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CLASSIFICATION

PROJECT EVALUATION SUMMARY (PES) – PART I

Report Symbol U-447

1. PROJECT TITLE	2. PROJECT NUMBER	3. MISSION/AID/W OFFICE
Central African Republic Rural Village Wells	676-0003	USAID/Yaounde

4. EVALUATION NUMBER (Enter the number maintained by the reporting unit e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 each FY)

☐ REGULAR EVALUATION ☐ SPECIAL EVALUATION

5. KEY PROJECT IMPLEMENTATION DATES			6. ESTIMATED PROJECT FUNDING	7. PERIOD COVERED BY EVALUATION
A. First PRO-AG or Equivalent FY 75	B. Final Obligation Expected FY 80	C. Final Input Delivery FY 80	A. Total $ ____ B. U.S. $ 500,000	From (month/yr.) 6/78 To (month/yr.) 1/80 Date of Evaluation Review

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A. List decisions and/or unresolved issues; cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.)	B. NAME OF OFFICER RESPONSIBLE FOR ACTION	C. DATE ACTION TO BE COMPLETED
Decisions		
1. Terminate well drilling activities outside the continental terminal (CT).	Richard Goldman	May/June 1980
2. Continue well drilling activities using existing equipment within CT.	Richard Goldman	April 1980
3. Initiate steps to undertake a hydro-geologic reconnaissance including discussions with UNDP and GOCAR, if further wells programs are to be funded by AID.	Richard Goldman	June 1980

9. INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

- ☐ Project Paper
- ☐ Financial Plan
- ☐ Logical Framework
- ☐ Project Agreement
- ☐ Implementation Plan e.g., CPI Network
- ☐ PIO/T
- ☐ PIO/C
- ☐ PIO/P
- [X] Other (Specify) IAA
- ☐ Other (Specify) ____

10. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

- A. ☐ Continue Project Without Change
- B. [X] Change Project Design and/or [X] Change Implementation Plan
- C. ☐ Discontinue Project

11. PROJECT OFFICER AND HOST COUNTRY OR OTHER RANKING PARTICIPANTS AS APPROPRIATE (Names and Titles)

Richard L. Thornton, Health Officer
Richard Goldman, Project Manager
Peace Corps, Bangui; Staff Travaux Publics
American Embassy Bangui

12. Mission/AID/W Office Director Approval

Signature: [signature]

Typed Name: James E. Williams

Date: March 6, 1980

AID 1330-15 (3-78)

AGR:RHGoldman [signature] HNPO:RCBrown [signature] DPRM:TEBratrud [signature] ADIR:FEGilbert [signature]

PES

13. Summary - The CAR Rural Village Wells Project was originally conceived to bring immediate relief to the drought-affected northern CAR under the Sahel Disaster Relief Assistance Program. Because of the nature of the problem addressed and funding used, an abbreviated Project Design procedure was utilized. It was intended that this project would take advantage of the relatively simple technology of the highly successful Relief and Rehabilitation Chad Wells Program. It was also intended that the project would begin as soon as possible and would realize its goal within 125 weeks beginning in December 1975.

This special evaluation has been requested by AID/W prior to re-authorizing project activities which were terminated when the U.S. government formally terminated its AID program in the CAR (then CAE) for human rights violations in September 1979. AID wants to take advantage of this suspension of project activities to collect information helpful for deciding whether to:

A. terminate the project's activities altogether;
B. make needed modification to project design and continue implementation;
C. consider consolidating the Wells Project with other AID activities in CAR (Ouham); or
D. expand the current Wells project (where feasible) to other areas of the CAR under the general rubric of rural public health.

The goal of the project is to improve the health and well-being of the rural village populations in the northern areas of the CAR which have been affected by the Sahelien drought. This was to be accomplished by the construction of 250 tube wells with simple hand pumps in rural villages. Concurrent with the undertaking of the wells, a health education component was planned which would enable the villagers to protect the well from contamination and make full use of the water that the wells made available. The project has experienced a series of problems which have delayed project implementation and planned progress towards the stated outputs. These have already been discussed in the August 1978 PAR.

The evaluation team has made the following observations:

1. The well drilling technology presently being used is not suitable for most of the area where wells were planned.

2. A) As a result of the unsuitable technology, only ninety-five (95) of the two hundred fifty (250) wells have been brought into production to date. Of the ninety-five (95) constructed, seventy-nine (79) are presently working.

B) To realize the ninety-five producing wells, more than five hundred (500+) holes were drilled.

3. The training of counterparts has not progressed as planned. The technical expertise of the Central African counterparts is adequate to perform the routine maintenance and repairs of the wells already installed but is not adequate to continue the construction program without expatriate assistance and supervision.

4. The GOCAR does not presently have the resources to continue the project after AID inputs cease.

5. The implementation of the health education component was not in evidence in the project.

6. The wells project itself has been well received by the villagers and local officials.

7. Both PCV's plan to give their termination notice on 1 March 1980 unless they receive some assurance that AID funding will be forthcoming in the very near future.

14. Evaluation Methodology

As noted in the summary, the evaluation is being used to assist AID in determining what wells activities, if any, AID should consider funding in CAR. The present evaluation was changed to focus on the following areas:

A. The suitability of the present well drilling technology of the CAR;

B. The general well success rate, pump performance and construction time per well;

C. The project's maintenance performance with emphasis on the training and skill level of the CAR counterparts and their technical capacity to continue to construct and maintain wells after PCV withdrawal;

D. The GOCAR inputs to date and capacity to finance ongoing construction and maintenance activities after termination of AID funding;

E. The factors in the physical and/or cultural environment which tend to affect the health value of wells completed; recommendations for approaches to deal with these factors; and

G. The possibility of combining the wells and OPRH projects.

To implement the evaluation, USAID/Y contracted for the services of Mike Glaze, a hydrogeologist with extensive LDC tube well drilling experience. Mr. Glaze and Richard Thornton, USAID/Yaounde representative, visited the CAR from 28 January 1980 through 8 February 1980.

During this visit the team met with representatives of various organizations with geologic/hydrologic components in Bangui and visited all ninety-five (95) wells constructed to date in the field.

The team's first visit was to the Institute Geologique in Bangui where we were surprised to learn that the Institute had neither geologic maps of any sort nor copies of any geologic surveys that had been done in the CAR. This initial paucity of detailed data was to set the tone for much of the trip.

The team then met with Mr. Quintepas, the Director of OSTROM in Bangui. Mr. Quintepas lent the team his only copy of a geologic map of CAR..which was copied partially by copying machine and partially by hand. OSTROM had no knowledge of recent detailed hydro-geologic studies.

This finding was again confirmed when the team met with Mr. Jean Biandya (Chef de Service) and Mr. Michael Goengonda (Engineer) from the Ministry of Mines and Geology. They also had no geologic maps.

The team met with Mr. Dionou Fidele, Deputy Resident Representative of UNDP in Bangui. Although his organization is planning water projects in CAR in the next few years, UNDP had no knowledge of hydro-geologic surveys in the CAR. One of the possible field projects that UNDP is considering is a country-wide five-year hydro-geologic and water resource survey which would begin in 1981 or 1982. Mr. Dionou also expects that the UN will initiate a small bore wells project similar to the PC/AID project within the next two years.

After reviewing all possible sources of information the team visited the well sites in the vicinities of Kaga-Bandaro, Kabo, Sido, Ouandago and Batangofo. The team was accompanied by the well PCV John Hettrick and the Chief Central African counterpart, Noel Mandanji.

To evaluate their technical well drilling capacity, the team observed the set up and drilling of one well in Kaga-Bandaro. The team also observed the maintenance/repair of two wells in the Kaga-Bandaro vicinity.

To evaluate the progress to date in well construction and to determine the present ratio of working to non-working wells, the team visited and inspected all 95 wells that have been constructed. Each well was inspected to see if it was pumping water of a sufficient quantity that the villagers were continuing to use it. These were reported as working. Wells which were not producing water or water with a flow rate that caused the villagers to abandon them were listed as non-working.

