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NATIONAL SHALLOW WELLS PROGRAMME

CHAPTERS 1 THROUGH 4
(DRAFT)

DECEMBER 1980 – DECEMBER 1981

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CHAPTER ONE

ORGANISATIONAL ASPECTS OF A NATIONAL SHALLOW WELLS PROGRAMME IN TANZANIA

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1. ORGANIZATIONAL ASPECTS OF A NATIONAL SHALLOW WELLS PROGRAMME IN TANZANIA

1.1. Introduction

The following notes are partly based on our experience with the Shinyanga- and Morogoro regional shallow wells projects and on a review of the existing literature on the subject. Furthermore we visited all ongoing regional projects in Tanzania and had discussions with the regional authorities in some other regions (cf. appendix 1) to obtain additional information on the organizational aspects of such projects and on the main problems encountered.
It should be noted that no new fieldwork could as yet be undertaken in the regions to substantiate (or reject) any conclusions reached in this paper.
Hence we have elected to refrain from drawing definite conclusions or from making firm recommendations at this stage, whenever clear policy options appeared to exist.
Consequently the following notes are submitted as a first attempt to review the current situation and to arrive at a conceptual outline for a national shallow wells programme in Tanzania. In our view the authorities concerned will have to take a number of important policy decisions before such a programme can be implemented.

There is a definite need to review the current strategies in the field of rural water supply. The various ongoing regional projects operate in different manners, in or (partly) outside the regular administrative structure. At the national level, there is little insight, leave alone control, over what is going on in the regions. There is even no clear understanding as to what role shallow wells can or should play in a rural water supply strategy.
Techniques used to dig shallow wells differ (ring wells, tube wells, hand- or machine digging etc.). There is little standardization, the hand pumps used in the various regions are not even interchangeable, unless they happen to come from the same supplier. In all projects operating within the normal administrative structure the supply of materials and spare parts constitutes a major problem. In Shinyanga region, for instance, the well construction programme came to a grinding halt, since cement, necessary to produce the rings, was not available. Adequate transport is often lacking, reducing the efficiency of the construction and maintenance effort. Uncertain annual budget allocations make planning and staffing in the Regional Water Engineer's department a recurrent headache for everybody concerned.

A much more fundamental objection against the current way in which rural water supply projects are implemented in Tanzania is that they are technology-centered (however "appropriate" that technology may be) and that they do not take the needs of the local community as a basis for action.

There is at best nominal participation (e.g. in the form of paid self-help, a contradiction in terms), a brief consultation as to the preferred site of the wells and a single meeting during which the importance of clean drinking water and the need for maintenance are explained. In some projects an unpaid local pump attendant is trained. Yet, once the well has been constructed, the villagers are generally left to their own resources. The Regional Water Engineer does not have the staff and the funds for maintenance and so, unless the villagers (or the construction project, if still in the area) do something themselves, there will be no maintenance at all.
Furthermore, it would appear that success or failure of especially foreign-sponsored projects is measured solely in terms of the number of wells constructed and similar quantitative targets. Efficiency of the (construction) operation is put before effectivity and impact.
It is a sad thought that despite a much greater effort from both donors and Tanzanian authorities during the past few years, the more fundamental issues of effectivity and impact still have not been raised other than in general statements at conferences etc.

At the same time, it should be admitted that nobody seems to have a clear idea about how a national or regional shallow wells project should be organized. The Morogoro Conference on Shallow Wells, for instance, did advocate a maximum participation of the villagers, but remained remarkably vague as to what this should mean in real life situations.

In the following pages an attempt will be made to outline a possible form of organization for a national/regional shallow wells programme. Where appropriate the existing policy options will be indicated.

1.2. A national shallow wells programme

Our point of departure here is, in accordance with our original Terms of Reference, a national shallow wells programme. However, the need or even the desirability of such a national programme is not self-evident.
First it should be recognized that shallow wells cannot be constructed everywhere in the country on a sufficiently large scale to supply everybody in the rural area with safe drinking water. There are of course other technical solutions, including other low-cost methods, used and this will remain so, simply because in some districts the chances to construct shallow wells are limited.
A one-sided emphasis on shallow wells could, therefore, mean neglecting these other districts or, conversely, separate organizations for piped supplies etc. and possible duplication of work.
On the other hand, it is argued that, at a conservative estimate, shallow wells can supply over 50 per cent of Tanzania's rural population with a dependable source of drinking water at a cost which the country, with the help of donors, can afford. The technology is relatively simple (and known from experience) so that implementation can proceed rapidly. In this sense, a specific effort directed at shallow wells could be highly rewarding.

The second question which should be posed is whether a national programme is required, or whether the current practice of regional projects (with some national assistance e.g. in the procurement of materials and spare parts) can be relied upon.
If the Ministry wishes to have a greater influence on the implementation, it will be necessary to have a national programme (with finance coming from the national level). Otherwise, the decentralization of authority as practised in Tanzania will automatically lead to regional projects (and finance allocated through the regional budgets). For the donors the chosen form should not make a major difference; they could presumably continue to support projects in specific regions.
Hence, the Tanzanian authorities must chose between four alternatives:

- a national rural water supply programme of which shallow wells constitute just one component
- X regional rural water supply projects in which shallow wells constitute a component, with some central assistance
- a national shallow wells programme
- regional shallow wells projects, with some central assistance

1.3. The national target in rural water supply

Tanzania has a fairly clear stated target in the field of rural water supply, i.e. to provide the entire rural population with ease of access to a dependable source of drinking water by the year 1991.
This target is not new, but unforunately, during the past ten years little progress has been made towards attaining this goal. New wells and piped supplies have been constructed in different parts of the country, but other, existing supplies have broken down at nearly the same rate. no figures!
It is abundantly clear, that unless an all-out effort is made by Maji and the donors together, the stated target will not be reached during the remaining decade. Both Tanzania and the donors will have to commit themselves to a long-term support for such an effort.
Constructing the required number of shallow wells and other supplies already represents a formidable task. Yet, the problem is greatly aggravated by the obvious need to maintain and (as time goes on) to replace the pumps, wells etc.
It should be emphasized that Tanzania does not have - and will not have in the foreseeable future - the means to construct and to maintain the required number of water supply systems, even with generous donor support.
It seems likely that donor-sponsored projects will concentrate on construction and related aspects, and much less on (prolonged) maintenance programmes.

If the Tanzanian authorities really insist - as they have repeatedly done in the past - that all domestic water must be supplied free of charge (with the exception of private house connections), the obvious implication is that Maji sooner or later will have to face the burden of maintaining all rural water supply systems, including over 40,000 shallow wells.

Tanzanian planners do of course realize that this is an unrealistic assumption and apparently it is now widely agreed - although usually tacitly - that in rural areas (as opposed to urban areas) the people themselves should take care of the maintenance. However, it remains obscure how precisely this should be done. Pump maintenance is not an ordinary type of self-help project. "The people" do not maintain and in practice it is always somebody - the pump attendant - who has a prime responsibility in this respect. Human nature being what it is, we must expect that most pump attendants will neglect their duties sooner or later, unless they are paid for their services in one way of another. If, as is the case, the Tanzanian government does not have the funds to pay the pump attendants, the village people will have to pay them. There is just no other solution to the problem.
But then the authorities will have to say so, loud and clearly, so that this solution can be adopted and implemented in the various projects.

1.4. Maintenance, the crux of the matter

Past experience in Tanzania and elsewhere has demonstrated that it is feasible to implement relatively efficient construction projects for shallow wells. Pump technology has developed sufficiently to state that it is now possible to build a hand pump which requires only a reasonable minimum of maintenance and may be expected to have a lifespan of, say, ten to twenty years. The construction of wells, and especially of tube wells, is comparatively easy and requires few special skills. Invariably it is maintenance which threatens the ultimate success of the effort. Thus in Shinyanga region it has been estimated that as much as 30 per cent of the hand pumps were out of order, only a few years after they had been installed and despite the existence of some sort of maintenance organization in Maji. The reasons for this state of affairs should be analysed carefully, so that possible shortcomings in the organizational set-up can be remedied.
However, one important conclusion can be drawn here: it makes very little sense to embark on a national shallow wells programme (or on expanded regional projects), unless a reasonably effective operation and maintenance of the water supply system can be guaranteed.
Ideally, not a single pump or tap should be installed before its maintenance has been secured.

1.5. Development is for the people

The title of this section is of course a truism, but one that is not often adhered to in the actual implementation of rural development projects. The authorities formulate the goals and timing of nearly all projects and in most instances the "participation" of the people will be confined to nodding their agreement/understanding during a meeting and supplying the required manual labour for the project.

Such an approach may work when it concerns the building of a classroom, or the construction of a village dispensary, but it will certainly not work in the case of a water supply project under the present circumstances.
Clearly, operation and maintenance of shallow wells - and consequently the effectivity of the project - hinges primarily on the readiness of the village people to pay for it and, equally important, to abide by certain rules (e.g. concerning the cleanliness of the surroundings, no pit latrines near the well).
Whether or not the people will be prepared to shoulder these obligations in turn depends on whether or not they perceive greater ease of access and cleaner/safer drinking water as a "felt need" (rather than an "ascribed" need), and expect to reap definite benefits.
In President Nyerere's words: "The purpose is man", but in rural water supply projects there can be no interpretation which adds "and we know what is good for you". A crucial requirement of any shallow wells project is that it must be people-oriented, rather than technology-oriented and involve the active participation of the village community right from the beginning.
This is an important principle, yet it must be made operational. It is of course not possible to ascertain in each and every village that an improved water supply is indeed a felt need through lengthy in-depths interviews with all the intricacies involved (no villager is likely to say that he is against an improved supply).

1.6. Water and felt needs

The question whether or not improved water supplies are really a felt need in Tanzania's rural areas is of crucial importance. However, it should be admitted that it is not at all certain that this is the case in many areas.
Two aspects may be distinguished here which should be viewed in combination with potential and perceived benefits:
- greater ease of access to water
- quality and quantity of the water

It is possible to list a number of potential benefits which people can derive from improved water supplies, ranging from time saved in collecting the water to various health-, social- and economic benefits. Heijnen and Conyers (1971) did this for Tanzania. It is perhaps significant, however, that very few of these hypotheses could be substantiated in subsequent research.
Greater ease of access/time saved in collecting water may be a very clear (and perceived) advantage of improved supplies in those areas where traditional water sources are far away (especially during the dry season).
At the same time, it should be remembered that is is usually the women and children who collect the water and the men who must provide the labour (and perhaps the cash) for the project.

In other areas, as in river valleys (Morogoro-south) which are often flooded during the wet season and where water is never far away even during the driest months, the benefit of easier access may be dubious at best.

Most authors (e.g. White et al, 1972) agree that a relationship exists between water and health. This in fact is one of the main reasons why improved supplies are advocated. There are many water-related diseases and more and/or better quality water can be pre-requisite to prevent their occurrence. Yet a better, nearby improved water supply is often not enough.
Thus Kreysler found in Ismani (Iringa region) that drinking water stored at home was heavily polluted, even though the water taken from the taps contained only very few coliforms. In the same area a longitudinal study conducted by Klaren and Heijnen (1971) showed that the amount of water used had not increased significantly after the improved supply had been installed.
Apparently storage vessels are only rarely cleaned (IRC, 1979, p. 44), while local beliefs may have a negative effect on the occurrence of potential health benefits.
A major problem in this connection is that very often the people are simply not aware of the complex relationship which exist between water, health and sanitation. This has, in the context of water supply projects, two major consequences. First the people do not perceive the potential health benefits of an improved supply and secondly, the potential health benefits are unlikely to materialize, because the people do not take the other necessary and complementary measures (cf. Van Amersfoort, 1969).

We may reasonably assume, therefore, that in many areas an improved water supply is not (yet) a felt need. The implication is that any rural water supply project in Tanzania must be accompanied, even preceeded, by an intensive educational effort.
In Tanzania there is a precedent for such an effort, namely the health education campaign in 1973, which also paid attention to water-related diseases and their prevention (cf. Hall, 1974 and 1978 and Hall and Dobbs, 1974). The "Mtu ni Afya" campaign was, however, a single effort, directed specifically at the new Ujamaa villages and lasted only one year. There was no direct link with specific developmental projects.
Here it is proposed to establish a direct link between the shallow wells implementation programme and the educational effort. Education must be an integral project component.

1.7. Towards on operationalization of a people-centered apporach

The approach of basing a water supply project on the active participation/felt needs of the people is not new. It has also been tried successfully in Tanzania (cf. for instance, Kreysler, 1968, Van der Laak, 1969, Matango & Mayerle, 1971). However, it is important to note that in all instances it concerned water supply projects in one or at most a limited number of villages in a single district.

Kreysler, for one, knew "his" village Mayo (in Lushoto district) very intimately. He had undertaken, together with the villagers several other projects, including a regular under-fives clinic, a school feeding programme, a vegetable and chicken farm for the school and a maize mill, before he initiated the (piped) water supply project. There were many formal and informal discussions, various alternative technical solutions were looked at, before the actual work began. The German Kübel Foundation paid for the materials needed and the villagers (and Kreysler himself) supplied the labour. In fact, the project may be regarded as one which came very close to the sociologist's ideal of how innovations should be introduced at the village level.
At the same time, we should also look at the reverse side of the medal. The real cost of such an approach is very high. Progress was often slow. During the wet season, for instance, and especially during cultivation and harvest time, people had to work in their fields, so that all self-help projects became stymied. The near-endless discussions, the participation in and the supervision of the work in Mayo took a great deal of Kreysler's time (which was not counted as a cost). Moreover, he had other work to do as well so that idle time (when the work stopped) did not come into the picture.

These remarks are not meant to criticize the value of Kreysler's work in Mayo, but merely to illustrate that the sociological ideal is an impossibility when the need arises to apply it on a much larger scale.
Elsewhere in this report it is estimated that, in order to supply 50 per cent of Tanzania's rural population with shallow wells, it will be necessary to construct 4,000 wells annually, at a cost of (probably well over) Tshs 1,000 million.
This amount does assume a reasonable level of operation efficiency and an implementation rate of several hundred wells per region/year, in other words, a smoothly functioning, year-round operation, with specialized survey- and construction teams etc.
Even if research into the felt needs and motivation of the people can and should be undertaken, it will obviously not be possible to gauge the people's attitudes in respect of improved water supplies in all villages concerned with the required precision. This would raise the cost of the programme to an unacceptable level and (probably) delay the implementation considerably. Even then, the validity of the research results would have to be tested. Surveys which attempt to gauge attitudes towards as yet non-existing innovations often yield a "normative" response. Very few respondents will admit that they do not value a better and modern water supply and even if the required precautions against such a bias are built in, it remains dangerous to rely on the survey results without additional tests.
The proof of the pudding is in the eating. If villagers are asked to make a contribution in kind and/or in cash, it will very soon become apparent whether they really want a better water supply (provided that the contribution demanded is reasonable).

Most studies in rural water supplies in Tanzania, especially during the early seventies, have assumed that the people in rural areas are not prepared to pay for a better rural water supply. Provided that people realize the benefits of an improved water supply, we see no reason why individuals or groups of people would not be prepared to pay for it. After all, the cost of a shallow well is not too different from that of a corrugated iron roof, ploughs, ox carts and other implements which are increasingly purchased.
Consequently, we believe that a reasonable financial contribution could be asked when a shallow well is constructed. It would establish beyond doubt that the people have a genuine interest in the new water supply and probably contribute to a sense of ownership and responsibility for its maintenance.

Experience in Tanzania and elsewhere has shown that people are unlikely to treat anything obtained "free" from the government or from any other outside organization as a valuable property of their own. The result is that they will also expect the government or organization to take responsibility for maintenance.
To prevent this it is essential that the villagers themselves take some kind of an initiative to obtain the shallow well, make a definite contribution and that the ownership of the well is very visibly transferred to the village.
In Mwanza a World Bank-financed project already demand a (relatively high) contribution from the village. One pump per village is constructed free of charge as a demonstration. No "second" pumps have as yet been applied for, perhaps because the contribution demanded is too high.

1.8. Proposed steps

The above considerations lead us to believe that a shallow wells programme in order to be successful should have a clearly defined approach, with (at the village level) the following steps:

1. a survey of conditions (including present sources of water) and needs (both ascribed and felt needs)
2. an educational campaign (continued during the construction phase and subsequently) to mobilize the people
3. to propose to the villagers (if it turns out to be technically feasible) that they apply for the well and meet certain conditions such as:
   - at least a token financial contribution , say in the order of Tsh 1,000, to meet the cost of local labour employed in well construction
   - sign a contract between Maji and the village (council) whereby the village undertakes to assume responsibility for maintenance and protection of the well
   - agree to send one or more men for training to become the future pump attendants

unacceptable

- levy a small water tax on each household to pay these pump attendance and other maintenance costs
- establish, for instance, a special sub-committee of the village council for water and health, responsible for collecting the levies and for supervising maintenance and cleanliness of the well site etc.

4. survey of possible well sites in close coöperation with the villagers (and especially with the sub-committee for water and health)
5. actual construction
6. handing-over ceremony of well to village by Maji/project
7. occasional checks on maintenance by project during the first two years

A few additional remarks can be made here. We have opted for a relatively low financial contribution. Given the present situation in Tanzania, villagers are often asked to make contributions in kind and/or cash for all sorts of developmental activities and there is a clear end to what we can espect poor villagers to do. Certainly at the moment, after a relatively dry year, in many areas people simply do not have cash available for anything but their most essential needs. Asking too much could mean that the poorest villages cannot afford to participate in the programme.
Unpaid (self-help) labour is rejected as a means to construct the wells. It is difficult to mobilize and often not sufficiently dependable to guarantee a smooth functioning of the project. Moreover, the demand is limited so that the burden would fall on a few people. The financial contribution asked will be used to pay the local workers needed, so that (as an added advantage) the money remains in the village. This could include the planting of hedges and other measures to protect the site. During the surveying of the village area for suitable well sites every care should be taken to consult and involve the villagers.
A check should be made in respect of the location of the traditional water sources (from the data collected during the initial exploratory survey) both during the wet and the dry season. If at all possible, the chosen well sites should be closer to the houses than the traditional sources, since otherwise it is likely that many people will continue to use the traditional sources.
A final decision should be taken only after approval by the village council.

The policy to leave much of the initiative with the people and the requirement of a financial contribution implies that the planning of the programme will become more difficult and that programme costs will go up. Some villages may decide not to make the application. This is, however, a logical consequence of the decision to base the programme on the people's felt needs and on their active participation to ensure also the necessary maintenance. There can be no real participation and decision making involving the local people without also giving them the option to say no.

It means also a greater flexibility in project targets, and a shift away from the number of wells produced to other, perhaps less tangible objectives like the number of people reached in the educational campaigns, areas covered etc.

Finally a word of caution is perhaps in order here in respect of the way in which the educational campaign should be conducted.
The improved supply should never be advocated as the panacea for all water-related diseases. Whatever research results are available from Third World countries point to multiple factors. Thus water from a clean shallow well can never be the sole effective preventive measure against cholera, typhoid, bilharzia, hookworm and a number of other water-related diseases and it would endanger the success of the project of this were suggested.
Campaigns always seem to have the tendency to simplify the issues at stake, especially when village people are addressed. It is, however, easy to imagine how the village people would react if a cholera epidemic struck their village after a well had been constructed, if they had been told that the well would protect them from cholera. It is of the utmost importance, therefore, to conduct the campaigns in an intensive manner, but without oversimplifying the issues at stake and overstating the potential benefits.

1.9. Maintenance organization in Maji

Even when one accepts the principle that the villagers themselves are fully responsible for the maintenance of their wells, it is clear that help from Maji will still be indispensable in many instances. There is, therefore, also a clear need for a maintenance organization in Maji.
At the national level there would be the proposed Shallow Wells Procurement Centre, to distribute pumps, spare parts and materials to the regions. For maintenance purposes a regional store will not suffice and it will be necessary to establish stores also at the district level, from where spare parts etc. can be distributed to the villages and the Maji maintenance officers as needed.
To assist the villages in maintaining their wells, it will be essential for Maji to have trained maintenance officers at the divisional level. Any defect that cannot be repaired by the pump attendants themselves must be reported to them so that he can go to the village to assist the pump attendant. The divisional maintenance officer, therefore, must have a small stock of spare parts (and of course access to the district store), as well as a bicycle so that he can actually reach the villages in his division and help out the pump attendants. He would furthermore make regular inspection tours to ensure that the pumps are in good condition, the well sites clean etc.
Unless the regions are prepared to make the necessary funds available for such a maintenance organization and acutally implement it, a shallow wells programme should not be initiated or continued.

1.10. The task of Maji and donors at the national level

Donor support is as yet not sufficient to create a nation-wide, meaningful shallow wells programme.
At present donor-sponsored rural water supply projects are organized on a regional basis.
Yet, with only a few of such projects now operational it is already clear that there is a need for greater coordination and cooperation at the national level.
A greater degree of standardization both of materials and of methods used would be highly beneficial for Tanzania and could lead to lower costs.
Maji and donors have agreed to establish a coordination committee, the Tanzanian Water Development Coordination Board, in accordance also with resolution of the Morogoro Conference on Shallow Wells. Presumably this will also lead to the setting up of a Technical Coordination Committee, TCmSW as a sub-committee of the Board, consisting of technical experts from the various projects. This TCC will advise on the adoption of a standardized pump and other equipment used in construction and maintenance of shallow wells.

Related to this is the desirability of a National Shallow Wells Procurement Centre. At present many regions find it difficult to secure a regular supply of pumps, other equipment, materials and spare parts. The Morogoro project attempts to provide a number of regions/projects with pumps and other materials. In Shinyanga another type of pumps is manufactured and (partly) sold outside the region.
The foreign-sponsored projects can import their requirements directly, but the other regions must go through lenghtly administrative procedures to meet their requirements. A national Shallow Wells Procurement Centre (with direct donor support and the possibility to import directly) could evade these bureaucratic procedures and, at the same time, promote greater standardization.
Three locations have been mentioned as possible sites for a National Shallow Wells Procurement Centre:

- Shinyanga, where a Tanzanian set-up is already engaged in pump manufacturing
- Morogoro, where the Dutch sponsored project at present in fact functions as a procurement centre for other regions
- Dar es Salaam, as Tanzania's main port of entry and chief nodal point of the road and rail network

Shinyanga appears to be the least suitable site because of its poor connections with most other parts of the country, which would raise transportation/distribution costs.
Morogoro is a possible choice, but the fact that the centre would be linked directly with a regional project may be a disadvantage.
will at present temporarily continue to function as supply center

Dar es Salaam has the best connections with its hinterland, but here a totally new organisational structure would be required. However, Maji already has Wazo Hill here, which could become the nucleus for such a Procurement Centre.

At this point perhaps some clarification is needed as to the use of imported pumps etc. versus the desirability of using locally manufactured pumps/parts and other equipment.
In respect of the materials used for the shallow wells, for instance, it is noted that at present, except in Shinyanga region, nearly everything needed in the projects is imported directly. Both the Morogoro and the Lindi/Mtwara project even import the complete hand pumps from the Netherlands and Finland respectively. Yet, at least in the case of the Morogoro project, it has been official project policy to use local components and to localize production of the pumps to the maximum possible extent.
A reversal of this policy in this respect was caused primarily by the fact that, in an effort to improve the pumps and to reduce the need for maintenance, it was necessary to use higher quality materials and parts which are not at present available in Tanzania.
Maintenance of rural water supply systems is a major problem in Tanzania and, even if maintenance can and must be improved considerably everywhere, the country still cannot afford an expensive maintenance system. Therefore an imported, high quality pump which requires a minimum of maintenance is preferred to a lower quality, locally made pump, even though the cost of the imported pump may be higher (which is, however, not necessarily the case) and the benefits usually ascribed to local manufacturing are lost to Tanzania.
In passing it is noted that a considerable proportion of the locally available materials and parts that have been used in pump- and shallow well construction in the Morogoro and Shinyanga projects have been imported in any case, so that the total net loss in added value to Tanzania is probably not as great as might be surmised. This is an area, however, where few precise data are known and subsequent research might be rewarding.
Also for the new Procurement Centre it will probably be necessary to continue the current practice of importing the complete pumps and materials from abroad. This means that it will be necessary to organize the centre as a separate project, financed by the donors and Maji together in such a way that it can order the required materials and pumps directly from abroad. Given the current financial and administrative constraints in Tanzania, this is the only way in which a reasonably reliable supply system can be guaranteed.
Only once the supply system functions satisfactorily, it seems worthwhile to study the possibilities for local assembly of the pumps. At first sight this appears to be an attractive possibility, given a sufficient demand (with more and larger projects) and an agreement on standardisation.

It could well be, however, that a thorough study would reveal that, in view of the necessary relatively high overhead costs (there must be an intensive supervision so that a constant, high quality of the product is guaranteed), the cost of a locally assembled pump compares unfavourably with the price of imported pumps. A decision to assemble pumps locally, therefore, merits careful consideration.

1.11. Training

For a national shallow wells programme, whether or not it is split up into regional projects, trained technicians are required. So far the Morogoro project has trained a number of people for other regions, but an enlarged programme makes a national training programme desirable. In Dar es Salaam the Water Resources Institute has already began the first courses and it could be envisaged that this institute plays this role also in future, on a somewhat larger scale and including the training of Maji Maintenance personnel.
It will be necessary to look at the institute's facilities and staffing, to decide, in the light of future requirements, whether additional means are needed and how these can be financed.
The training of local pump attendants can best be done on a regional basis, by the various project implementation units.

1.12. Organisation at the regional/district level

Maji (i.e. the Regional Water Engineer) is at present the first responsible authority for the implementation of any rural water supply project in the regions. At the same time, it is noted that several foreign-sponsored projects operate (e.g. in Morogoro, Lindi-Mtwara) as more or less separate entities, although some links and coordination usually exist. This does not mean, that cooperation is optimal, but it is difficult to determine to which extent any existing lack of cooperation between the project and the RWE is caused by organisational deficiencies or by the fact that different personalities, with different cultural backgrounds and very different financial and material means at their disposal, must work together.
Nevertheless, the organisational aspects should be given careful consideration, if only because sooner or later, foreign support will be withdrawn, so that the RWE will have to continue the programme. It is emphasized that shallow wells is an ongoing programme. Even if it were possible to produce the required number of wells before 1991, it will still be necessary to construct new wells, to replace existing wells (which have a life time of perhaps 10-20 years only) and to cater for population growth and other needs.

Maji should have a definite function in the mobilisation/education campaign and ideally, after perhaps the initial phase of project implementation, it should also take responsibility for dealing with applications from villages, planning and surveying of suitable sites, handing over the wells to the village and for the monitoring of the quality of the product (both of the wells themselves and of the water quality).

It should, therefore, be attempted to arrive at a type of organisation where the foreign project component is directly concerned only with the actual well construction (which at a later stage can probably also be left to local contractors).
It is realized that such a state of affairs cannot be reached overnight. However, in our opinion each implementation project should be planned in such a way that the RWE progressively takes over responsibility for the various tasks, after local personnel has been trained by the foreign-sponsored project. Ideally, after a few years foreign experts should, at most, act only as advisers to the RWE, with no direct executive tasks in implementation.
A first objective of the foreign-sponsored project should be to assist in building up the regional capacity to implement shallow wells projects, rather than to "dump" large numbers of shallow wells and other water supply systems on villages and Maji staff who are ill-prepared to deal with the consequences of such well-meant generosity.
At the sime time, it should be realized that this progressively greater involvement of the RWE will probably require a readiness on the part of the foreign donors to pay the salaries of Maji staff involved (perhaps coming from the projects) and other costs incurred by Maji for a considerable period of time before this aid can be phased out. The same in fact, holds true for the required maintenance organisation in Maji, from the regional and district stores, down to the divisional maintenance officers.
It would be of great advantage to Tanzania if Maji and donors, in the coordination Board, could agree on a clear-cut policy in this respect.

1.13. Other water uses

At present all shallow wells projects are directed solely at supplying water for domestic use. This is, in view of the existing targets in this respect perhaps understandable, but at the same time, there is a danger that such an apporach is not flexible enough to realize other substantial benefits.
By narrowly defining rural water use to drinking water, or at any rate to domestic use, there is a tendency to deny the possible developmental aspects of rural water supplies and, in extreme cases, this might even endanger the success of the programme, especially in pastoral communities.
To pastoralists, water for their cattle is a first priority and planners will have to consider this vital aspect of water need. In order to protect the well used by the people adequately, it may be desirable to construct special wells and facilities for the cattle at some distance, especially where the traditional sources are inadequate and/or far away. At the same time, we believe that a more substantial contribution could be expected from the people if such additional facilities were constructed and presumably these people would also have the means to pay for these additional services.

Similarly, though this is perhaps somewhat premature at the present stage, time has come to pay more attention to other potential water uses, such as water for small irrigation plots, for small-scale processing etc. There is little information about the aspirations of village people in respect of the necessary functions of a rural water supply. At least a beginning should be made to monitor these aspirations, so that in future Tanzania's rural water supplies can make a greater, and more visible contribution towards development. We have noted, for instance, that in many places where shallow wells have been constructed, the waste water from the pumps is used already to irrigate a few tomato plants etc. The village people definitely take advantage of such possibilities.

1.14. Water quality monitoring

At present water quality is monitored officially only in Ubungo, where facilities are totally inadequate to deal immediately with all samples sent there. Consequently it normally takes a long time before the results of the analysis are known, while, at least in part, these results are unreliable due to ongoing oxydation, reduction etc.
The Morogoro Conference resolved that, in order to improve the situation, zonal laboratories should be established. The idea is not new. The problem is that even zonal laboratories could only reduce the time lag between the taking of the samples and the analysis in the laboratory and ease the burden from the Ubungo central laboratory somewhat. Still, this solution is nog enough to make the results of the analysis more reliable in every respect. This requires an anlysis within 24 hours, which cannot be achieved with zonal laboratories. Before a decision is taken to actually implement this resolution and funds are committed for this purpose, we feel that this idea should be given further thought and be discussed also in the technical coordination committee. A cheaper and better solution might be a limited number of tests on essential elements (e.g. fluoride content, total solids, coli) with portable equipment in the projects themselves.

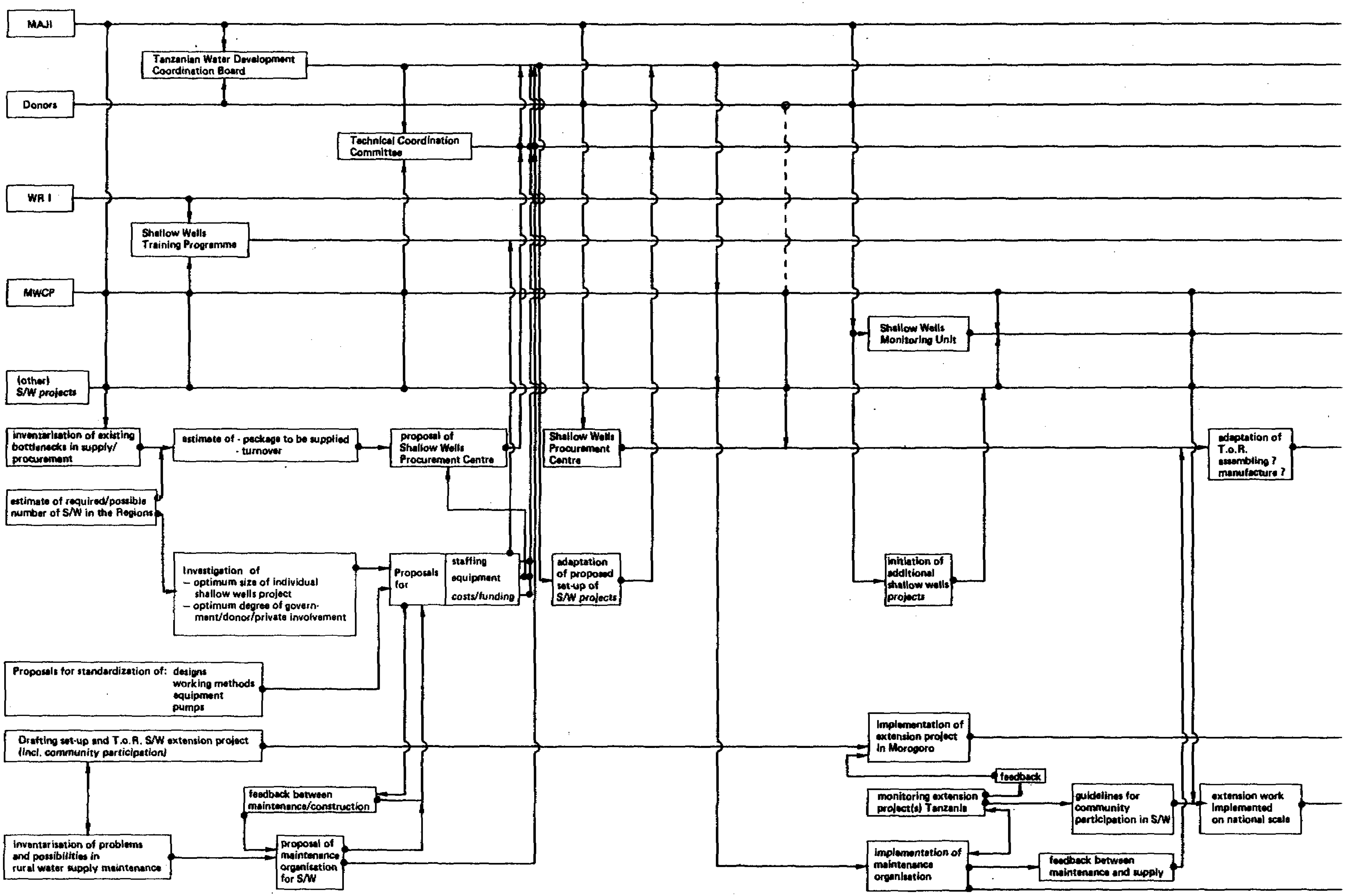
Uncertainties continue to exist in respect of the quality standards used.
Tanzania's water quality standards differ in some respects from those set by the WHO. Thus, for instance, a much higher fluoride content is allowed.
Yet, at present in at least one region wells have been approved with a fluoride content well in excess of the higher Tanzanian standard with the justification that otherwise no (ground)water could be made available at all and that bone deformations etc. that are supposedly the normal result of a high fluoride content of drinking water have never been observed in the area.
This is clearly a subject where more research and scientific discussions are urgently required. Are we sure that in the past these people have been drinking water with a similarly high fluoride content throughout the year, or is this just an assumption based, for instance, on observed use during the dry season when no surface water is available.

Until we know much more about this subject, it is felt that the present standards should be strictly adhered to, especially in respect of those components that (may) have a negative impact on health. Conversely, Maji should openly discuss these standards and not change them again without these prior discussions.

1.15. Future activities

In the accompanying diagramme the various necessary steps envisaged for the implementation of a national shallow wells programme have been set out, together with their interrelationships/feed back mechanisms. Subsequent chapters will deal with the various topics included in the diagramme. A more comprehensive list of subjects to be covered is presented in appendix 2.

