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WEST AFRICA
RURAL WATER SUPPLY AND SANITATION
PRE-PROJECT ANALYSIS

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RURAL WATER SUPPLY AND SANITATION

PRE-PROJECT ANALYSIS

with

ATTACHED COUNTRY REPORTS
FOR CHAD, UPPER VOLTA, TOGO

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CHAPTER II	SOCIAL ANALYSIS HARVEL SEBASTIAN
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Chapter 1

WEST AFRICA RURAL WATER SUPPLY

AND

SANITATION PRE-PROJECT ANALYSIS

INTRODUCTION AND OVERVIEW -

GUIDELINES AND RECOMMENDATIONS

Charles Pinec et al

This project was carried out by Pacific Consultants under its AID contract AFR-C-1197. The team consisted of the following four members:

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ACRONYMS

Chad -

BRGM (Bureau de Recherches Geologiques et Minières, (France)

BURGEAP (Bureau des Etudes de Geologie Appliquée, France)

CARE (Ministry of Agriculture and Pastoral Development

FDAR (Fonds de Developpement et d'Action Rural, Chad)

FAC (Fonds d'Aide et de Cooperation, France)

DEFPA (Direction d'Enseignement Professionale Agricole (Min Ag)

MSP (Ministere de la Sante Publique, Chad)

LCBC (Lake Chad Basin Commission, regional)

SERARHY (Service des Amenagements Ruraux d'Hydraulique, Chad)

FED (Fond Europeen de Development)

ORSTOM (Office de la Recherche Scientifique et Technique d' Outre-Mer, France)

WHO, UNDP, IBRD

Upper Volta -

AVV (Autorite des Vallees Voltaiques, Upper Volta)

HAER (Direction de l'Hydraulique et de l'Amenangement de l'Espace Rurale, Upper Volta)

CIEH (Comite Interafricain d'Etudes Hydraliques, regional)

LGA (Liptako-Gourma Authority, Upper Volta, Niger and Mali)

ORSTOM, BURGEAP, BRGM, FED

AFRICARE

OSFAM

UNESCO/ILO

Togo -

DMG (Direction des Mines et Geologie, Togo)

SH (Service de l'Hydraulique, Togo)

RNET (Regie National des Eaux du Togo)

SGR (Service du Genie Rural)

MMEH (Ministere des Mines, de l'Energie et de l'Hydraulique)

MFEP (Ministere des Finances, de l'Economie et de Plan)

FED, ORSTOM, BURGEAP, BRGM, CIEH

CIDA (Canadian International Development Agency)

WHO, UNDP, IBRD

Fed Republic of Germany

1. PREFACE

Rural Water Supply Pre-Project Analysis

This report is the result of studies of rural water supply and sanitation activities carried out in three countries in West Africa, namely in Chad, Upper Volta, and Togo by a team fielded by Pacific Consultants that included a well drilling expert, a geohydrologist, a social anthropologist and a sanitary engineer during the period from November 4 through December 15, 1977. The field study followed the same methodology in each country consisting of (a) preliminary briefing with USAID representatives (b) discussions with representatives of the various national, international, bilaterial and PVO's carrying out the more extensive water supply and sanitation programs in those countries, (c) literature research wherever pertinent publications were available; and (d) field trips to observe water supply and sanitation activities in operation or underway and to consult with the beneficiaries of those facilities.

The study has been undertaken as a preliminary step to the preparation of project papers by USAID in response to requests received from various countries in West Africa for assistance in developing and financing rural water supply and sanitation projects.

At present, assistance for rural water supply programs is being provided to many of the countries in West Africa by international and bilaterial agencies, as well as PVO's using different approaches and techniques, some well adapted to the needs of the people and others which have led to

early failure because of non-acceptance by the prospective beneficiaries or because of high recurrent costs and inadequate operation and maintenance procedures or organizations.

2.0 Objectives of the Analysis

The specific objectives of this analysis are to consider: (a) ongoing rural water supply/sanitation programs in certain areas of West Africa to determine, among other things, their present scope; techniques being used in carrying them out; national, regional, and local organizations responsible for them; international bilateral and PVO's supporting them and extent of that support; lessons that can be drawn from the results; capital and O and M (Operation-and-Maintenance) costs involved in the various types of programs; participation by the beneficiaries and their acceptance of the facilities provided; provision for operation and maintenance and for recurrent costs; manpower needs, and training planned to meet the needs; and research related to rural water supply and sanitation problems; (b) sociocultural patterns of these selected rural populations including factors, such as beliefs related to health, disease, drinking water, and excreta disposal, which may have marked bearing on project success; customs related to cooperative community action, willingness and ability of communities to bear cost (all or portion) of water supply and sanitation, facilities existence of mechanisms to promote community action and experience with same; (c)

methods presently being used to drill or dig wells, their efficiency, the type of equipment being used, problems being encountered, availability of experienced drilling and digging operators, and associated costs; (d) the experience with various types of hand pumping equipment, performance, local maintenance and repair capability, and spare part availability; and (e) to gather information related to water-bearing strata to indicate types of wells and degree and complexity in drilling or digging; (f) <u>based on the findings, to suggest project guidelines and cost data for use in developing specific projects to meet water supply and sanitation needs of rural poor with existing cultural and technical constraints and avoiding pitfalls which have beset such projects in the past</u>.

The water supply portion of the study is focused specifically on programs developed to provide water for humans, domestic use with some consideration being given to providing water for small family gardens and for a few livestock. Water for agricultural purposes, including livestock raising is being provided under agriculturally oriented programs which may be benefited by training and experience gained through the health oriented programs.

1.3. <u>Detailed Analyses</u>

Whereas resume's of the specific aspects of (a) social analysis; (b) water resources and well construction considerations; and (c) well drilling in West Africa are contained in

Chapter I, the detailed analyses of these aspects is contained respectively in Chapters II, III and IV of this report.

1.4 Country Reports

Observations made in Chad, Upper Volta and Togo are reported in Attachements I, II, and III to this report and summarized very briefly in Table I for rural water supply and Table II for extreta disposal. Suggestions for an ideal situation are contained in the same tables. These suggestions are expanded in this report to serve as the guidelines for developing specific projects to meet water supply and sanitation needs as indicated in the objectives above.

RURAL WATER SUPPLY TABLE I - A
December 7, 1977

	Suggested Ideal Situation	Information from 1979-ABS		
		CHAD	UPPER VOLTA	TOGO
Rural Water Supply				
Objectives	Provide water with improved quality in sufficient quantity within financial and technical reach of people served	Extend present program - water supply - drilling & Maint. 1	Improve rural health-provide with water	Improve health, general quality of rural life improve system 1 capacity provide adequate water rural populace
Political or Geographical Subdivisions				
Target Population	Rural poor in groups from 100-5000 pop., one region at a time	Rural poor country-wide min. 300 pop.	Rural poor country-wide AID West 3 Cap's 2545 villages, 1,700,000 pop. Country divided according to donor help	Rural population development pole - small area 3000-5000 pop. selected regions
Gov. Priority	Highest with financial and tech. support for const., O&M	High priority maint. oriented drilled wells	High-particularly for open wells have survey of more than 200 villages. Water supply situation	1st Priority training mid-level-well driller & maint. man, want water too
AID (ABS) Proposed Program Wells				
Open hand dug-new Est. Cost	Only where maint. cannot be assured at present-Just to provide water move to drilled- or protected-wells as soon as possible with adequate maint. assured		Dugpan 200 New 600 Majority open	*Peculiar polluted/potable dug well?? Mix 500 Togo 500 in Benin
Drilled with Hd. Pump Est. Cost		500 + Maint.	Small bore 1500 Large bore 500 Maint. not incl.	Maint. not incl. To encourage local entrepreneur
Drilling Equip. Need Est. Cost				
Pumps Proposed Est. Cost	See results of tests in Ghana, Nicaragua, Costa Rica, Bangladesh	Tyson type-simple, rugged	Investigating types including Vergnet-see Ghana/CIDA investigation $737	
Gravity Systems Springs Reservoirs Treatment	Use when possible Avoid if possible Avoid if possible	No treatment	Few small dams For rural farmer No treatment	Min. of mines suggests reservoirs

1 No mention of sanitation other than water supply. No latrines, no health education, very little community participation.

RURAL WATER SUPPLY TABLE I - B
December 7, 1977

	Suggested Ideal Situation	Information from 1979-ABS		
		CHAD	UPPER VOLTA	TOGO
Water (cont.)				
Catchments Roof/Cistern Hill side/ Reservoir	Short term solution Expensive first cost, be sure of rainfall & catchment area			
Total AID Funding		$2,909,000/ 5 year	U.V. $2,400,000 Other 22,720,000 12,800,000 79.83 37,120,000	$3,000,000 + Nat. $3,000,000 (Benin)
Promotion	Adequate promotion needed before const., during const., and operation	No promotion	Little By PCV.	
Organization/s Responsible 2				
National Level	One organization responsible for national rural water supply prog. schedule, set standards, coord., supervise	F/DAR - SERARHY AID - IBRD SERARHY formally responsible	HER. major part coordinator AW-new wells Several donors	Min. of Mines Coord.-Min. of of Planning Concepts, Programming, find funding Dept. of Rural Dev. incl. water promotion & implementation Min. of Land Dev. carry out plans of Planning Min.
State	Need Decentralization to make liaison with village continuous	None		
Regional		None	PCV. In some 11-ORD's self-help Open wells	
Village	Resp. on village committed. Need village org. Water or health committee	Practically none	Does all work for P.C. wells-Mason supervise	Wells turned over to Min. of Land Development
Construction				
Contract	For difficult well drilling	None	None	None

2 Little mention of maintenance, nor improvement of organization.

RURAL WATER SUPPLY TABLE I - C
December 7, 1977

	Suggested Ideal Situation	Information from 1979-ABS		
		CHAD	UPPER VOLTA	TOGO
Water (cont.)				
Administration	Use, plus self help		Well deepened into rock by HER	
Self Help	Use as much as possible	Practically none	Dig open well to hard rock	Villagers participate
P.C.V. Participation	As trainers	Supervise const.	In some ORD's-supervice, provide cement, reinf. st.	In some areas of country
Maintenance From				
National Office	Supervise-provide spare parts	F/DAR with P.C.V.	Ad Hoc on emergency cases	Min. of Land Development
Regional Office	Provide difficult maint. & preventive	SERAHY with P.C.V.	Some from ORD: should do more	
Local Community	Day to day protection & maint.	Hands-off policy	Simple maint. vary little now	Vary little
Warehouse & Spare Parts	Maint. shop at regional level with spare parts	AID/GOC/PC leave well equipt warehouse plus spare parts for five years	One small shop in capital; no fund for spare parts	
Training				
Well Drilling	Dev. training program, national & regional for drilling, maint., etc. use PCV exp. drill useable wells as part of training	New Proj. 1 admin., 12 well drillers and maintenance Trained by P.C.V.	In well digging, and lining	Min. of Mines wants in Togo middle level practical training well drillers
Mech. & Maint.			Little in maint. provided by HER	Mech. maint. maybe later expand regional
Other		Need to train more for south		To produce wells as part of training
Charge for Water				
Capital	Min charge & labor to obtain water system (winter) funds developed thru village coops	No charge to user	No charge to user	No charge usually except Mr. Winter charges $100 for well installation and villagers pay for repair parts plus B&R for men on job

RURAL WATER SUPPLY TABLE I - D
December 7, 1977

	Suggested Ideal Situation	Information from 1979-ABS		
		CHAD	UPPER VOLTA	TOGO
Water (cont.)				
O&M	Min. Monthly charge for O&M Money to stay in village with local committee	No charge to user	No charge to user	Charge in urban centers
Felt Needs				
Government	Improved			
Felt Needs				
Government	Improved water supply and sanitation	Prefer drilled wells with hand pumps-developing maint. competence	Open wells because of lack of maint. for pumps	
Villagers	(The same)		Want water readily available	
Goals	Comprehensive village survey as basis for long range plan-75% rural people with potable water in 10 years (in villages over 50 people)	No long range program	Have survey of over 7200 villages Basis for long range plan	
Research	Establish a documentation center in research capability. It would: 1) Build a hydrolog survey 2) Develop standardization requirements 3) determine appropriate technology 4) determine roles of different private and international donors.		Varied at CIEH, Vergnet, etc. VTIA working on centrifugal pump, other appropriate technology See report CIDA/Ghana hand pump-2 year investigation	UNDP-has postponed several times proposed GMD water investigation

RURAL EXCRETA DISPOSAL TABLE XI - A

	Suggested Ideal Situation	Information from 1979-ABS		
		DAHO	UPPER VOLTA	FOOD
Excreta Disposal				
Gov. Priority	Consider health aspects	Very low	Very low	100/year Very low-none for schools
AID Priority	Consider health aspects	Practically none evident	None	None
Agency Responsible	Assign existing staff, set up plantel in region to be covered	MH/MPH- 5-Sanit. Eng. 38-Sanit. Tech 5-Sanit. Insp. Staffed to carry out excreta disposal prog.	MH/MPH working through sanit. inspectors-nat. level	MH/MPH - 4 sanit eng. have 1 MDO, 3 in regions Nat. Health Offices could carry extensive program
Methods Used				
Open Field		Generally used	Generally used	Generally used
Inside Compound		Concentrate for new crop		
Pit Latrine	Encourage use of pit latrine for individual families	Women sometimes dig small pit A few squat type installed	Very few const., UNICEF trying to stimulate	6 holes for some schools
Holding Tank				
Septic Tank			Feeling against handling human excreta	
Bucket				Used in some cities
Used for Fertilizer		Not at all except as droppings in fields	Not at all except as droppings in fields	
Programs				
Promotion		No promotion	None	Promotion weak
Social Devel. including teams PCV, MPH & MSA	By health workers and other agents working with village health workers.	MH/MPH, some PAO	Very little	Furnish conc. slab
Installation	MPH thru MH. Dept. furnish cement, steel thru Soc. Deve. teams.	Dig hole, make building	UNICEF with women's group	Dig holes, const. building
Gov. Org.		CARE interested in coordinating AID financed program		
Villagers	Dig hole, make slab & house work w/ teams			
Est. Cost	Slab $6-10 paid for by funds generated thru village coops.			

RURAL EXCRETA DISPOSAL TABLE II - B

	Suggested Ideal Situation	Information from 1979-ABS		
		CHAD	UPPER VOLTA	TOGO
Excreta (cont.)				
Health Education	Soc. Devel. training and Resource teams provide continuous along with village health workers, schools, radio.	No program Steps in progress through schools by adult education AID to provide 400 health workers	Through women's organization	No sustained program
Research	Determine acceptable privy installation, investigate sanitary composting method acceptable to villagers		Composting, collect gas	

CHAPTER I:

RURAL WATER SUPPLY: DIMENSIONS OF THE PROBLEM

1. DIMENSIONS OF THE PROBLEM

1.1 The Questions:

What kind of assistance should the U.S. offer West/Central African countries in developing rural water supplies?

What are the elements of the total system whose end product is an adequate water supply?

Which of these elements exist already, and which need to be created?

What level of technology will the existing systems support now?

What level of technology is desirable and how can host countries be brought to support it?

What elements of the whole should USAID foster?

1.2 Systemic Dimensions

A functional rural water supply system for West and Central Africa's dry Sahel and Savannah lands involves, of necessity, more than a well-drilling program.

Well drilling and digging projects have multiplied in the past, but have not begun to solve the problem of water supply. Where wells have been brought in - without attention to the imperatives of the total system that keeps them operative - the well serves first as a status-symbol, and subsequently as another monument to ineffectual "gift basket" development philosophy. Sooner or later the wells stop working because the necessary operational context is lacking.

To establish a rural water system that can hope to remain viable, in addition to the actual drilling or digging of wells, the following basic elements must be considered. Correlating plans should be made to fill institutional, manpower, educational and material gaps. Factors which must be considered are:

Administration:

An adequate, unified, focussed administrative control system for water resources needs to be established in each country. Clear lines of responsibility should be defined at national, regional and local levels, and appropriate offices and modes of liaison developed. The link between the individual village and the closest pertinent government office should be as short as realistically possible.

Water Plan:

A coherent national water-plan is needed for each participating state. Ideally it should be related to regional (supra-state) planning, and based on sound knowledge of hydro-geologic resources, as well as local area needs. This water-plan should give full consideration to differing local life-styles with their variable patterns of water use. It should relate and respond to competing human, animal and crop-water requirements in these zones where water and development means are both limited. The water-plan should be based on the use of simple designs, intensive in the use of local labor and materials, stimulating the in-country manufacture of desirable hand pumps and well-drilling equipment.

Manpower

An adequate pool of trained rural water supply technicians should be created. Equally designated local-community members will need training in well and pump maintenance.

Maintenance and Supply

A logistics system encompassing supply of spare parts and equipment, transportation warehouse facilities and personnel is essential. Shop and field maintenance capability to service water installations should be developed and maintained.

Community Participation and Access

At the local level, the necessary elements of social organization must exist and be adapted or developed to insure requisite supervision of water installations, including day-to-day maintenance.

Community-wide and equitable access to water should be designed into the system.

Sanitation and Health Education

A well providing potable water, by itself, will not guarantee health.

Health problems posed by various water-sources, kinds of water use (washing clothes, dishes, bathing, watering animals, irrigation practices, play and leisure use), as well as by sanitary practices including waste and excreta disposal, must come to be fully understood in their practical effects by local communities. Health education must be a continuing process, not a one-short campaign.

Decentralization and Local Autonomy

An effective balance should be achieved between local and state control-and-support for vital water resources. Programs should be designed to give local communities necessary autonomy in defining their water problems, which they best understand. It is essential that projects be designed to permit water planning to be tailored to the individual community's perceived needs. Where a standard plan is simply imposed from above there will be minimal local support - either for maintenance or financing - because of limited involvement and irrelevance to felt needs and local social-structure and mores. Local people know better than any outsider the competing needs of people, crops and animals in the face of climactic and seasional water deficits.

A village should --itself--decide where wells should be located, water resources permitting. They should decide how the water supply is to be regulated. They will need to designate a village member(s) to learn to handle daily maintenance.

Financing

Within each community it will be necessary to determine the capacity to pay all - or a share of the costs - both for installation and subsequent maintenance. The current pattern is for all costs to be absorbed by the state. In these poverty endowed communities this translates into broken pumps without replacement parts, well-drilling rigs down useless for six months while programs are indefinitely postponed and people make-do from the marsh or standing ponds.

Most rural communities have some - but limited - contact with the cash economy. Where cash-cropping is done, there is seasonal cash income. Many women - petty trades in the secondary and tertiary regional markets - dispose of a few pennies earned from their commerce in bean-cakes, salt, baskets, etc. Most - though not all - African women have the right to dispose of each earned from their private gardens.*

Accessary planning to develop small industries and sub-regional trade - such as that which AID is considering for Volta's eastern O.R.D. - would engender funds which could service water installation requirements.

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* In Volta, however, the tendancy is for such cash to revert to the eldest man in the family grouping

Elements of the Larger Health Picture:

Any rural development health oriented program planned to conform with the congressionally mandated areas of increased food production and nutrition, health and population planning and human resources development should include provision for the following elements:

Health Education

Potable Water Supply

Sanitary Excreta Disposal

Continuing Operation & Maintenance of Physical Facilities

Community Participation

If one or more of the elements is missing, the expected health benefits will not result or will be seriously diminished. Water supply alone is not enough. Yet many of the projects proposed for AID assistance to rural areas provide only for water supply with no mention of the supporting health education and community participation needed to assure the continuing success of the SE supply programs.

1.3 Optional Program Goals and How They Translate:

The necessity to recognize the sine qua non back-up system faces AID policy-makers with the problem of defining precise goals and determining the limitations for an AID input which can realistically help Savannah/Sahel countries meet their water needs.

Should USAID aim for broad open-ended, or limited goals? To illustrate: Option II, (Limited Wells Program)

AID might choose "To assist hos.-countries to increase existing rural-water infra-structure to a determined level, providing water sources (wells and other) with minimum gross contamination."

Such a goal could translate into a program to provide 7,000 new wells in Upper Volta, in 2,000 community wells in Chad's Tandjile Province.

If such a limited goal were to be set, the AID should propose to:

1. Flag to the host government the necessity to look to other donars and sources for the means to build the other essential back-up elements in an operational water system.

2. Plan a project which would:

a) Dig large-diameter wells, which could be capped and fitted with hand pumps.

In the event of pump break-down, and e absence of spare parts, villa ers w l still have acce : to "improved" water - though no longer necessarily pure if buckets, skins, and gourds are dropped in for hauling. Such wells could - at best - offer potable water. Minimally they would still assure access and convenience. Such wells could usefully be fitted with pulleys and primary minimal equipment.

b) Deepen a given number of wells, or all the wells in a given area. This could return to production existing wells

which, dug by hand or inadequate machinery, penetrate into shallow and vulnerable aquifers which dry up as the water table falls at the end of the rainy season.

Advantages:

1. This limited program would vastly ease life for those affected. For women, the presence of water close at hand in sufficient quantity would free them from much wasteful drudgery, and give them time they might learn to use in other ways to improve life.

2. If this program were designed to incorporate village responsibility from the start, local labor during part of the digging could offset some of the cost of what is essentially an expensive well for reasons of materials cost.

3. This is a well at a level of technology which is largely supportable by the existing knowledge, technology and resource levels in the area: It improves upon traditional wells where they have existed, and is a quantum jump from practices of neolithic water gathering.* It fits into the existing schemes for administration and maintenance**in the three countries visited. It is the well most likely to be useful for the longest period, given the current context.

4. Health benefits should be much improved as long as the pump is intact and the well stays sealed. Equally, if it has become necessary - due to extended mechanical breakdown - to revert to opening the well and hand-drawing water - it

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*Commodity-gathering economies of the late-neolithic and early-neolithic periods immediately preceded the developmental stage of commodity production.

**(Adequate or inadequate)

will still be possible to repurify and seal a well once the higher-technology pump has been returned to order.

Disadvantages:

1. In this schema the emphasis is on acquiring water and health benefits are incidental. It would likely be unprofitable to make a gesture toward a latrines program, for which in most instances neither the conditions nor the perception of needs would provide a receptive climate, and therefore little interest felt by local people.

2. This is intrinsically a paternalistic system, in which the authority (read: donor, then Central government agency) provides. It is an input which - when no longer put in - with a bit of lag-time may cease to be functional - at least at the level desired, because there is an insufficient back-up system to carry it.

In our book, development signifies building the capacity to raise and maintain oneself at a higher level. It is not development when the sustaining capacity is left out.

3. This is a high cost well in - time: (often many months) - materials: a large amount of concrete is used in casings, curbs, etc. - construction equipment: through seemingly the simplest form, this well requires adequate machines to get through hard rock and penetrate to sufficient depth within an adequate aquifer.

4. A further caveat suggests that such wide, open-shafted wells are more vulnerable to climate hazards such as the drought of 69-72.

Option #2. Integrated Water, Health, Community Development Goal

As the polar strategy, AID could seek, through an integrated and phased program, " to assist host governments to ultimately produce self-sustaining systems yielding adequate potable water on a year-round basis to rural areas throughout the country."

This is a broad and open-ended goal, which could nevertheless be approached in manageable fashion, as long as the emphasis is clearly understood to be "to assist" a government in point "to produce (a) self-sustaining system."

Such a goal will generate a very different type of program typically embodied in a set of correlated projects. These should, in their sum, provide for the necessary organizational and resource increment, plus changes in motivation and perception which would serve to "naturalize" a higher level of service and technology within the subject society.

Advantages:

End of Program status would be achieved when:

1. a given number of wells in a given area had been dug-and-capped, or drilled;
2. affected communities had come to understand and act upon (were in a position to act upon) the cause/effect relationship between potable water/sanitation and health rewards.

3. the specified communities had developed the organizational and financial autonomy/resources to maintain water installations in continuous operation, calling upon higher administrative level resources only in case of major breakdown. But equally -
4. a national level infrastructure presenting administrative mechanisms, trained manpower, research/operation correlation, and installation/supply-and-maintenance adequacy had come into being.
5. AID might choose to conceive this as an integrated rural development program within a limited region of the host country; a pilot program could then be repeated in other areas if successful. It should be recognized, however, that regional/local levels will not function adequately without the requisite infrastructure (C.F. #4 above) developed at the national level.

Evidently the above represents the ideal situation, and ultimate goal.

The overall question then becomes: Viewed against the optimum model, and with full understanding of the necessary and sufficient conditions that must exist, how much of this package is it desirable for AID to undertake?

And the questions for any given country will be: Which pieces of the puzzle already exist in the country? What needs to be modified, extended, or reoriented? What extant agencies or programs should become the vehicles? What must be created new? What donors apart from AID can fit into the picture?

Disadvantages:

1. Taken in toto, this is a long-term commitment and an extensive, costly program. Project designers would find it necessary across the range of projects which would feed the program to carefully coordinate definitions of project purpose, and carefully weigh the verifiable indicators designated.

2. Timing and integration of research, manpower, training, and initiation of facilities will be delicate and crucial.

3. There may be political or cultural reasons in a given country why consolidation of control will not be easy to achieve. Water resource allocation is - after all - a vital interest, and its control is a political plum in arid regions. Diffuse control of this power is certainly a current fact in Togo. It will be necessary to find an approach adequate to socio-political realities.

4. The transition from low material-inventory society to high (or higher) inventory status will not be made overnight and attitudinal adjustment is sometimes out-ot-sync.

Cases are know to exist where warehousemen will not send out spare parts and replacements from a stocked warehouse- even though the need is acute - because in countries where useful things are scarce* - the careful conscientious guardian may feel his obligation is to conserve, not to disperse this material treasure.

It takes time for the idea-set surrounding new facilities and services to grow to match the new range of possibilities.

There is a third option possible expecially for regions possessed of fine, sandy or light clay soils.

*i.e. no tin can or plastic bottle is thrown away; everything is salvaged by someone who has nothing.

Option #3. Develop Artisanal Production Capacity

This project would develop local artisan/entrepreneur well-diggers, training them in the use of simple technology alternatives, which basically produce shallow wells.

For example, sludger methods - as described in Chap. IV, p. 160 - use bare minimum equipment, all of which could be produced locally, as well as ingenuity - to produce a small-bore well which uses a simple hand or foot pump.

Where soils permit use of this process, project designers should definitely give it consideration.

N.B. It should be noted that this is a small-bore well, with available water only as good as the functioning of the pump. Therefore, a necessary correlate to this type of program is a provision for realistic pump-maintenance capacity. The latter could be achieved, perhaps by training the local artisanal-well-specialist as a pump repair specialist too - as long as the pump parts can be replaced locally, (ex. the Peace Corps's Tysen pump).

Advantage

Here, human ingenuity enriches the skills-and-products level of the country, developing an adept personnel which - operating with inexpensive materials readily at hand - will provide an essential service. Once mastered, these skills should not be another "import technology" carrying a heavy load of support requirements in its train.

Disadvantage:

These methods are not feasible for most West African "crystalline-shield rock" formations, nor for zones where effective aquifers lie at depths over circa 80 meters.

Recommendation

Project designers - for suitable areas - might develop a dual technical-manpower-training program, producing:

1. Official Water Board Technicians. Their craft would prepare them to construct and maintain "import technology" wells: i.e.

a) modernized large-diameter cement-cased and curbed and aproned wells, to be capped with removable manhole cover and fitted with hand or foot pump.

b) Drilled, narrow bore wells, most likely produced with sophisticated drill rigs. These wells and hand pumps would have to be, of course, back-stopped with full panoply of maintenance shops, logistics, etc.

2. A Complementary Private Sector Artisanal Industry.

This training would produce local specialists equipped to use alternative and simpler methods, as auguring sludger procedures, etc.,* in appropriate districts.

If officially trained, then licensed and controlled through a Water-Board, such entrepreneurs could well be

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* Refer to Chap. IV, Sec. 7.0 and subsequent pages.

integrated into implementation of a National Water Plan.

Further, since in some areas traditional well-digging specialists already exist,* this training and licensing could help to standardize and improve quality and permanency of well construction undertaken in the traditional sector.

N.B. Variants could be worked out on such a plan: Example - Teach local producers to make an improved open well, well-shored against cave-in, stone curbed etc. . .

Range of Alternative Options

Needless to say, between the poles of "least" and "most" programs there is a range of permutations, differing with facilities, assets and existing programs in the various countries. Thus, in Volta, the felicitous concept of the ORD device** has already put in place much of the necessary administrative skeleton and lays the ground for essential programs***.

Existing agencies can be adapted to service water program needs as well. For example, in Volta's Eastern ORD: The MSU Research team would provide a focus for further micro-economic research. Community surveys, motivation and health education could be undertaken through the Bureau for Community Development, or alternatively by adding additional types of agents to the already active Extension Service. The basis for a fully functional Water Board exists in the Ministry of Rural Development in the Dept. of Technology's Office of

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* Notably certain Hausa and Dogon territories.
** Though new and not fully operational.
*** Reader is referred to USAID Document, Poulin, Morton, Mackie Nov/Dec 77: Evaluation of the Eastern ORD Integrated Rural Development Project.

Hydraulic Services, (HAER). The reader is referred to page 30 for criteria on when to select and when to develop an agency, as well as discussion on the process of choice and development.

Ongoing programs with convergent or parallel aims and activities could be integrated with a wells-project. Example, in Togo the Entente financed CERFER regional roads maintenance training program could be used as an existing base to piggy back a regional well-technicians-training-facility. Multi-discipline teams for community surveys, "animation", and health/sanitary education could, in Togo, employ PCVs and draw on the existing cadres formed by the Ministry of Social Affairs fund of "Agents Socials", and Min. Health's categories of "Agents itinerants de sante" and "Agents techniques de sanitation."

Not every program need be undertaken by AID. But a global assessment of related program categories would permit close correlation with UNDP, CIDA, and other donors.

1.4 Hydro Geologic Dimensions: Water Resources and Well Construction Considerations*

Ground water is widely available in the rocks of West Africa and can generally be found in sufficient quantity for the requirements of village wells. In some areas, however, because of adverse geologic conditions or deep water levels, it may not be economically feasible to use wells for village

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* For detailed discussion refer to Chapter III

water supply. Where such adverse conditions exist it will be appropriate to consider alternative water resources such as spring captations, rainwater catchment in cisterns, rainwater harvesting, streams with simple filters and tanks or even surface-water dams and reservoirs (gravity systems) for clusters of villages.

Ground water occurs in four major groups of rocks in West Africa - Precambrian, Paleozoic, Cretaceous-Tertiary and Quaternary. (See map for approximate location of these rock groups). The Precambrian terrains are the most extensive in West Africa. Wells in these rocks will generally yeild enough water for a village supply; that is about o.5 to 1.0 m3/h. About 10 to 15% of the wells, however, put down in these rocks are total failures or yield an inadequate supply for village wells. Consolidated Paleozoic sedimentary rocks, with some important exceptions, are about on a par with the Precambrian rocks as aquifers in West Africa. Well failures are extremely rare and adequate supplies of water for village requirements can be obtained from wells virtually everywhere in these terrains. Deep water levels can be a problem, however, in some areas, requiring special pumps for lifting water. The Quaternary unconsolidated deposits a/ also contain good aquifers and will yield sufficient water for a village well in many parts of West Africa.

Modern dug open wells, from which water is drawn by hand-line and bucket, are now widely used in West Africa to extract

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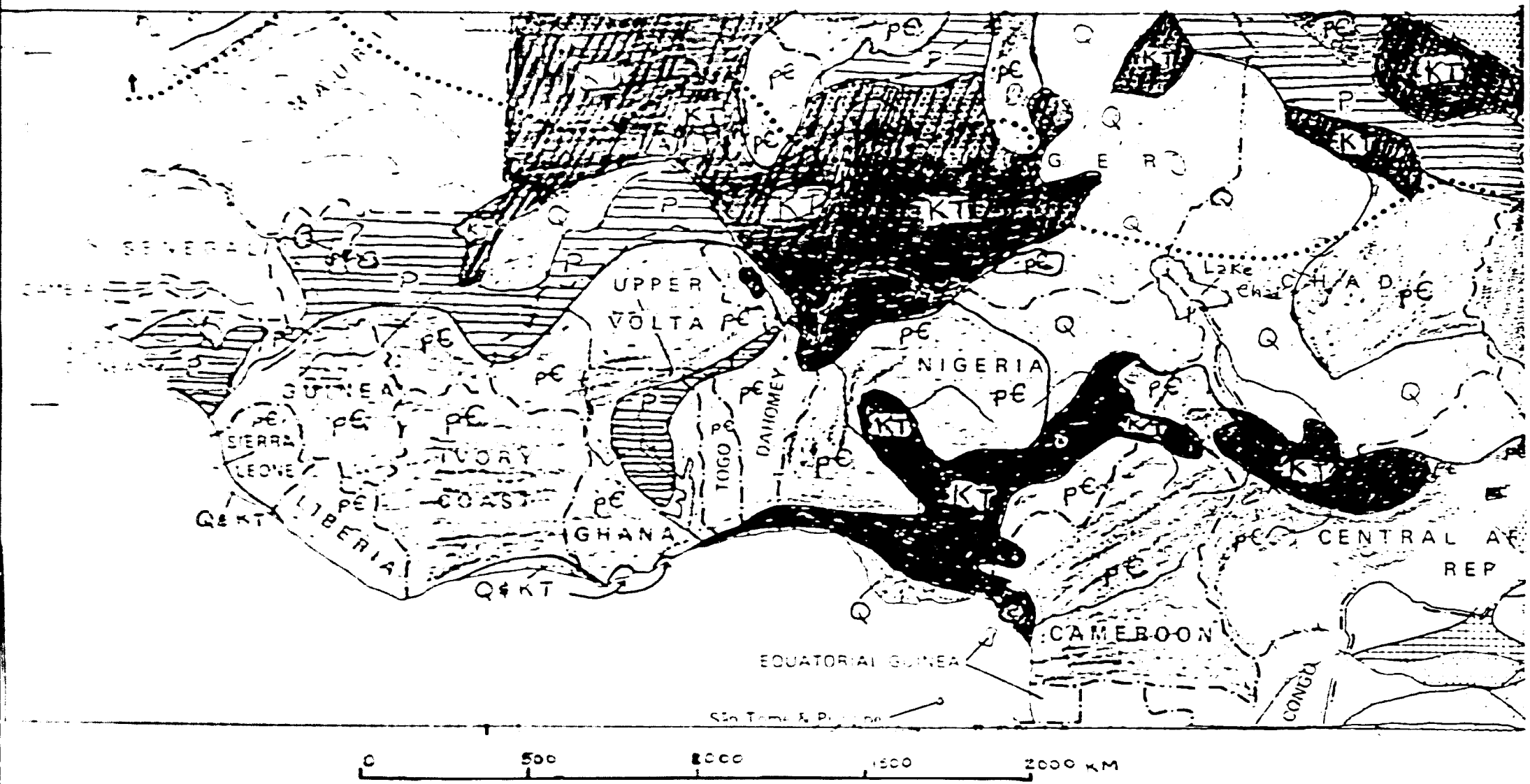
a/ See Glossary, Chapter III



Showing major geological terrains in West Africa

ground water for village water supply. They are a distinct improvement over polluted marigots and unlined traditional open wells of the past. Nevertheless, the modern open well is also easily contaminated when carelessly used. Its chief advantages are a low maintenance requirement and an absence of need for vulnerable pumping equipment. If there is water in an open well it can always be drawn with a hand line and bucket. Recognizing the sanitary limitations of the modern open well and also its high cost [a/] of construction, however, a number of West African countries are now turning to small diameter drilled wells with hand pumps for village water supply. The relative costs [a/] of a 35m modern open well vs. a drilled well of the same depth with hand pump are as follows:

	Modern open well	Small diameter drilled well hand pump
	Total Development	
Chad	$11, 690	$7,700
Ivory Coast	8,750	8,575
Upper Volta	9,625	5,950
Togo	17,500	9,450
Overall in Francophone West Africa	12,250	8,575

The chief advantages of a drilled well over a modern open well are (1) rapidity of construction, (2) ease of emplacement, (3)ease of sanitary protection, (4) lower cost per quantity of water obtained, (5) greater permanence and dependability of the water supply. The major problem is the need for a pump for water extraction from a drilled well. To

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a/ See Chapter III, for fuller discussion of well costs

operate satisfactorily hand or motor-driven pumps must be maintained. Effective maintenance demands trained service crews provided with adequate parts, supplies and transport for pump repair and/or replacement as well as effective support from national and regional organizations concerned with administration of maintenance programs. If any of of its essential components fails to function properly, a maintenance program rapidly becomes ineffective. There are today virtually no hand or power pump maintenance programs in the West African countries which are 100% effective. There are, however, a number of promising programs underway notably in Ivory Coast, Ghana, and Nigeria. They are badly needed elsewhere.
a/

1.5 Information on Hand Pumps

The central water agency should be informed of the (a) different types of hand pumps available; (b) advantages and disadvantages of each type; (c) first costs and frequency of costs of maintenance with the objective of selecting the pump most advantageous for the conditions in the country. It is desirable to select one standard pump for all of the country, thus assuring the ready availability of spare parts.

The types of hand pumps presently in use in West Africa and their relative characteristics and costs are shown in the following table. With the exception of the Vergnet pump all others are of the reciprocating lift type. The Vergnet pump, which operates with a foot pedal instead of a hand lever,

a/ For fuller discussion see Chapter III

has a number of advantages for ease of installation, operation and repair. Slight modifications in the diameter of the piston and the length of the stroke also permit raising water from depths as great as 65 m. Most other types of hand pumps in common use in West Africa are limited to lifts of about 40m.

Make	Type	Max. lift (m)	Max. yield (m)3/h	Approx. Cost (U.S.$)
Abi	M,MR	40	1.0	580
Bodin	Majestic	30-35		
Brian	Africa	(100 (40	(0.3 (0.9	2,990
Moyno		100	0.3	400-500 fob Columbus, OH
Dempster		30-35	1.2	415
Godwin	WIH 51 WIH 54	(100 (40	(0.4 (1.3	1,450
Uganda		(60 (50 (25	(0.4 (0.6 (0.9	?
Vergnet	4C 4A	65 10	0.6 1.7	744
AID/Deep Well		65 (3" cyl.)	0.3 a/	80-125

Another type of hand pump-cum-well has been developed in Chad through the joint efforts of U.S. AID and the Peace Corps. The 2-inch well casing also serves as the pump column. The wells range from 15 to 30m deep with water levels 10 to 25 m below land surface. The Tysen well, as the combined pump-cum well is called, including casing, screen and pumps, costs only

a/ In-country manufacture

$1,500 installed. The maintenance is estimated at $100 per year.

Information is available on the advantages of the AID/Battelle pump and on the possibility of making it in a developing country for use in that country or to supply a regional market. DSB/Eng/H/Wash can furnish details of tests made on the pump in Bangladesh, Costa Rica, Nicaragua, and other places as well as information about the possibility of obtaining technical assistance in setting up local manufacture to produce the pumps using existing in-country simple foundry facilities.

Different pumps are suitable for different sub-soil conditions. A national Water-Plan must therefore designate the pumps which will be used in different regions of the country.

AID might wish to join or augment current CIDA research on pumps for West Africa.

To be noted:

1.) VITA/Ouagadougu is developing a simple hand-pump which employs a new principle to raise water from greater depths.

2.) CIEH/Ouagadongon has established a fund of information on local performance of a variety of pumps.

3.) French-installed deep-wells for livestock are successfully employing solar pumps in the Sahel.

4.) DSB/Eng/H/Wash has extensive information on the advantages and disadvantages of other hand pumps as well, and should be consulted before final decision is made on the hand pump to be used in a specific program. Preference should be given to hand pumps which may be manufactured in the country or region.

Drilled vs. Dug Wells

Thus, in summary, there are many reasons to prefer drilled, narrow-bore, sealed wells utilizing a simple pump such as, for example, the Tysen or the impressive Vergnet model. Drilled wells are less expensive, and offer uncontaminated water as long as proper care is given to provide a sealing well skirt ring, and appropriate drainage. They are less vulnerable to climate contingencies, and seasonally dependable, important matters in a drought-prone area.

They are however, totally dependent on a pump which must be adequately maintained to function, and they offer no fall-back recourse. If the machinery breaks down, the water-supply does not exist. Therefore the back-up system must be adequate if this level of technology is to be established.*

A possible alternative - in a model program - might be to drill one well (small bore) and dig one well (large diameter) for each area serviced. At a planned distance apart, they could be scheduled and fitted out for differential and complementary use. The drilled well would offer potable water for food and drinking uses. The dug/capped well could serve a complex of uses: clothes washing, bathing (shower-laundry installation) animal watering, and ultimately gardening with drainage water. The large diameter capped well would also serve as fall back system in case of slow repair to the drilled well.

Funds employed in such a program would, perhaps not offer as extensive a geographical coverage, but would provide an intensive, quality installation within the zone that AID decides to assist.

* See Sect. 1.2, chap. I, "Systemic Dimensions"

1.6. Machine and Drilling Technology

Chapter IV of this report considers in detail alternative methods of constructing wells. Both wide and small bore well manufacture are discussed. Comparative costs in time, personnel, tools and machinery, productivity, and support systems are presented. As this chapter is brief and concise, the reader is referred to it directly for discussion and cost benefit comparison. We summarize conclusions in the following paragraphs.

1. Viewed from the standpoint of "best available technology" for the region, and the job to be accomplished, the optimum water well drilling rig for West Africa should be of rotary mud-and-air circulation type, with down-the-hole capability. It should be back-stopped with a full range of machine and maintenance equipment. Specifications for all rig and support equipment, operations and costs, in Chapter IV.

A high-technology machine-intensive approach will best be served by this combination.

If AID opts for an Open Dug-Wells Program, skilled labor, dewatering pumps, jack hammers and air compressors will still be required for hard rock terrains. Dug wells must be taken to a depth which will provide a minimum of five meters of water in-the-well, as the water tables drop as much as fifteen meters in the dry season in some places.

AID would find it advantageous to purchase all drilling support equipment from a company which would provide significant to drilling personnel as well.

If AID projects a labor-intensive, simpler technology program, alternative well construction methods are presented in Chapter IV. Techniques discussed include:

1) Hand-auguring
2) Well-point driving
3) Jetting
4) Hydraulic Percussion
5) Sludger percussion

Discussion of each indicates skills, costs, and equipment needed. It should be noted that each of these methods produces a shallow depth well, and all are suitable only for light soils of sand and non-compacted clays. The deepest well of this group would not exceed 250 feet, (Sludger method) in fine formations.

The point is made that a major and fully adequate program should expect to use a small rotary-rig, and full shop, maintenance, logistics, and training support.

An artisanal, small industry fostering program of well production could usefully employ the lower cost alternative methods. The reader is referred to discussion of options on page six and following pages of this chapter.

2. Elements of the System: DISCUSSION

2.1 Water Supply Resources

Alternative Methods for Providing Water to Rural Populations

Water supply for rural communities in the range of 100 to 5,000 population should be approached from the point of view of low cost technology using as much local labor and materials as possible, which does not require costly complicated installation, operation nor maintenance procedures and which can supply satisfactory water at all times, conveniently to the majority of the villagers. These criteria may be met in a number of ways using ground water and water from surface sources.

2.1.1 Gravity Supply

A gravity supply from a nearby protected spring is the simplest to maintain and probably the least expensive to construct and operate.

Sanitary protected spring captations are reportedly installed for rural water supply in the Guinea Highlands, the Atacovian Hills of Togo and Benin, and the Cameroon Highlands.

Such gravity-fed supplies are not widely used in West Africa at present, but could doubtless be developed in well-watered hilly areas such as the Western Guinea highlands, south-western Mali and southeastern Voltai in the Atacovian

Hills of Togo and Benin; in the Mt. Cameroon Highlands of Nigeria and Cameroon; in Camaroon's Adamawa Hills, and the hill country of eastern and southern Chad.

A gravity-spring water-supply program would necessarily begin with a national inventory of springs suitable for development and populations which could thus be served.

Sanitarily protected captations, can deliver water by gravity-pipeline to village fountains on lower ground. Where feasible they offer one of the simplest, healthiest, and often least costly sources of potable water.

In West and Central African arid lands, National Water Planners should find it necessary to exploit all possible sources of water. In susceptible regions local water plans should examine first the potential for gravity systems.*

2.1.2 Surface Water

2.1.21 Surface Water may be obtained from an infiltration gallery located along the edge of a stream, providing filtration from the polluted waters of the stream to furnish potable water for the supply.

2.1.22 Water supplies taken directly from a stream or a pond, however, require treatment which involves costly installations, continuing operation and maintenance under a well trained operator, as well as the use of costly chemicals.*

2.1.23 The development of a water supply reservoir by damming a river invites the spread of schistosomiasis which is prevalent in many parts of West Africa. Moreover, there is rapid evaporation from the surface of storage reservoirs.

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*See Chap. 3, sec. 6.0 and 7.0
*This is a technique least likely to be serviceable, given the necessity to continually import expensive materials, etc.

2.1.24 The disadvantages of open storage can be overcome by storing water in the sand and gravel which generally form the bed of a river. A cut-off wall, sheet piling or masonry, across the stream, reaching to a solid foundation could store the water which usually drains away. The water would be retained in the gravel of the river bed and could be drawn off through an infiltration gallery or well. The water would be naturally filtered and would not be subject to evaporation. The water might be drawn from the infiltration gallery by gravity, or, if necessary, it could be pumped from an infiltration gallery and well.*

2.1.3 Rainwater Harvesting

In some areas it may be necessary to resort to the collection of rain water from roof surfaces or paved ground surfaces. The former can serve individual homes while the latter may be developed for community supplies. In either case extensive storage space is required to store water enough to last during the dry season. These systems are comparatively expensive, but do lend themselves to community participation.**

2.1.4 Wells

Ground water is widely available in some terrains in West Africa in sufficient quantities for domestic village use.***

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*See Chap. III, s. 7.0 and following for discussion.
**See Chap III, s. 7.0 for further discussion and alternatives.
***See Chap. III, s. 1.0 - 4.0 for a discussion of water resources in West Africa.

In some places, these ground water sources have been tapped traditionally by open wells dug by villagers.

One problem inherent in the dug well is the difficulty in deepening the well into the water bearing aquifer to the depths necessary to provide a continuing supply throughout the dry seasons. It may be possible to deepen existing wells with mechanical equipment and this should be considered as one of the alternatives in upgrading and extending any rural water supply program.

The water is raised from the dug well by bucket, water-skins or can on the end or a rope which lies on the ground surface near the well as the rope is pulled up. When the receptacle and rope are lowered into the well again, whatever contamination that exists near the well is introduced into the well and the water becomes contaminated too.

The modern open well is a refined version of the traditional well in that the well is lined, protected by a concrete or masonry apron extending out from the well at ground surface and the lining of the well extends about a meter above the ground surface, thus preventing the entrance into the well of polluted water that may be standing around the well. The modern well is beset by the same pollution problems as the traditional well, resulting from the water being drawn out by a rope and bucket.

To obviate this danger the modern well could be capped with a concrete cover and the water could be drawn from the well by a hand pump. A protected manhole could be left in the concrete cap through which water could be drawn if the hand pump should fail.

It is suggested that the first step toward upgrading a modern well program should be the capping of the well and the installation of a reliable hand-pump, preferably one which could be manufactured in the country. At the same time a two-pronged preventive maintenance program should be launched; (a) assigning and training a local villager to be responsible for maintaining the pump; and (b) developing a back-up preventive raintenance program at the regional level stocked with adequate spare parts and responsible for periodic inspection of the wells and hand-pumps and on call for repairs beyond the capability of the local maintenance man.*

When this maintenance capability has been developed and regular maintenance financing is assured from both local and regional resources, then a drilled well program can be started. It is useless to start such a program until maintenance of the pumps required for drilled wells can be carried out adequately and expeditiously on a continuing basis.

There are many ways to drill a well from the simple handpowered percussion method to the sophisticated down-the-hole air hammer method. One of the advantages of the drilled well is that it can be drilled into the water-bearing strata to a depth which will guarantee a supply of water throughout the year. It is easier to maintain a drilled well free from pollution and it is often times faster, and less expensive to install than a hand-dug well. However, less village participation is possible with a drilled well.**

*Refer to Chap I, p.3, and Chap II, Sect. 4.1.2.
**For fuller discussion refer to Chap III, s. 7.0 and following.

2.2 Water Administration and Operational Infrastructure

2.2.1 A Central Agency Responsible for Rural Water Supply Program And Planning

Community water supply activities for rural populations should be the responsibility of one national agency attached to the most appropriate ministry, or administered through a semi-autonomous rural water authority.* Project designers will need to ascertain carefully the most capable agency to carry the load. In Upper Volta, this will undoubtedly be the HAEK of the Ministry of Rural Development, FDAR might well prove to be the more promising candidate in Chad.

In Togo it will be more difficult to choose one from among the many active agencies.

When to Select, and When to Create an Agency

Select an Agency when:	Create an Agency when:
1) An adequate rudimentary institution exists.	1) a. An adequate rudimentary institution does not exist or b. Too many inadequate competing agencies do exist.
2) A basically adequate organization and hierarchy exist.	2) Existing organizations are not structured to be effective.
3) A basic personnel is already formed.	3) Adequate personnel is not currently available.

*Reader is referred to Chap, II Social Analysis, Sec. 4.0 and subsequent paragraphs for full delineation of recommended program.

Steps In Selecting/Creating An Agency

1. Look for the most likely existing agency on which to base the needed organization.

   a) It should have some
      - similarity of goals
      - experience in the area of activity
      - necessary structural basis.

2. If no adequate agency exists on which to base what is needed, then look for the most suitable people (Training and skills, experience, effective political/or administrative status etc.) around whom to build the new agency.

2a) Determine the administrative level at which the agency must be incorporated into the system if it is to have necessary clout to function effectively.

3. Valurize the "new" agency by designing into its administrative level, and modes of liaison the requisite recognition, support, and decision-making power. This recessitates an adequate understanding of the structure, personnel, and actual operating-modes of the government at hand.

For the above reasons, it would be advisable in Togo to suggest creation of a new organization, a Water-Board apart from, but drawing necessary support seconded from each of the involved ministries. This Board should plug in at the highest level, depending directly from the Secretariat of the Presidence.

President Eyadema has given first precedence to ameliaration of water shortage in water supply services in Togo in the new Development Plan. It is velieved that the device sketched above could go a long way toward establishing a workable frame.

While a number of agencies may be carrying out rural water supply and excreta disposal activities in a country, these activities should be with the knowledge and guidance of the central agency which is designated as the focal point responsible for those activities, and coordinated within a National Water Plan.

The number of government agencies carrying out rural water supply and excreta disposal activities should be minimized to reduce administrative overburden and reduce geographic/ political infighting resulting in program ineffectiveness. Too many government units result in competition for program funds and subsequent breaks in work relationships. It is doubtful if there is sufficient skilled manpower in any of the countries of West Africa to staff more than one agency effectively. The central agency should control where different donor agencies are cooperating such as is being done in Upper Volta where the HAER has divided the country into well-defined segments to which are assigned specific donors that are working through and coordinated by HAER.

It is, of course, highly possible that the Host Government will not be prepared to accept modifications of the status quo. AID would then face the need to decide:

a) How much it could hope to build adequately within the frame provided; and

b) Whether available agencies offer a sufficient base to undertake a project.

Negotiation should be based on these points.

ONE OPTION: A Separate Agency for Rural Water Supply Program

Although there are theoretical advantages to assigning the responsibility for both rural and urban water supply activities to one overall agency, in practice it often develops that the urban systems get the most attention and the largest share of the funds even though there are generally more people living in rural areas. One possible solution to this problem is that a separate agency or department be assigned the responsibility for the rural water supply program.

Development of Long Range Plans, Standards, Guidelines

The central agency should develop long range plans for the rural water supply program geared to reach certain specific goals by certain deadlines, such as suggested by WHO (the WHO goals are guides only for the several WHO regions, with the suggestion that each country set its own goals in accordance with its own situations and possibilities). The central agency should develop standards for different types of water supply, installations and guidelines for building, operating and maintaining those facilities. All agencies should be required to follow the national standards and guidelines.

Survey of Water Supply and Sanitation Situation

One of the first activities of the central rural water supply agency should be to carry out a survey of all the rural populations for which the agency is responsible. Results of this survey should be meshed with information acquired from the recommended Hydrologic Survey* to provide a grid of the country from which planners of the Water-board could allocate resources pragmatically.

It is suggested that a population survey could best be accomplished by villagers themselves. Working with Social Development Teams**local community members could develop a map showing

*A full-field Hydrologic Survey is something which might best be accomplished through French assistance, as they have experts already highly knowledgeable on the area, and have accomplished many studies in these regions.

**Fully described in Chap. II.

1.) population, and its distribution in houses or shelters;

2.) location and condition of existing water-sources now used, with note of adequacy, need for rehabilitation, or for new systems;

3.) houses with sanitary latrines and conditions;

4.) health and education facilities with their location and accessibility by road at different times of year;

5.) availability of electricity.

6.) Competing human, animal and crop needs.

Such an inventory is invaluable in developing a long range plan made up of individual phases.* Such a procedure is being carried out in Upper Volta based on a survey of some 7,500 villages and should be the next step for any country interested in carrying out a rational approach toward solving its rural water supply and sanitation needs.

*It may, however, pose delicate problems. Often, local people fear that any survey may serve to increase their taxes or other burdens; that information about them in the hands of government will make them vulnerable. It will therefore be inperative that they fully understand the reasons for and uses of such a survey, and are agreeable to it.

2.2.2 Decentralization; Effective Management

The ultimate product of a rural-water-program is a water-supply system which must be effective at village base-level. Unless it has been planned by local people to meet local needs the sufficient conditions will not exist to maintain local support.

Thus, an avenue of decision and activity must perforce be sited at community level.

National Government however, must offer the infrastructure and certain resources which provide the necessary overall framework.

Decentralization to Regional Offices

For the most efficient operation, the national agency should work through regional or state offices which are located as close as possible to the villages to be served. Implementation of the operational programs should be delegated to these decentralized offices.* In large countries it may be necessary to have a third level even closer to the villages. The shorter the line of contact from the village to the government agency office, the better chance there is for a successful program. The Dominican Republic is cited as an example of decentralization where a small country is divided into 6 zones with individual zone offices, each responsible for the rural water supply activities of the surrounding villages.

Upper Volta has already established throug the ORDs (Regional Development Offices), a decentralization plan although little decentralization of responsibility for water supply and sanitation activities is still at an early stage of evolution.

*In Volta, the ORDs. In Chad, Canton level in likely candidate; in Togo, the circumscription.

The problem now becomes how to decentralize maintaining effective management.

We feel that one part of the answer is an adequate system design. The other part of this equation is obviously the socio-political field in which the system will operate. If the design is to be effectual, it must be based on a canny assessment of social mobiles operating within the local scene.

For many countries a delicate distinction should be made between the concepts of a "bureaucracy of competencies", and a "bureaucracy of statuses."