14. External Factors

The implementation of the project coincided with the last three years of a 14-year rule by a particularly economically ruinous and fiscally inept despotic regime in the CAR. These years were characterized by long series of steadily worsening financial crises which periodically deprived the country and the project of timely inputs, especially cement and fuel. The situation worsened considerably when President for Life Bokassa decided to become Emperor Bokassa in 1977. The acute financial drain accompanying the preparations for this change and the coronation ceremonies (estimated at 20+ million US dollars) resulted in civil servants not receiving their salaries for periods up to a year. Many civil servants stopped working and/or turned to other pursuits to support themselves and their families.

The project itself was terminated on September 30, 1979 as a result of the deterioration of CAE-US bilateral relations occasioned by human rights abuses by the imperial regime. Since September 30, 1979, the project has continued at a reduced pace with the Peace Corps and individual Peace Corps Volunteers funding the fuel needed to continue project operations.

16. Inputs

As noted in the previous evaluation (PAR) of August 1978, all of the project's planned inputs (expatriate personnel, commodities, local counterparts) were provided 6-12 months later than originally planned in the ProAg. However, these delays have not played the dominant role in the project's unsatisfactory progress to date towards achievement of the outputs/purpose/goal.

The entire project concept was extrapolated from a very successful PC small bore wells program in southern Chad. It was hoped/assumed that a similar project using an identical technology (personnel and commodity inputs) would also be successful in the northern areas of the CAR. Based on this assumption AID sent a civil engineer/hydro-geologist to the northern area of the CAR to assess the feasibilityof this type of a project in the northern third of CAR. This engineer, Mr. Bennie Griffin, conducted an aquifer study in 1975 which included test borings in Bozaum, Paoua,

Batangofo, Kaga-Bandaro, (Ft. Crampel) and Ndele. Based on his report that these five test borings showed the hydrogeology favorably for the Chadian type of well drilling program, AID proceeded to play the project along the Chadian model. As discussed under Outputs this hypothesis was proven invalid for most of the project area.

17. 18. 19. Outputs; Purpose; Goal/Subgoal

The goal stated in the 1978 PAR is to develop a program of health assistance for the rural poor, which includes provision of safe water supplies and a reduction of water-borne disease. The purpose as stated in the same PAR, is to install 250 small bore wells in the Northern area of the Central African Empire and to develop a well drilling and maintenance capacity in the Ministry of Public Works.

As noted under #16 Inputs the project was designed around the critical assumption that the geology of the CAR project area was similar enough to permit the use of the Chad Wells Program Technology. This assumption has not held up and is the prime reason for the project's poor progress on well construction to date, as noted below.

OUTPUT I - Well Construction

		77	78	79	80	81	Total
Planned Performance ProAg 1976	for year/cum	104	104	42	--	--	250
		104	208	250	--	--	
Planned Performance PAR 1978	for year/cum	45	50	60	50	45	250
		45	95	155	205	250	
Actual Project Performance	for year/cum	0	24	57	14		95
		0	24	81	95		

According to the original ProAg schedule all 250 wells should have been completed by the end of 1979. However, the project had completed less than a third (32%) of the planned total by that date. If one accepts the revised schedule of the 1978 PAR, the project completion rate is still only one half (52%) of target.

Perhaps what is more meaningful than the crude data on wells developed v.s. planned is the wells attempted v.s. wells brought into production. Although no project data has been kept on the number and location of holes drilled and time per hole drilled, the team conservatively estimates the total number of holes drilled at 500+. With a total number of 95 successful wells to date, this shows an extremely disappointing success rate of 19% compared with essentially a 100% success rate for the same type of well in Chad.

The simple, locally fabricated handpump has worked well and has not been responsible for the failures of those wells that have ceased working. However, the leathers do tend to wear out very quickly in those areas outside the CT due to the amount of gritty sediments that are not naturally screened out and are introduced into the pumping mechanism.

Based on what the team was able to observe in the field and in studying the geological map which was produced in 1963, it is apparent that the technology currently being used is unsuited to the geologic conditions in most of the project area. In general, the Continental Terminal in northern CAR forms a relatively small crescent extending from just east of Markunda south and east along the Ouham River to its most southerly point just below Batangofo where it proceeds due east to south of Nana where it turns north-east through the Brabingui National Park and into Chad at Miamere. The Continental Terminal is composed of mainly silty sediments with intercalations of clay and sand with thin laterite in some places. This area has the same geologic environment as Chad and here the Chad technology has been very successful. South of this line (CT) the geology changes to that of a lateritic cap overlying crystalline/metamorphic rocks. It is here that the original project's assumptions have proven invalid and it is here the present drilling technology has run into serious trouble. The Mobile B-53 drilling rigs are not designed for this type of terrain. Frequently the bore hole will collapse before the screen has reached the scheduled position. In addition, the material filling the hole is very often extremely silty or argillaceous and the screen either becomes blocked immediately or after short use.

Output #2

The program was to develop a well drilling capacity within the Ministry of Public Works. To this end five (5) Central African homologues (counterparts) have been named to the project and have been learning how to run the drilling/construction equipment and how to maintain the wells already in place. Based on the team's observations of two of the best counterparts, the team feels that their level of skill and experience for maintaining the wells is adequate. However, the team did not feel that they had the capacity to run the construction program without expatriate assistance/supervision. The team did note, however, that while the counterparts did appear to possess the necessary technical skills to perform the routine maintenance of the wells, no written maintenance schedule and procedures have been produced and maintenance seems to be done irregularly or as time and opportunity permit. The Central African counterparts also did not demonstrate the capacity to troubleshoot routine operating problems of their construction rigs.

There are several probable reasons for the Central African counterparts' present inability to completely manage the equipment and continue the program after the withdrawal of the PCV's. Part of it may be their weak technical background, or possible indifference to the success or continuation of the project. However, one point that did come across strongly, was that the PCV's perceive themselves as the prime implementers of the project and have expected that the project would continue with successive waves of replacement PCV's. They viewed their roles as trainers in a very secondary manner. They did not seem to grasp or accept the idea that they were there to work themselves out of a job.

The GOCAR does not appear to be capable of continuing project activities without AID support at this time. It is also probable that this situation will not change during the next 3 years. Observers in Bangui estimate that it will take at least 3 years of extreme fiscal belt-tightening before the GOCAR can even consider support to projects of this type. At present, most of the limited government resources are being put into the transportation sector and the production of cash crops.

Output #3 Health Education

Although this has been mentioned in the 1978 PAR as a recommended action, there is no evidence that this has been done. In many cases the effluent from the well creates a large saturated area around the slab which is frequently used as a wallowing area by hogs and other animals. In some cases the discharge from the pump was eroding a cavity back under the slab leaving an access point for the adjacent polluted water to seep into the well. The present PCV's and Central African counterparts see Health Education as important but do not perceive it as part of their job.

There seems to be no physical or cultural factors that are affecting the health value of the wells completed. Villagers prefer the pumped water from the wells, which is cooler and cleaner, than the other waters available from pools and streams. The extra effort to obtain the tube well water (i.e. pumping) is willingly given.

At this point it does not seem likely that combining the Ouham (OPRH) and the Wells project will be feasible. While the wells project is operating in north Ouham and Grabangui provinces there are no current or planned health activities in the small area of Ouham where the geology is suitable for the wells drilling technology.

20. Beneficiaries

While no studies are planned to demonstrate the effects of this project on the lives of the rural villagers in the areas where the wells have been dug it is reasonable to assume that the following benefits will accrue to the target population.

A. Reduction in mortality (especially infant mortality) due to diarrhea from drinking contaminated water.

B. Reduction in some skin diseases due to increased water easily accessible for bathing infants and small children.

C. Increased time and energy for village women for growing food and caring for children through elimination of long treks to water sources.

D. Village life is made more attractive through provision of services that have traditionally been found only in large cities.

21. Unplanned Effects

The team noted that several of the smaller villages who had not received a well had requested the sous-prefet to have one built in their village also. The project in a small way has mobilized the villagers to take steps to improve their own health status, if only by attempting to influence the political decision-making process.