JH/HBr/ABr
T6/I


MAJI
Tanzanian Water Development Coordination Board
Donors
Technical Coordination Committee
WR I
Shallow Wells Training Programme
MWCP
Shallow Wells Monitoring Unit
(other) S/W projects
inventarisation of existing bottlenecks in supply/ procurement
estimate of - package to be supplied - turnover
proposal of Shallow Wells Procurement Centre
Shallow Wells Procurement Centre
adaptation of T.o.R. assembling ? manufacture ?
estimate of required/possible number of S/W in the Regions
Investigation of – optimum size of individual shallow wells project – optimum degree of government/donor/private involvement
Proposals for staffing equipment costs/funding
adaptation of proposed set-up of S/W projects
initiation of additional shallow wells projects
Proposals for standardization of: designs working methods equipment pumps
Drafting set-up and T.o.R. S/W extension project (incl. community participation)
implementation of extension project in Morogoro
feedback
monitoring extension project(s) Tanzania
guidelines for community participation in S/W
extension work implemented on national scale
feedback between maintenance/construction
inventarisation of problems and possibilities in rural water supply maintenance
proposal of maintenance organisation for S/W
implementation of maintenance organisation
feedback between maintenance and supply

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APPENDIX 1

VISIT TO ON-GOING SHALLOW WELL PROJECTS AND REGIONAL AUTHORITIES

In the period between 28th August and 22nd September various on-going shallow well projects in Tanzania were visited in order to obtain first-hand information on the set-up of the projects (working methods, equipment used, problems encountered, etc.).

The organizational set-up of shallow well construction on a national scale and maintenance and supply problems were discussed with the projects' staffs and regional authorities such as Regional Planning Officers, Regional Development Directors, Regional Water Engineers etc. In Dodoma discussions were also held at the Prime Minister's Office.

The possible working methods discussed, alternatives for maintenance, community participation, procurement of materials and spare parts etc., will all be incorporated in special reports on these subjects. A summary of the organizational set-up, working methods and problems encountered in the on-going projects visited, is given hereunder. (The order mentioned is the chronological order in which the projects were visited).

1. MTWARA-LINDI REGIONS

Project	:	donor-financed regional water supply project, for piped supplies and shallow wells
Organization	:	more or less separate, but linked to RWE
Methods	:	survey by machine drilling rig and hand augers, construction with excavators, supplemented by hand-drilling for depths beyond 4-5 metres (ring wells) construction with hand augers (tube wells)
Well types	:	ring wells (diameters indentical to Shinyanga, Singida, Mwanza), tube wells
Pumps	:	imported hand pumps (Nira)
Maintenance	:	district maintenance units belonging to project itself; pump attendants in the villages
Training	:	on-the-job
Extension project	:	none

Remarks:
A start was made with coordination/standardization between the Mtwara/Lindi and Morogoro wells construction projects, regarding size of pump footplate, material and size of pumprod and rising main, etc.
Mutual testing of new versions of Nita pump and Kangaroo pump was agreed upon.

2. IRINGA REGION

Project	:	donor-financed regional water master plan project. Limited number of shallow wells made by trainees, trained in Morogoro. Problems with maintenance, especially transportation. approx. 40% of existing rural water supply schemes do not work. No stocks of spare parts kept; inadequate maintenance funds.

3. DODOMA REGION

No on-going rural water supply project.
Staff from RWE organization has been trained at Morogoro Wells Construction Project. Demonstration wells (hand-drilled) have been made in Dodoma Region.

Approximately 70% of water supply schemes is out of order.

Problems:
90% of vehicles out of order because of lack of spares.
Funds for O & M are available, but impossible to purchase enough spare parts.

4. SINGIDA REGION

Project	:	donor-financed regional ground water project with large shallow well component
Organization	:	more or less separate, but linked to RWE
Methods	:	copied from Shinyanga project (survey with hand auger, construction by hand digging) hand-drilling possibly in near future

Well types	:	mainly ring wells; possibly also tube wells in future
Pumps	:	supplied from Shinyanga (Shinyanga type) and from Morogoro (kangaroo type)
Maintenance	:	no special set-up
Extension project	:	none
Training	:	on-the-job

Problems:
Availability of cement/fuel because of long and vulnerable supply lines (materials and equipment from Morogoro, Shinyanga and elsewhere).

5. TABORA REGION

Project	:	donor-financed regional shallow wells project (RIDEP project)
Organization	:	integrated in RWE organization
Methods	:	similar to Shinyanga project
Well types	:	ring wells
Pumps	:	Shinyanga pump
Maintenance	:	no special set-up; one man appointed per village
Extension project	:	none
Training	:	none

Problems:
Lack of transport and equipment poor quality of moulds for well rings.

6. SHINYANGA REGION

Project	:	regional shallow wells project
Organization	:	integrated in RWE organization
Methods	:	survey by hand-drilling, construction by hand-digging
Well types	:	ring wells
Pumps	:	hand pumps (Shinyanga pump)
Maintenance	:	divisional maintenance officers (on bicycle, with toolkit)
Extension project	:	none; some instruction/education by divisional maintenance officers
Training	:	on-the-job; training course for div. maintenance officers to be started shortly

Problems:
Lack of transport and materials (cement-pipes) hamper production of Shinyanga pumps and have all but stopped well construction because well rings can no longer be made.

7. MWANZA REGION

Project	:	regional shallow wells project, donor-financed (RIDEP-project)
Organization	:	more or less integrated in RWE organization, with additional accounting and procurement via World Bank
Methods	:	survey by hand-drilling, construction by hand-digging and hand-drilling
Well types	:	ring wells and tube wells
Pumps	:	hand pumps (Shinyanga type and kangaroo type)
Maintenance	:	responsibility of village managers; no special set-up
Extension project	:	none. Apart from 1 demonstration well per village, a sum of TAS 6000 will have to be contributed by the villagers for the construction of each additional well

Problems:
Government bureaucracy.

Staffing:
Vacant posts remain vacant.

8. ARUSHA REGION

Project	:	Arusha planning and village development project. Donor-financed, with some activities in the rural water supply field. A survey group, trained in Morogoro, is operational. Some demonstration wells have been made. Actual construction of shallow wells not yet started.

9. TANGA REGION

Project	:	donor-financed regional shallow wells project (TIRDEP-project)
Organization	:	more or less integrated in RWE organization
Methods	:	survey and construction according to Morogoro practice: both with hand-drilling equipment
Well types	:	tube wells
Pumps	:	hand pumps (kangaroo type)
Maintenance	:	no special set-up
Extension project	:	none

Problems:
Of an administrative nature:
- government bureaucracy
- lack of transport facilities
- staffing problems

APPENDIX 2: LIST OF SUBJECTS TO BE COVERED IN REPORT

A. INVENTARISATION OF SHALLOW WELLS "MARKET" IN TANZANIA

1. Estimates by on-going shallow wells implementation projects.
2. Estimates mentioned in (regional) water master plans; reliability of those estimates because of limitations in available data.
3. Estimated population distribution over regions.
4. Estimate of required number of wells.
5. Determination of average size of regional shallow wells project.

B. INSTITUTIONAL SET-UP

1. Coordination and standardization on national level: TWC, TCC, SWPC, Maji HQ, WRI.
2. Advantages/disadvantages of special set-up for shallow wells implementation.
3. Involvement of Maji HQ.
   Degree of (direct) donor involvement.
   Possible shifting of donor and/or govt. involvement with time in S/W implementation → "national project", national project versus regional projects (involvement of private parties/enterprise).
4. Maintenance and repairs.
5. Procurement, assembling, manufacturing of equipment and materials.
6. Extension projects/village involvements/user participation.
7. Training:
   - national and on-the-job
   - only for Govt.; also for private parties
8. Funding:
   - external) investment
   - internal) running costs

C. CONSTRUCTION OF WELLS

1. Coordination/monitoring of S/W implementation in Tanzania on national level (TCC, SW Procurement Centre).
2. Degree of control by Maji HQ depending on type of project ("national project" or not).
3. Most acceptable size of wells construction project:
   - national
   - multi-regional
   - regional
4. Most desirable degree of government involvement in construction project:
   - direct involvement in actual execution

- limited to supervision/control

Degree of donor involvement and/or integration of donor-financed project in government organization.

(Possibility of) shifting donor involvement and/or govt. involvement with time.

5. Possibility of increasing participation of small private enterprises (under govt. supervision).
6. Selection/standardization of survey/well siting methods (TCC; SWDC).
7. Organization of survey units.
8. Selection/standardization of S/W and pump designs and implementation methods. Relation with requirements dictated by maintenance possibilities.
9. Staffing:
   - number and level of required staff
   - availability of staff within/outside govt.
   - required additional training
   - career opportunities within/outside govt.
10. Optimum organization for S/W survey and construction.
11. Requirements as to:
    - equipment, tools
    - vehicles
    - office, workshop facilities etc.
12. Costs:
    - investment costs
    - running costs
13. Revenue possibilities (community/village participation contribution in cash and/or in kind; water taxes.
14. Funding requirements and possibilities.

D. PROCUREMENT OF MATERIALS/TOOLS/EQUIPMENT

1. Investigation of existing bottlenecks:
   - foreign exchange
   - standardization
   - availability of spareparts (imported)
   - supply/distribution facilities within Tanzania
2. Investigation of options:
   - improving present system
   - establishing separate system
3. Inventarization of demand.
4. Priority ranking of items to be produced.
5. Coordination/standardization of equipment/materials to be used in S/W projects.
6. Centralized importation of items now imported by individual donors/donor projects.

7. Development models for national S/W procurement centre:
   procurement → assembling → local manufacture
   imported items only → (selected) S/W items → all rural W/S items
8. Set-up of central procurement centre:
   - available facilities (Shinyanga, Morogoro, Wazo Hill, elsewhere)
   - relative advantages/disadvantages
   - staffing
   - required facilities, machinery, tools, staffing
   - estimated costs
   - funding possibilities
9. Flow of foreign funds to central procurement centre: direct, through Treasury.
10. Internal (Tanzanian) distribution lines:
    - through Maji
    - through Govt. Stores
    should be open for "private" buyers (villages, individual).

E. EXTENSION PROJECTS

1. Drafting T.o.R. for shallow wells "extension project".
2. Possible input from:
   - Ministry of Water, Energy and Minerals
   - Ministry of Health
   - BRALUP
   - IRC-WHO
   - (DHV)
3. Implementation of extension project(s), directly connected with shallow wells implementation project(s).
4. Monitoring of extension project(s) → (re)adjustment of T.o.R./working methods.
5. Setting up generally applicable recommendations/T.o.R. for extension projects in rural W/S field.
6. Guidelines for implementation of community participation:
   - in cash
   - in kind
   - both

F. MAINTENANCE AND REPAIRS

1. Inventarization of existing constraints:
   - user acceptance/involvement → extension projects
   - availability of spareparts → procurement
   - organization of maintenance
   - funding
2. Organization of maintenance:
   - 2-tier system (village; District/Region)

- 3-tier system (village; Division; District/region)
- optimum frequency of maintenance/checks (relation to specifications of well and pump design)
- staffing requirements (village participation?)
- required facilities, vehicles, tools
- costs

3. Repair facilities on local, regional and national level, relation with degree of sophistication.
4. Water quality checks - contribution by:
   - central water lab. Ubungo
   - zonal water laboratories, when established
   - implementation projects (portable kits?)
5. Funding possibilities:
   - international (donor agencies)
   - national (Maji)
   - regional (PMO → RDD)
   - local (village contribution, water tax?)

G. TRAINING

chapter III

1. Inventarization of existing training programmes for survey and shallow wells construction:
   - M.W.C.P.
   - W.R.I.
2. Future training programmes:
   - W.R.I.: survey training
     construction training
   - R.W.E.) especially construction training on
   - Regional projects) the job additional survey training

NATIONAL SHALLOW WELLS PROGRAMME

CHAPTER TWO

POSSIBILITIES FOR SHALLOW WELLS IN TANZANIA

SEPTEMBER 1981

DHV

DHV Consulting Engineers

CONTENTS PAGE

2. POSSIBILITIES FOR SHALLOW WELLS IN TANZANIA

2.1. Introduction

This chapter seeks to give an impression of the numbers of shallow wells that can be constructed in Tanzania. The information on which the estimates are based was obtained from three types of sources:

a. from on-going shallow wells (implementation) projects
b. from water master plans
c. from personal communication with people that are active in the water supply field in the various regions

Needless to say, the first type of sources is generally the most reliable, since the information given is based on actual field experience, obtained during a project that focuses on the construction of wells.

The second group sometimes yields less reliable results. Two main reasons for this can be identified:

- the option of having (shallow) wells as a rural water supply source may have been given little attention or may not have been considered at all during the preparation of the master plan
- even if (shallow) well construction has been part of the master plan studies, results may turn out to be less representative because:
  a. The survey methods used render it impossible to detect shallow aquifers. This has happened where Schramm rigs were used for exploratory drilling: the temporary casing used in the upper part of the borehole effectively closed off any shallow aquifer
  b. Shallow groundwater may occur (and it often does) in a patchy pattern. Without specialized, experienced hydrogeological staff, and with the constraints in terms of available time and money as experienced with hydrogeological investigations during a water master plan phase, it may be difficult to obtain a representative impression of the shallow groundwater potential during such a phase. Experience of the shallow wells (implementation) projects appears to indicate that in practice the possibility of constructing shallow wells is better than assumed in the master plans.

Personal communication, finally, may yield additional information, but its effectivity in cases where neither shallow wells projects nor water master plan studies are carried out will, of course, be limited.

In the next paragraphs summaries will be given of the shallow wells potential per Region, in alphabetical order. Information given, was obtained in the period mid-1980 to mid-1981. Partly because of this extended period of information gathering, but also because not all master plan reports proved to be accessible, the information given sometimes is of a tentative nature, and adjustments may prove to be necessary.

2.2. Arusha Region

There is no water master plan for Arusha, nor is it being prepared. USAID is assisting in carrying out the "Arusha Planning and Village Development Project", which has a rural water supply component, and covers 3 of Arusha's 6 Districts, with approx. 70% of the total population. Two survey and two constructions teams were reported to have become operational at the end of 1980.
Partly because of the large number of existing piped supplies, the population that can (still) be served by shallow wells was estimated at 15% of the total rural population only.

2.3. Coast Region

and

2.4. Dar-es-Salaam (rural) Region

Conflicting information is available on the shallow groundwater potential in these two regions.
The Investigation Report by CBA Engineering Ltd. (Vancouver), of February 1978 states that "one zone, comprising the river deposits of the Wami, Ruvu and Rufiji rivers has a good potential for groundwater", whereas "in the rest of the project area the shallow groundwater has a low yield which may become negligible in the dry season".
The actual master plan report, of February 1979, however, states that from the 355 settlements in the project area:

74% use groundwater from shallow pits/shallow wells

24% use surface water
2% use boreholes

It continues "the most appropriate method of using groundwater sources in the Project Area is by constructing shallow, large-diameter wells in recent alluvial deposits associated with the major rivers and intermittent streams. Shallow wells located in the smaller alluvial deposits associated with ephemeral streams could be used for village water supplies, but the occurrence of drought periods makes the reliability of these shallow groundwater sources uncertain".

Nevertheless in its breakdown of water sources to be used in the future, the same report gives the following summary:

a. Ruvu pipelines : 21% of design population (62 settlements)
b. Groundwater sources : 25% of design population
   8 settlements to be supplied by boreholes
   100 settlements to be supplied by large-diameter wells
c. Surface water sources : 49% of design population (127 settlements)
d. Rainwater catchment tanks: 2% of design population

For the 100 settlements to be supplied by large-diameter wells the present population (1978) was quoted as 128,556 people. (The 74% of the population that appear to actually use shallow groundwater at present amount to 452,160 people < 1978 >).

2.5. Dodoma Region

No water master plan reports on Dodoma Region are available. In personal communication with representatives of the Regional Water Engineer it was mentioned that an estimated 25-50% of the rural population could be supplied with shallow wells. During the actual water master plan study investigations had never centered on shallow wells, however, and this option was given consideration only later. RWE staff has received a training in shallow well survey and construction in Morogoro, and shallow wells are being contructed in the Region.

2.6. Iringa Region

A water master plan is presently under preparation. So far the hydrogeological findings appear to indicate that relatively few areas in Iringa Region are suitable for shallow wells. Nevertheless it is the stated policy of the Danida Steering Unit for Water Project to have shallow wells constructed wherever possible. Construction units for shallow wells will be formed in the 3 Regions covered by this donor organization: Iringa, Mbeya and Ruvuma Regions. Construction targets for the financial year 1981/82 are 50 wells per Region.

2.7. Kigoma Region

There is no water master plan for the Region, nor is there any information on the feasibility of shallow wells.

2.8. Kilimanjaro Region

The final report on the water master plan for Kilimanjaro Region is dated December 1977.

Since the option of constructing shallow wells is hardly mentioned in the report, it is not clear whether ther are hardly any possibilities for shallow wells or that the option simply has not been investigated by itself and that all attention has been focused on the supply of surface water, as the predominant water source.

The impression is given that the latter is indeed the case and that the availability of groundwater has been investigated only in those cases where no suitable surface water is available. Furthermore, boreholes appear to have been considered as the principal means of groundwater abstraction.

In only one case shallow wells are mentioned: "There are only limited numbers of shallow wells in the region. A few shallow wells are found in the Kahe Basin and Sanya Juu areas.
In the Kaha Basin it is possible to make use of shallow wells; however, protection of water from contamination is necessary. The main reasons for shallow well contamination are collapse of the earthen wall and inflow of wasted water. But both of them can be prevented by making use of concrete rings.
In this area, it is recommended to use shallow wells for domestic supply where the size of the population is small (less than 1,000 persons) and there are no boreholes for irrigation. In this case protection of wells against flood is necessary.
In Sanya Juu, shallow groundwater is available in a patchy area; however, fluctuation of the water level is great so that the yield of the shallow wells is not so reliable as that of the Kahe Basin. Water quality has to be carefully examined in this area since fluoride contamination is found in many cases".

A more quantitative indication of the possibilities for shallow wells is not given, however.

2.9. Lindi Region

A "Rural Water Supply Construction Project in Mtwara and Lindi Regions" is carried out by Finnwater. In its phase I (January 1978-March 1980) a total of 556 shallow wells have been constructed, 40% of which are located in Lindi Region. Three types of shallow wells have been made: ring wells (476), machine auger wells (50) and hand-dug wells (39).
For phase II, which is currently under way, a total production rate of 300 shallow wells per year is foreseen. It is expected that at least 50 percent of the rural population of Lindi Region can be supplied through shallow wells.

2.10. Mara Region

A "Water Master Plan for the Mara, Mwanza and West Lake Regions" has been prepared by Brokonsult. It reports that 337 villages were surveyed in Mara Region, most of which use some kind of surface water, with slightly more than 10% using wells as water source.
A study of the shallow well potential in the 3 Regions resulted in maps, indicating the number of shallow wells that can be put down in every 2 x 2 kilometer block and which can produce during 19 out of every 20 dry seasons (95% reliability).

For Mara Region a mean of 9.95 wells per 4 km^2 was found, with a standard deviation of 33.1.
Taking the mean value of 9.95 on face value and relating it to the total land surface of Mara Region (approx. 21,750 km^2) would result in a total of more than 54,000 wells in this Region alone, which would be sufficient for 16.2 million people, theoretically.
The high standard deviation, however, indicates that there are very great variations in the shallow well potential within the Region.
Nevertheless, it may be assumed that a major part of the rural population, possibly as large as 75-80%, could be supplied through shallow wells.

2.11. Mbeya Region

A water master plan is presently under preparation by the same consultant (CCKK) as for Iringa and Ruvuma Regions. Again preliminary hydrogeological investigations appear to indicate that relatively few areas in this Region are suitable for shallow wells.
Nevertheless, in line with the stated Danida policy, shallow wells will be constructed wherever possible, construction units for shallow wells will be formed and 50 wells are planned to be constructed during the financial year 1981/82.

2.12. Morogoro Region

A shallow wells implementation project (the "Morogoro Wells Construction Project") is being executed by DHV/ONV, since mid-1978. The project, which is carried out in the northern half of the Region only, has constructed a total of 550 shallow wells in the period between July 1978 and July 1981. Based on the experience gained so far, the total number of shallow wells that can be constructed in, or close to, the villages in this part of the Region is estimated at 974, thus catering for about 292,200 people (or: 52% of the rural population in the northern half of the Region).
Hydrogeological conditions in the southern half of the Region are being investigated by the "Water Supply Survey Southern Morogoro Region" project. It is expected that up to 80% of the rural population in this part of the Region could be supplied through shallow wells, or: approximately 305,750 people (1978 situation).

2.13. Mtwara Region

As mentioned before (paragraph 2.9) Finnwater is carrying out a rural water supply project in the Mtwara and Lindi Regions. In the first phase of that project (january 1978-March 1980) a total of 336 shallow wells (60% of the total shallow wells production) were constructed in Mtwara Region.
Phase II, which will last until 1982, is expected to produce a total of 300 shallow wells per year, in both regions together. It is expected that 30% of the rural population of Mtwara Region can be supplied through shallow wells.

2.14. Mwanza Region

The "Water Master Plan for the Mara, Mwanza and West Lake Regions" referred to in paragraph 2.10, indicates a mean of 6.72 wells per 4 km^2 (producing not less than 6 m^3/day each, for at least 19 out of every 20 dry seasons) for Mwanza Region. Again combining the information with the total land surface of the Region (19,700 km^2), a total of 33,100 wells would be possible in theory, sufficient for 9.9 million people. Also in this case the standard deviation is relatively high (13.2), indicating that there are great variations in the shallow well potential within the Region.
Nevertheless, it is again assumed that a major part of the rural population, possibly as large as 75-80%, can be supplied through shallow wells.

The World Bank, in its appraisal report No. 1867a TA, mentions a target of 540 wells to be constructed over 5 years. A World Bank-sponsored wells construction project was thus set up in Mwanza Region, with an estimated production of 150 wells over the financial year 1980/81.

2.15. Rukwa Region

According to information received from Norad officers it is intended to construct approximately 800 wells. Not clear is whether these wells would be constructed in Rukwa Region alone, or in both Norad-sponsored regions: Rukwa and Kigoma, together.
In the first case the total number of people to be supplied through shallow wells (240,000), would amount to 61% of the rural population, in the latter case it would mean 24% of the combined rural population (based on 1978 census figures).

2.16. Ruvuma Region

This is the third region for which a water master plan is being prepared by CCKK (see also parts 2.6 and 2.11). The hydrogeological findings indicate better possibilities for shallow wells in Ruvuma Region than in Iringa and Mbeya Regions, and especially in Tunduru District.

As has been mentioned before, it is Danida's stated intention to have shallow wells constructed wherever possible, to form construction units for this purpose and to aim at the construction of 50 wells in this Region during the financial year 1981/82.

2.17. Shinyanga Region

The water master plan, prepared by Nedeco, and submitted in October 1974, estimated that a total of 2,200 shallow wells would be required (and could be found) in the Region.

One of the follow-ups of the water master plan was the "Shinyanga Shallow Wells Project" *carried out by DHV/Ilaco/ONV in the period 1974-1978.*
Extensive groundwater survey work was carried out in this period, and at the time the project was handed over entirely to the Tanzanian authorities (July, 1978) a total of 752 shallow wells had been constructed, with an estimated remaining potential of 2,573 wells: 1,523 with a maximum depth of 7 m, and 1,050 deeper wells.
The total of 3,325 wells would be able to cater for some 997,500 people *(or: approx. 80% of the rural population).*
At the time of the Morogoro Conference on Wells (August, 1980) some 994 shallow wells had been finished, serving 298,500 people in 297 villages (or: approx. 300 people per well).

2.18. Singida Region

The "*Tanzania/Australia Water Development Project Singida Region*", which effectively started in 1975, undertook a survey of the Region's Water resources late in 1977, with the following findings:

-	shallow wells (unlined)	are used by	39%	of the population
-	wells in rivers	are used by	17%	of the population
-	lined wells	are used by	7%	of the population
-	boreholes	are used by	23%	of the population
-	springs	are used by	8%	of the population
-	flowing rivers	are used by	1%	of the population
-	dams	are used by	5%	of the population

With wells, in one form or another, accounting for 63% of the total water supply, a separate shallow wells project was started in 1979. At the time of the Morogoro Conference on Wells (August 1980) a total of 32 ring wells and 7 tubewells had been constructed.
It is estimated that for the majority of remote villages properly constructed shallow wells form the optimal solution. The existing situation shows in any case that at least 63% of the rural population could be supplied with water from shallow wells.

2.19. Tabora Region

The "Tabora Region Water Master Plan" by Brokonsult states that the result of a survey of 162 shallow wells "suggests that it should prove feasible to locate reliable shallow wells in most places in the Region". It also says "Reliability of wells dug to proper depths and properly sited can be considered very good indeed. In Tabora there is no real difficulty with siting reliable shallow wells".
In most parts of the Region the supply of water by shallow wells is the only water source available and in many cases the wells give acceptable and sufficient water for the daily demands of the villages.
It is, therefore, assumed that at least 75% of the rural population could be supplied through shallow wells.
According to the RWE records there are 1570 existing shallow wells (situation 1979), 95% of which are unlined. With financial help from TRIDEP a shallow well program is being executed. Per mid-1980 approx. 30 wells had been completed. The initial goal was to construct 137 wells in the Region during the financial year 1979/80, with a final target of constructing 500 wells per year when the project is fully developed. Due to various difficulties the entire project suffered a delay of approximately one year, however.

2.20. Tanga Region

The Tanga Water Master Plan by AHT (1976) mentions that in 8% of the total area of the Region there are good prospects for shallow wells and deep wells; in 1% of the total area there are good prospects for deep wells only.
In 4% of the total area there are no prospects for shallow wells and only locally for deep wells; in 62% of the total area shallow nor deep wells are generally feasible and in 25% they are not feasible at all (outcrops, etc.).

Acoording to the master plan new rural water supply works are required for 1.27 million people, at an estimated total cost of TAS 385 million. Shallow wells are planned for only 26,000 people, or: 3% of the 1978 population.

Within the framework of the TIRDEP programme a shallow wells construction project is being carried out. During the financial year 1979/80 a total of 10 wells were constructed, with a construction target of 38 wells (+ rehabilitation of 9 existing wells) for the financial year 1980/81.

2.21. West Lake Region

In the "Water Master Plan for the Mara, Mwanza and West Lake Regions" by Brokonsult, mentioned in para's 2.10 and 2.14, for West Lake Region a mean of 15.9 shallow wells per 4 km^2 is indicated (producing not less than 6 m^3/day each, for at least 19 out of every 20 dry seasons). With a total land surface of 28,750 km^2 for the Region, a total of 114,990 wells would be possible, in theory, catering for some 34.5 million people.
The large standard deviation (28.5) already indicates that it is a theoretical value, and that great variations in the shallow well potential within the Region must be expected.
Nevertheless, it is again assumed that a major part of the rural population, say 75-80%, can be supplied shrough shallow wells.

2.22. Conclusions

Table 2.1. gives a summary of the rural population and the percentages (or numbers) that could be supplied through shallow wells according to the information contained in the previous paragraphs.
It has been mentioned before that part of that information is of a tentative nature, while no or hardly any information could be obtained about the feasibility of shallow wells in the Iringa, Kigoma, Kilimanjaro, Mbeya, Rukwa and Ruvuma Regions. When these regions are, therefore, not taken into account, table 2.1 shows that approximately 6 million of rural people out of a total of approximately 11 million (or: 55%) could be supplied through shallow wells. In the remaining regions the possibilities for shallow wells might be more restricted, but since no actual information is available so far, it is tentatively assumed that 50% of Tanzania's rural population could be supplied through shallow wells.

According to official statistics, in 1978 an average of 37% of Tanzania's rural population was served with water from an improved source. On the one hand this means that shallow wells most probably have been taken into account; on the other hand all completed (piped) water supply schemes must have been taken into account, whether in practice these are operating or not.

Table 2.1. - <u>Population data, per Region</u>

Region	Rural population (1978-census)	Rural population that can be supplied through shallow wells %	numbers	Percentage of rural population supplied with water **)
1. Arusha	934,397	15	140,160	37
2. Coast	516,849	25	129,200	37
3. Dar-es-Salaam	94,176	25	23,540	70
4. Dodoma	813,344	25-50	203,340-406,670	62
5. Iringa	865,619	no data yet	no data yet	28
6. Kigoma	590,162	no data	no data	24
7. Kilimanjaro	832,930	no data	no data	54
8. Lindi	500,594	50	250,300	41
9. Mara	679,315	75-80	509,490-543,450	20
10. Mbeya	790,315	~~no data yet~~ 11 %	no data yet	46
11. Morogoro-North	557,000*	52	292,000	)31
Morogoro-South	382,190*	80	305,750	)
12. Mtwara	723,216	30	216,960	35
13. Mwanza	1,435,418	75-80	1,076,560-1,148,330	30
14. Rukwa	394,095	no data	no data	31
15. Ruvuma	514,810	no data yet	no data yet	33
16. Shinyanga	1,254,736	~ 80	997,500	71 → 30% acc. to Anderson
17. Singida	558,138	≥ 63	351,630	52
18. Tabora	750,657	75	562,990	13
19. Tanga	892,043	~ 3	26,000	31
20. West Lake	932,357	75-80	699,270-745,890	12
Total	15,012,276		5,784,690-6,140,370	37

Notes *) estimated divison
**) situation 1978

Acc. to Anderson: 31-40 % of unserved pop. and 11 % currently served.

Field information as quoted by various Regional Water Engineers shows that actually only one-third to one-quarter of the piped supply schemes may be operating satisfactorily, so that in practice the rural population served with water (approx. 5-6 million people according to the data of table 2.1) might be as low as 2-3 million people.

When we restrict ourselves to the period up to the CCM's target year, 1991 (which happens to coincide with the end of the International Water Supply and Sanitation Decade) it will be obvious that during those years a number of water supply facilities will cease to operate because they will have become obsolete. This will again reduce the percentage of rural population that, while being served with water in 1978, would still have a reliable water supply in 1991.

Taking these factors into account, we can make the following calculation:

- rural population in 1978: 15 million people (rounded figure)
- population increase in the period 1978-1991, based on an average population growth of 2 to 3 percent per annum: 6 million people
- population served (in 1991) by water supply facilities that exist at present: 3 million people (or: 60% of official figure; this may be an over-estimation)

Consequently, the number of rural population for which water supply facilities would have to be constructed before 1991, in order to have a water supply coverage of 100% by that year, amounts to: 15 million + 6 million - 3 million = 18 million people.

If we assume, as argued earlier, that 50% of these people could be supplied with water through shallow wells, this means a total of 9 million people for which shallow wells would have to be constructed up to the year 1991. It is obvious that this figure must be used as a rough estimate only, but the order of magnitude is expected to be reasonable. Therefore, in the following chapters this number will be used.

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NATIONAL SHALLOW WELLS PROGRAMME

CHAPTER THREE

CONSTRUCTION OF WELLS

APRIL 1981

DHV Consulting Engineers

CHAPTER 3 - CONSTRUCTION OF WELLS

CONTENTS PAGE

3. CONSTRUCTION OF WELLS

3.1. Extent of possible workload

The investigation of shallow well possibilities in Chapter 2 indicates that it appears reasonable to assume that roughly half the Tanzanian rural population can be supplied with shallow wells. Taking into account that a population increase of approximately 25 to 30 percent may be expected in the next 10 years, a total of some 9 million people would have to be supplied with shallow wells before 1991. It is appreciated here that the number mentioned cannot be more than an indication at this moment, until reliable and detailed estimates would have become available.

In practice the number of consumers that can use one well fluctuates between 200 and 400. Taking 300 as a reasonably high average, a simple calculation shows that 30,000 wells would have to be constructed before 1991, or: approximately 3,000 wells per year, resulting in an average annual production, as required for each of Tanzania's Regions, of from 150 to 200 wells. Of course deviations from this average will occur, depending on the actual possibilities in each individual Region. Nevertheless, the order of magnitude appears to be realistic, also when compared with the currently operating shallow wells implementation projects. Thus, for the remainder of this chapter it will be assumed that the required output per Region equals 150-200 wells per year, and proposals for organization, equipment and costs will be based on this figure.

3.2. Coordination of shallow wells implementation on a national level

The policy decision has been taken that the construction of shallow wells, wherever feasible, should be emphasized upon (1980 Regional Water Engineer's Conference in Tanga: Resolution No. 6; Morogoro Conference on Wells: Resolutión No. 1). In actual fact this recommendation is already acted upon in several Regions where shallow well implementation programmes are under way: Shinyanga, Morogoro, Lindi/Mtwara, Mwanza, Singida, Tabora and Tanga. All of these programmes except Shinyanga rely on outside funding and do not always use the same techniques and types of equipment. This, together with the goverment's professed intention of stimulating the construction of shallow wells on a national scale, has led to the recommendation, as voiced various times, to establish a shallow wells coordination agency on the national level (4, 22.).

The tasks of such an agency should comprise:
a. to collect progress reports and other relevant information of all on-going shallow wells projects
b. to keep record of the performances of all shallow wells projects in Tanzania

c. to keep record of the financial progress of the various shallow wells projects and the ensuing per capita cost
d. based on the above, to (re)appraise the feasibility of meeting the 1991 target, at certain intervals
e. to initiate measures with the intention of adapting the on-going shallow wells projects, either in performance or in number, in order to attain the 1991 target
f. to stimulate improvement and standardization of working methods, organization, equipment and pumps (in collaboration with a Technical Coordination Committee?)
g. to advise on, and standardize, maintenance procedures and frequencies
h. to coordinate the so-called extension work (community education and participation) on a national level, in cooperation with the relevant Ministries and other governmental institutions
i. to make available information material for this extension work to the various implementation projects (e.g. brochures for use in the districts or villages)
j. to maintain international contacts regarding the shallow well technology
k. to keep track of all relevant developments in this field

Without neglecting the other activities, the importance of selecting and standardizing appropriate techniques and equipment for shallow wells implementation cannot be stressed enough. Already complaints can be heard, albeit often about other sectors of the water supply field, that the diversification of equipment, materials, designs etc. as used by the donors is detrimental to a streamlined operation and maintenance of water supply facilities (19, 22). It will also be clear that the regular exchange of staff that is the custom at present at RWE level, is jeopardized and/or that staff cannot be put to work according to their capabilities, when there are significant differences in set-up, working methods and/or equipment between shallow well implementation projects.

On a national level the Ministry of Water and Energy (further referred to as MAJI) appears to be the natural choice for establishing policies and coordinating rural water supply programmes, including shallow wells programmes. MAJI is the national authority responsible for the development and use of the country's water resources. It should be "the repository for all data and related information concerning water and should know of all the activities in the water development field" (12, 16). It is, therefore, recommended that MAJI establishes a unit for coordinating shallow wells activities in Tanzania. The Water Master Planning Coordination Unit (WMPCU) of the Project Preparation Division might form the nucleus of such a coordinating agency, since it is already very much involved in these activities (organization of the Morogoro Conference on Wells, etc.). It is, as a permanent secretariat to the Management Committee of the proposed Tanzania Water Development Coordination Board, also directly involved in the policy decisions that are taken by the Board.

Moreover, it can liaise easily with a Technical Committee or Technical Coordination Committee (TCC), that would be one of the Board's special committees. According to the preliminary recommendations such a Committee would be composed of representatives of the on-going shallow well (and possibly also other rural water supply) implementation agencies and projects, so that the exchange of first-hand knowledge and experience from the field is ascertained.
The scope of the coordination activities as mentioned earlier, and the ensuing need for regular information from the field should then be taken into account when formulating the additional tasks for the WMPCU as well as the TCC.

If another solution were to be chosen, e.g. with the coordination activities entrusted to another agency, but especially when no TCC or similar committee would be formed, special attention should be given to the establishment of an information link between MAJI Dar-es-Salaam and the various projects. Even if all implementation of shallow wells would be part of the RWE's activities (which at present it is not), such a set-up is not sufficient to guarantee a stream of information. On the contrary, although Regional Water Engineers do form part of the Ministry of Water and Energy, there is apparently a lack of communication between the two as the following excerpt from the P.S.'s Address to the RWE conference in Tanga (May 1980) illustrates (16):

"The key element for the success of the decentralised development programme is the healthy two way communication between the Regional Water Engineers and the MAJI Headquarters.
It is seen that this relationship has been deteriorating.
The Regional Water Engineer's loyalty is now divided between the Regional Development Directors from whom he must get administrative direction, and MAJI where he must get technical proficiency. It must be noted that there is a definite need for the Regional Water Engineer and the Regional Development Director to work closely and understand each other's views and problems and on the same token there is a greater need for the Regional Water Engineer to have a closer and professional rapport with the MAJI personnel. Perhaps, there is a need to develop a code of relationship on areas for consultation between these two levels and this in my opinion is one of the points to be considered in this conference".