1) Game-Plan for the former assumes a dynamic flow of tasking and supervision downward, met with a response of task-oriented production.

2) Game Plan for the latter defines a static set of hierarchical relationships.

The development problem then is how to design the rules which will permit the status-set to operate on the competencies pattern.

Questions:

1) How will the different levels communicate, liase, and synchronize?

2) What will be the effective strategy for supervision?

Ingredients:

Competent decentralization requires:

1) Clear determination of what responsibilities, decisions, and operations are handled at which level.

2) Organization machinery at each level sufficient to cope with the jurisdictional burden.

3) Horizontal communication and integrating mechanisms designed for each level.

4) Vertical communication pathways for instruction, supervision, and materiel.

5) A supervisory system where rewards are based on meeting required production.

6) A well trained, motivated staff with sufficient mobility and support to carry out the assigned responsibilities.

To accurately assess production:

- Written goals should be posited at outset;
- Reviews and evaluations at set points should document progress.
- Rewards should be generated through effectiveness at rural base-level.

N.B. - AID's continuing participation (disbursements, next phases, etc.) should be contingent upon satisfactory counterpart accomplishment.

2.3 Maintenance of Water Supply Facilities

As has been mentioned in several places in the report and is commonly understood, the success of any rural water supply program depends on (a) a continuing maintenance program with a strong preventive-maintenance component locally applied, (b) the capability of responding rapidly to a breakdown; (c) a local capability to make minor repairs; (d) an adequate stock of spare parts stored at strategic locations; (e) at least one workshop where routine repair work may be carried out; and

(f) the assurance of continual financing to guarantee the necessary maintenance of pumping equipment and drilled wells.

Such a maintenance program is absolutely essential where hand pumps are installed on drilled wells. The minute the handpump breaks down and cannot be repaired immediately, the villages are obliged to resort to some other source, probably grossly contaminated, or often located several miles from the village.

A maintenance system such as that detailed above is operated in Chad by the Peace Corps and could be used as an example in setting up similar programs in other countries. Financing of the maintenance operations are included as part of the AID financed project for the life of the project plus leaving the project with fully equipped workshops, vehicles and spare parts for five years maintenance with the continuation of the maintenance program guaranteed by GOC . Unless such a comprehensive system can be developed, the use of small-bore drilled wells with hand pumps should not be considered, for the pumps will soon be onoperative and the capital investment will be wasted.

Payment for Cost of Maintenance

While not a requirement for the installation of water supply facilities in a given village, it would be desirable to establish some form of local financing for the cost of operation and maintenance of the local facility, even if it be only a simple hand pump. For example: A minimal monthly charge could be established in accordance with the wishes of the villagers, to be collected and held in a village account to be used only for maintenance of the pump and well. When the account has

reached a sum sufficient to make any major repairs that might be necessary, then the excess over that amount could be used for other village projects as the villagers might agree.* This gives the villagers a true sense of ownership of the facility and responsibility for its operation and maintenance.

An arrangement should be made with the local water supply or development committee for the payment of an adequate salary for the community water supply technician (probably a part time worker) who has taken the training course. Payment would be made from the monthly contributions made by the villagers for the operation and maintenance of their water supply facility.

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*Some such program is now in progress in a few cotton-producing-villages in Sara-Chad, mostly villages where missionaries are an animating factor.

2.4. Water Quality Control

Inasmuch as the objective of any community water supply project is to provide the users with potable water which is safe to use and free of disease carrying organisms and injurious chemicals, water quality control laboratories are necessary to check the chemical and bacteriological quality of the water. This should be done before a possible source is approved, as soon as the facility is placed in operation and then wherever repairs are required to the facility. At all such times the facility should be chlorinated.

Development of Water Quality Control Laboratories

Quite often the MPH has at least one laboratory for making chemical and bacteriological tests. The project should consider strengthening this laboratory to carry out the necessary water quality tests and by training someone in the required membrane filter techniques.

Regional Water Quality Control Laboratories

In some countries it may be desirable to establish regional water quality control laboratories with adequate facilities, equipment, supplies and trained technicians. A regional hospital might provide the necessary space and some facilities.

Use of Laboratory Test Results

A system should be developed to assure that the results of the water quality tests are used to correct any contamination noted in the water quality. Sometimes the tests are made as a routine practice but are not used to stimulate the required corrective actions.

2.5 Training

Training Component

Each program should contain provision for a strong training component for professionals, sub-professionals and technicians, as well as for village level water supply technicians, and community health workers. Training for each element should be provided as close as possible to the area where the trainee is to work and should be specific to the task he is to perform in the environment where he is to work. A definite need for task and performance oriented training exists. Each training program should emphasize the health aspects of the work and should instill in each trainee the responsibility that he has to serve as a health educator in addition to his basic responsibilities. Supervision responsibilities should be clearly defined and training should be provided for those who are assigned these responsibilities. All too often adequate supervision from one level to the next lower level is lax or non-existent and performance suffers accordingly.*

Training for Professionals and Others

A few carefully selected candidates should be sent out-of-country for professional training in appropriate fields such as sanitary engineering, planning, water resources management, and administration and management of programs, in pre-

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*Refer to Chap. I, pp. 35-37, "Supervisory Management Effectiveness"

paration for responsible positions at the national or operating level. The sub-professionals should be trained in numbers sufficient to meet the needs of the proposed programs and the same applies to the village workers. The length of the training programs should be geared to the time necessary to impart to the trainees the working capabilities needed to carry out their specific assignments, with field practice to strengthen the theory. Shorter refresher courses should be given from time to time for both professionals and sub professionals, also seminars and workshops. Provision should be included in the project to cover the costs of these training elements.

2.5.1 Training Center

With the intensity of African governmental desire for rapid modernization, there will be strong incentives for using small-bore drilled wells to provide water to rural populations. It is therefore important that a rational facility be developed to train well-drillers, mechanics and maintenance men for each country. Such a facility could be developed first for the training of the necessary personnel for that country and then expanded for the training of personnel from other countries in the region in case training facilities are not developed in each country. Schooling should include some theoretical training in the classroom, but with emphasis on actual field experience with the types of equipment recommended in other sections of this report, working in the geological formations existing in the areas from which the trainees come. Formal didactic training for worker levels should be held to a minimum.

Training should be basically task and performance oriented, and coupled with ongoing operational programs for digging/drilling wells as appropriate. Field work should be carried out in areas where resulting wells will meet the need of local villages; thus the training will also result in producing wells.

Location of Training Center

A regional facility could be based on the CERFOR Rural-Road Maintenance Training Institute in Togo, which already operates with ENTENTE funds.

Another possibility is that the location of the training facility could be changed from time to time as the need for wells in a particular area are met. Thus training costs could be absorbed into well production operational program costs simultaneously. It might be advantageous to avoid placing this training institute in or very close to the national capital. Perhaps a secondary town servicing a very water-needy area would be a better location. In Togo this would translate to Dapango in the dry northern Savannah. In Volta this would be west of the Black Volta, in the region where AID has been asked to provide wells, perhaps at Bobo-Dioulasso, or Banfara. In Chad, until the dust settles (sic) from recent political efforts to restore peace, it is difficult to hazard an "optimum location" at this time.

Diplomas for Graduates from Training Center

Diplomas of proficiency should be awarded to the trainees at the end of each course and an attempt should be made to establish a pay scale that recognizes the added skills which each trainee has acquired.

Development of Training Center in Togo

Inasmuch as the Minister of Mines in Togo expressed a clear understanding of the need of a training facility for well drillers and maintenance men and an interest in developing such a program in Togo, it is urged that full consideration be given to such an undertaking. This could be considered as a part of a rural water supply and sanitation program or as a separate project. It is possible that other agencies might be interested in cooperating in such an endeavor, either in setting up and operating the facility or at least in sponsoring participants in the courses to be given.

2.5.2. Training Delivery Service (TDS)

AID/W, DS/H is investigating various existing technical management and training expertise resources for obtaining a central training and management focus in developing countries, to assist in coordinating the improvement of water supply and sanitation conditions and programs in those countries. The objective is to develop a Training Delivery System (TDS) in a country geared to the applicable sections of the population including users, business and service personnel. Water supply and sanitation systems will be established in selected villages as part of the training program so that the Training Delivery Service will train nationals required to carry out all aspects of a water supply and sanitation program and develop the systems required by that program. In addition the TDS will utilize local materials and resources so that most of the parts and supplies can be manufactured in the host country.

The TDS will train the workers who are needed at all levels for water supply and sanitation programs including top level administrators and planners; high level technicians who can handle and maintain the equipment used in carrying out the program plus that installed as part of the program; middle level technicians required for handling various aspects of water supply construction including well drilling, well digging; community residents required to operate and maintain community systems; also teachers to train and communicate with their fellow countrymen the knowledge and skills necessary to construct, operate and maintain their own systems. The training will be basically task and performance oriented at the worker levels coupled with ongoing operational programs.

Training and assistance will be given in applying the various available appropriate technologies listed below:

a. For sanitary dug wells including design, construction, development, operation and maintenance.

b. For simple drilled wells
   (1) auger
   (2) simple cable-tool

c. For design, construction, operation, and maintenance of alternate system
   (1) cisterns
   (2) infiltration galleries
   (3) simple pumping systems
   (4) springs
   (5) river-bed storage systems
   (6) hand pumps
   (7) hydraulic rams

d. For partially or fully automated cable-tool drilling equipment.

e. For rotary drilling equipment

f. For other appropriate technologies

g. maintenance organizations and procedures at national, regional, and local levels

h. health aspects and requirements for each of the above technologies

i. principle of community organization leading to community participation

2.6 Sanitation and Health Education

2.6.1. Excreta Disposal Program

Responsibility for installation of sanitary excreta disposal facilities should normally lie with the environmental sanitation department of the Ministry of Public Health (MPH), and should not necessarily be the responsibility of the same organization which is carrying out the rural water supply programs.

The importance of a sanitary excreta disposal element as part of any rural water supply and sanitation program, reinforced by a strong health education component and carried out with community participation, cannot be stressed too much. WHO[1/] states that "...studies show that improvement of water supplies alone, without concomitant provision of sanitary excreta disposal is much less effective." Excreta disposal by means of a simple latrine (pit-privy) or composting toilet for each family or family group is considered effective and inexpensive.[2/]

The main objective is to dispose of human excrement[3/] which may contain disease carrying pathogens in such a way that it is impossible for humans inadvertently to come in contact with the excreta, to prevent flies and other insects from reaching it, and to make sure that drainage from the pit does not reach the ground water aquifers to contaminate them.

1/ Community Water Supply and Excreta Disposal Situation in the Developing Countries - WHO, 1975.
2/ Excreta Disposal for Rural Areas and Small Communities. Wagner and Lanoix - WHO - 1958
3/ Stop the Fecal Peril. A Technology Review. IDRC Preliminary Report, July 1977.

Pit privies may be constructed in many ways, the simplest being a hole dug in the ground 6 or 8 feet deep, with a platform with an opening built over the hole so that the user may squat over the opening and deposit his urine and feces through the opening into the pit. The platform may be constructed of wood, but preferably should be of concrete as wood soon rots or is attacked by termites. A concrete slab costs about 8 to 10 dollars with wire mesh reinforcing and can be made by the householder with guidance of a CHW* or can be manufactured by EH/MPH in strategic locations throughout the country. The hole can be dug by the householder who can also build the protective shelter from local materials. Hence a simple pit latrine requires very little input from outside the village (cement and reinforcing steel), with all labor and local material being furnished by the householder and with the guidance of a community health worker, or development team member.

The major input from outside the village is a continuing health education program, first to help the villagers understand the need for sanitary disposition of human excreta, relating this to local customs and beliefs, and then continuing emphasis on the proper use and maintenance of the latrines. Unless the latrine is properly used and cared for, it can become a focus for spreading disease instead of a protective facility to improve environmental sanitation.

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*Community Health-Worker

Plant for Manufacture of Concrete Privy Slabs

In some countries the concrete slabs are manufactured by employees of EH/MPH in plants located strategically throughout the country for ease of distribution of the concrete slabs. With proper supervision and control at a regional plant a better slab is assured and it is possible to carry out the program of latrine installations more rapidly than when the concrete slabs are made by the beneficiaries. A full time project or program manager is absolutely necessary to have a successful program.

Public Latrines

Although community latrines ha e been tried in some countries, installed as an element of shower, laundry, latrine, and public faucet complex they have generally failed because of lack of proper, continuous maintenance and have soon become a public nuisance instead of furnishing the hygienic services for which they were designed. Public facilities should be furnished only for public markets, schools and hospitals; responsibility for keeping them clean should be assigned and enforced.

Latrines for Compound

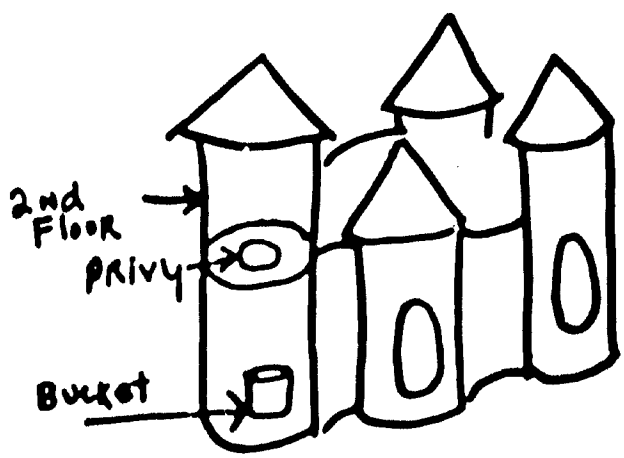
Where family groups live together inside one compound as is the case in some parts of Chad, Togo, and Upper Volta, it is possible to install a single latrine with several openings for communal use. A Peace Corps Volunteer in Togo has developed an ingenuous design locating 4 latrine holes, each in a pie-shaped cubicle, over a common round pit, thus decreasing the horizontal area of the pit to a minimum. Where necessary, the pit is lined with a thin cement/sand layer plastered over a set of horizontal reinforcing

rings slightly smaller in diameter than the diameter of the privy pit. In Togo this installation is being used for schools, but not for individual homes.

Latrines in High Ground Water Areas

Where the groundwater table rises close to the ground surface during the rainy season, it is possible to raise the latrine above general ground level and use a water tight holding tank which must be pumped out when it gets full. This is an expensive but effective method of being used in some of the urban areas of the Maritime Region of Togo.** Bucket privies with frequent emptying services are also used in the same urban area of Togo, similar to the bucket privies used in parts of Asia. As far as is known the collected material is not used for fertilizer but is dumped in a convenient water course or field.

Alternatively, a type of bucket privy could be built and raised above ground in areas where the ground becomes sodden during the rains.



*In several Sahelian areas (examples: Dagari Houses in Southwest Volta, and North-eastern Togo) people build multi-level houses. Local forms of architecture could be adapted.

**This method is complicated for use in most rural areas at the time. More supportable systems would be the bucket privy, or a composting toilet which would have to be developed in a water-tight version.

2.6.2 Health Education

Every water supply and sanitation program should be accompanied by a continuous health education program rather than by a sporadic health education campaign. The responsibility for the health education program should be assigned to the Health Education Department of the Ministry of Health with the authorization to work with, stimulate and coordinate the health education component of all development activities which might be underway in a village. The program should be directed to school children and parents with emphasis on individual and family hygiene plus food sanitation. Fullest advantage should be taken of a CHW and Social Development teams to carry all aspects of health education to the villagers.

Financing for Health Education Programs

Provision should be made in the project to finance an adequate health education program throughout the life of the project to assure that the water supply and excreta disposal facilities provided by the project are understood, properly used and maintained. Provision should be made in other health oriented projects to reinforce this effort.

In Chad health programs are largely at the drawing board stage, but a decision has been taken not to teach health in the schools.

Project designers should therefore plan to work through Village Health workers (AID Project), clinics and MCH centers, and social and agric. extension centers as discussed in attachment I, pps. 54 and 55. Social development teams as proposed in Chapter II, sec. 4.2.2 could be effectively used.

2.7 Community Level Motivation and Participation

The ultimate goal of a clean water and sanitation program is to ameliorate life-quality by improving health. But how, at the community base-level will you bring people to change their patterns of living in order to improve health and life quality?

Motivation

The following things can trigger a community to develop and maintain new ways:

1) A pressing unmet need which they themselves feel.
2) Understanding of a new idea, tool, process; and the sense that it is both applicable and available to their own problem.
3) A way to see it fitting in sensibly with everything they already know and understand about the practical world.

Constraints

Many groups, however, operate within a relatively closed perceptual universe. For them, the system for understanding the world is so integrated, complete, and self-reinforcing that what may seem urgent needs to outsiders will not, for them, generate the next step: i.e., taking the measure to meet the need. It is outside their frame of reference.

Where the universe is not considered an "indifferent system" people will feel that every change may generate its moral consequence. Change activity may be limited by this, and people's "vision of the future will reproduce the immediate past."*

*R. Redfield: The Primitive World and its Transformations

Change-Process

"Every change in men's lives is prefigured by a change in their ideas."*

What really generates change is conflict between ideas and behaviors. In Emerson's words,

"The history of reform is always identical - it is the comparison of the idea with the fact."

It is necessary, therefore, that ideas be changed to contrast possibilities with surrounding facts. This is why health-education must surround people with information about what kinds of sanitary and water-use behavior lead to health or disease. Such ideas, reinforced from as many sectors as possible, will need to become part of a local world-view. A sporadic lecture from the passing Grands Endemies team will not change the idea-set.

Relationship Between Health-Education and Sanitary Excreta Disposal

Around every activity, every tool people use, they weave a web of ideas that give it its place, use, and relation to other things. For new practices like building latrines, or maintaining a well it will be necessary to install not only the facility, but a requisite accompanying idea-set.

In most parts of Africa visited, people did not feel a need for latrines for some of the following reasons:

1. Many rural communities are either small, or dispersed. It is therefore usually possible to go outside the village for one's needs.

*R. Redfield: ibid.

2. Since facilities for clean latrines don't currently exist, a private bush, and nature to efface the evidence, are preferrable to "dirtying" the living quarters. A "latrine techn logy" just hasn't been produced.

3. Where ideas about sickness and health offer moral or social reasons for disease and misfortune, there is no incentive to build latrines to protect health.

Therefore if an environmental sanitation program is felt necessary, the idea-connections will need to be made. This can be accomplished through health-education.

It can also be accomplished through adoption of such ideas by key local people who are the role-models and opinion-setters in a group. For this reason information should be aimed at elders as well as at school-children.

We recommend a social development approach that funnels Health information to all groups. elders, farmers, women, youth-rallies, children, clinic visitors, etc. The ideas need to be presented that protected wells, sanitary-excreta disposal, and healthful water-use behaviors* are a package-all of which is required to keep well.

Installation of family latrines can be done almost completely by the families themselves with some technical assistance from regional offices, social development teams, and a CHW. For fuller discussion, refer to Chap. 1, Sect. 2.6.1.

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* i.e. "If you swim in the Maregot, the resulting schistosomiasis will cause blood in the urine." ...

2.7.1 Community Participation and Organization

Community development means community participation; therefore every opportunity should be provided to take advantage of the self-help potential available in each village.

An awareness of this potential should be stimulated by social development teams and community health workers. Where it does not exit , villagers should establish a community development committee to realize the potential for self-help which exists in the village.

Full community involvement in a project should be planned for, from the time the desire for a particular project emerges: stimulated by health workers, social development teams, or by interest in similar projects carried out in nearby villages or by some other means.

When, with or without assistance from social development teams, a village has decided it wants a better, more convenient water supply and is willing to contribute with labor, local materials and funds, if possible, toward the installation, operation and maintenance of the facility, the local committee conveys the request to the regional water office for approval and assistance in carrying out the project.

One method for securing effective community participation is by inviting village assistance in locating the water source. If two or more wells are to be installed, the villagers to be served by each of the wells should be invited to assist in locating their wells with the technical

assistance of a representative from the regional office

Village participation can play a major role in the manufacture of a hand dug well such as those being installed in many parts of West Africa. Usually labor and local materials are supplied by the village. Sometimes the villagers provide lodging and meals for the mason, supervisor and/or skilled workmen furnished by the regional office to assist with the project. In Upper Volta the villagers dig the open well down to the water level or solid rock, then are assisted in deepening the well by a brigade from the national office supplied with the necessary equipment and expertise to deepen the well.

On the other hand, very little local participation is involved in the installation of a drilled well.

Community participation should not stop as soon as the facility is installed. The community should organize for the operation and maintenance of the facility, even for a simple hand pump installation. An operator should be selected and trained. Arrangements should be made for the villagers to acquire sufficient cash funds to pay the operator, and for the cost of maintaining the facility*

These activities should be followed up by the CHW and supervised by a competent person from the regional level.

Community Organization: Village Health Committees

Key element in any program is a local community organization or committee through which regional development

*See Chap. II, sec. 4.2.1 and subsequent paragraphs.

offices,such as the branch water board, can reach the community and through which the villagers can approach the governmental agency for assistance and guidance. Such a committee may be a community development committee with special sections for health programs, or a committee set up specifically for carrying out a water supply or excreta disposal program. It is through this type of committee that community participation is stimulated and organized. Such a committe might be established within, or work with a local cooperative.

The committee should be legalized so that it can sign a contract for village participation; collect funds; arrange for local material and labor for a specific project; be responsible for the operation and maintenance of the facility when it is installed, collecting and holding funds for the cost of operation and maintenance of the system.

The regional office should maintain close and regular contact with local committees. It should be available at all times to provide technical assistance and guidelines as well as financial assistance at times when problems arise beyond the capability of the village committee members.

The local committee should be supplied with a year's supply of the basic spare parts for whatever hand pump is installed, the spare parts to be replaced by the local committee as they are used. A central warehouse for spare parts, both large and small should be maintained at the regional level.

In most places elements of task or goal-oriented organization already exist.

Volta's eastern ORD has groupments villageois organized at least in theory to permit village-level participation in development decision making.*

In their current status as "precooperatives," they emphasize credit and other services for male villagers, mainly involving and servicing farmers.

These semi-corporate village groups thus provide an incomplete vehicle to service water, health, and micro-industry cash producing efforts. They could, however, provide a base from which to generate the necessary organization of water and health committees, women's cooperative etc., since they already provide a forum.

It should be stressed that older village women in focal positions should be brought into health committees and community health worker roles. In Volta young women have low status, but tend to become effective public opinion arbiters as they grow older.

Togo, in theory, has a village health committee for every village. In operative terms this is not always a representative organization, but may involve the village headman, the school teacher where there is one, and perhaps the dispensary nurse where there is a dispensary. In some areas an important older woman - after referred to as La Cheftaine (female chief) - may participate, and is considered

*Evaluation of the Eastern ORD op. cit. Morton, Mackie, Poulin. p. 25

as the representative of distaff interests. Often the committees exist in name only, and the task will be to foster their effective development.

Only sporadic organization of this sort exists in CHAD. In rice and cotton cash-crop producing areas, marketing cooperatives have often been formed. In some instances these serve as the nuclei to promote health-efforts. Such groups may put money into the purchase of a community medicine-chest. Similar efforts are found in villages where missionary influence stimulates interest in health, clean-wells and sanitation. There is however, no national level infrastructure for health extention work.

In each country, a number of sodalities , i.e. 4-H Clubs, Young Farmers, Women's Unions, Cooperatives, etc - could be employed as vehicles for health-oriented organization, and should be looked toward (where they are present) as vehicles which project-designers might employ.

2.7.2 Development Roles

A set of development roles will need to be fostered in each community.

Community Health Worker (CHW)

As it becomes more and more evident that full community identification with and participation in any project for rural development is necessary for the success of the program, so it is also becoming more evident that there must be some type of community worker, drawn from the community, to serve as the local contact between the government agency and the community. The selection of the CHW for health projects by the villagers and the training by the government agency for the specific tasks to be carried out by the CHW in his/her own village, provides a continuing contact with the village and an opportunity to sensitize villagers to their health needs and the methods available to satisfy those needs through village cooperation with government assistance. In some countries the CHW carry out their tasks on a voluntary basis. In others they are paid a nominal sum. U.S. AID is now proposing to train community health workers for the CHAD.

In Togo the MINHLTH Agents Itinerants, Accoucheuses Auxilliares , and Agents Techniques de Sanitation share the work at the village-level. This is, of course, the "top-down" instead of village self-help option.

The training for CHW should be provided in the region of the CHW, should be completely specific to the activities

to be carried out by the CHW and should be as short as possible, reinforced by frequent refresher courses, seminars and workshops. The CHW should be provided with manuals to cover his various responsibilities. The CHW should be provided with the materials, supplies, drugs, etc. necessary to carry out the assigned duties, and these should be replenished periodically, preferably every three months, and on time so that the work of the CHW will not be limited by lack of supplies. Regular work and contact with social development teams will reinforce community health worker training.

The effectiveness of a CHW will depend not only on the personal interest and training of the CHW but on the type of supervision which he/she is given. This supervision from the regional level is sometimes provided through an auxilliary nurse, sometimes by a health educator who is in turn supervised from the national level, or perhaps through development team MH personnel.

All too often CHW's are trained and returned to their respective villages without adequate supervision and without adequate supplies. As a result the CHW loses his/her enthusiasm and the village fails to receive the benefits expected.

Technical assistance can be provided the CHW from the regional office and by development teams for carrying out

specific programs such as the installation of a well and hand pump, or the installation of latrines. When required, a mason, or a plumber or a work foreman can be provided to assist the villages in carrying out a program. Assistance in organizing the community and on health education matters (two important functions of the CHW) could be provided by Resources and training development teams.

Health Education work of the CHW would be supplemented by seminars organized for the villagers on a regional basis. These efforts might be strengthened through radio broadcasts at specified hours supported by the CHW with charts and illustrative material. Provision should be made in correlated social motivation and development programs to finance these activities. The financing of the CHWs and the training should be part of a correlated AID project, such as is planned in Chad.

2.8 Paying for Water at Community Level*

Most rural African communities are characterized by:

1) A lack, or severe limitation of resources; and

2) Limited, intermittent, and hampered participation in the wider cash economy. They will therefore, be severely constrained in their ability to pay for any services which fall within the modern sector where cash-payment is required. Another set of development roles which AID could seek to foster in an assisted community will therefore be that of artisans and small entrepreneurs and traders. It is expressly signalled that project designers look to help women in these areas, because women's pittances often provide the money now used to purchase water (See Togo report, Attachment III, p.44).

*See Chap. 1, p.10

In many African locales, the women are responsible for providing food and water: A husband often will provide supplies of staple grain, and perhaps meat, but everything else is provided by the woman. Yet - even where there is access to the cash-economy, only certain elements within the community will have this access. They are likely to be landowners (most usually male), other men with crops or goods to sell, perhaps nobles in class/caste societies, or elders who most often detain the group's capital. Women will only have what they can cull from their own small commerce, or from sale of produce from the small private gardens they work, after doing their stint in the husband's cash-crop field. Chapter II, outlines a model project which might be developed in-tandem with a wells project to help established competence at village base-level to pay the costs of water and health-services. Needless to say, this approach need not be limited to women, but should not overlook their needs and potential.

The research required to adequately base and design this type of program (Chap. II,) could, for example, in Volta, be housed within the MSU Research team already at work in the Eastern ORD. An economic anthropologist, or rural economist could be added to the team to survey the traditional trade sector, skills, and production of trade-items etc.

Data generated could be utilized by ORD's Bureau for Economic Analysis and Planning, which should correlate with Social Development Teams and Villagers to define Village options, and design specific plans and goals.

Such a plan would dovetail with recommendations proposed in the recent ORD Evaluation.

2.9 Alternative Implementation Agencies

Cooperation of Peace Corps Volunteers (PCVs)

Peace Corps Volunteers (PCVs) participate in rural water supply and sanitation activities to a greater or lesser extent in the three countries covered by the study. They were most actively involved in a programmed basis in Chad where they were actually carrying out the rural water supply programs being financed by AID through both FDAR and SERAHRY (See Chad report for details of the PC involvement). Their participation started with doing the work while training Chadians who later carried on the work under the supervision of the PCVs. The program includes not only the drilling and installing of wells and hand pumps (including the manufacture of the above-ground components of the pump) but also the maintenance of the pumps and wells installed as part of the program. Maintenance shops are included for both the well drilling equipment and for the well installations. Warehouses are stocked with spare parts sufficient to maintain the pumps and wells for five years after the programs are completed. A maintenance program has been developed and is being carried out by Chadian maintenance brigades. No maintenance work is done by the villagers themselves.

The present program is in the process of being extended for another five years and the GOC is guaranteeing to continue the maintenance program after the programs are completed.

PCV Participation in AID/Chad Rural Water Supply Program

It is suggested that the possibility of using a similar modus operandi in other countries in West Africa be explored with Peace Corps/Washington and, if agreeable to PC/Washington, AID/Washington and USAIDs, be considered as a method for strengthening manpower and carrying out rural water supply and sanitation programs in those countries, it being understood that AID would finance all costs beyond usual PC obligations.

The on-going rural water supply program in Chad could be used as an in-service training ground for PCVs being assigned to similar programs in other countries.

Implementation of Programs through Contract Arrangement

An alternative to using the PC modus operandi discussed above is the system being financed by CIDA on the Ghana Upper Region Water Supply Project, headquartered in Bolgatanga, Ghana. This project is being carried out by W.L. Wardrop and Associates, Ld. of Winnepeg, Manitoba, Canada through a contract with the GURWSP. Invitations for bid were issued and the W.L. Wardrop and Associates presented the acceptable bid. The contract includes the drilling of 2,500 wells, installation of hand pumps plus the design and construction of some urban systems, and includes maintenance of pumps and wells, plus a strong training component to prepare Ghanians to carry on the program after the contract is completed.

Artisanal Production

Pages 13, 14, and 15 of this Chapter discuss the

possibility of developing and strengthening an artisan-entrepreneur level in the private sector which might be integrated into water-production-planning. Such a small business approach to wells-production could operate in complement with large high-capital contractors, or equally with governmental efforts. The former would develop water-resources which could be produced through simple mechanical or labor-intensive means. The latter would approach projects where geologic factors necessitate a machinery -intensive technology.

Private Voluntary Organizations, National and International Agencies

Other agencies involved in water production are specifically discussed in individual country reports, to which the reader is referred.* Among these are private voluntary organizations, religious groups, IBRD, UNDP, and various national development assistance agencies. An elemental function of an adequate Water Plan would be to establish coherence and coordination of multi-donor efforts.**

Phasing

A major water program should unfold in several phases.

Phase I would involve four major activities, at least some of which would be handled through auxilliary or correlated projects, perhaps even through integrated efforts of other donors.

*CHAD: Attachment I, pages 6, 18 & 19
VOLTA: Attachment II, pages 2, 6 & 7
TOGO: Attachment III, pages 2, 4, 5, & 6

**See Chapter II, Sec. 4.1 and subsequent paragraphs.

7.10 Application of Basic Concepts in Developing Country Programs

While the above basic concepts are all considered essential for the development of a successful rural water supply and sanitat n program, it may be necessary to modify some of them in view of circumstances in a particular country, or even leave out some of the considerations during the first phases of a particular program.

3. General Recommendations

3.1 Decision/Action Levels

To promote self help and local level autonomy and for best coordination of efforts, we recommend the following distribution of decision and action responsibility be built into water-systems designs.

3.1.1 At the Village Level

a) First decisions should be made about what the community needs and is prepared to do.

b) Base level social data must be acquired.

c) Hydro-geologic survey, including exploration - drilling, needs to be conducted. Methods to organize these efforts are discussed in Chap II, sec. 4.2.2 and following sections. C.F. also Chap I, p. 52 and following, and Chap I, pgs. 33 & 34.

3.1.2 At the Regional Level

a) A Water-Board Regional Research and Planning Office (Documentation Center) should be able to plan and initiate both social and geologic research. Information and data flowing from research must then be integrated to plan area water-development activity.

b) Plans should then move to the Regional Technical and Supply Office to be put into production. This office should control technical manpower, implementation, and supply.

c) An Office for Coordinated Social Planning should then be able to direct:

1. community health - education and sanitation efforts; and
2. community level economic - resources generation. This latter should be broadly envisaged to include more than cash-cropping efforts. (See discussion in Chapter II, pgs. 57 through 63.

These plans could be carried out variously through social development teams, or extension workers (polyvalent) working in cooperation with villagers. For discussion see Chapter II, pg. 54 and following.

An Integrated Planning Committee should sit regularly to coordinate and synchronize activities of these three offices.

3.1.3 At the National Level

Three major activities should be conducted. These are:

a) Overall future planning. This would involve policy decisions allocating resources to meet competing water needs for human consumption, livestock, and agriculture. Donor efforts should be allocated and coordinated. A documentation center should establish and maintain country-wide records. (For discussion, Chapter II, pgs. 52 & 53, and Chap. I, pg. 72; Research: How to get a "tailor-made" plan.

b) Manpower training must be organized and administered from this level. (Discussion is in Chapter I, p.3, and p.42 through 47 and Chapter II, Sec. 4.2.1.

c) Supply and logistic planning and procurement are national level preoccupations. (Discussions is in Chapters II,s.4.1.2 and Chapter IV, s. 2.0 - 4.0.

d) Provisions should be made in these water-scarce Sahelian countries for National water-board planners to depend administratively from the highest government level. This would suggest a reporting liaison with the Interministerial cabinet or its secretariat.

3.2 Phasing

A major water program should unfold in several phases.

Phase I

Phase I would involve four major activities, at least some of which would be handled through auxilliary or correlated projects, perhaps even through integrated efforts of various donors.

1) Manpower Training

a) Formation of professional and management people to staff Water Board and its Documentation Center.

b) Establish Water-Technician Training Institute, and begin to train technicians.

c) Develop program for, and begin to train Social Development Teams. (See Chap. 2, Sec. 4.2.2).

2) Infrastructure Creation

Plan and begin to develop core administrative structures; i.e., Water Board, Documentation Center, Logistics and maintenance.

3) Research: How to get a local "tailor-made plan"

The "Documentation Center" would be set up to function as an operations-integration and planning focus of communication and integration as well as a records-keeping center. It should be decentralized: a) at the national level it should provide a "memory function." b) At regional level the Doc-center would initiate and supervise research. It would later synthesize data acquired to produce the necessary individualized planning to meet local needs of the area served.

Research efforts would involve: 1) area hydro-geologic exploration, including drilling of test-wells.
2) Population Survey . This could be handled by an anthropologist working with a local counter-part/ interpreter. Usefully, the counterpart could be an anthropology or sociology student who could be trained

thus on-the-job. Optionally, the survey could be generated as the initial efforts of the Social Development teams, who would help villagers to establish their own survey. In this case, questionnaires and Social Development teams should be supervised by a competent social-scientist operating in and from the regional Doc.-Center. This survey could generate much base-line data.

3) Regional and local micro-economic analysis.

(See Chap. 2, Sec. 4.2.3 - 4.3.)

4) Wells Program

Efforts at this stage should deal with rehabilitation of existing wells, and providing dug, capped wells. Where drilled small-bore wells programs are already in hand (ex.: CHAD), they should coordinate closely with manpower training efforts to insure maintenance capacity. They should offer only wells with simplest forms of hand or foot pump at this stage.

Phase II

Phase II should see the full development of the Water Plan, and full operational status of the infrastructure shadowed-out in Phase I. In Phase II, the apparatus should exist to replicate, using the locally individualized planning methods developed in Phase I.

3.3 Specific Country Recommendations

3.3.1 CHAD

The currently proposed AID/PC program in Chad is limited, but self-contained and sound because Peace Corps is training manpower and establishing maintenance and repair capability.

But this program is nevertheless only a bandaid effort. The ultimate development question that must be answered is: When Peace Corps leave, will the existing system be able to indefinitely sustain these wells?

We suggest that elements of the necessary total system are lacking and must be created for optimum water and health results.

Recommendations:

1) AID has begun a project to train village health workers for Chad. We suggest that an element of their training program teach need for, and methods to collect base-line social data. Part of the health workers task would be generation and update of this data, to be reported to the regional documentation center.

2) AID might choose to augment the health worker program with a project designed around the production of Health-Education materials, and a major Health-Education program. This should be a multiple target approach. (See chapter 2, Sec. 4, and Chapter 1, Section 3.8. This project might be undertaken through auspices of C.A.R.E.

3) A subsequent phase of this Health Education project might propose village-level research to determine where latrines could usefully be proposed (and accepted!), and what latrine designs would be effective. We expressly suggest that a sociologist or anthropologist explore these possibilities. Where positive reactions are assessed, a latrines program could be added to the village health-workers bootstrap tools.

4) AID might plan to enlarge upon the Peace Corps Training efforts for well drilling technicians, as these are proving quite successful to date. Perhaps additional training could be offered these technicians in a brief adjunct course; or selected people could be sent to a regional training center (as proposed based on Togo's CERFER.) CAVEAT: There have been problems with regional training in other technical categories, where participating countries have failed to pay their share of costs. Cost and payment feasibility should be carefully examined before choosing a regional training option.

5) AID could propose to help Chad develop the information and planning component of a prospective Water Board.

This would mean building the "Documentation Center" core of hydro-geologic and social information, and the National and Regional offices to utilize this information for water planning. We expressly suggest that research be scheduled to document the use and need patterns of north-Chaddian Transhumant and nomad populations. This could yield information of use throughout the Sahel and desert belt, as well as benefiting Chaddians. It might be quite acceptable to Chad government to promulgate water-resource planning efforts in the way of current peace initiatives.

3.3.2 Upper Volta

In the ORD structures, Volta has established the administrative institutions to permit rational Rural Development; and she has the base for a satisfactory central Water-Board in the HAER service. Further, a completed inventory indicates the numbers and adequacy of existing wells, and the roster of communities to be served. Volta has attracted assistance from at least twenty international and-or-private donors to help provide surely needed wells for the 63% of her villages as yet unserved.

But Volta is exceedingly poor, and has limited resources to fully flesh-out the sensible frameway she has laid down. Since a plethora of donors are already providing wells, perhaps USAID could concentrate its efforts at a more fundamental level.

Volta needs water; but, her real need is to develop a water-supply-system adequate for bad years as well as good, which her own people can sustain and control. And in a region where the major health hazards of schistosomiasis, river-blindness, dysenteries, and assorted parasites abound, Voltian citizens need to understand how to use water and sanitation to help - not undermine - their lives.

1) USAID might wish to help Upper Volta prepare to take the next step.

At this stage, many open, dug wells exist. Since, however, they only penetrate to lesser acquifers, yields are often limited, and many wells go dry yearly. It is frequently necessary to deepen existing wells.

There are, however, in a number of Volta's regions* with excellent water producing Strata (Sandstones and cavenous limestones) which can be penetrated to a depth of about 150 to 200 meters. Tube wells and power pumps are required as hand pumps will generally lift water to only about 40 meters; the Vergnet pump raising water from about a 64 m. depth.

Deep tube wells of this category require:

a) Skilled technicians to construct and maintain them.

b) Adequate machinery (which must be maintained) to drill them;

c) A reliable power source to fuel them;

d) A sufficient management organization to plan and control them; and

e) An effective logistical system to supply repair parts in a timely fashion.

All of this is in short supply in Volta.

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*See attachment II, pgs. 11-16.

But if Volta could develop a scientifically distributed grid of generous deep-wells - perhaps powered by solar energy - she should be able to withstand bad years without disaster.

2) In Volta, AID should give serious thought to real infra-structure development, perhaps leaving major production of wells themselves to other donors in the field.

Peace Corps might be funded to continue a program of deepening existing wells, perhaps to dig a certain increment of new ones yearly. The major thrust of AID intervention, however, could usefully lie in the direction of:

a) training water technologists and well technicians (i.e. Training Institute);

b) outfitting and developing the logistical and maintenance service (i.e. HAER has only 2 well-and-pump maintenance teams for the whole country.);

c) training of villages in water-systems management sample goals--every locale with a hand-pump maintenance man.

d) perhaps developing an artisanal/private sector water-supply competence.*

*See Chapter I, "Options" - pgs. 13 and 14.

3) AID could help research and develop alternative systems, such as:

a) gravity water supply for feasible areas like Southwestern Volta hills-country;

b) rainwater harvesting and stroage (see Attach II, pgs. 28-30.)

4) Health Education delivery through the series of rural development agencies within the Ministry of Rural Development (see attach II, p. 40) could be the focus of a project. As discussed in Chapter I, p. 51, and Chapter II (S. 4.2.1) massive health/sanitation indoctrination - coming from multiple sources - will be necessary to change behavior in this area. Special emphasis on health and water-use could be built into AID projects now being programmed.

5) AID might cooperate with CIDA to develop a chart of adequate hand/foot powered pumps to service each geological terrain. Attention should be paid to research now in hand by VITA, in Ouagadougou.

6) Possible IRD development in the Volta Valley Authority area would offer the limited frameways to try for the whole water/health/sanitation package in new settlements.

3.3.3 Togo

A sizable-body of hydro resource data from recent studies is available in Togo, where an inventory has also been initiated. But Togo badly needs a unified national water-agency, and a unified Water-Plan.

1) Togo has an apparatus for decentralization based on its five administrative regions. All planning, however is carried out at the national level. In effect, it is difficult to decentralize because the rewards system favors, people at the center, in Lomé Administration, liason and supply are all problematic up country. It will be necessary for project planners either to design a system where process and rewards favor competence at the regional level, or to adapt all planning to accomodate intense centralization at the Capital.

Emphasis should be put on processes of liason, supply, and parts-stocking at regional/local levels. Where maintenance and supply programs are now effective, they are in the hands of private agencies such as l'Eglise Evangelique and etc. Project designes might explore with Togolese authorities the advisability of planning to use agencies from the private sector in establishing, maintaining and supplying water-installations in accordance with a National Plan.

2) Because Togo has very limited water-supplies, she will need to exploit all possible alternatives; Rain-water harvesting systems, (as discussed in Chapter 1 pg. 27 and Chapter 3, might provide the focus for a special project. A well-engineered design for appropriate catchment and storage cisterns for a community, which might connect in some sort of fall-back grid, could present very real utility.

Togo is envisaging construction of small dams and reservoirs. This team, concerned with Africa's increasing schistosomiasis hazard, would strongly urge acquifer recharge and underground storage as described in Chapter 1, and Chapter 3.

3) Togo urgently needs more wells, and the thrust of several, active programs (example, CIDA's current efforts) is to provide deep-wells of intermediate diameter (8-10") fitted with power-pumps, and designed to supply a cluster of villages. This approach is prevalent in the densely inhabited coastal plain.

Deep wells are often necessary to penetrate an aquifer sufficiently to yield throughout the dry season. This team believes greater advantage might be offered:

a) By aiming for a ratio of one well per 300 people;

b) By deepening and capping susceptible existing dug wells which no longer yield adequately. (i.e. wells previously dug by AID or IBRD);

c) By developing a design utilizing hand-or-foot pumps in preference to expensive imported gas-powered pumps. Employment of hand- foot-developed energy is less liable to seriously deplete limited water stocks which are often slow to recharge.

Togo has several densely populated areas. AID might consider a program to develop (replicable) model sectors, with plans generated in cooperation with local people, adapted to specific local needs.

If an area within the heavily settled coast were chosen, then health education and sanitary excreta disposal for homes (in addition to schools, markets hospitals etc.) should be-a program sine-qua-non. Many acquifers in this area suffer extensive pollution because of unhealthy waste-disposal practices. Lome itself badly needs adequate sanitary infrastructure to substitute for its very trammeled beach.

4) AID may be asked to construct wells in the area now being freed from onchocerciasis. This currently unpeopled riverine land could offer the basis for integrated rural-development packages, where water-use planning will be a primary concern. Preliminary social analysis of group goals for settlers would be essential, given Togo's mixed ethnicities and cultures.

A water quality control program might best be undertaken, to begin, in such a limited framework. Successful, it could then be extended and repeated. (See Chapter 1, page 40.)

5) We find local-level decision and autonomy an underdeveloped resource in Togo, where most efforts move from top to bottom. AID might wish to assess Togolese interest in community development approaches to health and water construction, education, and financing, such as those presented in this paper, and based on a self-help philosophy.

The first step in such an approach is to be quite sure that wells and/or alternative water-supply systems are fully discussed with and explained to people whom they are to serve. Frequently people do not know basic things about how wells function and their technical operation.

6) AID should explore the possible advantage of combining a regional well-technician training institute with the Togo-based CERFER regional road-maintenance training center. CERFER is funded through the ENTENTE plan, and this could be a pragmatic way to train water technicians as well. Technicians should be trained, however, on types of terrain and equipment which they will later handle.

7) As a final point, we recommend that the Resource-Person/Social-Development Team approach* could offer special advantage to rural Toto. The current system for health-education and social "animation" offer respectively "caretaker", and "recreational" approaches, but could perhaps be modified to good advantage.

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*Chapter 2, pg. 54 for presentation.

PROJECT DESIGNER'S CHECK-LIST #1:

Country Rural-Water-Supply Assessment & Analysis

	COUNTRY HAS	DOES NOT HAVE	NEEDS TO ACHIEVE
I. National Level:			
1. Adequate, unified Administrative Agency			
Decentralized Decision making/ Implementation			
2. Water Plan			
a) Data on: Regional, Hydro-geological			
Local life-styles, desires, competing water needs.			
b) Integrative planning Mechanism			
3. Trained Manpower; to Manpower Training Facilities			
4. Maintenance and Supply System			
II. Wells and Alternative-Water-Supply Construction & Development			
1. Existing Infrastructure (Breakdown regionally)			
2. Is requesting from USAID			
3. Is requesting from other donors			
4. Level of Need			
5. Desirable Level of Response			
6. USAID-Policy Envisaged			
III. Correlated Development Programs at Regional and Local Levels			
1. Organizations with which to deal such as Health and Water Committees.			
2. Provision to assure equitable access and adequate maintenance.			
3. Provision for Health and Sanitation Education and Construction.			
4. Capacity to engender cash to meet costs.			

PROJECT DESIGNERS CHECK-LIST #2: (pairing)

Type of Installation	Necessary Back-stop-system	Necessary Correlating Programs	Notes & Comments
1. Gravity Supply			
2. Surface Water			
a) Stream w/infiltration Gallery			
b) Direct Stream or Pond Off take (pg. 136)			
c) Reservoir Surface Sob-soil Storage			
3. Rainwater-Harvest			
a) Roof Catchment w/cisterns (pg. 135)			
b) Eastern Dams			
c) Hillside collection (pg. 136)			
d) Hafir(impluvium)			
4. Wells			
a) Dug, wide-mouth well Open Capped, in Hand-pump			
b) Drilled, narrow-bone well a. Hand or Foot pump b. Gasoline pump			

PROJECT DESIGNERS CHECK-LIST #3
Threshold Conditions

If A, B, C,...N, Exist:	Then the System can Carry:	Notes & Comments, CAVEATS

PROJECT DESIGNER'S CHECK LIST #1:

Country Rural-Water-Supply Assesment & Analysis

	COUNTRY HAS --	DOES NOT HAVE	NEEDS TO ACHIEVE
I. National Level:			
1. Adequate, unified Administrative Agency			
Decentralized Decision making/ Implementation			
2. Water Plan			
a) Data on: Regional, Hydro-geological			
Local life-styles, desires, competing water needs.			
b) Integrative planning Mechanism			
3. Trained Manpower; to Manpower Training Facilities			
4. Maintenance and Supply System			
II. Wells and Alternative-Water-Supply Construction & Development			
1. Existing Infrastructure (Breakdown regionally)			
2. Is requesting from USAID			
3. Is requesting from other donors			
4. Level of Need			

	COUNTRY HAS	DOES NOT HAVE	NEEDS TO ACHIEVE
5. Desirable Level of Response			
6. USAID-Policy Envisaged			
III. Correlated Development Programs at Regional and Local Levels			
1. Organizations with which to deal such as Health and Water Committees.			
2. Provision to assure equitable access and adequate maintenance.			
3. Provision for Health and Sanitation Education and Construction.			
4. Capacity to engender cash to meet costs.			

PROJECT DESIGNERS CHECK-LIST #2: (pairing)

Type of Installation	Necessary Back-stop-system	Necessary Correlating Programs	Notes & Comments
1. Gravity Supply			
2. Surface Water			
a) Stream w/infiltration Gallery			
b) Direct Stream or Pond			
Off take (pg. 136)			
c) Reservoir			
Surface			
Sob-soil Storage			
3. Rainwater-Harvest			
a) Roof Catchment			
w/cisterns (pg. 135)			
b) Eastern Dams			
c) Hillside collection (pg. 136)			
d) Hafir(impluvium)			
4. Wells			
a) Dug, wide-mouth well			
Open			
Capped, in Hand-pump			
b) Drilled, narrow-bone well			
a. Hand or Foot pump			
b. Gasoline pump			

Chapter 2

West Africa Rural Water Supply and Sanitation Pre-Project Analysis

SOCIAL ANALYSIS

Harvel Sebastian

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2. Maps

Ethnic areas and population distribution are indicated. Where available, vegetation maps have also been included to give some indications of rainfall zones with accompanying catchment and recharge possibilities. Latter information must be viewed in connection with seasonal cycles. The presence or absence of the "little rains" - as in Togo - will often push food and water marginality into the famine and drought range; and several meager rainfall years in dry savanna, sahel, and sudanic regions, where great variation in quantity and distribution of rains mark the climates, can be catastrophic, viz. the case of the 1968 to 1973 period.

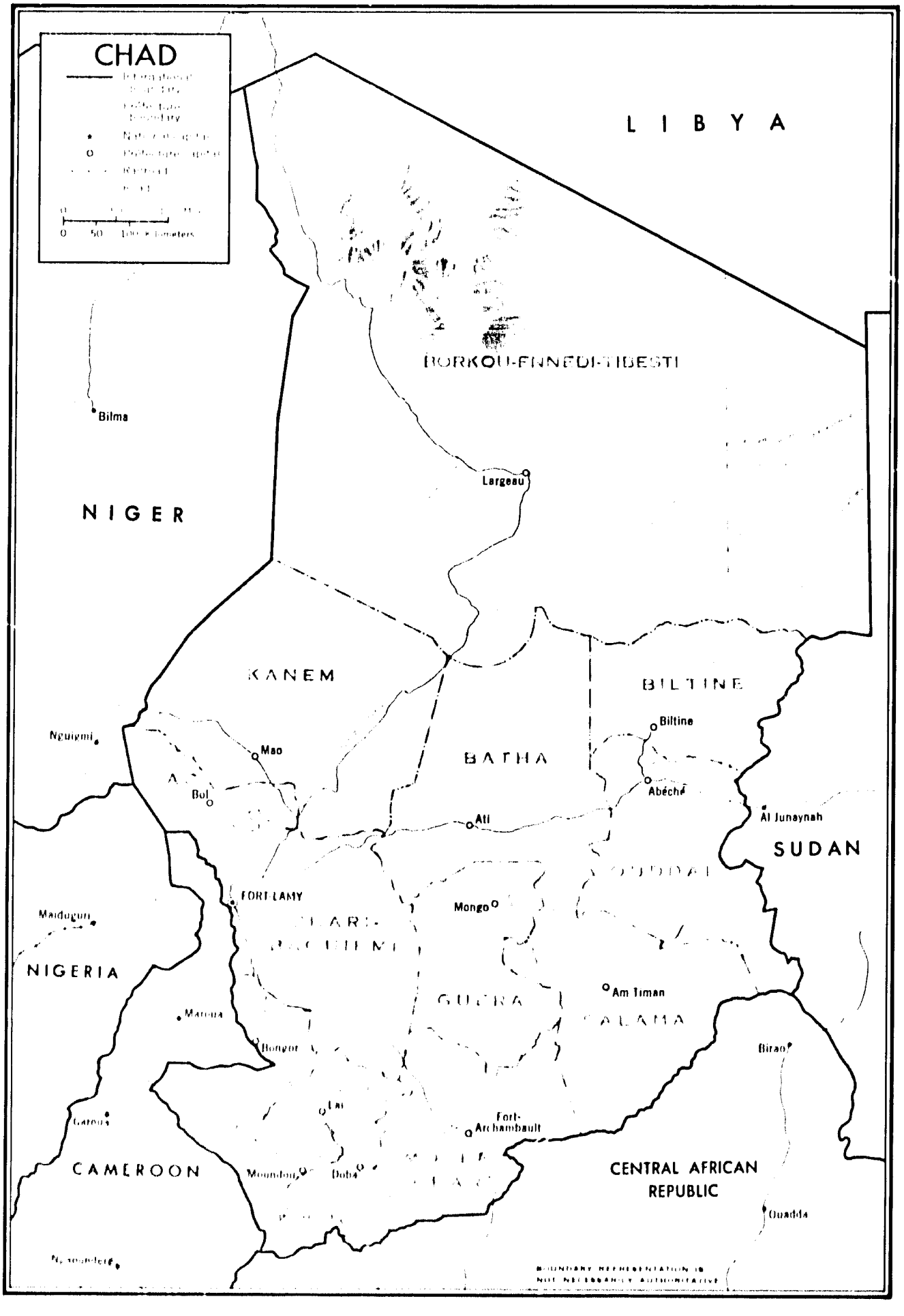
Seasons

Chad: Rains begin in the south in March, and around N'Djamena by April or May. They are heavy in July, August, September, slackening from Mid September till the end of October when they finish. They are of course heavy in the south, and diminish regularly as one goes to the north, until one reaches the 200 millimeter precipitation line which marks the beginning of true desert at roughly the 18th parallel.