22. Lessons Learned

It appears that the project was conceived, designed and initiated to take advantage of one-time-only funding possibility (i.e. Sahel Disaster Assistance). In doing this AID cut short or cut out some of the routine steps in project design. It is now obvious that the planning of a well project in an area with unknown geologic conditions must include adequate geologic investigation to insure the proper selection of well drilling equipment which will in turn insure an acceptable hold dug/well production ratio.

The field study which was made in 1975 made only five (5) test borings, none of them within the Continental Terminal (CT) area. Based on this limited investigation the decision was made to proceed with the project and to use the technology which had been successful in the Chad well program.

If a proper hydro-geologic investigation had been done, the project would have had to modify the technology or concentrate itself in the small area of the CT where the Chad technology worked.

In attempting to bring in producing wells in the area south of the CT the drilling team expended vast amounts of time, energy, resources and morale. The attempts at well construction outside the CT area produced only thirteen (13) working wells with more than half (seven) presently not working due to clogged screens and other problems related to the geology in that area.

In approaching either an extension of this present well project or any other well project, the following steps should be taken. Firstly, a well inventory reconaissance survey should be done to determine the location and depth of successful dug wells. Secondly, a full hydro-geologic reconnaissance with an adequate number of test holes or other data collection procedures should be done for all areas where wells are planned.

Counterpart training needs more emphasis if counterparts are to be realistically expected to continue without expatriate assistance/ supervision.

23. Special Comments or Remarks

If AID wishes to achieve the project outputs and purpose (250 tube wells in northern, rural CAR) the following alternatives may be considered:

1. a) Abandon all construction of machine dug small bore wells as originally specified in the project documents in all areas outside the Continental Terminal (CT).
   b) Limit construction of the remaining 155 originally developed wells to those areas inside the Continental Terminal (CT).

2. Acquire the necessary equipment and necessary personnel to construct machine dug large diameter gravel packed tube wells in those areas outside the Continental Terminal (CT).

3. Change construction design of wells to be constructed outside the CT area from machine dug, small bore tube wells, to hand dug large diameter traditional wells.

Discussion of Alternatives

1. This would require no change in the present technology and could be effected by simply changing the criteria for selecting villages to receive a tube well. (Present criteria demands a 200+ village population.) Drawback to this alternative is that the majority of the project's target area would remain unserved.

2. To implement this, two types of additional equipment would have to be considered. One, a rotary bucket machine (the GUS-PECH or the Calweld model would be suitable) for drilling through the upper laterite zone and into the underlying weathered bedrock. Because the predominant water-producing zone usually occurs at the base of the laterite, the weathered portion of the underlying bedrock could be used as a storage area adequate for small volume wells. The drawbacks to this type of machine are that it would not be suited for areas where no overlying laterite occurs and where little or no weathered crystaline/metamorphic facies exist and that it can usually be used only where the formation will stand without caving until the hole is drilled and the casing installed. A machine of this type fully equipped generally costs around $120,000 in the U.S. and requires an operator with a skill level not generally found in Peace Corps.

The second type of machine that is suited for areas outside the CT is the cable tool percussion drill. While this equipment cannot drill as wide a diameter hole as the Bucket Rotary Rig, it has a greater depth capacity. In particular, it will penetrate bedrock. This machine sells for around $100,000 in the U.S. fully equipped and also requires a highly skilled operator.

3. While hand dug, large diameter traditional wells have been constructed successfully in certain areas, they have several inherent limitations. These include:

1. A slow construction rate (usually several months each).
2. Extremely hazardous working conditions such as asphyxiation of workers from gas and injury to workers from falling debris as well as death from collapsing walls.
3. Difficulties in maintaining well sanitation.
4. Labor-intensive but not cost-effective.
5. Difficulties in construction below the water table creating seasonal dry periods as water table falls.

The present operational procedure does not disinfect the new well before use. Apparently, this practice was not done in the Chad program either. Failure to disinfect the well could result in bacteria being introduced into the well via the screen, pipe, etc.

after it has been in contact with the ground. The well could be easily disinfected by pouring in a 3 - 5% solution of household chlorine bleach or some granulated swimming pool chlorine.

LIST OF APPENDICES

A. WELL INVENTORY

B. GEOLOGIC MAP (CONTINENTAL TERMINAL-CRYSTALLINE-METAMORPHIC CONTACT)

C. WELL LOCATION MAPS

D. REPORT OF BENNIE GRIFFIN

E. REPORT OF DR. W. GRIMMELMAN

APPENDIX A

LOCATION	#MAP	DATE	C+	WT/M	CONDITION
Sido town					
Sido	31	26/10/78	I	2.92M	W
"	32	30/10/78	I	4.19M	W
"	33	3/11/78	I	5.15M	W
"	34	6/11/78	I	3.56M	W
"	35	8/11/78	I	6.65M	W
"	36	13/11/78	I	5.90M	NW
Road from Sido south to Kabo					
M'Bo (1)	37	15/11/78	I	3.20M	W
M'Bo (2)	38	16/11/78	I	2.20M	W
Danze	39	21/11/78	I	4.90M	W
Nambaza	40	23/11/78	I	4.50M	W
Kebito	41	27/11/78	I	6.85M	W
Sidokete (1)	42	29/11/78	I	4.10M	W
Sidokete (2)	43	31/11/78	I	9.40M	W
Sidokete (3)	44	?/2/79	I	5.10M	W
Bogayanga (1)	45	8/12/78	I	4.80M	W
Bogayanga (2)	46	6/12/78	I	4.80M	NW
5 Kilo	47	19/10/78	I	6.50M	W
Kabo Town					
Douane	48	13/4/78	I	6.75M	W
Sous Prefet	49	17/3/78	I	6.50M	W
Marche	50	7/12/77	I	6.37M	W
Chez Veronique	51	25/4/78	I	6.18M	W
Downtown	52	17/4/78	I	6.40M	W
Arab Quartier	53	8/3/78	I	8.25M	W
School	54	1/3/78	I	6.60M	W
Vets	55	19/4/78	I	6.30M	W
New Hospital	56	22/12/77	I	6.37M	W
Hospital Open Well*	57	15/5/79	I	7.40M	W*(pump on hand dug well)
Far East	58	23/4/78	I	5.40M	W
Abattoir	59	29/12/78	I	4.75M	W
South of KB Rd.	60	3/5/78	I	NA	W
Kabo II	61	29/12/78	I	6.30M	NW
Replacement	30	14/3/78	I	6.00M	W
Behind Hospital	24	17/4/78	I	4.60M	W
Kabo Barrier	25	5/1/78	I	6.80M	W
New Years	26	1/1/78	I	6.40M	W
Mud Brick	27	10/4/78	I	9.25M	W

INTENTIONALLY

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South End	28	1/3/78	I	NA	W
Kabo Kodro	29	28/11/77	I	6.00M	W

South of Kabo heading to Batangafo

Jobanba	62	18/11/78	I	6.55M	W
Jobanba	63	21/11/78	I	7.10M	W
Vafio (1)	64	18/6/79	I	9.00M	W
Ngonokira	65	23/3/78	I	10.00M	W
Moissala	66	16/6/78	I	9.15M	NW
Croisement-Moissala	67	21/6/79	I	5.90M	W
Vafio (2)	68	21/3/79	I	7.20M	W
Bouiciti	69	23/3/79	I	7.10M	W
Bamarakassat	70	22/3/79	I	7.10M	W
Kakouda	71	25/6/79	I	6.10M	W
Gofo (1)	72	11/4/78	I	8.30M	W
Gofo (2)	73	12/4/79	I	7.10M	W
Gofo-M	74	19/4/79	I	6.10M	W
Gofo (3)	75	16/11/77	I	9.20M	W

Batangafo Town

Bossekete	76	19/5/79	I	7.10	W
UCCA	77	12/2/79	I	7.30	W
T.P.	78	12/12/78	I	8.70M	NW
BAC I	79	25/11/78	I	6.40M	W
BAC II	80	8/12/78	I	8.30M	W
Mala	81	29/1/79	I	NA	NW
Combattant	82	7/5/79	I	5.50M	NW

