/85	1/86	7
1st PIO/C items arrive	8/85	10/86	14
Water Lab. advisor arrives	8/85	2/87	18
1st interim evaluation	9/85	2/87	17
Drilling trainer arrives	9/85	2/87	17
2nd PIO/C submitted	10/85	(in process)	

(1) Note that although delays developed, part of the delay can be attributed to the overly optimistic scheduling in the project paper--particularly for contracting technical assistance, issuing the first PIO/C, and turn-around time for the supply of commodities.

1.3 Water Supply and Sanitation Interventions

The project paper identifies tube wells (drilled wells with casing) installed with the India Mark II handpump as the preferred type of water system to be provided. In addition, rudimentary water systems (RWS) would be installed where handpumps are not feasible, usually in villages having a population of 250 or more. Operations research would be conducted on the feasibility of using ferro-cement roof top catchment reservoirs, but the project would not directly support their use. This prohibition is not explained in the project paper.

Ventilated improved pit (VIP) latrines will be provided for each household in villages participating in the project. Operations research is to be conducted on alternative excreta disposal systems.

The numerical targets for water supply and sanitation interventions given in the project paper are shown below in Table 2.

Table 2

Number of Systems to be Installed

	Year 1	Year 2	Year 3	Year 4	Total
Hand pumps					
Replaced	60	70	65	55	250
New	20	70	65	95	250
Rudimentary Water Systems	3	11	9	3	26 *
Latrines	—	1,000	1,000	1,000	3,000

* The Log Frame (Annex I of the project paper) shows only 20 RWS using tube wells with submersible pumps. The water sources of the other six RWS are not shown.

1.4 Purpose of the Assessment

From February 16 to March 6, 1987, a three-person team consisting of an AID/W staff member and two consultants (an engineer and a social scientist) conducted an interim evaluation of the IPTBH project. This evaluation covered the full range of issues concerning project implementation and proposed specific actions to be taken by each of the agencies participating in the project.

At about the same time, PRAGMA/MCD, the technical assistance contractor, fielded a well-drilling training specialist to provide training to the well-drilling crews and to assess the well-drilling activity. He spent nine weeks in the country from February 8 to April 12, 1987. In his report, he concluded that the existing drilling rigs (5 cable tool and one rotary) were inadequate and inappropriate for the task at hand and recommended the purchase of a large rotary drilling rig.

While the evaluation team raised several technical issues regarding the role and operation of the water quality laboratory and water supply and sanitation technologies, it found that the existing well-drilling rigs, if properly operating, could meet the numerical targets for drilled wells. This finding was in direct conflict with that of the PRAGMA/MCD well-driller and left the USAID mission without a clear line of action to follow.

One of the specific purposes of the present assessment is to resolve the issue concerning the adequacy of the well-drilling rigs and their operation. Beyond this, and other specific tasks, the assessment team is to review project design and prepare a plan to achieve project goals in the water supply sector.

1.5 Scope of Work

USAID/Belize provided the WASH team with the following scope of work:

Objectives: The objective of this assessment is to determine the adequacy of project design with respect to the water supply sector, and prepare a plan for effectively attaining the developmental goals of this sector.

Scope of Work: A two-person team is required to spend ten working days in Belize in pursuit of the objectives of this scope of work. The team will:

a) Evaluate the technical and economic costs and benefits of drilling 100-foot deep wells and deeper (250'-300') wells. This evaluation should include an assessment of the quality and continuous supply of water from each depth.

b) Conduct a thorough assessment of the capability of all the well rigs available to the GOB for the drilling of water supply wells, paying particular attention to their age, their likely capacity in the various soil and geological conditions in Belize, and the propensity for downtime.

c) Conduct a comparative assessment of costs for the two water supply solutions (handpumps, [illegible]S) in various sizes and dispersion of villages, based on recommended depth of wells.

d) Review and revise lists of equipment and material purchased and requested to accomplish targets in this sector.

e) Review the structure of planning, management and implementation in this sector, including technical assistance resources, and advise on optimum and alternative approaches to ensure development in this area, including employment of new resources, restructuring assignments of current personnel, and training.

f) Advise on the potential of the project to attain the current physical target, establish the conditions under which this would be possible, and recommend alternative target formulation, including focusing on process rather than physical accomplishment.

1.6 Methodology

The consultants reviewed project design papers, short-term consultants' reports, the recent evaluation report and other pertinent documentation. Interviews and field discussions were held with USAID/Belize personnel, GOB and the contractor (PRAGMA/MCD) staff, village counselors and villagers, and other water project personnel.

Telephone or personal contacts were made with selected personnel who were involved in the design of the original project.

Chapter 2

PROJECT STATUS

2.1 Accomplishments

Planning: The MOH/EHS prepared an annual project implementation plan for GOB fiscal year 1986 which was submitted to and approved by USAID/Belize. The plan for F.Y. 87 was submitted by the March 31 (End of F.Y.), 1987 target date in satisfaction of conditions precedent. However, the F.Y. 87 plan was prepared prior to MNR's official takeover of the water and sanitation program. Since the transfer of the rural water supply and sanitation portfolio to the WASA/MNR, a new implementation plan has been prepared and submitted to USAID/Belize. An operational project cycle which describes the sequence of field activities to elicit village participation has been established and is now being applied in the field (Appendix C, Project Cycle). The National coordinating committee on Water Supply and Sanitation has prepared national policies and guidelines for construction and maintenance of water and sanitation systems (Appendix B).

Management: WASA has prepared a tentative organization chart for its rural water supply and sanitation program which includes the IPTBH project as well as the UNICEF (Toledo District) and CARE (Corozal and Orange Walk Districts) projects (see Appendix D for the tentative organization chart.)

Staffing: WASA has appointed a new National Coordinator and a new Chief of Operations. They have also named District Coordinators, maintenance crews, and carpenter-foremen for each of the three districts covered by the IPTBH project. One District Health Educator has been appointed. Five of the six drilling crews are in place. (Note: The Canterra rotary drill and crew are assigned specifically to the UNICEF project in Toledo District.) The driller on the sixth crew died recently and his assistants are temporarily assigned to the maintenance crew in Orange Walk.

Vehicles, Equipment and Supplies: All six drilling rigs and accessories, all project-funded vehicles and some supplies have been transferred to and are under the control of the WASA.

Inventory: There is an inventory system (that needs strengthening) of equipment and commodities in use by GOB as well as a ledger system. A warehouse, not identified as a requirement in the project paper, is being constructed.

Basic Data and Files: Most of the basic hydrogeological and village level data has been transferred to WASA. Pertinent EHS/MOH files are in the process of being transferred to WASA/MNR.

Health Education/Community Development: Thirty villages have been selected to be included in the first-year project; village surveys have been completed in 29 villages; household surveys have been completed in 24 villages; health education/community development activities including meetings/workshops with village leaders, villagers, school teachers and students have been conducted in varying numbers in all of the villages referred to above.

VIP Latrines: Twelve sets of steel forms for producing VIP latrine slabs and risers have been designed, fabricated, distributed to the districts and are being utilized in the latrine program. Latrine construction has been essentially completed in 3 villages and started in 7 additional villages. Approximately 90 VIP latrines have been installed.

Well Drilling: Drilling of 11 wells has been attempted. Of these, two are considered to be potentially successful and are waiting to be completed. Seven wells have been abandoned as being unproductive and two are still in the process of being drilled.

Water Quality Laboratory: A water quality laboratory has been established, staffed and equipped on the third floor of the MOH central laboratory building adjacent to the PRAGMA/MCD offices and is operating satisfactorily. A short-term water quality advisor spent one month in Belize assisting in setting up the laboratory and training the water analyst. The water analyst is capable of performing all of the required chemical, physical and bacteriological analyses. She is able to analyze 30 samples per week, which provides adequate coverage at this time.

2.2 Shortfalls

Planning: Since assuming responsibility for the sector, WASA has not had the time to discuss and develop a national rural water supply and sanitation program or an operational strategy, nor has it been able to focus on the longer-term implications of ongoing problems with the well-drilling operations and how they might affect the IPTBH project.

Management: WASA has yet to decide on national goals and operational strategy for the GOB/USAID-funded water supply and sanitation activity. The National Coordinating Committee on Water Supply and Sanitation is no longer meeting or functioning.

Staffing: Certain key positions such as the Chief Health Educator and two District Health Educators are yet to be filled. Other key positions identified in the tentative organization chart that remain vacant are the Design and Planning Engineer and the Administrative Officer.

Vehicles, Equipment & Supplies: The WASA senior project staff presently share one pick-up pending the procurement of another pick-up to be assigned to the chief of operations. Of the three F-350 stake-body trucks, one was seriously damaged in an accident in 1987 and is still missing some spare parts before repairs can be completed. Meanwhile, the other two trucks are being used to cover the three project Districts.

Of the five rigs available for project use (2-Dando-400's, 2 Bucyrus-Erie 22Ws and 1 Bucyrus-Erie 20W) only three were in working order as of July 1 1987. Repairs on the second Bucyrus-Erie 22W were nearing completion when inspected by the WASH team on June 30, 1987. The Bucyrus-Erie 20W suffered a damaged clutch shortly after the WASH team observed it in operation, also on June 30, 1987, but has since been repaired. The damaged Dando 400, now located in the CARE project area, needs repairs.

Steel drill-casing is in short supply. There is also a limited supply of 4" diameter PVC well casing. A procurement list of equipment, materials and spare parts which is attached to this report as Appendix E is in the process of being finalized for submission.

Field Work: Although a number of villages have yet to be selected and surveyed and latrine construction completed or begun, the project has not yet completed the installation of its first water supply system.

Progress Reports: Although field activities reporting forms have been developed and distributed, no periodic or summary progress reports have been prepared for the project.

Inventories: The inventory system for equipment and commodities does not include all spare parts and supplies that are actually available, and does not satisfactorily track location. Therefore, the system needs to be strengthened. The team understands that improvements will be undertaken after the warehouse is completed.

2.3 Constraints

Planning: Neither the WASA regular staff nor the newly appointed rural water supply and sanitation staff have experience in planning the implementation of a nationwide rural water supply and sanitation project.

Management: WASA/MNR Senior staff, who are managing a semi-autonomous public utility, are unfamiliar with managing a public sector-financed program.

Staffing: The hiring of some key staff is being delayed due to a lack of office space. There are no job descriptions for most of the project staff.

Vehicles, Equipment and Supplies: While project equipment and commodity requirements are now fairly well established, procurement lists did not contain adequate detailed descriptions and/or specifications to allow the procurement of essential equipment, supplies and spare parts to proceed. The lack of drill casing is delaying the completion of wells in progress.

Basic Data: While forms for recording basic field data have been prepared, and, reportedly, distributed, field personnel have not been formally instructed on how to prepare and submit them. A reporting system for collecting and reviewing field data has not been established.

Field Work: Several factors are causing delays in field work. These are the lack of central and district level health education/community development staff, lack of essential supplies and spare parts for the drilling rigs, and delays in procurement and drilling rig breakdowns.

Progress Reports: A management information system has not been developed and put into effect. Basic field data is being recorded by field crews but it is not being assembled and reported at the district level for submission to the central office. Without this information available, the central office cannot document progress being made in the field.

Inventories: Warehousing facilities are generally inadequate country wide. There is no standard inventory control system established, nor are there specific personnel trained as warehousemen.

Technical Assistance: Within the water supply and sanitation component of the IPTBH project, one of the main technical assistance gaps is that of well-drilling expertise. The lack of expertise in well-drilling has crippled project implementation from the beginning of the project until now. It has caused gross errors in the procurement of well-drilling equipment and parts. It has also caused a setback in the upgrading of well-drilling rigs and the upgrading of drilling crew knowledge and skills.

The interim evaluation report described weaknesses in the coordination and integration of project activities, in preparing annual work plans, and in developing long-range strategies. These are responsibilities of the TA Chief of Party, who must play a dual role as vector control advisor which is the main area of his training, experience, and expertise. The lack of aggressive leadership in the TA Chief of Party's role has been a major constraint in the development of a well integrated project implementation strategy.

Chapter 3

FINDINGS

3.1 Introduction

The first set of findings presented below respond to the six tasks described in the scope of work. These findings are followed by others which address specific issues on topics directly related to project implementation in the water supply sector.

3.2 Task (a)

Evaluate the technical and economic costs and benefits of drilling 100-foot-deep (shallow) wells and deeper (250'-300') wells. This evaluation should include an assessment of the quality and continuous supply of water from each depth.

Finding (a)

The depths to which wells need to be drilled cannot be a specified standard depth. Each well will be different depending upon the depth at which water of satisfactory quality and quantity is found. In some instances, quality problems cannot be overcome with depth. In most cases where hydrogen sulfide tastes and odors are present the problem diminishes or is avoided at greater depths. In some cases it can be avoided if the upper portion of the aquifer or an overlying aquifer is sealed off. However, such action may not be possible in areas where salt water is found below a fresh water layer. Iron concentrations often increase with depth. Present data does not permit a clear determination of the origin of iron taste problems which may be partially, if not fully, due to corrosion of iron components used as a permanent part of completed wells.

Although corroborating data is lacking, it appears that any concept based on an average well depth of 100 feet is unrealistic. There is a need to extend drilling to greater depths than was apparently originally expected. The program's purpose in the water supply sector is to install rural water supply wells. It is not a hydrological exploratory program. Extraordinarily deep drilling can not be justified when the need is for relatively small amounts of water for handpump installation or as a source for a village rudimentary water supply. Based on the very little information presently available, they might run from 40 feet to 400 feet and average 200 to 250 feet. Groundwater quality is not a fixed issue that can be adequately assessed. The lack of current data permits speculation about quality and depth relationships only in connection with coastal areas. There is possibly a quality issue between the choice of wells vs. rainwater catchment--an alternative which is to be the subject of operations research but whose application, inexplicably, is practically ruled out in the project paper.

3.3 Task (b)

Conduct a thorough assessment of the capability of all the well rigs available to the GOB for the drilling of water supply wells paying particular attention to their age, their likely capacity in the various soil and geological conditions in Belize, and the propensity for downtime.

Finding (b)

It is obvious that the equipment available for drilling wells is in no condition to achieve any reasonable rate of progress. Although the two existing Bucyrus-Erie 22W rigs were mounted on new Ford F-700 trucks, no replacement of worn parts was attempted on these 25-year-old rigs. One of these rigs appears to require extensive replacement of most moving parts. The other appears to require less extensive replacements. Both well-drilling rigs are structurally sound. The drilling equipment available for the IPTBH Project and the CARE Project consists of the two Bucyrus-Erie 22W rigs, a new 20W rig provided from Project funds from the Buckeye Company (successor to the Bucyrus-Erie well rig manufacturer) and two Dando 400 rigs of British origin. The condition of the British rigs is equally as bad, if not worse, than the 22W units. They are mounted on old reliable Seddon Atkinson trucks (a company no longer in business). These units are over 20 years old.

Some idea of the number of wells installed in past years can be estimated through references to published figures and talks with individual well-drillers. A review of the table which appears on page 19 of the Project Paper, appended for reference (Appendix F) indicates the presence of 65 PVC cased wells in the fall of 1984. The Project Paper states that PVC for well casings was introduced late in 1982. The figure of 65 wells represents the total number of wells installed in a two-year period by the four old rigs not controlled by the MNR and the two rigs (22W) operated by MOW, at the time. The team's discussions with persons directly involved with well drilling at that time confirm that production in those years averaged about 10 wells per rig.

The two MOW rigs were sold to Tom Marsden in January 1987 after sitting idle for a number of years. Mr. Marsden is now operating a private well-drilling business with a single rig that he put together from the two derelict rigs and imported parts. While he has only drilled three wells, to date, he has a backlog of 65 requested farm wells.

In the CARE Project in Orange Walk and Corozal, one drilling rig has been periodically involved over a two and one-half year period (it was fully committed to the project in April 1986). Over the life of the project the well-production has averaged (based on the installation of the 31 wells listed in Appendix G) 16 wells per year. This low production was in an area where wells are relatively shallow and easily drilled.

Overall, the team estimates the production capability of the cable tool rigs and crews at approximately 10 wells per year per rig. These figures do not necessarily reflect on the capabilities of the well-drilling crews, who were hampered by recurring equipment breakdowns and shortages of materials to work with and install. In comparison, the UNICEF rotary rig has drilled 56 wells, of which 48 have been successful, since it started operation in December 1985.

The record of past well-drilling achievements clearly indicates that the Project target number of wells would not be obtainable even if equipment presently assigned to the UNICEF and CARE Districts were to be delivered to the three Project Districts. Prompt repairs are necessary to the new 20W well-drilling rig and some form of major overhaul is necessary for the two 22W rigs if they are to remain operational. Even with these actions, and the prompt purchase of an additional drilling rig it is unlikely that even one-half of the targeted goals would be possible in the 21 months left in the project.

3.4 Task (c)

Conduct of a comparative assessment of costs for the two water supply solutions (handpumps, RWS) in various sizes and dispersion of villages, based on recommended depths of wells.

Finding (c)

Background: The water supply component of this project is based on drilling wells up to depths of approximately 100 feet and installing India Mark II handpumps having a maximum working depth capability of approximately 120 feet. The level of service is based on providing one handpump for each 10 households. The average household size is estimated at six persons. Therefore, each handpump is to serve an average of 60 persons, providing up to 20 liters per capita per day.

Rudimentary Water Systems (RWS) are to be installed where handpumps are not feasible or appropriate. Limiting factors on the use of handpumps are the maximum working depth from pump head to the pump cylinder (approximately 120 feet). A rudimentary water system will provide piped water to each household. The source of water may be a drilled well, infiltration gallery, spring, or a stream. All RWS systems, except for spring-fed gravity systems, will require a pump, generator, and storage/distribution tank, as well as supply line and distribution system. They are designed to provide 75 liters of water per capita per day.

