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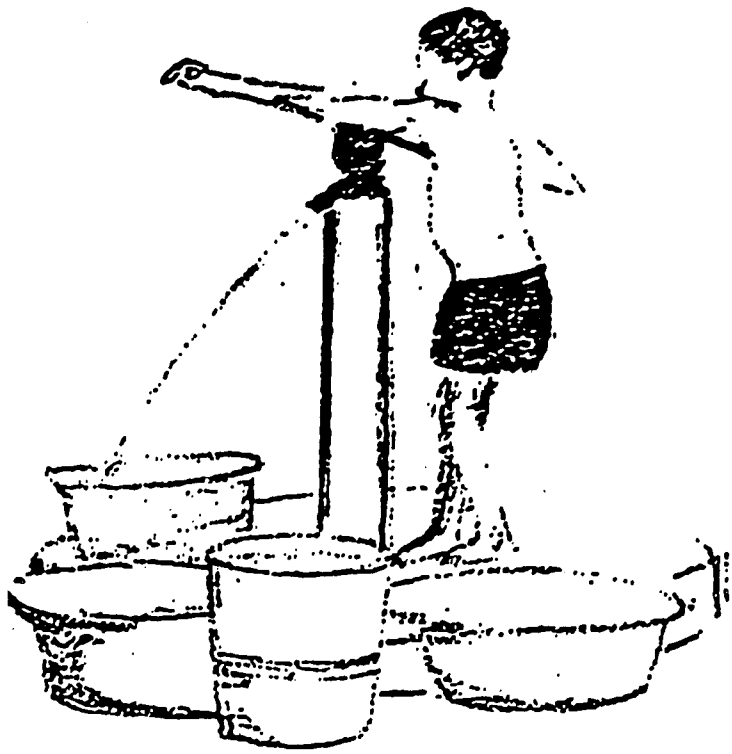
UPPER VOLTA RURAL WATER SUPPLY PROJECT



PROJECT NO. 686-0228

CONTRACT NO. AID/ AFR-C-1709

DIMPEX ASSOCIATES INC.

NEW YORK, NEW YORK

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Brad Wallach ----------Chief of Party
Financial/Administrative Specialist

Peter Ashelman[1/]----------Evironmental Health Specialist

Deborah Dishman[1/]----------Community Development/Health
Education Specialist

Houshang Youssof---------Hydrogeologist

Scott Welch----------Equipment Specialist

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Pierre Leger[1/]----------Project Officer/U.S.

1/ Medical Care Development (MCD)

1. INTRODUCTION

1.1 Project Goal

The over-all goal to which this project contributes is to "improve the quality of life of rural people in Southwestern Upper Volta."
- USAID Project Paper, June, 1979.

1.2 Project Purpose

The purpose of this project is "to provide rural people of Southwestern Upper Volta with a) portable water supply systems which will meet their minimum daily requirements and b) an effective community health education program."
- USAID Project Paper, June, 1979.

1.3 Scope of Work

The scope of work for which DIMPEX is responsible includes the provision of long-term specialists in administration, equipment, health education and hydrogeology, as well as selected short-term specialists, to perform technical assistance directed to: 1) the digging, deepening or drilling of 620 wells and 2) the creation of a viable and self-sustaining preventive health system in the villages associated with the wells program.
- Contract No. AID/afr-c-1709, October, 1980.

1.4 Contract Funding and Modifications

Initial funding up to a limit of $240,000 and effective for 6 months was authorized in a letter contract between AID, SBA and DIMPEX in October, 1980, pending negotiation of costs and execution of the final contract (C-1709).

On February 20, 1981, Amendment No. 1 to the Contract:

1) increased obligated funding by $240,000 to a total of $480,000;

2) modified the statement of work to reflect 42 months of service for the hydrogeologist and health educator, reduced from 48 months; and also amended the short-term technical assistance;

3) identified the period of the contract as starting on October 3, 1980 with an estimated completion date of December 31, 1984;

4) provided a line item budget and identified the total estimated cost of the contract as $1,924,271;

5) defined the basis for overhead rate and payment of fixed fee.

On November 9, 1981, Amendment No. 2 to the Contract:

1) increased obligated funding by $750,000 to a total of $1,230,000;

2) revised the description of services for the hydrogeologist and added a new contract position and scope of work for 36 months of services by an Administrative Manager;

3) revised the schedule and duration of long and short-term technicians' services;

4) Increased the budget to $2,314,084, reflecting the additional costs of the new Administrative Manager position and adding the wife of one of the contract technicians;

5) provided for changes in logistic support and for the inclusion of updated AID General Provisions and Additional General Provisions.

On April 26, 1982 Amendment No. 3 to the Contract:

1) revised the budget to $2,241,213 to reflect savings based on the first year's actual costs.

On September 3, 1982 Amendment No. 4 to the Contract:

1) A new overhead rate was negotiated and approved.

On May 17, 1983 Amendment No. 5 to the Contract:

1) Increase the obligated funding to $2,241,213 to correspond to contract cost of the same amount approved in Modification 3.

2) Revised the statement of work to reflect the 5 months' extension for the health education specialist.

On June 16, 1984, Amendment No. 6 to the Contract:

1) Increase the obligated funds by $379,798 for a total obligation of $2,621,011.

2) Increased the contract budget to $2,868,628, reflecting revised cost estimates submitted on January 30, 1984 by the Contractor.

3) Extended the contract period to 25 July 1984.

4) Revised the work statements, schedule and duration of long and short-term technicians' services.

SUMMARY

In 3 1/2 campaigns this project came remarkably close to attaining the well production targets expected to be attained in 4 campaigns. The impressive momentum developed during the last two campaigns (see Annex 1: Accomplishments and Projections of the Rural Water Supply Project) encouraged us to expect that in the final campaign it would be possible to complete 93 drilled wells and 80 dug wells and install 150 pumps. These were the targets set by the technical committee in September 1983, for the PACD in July 1984, in an effort to attain the overall project goal of 620 water points. In 1983 it was thought the proposed extension period would emphasize well deepenings, re-sitings, masonry and pump installations.

However, during the last campaign the Foraco drill rig was unexepectedly reassigned to Ouagadougou and the Ingersoll-Rand TH60 drill rig deadlined for the final six weeks due to a major breakdown. Thus the loss of both drill rigs, as well as vehicle downtime due to the rising frequency of repairs for the aging jeep fleet, severely limited output. As a result, the campaign total of 57 drilled wells represented a best effort under unforeseeably difficult conditions. There remains approximately 60 new water points to be constructed to complete the project total of 620 (see Annex 2: Accomplishments of the Rural Water Supply Project as of July 25, 1984).

It is now apparent that in programming activities for the extension period, additional resources may have to be allocated toward continuing well construction activities. This would mean that funds earmarked for other extension period activities may be curtailed and a re-examination of the priorities for the 1984-85 campaign will have to be carried out early in the next reporting period.

For hydrogeological activities the project obtained 94% rate of success (construction: siting) based on the analysis of 100 wells constructed in Kenedougou and Houet Provinces (see Annex 3: Report on the Implantation of Drilled Wells). The report identifies that all drilled wells have been analyzed to determine their lithological and hydrogeological characteristics. Hydrogeological maps and cross sections have been prepared. Apart from the new knowledge thus provided concerning groundwater conditions, there is indicated the general occurence of artesian conditions and springs. These finding suggest that further systematic study of the sedimentary basin warrants consideration.

During the report period Contractor home office staff (Messrs. Hazlewood, Carlson and Leger) were engaged in a field visit to the Project. They reviewed progress and proposed actions to improve performance under the current program and, also, provided USAID with a written review and recommendations relating to critical issues arising from the WASH proposal for the extension period.

With regard to health component activities, this reporting period was a particularly active one. For the first time in over a year the health side benefitted from the guidance of a single Technical Director able to fulfill his functions with a minimum of outside interference. Results were impressive. Training of nurses and IHWs continued apace with the latest graduating class completing their training in June. New initiatives in well disinfection and water quality analysis were introduced, a bacteriological testing program begun and an initial computer analysis of survey data completed. Health component personnel worked closely with their colleagues in HER on a number of points of common concern, notably the definition of a 50-village sample population to assess the effects of project interventions during the extension period. For the first time, health personnel actively participated in hand-dug well sitings, focusing attention on health and sanitation considerations, and personnel from both components began to address the difficult issues of village animation and pump repair.

2. CONTRACTOR CONTRIBUTION TO PROJECT OBJECTIVES

WATER SUPPLY COMPONENT

2.1 - Hydrogeologist

During the last reporting period, 50 well sites have been selected in Kenedougou, Houet and Bougouriba Provinces. The construction of wells in the Kenedougou and Houet Provinces has resulted in 100 drilled wells installed in the Sedimentary Basin, and is the subject of a separate report (see Annex 3). Some 30 drilled wells remain to be completed in Bougouriba Province. All drilled wells have been analyzed to determine their lithological character from well cuttings and results recorded in the well drilling record books.

By the end of the reporting period the project had received two portable field laboratories (HACH) and samples from wells and springs had been tested for complete chemical water quality analysis.

During the reporting period the hydrogeologist assisted in organizing a field trip for the students of the Interstate School of Engineers of Rural Equipment (E.I.E.R.) and for this prepared a report on the geomorphology and hydrogeology of the Bobo-Dioulasso region (see Annex 4: Summary of Report to the E.I.E.R.).

2.2 - Equipment Specialist

In addition to the day-to-day management of the garage and warehouse, the equipment specialist spent a considerable amount of time on the following activities:

- Recruiting, interviewing and hiring a new warehouse clerk.

- Conducting complete physical inventory of all project material and ensuring that inventory documents are correct and up-to-date.

- Ensuring that the minimum construction at the garage was expedited in order to complete the move from a leased facility to the project-built garage/warehouse complex.

- Investigating training possibilities for Ingersoll-Rand (I-R), General Motors and Mack equipment.

- Preparing a large I-R parts order to ensure that spare parts are available for the TH60.

With regard to the first two activities above, the need to reorient the warehouse under a new clerk had long been evident. The previous clerk did not pay enough attention to the maintenance of the inventory cards or to the entry and exit of material. Whereas the project administration had been aware for some time that the problem existed (see Semi-Annual Report No. 5, p. 11) it was upon completion of the physical inventory that the extent of the deficit became known and remedial action taken. It is felt by the contractor employee responsible for the management of the warehouse that the move to the new facility, which is more secure and better equipped; the completion of the physical inventory providing a "clean slate" for the new clerk; and the demonstrated competence of this new local employee (who will shortly be provided with an assistant) will lead to an efficient control of project material.

2.3 - Administrative Specialist

With financial reporting, accounting and local currency procurement systems in place and functioning well (see Semi-Annual Report No. 6, Sect. 4.3) the Administrative Specialist's role during the course of the 1983-84 campaign was to monitor disbursement of project funds and assure to the extent possible that field teams and the project direction were able to accomplish their respective tasks as efficiently as possible. In real terms, this meant the timely acquisition of material such as cement and reinforcing rod (see Sect. 3.3b), as well as the reorganization of the project warehouse and effective crisis management in the event of equipment breakdown (see Section 3.2a).

Moreover, since this reporting period was to be the last under the terms of the original contract, a special emphasis was placed on long-term planning, particularly in regard to training of project personnel and parts orders for project equipment.

The Administrative Specialist worked closely with the Equipment Specialist during this period on warehouse controls and parts orders; with the WASH team assessing project progress to date and new directions for the extension period; with USAID on U.S. training for two of the five brigade chiefs; with the Technical Director

on financial analyses and budgeting; and with the local-hire accountant on financial reporting and encumbrance (accrual) accounting. At the end of the period the Administrative Speclist spent considerable time briefing candidates for the replacement of present technical assistance personnel.

HEALTH COMPONENT

2.4 Collaboration with HER in Well Sitings

Following the pattern first established in November - December 1983, health sanitarians were given the opportunity to assist in the siting of wells and boreholes during the early months of 1984. The Environmental Health Specialist, Peter Ashelman, sought to communicate the HER work program in advance to health sanitarians. According to the sanitarian's statistics, 75 sitings involved sanitarian's input as to sanitation effects of the proposed location

2.5 Disinfection of Wide-Diameter Wells

The Health Component adopted a policy of disinfecting (as a one-time practice) existing open wells prior to their being equiped and sealed with pumps. Generally, the sanitarians took complete charge of this operations, at time necessarily delegating the actual physical task of adding chlorine solution to their respective Itinerant Health Agents (IHAs). While the practice of disinfection was recommended by the Environmental Specialist, it rapidly became clear that it had to fall to the sanitarians themselves. Since there was no possibility of bacteriological monitoring due to lack of materials prior to the disinfection procedure, one cannot be sure of the efficacy of the practice. The number is less than 70 open wells, primarily in Kenedougou and Poni Provinces.

2.6 Drainage Improvements at Well Sites

Well site improvements along the lines proposed at the time of the August, 1983 National Rural Water Supply and Sanitation Seminar were initiated over the past six months. Following the example of the demonstration drainage constructed during that Seminar, Project Sanitarians Ouedraogo, Tingueri, and Bouda Omer trained Project IHAs so as to organize drainage works in 14 villages. Villagers contributed cement, local materials and labor.

The Environmental Health Specialist has noted that these project well sites drain into a soakaway or watering trough, yet do not include protective enclosures against animals. He cited the need for site-specific engineering of these well-protection measures so as to minimize labor and material inputs while providing a durable structure adapted to conditions of local terrain. To this end, he proposed several technical models for drainage and enclosure; a copy is appended to this report (see Annex 5).

In general, the bacteriological testing of Project wells (still in progress at this writing) indicates that some pollution has occurred, notably in boreholes drilled before November, 1983 which did not benefit from the six-meter grout seal instituted after that date. In connection with continuing water quality monitoring over the next twelve months, the Health Specialist recommends increased emphasis on well protection measures in the Project extension phase. (See "Technical Specifications for the Development of Dug and Drilled Wells" by Pierre Leger in Annex F of the Semi-annual Report, No. 5).

2.7 Training in Chemical Water Quality Analysis

The Health Team organized a four-day training seminar May 28 - June 1 on physico-chemical water quality analysis for both well and health project technicians, including eight Voltaics.

After receiving four DREL/5 HACH kits ordered for the Project, the Environmental Health Specialist assisted HACH Sales Engineer Marc Legrand in directing theoretical and practical training in colorimetric and volumetric analysis, including a day of field testing (see Annex 6 for photos and content of seminar).

Following the seminar, Project Sanitarians Tingueri and Ouedraogo performed chemical analysis of several wells in Houet Province.

2.8 Monitoring of Bacteriological Water Quality

Through an agreement between the Project and a French "Cooperation" medical team sponsored by the Parasitology Laboratory of the Hospital Pitie-Salpetriere in Paris, the Environmental Health Specialist organized a complete survey of bacteriological water quality for all functioning Project wells. The survey, begun in June 1984, and expected to last into August, is part of a recommended continuing process of monitoring.

Results of the June survey of 201 dug and drilled wells in the Provinces of Houet and Kenedougou reveal seven (7) polluted Project wells: four drilled wells, two wide-diameter pumped wells, and one open well. (See Annex 7 for Mr. Ashelman's translation of the French report by Dr. Francis Guillemin, the survey field director).

2.9 Training of Nurses

During this six-month period, the Health Component instituted a strategy of placing strong leadership responsibility for Project health objectives in the hands of Nurses and IHAs based in the rural dispensaries.

First, individual visits with Provincial Health Directors (Phds) and a joint Health/Wells Seminar expressly for the PhDs (May 3 - 5, 1984) served to enlist the Provincial organization of Ministry of Public Health (MPH) personnel in support of the Project's contributions to primary health care, especially with regard to water and sanitation.

Second, two continuing education conferences were held for MPH personnel (Nurses and Midwives) responsible for Project villages: in Hounde for nine Nurses (April 10 - 12); and in Diebougou for 15 Nurses and two Midwives (June 20-22). Both conferences were planned and presided over by the Technical Directors of the Project (Health and Wells) and by the Director of DESAH (Health Education Division of the Central MPH). Well technicians, sanitarians, and specialists Mr. Ashelman and Ms. Dishman participated in presenting public health education topics and elements of well construction and sanitation (see MCD presentations, Annexes 5, 8, and 9).

Since Nurses in Upper Volta generally do not see themselves as motivators, one of the purposes of these conferences was "consciousness raising" -- to help them perceive possibilities of exploiting their intimate contact with the villabe population as regards illness prevention.

While conference participation was excellent, with generous input from MPH personnel, it is difficult to forsee long-term impact on Project field activity without continuing involvement of the Nurses in formulating and supervising Project objectives. The logistical problems of such involvement are not addressed under the present Project design.

2.10 Training of Itinerant Health Agents

The Health Educator, Ms. Dishman, participated in a one-week seminar of practical field work for IHAs of Bougouriba Province (Dano region), February 19 - 25, presenting the topic of water filters and appropriate technologies. Other topics covered were baseline surveys, well sanitation and latrine construction. All participants agreed that one week of practical training is insufficient, and suggested practical training be given as IHAs assume their posts.

The graduation of the second class of IHAs took place June 30 at the Ecole des Infirmiers Brevetes in Bobo Dioulasso. In attendance was a delegation from the MPH including the Minister and the Director of Public Health. The four-hour ceremony -- animated by many speeches, and a four-act play by the IHAs on "sensibilization" -- was recorded on video tape by the Health Educator. Later the playback was viewed and critiqued by the Minister and Project Health Director. The Minister is interested in retaping the play for national broadcast to publicize the national vaccination campaign.

2.11 Recruitment and Training of Community Health Agents

Encouraging the policy of increasing reliance on training by the Nurses and IHAs who cover a group of villages around their dispensary base, the Health Educator nevertheless assisted in community health training of both new recruits and "old hands." As seen in Annex 10, 60 new male Village Health Workers (VHWs) and 41 new female Traditional Birth Attendants (TBAs) were recruited and trained at nearby dispensaries in the four Provinces of the Project. In addition, MCD's Health Educator assisted in each of the four continuing education sessions for 135 experienced Community Health Agents (mostly VHWs) in all four Provinces.

2.12 Demonstration Latrine Program

Part of the training of a Community Health Agent (CHA) involves his/her construction of a demonstration latrine during or after the dispensary-based training period. Originally conceived as the digging of a hole, construction of a concrete squatting slab using Project materials, and enclosing the installation with mat fencing or mud walls, there has been no clear methodology for the transfer of an appropriate latrine technology from the CHA to fellow villagers.

In researching the problem, the Environmental Health Specialist found that, in practice, both local materials (clay, "banco") and concrete slabs construction are taught, the former at times being emphasized as being more accessible to the villagers (as in Bougouriba Province). However, it is not generally verified that the new CHA has, in fact, afterwards completed the latrine with an enclosure, only then making it usable. Finally, we have no statistics as to the "spinoff effect" of the existence of a CHA's demonstration latrine.

2.13 Analysis of 1983 Survey by Information Consultant to the Project

The Project contracted with Strengthening Health Delivery Systems/Abidjan (SHDS, based at Boston University) to supply computer analysis to the results of the Survey of almost 400 Project villages, which Project Health specialists had organized at the end of 1983 and the consultants transferred their data and preliminary report findings to SHDS consultants visiting Project headquarters in Bobo-Dioulasso May 16 - 19. The SHDS Report, completed in June, is appended to this report. (see Annex 12).

During the SHDS consultants' visit to Bobo, the Health Component staff introduced them to the two Technical Directors and elicited a discussion of possible Project information management needs to be met in the extension period. The SHDS consultants took note in preparation for an extended training phase in information management and computer processing should the Project wish to continue such services. Before departure the SHDS consultants demonstrated on a nearby Apple computer for Project staff (health and wells) selected accounting, statistical, and graphics capabilities as an example of what is possible with a management information system.

2.14 Institutionalization of Project Information System

The Health Component has been instrumental in building up a coordinated system of Project-wide information exchange among all parties. The steps in this began in September 1983 when both the Health and Wells Components undertook a joint survey of Project villages. Then in January 1984 the health office saw the accession of its present Technical Director. In May the Provincial Health Directors of the MPH were integrated into the Project implementation strategy.

With regard to the last step, the orientation seminar for Provincial Health Directors (PHDs) held May 3 - 5 at HER resulted from the suggestion of the Director of MCD's International Division during his trip to Bobo late February 1984. Although only two of the four PHDs could attend, the seminar must be deemed a success in view of the understanding and support for health issues shown by HER technicians.

Although the Environmental Health Specialist has urged that the seven information management steps set out in the December, 1983 "Survey Preliminary Report" be implemented, it was not until the adoption by the Technical Coordinating Committee (TCC) on May 15, (the Health Component Technical Director serves as Chairman) that information coordinaion was on its way to institutionalization.

The formation of the TCC represents a joint effort by Health/HER to institutionalize collaborative planning of all Project activities. The TCC is composed of both Health and HER Technical Directors, well brigade chiefs and the assistant geologist, sanitarians and health team technical assistants. In addition to its initial organizational meeting of May 15, it has scheduled monthly information and planning meetings. Its role is especially to prepare for the annual Coordination Committee Meetings with governmental administrators in each Province in order to establish a village-specific work program.

It will also study (through its secretariat) technical aspects of the Coordination Committee decisions and periodically evaluate work in progress. It thus provides a welcomed forum for exchange of ideas.

2.15 Participation in Village Animation Team (Cellule d' Animation)

The initial step in the creation of the TCC was the concept of a Village Animation Team which would be functional during the extension. Its purpose is to develop strategies and prepare village populations to initiate and sustain Project activities. The Team is composed of Project Sanitarians and the Health Specialists, with input from HER technicians. The Team is to arrive first, before well digging and health activities commence, to motivate and alert the population about these activities, and to elicit and organize their participation. The emphasis will be on well maintenance, water hygiene and latrines. An organizational plan was put forth at the TCC meeting May 15th.

2.16 Developing Health Education Materials

The Health Educator completed a slide series on latrine construction, and also video-recorded training sessions (1) for Project Technicians on the HACH water analyusis seminar, and (2) for continuing education.

3. PROBLEMS EXPERIENCED

WATER SUPPLY COMPONENT

3.1 - Hydrogeologist

The drilled well program has been delayed by the several breakdowns of the TH60 drill rig and the Moyno pumps continue to require repairs. The project has not been able to obtain the aerial photographs needed (scale 1:50,000).

3.2 - Equipment Specialist

A) TH60 failure: By far the most serious problem of a mechanical nature that the project has encountered to date occurred during this reporting period when the G.M. motor for the TH60 broke down. This followed a series of minor motor problems, likely interrelated, dating to February. Whereas the garage was able to "repair" these various problems, the general lack of expertise in dealing with this particular motor was evident. Also, there are no technicians in Upper Volta competent to repair the motor to whom the garage could refer. Nor are there technical manuals available in-country dealing with these repairs. The garage staff hoped to address these needs during the intercampaign period by scheduling training in the U.S. on the G.M. motor. However, by June the problem became serious enough (cracked cylinder head) that the motor had to be sent to Abidjan to be repaired by the G.M. motor representative, and the drilled-well campaign shut down. One positive aspect of these events is that the G.M. representative has expressed his willingness to train project mechanics as repairs are made to the engine, so the training planned to take place in the U.S. will no longer be necessary. Technical manuals will be ordered shortly. The results of the training and repairs will be discussed in the next reporting period. However, it is expected that the TH60 will be ready for the next drilling campaign.

B) Deterioration of the Jeep fleet: The excessive time for vehicle repairs has handicapped field activities in the other brigades. Pump installation teams which rely on Jeep J20 pick-ups (each with more than 150,000 kms) were particularly affected as down time for vehicle repairs cut into already tightly programmed work schedules. It should be noted, however, that masonry work has advanced well beyond the pump-installation teams, and that both groups will continue to work through the off-season. Since, under normal conditions, it is the masonry work which requires far more time and effort, given reliable means of transport, the rate of pump installations should be dramitically increased in the next few months.

C) Jeep parts order delay: Another problem experienced, leading to long down time for several Jeeps, was that an emergency order placed in early April through a

representative based in Germany had not arrived in Bobo Dioulasso as of the 24th of July. The order was placed through this representative because of significant savings that could be made, but the results demonstrate one more time that the best procedure for future orders is to go through local purchasing agents whose reputation is based on satisfying customers.

D) Relocation of garage and warehouse: The move to the new garage and warehouse complex was significantly retarded due to construction that was not completed, notably guard houses and toilets. Other important construction plans (parking area, bridge, roads) have not been completed and will make work at the new garage difficult. It should be emphasized that the project administration is doing all it can to get construction going but the procedures imposed are extremely cumbersome.

3.3 - Administrative Specialist

A) Cement shortfall/inventory discrepancies: For the project inventory system to function correctly, the warehouse clerk must complete a "Bon de Sortie" each time he issues project material or equipment. If this is not done the inventory records kept in the administrative office will not reflect the actual stock on hand. This was unfortunately the case early in the reporting period when the question was raised as to how much "surplus" cement could be sold off without risking an eventual shortage (see Semi-Annual Report, No. 6, Section 3.3E). The extent of the discrepancy between inventory records and actual stocks came to light shortly after a transfer of 124 tons to a Dutch-financed project cleared out much of the warehouse and a brigade chief's routine resupply order was unable to be filled because only some 7 tons remained in stock. This in spite of the fact that 147 tons were theoretically in the warehouse. An ensuing investigation determined that the bulk of the "missing" cement had been delivered to brigade chiefs during the course of the campaign and never noted, either on the master inventory cards or on the individual bons de sortie. In spite of the brigade chief's best efforts to reconstruct consumption records, more than 25 tons remain unaccounted for.

At this point it became obvious that a complete inventory of all project material would be necessary to determine the extent of the control problem and to delegate responsibility in a rational manner. This was done over a three month period as the new warehouse facility was put into service and shelving constructed. Results of this inventory revealed substantial shortages of project materials for which no records attesting to their disposition could be located. It is supposed that the majority of the missing stock was issued to the various field teams and never recorded on a bon de sortie. However, since fradulent use or theft cannot be ruled out, sanctions

against the responsible party are in the process of being determined at this writing. To prevent further problems of this nature a new warehouse clerk was hired and tight administrative/access controls installed. There is good reason at this point to assume that the problem has been effectively solved and the "damage" precisely defined and contained.

B) Gasoline controls: A chronic problem discussed in previous Semi-Annual reports, the system of gasoline controls, was bolstered this reporting period by the introduction of kilometer checks and standard printed forms. However, certain shortcomings of the system remain to be worked out before it can be said that gasoline consumption is being effectively monitored. Most notably, broken vehicle odometers and compressor hour gauges need to be repaired, field fuel dumps (55 gallon drums) need to be better controlled and a rational system of estimating acceptable MPG parameters for each type of vehicle/terrain must be completed.

C) Pump representation: Virtually no progress has been apparent regarding the question of Robbins-Myer Moyno pump representation in Upper Volta. This issue will take on importance as the recurrent cost and village-level pump maintenance questions are addressed during the next reporting period. No Robbins-Myer representative visited the project site during the last six months.

D) Micro-computers: The purchase and installation of an appropriate micro-computer system (Semi-Annual Report, No. 6, Section 3.3C) has not yet been realized. Although price and delivery quotations were obtained from a supplier in Abidjan and an initial request for import authorization made, no positive response has been forthcoming from the GOUV administrative authorities in Ouagadougou. At this point it may be prudent to await the arrival of the proposed extension phase "Data Base Management Advisor" before further actions are initiated.

E) Wells/Health component joint administrative office: An improvement has been recommended repeatedly, the establishment of a joint administrative office regrouping the two components of the project. This would make a considerable contribution to resolving the "collaboration" problem referred to frequently in past reports and evaluations. The most efficient means of achieving this goal might be to break the wall between the two accounting offices in the wells component complex, install the health component accountant in the place of the HER accountant, centralize all recoreds and administrative procedures, and, eventually, set up a computer system under the supervision of the project administrator. Whether the inconvenience to health component personnel of having their administrative support staff in a separate location precludes such a conception remains to be discussed next reporting period.