Heading East from Batangofo to Quandago

Bouba Vi (1)	83	21/3/79	I	6.70M	W
Bouba Vi (2)	84	15/3/79	I	6.30M	W
Bovondo	85	2/4/79	I	7.10M	W
Bngapele	86	26/3/79	I	6.80M	W
Bozoro (1)	87	28/11/79	I	5.20M	NW
Bogama (1)	88	24/11/79	I	5.60M	W
15 KM	89	4/4/79	I	6.80M	W
Bougama (2)	93	NA	I	NA	W
Bozoro (2)	92	NA	I	NA	W
Gbafio (1)	90	19/11/79	I	7.40M	W
Gabfio (2)	91	NA	I	NA	W

Quandago Town

Quandago (1)	14	14/7/79	I	11.80M	W
Quandago (2)	15	21/7/79	I	4.60M	W
Quandago (3)	16	26/7/79	I	3.50M	W

Heading North from Quandago to Kabo

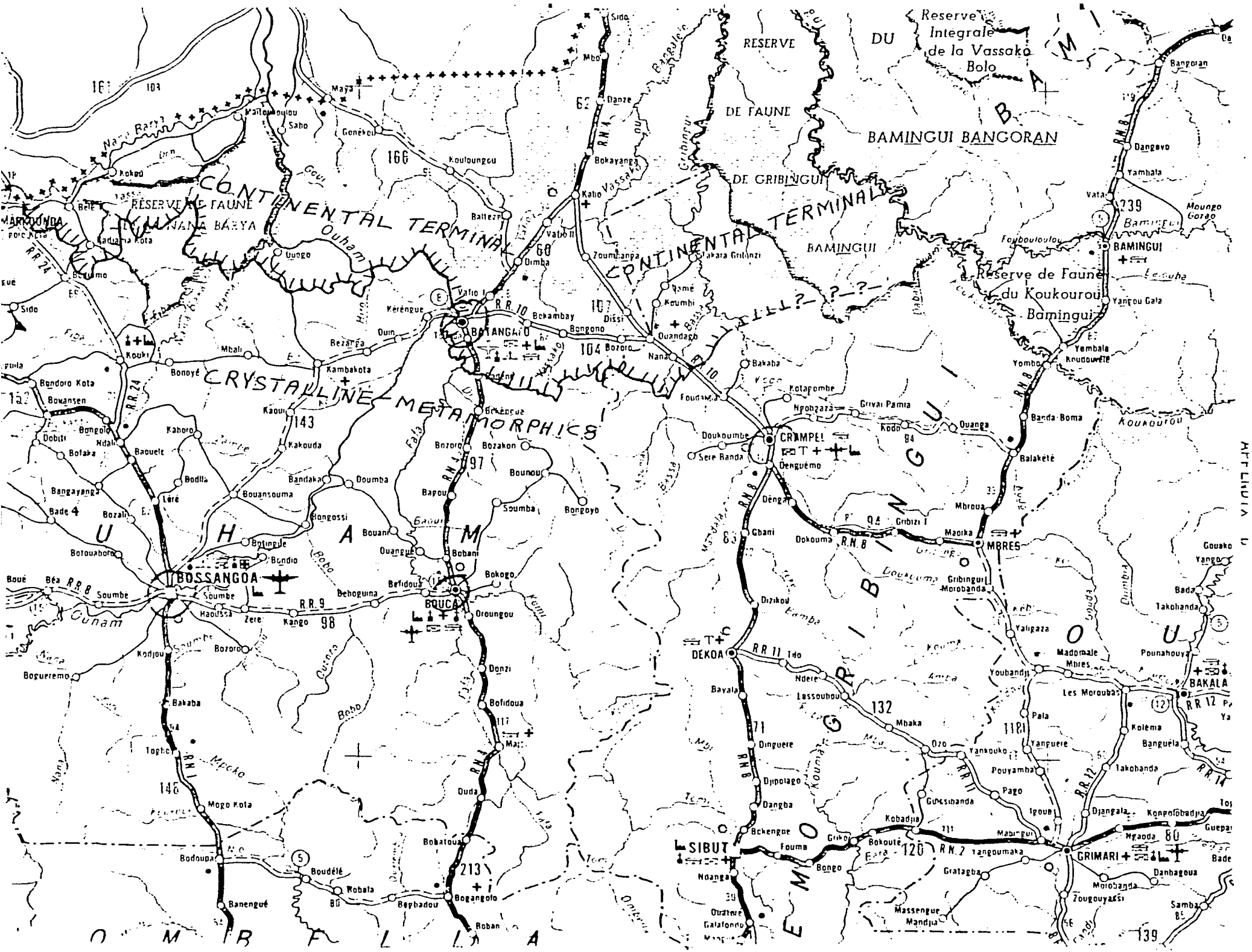
Dessi	17	19/11/79	I	4.60M	W
Farzala (4)	18	5/12/79	I	10.00M	W
Farzala (3)	19	4/12/79	I	10.60M	W
Farzala (1)	20	27/11/79	I	10.20M	W
Farzala (7)	21	29/11/79	I	10.62M	W
Zoumanga (1)	94	N/A	I	N/A	W
Zoumanga (2)	95	N/A	I	N/A	W
Mbolton (1)	22	27/10/78	I	6.80M	W
Mbolton (2)	23	22/10/78	I	8.00M	NW