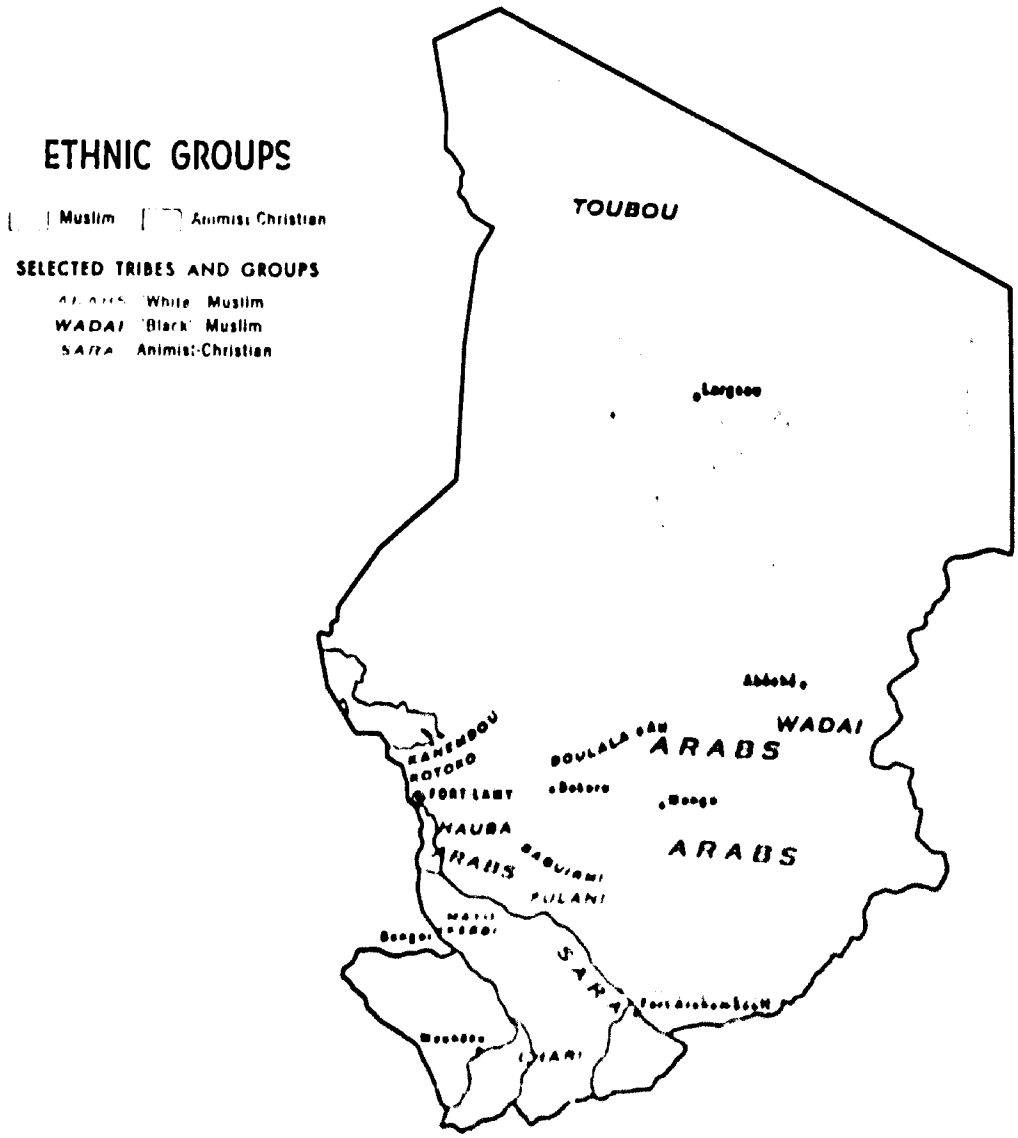
Upper Volta: Volta has what is characterized as a Sudanic climate, which is dry from about mid November to mid April. In the south, the rains begin around the 25th of April, and these areas have a range of 80 to 95 rainy days during the season.

The central part of the country, with approximately 60/70 days of rainy season, sees the debut of the wet season about the 25th of May. In the north, in the region of Goram-Goram, rains begin between the 15th and 30th of June, and the wet period runs for about 40 to 50 days yearly.

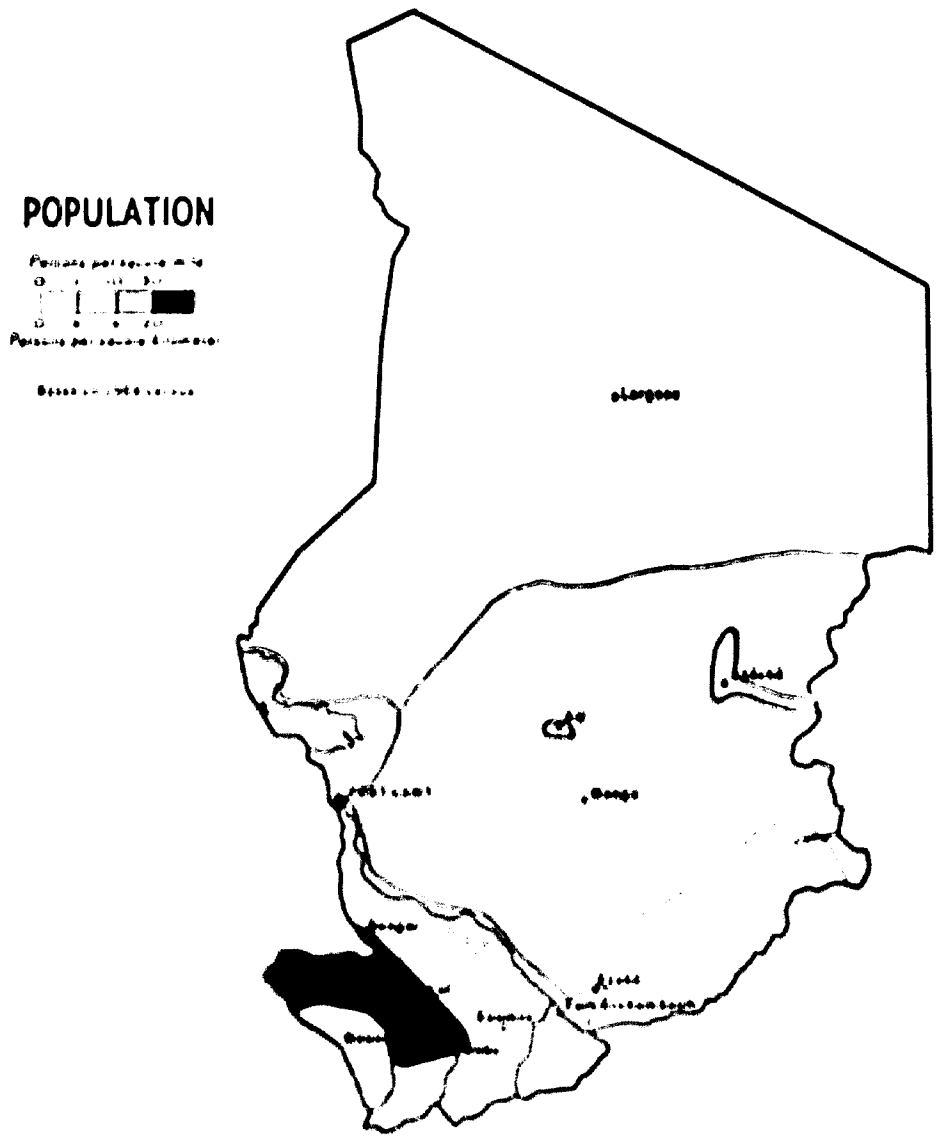
Togo: In the Maritime region of Togo, the major rains fall from March through July, and the little "Corn" rains come for several weeks in September/October. Central Togo and the northern savannas have one rainy season between April and October. Where they exist, the small rains come at the necessary interval after planting to ensure the ripening of the staple grains. When they fail for even one year, hunger and rising food-prices stalk the average household. Famine is never far away in these regions of little water.

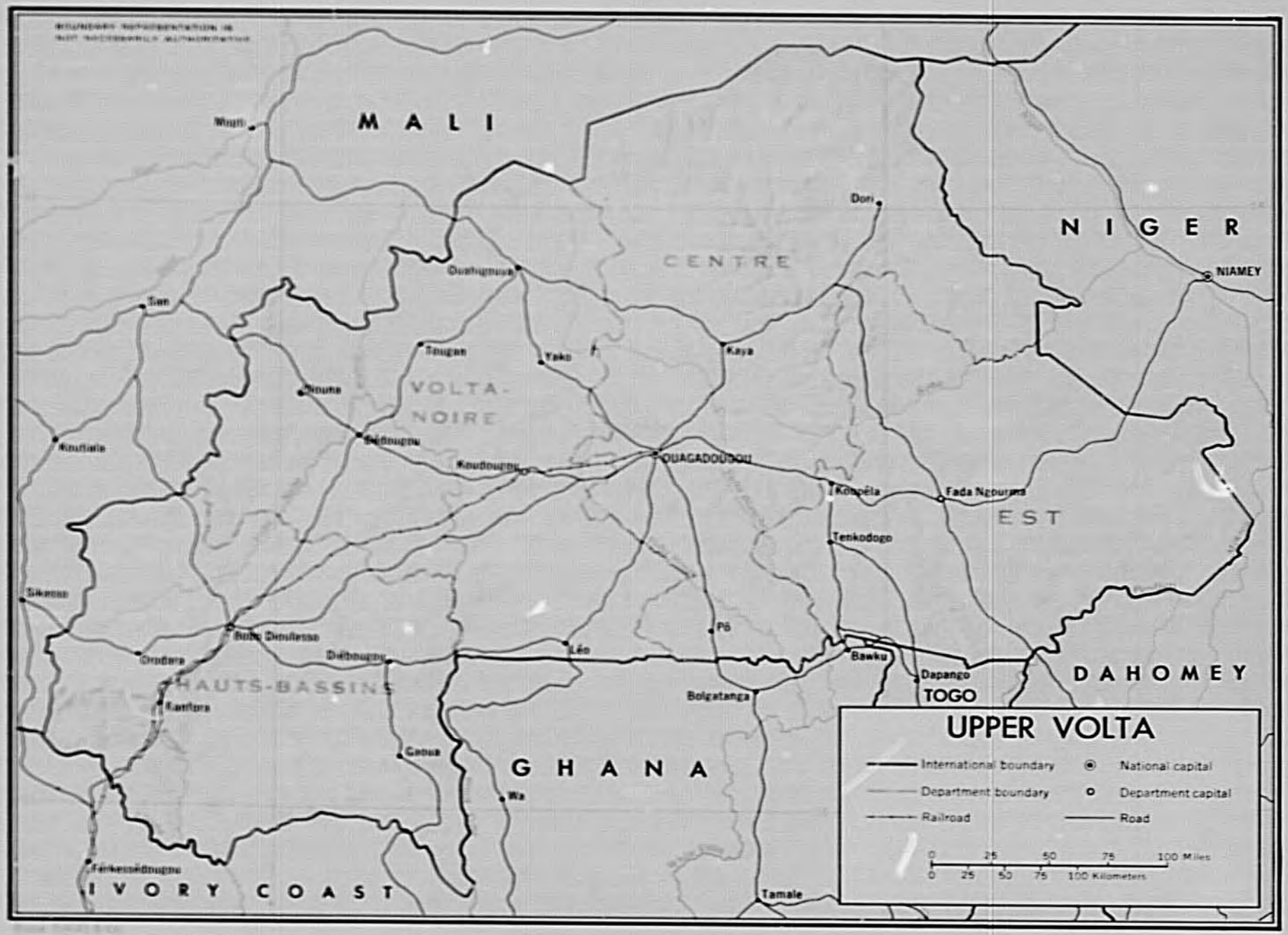

CHAD
0 50 100 Kilometers
LIBYA
BORKOU-ENNEDI-TIBESTI
Bilma
Largeau
NIGER
KANEM
BILTINE
Biltine
Nguigmi
Mao
BATHA
Bol
Abéché
Ati
Al Junaynah
SUDAN
FORT-LAMY
Mongo
Maiduguri
NIGERIA
GUERA
Am Timan
Mandoul
Bongor
Birao
Lai
Garoua
Fort-Archambault
CAMEROON
Moundou
Doba
CENTRAL AFRICAN REPUBLIC
Ouadda
BOUNDARY REPRESENTATION IS NOT NECESSARILY AUTHORITATIVE

CHAD
Ethnic Groups

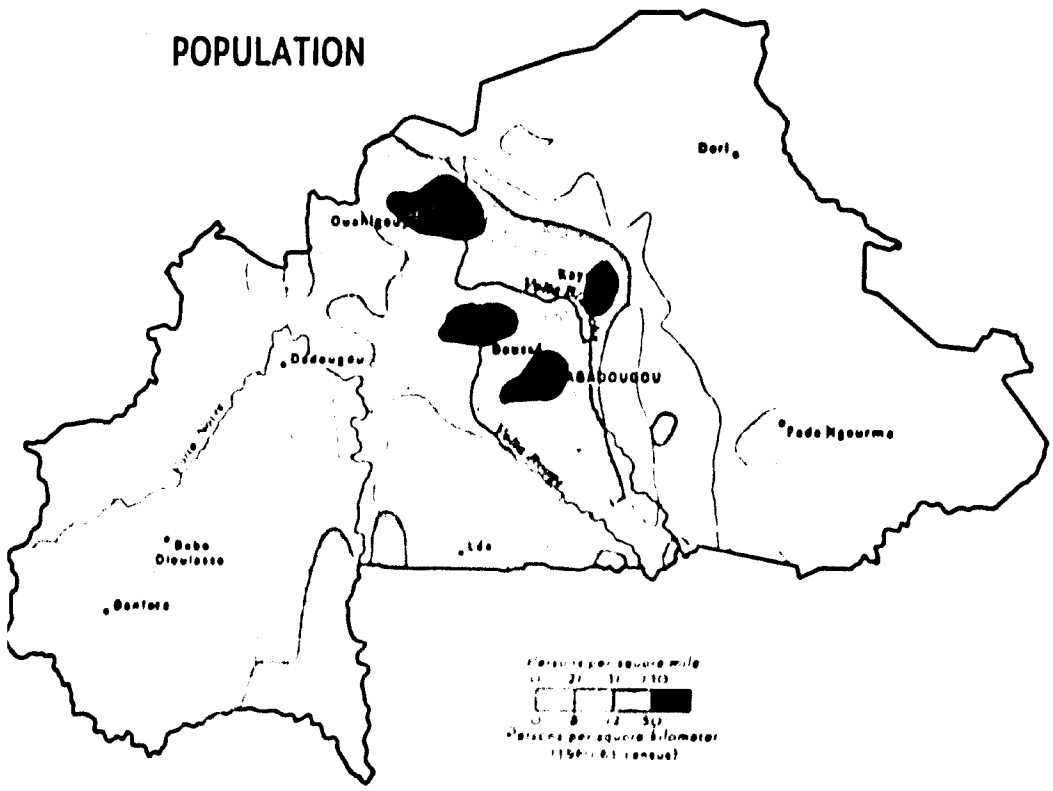


CHAD
Population

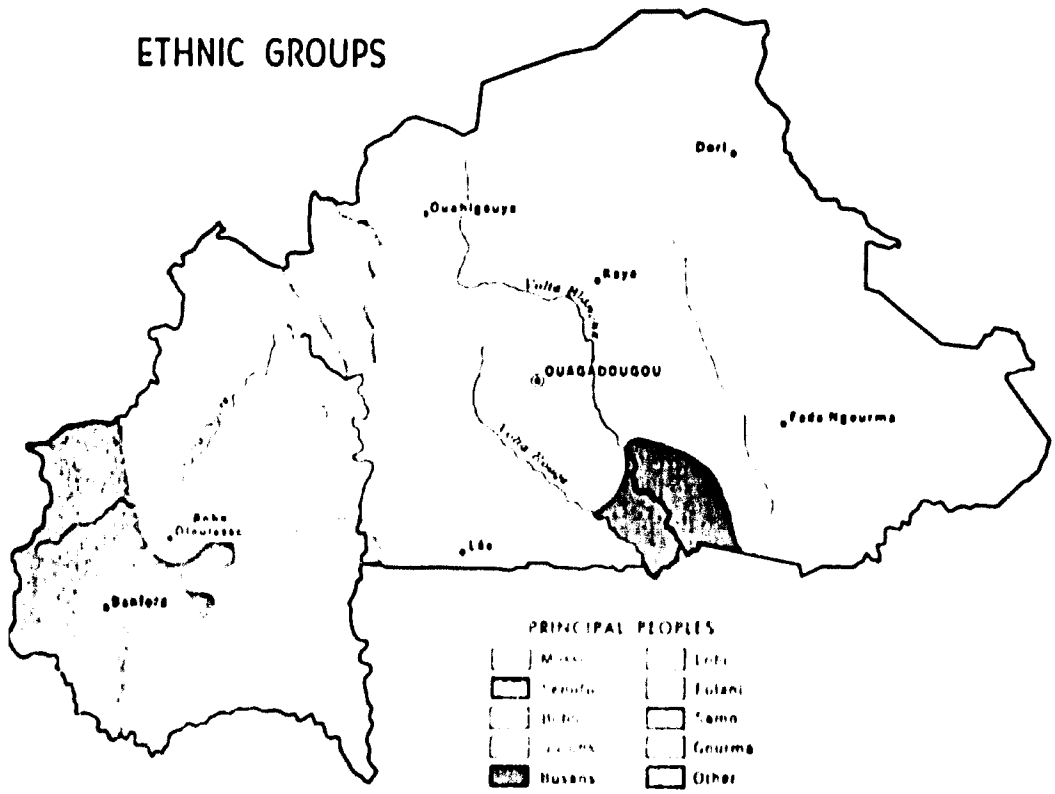



UPPER VOLTA
International boundary
Department boundary
Railroad
National capital
Department capital
Road
0 25 50 75 100 Miles
0 25 50 75 100 Kilometers
MALI
NIGER
DAHOMEY
TOGO
GHANA
IVORY COAST
CENTRE
VOLTA-NOIRE
HAUTS-BASSINS
EST
NIAMEY
OUAGADOUGOU
Dori
Kaya
Yako
Tougan
Dédougou
Koudougou
Koupéla
Fada Ngourma
Tenkodogo
Pô
Léo
Bawku
Dapango
Bolgatanga
Tamale
Wa
Gaoua
Bobo Dioulasso
Orodara
Banfora
Diébougou
Sikasso
Koutiala
Sun
Nouna
Mopti

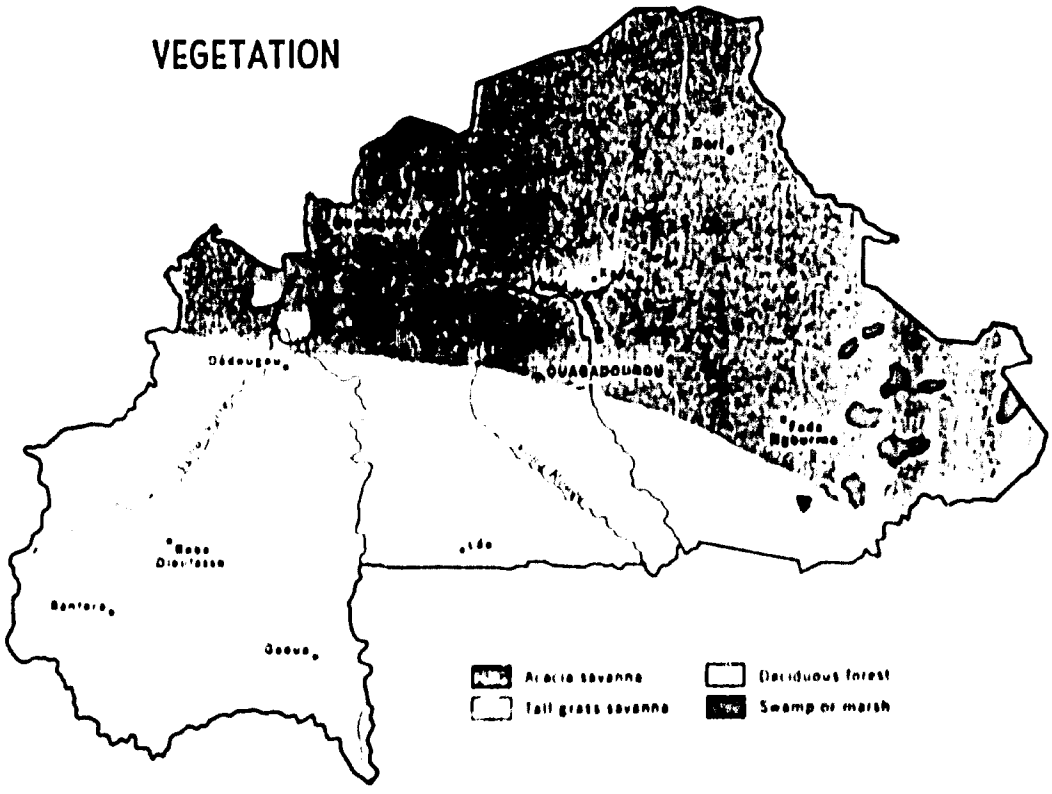
U. VOLTA
Population

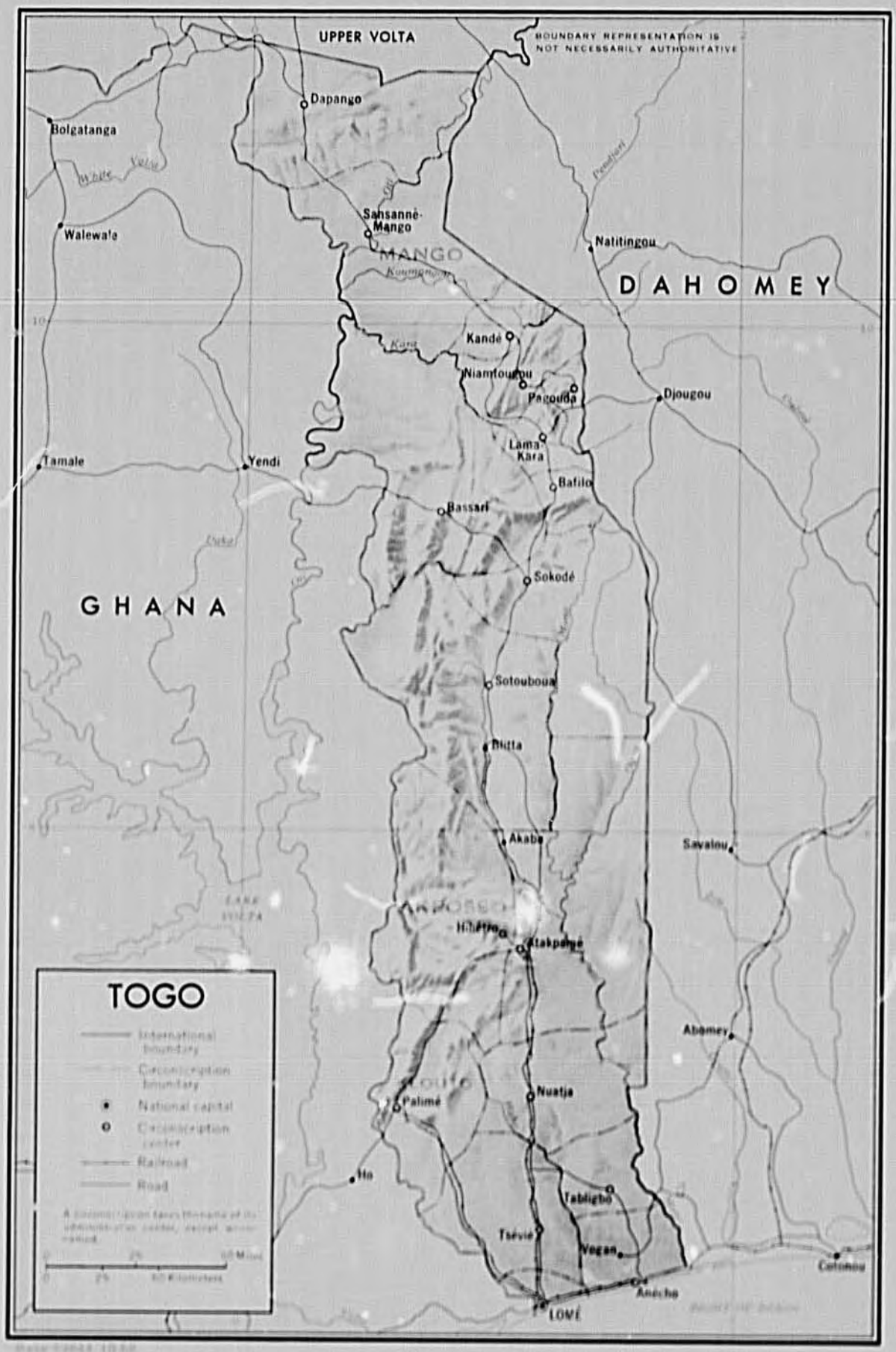


U. Volta
Ethnic Groups



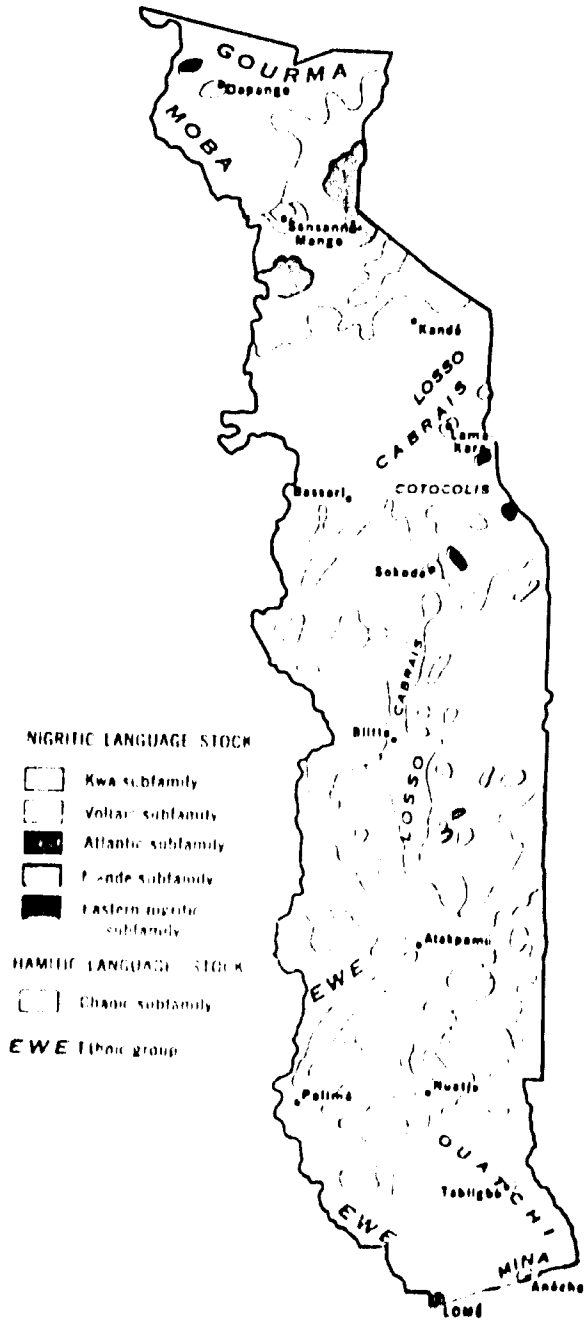
U. VOLTA
VEGETATION



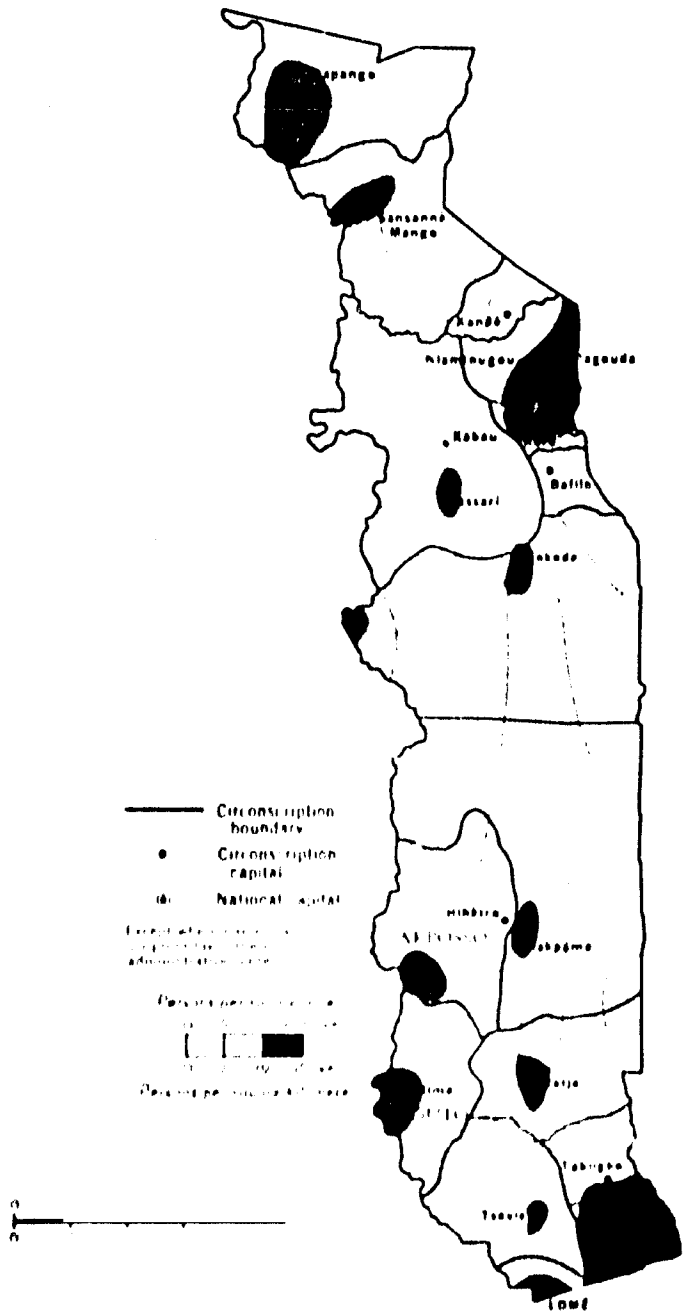

UPPER VOLTA
BOUNDARY REPRESENTATION IS NOT NECESSARILY AUTHORITATIVE
Dapango
Bolgatanga
Sansanné-Mango
Walewale
MANGO
Natitingou
DAHOMEY
Kandé
Niamtougou
Pagouda
Djougou
Lama Kara
Tamale
Yendi
Bafilo
Bassari
Sokodé
GHANA
Sotouboua
Bitta
Akaba
Savalou
Hohoe
Atakpamé
TOGO
International boundary
Circonscription boundary
National capital
Circonscription center
Railroad
Road
Abomey
Palimé
Nuatja
Ho
Tabligbo
Tsévié
Vogan
Aného
LOMÉ
Cotonou

TOGO

ETHNIC GROUPS

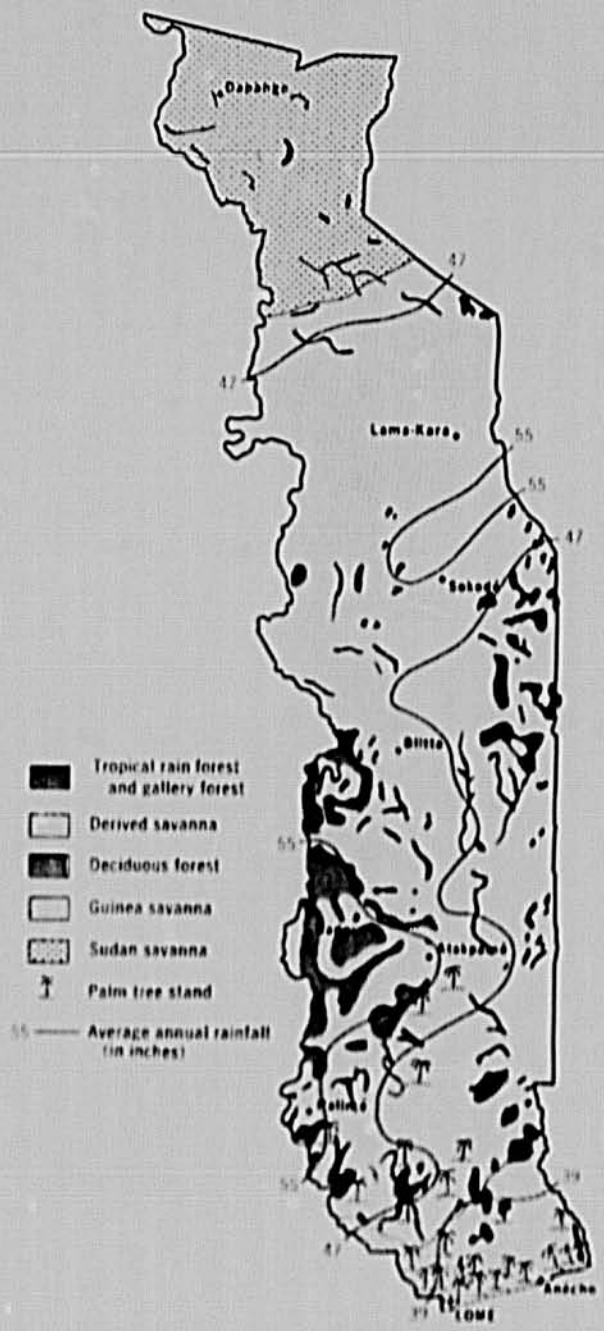


POPULATION AND ADMINISTRATIVE DIVISIONS



TOGO

VEGETATION



3. Discussion

To attain a viable rural water supply and adequate rural community sanitation in Sahel and West African countries, AID should undertake technical efforts only within an integrated socio-economic framework such as that presented in this paper. There is no single magic solution to these many stranded problems. Instead, it will be necessary to slowly build into the social fabric-with the effective collaboration of affected peoples-the combination of information and institutional capability that these folk societies have not yet developed.

3.1 Traditional Technology

People in the regions surveyed have always needed to get water, to take care of their health, and to dispose of their refuse, including excreta. The techniques they have adopted have related to:

- their environment
- their ideas
- their means

The state of underdevelopment signifies poverty of means, and often marginality of environment.

Traditional Problem-Solving Techniques

Customary local water technologies have included surface-water gathering, and rain-water harvesting in some places. People have carried it, dug for it, or learned how to do with minimum quantities of it. In line with their outlook on ultimate and universal things, people have arranged their health problems by attempting to placate or manipulate the causative factors in the universe through religion or magic. Or they have just died. Excreta has been handled by getting it out of the way "because it is dirty", as in defecating well outside the village edge, in the fields or scrub-bush. A well-brought-up person would not defecate within the living compound in many places. Sometimes during the rainy season people dig a hole in a remote corner of the compound, and fill it in with dirt as it is used.

In a few places, women will dig a hole within the dirt-floor of the living quarters and use it to defecate, then build a fire within the hole to purify. Often people feel it necessary to hide excreta, because leaving it can make one vulnerable to sorcery. Occasionally, people use human excreta as they would animal dung to fertilize a field which is cropped continually, but some people do not have the concept of using fertilizer, and many people would find it distasteful to use it for food-crops.

3.2 Required Policy Decision

A major policy question regarding wells must be resolved at the outset:

Option 1: Minimally, AID can contract to dig open wells, in adequate number to supply the areas for which it is given responsibility. Water shortage creates a pressing need for action. Thus, the Minister of Mines in Togo brushed aside talk of closed wells and sanitation with a brusk "We are not now concerned with purity of water. We just need water, and we need it badly."
Given African concepts of health-and-disease-causation, a western sense of urgency about closed wells and latrines will find little local counterpart. Indeed, there are western observers - among them medical men - who view latrines and pumps and closed wells as down-line priority.

If this option is chosen, then open wells with windlass or pulley, or dug-wells equipped with removable cover and simple pump should be envisaged*. Such wells, with minimal maintenance could permit continual access to water without laying requirements of cost or repair that rural

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* As described in Chaps. 3&4 of this report. Despite its evident shortcomings, this option has the great advantage of near-term feasibility and impact on affected populations.

communities are not prepared to meet. Further, local labor investment could reduce costs and increase community involvement and responsibility.

Option 2: AID can provide equipment and drill wells. It should then further assist host governments to develop the institutional capability necessary to ensure a permanent maintenance.

To remain viable for the long term, however this well-digging effort will minimally require that there be established at the national level:

1. An effective water control mechanism;
2. A logistical system offering supply, transport, and maintenance, and
3. That provision be made for technical manpower training.

This option should offer affected populations access to potable water. It has, however, the fundamental flaw of consolidating existing paternalistic methods which strip rural people of autonomy, and increase financial and implemetary load upon limited national resources. This is poor long-range development strategy.

Option 3: AID can adopt a unified strategy such as that proposed for the Club des Amis du Sahel Health/Water/Nutrition commission.[2] This proposal aims first "to provide an adequate quantity of water with minimum gross contamination." It proposes community involvement in the design and implementation of rural water programs. It subsequently calls for health education as well as training, logistical and technical support for environmental health activities. It specifies an urgent need for adaptive field research to determine water and sanitation technology suitable to local needs. In this connection, invaluable advice is prooffered by the African WHO physician in Ouagadougou (L. . Pie Masumbuku) (sic)! To succeed in developing viable rural water supply systems, that can and will be able to achieve the goals of pure water - and better subsequent health - it will be necessary to tailor-make your plans to the region and to the community.

Augmenting the Club proposals, this Report recommends a three-tier approach as set forth in the following section.

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[2] AID Contract Study #AID/AFR C-1138

4. Recommended Program

The following proposals represent a systemic approach incorporating necessary elements of an effective rural water supply program.

4.1 National Level

In each country a coherent rural water control agency is lacking. Numerous operators go their own ways and dig their own wells with little control. There is no standardization of well-sizes, depths, or equipment - thus rendering spare-parts procurement and maintenance difficult. In Chad, two water agencies: FDAR and SERARHY together do not fill the need. Volta's DHER is a rudimentary service, which could be built upon and completed. In Togo a scattering of effort needs to be rechanneled and focussed into the effective program which is lacking. Togo has a minimum of five ministries and numerous provate organizations engaged in water work, but there is no comprehensive plan and little control. To help compensate this institutional lack, AID should seek to promote or organize a three tier program to provide the following capabilities.

4.1.1 Establish a Water Control Board

This board should:

a) Define a Water Program which would have three major components, to wit: a wells system, a surface-water system, and a fall-back system for dry periods and dry years. (The Israeli interconnected water-grid is an example of such a system.)

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b) Standardize Requirements and norms for rural water development projects in all parts of the country. This should take into account, and correlate competing human, animal, and crop needs. Advise, license and control all water-seeking agencies.

c) Serve as a center to exchange information on problems and methods.

d) Establish and Supervise an adequate logistics supply, including warehouses at the regional (O.R.D., sub-prefecture, or circumscription) level, workshops, and maintenance capability at all levels. (Described under section 4.1.2.)

e) Hire and cause to be trained hydrogeologists, water prospectors, and other high-level water technicians.

f) Establish and monitor water-quality control.

g) Establish a local water-documentation center which would closely coordinate with the regional C.I.E.H. in Ouagadougou. This center would sponsor research. (This center described under section 4.4.3)

4.1.2 Establish a Logistics Systems (Water-Systems Implementary Network)

a) This component should formulate a logistics design, and develop it into a concrete system at national, regional and local levels.

b) It should assure purchase of drilling equipment, repair equipment, and spare parts. If a Water Board has been able to standardize wells-format, this should vastly simplify and lower costs in the logistics picture.

c) Maintenance Shops at national and regional level should be set up.

d) The logistics system would incorporate as a function of the Water Board.

4.1.3 Establish a Documentation Center with Research Capability

This would be a good area for multi-donor inputs of money, technical assistance, research, and expertise. This center would:

a) Build a competent Hydrologique Survey.

b) Develop standardization requirements.

c) Determine what is appropriate technology, including sponsoring research on such efforts as solar water-purification systems, etc.

d) Determine role of different private and international donors.

e) The Documentation Center would incorporate as a function of the Water Board.

4.2 Regional Level

A mid-level technician training institute, a social development program, and a village-resources research project should be established at the regional level. In Volta this would logically be handled at the O.R.D. administrative point. In other countries this might logically fall at the prefectural, or at the circscription grade.

4.2.1 Water Technicial Training Institute

This school should train well-digging, drilling, and repair crews, and teach well-management, preventive maintenance, and water-resources management generally to selected villagers. Students should drill both test and water wells as part of their training, and have competence for installing/maintaining dug wells equally. Such an institute might be placed in one country to service trained manpower needs for a multi-national region. In this case it should be phased first as a local training institution, then to be expanded. It should give practicum training to crews for well installation and maintenance for various terrains, and under varied national conditions.

4.2.2 <u>Develop Programs and Training for Two Categories of Social Development Teams</u>

a) <u>Motivation ("Animation") Teams</u>: These would be trained to inspire local-level communities to action for community health/water/sanitation/nutrition improvement. They might consist of Peace Corps Volunteers, and Host Country counterparts from Health and Social Affairs services. They would develop a Seminar program to present in local communities over a one to several week period. Peace Corps personnel should definitely be involved in the design of Seminar program materials and methods.* The Seminar would demonstrate to villagers the advantages of clean wells, latrines, and other improved health and nutrition practices. They would offer extensive health education to all possible groups in the community, and suggest that the community designate a Village Health Worker. They would also suggest the advantages of forming a (women's) cooperative with, among its goals, the improvement of health, services, and life-quality for the community.

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* Programs might be developed in collaboration with the newly established Sahel Institute.

This cooperative would also help women to develop financial resources which could be employed to lighten their physical burdens of farming and water-carrying.

b) Training and Resource Teams: These would consist of Peace Corps Volunteers and appropriate counterparts provided by host Government agencies; and would proffer a multi-faceted program. They would expect to work closely with, and help train the locally designated Village Health Worker.

Program Components: (1) Health, Sanitation and Nutrition Framework should be set up and tailored to village needs. With local people's participation, local health problems should be defined, and the appropriate actions determined. Health and nutrition education should be emphasized and constantly reinforced for all groups, i.e. council members, farmers, women, youth and student groups, etc. This information should be tendered as people are given the means to improve their situation. A self-help latrine construction, and general sanitation project should be part of this component. (2) Training and Resource Teams would also develop, in conjunction with community members, the cooperatives mentioned above, and to be described below under "Local Level" programs.

4.2.3 Research to Identify Village Financial Resources: This would be the preliminary phase to permit establishment of the Cooperatives on the basis of clear understanding of local economic conditions, needs, and possibilities. The product of this research would be to increase market entry for villagers - in particular for village women, in order to generate finances in the village to permit it to maintain and develop autonomous control over vital resources. This research project will be described below under the "Local Level" rubric.

4.2.4 Discussion: If rural people are to be able continuously to cope with closed wells and to gain the full health benefits that should derive from them, they will have the following requirements:

a) An understanding of water-related health problems, and what they can do about them. This includes for example the hazards of washing clothes in the (schistosomiasis-bearing?) waters of standing ponds.

b) They need to have the possibility to do something about their problems. Knowledge without the ability to act upon it is only frustration.

c) They need a maintenance capability within their own hands for things which vitally concern them - such as water resources. This also involves access to spare parts, perhaps locally produced. Government or foreign paternalism - however will-meaning - doesn't work a la longue. People will reject innovations which cannot be made relevant to their own scheme of things.

d) They need to have the ability to pay for their water and health needs themselves. In the long run, a government paternalistic approach is so open-ended that no government can afford it, and definitely not those whose minimal budgets don't cover the basic range of their needs. What people cannot maintain with their own skills, they need the money or exchange ability to commandeer from others. For this reason, the herein described systemic model offers resource-information-

gathering-research, and a project based on it for generating cash income at the village level. With wider resources thus secured, villagers should be able to do much to assure their own autonomy.

4.3 Local Level: Discussion

In Africa women bear the burden of providing water for domestic use, be it bathing, washing, cooking or drinking. Whether the source is a well, a river, a maregot-pond, or the reservoir of a more fortunate neighbor, it is the women and children who draw and carry the water. Some women must walk ten kilometers each way for their daily ration; there are others who repeat a four-kilometer round trip five times a day - when they are well enough - to provide the needs of their households. This time and drudgery spent in fetching water is a social waste, and could be better economized. We therefore suggest the following two-phased project which should:

a) Augment and strengthen activity at the local African market* level, bolstering traditional exchange patterns and helping to monetize them.

* We speak here of traditional markets and exchange patterns rather than the newer exchange circuits of foreign traders and imported goods. 2

2 "...Ongoing experiments in certain countries have shown and continue to show that, psychological and scientific factors aside, self-financing can be adequate at the level of "test-villages" which have enthusiastically participated in the start-up of activities; on the other hand when these activities must be continued and must resist the phenomenon of "fatigue" and especially when the project must be implemented on a more general scale, village resources are no longer adequate to ensure the continued success of such projects." This points up the need to develop simultaneously the economic resources within the village trading patterns.

Club du Sahel document, 1977; Elements of A Strategy for Health, Water, and Nutrition - pp. 29-30.

In the local community, the recommended program should help to establish a women's cooperative. Motivation teams should present the idea for a cooperative to village women during the Seminar period. Only if they are really receptive should these local projects be undertaken.

Phase 1: Research Project

An economic/social scientist should be engaged to do an in-depth survey of regional micro-economic patterns and trade goods. Where traditional African markets exist, they have usually exchanged the specialties of artisan production of one region or village with that of another. Perhaps one area produced smoked fish, and another clarified-butter and hides. Another village may make such excellent baskets that water can be carried in them. Another produces the very large clay jars used to store water. Someone else makes charcoal; in one village they weave, and in another they do indigo-dyeing. West African trades have been numerous and highly skilled in the past, and now risk being lost as markets are flooded with cheap imported items.

The research project should be scheduled for a minimum of 9 to 12 months for adequate coverage, and should study the whole region where AID envisages establishing a pilot water/health/sanitation program. The researcher should determine skills and trades that exist and the systems, methods, and extent of trade patterns. He/she should also

determine other goods or services, for which there is a need, which could be offered by the small producer. Among these could be production of simple water-filtrage and safe storage containers, latrine-slabs, spare parts for basic well maintenance, light-weight water carrying containers, and water trailers for home delivery, cement, and plastic pipe. On the basis of data obtained, he/she should propose a schema of small enterprises which could be village based and which should have real utility and development potential within the region, as well as marketability to service need or demand.

Phase 2: Development of Village Industries and Services Cooperatives

The Cooperative should have four elements aimed at women's participation in development:

a) Water Delivery Service. A form of water-delivery service should be established. The simplest and most practical means would be provision of a wagon, a mule, and some water drums, and the setting up of a delivery schedule. The delivery person should be paid from a cooperative central fund.

b) The Cooperative should purchase a set of basic tools, such as a mill to grind grain or corn, and agricultural tools such as seeders, threshers, binders, etc.

c) The Cooperative should establish training programs. These programs should be initiated and taught by AID - sponsored technical assistants who on the basis of data obtained through Phase 1 research, would help local women develop small enterprises to service and increase local markets. The women would be trained to improve skills, and to develop sound business management. This program should be managed and implemented jointly by the women and the Community Development Team.

d) Last plank of this project would be the employment of funds available in the Entente Program African Development Loans Project to provide a soft line of credit to launch village business(es). This effort would be given full assistance by the Community Development Team. Small business assistance has usually been directed toward men, and often in urban areas.

* Who could be Peace Corps personnel.

But in Africa, it is the women who provide both food and water for people. They also care for sick children and buy the medicine when possible. Helping women to enter the cash-levels of the economy will certainly give them more autonomy in some ways, but should promote useful change in areas that are basic to social needs.* In this context, water-programs could thus be organized through, and at least partially costed by the women's cooperatives. Since women are now responsible for family nutrition and water provisioning it is a logical correlation.

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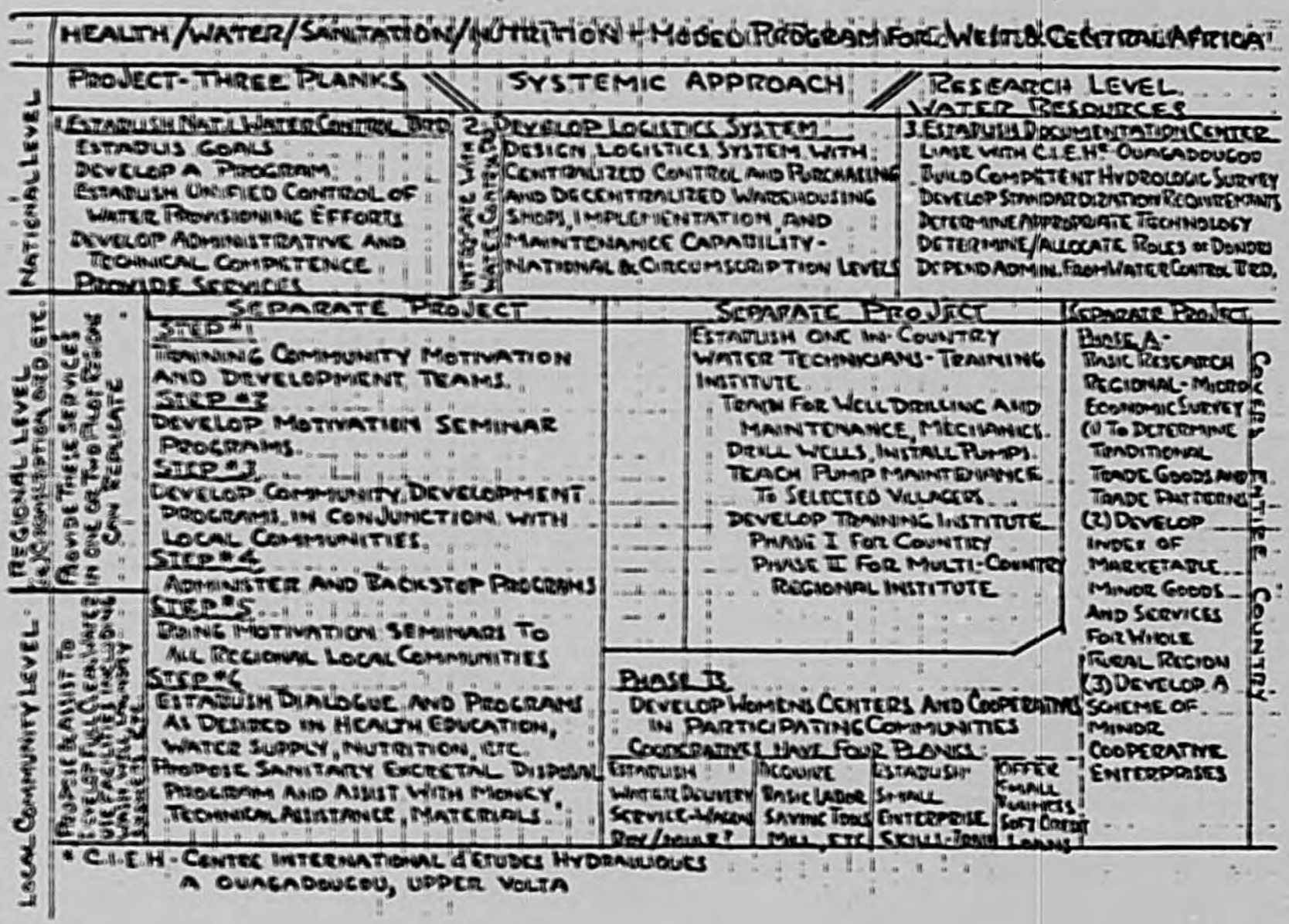
* Such a program is expressly supported by suggestions made in the CILSS/Club document - Sahel Strategy Document for Health, Water and Nutrition (see pgs. 53&54)

4.4 GRAPHIC PRESENTATION OF SYSTEMIC APPROACH TO INTEGRATED WATER/HEALTH EDUCATION/SANITATION PROGRAM, TO BE PAID FOR THROUGH GENERATIVE VILLAGE RESOURCES



Best Available Document

4.5 Recommendation: Appropriate Alternative Technology

AID should research and develop alternative strategies to provide pure water by focussing on additional points in the water supply process. Standard western strategies, (i.e. drilling and maintenance of clean, closed wells, aeration and chemical purification plants etc.) are relatively high technology approaches. These have generally proved, in the near to mid-term, to be beyond the maintenance capability of people they are intended to serve in LDC's, for both technical and financial reasons. Lacking clean wells, or when existing modern installations cease to function, rural people have recourse to polluted and contaminated open wells, or various sources of surface water.

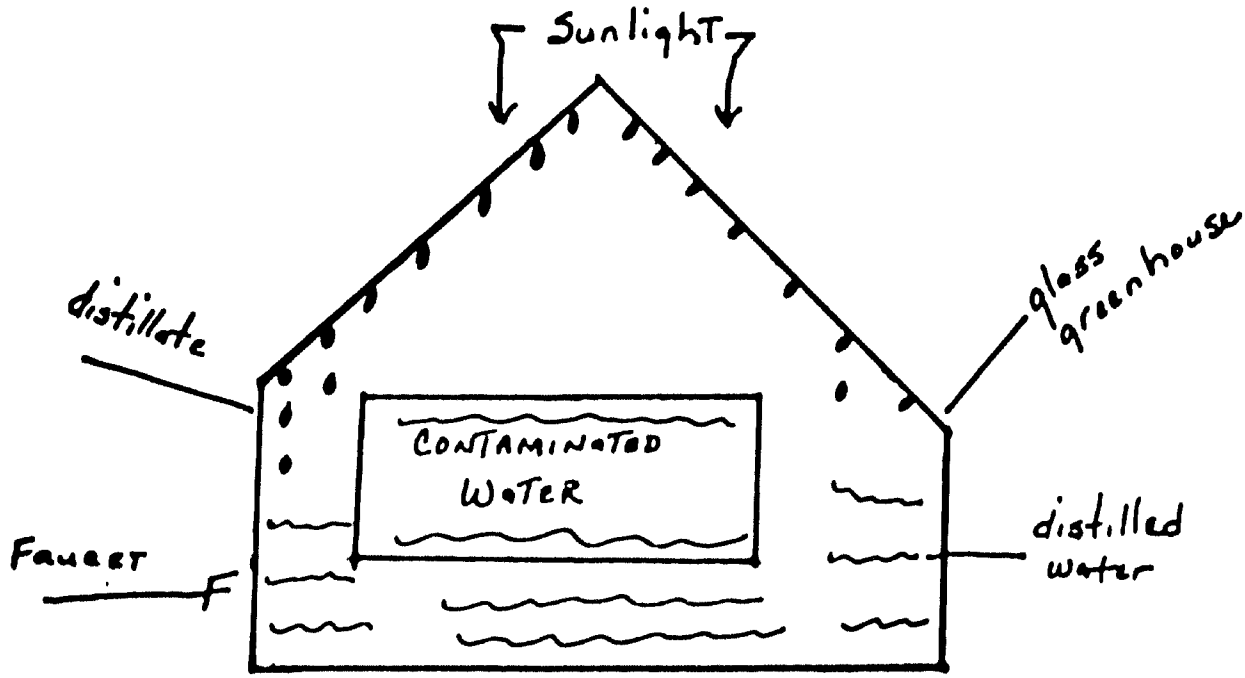
AID should therefore develop projects focussed on alternative technologies to render existing water supplies fit for human use. For example: Water could be purified at points of storage rather than at the source.

1. Polluted, brackish, or contaminated water could be made potable through solar distillation, using inexpensive locally available materials. Construction, maintenance and operation do not require high levels of skill, and the only item not immediately available locally would be glass, which could, perhaps be manufactured in country or within the region.*

* National Academy of Sciences Document: Energy for Rural Development, 1976 - pps. 71-78. Also appendices for information on suppliers.

2. Using sand, charcoal, or materials to be determined, and clay vessels, storage/filtrage systems could be devised to present clean water <u>at the point of use,</u> thus avoiding contamination possibility during transportation, even from clean sources.

   Research money would be well spent in devising these new intervention - point approaches.



5. Social Parameters

5.1 Eco-Base: Three basic life-styles

Three major kinds of economic production characterize the regions we are discussing, and should be seen as adaptation to available resources.