Only in case a project is turned into a National Project is MAJI's involvement such that the staff in Dar-es-Salaam is kept informed of all developments. For shallow wells implementation setting up a National Project does not seem to be the most appropriate step, however, and other ways should be found to ascertain the flow of information.
It is unclear at this stage whether the proposed appointment of officers charged with reporting project information in the RWE staffs (17) will improve the situation, but a set-up whereby coordination is the task of the WMPCU, supported by a TCC, appears the most promising.

It is, therefore, recommended that the Tanzania Water Development Coordination Board (TWDCB), when established, nominates a Technical Coordination Committee as soon as possible, and fixes terms of reference for this committee, also governing its relation to the WMPCU or any other MAJI agency to be entrusted with shallow wells coordination activities.

3.3. Operational level of shallow wells implementation

Though for coordinating the shallow wells activities and developing the shallow wells technology the national level seems the most appropriate one, for the actual execution of shallow wells implementation programmes there are more options:

- a national rural water supply programme of which shallow wells constitute just one component
- similar, but on a regional level
- a national shallow wells programme
- regional shallow wells programmes, with national coordination, and assistance when required
- any intermediate solution

There are a number of disadvantages connected with a national, as compared to a regional set-up. Firstly it is in contradiction with the Governments' declared decentralization policy, whereby as far as water supply is concerned, the Regional Water Engineers (RWE) and their District Water Engineers (DWE) are in charge of implementing water supply systems (excluding the so-called National Projects) and of their operation and maintenance. Responsibilities and decision-making power are in the hands of the RWE and DWE, with funds for development, operation and maintenance being provided by the Prime Minister's Office (PMO) through the Regional Development Directors (RDD).

Secondly, supply lines would become too long, effective control too difficult and the whole set-up unworkable, if a national basis for the implementation of shallow wells were to be chosen. In practice decentralization to the regional level, or lower, whould be required anyhow in order to make the organization work and this could in fact mean a duplication of the RWE's organization. For the same reason an organization which covers more than one Region may not be considered feasible either, apart from very special cases.

Since the governmental organization is working on a District - as well as a Regional level (DWE under RWE) - shallow wells implementation on a District level might be considered also. Although it might be feasible to have well siting and well construction done on a District basis a number of activities could better be organized on a Regional level in order to avoid unnecessary multiplication of facilities such as stores, workshops, etc. The fact that the current system whereby donors "adopt" parts of the country works Region-wise, also regarding funding, is another argument in support of selecting the Region as the level on which shallow wells implementation should be carried out.

If this suggestion is accepted, there still remains the choice between two alternatives: a shallow wells programme as such, or integrated in a rural water supply programme.
Although the latter offers certain advantages in overall water supply planning, in view of the large numbers of shallow wells required, their special technology and the fact that so far hardly any RWE is involved in constructing shallow wells on a sizable scale, a specific effort on shallow wells seems rewarding.

Our recommendation is therefore, to carry out shallow wells construction programmes on a regional scale, and - at least for some time to come - as separate activities, if not separate projects. An added advantage of such a set-up would be that all on-going projects fit into this concept.

3.4. Degree of government involvement in implementation of shallow wells

Essential elements of a shallow wells implementation programme are:
- survey (well siting)
- construction

with back-up facilities comprising:
- administration
- supply and stores
- workshops
- transport and vehicle repair

and maintenance and extension projects (community participation and education) as important additional activities that will be treated separately in following chapters.

Most of these activities are not uncommon in the RWE's normal practice, though extension projects are seldom included and shallow wells survey and construction do not (yet) form part of most RWEs' activities. In practice all on-going shallow well implementation programmes are executed by separate organizations that are generally funded by outside donor organizations and staffed, at least partly, with expatriate personnel.

Roughly speaking, three options can be distinguished for these regional shallow wells projects:

a. A set-up based mainly on foreign capital and expatriate staff, with direct access to foreign currency and/or suppliers abroad, the type of project found in Mtwara/Lindi and Morogoro Regions. Thus far this is the only type of set-up that has proven to be able to maintain the desired output throughout the years.
b. A shallow wells project that, either as a separate body, or fully integrated, forms part of the Tanzanian national or regional water supply organization, without direct access to foreign currency and/or suppliers abroad.

The Shinyanga Shallow Wells Project as it functions at present is an example of this set-up. In practice this approach suffers from the same draw-backs and constraints as the regular RWE organization.
The Proceedings of the RWE Conference of 1980 in Tanga list a number of reasons for the fact that RWE organizations are functioning sub-optimally (16, 19):
1. lack of trained manpower
2. lack of essential equipment
3. lack and misuse of transport, spareparts and fuel
4. lack of materials (pipes, cement)
5. lack of proper planning
6. uncertain annual budget allocations
7. lack of foreign currency allocations

Trained manpower is one of the most important constraints and also one that cannot be remedied at short notice, unless the output of the Water Resources Institute, University of Dar-es-Salaam (engineering faculty) and similar institutes could be vastly increased.
Essential equipment and materials are often lacking because of the uncertain budget allocations, the non-acceptance of LPO's by suppliers and the lack of foreign funds for purchases directly abroad. A special chapter will be dedicated to these procurement and supply constraints, and a special procurement agency will be recommended.

c. A set-up wherein, to the largest extent possible, use is made of private initiative, e.g. by (sub)contracting the construction and/or maintenance of shallow wells to cooperatives or private enterprises. Although such a set-up does not mirror the professed national policy, it is more or less in line with the current tendency towards stimulating productivity, self-reliance and private initiative in the rural areas of Tanzania. Moreover, as it does not possess any of the drawbacks of a more bureaucratic nature that are reflected by the RWE organization, it may prove to be an attractive solution in the long run.

Whatever option will be chosen, it is not realistic to assume that the existing RWE organizations would be able to absorb extensive shallow wells programmes in their present set-up. As it is, these organizations have a task which the constraints as mentioned earlier make near to impossible to fulfill, even without the added burden of shallow wells programmes.
It is clear that major steps are required to eliminate the constraints that prevent the RWE organizations from being transferred into smoothly operating, modern organizations. Until the moment this will have been achieved, shallow well programmes should better be implemented by separately founded projects.

Also in executing these programmes in the first stage, with direct financial support by donor organizations and with a partly expatriate staff, there are different organizational and operational approaches:

a. A completely separate set-up, not based on any Tanzanian civil service regulation, nor directly linked to the RWE's office. Next to obvious advantages, this set-up also offers certain disadvantages, however.
The advantages can be described as an operational flexibility and freedom of action, with as a result a possibly higher efficiency in operation, that can never be achieved in the framework of a bureaucratic approach as is the case, unfortunately, with several government institutions.
Direct access to foreign exchange already removes most of the difficulties that plague the Regional Water Engineer, but on the other hand this also indicates the inherent disadvantage: any decrease in direct foreign aid as may be expected when such programmes eventually become integrated in Government organizations will bring all these constraints back, unless drastic changes in the governmental organization itself have occurred in the meantime.

   Another advantage is the possibility to pay higher salaries than according to the regulations for government employees and/or to pay bonuses or give other incentives. The low pay scales for government employees, and especially for "blue collar" workers not seldom lead to a situation where the better workers leave Government employment for higher income in the private sector, whereas the less industrious remain, sheltered by (over)protective labour regulations.
   President Nyerere recently did advocate the principle of reward according to performance, but so far no practical measures to this effect appear to have been taken, although sometimes fictitious "overtime" or "nights-out" are paid as rewards for good performance. It may be clear that here again the only real solution is to change the system of pay scales, introduce incentives, etc. so as to make a good performance in government service also financially rewarding. Until such time as this will have been achieved also higher salaries paid by more or less independent projects will not form a lasting solution, since any transfer of such higher paid personnel back to the present government pay scales will not be acceptable to them. As a result one might end up with a project that showed good performance, but the staff of which is leaving because they will not or cannot be integrated in the regular Government service.

b. A set-up which is partly integrated in the RWE-organization, but still operates as an individual project. Direct access to foreign exchange may or may not be available, depending on the agreement between the donor and MAJI, and often to a large extent use is made of the RWE's facilities. Since this type of project generally follows Tanzania government regulations, there are no problems regarding transfer of staff, but the advantages of having a separate project are vastly reduced also.

Especially if foreign funds are channelled through Treasury, the situation is not essentially different from that of the average RWE organization. Indeed, several of these projects (in Mwanza and Tanga Regions, for instance) suffer from the same bureaucracy (10, 11) and the same constraints as the RWE. Only the fact that in practice they can obtain imported items against local currency from less dependent projects (Morogoro) or through the donor agency, and the availability of trained expatriate staff, enables this type of project to work more efficiently than the RWE's organization would be able to.

What organizational set-up to choose, is also depending on what is considered the most appropriate organization once the expatriate staff (and possibly also the foreign funds) have been withdrawn.

A set-up whereby all necessary water supply works are implemented by completely independent expatriate staffed projects is not considered here, since also, as far as shallow wells are concerned, their technical lifetime necessitates such programmes to be repeated after, say, 10 to 20 years, at which moment no trained Tanzanian organization would then be available to carry out this task. It is assumed, therefore, that after an initial phase - the duration of which will have to be determined later - the shallow well implementation programmes will be run entirely by Tanzanians, within or outside the Government organization.

The essential components of any shallow wells programme are: well siting (survey) and well construction.

Well siting (hydrological survey)

Expert knowledge on this subject is not available in cooperative or privately owned Tanzanian enterprises, nor is it likely that this will be the case in the near future. As it is essential that MAJI, or rather the RWE, has effective control over the implementation of shallow wells and any quality control is extremely difficult when the siting of wells would be left over to a third party, it is recommended that well siting is carried out (eventually) by RWE staff.
A formally trained geohydrologist or hydrogeologist is required in each project and scientific support from the Principal Geologist's office in Dodoma appears indispensable. Whether the staff mentioned should be part of the Principal Geologist's staff, seconded to the RWE, or belong to the RWE regular staff, is a matter for later discussion. It is assumed, however, that their status could be similar to the geological and hydrological staff that is at present employed at the RWE offices throughout Tanzania. It is not known whether the recent division of the Ministry of Water, Energy and Minerals into a Ministry of Water and Energy and a separate Ministry of Minerals does effect this situation in any way.

Well construction

For the construction activities proper, the situation is clearly different. The Regional Water Engineers already have an enormous task in keeping the existing water supply schemes in working order and, as a consequence of this, have not been able to achieve more than about 40 percent of the planned water development programme (19).
Since the target, set for 1991, involves an immense amount of work, whereas the available funds are very limited, it is imperative that the various water supply programmes, of which the construction of shallow wells would probably be the most important single activity, be realised at minimum costs.
Although it has apparently been a common phenomenon of the British colonial organization to do so, it is by no means a generally accepted method to have construction works carried out by Government organizations themselves (in this case: RWE).
Certainly when the RWE's facilities are as overstressed as they appear under their present workload, it does not seem appropriate to add the burden of constructing large numbers of shallow wells with all ensuing logistical problems.
Thus, serious thought should be given to (sub-)contract the construction (and possibly also the maintenance) of shallow wells to private or cooperative enterprises. Since overall control would remain with governmental agencies this might prove to be a valuable asset, which is worthwhile to be tested on a pilot project scale. It certainly is no different from situations all over the world, where contractors are used for the actual construction work, with the water works undertaking in control. Also in Tanzania this situation has existed for the larger water works' construction, although the sometimes erratic annual budget allocations have in some cases precluded the use of contractors.

A possible solution would be the following:

1. start (more or less) independent donor-financed and partly expatriate staffed shallow wells projects in each Region where sizable numbers of shallow wells can be constructed
2. for a limited number of years run a wells construction project in which surveyors and well sinkers are trained on-the-job, after having received an initial training at the Water Resources Institute (3 months' course)
3. gradually integrate the well siting/survey section in the RWE-organization
4. gradually prepare well sinkers for either:
    a. independent operation
    b. integration in the RWE organization

Activities 3 and 4b should not be performed until the constraints that currently hamper the RWE organization's functioning have been removed. An action programme to that extent is imperative also.

Whether construction should be part of the RWE's activities or an independent operation requires a policy decision. It is recommended that the latter option is tested on a pilot scale by an on-going project. The Morogoro Wells Construction Project has expressed its willingness to run such a pilot project with (part of) its construction staff.

3.5. The parastatal organization alternative

An alternative that has not been mentioned so far is the parastatal organization.
Integrating the construction of shallow wells in a parastatal Rural Water Supply Corporation, might be an answer to the problems that are manifest at the moment.
Regarding flexibility, availability of foreign funds, etc. the parastatal concept is somewhere in between the present RWE's organization alternative and the completely independent, partly expatriate staffed and outside-funded shallow wells project.
Still, a Rural Water Supply Corporation is less an alternative to the shallow wells implementation projects than to the RWE's organization. If the parastatal form of organization were chosen for the shallow wells component only, it would mean that at the regional level water supply would be divided over two mutually independent organizations (a parastatal and the RWE) which is clearly undesirable. The only feasible option would thus be to have all water supply activities at the regional level integrated in a parastatal, a Water Supply Corporation. This could either control all water supply activities, or only the rural water supply part. There would also be an option of parastatals restricted to the boundary of the Region only, or a nation-wide operating parastatal. A detailed proposal to incorporate all water supply activities in Tanzania in one or two Water Supply Corporations has been submitted in December 1979 by AIB (1, 21).

It will be clear that a decision to integrate all RWE activities in one or more parastatals is not one that can be taken overnight. On the other hand it might offer the solution that has been looked for, viz. offering a greater flexibility in salary scales and incentives than can be found in regular government service.
Thus it is recommended to further investigate the possibility of transferring at least the rural water supply activities of the Regional Water Engineers to (a) parastatal(s) as one of the means to increase the RWE's organization's effectivity.

Choosing for the parastatal approach would still leave open the options of carrying out the actual wells construction work inside such an organization or by contractors. It is, therefore, recommended to stick to the solution as recommended earlier, viz. starting separate shallow well implementation projects in each relevant Region, selecting the option of independent construction units ("contractors") or integrated construction units and eventually integrating all relevant components in a regional water supply agency.

The latter could then be a parastatal (including the present RWE organization) or a face-lifted RWE-organization with increased effectivity and adjusted remuneration procedures.

3.6. Selection of designs and working methods

3.6.1. Introduction

Survey for wells construction (well siting) and the construction proper of the wells, being the two main activities in each wells implementation programme, will be treated separately here. One of the reasons for this has been mentioned earlier (para. 3.4.), viz. the possibility that well siting and construction are carried out by different organizations (e.g. well siting by RWEs and construction by contractors). Another reason is the fact that in practice it has proven to be very difficult to integrate well siting and construction groups. At first sight such an integration appears very desirable, as it would reduce transport requirements and as such constitute a clear advantage in view of the shortage of vehicles, fuel and spare parts that are experienced at the moment.
In the field this approach has shown to be less advantageous, however, as it normally results in delays in execution of one of the two activities. In order to ascertain an undisturbed construction of wells it is essential that the surveyors build up a stock of approved well sites. Then the well sinkers do not have to wait for allocation of well sites and also in case certain areas are temporarily inaccessible because of water logging during the rainy season enough approved sites are available to shift the construction of wells to other, accessible, areas.
It is imperative, therefore, that the survey groups can operate more or less independently from the construction groups, though for the sake of economy sharing of transport and other facilities should be realized to the extent possible.

3.6.2. Survey/well siting

A wide variety of methods is being used all over the world for determining the presence of water in the subsoil. These include exploratory drillings, aerial surveys, seismic and geoelectrical methods, etc. Several of these are primarily aimed at providing insight in the water availability for larger consumers and in a very limited time span, and require sophisticated, sometimes extremely expensive equipment and highly specialized personnel.
In Tanzania many of these methods have been, or are being, used, often within the framework of water master plan preparation and then especially for the detection of deeper ground water, such as:

- well logging
- resistivity profiling
- cable measurements
- borehole drilling, etc.

For shallow well surveying most of these methods are less appropriate as they rely not only on complicated procedures but also on sophisticated equipment and highly qualified staff. Both are in short supply and, moreover, the results are often not better than with much simpler methods.

Though a general insight in the geology of the area is essential, as is the involvement of a trained hydrogeologist or geohydrologist, the selection of approved well sites is something that must be done on the spot and field practice in the on-going shallow well implementation projects indicates that test drilling is essential and also generally sufficient.

In selecting the test drilling method for any project, the following options can be chosen from:

a. machine drilling:
   - with heavy drilling rigs (rotary or percussion)
   - with medium heavy equipment (fig. 3.2.)
   - with light motor drills (fig. 3.1.)

b. handdrilling (fig. 3.3. and 3.4.):

Fig. 3.1 Light machine-powered auger drill for shallow well survey

Fig. 3.2 Medium-heavy machine-powered survey drill

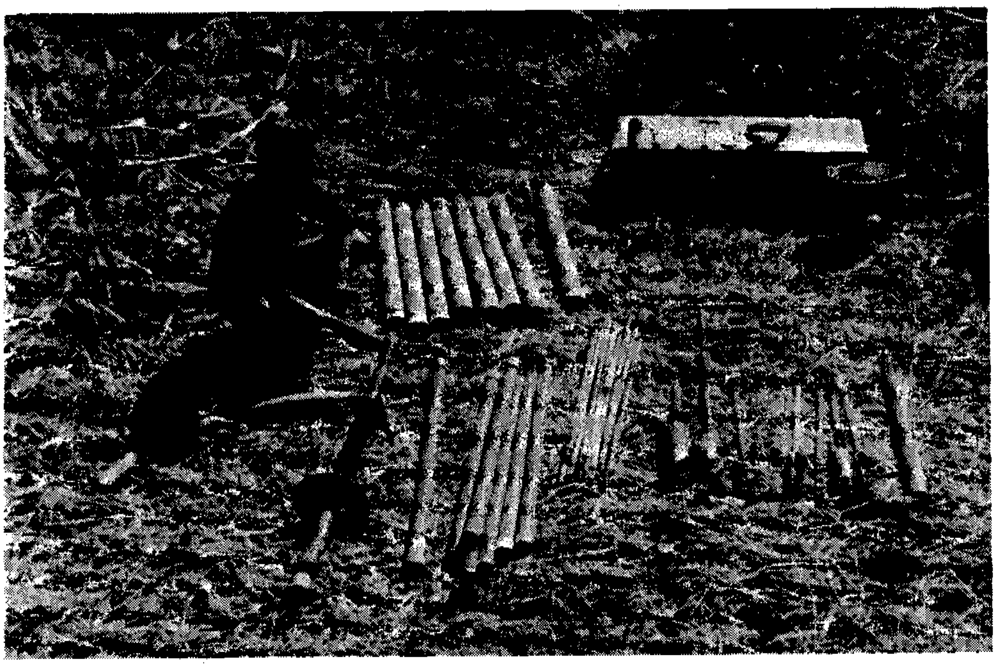

Fig. 3.3 Hand-drilling survey equipment

Fig. 3.4 Survey by hand-drilling

The use of heavy drilling rigs does not seem appropriate for the relatively shallow wells (down to approx. 20 m) that are the subject of this report. They are expensive in investment and running costs and require the fulfilment of a number of requirements that cannot normally be realized under rural water supply conditions in Tanzania. The constraints under which drilling rig teams operate in Tanzania were mentioned at the RWE Conference in Tanga and are illustrated by the fact that their performance has been less than 20% of the footage estimated (16).
It therefore seems more realistic to restrict the use of heavy drilling rigs to their first and foremost task: the drilling of boreholes for piped supplies.

Light and medium heavy motor drills have been used, and still are, in several projects. Though to a lesser extent, they suffer from the same drawbacks as the heavy equipments: all require fuel, spare parts and trained personnel for their operation and maintenance, requirements that are often not met.

The first project in Tanzania to embark on the large scale construction of shallow wells, the Shinyanga Shallow Wells Project, for the reasons as mentioned here, developed the concept of well siting by means of hand-drilled exploration boreholes. A lightweight and a heavyweight hand-drilling survey set were developed for that purpose, and are described in detail in various publications (14, 15).
Under normal conditions the light survey set can be used, and this is done in a number of projects (Morogoro, Shinyanga, Singida, Mwanza, Tanga) (6, 8, 9, 10, 11, 15). For harder soil formations the heavy survey set can be used, although the percentage of cases in which this is required may be rather limited (in Morogoro: less than 1%). The capacity of the heavy survey drill is clearly better than that of light machine drills (auger drills) like the Minuteman that were, and still are, used in parts of the Shinyanga Region.
In view of this and the fact that no imported spare parts nor fuel are required for the heavy survey drill as it is used in Morogoro, while repairs can easily be performed locally, there is in fact no advantage in using light motor augers apart from some added convenience to the operator(s).

Medium heavy motor powered drilling equipment may be used to advantage in specific cases. Its applicability is even more limited than that of the heavy (hand) survey set, however, because often sites where the heavy survey set is not able to penetrate are also less suitable for the construction of shallow wells by handdigging or handdrilling. In such cases the option of using a simple percussion rig for well siting as well as construction might be considered.

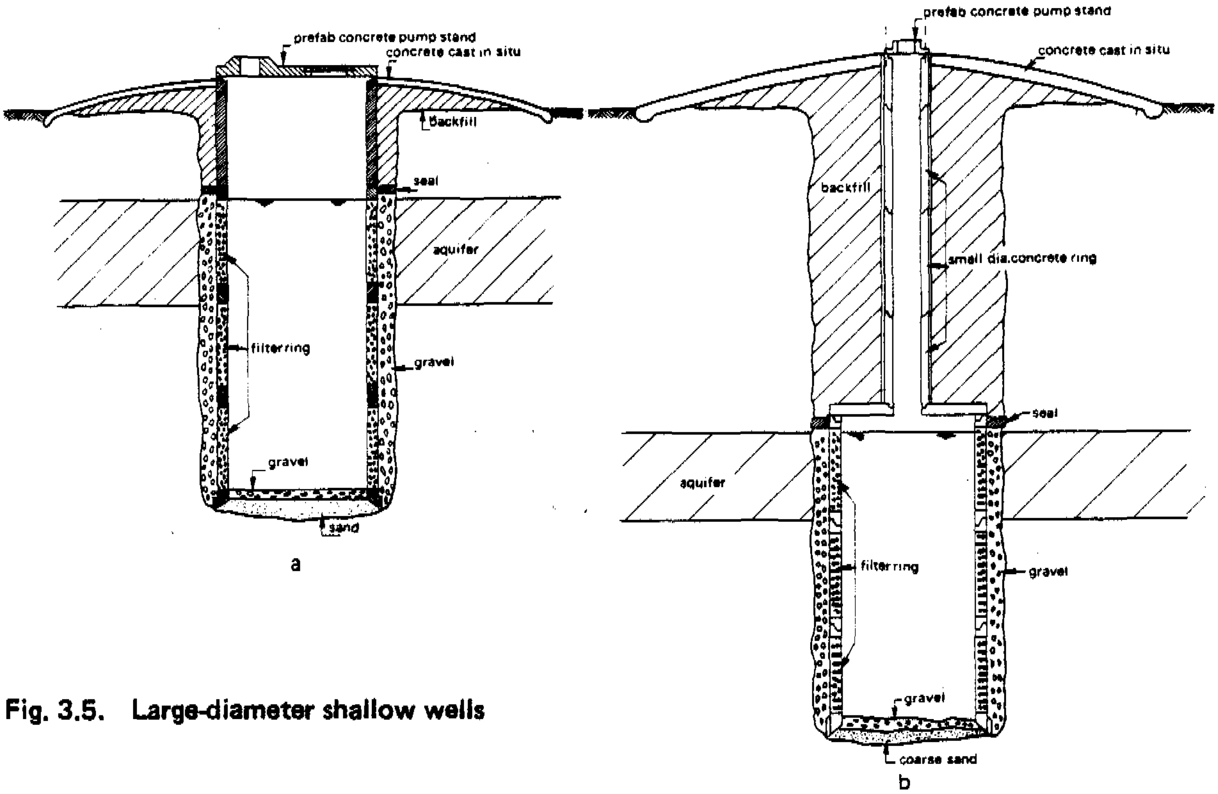

Fig. 3.5. Large-diameter shallow wells

Small-diameter wells have casings, screens and gravel-packs in the same way as traditional boreholes.

Large-diameter wells are generally dug by hand or by any mechanical means and are normally provided with an internal lining to prevent the walls from collapsing and surface water from entering and contaminating the well.

There are three main systems for lining a well (13):

A. Alternately deepen and line the shaft.
Possibilities for lining are:

1. reinforced concrete cast in place
2. concrete trowelled into reinforcing rod grid
3. brick or stone on concrete footing, anchored into sides of excavation

B. Excavate to the water table, and then build lining upward (the unlined shaft may be a safety hazard in this case).
Possibilities for lining are:

1. reinforced concrete cast in place
2. brick or stone on concrete footing
3. timber cribbing or other wood construction

C. Sink a pre-formed cylindrical lining by undermining.
Possibilities for lining are:

1. precast concrete caisson
2. brick or stone on reinforced concrete cutting ring
3. prefabricated steel caisson
4. vertical planks supported by horizontal ring

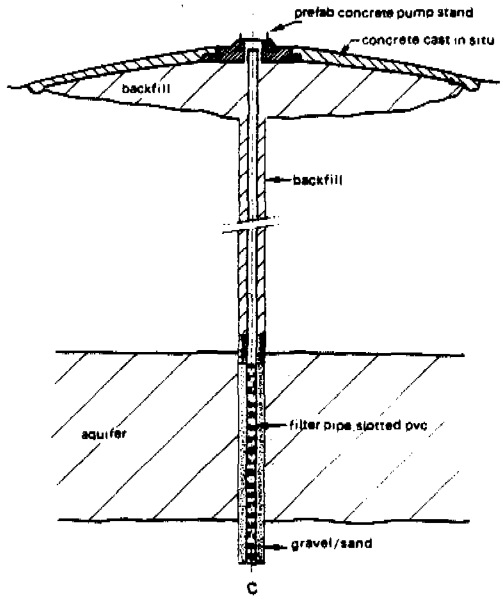

Fig. 3.6. Small-diameter well

Methods A and B must be used in conjunction with the caisson method (C) to finish the well, but have the advantage that the well depth may be virtually unlimited.
Caissoning over the entire depth, as is the practice in many projects, also in Tanzania, offers other advantages (3, 15):

- the equipment required is simpler
- the amount of steel reinforcing roads, required for reinforced concrete, is reduced
- practically all construction work is carried out on the surface
- advance site preparation and prefabrication techniques can speed up the work considerably

The method offers several disadvantages also, however:

- it is difficult to keep the shaft vertical
- boulders or large stones can cause the caisson to tilt
- the friction between lining and shaft wall is irregular, as a result of which stresses are set up that may cause slipping, jamming or opening of construction joints

Disadvantages of large-diameter wells in general are (as compared to small-diameter wells):

- greater effort and longer construction time are required
- safety hazards during and after construction are greater
- it is more difficult to prevent contamination
- the rate of inflow for the effort involved is generally lower

Typical well construction for a Kangaroo pump

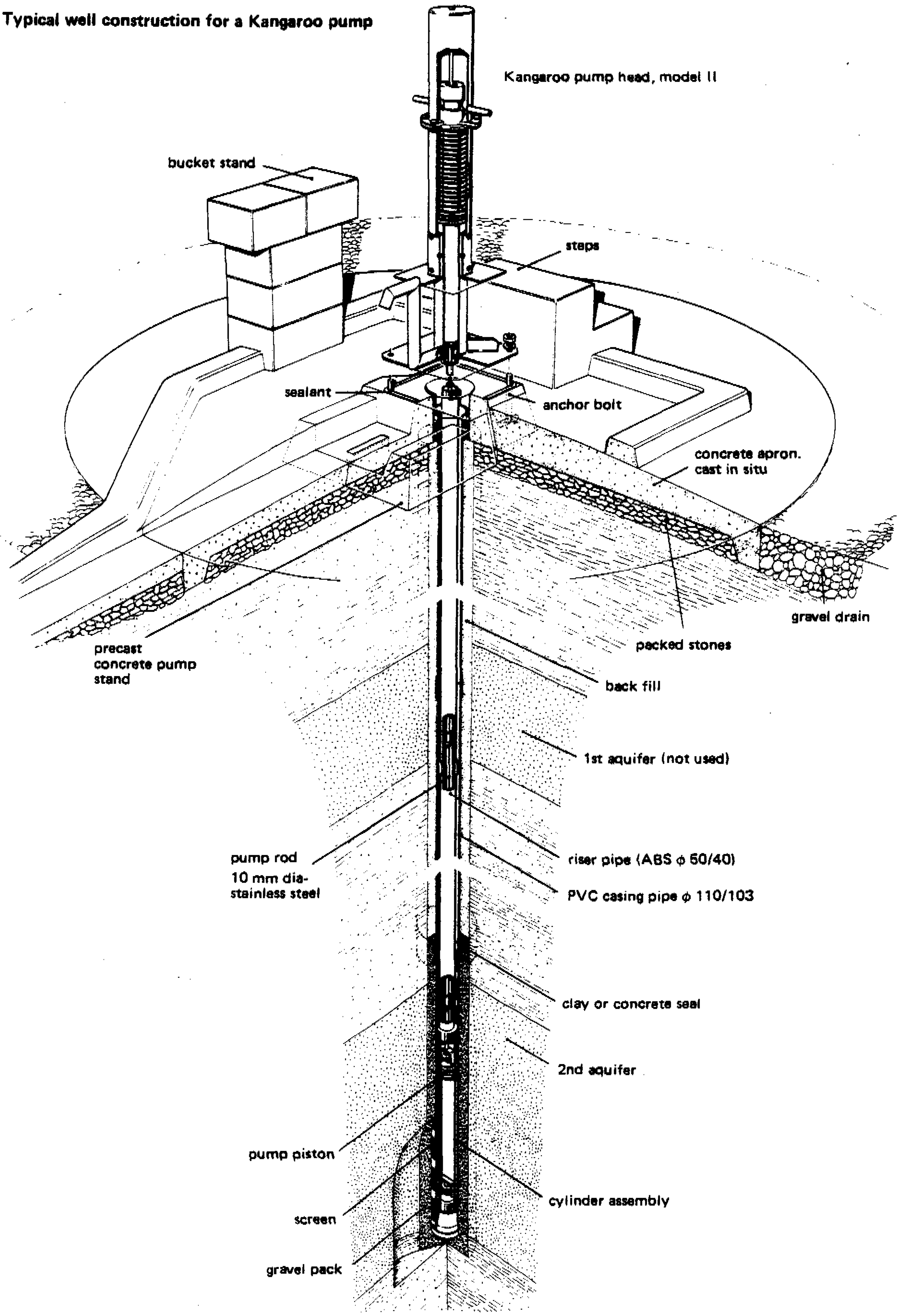

Fig. 3.7 Typical hand-drilled shallow well

Large-diameter wells may be the only feasible solution, however, when the aquifer characteristics are poor. Even then the effect of increasing the well diameter on the well yield is very limited (well yield varies less than directly proportional with the logarithm of the well radius) and an increase in yield might better be obtained by extending the depth of the well (if the aquifer is sufficiently thick). The real important asset of a large-diameter well is its storage capacity: the well is filled overnight, and during the day the well volume plus the direct inflow during the day hours can be abstracted.

Construction methods applied in Tanzania

The well construction methods applied in Tanzania are the following:

a. hand-dug wells with concrete lining (Shinyanga, Singida, Tabora, Mwanza) (9, 11, 14, 15)
b. mechanically excavated wells with concrete lining (Mtwara/Lindi) (7)
c. hand-drilled wells with PVC casing/filter pipe (Morogoro, Shinyanga, Singida, Mtwara/Lindi, Mwanza, Tanga) (5, 7, 8, 9, 10, 11, 14, 15) (fig. 3.7.)

a. Hand-dug wells

The large scale construction of shallow wells in Tanzania started in the Shinyanga Region. At that moment only limited experience with the construction of shallow wells was available and thus it was considered best to follow the traditional method of digging by hand. Wood not being considered a suitable material for lining a well and burnt bricks nor masonry skills being widely available, a concrete lining was selected.
For reasons of quality control centrally made concrete rings with only a nominal reinforcement (in order to withstand transport on trucks) were used. The shaft was dug without a lining as far as safety allowed, then the concrete rings were lowered into the shaft and this was deepened by continued digging, using the caissoning method.

After having reached the desired depth gravel or coarse sand was poured around the porous filter rings, the remainder of the space between the shaft wall and concrete rings was backfilled and a concrete cover put on top. A concrete apron was cast around the well and a handpump installed.
This method, which is described in detail in "Shallow Wells" (15) is still widely used in Tanzania: in the Shinyanga, Singida, Tabora and Mwanza Regions (fig. 3.8. and 3.9.).

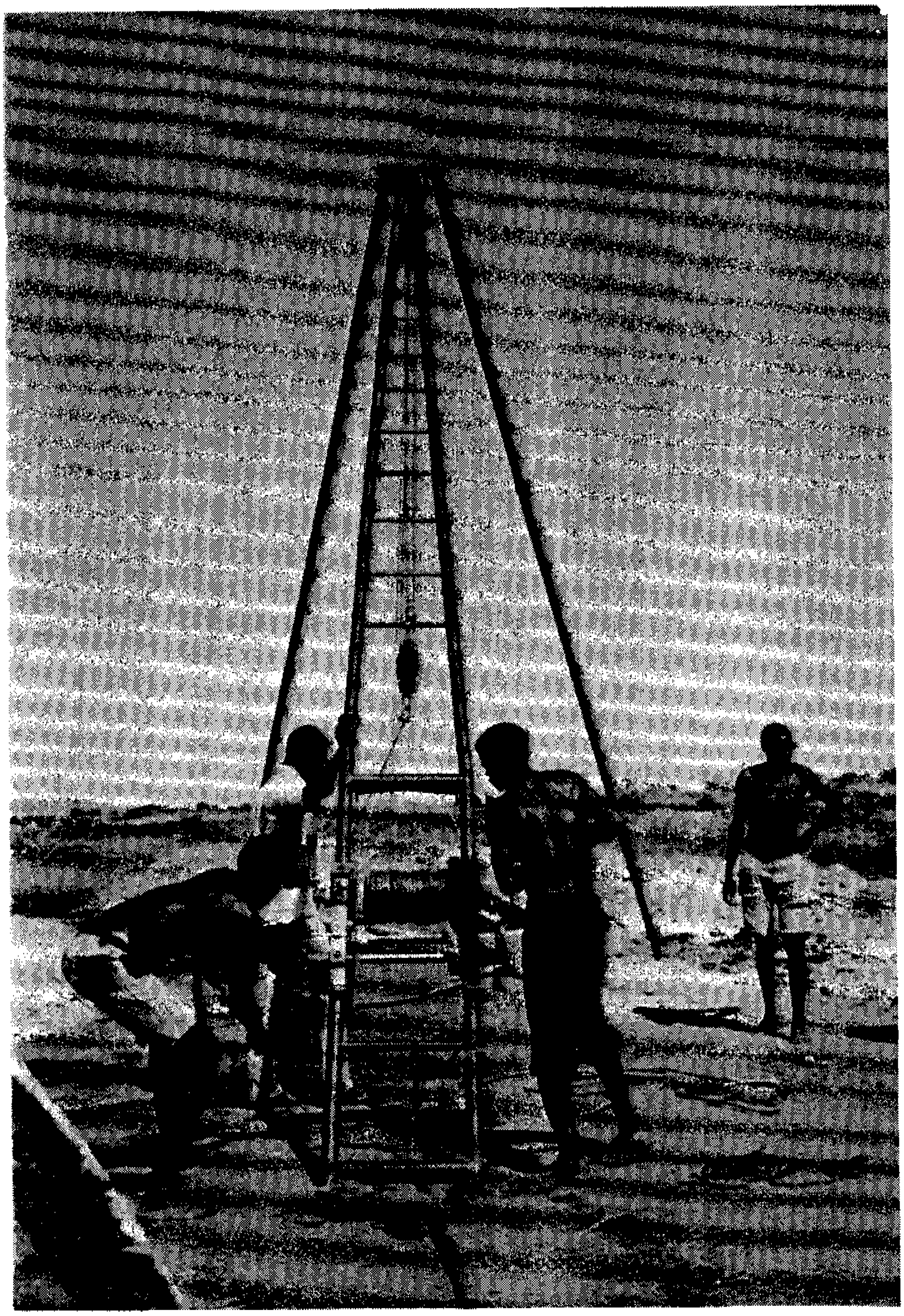

Fig. 3.8 Lowering of concrete rings in hand-dug well (Shinyanga Region)

As the experience with this method grew, several disadvantages became apparent:

1. The construction time is long (approx. 1 to 1½ months for a construction group of 8, as compared to 1 week or less for hand-drilled wells).
2. The wells require much cement (approx. 45 bags per well, whereas drilled wells require only about 7 bags). At the moment cement is in extremely short supply in Tanzania, which has resulted in the virtual discontinuation of all wells construction activities in the Shinyanga Region.
3. The costs per well are higher than for hand-drilled wells (see fig. 3.15.).
4. The weight of the concrete rings (approx. 1 ton for 1 m high rings) renders it essential that trained staff is involved in the actual construction work. The use of untrained personnel (village people only) might easily lead to accidents.
5. Especially when the aquifer recharge is large, digging a well to the required depth may be impossible because of the inflowing water. Then either the shaft has to be dewatered during construction, or the well is finished only after the water level has sunk, in the dry season.