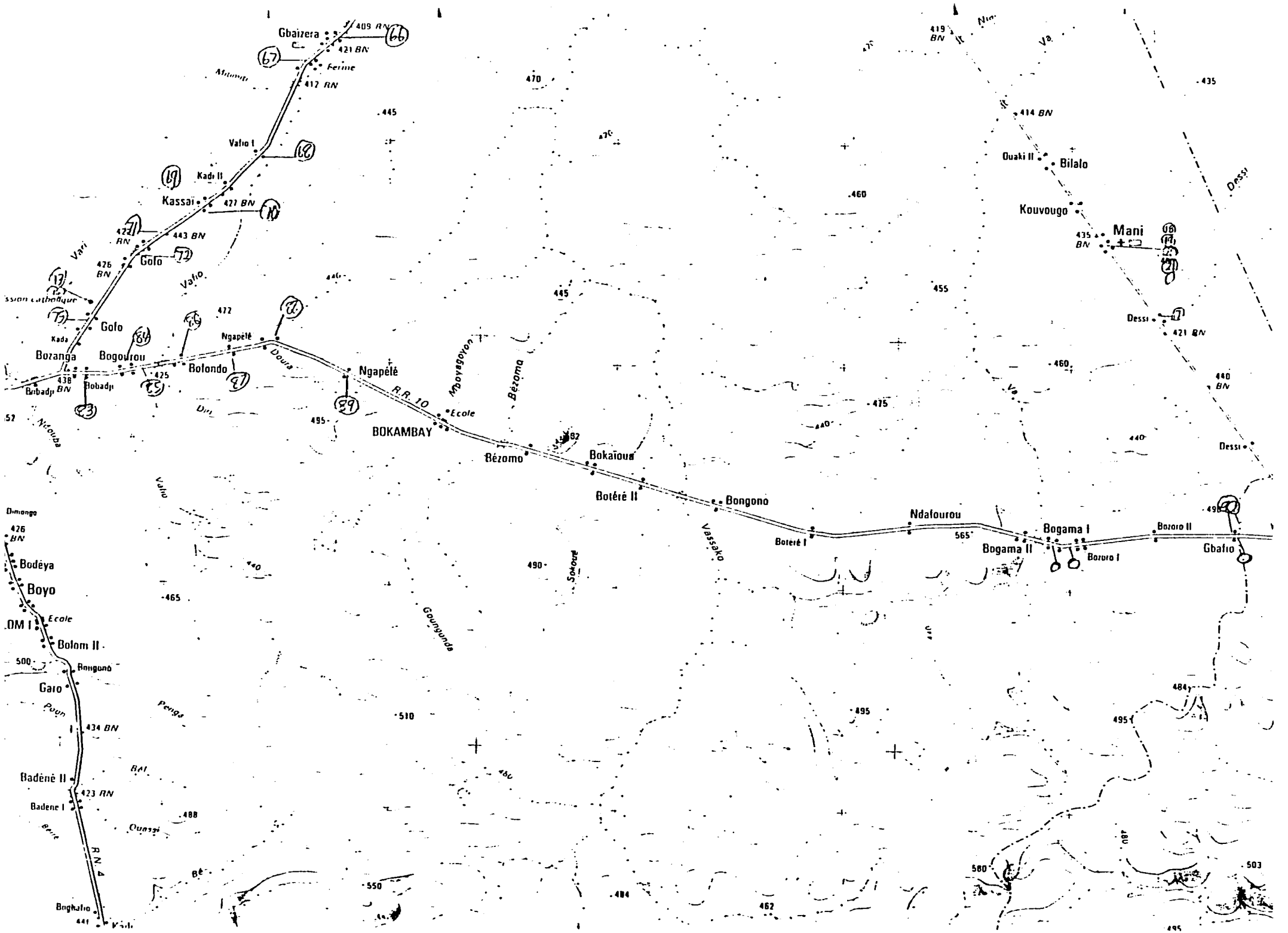
Just South of Kaga-Bandaro

Ndemete	1	4/5/79	0	13.20M	W
Ndemete	2	28/4/80	0	6.40M	W
Ndemete	3	10/5/79	0	12.50M	NW
Ndemete	4	11/5/79	0	14.60M	NW
Mbessingale	5	18/4/79	0	13.00M	W
Karoua	6	25/4/79	0	4.50M	NW
Ndemayo	7	10/4/79	0	8.50M	W
Oubi	8	13/4/79	0	11.00M	W

Kaga-Bandaro Town

TP	9	20/3/79	0	6.55M	NW
Gendarmarie	10	18/9/79	0	5.40M	W
Hospital	11	10/6/79	0	dry	NW
Mbeipou	12	9/6/79	0	6.00M	NW
Kansara	13	15/11/79	0	6.00M	NW


Reserve Integrale de la Vassako Bolo
RESERVE DU
DE FAUNE
BAMINGUI BANGORAN
DE GRIBINGUI
BAMINGUI
Reserve de Faune du Koukourou Bamingui
CONTINENTAL TERMINAL
CRYSTALLINE METAMORPHICS
RESERVE DE FAUNE
BAMINGUI
BOTANGARO
BOSSANGOA
BOUCA
CRAMPEL
MBRES
DEKOA
SIBUT
GRIMARI
BAKALA
BAMINGUI
Ouham
Vassako
Gribingui
Bangoran
Koukourou
Bamingui
Lobaye
Mbomou
Kotto
Ouaka
Kémo
Lim
Nana Barya
Mpoko
Lobaye
Sangha
Ubangi
Mambéré
Ombella
Lim
Nana
Kémo
Ouaka
Bangui
Bangui
Bangui



Gbaizera
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421 BN
Ferme
412 RN
Vafio I
Kadi II
Kassai
427 BN
443 BN
Golo
426 BN
Vafio
Golo
Kada
Bozanga
Bogourou
Bolondo
Ngapélé
Doura
Ngapélé
R.R. 10
Ecole
BOKAMBAY
Bézomo
Bokaïoua
Botéré II
Bongono
Botéré I
Ndafourou
Bogama I
Bogama II
Bozoro I
Bozoro II
Gbafio
Vassako
Bézomo
Mboyagoyon
Dessi
Ouaki II
Bilalo
Kouvougo
Mani
435 BN
Dessi
421 BN
440 BN
Dessi
Dimongo
426 BN
Bodéya
Boyo
Ecole
Bolom II
Bongono
Garo
434 BN
Badéné II
423 RN
Badene I
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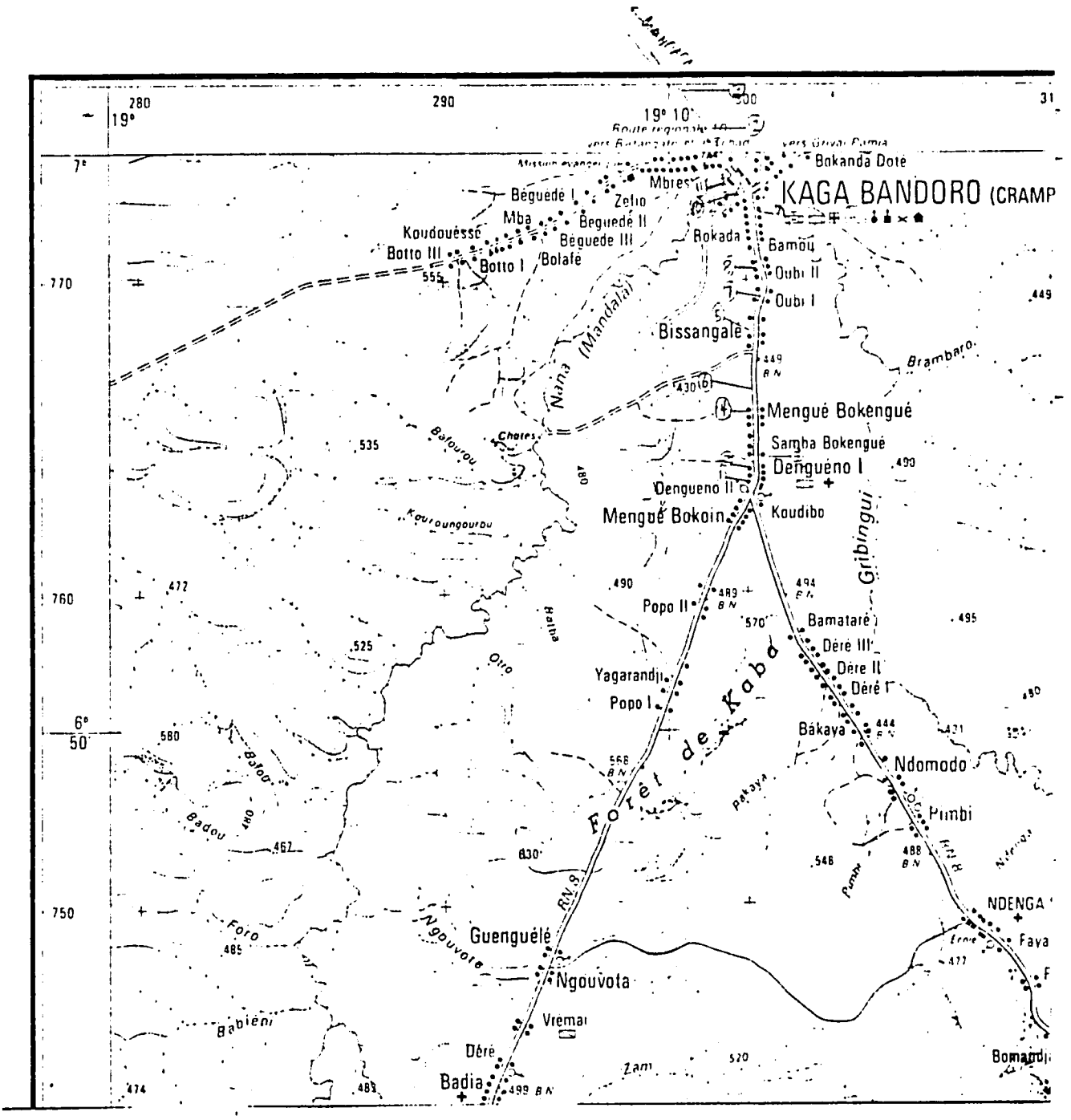
Boghafio
Gounguda
Sokoué
Penga
Ouassi
Vafio
Dessi

