6th WEDC Conference: March 1980: Water and waste engineering in Africa

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# HAND PUMP MAINTENANCE PROGRAMME: GHANA

## MAINTENANCE OF REGIONAL RURAL WATER SUPPLIES - THE GHANIAN APPROACH

### 1. INTRODUCTION

A Regional Well Maintenance Programme was implemented between 1974 and 1978 in the Upper Region of Ghana in support of the installation of 2 400 wells equipped with hand-pumps (see figure 1). This was part of Ghana's Upper Region Water Supply Project, jointly financed by the Government of Ghana, through the Ghana Water and Sewerage Corporation (GWSC), and the Government of Canada, through the Canadian International Development Agency (CIDA) and Consultants.

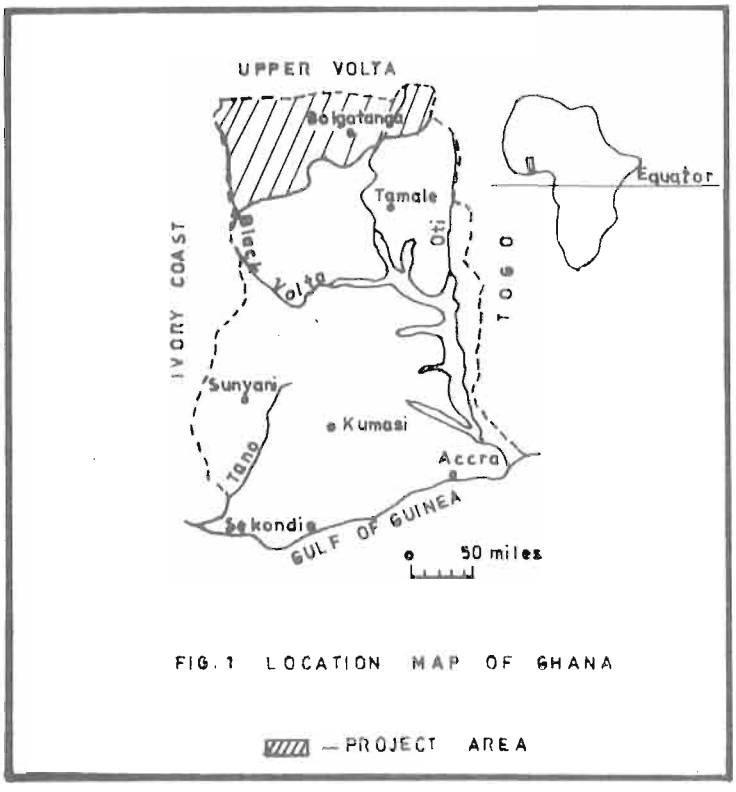


FIG. 1 LOCATION MAP OF GHANA

▨ — PROJECT AREA

The main objective of the Programme was to have a network of well water supplies throughout the Upper Region effectively maintained and kept in continuous operation in order to optimize the serviceability and life span of the units (see Plate 1).

### 2. SCOPE OF WELL AND PUMP MAINTENANCE

The well design and construction were carried out in a manner which would minimize the need for maintenance. Similarly, great care was exercised to ensure the selection of hand-pumps, which would require a minimum of maintenance within economic reason. Despite these precautions, it was evident that the ultimate success of the entire project would depend upon the effectiveness of the maintenance programme.

Generally, a pump malfunctions when the screen is clogged, the leather-cups have become worn, or the water table has dropped. In most cases, hand-pump mechanical failure develops where the pivot points become worn or the handle is broken due to rough usage.

It is desirable, therefore, that each well be checked and serviced periodically. This entails an inspection of the exterior working mechanism, lubrication of the bearings and replacing the worn out parts. At the same time, an examination of the pumping capacity would indicate if a major below grade problem existed.