   Large scale construction of wells in practice precludes waiting for the end of the dry season to finish wells. Pumps will thus have to be used in the construction phase. Suction pumps situated on ground level are simplest, but can only be used for water tables down to approximately 7 m (fig. 3.10.). For deeper wells lift pumps are required. Especially with larger inflows, these pumps should be machine driven, preferably electrical pumps, whereby great attention should be given to avoiding all risk of electrocution of the well sinkers working in the shaft. The problems with securing a reliable supply of fuel and spare parts, as well as trained maintenance mechanics, make the use of these motor pumps less desirable, however (fig. 3.11.).
6. In a number of cases dewatering of the pit during construction results in a running sand situation. Also the situation may occur, e.g. with alternating horizontal clay and sand layers, that the sandy aquifer material is washed out from between the clay layers, which subsequently collapse and seal off the aquifer.

   This has happened in the Shinyanga and Singida Regions, and has contributed to the introduction of handdrilling in Shinyanga, and later in Morogoro.

Fig. 3.9 Excessive inflow of groundwater necessitates the use of motor pumps

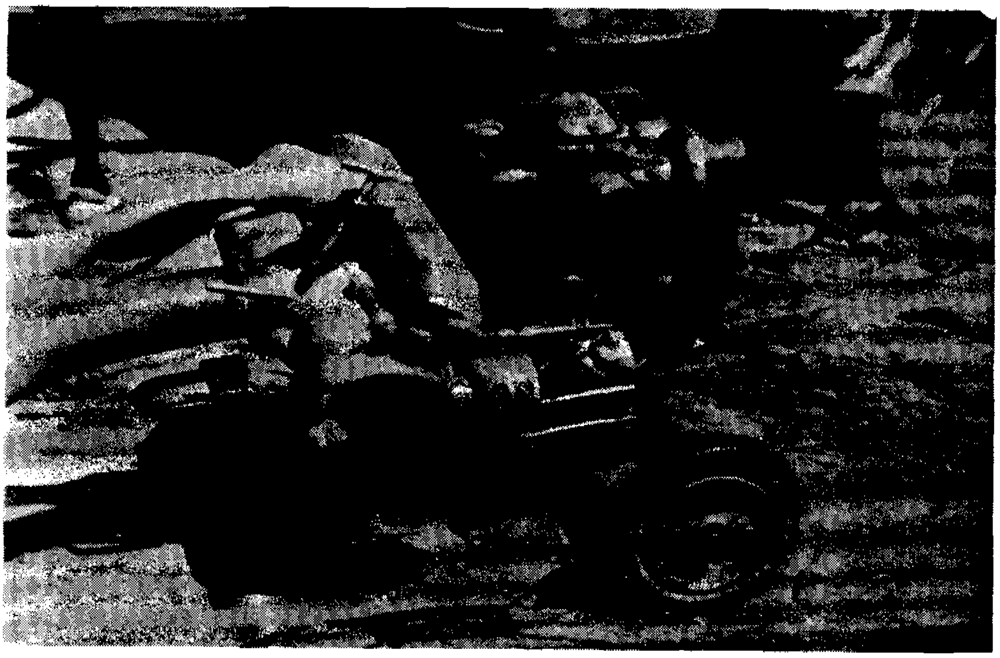

Fig. 3.10 Small motor pump, applicable for water depths less than approx. 7 m.

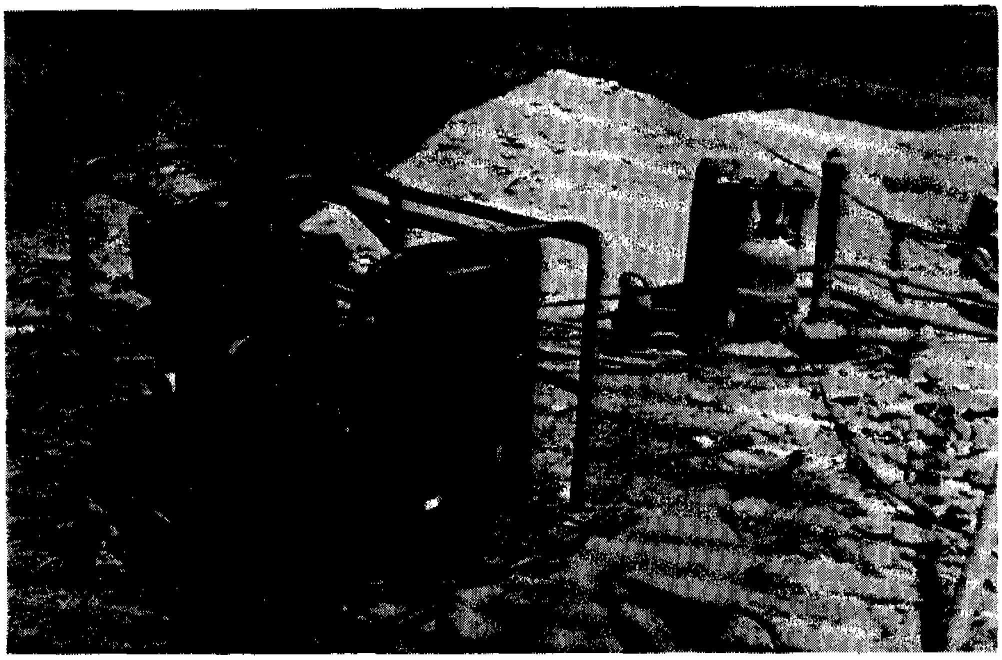

Fig. 3.11 Diesel generator for powering electrical pumps (water level lower than 7 m.)

b. Mechanically excavated wells

It was mentioned earlier that the Fins in Mtwara/Lindi make ring wells by means of a tractor-mounted excavator. Whereas most of the other projects use concrete rings of 1.25 m internal diameter and 1 m height, sometimes supplemented by a 0.5 m high ring at the top, all rings as used in Mtwara/Lindi Regions are only 0.5 m high and they also have a slightly smaller internal diameter: 1.00 m.
The tractor excavators can dig to a maximum of 5 m, so that deeper wells have to be dug at least partly by hand, often using 0.8 m wide rings that telescope inside the normal rings with 1.0 m internal diameter (fig. 3.12. to 3.14.).
Since mechanical equipment is used, which requires frequent maintenance and/or repair in the field, it is doubtful whether this solution is a feasible one for the average, fully integrated, RWE project. On the other hand the speed of construction as well as the relatively low overall costs render it a method that should be further investigated by the Technical Coordination Committee when drafting its recommendations for standardization of well designs and construction methods.
It should be realized, however, that the wells as made in the Mtwara and Lindi Regions are relatively shallow when compared to the other shallow well projects, which of course contributes to short construction times and low costs.

In the following proposals for organization of wells implementation projects and in the subsequent cost estimates the option with tractor-mounted excavators is not taken into account.

c. Hand-drilled wells

As already mentioned, dewatering dug wells sometimes causes severe problems and thus hand-drilling has gained a solid foot-hold in Tanzania.
Because generators and motorpumps are no longer required, initial expenditure can be brought down and also the overall costs per well are lower than for dug wells, as fig. 3.15. shows (the steep incline in the graph of the hand-dug wells cost for wells over 6 m deep is caused by the fact that motorpumps will then have to be used, while the difficulty of digging the well is also increasing more than proportionally with the depth of the well).
The requirement of a higher transmissivity of the aquifer when small-diameter wells are used (according to experience in Shinyanga and Morogoro Regions the yield during test pumping should be at least 500-1000 l/h rather than 200-500 l/h as for dug wells) generally does not present large problems (in Morogoro Region less than 2 percent of all sites were not suitable for small-diameter wells).

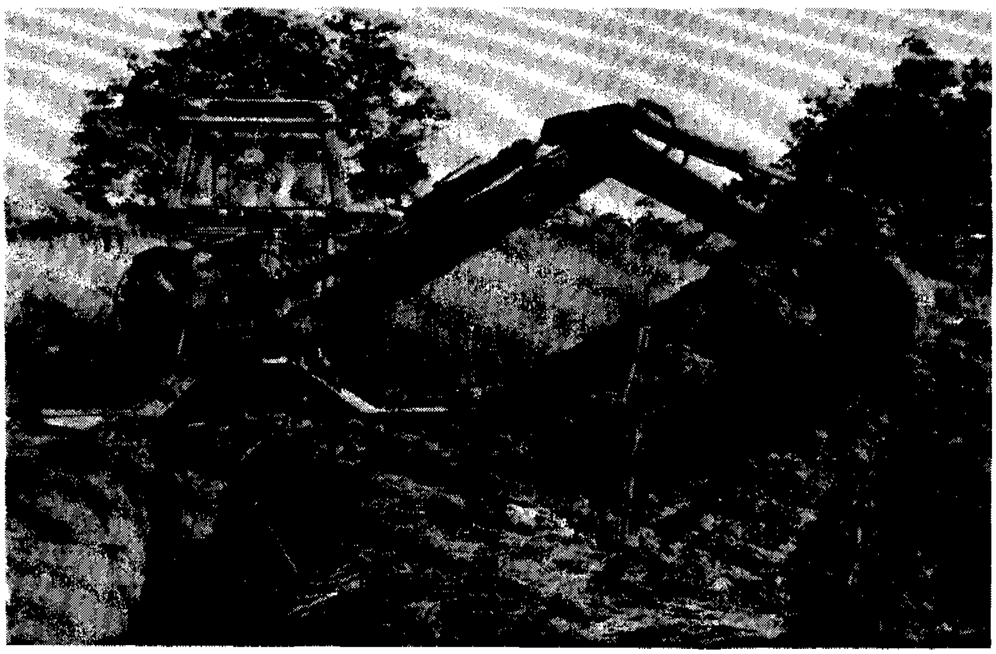

Fig. 3.12 Mechanical excavation of shallow wells (less than 5 m. deep)

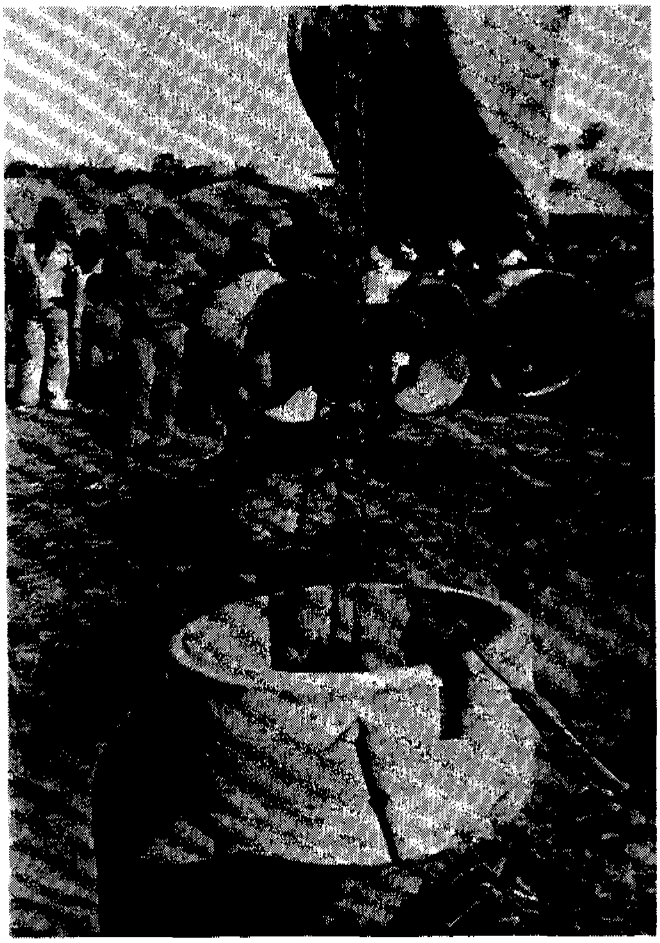

Fig. 3.13 Concrete rings are being lowered by tractor excavator

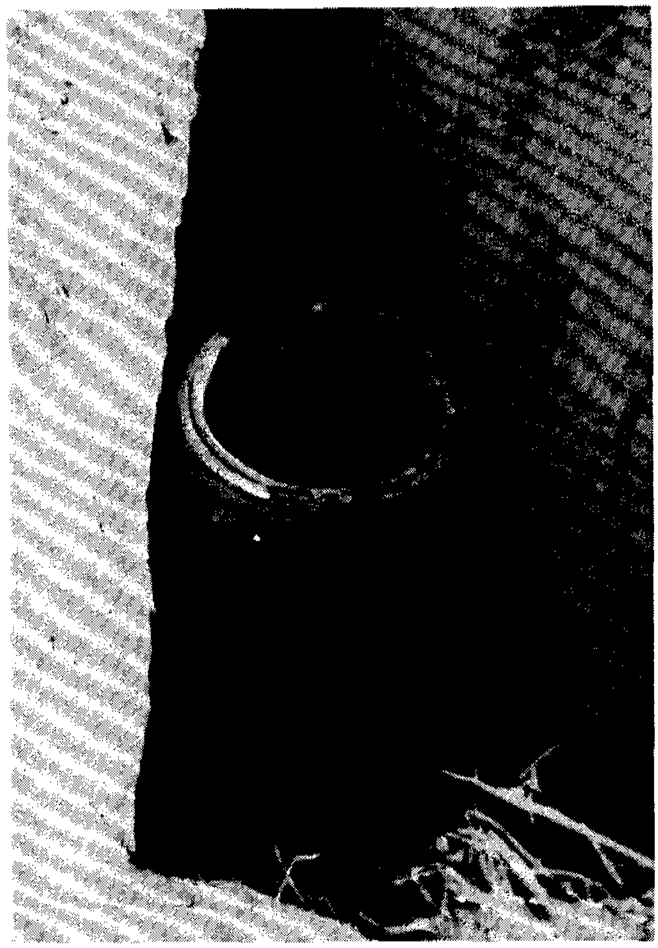

Fig. 3.14 Concrete well rings put into position

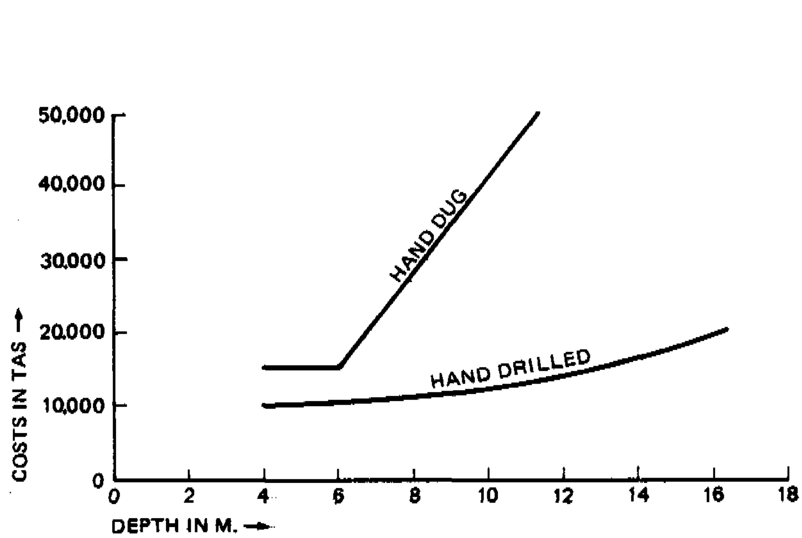

FIGURE 3.15 COSTS OF SHALLOW WELLS

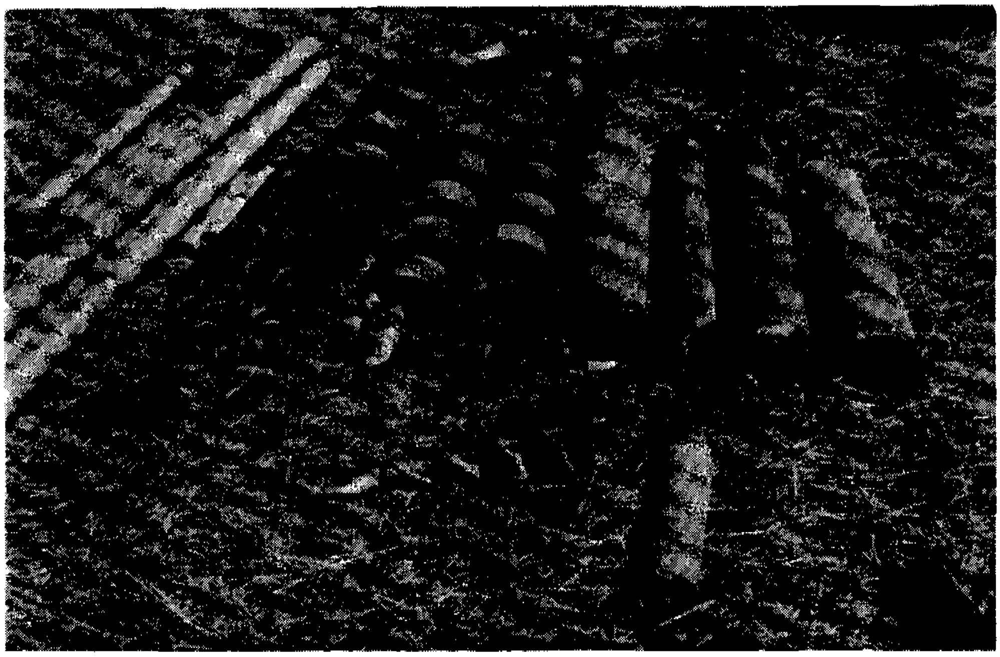

Fig. 3.16 Drilling bits and augers for hand-drilling wells

Hand-drilling equipment consists essentially of a continuous flight auger with various bits of two diameters (the smaller to be used inside a temporary casing), a cross piece for turning the drill, bailers, casing pipe, etc. (fig. 3.16. to 3.20.).

Sets in use in the Morogoro Region have bit diameters of 300 and 230 mm, 230 and 180 mm and 180 and 140 mm, respectively. Apart from the fact that this drilling equipment is manually operated there is no principal difference with the conventional boring/drilling of boreholes. When the hole is at the required depth a slotted PVC pipe is lowered into it (a combination of screen and casing), a gravel pack is put around the screen, and the well is finished in essentially the same way as a dug well.

The advantages of the use of hand-drilling equipment, such as:

- reduced construction time per well, or: a higher output per construction group
- reduced costs per well
- no need for using motorized equipment that would require trained operators as well as fuel and (imported) spare parts
- the possibility to repair the drilling equipment wherever welding facilities are available

- the possibility to work with virtually untrained personnel, without safety hazards

render the hand-drilling method one of the most appropriate ways of constructing shallow to medium depth wells for rural water supply in Tanzania.

After construction there is hardly any difference between dug and drilled shallow wells: in both cases a concrete slab is cast in situ, and a handpump mounted on the well.

Proposed construction methods

It is recommended that the Technical Coordination Committee prepares standards for the methods to be used in well construction. In view of the advantages and disadvantages of the various options as mentioned above it appears that hand-drilled wells are the most appropriate construction, with handdug wells as an alternative in case poor aquifers are encountered. The applicability of the Finnish system with tractor excavators might be considered as another option in case of shallow aquifers of poor transmissivity.

Fig. 3.17 Hand-drilling in progress (Morogoro Region)

Fig. 3.18 300 m auger drill

Standard designs will be required for the pump stand or slab to be used on top of the well and the apron around the well head. Much attention is to be given to the design of the drainage system for spill water (concrete gutter, gravel drain, etc.).
Options in which a washing slab and/or cattle trough are included in the design should also be worked out by the Technical Committee, based on experience from and recommendations by the on-going projects.

Fig. 3.19 200 mm auger drill

Fig. 3.20 Cleaning auger drill

3.6.4. Hand pumps

Traditionally, bucket and rope are often used for drawing water in larger diameter wells. Not only is contamination of the ground water almost certain in these cases, but for smaller diameter (drilled) wells the use of buckets is virtually impossible. Thus all on-going shallow well implementation projects only construct wells that are equipped with hand pumps.

For several years the "Shinyanga" pump, a modified version of the "Craelius", "Uganda" or "Kenya" pump used in East Africa, has been the only available handpump in Tanzania. It consists as far as possible of standard pipe fittings (fig. 3.21.), with the intention that it can be manufactured and maintained locally. The superstructure of the "Shinyanga" pump has been manufactured in Shinyanga, by the Shinyanga Shallow Wells Project.
Lately the steeply rising cost of some of the g.i. fittings, as well as the unavailability of several components have severely hampered the local manufacture of this pump. There is a large probability that the manufacture of "Shinyanga" pumps will be discontinued in the near future. Nevertheless, "Shinyanga" pumps are in use in the following regions: Shinyanga, Tabora, Singida, Mwanza and Kagera.

cost of SS pump :

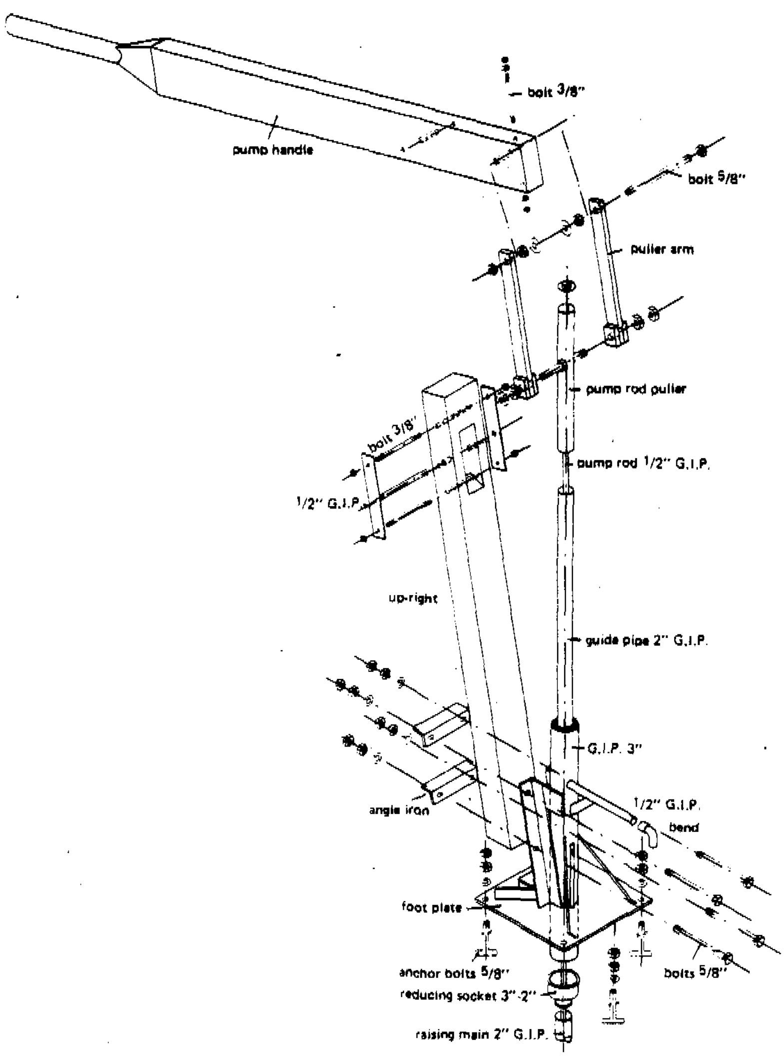

Fig. 3.21 Typical "Shinyanga" pump

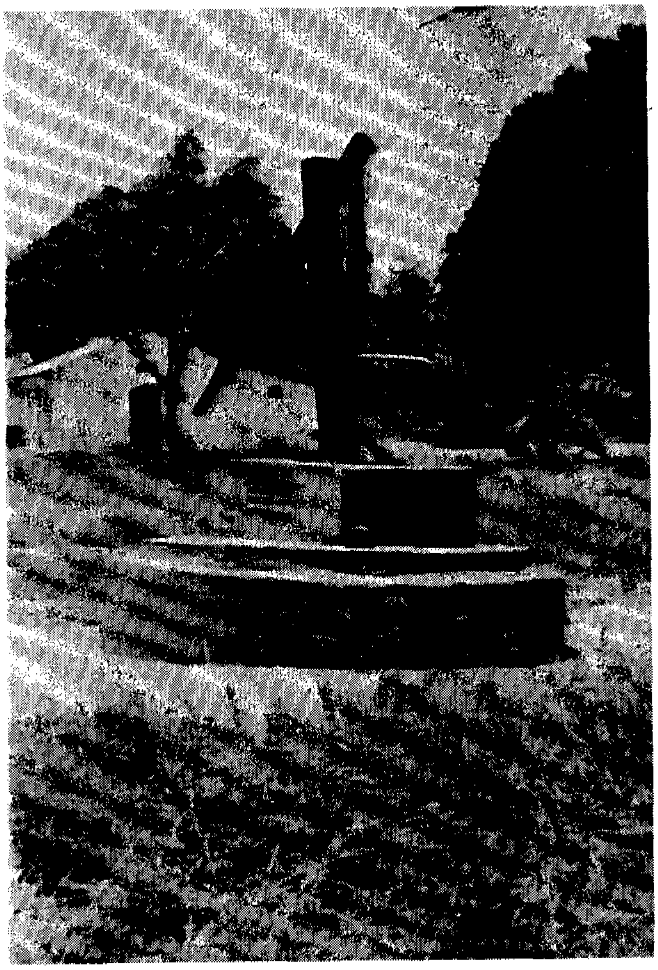

Fig. 3.22 Shinyanga pump on old shallow well (Tabora Region)

Fig. 3.23 Completed shallow well with Shinyanga pump (Mwanza Region)

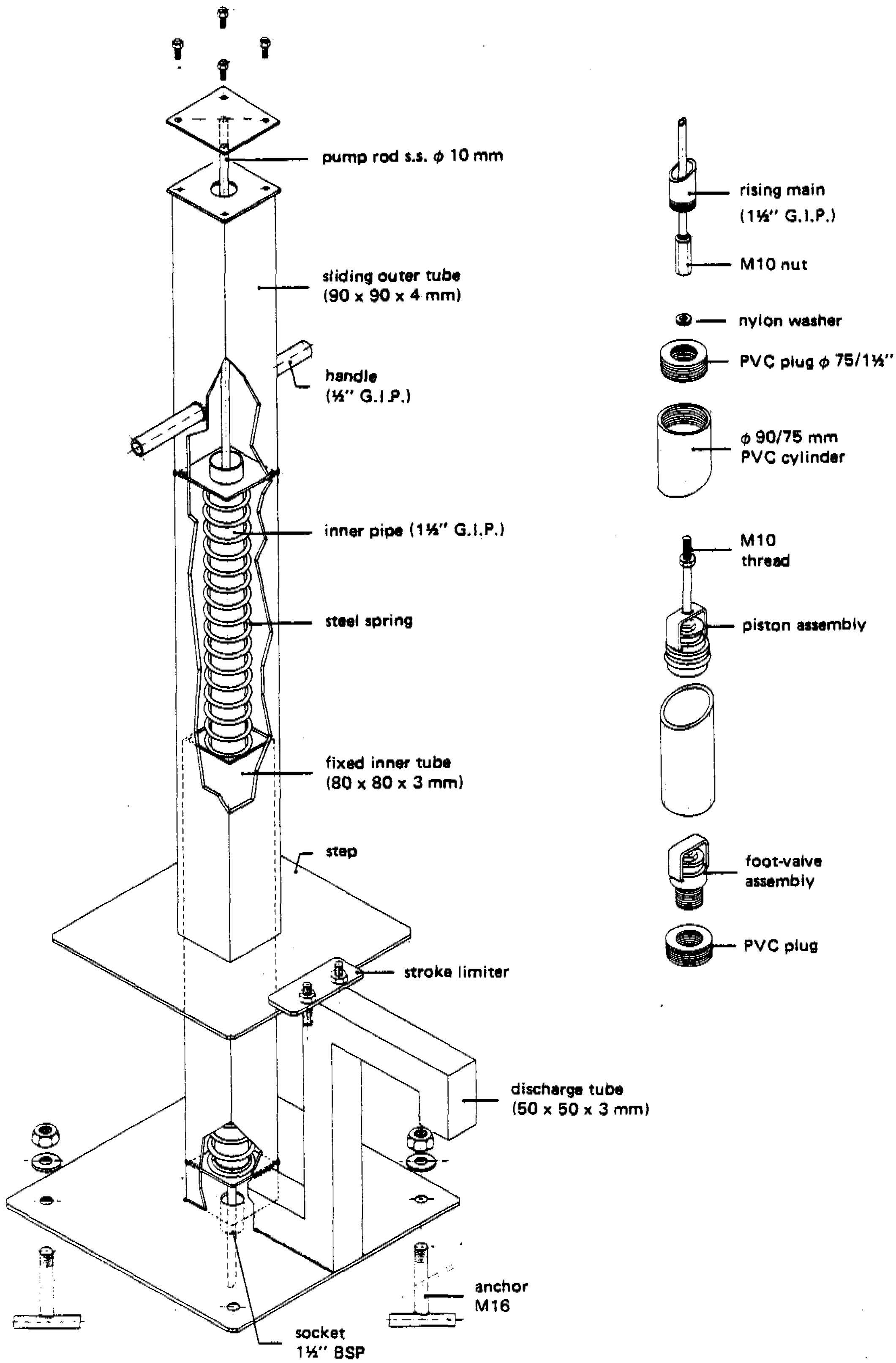

Fig. 3.24 Typical "Kangaroo" pump

Presently the pump cylinders used are the same as those in Morogoro and supplied by the Morogoro Wells Construction Project.

The second pump type to be used in Tanzania is the "Kangaroo" pump. It was conceived with the idea in mind to minimize maintenance requirements to the extent possible. By constructing a pump head that acts in the same way as a pogo stick, the vertical movement of the pump head is transferred directly to the pump piston, without any levers or hinges that require lubrication (fig. 3.24.).
The reason for trying to minimize on the number of parts that require regular and preventive maintenance is that trained maintenance personnel (pump attendants) are hard to come by, whereas centralized maintenance of pumps and wells in areas as sparsely populated as rural Tanzania is extremely costly. Thus money spent on eliminating maintenance requirements generally is money well spent.
Moreover, eliminating the wooden parts of the superstructure, which might be and indeed have been stolen for firewood, or the bolts and nuts of which were used on ox carts, adds to the life expectancy of the pump.
Since 1977 a number of modifications of the "Kangaroo" pump have been introduced, and development work on this pump type is continuing in Morogoro (Morogoro Wells Construction Project).
"Kangaroo" pumps and their cylinders are in use in Morogoro, Singida, Shinyanga, Mwanza, Arusha, Dodoma and Tanga Regions.
As was mentioned before, the same cylinders have also been used in the most recently installed "Shinyanga" pumps.

For deeper wells a disadvantage of the "Kangaroo" pump is the fact that the stroke of the pump head decreases as the head on the pump increases, because in the equilibrium state the spring is compressed further, to balance forces. This can be partly remedied by using smaller diameter cylinders, but that cannot be done unlimitedly, and in any case the yield per stroke will decrease for those deeper wells. Also, the maximum force to be exerted on the "Kangaroo" pump is limited to the body weight of the user.
For hand pumps that use the lever principle, the mechanical advantage will generally be a factor 5 to 10, so that - at least in theory - the force exerted on the piston may be several times the body weight of the user of the pump. It is clear that this will be of advantage when the ground water table is low.
For that reason extensive research is being carried out in Morogoro on hand pumps that should - again - require as little maintenance as possible. Experiments are going on with hand pumps there, some of which are imported ones, whereas others have been manufactured in Morogoro. Several types of bearings are being tested: heavy duty (oversized) ball bearings and wooden bearings (oil impregnated). Tests with water lubricated wooden bearings are also foreseen.
One of the pump types that are on test in Morogoro is shown in fig. 3.30.