APPENDIX C



KAGA BANDORO (CRAMP
Bokanda Doté
Mbres
Béguédé I
Zefio
Mba
Béguédé II
Béguédé III
Koudouéssé
Botto III
Botto I
Bolafé
Bokada
Bamou
Oubi II
Oubi I
Bissangalé
Nana (Mandala)
Brambaro
Mengué Bokengué
Samba Bokengué
Dengueno I
Dengueno II
Mengué Bokoin
Koudibo
Gribingui
Popo II
Bamataré
Déré III
Déré II
Déré I
Yagarandji
Popo I
Forêt de Kaba
Bakaya
Ndomodo
Pimbi
NDENGA
Faya
Guenguélé
Ngouvota
Vremai
Déré
Badia
Zam
Bomandji
Chotes
Bafourou
Kouroungourou
Otro
Badou
Foro
Babiéni
Ngouvote
RN 8
19°
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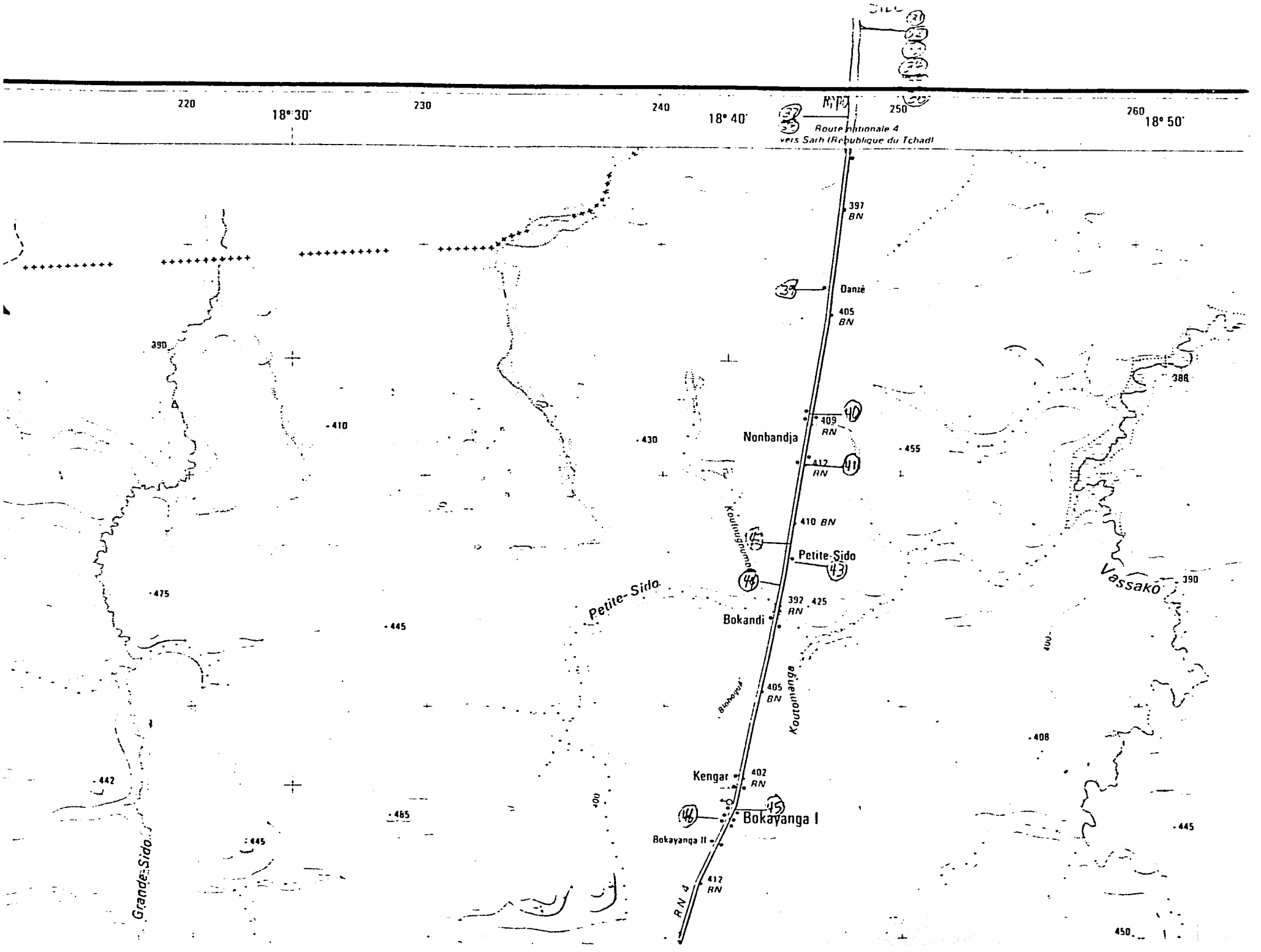
7°
6° 50'
280
290
770
760
750



220
18° 30'
230
240
18° 40'
250
260
18° 50'
Route nationale 4
vers Sarh (République du Tchad)
397
BN
Danzé
405
BN
409
RN
Nonbandja
412
RN
410 BN
Petite-Sido
392
RN
425
Bokandi
405
BN
Kengar
402
RN
Bokayanga I
Bokayanga II
412
RN
RN 4
Koutougnumo
Koutomanga
Petite-Sido
Grande-Sido
Vassako
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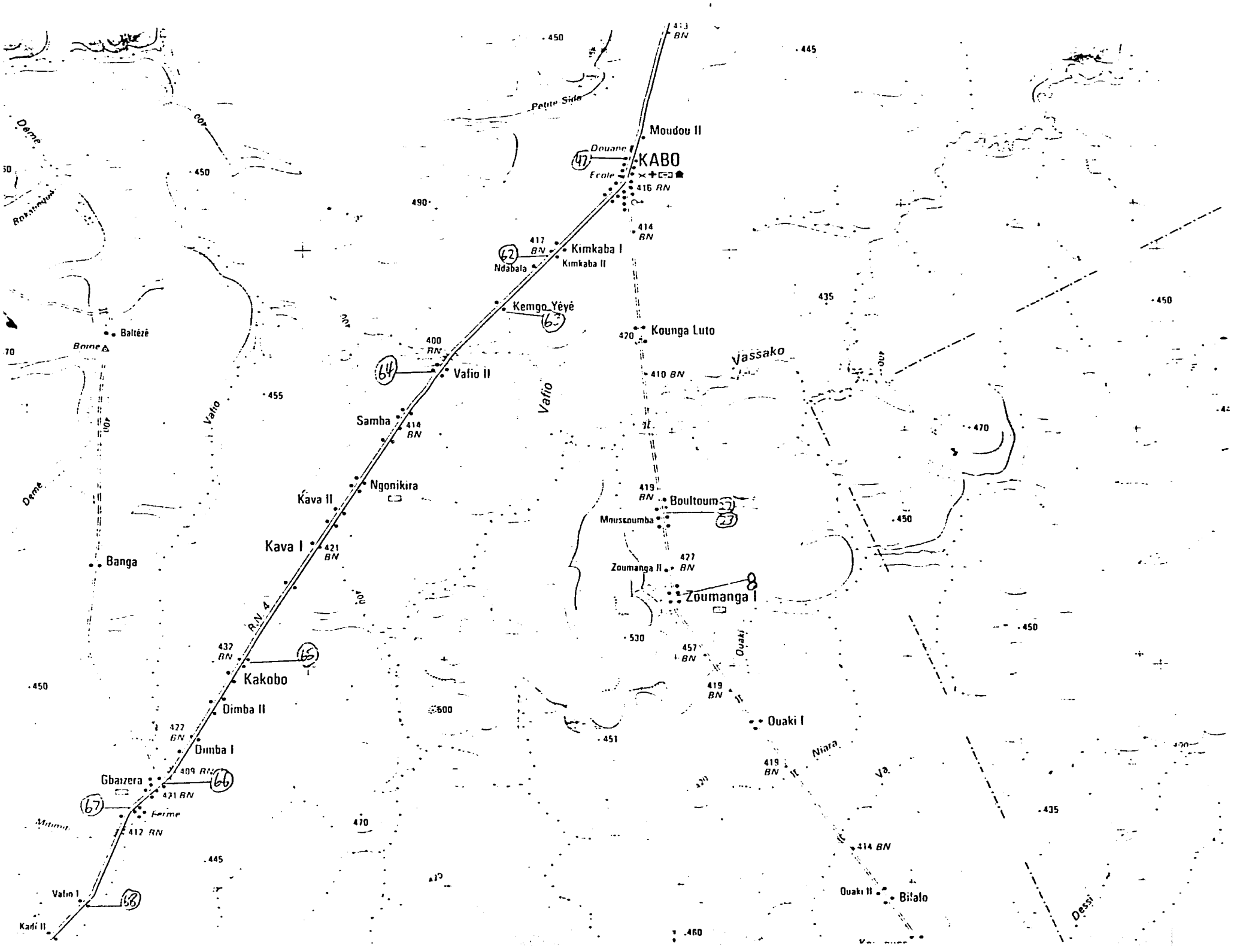