### 3. COMPONENTS OF THE MAINTENANCE PROGRAMME

#### 3.1 Organization Pattern

The amount of servicing which the wells and hand-pumps would actually require was the most important factor that determined the organizational structure, capital outlay, manpower, transportation and equipment requirements of such a Maintenance Programme. This, even though was difficult, must be predetermined.

The strategy was adopted was to:

(i) establish the well maintenance activity within the existing GWSC organization, with control at the regional headquarters;

(ii) operate the well maintenance function from five district centres, with defined boundaries;

(iii) construct and equip workshop facilities at the headquarters and at the district centres;

(iv) conduct maintenance of hand-pumps as two separate activities:

(a) inspection and minor repairs on a 2 to 3 month frequency;

(b) complete pump service on "as required" basis.

In order that rural wells and hand-pumps service would not have to compete with other services in the region, such as urban distribution systems, it was set up as a separate function.

3.2 Personnel

The GWSC Regional Manager was responsible for the Programme and provided general direction. He was assisted by the Maintenance Engineer and Field Supervisor who were responsible for the continuous functioning of the programme.

A total of 250 field and workshop staff consisting of a core of trained technicians and mechanics were assigned. At the district levels these personnel had only well maintenance responsibility.

Most of the staff were newly-hired. However it was found desirable to use some of the existing staff to fulfill some of the new functions and this facilitated training.

Training for the experienced staff was aimed at upgrading their organizational and technical skills through on-the-job experience. Newly-hired staff received training in the maintenance, servicing and repair of vehicles and hand-pumps; and in record keeping, related to work performed and materials used. The experienced staff were used to train the newly-hired through on-the-job and formal sessions.

3.3 Transportation and Equipment

A complement of vehicles, mechanical and electrical equipment for the districts and workshops were carefully selected, after consideration of the levels of service to be provided at each district.

Vehicle access to a large portion of the hand-pump sites necessitated following trails, footpaths and crossing cultivated fields. Thus transportation throughout the rural areas, especially during the rains and the growing season, was of particular concern.

Due to the poor access to the pumps, occasioned by the limited road network, and due to the ever increasing cost of fuel, it was decided to utilize lightweight trail motorcycles for routine inspection of the hand-pumps (see Plate 2).

Whereas inspection required a very limited service capability, complete field servicing of a hand-pump necessitated the availability of at least two men having a service vehicle, equipped to remove and replace hand-pumps, drop-pipes, cylinders, leather-cups etc., that is, all below grade components.

The type and number of service trucks located in the districts were dependent upon the number of wells to be serviced and the distances to be traversed. These trucks were equipped with front-mounted winches; rear-mounted derrick facilities; compartments on both sides of the truck for storing spare parts; tool boxes full of accessory tools and equipment (see Plate 3).

3.4 Workshops and Stores Depots

In establishing the workshops, consideration was given to the level of services to be provided at the regional headquarters and in the districts.

Maintenance workshop operations consisted of:

(i) repair, service and maintenance of vehicles (trucks and motorcycles);

(ii) repair of hand-pumps;

(iii) repair, service and maintenance of mechanized pumps;

(iv) storage and control of supplies and equipment.

Generally the workshop buildings incorporated the following facilities:

(i) offices for supervisor/foreman;

(ii) stockroom for pump and vehicle parts;

(iii) sanitary facilities;

(iv) maintenance and repairs sections.

At the Regional Stores Dept, a complete stock of pump, vehicle and equipment spares and consumable supplies was maintained. At the district depots only stocks of fast moving parts and consumables for pumps and vehicles were kept.

The Regional Stores had responsibility for the procurement of local supplies including: petrol, gas-oil, lubricants, cement and disinfectants required for well maintenance. Also, they were in charge of the identification and scaling of a large quantity of off-shore running spares, consumables and equipment.

Supplies were distributed to the districts and field under a controlled stores ledger system.