F) Funds available for project extension: The problem of assessing exactly how much money will be available to finance project extension activities should be one of the first priorities of the next reporting period. Without a precise determination of funds available, effective programming of extension activities will be impossible. This problem is complicated by the fact that considerable sums of unused money obligated through PIO/Cs dating back several years have not yet been de-obligated in cases where actual expenditures were less than earmarked amounts. A thorough analysis of the project budget remains to be done.

HEALTH COMPONENT

3.4 Work Plan Implementation

The ability of the Health Component technical assistants to thoroughly cover the six program areas assigned to them in September, 1983 suffered due to lack of manpower. Furthermore, schedules for short-term consultants suggested in the last semi-annual report were not honored, placing greater burdens on the two Health field staff.

3.5 Latrine Construction

The problem of latrine construction is complex and difficult, and merits more attention than was available. On occasion, delays in delivery of Project-furnished materials (cement and rebar) or the spoiling of cement sacks by moisture has held up latrine construction by a year or more. Recent cumulative figures indicate twice as many non-functioning concrete latrine slabs as there are concrete slabs in use (completed latrines). Several months of effort could have been devoted to a survey of the situation so as to make appropriate recommendations.

3.6 Village Health Committees and Workers

Several field visits by Health staff indicated that the Village Health Committees formed in earlier years were not functional, or that the Village Health Worker was receiving no recognition or benefit from performing his services, thus yielding to abandonment of his role. While the evidence is anecdotal, it seems prevalent enough to cause concern.

3.7 Project Extension Planning

In September 1983, Contractor personnel met with Voltaic and U.S. Project officials and presented a work plan which not only included rational steps to be taken until the anticipated Project completion date of July 1984, but also the steps to be taken by the Contractor during the nine month extension period planning.

In February 1984, a three-man WASH team (Water and Sanitation for Health Project) arrived in Bobo-Dioulasso to work with Project staff in order to develop an extension. Project staff and the Contractor's involvement in the process was relatively limited since the team worked by itself and prepared their report independently. While many of the concepts proposed in the WASH report were valid ones, their adaptation of some to the Project proved to be difficult, if not impossible at this time.

3.8 Survey Processing and Reporting

The arrival of the SHDS consultants in May to initiate computer processing and analysis of the December 1983 Survey results came too late for end-of-campaign evaluation and planning. Even as technical assistance personnel were leaving in July, the SHDS results were not available in Bobo-Dioulasso.

4. GENERAL OBSERVATIONS

WATER SUPPLY COMPONENT

4.1 - Hydrogeologist

Analysis of data obtained from the drillings in the Sedimentary Basin of the Project area (Kenedougou and Houet Provinces) gives an actual success rate of 94% in comparing producing wells to sitings.

The hydrogeological characteristics of deep aquifers: transmissivity, permeability, storage coefficient and specific yield have been determined and recorded.

Similarly, hydrogeological maps and cross-sections have been prepared which show ground water conditions of the area (see Annex 3). These sections also indicate whether water table or artesian conditions exist in the aquifers and provide evidence of the comparative importance of artesian well and spring supply.

Artesian Well

4.2 Equipment Specialist

A) Jeep fleet deterioration: The most pressing problem to be confronted early in the next reporting period is the renewal of the fleet of light vehicles. The jeeps are in very poor condition and the fleet has been reduced due to some serious accidents. The problem has been addressed in previous Semi-Annual Reports (see No. 5, p. 4; no. 6, pp. 9 and 13), but no solution has yet been found. It is clear, however, that purchasing Jeep vehicles will not solve the problem since they would not arrive until late next year even if an emergency order is placed immediately. It is also clear that the age of the car park, compounded by accidents totaling two vehicles and the excessively late arrival of the last Jeep parts order has seriously hampered field activities this last campaign.

B) Moyno pump: The modifications to the Moyno pump seem to have significantly improved its durability. However, breakdowns are still frequent because old parts are still in the field. It is also imperative that a thorough inventory of the pump stock be done in order to determine pump needs to complete the installations on project wells. It is impossible to determine at this time what the status of the pump requirements are (pumps installed vs. pumps to be installed vs. pumps in stock) since the teams are constantly at work with their field stocks of pumps and parts, and because there are mounds of old parts that can be reconditioned for reuse.

4.3 Administrative Specialist

Although numerically the project feel somewhat short of its orginal goals, considering the complexity of the operation and the various difficulties encountered, by most measures it may still be considered a resounding success. Administratively/financially the project is healthy and control procedures are in place which assure an adequate accountability. Field operations have been streamlined, working conditions vastly improved. From a technical point of view, what remains to be done is the necessary deepening and re-drillings which will insure a sufficient yield from each of the project water points. From a sociological point of view, what remains is the institution and refinement of village animation techniques to insure the long-term viability of project accomplishments. Both are daunting tasks which will require much additional input in terms of money, expertise and initiative. Clearly the arrival of the PACD does not signal an end to project involvement in the zone or herald the satisfaction of village health and water needs. It does represent a convenient point of reference for assessing the project accomplishments to date and for setting priorities for the future. The extent to which the cumulative efforts of the last five years yield a lasting impact upon the village populations will depend to a large degree upon the renewed and refocused intervention of the year to come.

HEALTH COMPONENT

4.4 Relief from Vehicle Crisis

With the arrival in late spring of a new Cherokee and two CJ 8 jeeps, the problems of insufficient quantity of roadworthy vehicles seemed resolved. However, use of the new CJ 8 jeeps reveals they are defective: one has a serious steering problem and has sprung a radiator leak twice; the other has defective lock hardware, so that it cannot be locked or opened by its keys.

4.5 Management Improvement

Many of the problems mentioned in the last semi-annual report are on their way to solution, thanks to the turn-around in MPH leadership. In addition, the request of the senior Health specialist for increased office support resulted in hiring an office boy to assist with photocopying, materials handling; errands, etc. at the end of June.

4.6 Continued Collaboration

The Health Component has been instrumental in obtaining Project collaboration, not only with the wells component, but also with other interested parties. Since last Fall, when the Health Component enlisted the aid of the Organisme Regional de Developpement (O.R.D.), the doors of that organization's village extension agents have always remained open to Project visitors. Moreover, the strategy of calling upon existing infrastructure within the Ministry of Public Health to promote increased coordination between primary health care and Project activities, can only strengthen the Health Component's unique role.

4.7 Increased Role of DESAH

The production of health education materials has improved with some major developments on the part of the DESAH (Direction de l'Education pour la Sante, Assainissement et Hygiene), the health education dividison of the MPH. Under the dynamic direction of Dr. Traore, DESAH wrote, directed and filmed with heavy input from project sanitarians, five short films (film titles: Malaria; Village Hygiene; Village Health; Clean Water, the Source of Health; Diarrhea) on public health and water hygiene in which the two Bobo-based Project Sanitarians supervised and acted. The films were done in local dialect and are intended for rural populations. The DESAH has also made presentations for the continuing education sessions for nurses and participated in several monthly project health staff meetings.

5. CONTRACTOR GOALS AND OBJECTIVES

WATER SUPPLY COMPONENT

5.1 Hydrogeologist

A) Sedimentary Basin: The following activities should be systematically undertaken:

- Provide a complete inventory of water sites, including springs;

- Conduct piezometric surveys;

- Continue exploratory drillings;

- Complete pumping tests; and

- Study and record chemical characteristics of the aquifers.

B) Basement complex (igneous and metamorphic rocks: To maximize successful drilling in the more difficult aquiferous zones, siting using fracture trace analysis from aerial photos and exploratory drilling should be complemented with geophysical surveys using resistivity and electro-magnetic or seismic equipment and methods.

5.2 Equipment Specialist

The immediate concern of the garage is to get the TH60 operating again. At the same time the mechanics will get excellent hands-on training on repair of the G.M. motor. A second phase of training has been tentatively programmed for the drill rig. This will be scheduled once the drill rig is functional and will be conducted in Bobo-Dioulasso by an Ingersoll-Rand mechanic who will supervise the disassembling and inspection of those elements of the machine that can be worked on by project mechanics with the tools available. Further training can be arranged if it is considered necessary after the initial session (scheduled for a two-week period) and would take place in Bouake, Ivory Coast.

Other issues to be addressed in the next reporting period are the renewal of the light vehicle fleet, overall maintenance and repair of the project equipment in preparation for the coming wells campaign, and order for I.R. compressor parts. The current Equipment Specialist will return for an overlap period with his replacement in October 1984.

5.3 Administrative Specialist

The Administrative Specialist intends to brief his successor during the time remaining and leave the project management systems in the best possible shape for the continuance of project activities after his departure in early August.

HEALTH COMPONENT

5.4 Fifty Village Pilot Project

One of the WASH Team recommendations for the Project extension is to identify fifty pilot villages. Progress demonstrated in these fifty villages would serve as a measure of the impact of Project activities for the extension period. The method for the identification of these villages was left open to Project staff. The Health team proposed a method of choice which was adopted July 16 by the Health/Wells Technical Coordinating Committee, as follows (see Annex 11 for Methodology).

Two "high risk zones" were designated: in Houet Province, Hounde Department with 25 villages; and in Bougouriba Province, Tiankoura and Diebougou Departments, with a total of 25 villages. A "high risk zone" is defined as a group of villages which lack both potable water and health infrastructures. These villages also must fit three pre-conditions: lack of natural water sources; proximity of IHAs; and accessibility by road.

These villages will receive the bulk of the animation team efforts and priority for wells; however, this will not exclude application of the same animation efforts in the other target villages of the extension phase.

5.5 Development of Management Information System (MIS)

Short-term Project consultants should be asked to undertake a training phase whereby they reside in Bobo to design and develop a Project Management Information System (M.I.S.) complete with hardware, software and in-service training. Groundwork for this was laid by SHDS in their May visit.

Major use categories of the M.I.S. would not only include socio-economic and medical data on Project villages, useful for the Health Component, but also categories needed for HER operations, such as geological research and well data, construction management (inventory, personnel) and well maintenance (including training). Both components would make use of computer financial management and inventory capabilities.

5.6 Participation in Technical Coordinating Committee

As contractors to the Project, it is important to foster the institutionalization of the collaborative mechanism of the Technical Coordinating Committee. This should be the primary forum for technical information exchange. Using the TCC's secretariat, a complete Resource Library should be developed. Moreover, the secretariat should act as the central diffusion point for the development of a central MIS.

5.7 Water Quality Monitoring

Contractor technicians should take a leading role in setting up a systematic, doable water quality monitoring system during three periods of the year. Along the line suggested by Dr. Guillemin (see Annex 7) these would fall in:

November - December (recharge conditions)
March - April (aquifer drain down)
June - July (rainy season)

5.8 Recruitment, Training and Supervision

Starting in October, 1984 the work of the Animation Team begins to set in motion the process whereby at least 100 new villages are systematically prepared during the 1984 - 85 campaign to receive wells, form Health Committees, support Community Health Agents, and receive supevision bvy Project-trained IHAs. Additionally, specific technical construction needs continued attention. Finally, nurses in all four Provinces will require at least three training sessions each, during the year's campaign, so that gradually they take a firmer hand in supervision of IHA field activities. For this, it would be helpful if the Project made Mobylette fuel available to proven nurses to allow field inspection visits in Project villages surrounding the Dispensary.

Accomplishments and Projections of the Rural Water Supply Project (as of September 1983)

ACTIVITY	79/80	80/81	81/82	82/83	TOTALS	PROJECTIONS 83/84	TOTALS
Drillings	-	25	91	91	207	93	300
New Wells	15	37	77	87	216	80	296
Project Wells Made Deeper	-	(9)*	(9)*	(5)*	(23)*	(1)*	(24)*
Other Wells Made Deeper	1	1	2	1	5	-	5
TOTALS	16	63	170	179	428	173	501
Pumps Installed	-	17	172	88	277	150	427

* wells drilled by the project and deepened due to a drop in the piezometrical level

	80/81	81/82	82/83	TOTALS
Pumps installed on wells	2	81	23	106
Pumps installed on drilling	15	91	65	171
TOTALS	17	172	88	277

Accomplishments of the Rural Water Supply Project (as of July 25, 1984)

ACCOMPLISHMENTS/YEAR	79/80	80/81	81/82	82/83	83/84	TOTALS	GOAL	% ACHIEVED
DRILLINGS	-	25	95	91	57	268	320	84
NEW WELLS	15	37	75	88	74	289	150	193
OTHER WELLS DEEPENED	1	1	2	1	2	7	150	
TOTALS	16	63	172	180	133	564	620	
PROJECT WELLS DRILLED AND DEEPENED	-	9	9	1	-	-	-	
PUMPS INSTALLED	-	17	172	88	91	368	620	

* 3 new wells are to be deepened

Bobo-Dioulasso
July 17, 1984

The Direction of H.E.R.
Village Hydraulic Project
H.E.R./U.S. AID

Attention: Mr. Diallo, Director

Dear Mr. Diallo:

Please find enclosed the report on the implantation of drilled wells in the Kenedougou and Houet Provinces.

The data acquired by the well drilling campaign has enabled us to define the deep aquifer in sandstone of the precambrian sedimentary basis. The nature of the aquifer materials has been analyzed and its hydrodynamic characteristics determined. A study of the nature of the deep aquifer has brought into evidence the general artesianism as well as the importance of the springs. It seems evident that the aquifers are abundant and the water reserve is promising.

May this modest study contribute to a better understanding of the aquiferous system existing in the sandstone basis, and encourage a rationalized management of this important hydraulic source.

Respectfully,

H. Youssof, Ph.D. Engineering
Hydrogeologist
DIMPEX ASSOCIATES, INC.

cc: Mr. John Ford, General Dev. Officer, USAID Ouagadougou
Mr. Elroy Carlson, Ruraly Water Supply Project Manager,
DIMPEX ASSOCIATES, INC., Washington, D.C.

HYDROGEOLOGICAL CONDITIONS IN THE SANDSTONE BASIN OF THE KENEDOUGOU AND HOUET PROVINCES

REPORT ON THE IMPLANTATION OF DRILLED WELLS

H. YOUSSOF

July 1984

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HYDROGEOLOGICAL CONDITIONS IN THE SANDSTONE BASIN OF THE KENEDOUGOU AND HOUET PROVINCES

SUMMARY

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MAPS

Map I. Hydrogeological cross section of the Kou Basin.

Map II. Hydrogeological cross section of the Tin Basin.

Map III. General Situation of the Tin Region.

HYDROGEOLOGICAL CONDITIONS IN THE SANDSTONE BASIN OF THE KENEDOUGOU AND HOUET PROVINCES

During the 1983-1984 Campaign, some 80 drilling sites have been installed in the Kenedougou, Houet and Bougouriba Provinces.

The drillings are underway in this latter Province (some 35 borings to be done). The construction of 30 wells in the Kenedougou and Houet Provinces has brought to 100 the number of drilled wells set up in the Upper Basins (Hauts-Bassins).

The report concerns the wells situated to the West of the Banfora Cliff in the Precambrian and sedimentary basin.

1. SUCCESS RATE

Analysis of the data obtained after the construction of the 100 wells gives a sucess rate of 84%. But this figure tends to be misleading. Only 6% of the failures have been due to lack of water or improper siting, thus the actual success rate is 94%. Similarly, 8 percent of the failure is a result of a faulty method of boring (the quality and the relative composition of bentonite drilling mud or the breakdown of the mud pump), whereas 2% is due to technical problems. Such failures can be rectified by redrilling.

2. DISCHARGE

The discharge resulting from the drilled wells has been tabulated in the following table:

Q(m3/h)	Number of Drilled Wells		Discharge Obtained (m3/h)
< 0-0.5	4		1.465
0.5-1	4	25	2.675
1-2	17		26.616
2-3	21		51.014
3-4	13		44.690
4-5	11	59	49.190
5-10	5		32.018
> 10	9		122.946
	84		330.614

It is noted that the discharge from the drilled well averaged 3.9 m3/h and that the average discharge surpasses the safety margin for the well hand pump.

Notice also that 70% of the drilled wells have a discharge greater than 2 m3/h.

3. NATURE OF THE AQUIFER

All of the drillings were done in Precambrian Sandstone. More than half (55%) are done in Grès à Galets De Quartz; formerly called Grès de Bobo, and 17% of them draw water from the Grès de Sotuba, with just as many from the Grès Rose. Also, 11% draw from the Etage Schisto-Grèso-Dolomitique.

Among these types of sandstone mention must be made of the good hydrodynamic characteristics of Bobo sandstone and Rose sandstone.

4. HYDRODYNAMIC CHARACTERISTICS OF THE "GRÈS A GALETS DE QUARTZ"

4.1 Transmissivity, Permeability, Storage, Coefficient

Considering the extent, the abundance and the importance of the Grès à Galets de Quartz in the project zone and in the country as a whole, it would be interesting to know the hydrodynamic characteristics of this aquifer.

In interpreting the results of some pumping tests, we have been able to determine the characteristics of the aquifer. The results were given in a previous note (December 1983)). We shall bring to mind here the results of two pumping tests which seemed most representative:

	Formula Dupuit		Formula Jacob	
			T m2/s	
	K m/s	T m2/s	Drawdown	Recovery
KOUMI	1.6×10^{-4}	0.32×10^{-2}	1×10^{-2}	0.6×10^{-2}
DINDERESSO	1.8×10^{-5}	4.5×10^{-4}	1×10^{-4}	0.8×10^{-2}

To these results we shall add those obtained from a long term pumping test carried out by IWACO in the town of Orodara between the 26th and 31st of March 1982. The Jacob method was used. The results are given in the following table:

	T m2/s	
	Drawdown	Recovery
Drilled Well Survey	8.71×10^{-3}	1.45×10^{-3}
Piezometer	1° Tr. 1.74×10^{-3}	
	2° Tr. 1.66×10^{-2}	0.87×10^{-3}
	9.00×10^{-3}	1.16×10^{-3}

Note also, the pumping terst carried out by SCET on the well drilled for domestic use in the town of Bobo between 11th of May and the 8th of June 1962. The method used provided the following test results:

$T = 1.15 \times 10^{-3}$ m2/s

$K = 1.9 \times 10^{-5}$ m/s

$S = 2.25 \times 10^{-4}$

The following table combines the results of all the tests:

	T m2/s	K m/s	S
KOUMI	0.6×10^{-2}	1.6×10^{-4}	-
DINDERESSO	0.45×10^{-3}	0.8×10^{-5}	-
BOBO	1.15×10^{-3}	1.9×10^{-5}	2.25×10^{-4}
ORODARA	0.50×10^{-2}	-	

These may be considered coherent. Also for the entirety of the aquifer, we shall retain the following average values which are representative.

- transmissivity T in the range of 3×10^{-3} m^2/s
- permeability K in the range of 1×10^{-5} m/s
- accumulation (intake) S in the range of 10^{-4}

The transmissivity is relatively high. The permeability, which corresponds to the interstitial permeability of fine sand, is rather low.

4.2 Specific Yield

The specific yield is the flow per hour obtained for 1 meter of drawdown. It is expressed in $m^3/h/m$. The parameter enables us to make an estimate of the drawdown for a given pumping rate, or to evaluate the discharge for a given drawdown. This information is used to predict whether a well would render a permanent discharge during the dry season. It also makes available an estimation of how deep to set the pump intake.

The operator in well drilling seeks to obtain a maximum discharge for as little drawdown as possible; in other words, an "optimum yield."

Knowing the value of Q/s for an aquifer in a given region enables us to make a comparison and to appreciate either the local conditions for well installation, or the possibility of obtaining an improved yield.

The specific yield varies essentially with the permeability and hence with the lithological nature of the aquifer. In sand it oscillates between 3 and 15, it is 0.5 for sandstone, and can reach and even go beyond 100 in fissured rock (especially calcerous rock).

How to calculate the specific yield (Q/s)

The "drawdown" is calculated by the logarithmic formula of approximation viz:

$$s = cQ + bQ^n$$

where c and b are coefficients which are a function of the permeability and resistance to flow through the screen and in the tubing. The second term, corresponding to the loss in charge, being negligible in the cases studied, we used the following formula:

$$s = \frac{\log R/r}{2.73\ T} Q$$

R: the radius of influence of the well in m

r: the radius of the well in m

Bobo well

$$Q = 18 \times 10^{-3}\ m^3/s$$

$$T = 1.15 \times 10^{-3}\ m^2/s$$

The radius of influence is calculated by Dupuit formula:

$$R = 1.5\sqrt{\frac{Tt}{s}}$$

where S, the storage coefficient is 2.25×10^{-4} and t, pumping time is 336h, 15 mn (1,210,500s),

R = 3731m and r = 0.114 m

Having all the terms of the formula, we can calculate the drawdown.

$$s = \frac{\log R/r}{2.73\ T} Q$$

$$s = 25.86\ m$$

Therefore the specific yield:

$$\frac{Q}{s} = \frac{18}{25.86} = 0.69 \text{ l/s/m} = 2.48 \text{ m}^3\text{/h/m}$$

Koumi Well

$Q = 4 \times 10^{-3} \text{ m}^3\text{/s}$

$T = 6 \times 10^{-3} \text{ m}^2\text{/s}$

$r = 0.10 \text{ m}$

The drawdown calculated by the Dupuit formula varies from 0.97 to 1.05 m when the radius of influence passes from 1 to 2 km. We adopted a drawdown of 1 m.

The specific yield is calculated at:

$$\frac{Q}{s} = \frac{4 \times 10^{-3}}{1} = 4.0 \text{ l/s/m} = 14.4 \text{ m}^3\text{/h/m}$$

Dinderesso Well

$Q = 3.7 \times 10^{-3} \text{ m}^3\text{/s}$

$T = 4.5 \times 10^{-4} \text{ m}^2\text{/s}$

$r = 0.10\text{m}$

For a radius of influence of 100m, we would obtain a drawdown of 9 m. The specific flow would then be:

$$\frac{Q}{s} = \frac{3 \times 10^{-3}}{9} = 0.4 \text{ l/s/m} = 1.5 \text{ m}^3\text{/h/m}$$

Orodara Well

$Q = 2.38 \times 10^{-3} \text{ /s}$

$T = 5 \times 10^{-3} \text{ m}^2\text{/s}$

$r = 0.10\text{m}$

The drawdown varies from 0.6 to 0.75 m when the radius of influence passes from 1 to 2 km. We have adopted a drawdown of 0.72 m. The specific flow would be:

$$\frac{Q}{s} = \frac{2.38 \times 10^{-3}}{0.72} = 3.30 \text{ l/s/m} = 11.9 \text{ m}^3\text{/h/m}$$

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5. THE AQUIFEROUS TYPE

In all the well drillings carried out, water mounted in the tubings by sudden spouts of several m^3/h, as soon as the horizon of aquiferous sandstone is reached. The water mounted almost to the surface.

In 34% of the wells, water mounted to between 10 and 20m. It came up to 20 to 30m in 12% of the wells and up to 50m in 6% of the wells.

In one well water came up just 1 m below the ground surface.

The Djissara well spouted to 3m above the ground surface, with a flow of almost 10 m^3/h.

The aquifer sandstone stretching between the Bobo plateau and the upper valleys of the Volta-Noire, the Comoe and the Leraba are under pressure. The artesianism is general in the deep aquifer of sandstone in the "Hauts-Bassins" (upper basins).

5.1 Causes of Artesianism

The existence of confined aquifers in the sandstone is directly related to the lithology (the aquiferous characteristics of the sandstone) to the tectonic and to the geomorphology of the sandstone sediments.

Tectonic movements, taking place most likely at the same time as the volcanic intrusions, were seen towards the end of the Paleozoic era as flexible displacements of the strata (anticlinal and synclinal successions) and whose general dip is about 5% N.W.

Sandstone, having little plasticity, broke under the impact of the tectonic deformations. The strata contain numerous

faults, fractures, and joints and the extent and disposition of these have played an important role in the elaboration of the topography and the hydrographic network. Watercourses have a very high linear digger power when streaming over faults and fractures.

The morphogenetic system was completed by the phenomenon of laterization. Everywhere a lateritic cuirass caps the sandstone formation.

Finally, the present relief is a result of the climatic variations of the Quarternary era. The desertic phase led to the formation of erosion apron. These are the ancient levels of peneplanation. They had been covered with laterite and cuirass probably by the the changes in the hydrostatic level during the tropical phases which followed and which are similar to the present climate.

The aquiferous system developed in the sandstone is hence composed:

- of an upper level (lateritic aquifer, water table);
- of a porous aquifer (sandstone aquifer, deep).

The two separated by a level that's impermeable, composed of altered clay, which creates a significant loading on the confined aquifer.

In brief the simple folded structures with faults and fractures, with the help of numerous volcanic inclusions, cause the impermeable level of clay to compress an aquifer with confined resources.

Two typical examples illustrate the morphogenetic system described above:

5.2 The Bobo Captive Layer

(See Map No.I)

The town of Bobo-Dioulasso is seated on sandstone formations. The sandstone here is locally friable, even sandy. The sandstone beds here can be considered as sedimentary formations with interstitial porosity (see Chap. 4). There is a certain uniformity of hydrodynamic characteristics in space.

The existence of the deep aquifer at Bobo is due first of all to the aquiferous nature of the sandstone and then to the tectonic. Folds are responsible for the Bobo synclinal and the Moami anticlinal. Causing the fractures and breaks, this tectonic helps to localize the placement of the underground reservoirs, and the direction of their drainage canals is influenced by the dip and orientation of the strata. The dip is small (5°) and oriented towards the N.W. from the Cliff of Banfora.

We are in the presence of a simple folded structure. The whole hydrology of the deep aquifer at Bobo is influenced by this structure.

The water infiltrates into the feeding zone (mainly on the Bobo plateau) and circulates from East to West and finally emerges at the other end of the synclinal in the Kou valley. In fact, the aquifer is situated at a higher altitude than the axis of its outflows. Observation of the hydrostatic levels of the aquifer shows that the Kou has an elevation of 350 m, while in the town's deep well the static water level is at a depth of 23m which means an elevation of 400 m. Artesianism in the springs in the Kou valley is due to a gradient of about 50 meters between the zone from where they are fed and the point of their emergent outflows.

5.3 The Djissara Artesian Well

(See Map No. II)

In December 1983, we set up a drilling site a Djissara in the Canton of Kuini. After having bored through about 10 meters of the laterite cuirass and the layer of clay, as well as about 30 30 meters of hard schist and sandstone the drill came up against a hard microgranular black rock. This rock is the form of a vein of about 6 meters thick, after which water springs from an opening and mounts to about 3 meters above the ground. The well feeds on fine to medium-sized sandstone (of the Rose sandstone series) with a thickness of about 10 meters.

Together with an examination of the geological and topographic map, as well as from on-the-site information, we were able to make a cross-section of the hydrogeological characteristics of the Tin, Soubakaniedougou and Djissara basins. This cross-section helps for a better understanding of the hydrogeological conditions.

The Tin basin drained by the Sinousa valley is topographically very uneven. In its South Eastern part, it is overhung by a hill of 733 meters in altitude, thus being the second culminating point of the country (see Map III).

From a geological standpoint, the basin is mainly a region of Rose sandstone. It is very fractured and fissured and studded with numerous doleritic dykes.

These conditions are favorable to the existence of an underground reservoir, and the direction of its flow is influenced by the dip of the sandstone layers (about 5°) and is oriented toward the NW.

The Djissara aquifer is fed by direct infiltration onto the sandstone heights where the topographic mark is higher than that of the drilling site. The variation of the hydrostatic surface

is about 100m. This is approximately about the same as the topographic surface.

The cause of the confinement of this layer is a volcanic intrusion which has mounted because of a fault that is spanned by the Djissara marigot. Before reaching the surface the magma seeped into the sandstone strata and formed a vein which comprises the impervious limit of the confined aquifer.

The boring of this impervious layer by the drill caused the up spout of water.

6. CONCLUSION

The campaign of drilled wells in the sandstone sedimentary basin marks a success rate of 94%.

The average output of 3.9 m^3/h per well is proof of the good state of the aquiferous material.

The sandstones have good hydrodynamic characteristics. The transmissivity(in the range of 3×10^{-3} m^2/s) and the specific yield (in the range of $10m^3/h/m$) are that of sand.