Moudou II
KABO
Douane
Ecole
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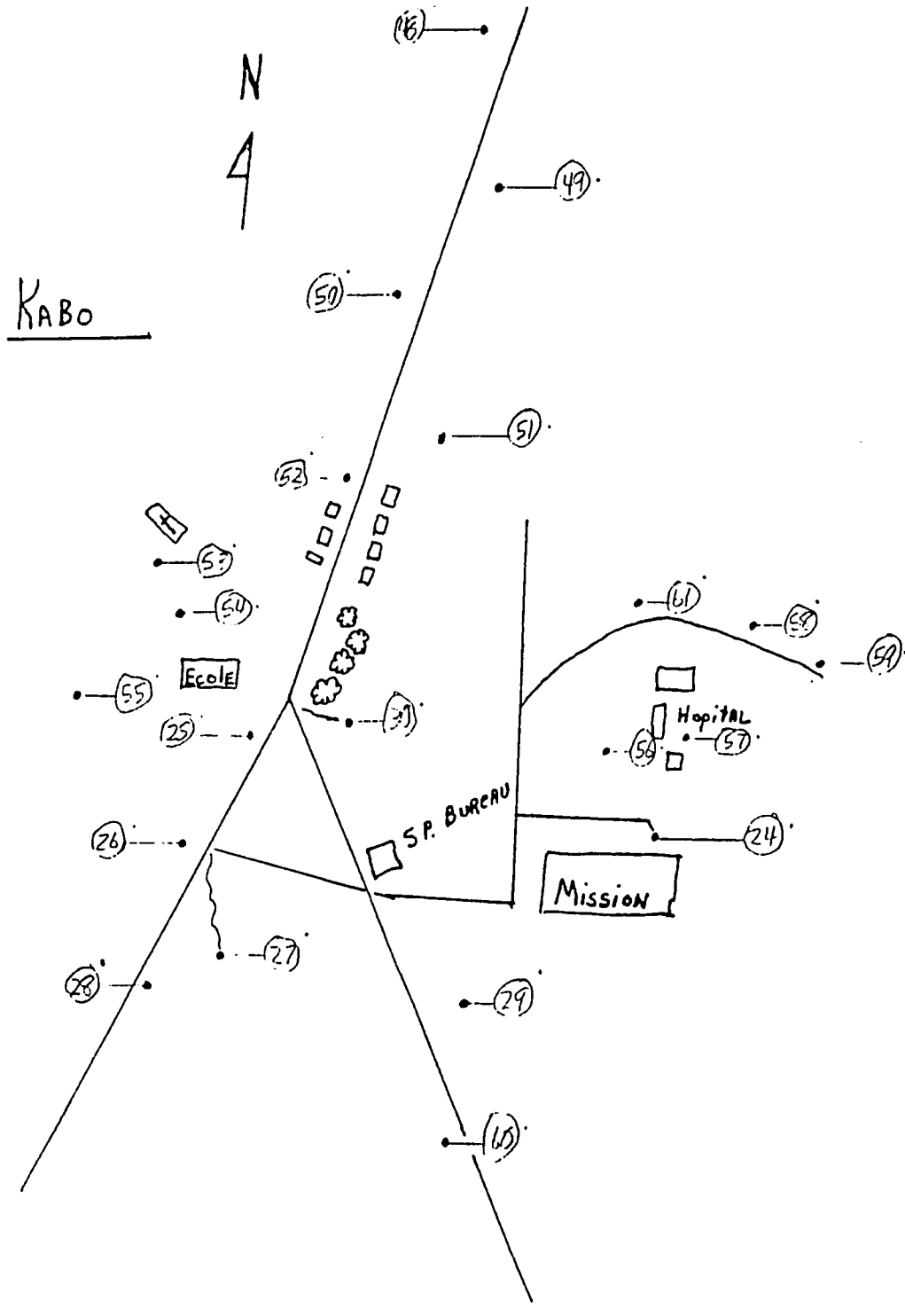
414 BN
417 BN
Kimkaba I
Kimkaba II
Ndabala
Kemgo Yéyé
Kounga Luto
Vassako
410 BN
400 BN
Vafio II
Vafio
Samba
414 BN
Ngonikira
Kava II
Kava I
421 BN
Boultoum
Moussoumba
Zoumanga II
427 BN
Zoumanga I
Ouaki
457 BN
419 BN
Ouaki I
Niara
Va
414 BN
Ouaki II
Bilalo
Dessi
Baltézé
Borne
Banga
Demé
Vafio
R.N. 4
432 BN
Kakobo
Dimba II
422 BN
Dimba I
409 BN
Gbaizera
421 BN
Ferme
412 BN
Vafio I
Kadi II
Petite Side
450
445
490
435
470
455
530
500
451
460


N
KABO
Ecole
Hopital
S.P. BUREAU
Mission

APPENDIX D

MEMORANDUM

TO: Ambassador William N. Dale
American Embassy
Bangui, Central African Republic (C.A.R.)

Joe D. Kimmins, Director, PC/CAR

Date: May 2, 1975

From: Bennie Griffin, Civil Engineer/Hydrology
Project Officer

Subject: CAR-Proposed R/R Well Drilling Project -- Aquifer Study

BOSSANGOA - Test Hole # 3

On April 17, 1975 after three days in Bangui for resupply, rest and recuperation from our 12 days trip to Crampel and N'Dele, we headed northwest to Bossangoa. The road over the 305 Km distance was very washboardy and this made travel tiring and time-consuming. We arrived at 21:00 hrs, crossing the Ouhame River into the well-lighted city. This was a welcome treat to dusty eyes after a hard day's travel. The next day we spent examining wells, studying the terrain, meeting officials, and selecting a drill site. Most of Bossangoa is located on the west side of the Ouhame River and extends some 2 Km up a very gradual incline to the west.

The topography of the area is mostly flat with sandy adobe overburden and covered with beautiful trees, mango, flamboyant, some teak, and natural scrub growth.

Water supply for the city population is mostly from hand dug wells. The water table varies from four to eight meters. The eastern side of the population

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area get their water from small springs located at the bottomland. In general, we found the well situation about the same as in Crampel and N'Dele. The wells that penetrate the aquifer deep enough have ample water. In this area they also have the problem of the wells caving in below the clay-laterite formation. Wells that have water the year round often measured less than one half meter in water. The best well in the city is at the Lycee of Bossangoa. It measured four and one half meters down to the water level and the water was three meters in depth. This would seem to indicate that other wells should have ample water if dug deeper into the aquifer.

OUR WATER REQUIREMENTS:

In as much as our drilling operation fell on Saturday and Sunday, we were able to use the water truck from the Ministry of Public Works to supply our needs for drilling.

Drilling the third Test Hole - Elevation 499 m.

The drill penetrated the overburden which consisted of two meters of sandy adobe clay and into the clay laterite at the rate of 4" per minute. At five meters we hit a sand strata. This was the water table. The sand strata (aquifer) was 2½ m. thick. Then through the aquifer we encountered solid rock and drilled 7 m. into it. The drilling was very easy in that we were fortunate not to hit hard laterite. There are many outcroppings of hard laterite in the area and we were able to avoid that type area. The site selected for this test hole was in the vicinity of some dry wells. However, since we found 2½m of water it stands to reason that were these dry wells made deeper, they would have ample water.

Sample corings were taken from start to finish for study. Two samples of the aquifer sand and two pieces of the bed rock core were saved for further viewing. See drill log attached.

The drill team was instructed to disassemble and load equipment in preparation for departing for Paoua 08:00 Monday April 21, 1975.

The test hole was closed by placing a concrete slab 2' x 2' x 6" over it flush with the ground. It is located by the left hand side of the road, one kilometer before the Lycee school.

The owner of the land where the test hole was drilled was instructed in regards to the findings and on the possible future development of the well. He said he would look after it. The Mayor also knows the location of the test hole.