3.5 Field Operations

The centre of the Programme was set up at Bolgatanga, the regional capital, where the main stores supply depot and the major repair workshop for pumps, vehicles and equipment were located. Here too a complete set of records of all the wells in the region was kept on file and up-dated as data were submitted from the District Maintenance Offices. Communication between the Head-quarters and the Districts was facilitated by radio communication.

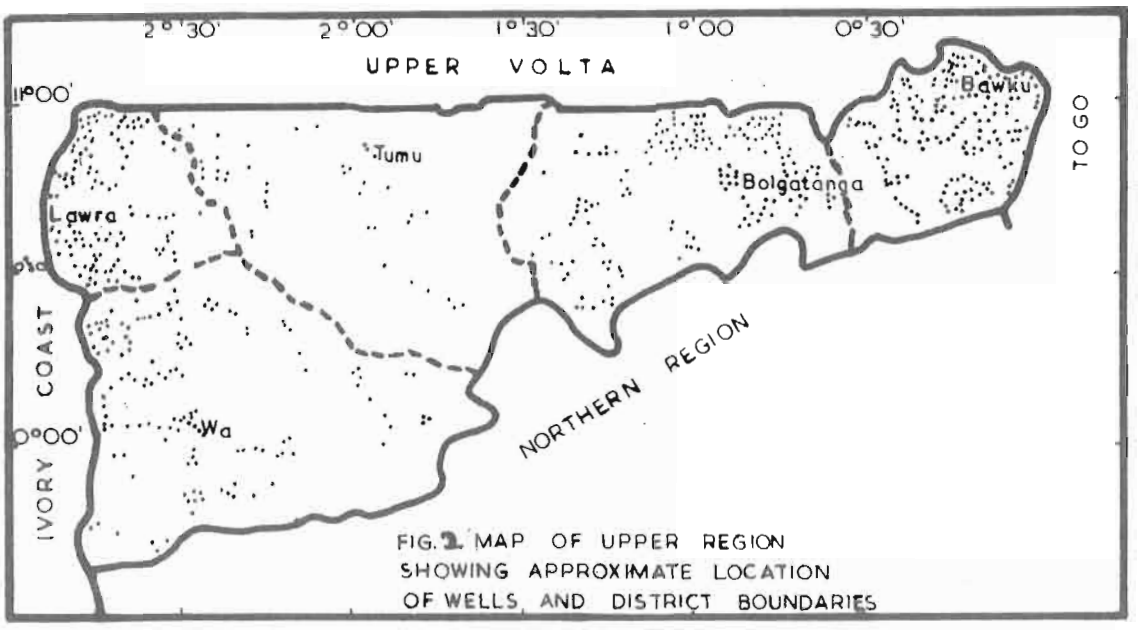


FIG. 2 MAP OF UPPER REGION SHOWING APPROXIMATE LOCATION OF WELLS AND DISTRICT BOUNDARIES

Field operations were carried out within five maintenance districts at Bawku, Bolgatanga, Tumu, Lawra and Wa (Fig.2). In each district, a system of motorcycle inspectors, service truck crews and workshop facilities was provided.

The operation was first established on a pilot stage in one district - Bawku - and on a successive district by district basis, until the entire region was fully serviced.

Each of the district organizations operated independently under the general direction of the Regional Headquarters, represented by the Maintenance Engineer and Field Supervisor. The District Officer was responsible for the repair, servicing and maintenance of hand-pumps and wells in his district.

Mechanics utilized eight lightweight trail motorcycles for routine inspections of the hand-pumps, along designated routes within the districts (Fig 3), providing a site visit every 2 to 3 months. They also carried out lubrication of pumps, provided preventive maintenance as well as made minor repairs and reported on pump failures. On the average 80% of the total hand-pumps in the region were inspected each month.

Eight specially equipped service vehicles also based in the districts carried out repairs on hand-pumps which could not be completed by the inspectors. These units did not make routine inspections, but responded only to reports from the inspectors or the villagers of pump failures.

