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COMMUNITY WATER SUPPLY AND SANITATION IN SUDAN

WASH FIELD REPORT NO. 37

APRIL 1982

Prepared For:
USAID Mission to the Democratic
Republic of Sudan
Order of Technical Direction No. 60

April 22, 1982

Mr.Arthur Mudge
Mission Director
USAID
Khartoum, Sudan

Dear Mr. Mudge:

On behalf of the WASH Project I am pleased to provide you with 15 copies of a report on "Community Water Supply and Sanitation in Sudan". This is the final report by Charles G. Chandler, Frank P. Araujo and Eddy K.C. Lo and is based on their trip to Sudan in October and November 1982.

This assistance is the result of a request by the Mission on September 16, 1981. The work was undertaken by the WASH Project on October 6, 1981 by means of Order of Technical Direction No. 60, authorized by the USAID Office of Health in Washington.

If you have any questions or comments regarding the findings or recommendations contained in this report we will be happy to discuss them.

Sincerely,

Dennis B. Warner

Dennis B. Warner, Ph.D., P.E.
Director
WASH Project

DBW:cdej

cc: Mr. Victor W.R. Wehman, Jr.
S&T/HEA

WASH FIELD REPORT NO. 37

DEMOCRATIC REPUBLIC OF SUDAN

COMMUNITY WATER SUPPLY AND SANITATION IN SUDAN

Prepared for the USAID Mission to the
Democratic Republic of Sudan
under Order of Technical Direction No. 60

Prepared by:

Charles G. Chandler, Ph.D., P.E.
Frank P. Araujo, Ph.D.
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April 1982

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Washington, DC 20523

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EXECUTIVE SUMMARY

A three member WASH team visited Sudan October 23 to November 28, 1981 at the request of the USAID Mission to Sudan. The purpose of the visit was to analyze several ongoing and proposed USAID projects as well as other more general water and sanitation problems in Sudan.

Two specific problem assessments received much of the team's effort. As part of the first, it is recommended that a water supply and sanitation component be added to the ongoing Northern Primary Health Care and Rural Health Care projects. Specific actions are recommended to improve the quality of water supply available in rural health care facilities served by these projects and to promote sanitation at these facilities through the provision of improved pit latrines. Improvements in training programs for rural health workers are also recommended.

As part of the second project assessment, it is recommended that the proposed Northern Kordofan Water Supply project not be funded as originally proposed by CARE because of technical problems with the proposal and potential environmental impacts that may result. However, funding is recommended for an alternative proposal that would substitute small diameter shallow wells fitted with handpumps for the originally proposed diesel-driven deep wells in order to minimize adverse environmental impacts, to overcome technical problems with the original proposal, and to closely coordinate siting of the wells with villages cooperating in the ongoing reforestation effort in the region.

In a general vein, it is suggested that more coordination is needed among the numerous multilateral and bilateral donors that are conducting water supply and sanitation related activities in Sudan. It is recommended that a workshop be held for all multilateral and bilateral donors active in water supply and sanitation in Sudan in order to discuss mutual interests, to share project successes and failures, and to promote coordination among donors and with the Government of Sudan.

A major problem in Sudan is the provision of facilities and services for the 500,000 to 600,000 refugees from Eritrea, Uganda, and Chad. Water supply and sanitation is no exception, although facilities in refugee settlements are often better than those in nearby Sudanese towns. There will continue to be a need to fund appropriate projects in this area.

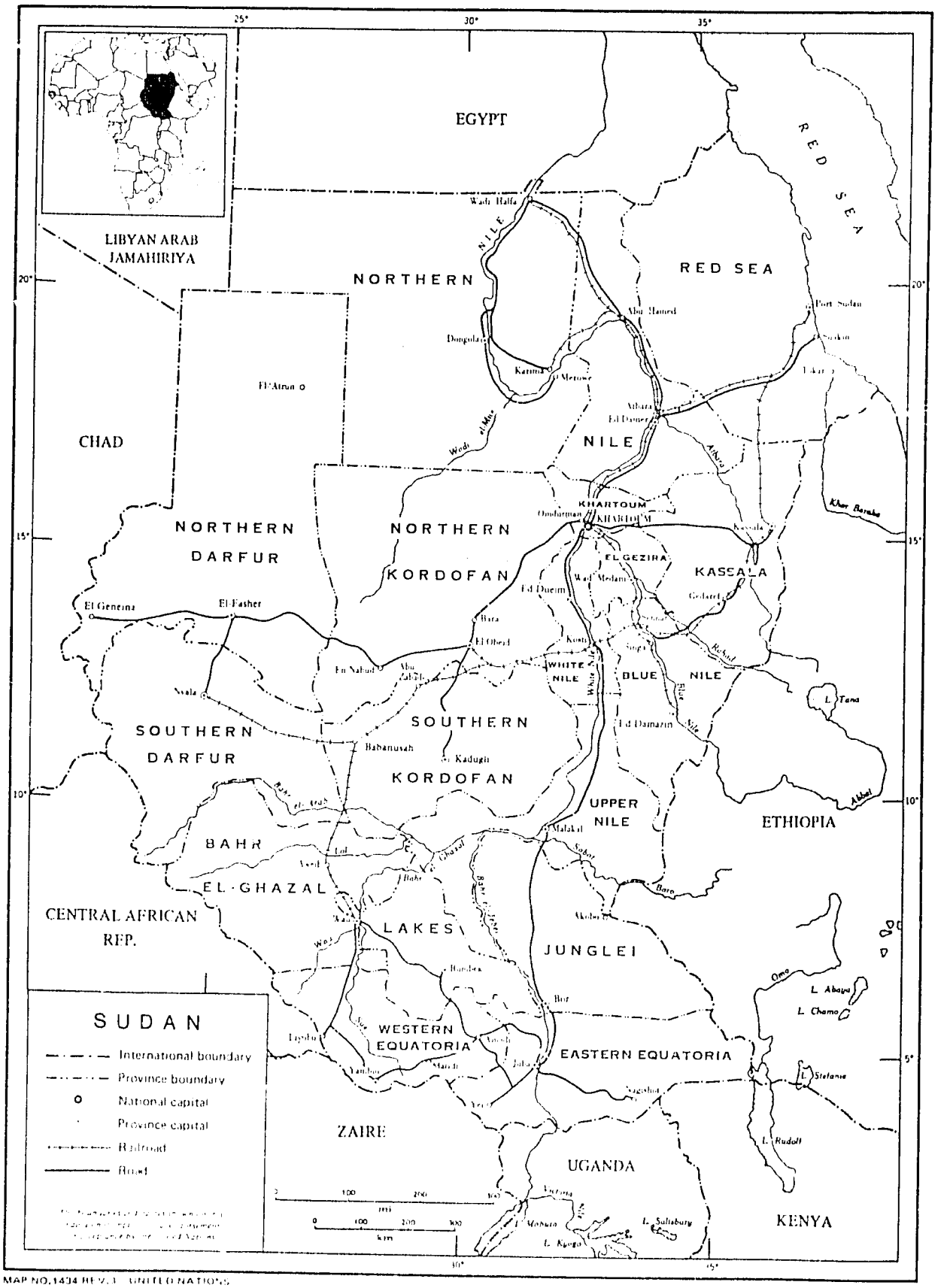
In Sudan it is time to assess prior actions in the water supply and sanitation sector in order to learn from past successes and failures. It is also time to look ahead to the goals of the International Drinking Water and Sanitation Decade (1981-1990) and to formulate and carry out plans to meet them.

ACKNOWLEDGEMENTS

An effort of this type is never possible without the help and cooperation of many individuals. Specifically, the writers wish to acknowledge the assistance and guidance of Dr. Mary Ann Micka, USAID Health Officer, and the many other individuals at USAID/Sudan who made the team's work an enjoyable experience. The USAID Mission was also of great assistance in providing air transportation to Juba, Kadugli, and El Obeid.

The team is also indebted to the many senior officials in the Government of Sudan who patiently briefed the team on their own activities related to water and sanitation.

The team would like to express appreciation to Dr. Raymond Isely of the WASH office in Arlington, VA, who coordinated and administered the team's work, and Mrs. Barbara Furst, also of WASH, who edited the draft report.



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MARCH 1981

Chapter 1

INTRODUCTION

In July 1981 the USAID Mission in Sudan requested the services of a consulting team to review several proposed and ongoing projects in order to improve project plans or add water supply and sanitation components to ongoing projects. The selected team was also to be asked to look at water supply and sanitation problems in Sudan in general. In response to the request for assistance, Order of Technical Direction No. 60 was issued by USAID/Washington under which a WASH team was formed (Appendix A). The team assembled in mid-October, was composed of Dr. Charles Chandler (team leader and sanitary engineer), Dr. Frank Araujo (medical anthropologist), and Dr. Eddy K.C. Lo (public health physician/epidemiologist).

The team arrived in Khartoum (Figure 1.1) on October 23, 1981. Although Dr. Lo departed November 16 for Malaysia because of a previous commitment, Drs. Chandler and Araujo were able to stay until November 28, when they completed the work. Initially, the team was requested to consider:

1. USAID's Northern Primary Health Care and Rural health Support Projects,

2. CARE's proposed water project for North Kordofan Province (USAID funding),

3. Possible future refugee water supply and sanitation projects in the eastern provinces, and

4. A request from the Governor of Northern Darfur Province for a water supply project within his jurisdiction.

The difficulties of travel in Sudan made field work on items 3 and 4 impossible within the time available, and the team therefore devoted itself to addressing items 1 and 2.

The report is divided into seven chapters. Chapter 1 details the general objectives of the WASH team as they carried out their work in Sudan. Chapter 2 summarizes the two specific problem assessments made with respect to ongoing and proposed USAID projects. Chapter 3 summarizes the work of the numerous multilateral and bilateral donors active in the general area of water supply and sanitation in Sudan.

Chapter 4 details the health-related aspects of water supply and sanitation activities in Sudan, particularly with respect to the GOS's health care system. Chapter 5 takes a look at the sociocultural aspects of water supply and sanitation project activities, and describes appropriate interventions that the team judged to be viable within the existing social and cultural framework of Sudan.

Chapter 6 summarizes the "Targets of Opportunity" for work in the water supply and sanitation sector in the near future. Chapter 7 contains the detailed recommendations that are an outgrowth of the team's work.

Chapter 2

SPECIFIC PROBLEM ASSESSMENTS

2.1 Northern Primary Health Care and Rural Health Support Projects

The Northern Primary Health Care and Rural Health Support projects are considered together in this report since they are both concerned with the Primary Health Care System in Sudan. These projects are virtually inseparable in terms of direction and goals.

The Northern Primary Health Care Project is a comprehensive community-based health delivery system and is specifically designed to reach the rural poor and the nomads in Northern Darfur, Southern Darfur, Northern Kordofan, and Southern Kordofan provinces. It is designed to supplement ongoing activities within the Government of Sudan's Primary Health Care Program (PHCP) in these four provinces. Key elements in the PHCP include:

a. community health care workers (CHW's) and nomad CHW's (NCHW's) who provide simple curative and preventive services and participate in promotive health programs;

b. primary health care units (PHCU's) which are small health care facilities serving a population of approximately 4,000 persons and are staffed by CHW's;

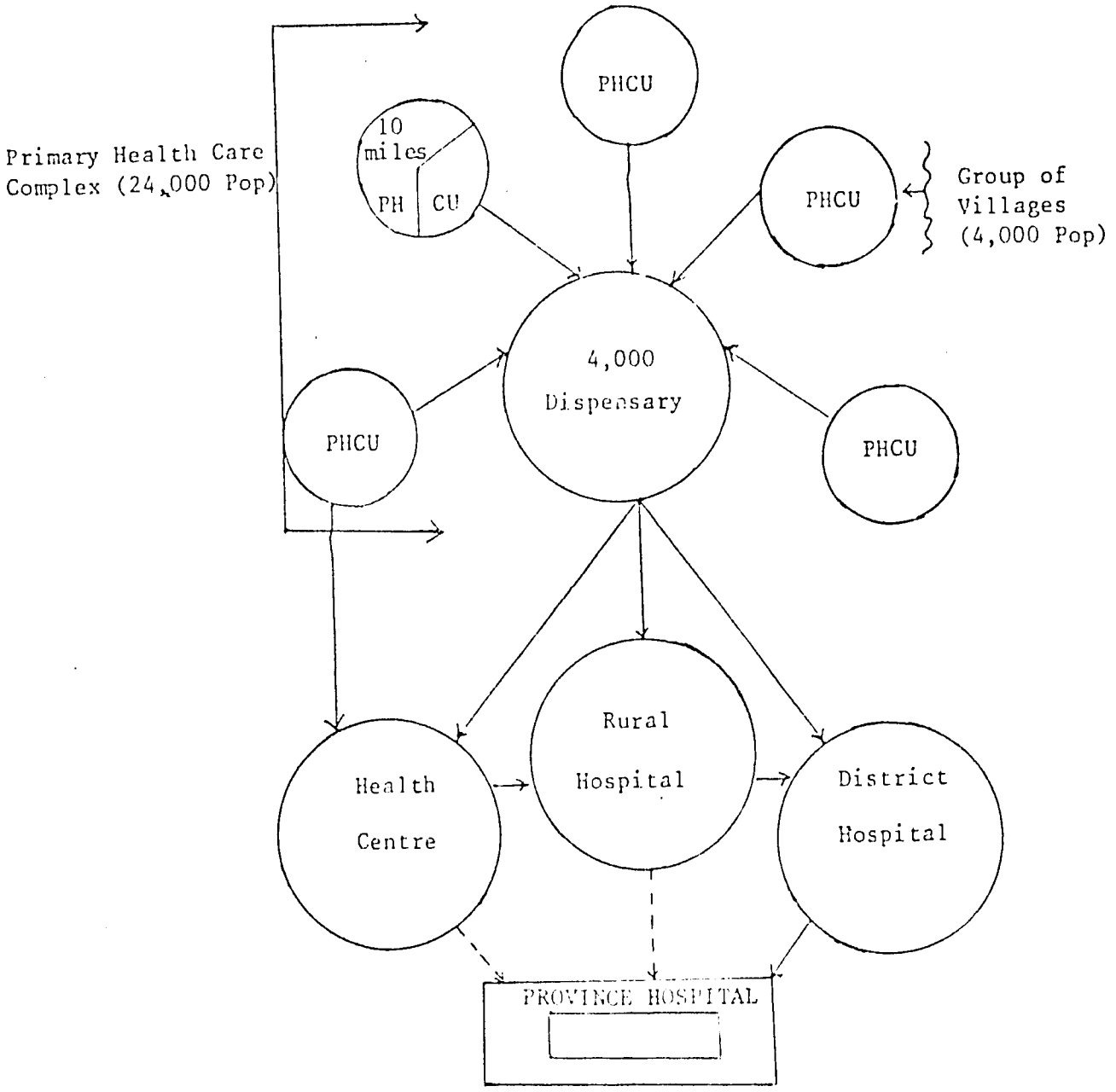
c. a logistics/supply system which provides equipment, drugs, and supplies to the CHW's, NCHW's, and PHCU's; and

d. a health and management information system which collects data on the health problems, services delivered, and supplies utilized at the PCHU's (38).

The heart of Sudan's Primary Health Care Program is the PHCU (38, 39). The PHCU is the most remote facility in the health delivery complex. Five PHCU's and their CHW's are designed to be supervised by a medical assistant from a nearby dispensary. The dispensary and its surrounding five PHCU's are termed a "primary health care complex" (PHCC), designed to serve approximately 24,000 persons (Figure 2.1).

The separate category of CHW is trained to serve nomads. These workers are selected from among the nomads themselves to deal with their special health problems, travel with them, and follow their life style. The NCHW's do not work from a static facility such as a PHCU, but move their health care facilities from place to place.

Figure 2.1. Components of a Primary Health Care Complex



Key: PHC - Primary Health Care

⟶ - Normal Referral

- - -→ - Emergency Referral

(Refs. 33, 34,54)

Both CHW's and NCHW's are selected by their fellow tribesmen and the government, and return to work among the tribesmen when their nine-month training program has been completed.

In addition to serving the geographical areas covered by the Northern Primary Health Care Project, the Rural Health Support Project is designed to complement the Northern Primary Health Care Project. The Rural Health Support Project also services the Southern Region. Here the African Medical and Research Foundation (AMREF) is the prime contractor for the Southern Primary Health Care Project (also USAID funded). The main features of the Rural Health Support Project are:

a. improved delivery of PHCP services through the provision of training facilities and through training of instructors for their role in this program;

b. inclusion of maternal/child health and family planning activities in the PHCP; and

c. provision of a mechanism to strengthen the planning, management, and logistical support of the PHCP.

Both the Northern Primary Health Care and Rural Health Support projects include construction components. As part of the Northern Primary Health Care Project it is anticipated that 20 dispensaries will be constructed with USAID funding in North and South Kordofan Provinces. As part of the Rural Health Support Project, USAID is planning the construction of 12 dispensaries and five schools in the Darfur provinces, the Kordofan provinces, and the Southern Region.

USAID/Sudan requested that the WASH team analyze the advisability of adding a water supply and sanitation component to the Northern Primary Health Care and Rural Health Support projects. The objective of the analysis was the determination of the components necessary to provide adequate water supply and sanitation facilities and/or programs to supplement the ongoing efforts.

In recent years, a number of options for the provision of low cost rural water supply and sanitation facilities have been documented by the international community (64, 65, 66, 67, 63, 69, 70, 77, 79, 73, 75). Even with numerous options, however, the challenge is always to find a solution that will work within the given social, political, and physical environment of the proposed project (76, 72).

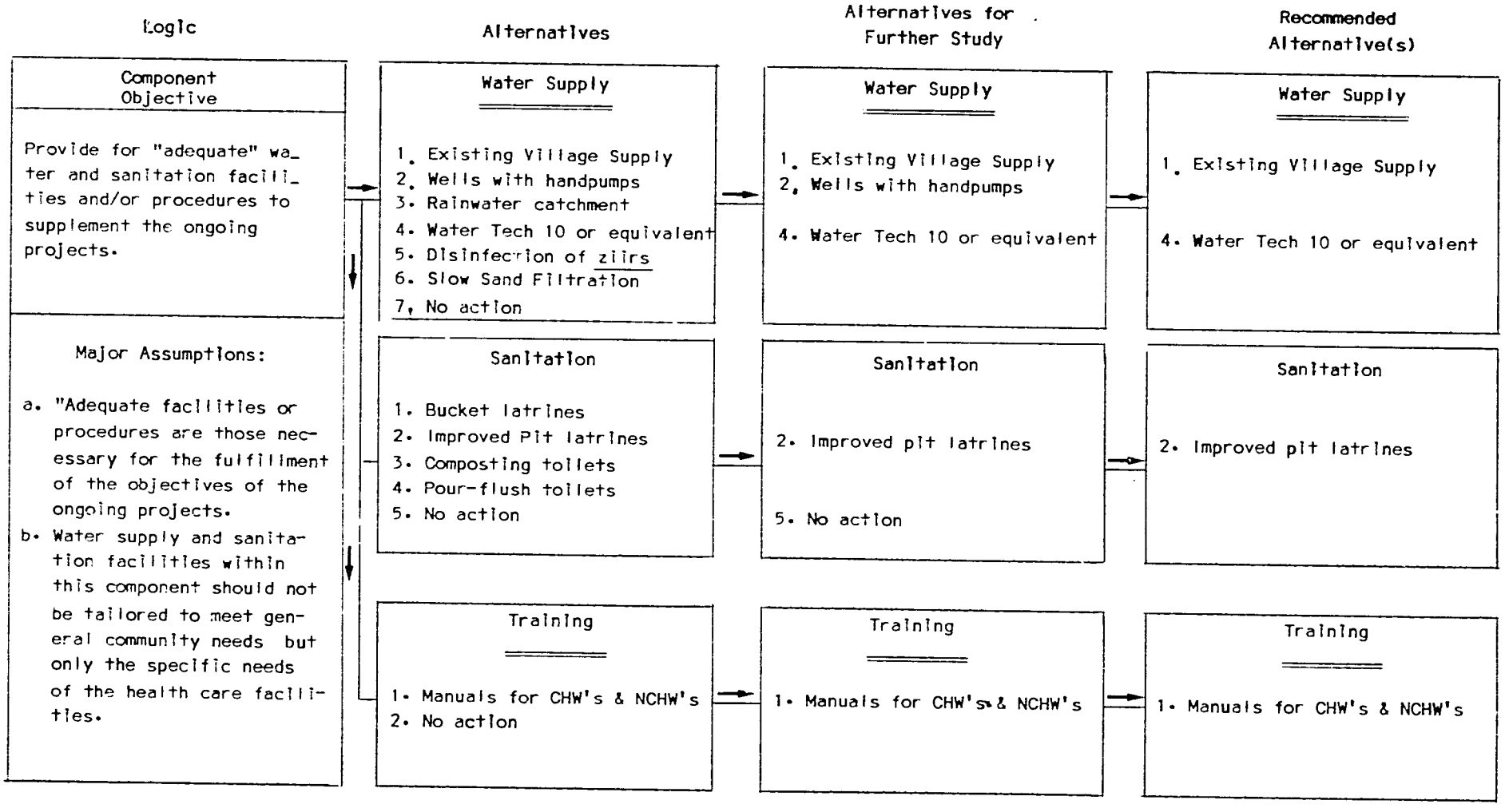
2.1.1 Water Supply

In the area of water supply, the team considered seven alternatives to be used in various health care facilities (Figure 2.2):

Figure 2.2 Assumption Analysis Chart

Northern Primary Health Care and Rural Health Support Projects

Water and Sanitation Component



1. use of the existing village supply,
2. use of rain water catchment facilities,
3. drilled wells and the use of handpumps,
4. use of a Water Tech 10 (or equivalent) purification system, and
5. disinfection of water in the existing ziirs (clay storage jars) at the project site.
6. slow sand filtration
7. no action

Use of the Existing Village Supply

It was determined that the quantity of water used at the PHCU's and dispensaries was not great enough to justify a separate program designed to provide an independent source of supply for each of these units. At all of the sites visited, the quantity of water available from existing sources was not limiting the provision of health care services.

Patient load at the facilities visited by the WASH team varied from about 10 to 50 per day. Services ranged from simple bandaging of wounds to giving innoculations to administering oral rehydration salts to combat the effects of diarrhea. The actual volume of water used at these facilities probably did not exceed 80 liters per day, but was often considerably less. The team believed that such needs could be met from existing village sources, at least in terms of quantity. It must be noted, however, that if more water were readily available, consumption might also increase. For example, handwashing between patients is not usually a part of nursing routine.

The quality of water from existing village sources was a concern, however, and is the reason the Water Tech 10 or its equivalent is recommended (see below).

Rainwater Catchment

Although rainwater catchment would generally provide a safe and reliable source of water during the rainy season and shortly thereafter in southern Sudan, this alternative is generally not feasible throughout most of Sudan. In northern Sudan, low rainfall throughout the year rules against this alternative. Rainwater catchment was thus generally not considered as a source of supply for PHCU's in Sudan and did not receive further consideration by the WASH team.

Wells with Handpumps

Although the WASH team considered the option of drilling wells and installing handpumps at each PHCU or dispensary site, the need for water at these facilities was not judged to be great enough to warrant a borehole and handpump program specifically for these users.

Where there are schools for village midwives and community health workers and water supplies are low, it would be desirable to develop an independent source of water because of the larger quantity needed by the students who live at the school. This would be feasible only where an existing handpump program is operating, such as UNICEF's extensive handpump program in South Kordofan and Bahr-el-Ghazal provinces. In areas, where well drilling and handpump programs do not currently exist, it is not feasible to begin them simply to supply these few sites. Problems can be avoided, however, by choosing sites for new schools where existing water supply systems are adequate.

Water Tech 10 (or Equivalent)

The Water Tech 10 device (Figure 2.3) is a simple water purification device to filter and disinfect water before it is used. This makes it possible to utilize even polluted sources for household or PHCU needs. The Water Tech 10 consists of an upper compartment into which water is poured. The water then passes through filter candles (to remove sediment) and Triocide resin (where bacteria and viruses are immediately inactivated). A residual of iodine is also added to the water as it passes through the Triocide resin. The water is stored in the lower container after filtration and disinfection until used. There is a simple faucet in the lower compartment for drawing water.

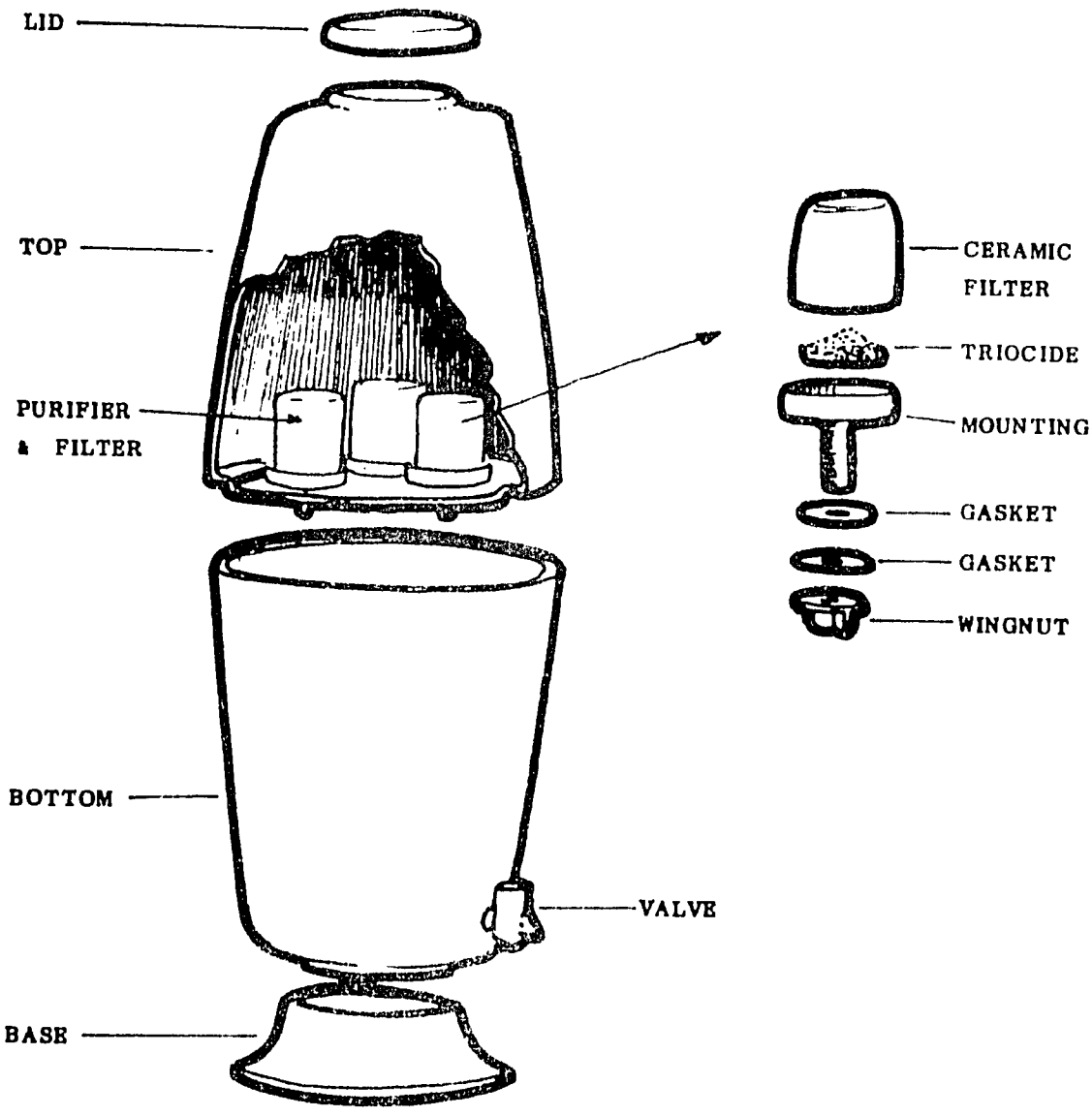
Although some experts have suggested that there may be a hazard from long-term use of iodine in drinking water, long-term data are sparse on this subject. In the case of the Water Tech 10 application recommended here, the risk of ill effects is extremely low, while the potential benefits are great. Generally only two types of persons are sensitive to long-term use of iodine: those with thyroid problems, and the unborn fetus of a pregnant woman. In the recommended application, long-term exposure would not be possible for anyone except the rural health workers, and they would receive training in the proper use of the Water Tech 10. There is evidence that exposure to iodine concentrations less than 1 milligram per liter (mg/l) in the Water Tech 10 would have no effect on the general health of users, even after may years of use.

Disinfection of Existing 'Ziirs'

A traditional method of storing water in Sudanese homes (and most PHCU's and dispensaries) is in a pottery ziir, which is a Sudanese earthenware pot, sometimes covered, but often without a cover. Water stored in such containers remains cool because of seepage through the pottery and evaporation at the exterior

FIGURE 2.3

Water Tech 10 Purification Device



surface. Ziirs are inexpensive and readily available in local markets.

As an alternate way of providing safe water in PHCU's, the team considered disinfecting water in the traditional ziirs with chlorine or iodine. However, because of the necessity of doing this each time the ziir is refilled (perhaps daily) and the difficulties and expense of supplying suitable disinfectants where none are currently available, this option was generally considered less desirable than the use of Water Tech 10s for water quality improvement in the PHCP.

Slow Sand Filtration

Slow sand filtration has received considerable support in Sudan for use in village and small town water treatment plants. The government has developed standardized designs for such plants and has gained considerable experience in their construction.

A slow sand filtration unit for a PHCU, dispensary, or health care center could be constructed from a used barrel (42 gallon oil drum) using local sand that has been graded and sifted. Water carried from the local village source could be poured in the top, to filter through the sand and come out the bottom. This was not recommended by the WASH team, however, because of the difficulty of obtaining suitable barrels and the necessity of training CHW's in all steps of the construction process. The Water Tech 10 device was preferred because of the iodine residual introduced in the water, the unit's compactness, and the ease with which it can be cleaned.