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PAOUA - Test Hole # 4

On Monday 07:30 hrs April 21, we headed some 180 Km farther northwest over the same type red dirt roads previously traveled. The day before a good shower of general rain had fallen over the entire areas from Bossangoa to Paoua. The rain lowered the temperature to a comfortable degree, settled the dust, cleaned the air and made traveling and life much more pleasant.

We arrived at Paoua 13:00 hrs, met the Sous-Prefet who gave us a great welcome and made introductions to other necessary officials. We spent the afternoon studying the terrain, examining wells, and selecting a drill site.

The city of Paoua is located on the Ndoula river which is only a drainage area with very little surface water during the dry season. The area is mostly flat inclining about two meters per kilometer. The top of the soil appears to be sandy but laterite is prevalent in most of the side ditches and bare areas. There are numerous outcroppings of gray granite type rock in the area.

Water supply for the population all comes from hand dug wells. Many are now dry and most of those with water year round only have a small (storage) supply. The water depth in the producing wells varied from six inches to a meter deep, depending on their depth below water table. Some of the wells had muddy water. Several owners said they did not drink water from their wells because it was dirty. They got their drinking water from nearby wells where there was clear water. The water table varied in the area from four to seven meters. As in other areas studied the wells fall in below the clay laterite formation. One well that was cased down to the bottom, nine meters, had one and one half meters of water in it. Our test hole gave us the thickness of the water

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bearing strata (aquifer). And based on this finding, owners can judge whether digging deeper will provide more water.

Our water requirements for drilling were met by hauling from the low land where a small amount of surface water stands. We used a sump at the drill rig to retain the water from the drilling operations so it could be recirculated. This prevented having to haul many loads with our 250 gallon water tank.

The ground culture consists of many trees, mango, flamboyant, and various other types of beautiful shade trees. The open land is covered with scrub growth ten to twenty feet in height. The entire area is green from the results of the mango showers.

Drilling the Fourth Test Hole - Elevation 600 m

The drilling team arrived with equipment at 12:00 hrs, April 22. The rest of the day was spent unloading and setting up for drilling at the site selected the day before. On April 23, 13:00 hrs, drilling began. The drill penetrated the overburden (sandy, dirty soil) at the rate of 10 inches per minute. At one meter depth clean sandy clay was encountered. The drill also penetrated this strata at the rate of 10 inches per minute. The level of the water in the surrounding wells was five meters down. At 16 meters in depth the drill passed through the sandy strata and into a soft brown crumbly rock strata. The drill penetrated this rock strata at the rate of six inches per minute. At the depth of 17 meters solid rock was encountered. We continued to drill into this formation for seven more meters to determine whether it was a thin strata of soft rock or solid bedrock. After penetrating the rock formation for seven meters we decided that it was the solid bed rock and that the requirements of our examination

had been met. The water table was established to be five meters down. The water strata extended to 17 meters. Thus the water bearing strata (aquifer) was measured to be 12 meters thick. the water level in the test hole remained at the five meter level. See drilling log attached.

On the afternoon of April 24, the drilling equipment was disassembled and loaded for travel to Bozoum - our fifth test site.

The Paoua test hole is located 50 meters to the right of the road, half way from the Prefet's office to the Catholic mission. It was closed by placing a concrete slab 2' x 2' x 6" over it, dug in, flush with the ground. The nearby neighbors, priest and the Sous-Prefet are aware of this location and should protect it for possible future development into a producing well. Father Stephen and Father Roman of the Catholic mission had great interest in our test drilling program. They were extremely pleased with the results. Their deepest well at the mission is 10 meters. It now has one meter of water. But gets much lower in June each year. The Fathers say that they now know that there is plenty of water and by casing down they can dig deeper and have plenty of water. The rock (17 to 24 meters) is soft enough to be dug by hand if necessary, also strong enough to support the well walls below 17 meters. The Fathers dissiminated the findings to the Sous-Prefet and the community. We departed April 25 leaving the priests and the Sous-Prefet very happy.

BOZOUM - Test Hole NO. 5

n Friday April 25 08:30 hrs we departed Pacua, headed south to Bozoum some 120 km over a fairly good clay road. We arrived at 12:00 hrs and met the Prefet and Mayor. He asked that we coordinate with the Sous-Prefet. He could not receive us until Saturday 08:00. We spent the afternoon studying the terrain and the water situation. Saturday morning was spent exmaining well and selecting a drill site. The drill team arrived 10:00 hrs and began unloading in preparation to set up for drilling. By Sunday 11:00 hrs the team was ready to start drilling.

Bozoum is located some two kilometers east over the hills from the Ouhame river in a valley surrounded by rock hills. The drainage stream through the valley to the Ouhame is known on the map as Kotali River. It has only a little surface water during the dry seasons. The valley floor is approximately 2 x 4 Km. The population is spread over the valley and on the hill sides.

Water supply for the population comes from hand dug wells and a surp in the Kotali river bed. The best well in the area is at the mission of the Evangelical Bretheren. It is 13 meters deep with one meter of clear water. This well usually supplies the mission with potable water. They boil and filter the water for drinking. They also have a back-up well down the hill with more water but it is cloudy or milky, from the chalky silt type strata it encounters. Of thirty dug wells examined they ranged in depth from 10 to 5 meters. Seventy five percent were dry. Those with water varied in water depth from 4" to 8". About half of those with water had milky or light muddy water. The site selected for drilling the test hole is located above the primary school in the center of the populated area. There are four dug wells nearby. Two are dry. One has

6" of milky water and the other has 8" of nice clear water. Water for drilling purposes had to be hauled with our 250 gallon tanker from the Ouhame River. This prolonged the drilling time considerably because we could not haul fast enough to keep the drill supplied.

The ground culture in the area consists of the same type of trees and scrub growth as other test areas. There has been very little mango rains in the area, therefore all the undergrowth is dry with very little green coverage.

Drilling the Fifth Test Hole - Elevation 680 m.

Sunday 11:00 hrs we began drilling the fifth test hole. The drill penetrated the overburden which consisted of six meters of clay, at the rate of four inches per minute. At the six meter level the drill went into a sandy clay strata. The washed out sand is course grained. This type strata continued down to nine meters. This three meters is good water bearing material which will seep water very freely. At nine meters the drill entered a very fine sandy, clayey silt area. It continued down to 20 meters. This fine silt strata is water bearing material, but seeps water very, very slowly. To use a sand point it would be a tremendous job to develop a reservoir in this material. The water table began at the six meter level.

APPENDIX E

Bangui, March 1, 197

VILLAGE RURAL WELLS PROJECT 676-0003

COMMENTS ON USAID/PEACE CORPS PROJECT

By Dr. W.F. Grimmelmann, Hydrogeologist, UN Economic Commission for Africa

1. Preliminary remarks :

As mentioned in the reports from 16 April and 6 May 1975 by Bennie Griffin the project was supposedly inspired by recommendations given by Glenn Sleeum and Joseph Mitchell in a report from 26 December 1974. The project was mainly based on the results of 5 test drillings of which only 2 were pumped for a few minutes. The distances between the test-sites range between 105 Km and more than 200 Km. A hydrogeological reconnaissance was obviously not made.

The undersigned was given transport to Kabo (25.2) and back (28.2) by USAID. He spent 2 days (26.2-27.2) with a Peace Corps team drilling 2 holes.

2. Situation :

2 teams using Mobile Drill B53 Anger rigs are operational. The team working in the region Batangafo-Kabo has drilled more than 70 holes of which 9 were cased and provided with pumps. They furnish excellent potable water.

The team working between Bozoum and Paova has drilled 16 holes without success.

3. Comments :

The area scheduled for 250 wells comprises extremely different geological units. For the preparation of a project of that size in such a difficult region 5 test holes are not a sufficient basis. In geologically more homogenious countries like Chad (large parts covered with mainly sandy sediments of quarternary age and with some tertiary

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silty, the screen forced subsequently into this mud will not yield enough water, although being at the level of a good aquifer.

It is recommended that the screen be brought into position immediately after completion of the hole and a padding of quartz-sand/gravel be tried, at least around the screen.