A reported breakdown of pumps was scheduled into the work programme of the service vehicles. Normally a response time of pump repair was at least 3 to 4 days after a failure was reported. Since there was usually more than one well in each community adjacent wells were used in the interim.

The service vehicle crews also undertook maintenance and repair of mechanized well pumps and periodic chlorination of the wells and pumps.

3.6 Reporting and Maintenance Records System

Proper communication among the Maintenance Staff themselves on one hand and between them and the rural water consumers on the other was particularly important at the very early stages of the programme implementation.

In fact, part of the reason for such frequent inspections of hand-pumps was because of the lack of adequate communication facilities. Therefore the routine inspections served as a reporting system for servicing needs. Hence procedures and lines of communication for reporting had to be clearly spelt out.

A record system was incorporated into the Programme so that a history of repairs for each well could be filed. The records were used as a basis of administering the routine servicing of each well. Other users were for stocking of spares, upgrading maintenance procedures and for programming future maintenance activities throughout the region.

The total cost of the implementation was approximately 8 million Ghanaian Cedis (Ø4.75 - 1 Naira, December 1979).

Operating Costs

As well maintenance was established as an integral part of the GWSC regional maintenance organization, it was difficult to assess the exact operating costs of the programme. Even though effort was made at the initial stages to keep separate accounts of its operations, things fell apart due to lack of interest and control by the responsible officers.

The nature and scope of operating costs however involved:-

(i) operating cost of service vehicles;

(ii) operating cost of workshop and repair

facilities; and

(iii) manpower costs.

Being part of regional maintenance, facilities such as personnel, buildings, equipment and vehicles were shared with other units. For example, some of the headquarters management, accounting and records personnel, had regional responsibility. Also, in order to avoid duplication of functions in the districts some of the staff such as accounting, sotres and security personnel were shared.

## 4. EVALUATION OF THE MAINTENANCE PROGRAMME

### 4.1 Pump Performance

Pump performance and well site conditions are a reflection on the efficiency of the Maintenance Programme. These were monitored monthly and annually through the record system. A survey was conducted at the end of the third year's operation of the programme to assess the performance of the hand-pumps and to assess the prevailing sanitary conditions. The highlights were as follows:-

(i) 83% of all the pumps in the region were in operation. The relative performance by districts indicated a variation between 68% and 90%.

(ii) For these pumps out of service 11% involved features above the pipe flange and could be repaired by the Motorcycle Inspector. The remaining 89% needed service trucks to hoist below-grade components.

(iii) A visual inspection of these pumps which were still in operation revealed that:

(a) 63% were in good condition
(b) 28% were in fair condition
(c) 5% were in poor condition
(d) 4% were in very poor condition.

These results were considered very satisfactory as compared with results of surveys conducted in East Africa and Bangladesh, where some systems actually failed at a more rapid rate than they were installed.

The survey results verified the accuracy of the on-going District Maintenance Records and the monthly reports pertaining to percentage of pump operating at any point in time. It also provided an accurate picture of the field situation.

### 4.2 Site Conditions

It was observed that 56% of all wells had some site improvements carried out. Of the wells inspected 38% had back-fill placed around the concrete pad, while an additional 18% had extended concrete pads constructed by the villagers. Well site sanitary conditions were considered to be:

(a) 52% in good condition
(b) 35% in fair condition
(c) 13% in poor condition

The problem of creating insanitary conditions around standpipes in urban distributing systems is not very different from this!

### 4.3 Field Operations

(i) To optimize the efficiency of the inspectional services preventive maintenance and minor repair capability was added on. Additionally, to avoid unnecessary duplication of site visits, service crews conducted some inspectional work on these hand-pumps which were in close proximity to defective units, which had been programmed for complete field servicing.

(ii) Field records were analysed and general statistics were developed on the down-time on:

(a) pumps, motorcycles and service trucks,

(b) number of pumps visited per day worked by motorcycle and truck;

(c) percentage of pumps inspected which required service trucks.