No Action

Under the "no action" alternative the PHCU's and dispensaries would use the existing village supplies as they do now with no improvement in water quality. This alternative was not considered to be the best, however, since impure water is used at PHCU's at present. Boiling of water at PHCU's is not common because of the high cost of charcoal and firewood. Yet waterborne diseases are quite prevalent in Sudan (see Chapter 4), and diarrheal diseases are the chief cause of mortality in children under five years of age.

Recommendations

Although the quality of the existing village water supplies varies considerably, it was found that many are unsafe. The WASH team recommends that the Water Tech 10 (or equivalent) be used in CHW training programs and be supplied to the PHCU's when the new CHW's go to their posts. Over a period of several

years most PHCU's will be supplied with these units, as existing CHW's return periodically for refresher courses.

Training in the use of these units is necessary before they are distributed, and this training can take place at the schools for CHW's. After 1984, these schools will concentrate on retraining and refreshing the training of existing CHW's.

It is also possible that these devices could be supplied to the health centers, rural hospitals, and district hospitals, although the water supply sources at these locations are often better. Such considerations were generally outside the scope of the team's efforts, however.

The Water Tech 10 has a long life and requires very little maintenance other than occasional cleaning. After the candles have been cleaned to the point where they have worn thin, they can be replaced. Replacement candles should be stocked in the supply system of the PHCP. Periodic replacement of the filter candles also ensures replacement of the Triocide resin in a timely manner.

2.1.2 Sanitation

In the area of sanitation, the WASH team considered five alternatives for use in the PHCP including:

1. improved pit latrines,
2. pour-flush toilets,
3. compost toilets,
4. bucket latrines, and
5. no action.

Improved Pit Latrines

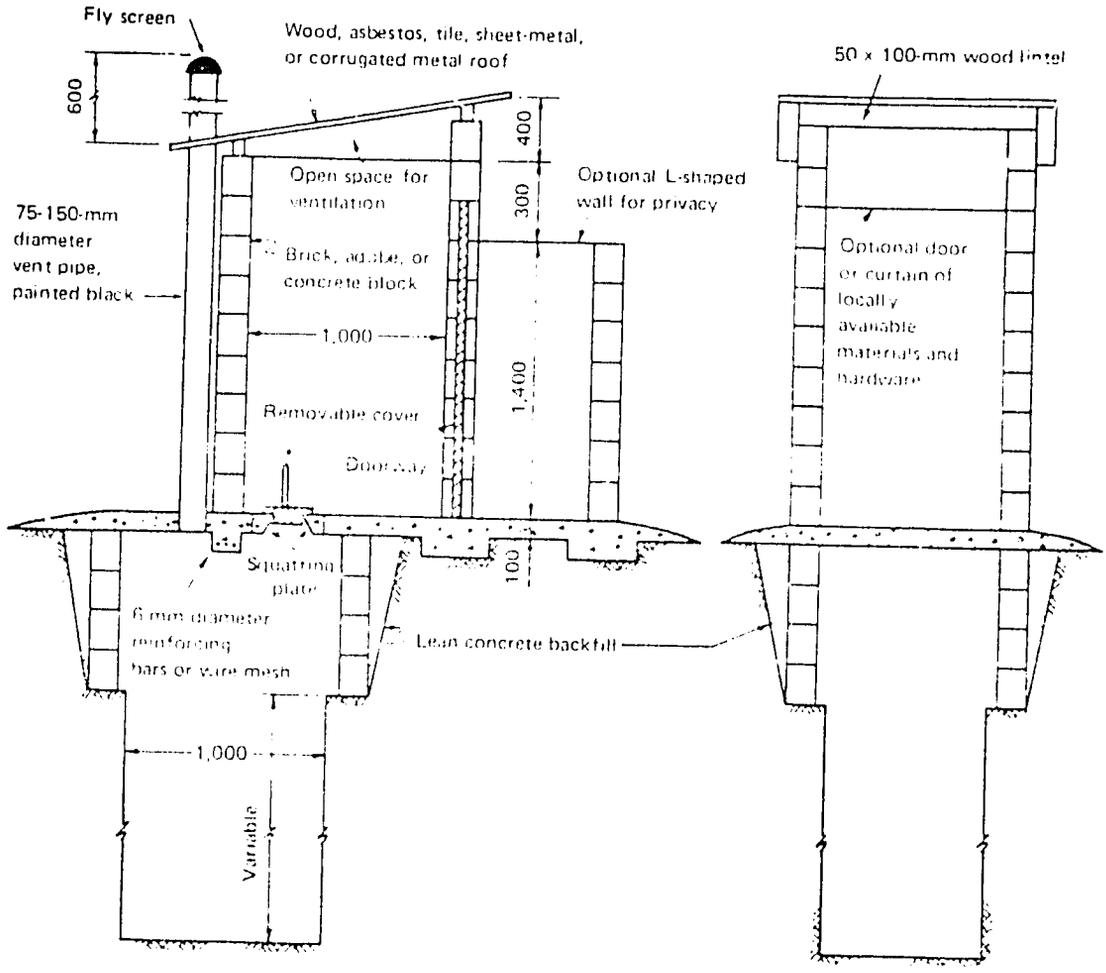
The use of an improved pit latrine (Figure 2.4) was judged to be the most viable alternative, particularly for the rural areas in which most PHCU's, dispensaries, and health care centers are found. The design shown in the figure is one that has undergone a good deal of testing throughout the world. The principal components include a dry pit, a squat plate made of concrete (or other solid material) a vent pipe painted black for thermal heating by the sun, and walls made of local materials. Odors escape up the vent pipe, and the shelter is ordorless if used properly. Fly screens and a removable cover for the floor hole should be provided to limit access by insects.

Pour-Flush Toilets

Pour-flush toilets have gained considerable popularity in suburban and rural areas of many developing countries. These may

FIGURE 2.4

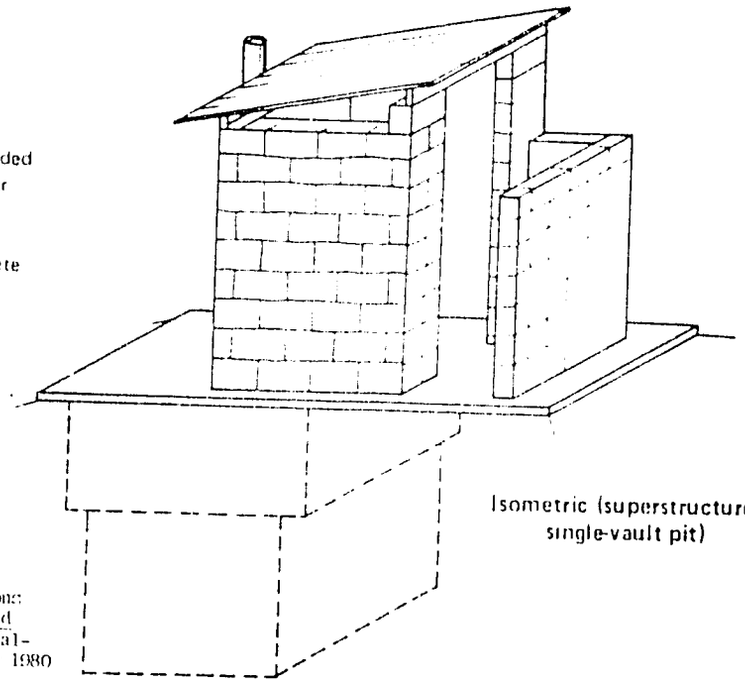
Improved Pit Latrine (measurements in millimeters)



Side view (section)

Front view (superstructure; L-shaped wall and vent not shown)

Note: Side view. Pedestal seat or bench may be substituted for squatting plate. An opening for desludging may be provided next to vent. Dimensions of the bricks or concrete blocks may vary according to local practice. Wooden beams, flooring, and siding may be substituted for concrete block walls and substructure.



Isometric (superstructure; single-vault pit)

Source:

World Bank, Transportation, Water and Telecommunications: Appropriate Technology for Water Supply and Sanitation: A Planner's Guide, Volume II, by John M. Kalbermatten, et al. 191p. Washington, D. C.: December 1980

be used with septic tanks (and leaching fields) or with seepage pits. If water is plentiful at the site, pour-flush toilets may be an option that is superior to (or at least more convenient than) the improved pit latrine.

Pour-flush toilets are not recommended in general for Sudan, however, because of the widespread need in most areas to conserve water, the somewhat greater hazard associated with leaching fields and seepage pits polluting groundwater resources, and the need to periodically pump out septic tanks.

Composting Toilets

Composting toilets have some advantages over other alternatives in areas where adequate amounts of plant material are available to generate sufficient heat in the compost pit. The WASH team judged that composting toilets (Figure 2.5) would generally not be feasible in Sudan except in the Southern Region where grass and other fodder type materials could be added to the compost pit. However, composting toilets are generally not as acceptable as improved pit latrines even in Southern Sudan, because of the general reluctance of Sudanese to touch wastes (even completely safe, composted wastes) due to religious beliefs. Composting toilets also tend to be more expensive to construct than improved pit latrines.

Bucket Latrines

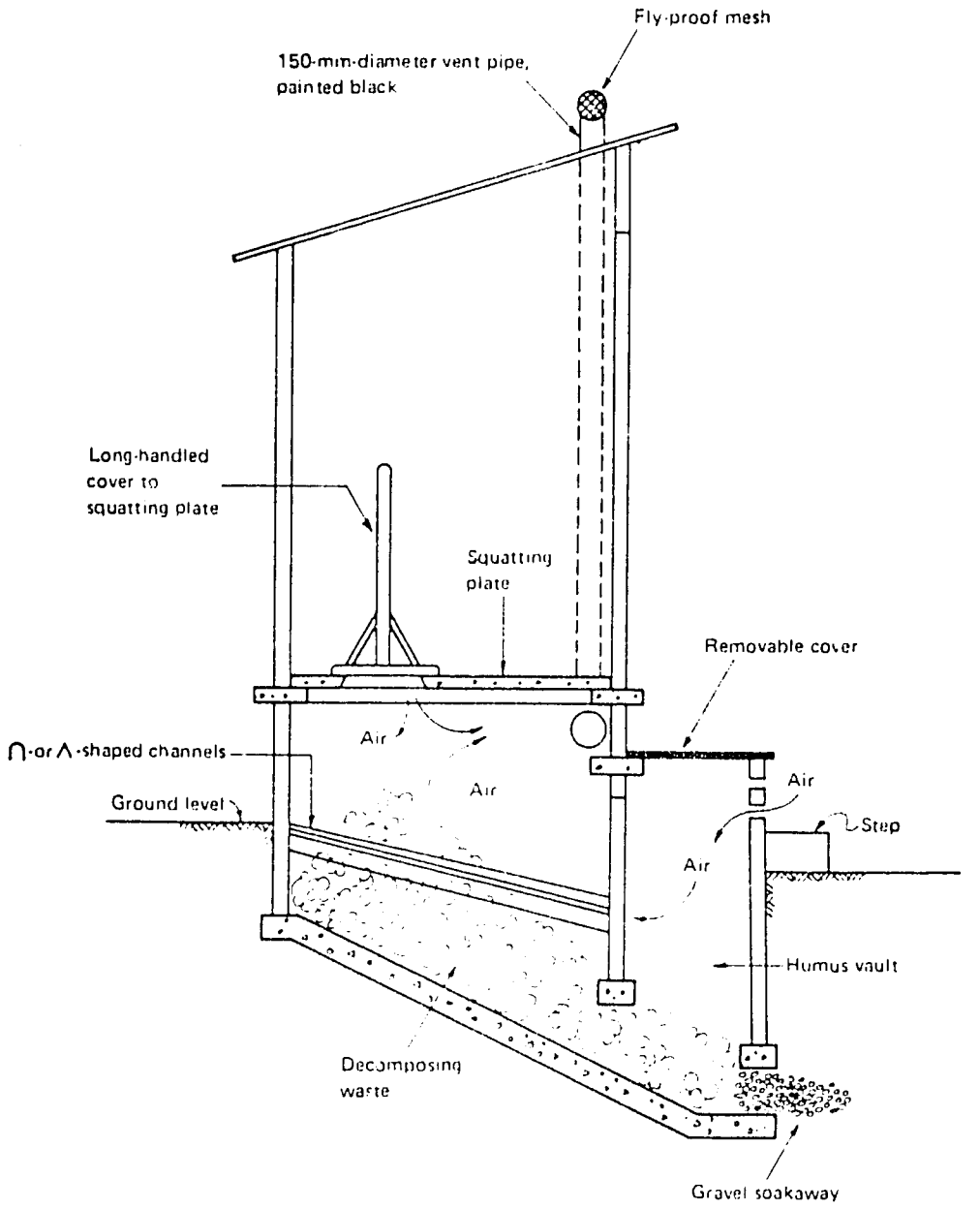
Bucket latrines have been utilized in many areas of Sudan in the past. The team particularly noticed their prevalence in El Obeid and Kadugli during field visits there, but the municipalities involved are slowly moving toward conversion of the existing bucket latrines to pit latrines because of problems with service and maintenance. Bucket latrines may be acceptable if properly serviced, but flies and vermin, as well as associated odor generally make them an unattractive alternative.

No Action

People commonly go into the bush and either dig a hole in the sand in which to deposit their excreta or deposit them behind nearby vegetation. In desert areas of Sudan the sun quickly transforms the excreta into dry matter for which further treatment may be unnecessary. In remote and sparsely populated areas this practice may continue with few ill effects. However, in the small towns in which PHCU's and dispensaries are located it would be desirable for CHW's to demonstrate the benefits of improved pit latrines through their construction and use at local PHCU's.

FIGURE 2.5

Composting Toilet



Source: Adapted from a drawing by U. Winblad.

Source: World Bank. Transportation, Water and Telecommunications Department. Appropriate Technology for Water Supply and Sanitation: A Planner's Guide, Volume 2, by John M. Kalbermatten, et al. 194p. Washington, D. C.: December 1980

Improved pit latrines are recommended for general use in Sudan, particularly in and near rural towns where PHCU's are located. It is also recommended that proper financing and materials should be made available to the CHW's for assistance during construction.

2.1.3 Training in Water Supply and Sanitation

The extension of the water supply and sanitation component to include the addition of a training component was considered in order to improve training at existing schools for CHW's and NCHW's.

The WASH team reviewed the existing manuals used in schools for CHW's and NCHW's (52) and noted that the material currently being used for water supply and sanitation training was weak in many areas. Because the team recommends the introduction of the Water Tech 10 and the use of improved pit latrines, it is believed that existing manuals are not adequate for the increased emphasis that should be placed in these areas, particularly to explain the construction, the need for, and the use of the new facilities.

Thus, it is recommended that a supplementary manual be developed to describe the use of water purification devices and the construction of improved pit latrines for PHCU's and dispensaries, and to cover other emergency methods for disinfection of water and the handling of wastes. Technical asssistance in this endeavor may be necessary in the future.

2.1.4 Summary of Recommendations

It is recommended that a water supply and sanitation component be added to the Northern Primary Health Care and rural Health Support projects. For water supply, it is recommeded that Water Tech 10 (or equivalent) devices be introduced into the training programs at schools for community health workers and into the PHCU's and dispensaries themselves once CHW's and other operators have been trained in their use.

In areas where well drilling and handpump installation programs are currently underway, PHCU's and dispensaries could petition the government to locate handpumps nearby to meet critical local needs. In general, however, the WASH team judged that the total use of water at these facilities was not of sufficient quantity to justify a new handpump program in areas where such programs were not now operating. Rural health centers, hospitals, and district hospitals, if not now supplied with adequate water, should also be considered for wells and handpumps if an existing drilling program is operating within their province.

In the field of sanitation, the WASH team recommends that improved pit latrines (see example, Figure 5.3) represent the best alternative, although introduction of these pit latrines and encouragement of their use will not be an easy task. Some method of financing and/or method to make construction materials available will be necessary in order to establish a viable latrine construction program.

In the area of training, it is recommended that a supplementary manual be developed to describe the use of water purification devices, the construction of improved pit latrines for PHCU's and dispensaries, and other emergency methods for disinfection of water and the handling of wastes. Technical assistance in this endeavor may be necessary in the future.

2.2 CARE Proposal for North Kordofan Province Rural Water Supply

The North Kordofan Rural Water supply Project was designed by CARE and submitted to USAID/Sudan as an unsolicited proposal (84). The stated objective of the project is to provide domestic and livestock water supply in North Kordofan Province through the construction or rehabilitation of 40 Government of Sudan water yards. The primary target area is in the shape of a triangle, with corners at the towns of El Obeid, Bara, and Um Ruwaba. The provision of reliable water supplies is expected to stem the dry season migration of people in the area and to encourage the harvesting of gum arabic from Acacia senegal trees. The sale of gum arabic on the international market generates a large portion of Sudan's foreign exchange earnings.

The project proposal calls for drilling deep boreholes (average depth 600 feet) from which to draw water. Pumps to bring the water to the surface would be powered with diesel engines. Included in each "water yard" would be a 10,000 gallon elevated water tank and taps for human and livestock use. The project proposal estimated that 2,000 to 4,000 people would be served by each water yard. In the same region there are currently 164 water yards (with a total of 204 boreholes). Based on studies in other areas of Sudan (55, 58), it is likely that many of the existing water yards are not functioning because of general shortages of diesel fuel and spare parts for the engines.

As envisaged by CARE staff, the project would be implemented by the National Administration for Water (NAW), through its Western Regional headquarters in El Obeid (North Kordofan Province). CARE would be responsible for commodity procurement and coordination with the Forestry Department (with respect to the reforestation effort) and would monitor program implementation. The proposed project represents an extension of NAW's reponsibilities in the management and maintenance of water

yards. For CARE the project would represent a new responsibility in Sudan, although CARE has recently been assigned responsibility for the administration of the Port Sudan refugee water supply project jointly funded by USAID and United Nations High Commission on Refugees (UNHCR).

Currently The UN Sudano-Sahelian Office (UNSO) and the Sudan Department of Forestry are carrying out an Acacia senegal reforestation project (46, 47, 48), designed to produce a total of 1.2 million Acacia senegal seedlings in six nurseries in North Kordofan Province. The seedlings are to be supplied free to cooperating area farmers for planting. It is hoped that the reforestation effort will reverse desertification in the area and, through the sale of gum arabic (derived from the mature trees), supplement the income of the small farmers and increase the foreign exchange earnings of Sudan.

2.2.1 Project Assessment

Assumption Analysis

The WASH team evaluated the CARE proposal based upon its stated objectives (Figure 2.6) using an assumption analysis technique (76). Two major assumptions are basic to the logic of the actions recommended for fulfillment of the project's objective:

1. that the lack of water in North Kordofan Province is causing the migration of rural inhabitants during the dry season, and

2. that if the migration is stemmed, either through the project or by other means, residents will cooperate with the Department of Forestry in the reforestation effort by planting and tending Acacia senegal trees.

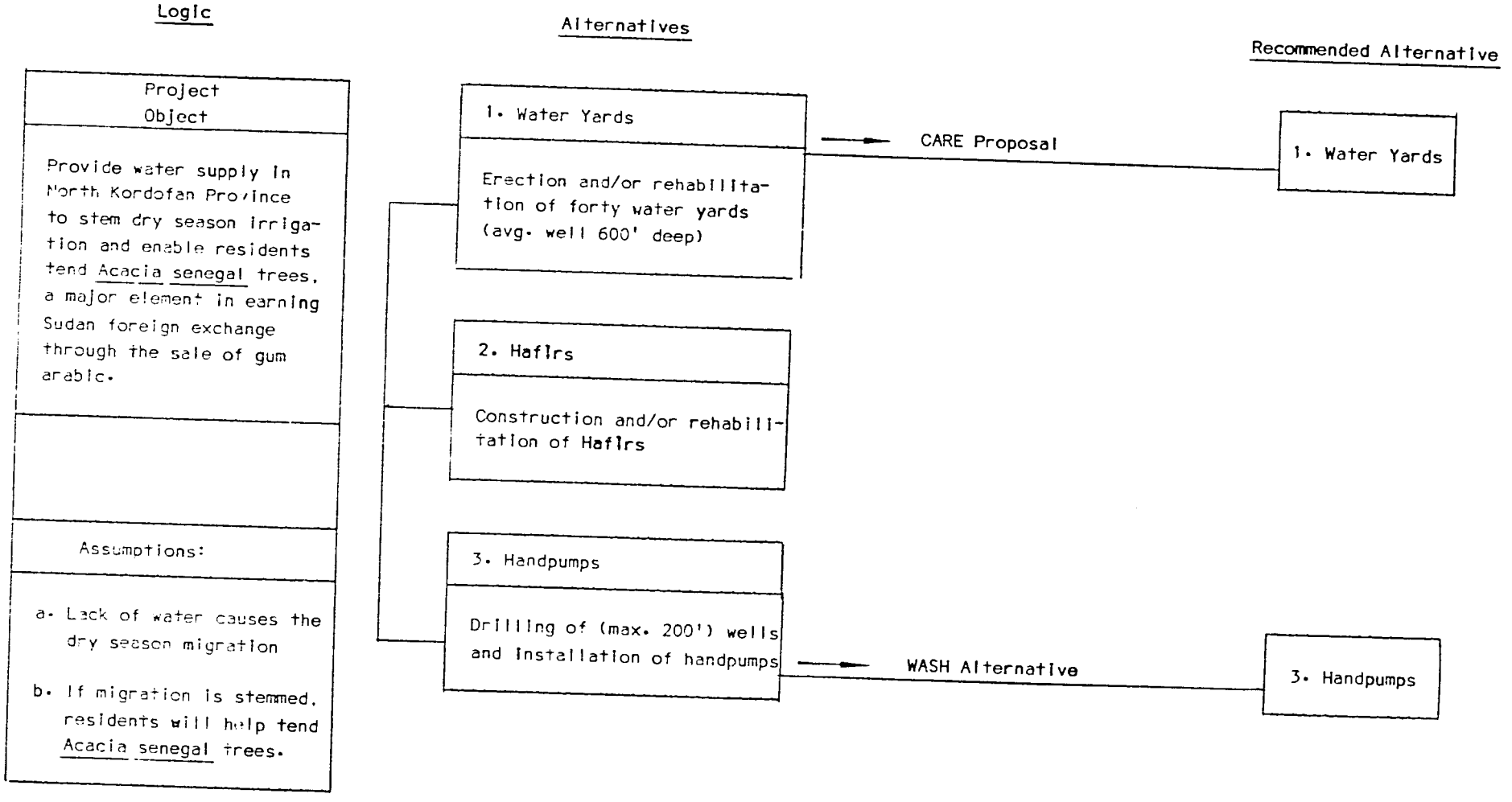
Assumption 1: The lack of water causes migration.

While there is some evidence that a lack of water in the area is contributing to dry season migration, there is considerable evidence that other factors are just as important, if not more important. The settlers in the area are subsistence farmers and frequently run short of their subsistence food supply (millet and sorghum) before the next year's crop is ready for harvest (61). As a result, the farmers often need cash in the dry season in order to buy food.

There are several ways that a farmer may obtain cash when necessary. For those with sufficient land, a portion of it may be planted in cash crops such as sesame and peanuts during the rainy season. If the sesame crop fails or there is a poor har-

Figure 2.5. Assumption Analysis Chart

NORTH KORDOFAN RURAL WATER SUPPLY PROJECT



vest of millet or sorghum due to dry weather or insects, other steps must be taken to earn cash.

One way to earn additional cash income during the dry season is for men to migrate to the Gezira or other locations to the south in order to work as wage laborers in government irrigation projects. When migration of the men does take place, the women and children generally remain behind.

Another way for farmers to obtain cash is through the harvesting of gum arabic from Acacia senegal trees.* These trees occur naturally in Africa in a wide band between 10 to 15 degrees north latitude. On the international market, Sudan supplies about 80 percent of world demand for gum arabic, which is a major source of foreign exchange. Some of the most productive areas are near El Obeid (3).

The trees are scored by the men of the household in early October, the start of the harvesting season. Gum arabic harvesting begins in November and December, with most of the gum arabic having been collected by the end of January. The gum is harvested once every two weeks, generally by women and children. The men also assist with the harvest early in the season when the quantity of gum arabic is heavy.

It is doubtful that there is currently a shortage of labor for gum arabic harvesting, since most of the harvesting takes place prior to migration of the men in the dry season. Since the women and children of the household normally remain behind, there probably is sufficient labor in the area to complete any remaining harvesting of gum arabic that may be necessary during the dry season.

Unfortunately, the returns from tending and harvesting gum arabic are meager considering the large amount of labor required. The WASH team estimated that the price for gum arabic at El Obeid was about LS 380 (Sudanese pounds, LS 1.00 = US$0.90) per metric ton in November 1981. This compares to a market price of LS 423 per metric ton in Khartoum (and LS 589, sorted and delivered to Port Sudan). International prices posted for the 1981/82 season by the Gum Arabic Company Limited ranged from $1,500 per metric ton for cleaned and graded gum arabic, to $2,250 per metric ton for the spray dried product (FOB Port Sudan). In the project area individual farmers may receive even less than the El Obeid market price if they sell to middlemen (usually local merchants) in rural areas.

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* Farmers can also earn cash by cutting the Acacia senegal trees for charcoal production and for firewood. Because the wood is very hard, it makes an excellent feed stock for charcoal production. It is believed that this trend has increased in recent years. The tree branches are also used to construct fences to keep animals away from the fields.

While the provision of more water in the area may stem some of the migration, it is doubtful that it would stem all of it. During a drought many of the crops will fail in any case (the area being marginal for rainfed agriculture). Thus it is likely that area farmers will have additional needs for cash income in the future, and migration may be necessary even with the provision of water for domestic needs.

Assumption 2: The provision of domestic water supply will allow farmers to assist in the reforestation effort.

In support of the second assumption, there is some evidence that the provision of water, particularly if it is distributed at points of use convenient to the residents, would reduce the labor currently required to fetch water from distant sources and from queuing in lines at water yards or drawing water from dug wells. Most of this activity is carried out by the women and children. Conceivably then, it could be argued that the provision of a domestic supply of water through handpumps or other facilities would reduce the labor currently expended by the women and children in fetching water and could free them to spend time assisting in the reforestation effort. This would only be logical, however, if the new domestic sources of supply were confined to those villages that were also cooperating in the Department of Forestry's program of reforestation.

Another question, however, is whether or not farmers will actually participate in the planting of Acacia senegal seedlings obtained from the Department of Forestry nurseries. Ideally these seedlings are moved from the nurseries in July and planted shortly thereafter during the rainy season, when the ground is soft and there is sufficient moisture for the seedlings to establish themselves.

The WASH team visited an area north of El Obeid in which seedlings had been intercropped with existing millet and sorghum and appeared to be doing well. There were no large Acacia senegal trees in sight at this location, so that the area was barren of trees except for the seedlings that had been planted by the farmers. No animals were seen in this area. In Acacia senegal forests nearby the team did not observe any planting of seedlings, although many seedlings were seen to be coming up naturally because of the proximity of larger trees which provided the seed stock.

The normal pattern in the area is that of shifting cultivation in which Acacia senegal seedlings return to the area only after the ground has been worn out due to cropping patterns. The land then remains fallow for several years and the seedlings grow into producing trees within five years. Trees produce gum arabic for about 15 years.

After the trees are 20 years or so old, production is minimal and the trees are cut for firewood and charcoal. Acacia senegal is thus the fallow crop between periods of cultivation. As increased population places more pressure on the land, there is a greater likelihood that the trees will be cut sooner to provide more crop land and produce firewood and charcoal.

Technical Problems with the CARE Proposal

Technical problems with the CARE proposal came to light while it was under investigation by the WASH team. They are listed below:

Basement Complex

The Um Ruwaba aquifer, which is assumed to be the underground source of water for the 40 proposed boreholes described in the CARE proposal (Table 2.1), underlies only about one half of the project area (Figure 2.7). The remainder of the area is underlain by the basement complex, made up of granite, gneiss, and schists (55, 56). In locating the sites of the 40 proposed drilling sites on a geological map of the area (Figure 2.7), it was found that five of the proposed sites were underlain by the basement complex. An additional three sites were located in an area of the Um Ruwaba that did not yield water to wells. Thus at least eight of the 40 proposed sites would not be able to tap the Um Ruwaba aquifer.

Water Quality

In addition to the proposed sites that are situated over the basement complex, other proposed sites are located over a portion of the Um Ruwaba aquifer where the chemical quality of water is poor. The water quality of the Um Ruwaba ranges from about 500 ppm to 3,000 ppm of total dissolved solids (Figure 2.8), an indication that the water quality in some areas may not be very good for drinking purposes. Values of TDS higher than 1,000 ppm render water undesirable for drinking. Any values above 3,000 ppm TDS would fall in the category of brackish water and would not be suitable for either human or livestock use. It is not possible to accurately estimate from available maps how many of the proposed sites would be affected although the number could be considerable.

Carrying Capacity

When the carrying capacity of the land for animal use was calculated in the CARE proposal (84), it was assumed that the animals were evenly distributed throughout the project area.