Comparative costs of various types of water systems were presented on page 67 of the Project Paper and are shown below as Table 3.

Table 3

Water System Cost Data
(in US dollars)

Type of System	System Capital Cost	Number of Users	Capital Cost per User	Annual Operating and Maintenance Costs per User
Tubewells/handpumps[1]	2,000	60	33	2
Community System				
a. Rudimentary gravity[2]	38,000	300	128	3
b. Well pump/generator[3]	75,000	500	151	20
c. Pump/surface water[4]	83,000	500	166	26
Catchments-500 gal. size				
a. Ferro-cement	260	6	43	minimal
b. Galvanized metal	450	6	74	minimal
c. Concrete	500	6	83	minimal

Cost estimates by the PP Team Water-Supply Engineer based on:

[1] Costs of drilling, complete handpump and PVC casing.
[2] Two mile distance to source--only main lines through community, with individuals paying for house connection.
[3] Same as Number 2, except with a tubewell, submersible pump, and generator.
[4] Same as Number 2, except for surface-water treatment (pre-sedimentation, coagulation, filtration.

In order to compare the costs of handpumps versus rudimentary water systems, the WASH team updated the cost estimates based on present market prices for equipment and materials and on estimated costs for concrete structures. The revised capital costs for water system alternatives are shown below.

India Mark II handpump installed on 100 ft. drilled well: Cost of a 100-foot drilled well cased with 4" diameter PVC Schedule 40 casing and installed with an India Mark II Handpump (in US $).

Drilling 6" diameter wells @ $25.00/ft. x 100	$2,500.00
4" diameter PVC casing @ $3.50/ft. x 100	350.00
Mark II handpump with cylinder	415.00
1/2" diameter pump rods with couplings @ $1.00/ft. x 100	100.00
1-1/4" diameter riser pipe with couplings @ $2.40/ft. x 100	240.00
Concrete pump foundation with apron and drainage channel	43.00
Total estimated cost of materials	$3,648.00

Assuming that each handpump serves 10 households and that each household contains an average of 6 persons, the per capita capital cost of this handpump system is $61/capita. Adding a surcharge of 10% for supervision, the capital cost would be $67/capita.

Note: Cost estimates do not include volunteer labor or the cost of drilling unsuccessful wells. The latter is a real cost to the GOB.

India Mark II handpump installed on a 200 ft. Drilled well:

Drilling 6" diameter wells @ $25.00/ft. x 200	$5,000.00
4" diameter PVC casing @ $3.50/ft. x 200	700.00
Mark II handpump with cylinder	415.00
1/2" diameter pump rods with couplings @ $1.00/ft. x 100	100.00
1-1/4" diameter riser pipe with couplings @ $2.40/ft. x 100	240.00
Concrete pump foundation with apron and drainage channel	43.00
Total estimated cost of materials	$6,498.00

Assuming that each handpump serves 10 households and that each household contains an average of 6 persons, the per capita capital cost of this handpump system is $108/capita. Adding a surcharge of 10% for supervision, the capital cost would be $119/capita.

Rudimentary Water Supply for Silk Grass

Cost of a rudimentary water system for Silk Grass using an infiltration well equipped with a centrifugal pump, diesel generator, 3" diameter PVC supply line, 7000 gallon elevated tank, 3" and 2" diameter PVC distribution lines and 74 household service connections. Actual population of 444, 74 households. Design population of 640 persons, 107 households.

	US $
Installation of infiltration well (materials only)	$200
Cost of pump house	$2,400.00
Centrifugal pump	2,000.00
Gasoline generator, 8hp, 240 volts, 13 amps.	1,500.00
3" diameter PVC supply pipe, 10,000 ft. @ $1.50/ft.	15,000.00
7000-gallon elevated concrete tank	11,000.00
3" diameter PVC distribution pipe, 2,000 ft. @ $1.50/ft.	3,000.00
2" diameter PVC distribution pipe, 3,500 ft. @ $0.75/ft.	2,625.00
107 house connections at $8.50 each	910.00
150 lengths of 1/2" diameter PVC pipe at $4.00 each	600.00
Total estimated cost	$39,235.00

Assuming a design population of 444 persons, the per capita capital cost of this rudimentary water supply system is $88/capita. Adding a 30% surcharge for supervision, the capital cost would be $115/capita.

Georgeville RWS Estimated Cost

Well drilling U.S. $25/ft. x 300 ft.	$7,500.00
Submersible pump	3,000.00
Generator	2,400.00
3" diameter PVC supply pipe, 800 ft. @ $1.50/ft.	1,200.00
11,000-gallon ground level storage/distribution tank	9000.00
3" diameter PVC distribution pipe, 1,200 ft. @ $1.50/ft.	1,800.00
2" diameter PVC distribution pipe, 3,500 ft. @ $0.75/ft.	2,625.00
80 house connections at $8.50 each	680.00
160 lengths of 1/2" diameter PVC pipe at $4.00 each	640.00
Total estimated cost	28,845.00

Capital cost of the Georgeville RWS based on the present population of 468 is $62/capita. Adding a surcharge of 30% for supervision, the cost would be $80/capita.

The revised cost estimates show that the per capita capital costs ($67) of a 100 ft. well installed with a Mark II handpump is slightly more than half that of the proposed rudimentary water system for Silk Grass ($115 based on actual population) using an infiltration well as its source. No treatment is planned for this supply. For a 200 ft. well, the handpump installation cost per capita is about the same as the Silk Grass RWS, i.e. $119 to $115. The estimated per capita cost for the Georgeville RWS is considerably less ($80).

The major difference between the two systems would be much higher recurrent costs of operation and maintenance of the Silk Grass system. The Project Paper on page 67 shows an annual per capita recurrent cost of $2/capita for handpumps and $20/capita for a pump/generator community system. Although the Project Paper does not include information on how these costs were calculated, they appear to be reasonable for hand pumps but high for RWS. Based on local fuel costs and caretaker salary, we estimate a $10/capita recurrent cost for the Silk Grass system.

Since drilling is the major cost item for handpump installation, the capital cost of handpump installation increases in proportion to the depth of the well. Therefore, we find that the per capita cost of a 200-foot well installed with a handpump is significantly higher than that for a 100-foot well. However, it should be emphasized that wells deeper than 100 feet should not be rejected outright due to their higher capital costs. There certainly will be situations where a deep well may be the only viable source of an adequate and reliable source of water and should definitely be considered in spite of its higher per capita cost. However, the feasibility of using rainwater catchment also should be explored where the depths of wells becomes prohibitive due to drilling costs or to pumping costs. Because of the reduced level of service handpumps provide, the long-term goal should be to provide water piped to each household.

3.5 Task (d)

Review and revise lists of equipment and material purchased and requested to accomplish targets in this sector.

Finding (d)

A complete and thorough review and revision of all lists of equipment and material purchased and requested to accomplish targets in the water supply sector was not possible in the short time that the team was in Belize. The team did spend many hours with the PRAGMA/MCD Vehicle Maintenance Mechanic and Water Supply and Sanitation Engineer in reviewing equipment formerly requested and delivered and pending requests.

In this regard, a complete review of project designs by qualified professionals in a number of different specialties should be performed for the PRAGMA/MCD field staff as home office back-up. The field staff have their own guidelines for rudimentary water systems, designed for other countries, and have collaborated with personnel involved with the CARE Project for help and standardization (where possible) but have received little or no help from the home office in assuring that specific design features, computations and system components are practical and best choices or even workable.

Major problems with well-drilling equipment now in country are:

- The request for a new percussion rig was not specific in its description and a lightweight 20W rig was furnished and delivered rather than a 22W of comparable size and general parts interchangeability with the two older 22W rigs.

- Because incorrect information was provided by MOH, rehabilitation parts that were supposed to be ordered for the two older 22W rigs, were ordered for a 20W sized rig and are now in Belize. As a consequence, while those two old 22W rigs were mounted on new Ford 700 trucks, only minor repairs were made to these rigs rather than the major overhauls originally planned.

A major problem with handpump installation, both with potential new wells and wells to be rehabilitated, is that while new pump heads and pump pistons were ordered, no 1-1/4 inch pipe to connect the pump head to the pump cylinder was ever ordered. This pipe can, however, be provided locally.

The WASH team reviewed and commented on the descriptions of items included in the procurement list now being processed. The team also prepared a new list of parts required to rehabilitate one 22W rig. These are attached as Appendix E and Appendix H.

The equipment and material purchased and requested has not resulted in the installation of a single handpump or rudimentary water supply system. Handpumps presently in stock could provide for 20 percent of target goals but no pipe is available to connect pump cylinders to the pump heads. No pipe, pumps or fittings are available to construct rudimentary water systems.

The problems related to the purchase of the 20W rig and the substantial rehabilitation of the 22W rig has been described earlier. The repairs to the 20W rig and rehabilitation of the 22W rigs, the purchase of an additional rig and an extension of time beyond the present termination date of the IPTBH Project will be required if original goals are to be considered as viable target figures for well completions.

It cannot be expected that any one person can combine the expertise of a piping system analyst, structural engineer, electrical and instrumentation engineer, pump expert and specifying engineer. Some form of back-up support is necessary to insure that rudimentary water systems with varying configurations, different forms of water supply, different pumping requirements and different types of controls and pump safeguards are appropriately designed and properly specified so that procurement lists are sufficiently specific that items delivered are what are needed.

3.6 Task (e)

Review the structure of planning, management, and implementation in this sector, including technical assistance resources, and advise on optimum and alternative approaches to ensure development in this area, including employment of new resources, restructuring assignments of current personnel, and training.

Finding (e)

Responsibility for the IPTBH project is divided among the three participating parties: USAID/Belize, PRAGMA/MCD and the GOB (initially involving the MOH/EHS and now the MNR/WASA as the key GOB agency).

The project paper assigns overall project management responsibility to the USAID/Belize general development officer (GDO). As overall project manager, the GDO is directly or indirectly responsible for project related operations research, training, construction, procurement, evaluations, and technical assistance. Through a direct AID contract, USAID/Belize delegates responsibility for providing technical assistance to a PRAGMA/MCD team of advisors. This team consists of a chief of party (vector control advisor), a health education/community development/training advisor, a water supply and sanitation advisor, and a vehicle maintenance specialist. Together, this technical assistance team is responsible for providing direction to and assistance in the day-to-day operation of the project.

The MNR/WASA and the MOH/EHS are directly responsible for project implementation. In the early stages of the project, the MOH/EHS was not able to provide the managerial, technical and material resources necessary to run the project effectively. In April 1987, the GOB officially transferred the rural water supply and sanitation portfolio from the MOH/EHS to MNR/WASA.

With the transfer of the rural water supply and sanitation portfolio from the MOH to MNR, WASA is now responsible for both urban and rural water supplies and excreta disposal. This transfer generates the need for additional technical assistance in the area of institutional development which could not have been foreseen.

As the interim evaluation report determined, there has been a serious weakness in the performance of the TA Chief of Party's role, which is in addition to his responsibility as the vector control advisor. The report noted shortcomings in the areas of coordination and integration of project activities, preparation of annual work plans and development of long-term sector strategy. The WASH team concurs with the evaluation's findings and recommends strengthening performance in these areas. To this end, specific recommendations are made in Chapter 4.

WASA is a semi-autonomous public utility which operates under the direction of the MNR. Agency policy is set by a board of directors and executed by the chief executive officer. GOB subsidies were terminated in 1982 and now WASA relies on revenues for its budget.

The transfer of the rural water supply and sanitation portfolio to WASA places it squarely in a public sector role. WASA now has two distinct roles to play, one to operate a profit-oriented public utility and the other to manage a government funded development program In a sense, WASA will have to develop a dual personality, managing both under one roof while keeping their identities separate. The successful execution of its dual role will test the management skills of WASA's top staff.

WASA, with the assistance of a CIDA advisor, is developing a modified organization structure including the preparation of new job descriptions. It may be an opportune time for USAID and PRAGMA/MCD to consider fielding a public administration advisor to work with WASA and CIDA in developing the sister organization for its rural water supply and sanitation program. At the present time, WASA's rural program is being run essentially by two persons--the national coordinator and the chief of operations--both of whom have been involved in the rural program but are assuming new and expanded national roles. They are now responsible for the management of three major water supply and sanitation programs: the UNICEF program in Toledo District, the CARE program in Corozal and Orange Walk Districts, and the USAID program in Cayo, Stann Creek and Belize Districts. The MOH now has mainly a regulatory role in the sector, that of controlling water quality. Their public health inspectors are also responsible for approving latrines and well sites.

WASA's urban staff has considerable experience in managing its public utility operation. This cadre of seasoned staff will serve as the foundation for building its rural water supply and sanitation organization. As new staff is hired and trained, this organization will gradually be able to assume more of the activities and responsibilities now being assumed by external agencies.

As noted earlier, USAID/Belize has delegated much of its technical assistance responsibilities to the PRAGMA/MCD team. However, it is ultimately accountable to the U.S. Government for the successful execution of the project. Therefore, USAID/Belize has assigned a project officer to monitor

the day-to-day operation of the project. The project officer maintains frequent and continuing contact with the host agencies' staff and with the PRAGMA/MCD advisors. Through these contacts, the project officer is able to maintain an up-to-date knowledge of project activities and problems.

At the time of this assessment, the acting GDO was in the process of making a complete and thorough review of project implementation issues and a detailed assessment of project status. He has identified specific problems and has begun to initiate actions designed to resolve them. This level of involvement by USAID/Belize staff will go a long way toward pinpointing problem areas and taking the necessary actions to address them. A continuation of this type of problem identification and problem solving approach is vital to project success.

The PRAGMA/MCD advisors work with their host country counterparts on almost a daily basis. Their main role is to provide technical direction and advice within their respective specialty areas. The water supply and sanitation advisor works full-time in the water supply and sanitation sector. The health education/community development/trainer advisor shares her time with the vector control component of the IPTBH project, as does the Vehicle Maintenance Specialist.

All told, the human resources which are focused on the project are considerable and fairly well-balanced. The advantage of hind-sight suggests that the hope of obtaining a strong team leader who was also a highly qualified vector control technical advisor was unrealistic. However, in addition, one critical area of expertise is lacking. This is in well-drilling. Aside from the serious impact of the delays experienced in project mobilization, the lack of expertise in well-drilling has had the greatest negative impact on the project. This knowledge gap has led to serious errors in the procurement of equipment and supplies. These procurement errors have placed the well-drilling activity and, therefore, the whole project in jeopardy. Filling this technical assistance gap is presently the most urgent action needed to be taken.

In-country Technical Resources (Rural Sub-Sector)

As noted above, WASA has a wide range of technical resources available to it through its relationship with multinational and bilateral development institutions, these include USAID, UNICEF, PAHO, CARE, CIDA and others. These institutions can provide technical services needed by WASA.

USAID: At the present time USAID provides technical assistance to the project through a contract with PRAGMA/MCD. Under this contract, PRAGMA/MCD has fielded a team consisting of a project manager (Chief of Party), a water supply and sanitation advisor, a health education/community development advisor, and a vehicle maintenance specialist.

UNICEF: Although UNICEF has provided technical assistance (and commodities, i.e., rotary drill and accessories) in the past, at present it has no technical staff in Belize.

PAHO: PAHO is providing no technical assistance in the rural water supply and sanitation program. It has been funding off-shore training of public health inspectors. The national coordinator is a past recipient of this training program.

CARE: CARE is actively engaged in managing the rural water supply and sanitation program in Corozal and Orange Walk Districts. It is in charge of all aspects of the program except for well-drilling and the installation of handpumps. At present, the program is staffed by a project coordinator, a construction engineer, two health educators, and two sanitation technicians. The position of field supervisor is vacant at present but will be filled in the future. (See Appendix I for CARE organization chart.)

CIDA: CIDA is financing a major long-term project to improve Belize City water system and to install a new severage system for the city. The project is being implemented through a contract with a Canadian consulting firm. The firm's resident manager is an engineer and is supported by a variety of short-term specialists. CIDA itself has a project coordinator who is also an engineer. He works directly with WASA and advises them on management and organizational matters.

WASA Staffing

The National coordinator and the Chief of Operations both have many years of experience in implementing a rural water supply and sanitation program. However, they are now responsible for implementing a nationwide program which is presently operated as three related but distinct programs each having its own idiosyncrasies. The effective operation of the total program will require the development of skills in pooling and coordinating the institutional, human, and material resources at hand in a rational and effective manner. At present, with three of the top five positions vacant, the two incumbents are so overwhelmed by the pressures of almost daily emergencies that they have had little time to focus on these broader issues.

As noted above, three of the top five positions in the tentative organization for rural water supply and sanitation program are vacant. These are Chief Health Educator, Planning and Design Engineer, and the Administrator. At the management level, the Chief Engineer of WASA, Mr. McCord, will have the additional responsibility for the rural program. At the district level, all positions have been filled except for two health educators.

Training Resources In-Country

Background: The Belize educational system provides primary school education on a countrywide basis for all school age children. This consists of two years of infant school (equivalent to U.S. first and second grades) and six years of middle school (equivalent to U.S. third through eighth grades).

The middle school years are referred to as "Standard Six." High school consists of four years and is equivalent to the U.S. high school although it may be referred to as a college or secondary school. The four years in high school are known as Form One through Form Four. Beyond the high school level, there are several colleges offering two-year programs which are equivalent to U.S. junior colleges. There is a Teacher's College, a Nursing College, an Agricultural College, the Belize Technical College, and St. John's College.

Technical Training Resources: Belize Technical College is the only educational institution in Belize that provides technical training. It offers a two-year course in the building trades (carpentry, masonry, plumbing and electrical), technical drawing, auto mechanics as well as in wood working/cabinet making and home economics. Its graduates are considered to be technicians. The U.S. equivalent would be at the senior apprentice level.