Sedentary Subsistance Farming*

Sedentary farming is typical of the southern savannas of Chad, all of Volta save the Fulani region which roughly corresponds to the Sahel sector north of the 14th parallel, and essentially all of Togo. Sedentary agriculture is the economic base for most of the populations of all three countries visited.

Generally people live and work with their close kinfolk. The pattern is usually one of exploitation by an extended family consisting of a man, his wives (usually two or three if possible), and their children. Often grown sons, their wives and children, or a man's brothers and their families, may augment the co-residence group. There is, however, a large range of variation in family composition from area to area. Kinship is most commonly counted in the paternal line, though matrilineal familie (kinship counted through the mother to the males of the mother's family) reside and work together in much groups as the Ewe and Mina of Togo, and Busansi people of the south of Volta.

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*Sedentary farmers live in and farm a fixed locale.

Groups who live and work together range in size from the very extended families of the Dagara in Lobi country of southwest Volta, to a single man with one wife and her children such as one frequently finds now in urban areas. Dagara live in family groups which may include 50 to 90 people, who all farm the family lands and share in the harvests. Their house, described as a pluricase (French), is really a village in a single branching household. Such households cluster into densely populated nebulous villages, where it is difficult to tell where one house ends and another begins.

Transhumance

As the wooded savanna grows dryer to the north, pastoral lifestyles begin to appear. Transhumance is a functional lifestyle adapted to very marginal lands. Transhumant nomads usually travel on a seasonal basis between two largely fixed areas. In Chad and the Voltaic Sahel, they keep their herds and raise small garden crops in seasonal stream-beds (wadis) during one season, and, of necessity, travel to other grazing areas as the pastures dry up. The fragile and limited ecology will not support permanent residence of men and animals in one place year-round. Transhumants have learned to build a delicate subsistance - economy balance between garden-cropping and stock-raising for their livlihood, but they usually nomadize on a back and forth basis between two or three fixed regions.

In better watered regions their herds will include cattle, sheep and goats. As one moves closer to the 200mm. percipitation isohyet which defines the desert's edge, cattle give way to sheep, which progressively give way to goats. In the 200 to 50mm. zone, (true desert), domestic herds are essentially camel-based, and true nomadism becomes the usual life-style.

Pastoral Nomadism

Nomadism is the economic adaptation which permits people to live in lands where life-support resources are minimal. Nomads move continually, because in so doing they use existing slender resources of water and fodder without the overuse which would destroy what these harsh lands offer. True nomads are the Toubou, and the black Arab tribes found in the Chaddian Sahel and Sahara, the Touareg and Bella peoples who move from Mali and Niger into the north and eastern sections of Upper Volta, and the 'Mbororo-Fulani who have remained pagan, and are the true gypsies of these regions. The latter are found in constant transit, scattered from Senegal and Guinea into Chad.

The first mentioned tribes base their economies on camels, keeping incidental herds of sheep, goats, and in some places excellent horses. The Fulani guard and move with mixed herds based on cattle, the Mbororo keeping essentially their own herds.

Elsewhere the Fulbe, or Peul-Fulani have usually established symbiotic relationships with the Sedentary populations whose lands their herding corriders traverse: The Fulbe charged with herding the peasants' animals collects payment in either money or kind for his expert services. These Peul, unlike the "Mbororo, often establish transhumant patterns. If true nomads, their migration circuits are limited in range.

It should be noted that even true nomads like the Teda (Toubou) of the Tibesti, or the desert Toureg base their movements on some oasis-camp where vassal-tribes such as Bella, or older people, women and children care for gardens and maintain constant liaison with the roving herding camps. Further, each tribal fraction has a roughly fixed area of circuits for any seasonal period, based on known wells and grazing areas and the sense of first-rights ownership of these resources. Scarcity of resource very often leads to conflict when non-related groups compete for water at the same well.

From the traditional neolithic-farming or herding production base, development-projects here and there attempt to raise the level of return. Thus in Chad, cotton production is the major export item; and rice, sugarcane, groundnuts and tobacco are grown in the experimental polders* in Lake Chad, or the riverine flood areas of the south.

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* Tracts of low land reclaimed from Lake Chad by means of high embankments. Now being exploited to raise agricultural products.

In Volta, the extensive modern farms of sugar-cane at Banfora have displaced many subsistance farming villages in a not totally successful bootstrap effort. AID offers a different development approach with seed-multiplication, and animal-traction projects. In Togo, copra, coffee and cocoa-beans are the beginnings of commercialized agriculture - mostly found in the maritime region.

But it must be emphasized that each of these countries has at least 90% of its population living in rural areas within the traditional social and economic frames of reference, and only with the most tenous connection to the money economy. Barter of various ranges of commodities is the nature of most economic exchange, and access to cash - especially for women outside urban areas - is only after the big harvest, and then marginally, if at all. If, in the rural water development programs it is envisaged to find payment of costs at the participating village level, then it is essential to plan for accessory and integrated projects which will enable rural communities to earn the necessary cash.

Recommendation

Because there are three different types of major life-styles found in rural areas of Sahelian and Savannah West Africa, AID will need to diversify in programming for well - types, locations, and community organization efforts to achieve continuously viable rural water-supplies. To be successful, these should be tailored to the given area. It is further suggested that particular attention be paid to the water-needs of nomadic people, who have frequently

been left out of planning efforts because they present special problems. This is unfortunate, as they are often the neediest of the "rural poor."

5.2 Religions and Traditional Perceptions

In the Sahel/Savannah regions, many traditional Africans regard the universe as an unchanging and sacred order. Within this frame, living men are part of an unbroken line tying together the dead, the living and the unborn. For the animist African, mystical powers of the ancestors are the major force which regulates social life: protecting, rewarding, punishing. Social authority derives from and is enforced by the ancestors who symbolize social relations and obligations. All life and all existance are intertwined, and seemingly unrelated parts can symbolize or affect each other powerfully. No minimal object is unrelated: every hoe or calabash is tied into man's life with a tissue of ideas which define its relation to everything conceivable.

Thus, to the Dogon of northwestern Volta and Mali, water is considered the divine semen of God, which fertilizes earth. In the times of origin, this divine seed conceived twin-beings, called Nummo, who were the forerunners of Vegetation and Termination. The Nummo, born perfect, are represented by the number eight, which is also the symbol for speech. Their essence is motion and life-force (vitalism.)

They are present in all water, and in fact, they <u>are</u> water. But they also produce copper, and excrete light! Because of the Nummo, twins are sacred and represent the ideal unit. Twin-birth - through many parts of Africa, is considered a divine, not a human event, and twins themselves (as well as their families often) are held throughout life to be very special.

The Nummo clothed the earth with plant fibers, which was the First Act in putting the Universe to order. But the fibers are whirlwinds, torrents, and eddies of water, and also reptiles. They are also the .atering of plants, and all wavy and undulating lines.

Water-vapour is speech (which is magical), and also spiritual revelation and all technical instruction. It is present in the plant-fibers, which are thus "full of water and words."*

This is only one set of examples of the layering and nesting of levels of meaning, symbols, identies and relationships characteristic of traditional African thought. Poetic and philosophical, this perceptive set is not reserved for Sundays and Scholars, but is built into the language and thought of everyday people.

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*Griaule: <u>Conversations with Ogotomeli</u> - c.f. Volta Bibliography

Communal religious celebration in turn defines social support groups based on common perceived kinship, marking off those who should expect to live or work together. These are lines along which community organization and cooperation can expect to be founded.

Among these animists of the savannah Belt Catholic and Protestant missionaries have made their most successful efforts. It should be understood, however, that the acceptance of Christianity's offers of salvation does little to change this basic conceptuality of social/universal relations and first causes.

Animism is the religious belief that all natural phenomena are animated by spirit or soul. There are variations in animist beliefs from region to region, although some themes hold common. Thus: in Chaddian locales such as Guera's mountain region, there is a cult of tutelary spirits who inhabit trees and rocks and belong to individual persons among the Hadjarai-group peoples. For others, like the Kotoko and Baguirmi of Chad's Beguirmi-Chari province, the most ancient Gods: spirits of earth and water and fertility - influence the nominal adherence to Islam.

In patrician Mossi society, religion functions both as a table of organization and as justification for the hierarchical and highly structured conquering group which, coming out of Ghana, provided the overlords of the Voltaic plateau. For the Mossi, the person of their Emperor, the Mog'Naba, is sacred: he is the representative

on earth of the eternal powers, and as such is linguistically identified with both the sun, and Mossi society as a whole. He is permitted no fallibility, and traditionally was murdered ritually when incable of performing his functions.* This symbolic king reigned, but even he was governed by custom, which in Africa has so often taken the place of administrative structures. As divine king, the Mog'Naba held the Nam, or mystic right to command others. This had passed from King to King from the founders of the Mossi State; and by association with the Mog'Naba, lesser Princes, Governors and Chiefs to the smallest village level held the divine right to rule. Since this Sun among the Princes of earth had innumerable wives, it has always been possible to dote the whole country with rulers of the royal blood lines. Only these chiefs held the right to perform the religious sacrifices that served to protect and maintain Mossi society.

The belief content of Mossi pagan religion combines solar and agrarian cults with the generalized African pantheon of Ancestors, and assorted spirits, whose visible supports may be tree-trunks, rocks, mountains, stones, rivers, or animals. The universe itself is a vast force-field, with complex and incomprehensible entities which act upon people and reality in obscure ways.

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*Like the Moundang King at Lere in Chad.

The different networks of forces are associated with dangerous or beneficial effects upon men.

Sahel

Across the Sahel throughout the region of the ancient sultanates and Kingdoms and throughout the desert, Islam is the prevailing religion. But this Islam is strongly influenced by the animist base over which it washed historically.

Here and there submerged groups - despised castes such as Chaddian Haddad (found in Kanem, and above the 13th parallel), by virtue of their special skills in mystically dangerous occupations such as butchery, leather tanning, and dying - although nominal Muslims-are known to manipulate magic and special supernatural forces.

Islam means "submission to God's Will", and Islam as a religion broadens men's sense of social-group participation. From the narrow view of tribe or residential group as community, the horizon is enlarged to encompass the Community of the Faithful as an - at least for some purposes - related group. Thus, across the flank of Islam, always strong in desert and sahel regions, the Sufi brotherhoods join men of different tribe or lineage who identify through religious co-participation in groups which may have pietistic, or political, or economic, or community welfare goals - or the set of these together.

In Chad, the Senoussi brotherhood coming from the Libyan oases is strong in the desert areas of Bornou, Ennedi, and Tibesti. Throughout the Sahel the Tidjanniyah cult is widely subscribed. Other brotherhoods such as Kadiriyah, Mirganniyah, etc. have small numbers of adherents, travelers across the classic desert-edge highway which the Sahel has for centuries offered to the Muslim Pilgrims bound for Mecca. As cross-cutting institutions the brotherhoods have historically offered a basis for varying sorts of community goal-oriented action, and might well serve as vehicle to incorporate new ideas of health-oriented action into communities. Walis, and Sheikhs who lead the brotherhoods are traditional teachers and magnetic leaders of Islam.

5.3 Traditional Concepts of Health and Disease

Savannah

Throughout the Savannah region, as in many other folk societies of the world, disease and general misfortune are understood to have one of two or three basic causes. These may be:

1. supernaturally directed malice, such as sorcery caused by living men, or,
2. anger of ancestors and/or other spirits who create havoc from the unseen world, or

3. Disequilibrium in the universe which is caused when people don't observe proper behaviour, either socially, or with relation to different categories of phenomena such as animals, things, places, ceremonies, etc. In the realm where concepts of totem and taboo are expressed in stylized respect or avoidance behaviour, improper actions can bring a punishing universe crashing down around your ears. What is more, the whole community, or innocent family members may be the ones to suffer the illness or death loss which will surely follow.
4. directly expressed malice - usually through poisoning is also expected as a possible cause of any form of disease or death.

It is useful to understand that these are not just unrelated tags of benighted superstition, but rather ideas from part of a coherent and circular system of beliefs as to the nature of existence. They form part of a different way of classifying existence in which the inner folk wisdom reflects a knowledge that, ultimately, most sickness is rooted in some sort of social cause. Africans are not childish: they know that you get onchocerciasis or sleeping sickness when you live near the river, or that someone died because a wall fell on him, but they will ask what is the cause behind the cause? Why me? Why my brother? For traditional Africans, ultimate causes are generated in social life.

Traditional Health Problems and Practices

Although people of the Savannah belt suffer from a wide range of diseases the most typical and most prevalent are gastro-enteritis, dysenteries, malaria, and assorted parasites which include guinea-worm, tapeworm, and hookworm. These exist everywhere and account for most illness and most mortality. In specified areas, schistosomiasis, and onchocerciasis are endemic hazards.

Illness is customarily treated in three ways. The first is by manipulations such as massage, bone-setting, splinting, etc,. which may be practiced by members of the family, or by some specialized person. The second is by the application of medication which may be internal or external, and is usually prepared from parts of plants, parts of animals, and sometimes minerals. By far the overwhelming practice to treat disease is the use of ritual and magic. Where supernatural cause is seen, manipulation of the supernatural is the logical cure. This is why traditional people, knowing that western medicine and health ideas are often powerful and effective, will often continue to have recourse to their time-worn customs. They consider that western medicine will only be effective if the ancestor is appeased, if the universe has been ritually put back in order.

In the Sahel belt of nomad and transhumant peoples there is much stomach trouble and dysentery. Malaria,

In general, the ideas of sorcery which burden the Savannah belt are not much evident in the Sahel and desert zones, though there is a frequent belief in the dangerous power of the Evil Eye. It is never wise to admire peoples' things or their children too extravagantly. Magic of the classic Arab brand is the purveyance of the Muslim feki, and offers cures for misfortune and disease throughout the desert belt.

5.4 Traditional Patterns of Cooperation

Work Parties

There are few places in Africa where the institution of the cooperative work-group does not exist. In the Mina vernacular of coastal Togo called lolonudo', In Chaddian Arabic shuula; the work-party is usually based on co-residence, sometimes on a kinship principle, and sometimes on the affinal relationship of inter-marrying groups. Whatever the basis of recruitment, work-parties group together to perform tasks that need many hands, like cleaning fields, building houses, digging wells. They work on a volunteer and reciprocal basis, and are usually "paid" by receiving beer and food from the wives of the family for whom they are working.

Specialized Well-Diggers

In Niger it is usually Hausa people who perform this task. Aronsen states that they are paid in cash and food while digging, and that a six-man team of these specialists from the south will receive upwards of 50,000 CFA for the finished well.*

In Volta, among the Dogon, there are reported to be specialists who dig wells to depths of 100 meters. The process is described: "They sit on the ground and take a hoe (universal type of agricultural and defense tool), draw a circle, and begin to dig down. As they get deeper they pass the dirt up in a gourd. When they get very deep, they must take "medecines" and prepare specially to go down, because they will become very dizzy from the darkness at the bottom." (It should be noted, that there is danger from carbon monoxide at the base of such a shaft.)[2]

Age Grade Work Obligations

Age-Classes ("Age-Grades") exist, and in some places, all men, and sometimes women are grouped into defined sectors within the community on the basis of the period of their birth. Thus all boys born within a (4) (7) (10) (specific to the society) year interval will be classed together, and will go through life as a group, franchising each stage of life, with its attendant social obligations and privileges together.

*Aronsen, op.cit.

[2]Personal communication from a Dagari youth who had worked in well-digging.

Thus in Togolese Lamda, or Kabre tribes (LamaKara and Plateau regions), corvee labor could be expected to fall to the lot of men in the youth or warrior classes. This is an organizing principle which is notable for producing task-oriented labor, and societies demonstrating this characteristic have always produced powerful armies. Perhaps because it fits into this institutional slot, modern organizations such as Boy Scouts (often 20 to 28 years old in Africa!), Four C's (Chad's equivalent of U.S. 4H) Clubs, and other "Jeunesse" groups are often very active. These usually, however, need the continual organizing talent of a community or religious or development agent.

Kinship Groups

The overwhelming principle of support-group recruitment in Africa is that of the claim to common kinship. Further, in rural areas it is rare that people who live together are not also "blood" kin in some way. Thus a man will usually live and work with his brothers and father, with his father's brothers and their sons, and with his grandfather's brothers' sons' sons. Frequently these ties yield corporate groups that own property together. Land may be conceived as communally owned, and wells would belong equally to the group, unless the fruit of one man's specific work or purchase.

eye-diseases, often viral pneumonia are seen; but the people are essentially subject to fewer diseases than in wetter tropical regions. Measles and meningitis are seasonal scourages.

In Chad before there were doctors, and still, people used the natron which is a local trade item mined in the desert, for diarrhea and stomach disorder. Put in water and drunk, it has a sovereign reputation as a cure. Certain clays found in the desert are also drunk in water for stomach sickness. People believe that the desert wind, which brings sand across the desert, gets into the ears, eyes, nose, and will make you sick. They also believe that people who work too hard especially at night, or where the wind blows, will get weak and tired and therefore will get sick. If a person is sick, they may say he has eaten or drunk something which is not clean. Perhaps it is poisoned, but more likely the wind put something in it. A supernatural cause of disease (particularly mental disorders) is felt to be affliction by a djinn. Djinn are a special category of beings, as men, and angels are. In the Sahel they like to sit in trees, especially at wells and oases, and in cool places where the wind blows through. Djinn also like clean places where people pray. After a person has prayed the five prayers of the day and gone home, the djinn who has been sitting there will go to his house and say to him angrily "But you didn't greet me." and he may afflict the person.

This principle of kin-groups usually defines the boundaries of a village, or co-resident community - even in nebulous settlement-pattern areas like the densely populated Mossi Plateau of Volta. These important sentiments about in-and-out-group boundaries are a factor that should always be taken into account where possible in determining the site for a well, as they form natural lines of schism.

5.5.1 Traditional Administration

Types of authority and socio-political organization in the Savannah/Sahel regions run the gamut of styles from the centralized divine-kingship states of the Voltaic Mossi,* and the Moundang at Lere in Chad, to the highly individualistic Arab bedu, whose autonomy is only limited by the pre-legal institution of the blood-feud, which promises him trouble when he oversteps too far the "rights" of others.

In the middle range fall the Chiefdoms, where family seniority, and the priority claims of the "senior" local lineage intersect to designate authority figures. This system, to be sure, is continually modified by magnetic personalities, and the personal power of individuals. In practice, it is seldom the oldest man in a family line, but perhaps the oldest man of forceful character who emerges as the nucleus of the primary political unit.

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*See Upper Volta country profile.

Habitual ways and public opinion, but above all the sense of "correct behaviour" to which a child is socialized - are the real forces of social control in these small communities where the sense of social inclusion goes little further than the borders of the village or immediate co-habiting group, and there are few "political" offices.

5.5.2 Modern Administration

Throughout the area we are discussing, and superimposed on whatever traditional mold of authority and political system existed, is the administrative structure left from the French colonial system.* Chad is, for example, divided into 14 prefectures, 51 sup-prefectures (circonscriptions), and 24 administrative posts. At an inferior administrative level, communities are grouped into a canton often based on the habitat of an ethnic group, or a major tribal fraction. A canton is headed by a traditional, often hereditary chief, with little administrative power but considerable moral authority. The circumscription, however, is administered by the Chef-Cir who is an administrative and appointed, rather than an heredity figure. In some instances, cantons are called village groupments, and are run by an elected council. These canton chiefs or councils report to the Chef de Circonscription (Chef Cir), or sous-prefect. Their responsibilities include public order, public works, health, taxes, and other local affairs. In Chad since 1969 a major effort has been made

*This does not equate with American Administrative Organization on a one-to-one basis, but follows its own structure logic.

to use traditional authority figures - Chiefs and Sultans - in modern administrative posts.

The same general administrative apparatus retained from the colonial period, and shored up in present time by French technical assistance and education, marks the whole of the French ex-colonial area. It is of course modified by local indigenous ethnic and political patterns. Thus, in Volta one expects to find modern state administrative posts filled by descendents of the royal and ministerial chiefly lines, the Nam which they posses by birthright being, after all, the right to rule.

In Togo the art of administration consists in balancing, accommodating, and integrating the divergent interests of the numerous ethnic groups, the two centers of dense population and of power being the Ewe/Mina group of the Maritime Province, and the Kabre people with related groups in LamaKara. Perhaps this need for large-scale access to positions within the modern sector is a cause of the Togolese habit of generating five competing agencies instead of one functioning one to deal with a problem. Thus water-services are administered in different (or sometimes the same) phases by ministries of Plan, of Rural Development, of Rural "Fitting-Out" (Amenagement-Rurale), and of Mines. While administrative flow-charts indicate planned coordination, in fact frequently the necessary actions fall between stools.

5.6 Competing Water Needs

This survey essentially addresses the problems of human water consumption in rural areas of sahel and dry savannah, but we must briefly consider pastoral and agricultural water use, because the populations involved do not make these rigid distinctions, and because they are forced to spread their meager water resources to cover all needs.

When temporary surface water is available at the beginning of the rainy season, animals are watered there. When (and where) no surface water exists animals must be watered from the wells, or driven to permanent water points of lake, river, or year-round pond. In the transhumant zones a combination of seasonal wadi-flow, rain-water pond and run-off puddles are employed as the herds move north with the greening from the rains. In the dry season the trails lead south; encampment is often around - but not too close - to the large wells, Herds must be mobile to search for pasture; and large accumulation of animals spreads disease from herd to herd. Transhumance is a very delicate adjustment to available resource and the ecological balance in marginal lands.

When water is short, and where accomodation is not worked out on lines of kinship or by payment for drawing rights, competition for use of wells may lead to bloody conflict.

There is much labor involved in drawing for and watering the herds, and all hands must pitch in. A precise vignette by Aronsen* describes well-use in the Niger Range and Livestock area, demonstrating the massive contamination of the well used to aliment both humans and animals. He concludes that devices such as improved pulleys, ropes and troughs designed for private ownership might increase efficiency in use of traditional dug wells, and find ready acceptance; but innovations costly to private owners of "investment wells" would not likely be viewed as worthwhile. Further, he questions the value of an attempt to avoid animal contamination of such wells, since animals and humans share life so closely in all other ways that contagion is unavoidable.

Governments are now developing chains of deep wells along recognized stock-trails. In the drought of 1968-73, disastrous animal-loss was caused by lack of mobility to seek pasturage where it still existed. Although surface water sources had disappeared, there was always water in the deep wells; but shallow wells along the trails dryed, and no water was available for the trek to available food supplies. Animals died of starvation because they were trapped around existing water points, and could not travel the parched trails.

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*Aronsen, D. Redso/West Doc., 1977. See Bibliography

For the pastoralists their herds are the life-support system, and people suffered accordingly from famine, the crops failing as well. Deep stock-wells equipped with powered pumps are planned (some now in use) to maintain necessary livestock mobility in the transhumance zones. There is reason to debate their advantage because maintenance and fueling are very expensive. In northern Chad (Batha), Serarhy has provided solar pumps, and these are being experimented as well in the Ivory Coast. These are French devices. Rainfilled artificial ponds, mud-wall storage dams, and reservoirs are among the resources planned to cope with crop and animal - as well as human needs. There is debate about the storage dams, which are expensive for small, dispersed community use, require maintenance, and could promulgate environmental problems such as malaria, schistosomiasis, and onchocerciasis vector-breeding in the spillways. There seems little discussion of artificial aquifer and recharge programs, which might be a much better solution to storage of seasonal rain-water abundance.

Recommendations

1. Animals, irrigation, and human consumption programs should be correlated by establishing inventories of total water resources by region.

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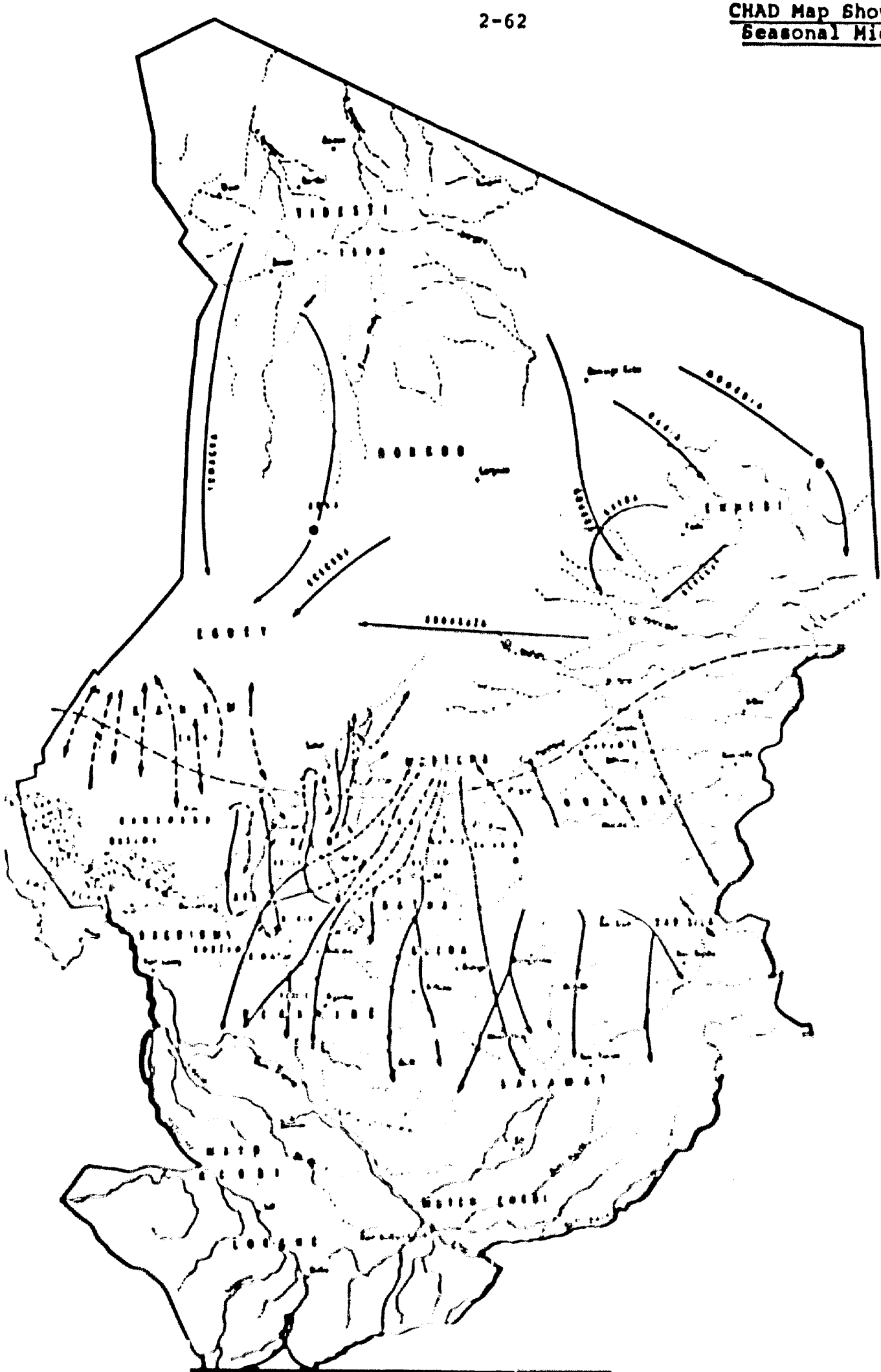
2. Where possible, surface water should be left for animal and crop use, bringing people to use clean well-water for all personal use, including bathing and washing of clothes, thus reducing risk of exposure to schistosomiasis, malaria, onchocerciasis, and trypanosomiasis. It will not be easy to do this, because it will require change in usual habits of bathing, washing, and amusement. It might be accomplished through the combination of health-education (over time), and the provision of a complex of facilities designed around the well which would offer place and water for laundry-basin, showers, and a waste-water catchment to be used for watering "sauce" gardens.
3. Where necessary to water animals from wells, it might be possible to dig wells in dual units - separated by an appropriate distance. Each well would be devoted to a different usage: one for humans, one for animals, and each equipped with a different constellation of facilities. The animal well would provide channel and trough facilities, and could use animal traction power to raise water.
4. Total water-planning should provide drought-period fall-back plans, and give consideration to population growth trends, and projection of ecological change.

CHAD Map Showing Seasonal Migrations.



5.7 Modern Regional Health Planning

Diseases related to contaminated water are among the primary causes of fatal illness throughout the African Sahel and Savannah. Following the useful classification of Drawers of Water White, Bradley & White 1972, these fall into three categories:

1. Diseases borne in and transmitted by water, such as dysenteries, typhoid/paratyphoid, cholera, guinea-worm (dranonculosis);
2. Diseases where water is the vector-supporting element for at least part of its life-cycle, i.e. Malaria, (anopheles mosquita), yellow fever (Aedes Aegypti mosquito), Schistosomiasis* (fluke and snail), Onchocerciasis**(black-fly), Kala-Azar (sand-fly), and Trypanosomiasis*** whose tsetse fly vector lives in the damp banks of thickets along streams;
3. Diseases caused by insufficiency of water for either internal or external (washing) use. These include nutritional deficiencies, and some skin, eye, and parasitic maladies.

African water-getting strategies, used and proposed, include dug and drilled wells, impluviums, reservoirs such as storage dams, and catchments with accompanying cistern-storage. Each of these has a set of related advantages and problems which it is useful to explore.

* Bilharzia
** River Blindness
*** Sleeping Sickness

The social and technical problems of different kinds of wells are presented at length in this survey. Related health problems are mainly those of water-borne pestilence, although standing waste-water and puddles around an improperly drained well-area can breed mosquitos. A nearby generous well can, in most instances, substantially reduce the third category of maladies: Where people have no more than 5 to 15 liters/day/person, water spent in washing is minimal to non-existant, and intake is insufficient for proper nutrition.

CILSS/Club Health Strategy water goals, as defined in March and April of 1977, propose a staged approach to the acquisition of rural water supplies. The first goal is access to a permanent sufficient supply, without gross contamination.

"Investors should give first priority to those programs which will ensure a constant availability of water in rural and semi-urban zones. The quantitative aspects should be dealt with in a first phase, the quality and potability of water being given special attention as soon as sufficient quantity is assured."*

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*CILSS document April 1977, Martin-Samos et al, op sit.

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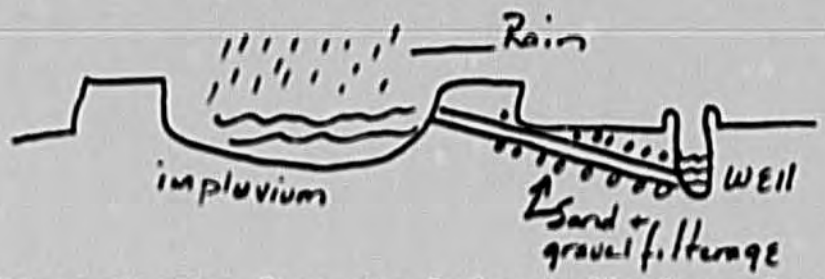
Wells

1. Drilled, capped wells would substantially reduce many of the problems of water borne dysenteries, and diseases of this category, as long as aquifers are protected from contaminating seepage. There is still left, however, a residual problem in the water transport and storage methods used to bring the water home from the well. This can only, for the foreseeable future - be tackled through solid and continuing health education.
2. Open dug wells, properly equipped with curb and apron, will continue to be subject to contamination by the ropes, buckets, gourds, skins etc. dropped in to haul the water. They should remain free however from gross contamination. A cheap, appropriate technology for water purification at the point of storage could solve this problem.

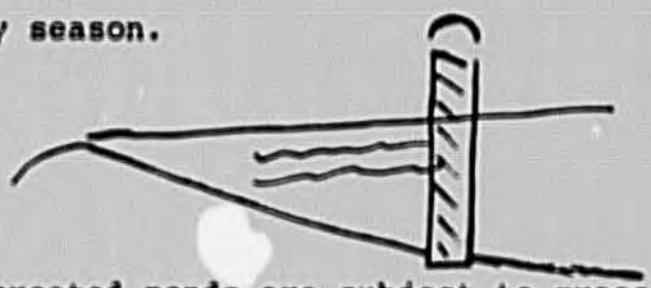
Rain, Seasonal-Stream Catchment and Storage

1. Impluviums are constructed in some Sahelian areas. These are subject to gross contamination by people and animals both unless direct access to them is impossible; but this is difficult to ensure. Fecal matter, schistosomiasis, guinea worm, etc. can all be hazards of the impluvium used as a step well.

Best method is to take the water off through an access-well joined through a filtering bed to the impluvium. There is still considerable water lost through evaporation from such facilities.

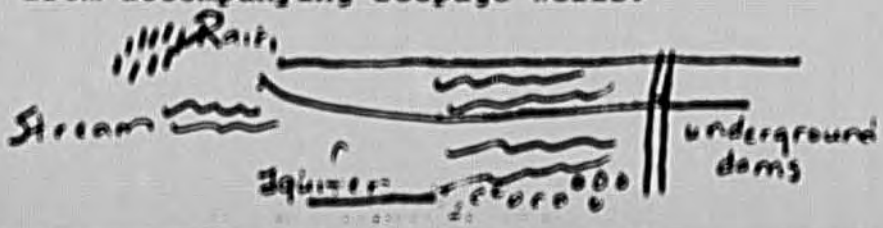


2. Water storage dams are being built by private and other donors throughout the region. The typical dam blocks the bed of a seasonal stream or wadi, retaining water which comes in abundance only during the rainy season.



These artificially created ponds are subject to gross contamination from animals watered there, and from people, as are the impluviums discussed above. They can easily become sources for the whole range of vectored diseases: If infected, they can augment malaria and schistosomiasis enormously (as have the man-made canals in the Sudan); Dam spillways are ideal breeding places for the black-fly carrier where onchocerciasis is endemic.

A safer strategy would be - where possible - to build dams for underground recharge and storage, and take off water from accompanying seepage wells.



3. The Togo maritime region, with its very serious lack of surface water, is dotted with rain-catch cisterns fed by roof-and-gutter contrivances to catch and channel downpour. Made of concrete, these large basins are expensive to construct; mostly unmaintained, they are cracked and inefficient. Water in them is subject to both contamination and pollution. In most instances they have been built with private funds. This means that only the owning family has access, other neighbors paying uncontrolled rates for each basin of water.

Here an organized and integrated community program to build and control water facilities might improve both access and quality of water. The village based health system, as suggested in the Sahel Health Stragegy* and as sketched in this report could undertake such projects.

Recommendation

In communities where this sort of storage facility would be a practical or necessary complement to the general water plan, AID could develop projects jointly with Peace Corps to plan, locate, and build an adequate network of rain-catch cisterns. Kelly Morris, Assistant Director of Peace Corps for Togo, suggested a simple, adequate and inexpensive cistern which Peace Corps is already helping to build in northern Togo. Some design work on the basis of this plan might yield a product widely usable for the region.

6. Research Methods Used

6.1 Chad

It is currently difficult for foreigners to travel in much of Chad. The team did not receive permission to travel to the countryside until over half the allotted in-country time had run out. Then transportation was not available. On-site rural observation was therefore largely impossible.

The following alternative data-gathering methods were therefore used:

An intensive documentary survey was followed by a series of interviews with knowledgeable expatriate observers such as Peace Corps Volunteers, Jesuit priests, Embassy and AID officers, University and Research Institute, expatriate staff members, and management personnel from the Lutte contre les Grandes Endemies medical service who know the country intimately. Every attempt was made to see and talk with Host Government officials in the Ministry of Social Affairs, Ministry of Agriculture DEFPA agency (Direction d'Enseignement et de la Formation Professionelle Agricole), the University and Research Institutes. This met with indifferent success because key figures were out of the country or not available despite promises.

Researcher was able from above sources to establish a frame of reference. Then, since N'Djamena, as capital, is full of people from all areas of the country, Chaddian respondents were sought in town who, native to a given

rural region, could intimately describe its lifestyle, problems and techniques. Questions designed to elicit a picture of general institutions were followed by direct questions on water use and sanitation practices. Conversation on each topic was pointed toward ideas and attitudes about the why and how of things. In this fashion both general and specific data were obtained.

Weaknesses of this method include: (1) the non-random nature of the sample, (2) a skew toward regional generalization which may not closely fit a specific locale because of Chad's great ethnic fragmentation and diversity, and (3) the fact that documentary information may be outdated, too general, biased or a repetition of accepted but erroneous information. On-site data collection in the field could eliminate much of this margin for error, but the team operated within the constraints described.

These methods should nevertheless provide the following useful results: (1) an acceptable degree of understanding of the characteristics of different regional lifestyles, (2) an appreciation of the frames of reference from which local peoples make decisions and on which they base behaviour and reactions. This should permit design teams to see people operating within the framework of their own logic instead of as "incomprehensible strangers", (3) a picture of local communities as interaction systems in which every element has multiplier influences, and

(4) a set of recommendations to AID based on knowledge of elements in the field of action.

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6.2 Upper Volta

In Volta information was sought from the following sources: Local Government officials, international development agencies, Peace Corps Volunteers, private voluntary agency staff, anthropologists working locally, and U.N. and CILSS program people. In addition trips were made to the Eastern O.R.D. and the Banfora O.R.D. where interviews were held. Documentation centers at the C.I.E.H. (Centre Inter-etatic des etudes hydrauliques) and S.A.E.D. (Societe _____?_____ des Etudes du Development) were consulted; an interview was carried on with researchers at the O.R.S.T.O.M. (Office des Recherches Scientifique et Techniques de l'Outre Mer.)

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6.3 Togo

O.R.S.T.O.M. Personnel were particularly cooperative and informative in Togo, as was Professor Tettekpoe of the Family Welfare Association, who has long first hand experience developing community organization and participation to define local problems. Useful interviews were conducted at the Ministry of Plan, and the Ministry of Social Affairs. Mme. Addaba, sociologist at the National Scientific Research Institute was particularly informative. The team anthropologist and geologist travelled by car through the Maritime Region with Togolese counterparts. During this trip, local people were interviewed, and water installations and catchment and storage methods surveyed and discussed.

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Briefings and People seen in Washington

1. Vic Wehman
2. John Blumgart
3. Anne Tinker
4. B. Lane - Togo Desk Officer
5. T. Damer - Chad Desk Officer
6. Jim Kelly

Briefings and Poeple seen in Abidjan

1. REDSO Asst. Director - Donald Miller
2. Anthropologist - Dan Aronsen
3. Team Control Officer - Jack Morgan
4. Chief Engineer - Richard Dudley
5. Canadian Embassy - Jacques La Vigne
6. In plateau market - Hamnedu - who dug wells in Mali and Upper Volta Dogin country
7. Lobi man
8. ORSTOM - M. Verdeaux
9. SHEDS - Director, Dr. French
10. CIRES - Asst. Director - M. Chataigner

List of Appointments and Poeple Seen in Chad

1. AID: Team Control Officer - R. Fontaine
2. Health Officer - Sude McGehey
3. CDO - John Lundgren
4. WID Officer - Inge Hvasloff
5. Econ. Officer - Ed Costello
6. Asst. CDO -
7. Amb William Bradford
8. P.C. Director - Bill Booth
9. Assit. Director - Phillip Infelise
10. Institut Nat'l des Sciences Humaines Secretary -
11. University of Chad/Soc. Geographer - M. Christian Bouquet
12. Peace Corps Volunteers:

Kevin Weideman	Sid Rosenberg
Mark Heferman	Ati Region
Richard Wheldon	Faya and Abeche Regions
Frank Wright	

13. Jesuit Priests:

Father Ferrar - Knowledgeable: Massa Areas and Mayo-Kebbi Region
Father Fournier - Sara Country

14. Steve Reyna - Anthropologist
15. Grandes Endemies - Dr. Favier

16. From Ati Region (Batha Province): Meran Abdellahi
17. From Mayo Kebbi: Mme. Gaim - Mandoung Region

Chief: Al Hadj Abu Ranee
School Teacher: S. Ahmed
3 Women Khamsa
Mme Gurma
Mme Birra

19. Min. Ag.: Director Enseignement et de la Formation
Prof. Agric.

Chef de Secteur: Dodih Bergos
Asst. Director: Jean Romnelngar

20. Embassy DCM: T. Dalsimer
21. Village: Medege: Moniteur: M.M. Courrta
Village Mogroum; Director: Mutamba Lumpungu

<u>List of Appointments and People seen in Volta</u>

1. (In Abidjan) discussion with REDSO Upper Volta Design Officer: E. Morgan Gilbert
2. Ouaga and U.S.AID: Gary Coulter - visit control
3. Martin Gilcrest - ex. PCV,
4. Tom Luche - Eastern Ord Projects
5. SAED Ms. Marilyn Hoskins - Anthropologist
6. AID Asst. Director - Atwell
7. C.I.E.H. - Documentation Center
8. S.A.E.D. Breaking for documents
9. VITA - Timennon
10. ORSTOM - M. Claude
11. WHO and CILSS - Dr. F. Martin/Samos
12. Dr. Pie Manumbuko
13. M. Maretto
14. Min. of Plan - M.M. Laure
15. Onchocerciasis ERADIC Campaign - Father Pairault
16. Peace Corps Director Finke
17. Kiaya Village - Eastern Ord Director - M. Kabore
18. "Foster Parents" Director ?
19. Service Hydraulique - Dir. Abj. - M. Kango
20. Ministry of Mines - M. Victor Ouande-Ouedraogo
21. Banfora O.R.D. Director - M. Mamadou Couliboly

List of Appointments and People seen in Togo

1. CDO - Sally Sharp
2. Charge - Bill Young
3. Peace Corps - Director Carl Berg
4. Assistant Director Morris
5. Plenary Session w/Ministries - List of Attendance attached
6. Ministry of Plan - M. Vincente Adigo
7. O.R.S.T.O.M. - Director M.J.F. Vizier
8. Sociologist - M.G. Pontie
9. Min. Social Affairs - Dir. M. Takouda Bouili
10. Directress - Promotion Femine MMe. Aithnard
11. C.N.R.S. Sociologist - Mme. Gemma Addaba
12. Min. of Mines - Technicians: M. Teophile Bruce, M. Teko Kuevi
14. Women at Ahepe Village
15. Women at Noepe Village
16. Boys at Mission Tore Village
17. At small town Circumscription Center: Tabligbo
    Social Affairs Agents: Koffi Amekoudi and
    Mme. Toffa Kiokoevi-Amekoudi
18. Women on the road to Alecho
19. Vogan Circumscription Center - Chef Cir. -
    M. Bikatui Nantob
20. Min. Rural Development: Rural Animation Director -
    M. Ahyi
21. Pres. Family Welfare Assn: Dr. Dosseh Tettekpoe

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LTKM
MINISTRE DES MINES, DE
L'ENERGIE ET DES
RESSOURCES HYDRAULIQUES

Plenary Session:
Team and Members of
all interested ministries

REPUBLIQUE TOGOLAISE
Travail - Liberte - Patrie

CABINET

Nom	Prenoms	Service
1. A. N'Djelle	Moukouli	Ministere des Mines, de l'Energie et des Ressources Hydrauliques
2. Creppy	Foly	" " " "
3. D.T. Lawson		Directour General des Mines
4. Adigo	Viwale	Direction du Plan
5. Harver (sic)	Sebastian	Delegation Americaine
6. Lester F.	Maupin	American Delegation
7. Ohin	Ata Quam	Genie Rural
8. Katakou	Kakou	Genie Rural
9. A. Osseni	Gafarou	Direction de l'Hydraulique et de l'Electricite
10. G.C. Taylor, Jr.		U.S. AID/Embassy
11. Nenonene	Komi	Chef du Service National d'Assainissement
12. Madame Sally R.	Sharp	Representante de l'US/AID
13. Charles S.	Pineo	U.S. AID/Embassy Lome, le

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Chapter 3

West Africa Rural Water Supply and
Sanitation Pre-Project Analysis

WATER RESOURCES AND WELL CONSTRUCTION CONSIDERATIONS IN THE DEVELOPMENT OF RURAL WATER SUPPLIES IN WEST AFRICA

George C. Taylor, Jr.

Water Resources and Well Construction Considerations in the Development of Rural Water Supplies in West Africa

George C. Taylor, Jr. Geohydrologist

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1.0 Availability of Water Supply

Traditionally, the rural people of West Africa have obtained water supplies for themselves and their herds from opendug wells and from streams, natural ponds, lakes or springs. Only in the steppes of the Sahelian Zone (annual rainfall 100 to 600 mm) and the drier parts of the Sudan savanna (annual rainfall 600 to 1,000mm) have wells been a traditional part of the rural water economy. Even in these regions, however, wells have been used only seasonally or intermittently in the absence of convenient, nearby sources of surface water. The well, then, is essentially considered as a source of reserve supply, when surface-water sources disappear during the course of the dry season. In the better watered parts of West Africa, that is, in the Guinea savanna and the tropical forest regions, where annual rainfall exceeds 1,000 mm, wells were not traditionally used for rural water supply in the presence of relatively abundant surface sources. Chiefly as a result of European influence since the latter part of the 19th century, wells have come to be accepted throughout West Africa as the cleanest, if not the most sanitary, and also the most reliable sources of water supply for human consumption in the rural environments.

2.0 Surface Water

Surface water is widely available in streams, lakes and ponds throughout the wet season which lasts about 3 months in the Sahelian zone and 3-6 months in the Sudan savanna.

In the Sahelian zone most streams cease to flow within a few months after the end of the wet season, and the only available water is that accumulated in permanent natural depressions (mares or marigots) along stream channels or in artifically constructed tanks and reservoirs. In the Guinea savanna and tropical forest regions, where the wet season is longer than the dry season, sufficient ground-water storage accumulates to sustain important spring discharge and the base flows of larger streams through most if not all of the relatively short dry season.

3.0 Ground Water

Ground water is widely available in sufficient quantity for rural water supply in virtually all the important rock terrains that occur in West Africa. (References B, F, and G) Nevertheless, because of geologic discontinuities and/or poor well drilling and construction techniques, local failures to obtain adequate water for village supply may and do occur. In such cases alternative sources of water supply may necessarily have been considered. Precambrian a/ igneous and metamorphic rocks, which are the most extensive of all the important rock groups, directly underlie the land surface of large parts of most of the West African countries with approximate areal extent in terms of the percent of the total national territorial extent of each country, shown in Table B-1.

a/ See "Glossary" for definition

Table B-1

Country	Areal Extent (% of Total)	Country	Areal Extent (% of Total
Guinea	60	Togo	90
Sierra Leone	95	Benin	86
Liberia	95	Nigeria	52
Ivory Coast	95	Niger	20
Mali	12	Chad	36
Ghana	55	Cameroon	84
Upper Volta	84		

Paleozoic[a/] sedimentary rocks which include consolidated sandstone and shales with some limestones and dolomites also directly underlie the surface of important parts of several West African countries notably the following (Table B-2):

Table B-2

Country	Areal Extent (% of Total)	Country	Areal Extent (% of Total)
Guinea	40	Togo	5
Mali	61	Benin	5
Ghana	40	Niger	5
Upper Volta	12		

Semi-consolidated sedimentary rocks of Cretaceous and Tertiary[a/] age include sands or soft sandstones interbedded with clays and clay shales and some soft limestones and marls locally. These deposits underlie narrow coastal plains in Guinea, Sierra Leone, Ivory Coast, Ghana, Togo, Benin, Nigeria and Cameroon. They also underlie important tectonic basins in interior areas with approximate areal extent as follows: (See Table B-3)

a/ See "Glossary" for definitions

Country	Areal extent (% of Total)	Country	Areal extent (% of Total)
Mali	27	Nigeria	47
Upper Volta	4	Cameroon	16
Niger	75	Chad	50

Quaternary [a] sediments include unconsolidated fluvial and lacustrine deposits, which generally are relatively restricted in areal extent. They occur together with the Cretaceous and Tertiary sediments of the coastal plains and are extensively developed in the Coastal Delta of the Niger River. Important inland areas of Quaternary deposits are in the great Lake Chad Basin of Nigeria, Niger, Cameroon and Chad. Another important area of Quaternary deposits occurs in the Inland Delta of the Niger River in Mali. Extensive tracts of Quaternary deposits also occur as sand dunes in the northern reaches of the Sahelian zone and extending into the Sahara.

Among the four groups of rocks of West Africa which have been previously mentioned, the rocks of the Precambrian terrain present the most difficult technical problems with respect to the extraction of potable ground-water supplies for rural requirements. The methods which must be adapted in the search for and recovery of ground water in these terrains are often costly with substantial risk of failure or only qualified success in obtaining even minimal supplies.

a/ See "Glossary" for definition

Nevertheless, there is no alternative source of ground water over large regions of West Africa. (As shown in Table B-1 in seven countries Precambrian terrains directly underlie 75 percent more of the national territory.) The Precambrian terrains, although including a wide variety of rock types, are chiefly intrusive granites and granite gneisses interspersed with bands of metamorphic rocks, principally schists, graywackes, quartzites and greenstones with phyllites and crystalline limestones present locally.

The most readily available ground water and presently the most extensively developed for rural water in the Precambrian terrains is that which occurs in the surficial mantle of weathered rock together with an underlying fractured zone (reference A & B.) In some lowlands and plains the mantle attains thicknesses of 30 to 50m or even more, but on higher ground near rocky outcrops or in hilly areas the mantle may be less than 10m thick. The weathered mantle from the land surface down generally has the following characteristics:

(a) Laterite carapace or duricrust. Thickness 0-12m. Seldom permanently water-bearing. Traditional unlined dug wells can sometimes yield up to 30m 3/h, while the carapace is temporarily saturated during the wet season.

(b) Clayey alterites, commonly koalinitic and up to 10m thick. Running or soupy saturated clays may cause problems in sinking the concrete curbings of modern open wells. Yields to wells can range from nothing to a few hundred liters per day.

(c) Friable sandy zone a few meters thick with communuted mineral aggregates in granites and gneisses. Yields to wells can range from a few hundred liters per hour to a few m 3/hr.

(d) Fractured zone as much as 50 to 100m thick, in places less or even more. Yields can range from 0.5 to 10m 3/h.

Most dug wells do not, and in some cases cannot, penetrate much into zone (d)(reference A). On the other hand, small diameter wells drilled by the percussion and rotary methods can penetrate into zone (d) and beyond to intercept water in deeper fracture systems. These two methods may become ineffective and uneconomic, however, if the rock becomes too hard. Penetration of hard rocks to depths of 100m or more can be accomplished with ease by the down-the-hole air-hammer drill. In the granites and granite gneisses of the Precambrian terrains the thickness and permeability of zone (c) conditions the yields of dug wells. On the other hand, dug wells sunk in the greenstones commonly find zones (a) and (d) most productive. The schists may be productive to dug wells in zone (b) but zone (c) is usually absent.

Zone (d) is usually productive to drilled wells in schist. Phyllites are commonly quite non-productive, but fortunately they are not widespread. Quartzites do not usually weather significantly but are productive to drilled wells in zone (d).

Ground-water occurrence in the Precambrian terrain, whereas homogeneous on a regional scale, is much less so on a local or well-site scale. Consequently, there is always a risk of failure or only qualified success in sinking any well in the Precambrian terrain. On the average about 5 to 10 percent of wells put down find no water, about 15 to 20 percent provide meager supplies, and 75 to 80 percent can be considered adequate to provide enough water or more for a small village supply. The risk of failure through poor well siting can, of course, be reduced by appropriate study of local fracture systems and the weathered mantle using well-established geologic criteria. For both dug and drilled wells the range and average yields and well depths usually encountered in the common rocks of the Precambrian terrain are as follows (Table B-4):

Table B-4

Rock Type	Well yield (m3/h)			Well Depth (m)	
	Range	Average	Exceptional	Range	Average
Schimst	0-20	8	40	25-80	40
Quartzite	0-5	3	15	25-80	40
Granite and granite gneiss:					
Zones (a)&(c)	0-5	0.2	10	5-30	15
Zone (d)	0-10	4	20	30-80	40

Because of their consolidation most ground water in the Paleozoic sedimentary rocks circulates through fractures and along bedding planes rather than through the interstices of rock grains. The Paleozoic rocks crop out extensively in the Voltaian sedimentary basin of Ghana extending into parts of Togo, Upper Volta and Benin. They are also extensively developed in the Taoudenni sedimentary basin of Mali and in the Guinea sedimentary basin. The sandstones generally form the most productive aquifers, but the shales or siltstones and dolomites may also be locally productive. (Reference F & G) For both dug and drilled wells the range and average yields and well depths usually encountered in the Paleozoic sedimentary rocks of those basins are as follows (Table B-5):

Table B-5

Rock Type	Well Yield (m3/h)			Well depth(m)	
	Range	Average	Exceptional	Range	Average
Sandstone	1-5	3	50	10-200	40
Shale and/or siltstone	0-5	1	10	5-70	40
Dolomite and/ or limestone	0-20	10	100	15-100	40

The Cretaceous and Tertiary sedimentary terrains contain the most productive aquifer systems in West Africa and are most extensively developed in Niger, Chad and Nigeria as well as somewhat less so in Mali and Cameroon (references F&G).

The thick sands and semi-consolidated sandstones constitute the most important aquifers. Equally thick but largely impervious clays and siltstones, which are interbedded with the sandy aquifers, bring about conditions which are conducive to artesian flows or subartesian pressures in several regions. Such conditions occur notably in the Sokoto and Chad basins of Nigeria extending into neighboring parts of Niger and Cameroon. The range and average yields and well depths from some of the more important aquifer systems of the Cretaceous and Tertiary sedimentary terrains are given in Table B-6:

Table B-6

Dug Wells				Drilled Wells			
Depth range (m)	Aver. depth (m)	Yield range (m^3/h)	Aver. Yield (m^3/h)	Depth range (m)	Aver. depth (m)	Yield range (m^3/h)	Aver. Yield (m^3/h)
Continental Intercalaire							
20-100	30	2-15	5	30-350	150	25-250	75
Cretaceous Marine							
20-50	30	1-10	2	50-150	100	10-150	50
Maestrichtian							
--	--	--	--	100-500	150	50-300	50
Paleocene & Eocene							
20-50	30	1-15	3	100-200	150	50-300	50
Continental Terminal							
10-50	30	1-15	5	50-300	150	50-150	50

The unconsolidated sediments of the Quaternary terrains contain important and productive aquifers notably in the sands which are intercalated with clays of stream and lake deposits and also in thick and extensive sand dune deposits in parts of the Sahelian zone. Open dug wells in these terrains common tap shallow aquifers at depths of 10 to 40m with an average of about 20m. Yields obtained from such wells range from 2 to 10m 3/h and average about 5 m3/h. Drilled wells range from 20 to 100m deep with an average of about 50m. Yields obtained may range from about 10 to 150 m3/h with an average of about 50 m3/h (references B,F, and G).

4.0 Water Levels

The depth, at which the water level lies below land surface in a well, is a very important economic and social consideration in the development of ground water for rural supply. The human labor involved in lifting water by bucket and handline from an open dug well or by hand pumps from a drilled well is the important factor. The deeper the water level the less attractive is a well for village water supply, using human labor for lifting water.