Table 2.1 Proposed Sites for N. Kordofan Water Supply

No.	Site Name	Coordinates Long.	Lat.	Location Verified on Map (X)
1	Halgarma	31 11'	13 08'	X
2	Es-Sarrhayia	30 34'	13 29'	
3	Qog-Er Rayasa	31 30'	12 52'	
4	El-Nigeia's	30 54'	13 10'	
5	Umm Garrany	31 30'	13 05'	
6	Umm Tugor	30 30'	13 33'	X
7	Umm Usheira	30 11'	13 30'	X
8	Kazgeil	30 10'	12 47'	X
9	Azhat	30 15'	13 37'	X
10	Umm Reika	30 50'	13 28'	X
11	El Tukeil	30 16'	12 46'	
12	Shabawiya	30 55'	13 24'	X
13	Suweilim	30 13'	12 48'	X
14	El Ain	30 23'	13 01'	X
15	Namli	30 45'	13 27'	X
16	Abu Owa Hosh	31 26'	13 26'	
17	Um Gerif	30 37'	13 31'	X
18	Radona	30 45'	13 08'	X
19	Sheibula	30 53'	13 12'	X
20	Kindua	31 00'	12 57'	X
21	Abu Sa'ad	30 48'	12 56'	X
22	Banat	31 13'	13 11'	
23	Dereisa	30 46'	13 17'	X
24	Fangoga	30 30'	13 00'	X
25	Umm Heglig	30 36'	13 16'	X
26	Sinjikia	30 30'	13 29'	X
27	Umm Gelgi	30 22'	13 32'	X
28	Maltut	30 44'	13 10'	X
29	Khorsi	30 27'	13 38'	X
30	Zureiga	30 37'	13 33'	X
31	El Fureia	30 45'	13 29'	X
32	Yasein	31 14'	13 12'	X
33	El Beida	30 42'	13 25'	X
34	Abu La'ot	30 36'	13 22'	X
35	Umm Saiyala	31 06'	13 16'	X
36	Wad Delu	31 13'	13 20'	X
37	Mealla	31 29'	13 10'	X
38	Asida	30 37'	13 35'	X
39	Sharbaniya	30 55'	13 34'	
40	Megeita	30 40'	13 06'	X

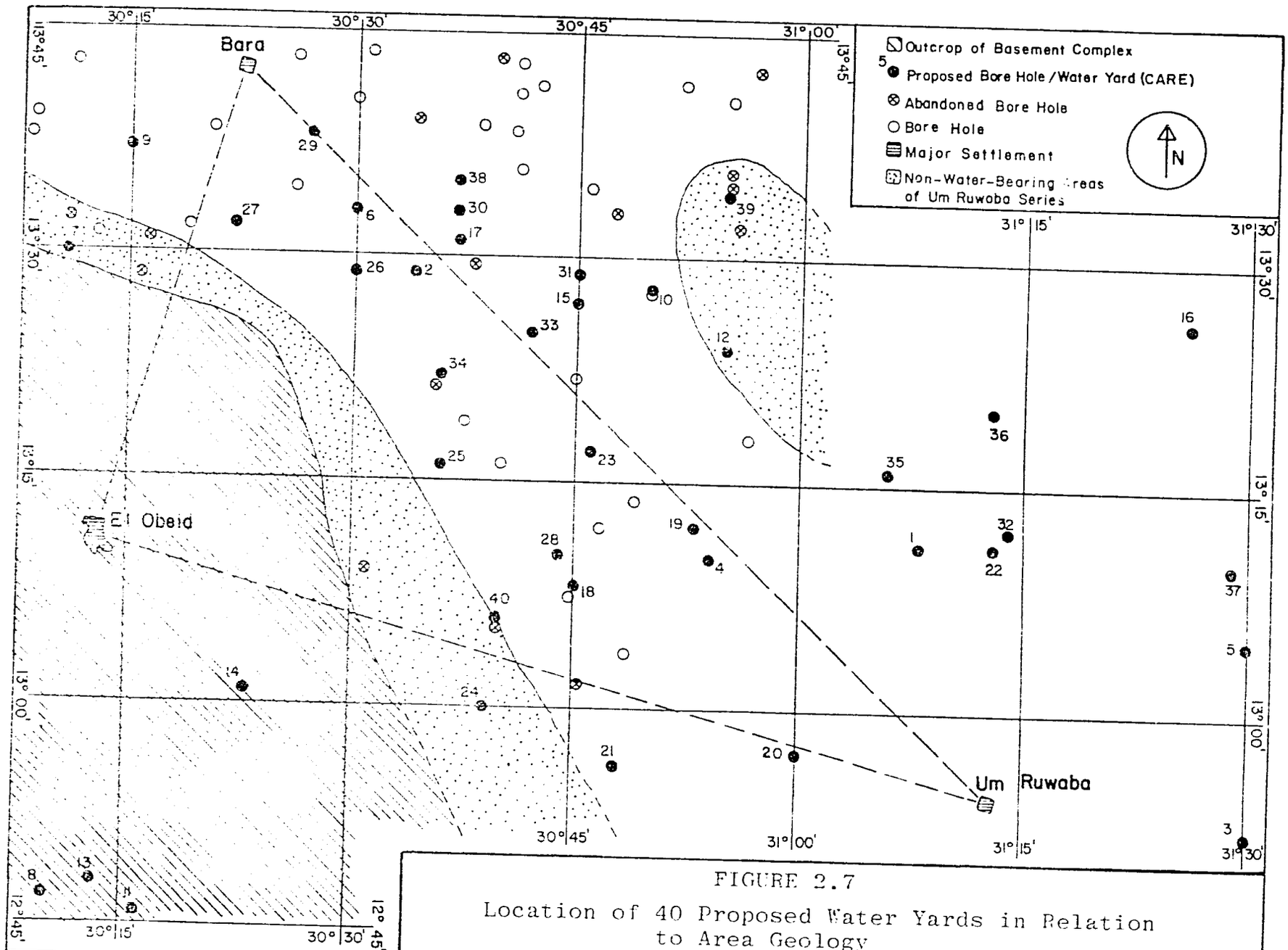
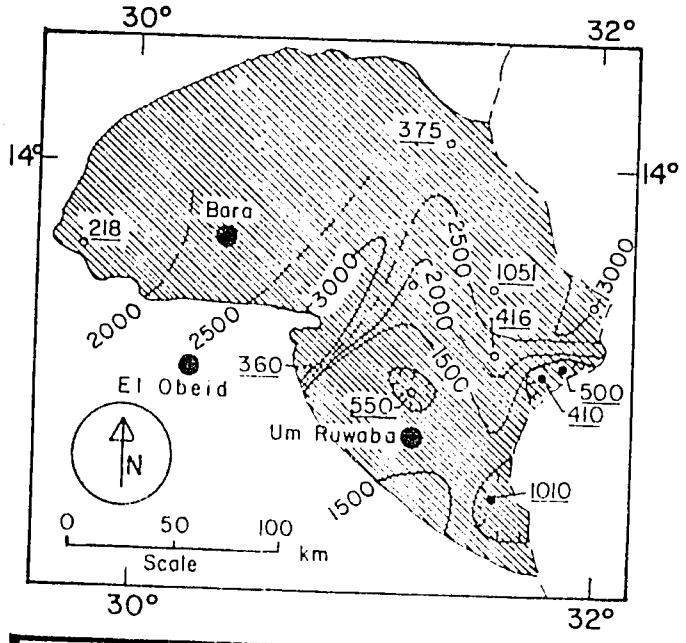


FIGURE 2.7

Location of 40 Proposed Water Yards in Relation to Area Geology

FIGURE 2.8

Areal Distribution of Total Dissolved Solids and Hardness in Water of the Um Ruwaba Aquifer (84).



Um Ruwaba Series Aquifer

2000

Line of equal total dissolved solids, in parts per million (ppm). Dashed where inferred.

Hachured area encloses area of water of low hardness.

∘218 Drilled well with water of total dissolved solids content greater than 1500 ppm.	∘500 Drilled well with water of low hardness from 32 to 160 ppm.

Number indicates depth of well below land surface, in feet.

In fact, water yards tend to cause animals to congregate in specific areas (43, 30). Animals need water every other day (on the average), and even daily in hot weather. Thus, particulary at high volume sources of water (such as water yards), the number of animals will be likely to exceed the carrying capacity of the surrounding range. Denudation within a radius of two to ten kilometers surrounding the yard will follow.

Depth to Water

Another problem relates to the way in which CARE estimated the depth to water at the 40 proposed sites. The proposal assumed that it was necessary to drill about 600 feet to tap the Um Ruwaba aquifer. For those sites in the basement complex, however, there is no need to go deep since the only water found in the basement complex is in the shallow weathered zone. Going deeper would offer no advantage other than assuring that a sufficient amount of water stood in the well.

Project Alternatives Considered by CARE

Only two alternatives to the project were considered in the CARE proposal: 1) no water development, and 2) a shut down of water yards in areas showing signs of severe land degredation. The first would not achieve the project objectives, and the second is identical to the proposed project except for a modified management policy.

Project Alternatives Identified by the WASH Team

The project objective of supplying additional water to rural areas in North Kordofan Province can be met by any of of three general alternatives identified by the WASH team (Figure 2.6 above).

1. The first is that proposed by CARE of constructing or rehabilitating 40 water yards with wells of an average depth of 600 feet.

2. The second is rehabilitation or construction of hafirs (traditional water storage ponds supplied by nearby intermittent streams).

3. The third is the development of a handpump program with wells drilled up to 200 feet in depth and the installation of handpumps. The limit of 200 feet of lift is a maximum for the general use of handpumps, because with greater depth it is difficult for women and children to operate a pump.

Each of the listed alternatives is considered below in detail.

Alternative 1: Water Yards

The water yard alternative proposed by CARE is favored by some Sudanese government officials and politicians. The main drawback is that water yards are costly (LS 40,000 each) and potentially hazardous to the environment because of overgrazing in the areas surrounding water yards. This is due to an increase in the animal population as a result of the additional available water. Another drawback is that government water yards have a poor operating record. They are frequently out of service because of a general lack of diesel fuel and spare parts for the engines.

A significant concern of the WASH team was the potential increase in the number of livestock in the area because of the increased availability of water from the water yard. A number of authors have documented that in the Sahel, livestock tend to increase until vegetation in the surrounding area is either nonexistent or minimal (30, 31). Although there is no quantitative data to indicate that animals have definitely increased as a result of existing government water yards, there was a strong feeling among many respondents that such was the case, and the WASH team felt that the evidence was strong enough to rule against this alternative.

Alternative 2: Hafir Construction or Rehabilitation

A hafir is an artificial depression into which surface runoff is channeled during the wet season for later use. By careful attention to the elevation of the depression in relation to the adjoining ephemeral stream, it is possible to divert water from the stream during flood conditions and store it in an adjoining hafir. Most of the project area is too sandy to allow hafirs to hold water, although there are a few in the southwestern corner of the area near El Obeid. These hafirs could be rehabilitated by dredging sediment and improving the diversion structures. However, the availability of hafir water to livestock in most cases makes animals the primary recipients of project benefits. Hafirs are frequently subject to pollution from animals as they drink from its banks. Even if adequate fencing is provided to prevent animal access, hafir water should be treated prior to human consumption to remove suspended materials (sediment, colloids, organic matter, and bacteria). Because the primary need in the project area is water for human consumption, the hafir alternative was not recommended by the WASH team.

Alternative 3: Shallow Boreholes with Handpumps

Shallow boreholes were suggested by the WASH team after visiting the project area and viewing a number of existing dug wells. The local dug wells are typically 50 to 70 feet in

depth, lined with bricks or concrete blocks, and are an indication that water can be found at shallow depths. At most of the dug wells water is obtained by manually dropping a leather bag on a rope and pulling it up. Local wells are not covered, a hazard not only to people that might fall in, but also a factor contributing to contamination of the well itself.

Wells visited had a considerable amount of sediment mixed with the water as it was drawn up from the well. Wells are typically constructed by digging to the water table and then a few feet beyond; there are usually no more than four or five feet of water standing in the well itself. The shallow depth of the water standing in the well probably contributes to failure of some wells under heavy use during dry periods.

The WASH team proposed that small diameter shallow wells be drilled up to a maximum of 200 feet in depth and handpumps installed for domestic use. A number of similar UNICEF handpump installations (using the Indian Mark II handpump) in South Kordofan Province were observed by the team. The UNICEF procedures were working well, although the maintenance program was being redesigned because of logistical problems.

Wells with handpumps are inexpensive ($1,000 to $1,700 each) and may be scattered about a community, thus making it possible to position wells closer to water users than is possible with water yards, each of which serves a larger area. Each handpumped well is generally designed for the use of 500 people or fewer. The number of animals served by each well is minimal because the manual labor required to draw the water makes it impractical to service a large number of animals at a handpumped well. The team judged that the handpumped wells would not significantly increase the stress on surrounding vegetation due to animals, and thus considered the environmental impact of this alternative to be minimal.

As mentioned previously, there is reason to believe that the handpumps would lessen the labor required by women and children in drawing water and also reduce the time spent in travelling from homes to well sites and back again. A reduction in the time needed to collect water by the women and children may indeed make it possible for additional labor to go into the cultivation of gum arabic, although this linkage is still somewhat tenuous. The linkage may be enhanced, however, if the sites for handpumped wells are chosen to coincide with the villages which are cooperating in the Acacia senegal reforestation project sponsored by the Department of Forestry.

Recommended Alternative

The WASH team recommends the implementation of the handpump alternative (number 3) because of its minimal environmental impact, its ability to supply a safe source at a reasonable

cost, and its potential for maximizing the distribution of use points and service to the people. Several factors led to the selection of this alternative, including (1) the fact that large numbers of animals are not served by handpumps, (2) the technology of handpumps is judged to be more appropriate than water yards in this region, (3) fossil fuels are not required for hand pump operation, and (4) the wells can be sited to benefit villages that are cooperating in the ongoing reforestation effort in the region.

2.2.2 Design of Baseline Study and Evaluation System

The WASH team was asked to design a baseline study and evaluation system for the North Kordofan Rural Water Supply Project. Although the WASH team is recommending against the funding of the CARE proposal as originally formulated, a baseline study and evaluation system may still be necessary under the handpump alternative, although considerably reduced in scale. The system described below was developed after talking with interested persons at the University of Khartoum, particularly Dr. D.L. Johnson.

The baseline study and evaluation system described below has as its core six points (Table 2.2). Each of these will be described in detail.

LANDSAT and Aerial Photographs

LANDSAT satellite photographs are available for Sudan, as they are for the rest of the world, from the EROS Data Center in Sioux Falls, South Dakota (USA). Infrared false color composits, in addition to black and white photographs, should be very useful in any baseline data system. It is suggested that LANDSAT photographs be obtained that were taken before the start of the project and that photographs of the same area(s) be obtained at regular intervals of one year or less after the project begins. Ideally, at least two photographs per year should be obtained, showing both wet season and dry season conditions. LANDSAT imagery is expected to show the presence of any long-term changes in vegetation in the project area, although image resolution is of such a gross nature that minute features will not be discernable. Long-term changes may be apparent in two to five years. Aerial photographs of areas surrounding selected new wells would be helpful. Dr. D.L. Johnson of the Department of Geography (Khartoum University) has indicated that photograhic coverage of the project area is available and could be purchased in Sudan from the Sudan Survey Department. A list and dates of existing photographs was not, however, available to the WASH team during their visit.

Table 2.2 Proposed Baseline Study and Evaluation System, North Kordofan Rural Water Supply Project

Major components:

* use of LANDSAT satellite photos and aerial photos to monitor areas surrounding new water supply points and control villages;

* census of human and animal populations in selected villages, to be carried out before the project and at intervals after the intervention;

* water use information collected at water use points to determine population served and user habits;

* monitoring of climatic data for the project area to enable comparison of the current project year data with long-term climatic trends;

* collection of statistical data on the incidence of disease in the project area through the GOS's primary health care system; and

* collection of data on social and economic status of individual households within the selected target villages and control villages as well.

If the existing photographs are not sufficient, or if additional documentation is necesssary, it should be possible to use the existing USAID aircraft and 35 mm photography to obtain photographs of limited areas of interest.

One of the features of primary interest would be the number and distribution of houses in test villages and control villages before and at intervals following project commencement. Increases in the denudation of vegetation surrounding new well sites should also be detectable from aerial photographs. The image resolution available from aerial photographs is much better than that available from satellite imagery, so that smaller features will be discernable.

Census of Human and Animal Populations

In selected villages it is proposed that a census of human and animal populations be taken before and after installation of new wells. This count should be done not only for villages receiving new water sources but for control villages as well, since the population is generally expected to increase over time in any case. Data should be collected three times a year for the first year to detect seasonal changes, and in the last year of the three-year project period.

Water Use Information

An estimate of the amount of water used at the water use points should be collected periodically, including the number of people who visit the water use point. The frequency of use, the usual time of day, the distance from home, and other information to indicate any increase in water use or decrease in the amount of time spent daily in collecting water should be surveyed as well. Data collection should be carried out both in the villages receiving new water sources and in control villages.

Collection of Meterological Data

Data on temperature, rainfall, wind direction, and soil moisture, should be available from the nearest weather stations. Data on the level of area water tables should be gathered periodically from observation of selected local wells.

Incidence of Disease in the Area

Information on water-washed and water-borne diseases in the area should be available from the records of patient visits to local PHCU's and dispensaries. These medical facilities should be contacted for such information in selected target and con-

trol villages. Data collected over time may be used to approximate changes in incidence of disease. which may in turn be attributed to increased use of water or the availability of safe water in the target villages. General area-wide patterns of change may be monitored through data from the control villages. As mentioned elsewhere in this report, data from rural medical facilities may be inaccurate; however, a properly designed study can minimize the effect of such inaccuracy on the study's outcome.

Measure of Social and Economic Status

During the census of human and animal populations, interviewers should also obtain data on household characteristics such as number of children, general income level, amount of land owned or cultivated, and other indicators of social and economic status. This data will provide an indication of the status of each village population in relation to other selected target villages, or the control villages. The data can be used as a statistical control for relevant factors among villages in the same area.

A baseline study and evaluation system would be useful no matter which project alternative is selected for implementation. A smaller and less costly survey would be possible under the handpump alternative because of the relatively small potential for negative environmental impact. Fewer data items would be collected as a result. The Institute for Environmental Studies and the Department of Geography at the University of Khartoum who have done previous work in the project area, are interested in implementing the baseline study and evaluation system. These organizations should be considered for this effort (42, 45).

Chapter 3

COMMUNITY WATER SUPPLY AND SANITATION ACTIVITIES IN SUDAN

Sudan encompasses a total of over 2.5 million square kilometers, making it the largest country on the African continent. From the rain forests in the south to the deserts in the north, Sudan is a land of contrasts, and of considerable natural resources (50, 51). Annual rainfall ranges from about 1 mm on the Egyptian border to 1,600 mm or more in the mountains near the Ugandan border (Figure 3.1). Successful strategies for water supply and sanitation cannot be easily generalized in a country of such large magnitude and climatic variation.

3.1 Government of Sudan (GOS) Program

Sudan, ranked among the world's least developed countries, is presently in the throes of an economic crisis. The crisis has been blamed in part on rising import costs (primarily petroleum) and slow export growth. A portion of the crisis also may be due to a misdirected effort during the mid-70's to broaden production and export bases. The crisis has had serious ramifications for the country's foreign exchange and debt burden and has placed constraints on its internal budget (6).

To confront the major economic and social problems, a six-year development plan (1977-1982) was announced by the Government of Sudan (GOS) in July 1977. Unfortunately, the Government's present economic crisis has seriously hampered effective implementation of the current development plan. It is expected that a new six-year plan, based on decentralized regional planning, will succeed the current plan beginning in the second half of 1982.

In water supply and sanitation, GOS has recently stressed the need to improve existing rural water supply sources and to expand efforts to increase the availability of new potable water supplies for domestic use, with the aim of reaching all the rural inhabitants of the country. In particular, hafir (surface pond) rectification and borehole drilling are to receive special attention over the next few years. Significant external assistance will be required to supplement the government's rural water supply agencies which face continual manpower depletion (7).

In the health services sector, increased emphasis will be given to the Primary Health Care Program (PHCP) with the goal of reaching an additional 8 million settled rural people and some 600,000 nomads by 1985. This will require the establishment of an additional 3,000 primary health care units (PHCU's)

FIGURE 3.1

Average Annual Rainfall in Sudan, 1931-1960 (mm)

for settled communities, and 800 mobile units for nomads. Trachoma control, immunization, and education in nutrition and health will also be promoted. Oral rehydration therapy will spearhead efforts for the control of diarrheal diseases among under-fives, the single most significant killer of children (7).

Within the Government of Sudan, funding and advisory services for water supply and sanitation in Sudan are controlled by six different ministries (Figure 3.2), including the Ministry of Energy and Mines; the Ministry of Agriculture, Food and Natural Resources; the Ministry of Cooperative and Rural Development; the Ministry of Construction and Public Works; the Ministry of Health; and the Ministry of Planning and Finance. Responsibility for water supply (left side of Figure 3.2) is divided first along urban and rural lines. In rural areas, responsibility for water supply is divided still further along regional boundaries.

Responsibility for urban water supply is held by the Public Electricity and Water Corporation, which is under the Ministry of Energy and Mines. Responsibility for rural water supply in most of Sudan is that of the National Administration for Water, under the Ministry of Agriculture, Food, and Natural Resources. In the Southern Region, rural water supply is the responsibility of the Rural Water Corporation under the Ministry of Cooperative and Rural Development.

Responsibility for sanitation is also divided (right side of Figure 3.2) among urban and rural jurisdictions, with urban sanitation the responsibility of municipal and local councils (with construction advice available from the Ministry of Construction and Public Works), and rural sanitation generally the responsibility of the Ministry of Health.

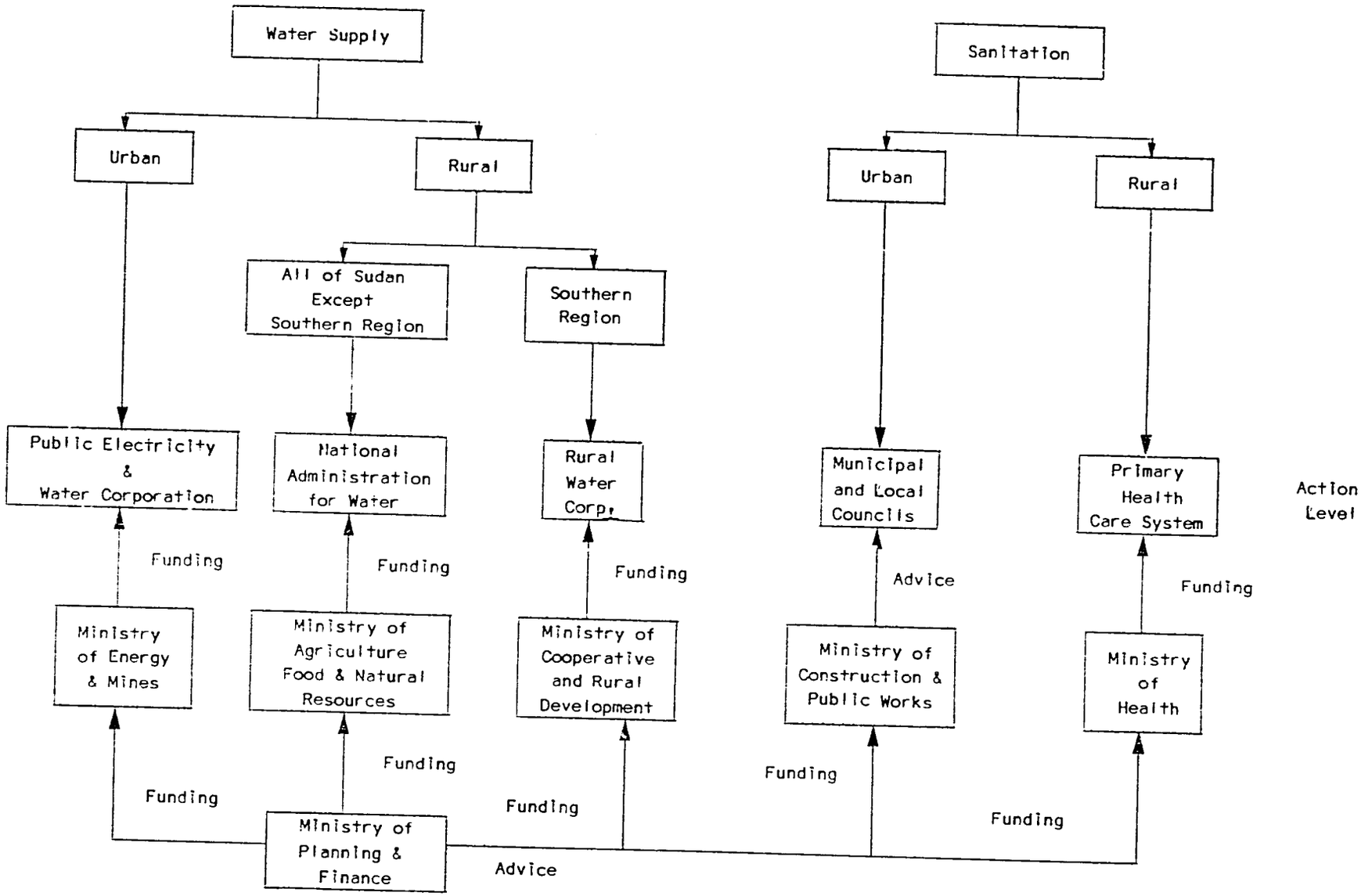
Overall responsibility for the apportionment of monies among the various ministries of the Government of Sudan is that of the Ministry of Planning and Finance.

3.1.1 National Administration for Water (NAW)

The National Administration for Water was established in February 1980 and took the place of its predecessor, the Rural Water Corporation (RWC), in all except the Southern Region. NAW is now the prime agency with responsibility for rural water supply in Sudan.

The history of rural water administration in Sudan goes back the early 1940's. In 1942 the Government formed the Soil Conservation Board which in 1944 was reorganized into the Soil Conservation Section of the Department of Agriculture. This agency is reported to have constructed about 300 hafirs during this period. In 1956 the Land Use and Rural Water Development

Figure 3.2 Authority for Water Supply and Sanitation in Sudan



Department was formed under the Ministry of Agriculture to carry out coordinated development in land and water use. In 1965 the Rural Water and Development Corporation was formed. This agency concentrated on strengthening rural water supply programs and coordinating them with land use, social services, and overall development, including the settlement of nomads.

In 1970, a national "Anti-thirst Campaign" was begun. In addition to local GOS contributions, international donors also joined the effort including the United Nations, the Arabian Council, the International Red Cross, and the bilateral aid organizations of Sweden, Yugoslavia, Egypt, Italy, Nigeria, and China.

In 1975, the name of the Rural Water and Development Corporation was changed to the Rural Water Corporation which concentrated on water research, the drilling of deep boreholes and improvement of shallow wells, construction of dams and hafirs, and the erection of water yards. The Rural Water Corporation was organized into five sections, including well drilling, water yard erection, water yard maintenance, hafirs, and hydrometry and equipment purchase.

The National Administration for Water evolved from the Rural Water Corporation in February 1980, as part of the decentralization process (then going on at the national level) in which more authority was given to the regions. Under the new alignment the NAW in Khartoum retained responsibility for finance and general supply of equipment while responsibility for construction programs was given to the regional centers (57).

3.1.2 Rural Water Corporation (RWC)

In the Southern Region with headquarters in Juba, the Rural Water Corporation continues to operate under the Ministry of Cooperative and Rural Development. In the South, the Rural Water Corporation performs the same functions as the NAW in other areas of Sudan, except that the current administrative capabilities of the RWC are considerably weaker because of staffing and budgetary constraints within the Ministry of Cooperative and Rural Development.

3.1.3 Public Electricity and Water Corporation (PEWC)

The Public Electricity and Water Corporation is the national enterprise responsible for the generation and the bulk distribution of electricity and water in Sudan (49). This corporation, which operates under the Ministry of Energy and Mines, has the authority and the obligation to (a) develop efficient, financially viable urban water supply systems throughout the country, (b) carry out all necessary investigations, (c) develop long-term plans, and (d) operate urban water supply systems.

The general manager of the PEWC has the authority and responsibility for the daily operations of the corporation. Ministerial approval is required mainly for PEWC's borrowing, annual budget, and changes in tariffs. Such approval is normally given with the concurrence of the Ministry of Planning and Finance (14).

As of 1977, PEWC administered 59 piped urban water supply systems (Table 3.1), 48 of which were in the Northern Region* and 11 in the Southern Region (14). According to a WHO/GOS study about 49 percent of the Sudan's urban population is served by house connections and street standposts, although service coverage varies considerably. It was estimated that in 1977, 53 percent of the urban population within the Northern Region were served, while only 17 percent were served in the Southern Region (14).

PEWC generally uses a policy of universal metering, including street standposts. Street standposts are often operated by open concessionaires, who sell water at the fountains and may also deliver it during off-peak periods to the homes of consumers (14).

The WASH team observed that household water fixtures were poorly maintained in Khartoum and elsewhere in Sudan. Although meters were commonly used at household connections and standposts, a lack of maintainence resulted in a high percentage of poorly calibrated or non-functioning meters.

Losses from water leakage in urban systems often cannot be evaluated because of an absence of master meters at central water works facilities (14). It is probable in view of the age of many of the distribution systems and the poor quality of maintenance that significant losses are occuring.

3.2 Multilateral Organizations

Numerous multilateral organizations are active in water supply and sanitation projects in Sudan. Many of these organizations fall under the general umbrella of the United Nations, such as UNICEF, UNDP, WHO and UNHCR. The World Bank is also funding some water supply and sanitation activities.

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* Prior to 1977 the "Northern Region" included all of Sudan outside of the Southern Region. A move within the GOS in the last few years to "regionalize" the government has led to a further division of the old "Northern Region" into Eastern, Western, Central, and Northern regions. Southern Region boundaries have remained unchanged. Regionalization has not yet fully taken place in all GOS activities, however.