While the college prepares technicians in several fields in the building trades and in auto mechanics which could provide useful skills to the rural water supply and sanitation program, it would not be an appropriate training resource due to the long two-year training period.

Management/Supervisory Training Resources: The Belize Institute of Management which is supported by AID funding provides a wide variety of short (2-1/2 to 3-day) workshops in the areas of management, supervision and administration. (See Appendix J for a list of recent workshops.) These workshops are repeated about every two months and offer an excellent opportunity for top and middle level managers. The Institute is also willing to develop and conduct workshops in technical areas. It can become the key in-country training resource for the project.

Training Needs: Since the rural water supply and sanitation program represents a new venture for WASA, to one extent or another all staff will require training or retraining. WASA's top managers who take their direction from a board of directors are now saddled with the additional responsibility for planning and managing a different type of program. This will require the development of new skills.

At the operational level, the national coordinator and his staff will need to acquire new skills in program planning and management in order to participate effectively with top management in developing short-term and long-term program goals and strategies. They will also need training and assistance in preparing work plans and implementation schedules.

At the district level, the district coordinators will need training in basic administrative and personnel management skills. District health educators need to receive specific training in health education and community development. Well drillers should receive periodic on-the-job drilling training and technical training in practical aspects of geology and hydrology, as well as training in community relations and how to support community involvement.

3.7 Task (f)

Advise on the potential of the project to attain the current physical target, establish the conditions under which this would be possible, and recommend alternative target formulation, including focusing on process rather than physical accomplishment.

Findings (f)

Assuming that three of the five existing drilling rigs will be available to the project area on a full-time basis and each rig completes one well per month, a total of 63 wells can be completed during the remaining 21 months of the project.

As previously stated, the team's conclusions are that no more than 70 wells would be anticipated to be completed in both the three IPTBH Districts and two CARE Districts in the next 21 months without major overhaul of the existing 22W rigs and the purchase of a new rig of equal or greater capability to the equipment furnished by UNICEF. Even these actions would not achieve target goals unless an extension of time together with a greater commitment of funds was granted.

The only possible way to attain the physical targets described in the Project Paper by the end of project date would be to eliminate the health education, community development participation and institution building purposes of the project and contract a U.S. well-drilling contractor and a construction company to come into Belize to drill wells and install handpumps, rudimentary water systems, and latrines. This would negate the main purposes of the project and make the development effort meaningless.

Even if the physical targets were reduced to levels that realistically could be attained within the present time frame of the project, (say 87 new wells, 63 rehabilitated wells, 6 rudimentary water systems and 1035 latrines), the 21 months remaining for project completion would now allow sufficient time to build a strong rural water supply and sanitation organization in WASA. As difficult as it may be to achieve the project's physical targets, the task of institution building is more complex and time-consuming.

3.8 Other Project-Related Findings

RWS Systems: The three RWS Systems now being planned (Silk Grass, Georgeville, San Antonio (Cayo)) should be completed and functioning within the next 12 months. It should also be possible to plan and start construction of another three systems before the end of the project. However, these systems may not be totally completed before the project ends. In addition, USAID and PRAGMA/MCD are planning to complete designs for another 6 RWS systems--that could be turned over to MNR for construction at the end of the IPTBH project.

Water Quality Analyses: The water laboratory with its single water analyst can analyze 30 samples per week. Assuming she works 48 weeks a year, she can analyze 1440 samples a year.

There are 108 villages and hamlets (Project Paper page 69) ranging in size from 50 to over 1000 in population in the three projects' districts.

The number of beneficiaries is estimated at 30,000. Assuming the installation of 250 new and 250 rehabilitated wells, there would be 500 wells to sample. An additional 20 rudimentary water systems, each requiring 5 samples, would add another 100 samples for a total of 600 samples. These can then be sampled and analyzed twice a year.

Well Depths and Well Siting: Various reports make reference to the fact that historically wells have ranged from 20 to 150 feet in depths. Actually, in sands along the ocean shoreline, shallow hand dug wells of 6 to 12 feet are commonly used to skim off the fresh water overlying saline or salt water, in addition to the deeper wells that are normally drilled further inland. From a practical standpoint, the availability of potable water is dictated by the geology and soils present at a particular location. The amount and seasonal distribution of rainfall, as described in an earlier chapter, is important to groundwater availability and topography is also important from the standpoint of siting individual wells. A basic description of the country's geology and past experience with conditions encountered during well-drilling is presented in Appendix K.

Specific Siting of Wells: Based on the discussions presented in Appendix K and field observations, it is apparent that the applicable geological information for siting specific wells in Belize is largely lacking. In general, the cost of undertaking a geologic study of each site is not warranted for low-capacity hand-pumped wells.

The limestone which underlies much of Belize is probably well jointed. The availability of aerial photographs is unknown by the persons contacted during the preparation of this report. If such photographs are available, photogeologic interpretation might be helpful in providing some well-siting guidance, since surface features may be linked to subsurface water bearing systems which tend to be linear and these features, as well as sink holes in karstic limestone areas, are favorable features for well sites

Health Education/Community Development

The design of the health education/community development component of the rural water supply and sanitation project provides the means for entering a village, introducing the project, developing community interest and participation in the installation of latrines and water systems and for continuing the health education and community development process to assure the proper operation and maintenance of these systems. Additionally, it provides the villagers the opportunity to identify and act upon other priority needs. Based on the experiences gained in the field, a step-by-step project cycle for this component (see Appendix C) has been developed and is being applied. As noted earlier, all thirty villages included in the first phase of project implementation have been visited. In some villages, the people were eager to get involved in the project. In others, the process of developing community interest has been slow, requiring repeated visits.

As a whole, the health education/community development component appears to be functioning well and making good progress. The main problem is that most health education staff positions in WASA have not been filled.

VIP Latrines

The VIP latrine component of the project is closely linked with the health education/community development activity. The initiation of the latrine component depends upon the success of the HE/CD activity to generate community interest and commitment to the program. Latrine construction and installation has begun in 10 villages and virtually completed in three villages. Some latrine superstructures have not been built due to the cost of lumber. Some poorer villagers need time to save enough money to buy the necessary materials.

While the latrine component is progressing in step with the HE/CD activity, it is encountering the problem of the pit flooding in certain villages (e.g. La Democracia) during heavy rains. This flooding has allowed mosquitoes to breed and hatch in the pits. The WS&S advisor is aware of this problem and will be using polystyrene beads in the pits (a solution already tested in Belize) to reduce the mosquito-breeding problem,

Project Implementation:

The project design presents a rational approach encompassing the necessary institutional, human, financial and material resources necessary for the successful implementation of a rural water supply and sanitation project. One of its major weaknesses lies in the short time period allotted for accomplishing its stated purpose.

Unfortunately, this flaw in project design was exacerbated by a series of circumstances which hampered or delayed project implementation. These included the inability of the MOH/EHS project coordinator to allot sufficient time to the project due to the demands of his other responsibilities, delays in acquiring project vehicles, inadequate office facilities for the technical

assistance team and the months-long disruption caused by the transfer of the Rural Water Supply and Sanitation portfolio from the MOH/EHS to MNR/WASA. In addition to these problems, the field work has been dogged continually by drilling equipment and vehicle breakdowns, lack of adequate drilling supplies and spare parts, and shortages in water supply materials. The problems related to well-drilling activities had their origin in the fact that well-drilling expertise was not provided for in the project design. This has led to a virtual standstill in the well-drilling operation.

The net result of these events has been to effectively delay project start-up by almost two years. This means that, in a very practical sense, the project has been undergoing a prolonged mobilization period, and certain activities, such as well-drilling, are yet to become fully operational. In the other components, i.e., health education/community development and latrine installation, the implementation phase is well under way. In fact, the technical assistance advisors are concerned about moving ahead too rapidly in view of the lack of success in the well-drilling component. They are reluctant to continue raising the expectations of villagers regarding the provision of a water supply if the project is going to experience continued delays in its effort to produce successful wells. As noted in a previous sector of this report, the project has yet to complete the installation of its first handpump or RWS. Unless this constraint is resolved in a timely manner, the total project may have to be slowed down to avoid problems with villagers.

Chapter 4

RECOMMENDATIONS

4.1 Introduction

As the project title states, the goal of the project is to improve the productivity of the Belizean population through better health. In order to accomplish this, the project must be implemented in such a manner that, at its completion, it leaves in place villagers who are more self-reliant and an agency capable of planning and managing a viable rural water supply and sanitation program. To do this, the project must maintain a balance between the achievement of its physical and institutional goals. Recognizing that the provision of water supplies is the 'carrot' that drives the project, there is always the danger of letting it become the only focus of attention. While the provision of adequate water supplies is an essential element of the project, in essence it only provides the means through which the project can also achieve its broader development goals.

However, building an institution capable of continuing the program not only in the current three districts but country-wide is not going to be achieved over a period of months.

The present project represents a vital element in the total GOB development effort. Therefore, in spite of the fact that project implementation has experienced more than its share of problems and frustrations, this project deserves the additional resources in both time and funds that will be necessary to reach a successful conclusion that approaches original goals in both physical accomplishments and the creation of a viable institution.

The following recommendations relate directly to the six tasks identified in the scope of work.

4.2 Task (a): Evaluate the costs and benefits of 100 foot deep wells and deeper (250'-300') wells.

Recommendation: The assumption that water of adequate quality and in adequate quantities could be found at the two proposed ranges of depths is an oversimplification of existing conditions. Throughout most of the country there exists a limestone aquifer from which water is available from fractures, solution channels or an upper-decomposed layer. In some areas the sediments which cover the limestone, at shallow depths of a few feet or 300 feet--or more, may contain lenses or layers of sand which comprise an unconsolidated aquifer. In those areas where unconsolidated sand aquifers are present, and where quality and quantity permit, they should arbitrarily be bypassed to install wells in the underlying limestone. For the foregoing reason, a comparison of cost and benefits is meaningless. Instead, it is recommended that wells be drilled to whatever depths necessary to obtain an adequate supply of water.

When, in some areas, it is only possible to find a productive aquifer at depths of 300 feet or more, it is recommended that equipment and supplies, as detailed later, be provided to accommodate wells deeper than have been previously considered necessary.

Note that although well depths may reach 250-300 feet, the water level in the wells will be much higher (within 100 feet of the surface). In fact, some wells in Belize (tapping deep artesian aquifers) have had a water level rise to the surface from hundreds of feet down. Therefore, water levels should be within reach of the available handpumps.

4.3 Task (b): Assess the capabilities of available well-drilling rigs.

Recommendations: The Mission should negotiate for a Buckeye supplied mechanic to visit Belize with the express purpose of rectifying the recurring clutch problem with the new 20W rig (at GOB Public Works Shop in Belmopan) after air-freighting replacement parts and spares. While the company may be willing to share some cost of this, the fact that they do not accept any responsibility should not be a deterrent to the prompt and timely implementation of this recommendation. A list of needed parts and an estimate of cost is presented in Appendix E.

USAID should take advantage of the presence of the mechanic to confirm the rehabilitation and maintenance strategy proposed below for the two 25-year-old 22W drilling rigs. At that time a better estimate of such rehabilitation through a subsequent visit by a Buckeye supplied mechanic should also be made.

Expeditious implementation of this recommendation is considered essential and USAID/Belize should determine if alternatives to regular AID procurement, such as obtaining a waiver to avoid bidding (and negotiate directly with the original manufacturer) are possible.

A rehabilitation strategy for the two 25-year-old 22W rigs is recommended as follows:

a. The complete rehabilitation of the 22W rigs now at Georgeville with a replacement engine, main jackshaft assembly, gears that come in contact with the gears of the new jackshaft assembly; shafts, pins and bushings of the sand reel, casing reel and bull reel. Replacement of the casing, sand line and crown sheave are important to obtain reasonable "life" expectancy from the wire ropes (cables) through which the drilling operations are carried out. The pins and bushings for these sheaves should be replaced as well as the crown shock absorber assembly (disk and plate assembly). A basic list of main parts as identified above is included as Appendix H for estimating purposes, but some items such as grease fittings and minor items do not appear and the manufacturer should be consulted as to the adequacy of the list.

The extent of the rehabilitation dictates that it be carried out by a Buckeye supplied mechanic utilizing the facilities of the GOB Public Works Shop in Belmopan in a follow-up or subsequent trip to the one necessary for the repairs to the 20W rig.

b. It is not anticipated that the second 22W rig, now in the Orange Walk District, will require such extensive rehabilitation. It is recommended that the replaced engine from the other rehabilitated 22W rig be rebuilt by the GOB Public Works facility for installation on the second 22W and determine if the less extensive rehabilitation of the second rig can be accomplished with their forces from spare parts ordered from an inspection of this rig during the initial trip of the factory mechanic.

c. It is recommended that the list of rehabilitation parts be ordered promptly together with a separately priced contract to provide the services of a mechanic to perform the rehabilitation work. Discussions should also be initiated with Mr. Melvin Hulse, General Manager of the Public Works Shop in Belmopan, about the use of their facilities and manpower in this activity.

d. It is recommended that the exact type of right-hand lay cable recently purchased be identified to insure that it is appropriate for installation on the equipment and that new cable be ordered conforming to the following:

Sand line wire rope	3/8 inch 6x7 fiber core, right hand lay.
Casing line wire rope	5/8 inch 19x7 non-rotating.
Bull reel wire rope	5/8 inch 21x6 plastic core, left regular lay.

Note: It is possible that the Buckeye factory mechanic/driller will not only be qualified to perform the repair and rehabilitation work, but may be a suitable candidate to train the drillers. Therefore, his performance in the field should be closely evaluated.

An additional well drilling rig is needed. The WASH team recommends that USAID purchase a new rotary drilling rig for use in the project. The new rig will be used to drill in formations requiring the rotary method and to increase the overall speed of well installation. The new rig should be another Canterra 211.

The WASH team recommends the purchase of the Canterra 211 (a Canadian rig) for the following reasons:

- The purchase of a second Canterra rig will allow MNR crews to apply their existing training and familiarity with Canterra directly to the new rig.

- Stocking and installation of spare parts and overall maintenance will be greatly simplified by having one make of drilling rig--rather than having to stock parts for and carry out maintenance and repairs on two distinct machines.

- Safety is a real concern. Familiarity with the controls and operation of one type of rig will help reduce the chance of injury during drilling operations.

- The new Canterra 211 can be specified to use a power take-off from a truck (eliminating the need for a deck mounted engine and heavier framework). This step will reduce the overall weight by about one ton--making the Canterra as flexible (and probably less expensive) as U.S.-made rigs that could be considered.

The WASH team recognizes the difficulties that USAID might have in purchasing this rig. However, because of the severe problems in the well drilling component of the project, the team believes that actions to speed up the purchase and provide the MNR with a familiar machine are warranted. Further, the team understands that the Canterra rig has more than 50 percent of its parts supplied by U.S. companies--a fact which has allowed AID to purchase this Canadian rig on other AID funded projects.

4.4 Task (c): Compare the costs of handpumps versus rudimentary water systems.

Recommendations:

Handpumps should continue to be installed on wells which produce acceptable water within the lifting capacity of the Mark II handpump, i.e., approximately 120 feet of pumping head. Unless the size of the population warrants a rudimentary piped water system, in those few instances where depth to water exceeds the Mark II capabilities, progressive cavity pumps such as the MOYNO can be employed. Once it is demonstrated that rudimentary water systems can be adequately maintained using the proposed three-tiered operation and maintenance system, and population size warrants, they should become the system of choice because they can provide a higher level of water service than the handpump.

Rainwater collection systems should not only be the subject of operations research as stated in the project paper, but should be installed where other sources of water are not feasible--i.e., where water is not available, even at 300 feet or where the water table is not within the pumping range of the India Mark II. Wells that could reach deeper aquifers (i.e., greater than 300 feet) could be drilled by a heavier, higher capacity rig than the proposed Canterra, but the heavier rig would have limited accessibility to remote sites.

4.5 Task (d): Review and revise procurement lists.

Recommendations:

That discussions with WASH be promptly initiated for assistance in the preparation of specifications for appropriate drill rig procurement details for the new Canterra rotary rig to put in water wells (not 1000 foot explorations) comparable to those installed by the UNICEF-supplied Canterra drilling rig.

That USAID/Belize require the PRAGMA/MCD water supply and sanitation engineer to obtain advice for system elements for which he is unfamiliar and to obtain reviews (for workability) of his RWS designs. The diversity of possible technical solutions requires a broad range of skills to design and specify the components for both WS&S systems. The technical review and assistance that are needed should be provided through the contractor's home office as outlined in the contract between USAID and PRAGMA/MCD.

4.6 Task (e) Review planning, management and implementation in this sector, including technical assistance resources, and advise on optimum and alternative approaches to ensure development in this area, including employment of new resources, restructuring assignments of current personnel, and training.

Recommendations:

USAID and PRAGMA/MCD should obtain the services of a Drilling Training Advisor with proper qualifications including current or recent ownership/management of a drilling company or service as a drilling superintendent of drilling operations involving cable tool drilling, past experience in formal driller training, some overseas experience preferred and confirmation of personality compatible with operating a training experience in Belize (patience, etc.). It is suggested that such selection might best be made if WASH concurrence of the selection were a requirement including time for briefing by WASH and orientation and clarification of training components and tentative training course content.

That the person described above be dispatched to Belize at the earliest practical time for a three-month period. Possibly this would be as soon as the 20W had been repaired or at the same time such repairs were scheduled so there could be some time overlap with the factory mechanic. Schedule a revisit for three months the following year. Suggest schedule might be October, November and December of 1987 and 1988.

That USAID and PRAGMA/MCD should obtain the services of a long-term drilling advisor with experience in both rotary and cable tool operations. This recommendation is discussed further under Section 4.8.5, Training.