These were used to establish time-targets for repairing pumps in each district. (See a sample of some of the forms which were completed monthly at the district level, for the records, in the Appendix).

(iii) Due to the ever-increasing cost of fuel and sometimes its unavailability in the region, it was decided to change from using petrol trucks to diesel trucks. The benefit was in terms of lower operational cost and more reliability.

(Would it not have been worthwhile using horses and donkey-carts in some peculiar environments!!)

(iv) The hand-pump water supply systems installed in this dry region were not designated to include the provision that livestock could be watered and small gardens irrigated.

Nevertheless, it was observed that small dug-outs or water holes existed at about 70% of the well sites. Of a total of 1178 water holes, 792 of them (67%) were considered unsatisfactory because they were less than 20 feet (6 metres) from the well.

However, evidence of excessive animal excrement around the well heads was observed at less than 1% of the wells, in spite of the fact that animals regularly came to many of the well-site water holes. It was similarly observed that the number of small vegetable

gardens in the vicinity of the well sites (in some of which fertilizer was applied) was multiplying. Even though these activities would most probably have significant economic impact, their nearness to the well sites, generated insanitary conditions and presented likely pollution hazards to the water supplies.

(v) The routine inspections provided the necessary public relations and training input required with the introduction of the new supplies to the villages. For example, an element of training was imparted to the rural populace who were not accustomed to using mechanical equipment such as hand-pumps.

(vi) Certain aspects of the records system such as measurement of static water levels would prove useful to future hydrogeological considerations regarding changes in the water resources of the region.

(vii) The personnel involved in the maintenance programme coped very well with the new concepts and tasks. They acquired such a high social status at the village level as was not envisaged at the on-set of the programme. Their visits to the well site proved useful in communicating with the villagers and educating them regarding pump usage, water conservation, well head sanitation and maximising the health benefits of the newly established water supplies.

### 4.4 Villager Involvement in Hand-Pump Maintenance

It was evident that most villagers were willing to participate in maintenance and could improve the overall pump performance and well site conditions if encouraged to do so.

Based on recent experiments which showed that the below grade components of hand-pump could be removed, repaired and replaced manually, without using a service truck, it is feasible that the villagers could one day provide a complete maintenance and repair service for their hand-pumps. It should be appreciated that a few locally made special tools would be needed to facilitate manual servicing. But it will undoubtedly take several years training before this can be achieved without outside assistance.

In view of the ever-rising cost of maintenance, the inherent problems of vehicle breakdowns, and the encouraging response by the villagers, this avenue is already being considered.

A Water Utilization Project has been initiated in the region with the objectives of stimulating the villagers towards maintenance of pumps by themselves and involving them in community development and adult and health education.

## 5. CONCLUSIONS

The Well Maintenance Programme has only been in operation for a little over three years. One is often tempted to evaluate the success or failure of the entire water supply programme by the maintenance performance but in doing so it should be appreciated that more time will be required for the evaluation of the programme. The performance and results to date can only be described as being borne out of the gestation period! It is important to monitor the maintenance on a continuous basis.

The types of hand-pumps installed on the wells are not the best types available yet to the programme. Resulting from the Hand-Pump Field Testing Programme which is currently being carried out in the area, improvements through upgrading and modifications are expected in the design of future pumps and this may affect the maintenance programme concept and field operational strategy substantially.

Even though the villagers could be trained to carry out regular maintenance and repairs of hand-pumps, but first a word of caution! Under no circumstances should consideration be given to eliminating the use of service trucks at this time. And complete maintenance at the village level without the technical know-how of motorcycle inspectors is unrealistic for the foreseeable future. Even if a giant step were taken toward village involvement and most maintenance was being provided at the local level, some service trucks would still be needed in the system for special circumstances and to transport new pumps and unwieldy sections of drop pipes and sucker rods.

To provide an independent maintenance and repair service by competent villagers will require an extensive training programme over a long period of time. Therefore, the present centrally controlled system involving service trucks and motorcycles will be essential for a long time to come.