Table 3.1 PEWC Administered Urban Water Supply Systems, 1977 (14)

Serial No.	Province & Location	System Capacity	Present Situation: Supply Source		Supply Method		Population 1977	Service Coverage %	
			Surface %	Ground %	Number of HC	Number of Standposts		By** HC	By*** Standposts
		m^3/d							
I	Khartoum								
1	Khartoum town & villages	103440	87	13	37241	59	451000	51	5
2	Omdurman town & villages	20640	77	23	26870	25	384000	43	2
3	Khartoum North town & villages	36750	31	69	28382	40	201000	88	7
	Subtotal	160830	73	27	92493	124	1036000	55	4
II	Blue Nile								
4	Singa	3110	0	100	1726	5	25000	43	7
5	Sennar	5900	86	14	3029	14	37000	51	13
6	Ed Damazin	2400	100	0	750	2	16000	29	4
7	Er Roseires	2280	100	0	N/A	N/A	17000	N/A	N/A
	Subtotal	13690	71	29	N/A	N/A	95000	N/A	N/A
III	El Gezira								
8	Wad Medani*	17300	72	28	11800	68	137000	53	17
9	Abu Usher	545	0	100	200	4	10000	12	14
10	Managil	1440	100	0	700	14	19000	23	26
11	El Ghurashi	2160	100	0	800	0	6000	83	0
12	El Hasaheisa	2880	0	100	1700	12	24000	44	18
13	Rufa'a	2880	0	100	1900	10	20000	59	18
14	El Kamlin	1680	0	100	700	12	9000	48	47
15	Hillaliya	1920	0	100	200	12	11000	11	38
	Subtotal	30805	52	48	18000	132	236000	47	19
IV	White Nile								
16	Aba	2160	100	0	350	16	29000	7	19
17	Rabak	2280	100	0	N/A	N/A	24000	N/A	N/A
18	Kosti	6480	100	0	4000	20	84000	30	8
19	El Kawa	320	0	100	200	18	4000	31	69
20	Ed Dueim	4500	100	0	2150	8	34000	39	8
21	Geteina	720	0	100	800	13	8000	62	38
	Subtotal	16460	94	6	N/A	N/A	183000	N/A	N/A
V	Northern Kordofan								
22	El Obeid*	7238	85	15	5614	44	108000	32	14
23	En Nahud	950	0	100	609	16	31000	12	18
24	Um Ruwaba	4364	0	100	996	10	24000	26	15
25	Bara	550	0	100	400	10	11000	23	32
26	Er Rahad	2280	100	0	N/A	N/A	17000	N/A	N/A
	Subtotal	15382	55	45	N/A	N/A	191000	N/A	N/A
VI	Southern Kordofan								
27	Kadugli	600	0	100	468	10	22000	13	16
28	Dilling	700	0	100	900	13	23000	24	20
	Subtotal	1300	0	100	21888	23	45000	19	18

PEWC Administered Urban Water Supply Systems, 1977 (continued)

Serial No.	Province & Location	System Capacity	Present Situation: Supply Source		Supply Method		Population 1977	Service Coverage %	
			Surface	Ground	Number of HC	Number of Standposts		By* HC	By*** Standposts
		m^3/d	%	%					
VII	Northern Darfur								
29	El Fasher*	4000	50	50	1130	32	72000	10	16
30	Geneina	600	0	100	139	7	49000	2	5
	Subtotal	4600	43	57	1269	39	121000	7	12
VIII	Southern Darfur								
31	Nyala	2680	0	100	1551	14	82000	12	6
IX	Red Sea								
32	Port Sudan*	18000	0	100	8801	277	178000	31	54
33	Tokar	400	0	100	1259	25	19000	41	46
34	Sinkat	1200	0	100	41	6	9000	3	23
35	Suakin	400	0	100	19	3	8000	1	13
36	Gebeit	1400	0	100	100	30	7000	9	91
	Subtotal	21400	0	100	10220	341	221000	29	52
X	Kassala								
37	Kassala	11500	0	100	6055	52	139000	27	13
38	El Gedaret	9092	100	0	3067	40	93000	20	15
39	New Halfa*	4320	100	0	2754	6	34000	50	6
40	Khashm el Girba	2275	100	0	250	0	12000	13	0
	Subtotal	27187	58	42	12126	98	278000	27	12
XI	Nile								
41	Shendi	4800	0	100	3062	4	26000	73	5
42	Ed Damer	500	0	100	1078	5	18000	37	10
43	Atbara*	12000	100	0	5788	0	72000	50	0
44	Berber	2000	0	100	1326	0	12000	69	0
45	Abu Hammed	1440	100	0	N/A	N/A	2400	N/A	N/A
	Subtotal	20740	65	35	N/A	N/A	130400	N/A	N/A
XII	Northern								
46	Karima	1440	100	0	250	15	8000	19	66
47	Dongola	5240	0	100	660	7	6000	68	32
48	Wadi Halfa	2000	100	0	2224	3	6000	92	8
	Subtotal	8680	40	60	3134	25	20000	56	38
XIII	Eastern Equatoria								
49	Juba*	3345	93	7	1320	18	94000	9	7
50	Torit	1440	100	0	1972	4	24000	50	6
51	Yei	720	100	0	100	12	20000	3	21
	Subtotal	5505	96	4	3392	34	138000	15	9
XIV	Western Equatoria								
52	Maridi	[illegible]	[illegible]	0	1200	12	16000	47	26
53	Yambio	364	100	0	N/A	N/A	11000	N/A	N/A
	Subtotal	1804	100	0	N/A	N/A	171000	N/A	N/A

PEWC Administered Urban Water Supply Sytems, 1977 (continued)

Serial No.	Province & Location	System Capacity	Present Situation: Supply Source		Supply Method		Population 1977	Service Coverage %	
			Surface	Ground	Number of HC	Number of Standposts		By** HC	By*** Standposts
		m^3/d	%	%					
XV	Bahr el Ghazal								
54	Wau	4500	100	0	1000	4	87000	7	2
XVI	Upper Nile								
55	Malakal	2880	100	0	765	13	58000	8	8
56	Renk	1440	100	0	290	4	23000	8	6
	Subtotal	4320	100	0	1055	17	81000	8	7
XVII	El Buheyrat								
57	Tonj	1440	100	0	N/A	N/A	14000	N/A	N/A
58	Rumbek	909	0	100	N/A	N/A	29000	N/A	N/A
	Subtotal	2349	61	39	N/A	N/A	43000	N/A	N/A
XVIII	Jonqli								
59	Bor	1440	100	0	200	6	20000	6	11
	Total Country	343,672	64	36	178,636	1,054	3,034,400	37	12

* Area Office
** Based on 6.2 persons per HC (house connection)
*** Based on 350 persons served by each standpost
N/A Information not available

Note: There are 27 communities with a population of 454,000 classified as urban not included in systems administered by PEWC and for which information is not available.

3.2.1 The United Nations Children's Fund (UNICEF)

UNICEF participation in water supply programs in Sudan has been designed to assist GOS efforts to improve the general health and socioeconomic conditions of rural inhabitants in two provinces, Bahr-el-Ghazal and South Kordofan. UNICEF offices in Wau and Kadugli, respectively, support the provincial efforts, while overall program offices for UNICEF are in Khartoum. Activities have centered around the provision of easily accessible and safe water for domestic use.

In Bahr-el-Ghazal Province, a new well drilling technique was introduce in 1976. By the end of 1980, a total of 400 boreholes had been drilled. Of these, 350 had been fitted with handpumps, and drainage aprons had been constructed by the end of 1980. Training courses were held for drilling crews, pump maintenance and repair teams, platform construction teams, and machine workshop staff. Two crews now provide mobile maintenance and repair services for pumps installed to date.

Laboratory and field water analysis capabilities have been developed, and in 1980 water samples were tested from 350 boreholes and found suitable for human consumption. Village women and children also received instruction from UNICEF in basic health, sanitation, and simple pump care during installation and demonstration of every new handpump (7, 13, 15, 41). Projected phased costs call for expenditure of $9.1 million from 1981 to 1985 for the installation of 3,500 boreholes and 3,500 handpumps with cement aprons surrounding the pump sites in Bahr-el Ghazal and two other Southern Region provinces (Lakes and Western Equatoria) by 1985 (8). The operations centered in Wau for Bahr-el-Ghazal began in 1978 and are now functioning satisfactorily. Because of the somewhat weak structure of the Rural Water Corporation in the Southern Region, there is an unfortunate lack of trained GOS counterparts to help administer the program (10, 58).

Operations that began in South Kordofan Province in 1978 were aimed at the repair of hafirs (surface ponds), water purification, and shallow borehole drilling and handpump installation. By the end of 1980, the drilling program in south Kordofan had completed 100 boreholes, 60 of which had produced sufficient water to justify the installation of a handpump and concrete apron.

UNICEF's hafir rectification program is also well under way, although it has encountered some difficulties because of unforseen delays in the arrival of supplies and equipment. So far, one slow sand filtration system has been rebuilt, and a design established for future filtration plants. Local government interest and assistance have been high. A provincial committee has been formed which has proven very useful in overcoming local problems. UNICEF programs in Sudan have had some difficulties generally beyond UNICEF's control because of the

erratic movement of supplies by road and rail within the country. Other difficulties in the recruitment and replacement of international personnel have limited the expansion and formalization of training programs.

A continuing unfunded balance of $5 million in UNICEF's program through 1979 and the first half of 1980 also seriously delayed implementation activities. In 1980, however, the receipt of $1 million from the Austrialian Committee for UNICEF and $1 million of private donations from Saudia Arabia spurred recent activities.

The WASH team visited the UNICEF project in Kadugli which oversees the South Kordafan activities. The team was able to visit several handpump installation sites, and two hafirs that had been repaired. The team was impressed with the progress of the program. The handpump program appears to be successful even though about half of the boreholes drilled thus far have been found to be dry, and some maintenance difficulties have occurred with the leather gaskets in the handpumps themselves (7, 58).

By 1985, operational areas in South Kordofan's water program will be expanded to include the establishment of 48 water filtration systems; rectification of 140 hafirs; drilling of 900 boreholes and the installation of handpumps; establishment of a handpump maintenance system; training of two drilling crews; and coverage of 300 villages with a health and sanitation education program (7).

In both Bahr-el-Ghazal and south Kordofan provinces, the water supply programs form the core of the area development program for basic services in health, education, nutrition, and child welfare (7, 11, 12). Other UN agencies are participating in these activities, as well as several bilateral donors and PVO's.

3.2.2 World Health Organization (WHO)

WHO is continuing to provide technical advice and assistance to UNICEF's water supply and sanitation programs as well as other health education programs pursued through the GOS's Ministry of Health. This assistance takes place through WHO's regional office in Khartoum and its staff elsewhere in Sudan.

As part of the activities associated with the UN International Decade of Water Supply and Sanitation (1981-1990), WHO has assisted in the formation of a National Action Committee to develop and discuss decade goals. The Sudanese National Action Committee for Drinking Water and Sanitation held a workshop from December 7 through 10, 1981 in Khartoum (after the WASH team's departure).

3.2.3 UNESCO

UNESCO will continue to provide technical advice and assistance through its central office and staff in Khartoum primarily in support of the UNICEF effort in water supply and sanitation (9).

3.2.4 UN High Commission on Refugees (UNHCR)

The UN High Commission on Refugees is in charge of the welfare and administration of refugee relief operations to support some 500,000 to 600,000 refugees in Sudan. These refugees are concentrated in three areas of the country:

1. the East, where some 400,000 to 450,000 Eritrean refugees are found, particularly in settlements around Port Sudan, Kassala, and Gedaref (Figure 3.3);

2. the South, where some 80,000 to 100,000 Ugandian refugees are concentrated south of Juba (Figure 3.4); and

3. the West, where some 10,000 to 18,000 Chadian refugees are found near the western border.

Water supply and sanitation facilities are major concerns in refugee settlements and yet are only one part of multifaceted efforts for which the UNHCR is responsible. Active water supply projects discussed with UNHCR staff during the WASH team's visit include:

1. construction of a combined domestic water supply system for Qala en Nahal/El Hawata refugee areas (Figure 3.3);

2. improvement of water facilities in Gedaref area (Figure 3.3);

3. extension of water supply lines at Tawawa settlement (21, 22, 23) (Figure 3.3); and

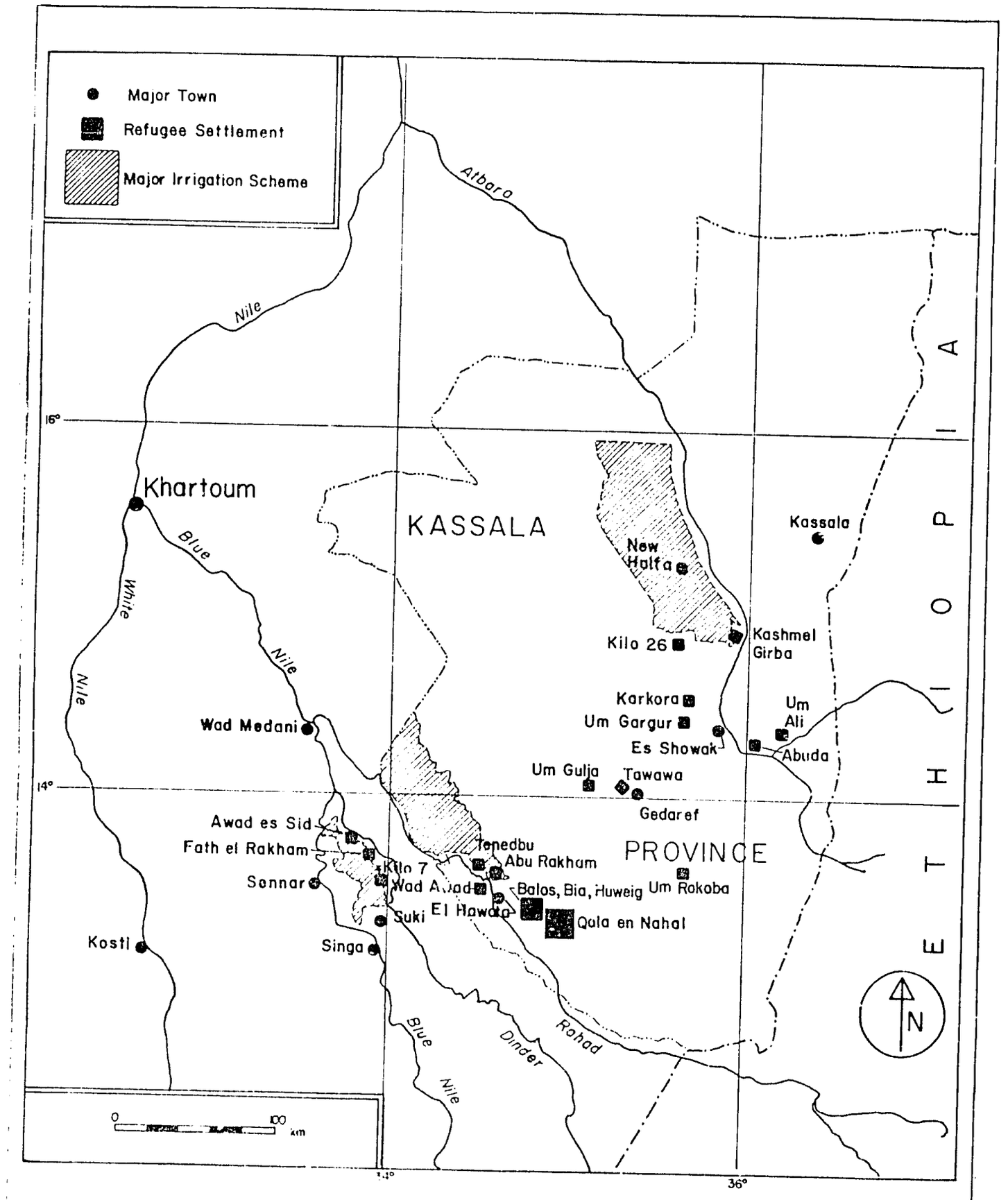
4. domestic water supply for a new refugee settlement at Port Sudan (see map, Figure 1.1).

3.2.5 The World Bank

The World Bank is currently the country's leading provider of commodity and project assistance as well as development planning policy and guidance. During the fiscal year ending June 1980, the Bank's International Development Assistance (IDA) loans totaled some $120 million, and for the current fiscal year could well increase to about $150 million (6).

FIGURE 3.3

Refugee Settlements in Eastern Sudan



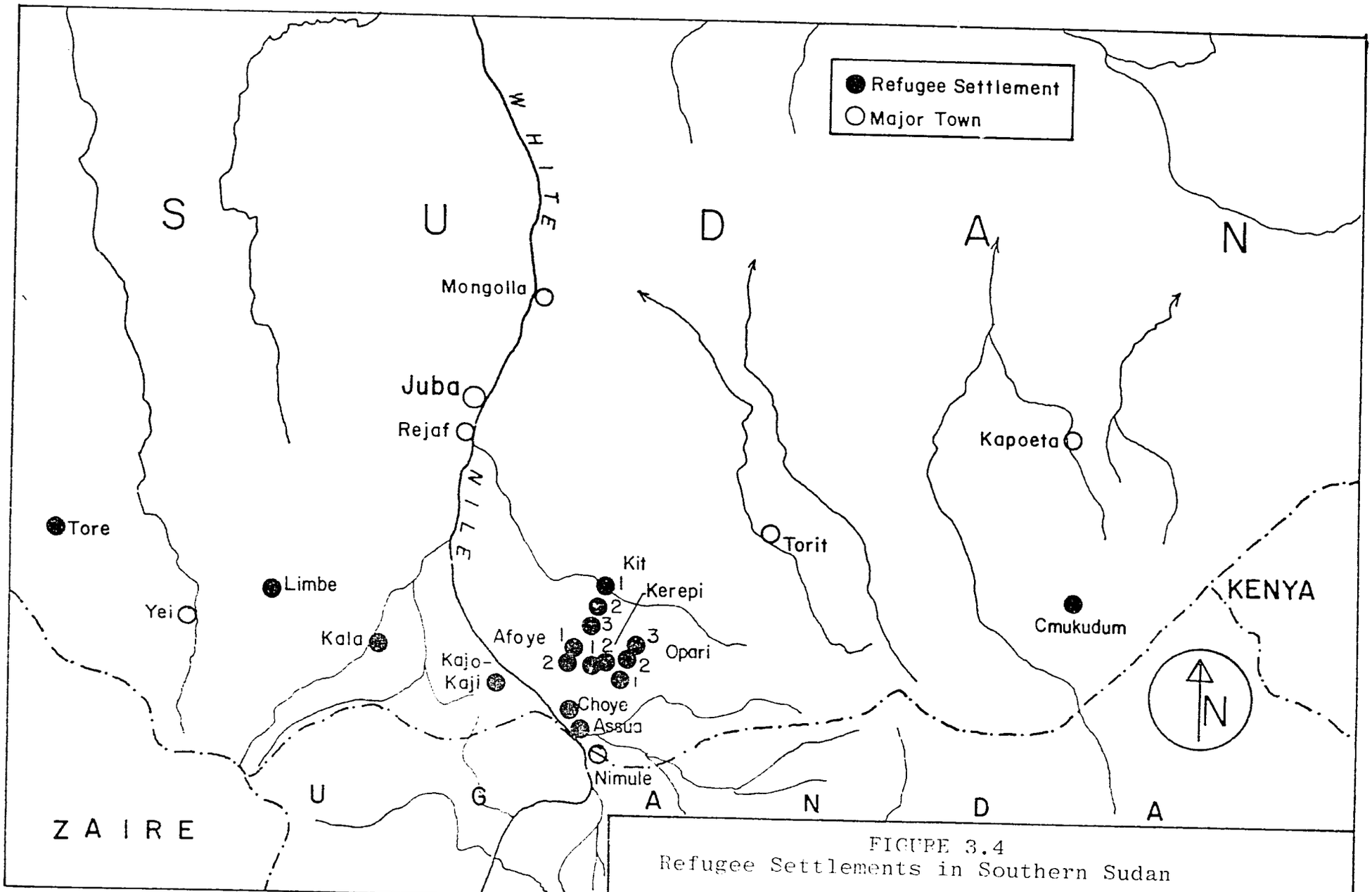


FIGURE 3.4
Refugee Settlements in Southern Sudan

The Bank is at present giving priority to projects involving the rehabilitation and intensification of existing irrigation schemes (the Gezira and Blue Nile) and projects which will help to alleviate key infrastructural constraints (Port Sudan development, railway reconstruction, power dams, highways, and feeder roads). It is also supporting longer-term developmental activities, (agricultural research, western savannah development, livestock marketing, education, and urban water supply).

The World Bank is currently funding a project aimed at improving urban water supplies in western Sudan. The project is now at the pre-feasibility stage; consulting services are being supplied by PRC Engineering Consultants, Inc., in cooperation with the Project Preparation Unit of the Ministry of National Planning. In the first phase of the study, the consultants identified the important population growth centers which would benefit significantly from an improvement in their water supply systems (55).

3.3 Bilateral Aid Organizations

3.3.1 U.S. Agency for International Development (USAID)

The USAID mission does not consider water supply and sanitation to be a major goal in itself, but rather a part of other ongoing efforts in many program areas.

In the past, USAID has participated in several multisectoral projects with a water supply or sanitation component. The Abyei Development Project in Bahr-el-Ghazal Province (16, 17, 18, 19, 20) included an effort to evaluate drilling and pumping of handpumps. Five wells were drilled and developed in the period between December 1979 and May 1980.

Equipment failures, lack of materials, and the departure of short-term technical advisors made water production at Abyei impossible. Although the effort to get the existing wells working continued in January 1981 (20), it was unclear whether or not the program would reach its original goal of becoming a self-sustaining effort since funding for the Abyei Development Project was in question beyond June 1981. Recently funding for the Abyei Development effort has been continued by USAID, although at a relatively low level.

In the past, USAID participated with other private voluntary organizations (including the International Voluntary Services and Catholic Relief Service) in a multi-faceted community development project in Wadi Halfa. One aspect of the project was the provision of water supply to the new town of Wadi Halfa (created because of the flooding of the old town by the rising waters of Lake Nasser/Nubia following the completion of the Aswan High Dam).

The Wadi Halfa project faced many problems including the difficulty of obtaining proper staffing, the logistics of getting equipment to the site (shortage of railway cars and poor road access), and general labor problems. The funding was eventually exhausted and tangible results of the effort were few (59).

USAID recently approved $2 million for the refugee water supply project in Port Sudan (24). This project is a joint effort of USAID, UNHCR, CARE, and the Government of Sudan. CARE acts as project administrator. The objective is to provide potable water supply to refugees in Port Sudan as follows:

a. improvements to the filter at Khor Arbaat;

b. an 8-inch branch line to the refugee settlement, taking off from the 20-inch main before it enters the city distribution system;

c. a ground-level storage tank of about 5,000 cubic meters capacity (four-day supply) at the branching off point;

d. pumps of 150 cubic meter per hour capacity to pump from the ground level tank to an elevated storage tank with a capacity of 2,300 cubic meters at the new refugee settlement to feed a gravity distribution system;

e. provision of up to 90 standposts in the new settlement, thus providing one standpost per 333 refugees (24).

The Port Sudan refugee water supply project received funding in FY82 and should be under construction within a few months.

3.3.2 Netherlands Technical Assistance Program

The Netherlands Technical Assistance Program has recently allocated $20 million for work in the health field. Activities are expected to be centered in rural areas in order to reach the poorest segment of the population. Projects are slated for North Kordofan, Kassala, and Junglei provinces. Proposed programs include improvement of water supplies, provision of drugs and equipment, building of schools for community health workers (CHW's) and village midwives, a health center, a primary health care complex in Junglei Province, and long- and short-term assistance (25).

3.4 Private Voluntary Organizations (PVO's)

The majority of private voluntary organizations working in Sudan are church-related. They have been very active in the Southern Region (centered around Juba) in response to the area's relief needs following the Addis Ababa Accord in 1972.

At that time the South had been devastated by 17 years of civil disturbance and desperately needed many types of relief. As the immediate needs were filled by the donor community, other, more long-term needs (particularly in relation to water supply) were being considered.

Some of the PVOs in Sudan are very small groups working in rural areas. They are generally isolated from other groups that may be doing the same things elsewhere, so that little coordination takes place.

3.4.1 German Medical Team

The German Medical Team works in the Southern Region, particularly in Eastern Equatoria and Western Equatoria provinces. Ongoing programs include the construction and renovation of facilities, the implementation of maternal and child care programs, immunization services, and training activities. A water supply program is also a part of this effort, generally concentrated in the major towns of the Southern Region (60).

3.4.2 The Action Committee for the Rehabilitation of Southern Sudan (ACROSS)

ACROSS began its activities in 1972 as an umbrella organization, including 15 development-oriented groups (three U.S. PVO's). Most of its work has been concentrated in primary health care and rural water supply activities in the Southern Region, although some activities have taken place in South Kordofan Province (25). The main thrust of ACROSS's activities has been in primary health care in Western Equatoria, Junglei, and Eastern Equatoria provinces.

3.4.3 International Voluntary Services (IVS)

International Voluntary Services has participated in rural safe water projects in the Southern Region and at the new town of Wadi Halfa in northern Sudan. In southern Sudan, IVS staff have carried out surveying, drilling, and testing of wells in selected rural areas. Drilling teams have been recruited from villages and their work has been supplemented by skilled workers. Through this local participation, villagers learn how to drill wells and, more importantly, how to keep them operating (25).

3.4.4 ACORD/CUSO

ACORD/CUSO is a coalition of two groups made up of European and Canadian organizations. Staff are currently working in southern and western provinces of Sudan, assisting in the implementation of the GOS's Primary Health Care Program. Activities include the supervision of CHWs and NCHWs, community education, and rural water activities (25).

3.4.5 African Medical & Research Foundation (AMREF)

AMREF is a U.S. organization based in Nairobi and is currently the prime contractor for USAID's Sudan Primary Health Care Program activities in the Southern Region. This program involves construction and administration of primary health care facilities, dispensaries, and other rural health activities.

3.4.6 Catholic Relief Services (CRS)

CRS began working in Sudan in 1972 with relief efforts in the Southern Region. Headquarters are in Khartoum, with small programs operating throughout the country. CRS has been active in developing water supplies in Hella Mazo and several Gezira villages, and a rural sanitation project in Torit District. CRS was also active in the community development project in Wadi Halfa, along with IVS and USAID (59). Proposed projects call for expansion of CRS activities in the areas of nutrition, water supply, and primary health care.

3.5 Summary

Within the GOS, funding and advisory services for water supply and sanitation are controlled by six different ministries. Responsibility for water supply is partitioned along urban/rural lines and regional boundaries (Figure 3.2, above). Responsibility for sanitation is divided along urban/rural lines.

There are many international organizations active in water supply and sanitation in Sudan. Of the multilateral organizations, the most active in rural water supply and sanitation is UNICEF, with a large shallow well drilling and handpump installation program in South Kordofan and Bahr-el-Ghazal provinces as well as hafir rectification and filtration activities. UNHCR is active in water supply and sanitation in conjunction with the provision of housing and other facilities for some 500 to 600 thousand refugees in Sudan.

Water supply and sanitation activities of international organizations in Sudan have been characterized by a lack of general coordination, both among donors and among the various ministries of the GOS with which they deal.

Chapter 4

HEALTH ASPECTS OF WATER SUPPLY AND SANITATION IN SUDAN

4.1 Water and Sanitation Related Diseases in Sudan

4.1.1 Disease Transmission

There are four mechanisms through which water supplies can affect human disease transmission (87, 85, 86). Knowledge of such mechanisms (Table 4.1) can point to appropriate strategies for the control and prevention of specific disease (68, 74).

Fecal-Oral Mechanism

Contaminated water may act as a vehicle for the spread of pathogens. For example, contaminated water may spread waterborne or water-washed diseases such as cholera, shigellosis, typhoid, dysentery, hepatitis A, and other diarrheal diseases. Preventive strategies include elimination of pollution, disinfection of the water, or selection of non-contaminated water sources.

Water-Washed Mechanism (excluding fecal-oral)

When water is scarce, costly, or difficult to obtain, personal hygiene may suffer, resulting in diseases that are not generally found when water is freely available for personal hygiene. Water-washed diseases that are not fecal-oral related include skin and eye infections and infestations like trachoma, conjunctivitis, skin ulcers, scabies and infectious diseases spread by ectoparasites (e.g., louse-borne typhus and relapsing fever). Preventive strategies include increased availability of water and, at the same time, health education to promote improved personal hygiene.

Water-Based Mechanism

The water-based mechanism involves pathogens which spend a portion of their life cycle in water, normally in an aquatic host. Examples of water-based diseases include schistosomiasis and dracontiasis (Guinea worm). Effective preventive strategies include certain engineering measures, control of intermediate aquatic hosts, separation of people from infested waters, and improvement of sanitation practices.

Table 4.1. Classification of Water-Related Diseases (87,74)

Category/ Disease	Reported in Sudan (x)	Pathogenic Agent
1. Fecal-oral (water-borne or water-washed)		
amebiasis (amebic dysentery)	x	protozoa
ascariasis (round worm)	x	helminth
shigellosis (bacillary dysentery)	x	bacteria
balantidiasis	x	protozoa
cholera	x	bacteria
diarrheal disease	x	miscellaneous
enterobiasis	x	helminth
enteroviruses (some)	x	virus
gastroenteritis	x	miscellaneous
giardiasis	x	protozoa
hepatitis (infectious-type A)	x	virus
leptospirosis		spirochaete
paratyphoid		bacteria
trichuriasis	x	helminth
tularemia		bacteria
typhoid	x	bacteria
2. Water-washed (excluding fecal-oral)		
(a) skin and eye infections		
scabies	x	mite
trachoma	x	virus
conjunctivitis	x	miscellaneous (mostly viral)
leishmaniasis, visceral (Kala Azar)	x	protozoa
other infectious skin diseases	x	miscellaneous
other infectious eye diseases	x	miscellaneous
(b) other		
louse-borne typhus	x	rickettsiae
louse-borne relapsing fever	x	spirochaete
3. Water-based		
(a) penetrating skin		
schistosomiasis	x	helminth
(b) ingested		
clonorchiasis (asiatic liver fluke)		helminth
diphyllobothriasis (fish tapeworm)		helminth
fasciolopsiasis (intestinal fluke)		helminth
dracontiasis (Guinea-worm disease)	x	helminth
paragonimiasis (lung fluke)		helminth
4. Water-related insect vectors		
(a) biting near water		
trypanosomiasis (African sleeping sickness)	x	protozoa
(b) breeding in water		
arboviral infections (some)	x	virus
dengue	x	virus
filariasis	x	helminth
malaria	x	protozoa
onchocerciasis (river blindness)	x	helminth
yellow fever	x	virus
West Nile fever		virus

Water-Related Insect Vectors

Some water-related diseases are spread by insect vectors that breed in or near water. These insects include mosquitoes of various types (Anopheles, Aedes, Mansonia and Culicine) that spread diseases such as malaria, dengue, West Nile fever, yellow fever, and filariasis. Other water-related diseases include onchocerciasis (river blindness) spread by the Simulium blackfly that breeds in running streams, and trypanosomiasis (African sleeping sickness), transmitted by a riverine tsetse fly.

4.1.2 Disease Types and Prevalence in Sudan

Introduction

There has been a long history of endemic and epidemic disease in Sudan (53). With few exceptions, water and sanitation related diseases found in Sudan are not unlike those in other developing countries. Table 4.1 (see above) indicates those that have been reported in Sudan. Unfortunately, epidemiological data on the prevalence of important water and sanitation related diseases in Sudan are scarce.