Recognizing the increased TA requirements in institutional development occasioned by the portfolio transfer to WASA and the weak performance in the TA Chief of Party's role, the WASH team recommends the establishment of a separate public administration advisor's position. This advisor would assume the TA Chief of Party's functions and also be responsible for addressing the institutional development needs of WASA.

USAID could obtain the services of this public administration advisor through existing contracts. This advisor would work through the PRAGMA/MCD team to improve coordination and integration of project activities, to prepare annual work plans, and to develop long-range program strategies for this sector. The advisor should also work in collaboration with the CIDA advisor to develop a functional organizational structure for the rural sector program and to improve the planning and management skills of the WASA rural water supply and sanitation staff. USAID should establish a careful screening process to assure the selection of a suitable candidate for this job.

Considering the urgent need for the project to complete successful water systems, USAID should continue to strongly urge the MNR/WASA to recruit and fill the vacancies in their central office and field staff. Further, in order to minimize the management load on WASA during its early formative years, USAID should ensure that all CARE training and start-up activities, particularly for the RWS systems, are completed and that all systems are fully operational before they are turned over to WASA.

USAID, together with WASA and PRAGMA/MCD, should explore the possibility of WASA staff participating in selected workshops being conducted by the Belize Institute for Management and also explore the possibility of developing technical workshops in subject areas relevant to the rural water supply and sanitation program.

4.7 Task (f): Advise on the potential of attaining current physical targets and recommend alternative target formulation.

Recommendations:

The WASH team, having concluded that project goals in health education, community development, and institution building cannot be achieved within the remaining time frame of the project, recommends that the project life be extended and that additional funding be provided to enable the project to achieve its intended goals. The amount of funding is discussed under project redesign alternatives in Chapter 5.

If additional funding is not immediately forthcoming, we recommend that the current project design be modified by reducing the physical targets and, therefore, the procurement of commodities, and utilizing the savings to maximize the provision of technical assistance in the areas of well-drilling expertise, in the repair and rehabilitation of cable tool drilling rigs, and the purchase of the new rotary drilling rig equal to the Canterra 211 purchased by UNICEF. However, it is a foregone conclusion that neither the physical nor institutional development goals would be achieved under these conditions.

The descriptions of the project redesign alternatives are presented in Chapter 5.

4.8 Other Recommendations

4.8.1 Well Siting and Well Depths

The recommendations for locating wells, adopted by the National Coordinating Committee on Water Supply and Sanitation on January 21, 1986, (See Appendix B for full text) were as follows:

- The Village Council will be consulted on the locations for the handpumps within the technical guidelines as follows:

  a. No bored wells on private property.

  b. Wells must be at least 100 feet from a latrine.

  c. Wells must be away from burial grounds and open wells.

  d. Swamps and low-lying areas to be avoided.

  e. Wells must be accessible to users, and clear of roads.

  f. The National Coordinator has final approval of each site.

In the absence of specific site information, the following guidelines for selecting well sites, from a technical standpoint, are recommended:

- Make observations of the topography of the area where wells are to be installed and select sites in the following order of preference:

  - A draw in a large catchment area
  - A draw in a narrow catchment area
  - Valley bottom or flood plain

- Lower part of an upland slope
- Broad flat upland
- Gentle upland slope
- Mid-point ridge slope
- Pronounced rounded upland
- Upland steep slope
- A steep ridge top

The last few locations are poorest and should be generally strictly avoided. The above list was developed by Le Grand through the study of thousands of wells in the North Carolina area of the USA but is generally applicable to a wide range of geologic conditions.

In the limestone areas of Belize, well sites in or near depressions (sink holes) should be favorable sites for locating underground, water-bearing solution channels.

4.8.2 Health Education/Community Development

In view of the recommendations made in the mid-project evaluation report, PRAGMA/MCD, with USAID/Belize concurrence, should proceed with its plan to obtain the services of a consultant to review the HE/CD activity, recommend appropriate actions and prepare guidelines for development of a field manual for use by MNR/WASA staff. (See Appendix L for a full description of this consultancy.)

4.8.3 Sanitation

Further studies should be conducted to find cheaper materials for the superstructure of the VIP latrine. At the same time, a small study should be conducted to determine to what extent the use of alternative materials (such as thatch), which allow light to penetrate the superstructure, would cause a fly problem. Finally, the proposed solution to the pit flooding/mosquito breeding problem needs to be implemented.

4.8.4 Technical Assistance

USAID should examine the feasibility and advisability of reprogramming and restructuring its project implementation arrangements with its present contractors to provide a comprehensive technical assistance package which is fully responsive to WASA's special needs to plan, manage, and operate a viable rural WS&S program. This package would consist of a long-term public administration advisor who would be the senior TA advisor and also the key liaison person with USAID, MNR/WASA and MOH/EHS. S/he would provide general

guidance and supervision to the PRAGMA/MCD team members, the proposed training advisor and the driller trainer. S/he would be responsible for coordinating the activities of the advisors. S/he would also pay special attention to CARE's in-country management and project implementation capabilities as well as to CIDA, PAHO and Peace Corps as sources of additional technical assistance. Discussions should be held with CIDA's project coordinator regarding how his activities in the urban program over the next two years might be supplemented, through the provision of additional TA resources, to cover and be coordinated with the rural programs.

4.8.5 Training

The training requirements in the rotary form of well-drilling should be covered by a long-term (14 months) rotary rig well driller/trainer advisor. The long-term advisor would also have responsibility for overall (for both rotary and cable crews) improvements to the well drilling program. These improvements would cover areas of management, logistics, well development, screen selection, etc. Immediate attention, however, should be given to identifying and employing a short-term, cable-tool well-driller/trainer to work with and train the cable-tool crews in procedures specific to the cable-tool rig. It would be desirable to schedule his first 3 to 4 month assignment working together with the short-term (3 weeks) drill manufacturer's representative carrying out repairs to the 20W and reviewing the rehabilitation needs of the 22W rigs.

The WASH team believes that strengthening of the training component of the project is needed to better identify the needs of the MNR and to design the appropriate assistance. The team understands that part of this task is the responsibility of the long-term CD/HE/T advisor. However, more attention needs to be given to technical components of the project and the interface between the technical and community participation/health education components. The WASH team recommends that USAID (through PRAGMA/MCD) consider using a short-term training consultant to work with the existing staff and the proposed long-term drilling advisor to address MNR's training needs. The identification of training needs and the design of assistance to MNR should also be carried out under the supervision of the proposed public administration advisor and in consultation with the MNR counterpart (when assigned).

The training consultant should conduct a thorough assessment of all of the relevant training resources in the country. S/he should also identify people having expertise in areas relevant to the rural water supply and sanitation program who could form a pool of talent to be drawn upon to participate in training sessions and workshops. One of the training resources to be assessed is the Belize Institute for Management. Although it was established primarily for the private sector and for tourism, the possibility for participation by WASA staff members in its current offerings should be explored. The training officer should also explore the possibility of having the BIM, in the future, develop and conduct technical training workshops on topics pertaining to the RWS&S program.

Chapter 5

PROJECT REDESIGN ALTERNATIVES

Two redesign alternatives are described below. They involve changes in project budget, the duration of the project and/or the use of funds. The advantages and disadvantages of each alternative are noted. Alternative A should be considered only as a temporary measure to provide USAID and the GOB time to work out project extension details for Alternative B and to secure additional funding. The two alternatives are followed by a sub-set of alternatives which involve the possibility of shifting some of the technical assistance responsibilities to CARE. Considering that CARE is a PVO with lower overhead costs than consulting firms, this shift would result in substantial savings. However, the mechanisms involved in making the necessary contractual arrangements and in defining the roles and responsibilities of the present TA contractor (PRAGMA/MCD) and of CARE will be complicated.

The new levels of physical targets are minimums based on past performance. The WASH team has used these lower numbers, which may possibly be lower than achievable with additional assistance, in part to reduce the focus on physical targets. The institutional development goals are all important for effective program continuance after termination of AID assistance but may not be achievable in the 21 months left in the current project. The additional training of well-drilling crews and the upgrading of drilling rigs should result in higher productivity. Should that happen, additional funds will be needed to purchase more equipment and commodities than are provided for in the alternatives.

The cost figures are based on the best available information but require verification by the Mission. The capital cost of rudimentary water systems is based on the estimated cost of the RWS for Silk Grass. Equipment and commodity costs are based on quotations from suppliers in most cases. However, where these were not readily available, the costs were estimated.

The required number of VIP latrines is derived from the estimated number of households to be served by new water systems. It was assumed that no new latrines would be installed where existing wells are to be rehabilitated. The estimated number of VIP latrines to be installed is based on past production figures and projections provided by the water and sanitation advisor, i.e. 45 latrines per month. These rates may be increased as more staff is hired.

The new targets for rehabilitated wells is based on an estimate that the two Dando rigs will be capable of rehabilitating 1-1/2 wells per month each. The potential diversion of repaired or rehabilitated drilling rigs to drill wells in the two CARE districts has not been factored in or restated. The well numbers include the two CARE districts as well. The targets for new wells are based on the past performance as described in Chapter 3 which indicate a rate of approximately one well per month for each rig.

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New Physical Intervention Targets

	End of Project Dates	
	4/1/89	4/1/92
Rehabilitated well/handpump (2 rigs)	63	171
New well/handpump (3 rigs)	63	171
New well/handpump (new rotary rig)	24	96
RWS (avg. pop. 300 = 50 households)	6+6 design	18+6 design
VIP latrines: Required	1470	3570
Installations at present rate	1035	2655

The following costs are to be included in each of the alternative project designs presented.

a)	Repair parts and repair of 20W by Buckeye company supplied driller/mechanic (2 wks)	$ 6,075
b)	Rehabilitation parts and work by company supplied driller/mechanic on the 22W rig (4 wks)	33,925
c)	Cable tool driller/trainer for 6 months. Already included in PRAGMA/MCD contract	0
		$40,000
	10% contingencies	4,000
	Total	$44,000

Note: 100 Mark II handpumps with brass-lined cylinders and pump rods have been purchased and are stored at WASA warehouse at Mile 10. The 2500 feet of 4" diameter well casing which appears in the PRAGMA/MCD-supplied inventory is currently being used and additional casing materials may be needed. No estimate of the quantity of additional casing is included in this report.

5.1 Alternative A

This alternative is based on retaining the original project budget and time frame but reducing the targeted number of interventions. This reduction will reduce the amounts of equipment and commodities required, thereby generating a saving in the amount budgeted for this purpose. The savings will be used to purchase a new rotary drilling rig (a Canterra 211, twin to the UNICEF rig) complete with tools and the services of a company-supplied driller/trainer to inspect and operate the rig and to train drillers in its use.

New Minimum Targets

Rehabilitated wells with handpumps	63	150
New drilled wells with handpumps	87	
Rudimentary water systems	6+6 designed	
Latrines: Required	1470	
Minimum installations	1035	

According to Table 2, "Summary A.I.D. Financial Plan," in the project paper, a total of $1,488,000 was allocated for water supply and sanitation equipment and commodities. Of this amount it is estimated that approximately $400,000 has been obligated, leaving a balance of $1,088,000. The costs of additional equipment and commodities for the new targets are:

50 Mark II handpumps, cylinder, pump rods @ $515	$ 25,750
150 Sets of 1-1/4" drop pipe + 4" casing @ $590	88,500
12 RWS @ $40,000	480,000
1470 VIP latrines @ $50	73,500
	$667,750

The purchase of equipment and commodities would leave a balance of $420,250. This will be used to cover the following costs:

Repair of 20W + rehabilitation of 22W	$ 44,000
Rotary driller/trainer (14 mo. at $10,500/mo.)	147,000
Canterra truck-mounted rig and tools	270,000
	$461,000

Based on the costs outlined above, it is estimated that there will be a shortfall of approximately $40,750 which may be covered out of short-term consultancy funds or some other budget items. The team understands that USAID is currently reviewing the overall project budget. Depending on the outcome of the financial review, USAID may decrease the number of RWS systems that are planned (12 systems) to reduce the shortfall and/or pay for additional casing materials that may be required.

Under Alternative A no additional funds would be available for technical assistance or training beyond that already included in the PRAGMA/MCD contract. The PRAGMA/MCD advisors will complete their tours of duty as scheduled. While the acquisition of the new rotary drilling rig and the upgrading of existing rigs would significantly increase WASA's drilling capabilities, very little assistance would have been provided in the area of institution building. The end result would be the creation of a public sector drilling agency having limited program planning and management capacity. Selection of this alternative would mean that neither the physical nor the institutional development goals of the project will be met.

5.2 Alternative B

This alternative involves an extension of the project (3 years) and requires a budget supplement of approximately $2.8 million. The minimum intervention targets would be near those of the original project.

Rehabilitated wells/handpumps	171	438
New wells/handpumps	267	
RWS	18+6 designed	
Latrines: Required	3570	
Minimum installations	2655	

The cost of equipment and commodities for these targets are:

338 Mark II handpumps, complete @ $515	$ 174,070
438 Sets of drop pipe and casing @ $590	258,420
24 RWS @ $40,000	960,000
3570 VIP latrines @ $50	178,500
	$1,570,990
Repair of 20W & rehabilitation of 22W	44,000
Purchase of new rotary rig & tools	270,000
	$1,884,990

This exceeds the amount allocated in the project paper for equipment and commodities ($1,088,000) by $796,990. This amount plus the following costs for additional technical assistance must be added to the original budget.

Additional Technical Assistance

1.	Long-term cable tool driller/trainer	24 mos.	@ $10,500/mo.	$252,000
2.	2-year extension of water supply and sanitation advisor		@ $160,000/yr.*	320,000
3.	2-1/2 year extension of health education/CD advisor		@ $160,000/yr.*	400,000
4.	4 yr. public administration advisor		@ $160,000/yr.	640,000
5.	12 mos. training advisor (see section 4.8.5)		@ $10,000/mo.	120,000
	Total additional TA Cost			$1,732,000
	Shortfall in equipment and commodities allocation			796,990
				$2,528,990
	10% contingencies			252,900
	Supplemental Budget			2,781,890

* These rates were taken from Table 5, "Technical Assistance," in the project paper.

This alternative provides the resources and time necessary to attain the original physical targets and to provide a sound basis for WASA public sector organization to plan and manage the water supply and sanitation program on an expanding basis. The end result of this project alternative will be a competent and viable organization capable of planning and operating a rural water supply and sanitation program as well as making significant gains in developing more self-reliance among villagers.

5.3 CARE Technical Assistance

As noted in Chapter 3, CARE is presently managing the water supply and sanitation project in the districts of Corozal and Orange Walk. CARE's present staff includes the country director, project coordinator, construction engineer, two health trainers, and two district sanitation technicians. CARE's organization chart is shown in Appendix I.

In addition to having an existing organization managing an ongoing project, CARE provides the advantage of low overhead costs which can significantly reduce the funds required for additional technical assistance services or, alternatively, extend the tours of advisors.

If Alternative B is selected (extending the LOP), USAID should give serious consideration to the transfer of project responsibilities for some communities directly to CARE. Discussions should be initiated with WASA, PRAGMA/MCD and CARE to consider the advantages and disadvantages and to explore ways to accomplish the transfer with minimal impact on project implementation.

This arrangement could have the advantage of reducing the work load on PRAGMA/MCD (allowing them to complete the majority of their targets and to focus on institutional development) and could result in a reduction in the overall cost of Alternative B.

In Alternative B, the cost of technical assistance (items 2,3,4, and 5) could be reduced by about one-third (or by approximately $488,400) because of CARE's lower cost structure. This will reduce the amount of supplemental budget needed to approximately $2.3 million. This would be the preferred alternative assuming that the mission could successfully negotiate the necessary contract arrangements.

Chapter 6

SCHEDULE OF ACTIONS BY USAID/BELIZE

August 1987

1. Order by air freight repair parts for the new 20W rig. Parts should be accompanied by factory mechanic/driller who will make the repairs. Repair parts are shown on page 3 of PIO/C 505-0018-5-70001 attached as Appendix E. Mechanic/driller should bring any special tools which are required to make the repairs. Ralph Preble/WASH has initiated contact with Buckeye Manufacturing Company.

October 1987

1. Buckeye factory mechanic/driller arrives with repair parts for the 20W and makes the repairs. Mechanic/driller to be briefed by WASH prior to departure to Belize. Mechanic/driller will also reassess the rehabilitation needs of the old 22W rig in Georgetown. He will revise the parts list for the 22W which is attached as Appendix H. Estimated time required is two weeks.

2. USAID to initiate recruitment of a cable tool driller/trainer for two three-month tours--the first during October-December 1987 and the second October-December 1988. WASH can assist in recruitment and selection of the candidate. It is possible that the Buckeye factory mechanic/driller referred to in the above items may also be qualified and suitable for this training assignment, therefore, his performance in the field should be closely observed and assessed.

3. USAID to submit the PIO/C for rehabilitation parts for the 22W to be shipped by surface freight. This action will follow item (1) above.

4. USAID to initiate identification and recruitment of the long-term rotary rig driller/trainer (14 months) barring the selection of project redesign Alternative B which does not include the purchase of a new rotary rig.

5. USAID requests WASH to provide specifications for a new rotary drilling rig.

November-December 1987

1. USAID submits PIO/C for new rotary drilling rig (except for Alternative B).

2. USAID contacts Buckeye Manufacturing to arrange for factory mechanic/driller to rehabilitate the 22W when the parts arrive.

December 1987-January 1988

Cable tool driller/trainer arrives to begin 3-month tour. The proposed 3-month tour may be extended (with USAID concurrence) if the advisor recommends a longer initial training (i.e., 4 months) and a shorter follow-up training period (i.e., 2 months) to achieve the total recommended time of six months.

January 1988

1. Expect rehabilitation parts to arrive incountry via surface freight.

2. Factory mechanic/driller arrives with necessary special tools to rehabilitate the 22W. Estimated time required is four weeks.