Sandstone can be considered as the most coherent of the porous rocks. There exists too a certain uniformity in space of the hydrodynamic characteristics of sandstone. In fact, the sandstone series are a succession of regularly stratified subhorizontal layers with lithological and hydrogeological characteristics relatively constant for a great distance.

To the porousness of the sandstone can be added the permeability of the fissures. False meanders can be noticed; they are in fact faults furrowed by watercourses.

Springs, marshes and marigots are legion in the sandstone aquiferous system. Along the Banfora Cliff, a whole series of springs in the sandstone Grèse de Base can be seen (springs at Koro,

Dafora, Dingasso, and Nje).

The morphogenetic system is also favorable to the formation of the perennial springs in the upper valleys (Guena Spring). There are spout holes formed from the aquifer in the lower areas. These are outshoots of the water table formed when the laterite is flooded, but these are also the source of depression, contact spring and artesian spring on impervious limits. The artesian phenomena is general along the entire zone.

Whatever is the cause of the appearance of springs one should try to improve their flow by appropriate fittings. We recommend that during the course of the Project a record be made of all the springs.

Finally, it must be noted that if the problem of deep circulation in the captive layers of sandstone seems simple on the whole, the detail is much more complex. This would necessitate that systematic investigation be made on the sandstone basin as a whole, especially concerning:

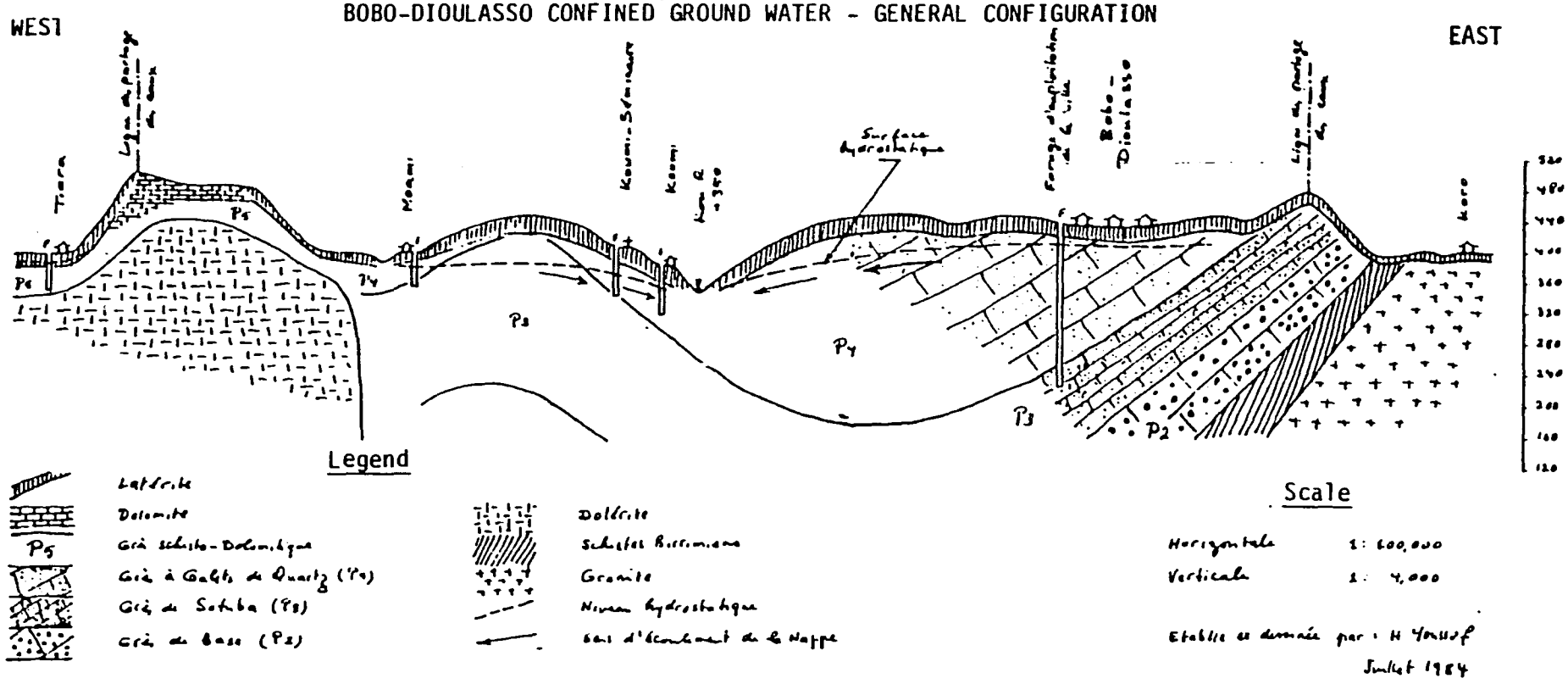
- A complete inventory of water-sites, including springs
- Piezometric survey
- Exploratory drillings
- Pumping tests
- Study of the chemical nature of the aquifers.

H. Youssof

Bobo-Dioulasso, le 13-7-84

MAP I

KOU BASIN HYDROGEOLOGICAL SECTION
- Along the Bobo-Orodara Road -
BOBO-DIOULASSO CONFINED GROUND WATER - GENERAL CONFIGURATION



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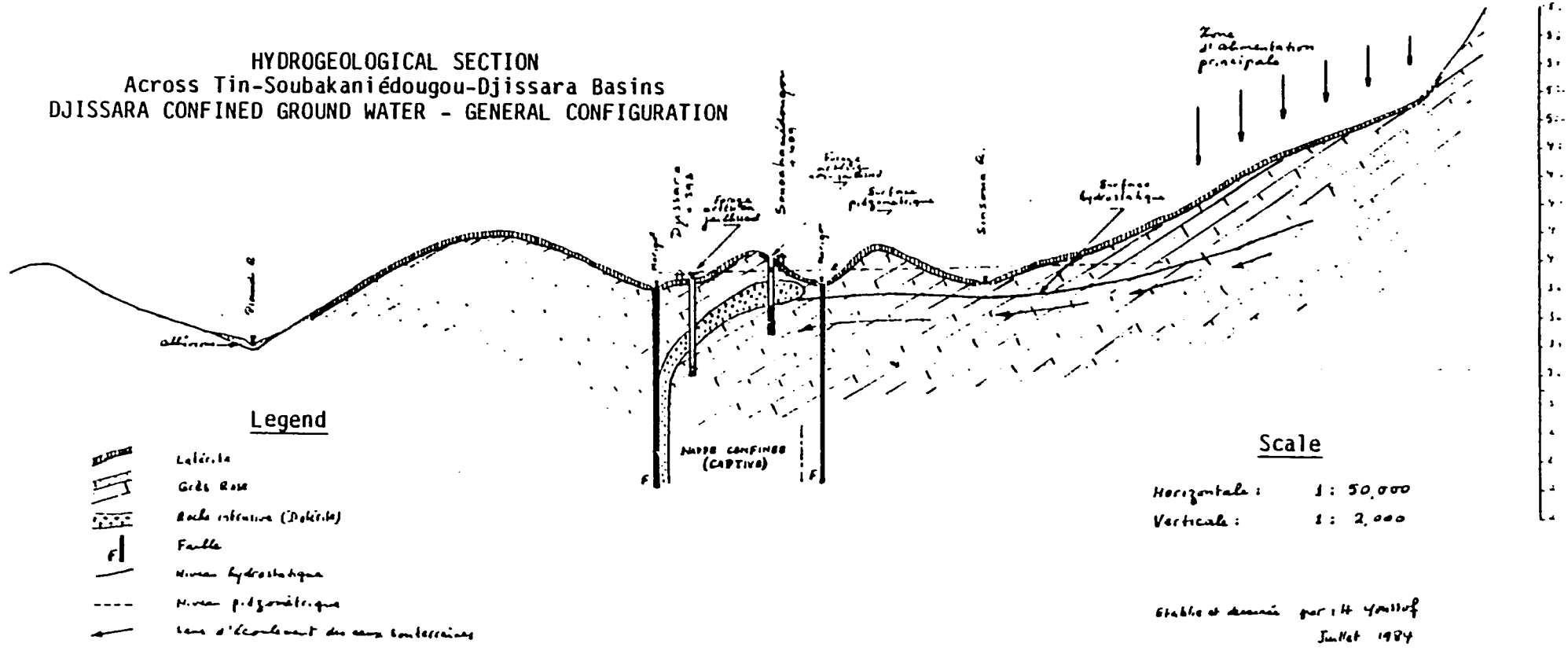
MAP II

NW

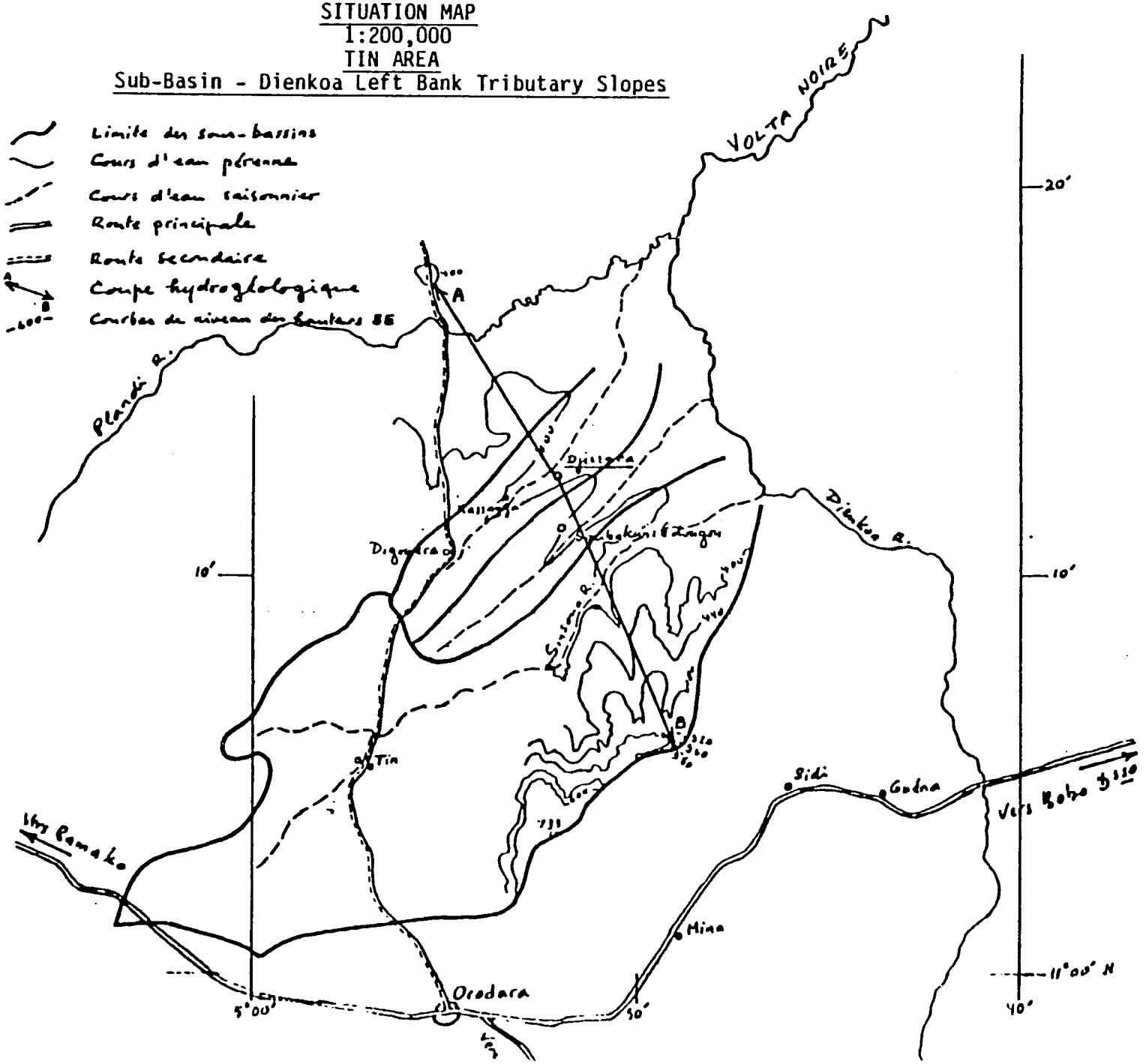
SE

HYDROGEOLOGICAL SECTION
Across Tin-Soubakaniédougou-Djissara Basins
DJISSARA CONFINED GROUND WATER - GENERAL CONFIGURATION



MAP III

SITUATION MAP
1:200,000
TIN AREA
Sub-Basin - Dienkoa Left Bank Tributary Slopes



Summary of Report

INTERSTATE SCHOOL FOR RURAL MACHINE ENGINEERS

E.I.E.R.

Ouagadougou, Republic of Upper Volta
B.P. 7023 - Phone 335-28/29
Bank Account # CC81541/95
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Professor at E.I.E.R.
H.E.R. B.P. 7023
Ouagadougou

Mr. Youssof Housha--
Hydrogeologist
USAID Project
H.E.R. B.P. 179
Bobo-Dioulasso

May 15, 1984

Dear Sir:

Thank you very much for sending us the geological and hydrogeological documents about the Bobo-Dioulasso region.

As we mentioned during our meeting in Bobo, I would be delighted to have you make a brief presentation about the documents to our students at the beginning of their tour. If you are willing we could set up a meeting on Thursday, May 31 at 3 p.m. on the road from Bobo to Ouagadougou to the right of the Koro quarries.

At this time the telephone lines between Bobo-Dioulasso and Ouagadougou are not working, but as soon as they are repaired I will call you to discuss your presentation and the details of the meeting.

Sincerely yours,

/signature/
/stamp/
M. Guinaudeau

NOTES ABOUT THE GEOMORPHOLOGY AND HYDROGEOLOGY OF THE BOBO-DSSO REGION

along the Boradougou-Souroukoudinga Route

H. YOUSSOF

May 1984

Notes about the Geomorphology and Hydrogeology of the Bobo-Dioulasso Region along the Boradougou-Sourkoudinga Route

The route begins in the village of Boradougou, located on the granite hardpan, and ends in the village of Souroukoudinga on the Precambrian sandstone plateau.

I. Geomorphological Summary

The route leads through Upper Volta's two major geological areas.

1. The Peneplain Hardpan

A vast peneplain extends over three-fourths of the country. This crystalline and metamorphic hardpan has not experienced any substantial changes since the primary era. The peneplation phenomenon began during this era and gave the area its present appearance. The result is a platform with an elevation that varies between 250 and 300 meters and a mostly flat surface.

In terms of its geomorphology, the region is one of low laterite plateaus which are occasionally encrusted or have soft rolling with many valleys. It also has low ground with barely noticeable drainage networks.

2. Sandstone Plateau

The sandstone sediments to the West, formed during the Precambrian Era, make up a uniform plateau with an average elevation of 450 to 500 meters. It is the largest sedimentary area in Upper Volta. Between Bobo-Dioulasso and Banfora the edges of the plateau are marked by a major unconformability, the Banfora cliff, located from 150 to 200 meters above the crystalline peneplain.

The cliff has a marine transgression and behind it the subhorizontal sediments form a plateau. The landscape is quite uniform except for some dolerite peaks and tabular reliefs made of laterite crust.

Generally speaking, it should be emphasized that the geomorphology of the present time and for both of the major areas is the result of climatic alternances from the Quartenary era. The desert phases resulted in the formation of erosion glacis, which were formerly levels of peneplanation. They were certainly laterized and encrusted when the water table was whipping around during the tropical phases that followed and that are similar to the present climate. Present-day erosion has attacked them to the point where only fragments of glacis remain today. Some have been reduced to tabular hills or evidence of mounds.

II. Hydrogeological conditions

In terms of the hydrogeology and with reference to both of the main geological units, two major areas can be distinguished.

1. The metamorphic and crystalline substratum area

The formations of the hardpan have the common characteristic of being impermeable as long as they are not altered or cracked.

The altered levels close to the surface contain the water wells. However, the most productive levels are located at the base or below the alterites, and especially in the cracked layer of granites and schists (Figure 1). These "deep" levels are used for drilling.

In Figure 1, the alteration profiles, the following may be distinguished from top to bottom:

a) A horizon of laterite clays, frequently encrusted, occasionally aquiferous and inside which water wells can be drilled.

b)A horizon of alteration clays, slightly permeable or not permeable at all, and flowing when saturated with water.

c) A coherent and productive horizon of granular sands in the granitoid rocks.

d) Rather productive cracked rocks.

The thickness of the various horizons varies greatly.

The thickness of the crusts depends on the morphological position of the crust. The most highly developed crusts are part of the high glacis and the upper glacis. They can be as tall as 10 meters.

The laterites have an average thickness of a few meters but can exceed 10 meters.

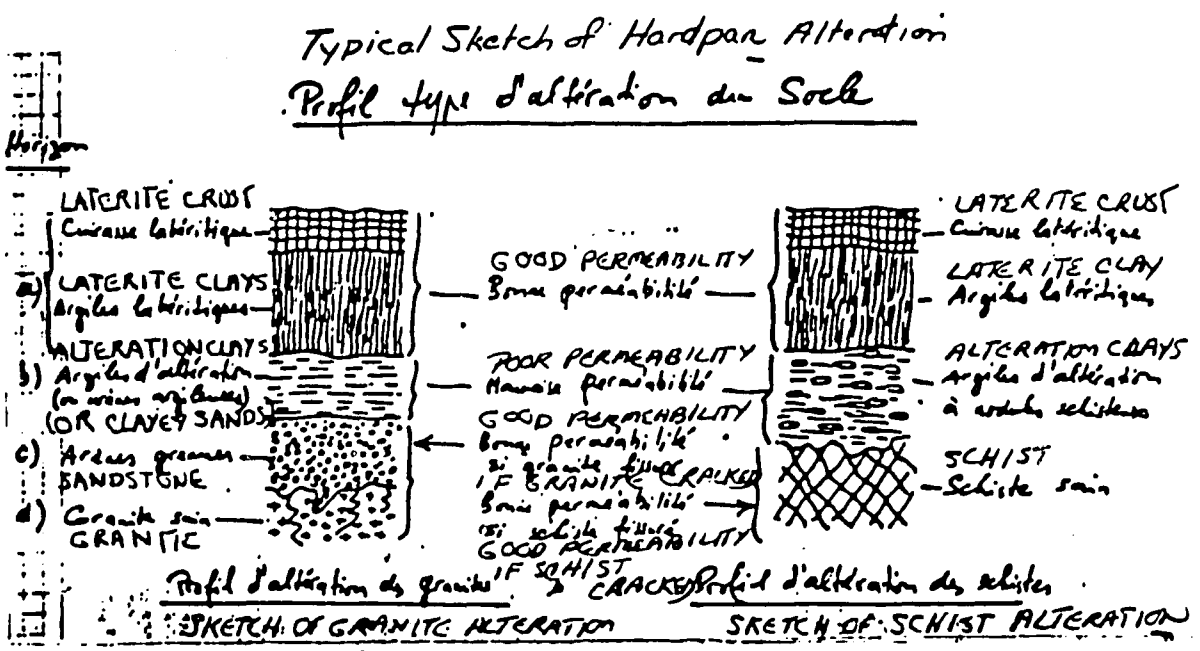
The average thickness of the alterites on top of the granite is between 15 and 20 meters and from 30 to 40 meters on top of the schists.

The granular sands are a few meters in thickness.

The horizon (d) can be as much as 100 meters.

These water tables are very well fed by infiltration from a quite sandy and leached but only slightly sloping soil.

Figure 1



2. The Sedimentary Area

This is the sandstone plateau of Bobo-Dioulasso-Banfora, Upper Volta's water tower. Compared to the local variations in the lithological and hydrogeological conditions, which are typical in the hardpan, the plateau's sedimentary series appear as a succession of subhorizontal seats with relatively constant lithological and hydrogeological characteristics.

III. The Bobo-Dioulasso Plateau

Given the hydrogeological importance of the Bobo-Dioulasso Plateau through which our route passes, it will be dealt with in this chapter.

Two sections are shown in order to better understand the hydrogeological phenomena. The first, along the Boradougou-Souroukoudinga road, is geological. The other, along the Bobo-Tiara road, is hydrogeological (Sketches I and II).

These sketches were drawn using the findings from the Bobo-Dioulasso drillings, especially those performed by SAFELEC and BRAVOLTA, as well as those performed in the HER/USAID Rural Water Supply Project and from field observations.

1. Physical Geography

The sandstone sediments from the Infracambrian Era are part of a uniform plateau of average altitude. Its border is in the form of a large cliff between Bobo-Dioulasso and Banfora.

Farther West, the Black Volta Watershed rises from 400 meters at Bobo to more than 600 meters at Orodara on the crests along the Bamako road.

Drainage North of the watershed is toward the North and East to feed the Black Volta's tributaries.

To the South, the area is drained toward the South by the springs and tributaries of the Comoé and the Léraba.

The Black Volta, the Comoé and the Léraba are practically Upper Volta's only permanent waterways.

2. Geology

The phenomena of alteration and crusting mask the upper levels most of the time.

Almost continuous outcrops can be observed along the Banfora cliff.

The sedimentary series include the following from bottom to top:

Base Sandstone	(P2)
Sotuba Sandstone	(P3)
Sandstone with Quartz Cobbles	(P4)
Schisto-Sandstone-Dolomite Sandstone	(P5)
Pink Sandstone	(P6)
Toun Schists	(P7)

It should be noted that there are dolerites set in the sediments in the form of deposits.

One other major characteristic of the geology is that the plateau has many faults and cracks.

3. Hydrogeology

3.1. Recent deposits - Water Table near the Surface

The recent sand, clay and laterite deposits are significant, especially on the Bobo plateau, where the thickness reaches approximately 50 meters.

Since the original area was the nearly impermeable alteration clay horizon, it plays an important role in the hydrogeology of formations near the surface. The rainwater may seep through the laterite crust and accumulate above the clay level and thus create the base for the laterite formation. Thus, there is a rather small surface water table which feeds the local wells.

Bobo's water table near the surface that supplies the city's wells is the laterite table.

3.2. Sandstone Series - Deep Water Table

With the exception of a band of schist sandstone dolomite sandstone (P5), which contains either little or no water, all of the Infracambrian sandstone series are sufficiently aquiferous.

Among the levels, the quartz cobble sandstones (P4) should be noted. In some earlier works they were called quartz-eye sandstone. This is the largest area layer in terms of the area of upper Precambian formations. The unit, whose power is an average of about 300 meters, is characterized by the presence of rolled quartz cobbles in most of the facies.

From Bobo-Dioulasso to Orodara and Koloko this sandstone is the seat of large springs (Kou springs) and perennial waterways (the Black Volta).

A brief analysis of the hydrogeological section shows that the city of Bobo-Dioulasso is located on asymmetrical synclinical sandstone with the presence of the Precambrian hardpan (Birrimien Schists) at a depth of 700 meters according to the BRGM report of 1969, and a dolerite rise slightly to the West of the Kou, on which the deep water table in the continuous sandstone hits against it as though it were an underground dam. This in turn, along with the great number of fractures, faults and diaclases enables it to emerge at Koukouroué.

The water table at Bobo is fed by rainfall in excess of 1 meter per year. The table is at a higher altitude than the spot at which the water emerges at Koukouroué. By observing the static levels of the water table, it can be seen that the Kou is at an elevation of of 350 meters, whereas the static level in the city's well is at a depth of 93 meters at the 400 meter elevation. Therefore, the sandstone water table in Bobo feeds the springs at Koukouroué. Its Artesien nature is explained by a drop of about 50 meters between the feeding and the emerging area.

IV - Comments about the Route

BORADOUGOU

Located near the cliff, an eroded laterite glacis rises above the village to the East. Granite outcrops are numerous to the North, and the base conglomerates on the altered granites are visible.

Toward the WNW, the granite area gives way to the Bobo cliff with its sandstone.

A well was drilled to the East of the village. It penetrated the layer of laterite clay and the area of alteration clays and then reached the granite 15 meters below. It is fed in the granular sands.

KORO

At Kilometer 12 on the Ouaga-Bobo road, a quarry mines the granities. The crushed rock is used as filtering solids for building wells.

Two kilometers from the quarry, the village of Koro is built on a granite mound.

To the West of the village, a spring flows downward from joints, diaclases and cracks from sandstone banks on the cliff and into a basin which feeds a stream.

Continuation of the Bobo-Dioulasso Road

Upon leaving the granite area and arriving at the Bobo cliff, the base sandstone series are visible.

The highly laterized Sotuba sandstones are not very visible from the road. The only way to see them is to take a detour toward the village of Pala, where a well was drilled in the formation.

On the Plateau

The phenomena of alteration and crusting mask the Sandstones of Bobo-Dioulasso. The Bobo Plateau is covered with a thick layer of crust, laterite clay and alteration clay.

The Bobo Sandstones are visible only in the Houet bed or by continuing on the road toward the West, in the Kou bed at Dindérosso.

Between Dindérosso and Souroukoudinga

The road climbs up a typical encrusted plateau. Then it descends into the village of Bana and it crosses a small stream. The rounded top that is visible near the little bridge is volcanic and made of dolerite.

Souroukoudinga

A well was built in the village. After crossing the laterites, the alteration clay and a schist bank, it meets the aquiferous sandstone level between 30 and 40 meters below.

Drilling section:

0	to	0.50 m	soil
0.50	to	7.00 m	red laterite
7.00	to	12.50 m	gray clay
12.50	to	30.00 m	solid black schist
30.00	to	42.50 m	fine silicon sandstone to yellowish sillicous clayey ciment

Two kilometers to the South of the vilage there are outcrops on the schist-sandstone-dolomite level. The lie has been used to make chalk, and the oven is still there.