Data from the Khor Tagat dispensary near El Obeid (North Kordofan Province) which serves about 3,500 persons, including 1,000 students (Table 4.2), are a good example of the diseases that are being diagnosed and treated by rural health workers. For the month of October 1981, malaria accounted for 36 percent of morbidity, and diarrheal diseases and urinary tract infections accounted for another 21 percent. It should be noted, however, that CHW's frequently give presumptive treatment for malaria to patients with fever. Although malaria is a problem in Sudan, incidence varies with the season and region of the country and it is doubtful that the incidence is as high as would be indicated by the data from PHCU's and dispensaries visited by the WASH team. In order to avoid incorrect diagnosis there is a need to stress the importance of a careful history of fever for patients suspected of having malaria, and the need, if possible, to take thick/thin blood smears for microscopic examination.

Another example of diseases that have been diagnosed and treated in Sudan comes from the International Rescue Committee's (IRC) clinic at Tawawa refugee settlement, where good records have been kept (Table 4.3). Note that malaria is a less important source of complaint in Tawawa than in Khor Tagat, either because of better diagnosis at Tawawa or less frequent occurrence of the disease. Unfortunately, the statistics available do not distinguish between new patients and follow-up visits, so that with some chronic diseases--especially tuberculosis, onchocerciasis, and Kala Azar--the actual

Table 4.2. Diseases Diagnosed and Treated in Khor Tagat Dispensary near El Obeid (North Kordofan Province), October 1981 (Population Served: 3,500)

Rank	Disease	Female	Male	Total (%)
1	malaria	132	111	243 (36)
2	acute respiratory infection	46	61	107 (16)
3	diarrheal diseases	44	49	93 (14)
4	miscellaneous	43	42	85 (13)
5	cuts/injuries	27	48	75 (11)
6	urinary tract infection (including those secondary to schistosomiasis)	33	14	47 (07)
7	blood diseases	12	2	14 (02)
8	obstetrical and gynecological	10	0	10 (01)
	TOTALS	347	327	674 (100)

Table 4.3. Frequency of Visits to IRC Clinic Listed by Diagnosed Problem, Tawawa Refugee Settlement, Kassala Province, June-August 1981 (21, 22, 23)

Diagnosis	Number of Visits, 1981		
	June	July	August
Gastritis	359	338	289
Trachoma	261	370	191
Anemia	227	233	156
Bacillary Dysentery	100	153	37
Upper Respiratory Infection	194	136	114
Bronchitis	85	95	80
Tapeworm	140	94	73
Low Back Pain	73	64	70
Urinary Tract Infection	65	47	65
Skin Infection	152	146	63
Amebic Dysentery	67	80	55
Otitis (externa & media)	73	70	54
Hepatitis	43	33	52
Giardia	53	43	45
Onchocerciasis	55	58	43
Headache	N/A	46	43
Nonspecific Gastroenteritis	84	50	41
Fungal Infection	N/A	37	40
Wound	N/A	19	36
Conjunctivitis	28	30	35
Arthritis	33	37	33
Vitamin A Deficiency	N/A	47	33
Pneumonia	36	24	30
Nonspecific Viral Syn.	43	46	29
Tonsillitis	67	56	29
Tuberculosis (old/new)	59	33	28
Sprain/Strain	28	44	28
Schistosomiasis	41	N/A	28
Pregnancy	30	N/A	27
Nonspecific Rash	30	35	25
Kala Azar	N/A	17	24
Scabies	N/A	N/A	23
Nonspecific Worm	22	N/A	23
Hookworm	N/A	21	23
Malaria	N/A	21	21
Menstrual Problem	N/A	26	19
Allergy	N/A	N/A	18
Constipation	N/A	N/A	16
Hemorrhoids	N/A	20	16
Round Worm	N/A	N/A	15
Asthma	N/A	26	15
Vitamin Deficiency	24	N/A	13
Pharyngitis	N/A	N/A	11
Lymphademitis	N/A	N/A	10
Strongyloides	N/A	N/A	10
Gonorrhea	N/A	23	N/A

N/A, data not available

number of patients may be lower than reported. At this clinic, 358 patients were being treated for tuberculosis (with 20 new patients) in August 1981 (22).

The following are the more important and notable diseases related to water supply and sanitation that are found in Sudan.

Malaria

Malaria is a serious water-related vector-borne endemic disease in Sudan. Its importance is indicated by its inclusion in Program No. 1 (malaria nation-wide) and 2 (malaria man-made) of the National Health Program of Sudan, respectively. The endemicity, seasonality, and health impact of malaria in Sudan is closely associated with the presence of breeding sites for the mosquito Anopheles gambiae. Thus malaria varies from hypo-endemic to meso-endemic in the desert areas of northern Sudan (except near the Nile River) where rainfall is low. In southern Sudan endemicity increases from meso- to hyper- to holo-endemic as the number of breeding sites increases with rainfall.

Man-made malaria is a major problem that requires regular control in areas where there is agricultural irrigation. Delay or failure of control measures has resulted in epidemics during the rainy season in Sudan. In the past, the prevalence of malaria has been as high as 20 percent of the population when control measures have failed. In 1977, over 1.8 million cases of malaria were reported by government medical services, and 37,766 cases were admitted to hospitals, with 889 deaths. The malaria species implicated was primarily P. falciparum (98 percent). Recently, antilarval measures introduced before the rainy season in the Gezira area have kept malaria prevalence under the five percent target level.

Anopheles gambiae is the most important vector in Sudan, since it is the most susceptible to malaria infection, and is an extremely aggressive, anthropophilic, exoendophilic mosquito. Anopheles funestus is a suspected vector in southern Sudan; it may coexist with A. gambiae, has a greater ability to survive in the drier months than A. gambiae, and may be responsible for extending the malaria season and maintaining a high transmission rate.

In the Gezira area of Sudan, malaria is of great socioeconomic importance because its agricultural products account for about 40 percent of the nation's gross domestic product, generate over half of its total employment directly or indirectly, and provide 98 percent of its export earnings. With the expansion of irrigated acreage averaging six percent per year, a rapid increase in the prevalence of man-made malaria can be expected unless anti-malaria programs are boosted in the region at the same time.

Schistosomiasis

Schistosomiasis (bilharziasis), due to Schistosoma mansoni and Schistosoma haematobium, has been found in all provinces of Sudan with the exception of the Red Sea Province. Schistosoma haematobium, the etiological agent of urinary schistosomiasis (found primarily in children) and its snail intermediate host Bulinus truncatus, tend to be distributed along river courses and locally within the surface water impoundments and streams of western and northern Sudan. This form of schistosomiasis is considered to be less of a cause of morbidity than Schistosomiasis mansoni, although high incidence of the former has been found from time to time.

Schistosoma mansoni, the causative agent of intestinal schistosomiasis, and its snail host Biomphalaria pfeirferi are most intense along the heavily populated areas of the Nile and the Bahr el Ghazal. It is a significant contributor to extensive liver and intestinal damage in adults and children alike, and its presence in irrigated areas of the Gezira and other agricultural project areas constitutes a major health hazard (40).

The exact magnitude of the schistosomiasis problem in Sudan is unknown, but apparently there has been an increase of about three percent per year in reported cases. In 1977, over 560,000 cases of bilharziasis were reported from health facilities, and 35 deaths recorded. It was estimated that Sudan suffers an economic loss of US$130 million per year as a result of this disease.

Diarrheal Diseases

Diarrheal diseases, including specific and nonspecific diseases with diarrhea as a symptom (such as cholera, dysenteries, E. coli and Rotavirus diarrhea, and gastroenteritis) are extremely prevalent in Sudan. They are the most important cause of morbidity and mortality in children under five years of age. Diarrhea is an important cause of morbidity and mortality through its effect on nutrition status. Diarrheal diseases resulting from poor sanitation and the lack of safe water supply were second to deficiency diseases as the leading cause of hospital death, accounting for 10.5 percent of hospital admissions in 1977. There were over 5.4 million episodes of diarrhea reported in 1977 in Sudan--over 50 percent in children under five years of age. Because of incomplete reporting the magnitude of the problem is probably even greater. Much work needs to be done to lower morbidity and mortality from these diseases (35, 36).

Leishmaniasis (Kala Azar)

Leishmaniasis is due to Leishmania donovani spread by the Phlebotomus sandfly. Little is known about this disease, yet

it is endemic in Sudan in the area bounded by the Ethiopian border on the east, the White Nile River on the west, and the towns of Kassala and Malakal on the north and south, respectively. The disease has been reported at all times of the year in men, women and children with about equal frequency. Other, widespread foci are known in the West and as far south as Jongeli and Eastern Equatoria provinces. Diagnosis is based on clinical grounds. In 1977, 4,501 cases were reported, with six reported deaths. The dynamics of leishmaniasis transmission and its relation with cutaneous leishmaniasis due to L. tropica need further study.

Trypanosomiasis

Trypanosomiasis (African sleeping sickness) is due to haemoflagellaes Trypanosoma brucei gambiense and Trypanosoma brucei rhodesiense. The disease is spread by tsetse flies (genus Glossina) which are found in southern Sudan. Gambian sleeping sickness is greatly feared as a chronic, progessively fatal disease in humans. In recent years, civil strife has interrupted control programs and dispersed populations, resulting in a sharp increase in the number of reported cases. Reports of new foci of Gambian sleeping sickness by WHO at Yei and Torit suggest the spread of the disease in the area around Juba. A focus of fulminating Rhodesian sleeping sickness can be found in the Pochala area of Upper Nile Province near the Ethiopian boarder. Trypanosomiasis of cattle makes grazing impossible in the highly endemic areas of Eastern and Western Equatoria provinces, with consequent economic loss.

Onchocerciasis

Onchocerciasis is due to a nematode Onchocerca volvulus, transmitted to man by the bite of the black fly Simulium damnosum. Cutaneous nodules and blindness in the victims results from infection. In Sudan, the disease is prevalent in Bahr el Ghazal Province. The distribution of the disease corresponds closely to the location of fast moving streams which are the breeding places of the insect vector. It has been estimated that in the absence of an integrated control program, the numbers of infected persons will approach 200,000 and blind persons 50,000 by 1984 without any increase in the rate of transmission.

Bancroftian Filariasis

Bancroftian filariasis, with associated hydrocele and elephantiasis, is presently restricted to the Zalingei area close to the Chadian border in Southern Darfur Province, in the Kadugli area in Southern Kordofan Province, and near the Ethiopian border in the southern portion of Blue Nile Province. Ban-

croftian filariasis is due to an infection from the nematode Wuchereria bancrofti which develops and remains in the lymphatics of the host. The disease is transmitted by the bite of a mosquito harboring infective larvae.

4.2 Health Services to Address Water and Sanitation Related Diseases in Sudan

4.2.1 Organization of Health Services

National Health Program of Sudan

In 1975, the Government of Sudan, with the assistance of the World Health Organization and other donor agencies, formulated an in-depth health plan which resulted in a new National Health Program (NHP) (33, 34, 54) for the period 1977/78 to 1983/84. The program is based on a detailed assessment of available health sector data. From the data, national problems were identified, policies and priorities established, and programs formulated to satisfy basic needs.

Policy

National health policy for the period 1977/78 to 1983/84 was formulated as follows:

a. Provision of preventive medical and social services as a top priority, with stress on six major areas,

   1. control of common endemic and epidemic diseases which are major causes of morbidity and mortality (e.g. malaria, schistosomiasis, tuberculosis, gastroenteritis, kala azar, communicable eye diseases, malnutrition, and anemia;

   2. maternal and child welfare services to cover the largest portion of the population;

   3. complete health coverage of school children through school health service units;

   4. immunization of children against common infectious diseases (e.g., tuberculosis, smallpox, diphtheria, tetanus, pertussis, and poliomyelitis);

   5. health education; and

   6. improvement of environmental health services, especially in the areas of refuse and excreta disposal, water supply and pest control;

b. Extension of primary health care services to the entire population, especially in rural areas, through rural health units (primary health care units, dispensaries, health centers, and rural hospitals),

c. Training of health manpower with greater stress laid on technical and auxiliary teams required to carry out preventive, social, and medical services and satisfy the needs for primary health care in rural areas,

d. Consolidation of the existing curative health service institutions through the provision of efficient and modern ancillary services (x-ray, blood banks, laboratory services, operating theaters, and modern equipment).

The above policy was based on the fact that 79 percent of the population of Sudan lives in rural areas (14), is faced with conditions of poor water supply and sanitation, is affected by a number of endemic and epidemic diseases, and a large percentage of the childhood population is suffering from protein-calorie malnutrition.

Priorities

The importance of water and sanitation related diseases in Sudan is clearly shown by the National Health Program (1977/78 to 1983/84) (33, 34, 54), which identified and ranked eight specific six-year programs as follows:

a. Program No. 1, malaria nationwide,

b. Program No. 2, malaria, man-made,

c. Program No. 3, Primary Health Care (PHC),

d. Program No. 4, bilharzia, man-made (schistosomiasis in irrigated areas),

e. Program No. 5, safe water supply,

f. Program No. 6, environmental health,

g. Program No. 7, food (dura) production,

h. Program No. 8, onchocerciasis (river blindness) prevention and control.

The Primary Health Care Program (No. 3), now being implemented, is the core program (32, 29, 28). Activities include communicable disease prevention and control, safe water sup-

ply, and environmental health. The safe water program (No. 5) has not been implemented, but has as a goal the protection of 1,900 public shallow wells out of an estimated 30,000 private wells or water holes which are now unprotected. Appropriate technologies for carrying out the program have not been identified, pending the outcome of a short-term pilot project involving the protection of 45 existing shallow wells. Regarding the proposed program for environmental health (No. 6), no details are available. The National Health Program Committee has pointed to a need for a detailed intersectoral program before the next socioeconomic development plan period.

Primary Health Care

In keeping with the Alma Ata Declaration of 1978 and WHO's "Health for All by 2000," the Government of Sudan has, with the assistance of WHO and UNICEF, placed a strong emphasis on the development of a Primary Health Care Program (PHCP) to cover the whole population by 1984, particularly the scattered majority of settled and nomadic rural peoples. The basis for overall design of the PHCP was the National Health Program 1977/78-1983/84 (33,34, 54).

Program formulacion criteria included the following:

a. accessibility of primary health care by the entire population;

b. simplicity, feasibility, and affordability of services,

c. acceptability (socioculturally to the people, technically and professionally to the staff, and politically to the government); and

d. adaptability of the program to a community-oriented approach, which includes community participation and community development.

The PHCP is an integrated approach to health care that includes the provision of basic promotional, preventive and curative services, with the emphasis on self reliance and partnership between communities and government. Maternal and child health (MCH), child spacing, childhood immunization, control of endemic diseases, nutrition, health education, and environmental and personal sanitation, and the health information system are all given due attention.

The basic infrastructure of PHCP consists of the primary health care complex (PHCC), which includes one dispensary and five primary health care units (PHCU's), serving a total population of approximately 24,000 (see Figure 3.1 above). The key health personnel in the PHCC are the community health

workers (NCHW's). These individuals are selected by their own communities and the Government, trained by the Government for nine months in promotive, preventive, and curative care, and then sent to work among their kinsmen.

The Primary Health Care Program has been implemented in 12 northern provinces* for the past three years. Some success has been achieved in the training of health workers and the renovation and construction of PHCU's through a self-help effort. Through June 1980, a total of 30 training programs had been held, graduating 1,822 CHW's and NCHW's. The number of operating dispensaries and PHCU's were 715 and 1,095, respectively (26). The 1984 goal for the program includes 2,817 CHW's (and NCHW's), 1,980 PHCU's, and 837 mobile health units for nomads.

Health Information System

A form has been designed by GOS and tested in the field for the collection of data as the basis for a health information system. The form includes death and birth registration, inventories of drugs and supplies, health care services performed, vaccinations given, and laboratory tests performed. The Ministry of Health has a Department of Epidemiological Service and Endemic Diseases. However, support is needed to strengthen department staff, define functions, and plan services.

Much of the health information system data comes from the PHCU and dispensary levels, the lowest in the report system. Because of a lack of equipment, limited training, and limited experience of the workers in these facilities, the diagnoses of disease reported through the health information system may not be reliable.

Expanded Program of Immunization (EPI)

The need for immunization against diptheria, whooping cough, tetanus, and tuberculosis nationwide has been recognized by GOS. Yet poliomyelitis immunization is currently limited to major towns and Gezira Province, and measles immunization is being tried only in some areas. The GOS has planned to establish, in phased steps, a continuing program of immunization in infancy as an integral function of the PHCP. Recently, a Plan of Action for EPI (27, 37) was drafted for the guidance of immunization program personnel. Immunization coverage is restricted, and the incidence of immunizable diseases remains high. There are many constraints and problems, including shortages of medical supplies, fuel, transport, and trained manpower, and the illiteracy of parents.

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* This term refers to the old "Northern Region," which includes all provinces outside of the Southern Region.

4.2.2 Public Health Laboratory Facilities

In 1974 there were four public health laboratories in Sudan. These are distributed in provinces throughout the country, one each in the Khartoum, Blue Nile, Red Sea, and North Kordofan provinces (34). In addition to these laboratories, certain laboratory equipment has been provided in rural health centers, and in hospitals throughout Sudan. According to a WHO team which toured Sudan in 1979, microscopes were generally found at the rural health center level and in hospitals, although some were not in working order (32).

Much of the health data collected in Sudan comes from the Primary Health Care Unit (PHCU) and dispensary levels, for which there is no laboratory equipment, nor is the training and experience of staff sufficient to insure correct diagnosis and treatment of diseases. For the immediate future, this will continue to be a problem throughout the Primary Health Care system.

4.2.3 Epidemiological Support for Health Information

Ideally, health information statistics should be used as a method of surveillance of communicable disease. This is not practical in Sudan at present, however, because of the nature of the health information system (i.e. data gathered by inexperienced observers at the lower levels of the health system, with logistical problems involved in data tabulation and reporting). Disease surveillance is not expected to improve significantly until the reliability of the basic data improves and the logistics of data collection and tabulation are solved. For the immediate future, attention should be directed toward solving the logistical problems of setting up an effective disease surveillance and reporting system.

4.3 Potential Health Benefits of Improved Water Supply and Sanitation Facilities

4.3.1 Disease-Specific Benefits to Users and Their Households

As previously discussed, water-related diseases can be divided into four categories on the basis of transmission mechanisms (Table 3.1): 1) fecal-oral, 2) water-washed, 3) water-based, and 4) water-related insect vectors. Improvements in water supply and sanitation will have the most effect on the first two categories of disease, fecal-oral and water-washed. Certainly improvement of supplies (e.g., improvement of open wells and installation of handpumps) will significantly affect the incidence and prevalence of diseases in the fecal-oral category.

This has been borne out in at least a preliminary fashion by a UNICEF study (11) in which village women in Bahr el Ghazal Province were interviewed after the installation of UNICEF handpumps nearby. It was reported in the study that most of the village women were aware of the relationship between good water and good health, and a majority of them reported a reduced incidence of illness for themselves and their families since using the handpump. Illnesses mentioned as occurring less frequently included stomach pains, fever, diarrhea, vomiting, and skin itching. The fact that this study interviewed only 14 women, however, tends to limit its general applicability, and additional studies elsewhere in Sudan in the same vein would be helpful.

Although it has been over a century since early researchers were able to link water-borne bacteria to epidemics, it is still difficult with existing data to show that improvements in water supply, particularly in rural areas, have measurable impacts in reducing disease. Reasons for this are multiple. Good data collection is necessary to establish the linkage, and rural facilities are generally less developed than those in urban areas, with more modest facilities and less reliable data collection.

Not only is data collection poor, but respondents are generally illiterate. In addition, their sanitation practices are poor. Often they do not use a single source of water, even if a good source is available. They may drink from polluted sources and may contaminate safe water in unclean carrying or storage vessels. All of these variables make it extremely difficult to determine the impact of improved water supply and sanitation on health.

Yet it is logical to expect that improvements in water supply and sanitation would reduce the incidence of disease in Sudan. Elsewhere in Africa, estimates have been made of the reduction of water-related disease treated at medical facilities that would result if water supplies were generally safe (Table 4.4). These estimates are based upon data collected at health facilities in Tanzania, Kenya and Uganda. The reduction in disease was estimated by using certain assumptions related to improvements in water supply.

4.3.2 Other Benefits of Improved Water Supply and Sanitation

It is not difficult to argue that there are benefits to rural water development other than reduced incidence of disease. Self-help type water projects which are generally easy enough to construct may in fact bring the community together and foster a spirit of community development. Water projects are often less threatening and are more likely to lend themselves to support by all elements of the community than other types of projects. The idea may also be prevalent that a water proj-

Table 4.4 Estimated Reduction in Diagnosed Water-Related Disease Treated in East Africa* if Water Supplies Were Generally Safe, 1966 (88, 75)

Diagnosis	Percent Reduction Expected if Water Supplies Were Generally Safe
Dracontiasis (Guinea worm disease)	100%
Typhoid	80
Urinary schistosomiasis	80
Leptospirosis	80
Trypanosomiasis, gambiense	80
Scabies	80
Yaws	70
Inflammatory eye disease	70
Schistosomiasis, unspecified	60
Trachoma	60
Shigellosis (bacillary dysentery)	50
Amebiasis (amebic dysentery)	50
Dysentery, unspecified	50
Tinea (ringworm)	50
Gastroenteritis	50
Skin and subcutaneous infections	50
Diarrhea of the newborn	50
Paratyphoid and other Salmonella	40
Louse-borne typhus	40
Intestinal schistosomiasis	40
Ascariasis (round worm)	40
Louse-born relapsing fever	40
Otitis externa (ear infection)	40
Classic skin (leg) ulcer	40
Trypanosomiasis, unspecified	10
Dental caries (tooth decay)	10
Water-Related Diseases, Overall	52
Deaths Due to all Diseases	6
All Diseases Among Inpatients	6
All Diseases Among Outpatients	11

* Tanzania, Kenya, and Uganda are included.

ect will act as a catalyst in primary health care innovations and community development so that small investments can start a process of social and economic change (87).

In general, however, too many benefits may be expected from improvements in water supplies. Historically there have been few innovations in any sector that could be singled out as the cause of economic advance in a country, but many small improvements over a number of years may have a cumulative effect on health and welfare (87). Certainly the benefits of investments in water supply cannot be predicted with certainty, but there are few other projects in less-developed countries that have an advantage in this regard. If guarantees must be made on rate of return and benefits to be gained, it is better to put the money in government bonds in the Western world. Yet if the aim is to serve developing countries, water supply and sanitation improvements are a visible method of supporting development that deserve consideration.

4.4 Modifications in Health Services Structure Needed to Realize Benefits from Improved Water Supply and Sanitation

4.4.1 Modifications in Service Delivery

In working toward the objective of improved health in Sudan, health services can work together with improvements in water supply and sanitation. Complete control of all relevant factors is many years away, however, particularly at the current level of funding. As detailed elsewhere in this report, there are numerous bilateral and multilateral donors active in the field of water supply, sanitation and health that are working toward the ultimate goal of clean water and adequate health facilities for all Sudanese.

Discussion in this report above of specific projects indicates certain recommended modifications in the Northern Primary Health Care and Rural Health Support projects (USAID funding). To recap here, it is recommended that water purificaiton take place within the PHCU's and dispensaries to insure that safe water is available in these facilities. It is also recommended that a latrine construction program be started with the CHW as the agent sponsoring and demonstrating these facilities after receiving training at the CHW schools. These are small steps which can make a difference in local areas.

The health service system in Sudan has under its new focus been designed to act as a community based and rural effort to extend health care to millions of Sudanese. It has trained local people from local villages and scattered tribes to minister to their own people and has given them training, although limited, with which to effectuate this help. CHW's

should receive further training in water supply and sanitation technology along with their other primary health care functions.

It is suggested that the existing health service network be expanded. Additional PHCU's and schools for CHW's are needed at this time, and various donors have indicated an interest. More money is needed for such expansion, however.

4.4.2 Improvement in Laboratory Services

In 1974 there were four public health laboratories in Sudan. More recent published data were not available which would indicate the number at present, but there is a need for increased laboratory services to assist in diagnosis and treatment of disease, and to provide epidemiological support to disease surveillance and evaluation of programs. It would be desirable to designate a team to go to Sudan specifically to look at laboratory services and how they should be improved to complement other ongoing and planned programs.

4.4.3 Improvements in Information Services

Great strides in information services have been made in the last few years. A great deal of data is now being collected as part of the health care system, particularly from PHCU's, dispensaries, and health care centers. Data forms have recently been redesigned and are continuing to be upgraded so that this information is valid and useful. Of course, the information itself will be questionable until the training and experience of the health care worker have increased, and reliable diagnoses can be made. Facilities do not exist at the present time to make this data available to others who might need it as part of surveillance work. The data tend to be collected and merely filed in Khartoum. It is hoped that funds will be directed to continue to improve this system.

4.5 Summary

There are four mechanisms through which water supplies can affect human disease transmission: fecal-oral, water-washed, water-based, and water-related insect-vector mechanisms. In Sudan there is a long history of endemic and epidemic disease. With few exceptions, water and sanitation related disease found in Sudan are not unlike those found in certain other less-developed countries. Some of the most important of these are malaria, schistosomiasis, diarrheal diseases, leishmaniasis (Kala Azar), trypanosomiasis (African sleeping sickness), and filariasis

The National Health Program of Sudan, 1977/78-1983/84, has identified and ranked eight specific six-year programs, all of which are directly or indirectly related to water supply and sanitation. The primary health care program is the core activity which is expected to have a major impact upon health care throughout the country. A health information system, which operates in conjunction with this program, is providing some information on disease prevalence in the rural areas. Unfortunately, because of logistic problems associated with collection and tabulation of this information, an adequate disease surveillance program has not materialized thus far. In addition, because of the limited facilities at the rural health care units and the limited training of rural health care workers, disease diagnoses which are reported as part of the health information system may not be reliable. There is a need for additional public health laboratory facilities and epidemiological support throughout Sudan.

Potential benefits from improvements in water supply and sanitation in Sudan are great, including reductions in the incidence of many diseases. Significant general improvement in water supply and sanitation practices in Sudan is many years away, however, because of the illiteracy and low income of rural inhabitants, the primitive nature of the existing water sources, and the current low level of funding for water supply and sanitation programs in general.

Chapter 5

SOCIOCULTURAL ASPECTS OF WATER SUPPLY AND SANITATION IN THE SUDAN

5.1 Water Supply

Water sources are among the most important determinants affecting human settlements. The availability or non-availability of water always affects the distribution and size of human populations. This is even more so in those arid and semi-arid regions of the world where perennial water shortages occur. In these regions rural and urban populations are found around water sites either concentrated in small villages or in a migratory pattern moving between various water sites.

The presence of water also dictates the economic and subsistence patterns of populations within such zones as well as the overall demographic distribution. When people are unable to grow adequate food, they will leave the area or follow a pattern of seasonal migration in which men travel in search of work as wage earners and bring income back to buy the food, clothing, and shelter they cannot produce. At base, the availability of water is the primary factor regulating the distribution and size of human and animal population in Sudan.

5.1.1 Water for Domestic Use

Drinking water is a vital physical necessity, the most dramatic example being that one can go without water little more than 24 hours in an arid environment, yet can go without food for several days. Consequently, the effects of drought and water shortages almost always have a severe effect on human and animal populations. Human beings have extended the uses of water beyond drinking by using it for cooking, washing, irrigation, ritual, and as a means of cultural expression in general.

The use of water in cooking is an extension of its use as a drink. By boiling meats and vegetables they are made more palatable and the amount of food is extended to feed more people. In addition, cooking food in water kills harmful pathogens. The use of water in brewing teas and other beverages is universal and can be seen as adaptive. In boiling water to make tea, pathogens in the water are removed or destroyed and the water is made safe to drink.

Using water to wash one's body and personal belongings is another cultural use of water. However, when water is in short supply, cleanliness is generally perceived to be quite secondary to drink and food. In fact, in those regions where water is in short supply, people generally bathe and wash their

clothes only occasionally. Such practices have important implications for health and disease control.

The use of water as a component of ritual is also to be noted. However, such usage is very specialized and frequently occurs in conjunction with eating and drinking and, as such, it has little effect on the water supply.

5.1.2 Water for Agricultural Use

The use of water in agriculture--particularly in developing countries--is restricted within arid regions to those zones with a constant source of water. Rain-fed agriculture in semi-arid zones is the most frequently encountered pattern and is a particular type of adaptation to those conditions where water is in short supply.

5.1.3 Water and Human Settlement Patterns

Sudan, the largest country in Africa, is a country of cultural and environmental variety and complexity. Environmental zones and distinctive habitats range from arid desert along the Egyptian border, to tropical forests along the borders with Zaire and Uganda to the extensive clay-based plains and savannahs of the west and south.

Although many irrigated agricultural areas are found along the main waterway, the Nile River and its tributaries, the critical element which contributes to the difference between zones is the amount of rainfall. The proximity of waterways and the character of topography and soil are other important variables, but rainfall determines the amount and type of food produced more than any other single factor.

Supplementing the natural souces of water are a variety of wells. These wells may be either hand-dug or drilled. Some wells, producing small amounts of water, will provide scarcely enough water for drinking and cooking for the local population. The amount of water produced affects the size of local human and animal populations.

5.1.4 Water, Animals and the Environment

Where more water is available in arid areas, rural inhabitants tend to increase the number of animals they keep, usually in the form of small ruminants (i.e., goats and sheep). Goats are preferred because they are less expensive (in terms of capital investment), more prolific, more disease resistant than sheep and they provide milk. Unfortunately, an increase in the number of goats tends to tax an area's natural resources because as browsers they eat vital range resources including trees and

bushes. Where sheep are preferred they tend to offset the destructiveness of goats. Sheep are kept in smaller numbers, prefer more succulent vegetation, and are not as destructive of trees and bushes. Sheep also have social and ritual value for the Moslem residents of Sudan.