February-March 1988

1. If ordered, new rotary rig complete with tools and accessories arrives.

2. Rotary rig company driller/trainer arrives to check, set up and operate new drilling rig and train drillers. Estimated time required is 3 weeks.

3. Rotary rig driller/trainer (long-term) arrives to start his 14-month tour at the same time as the company driller/trainer. (24 months if the 3-year extension is approved.)

October-December 1988

Cable tool driller/trainer returns for his second tour of duty. Length of stay depending on the balance left of the six months allotted. The second tour may not be necessary dependent upon the experience and effectiveness of the long-term (14 month) advisor who will have overall (for both rotary and cable crews) responsibility for improving drilling operations.

PERSONS CONTACTED

PERSONS CONTACTED

Government of Belize

Eleanor Hall	Permanent Secretary, MNR
David Cruz	Acting P.S., MNR
Albert Hoy	Chief Executive Officer, WASA
Roland Rivers	National Coordinator, WASA
Ivan Tingling	Chief of Operations, WASA
William Flowers, Sr.	Foreman, WASA
Ecort Montero	Driller, WASA
Charles Salgado	District Coordinator, WASA
Donald Bennett	Driller, WASA
Orlando Muschamp	Carpenter Foreman, WASA
Gerald McCulloch	Office Supervisor, WASA (urban)
Cecil Ramos	Assistant Office Supervisor, WASA (urban)
Herman Joseph	District Coordinator, WASA
David Diego	Health Educator, WASA
William Flowers, Jr.	Driller, WASA
George Andrews	District Coordinator, WASA
Dale Guzman	Village Council Chairman, Georgeville
Anthony Alvarez	Assistant Driller, WASA
Beverly Clare	Laboratory Technician, MOH
Nicholas Adrian	Community Developer, MSS
Melvin Hulse	General Manager, Equipment Shop, MOW

USAID/Belize

Neboysha Brashich	AID Representative
Dennis Conroy	Acting CDO - GDO
Sam Dowding	Project Officer
Edwin Gales	Acting GDO
Mellen Tanamly	GDO

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AID/W

Victor Barbiero	S&T/H
Ron Hendrickson	AID/W Engineer (TDY)

PRAGMA/MCD

Merrill Wood	Chief of Party
Harry Phillipeaux	WS/S Advisor
Terry McLean	HE/CD Advisor
Ray Robertson	Vehicle Maintenance Advisor
Richard Killian	PRAGMA Project Co-Director
Joseph Carter	MCD Project Co-Director

CARE

Frank Brechin	Country Director
Estelito Loria	Project Coordinator
Douglas Walker	Construction Engineer

PEACE CORPS

Teresa Lamasney	PCU Health Educator

WASH

J. Ellis Turner	Activity Manager

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REFERENCES

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PHOTOGRAPHS

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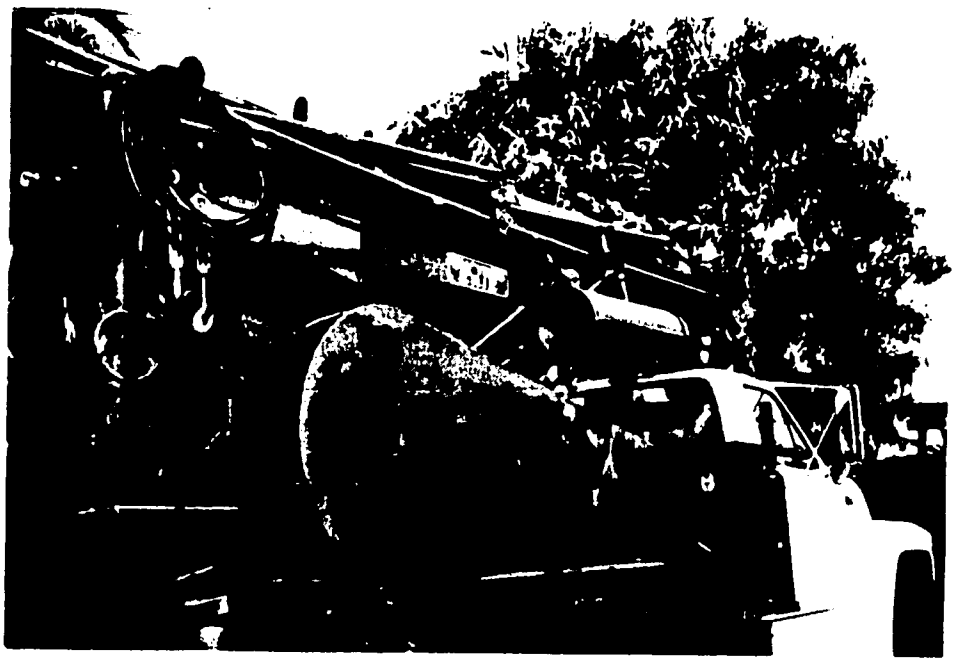

Photo 1. Old 22W Drilling Rig Mounted on new F-350 Truck under Repair at Orange Walk.

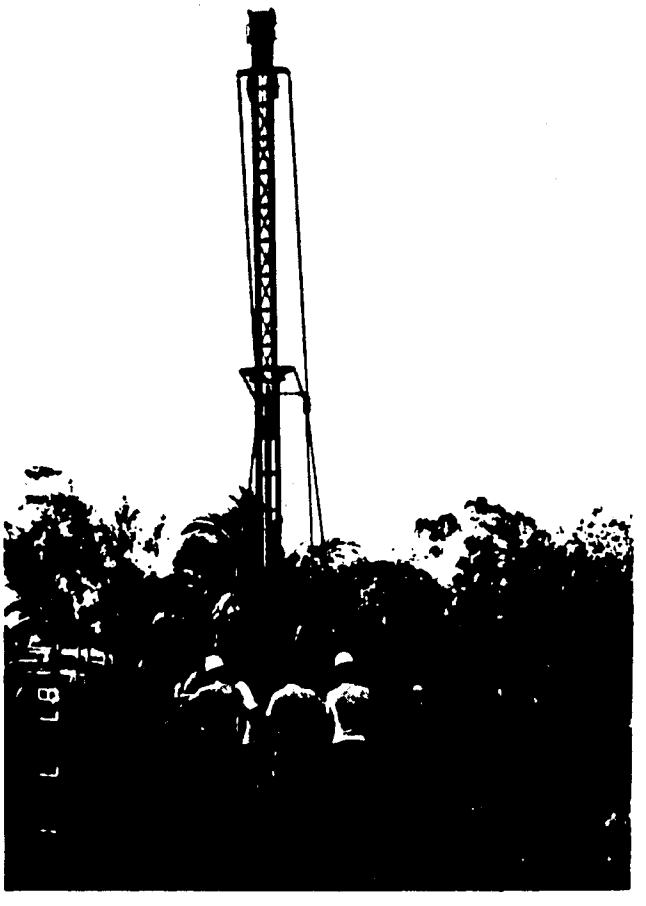

Photo 2. Old Dando Drilling Rig Awaiting Repairs at Santa Maria

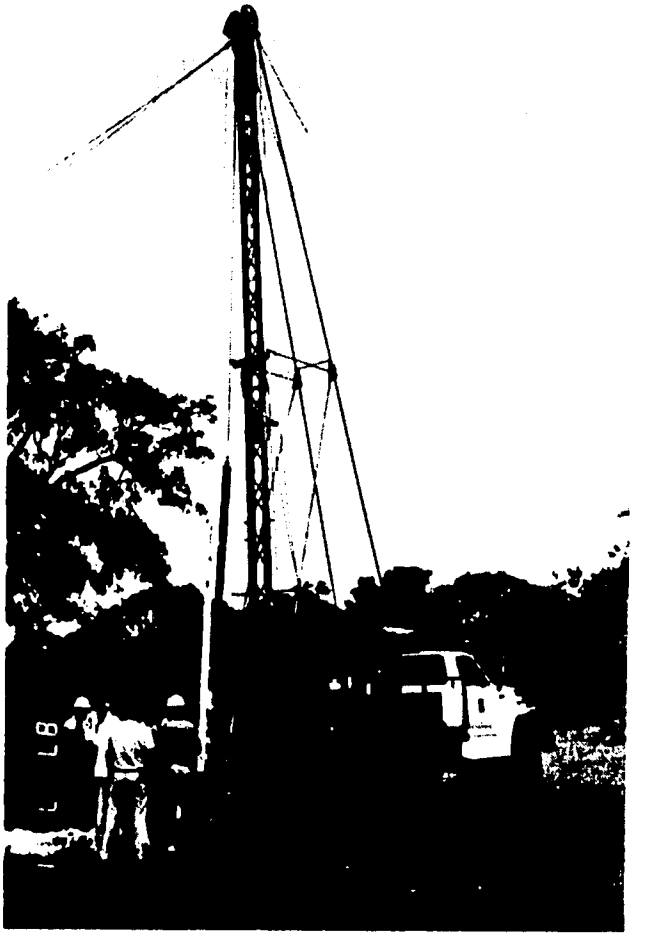

Photo 3. New 20W Drilling Rig Working Bermudian Landing

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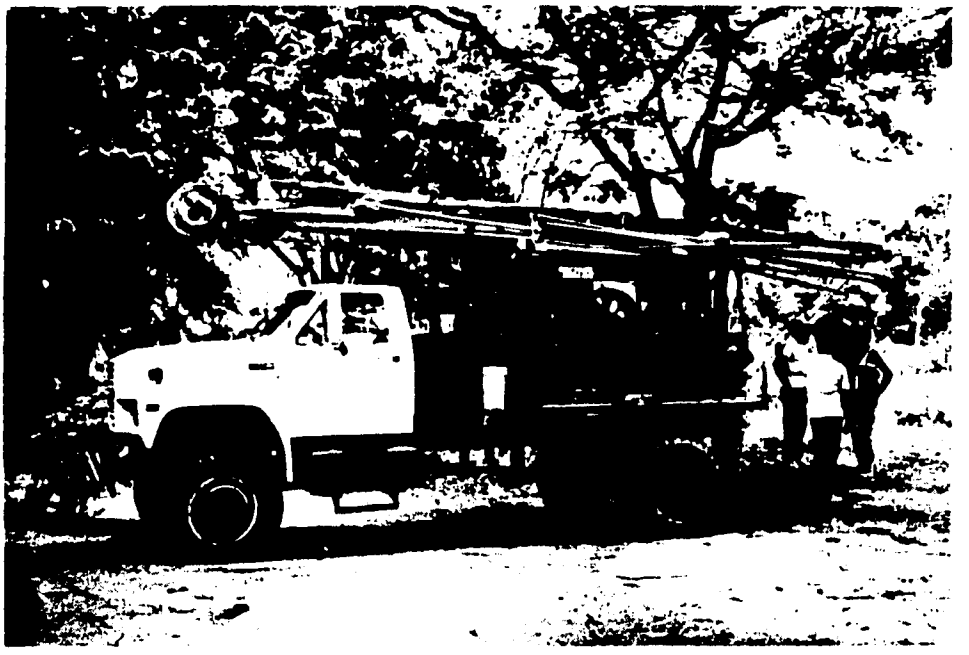

Photo 4. Old 22W Drilling Rig Mounted on New F-350 Truck at Georgetown

Photo 5. Old Dando Drilling Rig Mounted on Seddon Truck at Punta Gorda

Photo 6. UNICEF Canterra 211 Rotary Drilling Rig at Punta Gorda

Photo 7. MOH Laboratory Technician at work in water quality laboratory in Belize City.

Photo 8. Spring Source for Rudimentary Water System for Unitedville and Blackman Eddy

Photo 9. Construction of an Infiltration Well as Water Source for Town of Silk Grass

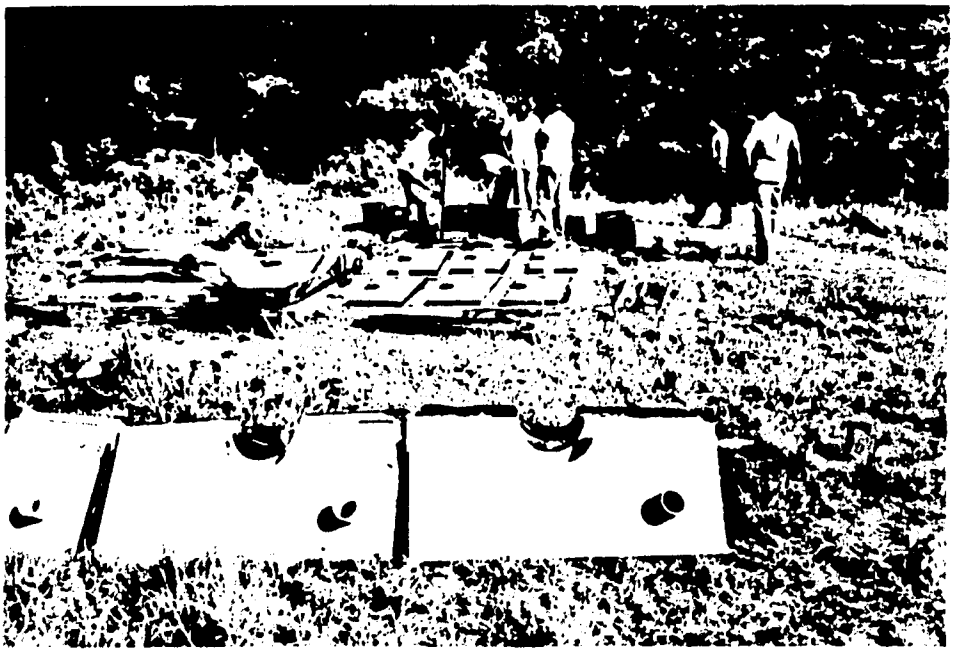

Photo 10. Latrine Slab Fabrication at Unitedville

Photo 11. Latrine Riser Fabrication at Unitedville

Photo 12. Uncompleted Well Awaiting Additional Supply of Steel Casing at Georgetown

Photo 13. Old Demster Handpump Installed Near Punta Gorda

Photo 14. VIP Latrine Installed Near Punta Gorda

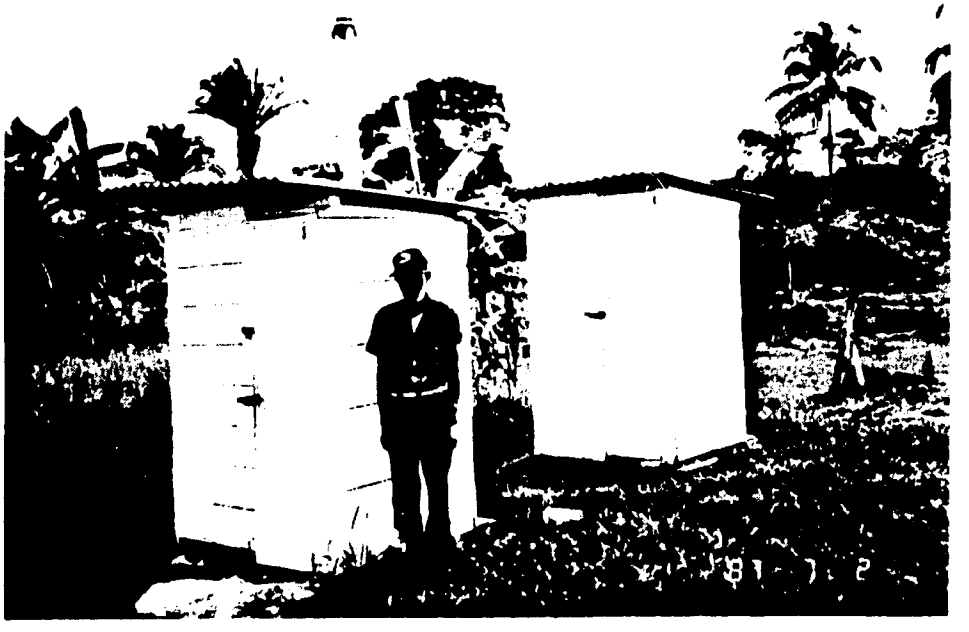

Photo 15. VIP Latrines Installed at School Near Punta Gorda

Photo 16. 4 Inch Diameter PVC Well Casing at WASA Mile 10 Warehouse.

Photo 17. Mark II Handpumps in Shipping Crates at WASA Mile 10 Warehouse

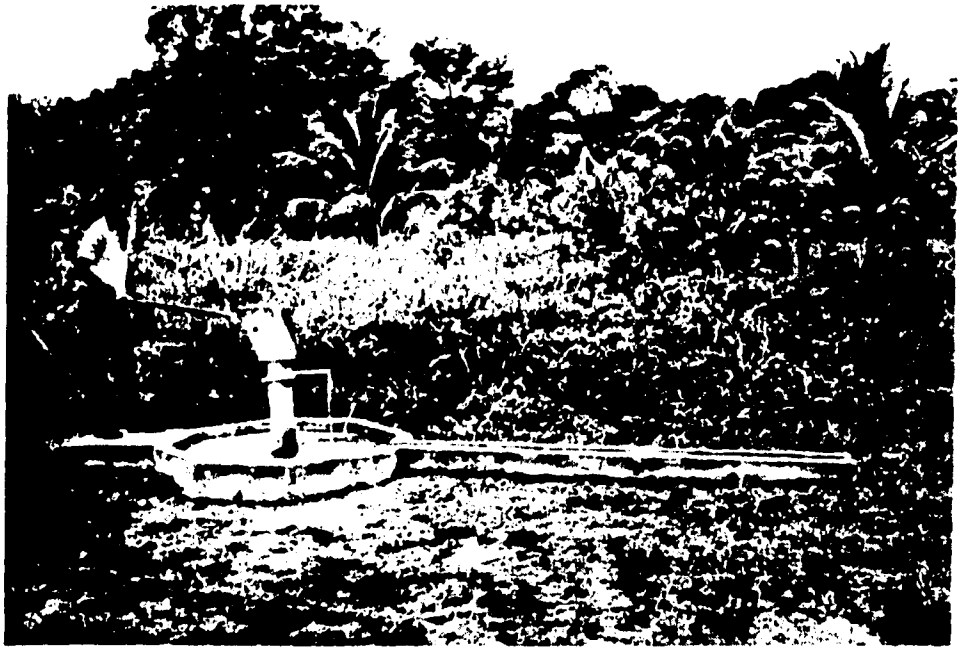

Photo 18. Mark II Handpump Installed Near Punta Gorda

Appendix A

PROJECT DEVELOPMENT TEAM

E. Project Development Team

Neboysha Brashich, AID Representative to Belize
Paula Feeney, LAC/DR/HN Health Officer
Lawrence Cowper, S & T/Health Vector Control Advisor
Mellen Duffy Tanamly, Consultant
Rose Schneider, Team Leader, Consultant
Richard Wilk, Social Scientist, Consultant
David Redding, Economist, Consultant
Robert Gearheart, Engineer, Consultant
Ray Beach, Entomologist, Centers for Disease Control (CDC)
Glenn Stokes, Entomologist, Consultant
Scott Goode, Graduate Student, Texas A & M University
David Donaldson, Engineer, Consultant
Ken McLeod, Engineer, Consultant
Mike A. Ramirez, Financial Analyst, USAID/Belize
Phillip R. Amos, Controller, USAID/Tegucigalpa

The team was supported in the development of the PP by Shelley Trifone, Shirley Crawford, Joy Dellinger and Liliana Koster, USAID/Belize.