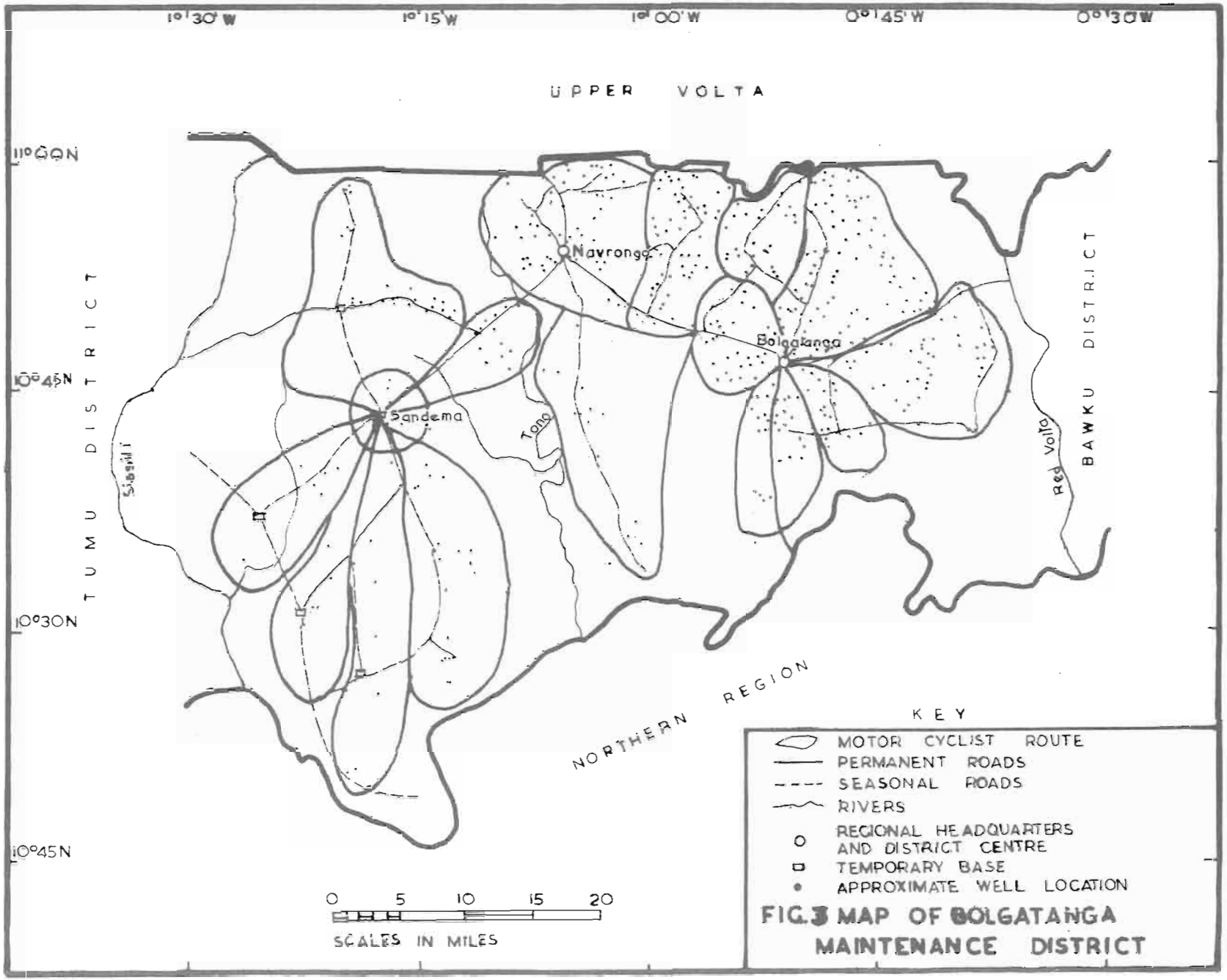


FIG.3 MAP OF BOLGATANGA MAINTENANCE DISTRICT

## DISTRICT MONTHLY REPORT

District ..... Month ending ..... 19..