The number of animals an area will support is always a critical issue. Overstocking occurs when the number of animals that can be maintained on a given range (i.e., the carrying capacity of the area) is exceeded. Many studies of rangeland resources demonstrate that pastoralists always tend to stretch the carrying capacity of their rangelands to the limit (90, 93). Again, one of the critical factors limiting the number of animals on a given range is the availability of water. Because camels and cattle require large amounts of water, these animals are found only in those areas where water is relatively abundant. It is rare indeed to see large animals being watered from a village well in arid regions if water has to be drawn by hand; the labor needed for drawing water is too great. Recognition of this fact is vital for programs which seek to develop water supplies. As more water is made available, a larger number of animals will probably be drawn into the area.

Cattle and camels are usually associated with migration. Animal husbandry generally serves to supplement cultivated agriculture; In rural areas only the poorest farmers have no goats. Hence, animal husbandry occurs in three forms: sedentary, transhumant, and nomadic. It should be borne in mind that these represent types, and there are many variations of each. For sedentary groups the animals are kept at a home site and are returned there after being taken to pasture. Transhumant groups have a home site, but also move animals seasonally between ranges. The nomadic form of animal husbandry differs from the transhumant in that pastoralists do not have a home site, but wander within a given range area living in tents.

The point that is often overlooked in discussions on patterns of subsistence is that the difference between a pastoralist and a cultivator may not be clear. However, in the case of water supply one feature does emerge, i.e. animal husbandry requires a substantial amount of water and people engaged primarily in raising animals for subsistence have an even greater need for water.

5.1.5 Water, Animals and Economics

Pastorialists get their protein mainly from milk and milk products, usually from goats, rather than from meat. For the people who keep large ruminants, the animals are a capital investment. Hence, animals are frequently a repository of wealth as well as a source of nutrition.

Pastoralists also depend on grains cultivated in the regions where they migrate. This grain may be bartered for but is usually purchased with money from the sale of surplus milk or milk products from the herds. Because these products are ways in scarce supply in many areas, pastoralists enjoy a ready source of monetary income that many cultivators do not.

Pastoralists are heavily dependent on water sources to supply their livestock. Owing to the value of livestock and the easy manner in which animals and animals products can be converted into cash they are usually in a better position to purchase water. Hence, where water is available, the likelihood that pastoralists will have access to it is great because of their economic viability.

5.1.6 Water, Animals, and the Sexual Division of Labor

The usual source of water supply in rural Sudan is the hand-dug well, with women most of the water for houshold needs. Women are thus active members of the production force within sedentary, cultivating and/or pastoralist groups, and drawing water is a major female occupation.

Men and boys usually are in charge of the herding in a pastoralist or partially migratory group, and in sedentary groups they also clear and weed fields and perform other chores. However, women also do such daily farming tasks in addition to child care, preparing and cooking the food, and fetching water. Women's work is shared with young girls, who are sent to the wells to fetch water for the household in addition to preparing food, watching younger siblings, etc. The task of drawing water for the livestock usually falls to one of the men or boys.

5.1.7 Water and Politics

Competition for range and water resources is another factor which often emerges as a problem in Sudan. Although pastoralists and cultivators are not constantly in competition, competition may occur across ethnic lines as in the case in the Bahr al Arab region of the Southern Kordofan where Dinks and Messeriya tribesmen have been in conflict. Conflicts over available resources of a given area also occur among similar ethnic groups (e.g., competition between Baggara and non-Baggara Arabs in the Northern Kordafan) where the competition for water is as great as that for land.

Because water is a scarce and valuable resource, its value is appreciated as a component in the power structure of the local region this phenomenon is most apparent in those areas where decisions are being made to allocate mechanized water sites.

The decision-making policy of water allocation and regulation is frequently made purely along lines of political expediency. Water sites are chosen in regions where political support can be gained, and regions which are more politically and economically prominent are more likely to be chosen for water resource development than those which are less so. The problem is that the decisions regarding the distribution of water sites are not based on need but on the political and economic advantage of a given group. Hence, water is quite important in the political economy of Sudan.

5.2 Sanitation

The water sources of a given population can be contaminated from careless toilet practices. Contaminated food and drink also provide a vehicle for pathogens. Contaminated food and water are the means for the transmission of cholera, schistosomiasis, and a host of other water-borne diseases. The concentration of households around water sites can lead to crowding which is a significant factor in the transmission of diseases (92).

Sanitation factors often relate to certain bodily functions, in particular defecation and urination practices of human beings and the animals they keep. Because humans are cultural beings, many aspects of sanitation are influenced by non-biological factors such as beliefs, perceptions and behavior. Hence, it is the interaction of the biological and cultural aspects of the way of life in a given area which makes sanitation a complex issue.

5.2.1 Bodily Functions, Taboos, Magic and Illness

Bodily functions are a sensitive area in virtually all cultural systems and many elaborate rituals are found in association with them--particularly in the areas of sex and elimination. The behaviors and beliefs associated with excrement are complex and are relevant because of their importance for disease. In addition, the perception of the smell of excrement as offensive appears to be universal, although there are recorded cases of the use of human excreta in certain rituals.

Because excreta is a body product, many societies have developed elaborate beliefs and practices regarding defecation. In those societies with beliefs in infectious or contagious magic, hiding one's excreta is an important way of protecting oneself from harmful spells. Urine in some societies is closely related to sexual behavior and there is not the universal revulsion to it as to feces. Touching and handling feces occur only under certain ritual conditions, and indeed

in the case of Moslem Sudan, cleaning anal and genital areas is viewed as ritually polluting.

Closely related to both beliefs and practices regarding sex and elimination are notions of modesty and cleanliness. Exposure of body parts may be considered obscene, and, in the case of village life, this may obstruct health education and medical efforts. In Moslem Sudan, for instance, men should never expose their legs in a public place. Women should keep their bodies covered and never expose themselves to the view of men other than their husbands. It is considered immodest even to mention certain parts of the body (legs, genitals, etc.) or toilet practices. However, it is not considered improper for a man to urinate in a public place, as long as he squats, modestly urinating between his legs. Likewise, women can also squat to urinate as long as their bodies are hidden from view.

Elaborate washing rituals are also part of Islamic culture. Before praying, the faithful are invoked to wash their hands and feet. However, cleanliness often is neglected when water is in short supply. The need for drinking water overrides that for bathing.

Perceptions of disease and illness also affect sanitation practices. When individuals perceive disease as a form of possession and believe that illness is due to the presence of demons or the like, attempts to explain illness in terms of germs or bacteria fall on deaf ears. When a community health worker promotes disease prevention practices based on current scientific knowledge it may well be that his clients will conclude that the arguments of the health worker are simply a function of his/her ignorance of the real world.

5.2.2 Defecation Practices

Toilet activities in rural villages take place at convenient spots close to living quarters. Individuals tend to have particular locations for defecation rather than urination owing to the fact that disposing of the feces may be a problem. As mentioned above, one's feces may be a means for some enemy to cast a spell through infectious magic. Feces also have an obnoxious odor and can be a source of contamination, both physical and ritual. Hence, while people in villages in Sudan have few reservations about urinating anywhere outside their homes, there is a tendency to leave the immediate area of the residence for defecating.

5.2.3 Disposal of Excreta and Implications for Sanitation Programs

The use of nightsoil by Arab Moslems in the Sudan is very rare due in large part to the Islamic notions of pollution. Even

among the Nuba and Christians in southern Sudan human feces are only used occasionally in agriculture. This suggests that bucket type latrines may be inappropriate because of the need to handle the waste. Another countervening characteristic is the persistence of obnoxious odors. The pit latrine may be more appropriate because odor can be reduced more easily.

Obviously, the practice of disposing of feces in areas near living quarters poses more serious problems for sedentary people than it does for nomads. Because the settled areas are usually close to water sources, there is a constant danger of contamination. Since people tend to visit the same defecation site repeatedly, large numbers of people are exposed to a variety of pathogens by defecating within a common area. This is further exacerbated by the fact that people tend to go to these areas around the same time of day, particularly promoting the transmission of diseases spread by helminths (91).

This problem is not grave among the nomads because of their pattern of camp relocation. Hence, the sanitation problems of nomads differ substantially from those of sedentary peoples.

5.3 Conclusions and Recommendations

5.3.1. Sociocultural Framework for Project Development

The cultural and social implications of water supply and sanitation measures in Sudan are complex. For any existing condition to be corrected or improved there must be a profound understanding of the extent to which people's perceptions and beliefs influence their way of life and day-to-day activities. The ability of interventions to effect any change in a rural or urban setting will depend upon a better understanding of cultural systems.

5.3.2 Perceived Needs of Client Population

Solutions should be sought which reflect the needs of the resident population and not simply the perceptions of officials at a higher level. Interventions should be closely examined to fit within the limitations and capacities of the resident population. Technology is not just the material means for carrying out work; it is also a mental set which might include the knowledge of how to use tools and project materials. Too often less emphasis is placed on the mental perceptions of the client population. "Appropriate" also implies a local willingness and capacity to cooperate in maintaining the system, including recurring costs in the form of fuel, and repairs.

5.3.3 Social and Environmental Impact of Projects

The social and environmental impact of water and sanitation projects should be carefully considered. Also to be considered are the economic and political elements at play, and how these will affect the target populations. It may be the case that a proposed intervention may be less consistent with the needs of a given population and more compatible with a political plan of a powerful local group. This kind of problem greatly interferes with long-term benefits which are the goals of such programs and can add greatly to their cost.

5.3.4 Need for Baseline Data

There is a need for the following types of baseline data on the environmental and social aspects of water supply and use:

1. numbers of village water sites and type of site (i.e., hand-dug well, borehole, hafir, etc.);
2. the effects of water obtained from handpumps versus mechanized boreholes on agriculture, herding, demographic patterns, etc.; and
3. subsistence patterns and food production levels in those areas which need more water.

In addition, donor agencies should encourage the government of Sudan to carefully study proposed sites for water improvement to determine the long-term environmental and social effects of the planned program. Studies should be undertaken locally to determine how to avoid indebtedness and recurring costs that might result from a proposed program. This can be done by determining the exact water needs of a local population and choosing the least expensive and most efficient means of filling that need.

Chapter 6

TARGETS OF OPPORTUNITY FOR WATER SUPPLY AND SANITATION IN SUDAN

Another objective of the WASH team's visit to Sudan was to discern "targets of opportunity" for future activities in water supply and sanitation. These could include not only activities that may be funded by USAID, but activities that may be funded by other donors once the need is made know to the international community. Table 6.1 lists targets of opportunity that came to the attention of the WASH team.

6.1 Water Supply and Sanitation for Refugees

As noted in Section 3.2.4 above, there are approximately 500,000 to 600,000 refugees in Sudan located in the eastern, southern, and western parts of the country, with the majority in the east and the south. UNHCR is generally overseeing the relief activities among these refugees, including the construction and administration of refugee settlements. These settlements were established according to GOS policy, to move the refugees from among the Sudanese in urban areas to camp sites in rural areas.

Water supply and sanitation is only one aspect of the multifaceted needs of refugee settlements. Future proposals from UNHCR for donor funding should be evaluated from a broad perspective. Since there are many aspects to the impact of these facilities on refugee populations, multidisciplinary teams will be necessary for such evaluations. Technical assistance may be necessary in this endeavor.

6.2 Coordination of Assistance with Other Donor Activities

Because there are numerous donors carrying out water supply and sanitation activities in Sudan, one major problem is coordination. The various GOS ministries have generally failed to coordinate donor activities.

Efforts should be made to evaluate and assist with pinpointing targets of opportunity among donors on an annual or biannual basis. There is a particular need for coordination of information on drilling equipment, handpump technology, and other simple appropriate devices, since many donors could use this information.

Present needs for coordination could be facilitated by a workshop for all multilateral and bilateral donors active in water supply and sanitation in Sudan in order to discuss mutual interests and share project successes and failures.

Table 6.1 Targets of Opportunity for Water Supply and Sanitation in Sudan

* Refugee Water Supply and Sanitation
Conduct feasibility studies and other analyses of the suitability of funding various water supply and sanitation facilities in Sudan.

* Workshop for Water Supply and Sanitation Project Donors
Coordinate and organize a workshop for all multilateral and bilateral donors active in water supply and sanitation in Sudan in order to discuss mutual interests, share project successes and failures, and to promote coordination among donors.

* Introduction of USAID-Sponsored Water Supply Devices
Investigate the feasibility of supplying Robo valves, Robo meters, Robo well screens, Water Tech 10's, and USAID handpumps in Sudan through in-country manufacture and/or supply from existing sources.

* Evaluation of Water Supply and Sanitation-Related Projects
Evaluate the effectiveness of various USAID and other-donor-sponsored water supply and sanitation-related projects in Sudan. Possible candidates include:

Blue Nile Health Project (WHO);
Port Sudan Water Supply for Refugees (UNHCR & USAID);
South Kordofan and Bahr el Ghazal programs for handpump installation, hafir rectification, and filtration plant construction (UNICEF & NAW).

* Training and Education
Develop a water supply and sanitation manual for Community Health Workers (CHW's) and Nomad CHW's (NCHW's) to be used in ongoing training programs at government schools. Training of instructors in the use of the manuals may be necessary.

* Short-Term Technical Assistance
Assist in the implementation of the proposed handpump alternative for water supply in N. Kordofan Province in cooperation with CARE and UNICEF.
Design and construct a standarized improved pit latrine using materials and fixtures available in Sudan. Investigate the feasibility of implementing the standard design throughout Sudan in cooperation with the Ministry of Health.

6.3 Introduction of USAID Sponsored Water and Sanitation Devices

Over the last several years a number of water and sanitation devices have been developed under USAID sponsorship including Robo devices (78, 80, 81, 82, 83) and USAID handpumps. Information about these devices is not generally known nor is the means of access readily apparent to most USAID missions. Thus there is a need to simplify the process of getting them into the field. It is particularly important at this juncture to make available samples of these devices so that they can be field tested and evaluated and compared with other alternatives.

6.3.1 Robo Devices

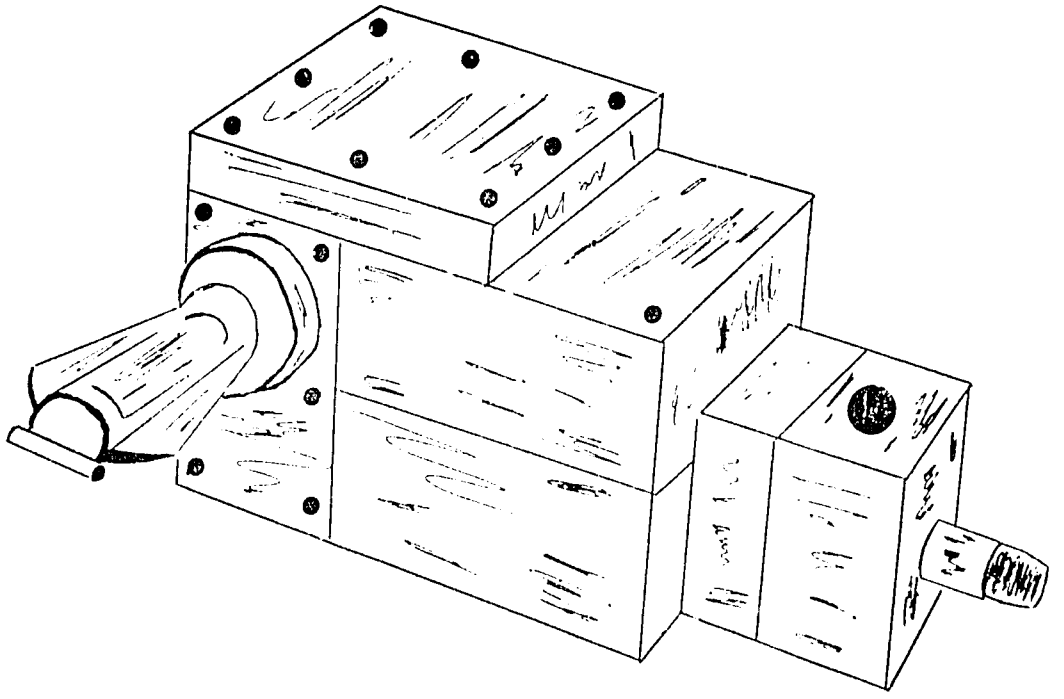
Robo devices include the recently developed Robovalves, Robometers, and Roboscreens. The Robometer (Figure 6.1) is a device to facilitate metering and payment for water and is particularly useful in urban fringe settlements where standposts are in use. This device allows the municipality to recover some of the costs of supplying water to these areas. In Sudan it may also have some usefulness at GOS water yards as an alternate means of determining payment since one of the deficiencies of water yards is the inability to ensure adequate metering and payment. Another use for the Robometer may be in refugee camps if municipalities are to be repaid for extensions of water lines to camps.

The Robovalve is an automatic shut-off valve for use at water taps and standposts (Figure 6.2). This valve is constructed of PVC through injection molding techniques. The Robovalve should have considerable usefulness in Sudan since existing plumbing devices, such as water spigots and faucets, get heavy use and maintenance is generally poor. Existing fixtures have rubber or plastic washers which are easily damaged by sand in the water, resulting in leaking taps. The Robovalve would be useful at GOS water yards, refugee camps, and in most municipal systems where standposts are used. The Robovalve is designed to be produced in-country. If manufactured in Sudan, costs could be low and a local market could develop.

The Roboscreen (Figure 6.3) is a PVC wellscreen that could have great usefulness in Sudan, since a large number of wells with handpumps are either under construction or have been completed. These wells tend to become inoperable as sand and other particles move upward through the pumps (damaging gaskets in handpumps). Screens are often not used in these wells because of the high cost of commercially available wellscreen made of brass or stainless steel.

FIGURE 6.1

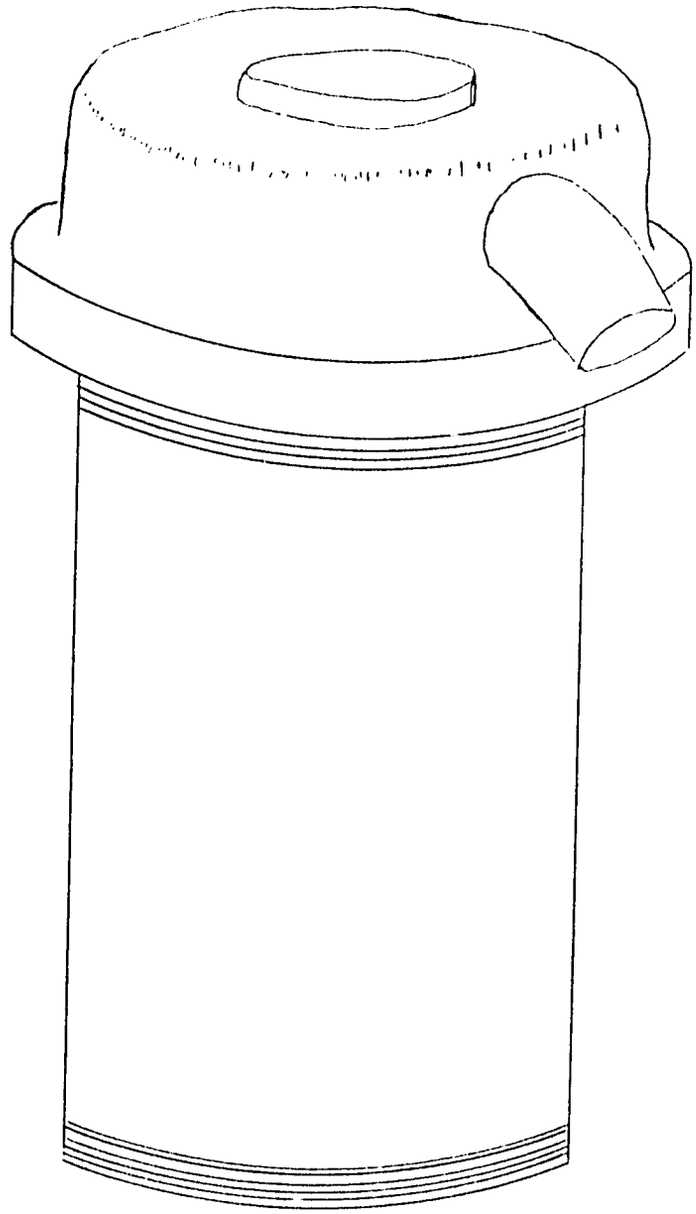
ROBOMETER



Source: University of Maryland, Dept. of Civil Engineering, International Rural Water Resources Development Laboratory. "Final Report on the Development of the Robometer," by Yaron M. Sternberg and Robert Knight. 34p. and appendices. College Park, Maryland: August 1980

FIGURE 6.2

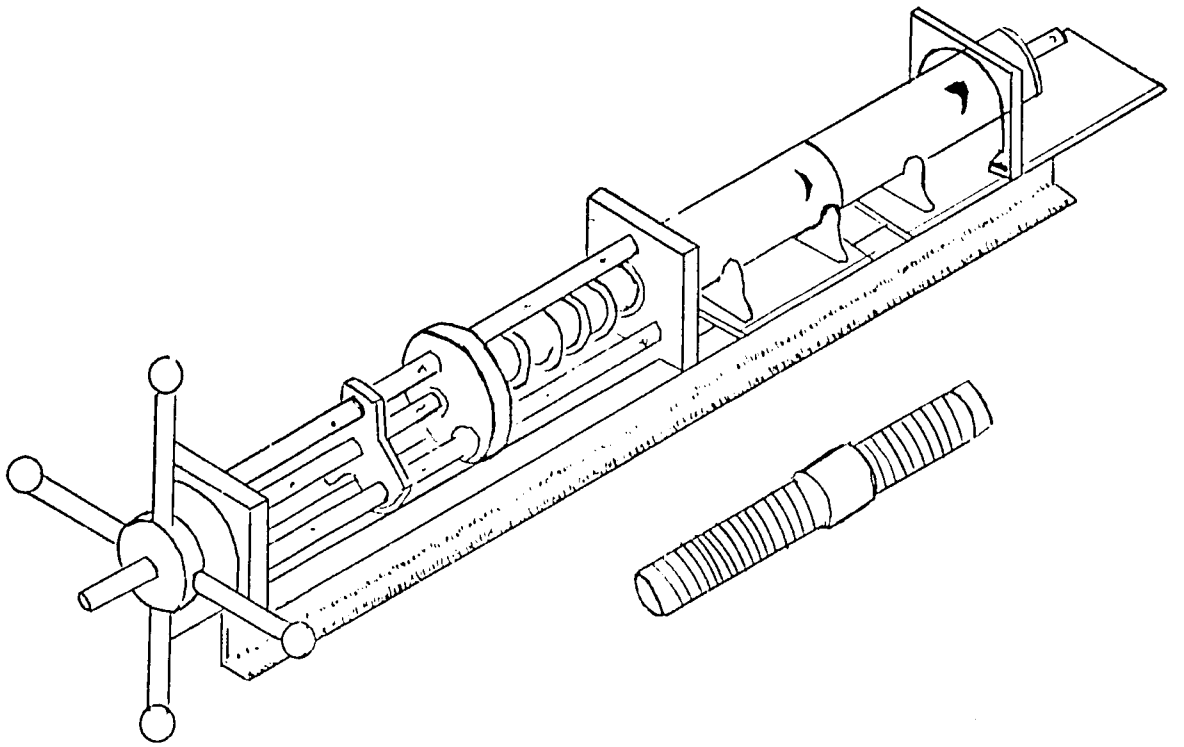
ROBOVALVE (Model for Standposts)



Source: University of Maryland, Dept. of Civil Engineering, International Rural Water Resources Development Laboratory. "Final Report on the Development and Testing of the Robovalve," Yaron M. Sternberg and Robert Knight. 34p. and appendices. College Park, Maryland: August 1980

FIGURE 6.3

ROBOSCREEN
(Broaching device, left, and completed screen section right)



Source: University of Maryland, Dept. of Civil Engineering, International Rural Water Resources Development Laboratory. "Final Report on the Development of a Broached Roboscreen," Yaron M. Sternberg and Robert Knight. 34p. and appendices. College Park, Maryland: August 1980

An inexpensive wellscreen such as the Roboscreen, which can be manufactured in-country, should provide an inexpensive way to protect wells and insure better service over a longer period of time. Existing wellscreens are generally imported and can cost $10 per foot (brass or stainless steel). Roboscreen could cost about $1 per foot if manufactured in-country.

None of the Robo devices have been tested extensively in developing countries, so they are not available for large-scale use. There is a need for small-scale tests and feasibility studies at this point in various parts of the world.

6.3.2 Handpumps

Many of the existing handpump programs in Sudan, including the UNICEF program, are currently using the India Mark II handpump. This pump has worked well in Sudan, except for some maintenance problems with the leather gaskets. A disadvantage to the pump is that there is approximately a one-year delay in their receipt once an order has been placed. USAID has developed and tested handpumps of its own design over the last several years (78). The advantage of the AID cast iron handpump is that it can be made in-country at a local foundry, and can become a source of growth for an existing industry. The handpump can be produced for as little as $160 in-country, while the Indian mark II pumps cost $300 to $500 delivered in Sudan.

Other handpumps have been tested in Sudan, including the "Ugandan pump" and the "petro pump" (44). Both of these have been shown to be somewhat inferior to the Indian Mark II in tests conducted in Sudan. The USAID handpump is considered to be of very rugged and has been tested under severe conditions in other countries. Generally the greatest problem has been with the leather gaskets, which have proved to be a problem in the Indian Mark II pumps as well. In Sudan the USAID design could be tested by UNICEF. Feasibility studies would have to be conducted in Sudan prior to manufacture at a local foundry

6.4 Evaluation of Water Supply and Sanitation-Related Projects in Sudan

The ability of the Sudanese government to evaluate projects has been weakened because of shortages of trained manpower. There is need from time to time to assess major public works projects for economic, environmental, and social implications, as well as for technical feasibility.

Many projects have a water supply, sanitation, or health component that could be evaluated. These projects include irrigation, water supply and wastewater treatment (urban and rural) as well as refugee programs and some aspects of rural agricul-

tural development projects. A list of candidate projects for evaluation is given in Table 6.1.

6.5 Training and Education

A need has been pinpointed in the Primary Health and Rural Health Support Projects (Section 3.1.3) for writing supplementary training manuals for Community Health Workers related to water supply and sanitation. Training of instructors in the use of the manuals may be necessary.

6.6 Short-Term Technical Assistance

From time to time there will be a need for short-term technical assistance to the USAID Mission in Sudan and to other donors as well. Immediate needs may include assistance in the implementation of the proposed handpump alternative for water supply in North Kordofan Province and design and pilot construction of an improved pit latrine using materials and fixtures availabe in Sudan (see Chapter 2).

Chapter 7

RECOMMENDATIONS

Major recommendations to the USAID Mission to Sudan are an outgrowth of the specific problem analyses discussed in Chapter 2. However, additional recommendations for water supply and sanitation related activities have been formulated based on the general situation in Sudan discussed in Chapters 3 through Chapter 6.

7.1 Northern Primary Health Care and Rural Health Support Projects

7.1.1 Water Supply

It is recommeded that a water supply component be added to the ongoing Northern Primary Health Care and Rural Health Support projects utilizing the following major steps:

1. Utilize existing village water supplies at proposed new sites for primary health care units, dispensaries, and health care centers. Proposed schools for CHW's and NCHW's, as well as mid-wife schools should be located in larger towns with adequate water supply (in terms of quantity) to serve the proposed schools (preferably a piped supply).

2. To meet acceptable water quality standards in health care facilities, introduce Water Tech 10 (or equivalent) water purification devices for use in PHCU's, dispensaries, and health care centers, as follows:

   a. Conduct a pilot program in one or more schools for CHW's/NCHW's to determine the acceptability of Water Tech 10 devices to trainees and their instructors. If they prove to be acceptable and desirable for use in rural health units, proceed to step "b."

   b. Conduct a feasibility study to determine the costs and advisibility of in-country manufacture of Water Tech 10's using local pottery manufactures. If costs and quality are acceptable, begin production in limited quantities. If not, import limited quantities from outside sources.

   c. Provide Water Tech 10 units to all schools for CHW's/NCHW's for use in their training programs. Supply devices to new CHW's (and NCHW's on request) after training is completed.

d. Evaluate the use and effectiveness of the Water Tech 10 program after the first year of implementation. Continue to supply Water Tech 10's to new trainees if effectiveness is proven in field trials. Eventually all CHW's will receive Water Tech 10's after returning to government schools for re-training.

e. Stock spare parts and replacement cartridge elements for Water Tech 10's as part of the dispensary system inventory.

7.1.2 Sanitation

It is recommended that a sanitation componenet be added to the ongoing Northern Primary Health Care and Rural Health Support Projects utilizing the following major steps.

1. Obtain Ministry of Health approval for the design and use of a standardized improved pit latrine in Sudan.

2. Design a standardized improved pit latrine using materials and fixtures available in Sudan, and implement a pilot construction project.

3. Teach procedures for construction of standardized improved pit latrines during ongoing training programs at the schools from CHW's/NCHW's, in cooperation with the Ministry of Health.

4. Provide incentives for construction of improved pit latrines at PHCU's, dispensaries, and health care centers, in the form of cash payments or the provision of scarce materials (e.g., cement, PVC pipe, precast floors, etc.).

7.1.3 Training in Water Supply and Sanitation

It is recommended that a training component be added to the ongoing Northern Primary Health Care and Rural Health Support Projects, as follows:

1. Develop a supplementary training manual on water supply and sanitation for use in training programs for CHW's and NCHW's at government training schools. The manual would concentrate on the use of the Water Tech 10 and other water treatment alternatives (e.g., slow sand filtration), as well as the construction and use of improved pit latrines.

2. Consider the use of outside technical assistance in the design and preparation of the manual and/or classroom materials for instructors.

7.2 North Kordofan Rural Water Supply Project

1. Deny funding to the CARE proposal as originally designed.

2. Explore with the Government of Sudan, CARE, and UNICEF the alternative of implementing a North Kordofan water supply program utilizing small diameter shallow wells, fitted with handpumps. Funding of such an alternative at the originally requested level is recommended if agreements can be reached with GOS and CARE on the use of handpumps. UNICEF has expressed a preliminary willingness to provide some technical assistance in training personnel for the program as part of their ongoing efforts in Sudan.