May 4, 1984

H. Youssof

MAP I

Geological Cross-Section along the Road from Boradougou to Souroukoudinga in the Bobo Region

LEGEND

FORMATIONS NEAR THE SURFACE

Laterite Crust or clay

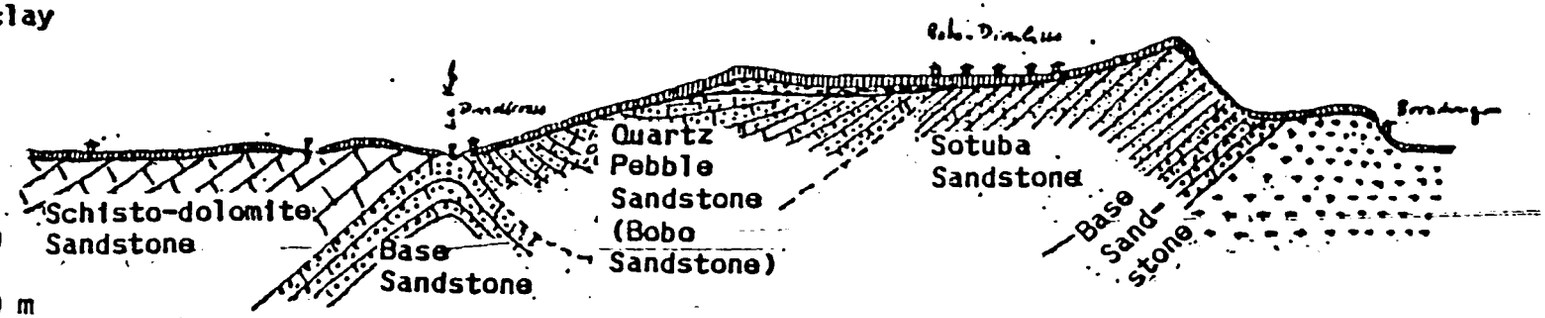
Alteration Clay

SCALE

Horizontal: 1: 100,000

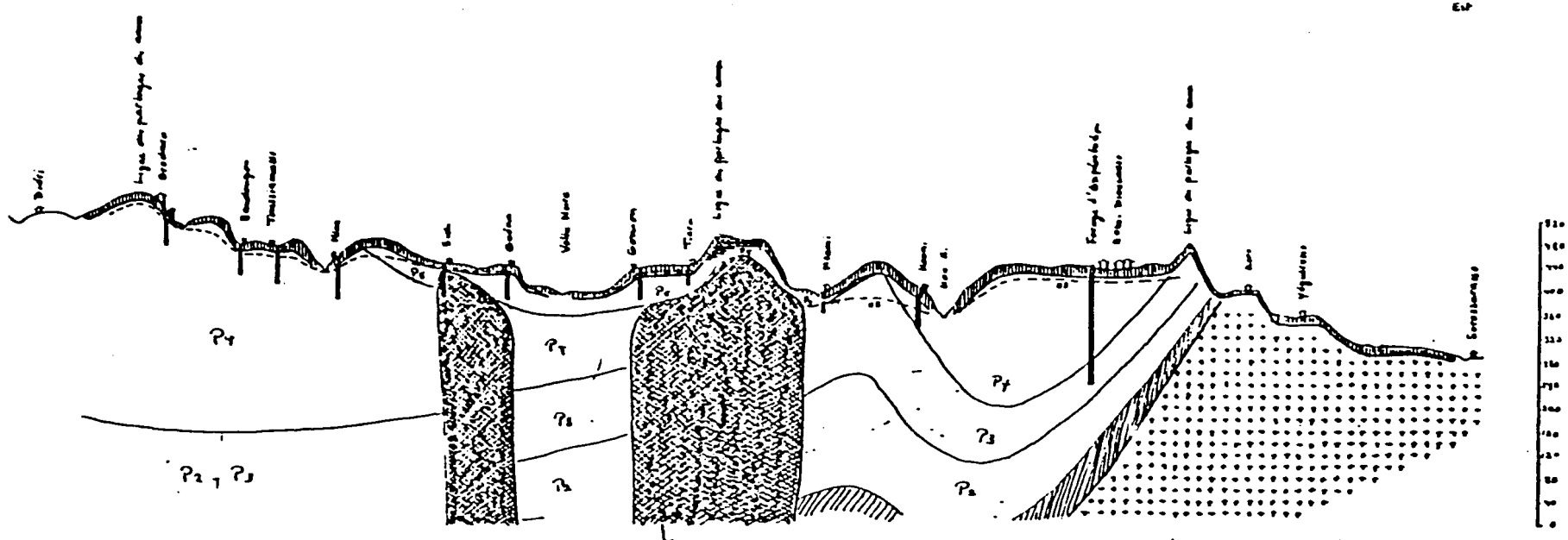
Vertical: 1 cm = 40 m

Prepared by: H. Youssof
April 1984



MAP II

HYDROGEOLOGICAL CROSS-SECTION OF THE ROAD FROM BOBO DIOULASSO TO BAMAKO



LEGEND

- Laterite
- **SEDIMENTARY ROCKS**
  - Dolomite
  - Schisto-Dolomite
  - Sandstone
  - Sandstone w/ quartz pebbles
  - Sotuba Sandstone
  - Base Sandstone
- **INTRUSIVE ROCKS**
  - Dolerite
- **METAMORPHIC ROCKS**
  - Birrimian Schists
- **CRYSTALLINE ROCKS**
  - Granite
- Static Level of Water Table
- Drilling

SCALE

Horizontal: 1:200,000
Vertical: 1: 4,000

Prepared by H. Youssof
June 1983

PROTECTION OF WELL SITES IN THE RURAL WATER SUPPLY PROJECT: ITS OBJECTIVES, TECHNOLOGIES AND COSTS

Goal

"A programme in sanitary education so geared as to profit to the maximum, from the improvements made in the water supply system."

Objectives

I. Sanitary Filling and Protection of the Water Sites

"To guarantee hygiene, all wells will be covered with reinforced concrete."

- The hand-dug wells will be sealed by the team of well-sinkers and they will provide an entrance by orifice that can be locked by key.
- Another team... will be in charge of filling the mechanically bored wells (drillings).

The three (3) essential elements:

1) Wells: sealed dug-outs (by HER)

2) Drained off water (the villagers with the help of the MSP) (SP = Public Health)

   - evacuation of residual waters, and those coming from rain
   - preventing the presence of mud and the infiltration of dirty water

3) Enclosed water sites

   - to avoid damage due to animals
   - to exclude animal and human excreta

II. Agents for the Popularization of Knowledge and Supervision by the MSP/Project (Ministry of Public Health

"The Project will form and pay 110 Itinerant Sanitary Agents (AIS) who will work in the 550 Project villages.

The AIS:

1) will supervise the Village Health Agents (auxiliaries) in the domain of:

. the construction and use of latrines;

. the control of the quality of the water

2) will also put together all fundamental data on the measures of sanitation useful for comparison and that can be used to evaluate the scope of the Project and to suggest modifications."

Who will supervise the AIS? Nurses from the MSP. The three (3) types of key personalities in-the-field.

1) Each nurse with the help of the Health Improvement Assistant and the AIS, will coordinate a programme of sanitation action in the Project villages covered by its CSPS/:

1. Itinerary Sanitary Agent

2. Village Sanitary Agent

Programme for Action for sanitation on:

. arranging the water sites

. proper evacuation of excreta

. other elements concerning primary health care

2) Each AIS to do a survey of the surroundings of the village and of the water site, as regards water consumption.

. putting together physical data

. making a census of available human resources

. imagining short term projects that can be done by the villagers themselves.

3) Each ASV with the help of the AIS and the participation of the villagers carries on Education for Health activities so as to:

. make aware and organize a Village Health Committee

- involve the villagers in efforts in common destined to improve their surroundings
- ensure a better hygiene in the potable water supply
- encourage the construction and use of latrines based on the example of the demonstration latrine.

Technology for the Sanitary Arrangements for the Water Sites

I. Tasks of the H.E.R. teams (Hydraulics & Rural Equipment)

300 wells of big diameter, hard dugm with the help of the villagers (new parts, deep parts).

300 mechanized drillings done by H.E.R. specialists. Filling (to be sealed with armed concrete).

A. Big Diameter Wells (see Fig. 1)

1) Elements for filling

a) Platform for pumping: two sealed half-slabs (see Fig. 2)

b) the anchorage on the ground label

c) the choke tubes right to the bottom of the wells, free access to the water site: lack of protection!

2) Existing Problems

a) Leaks in the joints of the half-slabs

b) Puddles of water and mud at the surface of the soil

c) Infiltration of dirty-water in the underground tubes

d) Animal excreta and human waste everywhere

B) Mechanized Drilling

1) Elements for filling

a) platform for pumping: solid concrete

b) the anti-mire on the ground level

c) cementing around the PVC plastic pipe cement: up to six meters; pipe: right to the bottom, strainer at the bottom up to three meters above the water outlet; problem: free access to the water-site: lack of protection!

2) Existing Problems

a) Erosion and digging beneath the antimire by pigs and by the action of water

b) Pools of water and mud at the surface of the ground

c) Infiltration of dirty water into the underground pipe containing a strainer

d) Animal excrete and human waste everywhere.

II. The Task of Popularization by the Agents (M.S.P. & Villagers)

On the arrangement of the confines destined to the protection of the water sites.

A. The Big Diameter Wells

1) A system of drainage for rapidly evacuating waste water from pumping and rain

Objective. To catch and evacuate waste water.

The elements (see Figures 4 & 5)

. earthen hillrock

. durable trench for impounding

. noncorrosive evacuating trench

. choix: cesspool, gardening, or slope for draining (naturally occurring or made)

Characteristics of this system (Figures 4 & 5)

. demands a lot of supervision

. costly

. because (see also Fig. 6) hillrock and impounding trench away from the edge of the well on a precise slope

. evacuation trench dug and cemented

. cesspool filled with stones

. this system is suitable however when the well is situated in low grounds (basin)

2) Objective. To catch and evacuate water coming from rain.

Alternative System, which serves at the same time to evacuate residual water from the platform of the wells.

When the work on the wells is accomplished then if would be best to clean up the immediate entrance to the wells on a radius of about 15 meters. For this the soil must be banked up in the vicinity of the platform so that residual water and water from rain can be drained down away from the wells.

As much as possible the natural slopes of the land are to be used, but sometimes and in certain places the land can be graded down and levelled off.

Characteristics of this alternative system (Figure 7):

. technically more simple than the first one

. residual water from the wells and water from rain are evacuated at the same time, by the slope on ground level

. the draining slope is made sometimes by shovelling, sometimes by banking

. the trench for catching the water from the platform, is situated close to the curbstone of the well

. besides prevention of erosion, upkeep of the system is a minimum

a) Special case: of wells implanted in a basinlike-dugout. The water is evacuated by a cesspool, but attention to the following: the volume of the trench for infiltration must be calculated in function of the surface to be drained, as well as of the average rainfall. The Assistants for Health Improvement could provide the necessary counts.

b) Special case: open well — baling out manually while awaiting the pump and the filling.

Problems

. of security as regards the risk of falling into them

. accessibility hampered by puddles and mud

. hygiene of the spades and of the cords used for pulling up

Precautions to take

. use of reinforced metal cover, after use

. making arrangements for drainage before installing the pump

. wooden stakes near the edge of the pits for hanging spades and cords

c) Mechanised Drillings: evacuating water. The same problem recurs: evacuation of residual water and water coming from rain. Practically the same elements intervene as mentioned on p. 3. However, the low level of the antimire makes it difficult to exploit the alternative solution of more or less natural drainage, even if this method is still recommended (See Figure 8). There remains of the choice of a method for the final evacuation of water: natural or drainage (Fig. 8), cesspool (Fig. 9), or jardinage. Using this latter method it is highly recommended to enclose the garden so protecting it from damage by animals. The manner of enclosing is treated in the following paragraphs.

III. The Villagers Task for Making a Protective Enclosure

This aspect of protection is very often forgotten, but the three last problems cited above can be resolved by putting an enclosure, which would be a protection notably against animals, The harm done by puddles, dirt from digging, the infiltration of dirty water to contaminate the underground water, dirt and excreta everywhere especially near the water sites — all these drawbacks could disappear by the presence of a solid durable well-kept enclosure with a bolted and corded gate.

The elements: (recommendations subject to change with variations on the work sites)

- circular shape, less costly, ± 3 meters radius
- cement brick foundations lower than the ground level (30 cm. minimum)
- walls of parpen agglomerate (cement or nere nere) for at least 50 cms (against pigs) total height 1.5 meters
- spikes on the outside to discourage animals from rubbing against the wall
- just one gate (more than one would be too difficult to control) with a foolproof locking system
- earth hillocks, if necessary, to deviate any streaming water from the foundations of the wall, protecting them from eroding
- watch-men near the wells to be sure that the gate is always closed and to see to it that children and animals respect the enclosed limits

The Cost of Sanitation Arrangements for the Water Sites

We have roughly described four (4) technologies with possible variations when there is a choice, for example: the raised shallow trench for evacuating, or the

cesspool with slope for draining, or gardening, for the final evacuation of water. The four types of technology are represented on the following Figs. 4, 7, 8, and 9.

A list of the elements constituting each technology and its variations follows:

Element Matrix by Technology

TECHNOLOGY EFFORT

Element Description	Quite [illegible] Dug		Porous Drilled	
	Figure 4 (et 7)	Figure 7	Figure 8	Figure 9
1 Hillrock with supporting rock	20 m. =2π R = [illegible],1 m.	14 m. = 2,[illegible] m.	[illegible] m.	11 m. =1,75 m.
2 Collecting Platform, 2 meter wide	2,[illegible] m³ (volume = [illegible])	- -	- -	- -
3 Banking Shovelling	= π([illegible]²-r²)([illegible],1[illegible]) m. et R=3 m., r=1 m.	OUI	- 0 -	Quite porous [illegible] choice
4 Durable water catching trench	10,[illegible] m. R = [illegible]	[illegible] m. R=2,1 m.	10,4 m. R = [illegible]	10,4 m. = [illegible]
5 Evacuation ditch				
a Elevated	-	5 m.(var.)	-	-
b Shallow	3 m.	5 m. min. (variable)	3 m.(var.)	-
c Trench	± 7 m. (variable)	-	-	5 m. min.
6 Final evacuation				
a Cesspool	Choix: a	Choix: a	Choix: a	Quite porous soulement (pas de choix)
b Natural drainage	ou b	ou b	ou b	- - -
c Gardening	ou c	ou c	ou c	- - -
7 Garden gate	selon choix	selon choix	selon choix	- 0 -
8 Pump Gate	25 m. R = [illegible]	31 m. R = [illegible]	20 m. R = 3,2 m.	20 m. = 3,2 m.

Best Available Document

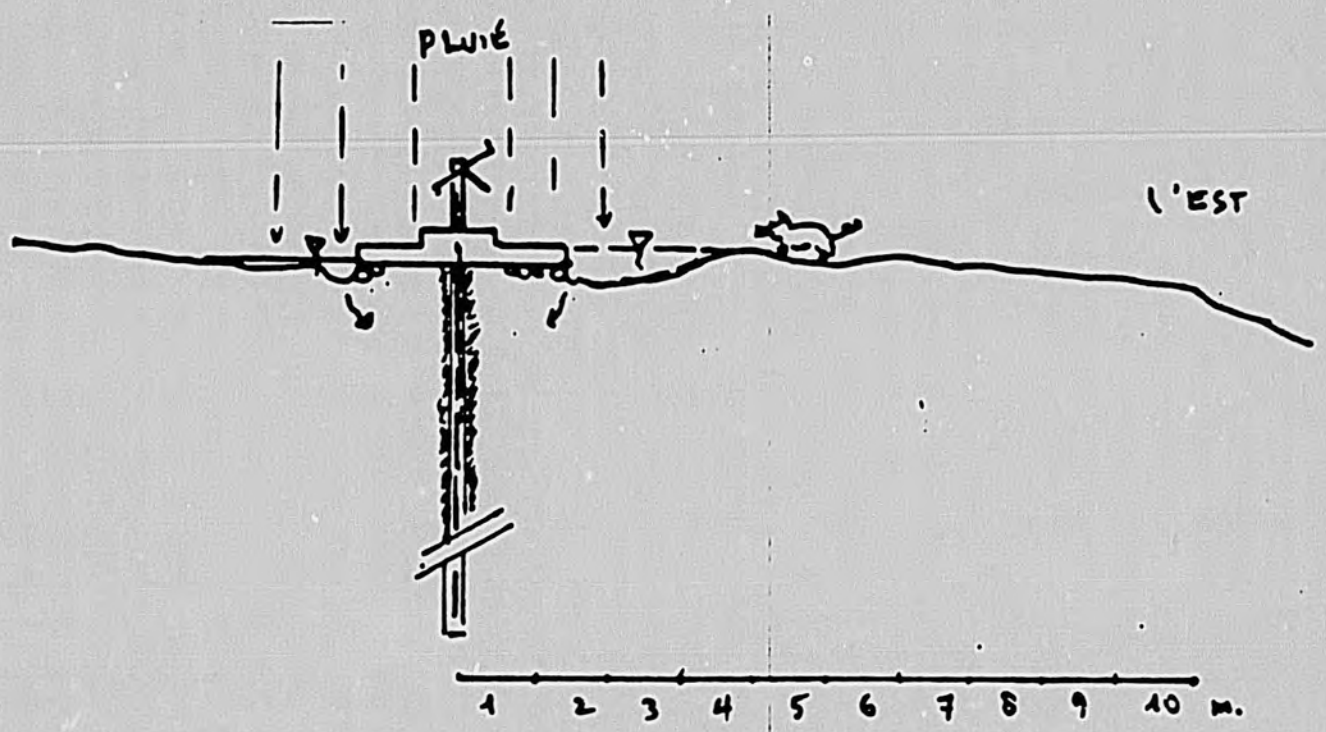
PROTECTION OF WELL SITES

PROBLEM NO 1: DRILLING WITH PUDDLES AND MUD

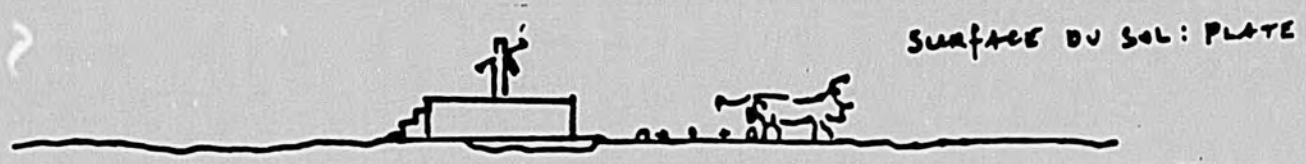
Prepare a list of the elements of the effort required to avoid well contamination

Natural eastbound slope

Pebbles, sand, nere-nere locally available



PROBLEM NO 2: WELLS WITH PUDDLES AND EXCRETA NEARBY



Prepare another list of the elements required to avoid puddles and excreta in the pump area; on the same page, draw a side view of what you intend to build.

PROBLEM NO 3: COSTS

In both examples, what protection system is more expensive? Why? Is there a big difference?

PROTECTION OF WELL SITES

DRAFT

Last Name and First Name:

Problem No 1:

Problem No 2:

Problem No 3:

PROTECTION OF WELL SITES

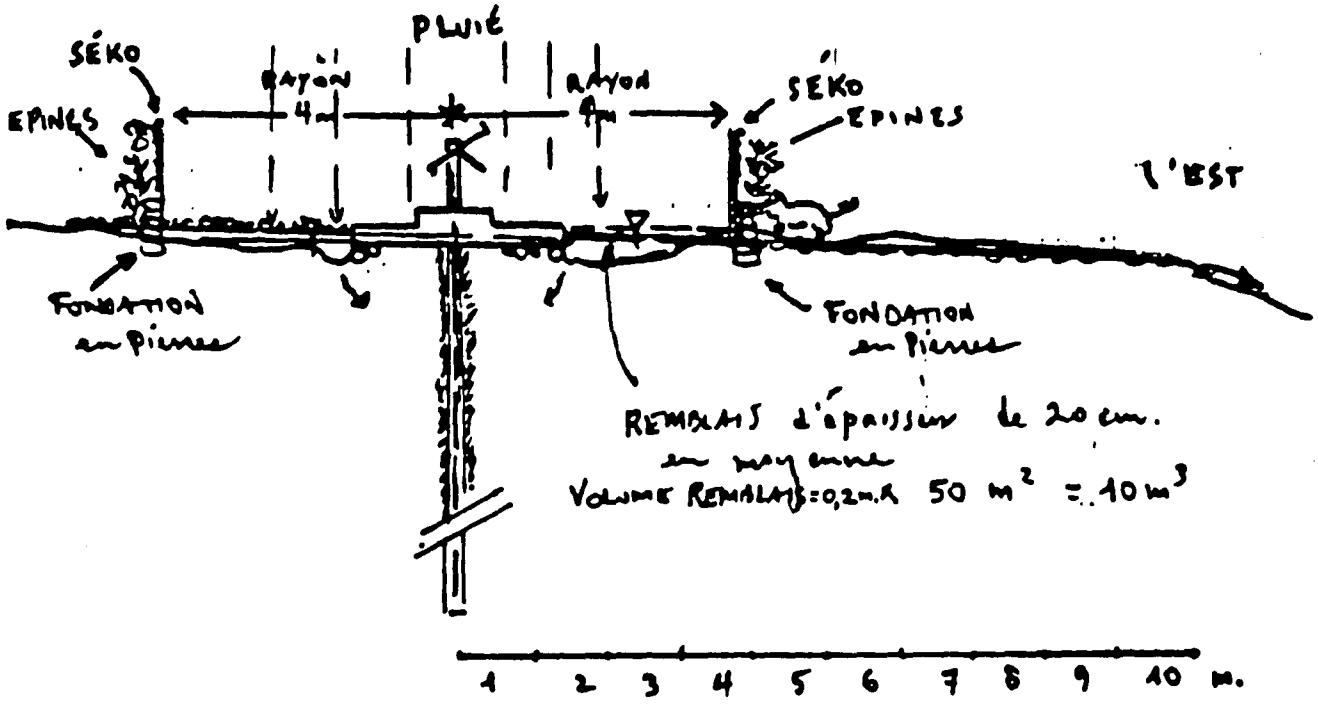
ANSWERS

PROBLEM NO 1: DRILLING WITH PUDDLES AND MUD

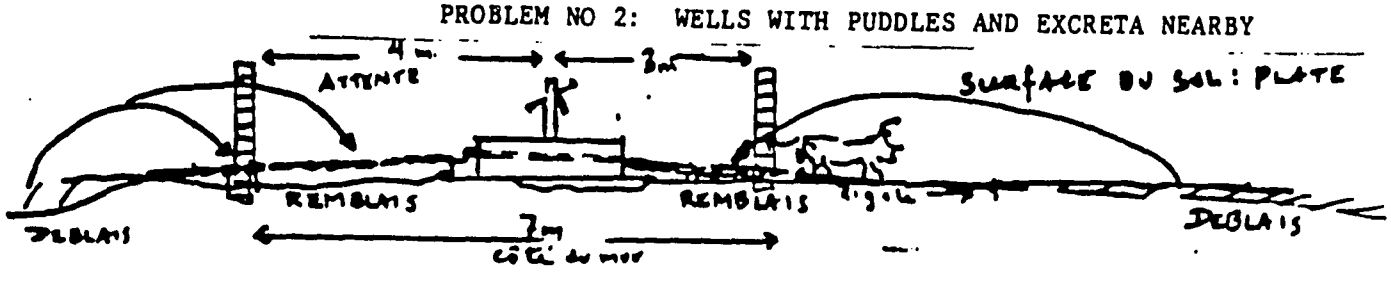
Prepare a list of the elements of the effort required to avoid well contamination

Natural eastbound slope

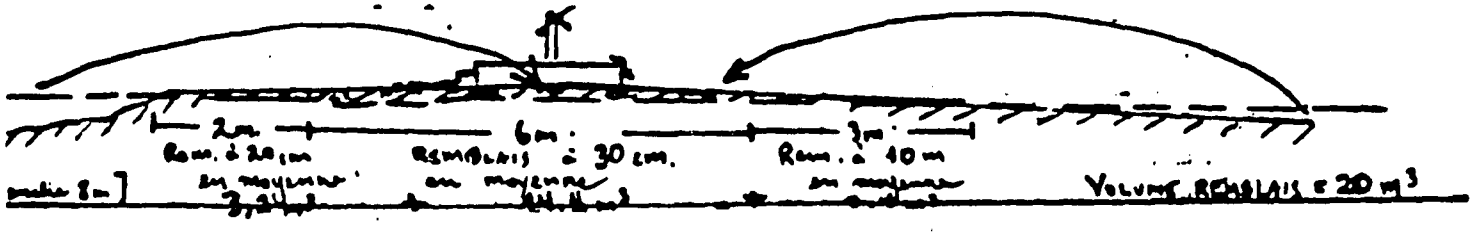
Pebbles, sand, nere-nere locally available



PROBLEM NO 2: WELLS WITH PUDDLES AND EXCRETA NEARBY



Prepare another list of the elements required to avoid puddles and excreta in the pump area; on the same page, draw a side view of what you intend to build.



PROBLEM NO 3: COSTS

In both examples, what protection system is more expensive? Why? Is there a big difference?

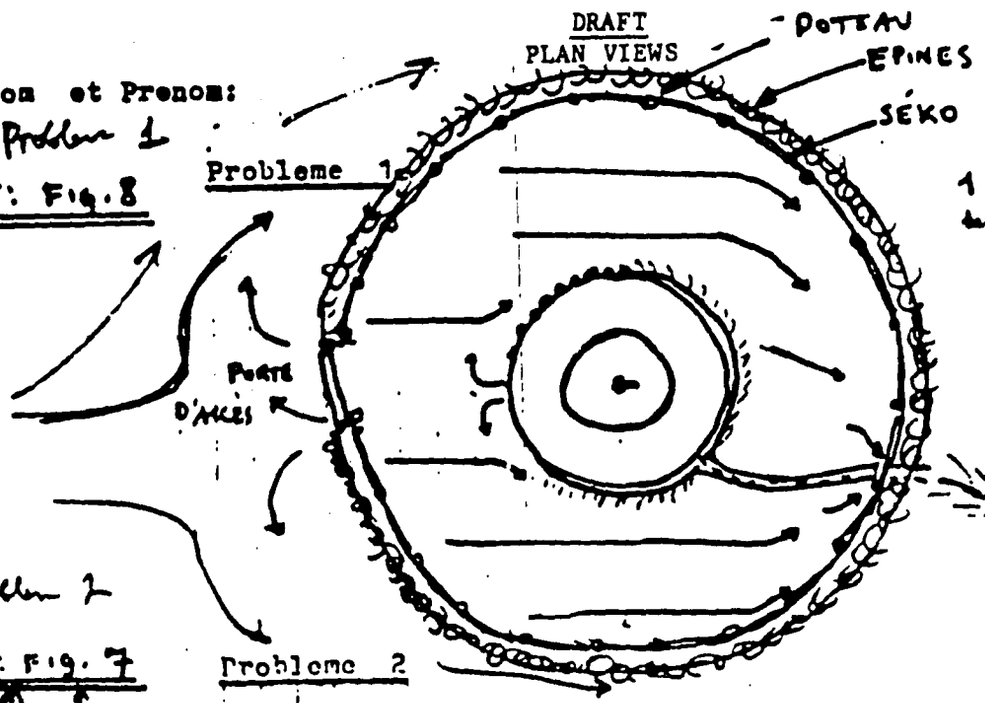
DRAFT
PLAN VIEWS

Nom et Prenom:

Problem 1

TYPE: Fig. 8

Probleme 1

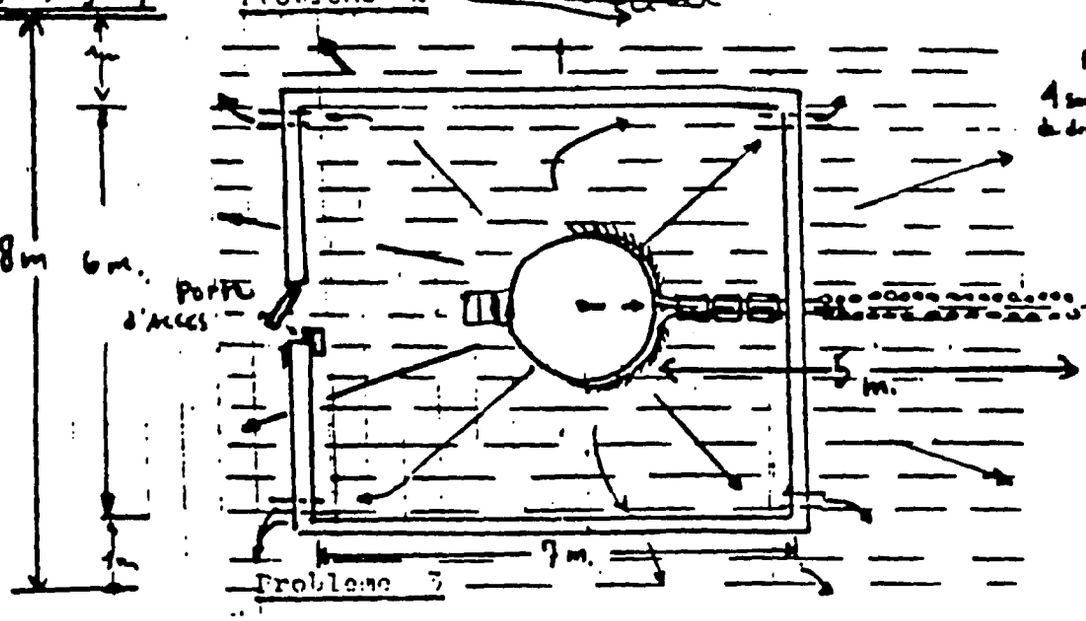


R: 4 m
Aire: 50 m²
Mur: Mètre linéaire:
1 sortie de drainage: 2πR - 1
= 24 m
Hauteur: 1,5 m
Superficie: Pour: 0,25 - 0,50
= 24 m x 1,5 m
= 36 m²
Briques:
~~24 x 45 B/m~~
180 Briques ~~= 300 Briques~~
soit ~~7,2 Br/m²~~
VOLUME REMBLAIS
= 10 m³

Problem 2

TYPE: Fig. 7

Probleme 2



Aire: 42 m²
Mur: Mètre Linéaire
4 sorties de drainage: 7 + 7 + 6 + 5 (porte)
= 25 m
Hauteur: 1,5 m
Superficie
= 25 m x 1,5 m
= 37,5 m²
Briques:
25 m x 15 B/m
= 375 Briques
soit 8,9 Br/m²
VOLUME REMBLAIS
= 20 m³

GIVEN THE PROPOSED ELEMENTS, IT APPEARS THAT:

THE END RESULT IS AS FOLLOWS:

	(A) Remblai Terre	(B) Ciment	(D) Banco Briques (15x30x40)	(F) Pierre Taillée (15x30x40)	(G) Pierre Brisée	(E) Pierre Taillée 10x15x30	(C) #	(K)
Problème 1	588 cuvettes (2 m.)	5 1/2 cuvettes 0,110 m³ 4/3 sac	—	180 (1 3/4 sac + Nécessaire)	75	130 (1 sac)	24 m 2 sac 24 pot 2	
3 sacs ciment (B)								
Problème 2	1.112 cuvettes	7 cuvettes 0,140 m³ = 4/3 sac	250	185 (1 sac)	90	165 (1 1/3 sac)	—	pot 2m
3 sacs ciment								

THE DEVELOPED WELL COSTS MORE!