The depth of the ground-water level is quite variable through West Africa and depends on the interplay of topographic, geologic, hydrologic and climatic conditions (Reference F.) In the Precambrain terrains the ground-water level generally ranges from a few meters to as much as 20 to 30m below the land surface and is commonly at about 10 to 15m.

In the Paleozoic, Cretaceous-Tertiary and Quaternary terrains the first water table is commonly from 10 to 40m below land surface, but in places it is as much as 80 to 90m. Ground-water levels are deepest in the Sahelian zone, generally 40 to 60m or more. Also where sedimentary terrains have been dissected by streams as in the coastal plain of Togo, the depth to water may be as much as 40 to 50m, even in relatively humid areas. In other regions, as for example in the Chad and Sokoto basins, deep aquifers may give rise to flowing wells or subartesian water levels may rise to within 10 to 20m of the land surface. The aquifers that provide such pressures may lie at depths of 100 to 250m or more below land surface.

The seasonal fluctuation of the ground-water level is also an important consideration in the development of ground water for rural water supply. The largest fluctuations generally occur in areas away from large streams where the water level may range from 7 to 8m between the high at the end of the wet season and the low at the end of the following dry season. Fluctuations of 3 to 5m are more common and near the mares and marigots fluctuations may be less than one meter.

The seasonal fluctuation of the water table is an important factor in the productivity of dug wells, most of which produce considerably less water at the end of the dry season than they do at the end of the wet season.

This phenomenon is a result of the relative penetration of the well into the water-bearing zone. Most dug wells in West Africa require one or more deepenings after initial construction before a year-round supply can be insured. Dug wells, to insure an adequate production, should extend at least 5m below the lowest dry season position of the water table. Dug wells, however, are particularly susceptible to prolonged dry cycles, as demonstrated by the recent Sahelian drought (1968-73) which induced a general water-level decline of several meters. Many dug wells have not yet recovered to pre-drought levels.

5.0 Present Status of Water Development for Rural Supply

Both surface-water and ground-water sources are presently used for rural water supply and livestock throughout West Africa. In the absence of awareness of the health hazards involved, a surface-water source, when it is available, may be preferred by villagers or herdsmen because of its relative convenience, in contrast to ground water, which may require considerable labor for its extraction from a well. In the tropical forest and Guinea savanna regions household supplies may be taken directly from nearby perennial streams or springs where these are conveniently located to village compounds. Wells are used, however, if surface-water sources are lacking or are located at more distant points. The relative physical labor to the water drawer and carrier is the critical factor.

Farther north in the drier Sudan savanna small earthen dams are used to catch and store surface-water runoff for dry season use, chiefly for irrigation of crops in valley bottoms (bas fonds) but also for livestock and household consumption. Water is also taken from perennial ground-water fed ponds and swamps (mares and marigots) and from shallow water holes dug in dry river beds to tap underflow. Still farther north in the Sahelian zone where surface-water sources are precarious through most of the year, wells are used almost exclusively for domestic and livestock water supply, more particularly in the dry season.

At present, the development of sanitarily protected surface water for rural water supply in West Africa is severely limited by economic constraints. Primarily because of difficulty of sanitary protection, susceptibility to the vagaries of rainfall, potential for generating disease vectors, and cost of maintenance and water treatment, open surface-water catchments are generally assigned a low priority insofar as concerns development for a sanitarily protected rural-water supply. Artificial rain-water catchments for covered cistern storage and protected spring captations, however, may be acceptable alternatives to wells for rural water supply. Sanitarily protected spring captations are reported to have been installed for rural water supply in a few places notably in the Guinea highlands, the Atacorian Hills of Togo and Benin, and the Cameroon highlands. Such captations, however, are not widely used in West Africa at present.

Present ground-water development in West Africa is relatively small as compared to total ground-water availability. Only in a few areas is ground-water development relatively intensive, as for example for urban and suburban areas from coastal aquifers near Abidjan, Lomé and Cotonou and from aquifers in inland for other urban areas as at Garoua in Cameroon, Zinder in Niger, and N'Djamena in Chad. Extraction of ground-water for rural use is presently widely dispersed in Guinea, eastern Chad, Cameroon, Ivory Coast, Togo, Benin, and Mali. Use is slightly more intensive in western Chad, Niger, Upper Volta, Ghana, and Nigeria, particularly in the Sokoto, Chad, Benue and Niger basins. A number of countries, however, such as Ghana, Ivory Coast, Togo and Upper Volta have embarked on important rural water-supply development programs involving construction of both modern dug wells and drilled wells with the assistance of foreign donors.

Wells, now installed and those proposed for construction in the immediate future for rural water supply, are and will be commonly separated from each other by distances greater than 100m. Also the withdrawals from individual wells, either by hand pump or by bucket and hand line, are commonly less than 5 m3/d. For these reasons virtually no significant lowering of the water table, caused by pumping overdraft from rural water-supply wells, is likely to occur in the forseeable future in West Africa.

Pathogenic bacteria and/or parasites of human and/or animal origin are not uncommonly introduced into open dug wells in West Africa through ignorance or by accident. Such pollutants, however, generally remain in the well itself and/or its immediate vicinity. Pathogenic bacteria and/or parasites introduced into a well do not normally travel more than a few meters away from the well. Also control of such pathogens can generally be effected by simple chlorination of the well itself, although repetitive treatment over a period of several days may be necessary where wells are severely polluted.

To extract ground water for rural domestic consumption, livestock and urban water supply there are essentially five kinds of wells presently in use in West Africa. These include (1) traditional dug wells, (2) modern dug wells, (3) larger diameter bored wells, (4) small or intermediate diameter drilled wells (tubewells), and (5) large diameter tubewells.

Traditional open dug wells for village and livestock water have been constructed in all of the geologic terrains of West Africa. These are dug by simple hand excavation techniques using a pulley or windlass with buckets and hand lines for removal of soil and rock. Such wells have been dug to depths of 50m or more. Many are unlined and as much as 5 to 10m in diameter. They are subject to gross pollution and occasionally have been known to cave in endangering the lives of local herders or cultivators.

Also because of inadequate penetration into the aquifer they commonly fail in the dry season. There are still many thousands of such wells in use in West Africa, but they are gradually being supplanted by modern open dug wells and drilled wells (tubewells).

The so-called modern open dug wells in West Africa are essentially adaptions of French technology developed during the late 1940s and 1950s (Reference C.) Also, the prevailing rationale for the continuing construction of the modern dug well has been the provision of relatively clean water (as against a marigot or a traditional well) for basic village use and a well from which water can be drawn by bucket and hand line with minimum maintenance requirements. Whereas most modern dug wells are adequately protected against lateral percolation of polluted surface seepage around the well curbing, pollutants including fecal matter and other human and animal offal can be easily and directly introduced into the top of the well from hand lines and buckets. Thus, modern dug wells without covers provide only a partial solution to the problem of sanitary water supply for small village requirements. Modern dug wells provided with covers for sanitary protection and equipped with hand pumps have been placed in service locally in some countries of West Africa, as for example Chad, Upper Volta and Togo. These installations have not proved viable however, except where regularly main tained by concerned expatriate volunteer, charitable or religious groups.

In the absence of maintenance the pumps break down, the covers are broken or removed, and water continues to be drawn by villagers by hand line and bucket.

The modern dug wells are mostly constructed by the "trousse coupante" method. An excavated hole is first put down as deeply as possible by village labor using hand tools and some supplies provided by the sponsoring agency. Concrete rings 2.0 to 1.6m in diameter are placed in the excavated hole above the water table reducing to 1.6 to 1.0m in perforated rings in the water-bearing zone. The perforated section is generally gravel-packed to prevent fine aquifer materials from entering the well. The lowermost ring is provided with a sinking shoe and concrete rings are poured in a mold and added at the top of the perforated section as the well is deepened. Virtually all dug wells require one or more deepenings after initial construction before a viable water supply can be assured through the dry season. The government agencies in West Africa involved in rural water supply development using modern dug wells virtually all employ considerable mechanized equipment, including derricks, air compressors, jack hammers, explosives, and sinking pumps. In addition to the government agencies regularly concerned, there are commonly many donor agencies and PVOs involved in well construction projects in the West African countries. For example, there are 20 such agencies in Upper Volta and 11 in Togo. Although no accurate inventory is available, it is estimated that there are probably 50,000 or more modern open dug wells now in operation in West Africa.

In addition to the prevailing modern dug well, which requires a large component of hand labor, mechanical boring equipment is currently being used to construct large-diameter (0.8 to 1.0m) wells for village water supply particularly in the weathered mantle of Precambrian terrains. This method, which has been used with some success in Ivory Coast, Togo and Upper Volta, is limited to soft ground with some cohesion. It is useful, however, for reconnaissance as well as production. The laterite carapace of zone (a) can generally penetrated with no problems. Also because of the rapidity of construction, the fluid or soupy clay layers of zone (b) can be controlled with the working casing, where not too thick. The method, however, does not lend itself to penetration very far into zone (d). Thus the effective depth of most wells constructed by this method is about 25m. Three reconnaissance holes or one production well can be constructed in one day. (A modern dug well may take as long as 2 months or even more to complete.) The yields of large-diameter bored wells are reported to be comparable to those of modern dug wells.

Small-diameter drilled wells (tubewells) equipped with hand pumps are increasingly being used in the West Africa countries for village water supply. There are reported to be more than 1,500 such wells in current use in Ghana, more than 2,000 in Nigeria and more than 4,000 in Ivory Coast. (All these village tubewell hand-pump projects are supported by strong maintenance organizations financed and administered by central, regional or state government agencies.)

A minimum diameter of about 4½ inches is required for installation of a hand pump in a tubewell with a nominal capacity of 1.5 m3/h. For a power pump the minimum diameter is about 6 inches, which diameter permits drafts up to about 12 m3/h. PVC is commonly used for shallow surface casing in Precambrian terrain, but steel casing may be required in deeper tubewells in the Paleozoic, Cretaceous-Tertiary and Quaternary terrains. Also well screens and/or gravel packed slotted pipe is required in unconsolidated or semi-consolidated sand aquifers of the Cretaceous-Tertiary and Quaternary terrains.

Until recent years most small-diameter tubewells were put down by conventional rotary or percussion drilling rigs. The rotary rigs operate quite satisfactorly, except in hard rock. The conventional rotary rig is particularly adapted to drilling conditions encountered in the alternating soft sands and clays of the Cretaceous-Tertiary and Quaternary terrains. A rotary drilled well about 50 meters deep is reported to require about 2 to 3 days at two shifts per day to complete in most soft rock terrains. Percussion drilling is well adapted to the Precambrian and Paleozoic sedimentary rock terrains, but progress may be slow if hard rock is encountered. In softer rock a percussion drilled well 50m deep can be completed in a week, but if hard rock is encountered the well may require a month or more to complete.

The down-the-hole air hammer drill has been introduced into West Africa in recent years. This drilling method is particularly well suited to the Precambrian hard rock terrains, because of the rapidity of penetration (20m or more per day) and of the indications given of water productivity from the fractures of zone (d). Although rotary and percussion drilling rigs are still widely used in West Africa, the down-the-hole air hammer rig is gaining increasing favor, as for example in a number of current rural water development projects in Benin, Togo, Ghana and Ivory Coast.

6.0 Costs of Hand Pumps and Well Construction

Several types of hand pumps have been installed on both dug and drilled wells in West Africa. None has proved entirely satisfactory under conditions of heavy use and lack of maintenance. The importance of maintenance in satisfactory pump operation is suggested in Table B-7:

Table B-7

Country	Approx. No. Hand Pumps Installed on Drilled Wells	Approx. % Pumps out of Order at Any One Time
Ivory Coast	4,000	10
Chana	2,500	15
Nigeria	3,000	10
Togo	500	50
Upper Volta	350	50
Chad	400	20

As shown in this table Ivory Coast, Ghana and Nigeria have established relatively effective national maintenance programs which can deliver required service at the village level. Experience in Ivory Coast appears to indicate that one technician with one fully equipped maintenance unit is necessary to service 125 to 130 hand pumps per year with about 90% efficiency. Some assistance from local villagers is also required. On the other hand in Upper Volta one service crew can maintain only about 100 pumps a year with 50% efficiency, because the pumps are widely scattered and requisite spare parts are commonly not available.

The types of hand pumps presently in use in West Africa and their relative characteristics and costs are shown in Table B-8 (reference D.) With the exception of the Vergnet pump all others are of the reciprocating lift type. The Vergnet pump which operates with a foot pedal instead of a hand lever, has a number of advantages for ease of installation, operation and repair. Slight modifications in the diameter of the piston and the length of the stroke also permit raising water from depths as great as 65m. Most other pumps in common use in West Africa are limited to lifts of about 40m.

Make	Type	Max. lift (m.)	Max. Yield (m 3/h)	Approx. Cost (US $)
Abi	M,MR	40	1.0	580 a/
Bodin	Majestic	30-35	1.0	660 a/
Brian	Africa	(100 (40	(0.3 (0.9	2,990
Dempster		30-35	1.2	415 a/
Godwin	W1H51 W1H54	(100 (40	(0.4 (1.3	1,450 a/
Uganda		(60 (50 (25	(0.4 (0.6 (0.9	?
Vergnet	4C 4A	65 10	0.6 1.7	744 a/
AID/ Battelle		65	0.3	150
Moyno		100	0.3	450

Another type of hand pump-cum-well has been developed in Chad through the joint efforts of U.S. AID and the Peace Corps. The 2 inch well casing serves also as the pump column. The wells range from 15 to 30m deep with water levels 10 to 25m below land surface. The Tysen well, as the combined pump-cum-well is called, including the casing, screen and pump, costs only $1,500 installed. Maintenance is estimated at $100 per year. There are some 200 such wells currently in operation in Chad maintained by the government with Peace Corps assistance.

a/ Delivered in Upper Volta

Most of the modern open dug wells in West Africa, which have been constructed by government agencies and/or through the auspices of their international supporting donors during the past 15 years have employed imported mechanical equipment (that is, derricks, steel cable, winches, air compressors, jack hammers, sinking pumps, etc.) as well as imported materials (that is, explosives, cement and reinforcing steel, etc.) in their construction. When overhead and the amortization of such equipment and material costs are included with costs for local materials, transport and some skilled labor, the gross costs of modern dug wells in West Africa are markedly higher (perhaps 3 to 4 times) than the costs of so-called traditional dug wells put down exclusively by hand labor.

The costs for a conventional modern dug well of the type put down in the Precambrian and Paleozoic terrains of West Africa are presently estimated to lie in the ranges shown in Table B-9.

Table B-9

	Range in Cost per Linear Meter of Well	Average Cost per Linear Meter
Chad	$ 275-395	$ 334
Ivory Coast	200-350	250
Upper Volta	205-310	275
Togo	300-800	500
Overall in Francophone West Africa	200-700	350

Thus the relative costs for an average modern open dug well about 35m deep would be approximately as shown in Table B-10.

Table B-10

	Range in Cost Per Well	Average Cost Per Well a/
Chad	$ 9,625-13,125	$11,690
Ivory Coast	7,000-12,250	8,750
Upper Volta	7.175-10,850	9,625
Togo	10,500-28,000	17,500
Overall in Francophone West Africa	7,000-24,500	12,250

Relative costs depend on the depth and diameter of the well, on the costs and availability of imported supplies and equipment, transport, labor and local overhead.

For a large-diameter (0.8 to 1.0m) bored well costs are estimated at about $165 per linear meter for a lined finished production well in Upper Volta and $200 to $250 per linear meter in Togo and Ivory Coast. The cost for a 20m well can thus range from about $3,300 to $5,000. For a reconnaissance hole using this mechanical boring method costs are less, about $125 per meter.

The present costs for small diameter (4 to 6 inch) drilled wells (tubewells) of the type that would be equipped with a hand pump and with a nominal yield of about 1.5 m3/h are estimated to lie in the ranges shown in Table B-11.

a/ Without Hand pump

Table B-11

	Range in Cost per Linear Meter of Well	Average Cost per Linear Meter
Chad	$150-250	$200
Ivory Coast	175-275	225
Upper Volta	100-200	150
Togo	200-300	250
Overall in Francophone West Africa	100-350	225

The costs in Ivory Coast and Togo are somewhat higher because of the down-the-hole air hammer drill is now being increasingly used for construction of small diameter tubewells. In Chad and Upper Volta such tubewells are more commonly constructed by the rotary and percussion methods.

The relative costs of an average small-diameter tubewell of about 35m would be in the ranges shown in Table B-12.

Table B-12

	Range in Cost Per Well	Average Cost Per Well[a]
Chad	$ 5,250-8,750	$7,000
Ivory Coast	6,125-9,625	7,875
Upper Volta	3,500-7,000	5,250
Togo	7,000-10,500	8,750
Overall in Francophone West Africa	3,500-12,250	7,875

a/ Without hand pump.

In addition to the drilling method, costs depend on the type of casing used (PVC is cheaper than steel casing), the type of screen (wire-wrapped screens are much more costly than gravel-packed slotted pipe), the availability of supplies and drilling equipment, transport, labor and local overhead.

The costs for larger diameter (10-12 inch) drilled wells that would be equipped with a power pump with a nominal yield of 50 m3/h or more are in the range of $700 per linear meter or $42,000 for a 60m tubewell. Wells of such capacity are suited, of course, chiefly to serve towns of 5,000 persons or more that are located in favorable Cretaceous-Tertiary and Quaternary terrains.

The depth of penetration into one or more aquifers is an important element in the cost of a well. With a dug well the cost increases with depth, whereas much of the cost of a drilled well is in fixed charges so that with increased depths costs are not incremental. Also per m3/h of water obtained a drilled well is cheaper than an open well. The chief advantage of a dug well is in the use of some local labor and materials. Nevertheless, about 50% of the gross cost of a modern open dug well lies in the use of imported materials and equipment (including its amortization) for its construction (Reference C.) About 80% of the gross cost of a drilled well (tubewell) lies in the use of imported materials and equipment (including its amortization) for its construction (Reference A.)

7.0 Opportunities and Constraints in Rural Water Supply Development

The chief advantages of a drilled well over a dug well are (1) rapidity of construction, (2) ease of emplacement, (3) greater ease of sanitary protection, (4) lower cost per m3/h of water that can be obtained, and (5) greater permanence and dependability of the water supply (reference A). The only real problem is the need for a hand or power pump for water extraction from a drilled well. To operate satisfactorily pumps must be maintained. Effective maintenance demands trained service crews provided with adequate parts, supplies and transport for pump repair and/or replacement as well as effective support from national and regional organizations concerned with administration of maintenance programs. If any one of its essential parts fails to function properly, a maintenance program rapidly becomes ineffective. There are today virtually no hand or power pump maintenance programs in the West Africa countries which are 100% effective. There are, however, a number of promising programs underway, notably in Ivory Coast, Ghana and Nigeria. They are badly needed elsewhere.

In view of the well-known constraints of open dug wells versus drilled wells and the pump maintenance problem, there may be possibilities for gravity water development for village water supply in some parts of West Africa. One possibility is the spring captation, which could doubtless be much more widely utilized in relative well watered hilly

areas as for example in the highlands of western Guinea, southwestern Mali and southeastern Volta; in the Atacorian Hills of Togo and Benin; in the Cameroon highlands of Nigeria and Cameroon; in the Adamawa Hills of Cameroon; and in the hilly areas of eastern and southern Chad. By constructing sanitarily protected captations or collecting boxes over spring heads unpolluted water can be delivered by gravity pipe line to village fountains on lower ground. Before such a spring captation program could be undertaken, detailed national inventories of potentially developable springs with the village populations to be served would have to be made together with estimates of the costs of development.

Another alternative to full dependence for village water supply on open dug wells is more extensive use of rainwater collection in covered cisterns, which are now used to a limited extent in the tropical forest and Guinea savanna zones where annual rainfall exceeds 1,000mm. Collection of water from roof tops, particularly where these are of corrugated iron, is one possibility. If the cisterns are constructed on or above ground level the water could be drawn off by relatively sanitary taps rather than the alternative of unsanitary dipping with hand lines and buckets. Such cisterns could be built of mortar and brick or blocks of laterite, which is widely available in West Africa, and lined with neat cement for impermeabilizing.

Still another alternative is to select uncultivated rocky knobs or hillocks, of which there are many in the Precambrian and Paleozoic terrains, and to develop these as rainwater harvesting areas. Ideally such areas should be protected from trespass by man and animals to reduce the pollution hazards. Rainfall runoff from rocky slopes could be diverted by low pitched rock dikes on the contours into collecting channels and thence led down slopes into one of more covered cisterns. Before embarking on any large-scale rainwater harvesting projects it would first be desirable to undertake feasibility studies including identification of potential sites or areas, potential water yields from such areas and approximate costs. To improve sanitary quality the collected rainwater could be chlorinated in the cistern or passed through simple sand filters before delivery into the cisterns (reference E.)

Other alternatives may also exist in dams and reservoirs for storage of the surface runoff of streams, and also collection of the underflow by means of infiltration galleries from permeable deposits of sand and/or gravel near stream channels In favorable topographic situations such water might be delivered by gravity pipe line to points of use. It is likely, however, that in most places pumping would be required. Also such supplies would require treatment before distribution, if sanitary quality is to be assured, and treatment facilities would have to be maintained if they are to operate effectively.

Such facilities are unlikely to be cost effective for dispersed village water supplies. They might, however, be considered for larger agglomeratious of villages in more densely settled areas of West Africa.

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9.0 GLOSSARY

Precambrian Terrain:

Hard igneous and metamorphic rocks more than 600 million years old. Ground water occurs mainly in a superficial weathered layer (mantle) developed on these rocks and in an underlying fractured zone. Little or no ground water generally occurs in these rocks at depths greater than 100m. Poor aquifers - but supply enough water to sustain village wells.

Paleozoic Terrain:

Consolidated bedded sedimentary rocks from 350 to 600 million years old. Ground occurs chiefly in the bedding planes and in secondary joint systems in these rocks. Little or no ground water generally occurs in these rocks at depths greater than about 250m. Mediocre to poor aquifers - but provide enough water to sustain village wells.

Cretaceous - Tertiary Terrain:

Semi-consolidated bedded sedimentary rocks from 130 to 150 million years old. Contains good to excellent aquifers, chiefly in sands and soft sandstones at depths which may range from 20 to 400m below land surface. Contains the most extensive and productive aquifer systems in West Africa.

Quaternary Terrain:

Unconsolidated sedimentary deposits less than 2 million years old. The sandy layers form good to excellent aquifers in some parts of West Africa at depths which may range from 10 to 150m below land surface.

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Chapter 4

WEST AFRICA RURAL WATER SUPPLY AND SANITATION PRE-PROJECT ANALYSIS

WELL DRILLING AND MAINTENANCE EQUIPMENT IN WEST AFRICA

Lester Maupin

CHAPTER 4

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1.0 INTRODUCTION

In West Africa the local mission project designers, knowing exactly the areas to be worked in and the subsurface characteristics of the area, must reach a tradeoff between drilling efficiency, cost of rig and support equipment, logistical support requirements, and attempts to stimulate local "cottage industries" to produce low cost, low maintenance drilling rigs and spare parts. USAID could opt to produce a large quantity of quality, expensive wells using sophisticated imported equipment, or to stimulate the development of a well "drilling" industry by introducing low cost, low maintenance "drilling" equipment appropriate to the areas being drilled in, using local manufacture of the rig and spare parts. A component of the second alternative would be a local competency-based drilling training program for local people interested in starting their own grass-roots family drilling company to drill wells in a small area of the countryside near their present home (or even forming a myriad of intinerant type drilling concerns.)

The National Water Well Association in Columbus, Ohio should be able to give USAID specific project designers a clear cut analysis of alternatives and approaches to local equipment manufacturing and appropriate training programs.

If hand dug wells are appropriate to an area, then considerably less complex dewatering pumps, compressors and jack-hammers could be used for deepening the well after it has reached the ground water level. Hand dug wells can be sanitarily

sealed and operated as efficiently as drilled wells, with the added benefit of allowing access to the water through a man-hole if the hand pump breaks down. The lack of access to the water in a small diameter drilled well when the pump breaks down is a serious problem for a village which has become dependent on a recently installed well with hand pump.

2.0 Well Drilling Methods

2.1 Simple Approaches

There are simple methods of making water wells . These methods can be used with very little equipment, in most cases, but can only be used is soft clay, silt, sand or otherwise unconsolidated formations. If there are boulders or hard rock formations, there is little or no chance that most of these methods will work. They, in all cases are slow but can make small (6-8") diameter bore wells to depths of up to 250 feet. These methods are best described in AID's "small wells manual" quoted here with personal observations added.

The term "well drilling methods" is being used here to include all methods used in creating holes in the ground for well construction purposes. The limitations on well diameter (8 inches and less) exclude the dug well from consideration. The sections that follow describe the bored and driven, the percussion, hydraulic rotary and jet drilled wells.

2.11 Boring

Boring of small diameter wells is commonly undertaken with hand-turned earth augers, though power-operated augers are sometimes used. Two common types of hand augers are shown in Figure 5.1. They each consist of a shaft with wooden handle

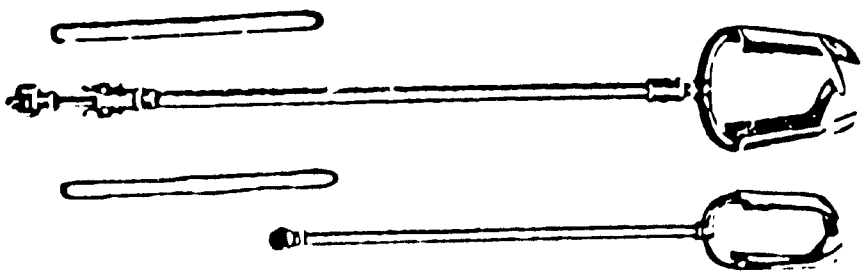

Fig. 5.1 HAND AUGERS. (From Fig. 6, *Wells*, Department of the Army Technical Manual TM5-297, 1957.)

at the top and a bit with curved blades at the bottom. The blades are usually of the fixed type, but augers with blades that are adaptable to different diameters are also available. Shafts are usually made up of 5-ft sections with easy latching couplings.

The hole is started by forcing the blades of the bit into the soil with a turning motion. Turning is continued until the auger bit is full of material. The auger is then lifted from the hold, emptied and returned to use. Shaft extensions are added as needed to bore to the desired depth. Wells shallower than 15 ft ordinarily require no other equipment than the auger. Deeper wells, however, require the use of a light tripod with a pulley at the top, or a raised platform, so that the auger shaft can be inserted and removed from the hole without disconnecting all shaft sections.

The spiral auger shown in Fugure 5.2 is used in place of the normal cutting bit to remove stones enc antered during boring operations. When turned in a clockwise direction, the spiral twists around a stone so that it can be lifted to the surface.

The method is used in boring to depths of about 50 ft. in clay, silt and sand formations not subject to caving. Boring in caving formations may be done by lowering casing to the bottom of the hole and boring ahead little by little while forcing the casing down.

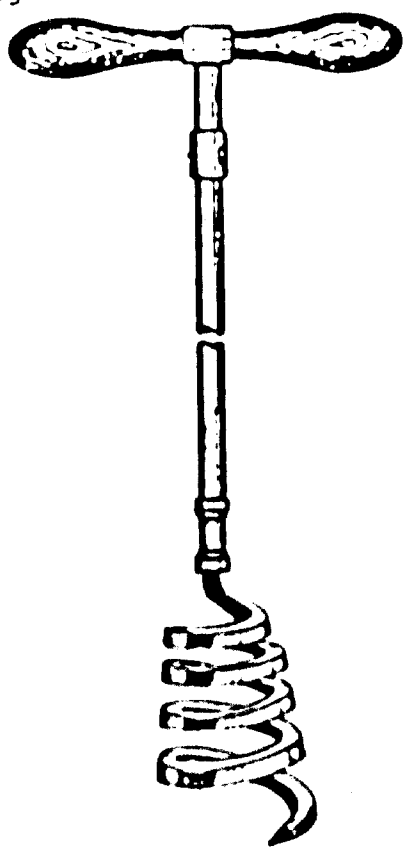

Fig 5.2 SPIRAL AUGER

This method of boring with a hand auger is most likely the second cheapest way to make a small production, shallow well. In West Africa there are places where the water table

is shallow enough to use this method. One well trained man, with some augers and hand tools, going from village to village, where wells are needed, and with the people of the village doing the work, could make a well every week to two weeks. The augers and tools would not cost over $1,000.00. He would also need logistics to carry hand pumps, pump pipes, and 5-6 sacks of cement, gravel and sand to make a base for the hand pump.

2.12 Driving

Driven wells are constructed by driving into the ground a well point fitted to the lower end of tightly connected sections of galvanized iron pipe. The well point must be sunk to some depth within the aquifer and below the water table. The riser pipe above the well point functions as the well casing.

Equipment used includes a drive hammer, drive cap to protect the top end of the riser pipe during driving, tripod, pulley and strong rope with or without a winch. A light drilling rig may be used instead of the tripod assembly. Well points can be driven either by hand methods or with the aid of machines. Figure 5.3 shows the assembly for a purely hand-driven method. The drive-block assemblies commonly operated by a drilling rig or by hand with the aid of a tripod and tackle are shown, in Figure 5.4.

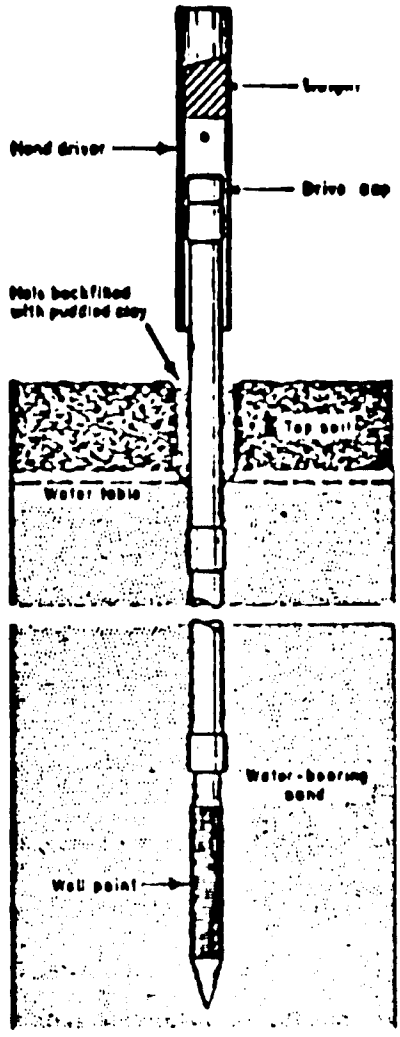

Fig. 5.3 SIMPLE TOOL FOR DRIVING WELL POINTS TO DEPTHS OF 15 TO 30 FT.

Whatever the method of driving, a starting hole is first made by boring or digging to a depth of about 2 feet or more. As driving is generally easier in a saturated formation, the starting hole should be made deep enough to penetrate the water table if the latter is sufficiently shallow. The starting hole should be vertical and slightly larger in diameter than the well point. The well point is inserted into this hole and driven to the desired depth, 5-ft lengths of riser pipe being added as necessary. Pipe couplings should have recessed ends and tapered threads to provide stronger connections than ordinary plumbing

couplings. The pipe and coupling threads should be coated with pipe thread compound to provide air-tight joints. The well-point assembly should be guided as vertically as possible and the driving tool, when suspended, should be hung directly over the center of the well. The weight of the driving tool may range from 75 to 300 pounds. Heavier tools require the use of a power hoist or light drilling rig. The spudding action of a cable-tool drilling machine is well suited for rapid well point driving. Slack joints should be periodically tightened by turning the pipe lightly with a wrench. Violent twisting of the pipe makes driving no easier and can result in damage to the well point. This must, therefore, be avoided.

Driven wells can be installed only in unconsolidated formations relatively free of cobbles and boulders. Hand driving can be undertaken to depths up to about 30 feet; machine driving can achieve depths of 50 feet and greater.

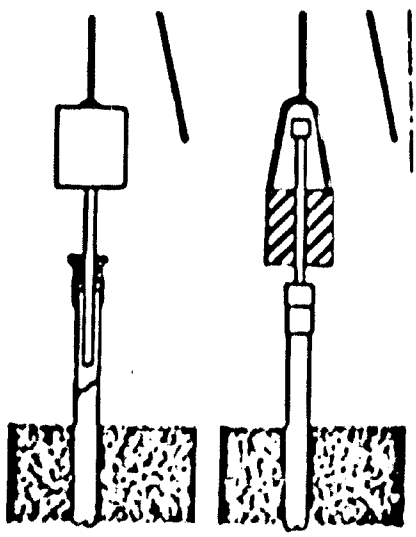

Fig 3.4 DRIVE BLOCK ASSEMBLIES FOR DRIVING WELL POINTS

The cost for doing this type of well would depend on what type of tools were to be used in driving the well point and pump pipe to its desired depth. All tools could be fabricated from a local machine and welding shop and the hand tools could be bought from the local shops. Until hand pumps can be made in a country, the pump parts and screen well point would come from AID at a cost of under $500.00 per well. Again, a man would have to be trained and supplied with logistics to move the pipe, driver and transport cement, gravel and sand for the sanitary upper structure.

2.13 Jetting

The jetting method of well drilling uses the force of a high velocity stream or jet to cut a hole into the ground. The jet of fluid loosens the subsurface materials and transports them upward and out of the hole. The rate of cutting can be improved with the use of a drill bit (Figure 5.5) which can be rotated as well as moved in an up-and-down chopping manner.

The fluid circulation system is similar to that of conventional rotary drilling described later in this chapter. Indeed the equipment can be identical with that used for rotary drilling, with the exception of the drill bit. Simple equipment for jet drilling is shown in Figure 5.6. A tripod made of 2-inch galvanized iron pipe is used to suspend the galvanized iron drill pipe and the bit by means of a U-hook (at the apex of the tripod), single-pulley black and manila rope. A pump having a capacity of approximately 150 gallons per minute

at a pressure of 50 to 70 pounds per square inch is used to force the drilling fluid through suitable hose and a small swivel on through the drill pipe and bit. The fluid, on emerging from the drilled hole, travels in a narrow ditch to a settling pit where the drilled materials (cuttings) settle out and then to a storage pit where it is again picked up by the pump and recirculated. The important features of settling and storage pits are described in the later section of this chapter dealing with hydraulic rotary drilling. A piston-type reciprocating pump would be preferred to a centrifugal one because of the greater maintenance required by the latter as a result of leaking seals and worn impellers and other moving parts.

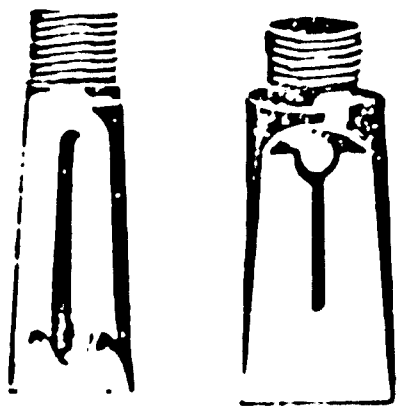

Fig. 5.5 BITS FOR JET DRILLING. (From Fig. 17, Wells, Department of the Army Technical Manual TM5-297, 1957.)

The spudding percussion action can be imparted to the bit either by means of a hoist or by workmen alternately pulling and quickly releasing the free end of the manila rope on the other side of the block from the swivel. This may be done while other workmen rotate the drill pipe. The drilling fluid may be and is very often plain water.

Depths of the order of 50 feet may be achieved in some formations using water as drilling fluid without undue caving. When caving does occur, then a drilling mud as described in the later section on hydraulic rotary drilling should be used.

The jetting method is particularly successful in sandy formations. Under these conditions a high rate of penetrati' ı is achieved. Hard clays and boulders do present problems.

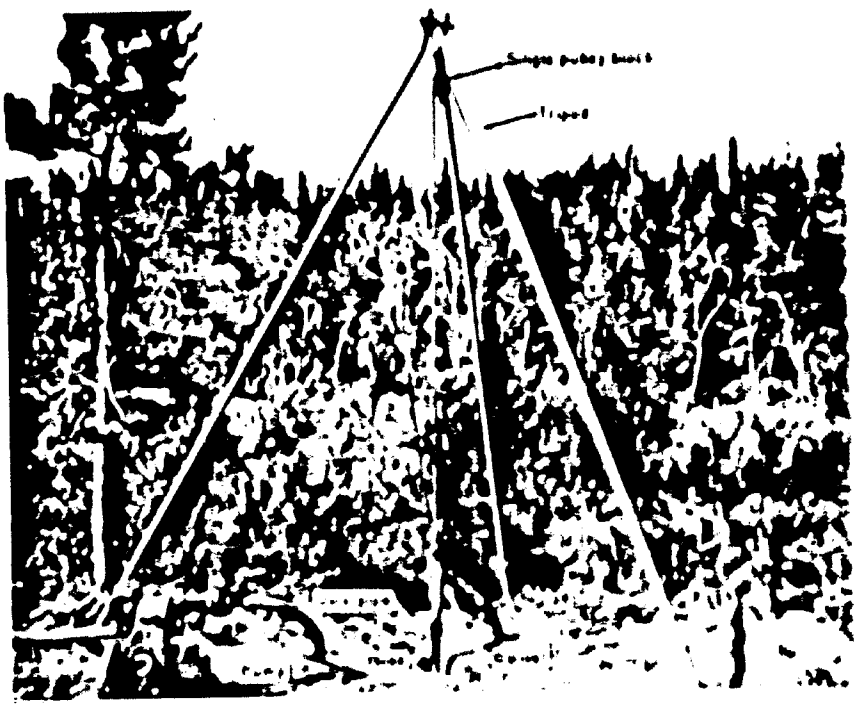

Fig 14 SIMPLE EQUIPMENT FOR JET OR ROTARY DRILLING

Here again you must train a man or men to do this type of drilling. The tripod, pulley, rope and drill pipe can be fabricated from material purchased from the local markets. The pumps (centrifugal) with suction hose, strainer

and discharger hose, the swivel and bit should be the only expense out of country. The pump with fittings and hoses would cost about $1,200.00; the swivel with fitting would cost $100.00; and the bit would cost $75.00. In most cases drillers should find a source of clay which can be mixed with the drilling water to form a very light slurry. This slurry, in most cases, helps the bore hole to stay open during drilling and the installation of casing and screeen.

Wells drilled by this method, using manpower, can drill down to depths of 100'. If a cathead is installed to the back axle of a vehicle and the axle jacked up off of the ground, one can use this for power to drill to depths of 250 feet.

One trained man with village help could do this work but two trained men and village help would be more efficient in the long run. They would also require logistics to haul their supplies and drilling equipment.

2.14 HYDRAULIC PERCUSSION

The hydraulic percussion method uses a similar string of drill pipe to that of the jetting method: The bit is also similar except for the ball check valve placed between the bit and the lower end of the drill pipe. A reciprocating, up-and-down motion applied to the drill pipe forces water with suspended cuttings

through the check valve and into the drill pipe on the down stroke, trapping it as the valve closes on the up stroke. Continuous reciprocating motion produces a pumping action, lifting the fluid and cuttings to the top of the drill pipe where they are discharged into a settling tank. The cycle of circulation is then complete. Casing is usually driven as drilling proceeds.

The method uses a minimum of equipment and provides accurate samples of formations penetrated. It is well suited for use in clay and sand formations that are relatively free of cobbles or boulders.

2.15 SLUDGER

The sludger method is the name given to a forerunner of the hydraulic percussion method described in the previous section. It is accomplished entirely with hand tools, makes use of locally available materials, such as bamboo for scaffolding, and is particularly suited to use in inaccessible areas where labor is plentiful and cheap. The first description of the method is believed to have come from East Pakistan where it has been used extensively.

In the sludger method, as used in East Pakistan, scaffolding is erected as shown in Figure 5.7. The reciprocating, up-and-down motion of the drill pipe is provided by means of the manually operated bamboo lever to which the drill pipe is fastened with a chain. A sharpened coupling is used as a bit at the lower end

Fig. 5.7 BAMBOO SCAFFOLDING, PIVOT AND LEVER USED IN DRILLING BY THE SLUDGER METHOD. (From "Jetting Small Tubewells By Hand," *Water Supply and Sanitation in Developing Countries*, AID USC/IPSED Item No 15, June 1967.)

of the drill pipe. The man shown seated on the scaffolding uses his hand to perform the functions of the check valve as used in the hydraulic percussion method, though, in this case at the top instead of the bottom of the drill pipe. A pit, approximately 3 feet square and 2 feet deep, around the drill pipe, is filled with water which enters the borehole as drilling progresses. On the upstroke of the drill pipe its top end is covered by the hand. The hand is removed on the downstroke (Figure 5.8), thus allowing some of the fluid and cuttings sucked into the bottom of the drill pipe to rise and overflow. Continuous repitition of the process causes the penetration of the drill pipe into the formation and creates a similar pumping action to that of the hydraulic percussion method.

New lengths of drill pipe are added as necessary. The workman whose hand operates as the flap valve changes position up and down the scaffolding in accordance with the position of the top of the drill pipe. Water is added to the pit around the drill pipe as the level drops. When the hole has been drilled to the desired depth, the drill pipe is extracted in sections, care being taken to prevent caving of the borehole. The screen and casing are then lowered into position.

Wells up to 250 feet deep have been drilled by this method in fine or sandy formations. Reasonably accurate formation samples can be obtained during drilling. Costs are confined to labor and the cost of pipe, and can therefore, be very low. The method requires no great operating skills.

Fig. 5.8 MAN ON SCAFFOLDING RAISES HAND OFF PIPE ALLOWING DRILL FLUID AND CUTTINGS TO ESCAPE. (From "Jetting Small Tubewells By Hand," *Water Supply and Sanitation in Developing Countries*, AID-UNC/IPSED Item No. 15, June, 1957.)

Using either of these two methods, hydraulic percussion and Sludger, is the cheapest way a village can make a water

well other than hand digging. The only cost is of the drilling pipe which can later be used as the pump pipe and the cost of a hand pump, below ground and above ground, with a two foot section of screen made out of a piece of their pump pipe and a hack saw to slot it with. They would also need cement sand and gravel for the pump base. A man would have to have some training on this type of work so that he could supervise the villagers. He would also have to know how to run the screen and pump. The pump parts would not cost more than $500.00.

These methods of putting down a well are for local contractors trying to make a living without having a large outlay in drilling equipment or a small selfhelp program run by the Peace Corps. or some other volunteer group.

2.20 Sophisticated Approaches

2.21 Rotary Equipment

If it is decided that the well drilling equipment to be used should have a capability for drilling in soft, medium hard and hard rock formations then the rig ideally suited for the needs would be a rotary mud and air circulation type with down-the-hole capability, although some of the other simpler methods described above would work but at a much slower pace.

2.212 Rig and Truck

The rig should be light, truck-mounted with 4-wheel drive and have sand or mud type wide tires. The truck also should have one front and two back hydraulic leveling jacks with high

enough capacity to lift truck and rig clear of ground level.

The truck should have an engine with enough H.P. to drive the drilling rig through a power takeoff.

The truck and rig should have pipe racks on one or both sides, that do not interfere with drilling operations, capable of storing a maximum of 300' of 2-7/8" x 20' drill stem and 1-4 1/2 x 20' drill collars.

Drilling rig mast should be high enough and deep enough to set back, in the mast, the swivel and kelly when making connections of 20' drill stem. The mast should also have a capacity of not less than 35,000 lb.

Drilling rig should have, mounted behind the draw works, a Gardner Denver type 5"x6" pump. The rig should have a small injection pump for foam or water, driven by air, to use when drilling with air. There should be an oil injection pump mounted on a rig so that oil can be injected into air stream to lubricate and cool rock bits and down the hole hammer bits while drilling with air.

The rig should have break out and make up tongs (hydraulic) to assist in going in hole and pulling out drill stems while drilling.

The rig should have a rotary table with a center opening or 8 1/2" so that 6" casing can be run through it, or a rotary table made so it can be drawn back and out of the way while running in casing.

The drilling mast should have slide guides for the swivel while drilling. Guides will bend back at top to pull swivel and kelly back out of the way for adding or pulling drill stem.

The drill stem, swivel and kelly should be 2-7/8" API and the kelly should have a saver sub on the bottom of it. There should be bit subs, 2 each, for all sizes of drill bits up to 12" in diameter. There should be 1 Mission type down-the-hole hammer with each rig and for every 2 rigs one standby down-the-hole hammer extra.

2.213 Fishing Tools and Hand Tools

Fishing tools or recovery tools to pull out lost in-the-hole drill stem, drill collars or casing should be provided. Included in this group should be 1 Boven overshot (release type) for 2-7/8" drill stem and extra slips for 4 1/2" drill collars, one set of jars, die taps and die collars for all sizes from 2" to 4 1/4" and a strong fishing magnet. (These tools for all rigs in the country).

2.221 Hand tools for each rig should be provided as follows:

1 - Master mechanic set.

2 - 12", 18", 24", 36" and 48" pipe wrench.

3 - Chain tongs for 2" up to 8" pipe.

4 - Pipe cutters for 2" to 4 1/2" pipe.

5 - Pipe threaders for 2" to 4 1/2" pipe.

6 - 12 and 16 lb. sledge hammers.

7 - large vise to be mounted on drill truck bumper.

Cost of All Handtools $4,000.00

2.214 Support Equipment

1 - Water tank truck 1,000 gal. capacity, 4-wheel drive with wide sand and mud tires and a 12-ton winch mounted on the front with trailer hook-up. $50,000.00

2 - Crew and drilling advisor pickups (every two years) $12,000.00 ea.

3 - House trailers (air conditioned) with generator, water storage and gas cook stove for drilling advisor. $25,000.00

4 - Electric welding machines 350 AMP that can also be used for electric lights (3 flood lights) at night when rig is in trouble. $5,000.00. Gas welding equipment (Victor). $250.00.

5 - Air compressors 150 PSI - 600 or more CFM. $31,800.00
All engines for rig truck, water tank truck and air compressor should be in the same series of D.D. or GMC either V-53 or V-71, then all parts are interchangeable.

6 - If there is to be more than one rig in each country and if they are to be working a long way from the base station there should be radios provided for each advisor's House Trailer and at base station maintenance shop or chief well drilling advisor's office. $1,000.00 per unit.

2.215 Other Support

1 - Maintenance shop should have an automotive and truck service, repair and gasoline and oil section with an advisor who will give on the job training to country personnel.

2 - Machine shops fully equipped so that parts can be made as needed for drill rigs: maintenance shop , welding shop, and pump repair shop. Shops will have an advisor giving on-the-job training as appropriate.

3 - Welding shop will work in conjunction with all other shops and rigs carrying out all types of welding, cutting, retipping used drill bits (to save cost of new bits), body work on all mobile equipment and general repair on all equipment; will have shop advisor giving on-the-job training.

4 - Pump repair shops that will have capacity to repair or rebuild pumps being used. Shop will have a crew that will travel to where pumps are to be repaired and repair same, and a shop advisor giving on-the-job training as appropriate.

5 - Logistics and warehousing which will be in a large 90' x 150' warehouse with at least 300' x 300' storage yard. Logistics will purchase all spare parts, pumps, casing, screens and keep records on all equipment that comes in or goes out. Warehousing will store, by bin, and numbers all spare parts, all new equipment and all casing and screens which will be issued out by logistics. An advisor will set up the system as he gives on the job training.

2.216 Drilling Operations

Each rig should be able to drill 100 wells, 90' to 100' deep, per year if each rig has an advisor assigned to it for

not less than two years. If 1,000 drilled wells are needed per year, then at least 10 drilling rigs would be needed, Each advisor will be training a counterpart to take over his job at the end of two or three years. If the drilling rigs are not operating too far apart, one advisor could watch after 2 to 3 rigs without too much trouble after the first 2 year training period is over. There should also be a chief well drilling advisor to handle administrative and logistics management and give technical assistance where needed. The chief well drilling advisor could be needed for the period of the program. He would also be training a counterpart to take over his job as soon as enough training had been absorbed.

Support equipment for drilling rigs and the rigs themselves, should last for 5 year service, if advisor has been successful in teaching good preventive maintenance. The engines on all this equipment would probably have to be rebuilt every two years. All pickups in the field should be replaced every two to three years.

Spare parts for drilling rigs and support equipment should not be less than 35% of the total cost of all equipment for first year and 25% each year thereafter. These spare parts should be selected by the well drilling advisor in conjunction with the company who built the equipment.

2.217 Estimated Costs

To estimate the cost of a drilling rig and all support equipment such as the one described in this report, with spare

parts, visits would be needed to some of the companies which are building water well drilling rigs such as Gardner Denver, Failing or Mobile Drilling Company to explain what is needed so that interested companies can provide cost estimates. A rough estimate of cost would be about $350,000 per unit for the first year's outlay. This estimate does not include pumps of any kind and it does not include the supporting facilities such as maintenance shop, welding shop, machine shop, pump shop or logistics and warehousing.

The cost of these supporting facilities roughly estimated is as follows.

A. A maintenance shop with an estimated under-roof of 3,500 sq. ft. with tools, lubrication racks, gasoline pumps and battery shop, approx. $100,000.

B. Machine shop with an estimated 2,000 sq. ft. under-roof floor space $350,000 (and this may be very low).

C. Welding shop with 1,500 sq. ft. of roofed floor-space, a 600 AMP electric welder, 2 - 350 AMP electric welders, two gas welding units, a "steel 4' x 8' x 2" welding table and needed tools approximately $75,000.

D. Pump shop with 1,500 sq. ft. of roofed space, work benches with vises and all necessary tools to work on all types of pumps, $50,000.

E. Logistic warehouse and outside storage. Warehouse $50,000 with office and shelving for spare parts and new equipment. Outside pipe racks for storing of casing and screens steel and PVC $20,000.

Total cost of supporting facilities would be $645,000.00.

It is possible, in some of the West Africa countries, that the incountry agency, to which a rural water program will be assigned, will have some of the supporting facilities listed here. They probably will have to have some tooling to bring them up to a standard where they can operate efficiently. It should also be understood that these supporting facilities listed are not, in total, essential to a rural water program but is the ideal support and on the job training program that is complete from top to bottom.

In any case these support facilities would be tooled to support the amount of drilling rigs in the program or the amount of water wells to be drilled during the life of the program. If a program is set at 1 to 3 drilling rigs which will drill 100 to 300 water wells a year then the support facilities could most likely be a small building and storage yard. All depends on how much training and how many water wells the program calls for each year.

5.0 Break down of rotary mud-and-air circulation drilling rig with down-the-hole capability - unit cost

Drilling Rig - with air compressor	$110,000.00
Tooling for rig to drill 360' in depth. Drill stems, drill collar, sub's & bits for 1 year.	60,000.00
Water truck 1,000 gal. cap.	50,000.00
Welder 350 amp.	5,000.00
Pickup 1/2 ton 4 wheel drive	12,000.00
House trailer	25,000.00
Drilling mud PVC casing & ss screen-1 rig for 1 year.	50,000.00

Spare parts 35% of cost of rig	$ 38,500.00
Total Cost*	$350,500.00

2.22 Percussion Equipment

Percussion type water well drilling rigs can be taken into consideration but it would mean fewer water wells drilled in a years time. A rough estimate would be: for every 3 water wells drilled by rotary rig you could only drill 1 water well by percussion drilling rig. If you are in hard rock formation it would drop lower. The cost of the percussion drilling rig and support equipment is less than for a rotary rig.

You would have the same supporting facilities for percussion rigs as those recommended for the rotary drilling rig. A breakdown of costs of a percussion drilling rig and its support equipment is as follows:

Breakdown of percussion drilling rig unit costs:

Drilling rig - percussion	$85,000.00
Tooling for rig	25,000.00
Water truck	50,000.00
Welding machine	5,000.00
Pickup 1/2 ton 4 wheel drive	12,000.00
House trailer	25,000.00
Steel casing and ss Screens for 1 year	20,000.00
Spare parts 35% total cost of rig	30,000.00
TOTAL COST	$252,000.00

3.0 Hand Dug Wells

Hand dug wells are less costly per foot but it takes three weeks to six months to dig one well depending on depth and subsurface conditions. Even if villagers are doing most of the work, you should have dewatering pumps, use jackhammers and run aircompressors in order to get through hard formations

*Freight cost from factory to nearest port in West Africa will run 12% to 15% of total cost of any drilling rig or support equipment and must be added to above cost.

needed to have an adequate perennial supply of water. Even if hard formations are not encountered you should have a pump for dewatering the well, while workmen dig to a sufficient depth to ensure that the well will have at least 10 meters of water in it. In some parts of West Africa, the water table has been known to drop as much as 15 meters during the dry season; however this is on an extreme with normal drops of 3-8 meters being most common.

4.0 Training

Whichever way water wells are to be produced, a large rural water training program is needed in West Africa. If either rotary or percussion drilling rigs are to be used, it would be advantageous to make a package deal by purchasing all drilling and support equipment from a company that could also furnish personnel to do all initial equipment training. While trying to obtain costs for drilling equipment, such a company was found: Koehring International Marketing, 200 Executive Drive, Brookfield, Wisconsin 53005. Koehring is the builder of Speedstar drilling rigs. The National Water Well Association of Columbus, Ohio could also be looked to field comprehensive field training programs and provide experienced on-the-job trainers of all types of ground water technology equipment.

ATTACHMENT I

RURAL WATER SUPPLY AND SANITATION

PRE-PROJECT ANALYSIS

COUNTRY REPORT - CHAD

(Study carried out Nov. 6-14, 1977
Sponsored by AID/Washington)

Team Members:

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December 15, 1977

Country Report - Chad

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Country Report - Chad

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2.0 Present Programs in Rural Water Supply and Sanitation

2.1 Responsible Agencies

2.11 SERARHY, 5/ the Service des Amenagements Ruraux d'Hydraulique has the formal responsibility for rural water supply. It is a specialized agency under the Genie Rural Department, is effective, well managed and depends almost entirely on foreign assistance for both capital and operating funds. It is concerned principally with water supply for livestock watering provided through large dug wells which are also used to meet domestic needs. The recently signed World Bank/SERARHY loan also provides for 110 small bore holes with foot pumps more specifically to supply domestic needs. See Figure 1 for organization chart for SERARHY and FDAR.

2.12 FDAR 5/ the Fonds de Developpement et d'Action Rural, has very broadly defined responsibilities including the provision of potable water for domestic consumption. It has its own source of revenues from specific taxes and is also being assisted by an ongoing AID/FDAR/PC rural wells program which is to be continued by a second rural wells project now under consideration. Last year FDAR came under new management and is becoming increasingly effective in rural development.

2.13 ES/MPH The Environmental Sanitation Department of the Ministry of Public Health formerly carried out a small scale program for the installation of domestic water supplies and of sanitary latrines. The small well program has been taken over

5/Appraisal of a Rural Projects Fund, CHAD, World Bank, Oct. 27, 1976.

EH/MPH has a staff of 5 sanitary engineers: 38 sanitation technicians with 3 year course at MPH; 5 sanitary inspectors who have trained in other countries. The MPH training program is turning out 20 graduates a year starting in 1979; most of this staff is working in urban areas on market and food sanitation. There is little emphasis on environmental sanitation; particularly in rural areas.