3. If agreement is obtained on the implementation of the handpump alternative, begin a design study to determine the type of drilling equipment needed and handpump to be used, begin field studies to site the wells for the first year's drilling, and complete hydrological studies of the area. Order drilling equipment, handpumps, and spare parts.

4. Begin implementation of the recommended baseline study and evaluation system.

5. Begin well drilling and installation of handpumps at selected sites.

7.3 Other Recommendations

1. Coordinate and organize a workshop for all multilateral and bilateral donors active in water supply and sanitation in Sudan in order to discuss mutual interests, share project successes and failures, and to promote coordination among donors.

2. Investigate (with outside technical assistance) the need for and the feasibility of supplying Robovalves, Robometers, and Roboscreens, Water Tech 10's and USAID handpumps in Sudan through in-country manufacture and/or supply from outside sources.

3. Conduct feasibility studies (with outside technical assistance, if necessary) prior to funding various water supply and sanitation facilities for refugees in Sudan in cooperation with UNHCR.

4. Periodically evaluate (with outside technical assistance, if necessary) the effectiveness of various USAID and other donor-sponsored water supply and san-

itation-related projects in Sudan. Possible candidates include:

a. the Blue Nile Health Project (WHO);

b. the Port Sudan Water Supply Project for refugees (UNHCR and USAID funding); and

C. the South Kordofan and Bahr el Ghazal province programs for handpump installation, hafir rectification, and filtration plant construction (Unicef funding).

REFERENCES

1. Gum Arabic Company Limited. "Second Market Report, 1980/1981 Season," 3p. Khartoum: 1 May 1981.

2. Gum Arabic Company Limited. "First Market Report, 1981/1982 Season." 3p. Khartoum: 1 December 1981.

3. Gum Arabic Company Limited. Untitled Brochure on Gum Arabic. 4p. Khartoum: no date.

4. U.S. Agency for International Development. "Annual Budget Submission, FY83, Sudan." 27p. Washington, D.C.: June 1981.

5. U.S. Agency for International Development. "Sudan Country Development Strategy Statement, FY82." 56p. Washington, D.C.: January 1980.

6. U.S. Agency for International Development. "Sudan Country Development Strategy Statement, FY83." 64p. Washington, D.C.: January 1981.

7. United Nations, Economic and Social Council. "Country Programme Profile, Sudan." 25p. E/ICEF/P/L.2032(REC), 31 March 1981.

8. UNICEF, Sudan Country Office. "Extension and Expansion Proposal: Wau Domestic Water Supply and Sanitation Project." 25p. and appendices. Khartoum: June 1980.

9. UNICEF, Sudan Country Office. "Draft First Addendum to the Plan of Operations of a Domestic Water Supply and Sanitation Programme in South Kordofan Province, Sudan." 32p. Khartoum: December 1980.

10. UNICEF, Sudan Country Office. "Draft Second Plan of Operations, A Domestic Water Supply and Sanitation Programme in the Southern Sudan." 41p. and appendices. Khartoum: December 1980.

11. UNICEF, Sudan Country Office. "Report on the Situation of Women in the Target Villages of the UNICEF Domestic Water Supply Project in Bahr el Ghazal Province, Sudan," by Annemarie Russell. 66p. Khartoum: October 1979.

12. UNICEF, Sudan Country Office. "Developing a Health Education Component for the UNICEF Water and Sanitation Programme in Sudan," by Norman Scotney (AMREF, Nairobi). 23p. and appendices. Khartoum: June 1980.

13. UNICEF, Sudan Country Office. "Popular Participation and the Bahr-el-Ghazal Domestic Water Supply Project: Lessons

and Implications for UNICEF Policy," by Joseph A. Sclafani. 24p. Khartoum: February 1981.

14. World Health Organization/World Bank Cooperative Programme. "Report, Water Supply and Sanitation Sector Study, Democratic Republic of the Sudan." Volume 1 of 2 volumes, 21p. and appendices. 1978.

15. United Nations Development Programme, Global Project GLO/78/006. "Low Cost Water Supply and Sanitation, Report on Mission to Sudan, February 1 to March 7, 1980," by Margot Badran. TAG/SUD/02. 84p. May 1980.

16. Development Alternatives, Inc. "Evaluation of the Abyei Development Project, Sudan," by A. H. Barclay, Jr., et al. for USAID/Sudan, Project 936-5300. 35p. and appendices. Washington, D. C.: April 1981.

17. Harvard Institute for International Development. "Report on Water Well Drilling at Abyei Development Project, Sudan, 22 October 1979 to 11 January 1980," by Bruce Eaton, Consultant to HIID. n.p. 1980?

18. Cole, David C. "Background Paper on the Abyei Water Program." 9p. July 1, 1980 (HIID Report?)

19. Claybaugh, William. "Report to the Harvard Institute for International Development on the Wells Program in Abyei, South Kordofan, Sudan, 5 March to 15 May, 1980." n.p. 1980? (HIID Report?)

20. Cole, David C. "The Abeyi Water Program, Results of 1979-80 and Prospects for 1980-81." 7p. and appendices. 23 July 1980. (HIID Report?)

21. IRC Clinic, Tawawa Refugee Settlement. "Monthly Report, June 1981. n.p.

22. IRC Clinic, Tawawa Refugee Settlement. "Monthly Report, August 1981. n.p.

23. IRC Clinic, Tawawa Refugee Settlement. "Monthly Report, July 1981. n.p.

24. U.S. Agency for International Development. "Project Paper, Refugee Water Supply, Port Sudan (Sudan)." Project No. 650-0050. April 22, 1981.

25. U.S. Agency for International Development. "Project Paper, Rural Health Support (Sudan)." Project No. 650-0030. 65p. and appendices. no date.

26. Democratic Republic of the Sudan, Ministry of Health. "Primary Health Care Programme, Third Annual Report, 1979-

1980." 13p. Khartoum: no date.

27. Democratic Republic of the Sudan, Ministry of Health. "Expanded Programme of Immunization, 2nd Quarterly Report 1981." 23p. Khartoum: no date.

28. Democratic Republic of the Sudan, Ministry of Health. "Primary Health Care Programme, Annual Report, 1978/1979." 16p. Khartoum: no date.

29. U.S. Agency for International Development. "Project Paper, Sudan--Northern Sudan Primary Health Care (Phase I), Proposal and Recommendations for the Review of the Bilateral Assistance Committee." AID/BAS-019. Project No. 650-0011. 111p. Washington, D.C.: July 14, 1978.

30. Obeid, Mubarak M. "The Impact of Human Activities and Land Use Practices on the Grazing Lands in the Sudan," Proceedings of the First International Rangeland Congress, Denver, 1978. pp. 48-51.

31. Helland, Johan. "Sociological Aspects of Pastoral Livestock Production in Africa." Proceedings of the First International Rangeland Congress, Denver, 1978. pp. 79-81.

32. World Health Organization, The Democratic Republic of the Sudan. "Report on Case Studies of Health Care Facilities within the Context of the Health Services System in the Democratic Republic of the Sudan and Conclusions of the National Conference on Follow-up Action." SPM/CS1. 137p. Khartoum/Geneva: December 1979.

33. Democratic Republic of the Sudan, Ministry of Health. "Primary Health Care Programme: Eastern, Northern, Central and Western Regions of the Sudan, 1977/78-1983/84." 248p. and appendices. Khartoum: 1 May 1976.

34. Democratic Republic of the Sudan, Ministry of Health. "National Health Programme, 1977/78-1983/84." 74p. Khartoum: 24 April 1975.

35. World Health Organization. "Infant and Early Childhood Mortality in Relation to Fertility Patterns: Report on an Ad-Hoc Survey in Greater Khartoum and in the Blue Nile, Kassala and Kordofan Provinces, 1974-76." 165p. Published in Cooperation with the Ministry of Health (GOS), Khartoum. Geneva: 1981.

36. Democratic Republic of the Sudan, Ministry of Health, Vital & Health Statistics Division. "Annual Statistical Report, 1977. 93p. and appendices. Khartoum: no date.

37. Democratic Republic of the Sudan, Ministry of Health, EPI Unit. "Modified Plan of Action, EPI Sudan, 1981." 63p.

Khartoum: no date.

38. U.S. Agency for International Development. "Sudan, Northern Primary Health Care, Project Paper." Project No. 650-0011. 111p. Washington, D.C.: August 1978.

39. Medical Service Consultants, Inc. "Report of the Health Sector Assessment Team, Sudan," prepared for Africa Bureau, Agency for International Development, Washington, D.C. v.p. Arlington, Va.: September 5, 1977.

40. Gibson, Dianna. "Blue Nile Project." World Health. August-September 1980. pp. 10-13.

41. Hooks, Wayne. "Hand Pump 2000." UNICEF News. Issue 103/1980/1. pp. 7-9.

42. University of Khartoum, Dept. of Geography. "Social Impacts of Environmental Change: Preliminary Thoughts on Indicators and Methodology for Investigation of Pastoral and Sedentary Communities," by M. O. El-Sammani and D. L. Johnson. Draft unpublished paper. 8p. no date.

43. University of Khartoum, Dept. of Geography. "The Impact of Improved Rural Water Supplies on the Environment: The Case of East Kordofan District," by Dr. Yagoub Abdalla Mahamed, et al. unpublished paper. 41p. April 1981.

44. Norwegian Church Relief Sudan Programme. "Report: Handpumps," by Knut Buer. 17p. and appendices. Torit, Sudan: September 1978.

45. Johnson, Douglas L. "Monitoring Environmental Change: Thoughts on Physical and Social Indicators in the Sudan." Preliminary Draft Report. ETMA-Sudan Working Paper No. 1. Clark University. 41p. Worcester, Mass.: no date.

46. United Nations Sudano-Sahelian Office. "Desertification Control and Range Management: An Approach to the Protection and Further Development of the Range Resources in Western Sudan." Findings of the UNSO Rangeland Mission, 16 May- 3 June 1981. Draft Report, 60p. and appendices. Khartoum, Sudan: no date.

47. United Nations Sudano-Sahelian Office. "Support to the National Desertification Control Co-ordinating and Monitoring Unit," Draft Project Report. UNSO/ DES/ SUD/ 81/ 001. 17p. and appendices. Khartoum, Sudan: 13 October 1981.

48. United Nations Sudano-Sahelian Office. "Restocking of the Gum Bell for Desertification Control," Project Report. 26p. and appendices. UNSO/ DES/ SUD/ 80/ 002. Khartoum, Sudan: 16 September 1981.

49. United Nations Development Programme/Unesco. "Sudan: Science and Technology Policy, Planning and Management in Sudan, Tech. Rpt. 7, Transfer of Technology," by J. L. Atrops and T. Barlag. UNDP/ SUD/ 75/ 005. 27p. Paris: 1977.

50. United Nations Development Programme/Unesco. "Sudan: Science and Technology Policy, Planning and Management in Sudan, Technical Rpt. No 4, Survey of Natural Resources," by R. H. Gunn. UNDP/ SUD/ 75/ 005. 20p. and appendices. Paris: 1977.

51. United Nations Development Programme/Unesco. "Sudan: Science and Technology Policy, Planning and Management in Sudan, Technical Rpt. No. 1, Science and Technology Policy, Planning and Management in Sudan (Executive Summary)," by T. Barlag. UNDP/ SUD/ 75/ 005. 39p. Paris: 1977.

52. Democratic Republic of the Sudan, Ministry of Health. "Manual for the Community Heath Care Worker." 268p. Khartoum, Sudan: 30 November 1976.

53. Baycumi, Ahmed. The History of Sudan Health Services. 351p. Kenya Literature Bureau. Nairobi, Kenya: 1979.

54. Democratic Republic of the Sudan, Ministry of Health. "Primary Health Care Programme Sudan, 1977/78-1983/84, Summary Statement." 22p. and appendices. Khartoum Univ. Press. Khartoum, Sudan: 29 April 1976.

55. Hunting Technical Services Limited. "South Kordofan Rural Planning Unit, Annex 2, Water Resources." 187p. Herts, England: July 1981.

56. Hunting Technical Services Limited. "El Obeid Water Supply." 126p. and appendices. Herts, England: January 1975.

57. National Administration for Water. Draft Mimeographed Material on the History of the NAW, in preparation for the meeting of the National Action Committee for the International Drinking Water Supply and Sanitation Decade, 7-10 December 1981.

58. Personal communication with UNICEF staff in Kadugli.

59. Personal communication with CRS staff in Khartoum.

60. Personal communication with AMREF staff in Juba.

61. World Bank. "Recognizing the 'Invisible' Woman in Development: The World Bank's Experience." 33p. Washington, D. C.: October 1979.

62. International Institute for Environment and Development. Water, Sanitation, Health--for All?: Prospects for the International Drinking Water Supply and Sanitation Decade, 1981-90, by Anil Agarwal, et al. 148p. Earthscan. London: 1980.

63. Saunders, Robert J., and Jeremy J. Warford. Village Water Supply: Economics and Policy in the Developing World. A World Bank Research Publication. 279p. John Hopkins University Press. Baltimore/London: 1976.

64. U.S. Environmental Protection Agency, Office of Water Programs, Water Supply Division. Manual of Individual Water Supply Systems. 156p. Washington, D. C.: 1973.

65. National Academy of Sciences. More Water for Arid Lands: Promising Technologies and Research Opportunities. 153p. Washington, D. C.: 1974.

66. Ross Institute, Information and Advisory Service. Small Water Supplies, by Sandy Cairncross and Richard Feachem. Ross Bulletin 10. 78p. London: January 1978.

67. Ross Institute, Information and Advisory Service. Small Excreta Disposal Systems, by Richard Feachem and Sandy Cairncross. Ross Bulletin No. 8. 54p. London: January 1978.

68. U. S. Agency for International Development. Water, Engineers, Development, and Disease in the Tropics, by F. E. McJunkin. AID/csd-188. 182p. Washington, D. C.: July 1975.

69. International Development Research Centre. Low-Cost Technology Options for Sanitation: A State-of-the-Art Review and Annotated Bibliography, by W. Rybezynski, et al. Result of a joint effort by IDRC and the World Bank. IDRC-102e. Ottawa, Canada: 1978.

70. International Development Research Centre. "Rural Water Supply and Sanitation in Less-Developed Countries: A Selected Annotated Bibliography," by Anne U. White and Chris Seviour. IDRC-028e. Ottawa, Canada: 1974?

71. World Bank. Transportation, Water and Telecommunications Department. Appropriate Technology for Water Supply and Sanitation: A Planner's Guide, Volume 2, by John M. Kalbermatten, et al. 194p. Washington, D. C.: December 1980.

72. U. S. Agency for International Development, Training and Development Division, Office of Personnel Management. Design & Evaluation of AID-Assisted Projects. 264p. Washington, D. C.: November 1980.

73. UNICEF, India Country Office(?). "Report of the National Conference on Deepwell Handpumps, Madurai, July 10-13, 1979." 78p. no date.

74. American Public Health Association. Control of Communicable Diseases in Man, Abram S. Benenson, editor. Thirteenth Edition. 443p. Washington, D.C.: 1981.

75. White, Gilbert F., et al. Drawers of Water: Domestic Water Use in East Africa. 306p. Univ. of Chicago Press. Chicago/London: 1972.

76. Chandler, Charles G. "Appropriate Technology for Planning Hydroelectric Power Projects in Nepal: The Need for Assumption Analysis." Center for Research in Water Resources, The University of Texas at Austin. CRWR-182. 220p. Austin, Texas: June 1981.

77. Cairncross, Sandy, et al. Evaluation for Village Water Supply Planning. John Wiley & Sons. New York/ Brisbane/ Toronto: 1980(?)

78. Georgia Insitute of Technology, Engineering Experiment Station. "The AID Hand-Operated Water Pump: A Classic Example of Technology Transfer," by Phillip W. Potts. 55p. Atlanta, Georgia: March 1981.

79. Swedish International Development Authority. "Continuous Compost Toilets in Tunisia, Part I." 21p. and appendices. College Park, Maryland: August 1980.

80. University of Maryland, Dept. of Civil Engineering, International Rural Water Resources Development Laboratory. "Final Report on the Development of the Robometer," by Yaron M. Sternberg and Robert Knight. 35p. and appendices. College Park, Maryland: January 1979.

81. University of Maryland, Dept. of Civil Engineering, International Rural Water Resources Development Laboratory. "Final Report on the Development and Testing of the Robovalve," by Yaron M. Sternberg and Robert Knight. 70p. College Park, Maryland: June 1978.

82. University of Maryland, Dept. of Civil Engineering, International Rural Water Resources Development Laboratory. "Final Report on the Development of a Broached Roboscreen," by Yaron M. Sternberg and Robert Knight. 34p. and appendices. College Park, Maryland: August 1980.

83. U. S. Agency for International Development, Water and Sanitation for Health Project. "Triocide Questions and Answers," WASH Technical Report No. 1. 12p. Arlington, Va.: November 1980.

84. CARE. "North Kordofan Rural Water Supply Project Proposal," submitted for funding to USAID/Sudan. USAID Project No. 650-0057. n.p. Khartoum: no date.

85. Bradley, D. J. "Health Aspects of Water Supplies in Tropical Countries." In: Feachem, McGarry and Mara (eds.), Water, Wastes and Health in Hot Climates. Wiley. London: 1977.

86. Feachem, R. G. "Water Supplies for Low-Income Communities: Resource Allocation, Planning and Design for a Crisis Situation." In: Feachem, McGarry and Mara (eds.), Water, Wastes, and Health in Hot Climates. Wiley. London: 1977.

87. Feachem, R. G., et al. Water, Health and Development: An Interdisciplinary Evaluation. 267p. Tri-Med Books Ltd. London: 1978.

88. McJunkin, F. Eugene. "Water Supply and Health: An Overview." In: The Impact of Interventions in Water Supply and Sanitation in Developing Countries, pp.1-25. U. S. Agency for International Development. Proceedings of a Seminar held at the Pan American Health Organization, March 25-26, 1980, Washington, D. C. April 1981.

89. Carruthers, I. D. "Impact and Economics of Community Water Supply: A Study of Rural Water Investment in Kenya." 120p. Agrarian Development Studies Rept. No. 6. Wye College, University of London. London: 1973.

90. Helland, J. "Sociological Aspects of Pastoral Livestock Production in Africa." In: Proceedings of the First International Rangeland Congress. Society for Rangeland Investigations. Denver: 1978.

91. Kocher, V. K., et al. "Human Factors in the Regulation of Parasitic Infections: Cultural Ecology of Hookworm Populations in Rural West Bengal." In: Grollig, F. X., and Healy, H. B. (eds.), Medical Anthropology. Mouton. The Hague: 1976.

92. Nelson, G. S. "Human Behaviour in the Transmission of Parasitic Diseases." In: Canning, E. V., and Wright, C. A. Behavioural Aspects of Disease Transmission. Academic Press. London: 1972.

93. Spooner, B. Cultural Ecology of Pastoral Nomads. Addison-Wesley. Boston: 1973.

APPENDIX A

MEMORANDUM

October 6, 1981

WATER AND SANITATION FOR HEALTH (WASH) PROJECT
ORDER OF TECHNICAL DIRECTION NUMBER 60

TO: Dr. Dennis Warner, Ph.D., P.E.
WASH Project Director

FROM: Mr. Victor W.R. Wehman, Jr., P.E., R.S.
AID WASH Project Manager

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Sudan.

REFS: A) Khartoum 08159
B) Khartoum 08038
C) Khartoum 07720
D) Khartoum 06506
E) Khartoum 06143

1. WASH contractor requested to provide technical assistance to USAID/Sudan as per Ref. D., para. 1-5 and Ref. A, para. 4.d. Scope of Work

2. WASH contractor/sub-contractor/consultants authorized to expend up to 95 person days effort over a three (3) month period to accomplish this technical assistance effort.

3. Contractor to provide draft final report to mission before leaving field. Consultants to return to WASH office in Rosslyn, Virginia to complete final versions of reports and for debriefing purposes before returning to consultant's home base. Final report due in S&T/HEA and mission within 30 days of consultant's finishing technical assistance mission and leaving Sudan.

4. Contractor to coordinate directly with USAID/Sudan (Dr. Micha). Ensure that this OTD is provided to and discussed with AFR/DR/HN (Dr. Shepperd), AFR/DR/ENGR (Mr. Gould and/or Mr. Snead), and Sudan desk officer. Keep these people appraised of progress, ETA's, etc.

5. Ninety (90) days of international or domestic per diem is hereby authorized.

6. Three international airfare round trips are authorized from consultant's home base to WASH CIC, to Khartoum, Sudan, to WASH CIC and return to home base.

7. Local travel and transportation within Sudan is authorized as necessary. WASH contractor authorized to rent car, vehicle, pay taxis or rent animals as appropriate to accomplish mission inside Khartoum and outside Khartoum.

8. Seven day work week authorized if necessary and proper and certified by team leader and WASH project director.

9. Miscellaneous expenses authorized NTE $2,000.

10. Contractor authorized to hire secretarial/interpreter services up to and NTE 25 person days to accomplish mission.

11. Contractor personnel should take 35 mm camera and take well composed photo essay of conditions to assist WASH CIC in debriefing and in allowing CIC staff to better understand water supply and sanitation and PHC problems of Sudan. Recommend contractor take 10 rolls of 36 black and white print film with team.

12. Mission and consultants should be contacted immediately and technical assistance initiated as soon as possible or convenient to USAID/Sudan. Ensure WASH consultants are well backstopped during period of technical assistance.

13. Contractor should require 7-10 day detailed progress reports by team leader by cable to WASH CIC.

14. Appreciate your prompt attention to this matter.

WWW:ja

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Department of State — INCOMING TELEGRAM

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INFO AMEMBASSY NAIROBI PRIORITY

UNCLAS SECTION 1 OF 2 KHARTOUM 8159

AIDAC

E.O. 12065: N/A
SUBJECT: FY 1982 PROJECT SCHEDULING PLANS

REF: (A) STATE 240823, (B) KHARTOUM 7720 (C) STATE 196827

1. BELOW IS LISTING AND SCHEDULING OF SIGNIFICANT FY 1982 PROJECT DESIGN/IMPLEMENTATION AND RELATED ACTIVITIES FOR USAID/SUDAN, WHICH REQUIRE SUPPORT BEYOND MISSION STAFFING CAPABILITIES. PER REF A PARA 5, PRIORITIES ARE INDICATED AS HIGH, MEDIUM, OR LOW.

2. ENERGY SECOTR:
A. ENERGY SECTOR STRATEGY FORMULATION; MEDIUM PRIORITY. NOVEMBER 1981. PERSONNEL REQUIREMENTS: MISSION: ENERGY OFFICER, PROGRAM OFFICER, SOCIAL SCIENTIST AND CAPITAL PROJECTS DEVELOPMENT OFFICER FOR 2 WEEKS.
REDSO: REGIONAL ENERGY OFFICER FOR 2 WEEKS.

B. RURAL RENEWABLE ENERGY PROJECT (650-0041); LOP AMT $4,000,000; CONTRACTING ACTION: MEDIUM PRIORITY.
OCTOBER 1981 TWO-WWEK REQUIREMENT FOR REDSO (OR AID/W) CONTRACTING OFFICER TO ASSIST MISSION (I) PREPARE/ISSUE RFP AND ESTABLISH SELECTION/CONTRACTING PROCEDURES FOR MAJOR TA CONTRACT; (II) DEVELOP PROCEDURES FOR MAKING RENEWABLE ENERGY DEVELOPMENT GRANTS.
FEBRUARY 1982 TWO-WEEK REQUIREMENT FOR REDSO (OR AID/W) CONTRACTING OFFICER TO ASSIST WITH NEGOTIATION WITH FIRM SELECTED TO PROVIDE TA.
FUNDING: FY- 1982 - $2.0 MILLION; FY 1983 - $2.588 MILLION.

3. AGRICULTURE SECTOR:
A. SOUTHERN MANPOWER DEVELOPMENT (650-0021); LOP AMOUNT $5.94 MILLION;
EVAULATION; HIGH PRIORITY. FEBRUARY 1982
PERSONNEL REQUIREMENTS; MISSON: EVALUATION OFFICER, PROJECT MANAGER AND AGRICULTURAL OFFICER FOR TWO WEEKS.
OTHER: OUTSIDE AGRICULTURE TRAINING SYSTEMS CONSULTANTS FOR ONE MONTH.

B. WESTERN SUDAN AGRICULTURE RESEARCH (650-0020); LOP AMT $26 MILLION;
EVALUATION; MEDIUM PRIORITY. JUNE 1982
PERSONNEL REQUIREMENTS: MISSION: EVAULATION OFFICER, PROJECT MANAGER AND SENIOR AGRICULTURE OFFICER.
OTHER: OUTSIDE AGRICULTURE RESEARCH AND EXTENSION AND AGRICULTURE DEVELOPMENT CONSULTANTS FOR ONE MONTH.
FUNDING: FY 1982 - $2.84 MILLION.
C. BLUE NILE INTEGRATED AGRICULTURAL DEVELOPMENT (650-0013); LOP AMT $12REQ MILLION; EVALUATION HIGH PRIORITY.
DECEMBER 1981
PERSONNEL REQUIREMENTS: MISSION EVALUATION OFFICER AND PROJECT MANAGER.
OTHER: OUTSIDE AGRONOMIST AND AGRICULTURE DEVELOPMENT EXPERTS, EACH FOR ONE MONTH.
FUNDING: FY - 1982- $2.505 MILLION
D. AGRICULTURE PRODUCTION & MARKETING (650-0054); LOP AMT $30 MILLION; PID/PP PREPARATION HIGH PRIORITY.
PID: BEGINS NOVEMBEN 1981; SUBMITTED TO AID/W DECEMEER 1981.

PERSONNEL REQUIREMENTS; MISSION: AGRICULTURE OFFICER, AGRICULTURE ECONOMIST, SOCIAL SCIENTIST, CAPITAL PROJECTS DEVELOPMENT OFFICER AND ENVIRONMENTAL OFFICER.
PP: BEGINS MARCH 1982. SUBMITTED TO AID/W APRIL 1982
PERSONNEL REQUIREMENTS: MISSION: SAME AS ABOVE
OTHER: 6 PERSONS MONTHS OOF TECHNICAL EXPERTISE INCLUDING SKILLS, RELATED TO PRIVATE SECOTR SUPPORT FOR AGRIC. PRODUCTION AND MARKETING.
FUNDING: FY 1982 - 16 MILLION; FY 1983- $.867 MILLION
E. SOUTHERN REGION AGRICULTURE DEVELOPEMENT (650-0046)
LOP AMT $20 MILLION; PID/PP PREPARATION: HIGH PRIORITY.
PID: BEGINS NOVEMBER 1981. SUBMITTED TO AID/W DECEMBER 1981.
PERSONNEL REQUIREMENTS: MISSION: SAME AS PARA 3 D ABOVE.
PP BEGINS FEBRUARY 1982. SUBMITTED TO AID/W MARCH 1982
PERSONNEL REQUIREMENTS: MISSION: SAME AS PARA 3 D ABOVE
OUTSIDE: SIX PERSON-MONTH OF TECHNICAL EXPERTISE.
FUNDING FY 1982 -$7.255 MILLION; FY 1983 -2.745 MILLION.
F. PL 480 TITLE III. LOP AMT. $100 MILLION; EVALUATION AND PERIODIC REVIEWS; MEDIUM PRIORITY.
PERSONNEL REQUIRMENTS: REDSO REGIONAL FOOD FOR PEACE OFFICER (RFFFO). OCTOBER 1981 - 1 WEEK; DECEMBER 1981 - 1 WEEK. JUNE 1982 - 1 WEEK AND SEPTEMBER 1982 - 1 WEEK.
FUNDING FY 1982 - $20 MILLION; FY 1983 - $20 MILLION.
G. PL 480 TITLE II. OUTREACH GRANT $1 MILLION. EVALUATION OF FIRST EIGHTEEN MONTHS OF ACTIVITIY. MEDIUM PRIORITY.
PERSONNEL REQUIREMENTS: REDSO RFFPO FOR 10 DAYS. JANUARY 1982.
DAVISON

(continued)

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UNCLAS SECTION 2 OF 2 KHARTOUM 8159

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4. HEALTH SECTOR.

-. NORTHERN PRIMARY HEALTH CARE (650-0011); LOP AMT $5.863 MILLION; EVALUATION MEDIUM PRIORITY; MID JANUARY 1982

PERSONNEL REQUIREMENTS: MISSON: HEALTH OFFICER, ENGINEER, EVALUATION OFFICER (PART TIME ONLY). AID/W : EVALUATION OFFICER AS TEAM-LEADER.
OTHER: LOGISTICS, ARABIC SPEAKING TRAINING, PRIMARY HEALTH CARE AND DATA ANALYST SPECIALIST. OUTSIDE CONSULTANTS EACH FOR 4 WEEKS.
FUNDING: FY 1982 - $.3 MILLION.
B. SOUTHERN PRIMARY HEALTH CARE (650-0019); LOP AMT $3.7MILLION; EVALUATION, MEDIUM PRIORITY. MARCH 1982

PERSONNEL REQUIREMENTS: MISSION: HEALTH OFFICER AND ENGINEER AND EVALUATION OFFICER (PART TIME ONLY). REDSO: HEALTH ECONOMIST.
AID/W: HEALTH OFFICER. OUTSIDE: BEHAVIORIAL SCIENTIST, LOGISTICS AND DATA ANALYST SPECIALIST. EACH FOR ONE MONTH.
C. DEVELOPMENT OF IMPLEMENTATION PLAN FOR POPULATION STRATEGY LOP AMT $3 MILLION; STRATEGY FORMULATION AND PID PREPARTAION: MEDIUM PRIORITY.
STRATEGY FORMULATION: NOVEMBER 1981
PERSONNEL REQUIREMENTS: MISSION: HEALTH OFFICER AND PROGRAM OFFICER.
AID/W POPULATION OFFICER; OTHER: 2 SPECIALISTS. EACH ONE MONTH. PID PREPARATION. BEGIN MARCH 1982 AND SUBMIT TO AID/W AUGUST 1982. PERSONNEL REQUIREMENTS: MISSION: HEALTH OFFICER, PROGRAM OFFICER, SOCIAL SCIENTIST, CAPITAL PROJECTS DEVELOPEMTNT OFFICER. OTHER: SIX PERSON MONTHS OF POPULATION ASSISTANNT.
-. WATER AND SANITATION IN HALTH (WASH); SUBSECTOR REVIEW AND STRATEGY FORMULATION: LOW PRIORITY.
OCTOBER-NOVEMBER 1981
PERSONNEL REQUIREMTTS: MISSION: HEALTH OFFICER, PROGRAM OFFICER, ENGINEER AND SOCIAL SCIENTIST (PART TIME ONLY).
OUTSIDE: 3 PERSON INTERDISCIPLINARY WASH TEAM, FOR 6 WEEKS.