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PROTECTION OF WELL SITES: Solutions to Problems

PROBLEM (1)

SOLUTION: Figure 8 Type, Natural Drainage with Mild Slope

(A) Earth Backing 588 basins 20 l (11.76 m3)
Elements *1 and *3

(B) Levelled and Cemented Earth
Elements *4 and *5 5.5 basins (0.110 m3)

(C) Cement bags (to mix with nere-nere) 3 bags (150 kg)
1/4 bag with (B)
1.75 bag with (E)
1 bag with (F)

(D) Banco Bricks (15 x 20 x 40) - Nothing - Seko and thorns are used

(E) Large dressed stones (15 x 20 x 40) 180 bricks for sub-base with sako

(F) Small dressed stones (10 x 15 x 30) 130 bricks for waterproof trench with cement
(Elements *4 and *5)

(G) Non dressed stones (about 10 x 15 x 20) 75 stones Anti Erosion Support
(Elements *1 and 5*)

(H) Seko 1.5 m high 24 linear meters

(I) Posts to support seko and door 26 Supports gate and door.
24 2

(J) Corrugated iron door 1

Presented by Peter ASHELMAN in Diébougou,
Refresher Training Seminar, 06/20/84

PROBLEM (2)

SOLUTION: Figure 7 Type, Drainage with Mild Slope

(A) Earth Backing 1. 112 basins 20 l (22.24 m3)
Elements *1 and *3

(B) Levelled and Cemented Earth
Elements *4 and *5 7 basins (0.140 m3)

(C) Cement bags (to mix with nere-nere) 3 bags (150 kg)
1/3 bag with (B)
1 bag with (E)
1 2/3 bag with (F)

(D) Banco Bricks (15 x 20 x 40) - 250 bricks - 25 lin. meters x 4 rows
(Element 8 with 125 bricks 10 bricks/lin.m.
/dressed stones below the first
two rows)

(E) Large dressed stones (15 x 20 x 40) 25 bricks 25 lin. m
(With cement in mortar) 5 br/lin. m.
wall foundation

(F) Small dressed stones (10 x 15 x 30) 165 bricks for waterproof trench
with cement
(Elements *4 and *5)

(G) Non dressed stones (about 10 x 15 x 20) 90 stones
(Elements *1 and 5*)
70 20

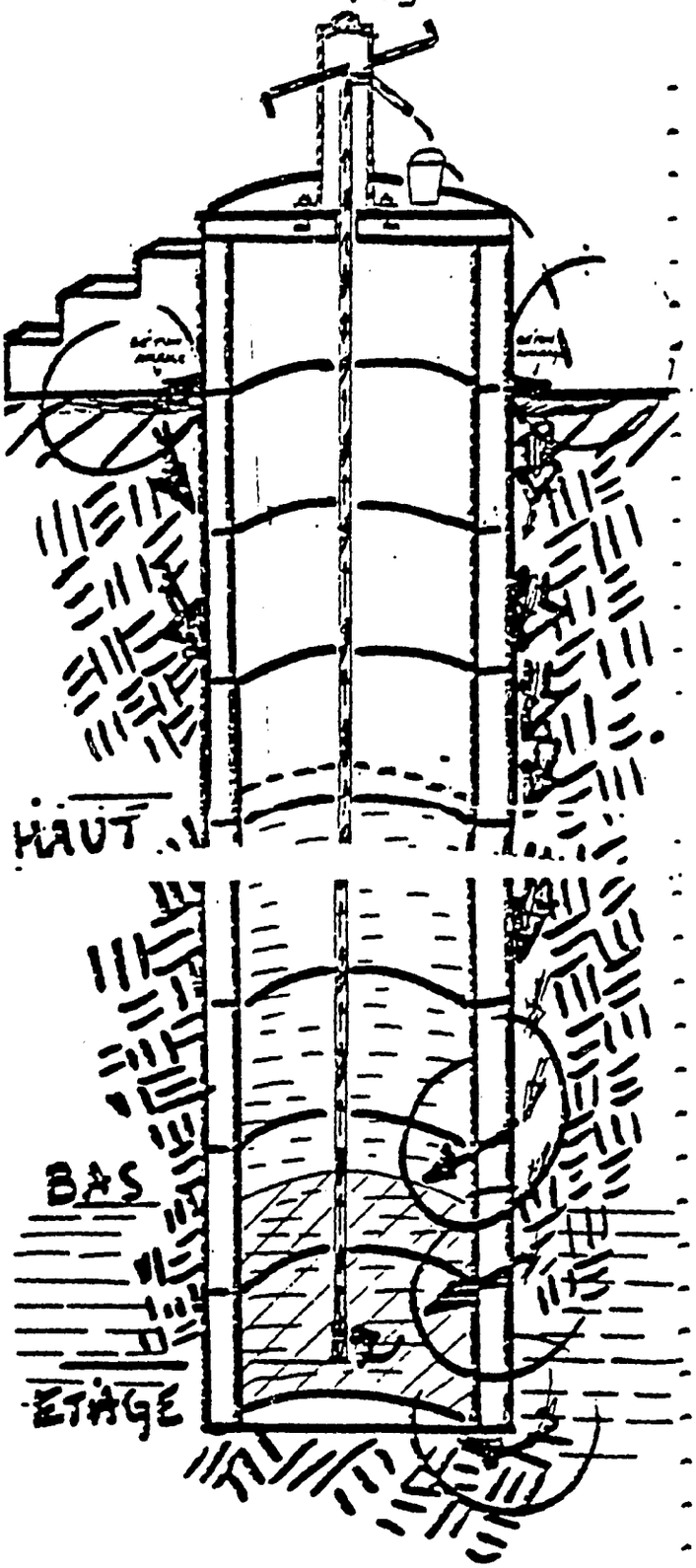
(H) Seko Nothing - Bricks are used for the gate.

(I) Posts 2 to support door

(J) Corrugated iron door 1

Dug Well

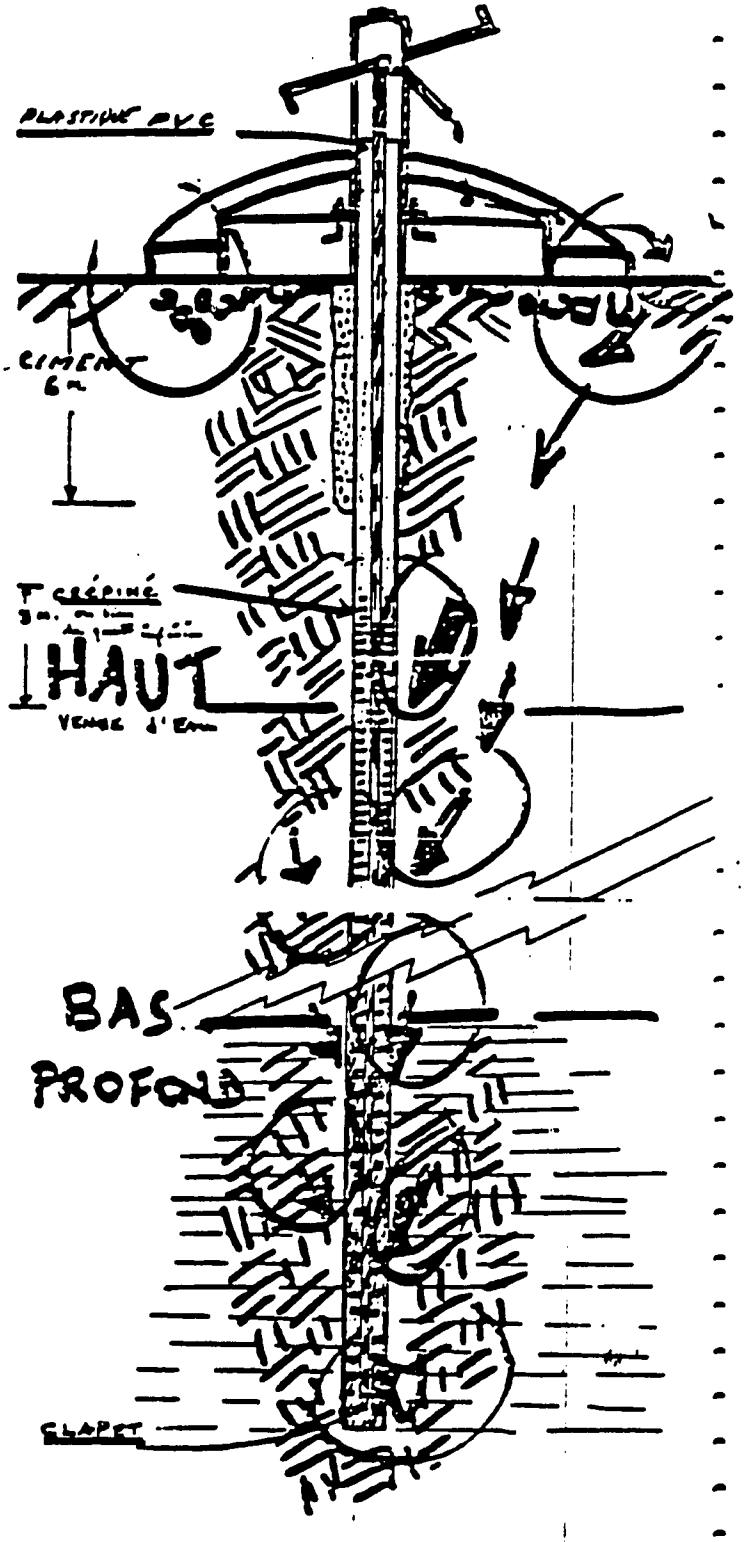
Fig. 1



D'après Peter Ansolmann en collaboration avec l'N.I.S.

DRILLED WELL

FIGURE 3



D' après Peter Ansolmo en collaboration avec l' [illegible]

Solution to Problem No 1	Problem No 3 Difference between solutions 1 and 2 Effort and Materials	Solution to Problem No 2
More:		More:
Materials		
(A)		524 basins Earth Backing
(B)		1 1/2 basins Levelled and cemented earth
(C)	- 0 - 3 cement bags (Same)	
(D)		250 banco bricks
(E) Large dressed stones 55		
(F)		Small dressed stones 35
(G)		Non dressed stones 15
(H) Seko 24 lin. meters		
(I) 24 Posts		
(J)	- 0 - One door (Same)	

CONCLUSION: PROBLEM NO 2 COSTS MORE!

PETER ASHELMAN
Environmental Health Specialist

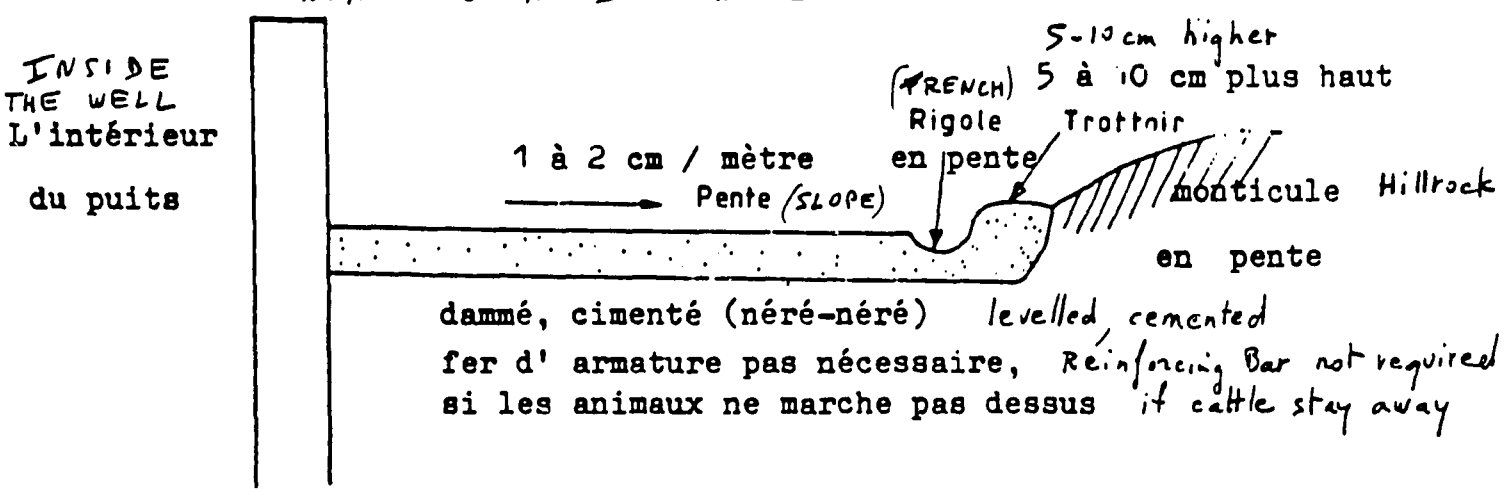
FIGURE 6

PENTE PRECISE — EXACT SLOPE

RIGOLE DE — IMPOUNDING

CAPTAGE — TRENCH

AU BORD D'UN PUITS AMÉNAGÉ
NEXT TO A DUG WELL



d' après P. Léger, From P. LEGER

Spécifications Techniques....

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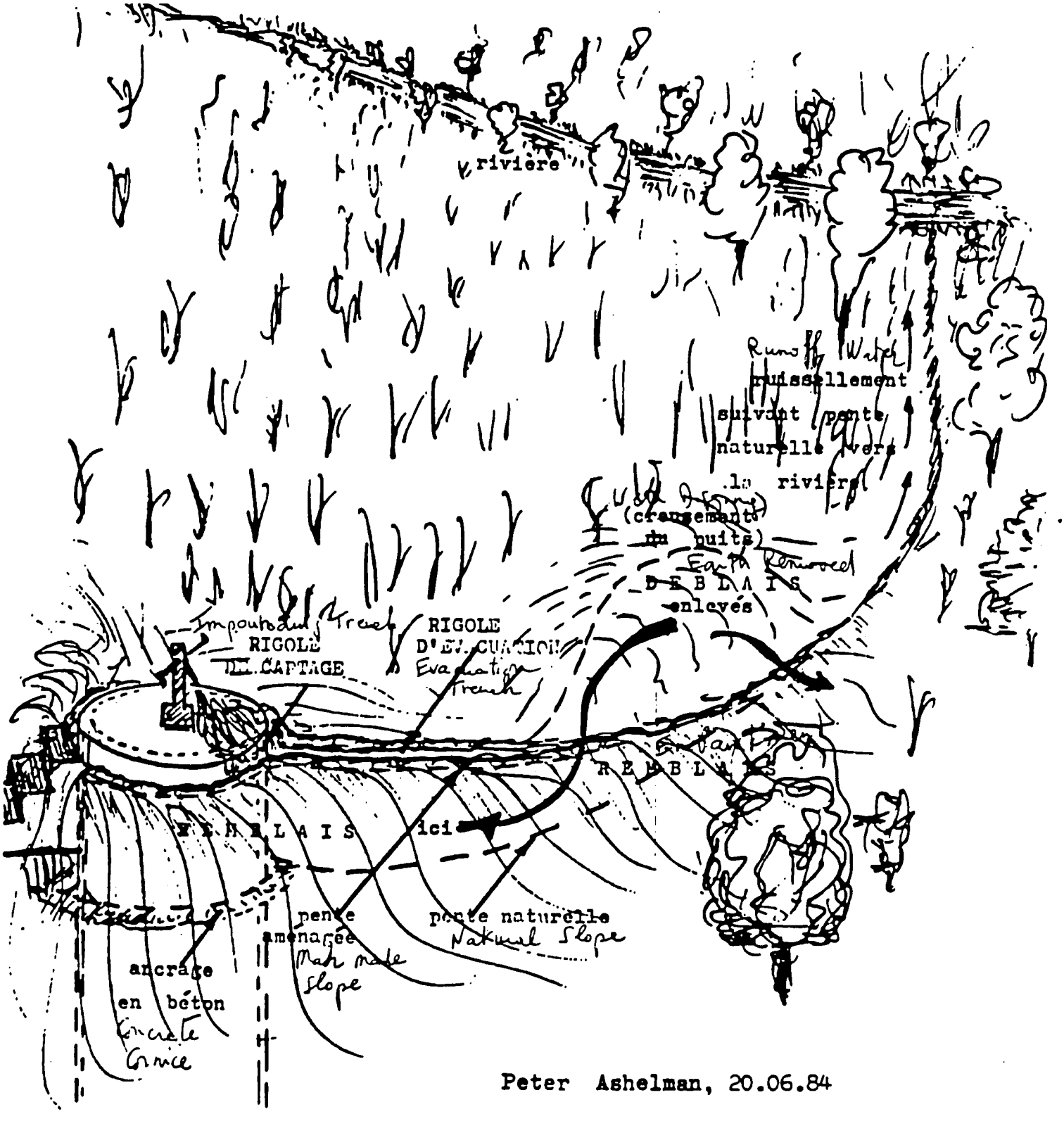
FIGURE 7

WELL AND RAIN WATER EVACUATION WITH

DRAINING SLOPE

(Alternative System: Shovelling and Banking)

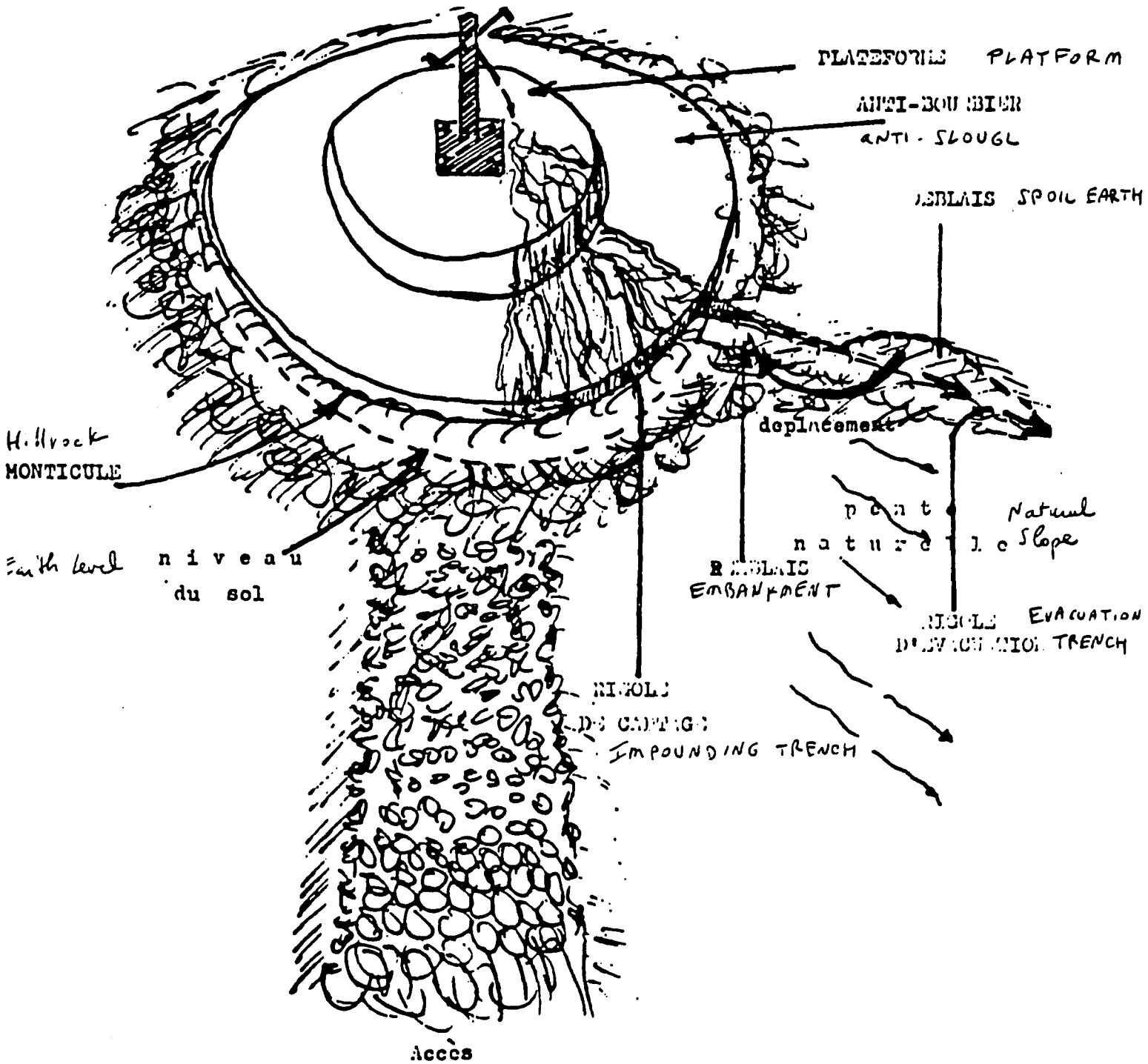


Peter Ashelman, 20.06.84

FIGURE 8

FINAL EVACUATION OF WATER:

NATURAL AND DRAINAGE



Peter Ashelman, 20.06.84

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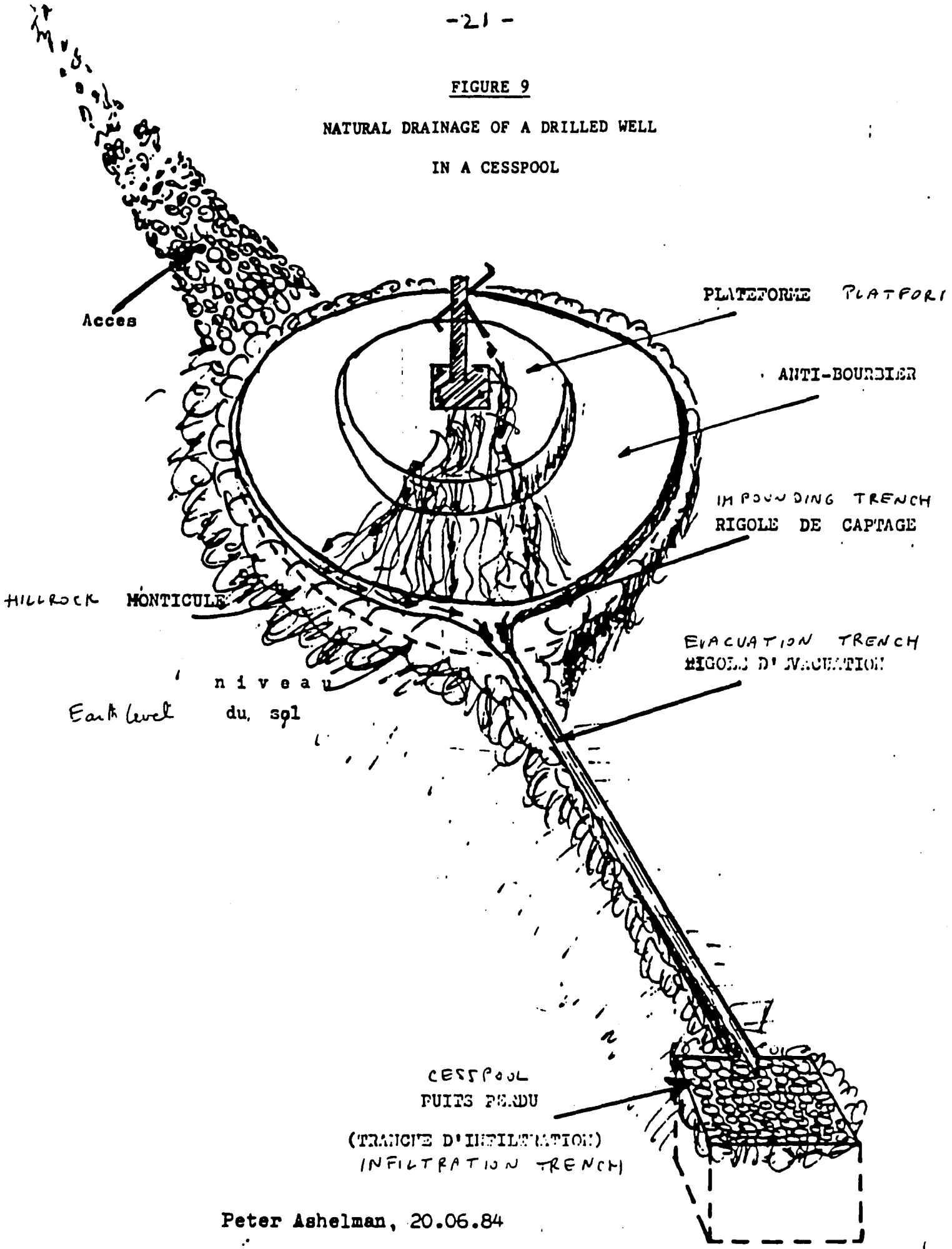
FIGURE 9

NATURAL DRAINAGE OF A DRILLED WELL

IN A CESSPOOL



Peter Ashelman, 20.06.84

TRAINING IN CHEMICAL WATER QUALITY ANALYSIS

INFORMATION BULLETIN

About the Training Seminar in the Use of the DREL/5 HACH[1] kits and Digital pH Meters for physico-chemical water quality analysis

Trainer: Marc LEGRAND of the HACH Company in Belgium[2]

Trainees: Technicians of Hydraulique et Equipement Rural and the Project Health Component (USAID), as well as any others invited by the Project Technical Directors

Duration: Five (5) days (as originally planned)

Dates: May 28 - 1 June, 1984

Place: HER/Bobo, Conference Room

Preparations: -

Water Samples: furnished by the H.E.R. Hydrogeologist

Laboratory Materials: beakers and recipients provided by the Health Component office

Equipment: 3 Complete DREL/5 kits (2 H.E.R., 1 Health)

2 DREL/5 simple kits (without conductivity) along with chemical products for specific analysis

Text: Manual of Water Analysis, by the HACH Company, in French and in English. The first part showing use of the kit is distributed in advance.

Mr. LEGRAND arrives in Bobo May 27 so as to begin training the next day. One full day is reserved for field trials.

Those invited are asked to check with the Secretariat of H.E.R. (TEL. 99.06.50) at 8 am Monday, May 28 for exact time of startup.

(signed) Peter Ashelman
Health Component

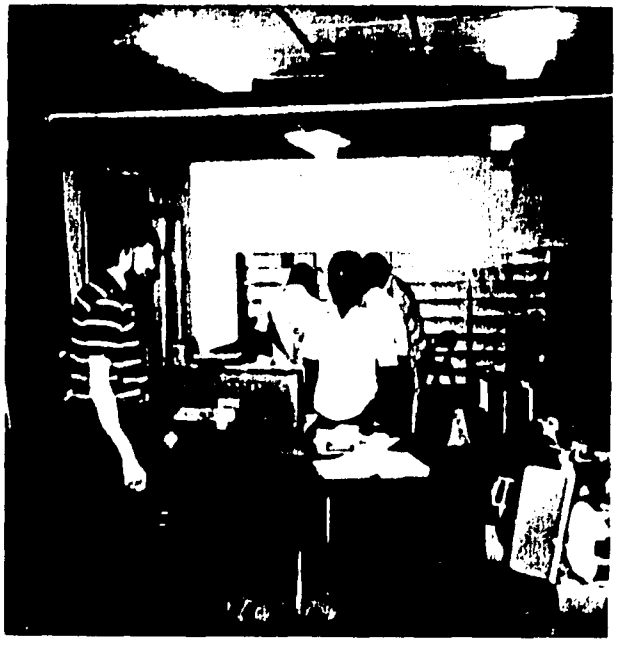
Notes: [1] World Headquarters, Loveland, CO

[2] Under contract with MEDICAL CARE DEVELOPMENT, Inc., International Division, Washington, D.C., Pierre Leger, Dir.