2.2 International Cooperation

Major cooperation for rural village water supply programs is being provided by AID to FDAR with FDAR/PC implementation and by the World Bank to SERARHY with SERARHY/PC implementation. Some other assistance is being provided by bilateral agencies and PVO's as components of cooperative projects. The extent of this input is not known, but it is believed to be a small percentage of the total international cooperation for rural community water supply and sanitation.

The World Bank project 5/ was proposed for the following funding in U.S. dollars in October 1976:

	Vehicles + Equipment	Civil Works	Expatriate Staff	Operating Costs	Total
Pastoral Wells Rehabilitate 300 wells	$178,000	$280,000	$266,000	$347,000	$1,071,000
Village Water Supplies (drilling 110 small bore tube wells with installation of Vergnet foot pumps.) (Est.per capita cost-capital and maintenance)	$760,000	$524,000	$191,000	$489,000	$1,964,000 $ 35.70

AID has already funded one rural water supply project at a total cost of _____

5/ Appraisal of a Rural Projects Fund, CHAD., World Bank, October 27, 1976.

A second rural water supply project to continue the above project is under consideration for AID financing as follows:

Personnel	$ 234,000	
Commodities	1,854,000	Est. cost per capita
Other Costs	336,000	Capital and maintenance = $21.10
Inflation	485,000	
Contingency and Research	250,000	
	$ 3,159,000	

2.3 Population with Adequate Water Supply and Sanitary Excreta Disposal Services

Tabulated below are the population estimates for 1970 and UN Population Projections (revised March 1975) for 1975 and 1985.

Population (Millions) 5/

	1970		1975		1985	
URBAN	0.41	11%	0.56	14%	1.00	30%
RURAL	3.23	89%	3.46	86%	4.00	80
TOTAL	3.64	100%	4.02	100%	5.00	100%

5/ Appraisal of a Rural Projects Fund, CHAD, World Bank, Oct. 27, 1976

PERCENTAGE OF POPULATION SERVED 6/

ADEQUATE WATER SUPPLY SERVICES

	URBAN			RURAL	TOTAL
	HOUSE CONNECTIONS	PUBLIC FOUNTAINS	TOTAL	EASY ACCESS	
1970	7	40	47	24	27
1975	7	36	43	23	26

SANITARY EXCRETA SERVICES

	URBAN			RURAL	TOTAL
	PUBLIC SEWERAGE SYSTEMS	PIT PRIVIES SEPTIC TANKS	TOTAL	PIT PRIVIES	
1970	1	28	7		1
	4	24	9	1	1

3.0 FUTURE PLANS

3.11 There is no evidence of a long range program to meet the country-wide rural needs in environmental sanitation. Sporadic programs in the past and those under consideration at the present time are ad hoc attempts to provide some community water supply facilities in the more heavily populated areas. No attempt is being made to face up to the excreta disposal problem in either rural or urban areas, where the situation is particularly acute. Present plans make very little use of community participation, but do involve a limited amount of health education by MPH personnel.

6/ World Health Statistics Report, Vol. 29, No. 10, 1976.

3.12 In addition to a few comparatively small rural water supply programs being carried out by the Ministry of Agriculture and some PVO's as part of other programs, there are the World Bank project mentioned above and the proposed AID/GOC/PC rural water supply program now under consideration by AID. Neither of these programs contains sanitation or health education elements, nor do they involve more than token community participation which should be essential parts of any rural water supply and sanitation program.

3.13 The recently approved World Bank project includes among other elements the following to be carried out by SERARHY:

3.13-1. The rehabilitation of a pastoral wells network (over 300 lined open wells) in the Batha prefecture in the Sahelian zone.

3.13-2. The establishment and initial operation of a tubewell drilling (similar to the AID/PC program) and open well maintenance unit to serve villages in three prefectures in the Cotton Zone, including the rehabilitation of about 146 lined wells and the installation of about 110 tubewells to be operated by foot pumps (the PC wells use the hand operated Tysen-type pump).

3.14 The proposed AID/GOC/PC rural water supply project to be carried out by FDAR/PC as a continuation of the present AID/GOC/PC sanitary wells project includes:

3.14-1. The installation of 500 drilled wells in villages which have a minimum of 300 inhabitants.

3.14-2. Research on the geologic conditions in some areas included in the proposed project, which are assumed to differ from the ideal conditions found for the present

project area. Some geologic structures found in the present project are known, however to extend into the proposed work area. This research will indicate procedures and equipment required for the geological conditions explored.

3.14-3. The full maintenance of these wells during the life time of the project.

3.14-4. Training for a Chadian in administration and coordination of all activities related to the drilling and maintenance of wells, plus on the job training for 12 Chadians for the installation and maintenance of small tube wells.

3.14-5. Installation of two fully equipped workshop-warehouses required for the wells program and for the maintenance of the wells during and after the proposed project with necessary tools and a five-year supply of commodities and replacement parts.

3.14-6. At the end of the project all vehicles needed for the continuation of the maintenance of the wells will be left in good condition at the workshop - warehouses.

3.14-7. GOC has expressed its intention to budget funds for the operation of these vehicles and to assume the maintenance of the 500 wells to be installed under the program. GOC is already budgeting for maintenance of wells installed in the SARH region.

4.0 VILLAGE WATER SUPPLY

4.1. Hydrogeologic Setting: In the Republic of Chad south of 17°N. lat. ground water occurs chiefly in three major groups or kinds of rocks, each of which requires an appropriate technology

for cost-effective development of rural water supply. A large part of the country is directly underlain by Precambrian igneous and metamorphic rocks, chiefly in the prefectures of Biltine, Ouaddai, southern Batha, Guera, northern Salamat, southwestern East and West Logone, and western Mayo Kebi. Tertiary sedimentary rocks, the so-called Continental Terminal, are present near the surface at moderate depth in virtually all the western and southern parts of the country. Tertiary sedimentary rocks lie at or near the surface in the prefectures of southern and central Salamat, most of Mayo Kebi, all of Tandjile, the central and northern parts of the Logones, eastern and southern Chari Baguirmi and east-central Batha. Quaternary deposits underlie the surface of virtually all the central part of the Lake Chad Basin, including the prefectures of Chari-Baguirmi, Lac and Kanem. (A)*

Among the three rock groups, the Precambrian terrain presents the most difficult technical problems with respect to development of potable water supplies for human use. The methods that must be adopted in the search and recovery of potable ground-water supplies in these terrains are often costly with a substantial risk of failure or only qualified success, in obtaining even minimal supplies The most readily available ground water in the Precambrian terrain occurs chiefly in surficial mantles of deeply weathered rock, which in places in the lowlands of eastern Chad attain thicknesses of as much as 30 to 50m, but generally are less than 10-15m thick in the uplands and mountains. These weathered rock mantles form important ground-water reservoirs which are tapped by more than 1,000 large-diameter open wells 30 to 70m deep in the central and eastern prefectures of Chad. These wells located mostly in the

* (A) -- (B) -- (D) etc., refer to footnotes at end of section.

prefectures of Ouaddai, Biltina and Batha tap water in the shallow alluvium of the wadis and/or in the deeper weathered rock. (D)

The dug wells in the Precambrian terrain are vulnerable to lack of recharge during dry cycles owing to the relatively low storage capacity of the weathered rock. For example, many existing open wells, constructed during the 1960's in the Precambrian terrain, went dry during the Sahelian drought of 1968-1973 and have not yet fully recovered. (D) Currently, some open wells are being deepened to tap whatever remaining storage capacity may exist in the weathered mantle at greater depth. Everywhere underlying the weathered mantle, however, is only hard, dense rock in which ground water occurs entirely in discontinuous fracture systems.(D) Presently, plans are being made by SERARHY to explore these fracture systems by deeper drilling to 100m or more using down-the-hole (air hammer) drilling rigs. Based on the results of this exploration, decisions will have to be made with respect to whether to continue with construction of deep and expensive open wells or to initiate a new program of well construction using intermediate diameter deep tubewells in the Precambrian hard rock terrain. (D)

The Tertiary sedimentary rocks mostly comprise semiconsolidated, interbedded clay and sand with occasional thin hard ferruginous layers (laterite). The Tertiary sediments attain a thickness of several hundred meters or more in western and southern Chad. (B) The sandy strata are commonly quite permeable and yield water to wells at depths which may range from 10 to 40 meters to 300m or more below the land surface. (B) These sand aquifers generally have

a lenticular shape and consequently are highly variable both in thickness and areal extent. Commonly, sand aquifers at depths of about 10 to 40m intercalated with clay will yield enough water on a continuing basis to sustain a small diameter village well, that is, about 0.5 to 1.0 l/sec. Deeper aquifers in the Tertiary sediments are generally more productive. For example, 12 large-diameter (12 to 8 inches) tubewells were put down by SERARHY with UNDP assistance in Chari-Baguirmi prefecture. These wells which are 40 to 150m deep develop individual yields ranging from 2.8 to 8.3 l/sec. (A), (B), (D).

In Moyen Chari prefecture 60 small diameter (2 inches) village wells have already been successfully completed by the FDAR with Peace Corps assistance in Tertiary sand aquifers at depths ranging from 15 to 30m and with water levels 10 to 25m below the land surface. Virtually all these wells could potentially sustain withdrawals of 0.5 to 1.0 l/sec (L) but are now pumped at rates of about 0.25 to 0.3 l/sec with presently installed hand pumps. Excellent possibilities exist for putting down village wells with comparable depths, water levels and yields in the other prefectures of southern Chad as well as in the Tertiary terrain of Chari Baguirmi. In places in the Tertiary terrain thick clays underlie the surface down to depths of as much as 50m before the first sand aquifer is encountered. The water level from such an aquifer commonly rises in the well close enough to surface for water extraction by hand pump. Because of the irregular distribution of surface clays and underlying sand aquifers, it is essential

that projects for construction of village wells in untested areas contain a funding component for advance exploratory drilling. By such exploration it will be possible to select the types of well design and depth as well as drilling equipment most appropriate for permanent well construction under local conditions.

The Quaternary deposits comprise interbedded fluvial and lacustrine sand and clay which are somewhat similar to the Tertiary sediments but less compact or indurated. These deposits directly underlie all the Chari-Logone flood plain including most of Chari-Baguirmi prefecture. Also the Quaternary deposits include vast expanses of dune sand northeast and east of Lake Chad in virtually all of Lac and Kanem prefectures. Like the Tertiary sediments the Quaternary deposits generally contain both shallow and deep sand aquifers through a wide range of depths. Near N'Djamena, for example, water-bearing sand interbedded with fluvial and lacustrine clay is tapped by village tubewells 15 to 31m deep with water levels ranging from about 10 to 20m below land surface. (L) Village tubewells 2-inches in diameter are pumped at rates of 0.25 to 0.3 l/sec with presently installed hand pumps. The full capacities of the wells are probably somewhat higher, that is, about 0.5 to 1.0 l/sec. Wells of comparable depth, water level and yield could also be successfully installed elsewhere in the Quaternary terrain, if accompanied by exploratory drilling as previously recommended for the Tertiary terrain. In places however, water levels are 40m or more below land surface so that some

modification in design of the hand pump presently used in the FDAR-Peace Corps project would be necessary for satisfactory operation.

The Quaternary dune sand of Lac and southern Kanem prefectures also forms an excellent aquifer where present below the water table. There are presently some 130 village wells in the region northeast of Lake Chad which develop water from an aquifer of this type. These wells range from 15 to 35m deep with water levels 10 to 20m below land surface in Lac prefecture and 15 to 30m in Kanem. (L) The wells, 2 inches in diameter, are fitted with hand pumps which produce yields comparable to those of the N'Djamena area. The dune sand aquifer is highly viable and productive being sustained by perennial northeastward underground flow from Lake Chad as well as direct infiltration from local rainfall.

4.2 Present status of ground-water development: There are essentially four types of existing wells in Chad used to extract ground water for rural domestic, livestock and urban supply. Those in present use include (1) traditional open wells, (2) modern open wells, (3) small or intermediate diameter drilled well (tubewells); and (4) large diameter tubewells. Also in the hilly and mountainous areas of the country some springs have been developed by captation boxes with the water delivered by gravity pipe line to villages on lower ground.

Traditional open wells for livestock and village water supply have been constructed in all the geologic terrains of Chad. They are generally dug by simple hand excavation techniques using buckets and hand lines for removal of soil and rock. Such wells have been dug to depths down to 50m or more. Many are unlined and

as much as 10m in diameter. They are subject to gross pollution and occasionally have been known to cave in, endangering the lives of local herders or farmers. There are reported to be several thousand such wells in operation throughout the country.

A more recent innovation is the so called modern open well. Construction of such wells began in the 1950s under the Fonds d'Aide et de Cooperation (FAC), or French bilateral aid and were continued in the 1960s under the Fonds Europeen de Developpement (FED). (D) More recently funds for construction of new open wells or rehabilitation of old ones have been provided by the United Nations Development Programme (UNDP) and the World Bank (IBRD). At present there are reported to be some 2,000 modern open wells in active use. These are approximately distributed as follows: Kanem - 400; Southern prefectures - 400; and elsewhere - 400. The repair and maintenance of these wells is presently the responsibility of SERAMHY (Service des Amenagements Ruraux d'Hydraulique) of the Chadian government.

The modern open wells are, for the most part, located in the lightly populated areas of the country where the economic activity is chiefly pastoral with some subsistence farming. (C) The wells which are 1.4 to 1.8m in diameter are intended primarily for livestock watering and secondarily for human use. Water is withdrawn from the wells by buckets and hand lines wich are sometimes passed over steel rollers or pulleys to facilitate extraction. The structural design of the wells is excellent, and adequate protection

is provided for exclusion of contaminated seepage from human and animal waste around the well. Nevertheless, pollutants can be easily and directly introduced into the open top of the well from unclean buckets, handlines, fecal matter or other offal. The prevailing rationale for construction of modern open wells by sponsoring donor agencies and the Chadian government has been to provide relatively clean water supply in water-short areas with secondary consideration to sanitary protection. Also because of the total absence of infrastructure for regular and periodic pump maintenance, tubewells have not been generally considered a viable means for water extraction in lightly populated rural areas of Chad.

Tubewells of large diameter, that is 10 to 12 inches or more, have been constructed to provide urban water supply for the larger cities such as N'Djamena and Sarh as well as some of the smaller cities and towns of Chad. Larger diameter tubewells which tap one or more deep aquifers in the Quaternary and Tertiary sediments can produce individual yields of 10 to 30 l/sec, when properly screened and developed and fitted with appropriate power pumps.

A project to utilize intermediate capacity tubewells for livestock watering was undertaken by SERARHY and completed several years ago in Chari-Baguirmi prefecture. This project with funding and technical assistance provided by the UNDP included

construction of 12 complete stock-watering facilities, similar to the long-established "water yards" of Kordofan province in central Sudan. The tubewells of 8 to 12-inch diameter range from 70 to 150m deep and are screened and gravel packed in sand aquifers of Tertiary terrain. The wells were all equipped with submersible pumps which produce yields ranging from 2.8 to 8.3 l/sec. Each of the wells was provided with two electric generators (one to serve for standby use). Two of the wells were later dedicated to providing municipal water for the towns of Massaguet and Massakori. These two wells are not operated on a continuing basis. Each of the remaining wells was equipped with 6 watering troughs and surrounded by a fence and control gate so that watering of animals could be controlled and scheduled and a head charge assessed for each animal using the facility. This approach to recovery of operation and maintenance costs proved less than successful as the herders went elsewhere with their animals. Presently, the facilities are operated only intermittently between January and July, and no charges are recovered from the herders. The SEMARRY is responsible for the operation and maintenance of these wells and the cattle watering facilities. (b)

A highly successful project using small diameter tubewells to develop potable village water supplies is currently in progress in the FDAR (Fonds de Developpement et d'Action Rurale) of the

Chadian government with the technical direction of the U.S. Peace Corps and funding by USAID. Some 130 wells have already been completed in Lac and Kanem prefectures under this project by the Peace Corps with USAID funding. Three wells have been put down in the vicinity of N'Djamena. Some 60 wells have also been completed by the Peace Corps in cooperation with FDAR in the Sarh area of Moyen Chari prefecture. The wells range from 15 to 35m deep in Lac and Kanem with water levels 10 to 20m below land surface in Lac and 15 to 30m in Kanem. In the N'Djamena area the wells range from 17 to 31m deep with water levels at 10 to 20m. The wells in Moyen Chari range from 15 to 30m deep with depth to water 10 to 25m.

The Tysen hand pump with which the wells are equipped delivers 0.25 to 0.3 l/sec with pumping lifts of 10 to 20m. Thus this pump, if operated continuously, could theoretically deliver 900 to 1,080 l/hr or 21,600 to 25, 920 l/d. In reality, however, probably no more than 4,000 to 5,000 l/d is actually withdrawn from most individual wells or about 25% of full pumping capacity. Actual withdrawals from the wells for human consumption are estimated to average about 15 l/d/c. The operation and maintenance of the wells is the responsibility of FDAR and is carried out with the technical assistance of the Peace Corps. Each well and pump is serviced at 4 to 6-month intervals and usually require only minimal maintenance because of the excellent design of the well

and the sturdy construction of the pump and its components. The Peace Corps has also placed strong emphasis in on-the-job training of well maintenance technicians and also of well drilling crews. The Peace Corps carries out a continuing educational program at the village level to insure proper use and care of wells and pumps. No charges are currently recovered from the villagers for water use. (1), (F)

4.3 Well construction costs: The costs of various types of wells in Chad vary according to geologic terrain, method of construction and the depth of the well. Other factors being equal, the most costly wells are those which must be put down in the Precambrian hard rock terrains of central and eastern Chad. Considerably less costly are wells constructed in the Tertiary and Quaternary soft rock terrains of western and southern Chad. The least costly are wells drilled in the Quaternary dune sands north and northeast of Lake Chad.

The modern open well commonly in use in Chad is essentially a product of French technology initiated some 25 years ago and adopted to prevailing socio-economic conditions in central and west Africa. (1) The wells are put down by derricks with mechanical hoists and clam shell or orange peel bucket for removal of excavated material. There is a large component of hand labor involved in the removal of excavated material, and local villagers or herders who will benefit from the well are normally called upon to provide the unskilled part of required labor. The wells are constructed in standard diameters of 1.4 or 1.8m, depending on anticipated intensity

of use, and are lined with reinforced concrete rings. As pumping equipment is not installed, the wells require only infrequent maintenance. Water is drawn by users with buckets and ropes which are passed over rollers or pulleys to facilitate lifting. The current cost for construction of new modern open wells in the Precambrian terrain is estimated by SERARHY at U.S. 334 per meter. (E) Thus a well of an average depth of 55m in this terrain would cost $18,257 with a range from $10,020 for a relatively shallow well of 30m to $23,380 for a deep well of 70m.

The World Bank (IBRD) has recently provided funds for repair of 73 modern open wells constructed more than 10 years ago in Batha prefecture under a FED program. The cost of these repairs has been estimated at an average of $14,473 per well. In Tandjile and East and West Logone prefectures, the World Bank is providing funds for repair of 146 modern open wells at an average of $5,925 per well. (D) Also in Kanem prefecture the Bank is to finance repairs on 40 modern open wells at an average cost of $5,575 well. (E) The high unit repair costs in Batha prefecture reflect total lack of well maintainance over a period of 10 years or more. Thus average repair costs on an old well which is not maintained can reach a level of almost 80% of the cost of a new well.

Several years ago under UNDP funding, 12 intermediate capacity tubewells 8 to 12-inches in diameter and 70 to 150m deep were drilled to deeper sand aquifers in the Tertiary terrain of Chari-Baguirmi prefecture. The original cost of the well is reported by SERARHY to have been about $207,500 or an average of

$17,292 per well. (D) Sufficient funds have never been available for full and effective operation of the wells for their intended use as livestock watering stations. Nor has the government been successful in devising a viable means for recovering operation and maintenance costs from the herders using the watering facilities. Recently, the World Bank has provided $224,000 for the operation and maintenance of the wells over a 2-year period while the government develops an appropriate means for taxing or assessing water charges for recovery of costs. (E) This fund amounts to $18,667 per well for 2 years or $9,333 per well per year. (Actual operation and maintenance costs are estimated by SERARHY to be $10,373 per well per year or almost 60% of the original capital cost.)

The only existing project in Chad exclusively directed toward provision of sanitarily protected water supply for human consumption at village level is that of the FDAR-Peace Corps. The 180 wells already constructed under this project have been put down in areas where population nuclei range from about 200 to 1,000 persons. Each well is designed to serve about 250 to 350 persons. The individual capacities of virtually all the wells are greater than 25 l/d/c for 300 persons or 7,500 l/d/well. The existing wells are located in areas of moderate to high population density which is semi-nomadic in the Lac-Kanem area and sedentary farming in the Moyen Chari area. The wells are used almost exclusively for human needs, as other sources of surface water are commonly available nearby for livestock requirements.

The FDAR-Peace Corps wells are all of a similar basic

design known as the Tysen well. A 4-inch hole is first put down by augering as far as possible into a sand aquifer. An assembly, which includes (1) a 2-inch Johnson continuous slot, stainless steel screen with drive point; (2) a 2-inch brass-lined pump cylinder with check valves; and (3) a 2-inch galvanized easing-cum-drop pipe, is lowered into the hole. The screen and point are than driven as far as possible into the sand aquifer by raising and lowering a 150-lb. weight. The well is than developed by surging water under pressure through the screen followed by back-washing until sand-free water is obtained. The piston, check valves, pump rods and surface components of the pump are then assembled and installed, and the well is ready for operation. The installed cost of the Tysen well including the casing-cum-drop pipe screen and pump is only $1,500. If overhead and amortization of drilling equipment are added in, the gross cost per well with pump still averages only $3,411 at current prices. Operation and maintenance costs for the wells are extremely low, averaging less than $100 per year per well during the past few years. (L)

A new USAID financed project will provide for additional construction of new wells and operation and maintenance of existing Peace Corps-FDAR wells up to a total of 500 wells. Many of the new wells would be located in accessible villages along and near the main road leading from N'Djamena and Sarh. With completion of this project basic sanitary water supply will have been provided to some 150,000 villagers through a corridor containing Chad's most dense rural population.

The World Bank has also recently provided funding to SERARHY for construction of 110 tubewells for village water supply in Tandjile and East and West Logones. The wells would range from 25 to 150m deep and average about 38m. The wells would be drilled with rotary or percussion rig with a hole 6 or 8 inches in diameter. The wells would be cased with 4½-inch pipe and slotted sections or screens with gravel pack set opposite in sand aquifers. The wells would be equipped with Vergnet type hand pumps which can deliver 0.14 to 0.42 l/sec depending on lift (depth to water). With a lift of 20m the pump could theoretically supply 25 l/d/c to 500 people or 12,500 l/d/well. This is equivalent to constant pumping at 0.42 l/sec for 8.27 hrs/day. (G)

The installed cost of a well in the 110-well project including materials, casing, screen-but no pump-is estimated at $1,946 per well. The cost for a Vergnet hand pump is currently estimated at $744 installed. If overhead and amortization of drilling equipment are added in the gross cost per well in the 110-well project will average about $7,182 per well excluding the pump. (E) It would seem then that the projected costs in the 110-well project for an operating well with pump are about 2.4 times greater than an operating well of comparable capacity and utility in the on-going Peace Corps-FDAR project.

4.4 <u>Well construction equipment and operations</u>: There is reported to be presently in Chad only one private drilling company known as SOTRAHY. This company managed by a European is based at N'Djamena and constructs wells for private individuals and concerns, chiefly in Chad and Cameroun. The company puts down both large open wells and also intermediate and small diameter tubewells using conventional rotary and percussion drilling rigs. It is reported to be the residual legatee of 4 defunct drilling companies. Another company, Ballakhany, Ltd., which is based in Lagos and London occasionally drills wells in Chad and has done work in the past for the Lake Chad Basin Commission. Balakhany, Ltd. has drilled several hundred small diameter tubewells in neighboring Nigeria west of Lake Chad. These wells ranging from 100m down to depths of 300m or more produce small artesian flows or where subartesian are equipped with hand pumps for village water supply.

In the public sector SERARHY has, in the past, been almost exclusively concerned with the construction and maintenance of the large-diameter modern open wells which have been previously described. Technical operations directed by expatriates are handled out of six centers namely Chari-Baguirmi (N'Djamena); Kanem (Mao); Batha (Ati); East and West Logone (Mongou); Moyen Chari (Sarh and Kourma); and Ouaddai (Abeche). An equipment pool under the direction of a Chadian is maintained at each center and operations are financed chiefly by UNDP, the World Bank, FED and other sources.

SERARHY has recently acquired 4 rotary-cum-down-the-hole (air hammer) drilling rigs and accessory equipment provided by UNDP funding. (D) These rigs are reported to be located at present at the Abeche center but have not been deployed on account of security problems. SERARHY proposes to use these rigs chiefly for exploration in the Precambrian hard rock terrains to locate the position of deeper water-bearing fractures beneath the weathered zone. Deep open wells could then be put down at favorable sites, and the risk of costly failures minimized. Alternatively, small diameter tubewells could be finished at favorable sites and furnished with hand pumps to extract water for village supply. A viable operation and maintenance scheme for hand pumps or other pumping equipment is the chief stumbling block to the utilization of tubewells, particularly in thinly populated areas of the Precambrian terrain.

As previously described, SERARHY also is currently embarking on a village water supply project in southern Chad involving construction with World Bank financing of some 110 small diameter tubewells equipped with Vergnet pumps. These wells will be put down with a truck-mounted drilling rig whose cost is budgeted at $132,000. Auxilary equipment includes a trailer-mounted air compressor budgeted at $40,000; a truck-mounted 30KW diesel general and 30 l/sec submersible pump for testing and well development; and 7 transport vehicles at $41,000. A maintenance and operation scheme for the hand pumps is yet to be devised. (E)

The Peace Corps-FDAR currently operates from two centers, one at N'Djamena and the other at Sarh. An equipment pool is maintained at each center and operation are financed by USAID and Chad government funding. Well drilling operations from the Sarh center are currently carried out with one 1964 Acker power rig which combines augering the 4-inch pilot hole with some driving to place the casing-cum drop pipe and screen, which have been previously described. Thus far 2-inch wells have been successfull drilled and completed down to depths of 35m. The well is developed by backwashing and surging using a 2.5 HP pump and a 2,000-liter tank which are mounted on the truck with the drilling rig. From the N'Djamena center well drilling operations are carried out with two Mobil Drill B-30 power auger rigs which have been modified for driving the well point and screen. This type of rig uses one-meter auger flights with which the 4-inch pilot hole is augered. The wells are designed and completed in essentially the same manner as that used in the Sarh area. (L)

The Peace Corps is currently planning to purchase through USAID financing 4 new Mobil Drill type B-53 rigs which combine direct circulation rotary and auger drilling capacity. Each rig would be truck-mounted at the factory at an estimated cost of $100,000 per unit. In addition a trailer-mounted air compressor at $25,000 each would be provided for each rig for well development. These rigs would be used to carry out some preliminary exploratory drilling down to depths of about 100m as well as for construction of new wells in the expanded 500-well project. The initial budget calls

for an expenditure of some $900,000 for the drilling and ancillary equipment, casing, pump parts and other supplies for the 500-well project. Ultimately some $3.2 million would be expended on the project over a 5-year term.

4.5 Conclusions and Recommendations:

(1) Because of unfavorable geologic conditions about 20 to 25% of tubewells put down in the Precambrian terrain are likely to be failures or only qualified successes. This means that about 1 tubewell out of 4 or 5 drilled on a random basis is likely not to produce sufficient water for even a hand pump to operate on a continuing basis. (A yield of 0.19 l/sec or 0.7 m3/h could be taken as a threshold,) Under such unfavorable conditions, an open well could have the distinct advantage of being able to accumulate and store even small inflows of water during periods of disuse. This storage can then be withdrawn at a rate greater than the rate of inflow for a short period of active use.

(2) Where static water levels are not greater than about 60m, drilled tubewells equipped with hand pumps of the Vergnet type could generally be used in central and southern Chad to extract sufficient water for a sanitary village water supply. Where water levels are 30m or less below land surface reciprocating - lift hand pumps may be more cost effective for lifting water than the Vergnet-type pump. In the Precambrian terrain tubewells might have to be drilled to depths of as much as 100m to intercept productive water-bearing fractures and a 20 to 25% risk of failure

might be anticipated. In the Quaternary and Tertiary terrains the risk of failure is probably less than 5%. Nevertheless, where thick surface clays exist tubewells might have to be drilled to depths of 50m or more, in order to find a sand aqquifer with a yield adequate to sustain a hand-pumped tubewell. Areas with such thick surface clays, however, are believed to be of rather limited extent. Generally in the Quaternary and Tertiary terrains sand aquifers sufficiently productive for a reciprocating-lift hand-pumped tube-well of the Tysen type can be found within 40m of the land surface. Also most of the deeper aquifers in these terrains have some artesian pressure so that water levels would rise to within 30m of the land surface.

(3) Where water levels are greater than 60m, it may still be necessary to continue resort, as at present, to large-diameter open wells with water withdrawn by hand lines and buckets, in spite of poor sanitary protection. If tubewells are used with deep water levels, air-lift pumping with diesel-driven air compressors could be considered, or alternatively submersible pumps with diesel-driven electric generators. Both these two alternatives are energy intensive and presently are probably not economically feasible solutions to the problem of lifting water from great depth solely for village water supply. If such installations were to become necessary because of deep water levels, however, multiple purpose tubewell installations that would provide water for livestock, some small-scale irrigation as well as sanitary village water supply could be considered.

(4) At present in Chad the ground-water resources are very lightly developed, except in the vicinity of the large urban centers of N'Djamena and Sarh. Development of ground water for village and livestock supplies from widely dispersed wells can be expected to have only minimal effect on ground-water levels. Irrigation from ground-water sources is virtually non-existent at present, though is potentially feasible from deep tubewells in the Quaternary and Tertiary terrains, where yields of 10 to 30 l/sec could be developed from properly designed and constructed tubewells.

(5) Although water extracted by pumps from tubewells will generally provide the most economic and satisfactory source of sanitary village water supply in most of Chad, other options may also exist. For example, in the hilly and mountainous areas of moderate to high rainfall of southern and eastern Chad perennial springs could be developed with protective masonry or concrete structures to intercept natural flows by gravity pipelines to village fountains on lower ground. Also settlements on "zores" tablelands of southern Chad, where ground water is too deep for economic extraction, could be provided with rainwater catchments from which water could be collected in porous earthen jars buried in sand-filled filtration pits. In places in mountainous areas of Ouaddai, Biltine and Guera, it may also be possible to store surface-water runoff in sand-filled reservoirs behind masonry dams located in large ravines. The stored water, which would be

filtered through the sand, could then be drawn as needed at control valves and small pipes penetrating through the masonry dams. (J)

(6) Insofar as sanitary water for human use is concerned, the drilled tubewell, protected with an impervious concrete apron and surface grouting in the annulus around the casing, is presently the best source of village water supply. Such a tubewell, however, requires a hand pump for extraction of water. Any hand pump requires periodic maintenance for effective operation, and only the most sturdily designed pumps should be considered for village use. The Tysen pump designed by a USAID engineer and perfected by the US Peace Corps in Chad appears to be quite effective where the lift (pumping water level) is less than 30m. The performance of the Tysen pump is likely, however, to diminish markedly where water levels exceed 35m. On the other hand the Vergnet pump, while costing somewhat more than the Tysen pump, can lift water with fair efficiency from depths as great as 60m. Thus where there are deep water levels, pumps of the Vergnet type may be indicated for water extraction.

(7) The costs for equipment and well construction quoted earlier in this report have not been fully verified nor has time been available to analyze costs in detail. The costs, therefore, should be considered only as "orders of magnitude". Real costs because of inflation, the geographic isolation of Chad, high shipping charges, or other may vary 100% or more from those indicated.

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4.6 AID/PEACE CORPS/GOC RURAL WATER SUPPLY PROGRAM IN CHAD

The Peace Corp Volunteers (P.C.V.) have been working on rural water program since 1968 starting with hand-dug lined wells, advancing to hand-augered wells, and most recently to rotary augered 2' well point wells. Each year has shown an improvement in their technical skills and as each PCV leaves he is overlapped by a new PCV who receives the advanced expertise gained by the PCV he is replacing. From a hit or miss system to a now workable system they can finish a well in two to three days where before it took up to 14 days.

The well design as it is today in Chad is very inexpensive (approximately $1,500.00 per well) and has a low maintenance cost (approximately $50.00) per year. The equipment used today in rotary augering a well down to 10 to 35 meters is a B34, Mobil Drilling Co. soil-sampling rig. In the Lac, Kanem and Sarh areas, the PCVs have had few problems with this rig, except in hard or sticky clays and laterite. Because there is no provision for water or air circulation on this rig, penetrating these formations at times may be difficult.

The well now being constructed is known as the Tysen well but the PCVs have considerable modified the original design, as needed. As the design now stands a 2" X 6' .06 or .08 slot Johnson well-point screen is used with a Clayton Mark 652-B brass lined cylinder (18" stroke) attached to the top of the screen and a 2" galvanized line pipe or column pipe on to surface.

The PCVs auger down with 4" auger to the acuifer and 5 to 10 meters on into aquifer if possible. In most cases the hole will stand open if the screen, cylinder and column pipe is quickly installed as soon as the auger is pulled. The saturated sand aquifer, however, will fill up as soon as the auger is pulled out so the well point, screen, cylinder and column pipe must be forced, either by moderate pushing or driving, to the desired depth.

The hand pump, which is wholly fabricated with local materials in the PCVs shop and at a very low cost, is then installed and cemented in place with a small cement base. The base is designed with a water run off drainage channel so that water will run away from the well and not allow contamination of well. The Clayton Mark check valve and piston are then run into the column pipe on a 3/16" pump rod down until the check valve is seated in the cylinder. The piston is unscrewed from the check valve and the pump handle hooked to the pump rod. The well is now ready for service.

The Peace Corps have been involved in drilling and installing hand pumps in wells in Chad, working with and under the supervision of Fonds de Developpement et d'Action Rurale (FDAR), since 1968, but their most important input has been since February 1976, when they received the two augering rigs. They have since drilled and installed hand pumps on 130 wells as well as reparied and put into operation some previously constructed wells that were in need of repairs.

During the severe drought which hit the Sahelian area of Africa, USAID in 1972 and 1973 started Relief and Rehabilitation (R&R) projects which made money available for a 180-well project for the Lac, Kanem region in late 1974. Equipment and supplies did not arrive until February 1976.

The wells to be drilled were for water supply in villages of 200 to 400 people and were designated by FDAR. In visiting some of these wells one can see how much they are used and how well they are recieved and are respected. Pumping rates of those wells visited were approximately 4.5 GPM which is not large. Use of these wells noticeably improved the health level in these villages as against villages with open hand dug wells.

The PCVs have always kept in mind that at some point, they must work themselves out of a job. Consequently, they have been giving the Chadians on the job training since the beginning. They already have taught some of their Chadian counterparts a degree of expertise, so they could work on their own, in the mechanical and technical skills of drilling, installing, and maintenance of water wells. A Chadian 3-man maintenance team were observed giving a 19 meter deep well a 4 to 6 months service job. They pulled the pump rods, piston and check valve out of the column pipe, inspecting each part as removed for wear and replaced all back in the well, after changing the leather cups on the piston, in just 25 minutes. The PCV report that two of the men on this team were also capable of drilling and completing a well without supervision.

Maintenance crews are servicing from well to well and no well goes longer than 6 months without service. PCVs report that, in the past 16 months, only one well was found to be inoperable when the maintenance crew arrived. This is quite a remarkable record but does show, that with adequate training, proper tools and operational funds, a hand pump project can be installed that a local government can sustain.

As the PCV program advances into its second phase it is realized that new and better rigs are going to be needed. Wells will have to be drilled deeper in some areas and harder formations of clay and laterite will be encountered. PCV plans (if possible) to purchase Mobil Drilling Co.'s rig B52 which has circulation rotary capability. This rig will also have capability for drilling to greater depth as well as for penetration of medium hard to hard formations, which is not possible with the present rigs.

Air compressors need to be added to these new rigs for development of wells as well as for drilling. The compressor should be 125 to 150 PSI and 400 to 600 CFM, trailer mounted (or as recommended by Mobil Drilling Co.) It is believed that drilling in some parts of Chad will call for drilling in very hard rock as much as 20 to 30m. If this is so, a small diameter down-the-hole hammer drill, can be used with air circulation. This type of operation will call for a small frame or water-injection pump and an oil lubrication injection system either on the air compressor or on the drill rig. By using an air compressor to develop the wells, developing time can be cut as much as 8 to

10 hours and also provide a more effective sand and gravel filter around the screen. The compressor also makes it possible to set the cylinder at a higher level, within 2 to 3 m of static water level, which in parts of Chad is several meters higher than the top of the aquifer. This will mean shorter pump rods and less weight on the pump handle. The PCVs have tried to use removable cylinders but due to corrosion they have not been effective. If a permanent cylinder is used, up in the column pipe and above the screen as at present the well cannot be developed to its best production. However, with air development through a 1" pipe run down to and inside the screen, jetting with air can be done until well is developed. Wells of this depth and size should not take more than 3 to 4 hours to develop by air. The production of the well can also be checked while developing and recorded.

All new drilling rigs should have air and mud circulation capability but until more information has been obtained on formation conditions, only one or perhaps two rigs should be equipped with down-the-hole hammer drills. Until the new equipment arrives in Chad one of the old rigs should be set to work on an exploratory program so this information will be available when needed. As PCVs now keep excellent well and maintenance logs of all wells, it should not be difficult to set up an exploratory program from information already on hand.

Until 1975 the PCVs program left much to be desired as they were working with limited funds so that little maintenance could be performed on any of the previously constructed wells. Therefore most wells dug or drilled in the past were in need of repairs. Most of these wells have since been put back in service with funds provided by AID. PC learned from this experience that maintenance expertise as well as drilling expertise are essential complementary part of any rural water supply project. They are training maintenance crews with a high level of expertise so that they can work without supervision. Also they have written into all projects a 5-year supply of spare parts to continue after the project is completed. The FDAR is actively supporting this program to the best of its limited resources. PC believes that this support will continue after they have left the country. Because of the simple construction of these wells maintenance should not cost more than $30.00 to $35.00 per well per year. All above-ground components of the hand pumps can be bought locally and parts that wear the most in the well itself (leather cups) could be made locally with a small cost outlay.

5.0 EXCRETA DISPOSAL

5.1 TYPES OF PROGRAMS

A few squat-type-pit (pit privies) latrines have been installed by ES/MPH and by PVO's as part of other programs. ES/MPH says that it is installing about 100 per year. The concrete slabs are made in the village where they are to be installed by the people under the guidance of the EH sanitary technician. The villager digs the pit, approximately 2 meters deep; installs the slab which he has helped make and builds the protective shelter of local materials, as he desires. In some cases a sheet of zinc has been supplied for the roof.

The latrines are usually installed at some distance from the houses, 40 meters was mentioned, although this appears excessive.

Some villagers, particularly Muslim women, who are not allowed to defecate outside their compound, lacking a latrine installation, scratch a small hole in one corner of their own living area and partially fill it with sand after each use.

There are some mitigating circumstances in many areas of Chad despite the lack of sanitary excreta disposal facilities. Sand, sun and dryness[1/] along with the practice of defecating outside of village limits, effective sweeping of compounds, and burning of limited trash, all help to maintain an acceptable level of sanitation. The recent introduction of Peace

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1/ The Northern Zone, Lake Chad Basin Environmental Sanitation Assessment, APHA, March-April 1977.

Corps-drilled wells and pumps (hand operated) appears to be the most practical additional public health measure which can at this time be taken. Continued maintenance of these pumps should be assigned maximum priority among whatever services are to be provided in the future.

Diarrhea and dysentery are omnipresent and the reported figures give no true indication of their prevalence. The bacterial etiologies are not diagnosed as such. Amoebiasis is also usually a clinical guess, and the intestinal worms are found everywhere. Despite Bucks[4/] failure to find evidence of Ascaris infection, this is also common.

Excreta disposal[2/] has no obvious solution at Sategui-Deressia. Latrines become open wells during the height of the flooding. It is hard to imagine the circumstance that would impel the local resident to go out of his way to find a latrine for purposes of urination. During the dry season, the problem takes care of itself, because parasite eggs succumb when deposited on dry, hot soil. In the case of Schistosoma mansoni infection, (quantitatively less important than the S. haematobium in this part of Chad), sanitary feces' disposal should be achieved at least for the rainy season, if the cycle is to be broken at this point. During the dry season, feces deposited on dry ground generally develop an internal temperature that kills schistosome eggs (mature eggs survive less than 24 hours at 22°C and are said to last about 1-2 days under the usual warm tropical temperature with the diurnal variations taken into account.)

2/ Environmental Assessment Report-Southern Zone, Republic of Chad, APIA, July 1977

4/ Buck

The following is quoted from the Northern Zone Lake Chad Environmental Sanitation Assessment, April 1977. "While no immediate dangers to the health of the inhabitants of Bol was observed during this study period, one must remember that the delicate balance of the traditional excreta disposal system can be lost overnight if the town were to be affected by an epidemic of diarrheal nature such as the cholera epidemic, which was reported in the Bol area in 1971 and 1973" (Bol Site Report, Peace Corps, September 1975). An epidemic of that type would quickly change one of the elements which makes the present excreta disposal system effective--the elimination of feces outside the physical limits of the town. During a diarrheal epidemic, the streets and living compounds will of necessity become receptacles for feces, thus closing a gap in the transmission cycle and thereby presenting an emergent threat to the populace.

5.2 PROPOSED PROJECT

Because (a) no sufficiently sanitary method of excreta disposal exists, except the drying effects of the sun during some times of the year and in some areas only; (b) investigations have proved that a potable water supply, without sanitary excreta disposal and health education, will not provide the complete health benefits which are only provided by all three factors; and (c) no program exists for aiding the villagers in installing sanitary excreta disposal facilities themselves; it was suggested to USAID/Chad that a parallel sanitary latrine project be developed in the same areas covered by the present and proposed AID/GOC/PC wells project to ensure that the hoped for benefits are obtained.

IV. F. PUBLIC HEALTH CONSIDERATIONS

An attempt is being made in the installation of the wells and pumps under the AID/GOC/PC program to assure that safer water is delivered by the pump. Water is obtained from an acquifer filtered through sand at a level deep enough to prevent pollution. A small protective concrete cap is poured around the casing at the ground level and a concrete trough is included to carry the excess water from the pump away from the well about one meter. The upper end of the pump is protected by a washer around the pump rod to prevent, as much as possible, the introduction of foreign matter into the pump cylinder. The pump cylinder is located below water level to avoid the need for priming the pump with the possibility of polluting the well.

People are instructed through the village chief not to water their cattle at the pump nor to do their laundry there. Some pumps are locked at night to prevent possible damage.

A few additional precautions are necessary to improve the delivery of potable water. The well should be disinfected with HTH after installation of the pump and then should be rechlorinated after each maintenance visit. A concrete lining should be poured around the upper 3 meters of the well casing. The concrete apron at ground level should be extended approximately 5 feet in diameter outside the pump base, raised at the center to slope to the outer edge of the apron where a concrete lip will conduct the water to a low point. There it will flow away from the pump area and will not be allowed to pond in a stagnant pool.

The PCV's and Chadian counterparts should be given indoctrination in the public health implications of the work they are doing and an understanding of the health problems involved, also in the basics of health education.

Location of the village well should take into consideration, not only the location of existing latrines, if there are any at the time of the well installation, but also the possible location of latrines which may be constructed in the future. By the same token, latrines to be installed in a village where a well has already been constructed should be located as far from the well as possible, at least 20 meters. The area around the well should be maintained clean and free of stagnant pools of water. Latrines should be maintained clean by daily flushing of the slab.

7.0 HEALTH EDUCATION

There is no single well-defined health education program directed toward helping the villagers understand the health implications of insanitary living conditions, food and personal luggage, first aid, the use of heavily polluted water and the unsanitary deposition of human excreta. Some atempts are being made to help them understand the basics of personal hygiene.

Some health education is being taught in public health clinics, village schools, social and MCH centers, and in centers where men and women receive agricultural training. An element of this education shows a causal link between disease and contaminated water along with unsanitary environment; therefore the use of potable water and sanitary latrines

must be promoted.

Steps are being taken to intensify these health education efforts,through reforming elementary education to include health education. AID is proposing a project to provide 400 village health workers selected by the villagers to work with the village health committees and to promote sanitation, hygiene, and first aid in the village.

AID has indicated that every effort will be made to coordinate its health-related activities, especially those which are carried out by the PEACE CORPS and CARE so that these activities will be complementary and mutually supportive.

Table 2: Reported New Cases of Selected Diseases in Chad, Selected Areas, and the S.G.E., 1975

Disease	Chad Total	Mayo-Kabbi	Prefectures Tandilla	Hospital N'Djemena	S.G.E. Nation-wide
Tuberculosis	1.689	112	--	200	969
Primary syphilis	12,173	553	107	6	3,061
Gonorrhea	19,223	1,810	854	58	2,853
Amebiasis	47,118	6,403	3,327	302	10,582
Bacillary dysentary	11,917	2,688	1,165	2	--
Whooping cough	8,328	1,098	590	56	2,128
Meningitis	2,045	172	786	120	100
Tetanus	760	172	119	92	0
Measles	2,183	97	90	23	387
Mumps	6,059	48	204	7	2,907
Infectious hepatitis	9,877	1,647	1,739	334	1,296
Rabies	33	3	6	0	0
Malaria	153,646	28,618	12,291	354	20,871
Schistosomiasis, urinary	22,695	5,419	1,691	27	4,125
Schistosomiasis, intestinal	4,874	561	161	72	856
Onchocerciasis	3,372	613	43	0	590
Chickenpox	16,845	785	320	73	692
Pneumonia	9,455	1,190	69	482	2,143

RECOMMENDATIONS

1. Team reviewed draft of CDO Project Paper for expansion of present project into other prefectures. Team made suggestions which are being incorporated into PP that CDO will submit to aid/w in near future. Most significant is provision of air compressor for each bore rig for maximum development of well. To assure smooth continuation of present project into proposed project through same mechanism AID/GOC/PC, it is urgent that proposed project be approved and funded earliest.
2. In PP prepared by CDO and submitted to study team for review, provision was made for short-term consultant only in second year of project because of budgetary constraints in FY 78. Team feels that exploratory drilling under supervision of short-term consultant should be carried out during first year in order to identify as early as possible equipment accessories and commodities which may be required for proposed project in areas which may differ geologically from those encountered in present program. However, as large area of proposed project is in geological formation similar to that o present program, work can be carried on in that formation while research work proceeds.
3. As proposed project is considerably more extensive than present project, it is strongly recommended that professional engineering backstopping be provided, for the AID/GOC/PC Project.
4. Study team wishes to stress importance of training elem . t already included in PP to prepare the Chadians to maintain the installations and continue the program in the future.

5. Study team suggests addition of parallel project in same areas covered by present and proposed AID/GOC/PC wells project to ensure full health benefits of small tubewell project through use of community participation in sanitary latrine program reinforced by continuing health education program in schools and health facilities. Since (A) the installation and maintenance of wells and (b) the construction of family latrines and health education are the responsibilities of different ministries, it is advisable to have two distinct projects running simultaneously in coordination. Discussions were held with CARE Director and Deputy who have had extensive experience in Tunisia implementing a successful Family Latrine Project in coordination with a wells project. CARE is ready to include a self-help Latrine construction program as a subproject of the "Food Delivery and Rural Works" OPG proposal under revision and some to be submitted to CDO for FY 1978 funding. CARE would carry out this project in conjunction with the Environmental Sanitation Department of the Ministry of Health. There is an excellent team spirit between CARE, PC and CDO which would ensure the coordination of the wells and latrine project. Study team recommends approval of cooperative AID/CARE/ES-MPH Sanitary Latrine Program with and funding throhgh CARE, to run parallel to and coordinated with proposed AID/GOC/PC well program.

8.0 SOCIAL ANALYSIS

8.1 Chad Government Goals: The Government of Chad projects economic development of the country within a liberal context. It wishes to reorient its socio-economic activities, strengthening economic structures. Above all it hopes to improve national living conditions using existing resources, but since these are extremely limited, it must have recourse to much external donor assistance. In this context, a substantial portion of Chad's total budget is assisted by French support. Within this framework, the director of FDAR, one of Chad's two water-development agencies, is eager to institute a full rural water program.

8.2 Climatic Zones: It is useful to see Chad as divided into three major climate and vegetation zones, to wit: the tropical southern band, where guinecan forest and wooded savannah shade into a tree-dotted sudanic type of savannah. At roughly the level of the 11th parallel, in the region of 'Ndjamena, this begins to give way to the scrub and acacias of the Sahel zone. Wind-washed sahelian steppe is the landscape just to the northern limits of the provinces of Kanem, Batha, and Biltine, from where between about 15 and 18 north latitudes, the dunes and naked expanse of the Sahara begin to appear.

8.3 Ethnicities: Chad's populations are customarily divided into twelve different major linguistic groups,

each one containing numerous sub-groups.* Of these, the three largest major categories are 1. Sara-Bongo-Baguirmien, 2. Tchado-Hamitic, and 3. Arab. Sara and related people are the preponderent population, and hold hegemony in the modern power structure. In the Sara cultural area one finds society traditionally organized through the major institution of male initiation, which cuts across family lines to incorporate all adolescent boys into the shared set of normative, social, and ritual order that defines membership in Sara society. Although abhorred by modernizers, Tombalbaye, the politician, was not far off in his assessment of the mobile in traditional society when he attempted to reinstitute and enforce ancient practices of "Yongo" initiation. Customary authority in Sara groups has been the rule of the elders, authority stemming from the limitless power of the ancestors. Priests, such as the "Master of Water", symbolize/celebrate the rites that mark social ties and obligations. There is a ritual Chief of the Earth, and usually a sacred grove for ancestor shrines. Illness and ill-fortune are chiefly caused, it is believed, either by behaviour which is disrespectful of conventions, thus angering the spirit-world, or else by sorcery.

Sahelian peoples present a very different culture largely based on transhumance; very independent, they want to handle their own affairs. To reach them fully educational efforts should be

*Major language classes are: Sara-Bongo-Baguirmien, Moundang-Toupouri-Mboum, Tchado-Hamitic, East-Saharan or Kanembou-Zagaoua, Mabang, Tama, Dadjo, Mimi, Boua, Banda-Ngbaka, Peul, and Arabic of which there are some thirty sub-languages.
Reference: J.P. Caprile, Atlas Pratique du Tchad.

made in their own languages or the Arabic lingua-franca of the Sahel and Desert, and couched, it is suggested, in an Islamic culture idiom.* AID might find it useful to obtain health-education materials for all this region from sources in Tunisia, Egypt, or the Lebanon all three areas being very active in the production of educational materials. Nomad peoples of the Tibesti, Borkou, Ennedi regions in the Chaddian/ Sahara are in full dissidence at this time, nd essentially not touched in other than military context by the 'Ndjamena government. For this reason it is not warrented to discuss them in the current report. While some of their groups may undoubtedly use large stock wells in the north, nothing is currently projected to consider their water needs.

8.4 Demography: Chad counts a current population growth rate of 2%/year, with no population control measures. 1970 population estimation yielded a figure of 3,640,000 inhabitants, with the provinces of Mayo Kebbi, Moyen Chari, and Chari Baguimi showing the heaviest concentrations. It should be remarked that in most parts of sedentary Chad villages are still extremely fragile groupings. For internecine reasons they often split and move apart, and many just wither away. Twenty-two "urban centers" count more than 5000 habitants, but "city" growth is moderate. Only 4 cities count more than 30,000, notably 'Ndjamena, Sarh, Moundou, and Abeche. It is a lightly peopled and feebly

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* c.f. Reyna, op cit.

urbanized country, with most of the population concentrated in the cotton-growing regions of the south-west. It is a country of immense empty spaces, where migratory movements are poorly known, and life-expectancy is no more than 31 years. Infant mortality is in the region of 160/1000 live births, and the majority of infantile deaths can be attributed to the diarrheas and gastro-enteritis associated with impure water.

8.5 Settlement Patterns: There are many different living and housing styles in this country of diverse peoples, and no overall residential rule can be stated. It is for such reasons that plans for a given area must be individually tailored to that locale. Areas around Sarh and Mboum have nucleated villages. In Lere the King's house is so large it comprises a village by itself, but the Masa living just to the north have a pattern of dispersed homesteads at distances of about 1000 feet apart to accomodate encircling gardens and cattle byres. The one recommendation which can be posited is that migratory patterns be considered closely in the placement of wells. For most of the Sahel transhumant region, potable wells, and the whole health education and village organization program should be planned for the Darat camps, which are the seasonal locations where large groups congregate. Stockwells and some method of storage-purification-reservoirs for potable water are what is needed along the customary migration trails.

8.6 Constraints: Though large on the map, Chad is not an effective political entity throughout the area claimed. Essentially only the region comprised within the drainage basins of the Chari and Logone Rivers is controlled by the 'Ndjamena government. No national sense nor consensus exists in the major portion of the territory claimed. Most of this territory is inhabited by diverse and inward-oriented tribal and regional groups with separatist or isolationist goals. The 'Ndjamena government expends most of its energy and approximately 50% of its financial resources in civil war, and on security problems.

National level administrative organization presents a picture of overlap and repetition in some areas and institutional insufficiency in others. The country is plagued by a lack of modern trained personnel in upper, middle and lower echelons. Lack of logistical and maintenance backup is a constraint at all levels. In most areas of the country transportation and communication follow age-old modes of foot and animal travel, of news carried by word of mouth through visits, travelers, and markets. Add to this schema the lack to date of a Development Plan or set of goals and timetables. And though an important resource, external donor efforts are sporadic and uncoordinated. This picture serves to emphasize the need in Chad for USAID to devise and adopt an integrated program, with a holistic approach to problems it will attack. Incidental projects, not conceived in their social context, are likely to have little lasting effect.

8.7 Regional and Local Administration: At the regional and local level, the pattern of administration offers a Prefect, a Sub-Prefect, a Cantonal Chief, and the Bulama, or Village Chief, who with the lineage heads of clan, major and minor lineages organizes the Council or Committee of Elders. Since the middle sixties, Chad has employed where possible the traditional "sultans" as cantonal chiefs, and this is a focal level for decisions. Probably this would be one level at which regional programs would plug in.

8.8 Patterns of Cooperation: In general, most communities are kin-based, and Reyna suggests that where there are multi-ethnic communities, one well to one ethnic or kin-group might make for easier consensus and decision-making. A kin-group or Zeribet usually forms a cooperative work-group, and intermarrying groups usually demonstrate cooperative relations as well.