1. From Motorcycle Inspection Log

a. No. of hand pumps inspected .....
b. No. working on arrival .....
c. No. working but repaired by motorist .....
d. No. not working and repaired by motorist .....
e. No. working but requiring service truck .....
f. No not working and requiring service truck .....

2. a. No of hand pumps reported not working by villagers but not reported by motorist .....
   b. No. of hand pumps reported not working by villagers and also reported by motorist .....

3. a. No. of hand pumps serviced .....
   b. No of pumps requiring service at month end .....
   c. No of mechanical pumps serviced .....

4. Hand Pump Inventory

| | TYPES OF PUMPS | | | |
|---|---|---|---|---|
| a. Hand pumps on wells in District at end of last month | | | | |
| b. Hand pumps removed from old wells | | | | |
| c. Hand pumps installed on old wells | | | | |
| d. Hand pumps installed on new wells | | | | |
| e. Total hand pumps on wells in District at end of month | | | | |
| f. Hand pumps in stock requiring repairs | | | | |
| g. Hand pumps in stock ready for installation | | | | |

5. Vehicle usage

| | miles travelled | gallons of fuel | m.p.g. |
|---|---|---|---|
| a. Motor Cycle No ..... | | | |
| b. Motor Cycle No ..... | | | |
| c. Service Truck No. ..... | | | |
| d. Service Truck No. ..... | | | |

## SERVICE TRUCK REPORT

Date .....

District ..... Service Unit .....

Travelling time ..... Time spent on site .....

Well number ..... Village .....

Type of pump ..... Static water level taken Yes / No (from top of concrete base)

Pump operating on arrival Yes ... No ...

| Work done | Parts replaced | |
|---|---|---|
| | Number | Name |
| ..... | ..... | ..... |
| ..... | ..... | ..... |
| ..... | | |

Comments: .....

*3 Copies*

1. *White to Region Officer*
2. *Canary to District Office*
3. *Pink remains in Report Book*

..... Serviceman's signature

..... Serviceman's name

## VEHICLE DOWN TIME

*NOTE: RECORD ONLY WORKING DAYS VEHICLE WAS NOT USED*

District ..... Month ending .....

Vehicle No ..... No of working days .....

No of days worked .....

| Date | No work to do | No Operator | No petrol | Mech problem | weather | other |
|---|---|---|---|---|---|---|
| .... | ..... | ..... | ..... | ..... | ..... | ..... |
| .... | ..... | ..... | ..... | ..... | ..... | ..... |

## WELL SERVICE RECORD

Well No .....

District ..... Village .....

Well Location .....

Type of pump .....

Date well drilled ..... Depth of well .....

Diameter of casing ..... Recommended yield ..... Igpm

| Date serviced | Pump operating on arrival | | Work done | Parts replaced | | Static water level |
|---|---|---|---|---|---|---|
| | Yes | No | | Number | Name | |
| | | | | | | |
| | | | | | | |

## RECORD OF BROKEN-DOWN HAND PUMPS

District ..... Month ending .....

| Well No | Type | AG | BG | Date down | Date repaired | Remarks |
|---|---|---|---|---|---|---|
| ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... |

## RURAL WELL INSPECTION LOG

| Well No. | Date | Village | Odometer reading | Well operating on arrival | | Work done | Parts replaced | Service Truck required | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Yes | No | | | Yes | No |
| .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

PLATE 1: A HAND-PUMPED WELL WATER SUPPLY

PLATE 2: A TRAIL MOTOR-CYCLE EQUIPPED FOR ROUTINE WELL INSPECTION

PLATE 3: A SERVICE TRUCK EQUIPPED FOR WELL AND PUMP MAINTENANCE AND REPAIR