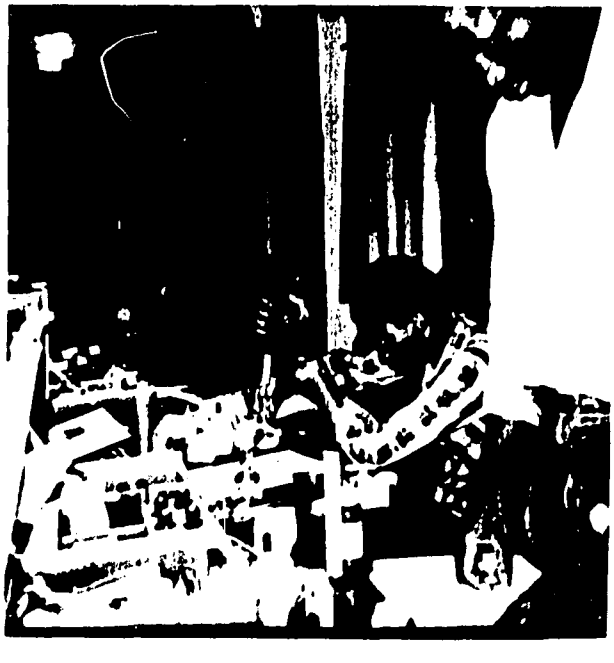
TRAINING SEMINAR IN USE OF H A C H WATER TESTING KITS

MAY 28 - JUNE 1, 1984 IN BOBO DIOULASSO, SPONSORED BY

MEDICAL CARE DEVELOPMENT FOR THE USAID VILLAGE WATER PROJECT



Marc LEGRAND, left Instructor from the HACH headquarters in Namur, Belgium with DREL/5 kits and H.E.R. trainees



Health Department Project Sanitarians performing titration analysis while MCD technical assistant Deborah DISHMAN observes

Photos by Peter Ashelman

(Content of the HACH Seminar)

Day 1: Introduction to the branches of quantitative chimistry, especially colorimetric analysis and the theory of the HACH kit. Initiation in the utilisation of the HACH DREL/5 kits, especially scale-card calibration with blanks.

Day 2: Volumetric analysis using the HACH digital titration apparatus. Physical testing for temperature, pH, and conductivity; special attention to calibration of the HACH digital conductivity meter. Testing equipment on samples from ten sites:

Leguema	Guena
Kotedougou	Guena- spring *
Koumi	Sidi
Koumi Liminary *	Matourkou - water tower (mixture of two boreholes)
Kcami	
Tiara	

* = non- Project water sources

Day 3: Laboratory analysis for the following, using collected field samples:

Acidity	Conductivity
Alcalinity	Temperature
Total Hardness	Manganese
Calcium	Total Iron
Magnesium	Nitrates
Chlorides	Ammonium Nitrogen
Total/Free Chlorine	Orthophosphates
Silicates	Sulfates

Day 4: All morning field trip: field testing of principal parameters at a non-Project drilled well at the Catholic Seminary near Koumi (20 km from Bobo) Clean-up and suggestions for further analysis capability.

Follow-up Use of HACH kits

In the Health component, Project Sanitarian OUEDRAOGO Soukary was appointed by Dr. SONDO to survey the use and inventory of the three DREL/5 kits at Volet Santé. He and colleague TINGUERI Simon plan immediately totake two HACH kits on field testing expeditions for bacteriological analys with Dr. GUILLEMIN's group, in case chemical quality is suspect.

At H.E.R., the two HACH kits with conductivity are entrusted to a Hydrogeologist Dr. Youssouf (Dimpex personnel) and his Voltaic colleague Mr. OUEDRAOGO Mamadou, Geologist Technician, both of who participated in field and lab sessions. Mr. ZIGANE

Victor, Chief of the M.E.R. western well brigade, participated in field and lab work as well. Other M.E.R. brigade Chiefs were often called away by their management duties during the week of training but gained a working familiarity with the apparatus.

POTABLE WATER PROJECT

POTABLE WATER PROJECT

Activity Report for June 1984*

I. Introduction

In the context of our ongoing study of the potability of pumped water in Upper Volta, we wish by this present effort to contribute to the work of the Health Component of the USAID Village Water Project.

During the month of June 1984, we performed bacteriological analysis of 201 functioning wells dug by the Project in the Provinces of Houet and Kenedougou.

The work was done by two (2) teams composed as follows:

1) Dr. F. Guillemin, survey field director, based in Upper Volta
   - Dr. C. Brylinski, a doctor coming for the survey from France.
   - Boukary Ouedraogo, Project Sanitarian

2) Ms. P. Henry, bio-medical technician, based in Upper Volta (team leader).
   - Dr. F. Letersec, medical doctor coming for the survey from France.
   - Simon Tingueri, Project Sanitarian

Management of the survey effort is the responsibility of Dr. L. Monjour, at the Parasitology Laboratory of the University Hospital Center Pitié-Salpetrière in Paris.

* Translation of the Report in French by Dr. Francis Guillemin, field director for bacteriological water quality analysis, associated with the Laboratoire de Parasitologie du CHU Pitié-Salpetrière in Paris. Translator: Peter Ashelman, MCD Environmental Health Specialist.

We are aiming at four objectives:

1) Perform the first systematic evaluation of the potability of Project wells. This takes one added importance when one considers that 50% of infant mortality follows upon diarrhea frequently due to drinking water contaminated by fecal matter.

2) Develop and make available a simple technique for bacteriological analysis, respecting the standards established by the W.H.O, using transportable equipment which is both duplicatable and reliable.

3) Ensure the transfer of competence by familiarizing Voltaic personnel with this technique, so as to:

4) Ensure regular follow-up monitoring of the potability of these wells.

II. Methodology

We make use of lightweight equipment which is transportable in a Peugeot 404 pick-up truck with canopy.

The analysis employs the membrane filter method using the dry medium Sartorius which is rehydrated when placed in the incubator.

We undertake the analysis of four variables using W.H.O. criteria:

1. Total germ density by placing a water sample (1 ml.) on a common medium, incubating for 24 hours at 37° C.

2. Total coliform count using the medium Tergitol TTC, incubating for 24 hours at 37° C.

3. Fecal coliform count using the medium Tergitol, incubating for 24 hours at 44° C, yielding bacteria suspected as a result of recent fecal contamination. When suspect bacteria are isolated, we proceed with the step API 20E (yielding biochemical characteristics of the bacteria). The finding of Escherichia Coli constitutes clear evidence of recent fecal contamination and allows us to declare the water unpotable.

4. Fecal streptococcus count using the medium AZID, incubating for 24 hours at 44° C, which determines semi-recent fecal contamination (1 to 2 months).

As regards this last parameter, we were never able to detect fecal streptococcus; apparently the stock of culture medium, normally designed for a temperate climate (20 to 25° C) is not well preserved at the ambient temperature of the field and is thus quickly decomposed (by oxidation). Thus we must express a caveat as to the reliability of this last analysis.

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III. Results

See Charts. (Note: Charts are available at the Health Component Office. P. Ashelman)

IV. Analysis and commentary

Of the 201 wells analyzed in these Provinces, we found seven polluted, namely: four drilled wells (i.e., boreholes), two wide-diameter wells equipped with pumps, and one wide-diameter open well.

The reasons for the pollution are:

1. Open wells. We noticed that the well installations included, besides the well casing, an animal watering basin located five to ten meters away. Yet rarely was there a system for draining waste water (spilled buckets, laundry washed nearby); so that a mudhole resulted next to the well. Animal wastes can be mixed with the mud, thus making pollution by infiltration.

   More immediately, pollution can occur by way of the drawing bucket, whose bottom comes into contact with this contaminating mud before it is plunged into the open well.

2. wells with pumps. Here again the construction was unsatisfactory, due to the absence of drainage and stagnant waste water.

   In certain villages the problem was made worse when the villagers, capitalizing on the surrounding moist soil, dug excavations to make bricks. Thus at the base of the pump platform you have a little pond with muddy clay, frequented by animals, which again leads to contamination by infiltration.

   In certain villages the seal of the platform semi-cercle slab was broken for either technical (pump breakdown) or practical reasons (water more accessible to several persons at once), thus bringing us to the problems of the open well.

3. Drilled wells. Here we must consider two types of boreholes:

   a) Those finished before November, 1983 with a cement platform covering the soil for a radius of 3 meters;

   b) Those finished after November, 1983 with concrete grout seal following down along the PVC tubing to a depth of 6 meters.

Our experience in the Sahel Privince - where in some places we found up to 10 percent of the boreholes polluted (campaign CEAO 1981-82, pastoral environment with animal presence and mud around the well)- allows us to assume that the boreholes of the first type are not immune to pollution due to direct infiltration into the gravel sleeve surrounding the PVC tubing. The size of the gravel stones is too large to ensure any purification of the water.

It turns out that the boreholes found to be polluted in our survey here are indeed of the first type (Bâ, Sala, Bossora and Béréba-East).

Thus we must emphasize the importance of correct surface water drainage. This was just done at Bâ and Sala a short while ago (written early July 1984). Thus, since the pollution happened recently, we may conclude that this residual contamination will disappear in a short while. Nevertheless, chlorination of the borehole after pumping it out would perhaps be desirable.

In addition, the seasonal factor appears to influence strongly the risk of pollution for these wells. In the rainy season, we observe considerable surface run-off which "washes" the well site, generally situated on a rise. For this reason, contamination by infiltration is reduced.

Besides, the utilisation of the well by both humans and animals diminishes, as they easily find water in ponds. This allows the water in the wells to remain undisturbed for a longer period of time and to develop a considerable number of bacteria. This is why we were led to determine the total germ density in the open and in the equipped wells. This is the meaning of the term "numerous bacteria" or "numerous klebsielles" (saprophytic bacilli) which merits attention because the risk of pollution is much greater.

And finally, this diminishing of well utilisation poses a problem for the technician. As it turns out, the turbidity increases (mud stagnation in the well, metal precipitates in the water due to the rust that flakes off the pump pipes) and causes a deposit on the membrane filters. This inhibits the growth of bacteria colonies on the culture medium, distorts the coloring, and tends to falsify the results. In addition, this change in water quality leads even more to abandoning the pump.

Thus we conclude, considering these (seasonal) variations, that one needs to carry out three surveys of water potability during a twlve-month period.

1. Before the rainy season (March-April) maximum utilisation; high rish of pollution.

2. During the rainy season (July-August) minimal utilisation.

3. After the rainy season (November-December) which takes into account aquifer recharge; average utilisation.

V. Recommendations

These different remarks cannot be made without leading to some recommendations:

1. Ensure in the future the improvement and drainage by concrete surfaces of the well site. It is desirable that the problem be foreseen at the time of introducing the idea of the well ("sensibilisation") prior to its installation.

2. As to drilled wells, we must confirm the wisdom of concrete grouting which is poured around the PVC tubing.

3. It also seems clear that, from a sanitation standpoint, drilled wells should be preferred over wide-diameter wells. But this cannot be done without considering social factors (the wishes of the villagers, information) as well as pump maintenance.

4. Finally we must insist on the importance of the health educator, who has the job of introducing to the people the problems of environmental hygiene. He should try to convince them, for example, of the utility of satisfactory drainage. Obviously, we are talking about a long-term proposition: we cannot expect short-term results, since we are aiming at a change in mentality.

Ministère de la Santé Publique

Direction de la Santé Publique

PROJET USAID HYDRAULIQUE VILLAGEOISE VOLET SANTE

REPUBLIQUE DE HAUTE-VOLTA
Unité-Travail-Justice

-o-o-o-

Modèle de Rapport d'Analyse Bactériologique de L'Eau

Nom et Adresse de l'Opérateur : _____

Localité _____
Sous-Préfecture _____
Département _____
Nature du Point d'Eau : Forage _____ Puits _____ Autres _____

Date et lieu du prélèvement _____
Date et heure de l'arrivée de l'échantillon au laboratoire _____
_____
Date et heure de l'analyse _____

RESULTATS

* Germes Totaux _____ /ml
* Coliformes _____ /100 ml
* Escherichia coli _____ /100 ml
  Strectocoques fécaux _____ /100 ml
  Clostridium Welchi _____ /100 ml

Rapport établi le _____
Observations et
Mesures à prendre _____

Signature de l'Opérateur :

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HEALTH EDUCATION

Presented by Deborah Dishman at the

Seminaries of Refresher Courses for Nurses

April and June 1984

HEALTH EDUCATION

What does EPS* (Health Education) mean?

Taking first of all the word EDUCATION:

- The transfer or the acquisition of knowledge
- Systematic formation, and finally
- The result produced by studios or any formation

Now, the word HEALTH:

The definition of HEALTH as proposed by WHO

- Physical, moral, and mental well-being

The synthesis of EPS: The transfer of knowledge for improving the physical, mental, and moral well-being of the population.

What's more important is the relation of EPS to culture expressed in the most precise terms; the impact of information on the way of thinking and perceiving. It can be said that the way of perceiving health depends on the culture of the population.

Now we shall deal with:

- the roles of nurses in l'EPS
- the preparation for l'EPS, for example, sensitizing and workshops; and
- a few down-to-earth pedagogical concepts

Translator's Note: *EPS refers to Education Pour la Sante = Health Education

The Role of Nurses in EPS

For health (western conception), you are the ones who have first-hand contact with the population. You are the ones who educate and reinforce all the ideas of the population on this matter. In the role of heads of the installations for health, you are the first ones responsible for the Agents of Community Health Services.

How to make use of this type of contact that you have with the population?

Despite the fact that treatment is a priority in your roles, remember than care alone does not mean health. The population must be encouraged to see the utility of changing (bettering) their sanitation practices. But above all, they have to be familiar with their milieu.

A Study of Surroundings (le milieu)

Important Aspects

- Demography

  The number and distribution of persons

- Socio Politics

  a) Traditional infrastructures

  b) Administrative infrastructures

  c) The notables and those citizens having an influence on the population

  d) The receptivity of the population

  e) Social cases, alcoholism, etc.

- Economy

  a) The structure of profitability, such as

     - the existence and duration of groups

     - their profitability

  b) Village taxes

- Profile of Sanitary Conditions
  - a) Current diseases (morbidity) and mortality
  - b) The caring methods (medicines preferred, etc.)
  - c) The hygienic conditions in the village
  - d) Food

Sensitizing and Workshops: A Pedagogy

After having drawn conclusions based on the study of the surroundings, a plan of action should follow, and the first step should be sensitizing and workshops. It is not enough to tell a population to undertake certain tasks if their share in them cannot be measured in concrete terms.

Here are some arguments that can be tried: First of all, saying "you will be less ill if you do this or that," is not very convincing to someone who believes that it's his destiny to be ill, i.e., "death cannot be cured." Make a few simple reckonings on the cost of treatment of some diseases prevalent in their milieu; example amoebic dysentery, paludism, intestinal worms, etc. After that go into the fields and show the loss of manpower when one cannot go to work. That is a concrete demonstration of that it is easier to prevent than to cure.

There is another reckoning, slightly more complicated, developed by Dr. Guiguemde of the Muraz Center, and which serves to estimate the economical cost of a disease especially draconculose (see sheet). The more you're ill, the more you spend and manpower is still lacking; there is less to eat and this creates more expense.

The idea of prevention is not foreign to the population. Traditionally there are always activities destined to avoid bad events such as disease and other things. Now they must be told that improving health habits, such as making up and taking care of protected areas and getting into the habit of making latrines and using them, will have the same effect on illness as their ritual sacrifices.

There is something that should never be forgotten.

There are several ways of transmitting knowledge and of educating a population — there is the practical side which is to begin with the example of one's self. "An image is worth a thousand words." It is of little effect to tell them to make latrines if we cannot show that we have them too. To conclude l'EPS is a process of evolution; one cannot hope for acquired results in less than ten years, and we have just begun.

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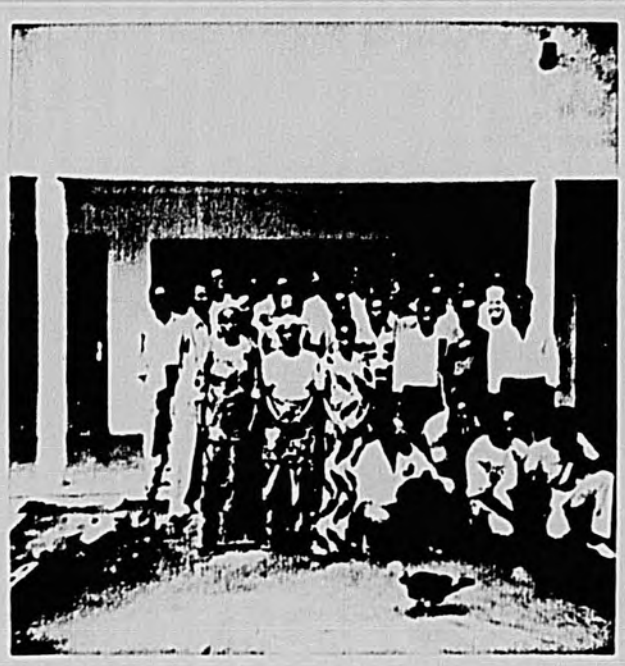
PARTICIPANTS AT DIEBOUGOU TRAINING SESSION

PARTICIPANTS DU RECYCLAGE A DIEBOUGOU

20 - 22 juin 1984

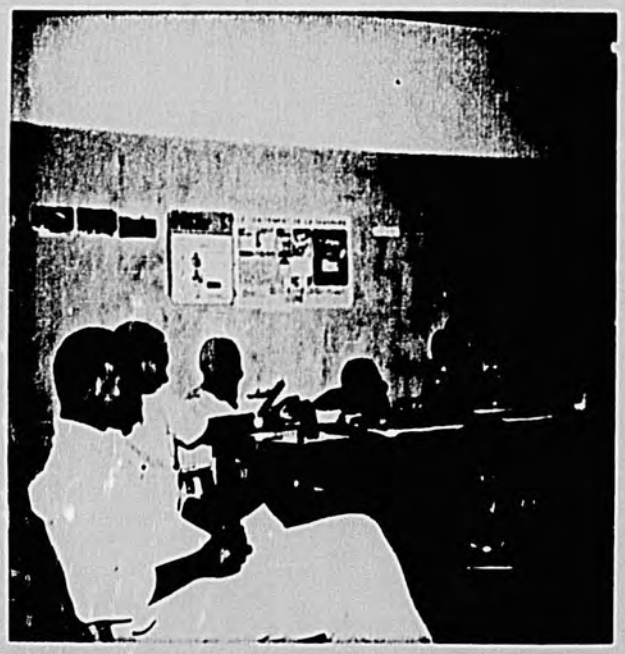


nurses, midwives, sanitarians, well drillers, doctors, health educators, and chauffeurs

DISCUSSION LEADERS AT TRAINING SESSION

CONFERENCIERS DU RECYCLAGE A DIEBOUGOU:

Dr Serme, Directer Provencial de la Sante;
Dr Sondo, Directeur du volet Sante, Projet OS 10
Dr Traore, Directeur de la Direction de l' Education pour la Sante, Hygiene et Assainissement (DESHA), Ouagadougou Ministere de la Sante Publique
Mr. Diallo, Directeur, Hydraulique et Equipement Rural (HER)
Deborah Lishman, Medical Care Development Health Educator



photos by Peter Shelman

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ECONOMIC COST OF ILLNESS

Presented By

DEBORAH DISHMAN

of the Seminaries of Refresher Courses for Nurses

June 1984

ECONOMIC. COST OF ILLNESS

Formula

$$C.E. = \frac{C}{2} + T = \left(\frac{P \times R \times N}{200}\right) + T$$

C.E. = Economical Cost

C = Cost in Agricultural Loss = $\frac{P \times R \times N}{100}$

T = Cost of Treatment

P = % Loss in Agricultural Activities

R = Agricultural Revenue Per Person

N = Equivalence of Ill Workers for Active Ones

Individual

P = 5 months of cultivating during which an individual is ill; (1 month = 4 weeks)

= 1/5 or 20% individual loss

R = 70 bags of millet harvested x 8.500F = $\frac{595.000F}{5\ (\text{persons})}$

= 120.000F/person

N = 1

T = 5.000F

C = $\frac{20\% \times 120.000F \times 1}{200}$ = 12.000

= 12.000 + 5.000 = 17.000F

= 2 bags of millet lost

6 bags of cement setting up of a protection zone; 3 latrine slabs

The Collectivity

The C.E. of an village (C.E. = Economical Cost), where P = calculate prevalence of general illnesses by age group to find the average invalidity time.

Prevalence

No. ill/age	0-15 yrs.	6-15 yrs.	16-45 yrs.	45	Total
Village					
Bamako					
Lokodia					
% ill/age					

Take the % of ill/age, apply to the total population by age group of a village x on y, for example.

Prevalence = 15% of population, 16 years to 45 years

No. of ill = M

No. of days divided by No. of ill = Average time

Invalidity

Total

Average Time = % No. work days = % loss of agricultural activities = (P)
(5 months = 150 days)

R = agricultural revenue/person

N = n_1 = 0 - 5 yrs.

n_2 = 6 - 15 yrs.

n_3 = 16 - 45 yrs. n = Prevalence/age group of a village population

n_4 = 45 yrs.

$$\frac{n_1 + n_2}{2} + n_3 + \frac{n_4}{2} = \text{Active Equivalent}$$

COMMUNITY HEALTH AGENT

TRAINING

COMMUNITY HEALTH AGENT TRAINING

Jan - June 1984

Province	Training of New Recruits			Continuing Education of Existing Agents		
	VHWs	TBAs	Total	VHWs	TBAs	Total
Houet	9	9	18	44	4	48
Kenedougou	21	12	33	12	3	15
[illegible]ouriba	11	9	20	52	0	52
	28	11	39	15	5	20
Total	69	41	110 CHAs	123	12	135 CHAs

*Notes: VHW: Village Health Worker (male)

TBA: Traditional Birth Attendant (female)

CHA: Community Health Agents: minimum team = 1 VHW + 1 TBA

Source: D. Dishman, MCD Health Educator

PROPOSAL FOR IDENTIFICATION OF 50 PILOT VILLAGES

Republic of Upper Volta
Unity-Work-Justice

Ministry of Public Health
General Secretariat
Direction of Public Health
USAID Project Village
Hydraulics: Health

"PROPOSAL FOR THE CHOICE OF 50 PILOT VILLAGES"

by Deborah Dishman and Peter Ashelman

MEDICAL CARE DEVELOPMENT

Method I

Sampling by groupings of 4 provinces

Stage 1

Make categories of all the villages within a radius of action of the 'PHV, then classify them. There are three (3) categories with the following variables attached: presence or absence of PHV water sites; CM/CSPS; CSV/ASC.

This method necessitates some previous information on preliminary data, such as: lack of water (high risk); proximity of the AIS (a radius of 10 to 20 km.); accessibility (the state of roads for the transport of personnel and drilling material).

The three categories give (6) six combinations 3! = 1 x 2 x 3 = 6 combinations (total). (See table).

Synthesis: (4) four provinces = 2 villages, which by combination gives 48 villages.

Stage 2

Statistical sampling

After having classified all the villages by categories, they can be numbered then chosen by a system of randomization or random regrouping.

Advantages

This is a statistical method which would enable us to establish a system of information.

Inconveniences

a) Problems of logistics due to:

   1) Supervision

   2) Transport

   3) Coordinating the activities of the two subprogrammes

b) Lack of technical means and time necessary to do a statistical sampling (computer, etc.)

c) The number of villages (50) as against the real total (530 villages) would be too small to give a statistically valuable sample.

Method II

Samplings by Groupings of 3 provinces

Stages 1 and 2 are the same as in the first method.

(3) provinces = 3 villages/combination = 54 villages

The Advantages: The same as in the preceding.

Proposal: Houet Bourguiba, and Doni provinces (on recommendation by the Wells Technician)

Method III

High Risk Zone

Identify 50 villages grouped within a region of Highest Risk (most remarquable — lack of water and sanitary structures — CSV/ASC).

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1st Possibility

The same classification as in the first stage of the previous methods. One (1) zone = 8 villages, by combination.

2nd Possibility

Only study "unbiased" villages (that have not been influenced by PHV intervention) grouped side by side in one or two departments.

Proposal: The Diebougou and Tiankoura Departments. There are only nine (9) drilled PHV water sites for the two Departments. Because of breakdown in the materials, nothing of the 1984 campaign has been accomplished (the implantation of 30 drillings not yet done), as well as the sanitation activities of the 1984 campaign that have been put off to another period. There will be six (6) AIS at Bondigui, Bapla, Dolo, Bamako, Tiankoura and Nioloniolo.

Hounde Department (District). Great lack of water; three (3) new water sites and two ASV accomplished in 1984.

Advantages

a) Logistically it is the most practical method allowing us to be able to concentrate our efforts of supervision and concentration.

b) The most rapid for the identification of 50 villages.

VARIABLES	Project Intervention			COMBINAISONS
	Project Well site	CM/ CSPS	CSV/ ASV	
Called:				"No intervention
"NULL"	0	0	0	(2 villages)(3 (3 vill) (8 vill)
*A	X	0	0	1st method 2nd method 3rd method
*B	0	X	0	No project intervention
*C	0	0	X	
*D	X	X	0	
*E	X	0	X	
	0	X	X	Exclusive combination (CM/CSPS/CSV/ASV)

FIXED DATA — Prerequisites

Preliminary conditions: Lack of water
Proximity of AIS (10-20 km radius) with new graduates.

Accessibility for drilling material

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PROPOSED VILLAGES*

HOUNDE DEPARTEMENT HOUET PROVINCE

Villages	Population	
Bankoni	197	
Bansié	537	
Bombi	112	
Bobi	499	
Bouahoun	250	(Boni District)
Dakoni	127	
Dora	423	
Dougoumato I et II	1.259	
Doumien et Duo	100	
Karaba	1.691	
Keindeni	90	
Koho	1.481	
Koumbia	1.684	
Koura	354	
Laho	336	
Lofikahoun	822	
Mamboni	~ 500	(Boni District) :
Minou	~ 150	
Pê	1.193	
Seini	519	
Tiawama	143	
Tiomboni	78	
Tiombio (Tionbo)	540	
Tiouro	440	
Diokui	124	

..../....

According to the 3rd method, 2nd option (villages with no previous intervention)

BOUGOURIBA PROVINCE

DIEBOUGOU

TIANKOURA DEPARTEMENT

Villages	Population
Tinguera	
Kpolo	
Kouro	
Minao	
Kourgueno	
Kanséo	
Tiopanao	
Hebrimpono	
Barkoura	
Gairo	
Gongombiro	
Werinkera	
Milpo	
Sangolo	
Gningue Bingue	

DIEBOUGOU DEPARTEMENT

Bondigui	
Ouan	
Sorindigui	
Bonfesso	
Dolo Nord	
Kousabla	
Diasser	
Tampé	
Nisseko	
Navielgane	
Birifor	
Tansié	

REPORT ON VILLAGE WELLS PROJECT

USAID #686-0223

JUNE 27, 1984

Prepared for

MEDICAL CARE DEVELOPMENT INC

UNDER DIMPEX CONTRACT AID/AFR-1709

by

BOSTON UNIVERSITY

CENTER FOR AFRICAN AND MIDDLE EASTERN HEALTH PROGRAMS

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ACKNOWLEDGEMENTS

The authors of this survey effort, a project of three-and-a-half months duration, recognize its timely accomplishment is due to the extraordinary collaboration of many well-wishers. First of all, gratitude is expressed for the warm and appreciative reception offered by the villagers themselves, who are benefiting from the project wells and health training.