There are of course other institutions which develop and regulate group cohesion and cooperation, but one in particular should be singled out for the Muslim areas. The classic Sufi brotherhoods which are a fundamental element in all Muslim society are commented in Gilsenan.*

"The classic study of a tariqa** in a transhumant society, Evans-Pritchard's Sanusi of Cyrenaica, shows, for example, how the Sanusiya established themselves in the Bedouin society of the Western Desert of Egypt. The order fitted its own structure 'interstitially' to that of the

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* M. Gilsenan Saint and Sufi in Modern Egypt Oxford, 1973 quoting E.E. Evans-Pritchard The Sanusi of Cyrenaica London, 1949

** Tariqa the "mystic path" of a Brotherhood. Plural: Turuq.

tribes, setting up zawiyas* on the boundaries of group territories, and often also on the major trade routes (this establishment of Sufi lodges along caravan routes has always been a significant factor in their growth throughout Africa and the Middle East). Coming from outside the social system and being therefore unattached to any particular interest or dominant lineage, they were able to operate over the normal divisions in the segmentary lineage structure. The lodges developed a multiplicity of spheres of activity. They were at once schools, caravanserai, commercial and social focal points, law courts, banks, storehouses, poor houses, burial grounds, and the source and channel of divine grace. In the very different setting of agricultural Senegal, on the other hand, the Muridiya Order administer whole villages centering on the Sheikh and the community of young disciples who for some of the year work in the fields and for the rest study and travel as missionaries....The Tariqa pioneers sedentarization and land reclamation, and in a country where the economy depends in large measure on the ground-nut crop, the Muridiya communities produce a little more than half of the total harvest...." Where no Zawiyas exist, the Orders nevertheless establish prayer groups which have always been focal points for dissemination of ideas and opinion. These should not be overlooked -- nor should the Khuttab (Koranic Schools) for the teaching and reinforcing of health and sanitary education.

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* Zawiya the House, or "monastary" of the Order

8.9 Women: "In Chad, women have low visibility but high-status. They make decisions in their own areas, and do their own work and have their own money!"* Although women's organizations were dissolved by the present government, seven centers under the Ministry of Social Affairs are teaching handicrafts, nutrition and health education, and women's skills. Seven Peace Corps Volunteers will help with this program in Moundou, Bongor, Qumra, Lai, Doba, and 'Ndjamena, during a two year project. USAID's Women in Development Program is establishing a Village Women Project for Bongor and Sarh involving some of the program which we have elaborated in the central part of this Survey. We are indebted to the Project Director for ideas which we have incorporated into the recommended overall program.

It has further been suggested that in Chad -- especially in the South -- women are extremely influential in establishing public opinion. "You can make the** issue of water the number one topic and problem which a village must solve, by discussing with the women the burdens of health, transportation and sufficiency that water poses to them and their families. And where they begin, they won't rest till they have a well!"

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* Personal communication from I. Hvasloff, 'Ndjamena.

** Personal communication from a long-time resident.

8.10 Health and Health Services: Health in Chad is threatened by:

leprosy	schistosomiasis
trypanosomiasis	parasites, but especially tape and guinea-worms
trachoma	
measles	malaria
yellow fever	dysentaries, and
meningitis	gastroenteritis
	assorted skin diseases.

In the past, all curative medicine was brought to the nomads by the Service des Grandes Endemies. They now reach none of the B.E.T. region of the north, and find it difficult to get to many parts of Kanem, Salamat, and the north of Batha. Chad possesses a limited health-services infrastructure, with

4 hospitals	88 dispensaries, and
8 medical centers	6 sectoral bases for the Service des Grandes Endemies.*
30 infirmeries	

Clearly Chad needs to develop its Health Services, and the proposed CILSS/CLUB Health/Water/Nutrition plan, with its Village Based Health Program can offer greater possibilities than the purely treatment-oriented efforts of the past. Currently no overall program exists, though in some villages Health Committees, often stimulated by missionary effort, or such private centers as those run by the Centres Suisses du Moyen Chari, the Maisons Familiales Rurales in the Logones,

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* 1972 Atlas Pratique du Tchad Ch. Bouquet

and les Cooperands Allemands in Mayo Kebbi, are beginning to establish themselves, and to develop a village fund to purchase a kit of simple medicines. Often a Village Health Agent is named to control this medicine chest. Some of the above-mentioned assistance groups, notably the Swiss, have developed quite successful training programs for health agents and villagers. It is suggested that delegates for such training be chosen by a village, rather than through voluntary attendance, because more profit is liable to redound to the village when it is thus involved in the acquisition of skills and knowledge by its members. Project designers might also usefully explore the training programs established by the DEFPA* agency of the Ministry of Agriculture which are teaching health, nutrition and agricultural methods to rural people -- men and women. This seems to be a viable and effective agency and effort.

AID is currently working on a project to train midwives for 400 villages. In connection with the recommendations of the CILSS/CLUB strategy, AID could consider research on the possibility of developing and using skills of traditional medical practitioners. Traditional professional midwives exist in many areas; and Fekis, among the Muslim population, are usually enterprising gentlemen who treat illness with the curative tool-kit they possess. In some instances this is magic or religious or spirit-manipulation cure. But a traditional pharmacopoea also exists, and useful long-term social, pharmacological, and medical research could determine

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* Direction d'Enseignement et de la Formation Professionelle Agricole

its value. We here signal, for those interested, the following existing study of plants and their uses made in the Sara region:

Pierre Palayer — Lexique de Plantes de Pays Sar Tome II: Noms Scientifique/Noms Sar (avec indications d'utilisations)
Polycopie du Centre d'Etudes Linguistique
College Charles Lwanga de Sarh.

Regarding health education in Chad, one other point is of note and possibly useful to project designers. The INSE* Linguistic Center, connected to the College Charles Lwanga de Sarh, under the direction of Father Fournier, a gifted linguist, would have the skills and be prepared to produce health-education materials in local languages. Since health education is not a proposed part of the new "reformed elementary education" plan, it will be necessary to seek other centers and groups and methods of disseminating health and sanitation knowledge.

8.11 Water: People wash their clothes in streams and ponds, and they like to bathe in swamps or rivers -- perhaps because it's more fun! As long as these usages hold, all the clean wells will not keep them free of many harmful diseases and parasites. Further, they often like the taste of a pond's water better than that of a well. It is not frivolous, then, to suggest that local preferences and recreation needs should be considered in the necessary "tailor-made" plan for a given locale. This team-member has seen bath-houses in one African country, which filled the need for recreation and social participation. A women's

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* Institut National des Sciences Educatives

side and a men's side existed, and groups -- from bridal parties to spirit-curing sessions used to come for a morning's, or all-day, or all-week social! Some such solution might perhaps wean people away from the danger in the waters of the swamp.

In Chad hand-dug wells are everywhere, because there is much sub-surface water. In the north the traditional animal watering wells are monumental holes "as deep as thirty men standing one over another". It is said they were constructed by "ancient conquerors, so long ago no one knows who or when". Those pragmatic people also built smaller wells for human consumption only, and these are about "five men deep". The great stock-wells are placed a bit more than a day's travel apart, and are criss-crossed with large timbers permitting a support for people to drop and haul their skins or buckets. From time to time people clean these wells. "Bush wells" are considered to be usable by any comer, "because water-in-the-ground comes from God, and people should not have to pay for it." However in areas considered as tribal land, all the tribe may use it, but no stranger without permission of the Sheikh. Still, if two groups arrive at the same time, and there is not enough for all, they may fight.

Reyna suggests one problem that appears with the new multi-village wells in Assale Servowel: No institution exists to regulate access, and therefore some such wells are overused, some underused, and in either case the situation

generates distrust if not conflict in societies where ingroups and out-groups are rigidly defined, and the field of cooperative relations usually does not extend past the border of the face-to-face community."

When asked squarely if people would be willing to pay for good, clean wells, one respondent said, "People will pay for rain-water which has been gathered, because it is someone's work, and the water is pure. For good wells, people might be willing to pay. They would not have money, but they could barter an animal perhaps." This respondent was from the Missiriye Arab area in Batha province.

In the south, until French time, people did not have wells, but used surface water only, so there is no traditional technology to discuss.

ATTACHMENT II

RURAL WATER SUPPLY AND SANITATION

PRE-PROJECT ANALYSIS

COUNTRY REPORT - UPPER VOLTA

(Study Carried Out Nov. 20-27, 1977
Sponsored by AID/Washington)

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COUNTRY REPORT - UPPER VOLTA

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RURAL WATER SUPPLY PRE-PROJECT ANALYSIS FOR UPPER VOLTA

1.0 INTRODUCTION

The present analysis covers only the community water supply and sanitation situation in the rural community of Upper Volta in the range from 100 to 1500 population. The analysis is based on observations made during the period from November 20 through 27, 1977 by a study team composed of a well drilling expert, a groundwater/surface water geohydrologist, a rural social/cultural anthropologist and a sanitary/environmental/public health engineer. Discussion with the pertinent representatives of USAID, P.C., HER, CIEH/TAMS, VITA, WHO, were supplemented by field visits accompanied by representatives of HAER to observe well installations made by various agencies in cooperation with HAER, to discuss the public health socio/cultural situation with the villagers benefited by these installations. Discussions were also held with the Director of the ORD's in Kenya and Banfora. Observations on the ground were supplemented by an overflight by chartered plane of the country coverning a route from Ouagadougou.

The rural population has a widely dispersed settlement pattern consisting of small clusters of houses in family-related compounds. Water is obtained generally from shallow surface pools and hand-dug wells. During the past 15 years the unlined wells dug by the villagers have been supplemented by comparatively modern open hand-dug wells lined with concrete rings, and a few drilled wells with hand pumps. The emphasis

is still on open wells. Voltans seem to prefer open wells because of a greater assurance of access to water.

In addition to the usual tropical diseases of diarrhea, dysentery, enteritis and near 100% infestation by intestinal parasites plus the prevalence of Guinea-worms, schistosomiasis is common around the many natural bodies of water and man-made lakes. Onchoceriasis has been rampant along most of the rivers, adding enormously to the public health problems in Upper Volta.

2.0 PRESENT PROGRAMS IN RURAL WATER SUPPLY AND SANITATION

2.1 Agencies Responsible for Programs

The Directorate of Hydraulics and Rural Equipment (HAER), created in 1965 as part of the Ministry of Agriculture and now under the Ministry of Rural Development, is responsible for water supply and sewage disposal throughout Upper Volta. The function of HAER is to plan and construct all new water supply and sewerage works and to operate small systems in rural communities. The organization of HAER is shown on Fig. 1.

The water supply activities financed by the various donor agencies are funneled through HAER which has divided the country as shown on Fig. II. alloting specific sections of the country to each of the various agencies. These agencies, coordinated by HAER, work in cooperation with the regional offices for Rural Development (ORD).

There are 14 ORD's which generally follow the prefecture sub-divisions and are headed by appointed Directors.

The ORD's are integrated development organizations through which the different ministries work. In general, each ORD has a foreign angel providing funds, supplies and technical assistance.

The villagers petition their ORD office through their prefect for a water supply or the rehabilitation of an existing well which has gone dry. The ORD's establish priorities and advise the HAER of their needs after which the HAEP prepares a list of villages to receive assistance during the year. The ORD arranges for local participation.

The AVV, The Volta Valley Development Authority, which is working on a resettlement of the area along rivers from which onchoceriosis has been eradicated, has a few well drilling rigs and is drilling wells for its newly established settlements.

The Peace Corps has a well digging component in the program in Upper Volta. Former Peace Corps Volunteer, Mark Gilcrest, now PSC for AID and for Peace, gave us a run down on what PCV's had been and were doing at present time with hand dug wells. On a grant from AID of some $300,000.00 in 1975 they have dug some 200 new wells 6 to 30 meters deep and deepened some 200 wells. For hard rock formations they have two air compressors with jackhammers. These are used mostly for redeepening dried up wells.

In the ten years since PC has been working in Upper Volta they have dug some 1500 wells along with deepening

some each year. In Mark's area he would go to a village and ask if they wanted a well. If the answer was yes, he asked would they pay for it, if not, would they pay the mason (400 CFA per m.), if not would they pay for materials. Sometimes the villagers would pay and do all the work except for the mason's work. Sometimes they would pay all the mason's salary and sometimes not. Every village had a different way to be dealt with. As he lined up the villages for wells he would leave a mason at the village site and move on to the next village. He might have 4 or 5 wells being dug at one time. He had a two ton truck to keep his masons with equipment they needed so the work did not stop. Picks and shovels, rope and pails, cement and reinforcing steel and molds for interlining of wells were the requirements for each well and project cost of each well depended on how much the village paid. The one thing required of all villages was that they had to do all the digging.

Mark said that there was no assigned village by any government agency. In the past, a PCV went to any village in his area and started a well. He also said that none of the PC wells were the same size as wells dug by the government agencies but that they were changing to same. PC wells were 1.6 meters diameter while the government wells were 1.8 meters diameter. As far as is known there was no records kept on any wells done by PC. Wells, without a log or records, are as

worthless to any program in which they are dealing with the development of a nation, as they were good for the people at the time of being dug. Hand dug wells without a pump and cap are no better after 5 months' use health-wise, than the severely contaminated water hole which the people and animals have been using. The hand dug well has a utility -- but little health -- value to the community it serves.

2.2 International Cooperation

At present HAER has planned a rural water supply program for the next three to four years based on the following anticipated international cooperation:

Agency	Cooperation (Billions CFAF - U.S.$1.00 - CFAF 240) CFA	Millions $U.S.
USAID	3.500	14.6
Entente	1.200	5.0
German Fed. Rep.	0.900	3.75
FAC	0.300	1.25
World Bank	0.100	0.42
UNICEF	0.035	0.15
UNDP	0.025	0.10
Fed. National Bank	0.56	2.33
		27.6

This is equivalent to more than twenty-six million dollars. (See Fig. II. for geographical distribution of donor participation)

2.3 Population with Water Supply and Excreta Disposal Services

In 1970 it was estimated that the population in Upper Volta was distributed as follows:

Urban (more than 10,000)	470,000
Semi-urban (5,000-9,000)	349,000
Rural (below 5,000)	4,753,600
	5,572,600

In 1970 the distribution of villages by number of inhabitants was as follows:

Population	No. of Villages	Population	No. of Villages
1-100	948	2000-3000	170
100-250	1716	3000-4000	75
250-500	1799	4000-5000	24
500-1000	1550	5000-10,000	13
1000-2000	794	10,000-202,000	13
1-1000	6807		295

The preponderance of villages, over 6000 (85%), had less than 1000 population and only 4% of the communities in Upper Volta had more than 2000 population. This points up the importance of developing programs for small rural populations.

Through its Documentation and Water Supply Research Section, HAER carried out a detailed survey of nearly 7500 villages throughout Upper Volta to determine the villages which have satisfactory wells (most of them open hand-dug wells), the amount of work necessary to rehabilitate wells which have gone dry, and where new wells are needed. This survey serves as the basis for scheduling the rural wells program.

The survey revealed that 17 percent of the villages had water service from comparatively satisfactory sources; 2700 wells in 1500 villages needed to be deepened to provide water throughout the year; and 63% of the villages (nearly 4500 villages) lacked any type of protected well. Very few of the wells are provided with hand pumps because the pumps break

down frequently and an adequate maintenance program is lacking.

As mentioned above, about 17% of the rural villages were served satisfactorily the year round (satisfactorily meaning water from open wells, which is far from satisfactor from a sanitary point of view, it is, however, satisfactory from the point of view of a constant supply within the village limits which doen not have to be carried for miles).

A very rough estimate indicates that from 300 to 350 wells, each serving between 100 and 1000 people are being dug each year in Upper Volta. The villagers provide the labor for digging the wells, under the guidance of a mason furnished by HAER or the agency responsible for the program. The wells are lined, generally with concrete liner rings and the lining extends above the ground surface for approximately a meter. A concrete apron extends out from the liner at the ground surface to prevent filtration of spilled water down the outside of the liner.

When the villagers reach solid rock in digging their well, HAER provides assistance in excavating the rock until sufficient depth is reached to provide water storage to meet the needs of the village. However during recent years because of long dry periods, a number of these wells have gone dry and people have had to resort to the former grossly polluted sources miles from

the villages. The most satisfactory technical answer is a drilled well which penetrates the acquifer to a depth to assure year around potable water. Some such wells are being drilled and provided with hand pumps. Unfortunately, without an adequate maintenance program, the pumps become inoperative and the well is out of service. A continuous preventive maintenance program is required, and could be carried out at the ORD level with adequate financing and supervision.

3.0 Water Resources and Well Construction Considerations

Hand Pump Research

Research is underway by CIEH, (See report Les Moyens D'Exhaure en Milieu Rural by Andre Benamour, dated March, 1977 - financed by the World Bank and other agencies) to find a hand pump which is comparatively maintenance free. CIDA, through a Canadian firm of consultants, has also carried out an extensive research project.

AVAILABILITY OF WATER SUPPLY:

Traditionally the rural people of Upper Volta have obtained water supplies for themselves and for their herds from wells and from streams, natural ponds, lakes or springs. Only in the steppes of the Sahelian zone and the drier northern part of the Sudan savannah have wells been a traditional part of the rural water economy. Even in these regions, however, wells have been used only intermittently or in the absence of convenient, nearby sources of surface water. The well, then, is essentially considered as a source of reserve supply when surface-water sources disappear during the course of the dry season. In the better-watered parts of the country south of the 900mm isohyet wells were apparently not traditionally used for rural water supply in the presence of relatively abundant surface sources. Chiefly, as a result of European influence since the latter part of the 19th century, wells have come to be accepted throughout the country as the cleanest, if not the most sanitary, and also the most reliable sources of water supply for human consumption.

Surface water is widely available in the streams, lakes and ponds throughout the wet season, which lasts from 3 to 6 months. North of the 900mm isohyet where the dry season may last from 6 to 9 months most streams go dry within a few months after the end of the wet season, and the only available water is that accumulated in natural depressions (mares or

marigots) or in artificially constructed tanks and reservoirs. South of the 900mm isohyet where the wet season is longer, sufficient ground-water storage accumulates to sustain the base flows of larger streams during most if not all the relatively short dry season. The highest water yields occur in the southwestern part of Upper Volta where a favorable combination of high rainfall with aquifers of high ground-water storativity generate relatively high base flows, particularly in the headwaters lie north of the 900mm isohyet where rainfall is comparatively low and the rocks have mediocre to low ground-water storativity. (A)*

Ground water in Upper Volta occurs in four major groups or kinds of rocks, each of which requires an appropriate technology for economically effective development for rural water supply. Precambrian igneous and metamorphic rocks directly underlie the surface of about 75 percent of the country and form part of a vast erosional plain or peneplain extending south into Ivory Coast and Ghana and northeast into Niger. A belt of Paleozoic sedimentary rocks about 50 to 150km wide, which extends along the western and northern border of the country, forms the southern margin of the great Taoudenni sedimentary basin of Mali. In the extreme east is another belt of Paleozoic sedimentary rocks about 10 to 70 km wide which forms the northeastern extension of the Voltaian sedimentary basin of Ghana. Also in the northwest, tertiary

*See pg. 31 for list of references.

sedimentary rocks of the Continental Terminal lie near the surface over an area of several thousand square kilometers. Quaternary deposits are poorly developed in Upper Volta occurring only in thin narrow alluvial ribbons along the larger streams or in sand dune tracts in the Sahelian zone. (A), (E).

Among the four rock groups of Upper Volta, the rocks of the Precambrian terrain present the most difficult technical problems with respect to the extraction of potable ground water supplies. The methods which must be adopted in the search for and recovery of ground water in these terrains are often costly with substantial risk of failure or only qualified success in obtaining even minimal supplies. Nevertheless, there is no alternative source of ground water in some 75 percent of the territorial extent of Upper Volta. The Precambrian terrain includes intrusive granites separated by northeast-trending belts of metamorphic rocks, chiefly schists, graywackes, quartzites and greenstones. (A), (E).

The most readily available ground water and presently the most extensively developed for rural water supply is that which occurs in a superficial mantle of deeply weathered rock in the Precambrian terrain of Upper Volta. In some places in the lowlands and plains the mantle attains thicknesses of as much as 30 to 50m, but on higher ground near rocky outcrops or in hilly areas the mantle may be less than 10m thick. The weathered mantle on the Precambrian rocks forms important

ground-water reservoirs which are tapped by several thousand large-diameter open wells. These range from about 5 to 45m deep and average about 15m deep on a country-wide basis. (b).

The weathered mantle from the surface down generally has the following characteristics:

(a) Laterite carapace or duricrust 0-12m thick, seldom permanently water-bearing. Traditional, unlined open wells can sometimes yield up to $30m^3/h$, while the carapace is temporarily saturated during the wet season.

(b) Clayey alterites. Running or soupy saturated clays may cause problems in sinking the concrete curbings of modern open wells. Yields can range from nothing to a few hundred liters per day.

(c) Friable sandy zone with comminuted mineral aggregates in granites. Yields can range from a few hundred liters per hour to a few m^3/h.

(d) Fractured zone. More or less hard and generally productive. Yields can range from 0.5 to $10m^3/h$. Most open wells generally do not penetrate much into zone (d). On the other hand, wells drilled by the percussion and rotary methods can pass into zone (d) and beyond to intercept water in deeper fracture systems. These two methods may become ineffective and uneconomic, however, if the rock becomes too hard. The down-the-hole air hammer drill, however, can penetrate hard rocks with ease down to depths of 100m. In the granites of

the Precambrian terrains the thickness and permeability of zone (c) conditions the yields of open wells. Among the metamorphic rocks open wells sunk in the greenstones commonly find zones (a) and (d) most productive. The schists may be productive to open wells in zone (b) but zone (c) is usually absent. Zone (d), however, is generally productive to drilled wells in schist. The metamophcsed volcanic-sedimentary complexes also behave like the schists, insofar as water yields are concerned. (B).

The water table in the Precambrian terrain generally lies at depths ranging from near the land surface to about 20m and averaging about 10m at the end of the dry season. In some regions of Upper Volta, however, the water table lies at depths of more than 30m as in the Kaya area and along the edge of the Goudo plain in the northwest. The water table lies at or near the surface in ephemeral or permanent swampy areas (mares or marigots), chiefly along the channels of the larger streams. Temporary water holes, which may become badly contaminated, are commonly dug in these places to provide water for human consumption, livestock or irrigation of small gardents. The water table fluctuates in response to recharge from rainfall during the wet season and dissipation of ground water storage by evapotranspiration and spring flow during the dry season. The largest fluctuations occur in the inter-fluvial areas away from large streams where the water level may

range 7 to 8m between the high at the end of the wet season and the low at the end of the following dry season. Fluctuations of 3 to 5m are more common, and near the mares and marigots fluctuations may be less than one meter. Because of the large fluctuations, open wells are vulnerable to drought cycles and commonly must be deepened two or three times after initial construction before they can be expected to yield water throughout a normal dry season. The annual recharge to the water table has been estimated to range from 150 to 250mm generally, with up to 400mm in the more rainy parts of the country. The specific yield of the more permeable parts of the weathered rock mantle have been estimated to be about 5 percent. The chemical quality of the ground water in the weathered mantle is reported to be generally good. The water is usuable for all basic water requirements. (B).

The Palezoic sedimentary rocks include thick relatively permeable sandstones interbedded with equally thick but largely impervious shales and siltstones. These sedimentary rocks attain a thickness of several hundred meters in the elevated plateau to the west of the Banfora Escarpment. Conglomeratic sandstones which crop out in an area of about 3,000km^2 form important aquifers south of Bobo-Dioulasso. These sandstone aquifers give rise to large springs feeding the headwaters of the Black Volta, the Komoe and East Leraba Rivers. One spring at the head of the Kou River rises from conglomeratic sandstone and is reported to have a perennial flow of about 3m^3/s. Two tubewells tapping water-bearing

sandstones at Bobo-Dioulasso are each reported to be about 150m deep. Each yields about $50m^3/h$ for a total of $100m^3/h$. The water is of excellent quality with only about 20m/l of total dissolved solids. Generally, individual tubewells in the western plateau can be expected to yield 50 to $100m^3/h$ from sandstone aquifers from tubewells 150 to 200m deep. (B).

Paleozoic limestones and dolomites in the Tiu Hrassan and Christine areas of the extreme north of Upper Volta were explored about 2 years ago by 12 tubewells. Some of these exceptionally develop up to $100m^3/h$ from cavernous openings in these rocks. Most of the tubewells yield individually only a few m^3/h, sufficient for livestock watering. The depth to the water level below land surface ranges from about 15m at Tiu Hrassan to 4m at Christine. The chemical quality of the water is good with only about 400m/l of total dissolved solids. (B).

The Gondo Plain north of Nouna and northwest of Thiou is underlain by semiconsolidated Tertiary clays interbedded with layers of sand. The sandy layers of the Tertiary rocks as well as underlying Paleozoic sandstones and dolomites are reported to yield substantial quantities of water to drilled wells 100m or more deep. The depth to water in this region is reported to range from 30 to 80m below land surface. The dissolved solids content of the water ranges from 200 to 700mg/l. (B)

Present Status of Water Development for Rural Supply:

Both surface-water and ground-water sources are presently used for rural water supply and livestock throughout Upper Volta. In the absence of awareness of the health hazards involved, a surface-water source, when it is available, may be preferred by villagers because of its relative convenience in contrast to ground water, which may require considerable labor for its extraction from a well. In southwestern Upper Volta, where rainfall is relatively high, household supplies may be taken directly from nearby perennial streams or springs where these are conveniently located to village compounds. Wells are used, however, if surface-water resources are lacking or are located at more distant points. The relative physical labor to the water drawer and carrier is the critical factor. Farther north, where the climate is drier, small earthen tanks are used to catch and store surface-water runoff for dry season use, chiefly for irrigation of crops in valley bottoms (bas fonds) but also for livestock and household consumption. Water is also taken from perennial ground-water fed ponds and swamps (mares and marigots) and from shallow water holes dug in dry river beds to tap underflows. Still farther north where surface-water sources are precarious through most of the year, wells are used almost exclusively for domestic and livestock water supply, more particularly in the dry season. (C).

At present there is virtually no development of sanitarily protected surface water for rural supply in Upper Volta. It appears to have been more expedient in rural development projects to obtain water supplies from wells, which can be more easily protected in the rural environment, than from surface water. Sanitarily protected spring captations have reportedly been installed in some places in southwestern Upper Volta and are potentially possible elsewhere, particularly in the hilly plateau country of the Orodara and Bobo-Diousosso regions. For example, a captation on Kou spring, which was developed primarily for the irrigation of sugar cane in the Banfora Sugar Complex, also provides domestic water supplies by gravity pipelines to several worker villages in and near the 4,000 hectare plantation. Nevertheless, large surface-water dams and reservoirs with limited water treatment are considered the best solution to the public water-supply requirements of urban areas such as Ouagadougou, Bobo-Dioulasso, Koudougou, Fada N'Gourma and other smaller towns. (C).

To extract ground water for rural domestic consumption, livestock and urban supply, there are essentially five kinds of wells presently in use in Upper Volta. These include (1) traditional open dug wells, (2) modern open dug wells, (3) larger diameter bored wells, (4) small or intermediate diameter drilled wells (tubewells), and (5) large diameter tubewells.

Traditional dug wells for village and livestock water have been constructed in all the geologic terrains of Upper Volta. They are generally dug by simple hand excavation techniques using a pulley or windlass with buckets and hand lines for removal of soil and rock. Such wells have been dug to depths of 50m or more. Many are unlined and as much as 5 or more meters in diameter. They are subject to gross pollution and occasionally have been known to cave in endangering the lives of local herders or farmers. Also because of inadequate penetration into the aquifer they commonly fail in the dry season. There are reported to be several thousand such wells in use throughout the country. (D).

So-called modern open dug wells in Upper Volta are essentially extensions or variations of French technology developed in West Africa during the 1950s. These wells use the "trousse coupante" method of construction. Concrete rings 2.0 to 1.6 in diameter are placed in the excavated hole near the surface reducing to 1.6 to 1.0 in perforated rings in the water-bearing zone. The perforated section is generally gravel packed to prevent fine aquifer materials from entering the well. The lowermost ring is provided with a sinking shoe and concrete rings are poured and added at the top of the perforated section when a well is deepened. Virtually all dug wells require one or more deepenings after initial construction before a viable water supply can be assured through the dry season. The wells should extend at least

5 to 10m below the dry-season position of the water table to insure an adequate supply. Deepening operations are generally started in February or March and are continued through the end of the dry season (c), (D).

The principal governmental agency involved in construction of modern open dug wells is the Service Hydraulique et Amenagements des Equipments Ruraux (HAER) which employs considerable mechanized equipment in the construction of its wells including derricks, air compressors, jack hammers, and sinking pumps. About 2 months, over all, is required for completion of a modern open well. There are, however, some 20 agencies, public and private, which have been constructing both open and drilled wells in Upper Volta during recent years. The HAER attempts to coordinate well consturction activities throughout the country, and all PVOs, international and bilateral agencies are required to submit annual reports and records of wells including location and construction detail to the HAER. The Bureau des Etudes of HAER has compiled a national inventory of both dug (open) and drilled wells and is presently updating it. There are presently estimated to be several thousand modern open dug wells in Upper Volta. These range from about 5 to 45m deep and average about 15. The Peace Corps estimated that it has completed between 1,000 and 1,800 of these on a country-wide basis since 1967. (D).

The prevailing rationale for the modern open dug well has been the provision of relatively clean water for basic village use and a well from which water can be drawn by bucket and hand line with minimum maintenance requirements. The yields obtained from modern dug wells in the Precambrian terrain range from about $0.5m^3/h$ to $10m^3/h$ and average $2m^3/h$. Also well yields fluctuate seasonally. For example a well which produces $5m^3/h$ during the rainy season may produce only $1m^3/h$ at the end of the dry season. In the Precambrian terrain, however, about 5 percent of modern open wells put down find no water, about 10 to 15 percent provide very meager supplies, and only about 80 to 85 percent can be considered adequate to provide a small village supply. Modern open wells provided with covers for sanitary protection and equipped with hand pumps have been attempted locally but have not been viable, except where regularly maintained by concerned volunteer, charitable or religious groups. In the absence of maintenance the pumps break down, the covers are broken, and water continues to be drawn by the villagers by hand line and bucket. The HAER has at present two well and pump maintenance teams, one at Ouagadougou and another at Dori to serve the entire country. Because of inadequate supplies, personnel and financing these items are only nominally effective. Until the management problem is resolved, however, HAER presently believes that open

wells must continue to be provided for most basic village water supplies. (C), (D).

In addition to the prevailing modern open dug well, which requires a large component of hand labor, the Autorite des Valles Voltaiques (AVV) is currently using mechanical boring equipment to construct large-diameter (0.8 to 1m) wells. Some 45 of these wells have been put down by the AVV in six areas in and near the valleys of the Volta Rouge and Volta Blanche east and southeast of Ouagadougou. The wells average about 20m deep. The method is limited to soft ground with some cohesion but it is useful for reconnaissance as well as for production. The laterite carapace of zone (a) can generally be penetrated with no problems. Also because of the rapidity of construction, the fluid or soupy clay layers of zone (b) can be controlled with the working casing, where not too thick. The method, however, does not lend itself to penetration very far into zone (d). Three reconnaissance holes or one steel-cased production well can be constructed in one day. The yields of the large-diameter bored wells are reported to be comparable to those of the modern open wells; that is, a range of about 0.5 to $10m^3/h$ or an average of about $2m^3/h$. (B).

As of the present (1977) there are estimated to be about 350 drilled wells (tubewells) in Upper Volta. THose in the Precambrian terrain range from 20 to 80m deep and produce yields ranging from 1 to $3m^3/h$. (Yields exceeding $10m^3/h$, however, are potentially possible.) In the Palezoic terrain of the western plateau tubewells 150 to 200 in. deep may yield individually up to $50m^3/h$. Aquifers in Paleozoic rocks of the Tiu Hrassan and Christine areas of northernmost Upper Volta yield exceptionally as much as $100m^3/h$ to individual tubewells from cavernous limestones, but most yield only a few m^3/h. The Tertiary sand aquifers of northwestern Upper Volta are also reported to yield substantial quantities of water to drilled wells 100m or more deep. (B).

Drilled wells (tubewells) in Upper Volta generally range from 4 to 10-inches in diameter. PVC is commonly used for shallow surface casing in the Precambrian terrain, but steel casing is required in the deeper drilled wells in the Paleozoic and Tertiary terrains. A minimum diameter of about 4 inches is generally required for installation of a hand pump. For a power pump the minimum diameter is about 6 inches, which diameter permits drafts up to $12m^3/h$. Only conventional rotary and percussion drilling rigs are reported to have been employed in recent years for construction of drilled wells. The rotary rigs operate quite satisfactorily except in hard rock. A rotary drilled well 50m deep is reported to require

about 3 to 4 days at 2 shifts per day to complete. Percussion drilling is well adapted to the Precambrian terrain, but progress may be slow if hard rock is encountered. In softer rock a well 50m deep can be completed in a week, but if hard rock is encountered the well may require a month or longer to complete. The HAER is presently (1977) reported to have two operational percussion drilling rigs for use throughout the country. There are, however, other rotary and percussion rigs active in the country under the direction of donor agencies and PVOs. The HAER uses its rigs chiefly in areas where it is difficult to construct dug wells, because of hard rock conditions. Apparently, down-the-hole (air hammer) compressed air drilling has not been introduced in Upper Volta. Such rigs would have considerable merit for drilling of wells down to depths of 100m in the Precambrian terrain, because of the rapidity of penetration, (20m per day), and of the indications given of water productivity from fracture zones.

Several of the smaller towns in Upper Volta depend on drilled wells and/or open dug wells equipped with power pumps for the municipal water supply. These include Dori ($100m^3d$) and Dedougou ($65m^3/d$). Other larger cities such as Bobo-Dioulasso, Koudougou and Fada N'Gourma depend on wells with power pumps for a substantial part of the municipal water supply.

Such wells and pumps are maintained by the municipality. (B).

Costs of Hand Pumps and Well Construction: Several types of hand pumps have been installed on both open and drilled wells in Upper Volta. None has proved entirely satisfactory under operational conditions of heavy use and lack of maintenance. The HAER attempts to maintain about 200 wells with hand pumps with two service crews for the entire country. Because of infrequent and inadequate maintenance, at least half these pumps are out of service at any one time. The only successful hand-pump installations are those locally maintained by private owners or by PVOs. The types of hand pumps presently in use in Upper Volta and their relative characteristics and costs are shown in the following table. With the exception of the Vergnet pump all the others are of reciprocating lift type. The Vergnet pump, which operates with a foot pedal instead of a hand lever, has a number of advantages for ease of installation, operation and repair. Slight modifications in the diameter of the piston and the length of stroke also permits raising water from depths as great as 65m. Most other pumps in use in Upper Volta are limited to lifts of about 40m. All pumps are subject to wear with use and should not be installed unless some continuing preventive maintenance system can be foreseen and sustained. In the absence of maintenance no hand-pump project has likelihood of continuing viability in Upper Volta. (G).

Make	Type	Max. Lift (m)	Max. Yield (m^3/h)	Approx. Cost ($US)
Abi	M, MR	40	1.0	580
Bodin	Majestic	30-35	1.0	660
Brian	Africa	100 40	0.3 0.9	2,900
Dempster		30-35	1.2	415
Godwin	W1H51 W1H54	100 40	0.4 1.3	1,450
Uganda		60 50 25	0.4 0.6 0.9	?
Vergnet	4C 4A	65 10	0.6 1.7	744

See reference (G, p. 29)

The present costs for construction of modern dug wells of the type put down by HAER in the Precambrian terrain are estimated to range from $205 to $310 per linear meter depending on the diameter and depth of the well. The deeper the well and the larger the diameter the higher the cost per linear meter. For large diameter bored wells, of the type put down by AVV, costs are estimated at about $165 per meter for a lined finished production well. For a reconnaissance hole costs are less, about $125 per meter. Overall costs for drilled wells put down by HAER in Precambrian terrain by percussion drilling rigs are estimated at about $175 per linear

meter for a larger diameter (6-8 inches) tubewell with a nominal yield of up to 12.0m^3/h. For a smaller diameter (4-5 inches) well of about 0.5 to 1.0m^3/h yield the cost is estimated at $150 per linear meter. Comparable costs for a drilled well put down by the down-the-hole (air hammer) would be about $210 per linear meter if contructed in limited numbers or $105 per meter if constructed in large numbers. (B).

The depth of penetration in a water-bearing zone is an important element in the cost of a well. The cost of an open well increases with depth, whereas much of the cost of a drilled well is in fixed charges so that with increased depth costs are not incremental. Also, per m^3/h obtained, a drilled well is cheaper than an open well. The advantage of a modern dug well is in the use of local labor and materials. Nevertheless, if a drilled well requires 80 percent of imported equipment, parts and supplies for its construction, a modern dug well equally requires 50 percent of imported materials.

Opportunities and Constraints in Rural Water Supply Development: The chief advantages of a drilled well over modern dug wells are (1) rapidity of construction, (2) ease of emplacement, (3) greater ease of sanitary protection, (4) lower cost per m^3/h that can be obtained, and (5) greater permanence and dependability of the water supply. The only true problem is

the need for a hand or power pump for extraction of water from a drilled well. Pumps and/or motors must be maintained. In the absence of pump maintenance a drilled well is not viable for village water supply or for that matter any water supply. (B).

In view of the well-known constraints of open wells vs. drilled wells and the pump maintenance problem, there may be other possibilities for gravity water development for village supply in parts of Upper Volta. One possibility is the spring captation, which could doubtless be more widely utilized in the relatively well-watered hilly areas of southwestern Upper Volta. By constructing sanitarily protected captations or collecting boxes over spring heads water can be delivered by gravity pipeline to village fountains on lower ground. Many such captations would seem to be potentially feasible in the hilly plateau country of the Bobo-Diolasso and Orodara region and also in the Kampti-Gaoua area. Before such a captation program could be undertaken, however, a detailed inventory of potentially developable springs would have to be undertaken and estimates made of the costs of development.

Another alternative to full dependence for village water supply on open wells is rainwater collection in covered cisterns, which are now virtually absent in Upper Volta. Collection of water from rooftops, particularly where these

are of corrugated iron, is one possibility. If the cisterns are constructed on or above ground level the water could be drawn off by taps without the need to resort to buckets or hand pumps. Such cisterns could be built of mortar and blocks of laterite, which is widely available in Upper Volta, and lined with neat cement for impermeabilizing.

Still another alternative is to select rocky knobs or hills, of which there are many in Upper Volta, and to develop these as rainwater harvesting areas. Ideally these should be protected from trespass by men and animals to reduce the pollution hazard. Rainfall runoff from the rocky slopes would be diverted by low pitch rock dikes on the contours into collecting channels and thence led down the slopes into one or more covered cisterns from which water could be drawn by taps. Before embarking on any large-scale rainwater harvesting projects it would be desirable to undertake feasibility studies including identification of potential sites or areas, the potential water yields of such areas, and the approximate costs. To improve sanitary quality, the collected rainwater could be passed through simple sand filters before delivery into the cisterns. (H).

Where ground water is too deep for economic extraction, other types of rainwater harvesting could be considered. Relatively flat or gently sloping areas, for example, could be surfaced with pitched slabs of rock from which runoff would be led into sand-filled filtration pits. Interconnected

porous earthen jars would first have been buried in the pits. The stored water could then be drawn as needed by simple suction pumps placed in a protected vertical aperture in one of the jars. (H).

Other more elaborate alternatives exist but most would require investment of considerable sums of money for recovery of relatively modest quantities of potable water. There is little question but that a protected drilled well with an operable pump is still probably the best source of sanitary rural water supply and probably also the most cost-effective of Upper Volta. Until the pump maintenance problem is resolved, however, other viable alternatives for rural water supply must be identified and developed where economically feasible.

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Draft: Lester Maupin
December 1, 1977

GHANA WELL DRILLING AND TRAINING PROGRAM

We learned in Ouagadougou of a Canadian engineering firm (W.L. Wardrop and Associates, Ltd.), carrying out a contract for well drilling in the Upper Region of Ghana and drove down to talk to them. In talking with Mr. Kenneth Paterson, drilling superintendent advisor, it was found that the problems encountered in drilling water wells in Ghana are about the same as in Upper Volta and much of Chad.

To begin with, the contractor brought in to Ghana three complete drilling rigs with all tools and equipment needed to set up maintenance shops, warehousing and a good supply of spare parts for the drilling rigs. The rigs are 1-Gardner Denver 1500 and 2-Sanderson Cyclone T.H. 60's, which are good up to 1,500 feet. The rigs are thus much too large for the drilling they are doing. The deepest well drilled to date is 200 feet, but most of the wells drilled are 90 ft. to 100 ft. deep.

When drilling first started the project personnel included 3 Canadian drillers, a supervisor, a drilling superintendent, a maintenance foreman, two geologists and a project manager, all of whom were advisors. The on-the-job training has been quite effective and Canadian drillers are no longer assigned to the project. The Ghanaians are doing all drilling under the general supervision of a Canadian and his counterpart who answer to the Canadian drilling superintendent

and his counterpart. The maintenance crews, for repairing hand pumps, have been trained to the point where they no longer need supervision. The geologists are still working with their counterparts, and so is the shop foreman training his counterpart.

When the contractor first started drilling operations they made both formation and electric logs of each well. Formation logs of each well drilled are still recorded but the electric logger is seldom run as it has been found that all electric logs are just about the same.

The contractor started with a project for drilling 2500 wells and installing hand pumps in each well. To date 1500 wells have been completed. From September 1974 to July 1976 1100 wells were drilled. So much trouble was encountered with the hand pump first used that a test program was undertaken to see which types of pumps are most durable. As of today no firm conclusion has been reached as to which type of pump is most durable. The trouble is not so much with the components of the pump which are in the well but in the components above land surface. They have and still are testing some 15 different makes of hand pumps, pumps made in all parts of the world, and still have not found the right pump. Some of the pumps undergoing test are Abi, Bodin, Dempster and Vergnet.

Their well design is of low cost as they use PVC casing and screens in all wells. PVC is manufactured locally in 2", 3", 4", 6" and 8" sizes. The 8-inch PVC comes threaded from the factory but all other sizes have couplings which Wardrop and Associates make in their shop. They purchased from Rice Engineering and Manufacturing Co., Edmonton, Alberta, Canada, the necessary equipment to heat, form and cool the couplings out of 2", 3", 4" and 6" PVC. There is very little loss from breakage in any of these sizes as they can use that which is not broken in a 20 ft. length for couplings. PVC has to be stored carefully as it will warp if it is not stored very straight.

Wardrop and Associates also make their screen from PVC. They bought a slotting machine from Rice Engineering and Manufacturing Company that can slot 2", 3", 4", and 6" sizes in their own shop. Eight inches is slotted at the factory that manufactures the PVC. They have found that the best size slot for their use is .028 thousands of an inch.

The 1500 wells that have been completed average from 90 to 100 ft. in depth. Some have had to have surface casing and some not. Where casing had to be used throughout the full depth of the well, 3" to 4" PVC were the standard average size. The screens were gravel packed, with local screened gravel, to well above the top of the screen. The cuttings from

the bore hole were dumped back in the annulus to within 10 ft. of the surface then neat cement to surface giving a good seal from surface pollution. A hand pump was then installed and the well turned over to the village.

The contractor has also drilled 16 or 17 large diameter wells in which 6" or 8" casing was used; this is over and above the 1500 small diameter wells. The design is the same as that used for small diameter wells but they have installed 6" or 8" casing and screens. These wells are also deeper, 150 to 200 ft., the deepest well drilled to date is 200 ft. which also has the largest yield (150 GPM by pump test with 12 ft. drawdown). This well is located in a large village on the Ghana-Upper Volta border. The large diameter (6-8 inches) wells all have deep well turbine pumps installed in them.

The wells thus far completed could have been drilled with much smaller drilling rigs equipped with air compressors the same as those presently in use (Leroi 256 S.D.S. - 250 PSI 600 CFM). The mud pumps (Gardner Denver 5x6 hydraulic powered) would have been better if they had used a steam pump, and had used air for power instead of hydraulic power. The present cost per foot is approximately $25 where in the beginning it was twice as much ($50 per ft.). This cost will most likely drop to below $20 per ft. in the remaining 1000 wells to be drilled.

4.0 SOCIAL BACKGROUND INFORMATION

4.1 Demography

The great peneplain of Upper Volta in January 1973 had 5,516,000 inhabitants, or a ratio of 20 inhabitants per kilometer square. At least one tenth of its nationals live abroad, however, in either Ghana or the Ivory Coast for the most part, because Volta's economic state cannot support the population it has produced. It is producing more population at an extravagantly high rate: the U.N. 1965 to 1970 estimate offers 49.4/1000 annual birth rate, with a death rate of 29.1/1000. Later figures show a growth rate of 21.3% during the years 1970-1975. Ninety-seven percent of Volta's people live in rural areas, the majority in villages of 250 to 500 population. The heaviest concentrations are on the Mossi plateau.

4.1 Ethnic Composition

The Mossi account for 48% of Voltan population: this can be ascribed to the peculiarly successful structure of the ancient Mossi State, whose politico-military power protected Mossi peasants during several centuries which were -- because of the slave wars -- devastating for neighboring peoples.

Other major ethnic groups in Volta are Fulani (Peul) located mainly in the Sahel zone in the north and east, Lobi/Dagari toward the east-south-east, Mande groups to the north-west, Bobo people in the west central region, Senoufou to the far south-west, Gourounsi in south-central

Volta, with the Busansi to their east, and Gourmantche, who occupy Fada n'Gourma and all country eastward.

4.3 Economic-Base

Subsistance Agriculture is the predominant mode of production, but the herds play an important role as well. Voltaic farmers work terribly hard for their meager harvests, and in the best seasons are stalked by the prospect of insufficient food to carry through. Rains are capricious, and sometimes fail completely.

4.4 Nomadic Herders

In the north, the Sahel zone is largely occupied by Peul herders, who take their herds north with the rains, and from end March to end September, in the dry season, move south toward more reliable water sources. Cattle-driving corridors are used to move the herds from Mali, Niger, and the northern Sahel of Volta south to the beef markets of Ghana; and the Volta government has plans for a chain of livestock wells at approximately two-days stock-drive intervals. These wells (some already in existence) define the corridor, and are of fundamental importance to herdsmen as they insure mobility, without which the herds will perish during dry periods like the recent drought, where the mortal problem was not lack of water, but of forage. This is, however, only one side of the problem. Knowledgable people feel the land is carrying too many cattle for its fragile ecological balance. And in the ideas of people for whom the herds are the basis of a way of life, more water means the possibility of building larger herds. This also augments

the competition for already limited supplies of water, and further emphasizes the difference in interests between farmers and herdsmen. To cattle people, who know each cow by the shape of its horns, and the delicate shadings of its hide; for whom marriage, friendship, and social status all are based on the ownership and exchange of cattle; it is difficult to make economizing decisions for herd-take-off on the basis of optimum levels of "TBU"* in something impersonal and unrelated termed "the Biomass". Only long-term range-management training, coupled with veterinary services, and taking full account of local wisdom, knowledge and attitudes is liable to arrange these problems.

4.5 Water Goals

Volta has 9000 villages and hopes to provide at least one well per village. 4000 wells have already been dug, and the HAER**, in cooperation with the CIEH*** has established an inventory of all wells in the country. Wells are dug by the HAER; by the Volta Valley Authority (AVV) in connection with resettlement projects for the river valleys; and by twenty foreign-assistance and private voluntary agencies.

4.6 Administration and Institutions

Haute Volta has developed a logical and coherent administrative framework to further her development aims. She is moving toward a full water program which will and must take account of human, livestock and agricultural needs.

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* TBU signifies "Tropical Beef Unit".

** Hydraulic Service of the Ministry of Rural Development.

*** Centre International des Etudes Hydrauliques.

Progress is very slow, however, because of lack of financial and trained manpower resources.

The normal modern-state administrative chain descends from prefect, through sub-prefect, through Sectoral Chief, to Village Chief. The latter is assisted by a Council of Elders, but many villages begin to have various activity groups: a youth-group, a women's group, and leaders or representatives of these latter counsel with the Chief on pertinent concerns as well. Apart from the normal administrative chains, Volta has created under her Ministry of Rural Development a parallel administrative system which deals directly with the plans, implementation and problems of development. The country is divided in 14 ORD(s) which report through a permanent secretariat to an Interministerial Council. The ORD system is a cross-cutting control which manages personnel from all ministries which act within its domain. At the national level, management and liason for all ORD's depend from the cabinet of the Rural Development Minister. The ORD provides the necessary decentralized decision-making administrative apparatus, which should effectively pull-together different agency activities to service a unified regional development plan.

ORD's are directed by highly capable expatriate-educated young men. The two Director's (Kastein, and Banfora ORD(s)) who talked with the team were very knowledgable and sympathetic long-range-planners. It may, perhaps be assumed that, in so new a venture as the ORD scheme, each regional organization will be strongly marked by the personality and personal

outlook of its early directors. Volta seeks to dote each ORD with a foreign-donor "angel" for technical and financial assistance.

The HAER is one of the technical services of the Ministry of Rural Development, and services ORD water-development plans. (ORD determines sites for wells through the efforts of extension agents.) Equally within this same Ministry, and reporting to the permanent secretariat are services for Community Development, Home Economics, Rural Economic Institutions, Youth, Women's Organizations, and improvement and teaching of Nutrition and Alimentation. It is planned to make these services available from the national level, but to coordinate planning and implementation at the administrative level of the ORD. (See accompanying "Organigramme").

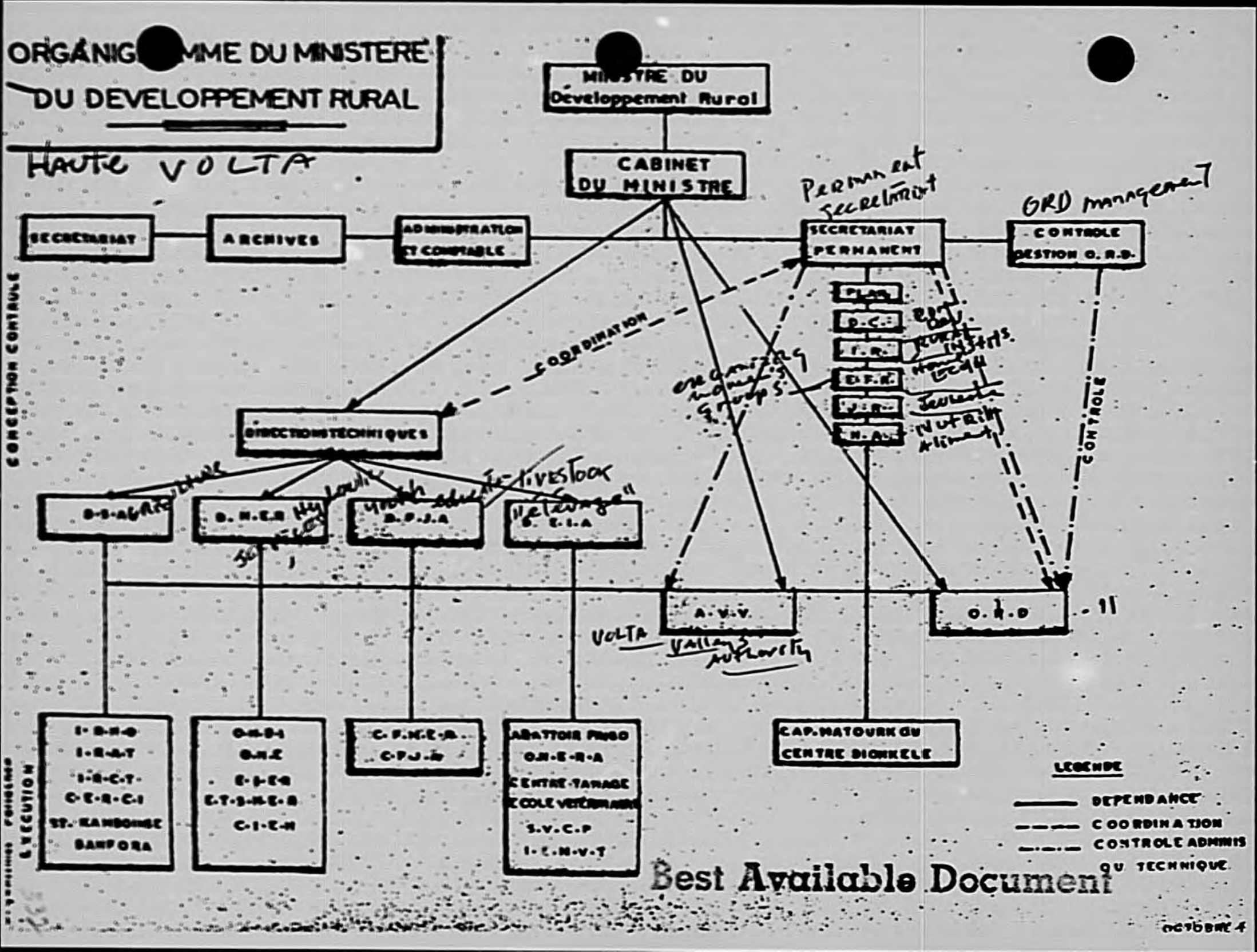
4.7 Traditional Mossi Society

Mossi society was built on a hierarchical political principle, incorporating a class system comprised of nobles, commoners, and slaves. Despite this rigid stratification, competition within and among noble lineages permitted social mobility for talented people, and allowed the system to renew itself with the rise and wane of dynasties, and the greater or lesser importance of central power. Personal charisma has always played an important role in Mossi politics.

The highly structured political network provided many titled positions with defined responsibilities and perquisites. The divine King -- the Mogo-Naba -- was the the central source of authority, but delegation of authority

ORGANIGRAMME DU MINISTERE DU DEVELOPPEMENT RURAL

HAUTE VOLTA



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and decision keynoted the system, and there were several lesser centers of power.

A ritualized concept of the right/power to rule, called the Nam, was universally accepted, and this belonged to the noble lineages. Able commoners could, however, aspire to positions of command within the Ministries of the Mogo-Naba; and these conflicting interests and powers of the nobles and the commoners formed the basis of a dynamic balance of power mediated by the Mogo-Naba.

Relationships were established and tied through a practice of constant gift exchanges -- both up and down the hierarchy, and laterally: cementing peer to peer. Women were the most valued article of gift exchange, and the prudent politician arranged to have the disposition of many fertile maidens as a sine qua non along the path to power.

4.8 Women

Women were valued for their agricultural labor, as well as for their child-producing capacity. For women there were very few differentiated or special roles, save for the position of first wife of a ruler or very important man. For men there were many different roles and occupations. Although women were the major productive force in the country, they held few areas of decision.

In many respects the Volta of today is true to its traditional character. It is still marked by intelligent and competent administrative structures, and a vital and energetic people. Women still provide most of the farm-labor, grow the family food gardens, fetch the water and carry wood.