5. INFRASTRUCTURE IN SUPPORT OF AGRICULTURE/HEALTH SECOTRS.
A. PORT SUDAN REFUGEE WATER SUPPLY (650-0050); LOP AMT 12.0 MILLION ENGINEERING REVIEW OF FINAL DESIGN: HIGH PRIORITY. DECEMBER 1981 FOR 1 WEEK.
PERSONNEL REQUIREMENS: REDSO ENGINEER ALONG WITH MISSION ENGINEER.
B. SOUTHERN SUDAN ACCESS ROAD (650-0036); LOP AMT 110 MILLION; ENGINEERING MONITORING OF RAOD CONSTRUCTION; HIGH PRIORTY. PERSONNEL REQUIREMENTS: ONE WEEK PER MONH OF REDSO SENIOR ROAD ENGINEER DURING FY 1982.
C. SOUTHERN RURAL SUDAN INFRASTRUCTURE PHASE II (650-0043); LOP AMT $20 MILLION: PID PREPARATION: MEDIUM PRIORITY. BEGINS JUNE 982. SUBMIT TO AID/W JULY 1982.
PERSONNEL REQUIREMENTS: MISSION: ENGINEER, SOCIAL SCIENTIST AND CAPITAL PROJECTS DEVELOPMENT OFFICER.
REDSO: SENIOR ROAD ENGINEER FOR ONE WEEK.
OTHER: ROAD ECONOMIST FOR ONE MONTH. FUNDING: FY -1983-12GMILLICH
D. RIVER TRANSPORT; LOP AMT TO BE DETERMINED: DETERMINE POSSIBILITES OF USE PL 480 AND CIP LOCAL CURRENCY PPOCEEDS, CIP US GOODS AND/OR SEPARATE PROJECT TO SUPPORT RIVER NAVIGATION IN SUDAN IN SUPMORT OF AGRICULTURAL PRODUCTION: HIGH PRIORITY. NOVENGER/DECEMBER 1981. TWO PERSON MONTHS OF OUTSIDE RIVER NAVIGATION TRANSPORT/AIDS EXPERTISE.

6. DEVELOPMENT MANAGEMENT SECTOR.
-. SUDAN REGIONALISZATION PROJECT; LOP AMT $3.0 MILLION;
PID AND PP PERPARATION: HIGH PRIORTY.
PID BEGINS SEPTEMBER 1981. SUBMITTED TO AID/W NOVEMBER 1981
PERSONNEL REQUIREMENTS: MISSION: PROJECT MANAGER, ECONOMIST SOCIAL SCIENTIST AND CAPITAL PROJECTS DEVELOPMENT OFFICER.
AID/W: ECONOMIST FOR 2 WEEKS.
PP BEGINS MARCH 1982. SUBMITTED TO AID/W APRIL 1982
PERSONNEL REQUIREMENTS: SAME AS ABOVE FOR PID PLUS 3 OUTSIDE CONSULTATNS IN FINANCE, PUBLIC ADMINISTRATION AND DECENTRALIZATION POLICY. EACH FOR ONE MONTH
FUNDING: FY 1982 - $1 MILLION; FY 1983 -$2 MILLION

7. HOPE ABOVE PROVES USEFUL TO AFR/DR AND REDSO FOR FY 1982. PROJECT SCHEDULING.
STENVEN MINTZ, USAID CAPITAL PROJECTS DEVELOPMENT OFFIER, WILL REPRESENT MISSION AT SUBJECT CONFERENCE IN NAIROBI ETA TO FOLLOW SEPTEL. DAVISION

10 Sept 81

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Department of State

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AID/W FOR ENVIRONMENTAL OFFICER, AFR/DR/SDP

NAIROBI FOR REDSO/EA

E.O. 12065: N/A
SUBJECT: NORTH KORDOFAN RURAL WATER SUPPLY--1974 AFDROUGHT CARE PROPOSAL (650-0057)

REF: STATE 235068

1. INITIAL ENVIRONMENTAL EXAMINATION (IEE) BEING POUCHED TODAY ALONG WITH REVISED DRAFT OF REDSO ENVIRONMENTAL AND ENGINEERING ANALYSIS (EEA). EARLIER ROUGH DRAFT OF EAA HAND-CARRIED ON SEPTEMBER 5.

2. REQUEST NEGATIVE DETERMINATION ON IEE PROVIDING THE FOLLOWING RECOMMENDATIONS FROM THE REDSO ANALYSIS ARE INCORPORATED INTO PROJECT AGREEMENT.

3. RECOMMENDATIONS AS FOLLOWS:
A. CONCRETE PLATFORMS AND PROPER DRAINS WILL BE INSTALLED WITHIN THE WATERYARD WHEREVER DRINKING WATER TAPS ARE LOCATED. ADEQUATE FENCING WILL BE INSTALLED TO INSURE ANIMALS AND WASTE DO NOT COME IN CONTACT WITH HUMAN WATER SUPPLY. CARE WILL COLLABORATE WITH RURAL HEALTH SUPPORT PROJECT IN THE TRAINING OF NEW COMMUNITY HEALTH WORKERS AND THE RETRAINING OF CHWS ALREADY IN SEVICE, AND OTHER DONORS FOR SANITARY TRAINING FOR THE WATERYARD MANAGERS AND WATER HANDLERS.
B. PRIORITY FOR FINAL LOCATION OF WATERYARDS SHOULD BE BASED ON A COMBINATION OF POPULATION DENSITY AND NATURAL RESOURCE AVAILABLITY. LARGE VILLAGES SHOULD BE GIVEN PRIORITY ONLY WHEN LOCATION HAS EXISTING OR POTENTIAL ECONOMIC ACTIVITY INDEPENDENT OF LOCAL NATURAL SOURCES.
C. CARE WILLL INSURE THAT DATA ARE COLLECTED ON NUMBERS OF ANIMAL AND HUMAN USERS, TYPES OF LIVESTOCK, WATER CONSUMPTION LOCATION OF HERDS AND RATE OF ANIMALS. THIS INFORMATION WILL COMPRISE PART OF THE PROJECT EVALUATION TO BE PERFORMED AFTER TH FIRST TEN WELLS HAVE BEEN INSTALLED (MID-PROJECT EVALUATION). IT IS SUGGESTED THAT THIS EVALUATION BE CARRIED OUT BY THE SUDANESE INSTITUTE FOR ENVIRONMENTAL STUDIES. FOR THE BASELINE DATA CARE WILL DRAW ON THE WESTERN AGRICULTURAL RESEARCH PROJECT AND THE COOPERATIVE RESEARCH SUPPORT PROGRAM NOW IN OPERATION IN EL OBEID.
D. CARE IN CASE-BY-CASE DECISIONS OF WATER PROGRAM DEVELOPMENT MUST CONSIDER PERIODIC SHUT-DOWN OF WATERYARDS OR ESCALATION OF RATE CHARGED IN AREAS SHOWING SEVERE SIGNS OF LAND DEGRADATION, WITH THE POSSIBILITY OF REOPENING IN THE FUTURE, IF THE LAND RECOVERS
E. A POSITIVE EFFORT MUST ALSO BE MADE BY CARE TO MAINTAIN LIAISON WITH THE AGRICULTURAL AND FORESTATION WORKERS TO ENSURE THAT THE NEW WATERYARDS WILL PROVIDE MAXIMUM SUPPORT OF THE

KHARTO 02838 1005212Z 4796 070136 AID5523
REHABILITATION O. THE AGRICRADIC BELT.

4. FOR ANY ADDITIONAL INFORMATION CONTACT REGIONAL ENVIRONMENTAL OFFICER, REDSO/EA, DIRECT. DAVISION

McDermott

Woods

Moore

UNCLASSIFIED

29 Aug 81

PAGE 01 KHARTO 07720 291741Z 5294 062665 AID0815
ACTION AID-35

ACTION OFFICE AFDP-06
INFO AAAF-01 AFFA-03 AFDP-02 AFDA-01 RELO 01 MAST-01 DO-01
-016 A1 5

INFO OCT-01 038 W
125706 291741Z 44

P 291258Z AUG 81
FM AMEMBASSY KHARTOUM
TO SECSTATE WASHDC PRIORITY 2088
INFO AMEMBASSY NAIROBI PRIORITY

UNCLAS KHARTOUM 7720

AIDAC

AID/W FOR N. COHEN, AFR/DR
NAIROBI FOR REDSO-EA

E.O. 12065: N/A
TAGS:
SUBJ: FY 1982 PROJECT SCHEDULING PLANS

REF: STATE 196827

DUE TO CHANGE USAID S DESIGN OFFICER PERSONNEL IN AUGUST, REPORT INFO REQUESTED REFTEL NOT COMPLETED BY AUGUST 28. MISSION WILL ENDEAVOR TO COMPLY WITH REFTEL BY NLT SEPTEMBER 4.
KONTOS

Department of State

INCOMING TELEGRAM

PAGE 01 KHARTO 06143 02 OF 02 - 110842Z 3393 014131 AID3360
ACTION AID-35

ACTION OFFICE AFHA-01
INFO AFEA-03 AFDR-06 STA-10 IDCA-01 PPIA-01 PDC-02 AADS-01
DSAG-02 FFP-03 OFP-01 DRC-01 ES-01 AGRI-01 CIA-05 DOD-08
COM-02 DOE-01 HEW-09 NSC-05 OMB-02 TRSY-05 RELO-01
MAST-01 /073 A2 011

INFO OCT-01 /036 W

311642 110842Z /34

P 110649Z JUL 81
FM AMEMBASSY KHARTOUM
TO SECSTATE WASHDC PRIORITY 1284

UNCLAS SECTION 2 OF 2 KHARTOUM 6143

AIDAC

HOST COUNTRY AND OTHER DONOTS- THE UN SUDANO-SAHELIAN ORGANIZATION IS PROVIDING S 1.6 MILLION FOR THE REAFFORESTATION PROGRAM. THE GOS RURAL WATER CORPORTATIO, AS IMPLEMENTING AGENCY, IS PROVIDING ALL STAFF, BUILDINGS, LAND, ETC. FOR THE POTABLE WATER PROJECT, THE GOS WILL SUPPLY ALL TECHNICAL STAFF, LABOR, LAND, ETC. CARE WILL OVERSEE IMPLEMENTATION, AND WILL BE RESPONSIBLE FOR PROCUREMENT OF ALL EQUIPMENT, CARE WILL ALSO SEEK TO EXPAND THE GEOGRAPHIC SCOPE OF THE PROJECT BY SOLICITING SUPPORT FROM OTHER DONORS FOR ADDITIONAL CAPITAL INPUTS.
MAJOR OUTPUTS- 40 DEEP BOREHOLES SUNK, LINED AND OPERATING WITH RECIPROCATING DEISEL PUMTS. EACH BOREHOLE WILL ALSO BE PROVIDED WITH A 10,000 GALLON STORAGE TANK. 8 SUDANESE TRAINED IN THE OPERATION AND MAINTENANCE OF THE PUMPS AND DIESEL ENGINES.
AID FINANCED INPUTS- ($000) ILLUSTRATIVE BUDGET

COMMODITIES	725
LOCAL OPERATING COSTS	90
CARE ADMINISTRATIVE COSTS	65
TOTAL	880

3. USAID/S REQUESTS AID/W CONSIDER CARE PROPOSAL FOR FUNDING UNDER COOPERATIVE AGREEMENT MECHANISM. USAID/S WILL ESTABLISH A CLOSE COOPERATIVE AND COLLABORATIVE RELATIONSHIP IN TTHE DEVELOPMENT OF THIS PROJECT. TO DATE USAID/S HAS BEEN ACTIVE IN PRELIMINARY PLANNING DISCUSSIONS WITH LOCAL CARE REPRESENTATIVE.
THE MISSION SCENARIO FOR ACHIEVING OBLIGATIONS REQUESTED FUNDS IS AS FOLLOWS:
(A) AID/W REVIEW THIS CABLE TO DETERMINE APPROPRIATENESS THIS PROJECT PROPOSAL FOR FUNDING FROM POLICY PERSPECTIVE.
(B) IF STEP A POSITIVE, SUBMISSION OF CN (IF NECESSARY) BY AID/W USING INFORMATION IN THIS CABLE.
(C) USAID WITH AUTHORIZATION FROM AID/W SUBSEQUENT TO STEPS A & B ABOVE, WILL REVIEW FINAL CARE PROPOSAL AND AUTHORIZE PROJECT.
(D) USAID WILL EFFECT OBLIGATION BY FUNDS BY GRANT AGREEMENT WITH GOS.
(E) UPON OBLIGATION USAID WILL WORK WITH RCO/REDSO/EA TO NEGOTIATE COOPERATIVE AGREEMENT FOR PROJECT IMPLEMENTATION, AN ALTERNATIVE TO STEPS D AND E EXISTS WHEREBY USAID COULD OBLIGATE FUNDS DIRECTLY WITH COOPERATIVE AGREEMENT MECHANISM. HOWEVER, GIVEN ROLE OF RWC AND CLOSE RELATIONSHIP THIS PROJECT HAS WITH GOS/UNSO PROJECT, USAID BELIEVES TIME PERMITTING, THAT FORMAL INVOLVEMENT OF GOS IS PREFERABLE.
KIRBY

COPY

Department of State

TELEGRAM

PAGE 01 KHARTO 06506 211128Z 6796 022488 AID0436

ACTION AID-35

ACTION OFFICE OSHE-01
INFO AAAF-01 AFEA-03 AFOP-02 AFOR-06 PPCE-01 PDPR-01 PPPB-03
PPEA-01 AADS-01 AFDA-01 RELO-01 HAST-01 /036 A1 1123

INFO OCT-01 /036 W

144615 211121Z /34

R 211025Z JUL 81
FM AMEMBASSY KHARTOUM
TO SECSTATE WASHDC 1463
INFO AMEMBASSY NAIROBI

UNCLAS KHARTOUM 6506

AIDAC

AID/W FOR DS/HEA/EH
NAIROBI FOR REDSO

E.O. 12065: N/A
TAGS:
SUBJ: WASH PROJECT REQUEST FOR ASSISTANCE

REF: (A) STATE 278993 (B) KHARTOUM 6143

1. USAID REQUESTS SUBJECT PROJECT SERVICES PER REF (A) TO ASSIST WITH ASSESSMENT OF WATER-RELATED ISSUES ASSOCIATED WITH CURRENT HEALTH PROJECTS AND BROADER WATER QUESTIONS SPECIFIC TO SUDAN. USAID INVOLVEMENT WITH SEVERAL WATER- RELATED ACTIVITIVITIES INVARIABLY LEADS TO QUESTIONS OF ENVIRONMENTAL IMPACT, HEALTH AND SANITATION IMPLICATIONS, WATER RESOURCE COMPETITION, MISMANAGEMENT, ETC.

2. USAID REQUESTS WASH COLLABORATION WITH TWO ON-GOING HEALTH PROJECTS.
- NORTHERN PRIMARY HEALTH CARE (650-0011) THIS PROJECT WILL BE CONSTRUCTING 28 NEW CLINICS IN NORTH AND SOUTH KORDOFAN PROVINCES. EACH CLINIC HAS PLANS FOR WATER/SANITATION FACILITIES. REQUEST WASH REVIEW PLANS FOR APPROPRIATENESS AND MAINTENANCE REQUIREMENTS.
- RURAL HEALTH SUPPORT (650-0032) THIS PROJECT WILL BE CONSTRUCTING 12 DISPENSARIES AND 5 SCHOOLS IN DARFUR, KORDOFAN AND SOUTHERN REGIONS EACH WITH WATER/SANITATION FACILITIES.

REQUEST WASH COLLABORATION AS ABOVE.

3. ~~USAID HAS SUBMITTED PROPOSAL~~ FROM PVO CARE, REFTEL B, FOR A WATER-WELL PROJECT IN NORTH KORDOFAN PROVINCE. USAID REQUESTS ON-SITE COLLABORATION WITH CARE TO REVIEW TECHNICAL QUESTIONS INCLUDING POSIBLE ALTERNATIVES TO DEEP BORE HOLES, AS WELL AS RECOMMENDATIONS FOR MAINTENANCE TRAINING.

4. USAID REQUESTS WASH TO UNDERTAKE DIALOGUE WITH GOS AND UNHCR REGARDING POSSIBLE REFUGEE RELATED WATER/SANITATION PROJECTSIN EASTERN PROVICES.

5. USAID PROPOSES WASH TEAM OF 1-3 PERSONS WORK IN COUNTRY 4-6 WEEKS BEGINNING AFTER RAINS, O/A MID OCTOBER. TEAM SHOULD BE MULTIDISCIPLINARY, ENGLISH SPEAKING, ABLE TO TRAVEL IN RURAL AREAS. FUNDS SHOULD BE PROVIDED TO COVER COST OF TRANSPORTATION WITHIN KHARTOUM. USAID CAN FURNISH ACCESSTO USAID PLANE FOR TRIPS OUTSIDE KHARTOUM, HOTEL ACCOMMODATIONS IN KHARTOUM ONLY AND AIRPORT CLEARANCE. FYI-USAID DOES NOT, REPEAT NOT, PRESENTLY HAVE ENGINEER ON STAFF, THOUGH WE HOPE TO HAVE ONE BY THE TIME WASH TEAM ARRIVES.
KIRBY

WEITHMAN

Please route

Passed to WASH 7/31/81

I am familiar with this project.

Consultants should have physical stamina and high tolerance of hardship. Harry Brown would be excellent on this.

UNCLASSIFIED

Department of State

INCOMING TELEGRAM

PAGE 01 KHARTO 06143 01 OF 02 110814Z 3371 014127 AID3349
ACTION AID-35

ACTION OFFICE AFHA-01
INFO AFEA-03 AFDR-06 STA-10 IDCA-01 PPIA-01 PDC-02 AADS-01
DSAG-02 FFP-03 OFP-01 DRC-01 ES-01 AGRI-01 CIA-05 DOD-03
COM-02 DOE-01 HEW-09 NSC-05 OMB-02 TRSY-05 RELO-01
MAST-01 /073 A2 011

INFO OCT-01 /036 W
------------------311534 110314Z /34

P 110549Z JUL 81
FM AMEMBASSY KHARTOUM
TO SECSTATE WASHDC PRIORITY 1283

UNCLAS SECTION 1 OF 2 KHARTOUM 6143

AIDAC

E.O.12065: N/A
TAGS:
SUBJ: 1974 AFDROUGHT FUNDING FOR SUDAN

REF: (A) STATE 153750 (B) KHARTOUM 5480

1. MISSION HAS RECEIVED PROPOSAL FROM PVO CARE, FOR UTILIZATION OF SUBJECT FUNDS PER REFTEL A.

2. SUMMARY OF PROPOSAL FOLLOWS:
PURPOSE- THIS PROJECT WILL PROVIDE POTABLE WATER TO SMALL FARMERS IN NORTH KORDOFAN PROVINCE, THE PROJECT WILL ASSIST IN COUNTERING THE EFFECTS OF DESERTIFICATION RESULTING FROM OVER-CROPPING, OVERGRAZING AND INCREASING DEMANDS FOR FIREWOOD, AND EXACERBATED BY THE SEVERE DROUGHT OF 1974-1975. IN COORDINATION WITH A GOVERNMENT OF SUDAN/UN SUDANO-SAHELIAN ORGANIZATION (UNSO) PROGRAM TO RE-AFFOREST THE ACACIA SENEGAL (GUM ARABIC) BELT, THIS PROJECT WILL PROVIDE POTABLE WATER FOR SMALL FARMER IN THE AREA, THEREBY INCREASING THE CHANCES OF SUCCESS OF THE GOS/UN PROGRAM, AND ENHANCING ITS IMPACT.
BACKGROUND- GUM ARABIC, EXUDED BY THE ACACIA SENEGAL TREE, HAS LONG BEEN A SOURCE OF FOREIGN EXCHANGE EARNINGS FOR THE SUDAN, AND A SOURCE OF ADDITIONAL INCOME FOR THE SMALL FARMER IN NORTHKORDOFAN PROVINCE. INCREASED DESERTIFICATION" 9SS.',9&69,, HOWEVER, HAS BROUGHT A REDUCTION IN THE SIZE OF THE ACACIA SENEGAL FORESTS, AND A CONSEQUENT LOSS OF BADLY NEEDED INCOME TO THE FARMERS. A REDUCTION IN CROP YIELDS HAS NECESSITATED THE CLEARNING OF MORE FOREST LAND FOR THE GROWING OF FOOD CROPS. A LACK OF POTABLE WATER DURING THE DRY SEASON FORCES MANY FARMERS TO MIGRATE, THEREBY LEAVING THE GUM ARABIC TREES UNTAPPED, AND SEEDLINGS UNTENDED. THE GOS, SUPPORTED BY UNSO, HAS RECENTLY INITIATED A THREE YEAR PROGRAM TO RESTOCK PART OF THE ACCACIA SENEGAL BELT. THROUGH THE PROVISIONS OF NURSERIES, IMPROVED SEEDS AND SEEDLINGS, AND EXTENSION SERVICESS. HOWEVER, THE ABSENCE OF A YEAR-ROUND SUPPLY OF SAFE DRINKING WATR IS A SERIOUS HANDICAP TO THE SUCCESS OF THIS UNDERTAKING, CARE, IN CONJUNCTION WITH THE RURAL WATER CORPORTATION (RWC) OF THE WESTERN REGION, PLANS TO HELP AMELIORATE THE SITUATION BY SUPPLYING POTABLE WATER FROM DEEP BOREHOLES TO THE RURAL INHABITANTS OF THE AREA. THIS WILL REDUCE BOTH THE TIME SPENT OBTAINING WATER AND THE COST OF PURCHASING IT, AND WILL ALLOW THE FARMERS TO REMAIN IN THE REGION THROUGHOUT THE YEAR.
RELATION OF THE PROJECT TO AID COUNTRY STRATEGY
THE PROPOSED PROJECT IS CONSISTENT WITH THE CURRENT U.S. ASSISTANCE STRATEGY AS SET FORTH IN THE FY 1983 CDSS. WITH POTABLE WATER, SMALL FARMERS WILL BE ABLE TO REMAIN IN THE DROUGHT-AFFECTED AREA YEAR-ROUND, AND WILL BE ABLE TO INCREASE THEIR PRODUCTION AND INCOME-A PRINCIPAL GOAL OF AID/S CURRENT STRATEGY. THE INCREASED FOREIGN EXCHANGE TO BE EARNED FROM EXPANDED SUDANESE EXPORTS OF GUM ARABIC WILL HELP TO ALLEVIATE THE COUNTRY'S BALANCE OF PAYMENTS CRISIS- A

KHARTO 06143 01 OF 02 110314Z 3371 014127 AID3349

SECOND MAJOR AID OBJECTIVE.THE PROPOSED PROJECT WILL ALSO HELP TO IMPROVE THE HEALTH OF VILLAGE INHABITANTS IN THE DROUGHT AREA, MANY OF WHOM HAVE SUFFERED ILLNESSES BECAUSE OF THE LACK OF POTABLE WATER.
BENEFICIARIES- THE BENEFICIARIES WILL BE RRURAL FAMILIES IN THE GUM ARABIC PROJECT AREA, WHO WILL RECEIVE A SAFE AND DEPENDABLE DRINKING WATER SUPPLY, OBVIATING THE NEED FOR SEASONAL LABOR MIGRATION, ENABLING THEM TO DEVOTE MORE TIME TO RE-AFFORESTATION ACTIVITIES, THEREBY HELPING TO REGENERATE THE LAND AND IMPROVE THEIR STANDARD OF LIVING. OF THE ESTIMATED 500,000 INHABITANTS IN THE PROJECT AREA, ROUGH CALCULATIONS ARE THAT OVER 150,000 WILL BENEFIT FROM THIS PROJECT.

D. Mendelson (desk officer)
Rm 1061A
632-9714

Received DS/HEA (Dekmon) 7/24/81
Passed to WASH 7/24/81

WASH Proj. Dir.
fyi, discuss
9.WW

rec'd in WASH
7-24-81

APPENDIX B

WASH TEAM TRAVEL ITINERARY

Date	Departure		Flight	Arrival	
Drs. Chandler and Araujo:					
10/16	Briefing in Arlington, Virginia (at WASH office)				
10/21	New York (JFK)	7:10PM	TWA 880	Cairo	1:50PM (10/22)
10/23	Cairo	2:00AM	DS 103	Khartoum	4:30AM
10/29	Khartoum	6:30AM	(USAID)	Juba	10:39AM
10/30	Juba	12 noon	(USAID)	Khartoum	4:30PM
11/04	Field trip to PHCU's north of Khartoum (via Land Rover)				
11/10	Khartoum	6:30AM	(USAID)	El Obeid	7:40AM
11/12	El Obeid	7:40AM	(USAID)	Kadugli	9:00AM
11/15	Kadugli	11:30AM	(UNICEF)	Khartoum	1:00PM
11/27	Khartoum	6:15AM	MEA 375	Beirut	11:00AM
11/27	Beirut	12:15PM	MEA 251	Athens	2:45PM
11/28	Athens	10:45AM	TWA 841	New York (JFK)	4:45PM
1/06	Debriefing in Arlington, Virginia (at WASH office)				
Dr. Lo (as above, with exceptions listed):					
10/29-30	Remained in Khartoum (no additional seats on Juba shuttle)				
11/14	Kadugli	12:30PM	(USAID)	Khartoum	1:45PM
11/16	Left Khartoum for Kuala Lumpur, Malaysia				

APPENDIX C

PERSONS CONTACTED IN SUDAN

USAID Mission/Sudan

Dr. Mary Ann Micka	Health Officer
Ms. Joyce Turk	
Mr. Lynn Sheldon	Engineer
Ms. Michele Foster	Assistant Project Design Office
Mr. Steve Mintz	Project Design Officer
Mr. Jerry Weaver	Refugee Relief Coordinator
Mr. Gary Leinen	
Mr. Art Mudge	Director, USAID Mission
Mr. David M. Bess	AID Consultant
Dr. John J. Gaudet	REDSO, Nairobi
Mr. Bob McCandliss	Juba Office Manager

Ministry of Health, GOS

Dr. Kabbashi	Director General, PHCP
Dr. Ali el Biely	Deputy Director General, PHCP
Dr. Ahmed Mohd. Ahmed Alaba	Assistant Commissioner of Health, Darfur Province
Dr. Heider	Dir. of Epidemiology & Endemic Diseases
Dr. Magda Mohd. Ahmed Ali	Deputy Director, PHCP
Dr. Mohmad Baroudi	Operations Officer, PHCP
Dr. Pamina	PHCP, Juba
Dr. Abbas H. Nasr	Senior National Consultant, Malaria
Dr. Al Hanid	EPI Director
Mr. Tom Ateka	Public Health Officer, Juba
Mr. Mike Lauya	Public Health Officer, Juba
Dr. Abbas Bashr	Director General of Preventive Medicine, El Obeid
Dr. Fareed	Director General of Health Services, El Obeid

United Nations Development Programme

Mr. Dragoslav Zdravkovic	Deputy Resident Representative
Mr. Raouf Gabal Eldin	Assistant Resident Representative

WHO, Sudan

Dr. F. Khan	WHO Resident Representative
Dr. Nabil S. Al Tawil	WHO Senior Advisor
Dr. Jean-Marc J. Olive	Medical Officer, EPI
Dr. Singh	Representative, Juba Office

University of Khartoum

Prof. El Tom	Social and Preventive Medicine
Dr. Asim I. el Moghraby	Institute of Environmental Studies
Dr. Douglas Johnson	Dept. of Geography (Clark Univ., USA)
Dr. Yagoub Abdulla Mohamed	Dept. of Geography
Dr. El Arifi	Dept. of Geography

UNICEF

Mr. Thomas McDermott	Acting Representative, Sudan
Mr. Leif A. Rosenhal	Chief of Water Section, Khartoum
Mr. P. Balasubramanian	Programme Officer, Juba
Mr. Gianni Baciego	Project Engineer, Kadugli

African Medical & Research Foundation (AMREF), Juba

Mr. James C. Paton	Project Manager, PHCP
Mr. Daniel Marwa	Survey & Evaluation Officer, PHCP

CARE

Mr. Stanley Dunn	Resident Representative, Sudan

International Bank for Reconstruction and Development (The World Bank)

Mr. Shawki M. Farag	Former Resident Representative in the Sudan

Catholic Relief Services

Mr. Thomas B. Mulhearn	Director, Sudan Program

Gum Arabic Company, Ltd.

Mr. A. M. Abdel Hai	Secretary to the Board of Directors

Hunting Technical Services

Mr. C. J. Howse	Resident Manager, Khartoum

UNHCR

Mr. Patrick Smith	Assoc. Programme Officer, Eastern Region (Gedaref)
Mr. Ekber Menemencioglu	Public Information Officer
Mr. Christopher West	Engineering Consultant to UNHCR

National Administration for Water

Mr. Khair Alla Mahgoub Khair Alla	Director General
Mr. Ramsis B. Salama	Director of Research and Water Resources Development
Mr. Shawgi Amin El-Sayed	Co-manager, UNICEF/NAW Rural Water Supply Project, Kadugli
Mr. Hamid Hassan	Regional Manager, South Kordofan Province, Kadugli

Department of Forestry

Dr. Farouk Hassan Ahmed	National Coordinator, Desertification Control Coordination and Monitoring Unit

University of Kentucky Team in El Obeid

Dr. Ed Reeves	Project Leader
Mr. Tim Frankleburger	Research Assistant

Western Sudan Agricultural Research Project

Dr. Trent Bunderson	Range Management Specialist

International Rescue Committee

Mr. Ed Schodorf	Environmental Specialist
Mr. Jon Eklund	Administrator, Sudan