Fig. 3.25 Kangaroo pump (Morogoro Region)

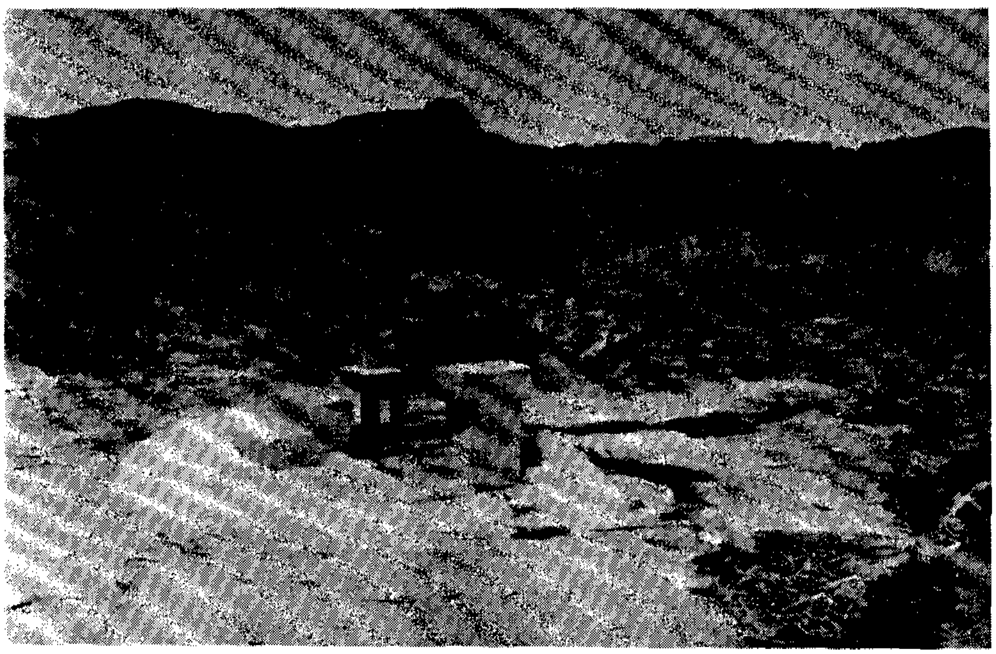

Fig. 3.26 Completed well with Kangaroo pump (Iringa Region)

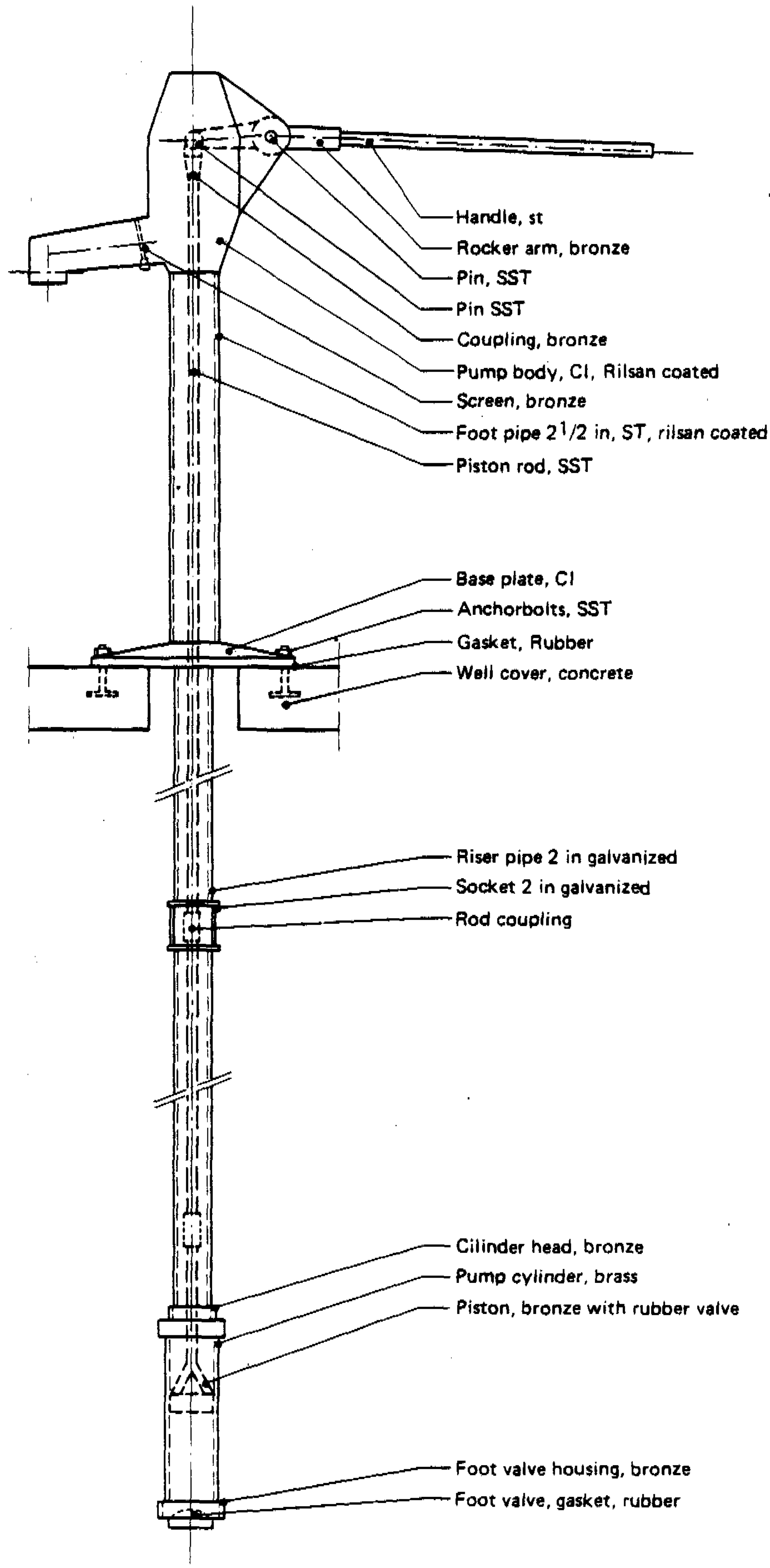

Fig. 3.27 Typical "Nira" pump

The third pump that is widely used, albeit in the Mtwara and Lindi Regions only, is the Finnish "Nira" pump (fig. 3.27.). The first "Nira" pumps to be used were in fact Finnish farm pumps that have proven to be very reliable in Finland. Unfortunately they did not last long under Tanzanian conditions and the Nira pumps that are used at present, are modifications of the original ones. As is the case with the "Kangaroo" and "Morogoro" pumps the "Nira" is continuously being tested and modified.
A completely new design was expected to be realized at the end of 1980. Instead of using (partly) cast iron components, as is the case with the "Nira" pumps so far, the new pump would be entirely built up from sheet metal, welded components, and is expected to be rather similar to the newest "Morogoro" pump designs. The apparent advantage of welded pumps is that they can be easier repaired locally, which is virtually for cast iron pumps.

Fig. 3.28 Installation of Nira pump (Mtwara Region)

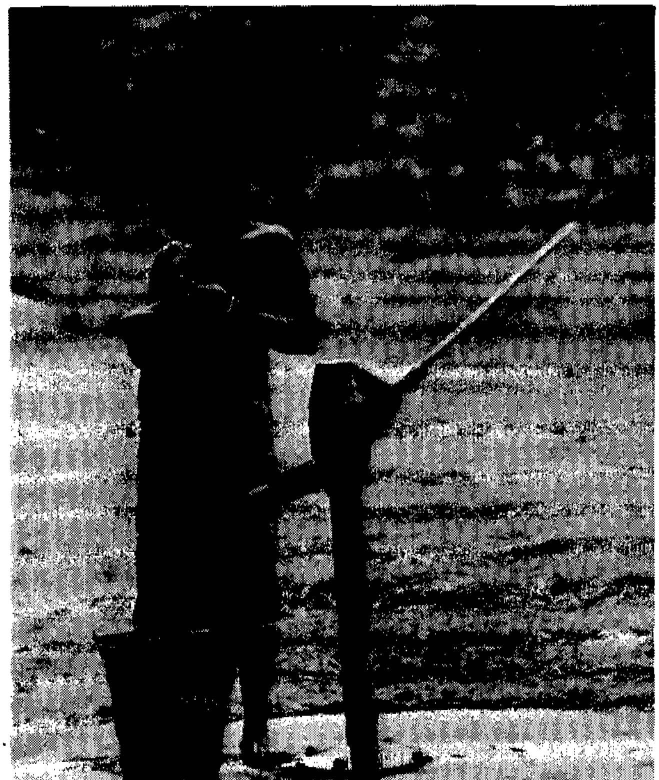

Fig. 3.29 Nira pump on completed well (Mtwara Region)

Recently, and in order to start standardization, or at least interchangeability, of pump components, the Morogoro and Mtwara/Lindi shallow well projects agreed on the following:

- The pump base of the "Nira" pumps (or its successor) will be modified in such a way that its dimensions become identical to that of the "Kangaroo" pump, especially the anchor bolt hole dimensions and locations. As the "Shinyanga" and "Kangaroo" pumps have identical foot plates, this would mean that in practice any of the three pump types could be mounted on the same well.
- Rising mains (connecting the pump superstructure and the pump cylinder) have a regular gas thread connection of 1½" or 2" diameter, in both pumps.
- The pump rod of the "Kangaroo" and "Morogoro" pumps will be adapted in conformity with the "Nira" pump: Ø 10 mm stainless steel rods with long hexagonal couplings (nuts). This would make it possible to use "Nira" pump heads with "Kangaroo" or "Morogoro" cylinders, or vice versa.
- The newest modifications of the "Nira" and "Kangaroo" or "Morogoro" pumps have been exchanged - and will be exchanged in the future when new modifications will have been developed - in order to be tested by the other project, under field conditions. After some time information is to be exchanged about experience with the pumps and recommendations for improvement given.

In fact the above mentioned activities are undertaken while awaiting the formal creation of a Technical Coordination Committee. One of the tasks of such a committee could be to draw up specifications and standards for pumps to be used on shallow wells in Tanzania. It is recommended to limit the number of pumps to be used in Tanzania to the extent possible, for the obvious reason of reducing the diversity in spare parts. The attention should be focused on promising pump types that are already in use or under development in Tanzania (Nira, Kangaroo, Morogoro and Shinyanga pumps) and on promising alternative solutions.

It should be taken into account, however, that pumps that are considered appropriate under the rural water supply conditions of, for instance, India or Bangla Desh are not necessarily suitable for use under Tanzanian rural conditions. The local infrastructure and institutional set-up may be too different for that. In any case the choice should be limited to lift pumps (pump piston below water level).

Possible additional design criteria for handpumps in Tanzania may emerge from the studies and pilot projects on community education and participation that will be carried out by BRALUP and the International Reference Centre on Community Water Supply.

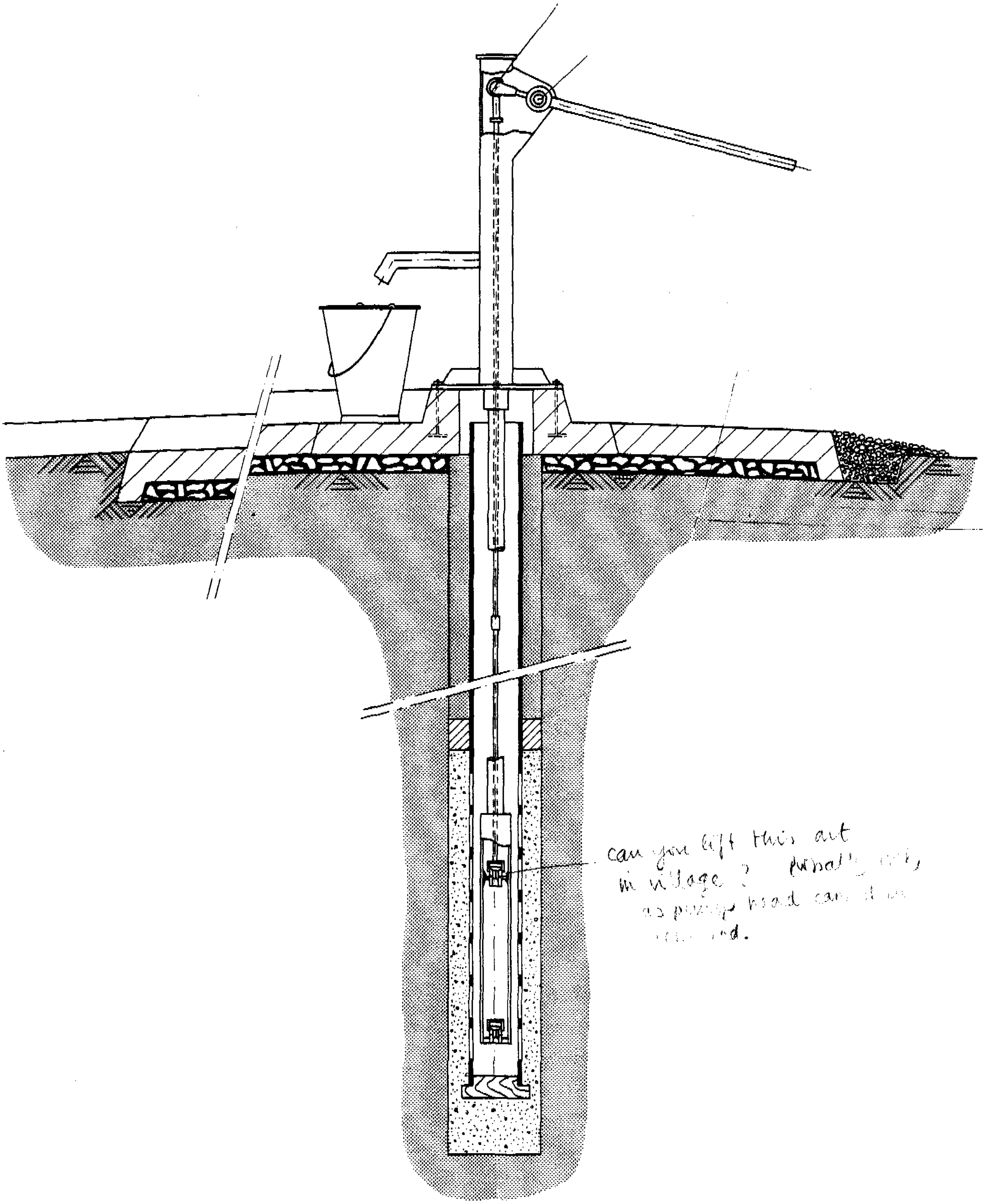

Fig. 3.30 Sketch of Morogoro SWN 80 pump

It is recommended that a TCC sets up procedures for involving the current shallow wells projects in Tanzania in testing and developing pump components. As a first phase the standardization of connections etc. might be realized, so as to facilitate testing out of (new) pump components in pumps that the on-going projects are already familiar with. Later the TCC could give recommendations on pump specifications also to a (shallow wells) procurement agency, when such a body would have been created.

3.7. The organization of a regional shallow wells project

Based on experience with the on-going shallow wells projects, the following organizational options will be worked out:

A. Construction method: hand-drilling

- A.1. Organization is not integrated in the RWE's organization, though administrative links may exist.
- A.2. Organization is integrated in the RWE's organization, but may be based on outside funds and some expatriate staff. To the extent possible the RWE's facilities will be used.

B. Construction method: hand-digging

- B.1. Organization is not integrated (see option A1).
- B.2. Organization is integrated (see option A2).

Of course in practice a combination of hand-drilling and hand-digging may be of advantage in specific cases.

In all cases the target, in number of approved well sites to be found annually, as well as wells to be constructed per year, is assumed to be in the range of 150 to 200 wells for each project.
The well siting capacity of a trained surveyor (with one assistant and a driver) is between 40 and 50 wells per year.
A hand-drilling group, consisting of one foreman, one assistant foreman and about 5 daily paid labourers from the village concerned, can also make about 40 to 50 wells per year.
A hand-dug well construction group, also consisting of one foreman, one assistant foreman and 5 daily paid labourers can make an average of 8 wells per year (approximately 6 weeks required per dug well).

3.7.1. Hand-drilling; separate organizational set-up (option A1)

The organizational set-up includes the following departments:
- Management
- Administration
- Survey
- Construction
- Workshops/Garage
- Stores + Yard

No provisions for a maintenance organization have been included yet, while awaiting the results of studies on community education and participation that are going on.

The set-up of the organization, which is visualized in fig. 3.31., is based on the assumption that the project is fully self sufficient and that it uses a separate compound.

The survey department consists of a staff group and four complete survey groups. Survey groups do not have their own transport, as their area to be covered is fairly limited in size. When required, they are transported by means of the two landrover/trailer combinations that are assigned to the survey department. While in the field, the survey groups either have separate camps (tents) or camps jointly with construction groups.

The construction department consists of a staff group and two units, each unit again having a staff group and two construction groups. On unit level base camps with storage facilities are established in the field. Construction groups either use these camps or separate camps in case the distances between the site and the unit camps increase.
As most of the labourers working at the construction site are villagers, paid on a daily basis, transport requirements are rather limited, and one landrover/trailer combination per unit should be sufficient for transporting the groups, supplemented, when necessary, by the construction manager's landrover. Supply of equipment, materials, pumps etc. from the project compound is the responsibility of the stores + yard department.

Workshops/garage and administration departments take care of repairs of vehicles and equipment and day to day affairs, respectively. One landrover, when necessary supplemented by the project manager's landrover, should be sufficient here.

The stores and yard department has several tasks:
- Supply/storage of equipment and materials. Two trucks are required; one for fetching items from the supplier and one to supply the groups in the field.
- The concrete factory produces the precast well covers/pump stands.
- The yard section employs gatekeepers and watchmen, possibly supplemented with sweepers or other daily-paid staff.

A detailed breakdown of the staff employed is given in table 3.1. (page 52).

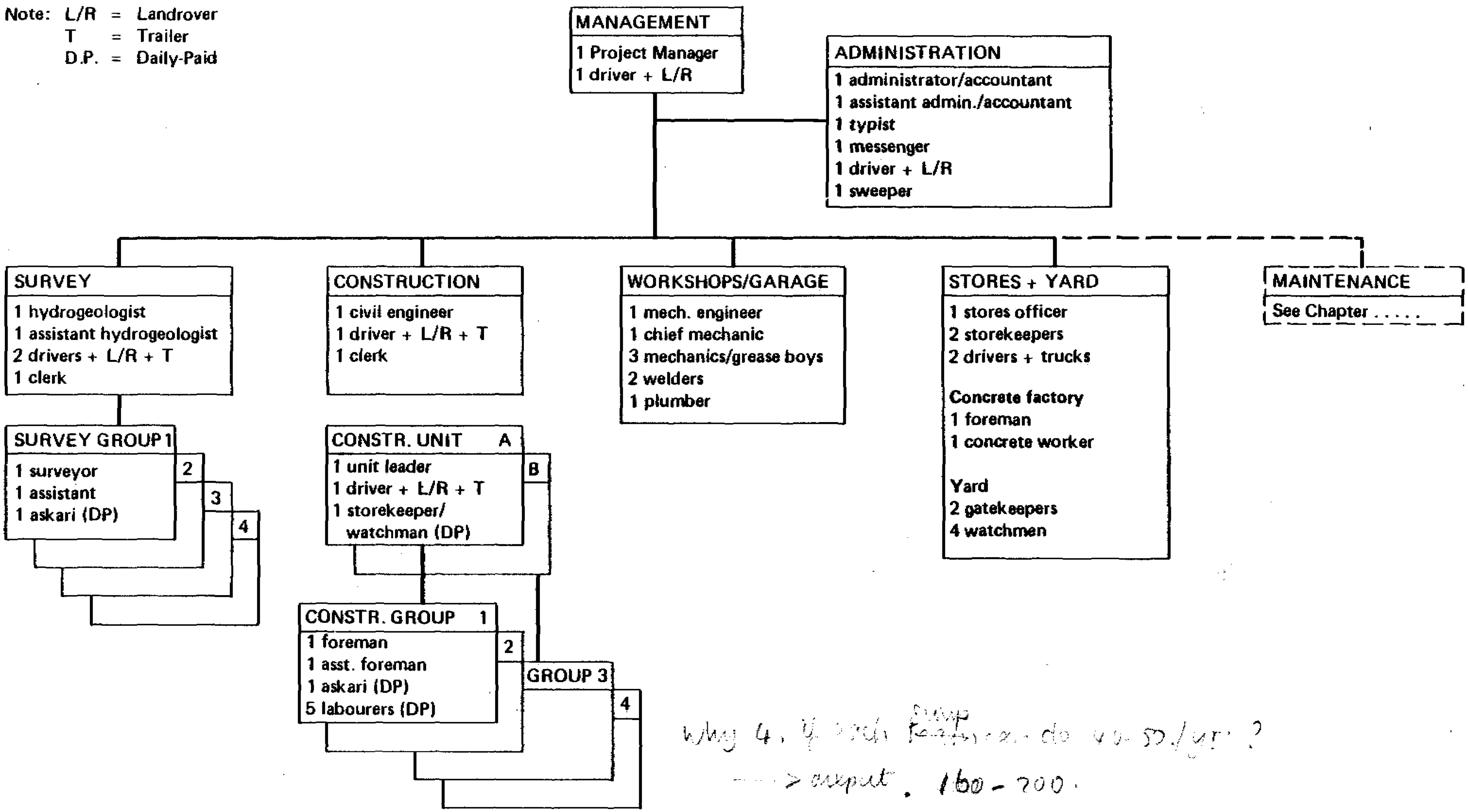

FIG. 3-31; ORGANIZATION SCHEDULE, REGIONAL SHALLOW WELLS PROJECT, OPTION A1
(hand-drilling; separate organization)

3.7.2. Hand-drilling; organization integrated in RWE's organization (option A2)

The organizational set-up includes the following departments in addition to the existing organization of the Regional Water Engineer:

- Management
- Survey
- Construction

The set-up of these departments is identical to that of the independent organization option (A1).

No additional staff is assumed to be required for administration and workshops/garage, while provisions for a maintenance organization have been left out, as in option A1.

It is assumed that offices and storage space are available at the RWE's compound and that no additional staff for these activities is required, except for the following:

- two drivers + trucks for fetching shallow well materials from the suppliers, and supplying them to the units in the field
- a foreman and a concrete worker for manufacturing the concrete pump stands at the RWE's yard

The organizational set-up is shown in fig. 3.32. A breakdown of the staff employed is given in table 3.1.

3.7.3. Hand-dug wells; separate organizational set-up (option B1)

The organizational set-up includes the same departments as in option A1:

- Management
- Administration
- Survey
- Construction
- Workshops/Garage
- Stores + Yard

The management, survey and workshops/garage departments are even identical to those in option A1. The stores and yard department is also almost the same; only the concrete factory has a larger staff now (5 concrete workers and 5 daily paid labourers, instead of 1 concrete worker, apart from the foreman).

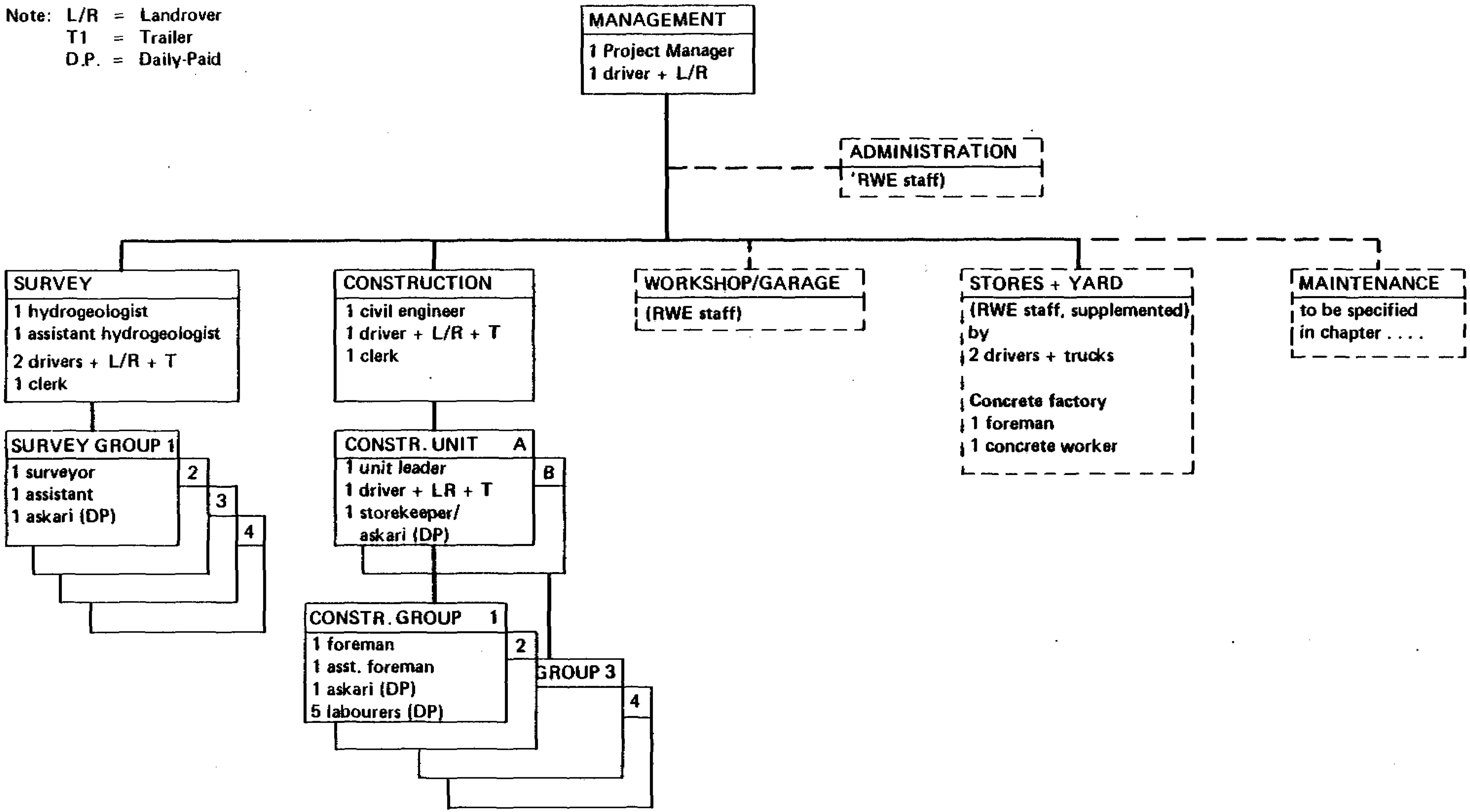

FIG. 3-32; ORGANIZATION SCHEDULE, REGIONAL SHALLOW WELLS PROJECT, OPTION A2
(hand-drilling; organization integrated in RWE's)

There is a large difference in the construction department, however. Although the staff group is identical to that in options A1 and A2, the number of units is increased to four; each unit having a total of not less than 6 construction groups. The large number of construction groups is a result of the much longer construction time per hand-dug well. Again base camps with storage facilities are established in the field, and the construction groups either use these camps or separate camps. The mobility of the groups is much smaller than in the case of hand-drilled wells so one vehicle per unit is considered adequate, even with 6 groups per unit. Because well rings with a weight of 500-1000 kilogrammes have to be transported 7-ton trucks rather than landrovers should be used. The same trucks can be used also to assist the stores department's trucks in transporting concrete well rings and covers from the project compound to the unit camps, if and when required.
The number of staff per construction group is identical to that in options A1 and A2.

The organizational set-up is shown in fig. 3.33., whereas a breakdown of the staff is given in table 3.1.

3.7.4. Hand-dug wells; organization integrated in RWE's organization (option B2)

The organizational set-up resembles that for option A2, with the same modifications as option B1 shows with respect to option A1:
the number of construction units and groups is four and twenty-four, respectively, identical to option B1, and similarly the concrete factory employs a total of eleven people (as in option B1) rather than two (as in options A1 and A2).

The organizational set-up is shown in fig. 3.34., whereas a breakdown of the staff is again given in table 3.1.

3.7.5. Selection of organizational set-up

In selecting the organizational set-up there are two sets of options:
a. separate organization versus organization integrated in RWE's organization
b. hand-drilled shallow wells versus hand-dug shallow wells

The decision to have a separate or integrated organization will depend on recommendations to be made by the Tanzania Water Development Coordination Board, the Ministry of Water and Energy, the National Shallow Wells Coordination Agency to be established, the Technical Coordination Committee to be established, or a combination of those, and may also depend on the preference of the donor organization involved.
Possible advantages and disadvantages have been mentioned in paragraphs 3.4. and 3.5.

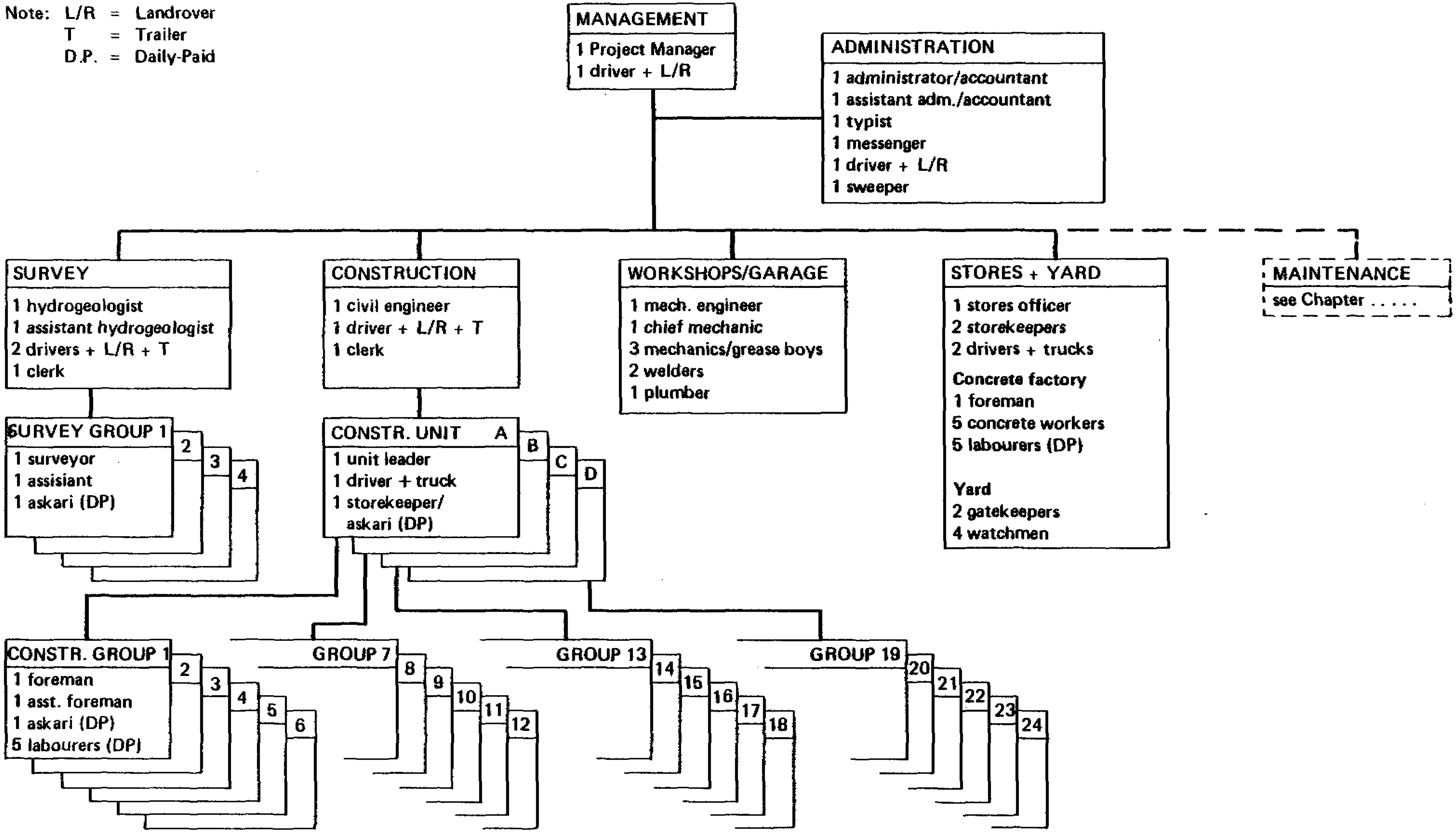

FIG. 3-33; ORGANIZATION SCHEDULE, REGIONAL SHALLOW WELLS PROJECT, OPTION B1
(hand-dug wells; separate organization)

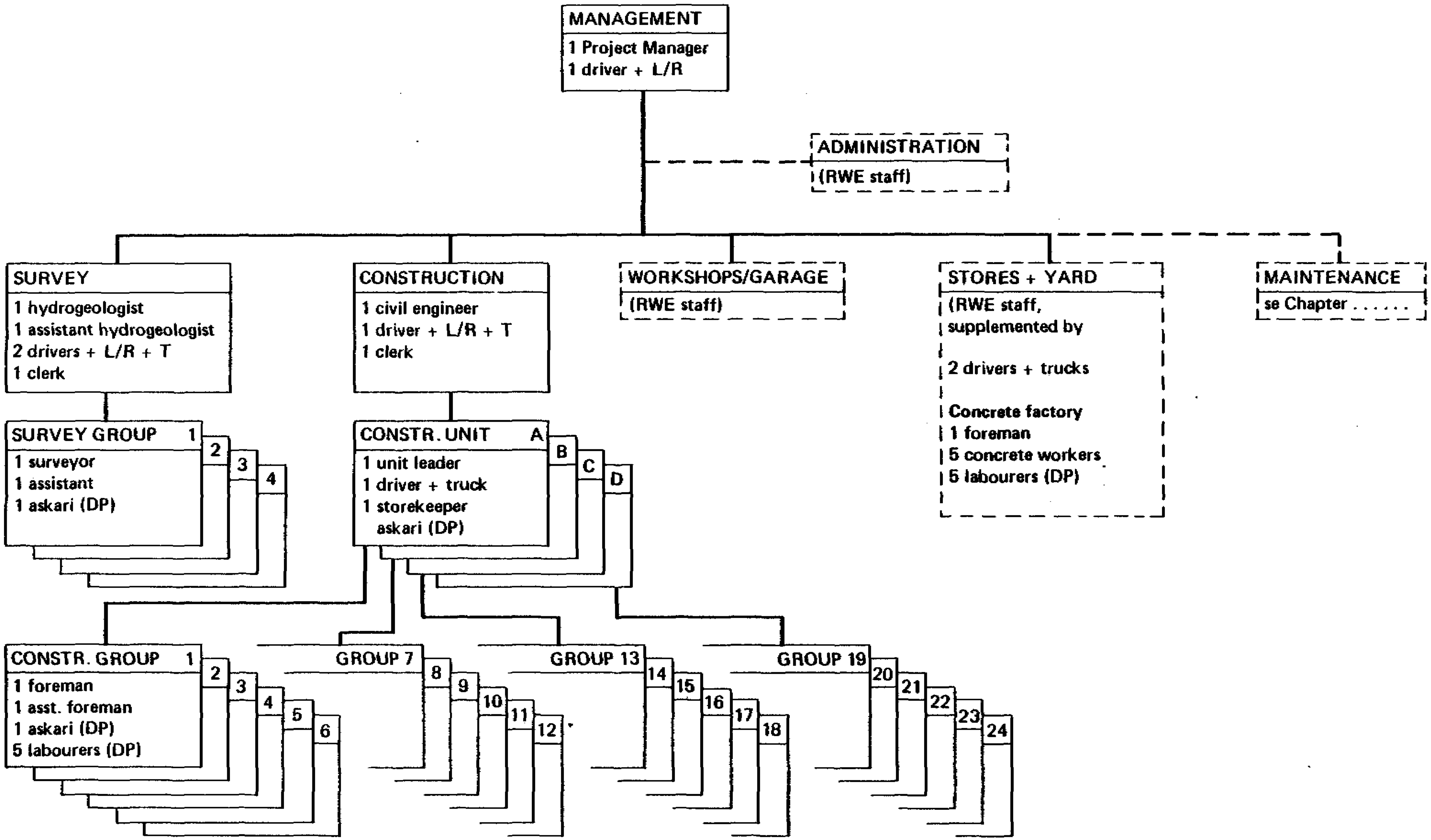

FIG. 3-34; ORGANIZATION SCHEDULE, REGIONAL SHALLOW WELLS PROJECT, OPTION B2
(hand-dug wells; organization integrated in RWE's)

The working method to be selected (hand-drilling or -digging) will most probably depend on recommendations to be made by the TCC, as well as on the aquifer characteristics in the respective Regions. Advantages and disadvantages of the respective methods have been spelled out in paragraph 3.6.3.

An important criterion in selecting the organizational set-up of a regional shallow wells project is the number of shallow wells that could be constructed per Region, as for limited numbers of wells a separate project may not appear appropriate. In this respect there is a definite constraint in that reliable figures on potential numbers of shallow wells are not available for several Regions.
Obtaining insight in the feasibility of shallow wells in those Regions requires time and the availability of geologists or hydrologists that are familiar with shallow wells from their own practical experience. Unfortunately, such experts are limited in number. Some ways will thus have to be found to make use of their experience to the extent possible.