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Appendix B

NATIONAL COORDINATING COMMITTEE ON WATER SUPPLY AND SANITATION

RECOMMENDATIONS FOR NATIONAL POLICIES AND GUIDELINES

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APPENDIX B

National Coordinating Committee on Water and Supply and Sanitation

January 21, 1986

Recommendations for National Policies and Guidelines for Construction and Maintenance of Water and Sanitation Systems

The coordinating committee is composed of representatives of the Ministry of Health, WASA, Social Services, MECOPAD, CARE, USAID, UNICEF, and Peace Corps. The inception of three major water and sanitation projects in Belize has highlighted the need for consistent national policies under which Donor assistance in water and sanitation can be implemented. The committee has produced the following list of proposals and recommendations for those policies, to be considered at the highest levels of Government.

This document presents the committee's findings in three parts for each major activity. First are the committee's recommended policies and guidelines, followed by a list of conditions that must be met if these policies are to work.

CONSTRUCTION

Water Systems

I. Hand pump systems

A. Recommended Policies

1. Health education efforts should be conducted in every community prior to the installation of handpumps.

2. The GOB/Donors should provide in all cases the well drilling, casing, pump, and materials for pad. Community or direct beneficiaries contribute labor in pad construction, site preparation, and drainage under direct MOH supervision.

3. If the pump exists already GOB/Donors will rehabilitate as needed, or replace with MARK II.

4. There should be educational programs on protection, improvement and sanitation of water vats and hand-dug wells where they exist.

B. Conditions

1. Village Council should have advance notification of the number of pumps to be placed in village.

2. The Village Council will be consulted on the locations for the hand pumps within the technical guidelines as follows:

   a. No bored wells on private property.
   b. Wells must be at least 100 feet from a latrine.
   c. Wells must be away from burial grounds and open wells.
   d. Swamps and low-lying areas to be avoided.
   e. Wells must be accessible to users, and clear of roads.
   f. National Coordinator/P.H.I. has final approval of each site.

3. Agreement by Community on labor contribution in timely and effdctive manner for both new pumps and rehabilitated ones.

4. Government agrees not to begin hand pump programs in villages that do not agree to contribute labor in pad construction and a maintenance program.

5. If the community does not want hand pumps (because of existing alternatives) and does not qualify for a RWS, donors and GOB will provide assistance in testing and upgrading the quality of the existing water systems.

6. After the Donor projects end the GOB will continue to provide new

handpumps for new villages and new population. (Note that the not present cost of a well and MARK II hand pumps is about ($3,500).

II Village Rudimentary Water Systems (RWSs)

A. Recommended Policies

1. No village with less than 250 people will receive a RWS unless the cost of the RWS will be lower than the cost of handpumps installed at the rate of one pump for 10 households. Donor projects are not committed to a RWS in villages of over 250 people if such a system is financially or technically unfeasible.

2. In negotiating with each eligible community the GOB/Donors should offer an established minimum level of support to <u>every</u> community.

3. GOB/Donor agencies will provide:

   a) Well, pump, Engine, filtering system if needed
   b) Tank/Tower
   c) Distribution mains

   The Community in every case, will be responsible for all unskilled labor for system installation and cost for home hook-ups. Where there are available sand and stone will be provided.

   In the distribution of the allocated funds, GOB/Donor agencies will prioritize in most needed area.

4. The GOB/Donor projects will provide technical assistance to each community in making decisions about storage/distribution systems, and in financial planning. Consultants will be made available as needed.

5. If a village council decides it does not want to have a RWS, on this basis GOB donors will explore alternatives.

6. Village councils should agree to a RWS maintenance program and a committment to provide labor for construction, in a formal agreement with the GOB/Donor project, prior to the beginning of construction.

7. Pipes and equipment for RWSs will be procured through Government or donors by the least expensive possible means that ensures quality, standards, and timely delivery. GOB will commit to expedite the duty-free importation of pipes and supplies.

8. WASA and the MOH agree on the following division of duties and activities: WASA will be responsible for urban water and sanitation (Belize City, Belmopan, and all Towns) and other systems hooked up to a WASA town system. MOH, thru' the village councils, will bear responsibility for other systems, <u>except</u> wells bored and developed by the Ministry of Agriculture for agricultural purposes.

B. Conditions

1. GOB at all levels must agree to stick to a standard policy towards village RWSs, regardless of the total cost of each system or the size of the community. There can be no special pleading or special arrangements for any community in regard to the guidelines adopted.

3. GOB/Donor projects will be given decision-making power about the best and most cost-effective means of providing adequate quantities of water for the community storage/distribution system. If the project personnel decide that hooking up to an existing town supply or using a spring is cheaper in the long,run, they will not be expected to provide a well system.

3. GOB/Donor will consult with each community to make conditions clear before beginning planning or construction of a project. The community should assist by providing labour in the construction of the tower, the reservoir and the digging and laying of distribution lines.

4. WASA and MOH must agree on a division of labor and a cooperative arrangement, so that the option of hooking villages up to town water systems can be pursued where appropriate.

5. Villages must be given statutory powers to assess village members for both maintenance and users fees.

Sanitation Systems

A. Recommended Guidelines

1. There will be no latrine construction program that does not involve a health education program before, during and after.

2. In all cases community members will be responsible for digging pits and building superstructures (They will provide materials for their superstructures). Project will provide assistance for materials and technical assistance for construction of slabs,risers and vent pipes if required.

3. There should be a variety of options available to households that want to improve sanitation. If people in a community want something more elaborate than a pit latrine, Donors will privide Technical assistance and materials of a value equivalent to the subsidy being offered on slab riser systems.

B. Conditions

1. Uniform sizes and standards for slabs and risers should be established.

2. Donors must perform sufficient technical studies to be able to offer cost estimates on various technical options with some indication of relative advantages and disadvantages.

I. Water Systems

A. Recommended Guidelines

1. Years of experience has shown that the success of any water program hinges on the maintenance of water systems. While maintenance is expensive and time-consuming to organize, no system will be constructed unless resources are present and committed to maintaining that system.

2. There should be a single maintenance structure for Handpump systems and rudimentary water systems, though in operation the sutructure will deal differently with the two types of system.

3. We recommend a 3-tier system as follows:

   a. Village Safe Water Groups - cleans, monitors pumps,condition and reports damage to next level. For RWSs this group would monitor condition of taps and pipes, and pump house and tanks.

b. Village Mechanics - Will grease, tighten nuts and bolts, they will be unpaid in villages with a hand pump system, but will be trained in both system maintenance and other useful small machine repairs and given custody of a set of tools. Each community should have two such specialist. For handpumps they will perform above-ground repairs. For RWSs they will organize tank cleaning as well as basic maintenance and minor repairs of pre-existing handpumps, engine pumps and tank and major piping repairs. RWS mechanics should receive a small stipend from the Village Council and should be responsible to that body. The VMs report all breakages they cannot handle to the next level of the system.

c. District Maintenance Team (DMT) - a minimum of 3 teams are recommended to cover the country. Minimum staff of three with a truck, tripod, tools and radio for dispatching. The DMT will have regular maintenance and monitoring rounds and will respond to emergency situations. The district P.H.I. in charge of water supply would monitor the performance of the DMT as well as the quality of water supplied and the performance of pumps, wells and tanks. Very large and specialized repair jobs should be contracted out at the expense of the Village Council.

4. Spare parts for RWS and hand pumps should be stored in the country, and all costs for RWS should be assumed by the communities. If there are product defects proper installation problems the cost of parts remains with the M.C.H.

5. The village will pay operating costs for the system out of funds they collect as user fees. The GOB/Donor projects will provide education and TA to help villages establish collection and assessment systems. Village councils must have legal authority to do so.

6. MOH has a standard contractual agreement with each community which defines the level of maintenance support which will be provided by the GOB and the noncommittant responsibilities for maintenance by the community.

7. The MOH will make up a job description for the Village Mechanics including duties and rates of pay, which will serve as guidelines to Village Councils in hiring VMs.

8. District Maintenance Teams will have a regular system for dispatching to trouble spots for service and repairs. All reports of emergency breakdowns will go through proper channels, and repairs visits will then be scheduled. The District PHI in charge of the maintenance unit will make decisions about scheduling, and all reports will go through him.

B. Conditions

1. Villages must have statutory authority to collect fees from members. There must be a channel established for the MOH to bill the Village council for repairs to equipment.

2. GOB at all levels must agree to apply the system consistently and equitably. Those villages with RWSs currently supported by government will approve resistant at first and will have to be a special target for education and TA.

3. GOB MUST agree to the long-term support and supply of the 3 district maintenance teams. If this cannot be done, the entire systems will fail.

4. MOH must create a filing and information system to monitor all pumps and RWSs in each district. The District PHI in charge of water will be responsible for dispatching the DMT by radio from a central point.

5. Donors must commit to major educational effort aimed at promoting village autonomy and decision-making in planning and maintenance.

6. The Village maintenance person must be responsible for keeping records and logs of equipment use and performance, with the District PHI supervising the process. As VMs are lost through attrition and new ones are added, GOB must continue to pay for training programs for the VMs.

Appendix C

INCREASED PRODUCTIVITY THROUGH BETTER HEALTH PROJECT

PROJECT CYCLE FOR H.E./C.P./C.D

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INCREASED PRODUCTIVITY THROUGH BETTER HEALTH PROJECT

WATER AND SANITATION

Project Cycle for H.E/C.P/C.D

Community Awareness	Community Mobilization	Sort out information-gathering, assessment of resources, beliefs, conditions	Community decision-making	Design	Construct project	Maintain and repair	Evaluation	Next phase
ºProject introduced to Village Council	ºOrganize health committee or another action group	ºIdentify taboos, understandings, and beliefs concerning sanitation	ºYes/no to latrines	ºSelect type of latrine	ºVillage economic activity/timing	ºEstablish system to assure continuing maintenance and repair activity	ºEvaluation process in place	ºContinuing education
ºProject introduced at general village meetings	ºIdentify community needs and priority	ºAssess natural and human resources	ºWhat community will be responsible for	ºSchedule construction	ºLatrines built as agreed	ºSafe water groups formed		ºOther projects as per communities priorities
ºUser's benefits, explained	ºProvide information on health for better understanding	ºAssess physical nature of community and land	ºWhat individuals will be responsible for	ºArrange for material and outside resources	ºWater systems constructed as agreed	ºVillage mecnanic trained		
ºThree tier maintenance system introduced		ºVillage survey enumerators trained	ºWhat project will be responsible for		ºHandpumps sited with Village Council & health committee			
		ºConduct home-level survey	ºProject agreement signed		ºVillage monitors project			
			ºVillage plan of action					

Appendix D

ORGANIZATION CHARTS FOR MINISTRY OF NATURAL RESOURCES WELL DRILLING OPERATIONS

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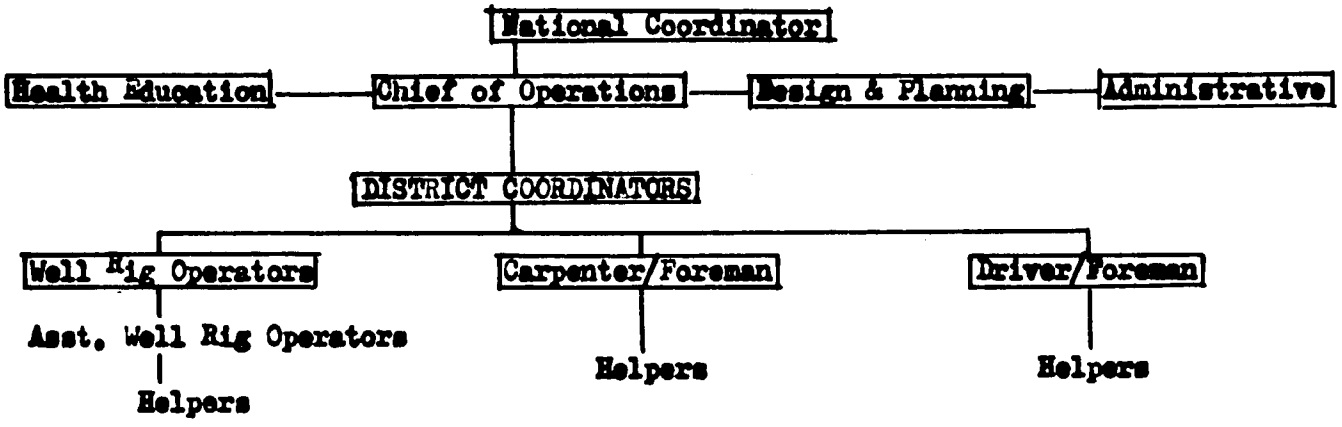
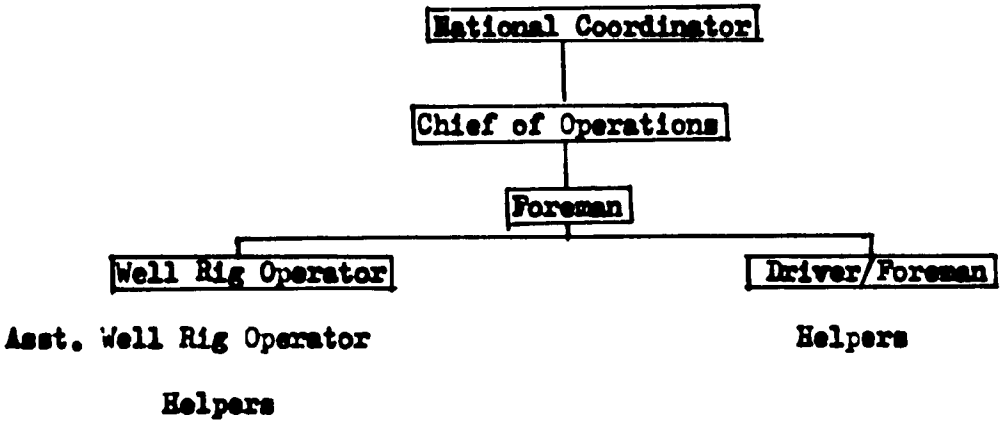
APPENDIX D



In the case of the Orange Walk and Corozal Districts: (CARE PROJECT)



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Appendix E

REVISED PROCUREMENT LISTS
(AS MARKED-UP AND PROVIDED TO USAID/BELIZE)

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Note: Item changes and additions checked and confirmation for acceptability checked with R. Robinson PRAGMA / MCD Mechanic Advisor — Ralph Preble / 13 July 1987

GROUP A

VEHICLES

Item Number	Description	Unit	Qty.	Unit Price	Amount
1.	Ford F-150 pick up truck 4X4, HD suspension, all terrain tires with tubes, manual transmission, double fuel tanks, airconditioning delete audio option, rear bumper	ea	5	13,000.00	68,000.00
	Total				68,000.00
	Insurance, Freight 25%				17,000.00
	Total this Group				85,000.00

The above description for Ford F150's (to be used by the GOB/MNR Rural Water Supply Coordinators) is not sufficiently specific to place a proper order. The following is a suggested rewording.

Ford F150 (a) left hand drive (b) color white
(c) 4x2 with traction locked rear axle
Note: this is less expensive and less problem to repair than 4x4 and ~~[illegible]~~ probably more effective in most poor road conditions
(d) regular cab with standard trim
(e) body box length 6 3/4 feet
Note: need to specify 8 or 6 3/4 feet (6 3/4 best for light loads) as there is a wheel base length change
(f) engine 4.9 liter 6 cylinder
(g) auxiliary fuel tank
(h) standard 4 speed manual transmission
(suggest specifying ~~the following~~ a trailer towing package rather than just HD suspension as this package gives needed super engine cooling and other items in addition to HD suspension)
(i) trailer towing package / rear step bumper ← (n)
(j) all terrain tires ~~[illegible]~~ standard size
(k) spare tire / rim and mounting
(l) also suggest sliding rear window but ~~delete~~
(m) DELETE - air conditioning and audio options

Note: it is imperative that 3 piece toothed engine clutch drive plate Q267 be added as Item 1(i) and delivery expedited AIR FREIGHT for all items 1(a) through 1(h) — Note: two Q267 parts torn out in 6 months!