Among U.S.A.I.D. Project personnel who made this survey possible, thanks go to the two Technical Directors, Dr. Irenée OUEDRAOGO, Volet Santé (Health Component), and Mamadou DIALLO, Hydraulique Et Equipement Rural (H.E.R.), who approved the initial concept of the survey; H.E.R. Brigade Chiefs Claude KAMBOU, Mamadou Victor ZIGANE, Benjamin SANOU, and Amidou BORRO, who provided essential field information; Volet Sante Sanitarians Omer BOUDA and Etienne HIEN, who supervised research teams and tabulated responses; Sanitarian Boukary OUEDRAOGO, who helped train interviewers of the Organisme Regionale de Developpement (O.R.D.); Zouri DRAMANE, Gaoussou KI, and Paul SANOU, detached from H.E.R. pump installation during Novemeber to collaborate full-time; Miss Joanne SPALDING, Peace Corps Volunteer who interrupted her itinerant health work to provide field and office support in Bobo-Dioulasso; Madame Juliette GNOUMOU and Madame Fatimata KONATE, Volet Santé and H.E.R. secretanjes, respectively.

The O.R.D. at Bobo-Dioulasso generously extended collaborative support from the beginning . Bobo O.R.D. Director

Ibrahim MEEIE promptly agreed to Voiet Sante's request for O.R.D. participation; the Chefs of Secteurs Bobo-Nord and Bobo-Sud, Germain ZONGO and Roger BONKO, then arranged for the survey authors to develop the questionnaires content and form in working sessions with O.R.D. Sous-Secteur Chiefs.

Field work in Houet and Kenedougou Provinces was accomplished almost exclusively by O.R.D.'s knowledgeable local extension workers (Encadreurs). Gratitude is due to O.R.D. Secteur Chiefs Germain ZONGO, Bobo-Nord; Roger BONKO, Bobo-Sud; Daouda KAMBIRI, Oradora; Sie PALM , N'dorola; and Noufou ZANGO, Hounde; and all the Sous-Secteur Chiefs who supervised and assisted the field interviews. No fewer than seventy O.R.D. personnel were involved; their expertise and cooperation greatly facilitated the research.

Most of the Project-trained Itinerant Health Workers, newly placed in the field, assisted in the village field survey. Those in Houet and Kenedougou Provinces collaborated under the supervision of the O.R.D. Sous-Secteur Chiefs, whose O.R.D. extension workers did most of the interviewing. In Poni and Bougouriba Provinces to the East, where the O.R.D. was unable to program a joint field effort under the time frame of the survey, Project personnel from Bobo-Dioulasso did the field interviews in collaboration with the two Project Sanitarians responsible for the region, along with local Itinerant Health Workers and Ministry of Health personnel.

I. PROJECT BACKGROUND

The U.S.A.I.D. village Wells Project (Project no. 686-0228) is a collaborative effort by the Ministry of Public Health (MPH) and Hydraulic and Rural Equipment (HER). The Project's main goal is to improve the health of the people in the area. The Project is now in its fourth year.

The primary purpose of the Division of Rural Development Component is to introduce 620 well systems (well development and pump maintenance) into 550 villages located in the HOUET, KENEDOUGOU, PONI, and BOUGOURIBA provinces in Upper Volta, and to conduct hydro-geological studies. Mr. Mamadou DIALLO is the agency's director, supervising up to 200 personnel.

Then Project's health component is headed by Dr. Blaise SONDO, the Director of Urban Health. The health component involves health workers from the civil service, those trained by USAID, those selected by the villages themselves, and volunteers. The primary purpose of the health component is to establish at least one primary health post per village as a basis for increased public health delivery at higher levels. The Project implementors have given a high priority to public mobilization on the village level (i.e. training of 550 village health workers and health education) as proper methodology to reach their health objective.

The subject of this report is a survey conducted in October and November 1983 relating to the Project. It was developed, in September of that year by HER and ORD/Bobo-Dioulasso in

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collaboration with Medical Care Development, Inc./Dimpex Associates, and was intended to inventory the project.

The scope of the data encompassed 395 out of 550 villages. It was recorded on 395 21-page documents, each asking 317 questions. The Boston University Center for African and Middle Eastern Health Programs (BUCAMEHP) was asked in April 1984 to do the following: 1.Process the survey; 2.Write the final report; and 3.Make recommendations for improving the project information system.

In May 1984 BUCAMEHP sent a team of two Health Information System consultants to Ouagadougou and Bobo-Dioulasso, Upper Volta to work towards the first phase of the task outline. The BUCAMEHP consultants had the opportunity to meet USAID Project officers as well as the directors of contracting companies, Medical Care Development, Inc./Dimpex Associates while still in Ouagadougou. These meetings were useful as a partial orientation to the Wells Project. In addition, the team was also able to meet the director of CENATRIN a para-statal Voltan computer authority, with whom they were able to discuss existing computer activities in Upper Volta and possibilities for future applications of computers in the country's development process.

The team's visit to the Project at HER in Bobo-Dioulasso afforded the opportunity to meet the director of the Direction de Sante Publique/Bobo-Dioulasso, the technical assistance personnel, project staff and director, and to visit four well sites.

The majority of the visit to Bobo-Dioulasso was spent making

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preparations for the analysis of the survey data to be done at the BUCAMEHP office in Ivory Coast. No computers had been purchased by the Project, and others earmarked for use during the visit were not functioning; therefore all data recording and staff training were precluded. However, a suitable micro-computer was eventually made available for a brief demonstration of software presently in use in Abidjan.

II. SURVEY PURPOSE

The goal of the Village Wells Project is to improve the health of the people in the area. The criteria to use to measure that goal are as follows:

1. Provision of a sanitary water system, free of pollution
2. A functioning pump, providing at least six liters of output at fifty rotations per minute
3. An adequate water source for the population. The chosen standard of adequacy is ten liters per capita per day.
4. Little popular objection of quality of water for consumption
5. The existence of a Village Health Committee
6. The existence of a Village Health Worker
7. The existence of a Village Health Education Program
8. One demonstration latrine in each village

From these established criteria it is now possible to determine what questions should be asked to properly measure project criteria, and therefore goals. The following questions attempt to do so.

1. How many project water systems are surveyed?
2. What information is available on type of system?
3. Are the pumps functioning?
4. Is the water level acceptable?
5. Is the village demand for water satisfied?

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6. Are the Village Health Committees functioning?

7. Are the Village Health Workers functioning?

8. Is there an on-going health education program?

9. Is the water quality acceptable?

10. Are the water systems sanitary, with no pollution?

11. Are demonstration latrines constructed and being used?

The survey's purpose is to provide inventory information related to these questions. Later a second survey may be initiated to assess project performance.

III. SURVEY ANALYSIS

This section will attempt to find questions from the actual survey which may give inventory information relevant to the questions posed in the previous section. The relevant questions will also be analysed in terms of statistical useability.

1. How many project water systems are surveyed?

This can be determined by counting the total number of surveys completed.

2. What information is available on type of system?

The survey requests the type of pumps be categorized as open well, well with pump, and bored well with pump. These results can be tabulated, listed, and separately tabulated by province.

3. Are the pumps functioning?

The survey yields useful data on well output at an observed rotation rate, and villager impressions on well function. These data can be analysed individually and compared against each other to see how H.E.R. records compare with villager impressions. The H.E.R. records were collected up to a year before the surveys were collected.

The survey asks whether the well is functioning. The question allows for one of three responses: 1. the pump doesn't work at all; 2. the pump possibly serves the needs of the village despite a surface or underground malfunction; 3. the pump works well at 30-50 rotations per minute, (at least six liters per minute). For response number two it is not easy to tell whether

to consider these pumps as functioning or non-functioning. It also was answered from the H.E.R. files.

The survey also asks for the well output of wells with pumps if the well is operated at 30-50 rotations per minute. This is a much better indicator of whether or not the well is functioning properly, but still leaves the survey with no reliable measure of proper functioning of open wells without pumps. Also, the survey sheet specifies that this section be answered at H.E.R. and not by the surveyor. However, within the section this particular question asks the surveyor to respond if convenient. So the data is mixed between survey and H.E.R. data. Since the number of rotations used in the test was not standard it was decided to normalize the data to 50 rotations per minute to compare the liters of output.

Additional questions are asked of the surveyor on site but no quantitative data concerning well output can be derived.

The villagers are asked if the quantity of output is sufficient for their needs. This question is well worded and gives qualitative information concerning villager impressions of well output.

4. Is the water level acceptable?

The survey contains acceptable data on well depth, and static water water level. However, the wells were always dug or bored to a level equal to, or greater than, the recorded static water level for that area. Since those same static water levels were also placed on the surveys, it is reasonable to expect all well depths to be acceptable when compared against static water

levels.

5. Is the village demand for water satisfied?

The survey yields useful data on village population served by the well. Therefore standards can be developed for the well output that is neccessary to serve each village. Based on twelve hours of well output per day the standards developed are as follows:

- o For a village of 500 or less the pump should yield at least 6 liters/minute.
- o For a village of 500 to 750 the pump should yield at least 10 liters per minute.
- o For a village of 750 to 1000 the pump should yield at least 14 liters per minute.

Therefore wells serving villages with a population greater than 500 will be not be expected to meet criteria if only one project well is in the village. This data can also be compared against villager impressions to examine how their impressions compare with H.E.R. records.

6. Are the Village Health Workers functioning?

The survey contains a section which asks four questions, all with three possible answers, relating to the presence and impact the village health worker in the village. The first question asks: 1.Does the village health worker exists in the village and if not; 2. Is it because he has moved?, or; 3. He does live in the village but the surveyor was unable to find him. The second question inquires about villager appreciation for the village health worker. The possible answers are: 1. Very much

appreciated; 2. Appreciated, and; 3. Not at all appreciated. The third question asks about villager support for the village health worker. The possible answers are: 1. Well supported by the village population; 2. Mediocre support, and; 3. No support. The fourth question asks about the level of villager participation. The three possiible answers are: 1. The participation is good; 2. The participation is mediocre, and; 3. The participation is insufficient.

The first three questions relating to villager appreciation and support are well worded and provide, in additjon to data attesting to the village health workers presence, useable qualitative assessments of their impact on the village.

7. Are the Village Health Committees functioning?

The survey contains the same questions regarding the village health committees as it does for the village health workers except for the most essential one: Do they in fact exist in the villages? Furthermore, since the village health worker is instructed to fill in this part of the survey, the answers to these questions depend, first of all on the presence of the village health worker and, secondly on the presence of the village health committee itself. For these reasons the question's design does not provide useful data for measuring the project's success based on the criterion of the presence of village health committees.

8. Is there an on-going health education program?

The survey does not directly address this question.

However, information regarding villager appreciation, acceptance, and participation in Village Health Worker, Voluntary Birth Attendant, and Village Health Committee activities can provide useful clues regarding on-going health education in the village. An examination of the data reveals that less than five percent of these questions had responses on the 395 surveys. Therefore the data was not useable for this question.

9. Is the water quality acceptable?

The survey asks the villager: 1. Is the taste of the water preferred over other sources, good, acceptable or bad; 2. The same ratings regarding smell and; 3. The same ratings regarding color. The question is well constructed and should yield useful qualitative data on villager impressions of water quality. Quantitative measures of water quality, however are not present. Dr. Sondo has specific recommendations concerning questions on water quality which will be explained in the last section on recommendations for future surveys.

10. Are the water systems sanitary, with no pollution?

The survey yields data on eight measures related to sanitary conditions around the well. The survey requests the respondent to refer to conditions within a twenty meter radius around the well. The majority of responses revealed a lack of understanding of the question by the respondent. The remaining responses can still provide useful data on sanitary conditions.

11. Are demonstration latrines constructed and being used?

The survey reveals useful information regarding the

existence of a demonstration latrine in the village. While no question directly addresses whether or not the well is being used, the survey does ask the villager if a latrine is considered to be important. This should provide sufficient clues as to whether or not the well is being used.

Other Questions

In addition to these questions, the survey includes a large volume of socio-cultural questions which occupy the bulk of the entire document. These questions are not directly related to the success of the Wells Project, yet they may be useful as base-line data for more general goals in this or other projects in Upper Volta.

The survey also contains a large amount of disease-related information. The survey first asks a village man and a village woman each to respond to a question which rates the severity of twenty diseases. Each disease is to be rated as: 1. Serious; 2. Less Serious; 3. Troublesome; 4. Exists, but not significant, and; 5. Doesn't Exist.

This rating system does not ask the villager to rank the severity of each disease in relation to the other diseases, against some standard, or as compared to past incidence of the disease. Three of the twenty diseases on the question are potentially water-borne diseases. These are: 1. Diarrhea; 2. Intestinal Worms, and; 3. Guinea Worm.

For the purpose of future surveys data on disease rates prior to well installation, data on villages without wells, data on diseases prior to the health education program, and data on

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disease rates of villages without village health workers or committees should be collected, if possible.

The survey next asks a local nurse to respond to the same questions as the villagers. In this case 52 of the 395 surveyed villages had responses to these question. This is not enough of a sample to yield statistically reliable means or other descriptive statistical measures. However cross-tabulated totals may yield some useful information. One nurse usually covers several villages and if those villages were known for each nurse the data could be treated as reliable data. Unfortunately, the respondents don't specify the villages covered by the responding nurse.

The 52 responses to the questions asked of nurses would yield correlations with well and education data that was well less than 50% reliable. The disease questions asked of the man and women in the village may have enough responses to allow for these correlations, however the data is not available for this report.

The survey also contains a section of questions related to village demographic profiles. For each village the survey asks: 1. Total village population; 2. Number of neighborhoods per village; 3. Population per neighborhood; 4. The number of persons who make use of the Project well in a) the rainy-season. and b) in the dry-season; 5. The distribution of age in the village; 6. The birth-rate (for each sex); 7. Seasonal population of emmigrants from the village (by trimester, and, by region of destination); 8. Seasonal population of immigrants to the village (controlled for the same factors as for emmigration), and; 9. The

physical layout of the village in relation to the well-site drawn on two maps by the surveyor.

These questions are all valuable as basic demographic measures and, if effectively used, will provide useable base-line data for future survey analysis. However, at best these figures are good estimates, not exact figures. For this particular survey, this created a problem for fields, such as total village population vs. seasonal well use population. In this case, the variability of response strongly suggests that the data on wet and dry season populations is not usable.

The survey requires a total of 319 responses to be totally filled out. Of those 160 are socio-cultural in nature, and except for the 4 on population data, do not address the problem of assessing the success of the wells project. An additional 39 required responses are classified as 'Administrative' or 'Communications'. None of these directly address the success of the wells project. The remaining 124 survey responses come closest to directly addressing the criterion used for assessing the wells project. The survey questions already discussed in this chapter comprise 87 of the remaining 124 responses. The remaining 37 of the 124 responses are questions which are interesting, and attempt to address the criterion but do not actually tell anything of the effectiveness of the program. The responses for each of these 37 questions for all 395 villages are listed in appendix B.

Of the 87 responses that directly address the criteria, 40 pertain to the village man and woman each asked to respond on the

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severity of 20 diseases. As mentioned above these were not useable. Therefore the project is left with 47 required responses on each of the 395 surveys that can be analysed. The following chart should help to clarify this.

395 surveys each with:

319	required survey responses
-156	socio-cultural question not pertaining to project assessment criteria
- 39	administrative and technical not pertaining to project assesment criteria
- 37	interesting but not pertaining to project success criteria. The results are listed in Appendix B.
- 20	Unusable for this report do to prior tabulation errors

= 47	Survey responses useable for statistical analysis in assessing the wells project.

The next section will display the results of these questions. All data has been analysed through use of the micro-computer based health information system developed by BUCAMEHP for S.H.D.S., Abidjan for use in field epidemiological analysis.

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SURVEY RESULTS

1. How many project water systems are surveyed?

A total of 395 village surveys were used to compile the results. Additional surveys were taken but not used in the calculations for a variety of reasons. In some cases surveys were done twice for the same well. Other reasons for exclusion included illegibility and insufficient well identification information.

2. What information is available on type of system?

The following tables are cross-tabulated totals of well type versus province. The first table shows the simple totals. The second table is identical to the first, except that row and column percentages are included.

Houet had the greatest number of wells installed among the four provinces. Kenedougou had the least. The vast majority of Kenedougou installations were dug wells without pumps.

WELL TYPE BY PROVINCE
ROWS: PROVINCE / COLUMNS: WELL TYPE

	FORAGE EQUI. BORED W/PUMP	PUITS EQUI. WELL W/PUMPS	PUITS OUV. OPEN WELLS	*ROW TOTALS*
HOUET	62	60	8	130
KENEDOUGOU	1	1	44	46
PONI	91	0	28	119
BOUGOURIBA	21	42	7	70
	175	103	87	365

WELL TYPES BY PROVINCE
ROW AND COLUMN PERCENTAGES INCLUDED
ROWS: PROVINCE / COLUMNS: WELL TYPE

	FORAGE EQUI. BORED W/PUMP	PUITS EQUI. WELLS W/PUMP	PUITS OUV. OPEN WELLS	*ROW TOTALS
HOUET	47.7 62 35.4	46.2 60 58.3	6.2 8 9.2	100.0 130 35.6
KENEDOUGOU	2.2 1 0.6	2.2 1 1.0	95.7 44 50.6	100.0 46 12.6
PONI	76.5 91 52.0	0.0 0 0.0	23.5 28 32.2	100.0 119 32.6
SOUROURIBA	30.0 21 12.0	60.0 42 40.8	10.0 7 8.0	100.0 70 19.2
COL TOTS	47.9 175 100.0	28.2 103 100.0	23.8 87 100.0	100.0 365 100.0

3. Are the pumps functioning?

Paired sample techniques for measuring correlation showed no correlation between survey reports of pump function and H.E.R. records of pump output. The surveyor report conflicted with H.E.R. records of pump output as often as they matched.

For question #1 the results of the survey question regarding number of wells in each province was cross-tabulated with the survey question regarding the functioning of the pump. The data, derived from H.E.R. records, lists the rates the functioning of the pump for 258 of the 395 villages surveyed. The results show Poni as having the largest percentage of pumps functioning "well"

(79.1%). The percentage of pumps functioning "well" for all four provinces is 65.5%.

The following page illustrates the cross-tabulation results.

In each cell the center number is the total number of villages for that cell.

The top number in each cell is the percentage that number represents of all "pump function" categories for that province. That is, the percentage that cell represents for that row.

The bottom number in each cell represents the percentage that number represents of all provinces for that "pump function". Thatis, the percentage that cell represents for that column.

The "pump function" headings are:

PANNE A: Pump doesn't work at all

PANNE B: Pump possibly meets needs of village despite failure at surface or underground

BIEN: Pump outputs well at 30-50 RPM, (6 liters / minute)

PUMP STATUS

Rows: PROVINCE \ Columns: SEVERITY

	PANNE A	PANNE B	BIEN	*ROW TOTS*
HOUET	11.3 12 41.4	27.4 29 48.3	61.3 65 38.5	100.0 106 41.1
KENEDOUGOU	0.0 0 0.0	50.0 1 1.7	50.0 1 0.6	100.0 2 0.8
PONI	4.7 4 13.8	16.3 14 23.3	79.1 68 40.2	100.0 86 33.3
BOUGOURIBA	20.3 13 44.8	25.0 16 26.7	54.7 35 20.7	100.0 64 24.8
COL TOTS	11.2 29 100.0	23.3 60 100.0	65.5 169 100.0	100.0 258 100.0

Next the survey question regarding functioning of the pump was cross-tabulated against the type of pump. 75% of the bored wells functioned well and 50% of the covered wells equipped with pumps functioned well. An interesting observation on the quality of this data is that two surveys reported how the pump was functioning on a well that never had a pump. (They both reported that the non-existant well possibly meets the needs of the village despite some surface or underground problem. Such bizzare answers were common among many of the other discarded questions, but minimal for this question.

The cross-tabulation is illustrated on the following page. The format is the same as the the other cross-tabulations. The headings for type of well are:

FORAGE EQU: 'Forage Equipe' - a bored well equipped with a pump

PUITS EQUI: 'Puits Equipe' - A dug well, covered, equipped with pump

PUITS OUVE: 'Puits Ouvert' - A dug well without a pump

The raw data used in these crosstabulations is listed in Appendix A.

ID:PUMP TYPES

Rows: PUMP TYPES \ Columns: STATUS

	PANNE A	PANNE B	BIEN	*ROW TOTS*
FORAGE EQU	12	28	120	160
PUITS EQUI	17	30	47	94
PUITS OUVE	0	2	0	2
COL TOTS	29	60	167	256

Rows: PUMP TYPES \ Columns: STATUS

	PANNE A	PANNE B	BIEN	*ROW TOTS*
FORAGE EQU	7.5 12 41.4	17.5 28 46.7	75.0 120 71.9	100.0 160 62.5
PUITS EQUI	18.1 17 58.6	31.9 30 50.0	50.0 47 28.1	100.0 94 36.7
PUITS OUVE	0.0 0 0.0	100.0 2 3.3	0.0 0 0.0	100.0 2 0.8
COL TOTS	11.3 29 100.0	23.4 60 100.0	65.2 167 100.0	100.0 256 100.0

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Next the state of the pump was cross-tabulated against the date of installation, first for bored wells, then for dug wells. The results of that analysis follow below.

DATE OF INSTALLATION VERSUS STATE OF PUMP
FOR BORED WELLS ONLY
ROWS: INSTALLATION DATE / COLUMNS: STATE OF PUMP

	PANNE A MALFUNCTION A	PANNE B MALFUNCTION B	BIEN GOOD		*ROW TOTALS*
BLANK	4	15	73	:	92
5/81-12/81	0	2	11	:	13
1/82-12/82	2	3	12	:	17
7/82-12/82	6	6	12	:	24
1/83-6/83	0	2	14	:	16
	12	28	122	:	162

DATE OF INSTALLATION VERSUS STATE OF PUMP
FOR BORED WELLS ONLY
ROW AND COLUMN PERCENTAGES INCLUDED
ROWS: DATE OF INSTALLATION / COLUMN: STATE OF PUMP

	PANNE A MALFUNCTION A		PANNE B MALFUNCTION B		BIEN GOOD		*ROW TOTS*
	4.3	:	16.3	:	79.3	=	100.0
BLANK	4	:	15	:	73	=	92
	33.3	:	53.6	:	59.8	=	56.8
	0.0	:	15.4	:	84.6	=	100.0
5/81-12/81	0	:	2	:	11	=	13
	0.0	:	7.1	:	9.0	=	8.0
	11.8	:	17.6	:	70.6	=	100.0
1/82-6/82	2	:	3	:	12	=	17
	16.7	:	10.7	:	9.8	=	10.5
	25.0	:	25.0	:	50.0	=	100.0
7/82-12/82	6	:	6	:	12	=	24
	50.0	:	21.4	:	9.8	=	14.8
	0.0	:	12.5	:	87.5	=	100.0
1/83-6/83	0	:	2	:	14	=	16
	0.0	:	7.1	:	11.5	=	9.9
	7.4	:	17.3	:	75.3	=	100.0
COL TOTS	12	:	28	:	122	=	162
	100.0	:	100.0	:	100.0	=	100.0

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DATE OF INSTALLATION VERSUS STATE OF PUMP
FOR DUG WELLS ONLY
ROWS: INSTALLATION DATE / COLUMNS: STATE OF PUMP

	PANNE A MALFUNCTION A	PANNE B MALFUNCTION B	BIEN GOOD		*ROW TOTS*
BLANK	9	16	13	:	38
5/81-12/81	0	0	2	:	2
1/81-6/82	3	5	14	:	22
7/82-12/82	4	9	17	:	30
1/83-6/83	1	0	1	:	2
COL TOTS	17	30	47	:	94

DATE OF INSTALLATION VERSUS STATE OF PUMP
FOR DUG WELLS ONLY
ROW AND COLUMN PERCENTAGES INCLUDED

	PANNE A MALFUNC. A		PANNE B MALFUNC. B		BIEN GOOD		*ROW TOTS*
	23.7	:	42.1	:	34.2	=	100.0
BLANK	9	:	16	:	13	=	38
	52.9	:	53.3	:	27.7	=	40.4
	0.0	:	0.0	:	100.0	=	100.0
5/81-12/81	0	:	0	:	2	=	2
	0.0	:	0.0	:	4.3	=	2.1
	13.6	:	22.7	:	63.6	=	100.0
1/82-6/82	3	:	5	:	14	=	22
	17.6	:	16.7	:	29.8	=	23.4
	13.3	:	30.0	:	56.7	=	100.0
7/82-12/82	4	:	9	:	17	=	30
	23.5	:	30.0	:	36.2	=	31.9
	50.0	:	0.0	:	50.0	=	100.0
1/83-6/83	1	:	0	:	47	=	94
	5.9	:	0.0	:	2.1	=	2.1
	18.1	:	31.9	:	50.0	=	100.0
COL TOTS	17	:	30	:	47	=	94
	100.0	:	100.0	:	100.0	=	100.0

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4. Is the water level acceptable?

All responses to the well depth and static water level questions indicate that well depth is at or below the static water level. A listing of date of pump installation, depth of pump, static water level, and filter for all 395 villages surveyed is included in Appendix A.

5. Is the village demand for water satisfied?

Paired sample statistical techniques for measuring correlation showed no correlation between villager reports of adequacy of well output for the needs of the village and H.E.R. records of well output per village population. The surveyor report conflicted with H.E.R. measures of adequacy of well output for a given village population as often as they matched.

First, villager impressions of water quantity are cross-tabulated by province below.

VILLAGER IMPRESSIONS OF WATER QUANTITY BY PROVINCE
ROWS: PROVINCE / COLUMNS: VILLAGER IMPRESSIONS

	MANQUE NEGLIGEABLE	PAS ASSEZ NOT ENOUGH	SUFFISANTE SUFFICIENT	*ROW TOTALS*
HOUET	17	35	39	91
KENEDOUGOU	0	1	1	2
PONI	21	43	18	81
BOUGOURIBA	7	25	17	49
COL TOTS	45	103	75	223

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VILLAGER IMPRESSIONS OF WATER QUANTITY BY PROVINCE
ROW AND COLUMN PERCENTAGES INCLUDED
ROWS: PROVINCE / COLUMNS: VILLAGER IMPRESSIONS

	MANQUE NEGLIGEABLE	PAS ASSEZ NOT ENOUGH	SUFFISANTE SUFFICIENT	*ROW TOTALS*
HOUET	18.7 17 38.8	38.5 35 34.0	42.9 39 52.0	100.0 91 40.8
KENEDOUGOU	0.0 0 0.0	50.0 1 1.0	50.0 1 1.3	100.0 2 0.9
PONI	25.9 21 46.7	51.9 42 40.8	22.2 18 24.0	100.0 81 36.3
BOUGOURIBA	14.3 7 15.6	51.0 25 24.3	34.7 17 22.7	100.0 49 22.0
COL TOTS	20.2 45 100.0	46.2 103 100.0	33.6 75 100.0	100.0 223 100.0

Next, those same villager impressions are cross-tabulated against the size of the village below.

POPULATION VERSUS VILLAGER IMPRESSIONS OF WATER ADEQUACY
ROWS: POPULATION/COLUMNS: VILLAGER IMPRESSIONS

	MANQUE	PAS ASSEZ	SUFFIS	N/A	*ROW TOTALS*
BLANK	7	10	3	2	22
1-500	20	38	40	1	99
501-750	5	17	9	0	31
751-1000	6	10	8	1	25
>1000	15	37	24	4	80
COLUMN TOTALS	53	112	84	8	257

POPULATION VERSUS VILLAGER IMPRESSIONS OF WATER ADEQUACY
ROW AND COLUMN PERCENTAGES INCLUDED
ROWS:POPULATION / COLUMNS:VILLAGER IMPRESSIONS

	MANQUE	PAS ASSEZ	SUFFIS	N/A	*ROW TOTALS*
BLANK	31.8 7 13.2	45.5 10 8.9	13.6 3 3.6	9.1 2 25.0	100.0 22 8.6
1-500	20.2 20 37.7	38.4 38 33.9	40.4 40 47.6	1.0 1 12.5	100.0 99 38.5
501-750	16.1 5 9.4	54.8 17 15.2	29.0 9 10.7	0.0 0 0.0	100.0 31 12.1
751-1000	24.0 6 11.3	40.0 10 8.9	32.0 8 9.5	4.0 1 12.5	100.0 25 9.7
>1000	18.8 15 28.3	46.3 37 33.0	30.0 24 28.6	5.0 4 50.0	100.0 80 31.1
COLUMN TOTALS	20.6 53 100.0	43.6 112 100.0	32.7 84 100.0	3.1 8 100.0	100.0 257 100.0

Finally, H.E.R. records showing pump output in liters per minute for each grouping of village size are cross-tabulated below.