It must be clear that in individual cases the potential number of shallow wells per Region deviates from the assumption used before (1500 to 2000 per Region, or: 150 to 200 per year per Region, for a period of 10 years, up to 1991). The organization will thus have to be adapted. Nevertheless, the options as presented here (A1, A2, B1 and B2) will be worked out, regarding staffing, investments and running costs, and any modified solution can be costed by interpolation of these examples.

3.7.6. Staffing or regional shallow wells project

A summary of the staff required for each of the four organizational options is given in table 3.1. Since regional shallow wells projects are operating in a limited number of Regions only, various projects would have to be built up entirely. In view of the present shortage of trained staff, whereas such staff is essential for the success of any shallow wells project, it will most probably be essential to fill a limited number of posts by expatriate personnel.
The barest minimum of expatriate staff for options A1 and B1 would be three:

- project manager
- hydrogeologist
- construction manager

Most probably, however, it would be more realistic to assume that all posts indicated by an asterix in table 3.1. would initially have to be filled by expatriates. This would mean the following numbers of expatriates (excluding maintenance and "extension" work):
for option A1: a total of 6 expatriates
for option A2: a total of 3 expatriates
for option B1: a total of 6 expatriates
for option B2: a total of 3 expatriates

Table 3.1. - Breakdown of staffing for regional shallow wells project

Department	Function	Number of staff required for hand-drilling: separate organization (A1)	hand-drilling: integrated in RWE (A2)	hand-digging: separate organization (B1)	hand-digging: integrated in RWE (B2)
MANAGEMENT	* Project Manager	1	1	1	1
	Driver + L/R	1	1	1	1
ADMINISTRATION	* Administrator/Accountant	1	-	1	-
	Asst. Administrator/ Accountant	1	-	1	-
	Typist	1	-	1	-
	Driver + L/R	1	-	1	-
	Messenger	1	-	1	-
	Sweeper	1	-	1	-
SURVEY	* Hydrogeologist	1	1	1	1
	Assistant Hydrogeologist	1	1	1	1
	Clerk, Form IV	1	1	1	1
	Driver + L/R + trailer	2	2	2	2
	Surveyor	4	4	4	4
	Assistant Surveyor	4	4	4	4
	Watchman (D.P.)	(4)	(4)	(4)	(4)
CONSTRUCTION	* Civil Engineer/Construction Manager	1	1	1	1
	Clerk, Form IV	1	1	1	1
	Driver + L/R + trailer	1	1	1	1
	Unit Leader, Form IV	2	2	4	4
	Storekeeper/Watchman (D.P.)	(2)	(2)	(4)	(4)
	Driver + L/R + trailer	2	2	-	-
	Driver + truck (7 tons)	-	-	4	4
	Foreman	4	4	24	24
	Assistant Foreman	4	4	24	24
	Labourer (D.P.)	(20)	(20)	(120)	(120)
	Watchman (D.P.)	(4)	(4)	(24)	(24)
WORKSHOPS/GARAGE	* Workshop Manager	1	-	1	-
	Chief Mechanic	1	-	1	-
	Mechanic/Grease boy	3	-	3	-
	Welder	2	-	2	-
	Plumber	1	-	1	-
STORES + YARD	* Stores Officer	1	-	1	-
	Storekeeper	2	-	2	-
	Driver + truck (7 tons)	2	2	2	2
	Foreman (concrete factory)	1	1	1	1
	Concrete worker	1	1	5	5
	Labourer (D.P.)	-	-	(5)	(5)
	Gatekeeper/Watchman	6	-	6	-
TOTALS	Permanent Staff	57	34	105	82
	Staff on daily paid basis	30	30	157	157
GRAND TOTAL	Total staff	87	64	262	239

Note: L/R = landrover
D.P.= daily-paid

Educational requirements for the senior staff (Tanzanian) would be:

Project Manager	-	Water supply engineer with university degree, or WRI alumnus, with managerial skills
Administrator/Accountant	-	Senior accountant/administrator
Hydrogeologist	-	Geologist or hydrologist with university degree
Assistant hydrogeologist	-	Geological assistant, trained by Principal Geologist
Clerk	-	Form IV certificate as a minimum
Surveyor	-	Alumnus of special WRI training course in shallow well survey
Construction Manager	-	University graduate or diploma holder in civil engineering; very promising WRI (regular course) alumnus
Clerk	-	Form IV certificate as a minimum
Unit Leader	-	Form IV certificate (minimum); preferably alumnus of WRI course in shallow well construction, with managerial skills
Foreman	-	Alumnus of WRI course for well sinkers; alternatively: trained on-the-job
Assistant Foreman	-	Trained on-the-job
Workshop Manager	-	Mechanical Engineer, or Senior Mechanic with managerial skills
Chief Mechanic	-	Senior Mechanic (Grade I)
Stores Officer	-	Form IV (minimum) with technical insight and feeling for accuracy; preferably with engineering background and/or special training in storekeeping and supply matters

3.8. Costs

Investment and recurrent costs for the organizational options A1, A2, B1 and B2 will be determined, based on an output of 200 wells per project and per year. The basis for calculation of the various costs will be given in the next paragraphs. Investment costs and recurrent costs are summarized in tables 3.14. and 3.15, respectively.

3.8.1. Personnel

The staff composition as given in table 3.1. is used as basis for the calculation. The following (rounded) monthly salary figures have been used, based on an entirely Tanzanian staff.

TAS 4,000 per month :	Project Manager
TAS 3,000 per month :	Administrator/Accountant; Hydrogeologist; Construction Manager
TAS 2,500 per month :	Asst. Admin./Accountant; Workshop Manager; Stores Officer
TAS 1,200 per month :	Assistant Hydrogeologist, Unit Leader, Chief Mechanic
TAS 800 per month :	Surveyor; Storekeeper (yard)
TAS 700 per month :	Foreman (construction); Foreman (concrete factory); Welder; Plumber
TAS 600 per month :	Driver; Typist; Clerk; Assistant Surveyor; Assistant Foreman; Mechanic/Greaseboy; Gatekeeper/Watchman; Watchman (D.P.)
TAS 500 per month :	Messenger; Sweeper; Concrete Worker; Labourer (D.P.)

Annual salary costs, including holiday allowances, are assumed to be equal to 13 months' salary, with the exception of daily paid labourers, for whom 12 months' salary will be taken into account.

Nights-out allowances have been taken into account only for staff that is regularly in the field and to the following monthly maxima:

maximum monthly nights-out allowances:

TAS 1000 :	Hydrogeologist; Construction Manager
TAS 700 :	Asst. Hydrogeologist; Unit Leader
TAS 400 :	Driver; Surveyor; Asst. Surveyor; Foreman (construction); Asst. Foreman (construction)

Table 3.2. shows the build-up of the annual salary costs calculation.

Table 3.2. - Annual salary costs (TAS)

	Department	Salaries	Wages (D.P.)	Nights-out	Grand total
OPTION A1	Management	4,600	-	-	
	Administration	7,700	-	-	
	Survey	11,600	2,400	5,700	
	Construction	13,000	13,600	6,800	
	Workshops/Garage	7,600	-	-	
	Stores + Yard	10,100	-	-	
	Monthly totals	54,600	16,000	12,500	
	Annual costs	709,800	192,000	150,000	1,051,800
OPTION A2	Management	4,600	-	-	
	Administration	-	-	-	
	Survey	11,600	2,400	5,700	
	Construction	13,000	13,600	6,800	
	Workshops/Garage	-	-	-	
	Stores + Yard	2,400	-	-	
	Monthly totals	31,600	16,000	12,500	
	Annual costs	410,800	192,000	150,000	752,800
OPTION B1	Management	4,600	-	-	
	Administration	7,700	-	-	
	Survey	11,600	2,400	5,700	
	Construction	42,600	76,800	25,000	
	Workshops/Garage	7,600	-	-	
	Stores + Yard	12,100	2,500	-	
	Monthly totals	86,200	81,700	30,700	
	Annual costs	1,120,600	980,400	368,400	2,469,400
OPTION B2	Management	4,600	-	-	
	Administration	-	-	-	
	Survey	11,600	2,400	5,700	
	Construction	42,600	76,800	25,000	
	Workshops/Garage	-	-	-	
	Stores + Yard	4,400	2,500	-	
	Monthly totals	63,200	81,700	30,700	
	Annual costs	821,600	980,400	368,400	2,170,400

3.8.2. Vehicles

Table 3.3. shows the investment costs on vehicles for the four options. Annual costs have been calculated, based on the following assumptions:
Technical lifetime of a truck : 100,000 km.
Technical lifetime of a landrover : 120,000 km.
Landrovers cover an average of 40,000 km per annum. Hence: depreciated (without interest) in 2½ years.
A truck covers 25,000 km per annum in a hand-drilled wells project and 30,000 km (much increased transport because of concrete rings) for dug wells projects. The technical lifetime, therefore, equals 4 years and 3.33 years, respectively.

Fuel used is diesel for trucks; petrol for landrovers.
Running costs, including fuel, oil, grease, tyres, batteries, small repairs, registration and insurance, are TAS 4.- per kilometre, for landrovers and trucks alike.

A summary of the annual kilometrage, depreciation and running costs is given in table 3.4.

Table 3.3. - Investment costs (Vehicles)

Vehicle	Destination	Investment cost (TAS) for option A1	A2	B1	B2
1 LR	Project Manager	125,000	125,000	125,000	125,000
2 LR + trailers	Hydrogeologist + Asst.	330,000	330,000	330,000	330,000
1 LR + trailer	Construction Manager	165,000	165,000	165,000	165,000
2 LR + trailers	Unit leaders	330,000	330,000	-	-
4 trucks (7 t.)	Unit leaders	-	-	800,000	800,000
2 trucks (7 t.)	Stores Officer	400,000	400,000	400,000	400,000
1 LR	Administrator	125,000	-	125,000	-
spares (10%)	-	150,000	150,000	200,000	200,000
	Total	1,625,000	1,500,000	2,145,000	2,020,000

Table 3.4. - Annual costs (Vehicles)

	Total annual costs (vehicles) for option:							
	N° of veh.	A1 (TAS)	N° of veh.	A2 (TAS)	N° of veh.	B1 (TAS)	N° of veh.	B2 (TAS)
Landrover (40,000 km/year)	7	560,000	6	480,000	5	400,000	4	320,000
Truck (25,000 km/year)	2	100,000	2	100,000	-	-	-	-
Truck (30,000 km/year)	-	-	-	-	6	360,000	6	360,000
Total running costs		660,000		580,000		760,000		680,000
Depreciation:								
Landrovers		358,400		316,700		248,400		206,700
Trucks		100,000		100,000		360,000		360,000
Spareparts		45,900		41,700		60,900		56,700
Total annual costs		1,164,300		1,038,400		1,429,300		1,303,400

3.8.3. Offices, buildings and office equipment

Included are: offices, workshop, garage, stores and concrete factory (concrete rings, covers and pump stand production). Tables 3.5. and 3.6. show the sizes and costs involved for all four options. In options A2 and B2 it is assumed that some offices and office space can be made available by the RWE, but that additional construction work is required. Investment costs are thus taken at 50% of those of options A1 and B1, with the exception of the concrete factory. This is assumed to be paid entirely also in option B2. Land acquisition costs are not included in the cost estimate.

Investment costs for office equipment are identical for all four options.

Annual costs (see table 3.7.) have been based on:
- depreciation of offices and buildings: 30 years (no interest)
- maintenance and repair costs of these : 1% of investment costs, per year
- depreciation of office equipment : 5 years (no interest)

Fig. 3.35 All-wheel drive for vehicles is necessary

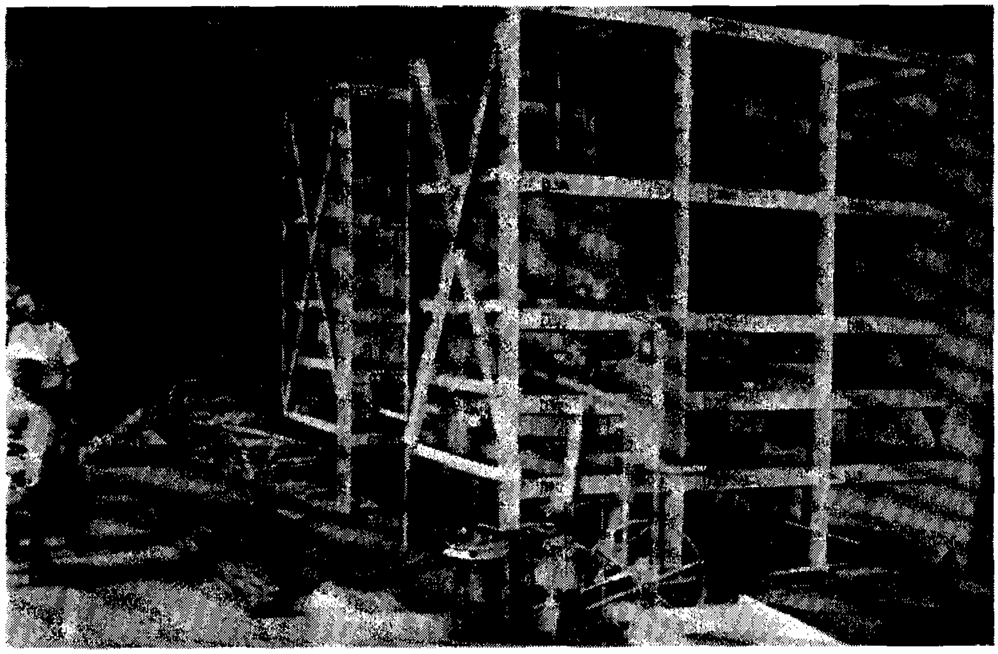

Fig. 3.36 Storage of construction materials and equipment

- office costs (water, electricity, telephone, stationery):
  . TAS 50,000 per year for options A1 and B1 (independent organizations)
  . TAS 25,000 per year for options A2 and B2 (integrated organizations)

Table 3.5. - Investment costs (offices, buildings)

Buildings		Unit Cost	Destination	Investment costs (TAS) for option A1	A2	B1	B2
Office	(30 m^2)	TAS 3000/m^2	Project Man. + Constr. Man.	90,000	45,000	90,000	45,000
Office	(30 m^2)	TAS 3000/m^2	Hydrogeologist	90,000	90,000	90,000	90,000
Office	(30 m^2)	TAS 3000/m^2	Administrator	90,000	-	90,000	-
Office	(30 m^2)	TAS 3000/m^2	Stores Officer	90,000	45,000	90,000	45,000
Workshop	(100 m^2)	TAS 2000/m^2	Workshop Manager	200,000	100,000	200,000	100,000
Garage	(100 m^2)	TAS 2000/m^2	Workshop Manager	200,000	100,000	200,000	100,000
Stores	(150 m^2)	TAS 2000/m^2	Stores Manager	300,000	150,000	300,000	150,000
Concrete factory	(200 m^2)	TAS 500/m^2	Stores Manager	-	-	100,000	100,000
Total investments				1,060,000	530,000	1,160,000	630,000

Table 3.6. - Equipment costs (offices, buildings)

Description	Destination	Investment costs (TAS) for option A1	A2	B1	B2
Office equipment	Project Manager/ Constr. Manager	5,000	5,000	5,000	5,000
Office equipment	Hydrogeologist	10,000	10,000	10,000	10,000
Office equipment	Administrator	20,000	20,000	20,000	20,000
Office equipment	Stores Officer	5,000	5,000	5,000	5,000
Total investment costs (office equipment)		40,000	40,000	40,000	40,000

Table 3.7. - Annual costs (offices, office equipment, buildings)

	Costs (TAS) for option:			
	A1	A2	B1	B2
Investment costs offices and buildings	1,060,000	530,000	1,160,000	630,000
Depreciation period (years)	(30)	(30)	(30)	(30)
Investment costs office equipment	40,000	40,000	40,000	40,000
Depreciation period (years)	(5)	(5)	(5)	(5)
Annual costs:				
Depreciation of offices and buildings	35,400	17,700	38,700	21,000
Maintenance and repairs (1% of investments)	10,600	5,300	11,600	6,300
Depreciation of office equipment	8,000	8,000	8,000	8,000
Overhead + running costs office	50,000	25,000	50,000	25,000
Total annual costs	104,000	56,000	108,300	60,300

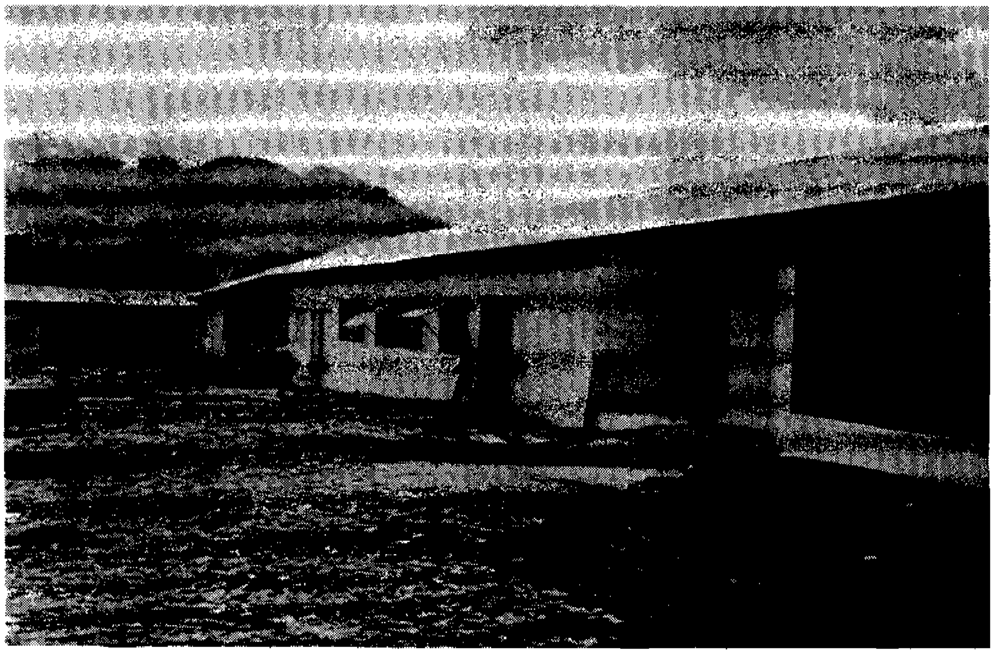

Fig. 3.37 Storage and garage for shallow wells project (Morogoro Region)

3.8.4. Technical equipment

Included are:

- workshop equipment (drilling machine, welding equipment, pipe threading equipment), hacksaw, miscellaneous tools)
- garage equipment (lubricating/greasing equipment, engine tuning set, type repair set, compressor, battery charger, miscellaneous tools)
- stores facilities (racks, cupboards, etc.)
- concrete factory facilities (moulds for well rings, covers, pump stands; concrete mixer)
- survey equipment (hand-drilling set) for all options
- construction equipment (hand-drilling) for options A1 and A2
- construction equipment (hand-digging) for options B1 and B2

Workshop outfit, garage outfit and stores facilities are the same for hand-drilling and hand-digging. It is assumed that in the options with an integrated organization (A2 and B2) part of the required equipment is already available with the RWE. For these options the required investment costs have thus been reduced to 50 percent.
The equipment for the concrete factory is assumed not to be available with the RWE. Investment costs for options A1 and A2 will thus be the same, as is the case for options B1 and B2.
In options A1 and A2 only a light mould for concrete pump stands is required, whereas in options B1 and B2 much higher investments are necessary because of the expensive well ring and cover moulds.

Breakdowns of the costs of survey and construction equipment are given in tables 3.8. through 3.10. Overall investment costs for technical equipment are given in table 3.11.

Tabel 3.8. - Investment cost survey equipment

Description	Investment costs
Light drilling set Ø 100/70 mm	TAS 16,500
Heavy drilling set Ø 100/70 mm	TAS 9,500
Casing set Ø 90/76 mm	TAS 16,500
Test pump set	TAS 3,500
Instruments	TAS 6,000
Camping equipment	TAS 5,000
Contingencies/Miscellaneous equipment	TAS 3,000
Total	TAS 60,000

Table 3.9. - Investment cost construction equipment (hand-drilling)

Description	Investment costs
Hand-drilling set Ø 230/180 mm	TAS 36,000
Casing set Ø 225/200 mm	TAS 65,000
Tripod + winch	TAS 14,000
Dewatering pump set	TAS 10,000
Camping equipment	TAS 10,000
Miscellaneous tools + contingencies	TAS 15,000
Total	TAS 150,000

Table 3.10. - Investment cost construction equipment (hand-digging)

Description	Investment costs
Tripod + winch	TAS 14,000
Diesel generator (3 KVA)	TAS 36,000
Electrical pump (~ 20 m^3/hr)	TAS 10,000
Dewatering hand pump set	TAS 10,000
Electrical breakhammer	TAS 26,000
Camping equipment	TAS 10,000
Miscellaneous tools, cable, hose + contingencies	TAS 24,000
Total	TAS 130,000

Table 3.11. - Investment costs (technical equipment)

Description	Destination	Investment costs (TAS) for option A1	A2	B1	B2
Survey equipment	Survey group (4x)	240,000	240,000	240,000	240,000
Construction equipment (hand-drilling)	Constr.group (4x)	600,000	600,000	-	-
Construction equipment (hand-digging)	Constr.group (24x)	-	-	3,120,000	3,120,000
Workshop equipment	Workshop	100,000	50,000	100,000	50,000
Garage equipment	Garage	60,000	30,000	60,000	30,000
Stores facilities	Stores/yard	20,000	10,000	20,000	10,000
Concrete factory	Stores/yard	20,000	20,000	120,000	120,000
Contingencies	-	20,000	10,000	20,000	10,000
	Total costs	1,060,000	960,000	3,680,000	3,580,000

Annual costs related to the technical equipment are shown in table 3.12. They are based on the following assumptions:

- survey equipment is written off after 100 approved well sites. With an average of 40 approved wells per survey group and per year, the depreciation period is thus 2½ years
- hand-drilling equipment (construction) is also written off after 100 constructed wells; again the average production rate is 40 wells per year, resulting in a depreciation period of 2½ years
- the hand-dug construction equipment is written off in 3 years
- the depreciation period of the workshop outfit, the garage outfit and stores facilities is assumed to be 5 years
- the depreciation period for concrete factory equipment is 3 years in the case of hand-drilled wells and 10 years for hand-dug wells construction

Table 3.12. - Annual costs (technical equipment)

	Costs (TAS) for option A1	A2	B1	B2
Depreciation costs:				
- survey equipment	96,000	96,000	96,000	96,000
- hand-drilling equipment	240,000	240,000	-	-
- hand-digging equipment	-	-	1,040,000	1,040,000
- workshop/garage/stores equipment	36,000	18,000	36,000	18,000
- concrete factory	6,500	6,500	12,000	12,000
Total costs	378,500	360,500	1,184,000	1,166,000

3.8.5. Material costs per well

The costs of materials used for constructing the wells and hand pumps are shown in table 3.13. They are based on an average well depth of 8 metres.

Table 3.13. - Material costs per well

	Costs (TAS) for option A1	A2	B1	B2
Hand pump assembly	5,200	5,200	5,200	5,200
Casing and fitter pipe (PVC)	1,800	1,800	-	-
Pump stand and slab	1,000	1,000	-	-
Rings, pump stand and slab	-	-	6,500	6,500
Fuel/lubrication (generator, breakhammer, etc.)	-	-	1,600	1,600
Breakhammer chisels, cable, hose, etc.	-	-	800	800
Replacement of small tools	200	200	200	200
Total material costs	8,200	8,200	14,300	14,300

The material costs given in table 3.13. are based on the following assumptions:

pump head	TAS 2,500 each
pump cylinder	TAS 1,600 each
stainless steel pump rod	TAS 550 (6 m total length)

ABS riser	TAS	550 (6 m total length)
PVC filterpipe Ø 110/103 mm	TAS	800 (3 m length)
PVC pipe Ø 110/103 mm	TAS	1,000 (5 m length)

Number of bags of cement per well:
7 bags for drilled wells
45 bags for hand-dug wells of 8 m depth
Generator:
used for 8 hours per day during half the construction period of 1.5 months, or: 3 weeks x 5 days x 8 hours = 120 hours.
The fuel consumption equals 3 kVA (or: 6 gross HP) at 200 gr/HP/hr = 1.2 kg/hr = 1.5 l/hr, or: TAS 1,450 per well. For lubrication add 10%, resulting in total fuel/lubrication costs of TAS 1,600 per well.

3.8.6. Summary of costs

A. Investment costs:

Table 3.14. shows the investments required for a regional shallow wells project, based on the data given in tables 3.3., 3.5., 3.6. and 3.11.

Table 3.14. - Summary of investment costs

Description	for details see table	Investment costs (TAS) for option A1	A2	B1	B2
Offices and buildings	3.5	1,060,000	530,000	1,160,000	630,000
Office equipment	3.6	40,000	40,000	40,000	40,000
Vehicles	3.3	1,625,000	1,500,000	2,145,000	2,020,000
Technical equipment	3.11	1,060,000	960,000	3,680,000	3,580,000
Total investments		3,785,000	3,030,000	7,025,000	6,270,000

B. Annual costs:

A summary of the annual costs, including depreciation of investments, but discounting any interest payable, is given in table 3.15.
Taking into account the cost of materials per well as shown in table 3.13., and assuming a production of 200 wells per year per project, the cost of a well is calculated, as is the cost per consumer (based on an average of 300 consumers per well).

Table 3.15. - Calculation of annual costs and costs per well or consumer (no interest payable)

Description	For details see table	Costs (TAS) for option A1	A2	B1	B2
1. Annual salary costs	3.2	1,051,800	752,800	2,469,400	2,170,400
2. Annual cost vehicles	3.4	1,164,300	1,038,400	1,429,300	1,303,400
3. Annual cost office, office equipment and buildings	3.7	104,000	56,000	108,300	60,300
4. Annual cost technical equipment	3.12	378,500	360,500	1,184,000	1,166,000
Sub totals		2,698,600	2,207,700	5,191,000	4,700,100
5. Material costs (200x)	3.13	1,640,000	1,640,000	2,860,000	2,860,000
Sub totals		4,338,600	3,847,700	8,051,000	7,560,100
6. Contingencies: add 5%		216,900	192,400	402,600	378,000
Total annual costs		4,555,500	4,040,100	8,453,600	7,938,100
Average cost per well (rounded)		22,800	20,200	42,300	39,700
Average cost per consumer		76	67	141	132

In the calculation of annual costs so far no interest payable has been taken into account. More than 80 percent of all development costs for rural water supply in Tanzania are made available by donor agencies and are generally grants or, sometimes, soft loans.
Moreover, it is not common in Tanzania Government practice to include interest in the cost calculation of water supply works, nor is depreciation taken into account as a rule.

Therefore, the calculation as shown in table 3.15. may be realistic. Nevertheless, interest rates (payable) of 2.5, 5, 7.5, 10 and 15 percent (per annum) have been used for alternative calculations. The results are given in tables 3.15A through 3.15E.

The resulting total costs per well and per consumer are shown in Fig. 3.38. It is clear, from this figure, that the interest payable does not significantly change these costs. This was to be expected, since a large proportion of the costs per well is built up of running costs that are not subject to depreciation at a certain interest rate: salary costs, vehicle running costs and construction materials (see also table 3.16.).

It is emphasized here that some costs have not been included in the calculation, because they would vary too much from one Region to the other. These include:

- cost of land acquisition
- staff housing
- cost of expatriate staff (if necessary)

Generally it will be possible to have land made available for building a project yard, without cost, and certainly in the case of an integrated organization (options A2 and B2) there should not be any costs involved in land acquisition.
In case the separate organizational set-up (option A1 or B1) is selected, total land requirements will amount to some 6000 square meters for option B1, and some 5000 square meters for option A1, because of the much smaller area required for the concrete factory. For option B2 an area of approximately 1300 square metres is required for the concrete factory and well rings storage.

No provisions for staff housing have been taken into account. Firstly, they may not be required in case local staff of a sufficient level would be available, and, secondly, staff houses may be available locally.

By far the greatest influence on annual costs would be caused by hiring expatriate staff.
Even if the number of expatriate staff members would be limited to six, as indicated in paragraph 3.7.6., the cost of hiring qualified and experienced expatriate staff and providing living quarters for them could easily mean adding annual costs of TAS 2.5 million to TAS 5 million, or: an increase of the costs per well with between 30 and 100 percent. This illustrates the need to have trained Tanzanian staff take over as soon as possible.
It must be emphasized, however, that any transfer of duties to Tanzanian staff that is not (yet) qualified for the job, will backfire: salary costs may indeed be reduced, but the output of the project might suffer so much, that in the end the costs per well are even higher instead of lower. The training of Tanzanian staff with the right professional background should, therefore, be given highest priority.

Table 3.15A - Annual costs etc. at 2.5% annual interest

Description	A1	A2	B1	B2
1. Annual salary cost	1,051,800	752,800	2,469,400	2,170,400
2. Annual cost vehicles	1,185,300	1,057,600	1,457,000	1,329,500
3. Annual cost office, buildings, etc.	119,400	63,900	125,100	69,700
4. Annual cost technical equipment	392,200	373,100	1,305,900	1,286,800
5. Material costs	1,640,000	1,640,000	2,860,000	2,860,000
Sub total	4,388,700	3,887,400	8,217,400	7,716,400
6. Contingencies: add 5%	219,400	194,400	410,900	385,800
Total annual costs	4,608,100	4,081,800	8,628,300	8,102,200
Average cost per well (rounded)	23,000	20,400	43,150	40,500
Average cost per consumer	77	68	144	135

Table 3.15B - Annual costs etc. at 5% annual interest

Description	A1	A2	B1	B2
1. Annual salary cost	1,051,800	752,800	2,469,400	2,170,400
2. Annual cost vehicles	1,207,000	1,077,600	1,485,600	1,356,100
3. Annual cost office, buildings, etc.	138,000	73,600	145,500	81,000
4. Annual cost technical equipment	406,100	385,700	1,357,300	1,336,900
5. Material costs	1,640,000	1,640,000	2,860,000	2,860,000
Sub total	4,442,100	3,929,700	8,317,800	7,804,400
6. Contingencies: add 5%	222,100	196,500	415,900	390,200
Total annual costs	4,664,200	4,126,200	8,733,700	8,194,600
Average cost per well (rounded)	23,300	20,600	43,700	41,000
Average cost per consumer	78	69	146	137

Table 3.15C - Annual costs etc. at 7.5% annual interest

Description	A1	A2	B1	B2
1. Annual salary cost	1,051,800	752,800	2,469,400	2,170,400
2. Annual cost vehicles	1,229,200	1,097,900	1,514,900	1,383,500
3. Annual cost office, buildings, etc.	159,200	54,200	168,600	93,900
4. Annual cost technical equipment	420,300	398,600	1,410,000	1,388,300
5. Material costs	1,640,000	1,640,000	2,860,000	2,860,000
Sub total	4,499,700	3,943,500	8,422,900	7,896,100
6. Contingencies: add 5%	225,000	197,200	421,200	394,800
Total annual costs	4,724,700	4,140,700	8,844,100	8,290,900
Average cost per well (rounded)	23,600	20,700	44,300	41,500
Average cost per consumer	79	69	148	138

Table 3.15D - Annual costs etc. at 10% annual interest

Description	A1	A2	B1	B2
1. Annual salary cost	1,051,800	752,800	2,469,400	2,170,400
2. Annual cost vehicles	1,251,900	1,118,700	1,544,700	1,411,400
3. Annual cost office, buildings, etc.	187,500	96,400	194,000	107,900
4. Annual cost technical equipment	434,700	411,800	1,463,700	1,440,800
5. Material costs	1,640,000	1,640,000	2,860,000	2,860,000
Sub total	4,565,100	4,019,700	8,531,800	7,990,500
6. Contingencies: add 5%	228,300	201,000	426,600	399,600
Total annual costs	4,793,400	4,220,700	8,958,400	8,390,100
Average cost per well (rounded)	24,000	21,100	44,800	42,000
Average cost per consumer	80	71	150	140

Table 3.15E - Annual costs etc. at 15% annual interest

Description	A1	A2	B1	B2
1. Annual salary cost	1,051,400	752,800	2,469,400	2,170,400
2. Annual cost vehicles	1,229,000	1,161,800	1,606,700	1,469,500
3. Annual cost office, buildings, etc.	232,900	122,200	249,100	138,400
4. Annual cost technical equipment	464,700	439,000	1,575,100	1,549,000
5. Material costs	1,640,000	1,640,000	2,860,000	2,860,000
Sub total	4,687,600	4,115,800	8,760,300	8,187,300
6. Contingencies: add 5%	234,400	205,800	438,000	409,400
Total annual costs	4,922,000	4,321,600	9,198,300	8,596,700
Average cost per well (rounded)	24,600	21,600	46,000	43,000
Average cost per consumer	82	72	154	144

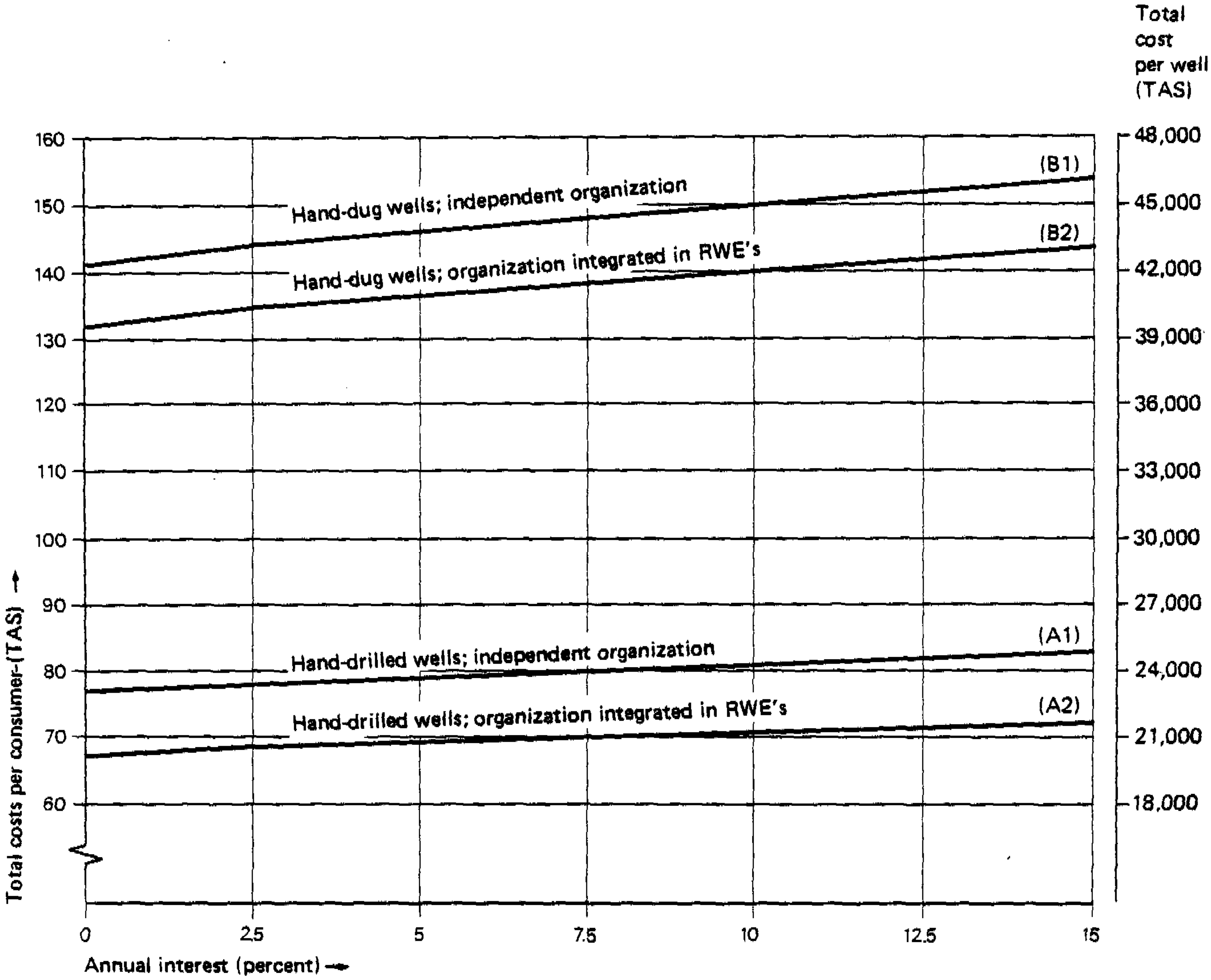

Fig. 3.38 Influence of interest payable, on costs per well/per consumer

For cash flow calculations not the annual total costs but the recurrent expenditures are important. They are shown in table 3.16.