GROUP B

WELL DRILLING EQUIPMENT

Item Number	Description	Unit	Qty.	Unit Price	Amount
1.	Repair parts ~~Tools~~ for Buckeye Drilling Rig 20W serial No. 139488				
	a) Main Belt R 1215	ea	1	77.00	77.00
	b) Pulley Bracker fulcrum with belts R 2187	ea	1	47.00	47.00
	c) Main belt tightener pulley bracket R 1172	ea	1	255.00	255.00
	d) Main belt tigntener pulley bushing R 1342	ea	1	8.00	8.00
	e) Main belt tightener pulley spring R 1340	ea	1	21.00	21.00
	f) Clutch housing bearing Q 427	ea	2	19.00	38.00
	g) Bearing retainer Q 428	ea	1	32.00	32.00
	h) Main belt tightener pulley R 1165	ea	1	700.00	700.00
2.	Belts (for Buckeye ~~W/20~~ 22W cable ~~tool~~ rigs Ser. No. 112501 and 116326 tool rig) 16 ft. long, 6 in. (possibly 2 different belts - please refer to Ser. No.s) wide 6 or 8 ply.	ea	~~5~~ 2	100.00	~~500~~ 200.00
3.	~~Jackshaft for W/22 Buckeye Drilling Rig complete with bearings, clutches and pinion gears~~	ea	1	DELETE for now as is on COMPLETE REHAB LIST - if meshing gears with this unit not replaced everything torn up! $7,540.00 ~~1,250.00~~	~~1,250.00~~
4.	Cable, steel, ~~3/4"~~ 3/8" right hand lay. 6x7 fiber core for sand line	~~5~~ 400 ft roll	1	0.36/ft ~~400.00~~	180.00 ~~400.00~~
5.	Cable, steel, 5/8" ~~right~~ left hand lay 6x21 filler wire, plastic core of improved plow steel for cable tool drill line	~~5~~ 400 ft roll	1	0.80/ft ~~400.00~~	400.00
6.	Fishing tools for W20 and W22 Buckeye Drilling Rigs	set	3	800.00	2,400.00
7.	Tricone Carbide Button bits for Cable Tool W20, W22 Rigs				
	a) Soft Medium bit 8-1/2" dia.	ea	2	600.00	1,200.00
	b) Medium Hard bit 8-1/2" dia.	ea	2	600.00	1,200.00
	c) Soft Medium bit 6-1/2" dia.	ea	2	500.00	1,000.00
	b) Medium Hard bit 6-1/2" dia.	ea	2	500.00	1,000.00

Tools usable only with UNICEF rotary rig whose head driller said he would not use them — the description is incomplete (no pin size) and inappropriate - buttons not designed for bits except those for hard formations

for 8 & 9 below
Same comment
as for 7 prior page

GROUP B CONTINUED

WELL DRILLING EQUIPMENT

Item Number	Description	Unit	Qty.	Unit Price	Amount
8.	Sub valve, with check valve to fit 8-1/2" tricone bit	ea	1	300.00	300.00
9.	Spare check valves for item 8 above	ea	2	100.00	200.00
10.	Bit, straight 8-1/2" for W20, W22 Buckeye Cable Tool Rigs	ea	2	600.00	1,200.00
	Total				12,028.00
	Insurance, Freight (25%)				3,007.00
	Total this Group				15,035.00

bits not made in this size
and there are 16 different weights of 8 inch bits
— cover for 8 inch 300 lb bits from Buckey Company
with pin size to match tools furnished for
20W Serial No. 139488.

GROUP C

WELL CASINGS

Item Number	Description	Unit	Qty.	Unit Price	Amount
	Water well with 30 slot (0.030 inch) of flush joint				
1.	Screen ~~casing~~ screw type, PVC, 4" ~~6"~~ dia., schedule 40 or higher, in 10 ft. lengths.	ft.	1200 ~~2000~~	1.50	~~3,000.00~~
	Water well				
2.	~~Blind~~ casing, steel, screwed and coupled (0.322 inch minimum wall thickness) ~~type~~, 8" dia. in 10' lengths	ft.	~~4000~~ 1,000	~~15.00~~ 12.00	12,000.00
	Water well				
3.	~~Blind~~ casing, PVC, 4" ~~6"~~ dia., flush joint screw type schedule 40 or higher, 10' lengths.	ft.	5000 ~~20000~~	0.85 ~~1.50~~	~~30,000.00~~
4.	Cap, cone, PVC 6" diameter	ea.	100 ~~200~~	2.00 ~~10.00~~	200.00 ~~2,000.00~~
~~5.~~	~~Cap, flat, PVC 6" diameter~~	~~ea.~~	~~200~~	~~10.00~~	~~2,000.00~~
6.	Couplings, ~~steel~~, threaded for 8" diameter casings	ea.	~~60~~	~~25.00~~	~~1,500.00~~
	should come with (2) above	Total			50,500.00
		Insurance, Freight			12,700.00
		Total this Group			63,200.00

Notes:

1. Present inventory shows 2,500 ft of PVC 4 inch schedule 40 in stock or 10 wells (75 ft) plus 5 wells (150 ft) and 4 wells of (250 ft) average — since water is a problem at present it is suggested that only 5,000 ft be ordered until progress of installations is increased by rehabed and new equipment — with what is on hand this might be enough for 50 or 60 wells

2. Well casing and well screen in 5 inch (not 6 inch) should be considered in rudimentary water system wells to facilitate use of submersible pumps.
Some 3,000 feet of well casing and 200 ft of well screen conforming to the descriptions above (except for size) is recommended.

GROUP D

OFFICE AND AUDIO VISUAL EQUIPMENT AND SUPPLIES

Item Number	Description	Unit	Qty.	Unit Price	Amount
1.	Drawing table, 36"x48" board, metal base (1985 Nationwide Office Products Catalog No. ~~26~~ Q-34AG-136 or equal)	ea	2	175.00	350.00
2.	KOH-1-Noor Rapidograph pen set of seven (National Office Products Catalog No. ~~27~~ Q-3165-3P7 or equal)	set of 7	2	80.00	160.00
3.	Drafting machine, complete with T-Square, triangle, straight edge, scale and protractor (NOPC catalog No. Q6-34JP-248 or equal), Counter Balance (NOPC Q6-34JG-010 or equal) and Engmeer style Drafting machine scales (NOPC Q6-34HK-15M or equal)	ea	2	370.00	740.00
4.	Drawing table lamp, complete with flourescent bulb, ball/socket joint to rotate 360° 36" reach (NOPC K1-~~18762~~ 17360 or equal)	ea	2	85.00	170.00
5.	Adjustable drafting stool (Sears T3H6440N or equal)	ea	2	120.00	240.00
6.	Blutex heavy vellum, for ink and pencil drafting, tear resistent. (NOPC #Q6-18AD-13A or equal) 20yd. x 36" wide	roll	6	25.00	150.00
7.	Cross Section paper, in rolls of 20 yds. or more, 18" wide or greater, 10 per in.^{2}.	roll	6	25.00	150.00

GROUP D CONTINUED

OFFICE AND AUDIO VISUAL EQUIPMENT AND SUPPLIES

Item Number	Description	Unit	Qty.	Unit Price	Amount
8.	Blue line print machine, (Eg. GAF 240 Diazo printer, available from GAF Corporation, International Services, 140 West 51 Street NY, NY 10021)	ea	1	1,000.00	1,000.00
9.	Film Strip Projector, 110/115 volts	ea	1	250.00	250.00
10.	Blue~~print~~ Line printing paper, compatible with item 8 above.	rolls	6	25.00	150.00
11.	World Bank "User Participation Package" of Water/Sanitation educational materials	Pkg.	1	1,000.00	1,000.00
12.	World Bank Films "Problems and Solutions" ~~Sanitations~~" on VHS video-cassette	ea	1	150.00	150.00
	Total				5,250.00
	Insurance and Freight				1,320.00
	Total this Group				6,570.00

ALL OF GROUP E
Needs to be checked by properly qualified pump people instrumentation engr etc. for quantities and system workability before ordering
Ralph Preble
13 July 1987

GROUP E

WATER PUMPS, PIPE

Item Number	Description	Unit	Qty.	Unit Price	Amount
1.	Submersible Pump, for 4" dia. well, 50 gal/minute, 300 ft. charge ?	ea	6	3,000.00	18,000.00
2.	Submersible Pump, for 4" dia. well, 50 gal/minute, 400 ft. charge ?	ea	4	3,000.00	12,000.00
	NO CONTROLS AND UNSURE IF THEY WILL WORK WITHOUT CHECK ON CONDITIONS OF EACH INDIVIDUAL SYSTEM				
3.	Centrifugal Pump, 50 gal./minute, 300 ft. charge ?	ea	4	2,000.00	8,000.00
4.	Diesel Generator, complete, 110/220, 10KW/60HZ, (to power items 1-3) ?	ea	14	3,000.00	42,000.00
5.	Galvanized pipe 3" dia., 20 ft. lengths. Standardize on 3", use Dresser couplings to join field cuts	ft.	4000	.50	2,000.00
6.	~~Galvanized pipe 2" dia., 20 ft. lengths.~~	ft.	4000	.50	2,000.00
7.	PVC Pipe, schedule 40, 3" dia., 20 ft. lengths.	ft.	20000	.50	10,000.00
8.	PVC Pipe, schedule 40, 2" dia., 20 ft. lengths.	ft.	30000	.50	15,000.00
9.	Elbows, galvanized for 3" dia. pipe 45°	ea.	20	1.00	20.00
10.	Elbows, galvanized for 3" dia. pipe 90°	ea.	100	1.00	100.00
11.	Tees, PVC, for 3" dia. pipe	ea	100	.50	50.00
12.	Elbows, PVC, for 2" dia. pipe 90°	ea	150	.50	75.00
13.	Tees, PVC, for 2"x2" dia. pipe	ea	500	1.00	500.00

GROUP E CONTINUED

WATER PUMPS, PIPE

Item Number	Description	Unit	Qty.	Unit Price	Amount
14.	Bushings, PVC 2"x~~2"~~ 1/2 "	ea	1500	1.00	1,500.00
15.	Bushings, PVC 3"x2"	ea	200	2.00	400.00
16.	Adaptors, PVC - galvanized, 3"	ea	120	2.00	240.00
17.	Adaptors, PVC - galvanized, 2"	ea	300	2.00	600.00
18.	Globe valves, bronze, 2"	ea	120	5.00	600.00
19.	Globe valves, bronze, 3"	ea	60	5.50	330.00
20.	Check valve, bronze, 2"	ea	20	5.00	100.00
21.	Check valves, bronze, 3"	ea	20	5.50	110.00
22.	Sleeves, PVC, 2"	ea	1000	2.00	3,000.00
23.	Sleeves, PVC, 3"	ea	200	3.00	600.00
24.	Glue, for PVC pipes	gallon	100	10.00	1,000.00
25.	Thinner, for cleaning PVC pipes, glue	gallon	200	10.00	2,000.00
	Total				120,225.00
	Insurance and Freight				29,775.00
	Total this Group				150,000.00

GROUP F

HAND PUMPS, PARTS

Item Number	Description	Unit	Qty.	Unit Price	Amount
1.	India Mark II deepwell hand-pumps, (available from Dempster in U.S.) complete with head assembly, brass lined cylinder, (2-1/2"x12")	ea.	Note ordering more than 50 is not appropriate until final goals for number installed in program is established ~~150~~ 50	375.00	~~56,250.00~~
2.	* Galvanized Steel pump rod 1/2"x10' for above pumps	ft.	4500	1.00	~~4,500.00~~
3.	Galvanized Steel pump ~~rod~~ drop pipe 1-1/4"x10' Schedule 40 threaded and coupled	ft.	~~3,000~~ ~~1500~~ 15000	2.00	~~3,000.00~~
**	(Pump rods to be threaded, and with matching coupling units)		Note: 100 wells at 150 ft or 150 wells at 100 ft		
	Total				60,750.00
	Insurance and Freight				15,250.00
	Total this Group				76,000.00

* wells may be deeper than planned and some of the rod may be needed for pumps in stock so let qty. stand.

** it is understood that no 1 1/4 inch pipe is in stores so suggested quantity (at this time) of 150 ft with 85 ft setting per well (this is independent of well depth) allows on 17 pump installations (for wells over 100 feet but dependent on weight needed to permit pump operation) would recommend doubling the amount to provide a reasonable quantity of pipe on hand.

Rep'd Feb 6 13 July 1957

Appendix F

PRELIMINARY REPORT OF RESULTS

PRE-PROJECT SURVEY OF EXISTING HANDPUMPS

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Preliminary Report of Results: Pre-Project Survey of Existing Handpumps

The data in the Summary Table presented summarizes the technical information on pumps, pump pads, and water quality necessary for the design of the engineering aspects of the Project. Socio-economic and community development information, and more complete technical/engineering data from the pre-project survey are available in the AID Belize Mission. Information from the survey and in-country studies will be used as a baseline for project implementation. This preliminary report indicates the working status of 335 handpumps inspected in this study. In a report prepared in 1982 for the Belize National Health Plan approximately 438 installed pumps were identified.

DISTRICT	TOTAL INSTALLED	TOTAL INSPECTED	NO. WORKING	NO. NOT WORKING	%	CASING PVC	CASING IRON	CASING UNKNOWN	DRILLER	RESPONSIBILITY
BELIZE	159	32	29	8	25	4	32	1	WASA	WASA
CAYO	49	56	49	7	12.5	19	33	4	MOH,MOW, MNR,WASA	MOW, MNR
COROZAL	101	57	51	6	10.5	1	55	1	MOW,MOH	MOH
ORANGE WALK	58	58	57	1	1.7	9	49	-	MOW,MOH	MOH
STANN CREEK	40	51	49	2	3.9	5	39	7	MOW	MOW
TOLEDO	31	76	65	11	14.4	31	39	5	MOH	MOH
TOTAL	438	335	300	35	10.5	65	197	18		

Site conditions of the wells vary by district. In general, the older Ministry of Works' pump pads are totally inadequate in size. Approximately 50% of the well sites have puddled stagnant water or seepage on the pad site. Water quality varies regionally. In the northern district hardness is often a problem with the conditions more predominant in the western frontier. Water quality is generally good in Cayo and northern Stann Creek with some iron encountered in southern Stann Creek. Toledo is generally good, however, marine shales in the area often contribute sediment to ground water, especially in the western interior. The major complaint, however, is the iron from steel pipe casing. Many of the wells were abandoned for this reason and casing replacement with PVC pipe was a consistent request among users.

Appendix G

VLWS HANDPUMPS INSTALLATION COMPONENT

LIFE OF PROJECT SUMMARY

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APPENDIX G

A) VLWS HANDPUMPS INSTALLATION COMPONENT
LIFE OF PROJECT SUMMARY

	VILLAGES IN	TARGET	UNDER CONSTRUCTION	ACTUAL INSTALLED	BALANCE	PERCENT COMPLETED	NOTES
A.	COROZAL						
1.	BUENA VISTA	7		7		100	
2.	SAN VICTOR	10		10		100	
3.	CHUNOX (1)	10		0		0	
4.	SAN PEDRO	7		0		0	
5.	LOUISVILLE	10		0		0	
6.	SANTA CLARA/SAN ROMAN*	0	1	0		0	
7.	CRISTO REY/YO CHEN	11	1	1		9	
8.	CHAN CHEN	8		0		0	
	SUB-TOTAL	63	2	18		29	
B.	ORANGE WALK						
1.	SAN ANTONIO*	0	1	0		0	
2.	NUEVO SAN JUAN	6		6		100	
3.	SAN LUIS	5		5		100	
4.	SANTA MARTHA (2)	7	1	2		29	
5.	SANTA CRUZ (3)	4		0		0	
6.	CHAN PINE RIDGE (4)	7		0		0	
7.	TRINIDAD	7		0		0	
8.	DOUGLAS (5)	1		0		0	
	SUB-TOTAL	37	2	13		35	
	TOTAL	100	4	31		31	

NOTES:

* - A Rudimentary Water System will be installed rather than hand pumps in these two villages.

1 - Although 10 hand pumps are planned for Chunox, problems are expected to be encountered due to salinity of the soil.

2 - Although 7 hand pumps are planned for Santa Martha, problems will be encountered due to low-lying areas.

3 - Although 4 hand pumps are planned for Santa Cruz, the community is requesting a type of catchment system.

4 - Although 7 hand pumps are planned for Chan Pine Ridge, problems are expected to be encountered due to salinity of the soil.

5 - Only 1 hand pump is planned for Douglas since the community already has a water tank. One problem anticipated will be to find a source of good water.

As of Jan. 30, 1987

Appendix H

MAJOR ITEMS INVOLVED WITH REHABILITATION OF 22W

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APPENDIX H

Major Items Involved With Rehabilitation of 22W. Drilling Rig Serial # 112501.

It is advised that this list be checked with the manufacturer prior to initiating procurement procedures - prices have been rounded off to even dollar amounts.

Part #	Description		price
R 1112	Gear		$3,167
R 1118	Jack Shaft Assembly		7,540
R 1281	Gear Assembly		3,207
R 1424	Cat Head Drive Sprocket Assembly		672
	Bushings		
R 1350	Casing head bushing	($59 x 2)	118
R 1520	Bull reel shaft bushing	($56 x 2)	112
R 1763	Sand reel bushing	($44 x 2)	88
JM 2	Pitman arm, upper bushing		45
JM 3	Pitman arm, lower bushing		65
R2452	Bushing		35
R2453	Bushing		113
	Sheaves		
JM 14 and 22	Heel and Beam sheaves	($804 ea)	1608
JR 441	Sand reel sheave		309
JR 429	Drill line sheave		902
	Other Derrick Parts		
JR 436	Shock Assembly		611
JR 569	Guide pin Assembly		92
JR 112	Guide pin bushing		112
Grease fittings and misc. small items			(?)
	Sub Total Approximately		$19,000
Replacement engine			5,618
COST OF PARTS ESTIMATED		TOTAL	$24,700

Note: Need to add R1161 Lining Kit and R 1396 Brake Band Assembly to list.