In spare time they may spin, or make bean-cakes and dolo -- beer to sell in the market. Unlike other West African sisters, they usually do not keep for themselves the money earned, but give their pittance to the headman of the family line. More self-sufficient than the men who are dependent for services, Voltan women are in some ways quite independent, and keep things going despite the high level of out-of-country migration practiced by Voltan men.

UNESCO has established a program for women which attempts to give them wider possibilities for money-earning and basic education. This program includes radio-instruction handled through the Ministry of Information Radio Rurale program.

AID is now establishing "Women in Development" programs in four ORD's, and will undoubtedly be able to profit from the experience and knowledge developed in the UNESCO efforts. A Peace Corps Volunteer very familiar with rural Volta suggests that only women development-agents be scheduled to work with Voltan women, as their world is not easily penetrated by men.

4.9 Prognosis

What is needed to obtain a continuously viable water supply in Volta, is, as in all other areas observed, the necessary range of infrastructure and the necessary financing to make it run. This involves conscious decisions on how to balance efforts for competing water needs. It involves the spread and acceptance of practical and realistic ideas about health and sanitation accompanying the possibility of effective implementary action. It involves motivation

and development of community participation, to augment the ability to foster their own well-being at the local level. It also involves developing the capability to operate and maintain the wells now being provided enthusiastically in Volta, and in the long run, this is the telling item. We feel that Volta is farther along the planning and administrative-organization path than many in the region, but money, manpower, and operating mode constraints must be knowledgably dealt with if the framework is to be developed and used effectively. It is felt that the overall plan recommended in this report, which channels AID assistance -- not just to the actual digging/drilling of wells -- but to an overall view of the systemic problems, putting water provisioning appropriately in context, would help this deprived land achieve adequate life-support water supplies.

Attachment III

RURAL WATER SUPPLY AND SANITATION

PRE-PROJECT ANALYSIS

COUNTRY REPORT - TOGO

(Study carried out Nov. 28 - Dec. 6, 1977

Sponsored by AID/Washington)

Team Members:

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surface water geohydrologist, and a rural social/cultural anthropologist and a sanitary/environmental, public health engineer.

Discussions with pertinent representatives of USAID, American Embassy, PC, German Embassy, GOT[1], including Ministries of Mines, Planning, Rural Development, Rural Works, Public Health and Social Affairs and PVO's were supplemented by visits to AHYIGBEHAME, WUKRO, AGOHOE, ATAKPAME, TSEVIE, TABLIGBO AND ANECHO in TOGO. An over-flight planned with stops at DAPANGO and LAMA-KARA was canceled at the last minute because of weather conditions.

2.0 Present Programs in Rural Water Supply and Sanitation

2.1 Responsible Agencies

As in the other countries visited, a number of governmental agencies are involved in the rural water supply and sanitation programs in Togo. The Ministry of Mines, Energy and Hydraulic Resources through its Planning Department, coordinates all activities in rural water supply, developing the concepts, programming and locating funding for the program. The Department of Rural Development is responsible for developing and promoting rural water supply projects while the Ministry of Land Development implements the rural water supply plans. Once the well has been dug it is turned over to the Department of Rural Development for maintenance.

[1]Govt. of Togo

One comment heard in Togo was that when the recent reshuffling of responsibilities for the rural water supply activities took place, the head of the program was placed in one agency, the body in a second one, the arms in a third one and the legs in still a fourth agency. The resulting confusion can be imagined.

For rural water supplies under the Department of Hydraulics and Electricity the country is divided into two sub-sections, the South Sub-Section with headquarters in Lome and the North Sub-Section with headquarters at Sokode. Organization charts have been promised by the Director General of Mines, Geology and the National Mining Research Bureau.

Togo is divided into five regions as indicated on Map A with a sub-division of each of the national level ministeries located at each of the regional headquarters. There is also a sub-division in each of the five regional offices. Planning and guidelines are developed at the national level, but implementation is the responsibility of the sub-division offices at the regional level. This decentralization has been in effect since 1968.

An interesting well drilling program is being carried out by Projets Techniques Sociaux - Eglise Evangelique du Togo in the area of HIHETRO with headquarters at ATAKAME.

At least 100 walls have been drilled by hand under this project during the past 10 years.

The wells are installed with full village participation. The village contracts to pay the PTS $100 for a drilled well with a hand pump installed. The village furnished 8 men to operate the hand-powered well-drill and furnishes food and lodging for the technical supervisor furnished by PTS. The drilling is in hard rock and it takes two to three months to drill a well. The wells and hand pumps are maintained by PTS which visits each well at least once a month. The villagers pay for the service plus the cost of spare parts. Here is one proof that villagers can and will pay for a potable water supply. PTS has a long list of applications for wells on the above basis.

The rural environmental sanitation program comes under the National Sanitation Service under the Director General of Public Health of the Ministry of Public Health and Social Affairs. The National Public Health Service also has sub-sections; three of which are now in operation, namely in Lama Kara, Sokode and Dapango, each directed by a sanitary engineer. There is also a sanitary engineer in charge at the national level with an assistant, and arrangements are underway to assign a sanitary engineer in charge of training for environmental sanitation workers.

In addition to other duties the National Sanitation Service makes and installs concrete privy slabs at the rate of about $100/year.

Togo is working vigorously to control onchocerciasis and return areas from which oncho has been eliminated to useful production. A part of the GOT strategy for this cleared area, which has been set aside for resettlement of farmers, calls for the development of growth poles in northern Togo in an attempt to decrease the emigration to the urban centers and to harness the development potential of the north.

2.2 International Cooperation

In the past, participation by AID and IBRD in the construction of open wells has been less than successful as the wells were not dug deep enough into the water bearing acquifers and hence dried up during the dry season.

The PC at one time cooperated in the construction of open wells, but recently has discontinued this type of cooperation because of the confusion of responsibility for the rural water supply program.

The PC is continuing the construction of rural schools and with each school installs a multiple opening latrine. An ingenuous solution has been developed by a

PCV to position 4 latrine openings in a concrete slab installed over a circular pit. The latrine openings are separated by partitions radiating from the center of the slab so that each opening is in a quarter segment of the slab. The pit is lined with a thin layer of cement mortar plastered on a matrix of reinforcing bar rings slightly smaller in diameter than the pit.

The UNDP has postponed several times a project to catalogue the water resources in Togo.

The German bilateral assistance agency has helped to finance an urban water supply system in Sokode from which water is supplied to 8 nearby villages by public fountains. This system has a treatment plant for which maintenance is a continuing problem because of poor administration and lack of funds for maintenance. A contract has recently been let for water supply systems to be fuilt in Tabligbo, Mango and Bassan at an estimated cost of 14,200,000 German Marks (U.S. $4.5 million). The contract has been awarded to a French contractor (SOCEA) under German supervision. The German bilateral program is not financing any rural water supply or sanitation activities, although it is financing some agricultural activities as part of a rural development project.

3.0 Populations with Water Supply and Excreta Disposal Services.

3.1 Population

As of the end of 1975 it was estimated that Togo had an urban population of 350,176 people living in 9 communities and 1,874,628 (84%) people living in rural areas, for a total of 2,224,804.

3.2 Water Supply

According to the Third Plan for Economic and Social Development, the construction of wells realized during the second plan amounted to less than one quarter of the 470 planned for that five year period.

The Third Plan contemplates the construction of 500 open wells at the rate of 100 wells per year at an estimated cost of CFA 1,000 million (U.S. $4.15 million) as distributed below:

Estimated Cost (Millions CFA - 241 = $1.00)

Region	Total	1976	1977	1978	1979	1980
200 wells in the Savanna and La Kara	400	200				200
200 wells in the Central Plateau	400		200		200	
100 wells in Maritime	200			200		
Total	1000	200	200	200	200	200

The National Sanitary Service has proposed the following program for the year 1976-1980.

Water Supplies

Year	No.	Cost Millions CFA	No.	Latrines* Millions CFA	Total
1976	40	6.0	400	20.0	26.0
1977	50	7.5	410	20.5	28.0
1978	60	9.0	420	21.0	30.0
1979	70	10.5	430	21.5	32.0
1980	80	12.0	440	22.0	34.0
TOTAL	300	45.0	2100	105.0	150.0

*6 Hole type for schools, markets, public places.

3.2.1 Training for Well Drilling and Maintenance

The Minister of Mines stated very clearly that the GOT was interested first in providing water for its people by open wells, if necessary, leaving concerns about water quality for the future. Yet, having made the statement he immediately launched into an enthusiastic plea for a program to train well drillers, mechanics and maintenance men. He wants to train Togolese so that a well-drilling program can be launched as part of the training program so that producing wells, with hand pumps, are installed as part of the on-the-job training activities. At the same

time the maintenance expertise will be developed and the necessary organization established to carry out an effective maintenance program, making it possible to carry out a program based on drilled wells with hand pumps.

Once the program for training Togolese well drillers and maintenance men and establishing the program has been solidified, the training program could be expanded to a regional center.

3.2.2 This forward thinking attitude looking toward safe water supply was evident in the remarks of the Sanitary Engineering Director of the National Health Service who emphasized the need for establishing water quality control laboratories. He would like to start with a small laboratory for control of water quality and food in Sokode. Later on laboratories whould be established in the other regional headquarters. Assistance is needed in setting up and equipping technical people to operate them.

COUNTRY REPORT - TOGO

1.0 INTRODUCTION

In the Third Plan for Economic and Social Development (1976-1980) the Togo Planning Ministry states - "The lack of water is so important over the entire territory that it hinders the economic, social and cultural programs of the country. It is not uncommon to see people walking 10 to 15 kilometers or even more to look for water which is often contaminated and which can only aggrevate the state of their health and reduce their capacity to produce, without speaking of the enormous loss of time that results, thus reducing production time." Repeatedly, throughout the Third Plan, reference is made to the need for water for human and animal consumption and assigning it the highest priority during the period of the Third Plan.

The present analysis covers only the community water supply and sanitation situation in rural villages of Togo from 100 to 1500 population, although the Minister of Mines expressed a deep concern for communities ranging from 3000 to 5000 population. The analysis is based on the observations made in Togo during the period from November 28 through December 6, 1977, by a study team composed of a well drilling expert, a ground water/

Draft: George C. Taylor, Jr.
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4.0 Water Resources and Well Construction Consideration in Rural Water Supply Development in the Republic of Togo

4.1 Availability of water supply: As contrasted with the general regional east-west banding of climatic zones that prevails in West Africa, much of Togo as well as neighboring areas in southeastern Ghana and much of Benin lie in a zone of climatic anomaly. Orographic* effects created by the Atacorian Hills apparently generate this anomaly. Consequently, in the Coastal Plain of Togo and extending inland as far north as Akaba the Sudan savanna type of climate prevails with relatively low rainfalls of less than 1,000mm annually. Further north rainfall increases to as much as 1,400 to 1,600mm in the Atacorian Hills of western and north-central Togo and then decreases northward to about 1,100mm in the Dapango region of the extreme north. Also as a result of this anomaly rainfall and stream flow from year to year tend to be highly variable and local water shortages are chronic. Rainfall in the Dapango area and in the middle Oti River basin (Sansanne-Mango region) is genetally concentrated in the months between April and October. November through March is the dry season. In the south of Togo the rainy season is a month or so longer even though the annual rainfall is less than in the north. Also in the south there is usually one dry month, August, in the middle of the rainy season. (h)**

*Rain-Shadow
**See pg. 31 for references

Because of the rainfall distribution most of the larger streams in Togo that head south of the Atacorian Hills are flashy with high discharges in the rainy season and very low base flows in the dry season. The most important of these streams are the Sio, Lili and Haho Rivers. The flow of the Sio inland from Lome is at times less than 0.3 m^3/sec during the dry season. The Mono River, whose tributaries head in the high rainfall belt of the Atacorian Hills, has important base flows even during the dry season. The Oti River, whose middle and upper tributaries rise in the Atacorian Hills of norther Togo and Benin, also has important dry season flows.(B)

Because of the seasonal variability of the water supply the Government of Togo has been making strong efforts during the past 15 years with the help of foreign donors to ameliorate water shortages in rural areas through construction of modern open wells and also some drilled wells (tubewells) and for the larger urban centers through building of dams and reservoirs, treatment plants and water distribution systems. Nevertheless, and inspite of these efforts more than 50 percent of the rural population continues to depend on polluted water supply obtained from unprotected springs, unlined traditional open wells, artificial tanks and contaminated natural water holes. With some

exceptions, however, due to unfavorable geologic conditions or deep water levels, ground water can be obtained from wells in quantity adequate for village supply in 80 to 85 percent of the national territory of Togo. Where ground water is not available or too costly to develop, surface water sources are only seasonally available.* If sanitary quality of rural water supply is to be taken as a valid goal, however, adequate measures must be taken to protect wells or surface-water sources against pollution and to assure continuing maintenance. In the absence of maintenance programs to assure continuing sanitary quality, investments in water-delivery systems are of dubious merit.

4.2 Hydrogeologic setting: Togo contains within its national territory three general groups of rocks, each of which presents particular problems with respect to ground water development and management. The oldest of these groups are the Precambrian crystalline rocks which directly underlie more than two thirds of the central region of the country. Somewhat younger are the consolidated Paleozoic sedimentary rocks of the Oti sedimentary basin in northern Togo. Youngest is the Coastal Plain which is underlain by unconsolidated and semi-consolidated sediments ranging from Cretaceous to late Tertiary age.(h)

The Precambrian group includes Dahomeyan migratized gneiss and mica schists; ancient gneissic granite shield

*Rain water - harvesting may be essential.

rocks of the Dapango and Palime areas, and younger quartzites, phyllites and slates of the Buem, Atacorian and Kande systems which form the mountainous ridges and valleys trending north-east through the western and north-central part of Togo. Ground water occurs in the Precambrian rocks in the weathered mantle, where it is thick and permeable, and in deeper fracture systems. The weathered mantle on the granites, granite gneisses and mica schists may attain thickness of up to 40m; on the Dahomeyan migmatites it averages about 10m thick; and on the Buem, Atacorian and Kande rocks it is commonly less than 2m thick. Many open dug wells of both traditional and modern design have been put down throughout Togo to serve rural water supply needs. The wells which tap water in the weathered mantle of the Precambrian terrain range from about 5 to 25m deep and average about 15m. The yields obtained from such wells are commonly no more than $5m^3/d$ in the dry season, and many fail completely. The water table commonly fluctuates widely in the Precambrian terrain rising in places to less than 5m below the land surface during the rainy season and then declining as much as 5 to 10m during the dry season. Because of these large fluctuations many open dug wells must be deepened to two or three times before a stable supply through the dry season can be assured. (B)

Because of the uncertainty of water supplies from open dug wells and beginning with the UNDP ground-water survey of Togo in the mid-1960's, increasing efforts have been made to tap deeper fracture systems in the Precambrian rocks with drilled wells (tube wells). Whereas a certain percent (perhaps 10 to 15 percent) of such drilled wells can be considered failures, most succeed in tapping larger and more permanent water supplies than those obtainable from open wells, At Dapango, for example, four drilled wells put down to depths ranging from 19 to 58m in gneissic granite obtained yields ranaging from 3.5 to 15m^3/h. There was also enough yield among the 4 wells to supply about 500m^3/d at Dapango. At Bassari, however, the Buem quartzites contain very little ground water at a depth of 22m. Three wells drilled 17 to 45m deep at Kande in schists and phyllites produced yields ranging from 7 to 12 m^3/h, but the average yield to be expected from a drilled well of this depth in this area is about 1.5m^3/h. In the Atacorian schists at Sokode 9 wells 15 to 45m deep were drilled. Four or 45 percent were total failures and yields in the remaining 5 wells ranged for 0.3 to 5.0m^3/h. Most ground water in the schists occurs in the facture systems and not in the overlying weathered mantle. Dahomeyan migmatized gneisses at Loma Kara produced yields ranging

from 1.8 m^3/h to 7.2 m3/h in three drilled wells, 20, 46 and 70m deep. At Nantja Dahomeyan migmatites yielded 3.0 and 4.0 m^3/h to two drilled wells 52 and 70m deep. (B)

The consolidated Paleozoic sedimentary rocks of the Oti basin include interbedded shales and sandstones in which ground water occurs chiefly in fracture systems. Shallow ground water in these rocks in tapped by dug wells at depths comparable to those found in the Precambrian rocks. The yields obtained from such dug wells are about 2 to 3 m^3/d. The depth to water ranges from about 10 to 15m in the dry season to as little as 2m in the wet season. At Boumbouaka two wells drilled to depths of 50 and 37m in fractured argillaceous sandstone produced yields of 7 and 0.3m^3/h, respectively. It is estimated that 50 to 100m^3/d could be obtained from individual drilled wells in this area. (B)

The Coastal Plain of Togo is directly underlain by semiconsolidated sands and clays of late Tertiary age. These range from a thickness of about 10m near the inland edge of the plain to a maximum of about 100m near the coast. Most open dug wells in the Coastal Plain tap water in sands of the late Tertiary deposits at depths ranging from less than 15m below land surface near the coast to as much as 65m in the Tabligbo area. Owning to dissection of the Coastal Plain surface by streams flowing south to the sea, the plain is broken up into 6 discrete

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(B), (C), etc. signifies footnote reference at end of section.

"plateaux" beneath each of which the shallow ground water is controlled by local base levels of adjacent streams. Consequently, the water table is remarkably deep below land surface - for example, some 20 to 50m in the Tabligo and Tsevie areas and 10 to 30m in the Vogan area. Because of deep water levels and the labor involved in lifting water for domestic supply, open dug wells are used by villages as a source of second choice. Cisterns and nearby streams or marigots are preferred water sources during the rainy season, and dug wells are used chiefly in the dry season. (C)

In several places in the Coastal Plain tubewells have been put down to tap water in the late Tertiary sands as well as water-bearing sands in deeper Paleocene and Cretaceous sediments. Thsese wells range from 45 to 150m deep and yields from individual tube wells equipped with turbine pumps range from 50 to as much as 150m^3/h. Static water levels appear to be comparable to those found in the open wells. (C).

4.3 Present status of water development: A considerable number of water-resources studies and development projects have been undertaken and completed in Togo with international and bilateral donor assistance during the past 15 years. The studies have produced a large volume of useful information essential for orderly development and management of

the country's water resources. Also a considerable number of surface-water and ground-water development projects have been undertaken and completed for town and small city (15,000-30,000 persons) water supplies. Foreign donor assistance for construction of both dug and drilled wells for village water supply has also been provided in several parts of Togo. Some of the more important of these are as follows:

Studies:

(1) ORSTOM (French Office de la Recherche Scientifique et Technique Outre Mer) in cooperation with the Togo Service du Genie Rural and Ministere des Travaux Publics (continuing streams-gaging and hydrologic studies of important river basins).

(2) ASECNA in cooperation with the Togo Direction Generale de Meteorologie (containing meteorologic observations and data collectin).

(3) United Nations Development Program (UNDP) in cooperation with the Direction des Mines et Geologie. TOG 4 (Survey of Ground Water Resources, Togo) 1967; TOG/70/511 (Ground Water Exploration in the Coastal Zone, Togo) 1975; TOG/75/008, in progress (Strategy for Water Development, Togo). (B), (C)

(4) CIDA (Canadian International Development Agency) in cooperation with Direction de Mines et Geologie (Feasibility study of a project for provision of water to the city of Lome and nine other villages in the Eastern Plain), 1974-76. (D)

(5) Italconsult - UNDP. (Study for the provision of water for Lome, Tsevie, Anecho, Tabligbo and Phepe), 1969.(A)

(6) Federal Republic of Germany in cooperation with Dir. Mines et Geologie, (Ground water exploration project in Tablibo region). (G)

(7) Direction des Mines et Geologie (continuing exploratory drilling ground water and hydrogeologic studies; country-wide survey of existing water points).

(8) Service de Genie Rural (Country-wide survey of existing dams and tanks).

4.5 Development projects:

(1) Fond Europeen de Development (FED) in cooperation with service de l'Hydraulique (SH). FED has financed construction of some 800 dug and drilled wells for village water supply in the course of three loan agreements. Some 250 open wells were constructed during the life of the third agreement between 1974-77. Under a fourth agreement 200 wells are to be drilled by contractor using the down-the-hole air hammer methods. (H)

(2) UNDP is currently reported to be financing a 400-600 well project for village water supply. A local private well contractor, Guigliano, has contracted for part of the project. (H)

(3) Three cities Lama Kara, Niomtougou and Pagouda will share, in the near future, a piped water system provided by a dam and reservoir on the Kara River. The work is now being carried out by a French construction company, SOCEA. The city of Atakpame will also have a municipal water supply provided by a surface-water reservoir. (F)

(4) German National Development Bank (KVV) also loan funded construction of a municipal water supply for the city of Kode. Completed in 1971, capital works include a barrage and reservoir, a water treatment plant, a 32km adduction pipe line, a settling basin, and a water tower and distribution system in town. The system serves 49 public taps and 150 private connections in the city (pop. 30,000) and 8 villages along the adduction line (pop. 5,000 total). The system is currently being managed by the Regie National des Eaux de Togo. (G)

(5) The KVV is currently loan financing other water supply development projects for Tabligbo (tube wells 80-100m deep), Mango and Bassari (dams and reservoirs).

The work is to be carried out by a French construction company, SOCEA. (G)

The principal action agencies in the Government of Togo concerned with water resources are the Service de Genie Rural, the Regie National des Eaux du Togo (RNET), the Service Hydraulique (SH), the Direction des Mines et Geologies (DMG) and the Ministeres des Finances, de l'Economie et du Plan. Coordination among these agencies in water resources development planning is virtually non-existent, and as a consequence there is considerable confusion and overlap with respect to areas of operational authority among the agencies involved. There is little question that some sort of a National Water Board at policy-making level is needed to coordinate all the disparate water resources development activities presently in progress in the country.

Service de l'Hydraulique (SH) is the principal government agency involved in the construction and maintenance of wells for rural water supply. There are however, some 10 other organizations private and public also involved in construction of village wells in Togo. The SH operates in two divisions, the southern one headquartered at Lome and the northern one at Sokode. The SH now puts down about 15 to 20 modern open dug wells per year departmentally and contracts out other well construction

activities to private companies. The SH has completed departmentally about 150 wells ouring the past 10 years. The SH well construction program is highly mechanized with extensive use of derricks, air compressors, jack hammers, explosives and sinking pumps. The SH employs the standard design for the modern open dug well used throughout Francophone West Africa. In the Precambrian and Paleozoic terrains SH reports that its dug wells generally range from about 15 to 25m deep with average yields about $0.15m^3/h$ but some yield as much as $3.0m^3/h$. In the Coastal Plain dug wells must in some areas be put down to depths of 50 to 60m to obtain water sufficient for a village water supply. For this reason the SH believes that an intermediate diameter (8-10 inches) drilled well with power pump to lift water to a central water tower for distribution to a cluster of villages through pipe lines may be the most appropriate solution to the rural water supply problem in the Coastal Plain. The rural population density in the Coastal Plain is much higher than in the Precambrian and Paleozoic terrains of the interior. (E)

The Direction de Mines et Geologie (DMG) is the chief agency concerned with hydrogeological investigations and research and exploratory drilling for ground water. The DMG served as the chief counterpart agency for UNDP and

Federal Republic of Germany financed ground-water investigations and most recently CIDA. The DMG has in its custody most of the departmentally controlled water well-drilling equipment in Togo. The equipment, all inherited from past technical assistance projects, includes the following:

1 - WABCO 1250 rotary drilling rig mounted on a Ford Truck.

1 - Failing Walker-Neer (FWN-40) combination rig. Capable of drilling to 1,000m. Truck mounted. Now broken. Inherited from CIDA.

1 - Bucyrus Erie percussion dribling rig.

1 - Speed Star 71 percussion drilling rig, mounted on a Dodge truck.

(The DMG reports there is only one down-the-hole air hammer rig in the country. It is in the hands of a private company.) The DGM uses its equipment for exploratory drilling and also for production drilling on contract to other government agencies. (D)

The DMG is currently managing the operation and maintenance of eight (8) tubewells in the Coastal Plain put down as part of the recently completed CIDA project. Each of the wells serves populations of 3,000 to 5,000 persons with from one to three covered ground level reservoirs from which water is drawn by users from 10 to 40 faucets. Each

well is in care of a pompiste who is responsible for operating the pump, the routine lubrication of the pump and engine, and the procurement of fuel. The wells were drilled in diameters of 8 to 10 inches, are fitted with Hohnson-type stainless steel wire-wrap screens in water-bearing sands, and are reported to be in the range of 60 to 90m deep. The tube wells are equipped with Berkley vertical shaft turbine pumps coupled by horizontal drive shaft and universal joint to Lister diesel engines. The yields of the tube wells are nominally about $50m^3/h$. The DMG wishes to turn over the tube wells to SH as soon as that agency is in a position to assume responsibility for their operation and maintenance. The tube wells have been in the care of DMG for the past two years. (D)

In past years the Peace Corps (PC) has been active in Togo in construction of both large-diameter modern open dug wells and small diameter drilled wells (tube wells). All PC well construction programs in Togo are currently inactive owing to excessive confusion and overlap among government agencies concerned with rural water supply development activities. The PC directed a hand-operated percussion well-drilling program in the Atakpame-Akposso region from 1972 until recently under the sponsorship of the Eglise Evangelique, the United Church Board for World

Ministries, the OXFAM, the AFVP and others. Each recipient village was required to contribute cash and labor amounting to about one-third the total cost of the tube well and pump. The wells were started with a hole 5-inches in diameter in which 4-inch casing was placed if caving ground was encountered during drilling. This casing was removed and reused when a permanent 2-inch galvanized drop pipe casing with a stainless steel drive point was placed in the well for the final hand-pump installation. Yields of 0.5 to 1.0m^3/h were obtained by pump test before a well was considered statisfactory for routine hand-pump operation. Sanitary protection was provided by a square concrete apron poured around each well collar. The tube well put down by this method range from 10 to 25m deep with an average of about 15m. The yields obtained from the tube wells are reported to be generally satisfactory. Also the Eglise Evangelique set up a maintenance service and shop at Atakpame for the hand pumps including servicing trucks, spare parts, and trained hand-pump mechanics. Operating costs have proved to be quite high owing to frequent break-downs and repairs required for Bodin Majestic and ABI pumps used on the tube wells. (F)

Elsewhere in Togo the Peace Corps has been involved since the late 1960's in construction of open hand-dug wells most of which are curbed with concrete rings 1.0 to 1.5m in diameter and as much as 60m deep. The villagers normally

provide labor, sand and gravel and sometimes a cash contribution. The PC provides cement, reinforcing steel, molds for the concrete curbing, and tools. Of the gross cost of an open dug well villagers have generally provided about 50 percent. Although no accurate figures are available it is estimated that the PC has put down more than 1,000 modern open dug wells in Togo since the late 1960s.(F)

The chief private water-well drilling contractor operating in Togo is SASIF, a French-based company which presently enjoys a virtual monopoly in the country. There are however, reported to be one or two smaller competing companies SASIF, which has been active in Togo since the mid-1950's, employs both rotary and percussion rigs in its drilling operations and is also reported to have recently acquired a down-the-hole air hammer rig. (E)

4.6 Costs of well construction: Costs of well contruction in Togo appear to lie in the same general range as those in other West African countries. The Service Hydraulique reports that its large-diameter open dug wells, which range from 2.0 to 2.5m in diameter, are currently costing about $413 per linear meter. Thus a well of this type of 25m deep would cost about $10,325. Much of the cost, however, is reported to be in overhead. Open wells 1.0 to 1.5m in diameter of the type put down by the Peace Corps are reported to cost only about $165 per linear meter or $4,125 for a 25m well. Other wells, 0.1 to 1.0m in diameter and

constructed with mechanical boring equipment under contract in Togo, are reported to have cost as much as $800 per meter or $16,000 for a 20m well.

Small diameter (4 to 5 inches) tube wells constructed under contract in Togo are currently reported to cost about $240 per linear meter, thus a well 50m deep would cost about $12,000. The Peace Corps small-diameter hand-drilled wells in the Atakpame-Akposso region cost at today's prices, about $43 per meter for wells less than 15m deep and $31 per meter for wells 15 to 25m deep. A 25m well would thus cost about $775. (The yield obtainable from the contractor well in the Precambrian or Paleozoic terrain might not be appreciably greater than that from a PC tubewell.)

4.7 Constraints and alternatives in rural water-supply development: The chief constraints to effective rural water supply development and management in Togo are administrative and organizational rather than technical. Thus any program of well construction for village water supply must also have a large and continuing component of training for well and pump maintenance, if a program is to have permanent impact on the infrastructure. From a technical point of view there is little question that a drilled well with a hand or power pump is superior to dug open well as a source of water supply in the rural environment. The drilled well provides a sanitarily protected supply of relatively stable year-around yield. The drilled well is also more cost

effective in terms of initial investment and of volume of water produced per well. The only major problem is that of the pump required for extraction of water from a drilled well and its continuing need for maintenance. Although there is considerable awareness of the advantages of drilled wells for village water supply in the upper echelon of the government, there is little evidence of a will to dedicate the national resources necessary to make a well and pump maintenance program operate effectively at village level. Indeed present national policy emphasizes provision of water to large towns and cities with second priority to water supply in rural areas.

Other than protected [a/] wells which require pumps for extraction of potable water, there may be some alternatives for developing gravity supplies. There are reported to be numerous perennial springs scattered through the Atacorian Hills of north-central Togo. By covering the spring heads with closed collection boxes or captations of concrete or masonary, potable water could be delivered by gravity pipelines to storage tanks and village fountains on lower ground. Before a spring-captation program is undertaken, however, it would first be necessary to carry out a national inventory of springs to ascertain their elevation, flow suitability for captation and length of pipeline necessary

[a/] Either covered dug wells or drilled wells

to deliver water to target villages.
Cisterns are used rather commonly in the Coastal Plain of Togo to collect water from corrugated iron roof tops. Most cisterns are designed, however, so that it is necessary to dip water from them by unsanitary hand lines and buckets. By raising the base of cistern 80cm above ground level the water could be drawn off by hand faucets. Better sanitary protection could also be assured by more effective covering of the cisterns, though many existing ones are partially protected by corrugated metal roofs. Greater quantities of water could be collected from larger surfaces notably the roof tops of government buildings, warehouses and other large buildings. Potential for greater use of cisterns also exists in areas of relatively high rainfall, but where yields from wells are poor or mediocre. If cistern construction projects were to be undertaken on any substantial scale, prior evaluation and study would be desirable to determine the most effective design in terms of volume of water stored and possible alternatives in design and materials.

Another alternative is rainfall harvesting particularly from the uncultivated rocky knobs and hillocks of central and northern Togo. By protecting these areas against human and animal trespass runoff of fair sanitary quality could be

collected behind pitch rock dikes on hill-slope contours and led through settling basins into one or more covered storage tanks around the base of a hill. These tanks could be periodically chlorinated to assure the sanitary quality of the supply and water could be drawn off from hand faucets in the base of the tank. The tanks could be constructed of rock masonry or other locally available material and lined with neat cement for impermeablization.

In flatter terrain, protected areas could be surfaced with rock slabs and mortar with gentle slopes of 1° or so inward to a central circular or rectangular sump. The sump would be filled with clean sand in which a series of interconnected earthen jars had been buried. The rain-water running off the slab and mortar surface would filter through the sand and seep into the earthen jars. Water could be drawn off as needed by a simple hand pitcher pump passed through an aperture in the central collecting jar.

Other alternatives may also exist in the collection and storage of stream flow for gravity distribution. Such supplies would require treatment before distribution, if sanitary quality is to be assured. Also treatment facilities would have to be maintained if they are to operate effectively. Such facilities are unlikely to be cost

effective for dispersed village water supplies. They might, however, be considered for larger agglomerations of villages in more densely settled areas of the country.

4.8 References:

(A) Italconsult - UNDP, 1969, Situation actuelle de la position de l'approvisionment en eau de Lome, Tsevie, Anecho, Tabligbo, et Ahepe et previsions futures.

(B) UNDP - Italconsult, 1967, Survey of ground water resources, Togo with tables, maps, diagrams.

(C) UNDP, 1975, Prospection des eaux souterraines dan la zone cotiere, Togo, United Nations, N.Y.

(D) Verbal communications, Directio des Mines et Geologie.

(E) Verbal communications, Service de l'Hydraulique.

(F) Verbal communications, Peace Corps.

(G) Verbal communications, Embassy, Federal Republic of Germany.

(H) Verbal communications, World Bank (Abidjan)

Draft: Lester Maupin
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5.0 Trip from Lome to Hihetro, Togo

On a field trip from Lome up to Hihetro we inspected several open hand-dug wells under Director Osseni's Electric and Rural Water Program. One at the village of Anyegbameme has a 61 meter deep, 1.80m in diameter, cement lined hand dug well with a static water level of 41 meters. It took eight months to dig and cost more than 2,500,000 CFA or US $10,416.66 or $170.77 per meter. This well we were told was funded by Europe Development Bank. The water from this well looked contaminated already even though it had only been in service 8 or 9 months.

The next village, Wukpo, we stopped at, had two wells: one was a 17-meter bored well with a Vergnet pump installed. When the pump was operated, water shot out from around the piston rod showing that the piston was badly worn. Even though it was leaking at the piston rod, it was still pumping water at the head but not quite as much as it should have been. This well we were told could only be used at the orders of the village headman. The well and pump had been turned over to the village in 1974.

The other well was hand dug to 12m deep, 1.40m diameter, and had a static water level at 9 to 10m. It had been given to the village in 1972. This well goes dry at the beginning of each dry season. This was most likely the reason that the well with the Vergnet pump on it was not to be used. The village headman

only let it be used when there was no water in the hand dug well.

The next village we stopped at was Agohoe and they were just completing an open dug well but had not turned it over to the village yet. This well is 21m deep, 1.80m in diameter, cement lined, and ended up in 7m of weathered rock. The static water level in this well was at 13m. The well was dug by hand down to the rock formation and then with jack hammer and air compressor on to the bottom. An air-driven pump was used to keep the well dewatered while deepening was going on. The well took 3 months to dig and cost more than 1,500,000.00 CFA or US $6,250.00 - $297.62 per meter. We were told that this was funded by EDB.

We next drove to Hihetro where we talked to Mr. Winters, a missionary who has been in Togo for 10 years, and is operating a drilling program of his own. His program covers a radius of 100km in all directions from Hihetro. He has five crews that drill percussion holes by hand down to 15 to 25m. The rig used is a three leg tripod 8m high with a sheave at the top. All tools used to drill the well are designed and made by Mr. Winters or his maintenance men. His way of operating is as follows: A village asks for a well, and agrees to pay $60.00 before the crew and rig willcome to their village. They also agree to feed the crew until the well is finished, and give the crew 8 men every work day from their village to

help with the work. When the well is drilled the village must pay another $60.00 before the pump is installed. After pump is installed, the villagers are told how to take care of it and one man is picked to grease and oil the moving parts of the pump. Every 4 to 6 weeks the maintenance man from Mr. Winters' mission checks the pump, and if it is broken he repairs it. The villagers are charged for all spare parts, along with the cost of delivery of those spare parts.

As this is hilly country, hard rock is encountered which is difficult to penetrate by hand drilling. In some cases it is necessary to drill several holes before a productive well is obtained. There is no charge to the village unless a productive water well is obtained. Mr. Winters estimates his wells with a pump installed cost approximately U.S. $600.00 or approximately $10.00 per ft.

He also has a Longyear #22 soil sampling rig which he has just purchased which has a diamond core barrel. With this, he hopes to drill through some of the hard rock formation and reduce the number of dry holes. This rig he operates himself.

His problem at present is that he wishes to go home but has no one to turn his program over to. He has never worked with any of the Togo government agencies, consequently has no one to turn the program over to.

Mr. Winters has never tried to develop and train a counterpart in the mission which he should have done when he first started his drilling program. Of the hundred or so wells

he has drilled not one will be operational in 2 years unless someone takes his place to supervise and manage the whole hand-pumped tubewell network and buy spare parts as needed.

6.0 Social Analysis

Togo Country Profile

6.1 Situation, Problems, Constraints

Although situated in the usually well-watered coastal and savannah regions, Togo has a very serious shortage of available water in the dry season, and extreme seasonal fluctuations in ground water levels. Undependable rains may create serious shortfall, resulting in poor harvests and sometimes none at all. In September to November 1976 the short rains failed in the north; thus by February 1977 drinking water was short at Dapango, and the hundred-weight of millet cost 12-13,000 CFA instead of the normal 7,000. This year, (1977), the coastal rainfall should have produced 800mm, but only 385mm fell. The rains have stopped and the corn is very poor. The rain-catch reservoirs are already dry. President Eyadema has therefore rightfully identified water as a key problem to be given first priority in the 1976 to 1980 five-year Plan.

In Togo there are whole regions which have no surface water. Peace Corps reports locales where women must go 20kms daily with their basins for a meager supply, and a 10 to 12km trek is not extraordinary. What is more, this may be repeated two or three times in a day as needed.

Because of water-table fluctuation many wells go dry in the dry season, and others render only a feeble quantity of water. If this is not managed carefully, the limited aquifer may be drawn down to the point of total depletion. Everywhere

there are visible two or three generations of wells that no longer work. Some of these are no more than two or three years old.

Wells may have ceased to function for one of a variety of causes:

-- They may descend to a shallow aquifer totally vulnerable to seasonal flux.

-- They may locate in a limited water-pocket for which, once exhausted, there is no further resource.

-- O.R.S.T.O.M. advises that most village wells have a debit which is insufficient to accommodate pumping, as it draws them down too rapidly. Thus they are more subject to infiltration and contamination. A rational economy of water outtake equaling well production would act to maintain well-purity and continual supply. There is, however, usually no one at local level adequate to take responsibility for appropriate use and control of the well.

-- In some instances wells dating from early German, or later French efforts still have water, but pumps have burnt out, or parts or missing. The next comer has simply made a new installation, leaving the relics to bear witness to unadapted technology. But the visible lessons have not necessarily been learned.

-- In some instances, current wells are missing a part, or lacking pump fuel. The logistics chain is sporadic and uncertain. The maintenance capability is limited; oriented

to repair instead of preventive maintenance, and long and slow to appear. Not a lack of goodwill -- this is rather a major institutional and material insufficiency. Repair items and spare parts do not exist at local or regional levels. Often not even in country, they must be ordered at the time of break-down, occasionally several months of delay while people struggle to cope.

-- Financial shortfall at government level, and lack of organization at the local level which might provide funds for supply and maintenance, further complicate the picture.

The national level presents the familiar picture of "water-tight" verticality and lack of coordination between branches of government, each of which involves in launching its own water-seeking ventures. There is nowhere a unified control, nor a bringing together of information, nor a national or regional total water-resource program.

Ministries of Plan, of Mines and Energy, of Amenagement Rural, of Social Affairs, of Agriculture, all dig their wells and guard their turf from subsumption. This is sometimes a strenous battle! It is felt in knowledgeable quarters that any attempt to rationalize control would have to emmanate as a command from the top.

There is equal lack of coherence on the foreign-donor and private-voluntary agency scene: French, Canadian, German, English, and Italian efforts are equaled by UNDP, FED, CIDA,

Peace Corps, Maison Familiale, White Fathers, and various Protestant Missions' bids into the water-game. At no point is there one seat of control for these efforts. I.e., The American Missionary who has dug 500 wells in Palime region received short shrift from the Team's Hydraulique Service counterparts. The Missionary knew himself to be perfectly en regle, but the Hydraulique Service did not know that he or his wells existed.

Rural water provisioning offers two sets of problems which must be faced sequentially. The first level is basic access to sufficient water for life-support and agriculture. The next and subsequent level attempts to furnish pure water, considering water as a health moderator on the plus or minus sides. Togo is at the stage of trying to assure a sufficient supply of water. It has come nowhere near solving its very marginal situation, and does not really see itself prepared to address the necessity for pure water. Indeed, Lome itself, has a water system that provides no more than seven liters per average day per habitant. Many Lome dwellers therefore draw their supplies from wells. But the aquifer -- at 5 and 6 meters depth is shockingly polluted. A knowledgeable estimate suggests that no pure well exists in Lome proper. It is therefore perhaps futile to expect les responsables to think of uncontaminated water supplies as an immediate rural goal.

It should be finally noted that -- with Togo's five separate climatic zones, and twelve different major cultural regions -- it would be very difficult to devise one solution that will work all over the country to resolve the water predicaments.

Social Soundess Analysis

TOGO COUNTRY PROFILE

6.2 Discussion.

Water Use: Team members spent a day visiting wells throughout the Maritime Province. In this region where people keep no cattle, the few goats, dogs and chickens forage for themselves, and are only watered where no surface water exists at all and during the dry season.

Water is used, then, to cook and drink, to bathe and wash clothes. A woman carries the waste water to her small garden where she raises vegetables and condiments for "the sauce".

If there is a maregot or a ditch the women go there in preference to wash their clothes and bathe. Away from the houses and village there is room to spread the clothes on the grass to dry in the sun. There is company to talk to and bathe with. People enjoy a bath in the maregot, and often a whole family will go together. It is an outing, and time for amusement, but this is during the rains when there is surface water; but a short time into the dry season little surface water exists in Togo. Only the Oti River and the lower Mono have water. Most maregots dry up.

Wells: In the dry period, many open wells dry up and others produce a limited debit. Since too many people use the existing wells -- sometimes there are several thousand to a well -- in some places people are forced to come 24 hours a day

to draw their water. Women form in long queues of a hundred people or more in some places. Sometimes they fight, but often they wait for hours. In one village the team saw over two hundred people waiting to use the two taps that dribbled water from the concrete tank containing the well's production. Peace Corps feels there should be one well for each 300 people.

In the large village of Mission Tove there are six wards: Kpeme, Kpogonu, Asetese, Afeyeyeme, Senya, and Diose. The Canadian installation there was well done, and provided the cistern with five taps for each ward. The cistern is marked off into three sections on each side, and people are supposed only to draw from the taps labeled for their own quarter. Here there is plenty of water, a good well. But there is no preventive maintenance. If the pump breaks down the guardian goes to Lome to report, and then parts must be reordered. The government pays the costs of the water: gasoline for the pump and eventual repair. The guardian is apparently not paid.

For open wells, the two problems are contamination and stockage. People do not understand a correct economy of the well where contamination would be lessened if outtake is equalled to the well's input of water. Although there is always a guardian, there is no management of the water use.

In the north, wells are recent, and often the Chief forbids people to take water from the well as long as there is water in the maregot. In many areas the well is considered "special" and is treated as a reserve. Often the whole concept of the well and how it does and should work is not explained to people. The Seminars proposed in this paper for village motivation/activation could usefully devote time to educating villagers on the mysteries of wells and how they work -- both for open wells, and for closed ones. In African rural areas consensus is very important, and decisions are reached only when people have arrived at a common attitude. Group understanding of development efforts is essential if permanent steps forward are to be taken.

Catchment and Storage of Water: In most villages of the Maritime Province one can see round concrete cisterns of perhaps 12 to 15 foot diameter, siting four to five feet above ground, and another four feet under ground level. They are usually loosely covered with bits of sheet iron, and whatever can be found. They are alimented from a flimsy set of run-off gutters from the sheet-metal rooves of houses from which water is conveyed by other gutters held up crazily on bamboo poles. Here the small rains fal from 15 September to 15 November, and by end November the Team found all cisterns dry.

In Ahepe Village, where the well had not functioned for three days because the pump was out of gas, a local entrepreneur had built a large new reservoir, which he filled by paying water-delivery from the Circumscription deep well. The Circumscription has a tank-truck, but it only makes deliveries to those who can pay the 700 francs CFA for 2½ cubic meters of water. Ahepe women, and those from the sister village Noepe which uses the same well were buying water from the entrepreneur. He had raised the price 15 francs, determined to make a windfall of the closed down well.

Ahepe/Noepe women carry their water in 30 liter enamel basins which they buy in the local market. With 15 people in her household, one woman told the Team she needs at least 4 basins-full a day. If she must carry water to wash clothes, she needs 8 basins-full.

Dams: Togo has begun a program to build dams to store water from the rainy season. This is probably essential in a region so short of water resource, but it would be wise to give thought to the four disease factors which could be considerably augmented if this water is not properly controlled. Onchocerciasis is present in a belt cutting from northeast to west-south-west across central Togo, and particularly in the Valley of the Loti. The Onchocerciasis Control Program is dripping chemicals into the stream, but it is early to know

whether the risk of infection is down. The black-flies which vector Oncho have a limited eco-niche in which they breed, but fast running water, in shallow depth over the lip of a dam, provides just the mixture of air and sun and water which is ideal.

Malaria must always be considered in Togo's tropical region, and a look at Sudan's man-made Malaria problem caused by the canals built in the Gezira should suggest the wisdom of prior-planning if water storage basins are conceived as a widespread plan. Malaria is already the number-one killer in Togo, and the possibilities of statistical increase should not be discounted.

Equally, it would be wise to limit physical access to water stored in such dam-basins on three counts of contamination, these being concern for Schistosomiasis, for Guinea-Worm, and the standard Shigella, Coli-bacillus, and possible Cholera. It would be possible to plan for stored water to be accessible only through take-off pipes, so that neither people nor animals could risk contaminating it.

As long as people wash and bathe in the ponds and maregots they are fully subject to infection with schistosomiasis and Guinea Worm, even if they take their drinking/cooking water from a pure well. Any general water/health/sanitation program must face this problem squarely, and it is a difficult one wih

which to deal. Essentially it requires the regulation of two factors:

1) People must be given an alternative, and

2) They must develop a full understanding of what is at risk.

One possible way to handle this problem would be to develop a dual-well program. This would mean that, instead of sinking one closed well, you sink one narrow-bore closed tubewell to be used only for consumption, and at a correct distance you automatically establish a second well which would be open and wide-diameter, but could be covered and given a pump as necessary. Along with the second well you build a wash-basin for clothes, watering troughs for animals (at a small distance), and a set of showers. Drainage could perhaps be arranged to provide water for sauce-gardens. The Community-Development teams would need to help people come to an understanding of the different set of activities to be associated with each well. The second well would also have a fallback function; in case of breakdown in the more complicated technology of the bore-well it would still provide access to water. And its cost might be largely covered through supervised labor provided by the villagers.

Sanitary excreta disposal in Togo is not more developed than in other countries surveyed, but certainly the need in

the densely populated coastal region -- not to mention the plight of Lome, the capital -- is intense. In this area, particularly, parasitosis is a major health problem, and one which could be effectively reduced with provision of sanitary disposal facilities. In some few instances the Team saw public privies, mostly connected with schools or markets. School facilities were unappetizing, and the market facilities were very clean because locked up. Public toilets do not seem much appreciated, and the wisdom of building them in an area where veneral disease is so prevalent, as it is all over Africa, is perhaps to be questioned. But in many villages, a private privy let into the outside wall of a compound might find acceptance in the densely populated areas such as the coast, or Lama Kara region.

Good manners in the past have taught that a proper person went outside the village discreetly to take care of his needs, and would not think of soiling the living compound with excreta. Older people still look askance at a water-flush toilet in the house, considering it out of place where one lives. It would be well, therefore to consider emplacement as much outside living quarters as possible, and closed pits and use of lime, or a removable bucket system might be desirable.

Since Togo and Benin are the home of Voodoo religion, it is of course an area par excellence where people are concerned

that body effluvia not fall into dangerous hands. Sorcery is practiced by the use of things which have been personally connected with an individual, and hair, nails, clothing, -- fragments of the personality -- all leave one vulnerable to attack. The more so excrement and urine, because these being impure cast-offs of the personality are already ambivalent in their nature. In traditional systems of classification, whatever is ambivalent is mystically dangerous, and particularly vulnerable to attack. Ritual and magic very often make deliberate use of things which are considered impure, because their use reverses normal patterns of behaviour, and magic is often conceived as everyday behaviour put-on backward.

The final point to make in discussing Togo is that, while various forms of organization are supposed to exist at the village level -- i.e. health committees, cooperatives, youth-groups, etc. -- in fact in real villages they do not seem to be operative. There are the formal administrative features: the Village Chief, who enjoys quite a real moral authority, and his "Council of notables", usually the elders of the family lines in the village. There are social affairs agents, and various health personnel such as the "agent itinerant" and "accoucheuse auxiliare" who are supposed to work in community development. In fact their time is mostly spent at the Circumscription center, and the village goes about

its everyday life as it always has. Partially this is due to tenuous systems of supervision and accountability in the official government services, where most decision must be made at the top: But the communication chain to the top is inadequate. Partially it is due to lack of clearly set goals, of motivation and motivators. There are more desires than there are programs. In fact it adds up to a never-never world in which many things exist -- on paper.

To resume then, the problems in Togo are both technical and social. There is a very real scarcity of water, both in available ground and surface water, and in the added hardships of the dry season. Problems of the social order have to do with access to water, maintenance of facilities, functional ways to bear the cost, and the necessary information and infrastructure which the community must obtain in order to enjoy the full set of health rewards which a sufficient quantity of pure water should offer them.

Social Soundness Analysis

Togo Country Profile

6.3 Regions, Demography, Ethnicity

Togo counts five economic/administrative regions based on the different climatic zones. The following table will give area and population densities.

Region	Areas in Km.^{2}	No. of Inhabitants	Densities *
Maritime	6,395	749,087	124
Plateau	16,975	541,685	32
Central	20,450	322,632	16
La Kara	43,625	252,355	58
Savannah	86,005	265,127	31
Total	56,785	2,175,886	38

Togo has a population of close to 2.2 million, and a population growth rate of 2.7 percent. This means, if present trends continue, a redoubling within the next 26 years. There is, however, considerable interest in Togo in family planning as a way to space children, and USAID and UNFPA are offering relevant assistance. The crude birth rate is currently at 55/100, and the crude death rate at 29/100. Life expectancy is in the range of 40 years.

The following we quote from Sebastian, February, 1977, in the Togo Family Health Project Paper, USAID Project No. 693-0212, Annex L.

*WHO 1972 statistics.

"Who Lives Where

Togo does not find itself overpopulated, but population distribution is uneven. While there exist uninhabited regions to the west, population is dense in the coastal areas (124 inhabitants/km^2) and in the La Kara zone (58/km^2). A median density for the country is given as 38 persons/km^2. But from a 1965 baseline, Togo is expected to double her population by 1985. A high growth rate of 2.7 percent is currently offset by childhood mortality in the region of 50 percent. With improving health facilities and accompanying reduction in mortality, Togo will have to look seriously to her Man/Land-Productivity ratios ....

"There are many tribes in Togo. Within large groups such as the coastal Ewe, even clans may signal their boundaries with different languages. Thus, a complicated language map appears. From out of this prodigality, three languages have become vehicular, or trade tongues: to wit, Mina, spoken in the south, Kotokoli in the central regions, and Kabiye in the north. In all, Togo counts 44 languages, and basically twelve cultures. Typical cultures will be, going north to south: at the north Moba and related groups such as the Mossi, Kondomba, Dya, and Gurmanchi.* These people occupy lands from the northern border south to below Mango.

* As found in southern Haute Volta

They will extend across the border into Ghana.

"To the south and east, in the region of Lakara, the Kabre (Kabiye) people exhibit a segmentary culture, marked by age-classes, famous for its warrior values, and generally considered less accessible than other parts of Togo to outside influence. The President, General Eyadema, comes from Pya, a village of this region. Related tribal groups are the Lamba and Naoudemba.

"Continuing south, radiating from the region of Sokode, live the Bassari, Kotokoli, and Tchamba peoples. Among them, live diverse groups of Muslims, immigrating from Niger and the Western Soudan. In this region Fulani cattle people who came from Nigeria in the 19th century, now live in symbiosis with the peasants, whose herds they guard.

"In the Plateau region extending from Atakpame into Ghana, live the Akebou and Ntibou. Continuing south one comes to Akposso country, with related groups of Fon, Ana, and Mina.

"In the Maritime region, from Palime to the coast, predominant cultures are the Ewe and Mina, with many Fon as one approaches Dahomey.

"This listing only includes major groups. There are many other pockets of minor ethnic groups often totally different in lifestyle, values and social structure from the

surrounding peoples. Incessant in-and-out migration, for historic (war), economic (exhaustion of lands), or social (tyranny of a particular Chief) reasons have dowered Togo with a fragmented social scene.

"It is difficult for the foregoing reasons to define a religion, a set of values, a type of social-structure for all of Togo.

"Togo's populations divide geographically by tribal origin, stratify into "Class" structures by differential access to socially valued goods such as land-rights, rights to perform valued rituals; stratify into age-groups characterized by differing sets of rights and obligations. They further differ in outlook and behaviour according to participation in modern or in traditional settings and activities. There is another major split along lines of rural vs. city life, of peasants vs. fonctionnaire. At the very fundamental base of all social life, are the diverging and complementary roles of man and woman with their differences in status, in jural and ritual rights, in occupation, possessions, and participation.

"Nevertheless there are some basic themes.

6.4 "Traditional Religion, Values, Norms, and Social Control.

"The family is the central motif, and the family extends in time beyond death and before birth. Therefore fertility, which protects the marginal and precarious life of Man is an

ultimate value, not to be tampered with lightly.

"The unit: Mother/Child is the generating node of Family and is seen as sacred. A woman's role, therefore is defined as biological and nurturing; but control of her fecundity is an ultimate political act .... All sexual behaviour is therefore stylized, emphasized, controlled. Sex roles are learned and formally conferred in "puberty schools" and "rites of passage". Elaborate symbolism and philosophy link the life, sexuality, and fecundity of Man with all that is generative in the universe: i.e., Water, Spirits, and Language ....

"One lives within the extended family; and in a hostile world, social life is equal to survival." Therefore: "...there must be ways to minimize or control conflict, (which) ...destroys the social groups which are the essential life-support system in all traditional societies...Authority is more often persuasive then coercive. Most often authority is ritual.

"Ancestors are just the part of the family that is across the dividing line of death. By crossing over, they have gained mystic power, and it is well understood that they use it to control the behaviour of the living family members...

"Elders within the family are nearest death, i.e.

will soon accede to mystic supernatural power. As such, they control the family shrines... (which...can) placate and manipulate the ancestors, as well as assorted non-related and ambiguous spirits which also people the crowded universe.

"Here you see the essential lines of authority. Competent old age confers a power role.** A strong personality, skilled in the politics of persuasion, manipulation, can lead a man to become a family, then lineage, then clan and tribal leader. Ultimately he will move across to become One-of-the-Ancestors-Who-Counts, i.e., who is specifically remembered. ...In life the powerful Elder controls access to land and economic life-support systems. Thereby he controls access to marriage-and-children, and thus to full social participation. After death, his righteous anger chastens and punishes immoral and asocial behaviour...

"Gerontocracy, Ancestor Worship are major elements of traditional social control in Togo, but equal to, and counterbalancing these is the weight of public opinion. In the face-to-face society nothing is hidden... In Togo, developing and influencing public opinion is a delicate art, and one which must balance information with due attention and respect to norms and values ....."

**This is particularly true in rural areas, and in the City within families. It should be borne in mind that we here speak of the traditional system, and that the City and the modern sector have their own characteristics.