Table 3.16. - Annual recurrent expenditures (TAS)

Description	Costs (TAS) for option: A1	A2	B1	B2
Personnel (salaries)	1,051,800	752,800	2,469,400	2,170,400
Running cost vehicles	660,000	580,000	760,000	680,000
Running cost offices	60,600	30,300	61,600	31,300
Materials for construction	1,640,000	1,640,000	2,860,000	2,860,000
Sub total	3,412,000	3,003,100	6,151,000	5,741,700
Add 5% contingencies	170,600	150,200	307,600	287,100
Total recurrent costs	3,583,000	3,153,300	6,458,600	6,028,800
Ditto per well	18,000	15,800	32,300	30,200
Ditto, percentage of total annual costs	79%	78%	76%	76%

3.8.7. Conclusions

The cost figures given in the preceeding paragraphs are costs at the April 1981 level, based on experience with current shallow well projects in Tanzania.
As such they are realistic costs. If any, the costs quoted for the options with an integrated organizational set-up may be somewhat underestimated, especially if in practice the Regional Water Engineer cannot make available the services of an administration and stores/yard department and/or when offices etc. are not available at the RWE compound.
Even if these services and facilities could be made available the difference between the independent and integrated organizations, in terms of total costs per well, is rather limited:
11% difference in costs per well between options A1 and A2 (0% interest)
6% difference in costs per well between options B1 and B2 (0% interest)

In case interest payable on investments is taken into account, the differences will be reduced even further.
The financial advantage of integrating the shallow wells inplementation in the RWE's organization is thus not very large. On the other hand the disadvantages of such an integrated approach (see paragraph 3.4.) are clear in that they delete the options of having the wells construction carried out by an independent body or having the entire shallow wells implementation work done by a parastatal organization.
It is, therefore, recommended to select options A1 or B1, rather than A2 or B2.

Tables 3.15. through 3.15E clearly show that making hand-dug wells is approximately twice as expensive as making hand-drilled wells. Every component of the annual costs is more expensive for hand-digging, be it salary costs, vehicle costs, office costs, cost of technical equipment or cost of material per well.
Investments are also about two times as high for hand-dug wells (table 3.14.).
When also the facts are taken into account that the hand-dug wells options (B1 and B2) require much more construction personnel, that should also be relatively more experienced than for hand-drilling (because of the heavy concrete rings to be handled), whereas there are about 24 diesel generating sets to be kept in running condition (fuel, spare-parts, repairs) it may be clear that generally hand-drilling shallow wells is to be preferred over hand-digging.
Only in case the aquifer characteristics are so poor that storage of water in the well itself is essential, should hand-dug wells be constructed, preferably as a complementary activity in a hand-drilled wells construction project.

If it is assumed that shallow wells projects of the size indicated in the preceeding paragraphs can be established in each Tanzanian Region (which, most probably, is not the case but has to be checked thoroughly) the total initial investment costs (based on option A1) would be approximately 20 x TAS 3.8 million, or: TAS 76 million for Tanzania as a whole. Of course such initial investments are not required for the on-going shallow wells projects, so that the actual total initial investment costs might be around TAS 55 million.
Various investments have to be repeated at intervals between 2½ years (e.g. hand-drilling equipment) and 10 years (moulds for concrete factory for instance) resulting in an average reservation of TAS 1 million per project and per year for reinvestments, or: TAS 20 million per year in all.
Recurrent expenditures furthermore amount to some TAS 3.6 million per project, or: TAS 72 million per year for Tanzania as a whole, resulting in total annual reinvestment and running costs of some TAS 92 million for the whole country.
In recent years the development budget for rural water supply of the Ministry of Water and Energy has been around TAS 200 million per year. Spending approximately half that amount per year for providing half of Tanzania's rural population with water within 10 years should thus be well within Tanzania's financial capabilities.

initial investment

annual reinvestment

3.9. Summary and recommendations

3.9.1. Summary

It is expected that approximately half of Tanzania's rural population can be supplied with water by means of shallow wells.

This implies that an average of 150 to 200 wells is to be constructed per Region and per year, for a period of 10 years. In practice additional investigation by hydrogeologists with experience in shallow well siting is required in order to obtain a more detailed insight into the possibilities per Region.

In order to institutionalize and standardize the construction of shallow wells in Tanzania a national body should be charged with coordinating the shallow wells activities in the country. Maji's Water Master Planning Coordination Unit (WMPCU) might be charged with this task, also in view of its activities as permanent secretariat of the Tanzania Water Development Coordination Board (TWDCB) that may be expected to play an important role in the realization of Tanzania's rural water supply development targets.

For the operational level of shallow well construction various options are shown: national, supra-regional, regional and sub-regional (Districtwise), and as part of an overall rural water supply activity or restricted to shallow wells only. For various reasons a set-up based on shallow wells construction only and on a regional level appears the most appropriate.

Discounting maintenance and community participation and education, the most important activities in shallow wells implementation are well siting (survey) and well construction, plus supporting activities (administration, supply, workshops, etc.). Next to having these activities carried out by a governmental organization, viz. the Regional Water Engineer's office, the alternative of having at least a part of them carried out by contractors or by a parastatal, is discussed and recommendations for the organizational set-up of regional shallow wells projects are given (see also par. 3.9.2.).

Various options for survey methods, in use in- and outside Tanzania, are compared. A preference is voiced for solutions that use simple equipment (that can be maintained, or even manufactured, locally) that does not require special skills in operation, e.g. survey by hand-drilling as used in most of the current shallow well projects in Tanzania.

Shallow wells can be divided in two groups: small-diameter wells (actually shallow boreholes) and large diameter wells (in Tanzania: wells lined with concrete rings of approx. 1 m diameter). Both types of wells can be found in Tanzania and for both alternatives a project organization and cost figures are given.

For reasons of hygiene the wells should be covered and a hand pump mounted on it. Hand pumps used in Tanzania include the Shinyanga, Kangaroo, Morogoro and Nira types. All are discussed, and recommendations are given for standardization and cooperation in further development of these types.

For the organization of a regional shallow wells project four options are discussed in detail. They are based on hand-drilling and hand-digging, respectively, each with the option of an independent organization or one that is (at least partly) integrated in the RWE's organization.
The respective organigrams are shown in figs. 3.31 through 3.34.

The total number of personnel per project ranges from 64 (hand-drilling; integrated organization) to 262 (hand-digging; independent organization). The minimum number of expatriate personnel (at least for the initial phase) is 6 (independent organization) and 3 (integrated organization), respectively.

Investments and recurrent costs are given in par. 3.8. They include: personnel, vehicles, offices and other buildings, technical equipment and construction materials and hand pumps.
The investments for a regional project range from TAS 3 to 3.8 million (for hand-drilling) to TAS 6.3 to 7 million (hand-digging). Annual running costs per project are in the range of TAS 3 to 6.5 million per year, based on an entirely Tanzanian staff. Employment of expatriate key personnel would add some TAS 2.5 to 5 million per year to this figure. Including depreciation of investments and depending on the percentage interest payable on investments (loans, grants, etc.) total annual costs per project range from TAS 4 million to TAS 13 million, depending on the option that is selected and whether expatriate staff is employed or not.

Basing the cost calculation on the assumption that regional shallow wells projects with an independent organizational set-up construct wells by the hand-drilling method, and subtracting investments made for the on-going projects, the total investments would amount to approximately TAS 55 million for the whole country.

Annual costs, including debt service and depreciation costs, would amount to some TAS 92 million, which is roughly half of Tanzania's annual budget for rural water supply development over the last few years. As such it must be regarded to be well within Tanzania's capabilities to finance shallow wells implementation (which would, after all, supply half the rural population with water), assuming that the present level of financial contribution by the donors will not be decreased.
Total costs per consumer (at 300 consumers per well) would be approx. TAS 75-80.
This figure would have to be increased to TAS 100 to 150 in case expatriate key personnel would be employed. In view of the shortage of trained and experienced Tanzanian personnel this might be unavoidable for some time to come, however.

3.9.2. Recommendations

It is recommended to:

a. Nominate a Maji agency, preferably the Water Master Planning Coordination Unit, as national coordinating body for shallow wells implementation.
   Its tasks should comprise:
   1. drawing up a programme for having the possibilities for shallow wells implementation thoroughly investigated in those Regions where no shallow wells projects are operating
   2. collecting progress reports and other relevant information on all on-going shallow wells projects and keeping record of their performance
   3. keeping record of the financial progress of these projects and of the resulting per capita costs of shallow wells
   4. (re)appraising the feasibility of meeting the 1991-target, at certain intervals
   5. initiating measures to adapt the on-going shallow wells projects, either in performance or in number, in order to reach the 1991-target
   6. stimulating improvement and standardization of working methods, organizational set-up, equipment and pumps, on recommendation by the Technical Coordination Committee of the Tanzania Water Development Coordination Board
   7. advising on, and standardizing, maintenance procedures and frequencies
   8. coordinating community education and participation work on a national level, in cooperation with the relevant Ministries and other governmental institutions
   9. maintaining international contacts regarding the shallow well technology
   10. keeping track of all relevant developments in this field

   In order to fulfill this task, the WMPCU should have the authority to impose standards and certain regulations, either directly or indirectly, on the on-going and future shallow wells projects.

b. Establish regional shallow wells projects in each Region where larger numbers of shallow wells are feasible and no such projects are already operating.
   These projects should:
   1. be independent of the RWE's organizations until a final decision has been taken as to the most appropriate and workable, final, organizational set-up
   2. for a limited number of years train surveyors and well sinkers on-the-job after they have received an initial 3 months' training at the Water Resources Institute in Dar-es-Salaam
   3. gradually integrate the well siting/survey section in the organization that will be selected for shallow wells implementation (RWE, parastatal?)

4. gradually prepare well sinkers for:
   a. independent operation as small contractors/cooperatives
   b. integration in the organization mentioned in (3) above
5. use methods and equipment, and construct wells, according to standard specifications and designs as laid down by the national coordinating body (WMPCU?) on recommendation by the Technical Coordination Committee

c. Have the Morogoro Wells Construction Project try out, on a pilot scale, alternatives for the most appropriate organizational set-up and working method for a regional shallow wells project with a fully Tanzanian staff.

d. Establish a Technical Coordination Committee (TCC) composed of Maji representatives and representatives of the on-going shallow well implementation projects, as committee of the Tanzania Water Development Coordination Board.
Its tasks should comprise:
1. establishing guidelines and drafting standards for equipment and methods to be used in survey/well siting, taking into account the favourable experience with hand-operated survey equipment. In sofar as other than manually operated equipment would be recommended under specific circumstances, it is essential that the Principal Geologist's office in Dodoma be involved in drafting the recommendations
2. working out, in coordination with the Principal Geologist's office, standards for filing survey data on shallow wells
3. preparing standards for the methods to be used in constructing wells. In view of the advantages and disadvantages of the various construction methods, and the costs involved, it appears that hand-drilled wells are the most appropriate construction, with hand-dug wells as an alternative in case poor aquifers are encountered. The applicability of the Finnish system with tractor excavators might be considered as another option in case of poor transmissivity of shallow aquifers
4. preparing standard designs for concrete well rings, well covers, pump stand and well head construction, including bucket stand, washing slab and cattle trough if and when required
5. drawing up specifications and standards for pumps to be used on shallow wells. The attention should be focused on promising pump types that are already in use or under development in Tanzania, and on promising alternative options.
   The pump type to be selected have to plunger below the ground water level (lift pump).
   Possibly additional design criteria for hand pumps may emerge from the studies and pilot projects on community education and participation to be carried out by IRC/BRALUP
6. establishing procedures for involving the current shallow wells projects in Tanzania in testing and developing pump components, such as:

- standardization of foot plate size and distance between anchor bolts
- standardization of connections between superstructure and riser, and riser and pump cylinder
- standardization of pump rod size and connections
- exchange of prototypes for testing by other projects

7. specification of construction materials, pump components, etc. for supply through a central procurement centre (to be established) and for eventual local production

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    Address by Nd. H. Bakari Mwapachu, Principal Secretary, Ministry of Water, Energy and Minerals, on the development of the water sector in Tanzania.
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18. Ibidem - Problems of Communications between Maji Headquarters and the Geology Section at Dodoma, Nd. Chao, Principal Geologist.
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20. Ibidem - Problems of Procurement of Materials and Equipment. Problems of supplying materials. Nd. Chakrabat, Chief Supplies Officer.
21. Ibidem - Proposal to reorganize Rural Water Supply Sector, AIB.
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LIST OF ABBREVIATIONS

MAJI	=	Ministry of Water and Energy (Headquarters Dar-es-Salaam)
WMPCU	=	Water Master Planning Coordination Unit
MWCP	=	Morogoro Wells Construction Project
PS	=	Principal Secretary
RWE	=	Regional Water Engineer
SSWP	=	Shinyanga Shallow Wells Project
TWDCB	=	Tanzania Water Development Coordination Board
TCC	=	Technical Coordination Committee

NATIONAL SHALLOW WELLS PROGRAMME

CHAPTER FOUR

PROCUREMENT OF MATERIALS AND EQUIPMENT

DECEMBER 1981

DHV

DHV Consulting Engineers

CONTENTS PAGE

4. PROCUREMENT OF MATERIALS AND EQUIPMENT

4.1. Procurement, its importance and constraints

Procurement of materials and equipment, when taken in its broader meaning of comprising purchase or manufacturing, transportation, storage and distribution, is an essential element for a successful implementation of rural water supplies, as well as for their maintenance.
Construction materials and equipment account for 50 to 60% of overall project costs for the average water supply project as carried out by the Ministry of Water and Energy. Similarly, for shallow wells implementation projects, a large proportion of the project costs is spent on materials and equipment.
Table 3.16. (Chapter Three: "Construction of Wells"; separate volume) indicates that, whatever option be chosen (bored wells or dug wells; organization separate or integrated in that of the Regional Water Engineer), the cost of materials amounts to about 50% of the annual recurrent expenditures, a percentage that will be even higher when fuel and spare parts required for transportation are also taken into account.

Without a properly functioning procurement system severe setbacks will be experienced in the construction and maintenance of (rural) water supply systems. Unfortunately, the situation in which most Regional Water Engineers find themselves, is an example of the impact of a less than adequate procurement and supply system.
During the Annual Conference for Regional Water Engineers and Ministerial Officials, held in Tanga from 6 May 1980 to 9 May 1980, MAJI's Chief Supply Officer listed the major problems as follows:

A. Procurement (in a restricted sense)

a. Procurement procedures are time consuming, sometimes taking as long as 1 year.
b. Procurement planning has to be based on project scheduling. In practice this is not the case, however.
c. The Ministry's accounting officer can authorize purchases not exceeding TAS 40,000; for larger amounts the case has to be referred to the Central Tender Board for approval. In view of the price escalations during the last few years the ceiling level of TAS 40,000 needs to be adjusted.
d. The Central Tender Board in most cases insists on international competitive bidding, causing considerable delays and introducing the implicit danger that makes and manufactures of certain items change frequently during a certain period, thereby rendering standardization almost impossible and greatly complicating the timely availability of spareparts at a later date.

e. For the importation of materials and equipment foreign exchange is required.
   In practice this means that the Ministry must have a foreign component in its funds. In any case, however, Import Licenses are required. Obtaining these from the Bank of Tanzania is time consuming and sometimes impossible, where the Bank stopped issuing Import Licenses altogether.
f. Long delays in the processing of shipping documents result in clearing delays and storage charges.
g. Slow action by the sole Government Clearing and Forwarding Agents.
h. Difficulty in identifying materials and equipment once in port
i. Delays in completing claim formalities due to late receipt of short landing certificates.
j. Local parastatals often fail to honour confirmed orders.

B. Storage

a. Inadequate storage space at MAJI's main store, in Kurasini.
b. Insufficient security at Kurasini stores.
c. Storage of dormant materials and equipment at Kurasini stores.
d. Acute shortage of qualified and experienced staff at Kurasini stores.

C. Transportation

a. Due to a lack of adequate vehicles, the MAJI store in Kurasini cannot despatch goods, but these have to be collected by vehicles sent by the appropriate RWE.
   In order to expedite the matter he himself or his representative normally has to go to Dar-es-Salaam as well.
b. The transport situation in the region is not encouraging, mainly because of deficiencies in maintenance, caused by a lack of proper equipment and spareparts. This complicates the transportation of materials from Kurasini to the region even more.

In order to speed up procurement, the MAJI stores revolving fund was established, so as to facilitate the advance procurement of materials in bulk. In practice, however, the success of the revolving fund is frustrated by the unavailability of materials on the local market and the lack of foreign exchange, resulting in an acute shortage of pipes, pumps, fittings, etc. at the Kurasini stores.

For typical shallow well related equipment, such as survey equipment, hand-drilling equipment, moulds for well rings, covers and pump stands, hand pumps, etc. the situation is even less encouraging, because the specialized knowledge regarding this sector is not available within the Ministry, but with the various shallow wells implementation projects in the regions.

Especially for those projects that are funded by external donor agencies it is understandable that they have taken their recourse to direct importation of materials and equipment from abroad. This possibility does not exist for those projects that do not have access to foreign funds. Partly because of this situation first the Shinyanga Shallow Wells Project and later the Morogoro Wells Construction Project have taken up certain activities in order to supply third parties with shallow well-related items that are not normally available locally. The success of these activities may be measured by the volume of goods that have been procured through the Morogoro Wells Construction Project's supply section lately:

1978	:	TAS 100,000/-
1979	:	TAS 1,100,000/-
1980	:	TAS 2,500,000/-
1981 (first half year only)	:	TAS 2,500,000/-

Nevertheless, certain delays in deliveries are unavoidable, because of the ad-hoc nature of these activities. They should, therefore be regarded as a temporary, gap-stopping, measure, pending decisions on a more permanent supply structure.
It is the aim of this chapter to describe the workable options and recommend certain actions to be taken for this procurement and supply set-up.

4.2. Estimate of turnover

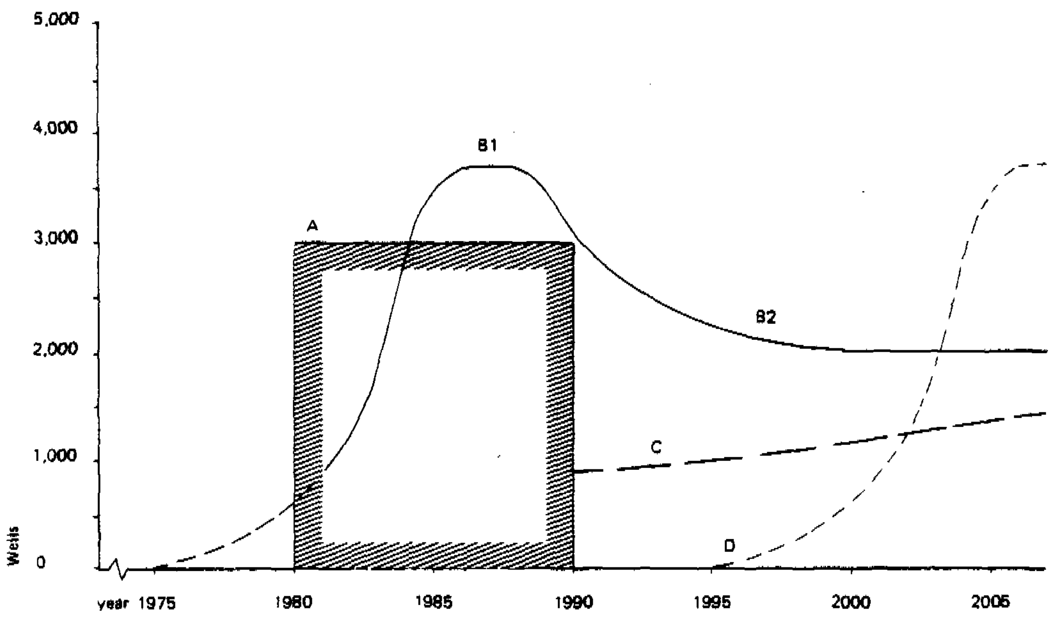
In order to determine what actions are required for safeguarding the procurement of items that are essential for the construction and maintenance of shallow wells with hand pumps, it is necessary to obtain an impression of the quantities of equipment, materials and pumps that might be required annually.
To that effect certain assumptions must be made as to the numbers of shallow wells than can (and will) be constructed during the next decade.

This estimate will be based on the following assumptions:

a. According to the TANU/CCM derectives, by 1991 the Tanzanian population should have "ease of access" to clean water. It is therefore assumed that, wherever feasible, the shallow wells that are necessary to supply the 1991 population, are indeed constructed within this decade.
b. In accordance with the estimate made in chapter 2 ("Possibilities of shallow wells in Tanzania") it is assumed that shallow wells would have to be constructed for approximately 9 million people. Taking an average of 300 people to be supplied with water per shallow well, this implies a total of about 30,000 wells to be constructed within 10-11 years.
c. If, indeed, the demand for shallow wells will have been satisfied by 1991, this does not mean that the construction of wells can be terminated by that year.

In order to keep pace with the population growth, the number of operational shallow wells must be increased by some 2.5 to 3.5% annually, or 750 to 1050 wells (initially) per annum.
Furthermore it must be assumed that existing wells will have to be replaced after, say, 20 years of service. In theory this means that the entire wells construction programme will have to be repeated after 20 years (provided that no other rural water supply option will have become more attractive and/or feasible in the meantime).
In practice the actual lifetime of the individual wells will deviate somewhat from the theoretical value, so that - after some time - a relatively continuous replacement programme would have to be carried out at an average rate of 30,000 : 20 = 1,500 wells per annum.
Combining the two effects of replacement and population growth, production of shallow wells may have to be continued at a rate of 2,000 - 3,000 wells per annum. or 100-150 wells/region/year.

Fig. 4.1. shows the theroretical demand, as well as a more probable demand curve, which also takes into account the numbers of shallow wells that have been realized so far, notably by the projects in the Shinyanga, Mtwara/Lindi and Morogoro regions.



Legend: A. Theoretical block production of 3,000 wells per annum, required to reach 1991-target
B1. Assumed actual production of shallow wells (1975-1990)
B2. Assumed continuation of production after 1990 (to compensate effects illustrated by curves C and D)
C. Required construction of wells, to compensate growth of population
D. Theoretical replacement of wells after 20 years (identical to curve B1, shifted over 20 years)

FIGURE 4.1 THEORETICAL AND ANTICIPATED WELLS CONSTRUCTION LEVELS

Again the point is stressed that the estimates are based on the offical 1991 target and on theoretical possibilities, rather than on hard facts, and that a great number of measures still have to be taken before even the average production capacity for the next decade (3,000 wells per annum) will have been reached. Figure 4.1. takes into account the fact that it will take some time before this level might have been reached, and assumes that the maximum annual production level will have to be considerably higher in order to still realize the 1991 target of having approximately 30,000 wells constructed (about 2,000 of which have already been constructed before 1981).

The shallow well-related materials and equipment will be broken down into the following main groups, to be treated in separate sub-paragraphs:

a. Survey equipment.
b. Equipment for the construction of wells.
c. Materials used in constructing wells
d. Hand pumps.

4.2.1. Survey equipment

Most of the projects that are involved in the construction of shallow wells in Tanzania use the survey method as described in paragraph 3.6.2. of chapter 3 "Construction of wells", i.e. surveying by means of trial holes made with hand-drilling equipment. The assumption will be made, therefore, that all survey activities for shallow wells, also in the future, will be carried out with the equipment as used at present in the wells construction projects in Shinyanga, Mwanza, Morogoro, etc.

Basically this survey equipment can be divided in five groups, a more detailed description of which is given in Appendix 4.1.:

a. Lichtweight survey set (hand-drilling), consisting of:
    - handle
    - extension rods (with conical thread connectors)
    - bits
    - bailers
b. Heavyweight survey set (hand-drilling), consisting of:
    - cross piece and handles
    - extension rods with square, bolted connectors
c. Casing set, consisting of:
    - casing pipes with thread protectors
    - shoes
    - heads
    - tommybars
    - clamps
    - retrievers

d. Capacity and quality control set, comprising:
   - "jolly jumper" test pump (in components)
   - water level meter
   - electrical conductivity (E.C.) meter
   - timer
   - water quality test kit

e. Miscellaneous items:
   - boxes for survey set and casing pipe
   - small tools
   - compass, etc.

It is obvious that from the procurement (or local manufacturing) point of view those items are most important of which large numbers are required consecutively, because their technical lifetime is relatively restricted, and/or which have to be used in large numbers simultaneously. In practice this means that the emphasis will be on groups a, b en c, as well as on the "jolly jumper" test pump set of group d. The remaining items are either available on the local market or their small number will not present any problem in securing supply through the regular supply channels, notwithstanding the foreign component that may be involved.
Setting up a special procurement system and/or local manufacturing is, of course, out of the question for such items as EC meters, timers, water quality test kits, compasses, etc.
Moreover, several of these items have such a long lifetime that, once they have been purchased (often by or through the donor organization) in practice they will not have to be replaced at all.

Based on the present level of experience the "production" capacity of the lightweight survey set (as an average) is 40 approved well sites per annum. This means that for the maximum production level indicated in fig. 4.1. (approx. 3700 wells per year) in theory a total of 93 survey sets would have to be in operation sumultaneously. The actual number of survey sets to be procured in any particular year depends on the assumed increase in the output of shallow wells (see fig. 4.1.), as well as on the rate in which used survey sets have to be replaced because their component parts have worn out.

Based on present experience, it may be assumed that the entire lightweight survey set, casing set, capacity and quality control set, and miscellaneous items, must be written off in 2½ years, or over a total production of 100 approved well sites. This implies, however, that the survey set contains spare cutting edges for bits and bailers and that the respective shallow wells projects have the facilities for welding on the wearing parts of the cutting edges.

A production of 30,000 wells over a 10-year period would imply that 30,000 : 100 = 300 survey sets would have been used up, or an average of 30 survey sets per year.

In practice the number of survey sets to be procured annually will depend on their distribution over the Regions, whether or not they will be used continuously, and whether or not the assumed production curve of figure 4.1. will prove to be anywhere near the truth.

Assuming that fig. 4.1. is correct, that each survey set will produce an average of 40 approved well sites per year, and that the sets need to be replaced after 2½ years of service, the total number of complete survey sets to be procured within the years 1981-1991 would be 306, starting at an assumed level of 12 sets per year, to quickly increase to a level of 35-39 sets per year, and eventually drop to a level of 26 sets per year (see figure 4.2.).

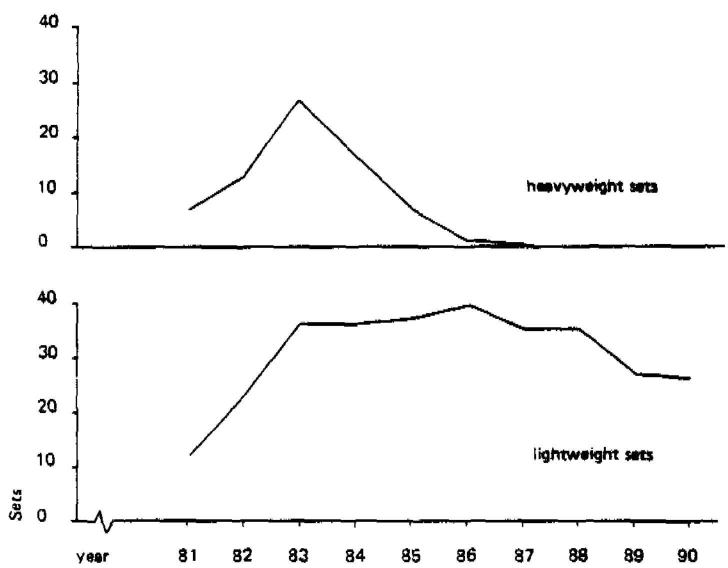


FIGURE 4.2 PROCUREMENT OF SURVEY EQUIPMENT

In the above, the possible contribution by heavyweight survey sets has been left out of consideration. Based on the experience gained so far, the application of this type of survey equipment is much more limited, and will not influence the numbers of lightweight survey sets to be used.

The calculation of the required number of heavyweight survey sets is based on the assumption that one heavyweight survey set will be required for every lightweight survey set (each survey group to be equipped with both sets), but that their actual use is much more restricted (presumably to 20-25% of that of the lightweight set) as the result of which the heavyweight survey set may be assumed to last for about 10 years, before replacement will be necessary.
Again welding facilities for restoring worn cutting edges of bits and bailers are essential.

Following the assumptions of figure 4.1. a total of 93 heavyweight survey sets would be sufficient until 1991. Because the peak of the construction effort would be reached in 1986, all heavyweight sets would have to be procured before that time, necessitating a maximum supply level of 27 sets per year (in 1983). (fig. 4.2.).

4.2.2. Construction equipment

In Chapter 3 "Construction of wells" the shallow wells construction methods are described, as used in Tanzania. They comprise:

- mechanical excavation of large-diameter wells (as practised in Lindi/Mtwara)
- manual digging of large-diameter wells (as practised is Shinyanga, Tabora, etc.)
- manual boring of small-diameter wells (as practised in Morogoro and most other Regions).

The mechanical excavation method uses the same concrete well rings and cover as the hand-digging method, the only difference being the excavation equipment itself. In the Finnwater project in Mtwara/Lindi, the only project that is using this method, a number of tractor excavators (of a Finnish make) are used. It will be obvious that procurement of such equipment will have to go through the donor agency or the Central Tender Board, whichever body is most appropriate in any specific case. It has been said before, however, that constructing shallow wells by means of tractor excavators is not recommended under normal Tanzanian circumstances.

Appendix 4.2. lists the construction equipment that would be required for a shallow wells implementation project that uses the hand-digging method as developed in the Shinyanga Shallow Wells Project. The following groups of equipment can be distinguished:

a. mechanical/electrical equipment:
   - mobile generators
   - transformers
   - electrical breakhammers
   - electrial pumps
   - concrete mixers
   - petrol-driven pumps
   - hand-operated membrane pumps

b. remaining larger equipment :
- tripods
- winches and rope
- wheelbarrows
- camping equipment

c. remaining smaller equipment :
- pick-axes
- shovels
- buckets
- hammers
- trowels
- floats
- saws
- etc.

In practice, the items mentioned under c. are available on the Tanzanian local market. Hence no special measures for the procurement of these items appear to be necessary. The items of group a. will have to be imported, however, as will the spareparts that are required for their upkeep.
The problems that are experienced with the procurement of spareparts and fuel for these items in practice are one of the reasons that the construction of hand-dug (ring) wells is recommended as a last resort only, viz. when the characteristics of the aquifer (low permeability) render it necessary to build large-diameter wells with their inherent storage capacity.

Several components of group b. will have to be imported also (e.g. winches and steel cable), whereas other components, such as tripods and wheelbarrows, micht be purchased or constructed locally, as is presently being done in Morogoro.
Since tripods are an essential element in the hand-bored wells construction method (to be discussed later) their possibilities for local construction will be mentioned later, within the framework of the hand-bored (also called hand-drilled) wells construction procurement possibilities.

Because of the emphasis on hand-bored wells construction (see Chapter Three, "Construction of wells") the requirements for hand-dug wells construction equipment will be rather limited. It is, therefore, assumed that approximately 10 percent of the shallow wells to be constructed in Tanzania will consist of large-diameter wells, constructed by the hand-digging method.

The total number of hand-dug wells to be produced in the period 1981-1991 will thus be: 10% x (30,000 - 2,000) = 2,800, or: an average of 14 wells per Region and per year. With an average production capacity of 8 wells per year per set of construction equipment, 2 sets per Region, or 40 in total, would suffice.
Taking into account the assumed production levels (fig. 4.1.) and the need for replacement of the construction sets after 3 years of uninterrupted use, a maximum of 47 sets would be in use simultaneously, with procurement levels generally ranging between 10 and 20 sets per year (see fig. 4.3.).

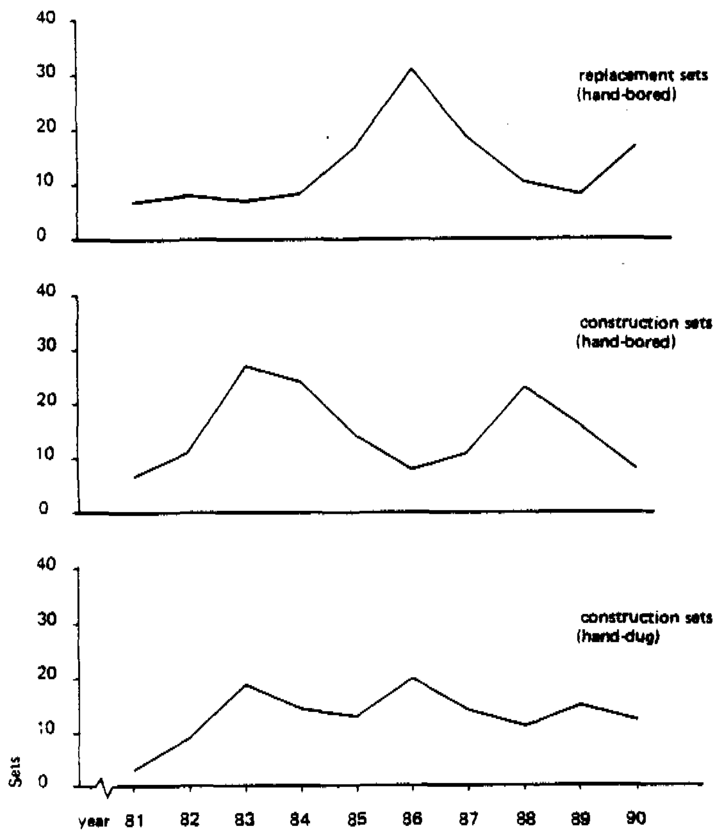


FIGURE 4.3 PROCUREMENT OF CONSTRUCTION EQUIPMENT

In conformity with the recommendations of Chapter Three it is assumed that most of the wells to be constructed in Tanzania will be made by means of the hand-boring (hand-drilling) method, using the HHD (heavy-hand-drill) equipment, developed originally in Shinyanga, but further mainly in Morogoro.
Subtracting the wells for which hand-digging is assumed to be more feasible (see above) approximately 90 percent of the shallow wells to be built in the period 1981-1991, or: 90% x 28,000 = 25,200 wells in total, would have to be made according to this method.
Basing the construction level in any particular year on the curve shown in figure 4.1., this means a maximum of 3,330 hand-bored wells to be produced per year.

The HHD equipment, being similar to the heavyduty survey equipment, comprises the following elements (for details see Appendix 4.1.):

a. hand-drilling tools
  - cross piece and handles
  - extension rods (with 38 mm hexagonal connectors)
  - bits
  - bailers
  - stabilizers
  - rod hangers and rod catchers

b. casing set, consisting of:
  - casing pipes with thread protectors
  - casing shoes
  - casing heads
  - tommybars
  - clamps
  - retrievers

  etc.

c. additional equipment, comprising:
  - tripod and winch assembly
  - membrane pump with suction hose
  - camping equipment
  - miscellaneous equipment.