H.E.R. WELL OUTPUT DATA CLASSIFIED BY VILLAGE POPULATION
% VILLAGES WHICH HAVE ADEQUATE WATER

POP. FROM	POP TO	% VILLAGES WITH ADEQUATE SUPPLY	# VILLAGES IN POP GROUP	# VILLAGES WITH ADEQUATE SUPPLY
> 0	< 500	68.36	98	< 6 LITRES=67
> 500	< 750	22.06	30	> 10 LITRES=8
> 750	< 1000	4.16	24	> 14 LITRES=1

6. Are the Village Health Committees functioning?

The question is not actually asked on the survey and responses to related questions are less than 5% of the total villages surveyed. The data is not usable.

7. Are the Village Health Workers functioning?

The survey asks the respondent to reply:

NON- There has not been one established in this village

PARTI- There had been one established but he doesn't live here any more.

PAS TROUVE- One lives here but the investigator was not able to find him

Two additional categories were derived from other survey questions. They are:

OUI- Yes there is one. This is an assumption based on whether or not survey questions regarding the village's appreciation, support, and participation of the VHW were filled out.

MISSING- No information about a VHW

The following page illustrates the cross-tabulation of these categories with the number of villages responding from each province. In 44.3% of the cases, no VHW existed.

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A.S.V. IN VILLAGES

Rows: PROVINCE \ Columns: A.S.V

	NON	PARTI	PAS TROUVE	OUI	MISSING	*ROW TOTS
HOUET	63	0	7	54	8	132
KENEDOUGOU	30	7	5	2	2	46
PONI	58	0	4	33	39	134
BOUGOURIBA	24	5	5	36	13	83
COL TOTS*	175	12	21	125	62	395

Rows: PROVINCE \ Columns: A.S.V

	NON	PARTI	PAS TROUVE	OUI	MISSING	*ROW TOT
HOUET	47.7 63 36.0	0.0 0 0.0	5.3 7 33.3	40.9 54 43.2	6.1 8 12.9	= 100. = 132 = 33.4
KENEDOUGOU	65.2 30 17.1	15.2 7 58.3	10.9 5 23.8	4.3 2 1.6	4.3 2 3.2	= 100. = 46 = 11.6
PONI	43.3 58 33.1	0.0 0 0.0	3.0 4 19.0	24.6 33 26.4	29.1 39 62.9	= 100. = 134 = 33.9
BOUGOURIBA	28.9 24 13.7	6.0 5 41.7	6.0 5 23.8	43.4 36 28.8	15.7 13 21.0	= 100. = 83 = 21.0
COL TOTS	44.3 175 100.0	3.0 12 100.0	5.3 21 100.0	31.6 125 100.0	15.7 62 100.0	= 100. = 395 =100.0

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8. Is there an ongoing health education program?

Of the questions on the survey which relate to this question there was a response rate of less than 5% . This is insufficient to yield meaningful results.

9. Is the water quality acceptable?

The survey question regarding the quality of the water was cross-tabulated against the number of wells in each province for three measures of quality. The three measures are villager impressions of: 1. Taste; 2. Color, and; 3. Odor.

The villagers were asked to rate each as: 1.Bad; 2.Acceptable; 3.Good and 4.Preferred over other water sources. A large number of villages responded to these questions. On the subject of 'Taste' 377 village responded. 25.5% of the respondents preferred the well water taste over the taste of other water sources.

On the subject of 'Color' 374 villages responded. 34.5% reported preferring the color over other water sources.

On the subject of 'Odor' 377 villages responded. 25.5% reported preferring the odor over other water sources.

The cross-tabulated results are presented on the next three pages.

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GOUT (TASTE)

Rows: PROVINCE \ Columns: QUALITY

	MAUVAIS	ACCEPTABLE	BON	PREFERE	*ROW TOTS*
HOUET	16	38	51	24	129
KENEDOUGOU	4	3	26	10	43
PONI	12	11	60	43	126
BOUGOURIBA	9	16	35	19	79
COL TOTS	41	68	172	96	377

Rows: PROVINCE \ Columns: QUALITY

	MAUVAIS	ACCEPTABLE	BON	PREFERE	*ROW TOTS*
HOUET	12.4 16 39.0	29.5 38 55.9	39.5 51 29.7	18.6 24 25.0	100.0 129 34.2
KENEDOUGOU	9.3 4 9.8	7.0 3 4.4	60.5 26 15.1	23.3 10 10.4	100.0 43 11.4
PONI	9.5 12 29.3	8.7 11 16.2	47.6 60 34.9	34.1 43 44.8	100.0 126 33.4
BOUGOURIBA	11.4 9 22.0	20.3 16 23.5	44.3 35 20.3	24.1 19 19.8	100.0 79 21.0
COL TOTS	10.9 41 100.0	18.0 68 100.0	45.6 172 100.0	25.5 96 100.0	100.0 377 100.0

COULEUR (COLOR)

Rows: PROVINCE \ Columns: QUALITY

	MAUVAIS	ACCEPTABLE	BON	PREFERE	*ROW TOTS*
HOUET	16	20	52	41	129
KENEDOUGOU	5	1	23	13	42
PONI	6	13	48	57	124
BOUGOURIBA	9	13	39	18	79
COL TOTS	36	47	162	129	374

COULEUR (COLOR)

Rows: PROVINCE \ Columns: QUALITY

	MAUVAIS	ACCEPTABLE	BON	PREFERE	*ROW TOTS*
HOUET	12.4 16 44.4	15.5 20 42.6	40.3 52 32.1	31.8 41 31.8	100.0 129 34.5
KENEDOUGOU	11.9 5 13.9	2.4 1 2.1	54.8 23 14.2	31.0 13 10.1	100.0 42 11.2
PONI	4.8 6 16.7	10.5 13 27.7	38.7 48 29.6	46.0 57 44.2	100.0 124 33.2
BOUGOURIBA	11.4 9 25.0	16.5 13 27.7	49.4 39 24.1	22.8 18 14.0	100.0 79 21.1
COL TOTS	9.6 36 100.0	12.6 47 100.0	43.3 162 100.0	34.5 129 100.0	100.0 374 100.0

ODEUR (ODOR)

Rows: PROVINCE \ Columns: QUALITY

	MAUVAIS	ACCEPTABLE	BON	PREFERE	*ROW TOTS*
HOUET	16	38	51	24	129
KENEDOUGOU	4	3	26	10	43
PONI	12	11	60	43	126
BOUGOURIBA	9	16	35	19	79
COL TOTS	41	68	172	96	377

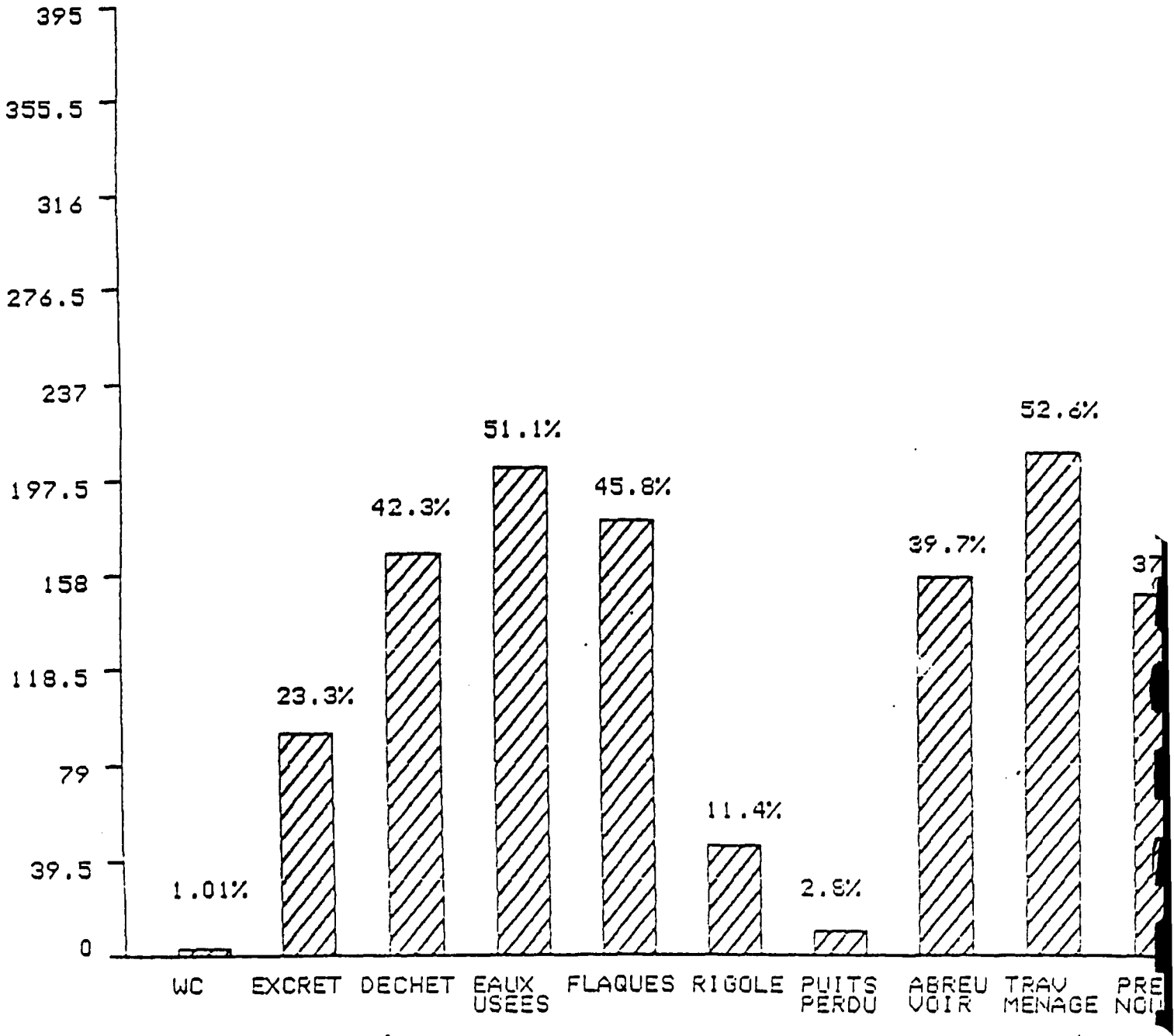
ODEUR (ODOR)

Rows: PROVINCE \ Columns: QUALITY

	MAUVAIS	ACCEPTABLE	BON	PREFERE	*ROW TOTS*
HOUET	12.4 16 39.0	29.5 38 55.9	39.5 51 29.7	18.6 24 25.0	100.0 129 34.2
KENEDOUGOU	9.3 4 9.8	7.0 3 4.4	60.5 26 15.1	23.3 10 10.4	100.0 43 11.4
PONI	9.5 12 29.3	8.7 11 16.2	47.6 60 34.9	34.1 43 44.8	100.0 126 33.4
BOUGOURIBA	11.4 9 22.0	20.3 16 23.5	44.3 35 20.3	24.1 19 19.8	100.0 79 21.0
COL TOTS	10.9 41 100.0	18.0 68 100.0	45.6 172 100.0	25.5 96 100.0	100.0 377 100.0

10. Are the water systems sanitary with no pollution?

This graph lists each total of ten measures of potential pollution. The English translation is as follows: WC=latrine, EXCRET=excreta, DECHET=garbage, EAUX USEES=used water, FLAQUES=puddles, RIGOLE=ditches, PUITS PERDU=old wells, ABREUVOIR=drinking trough, TRAV MENAGE=household chores, PREP NOURRI=food preparation



VILLAGES REPORTING POLLUTION OF VARIOUS TYPES

11. Are demonstration latrines constructed and being used?

Cross-tabulated results are listed for the two related questions below.

TABLE #8
LATRINE DATA BY PROVINCE

PROVINCE	LATRINE IMPORTANT	LATRINE EXISTS
HOUET	77	28
KENEDOUGOU	18	6
PONI	97	21
BOUGOURIBA	62	20
	254	75

Other survey questions

A local nurse was asked to rate each of twenty diseases according to degree of severity. A maximum of 52 surveys had reponses for any one disease. The potentially water-borne diseases that were surveyed are: 1.Diarrhea; 2.Vers Intestinaux (Intestinal Worms); and 3.Ver de Guinee (Guinea Worm). The respondents were asked to rate the diseases as:

1. Doesn't Exist
2. Exists but not significant
3. Troublesome
4. Less Serious
5. Serious

For diarrhea the largest response (51.9%) ranked the disease as less serious. (Of course it is unclear from the way the question is asked exactly what comparison the respondent is making.)

For intestinal worms the largest response (38.3%) also is for the 'less serious' rating.

For Guinea Worm the largest percentage (70.5%) ranked the disease as 'Doesn't Exist'.

The cross-tabulation for all diseases is illustrated on the next three pages.

Rows: MALADIES \ Columns: SEVERITY

	NEXISTE PA	PAS D'IMPO	EMBETANT	MOINS GRAV	GRAVE	*ROW TOT
PALU	0	1	0	8	39	48
DIARRHEE	0	2	4	27	19	52
VERS INTES	2	8	13	18	6	47
VERS GUINE	31	6	3	2	2	44
TOUX	0	5	13	21	10	49
RHUME	1	7	23	14	3	48
CONJONCTIV	0	9	17	20	3	49
OITE	0	8	19	18	3	48
STOMARITE	3	12	17	13	1	46
PLAIES/DER	0	2	17	16	14	49
POLIO	25	5	5	4	4	43
MENINGITE	10	4	1	11	21	47
ROUGEOLE	10	4	2	8	26	50
ONCHO	19	9	9	4	3	44
TRYPANO	39	3	1	1	0	44
TETANOS	17	9	4	1	16	47
LEPRE	5	13	9	15	6	48
TUBERCULOS	8	18	5	11	5	47
GOITRE	12	20	12	0	0	44
AUTRES	5	1	5	5	5	21
COL TOTS	187	146	179	217	186	915

Rows: MALADIES \ Columns: SEVERITY

	NEXISTE PA	PAS D'IMPO	EMBETANT	MOINS GRAV	GRAVE	*ROW
PALU	0.0 0 0.0	2.1 1 0.7	0.0 0 0.0	16.7 8 3.7	81.3 39 21.0	= 10 = 46 = 5.2
DIARRHEE	0.0 0 0.0	3.8 2 1.4	7.7 4 2.2	51.9 27 12.4	36.5 19 10.2	= 10 = 52 = 5.7
VERS INTES	4.3 2 1.1	17.0 8 5.5	27.7 13 7.3	38.3 18 8.3	12.8 6 3.2	= 10 = 47 = 5.1
VERS GUINE	70.5 31 16.6	13.6 6 4.1	6.8 3 1.7	4.5 2 0.9	4.5 2 1.1	= 10 = 44 = 4.8
TOUX	0.0 0 0.0	10.2 5 3.4	26.5 13 7.3	42.9 21 9.7	20.4 10 5.4	= 10 = 49 = 5.4
RHUME	2.1 1 0.5	14.6 7 4.8	47.9 23 12.8	29.2 14 6.5	6.3 3 1.6	= 10 = 48 = 5.2
CONJONCTIV	0.0 0 0.0	18.4 9 6.2	34.7 17 9.5	40.8 20 9.2	6.1 3 1.6	= 10 = 49 = 5.4
OITE	0.0 0 0.0	16.7 8 5.5	39.6 19 10.6	37.5 18 8.3	6.3 3 1.6	= 10 = 48 = 5.2
STOMARITE	6.5 3 1.6	26.1 12 8.2	37.0 17 9.5	28.3 13 6.0	2.2 1 0.5	= 10 = 46 = 5.0
PLAIES/DER	0.0 0 0.0	4.1 2 1.4	34.7 17 9.5	32.7 16 7.4	28.6 14 7.5	= 10 = 49 = 5.4
POLIO	58.1 25 13.4	11.6 5 3.4	11.6 5 2.8	9.3 4 1.8	9.3 4 2.2	= 10 = 43 = 4.7
MENINGITE	21.3 10 5.3	8.5 4 2.7	2.1 1 0.6	23.4 11 5.1	44.7 21 11.3	= 10 = 47 = 5.1

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Rows: MALADIES \ Columns: SEVERITY

	NEXISTE PA	PAS D'IMPO	EMBETANT	MOINS GRAV	GRAVE	*ROW TOT
ROUGEOLE	20.0 10 5.3	8.0 4 2.7	4.0 2 1.1	16.0 8 3.7	52.0 26 14.0	100 50 5.5
ONCHO	43.2 19 10.2	20.5 9 6.2	20.5 9 5.0	9.1 4 1.8	6.8 3 1.6	100. 44 4.8
TRYPANO	88.6 39 20.9	6.8 3 2.1	2.3 1 0.6	2.3 1 0.5	0.0 0 0.0	100. 44 4.8
TETANOS	36.2 17 9.1	19.1 9 6.2	8.5 4 2.2	2.1 1 0.5	34.0 16 8.6	100 47 5.1
LEPRE	10.4 5 2.7	27.1 13 8.9	18.8 9 5.0	31.3 15 6.9	12.5 6 3.2	100. 48 5.2
TUBERCULOS	17.0 8 4.3	38.3 18 12.3	10.6 5 2.8	23.4 11 5.1	10.6 5 2.7	100. 47 5.1
GOITRE	27.3 12 6.4	45.5 20 13.7	27.3 12 6.7	0.0 0 0.0	0.0 0 0.0	100. 44 4.8
AUTRES	23.8 5 2.7	4.8 1 0.7	23.8 5 2.8	23.8 5 2.3	23.8 5 2.7	100. 21 2.3
COL TOTS	20.4 187 100.0	16.0 146 100.0	19.6 179 100.0	23.7 217 100.0	20.3 186 100.0	100. 915 100.0

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Numerous additional survey questions were processed and listed in the Appendices. They may serve as the basis for future surveys conducted to assess on-going project inventories and performance.

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CONCLUSIONS AND RECOMMENDATIONS

I. SURVEY FINDINGS

This section summarizes the survey results which pertain to the eleven questions established for measuring Project status tabulated in the previous section. A detailed listing of the raw data used in this and the last section can be found in Appendix A.

1. How many Project water systems are surveyed?
   The survey has produced 395 usable questionaires.

2. What information is available on type of system?

Of 365 wells categorized, bored wells with pumps totalled 175, dug wells with pumps totalled 103, and dug wells without pumps totalled 87.

3. Are the pumps functioning?

For any given village, villager reports on the state of the pump conflicted as often as they concurred with H.E.R. records. Villager totals are as follows:

Of the 103 dug wells with pumps, responses to the question on the state of the pump totalled 94. Of these 94, a total of 47 or 50% reported that the state of the pump was good.

Of the 175 bored wells with pumps, responses to the question on the state of the pump totalled 162. Of these 162, a total of 122 or 75.3% reported that the state of the pump was good.

The reported state of the pump was compared to the date of installation and was found to be relatively constant across the span of installation times.

4. Is the water level acceptable?

All well depths are at or below the static water level.

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5. Is the village demand for water satisfied?

For any given village, again, villager reports conflicted as often as they concurred with H.E.R. records.

In the 99 villages with reported population of 500 or less, 40 or 40.4% reported having sufficient water for the village. H.E.R. records show that of 98 villages, 67 or 68.36% of these villages have wells that yield greater than 6 liters of output per minute, which is necessary for a village of this size.

In the 31 villages with reported population of 501-750, 9 or 29% reported having sufficient water for the village. H.E.R. records show that of 30 villages 8 or 26.6% of these villages have wells that yield greater than 10 liters of output per minute, which is necessary for a village of this size.

In the 25 villages with reported population of 751-1000, 8 or 32% reported having sufficient water for the village. H.E.R records show, that 1 or 4.16% of these villages have wells that yield greater than 14 liters of output per minute, which is necessary for a village of this size.

In the 80 villages with reported populations of more than 1000, 24 or 28.6% reported having sufficient water for the village. H.E.R. standards suggest one well is never sufficient for a village of this size.

6. Are the Village Health Committees functioning?

Less than 5% response yielded ~~no~~ usable data from the survey on the existence of the Village Health Committee.

7. Are the Village Health Workers functioning?

In 44.3% of the responses no VHW existed.

8. Is there an ongoing health education program?

Less than 5% response yielded ~~no~~ usable data.

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9. Is the water quality acceptable?

On the subject of 'Taste' of 377 responses, 25.5% preferred the well water taste over the taste of other water sources. On the subject of 'Color' of 374 responses, 34.5% reported preferring the color over other water sources. On the subject of 'Odor' of 377 responses, 25.5% reported preferring the odor over other water sources.

10. Are the water systems sanitary with no pollution?

The following are the percentages of villages reporting the existance of each possible contaminant within 20 meters of the well.

Latrine: 1.01%	Ditches: 11.4%
Excreta: 23.3%	Old Wells: 2.8%
Garbage: 42.3%	Drinking Trough: 39.7%
Used Water: 51.1%	Household Chores: 52.6%
Puddles: 45.8%	Food Preparation: 37.9%

11. Are demonstration latrines constructed and being used?

Of the 395 villages surveyed 75 reported the existence of a demonstration latrine. When asked whether or not a latrine was important, 254 reported that a latrine was important.

II. SURVEY DESIGN AND METHODOLOGY

Future surveys by A.I.D. to determine Project effectiveness, for this or any other Project, should be designed in a fashion similar to the procedure used to prepare this paper. First, the goals of the Project must be clearly listed. Second, the criteria for determining Project success in attaining these goals must be listed also. Third, a list of questions that directly address whether the criteria have been met must be clearly listed. These questions, derived from the above procedure, form the basis of a well designed survey. The last survey apparently

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stressed from such a procedure and consequently revealed large amounts of data that, although interesting, tell nothing of the Project's effectiveness.

Future surveys conducted by A.I.D. to determine Project effectiveness, for this or any other Project, should be conducted in a fashion that maximizes the probability of collecting valid and reliable data. This dictates a need for the training of surveyors to ask the questions exactly as they appear on the survey sheet, and to record the exact reply of the respondant.

Future surveys by A.I.D. to determine Project effectiveness, for this or any other Project, should be analysed in a fashion that maximizes the probability of achieving valid and reliable results. The number of times that the survey data is transcribed and re-transcribed from survey form to the final report should be reduced as much as possible. And, the necessity for having individuals encode the data for tabulation should be eliminated. Transcription and encoding errors have always been a potentially great source of error; the last survey proved to be no exception.

III DATA

A properly executed survey done once will yield no results for time-dependent variables. Therefore it is of upmost importance to develop questions specifically for the creation of base-line data with history as a control group. Equally important is the execution of follow-up surveys to allow for this comparison over time. This procedure is vital for the critical measures of Project success, since data analysed over time yield more valuable results on Project performance than do data which

can not be verified over time. The last survey contains relatively little useful base-line data controlling for historical variations. Among the questions in the survey, candidates for base-line data controlling for history are:

* Pump Function: Only those which function well were found to be statistically useable (see Results section); therefore the other measures for pump function are excluded as base-line data.
* Pump Function by Type: Again, only those pumps which functioned well are statisticaly useable.
* Normalized Well Output
* Villager Impressions of Water Color, Odor, and Taste
* Villager Impressions of Disease Severity: This field is a potentially workable data item for base-line data. It was not tabulated in this report because it does not provide quantifiable data on disease prevalence; may, however, be useful for subjective assessments.

Dr. SONDO, apparently aware of the weak health component data collected by the survey, made several reccomendations to improve the quality of health questions. Some of his reccomendations could be used as base-line data, in addition to being improvements over the previous survey. They are:

* ~~Well Water Temperature~~.
* Type and Amount of Disinfectant used.
* No. of Monthly Visits Made by the Itinerant Health Workers By Village.
* Village Population Verified by Itinerant Health Worker

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each month.

In addition to these a useful set of base-line data items not included on the survey can be accessed from hospital records. These records may indeed prove in some cases to be the most accurate and the most up-to-date.

It is also important to control for villages which don't have pumps (or other respective item) in the analysis of base-line data. As opposed to the time-analysis which controlling for history provides, controlling for this variable makes it possible to compare Project success based on the advantage that pumps may offer to particular villages.

IV RECOMMENDATIONS FOR FUTURE INFORMATION MANAGEMENT

The design and conduct of future surveys for the Wells Project should be done in concert with the implementation of a Health Information System (H.I.S) developed for the specific data requirements of the Project. The effectiveness and accuracy of future surveys will be significantly improved if an information collection and processing system, based on the guidelines outlined in this section, is designed to support the survey itself. Such a system was noticeably lacking in the last survey, the consequences of which were: 1. Non-standard, and hence, inaccurate data collection techniques; 2. Inadequate controls and uneccesary encoding during the tabulation of data, hence frequent false or missing data entries on tabulation sheets, and: 3. The absence of a data processing or interpretation capability. These areas of data control are efficiently and easily manageable with a properly adapted health information system.

The Health Information System eventually adopted by the Wells Project will provide the capacity to manage all three of the defective areas mentioned above from the last survey if properly developed. In doing so, the use of micro-computer-based data processing should be incorporated into the design of the H.I.S.

The H.I.S. should be introduced as a componenent of a Management Information System (M.I.S.) designed to manage the flow of information affecting all aspects of the Wells Project's activities.

When properly implemented, the functioning M.I.S. will provide quick access to feedback data at the periphery so that changes over time and changes between areas affected and/or not affected by Project activities can be assessed and ranked for prompt decision making at the H.E.R. and health component offices. When properly implemented, the functioning Management Information System will also provide quick channeling of resources in response to those changes which the System detected and the decision makers acted upon. Finally, when properly implemented, the functioning Management Information System will manage and assess those resources which are available and which become available for Project use.

Micro-computers are the essential tool for making the M.I.S. work well and fast. Although they do pose an initial challenge make full use of them, experience in the Ivory Coast and Sierra Leone (and elsewhere) prove that their mastery is feasible for those involved in health management. It has been

the experience of the programs which now make use of micro-computers in those countries, that the improvements that were made involving the micros in their information systems outweigh any and all investments in time and in resources for the development of the working system.

The system for the Wells Project would require at least two (2) transportable micro-computers, two (2) dot-matrix printers, uninterruptable power-sources (UPS) for each computer; and for each computer an accounting software package, a word-processing software package, a data base software package, a statistics software package, a graphics software package, extra ribbons, paper, and diskettes.

The following brands are reccomended based on field tests in the Ivory Coast and Sierra Leone:

> Kaypro-10 micro-computer: It was chosen for its compactness and transportability (the screen, 3 logical drives, the key-board, and the main computer-board are all contained in one unit which can be easily transported and is completed encased in rugged metal The Kaypro-10 also comes with a large package of "bundled software" written to a hard disk located internally. This makes it unnecessary to separately purchase much of the required software [only the statistical and graphics software packages are not included with the Kaypro], and also eliminates the need to interchange floppy diskettes to execute the programs.)

* C.Itoh dot-matrix printer.
* Software Packages: Accounting and general "data-base" functions can be performed with the same software. The Kaypro comes with dBase II, a powerful and popular program; however a less versatile but simpler program called "D.B. Master" has been tested successfully, but it must be purchased separately from the Kaypro. "Statpak" is currently in use in Ivory Coast and Sierra Leone for statistical analysis of almost any type. It does not come with the Kaypro, but is available for it.

The above equipment should perform extremely well in a Management Information System formed along the lines described in this section. All of it is inexpensive, and given its possibilities, should not be considered as low priority.

Training should be done on an individual basis until a working knowledge of the entire system and its several components are obtained by all involved staff.