R1161 LINING KIT $ 108

R1396 BRAKE BAND ~~ASSEMBLY~~ ~~$ 70~~ 66

New Total ~~$ 24,808~~ $24,874

Appendix I

CARE ORGANIZATIONAL CHART

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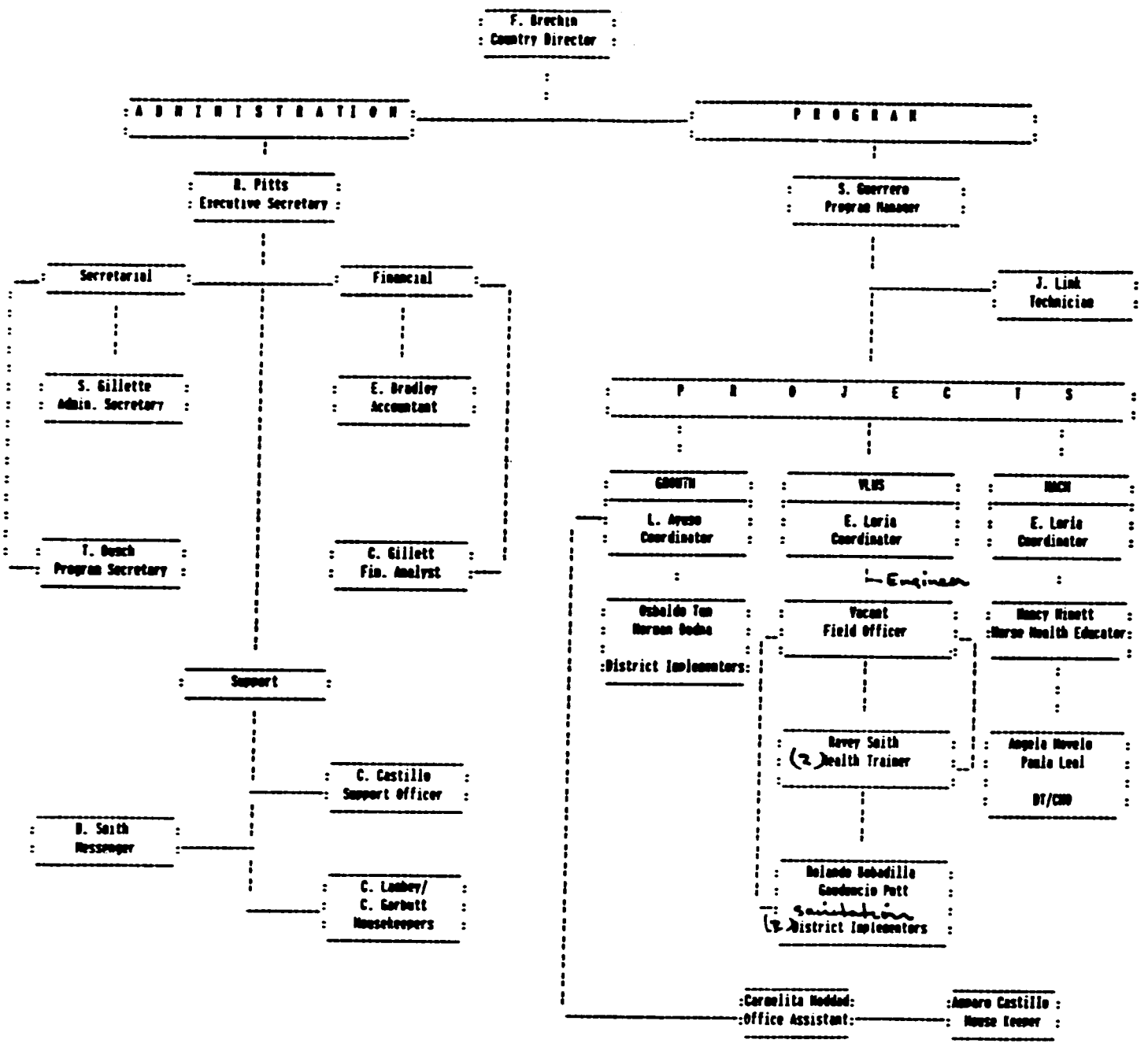
APPENDIX I

CARE ORGANIZATIONAL CHART



Appendix J

BELIZE INSTITUTE OF MANAGEMENT

SCHEDULE OF SEMINARS JUNE TO AUGUST 1987

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APPENDIX J

Belize Institute of Management

ITS SCHEDULE OF SEMINARS FOR JUNE TO AUGUST 1987.

June 4-6	USING COMPUTER AS A MANAGEMENT TOOL - for managers who want to learn about computers and how they can be used.
June 10-12	SUPERVISORY MANAGEMENT - for first-line managers who want to improve their supervisory abilities.
June 24-26	EXECUTIVE LEADERSHIP for executives/managers who want to improve their leadership and people skills.
July 1-3	SUPERVISORY MANAGEMENT
July 6-10	STARTING & RUNNING A SMALL BUSINESS - for entrepreneurs who own or plan to start a small or medium business.
July 15-17	FUNDAMENTALS OF MANAGEMENT - designed to introduce senior managers to concepts and principles of general management.
July 27-29	TOURISM HOSPITALITY - for owners or managers of hotels/restaurants who want to learn more about successful hotel/restaurant management.
August 10-14	STARTING AND RUNNING A SMALL BUSINESS.
August 24-26	MANAGEMENT BY OBJECTIVES - for senior managers who want to develop and operate an effective and efficient system.

TO ENROLL OR FOR MORE INFORMATION, PLEASE CALL (02) 7117/44543. SPACE IS LIMITED, SO CALL EARLY AND ENROLL IN ONE OR MORE OF THESE HIGH QUALITY COURSES.

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Appendix K

HYDROGEOLOGY

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Hydrogeology: APPENDIX K

Geology: A geologic summary together with a description of soil types and distribution is included in the February 1982 Belize Enviromental Profile Draft prepared for AID under the U.S. Man and the Biosphere Program.

Hydrogeology: Limestone, of one form or another, is predominate throughout most of Belize and is present from shallow depths of a few feet to depths of over 200 feet. Granite, quartzites, slates and shales (sometime extensively folded) are present in the Maya Mountain area and, while the igneous granite is confined to this area, shales and other metamorphic rocks are also found at lower elevations in the south of the country. Relatively shallow and permeable alluvial deposits are associated with many of the perennial streams and rivers. Frequent springs are present in the Maya Mountain area and offer alternate sources of water to wells.

The origin of most of the springs is from rainfall in the high lands percolating downward through fractures or solution channels in limestone and surfacing at lower levels.

As noted above, local geology is variable and it is nearly impossible to describe all of the conditions which exist where wells can be installed to utilize the groundwater that may be present. Some typical conditions are:

- Intergrain pores in unconsolidated sand and gravel
- Intergrain pores in sandstone
- Intergrain pores in shale
- Systematic joints in metamorphic and igneous rocks

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- Solution cavities in limestone
- Systematic joints in limestone
- Openings in fault zones

Unfortunately, rock masses are rarely homogeneous and adjacent rock types may vary significantly in their ability to hold water. Nevertheless, intelligent groundwater assessment and well installation design requires an understanding of how water exist in each type of formation(rock or unconsolidated) where wells are to be attempted.

Well yields in sands and gravels, relatively free of clay and silt, can be highly productive. Successful wells are generally associated with sandstone and limestone but some shales can present problems. When exposed to drilling some clays and shales swell to much larger volumes handicapping cable tool drilling and stopping other forms of drilling.

Yields from granites and associated crystalline metamorphic rocks, in general, produce only a few gallons per minute. While some wells in these formations may produce 30 to 40 gallons per minute, unsuccessful wells are more common and it is seldom practical to drill below 200 feet in such rocks. Some anothers extend the practical drilling depth considerably greater depths but in general these would be in special conditions and locations.

Frequent jointing in limestone is conducive to the success of wells and unusually large yields may occur in carbonate rocks where rainwater has entered the rock and created solution channels.

In calcium-rich deposits (limestone and dolomite) little void space exists for fluid storage except in joints or faults. This is not always true of coral reefs (organic calcium deposits), where initial void spaces do occur frequently but are spaced irregularly. Time and other factors, however, do make calcium-rich deposits more rigid and, in some cases, more dense. This type of sedimentary rock, known as limestone, is inflexible and can easily crack when supported unevenly. Therefore, almost all calcium-rich sedimentary deposits show extensive joint or fault systems because of uneven adjustment and local stresses produced by solution effects and erosion. Under certain conditions, some of the calcium in limestone can be chemically replaced by magnesium from sea water, either during deposition or after the rock strata was formed. Limestone with high concentration of magnesium is called dolomite.

It is not known with any certainty how this process happens, but the addition of small amounts of magnesium causes a pronounced toughening of the rock. Once exposed at or near the land surface, limestone and dolomite can undergo a remarkable

change. Rainwater, in its descent to earth commonly absorbs carbon dioxide from the air and thereby forms a weak acid, called carbonic acid. When rainwater enters cracks and crevices in carbonate rocks, the acidic water may dissolve small volumes of rock.

Over time the removal of limestone along cracks can be extensive, and voids can be created. If these voids are close to the land surface, the roofs of the resulting caverns may cave in and thus produce ponds or sink holes. Lakes in this type of terrain, which is call karst topography, are intimately connected to the groundwater system. Water usually moves rapidly through these channels in karstic terrain and extreme care must be taken to prevent contamination of the groundwater.

Limestone does not initially offer much of a reservoir for storage, but through the processes described above, many deposits of limestone and dolomite can become large-capacity reservoirs for groundwater storage. Other limestones are not cavernous and the only water in them exists in cracks and crevices.

Well Drilling Conditions - Historical

Most of the water supply wells that have been drilled in Belize have obtained water from semi-cemented sands, fractures in limestone or shale rock and solution channels (open or filled with layers of silt, sand and clay) in limestone. Few, if any, of the successful wells were installed at depths greater than 150 feet and most wells were drilled to depths of 100 feet or less.

No wells are reported to be installed in granite rock although granite is shown on geologic maps to be present at Pomora, Alta Vista and Middlesex (in the Stann Creek District) and at San Luis, Augustine and Guacamallo (in the Cayo District). It was reported that each of the places named above obtain their water supply from surface water streams or shallow wells dug into the banks of streams. It was also reported that a few of the wells, installed in past years, have encountered very hard quatzite but the specific locations for such conditions would need a review of records not readily available.

General information on subsurface conditions, encountered in past drilling operations, in the various districts were reported as follows:

Toledo District - UNICEF Project: To the west of Punta Gorda, drilling along the edge of the Maya Mountains and upland areas encounter layers of limestone, shale and a 2 to 3 foot thick layer or zone termed shifting sand by the drillers. The shifting sand zone typically contain layers of clay, sand and silt. The silt may be red in one location, brown in another and black in a third. Often such zones are screened and gravel packed under the assumption that they are the best water producing zones. While most wells are completed at 70 to 80 foot depths, a well in San Antonio penetrated 130 feet of shale without encountering an adequate flow of water to warrant the installation of a pump.

In some areas below 80 feet, water takes on an oily sheen when drilling in shale rock. No taste or odor problems are reported under such circunstances but hydrogen sulfide is apparently prevalent in some hard dug shallow wells along the shoreline especially when swamp areas have been filled for building sites. At Red Bank a village on the Southern Highway approximately half way between San Antonio and Mango Creek, water was present in a gravel layer associated with a shifting sand zone in shale. Water with a strong iron taste is frequently a problem in the Toledo District. To a somewhat lesser degree it is reported to be a problem in other Districts. The local population appear to believe that the problem is associated with corrosion of steel pipes used as well screens and permanent casing in wells installed under previous programs.

Steel pipe may be part of the problem but water from two separate iron cased wells were tasted (wells separated by only a few hundred feet) and one had a strong taste while water from the other had a taste that was barely noticeable.

While the driller, assigned to the UNICEF supplied Canterra rotary rig, reports that three wells per week can be drilled, if everything is going right, the total production in a two year period has been 48 successful wells and 8 unsuccessful wells. At present there are enough supplies of PVC casing, well screens, drilling supplies and pumps to complete about 50 more wells.

Stann Creek District - IBPTH Project: Like other districts, shallow dug wells of 5 or 6 feet in depth are utilized along the coast. As noted previously, geologic mapping indicates the presence of granite along the Hummingbird Highway but no water wells have been tried in those areas. At mile 33 on the Hummingbird Highway a well penetrating only limestone was successful when a fracture was encountered at 50 foot depth.

Cayo District -IBPTH Project: A number of successful wells have been completed in limestone between the Capital City of Belmopan and the Guatemalan border. A well at Belmopan encountered a large solution channel typical of Karstic limestone (named for a city with rocks of this type in the

country of Yugoslavia). Karstic conditions were encountered during the drilling of a well (no pump yet), at Georgeville , near San Ignacio. Just north of Georgeville, at Spanish lookout, a 200 foot unsuccessful well was drilled which did not encounter any permeable material (only clay). Karstic conditions were found at San Antonio, south of Georgeville, but only after two unsuccessful wells had been tried on nigher ground. Between Georgeville and Belmopan three wells encountered water bearing fractures at aproximately 50 feet in depth at a location called Teakettle.

Belize District - IBPTH Project: Wells along the Western Highway have been generally unsuccessful. At mile 38, drilling encountered only clay when stopped at a depth of 150 feet. Permeable sand layers in clay exist at Hattieville some 16 miles west of Belize City but the water is progressively salty below a 25 foot depth. The original municipal water supply for Belize City was from dug wells,now abandoned,at Hattieville near The Belize International Airport, but wells a short distance to the north (Burrel Boom and Sand Hill) encounter salt water. Further west at Rancho Dolores no water was found after drilling through clay to a depth of 100 feet. Also at Bermudian Landing only clay was encountered during a recent 151 foot drilling. Double Head Cabbage, less than 2 miles to the west of Bermudian Landing, has a well but it becomes dry in the dry season.

Throughout most of the northern part of the district water, is obtained from semi-cemented sand layers in stable clay at depths of 40 to 50 feet. At Santana and other locations along the Northern Highway it is reported that salt water is present at depths below this level.

Discussion with GOB drillers indicate that a 40 foot well can be completed in a day or two in this area but it is estimated that not more than 20 were installed in 1985 - 86 by one rig due to equipment breakdown, lack of transport for materials, lack of well completion materials/supplies and lack of temporary steel casing for drilling. Also, these problems are still present at this time.

Orange Walk District - CARE Project: Drilling conditions along the Northern Highway in this district are reported to be similar to those encountered along this highway in the Belize District. It was reported that large rocks, not gravel, frequently produced drilling problems at depths of 30 to 40 feet. Wells installed in a 9 to 10 mile radius around Orange Walk Town have frequently been completed in a sand lens in white marl at depths of 40 to 50 feet. Often these wells become dry in the dry season and the water in those wells often has a strong iron taste. A 100 foot well was installed at Yo Creek but this well was not visited and taste and quality of the water was not determined. Yo Creek is about 8 miles west

of Orange Walk Town. Some 2 miles further west at San Antonio, a well was drilled through white marl and through a limestone layer where an artesian flow of water (rising above the ground surface) was encountered at a depth of 70 feet. The thickness of the limestone layer was estimated at 15 feet as the well log record was not available.

The southern two - thirds of the Orange Walk District has very few inhabitants and is generally inaccessible to vehicular travel. Nothing appears to be known about possible well drilling conditions.

Corozal District - CARE Project: In an area 2 or 3 miles to the west of Corozal Town, wells have generally been completed at depths of 50 to 70 feet after penetrating decomposed limestone for their full depth. In this area cable tool rigs can drill without using casing. Salt water is sometimes encountered but apparently can be avoided by moving the location a short distance away from the original hole. It is unclear if the move laterally or a shallower well depth is responsible in avoiding salt water in subsequent drillings.

Appendix L

STATEMENT OF WORK

APPENDIX L

STATEMENT OF WORK OF THE CONSULTANT FOR REVIEWING THE COMMUNITY DEVELOPMENT/COMMUNITY PARTICIPATION/HEALTH EDUCATION (CD/CP/HE) ACTIVITIES FOR THE WATER AND SANITATION PROGRAM. BELIZE C.A.

A. OBJECTIVE:

Determine usefulness of current methodologies in the Community Development/Health Education activities of the Project and develop problem solving strategies and materials that will assist the Project to evaluate their effectiveness and improve their capabilities.

B. SCOPE OF WORK:

1. Review the planning for and organization of the Community Development and participation activities;

2. Review the strategies developed and utilized to date for promoting community involvement;

3. Review the established systems for collecting information on village activities with a view to measuring the impact of project interventions. This should include recommendations on the data collected and means of evaluating community development efforts;

4. Recommend appropriate actions that need to be taken to improve community development efforts in the water and sanitation component.

5. Prepare a comprehensive Guideling for the development of a Field manual for use by technical staff, principally the MNR/WASA staff for Water Supply and Sanitation, detailing step-by-step suggestions for heightening rural Belizean community awareness and participation, planning, resource mobilization (social, economic and physical resources), implement action, benefit-sharing and evaluation.

6. Review indicators to monitor and evaluate the attainment of project goals.

C. METHODOLOGY:

The Consultant will meet with the long term CD/HE/T advisor, district health educators, and other water and sanitation projects personnel in conducting the reviews of the community development planning, organization, strategies etc. Field visits to observe the delivery of C.D. activities and to discuss with villagers and councils will also be undertaken. All material developed to date by the projects will be made available to the Consultant.

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D. LEVEL OF EFFORT:

40 person-days

E. EDUCATIONAL REQUIREMENT:

The Consultant should have a post graduate level degree in community development or Anthropology, and English/Spanish proficiency.

F. EXPERIENCE:

It is necessary that the Consultant have at least 5 years developing country experience in implementing and evaluating community level CD/HE activities.