The experience gained so far suggests that it is possible to make an average of 40 hand-bored wells per year with one HHD set. According to the wells production curve as indicated in figure 4.1. this implies that for the maximum production level of 3,330 hand bored wells per year some 84 HHD sets would have to be operated simultaneously.
The slope of the curve illustrates the growth in construction capacity, thus, at a certain scale, the increase in the number of HHD sets to be used at any time.

The lifetime of the various components of the HHD set, if used at the rate of producing 40 wells per set and per year, is as follows:

A. hand-drilling set (excl. of wearing parts), casing set, tripod, dewatering pump set and part of the miscellaneous tools and equipment (total value: TAS 105,000): 5 years

B. wearing parts of hand-drilling set, winch and cable, camping equipment, set of pump membranes, part of the miscellaneous tools and equipment (total value: TAS 45,000): 2½ years

Based on the above data the following quantities of HHD equipment would have to be procured:

- complete HHD sets: 149 sets in 10 years, with a maximum of 27 sets per year
- replacement parts acc. to (B) above: 131 sets in 10 years; maximum: 31 sets per year (see figure 4.3.)

4.2.3. Well materials

Again a distinction is made between large-diameter wells (dug wells or ring wells) and small-diameter wells (bored wells):

A. Dug wells (ring wells)

The following materials are used:

- concrete filter rings (porous concrete: no-fines concrete)
- concrete well rings (normal concrete)
- well cover-cum-pump stands (normal concrete)

Although in theory these items might be purchased from others, it will normally be worthwhile to have them manufactured by the project itself. If well rings, filter rings and covers are produced at a central yard in each Region, the following is required:

- ring moulds (production capacity of 200 rings/year for one mould)
- cover moulds (production capacity of 400 covers/year for one mould)
- cement (approx. 45 bags of cement for an average well of 8 m depth)
- sand and gravel (approx. 9 m^3 for an average well)

With a maximum annual wells' production equal to 3,700, a maximum of 370 hand-dug wells will be required for any year, or: an average of 19 wells per year per Region.
With an average well depth of 8 m, not more than 152 well rings and filter rings would be required annually in any Region. One ring mould and one cover mould per Region would suffice, therefore, or: approx. 20 sets for the entire country, thus hardly presenting any procurement problem.
Assuming that sand and gravel can normally be obtained locally, the only problem might be the availability of cement. Though indeed cement is sometimes in short supply (another reason for focusing on hand-bored rather than dug wells) the total cement requirements are relatively small. With an average of 45 bags of cement per dug well, and 2,800 dug wells in total (within 10 years), total cement requirements would be 2,800 x 45 x 50 kg = 6.3 million kg, or 6,300 tonnes.

B. Hand-bored wells

Materials for hand-bored wells comprise

- PVC pipe, plain and slotted
- pump stand (precast concrete)
- slab (concrete, cast in situ)

For the last two elements the following specific equipment and materials are required:

- mould for pump stand
- cement
- sand and gravel

For the average hand-bored well about 9 m of PVC pipe (6 m plain; 3 m slotted) is required. With the construction of wells as indicated in fig. 4.1. this amounts to a total of 226.8 km of PVC pipe, required over 10 years, with a maximum annual requirement of approximately 30 km of pipe.

For the centralized manufacturing of the precast concrete pump stands one mould per Region would be more than sufficient, restricting the total requirement to less than 20 units.

Assuming that the required volumes of sand and gravel can again be found locally, the only remaining requirement is cement. For the construction of the average hand-bored well, inclusive of pump stand, slab and bucket stand, about 7 bags of cement are required. For a total of 25,200 wells to be constructed in a period of 10 years, this means a total of 8,820 tonnes of cement, with a maximum annual cement requirement of 1,166 tonnes (in 1987).

Combining the cement requirements for hand-dug and hand-drilled wells, a total of 15,120 tonnes of cement would be required, over a 10 year period.
With cement requirements obviously being lowest at the start of that period, a maximum level of 2,000 tonnes/year would be reached in 1987, to drop to 1670 tonnes/year in 1990. These figures represent slightly more than one day's production of each of Tanzania's two operating cement factories (see fig. 4.4.).

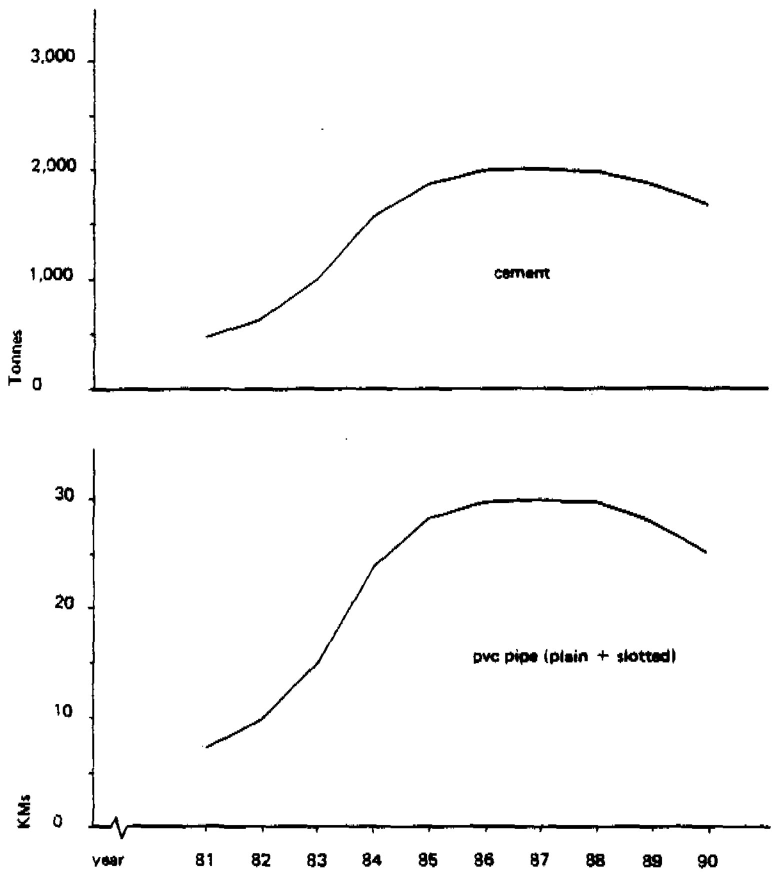


FIGURE 4.4 PROCUREMENT OF WELL CONSTRUCTION MATERIALS

4.2.4. Hand pumps

In terms of required numbers, and costs involved, hand pumps are the most important single item to be procured (see table 4.2. and figure 4.6.).
The estimates of required numbers, cost and lifetime of its component parts will all be based on the most promising pumps that are available in Tanzania today, the SWN 80 and SWN 81 pumps. Though the SWN 80 pump will be the basis for the following detailed estimates, the SWN 81 or any other type of hand pump - eventually selected by a Technical Coordination Committee - might have been used as well, be it that some assumptions might have to be revised in such a case.

The estimated lifetime of the various component parts of the SWN 80 is expected to be as follows (assuming that no regular maintenance is carried out):

- pump head : 5 years (or more)
- pump rod : 5 years
- riser : 3 years
- cylinder assembly : 5 years

It is assumed that, at the end of its estimated lifetime, any component is replaced by a new one.
According to the shallow wells production curve of figure 4.1., a maximum of 3,700 new pump sets would be required in any year. Taking into account also those pump sets that will have to be replaced after 5 years, a total of 40,390 pumps would theoretically be required over the years 1981-1991, with a maximum annual requirement of almost 7,000 pumps (in 1990/1991).

According to the above, roughly halfway each pump's lifetime its riser would have to be replaced (unless better materials will have become available before then). This means that a total of 21,900 sets of riser pipe would have to be procured in total before 1991, with an annual maximum of 5,020 sets (in 1990/1991) (see fig. 4.5.).

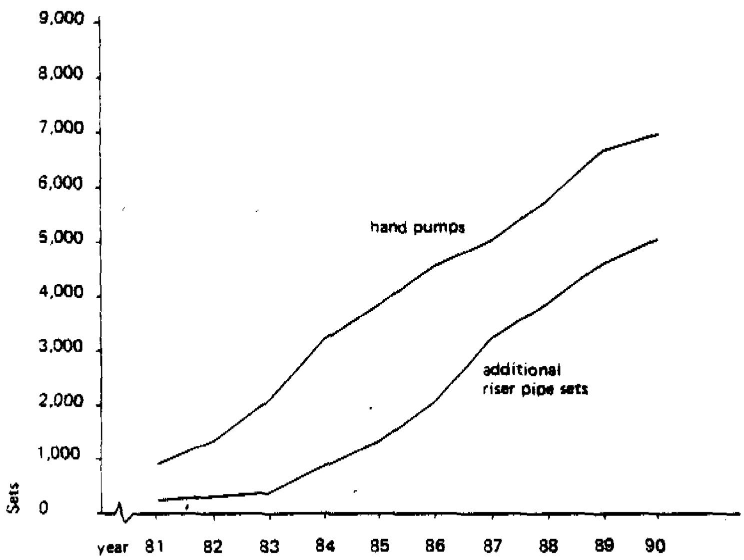


FIGURE 4.5 PROCUREMENT OF HAND PUMPS

4.2.5. Summary

A summary of the volumes of most important items to be procured until 1991, based on the preceding paragraphs, is given in table 4.1.

Table 4.1. - Summary of procurement volumes

ITEMS	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
SURVEY EQUIPMENT											
- lightweight sets	12	23	36	36	37	39	35	35	27	26	306
- heavyweight sets	7	13	27	17	7	1	-	-	-	-	72
CONSTRUCTION EQ.											
- hand-digging sets	3	9	19	14	13	20	14	11	15	12	130
- hand-boring sets	7	11	27	24	14	8	11	23	16	8	149
- replacement sets	7	8	7	8	17	31	18	10	8	17	131
WELL MATERIALS											
- cement (tonnes)	486	659	1005	1577	1885	1993	1999	1983	1863	1670	15120
- PVC pipe (km)	7.3	9.9	15.1	23.7	28.3	29.9	30.0	29.7	27.9	25.1	226.8
HAND PUMPS											
- complete sets	900	1320	2080	3220	3870	4590	5020	5750	6670	6970	40390
- additional riser sets	220	300	380	900	1320	2080	3220	3870	4590	5020	21900

In table 4.2. the value of the procurement according to table 4.1. is indicated, based on the following unit costs:

- lightweight survey set : TAS 50,500 per set
- heavyweight survey set (additional items) : TAS 9,500 per set
- construction set, hand-digging : TAS 130,000 per set
- construction set, hand-boring (HHD) : TAS 150,000 per set
- replacement set, hand-boring : TAS 45,000 per set
- cement : TAS 1,300 per tonne
- PVC pipe plain + slotted, set of 9 m : TAS 1,800 per set
- complete hand pump set (SWN 80) : TAS 5,900 per set
- additional riser pipe set : TAS 400 per set

Table 4.2. - Value of procurement (rounded figures in millions of Tanzanian shillings)

Items	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
survey equipment	0.7	1.3	2.1	2.0	1.9	2.0	1.8	1.8	1.4	1.3	16.3
construction equipment	1.7	3.2	6.8	5.8	4.6	5.2	4.2	5.3	4.7	3.5	45.0
well materials	2.1	2.8	4.3	6.7	8.1	8.5	8.6	8.5	8.0	7.2	64.8
hand pumps	5.4	7.9	12.5	19.4	23.4	28.0	30.9	35.5	41.2	43.2	247.4
total	9.9	15.2	25.7	33.9	38.0	43.7	45.5	51.1	55.3	55.2	373.5

Figure 4.6. indicates the value of the procurement in a graphical way. It shows that the value of survey and construction sets and materials, after an initial growth, stabilizes at a level of around TAS 15 million a year, whereas the hand pump component continues to grow. Hand pumps clearly are the most important single item to be procured, their share in the annual procurement value increasing from around 50% to 78%, with an overall share of 66% of total procurement during the next 10 years.

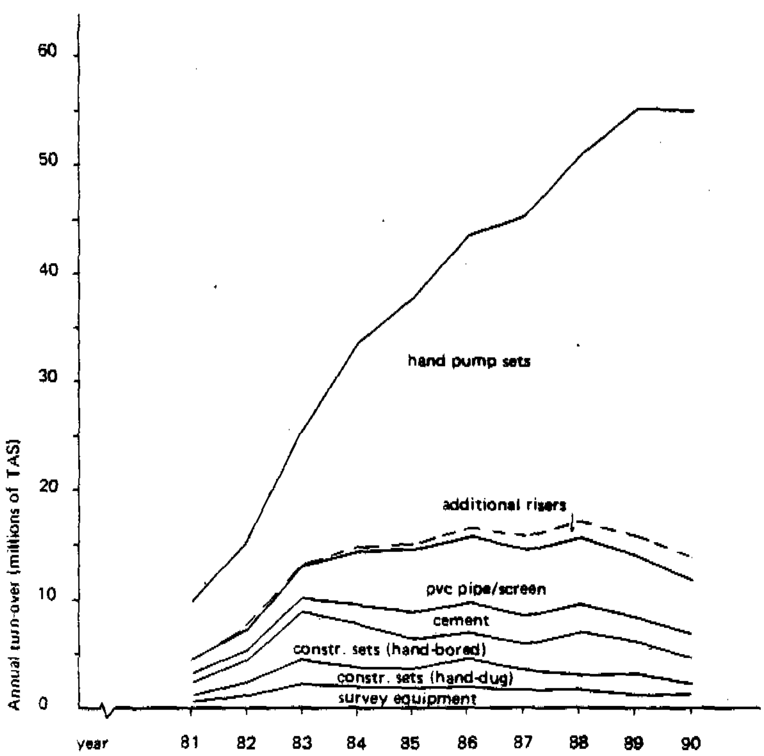


FIGURE 4.6 VALUE OF SHALLOW WELLS PROCUREMENT (CUMULATIVE)

4.3. Organization of the procurement

4.3.1. Existing situation

The existing situation regarding the procurement of items for water supply projects has been briefly touched upon, at the beginning of this chapter. A distinction will be made between two types of projects, however:

- projects implemented by MAJI
- projects implemented by donor-sponsored organizations

In the first case, generally the Regional Water Engineer will be in charge of project execution, either under the control of the Regional authorities, or, in the case of a so-called "national project", under the control of the Ministry of Water en Energy in Dar-es-Salaam.

In either case procurement of all required materials and equipment will have to follow established government procedures. In practice this means that the following supply possibilities exist:

- local (private) shops
- Government Stores
- larger suppliers of special items
- MAJI stores at Kurasini

Smaller items of a more general nature, but also including galvanized iron pipes and the like, are supplied by Government Stores. The RWE can obtain these items their, on an LPO (Local Purchase Order), provided he has a vote for such purchases, the vote number of which should be indicated on the LPO. If items that are normally supplied by Government Stores (GS) are out of stock the RWE is not allowed to purchase these elsewhere, e.g. from local private shops, unless he has obtained an endorsement from GS on his LPO.
Even in that case, however, it may be difficult to obtain the required goods, since private shopkeepers tend to be very reluctant in accepting LPO's, because cashing these generally takes a very long time.

Certain goods, the most important of which are cement and fuel, are obtained from special suppliers. Normally cement can be obtained from the RTC (Regional Trading Corporation), but because of a limited availability and rather high price it has become a widespread practice to obtain it straight from the cement factory (Wazo Hill; Tanga). Again the goods are purchased on an LPO, against a certain vote number.

For fuel, similar arrangements are made with the distributors of the major brands.

Special water supply related items, such as larger-diameter pipes, valves, pumps, etc. should be obtained through MAJI's central procurement organization at Kurasini.

Depending upon the available budget, each year a list of items are procured and stocked at Kurasini, for use by the various RWEs. As a rule these have to collect the items themselves and to provide the vehicles for transporting these items to their own Regions.

The difficulties with which the MAJI supply organization has to cope, and of which a general lack of foreign funds is not the least, have been mentioned before, at the beginning of this chapter (paragraph 4.1.). In practice the result will often be that requirements in terms of pipes, pumps, fittings etc. can be met only partly or not at all, at least not in time, often leading to impromptu changes in design, when the latter is adapted to the available materials.
Complaints have been heard from Regional Water Engineers that their maintenance budgets, even in those rare cases where they would have been sufficient to cover all maintenance requirements, could not be spent simply because spareparts etc. were not available.
It is obvious that such a situation would lead to water supply systems being non-operational for very minor reasons.

In case the projects are implemented by organizations that have access to foreign currency, either direct or through a donor organization, most of the abovementioned problems do not exist.
Generally these projects will have the possibility to purchase items from Government Stores in the same way as RWE-controlled projects have. On the other hand, purchases with local shops or suppliers, also for cement and fuel, are much easier done, and often a certain degree of preference will be given to those projects because they pay in cash and not through LPO's.
As a rule these projects will not purchase items through MAJI's central stores in Kurasini, but obtain those items direct from the supplier, especially if they have to be imported.

For both types of projects another supply possibility exists, viz. procurement of typically shallow-well related materials and equipment through the Shinyanga and Morogoro shallow wells projects. Procurement of these items was started at the time the Shinyanga Shallow Wells Project was still a bilateral cooperation project (before July 1978). After that time most of these activities were shifted to the Morogoro Wells Construction Project, whereas procurement from Shinyanga dropped because of the non-availability of hard currency and the consequent constraints in obtaining good-quality materials, a situation that was aggravated by the hostilities with the Amin régime in Uganda.

Currently the Morogoro Wells Construction Project supplies the following items to third parties:
- lightweight survey equipment
- heavyweight survey equipment
- HHD hand-boring equipment
- mould for concrete pumps stand

- hand pump assembly (pump head, riser, pump rod, cylinder)
- PVC pipe, plain
- PVC pipe, slotted (filter pipe)

Thus far, the following parties have obtained or ordered materials or equipment from the MWCP:

1. Arusha, RIDEP
2. Bukoba, RWE
3. Coast Region, RWE
4. Dodoma, RWE
5. Dar-es-Salaam (Rural), RWE + Water Resources Institute
6. Iringa, RWE
7. Iringa, DWE Njombe
8. Iringa, DWE Mafinga
9. Mara, RWE
10. Mara, RIDEP
11. Ministry of Health
12. Mwanza RIDEP
13. Shinyanga Shallow Wells Project
14. Singida, Tanz-Austr. Groundwater Development Project
15. Singida, RWE
16. Tabora, RWE
17. Tanganyika Christian Refugee Service
18. Tanga TIRDEP + RWE
19. Mbeya, RWE
20. Ifakara, DWE
21. Ulanga, DWE
22. Mtwara/Lindi, Finnwater project

The total value of procurement through the Morogoro Wells Construction Project, up to July 1981, amounts to approx. TAS 6.2 million, with the annual turn-over more than doubling each year for the last two years (see para. 4.1.).

4.3.2. Possibilities for the future

When selecting possibilities for future procurement systems, it is essential to bear in mind the purpose of the procurement. This is to make available, to all parties concerned, specialized items for the construction and maintenance of shallow wells. These parties include:

a. shallow well implementation organizations
b. shallow well owners
c. shallow well maintenance organizations.

Depending upon which option will eventually be selected, the implementation organization might be:

- a government body (MAJI, RWE, PMO, RDD, etc.)
- a semi-government body/parastatal (e.g. Rural Water Corporation)
- a more or less independent, donor-sponsored project
- a co-operative or local contractor

The same options exist for maintenance organizations and owners, with the addition that:
- individual villages
- individual institutions, such as missions, schools, hospitals, etc.
- individual citizens

might be well owners, and thus also responsible for maintenance of their wells.

Summarizing, the possibility that individuals, villages or institutions, which are not integrated in the Tanzanian governmental system, and which do not possess any votes or LPO books, will have to have access to the specialized items to be procured must not be ruled out.

This implies that procurement of those specialized items may not be done exclusively by either Government Stores, or MAJI Kurasini and the RWE's organization, as these cannot supply to non-government or non-MAJI customers.

A possibility might be to supply these items through the RTC's (Regional Trading Corporations) in the respective Regions. A drawback here is that the RTC's do not extend to above the regional level, whereas coordination of the procurement of shallow well-related items should take place at the national level. Moreover the specialized knowledge required for the procurement of these items is not available within the RTC's.

A workable proposition may be to set up a National Shallow Wells Procurement Centre, at least initially as a separate body, with direct access to hard currency provided by one or more donors, and under the control of those donors. This centre would have to procure specialized shallow well-related items, following the recommendations of the Tanzania Water Development Coordination Board, the Shallow Wells Coordination Centre, and - especially - of the Technical Coordination Committee, whenever these bodies wil have come into existence.

Parties to be supplied with these items (on request) could include:
- MAJI Kurasini, for further distribution through MAJI's supply system (to RWE's, DWE's, etc.)
- shallow wells implementation projects, for their own use
- Government Stores' supply organization, for use by other government agencies
- RTC's supply organization, for supply to individuals or private organizations

Because the possibility of supplying all these institutions must be kept open, it will be impossible to integrate the shallow wells procurement component in the MAJI system, which might otherwise have been an option. The fact that the direct input of hard currency is also a prerequisite for the Shallow Wells Procurement Centre is another reason why a separate body is recommended, in any case initially.

It is recommended to use (part of) the existing procurement organization of the Morogoro Wells Construction Project (MWCP) as the nucleus for such a Shallow Wells Procurement Centre (SWPC).
In that case it should be separated from the MWCP proper. The reason why this particular organization is proposed, is the fact that in practice the MWCP supply section is already acting as a national supply organization for shallow wells equipment and materials (and no other project or organization is), that the required specialized knowledge is available in Morogoro, and that in this way there would be a possibility of coordinating or integrating the procurement activities and local manufacturing at the MWCP yard. The possibilities of locally manufacturing shallow well-related items will be discussed in more detail in paragraph 4.4.2.

Separating the supply and local manufacturing activities from the rest of the MWCP also opens possibilities for other parties, e.g. other donors, to participate in the Shallow Wells Procurement Centre.
This participation might be in the shape of making staff available, or even putting in foreign currency or supplying certain raw materials that might be required for locally producing shallow wells equipment. The value of the currency or materials imput could then be booked against deliveries to parties or projects that are financed by that particular donor. The overall effect of such an approach would be that those parties or projects receive their donor support at least partly in kind, rather than in cash, while the coordination of procurement is enhanced, and the standardization of equipment and materials is promoted.

Distribution of goods to the final consumer is not done by the supply section of the Morogoro Wells Construction Project; neither is it done by MAJI in its procurement set-up. According to present practice the various "clients" of the MWCP supply section collect their ordered goods in Morogoro and arrange transportation themselves. In a similar way RWE's collect their materials and equipment in Dar-es-Salaam, at MAJI's main store in Kurasini.
In the set-up as described above, with a Shallow Wells Procurement Centre supplying through Government Stores, MAJI Kurasini and/or RTC's, the existing transport and distribution lines of these organizations can be used. Therefore, no special transport or distribution facilities for typical shallow wells equipment or materials ase foreseen, with the possible exception of bulk transportation to the organizations that coordinate the procurement through Government Stores and RTC's on a national level.

4.4. Local assembling/manufacturing

4.4.1. Existing situation

The origin of the typically shallow well-related materials and equipment is as follows:

A. Survey equipment (in same order as mentioned in Appendix 4.1.):

Lightweight set	:	Most parts are or can be manufactured/assembled in Morogoro; however, spare valves for bailers, cutting edges/teeth for bits, complete stone augers and stone catchers, as well as thread connectors are imported.
Heavyweight set	:	Most parts are manufactured/assembled in Morogoro; imported parts include cutting edges/teeth for bits, stone augers, bolts and nuts.
Casing set	:	Most parts are imported; parts made in Morogoro comprise casing clamps, retrievers and boxes.
Capacity and quality control set	:	Imported parts comprise: spring of jolly jumper pump head, buckets, rope, timers/alarm clocks/compasses and fluoride test kits. The remainder of the jolly jumper pump heads, pvc risers, foot valves and water level meters is made or assembled in Morogoro.
Additional tools	:	Spanners for thread connectors, auger cleaners and trolleys are made/assembled in Morogoro (tyres and bearings for the trolleys are imported). All other items are imported.

B. Construction equipment

Hand-drilling tools	:	Most parts are or can be manufactured/assembled in Morogoro; however, cutting edges/ teeth for flight auger bits and riverside augers, hexagonal couplings, valve assemblies for bailers, bolts with chain and R-spring, bolts, nuts, washers, etc. are imported
Hand-digging tools	:	(see Appendix 2). Most items can be purchased locally. Items to be imported include hand membrane pumps, winches, pullies, rope, ring moulds and communication equipment.
Casing set	:	Almost all items are imported. Full steel casing pipes could be made locally (from imported raw materials), but the lathe in the Morogoro factory is not large enough for cutting thread on the casing pipe. MAJI's Wazo Hill factory would be able to do this, but due to practical problems this proves to be no workable solution.

Additional equipment:	Imported are the following items: winches, pulley blocks, swivel hooks, D shackles, thimbles, clamps, hand membrane pumps, suction hose, hose connectors, hose clamps, alarm clocks, spirit levels, mechanical jacks, etc. All other items are manufactured or assembled locally.

C. Construction materials

Sand and gravel :	Are locally available
Cement :	Is locally available
PVC casing/screen :	Is imported
Concrete well covers:	Covers for hand-drilled wells are produced locally in Morogoro

D. Hand pumps

Pump heads :	These are imported except for a few locally made prototypes that are undergoing field trials
Pump cylinders :	Are imported
Pump rods and risers:	Are imported

Even those items that are locally available or locally manufactured, are generally composed of imported raw materials. Therefore, the availability of raw materials in Tanzania is also an important criterium.

Steel:

- Locally galvanized steel pipe is available, but of such inferior quality that it is unfit for use as transmission or distritution pipe. In many cases, however, it is still suitable for construction purposes.
- Non-galvanized steel pipe of larger diameter (6, 8 or 10 inches internal diameter) sometimes can be obtained through MAJI's supply organization.
- Sheet iron, angle iron, reinforcement steel etc. is generally available.

All locally available steel is of relatively low quality, which is often sufficient for construction purposes, however. Better quality steel, such as tool-steel, spring steel or even stainless steel, is not available on the local market, nor is steel available in special shapes, such as square tube, square rod, hexagonal tube or rod, etc.
Welding electrodes are locally available, but of inferior quality (Chinese or Indian makes)

Plastics:
- ABS pipe is not locally available.
- PVC pipe is, in theory, manufactured by two local manufacturers: Simba Plastics (Ltd.) and Tanganyika Tegry Plastics (Ltd.). Both have difficulties in obtaining raw materials and procurement thereof may have to be done by the client. Moreover the quality of the finished product is inferior, whereas the overall cost is much higher than in the case of imported, good-quality, pipes.
  Slotted pvc pipe, to be used as screen, is not normally available. MAJI's Wazo Hill workshop comprises a pipe slotting machine which makes horizontal slots (perpendicular to the pipe axis). This diminishes the strength of the pipes more than with axially slotted pipes (such as made formerly in Shinyanga, and imported through Morogoro) and in any case the slotted pipe is not available in large quantities or to individual customers.
- Nylon is not locally available, nor PVC or ABS in blocks, as used during the construction of the pump cylinder assembly.

Tools and small equipment: these are often available on the local market. Being mostly of Chinese or Indian origin, the quality of these items is variable. In certain cases importation of tools may, therefore, be recommended.

4.4.2. Items to be manufactured/assembled locally

After a study of the preceding paragraphs it will be clear that large parts of the equipment are or can be manufactured locally. For most parts of the survey equipment and hand-bored wells construction equipment there are no major problems that stand in the way of local production. Nevertheless, almost all component parts, or at least the basic materials therefore, will have to be imported. Actually, at present this is already the case, be it that importation is sometimes effectuated through other agencies, which may apply standards that differ from those that would have to be set for shallow well-related equipment.

Also the mere fact that something can be manufactured or assembled locally is not in itself a reason to start doing so. Factors that have to be considered are:
- quality of the finished product
- price
- delivery time

Which factors in turn depend on:
- availability of skilled personnel
- availability of machinery
- availability of raw materials in sufficient quantities and of sufficient quality
- required numbers of items within a certain period
- continuity in demand

  etc.

Figure 4.6. indicates that, on the basis of earlier made assumptions regarding the required number of shallow wells in Tanzania (see paragraph 4.2.), hand pumps are the most important item, both quantitatively and in terms of money involved. It is, therefore, logical to investigate the possibilities of locally producing or at least assembling these pumps.

A. Hand pumps

From paragraph 4.4.1. it will be clear that the hand pumps that are available through the existing MWCP supply organization are manufactured abroad and imported in Tanzania. The reasons for this are that thus far the pumps used in Shinyanga and Morogoro have been in a transition phase, in which the pump design has been continuously adapted in order to improve the reliability of the product.
The fact that the availability of high quality raw materials and half products in Tanzania is rather limited, whereas the same items are available "off-the-shelf", at short notice, and often at lower cost, in the Netherlands has been the main reason to have the development of the hand pumps being effectuated in the Netherlands. Similarly, the Finnish Nira pump has been, and is, completely imported from abroad.

Another reason for not yet starting any pump manufacturing in Tanzania has been the fact that due to a lack of appropriate raw materials, skilled personnel, etc. there is no factory, cooperative or similar institution in Tanzania that is capable of manufacturing a high-quality hand pump at this moment. Simple hand pumps are being manufactured at the Arusha Appropriate Technology Project, but these pumps require intensive preventive maintenance, which renders them unsuitable for use under normal rural Tanzanian conditions.
Shinyanga-type pumps have been manufactured in Shinyanga during the period that the Shinyanga Shallow Wells Project was a bilateral project, and shortly thereafter. Though being a good pump, the Shinyanga pump required constant maintenance, which - as a rule - is not being carried out in the rural areas (because of this fact the Morogoro Wells Construction Project switched to the Kangaroo pump). The situation was aggravated by difficulties experienced in Shinyanga because of scarcity of good-quality g.i. pipe, non-availability of fittings, etc. as well as problems with replacing older equipment (lack of hard currency), which resulted in the manufacturing of Shinyanga pumps having virtually stopped.

The fact that the Morogoro Wells Construction Project did not embark on manufacturing its own pumps at the project factory in Morogoro, was caused by several reasons:

- as mentioned earlier it was deemed more appropriate to have the development of a suitable hand- or foot-operated pump carried out in the Netherlands;

- the project itself was undertaken for a limited period initially, with the option of successive extension of the project period. This resulted in the project period being fixed with certainly (at any given moment) for short periods only, that did not warrant setting up a local pump factory;
- the lack of firm commitments from either the Tanzanian authorities or donor organizations, regarding required numbers of hand pumps, standardization of pump design etc. did not warrant setting up a pump factory either.

A crucial point in discussing the possibility, or feasibility, of locally manufacturing hand pumps is the fact that the pumps will generally be used under adverse conditions. This will be discussed in much more detail later, when dealing with the maintenance aspects of shallow wells and hand pumps (Chapter 5).
Already now it can be said that the maintenance of shallow wells with hand pumps - the emphasis of which would normally be on hand pump maintenance - will be a very costly matter if it has to be carried out by a centralized organization. Operation and maintenance of piped supply systems, traditionally the responsibility of the Regional Water Engineer, are being gradually shifted to the beneficiaries already, for mainly financial reasons.
Maintenance of the much larger numbers of shallow wells with the inherent problems of large numbers of staff and vehicles, high transport costs, etc. will, therefore, certainly be beyond the practical and financial possibilities of the Regional Water Engineer, unless other measures are taken as well, which would reduce the effort to be spent by the RWE's organization.

One of these measures would be to have maintenance carried out, as far as possible, at the village or ward level. This would substantially reduce the input required from the RWE's maintenance organization, which now might focus more on centralized tasks, e.g. doing more complicated repairs, making spareparts available at the ward or village level, etc. Having maintenance carried out at the village or ward level will be possible only when pumps attendants can be found that are willing and able to perform the required tasks.
Apart from the need to train these people, there will be the need to motivate the village or ward people (who may also have to pay the pump attendant's salary), because the entire system is bound to fail otherwise. Experience with the average Tanzanian villager's willingness to contribute time or money to the operation and maintenance of simple rural water supply works is rather disappointing.
As a rule much effort in the sphere of community development, community participation and extension project work may thus be necessary before maintenance at village level will have become a reality.

Until such time, but possibly also thereafter, it will be essential to preclude the necessity of regular, preventive maintenance by:

- an optimal pump design
- over-dimensioning critical parts
- using sealed and/or "life-greased" components rather than those requiring regular lubrication.

Consistently pursuing the ideal of a "maintenance-free" pump by the Morogoro Wells Construction Project has led, first, to a switch from the Shinyanga-type of pump head to the Kangaroo pump head and, recently, to the adoption of the SWN 80 and SWN 81 as the regular shallow well pumps. The latter two are examples of applying the above rules: the design of both pumps is based entirely on the principle of reducing maintenance requirements, incorporating vastly over-dimensioned and life-greased bearings and being entirely hot-dip galvanized in order to reduce corrosion as much as possible.
Also for the cylinder assembly non-corroding materials are used: ABS and pvc for the cylinder itself; stainless steel, brass nylon and neoprene for the piston and valves.

It was mentioned before that most of the materials that are used in constructing the hand pumps (pump head and cylinder assembly) are not available in Tanzania. Switching to local production of the hand pumps would thus mean that all basic material would have to be imported in any case.
The same holds true for the pump rods and risers (stainless steel and pvc) that are obtained direct from other suppliers.

Manufacturing the hand pumps locally - whether the SWN 80 or an equivalent pump type is selected - will, certainly in the initial phase, mean that the quality of the finished product is most probably adversely affected. It is recommended, also for this reason, that the feasibility of manufacturing the pumps locally is carefully investigated, taking into account such factors as:

- certified quantities of hand pumps to be produced
- suitable locations for establishing a pump factory
- cost of investing in machines, tools etc.
- availability of expert knowledge, trained staff etc.
- availability of galvanizing plants
- cost of transporting raw materials
- cost of importing pump sets
- independence from imported items
- promotion of Tanzanian industry
- increasing the skills of Tanzanian industrial workers

Especially the last few items are difficult to weigh against the other factors, whicht are of a more tangible nature.

The conclusion may well be that a clear decision cannot be reached and that it may be worthwhile to start a pilot project. Such a project might be restricted initially to locally assembling prefabricated (imported) parts, with a gradual increase in the number of components that are locally produced. This could be a step-wise progress, with each step being identified after a through evaluation of the results of the preceding one.
Complete local production may not be reached anyhow, since some components may require machinery of which the purchase is not warranted by the relatively limited turn-over, whereas other items may be commercially available abroad at rates which cannot even be remotely realized by local manufacturing because of the sheer quantity in which they are mass-produced abroad.
More details of the set-up required for locally manufacturing hand pumps will be given in paragraph 4.4.3. Setting up a local pump factory will in any case require that firm commitments are made, by donors and Tanzanian authorities alike, about the adoption of a standard pump design and selection of a location for such a factory. The later will be discussed in paragraph 4.4.5.

B. Pump rods and rising mains

Pump rods as used by the major users/suppliers of shallow well pumps, the Finnwater project in Mtwara/Lindi and the Morogoro Wells Construction Project, are completely interchangeable. Both projects use 10 mm diameter stainless steel rods with hexagonal couplings. These pump rods are imported and local production will not be feasible.

For rising mains galvanized iron pipe and PVC or ABS pipe have been used.
Galvanized pipe of the required sizes (1½" and 2" dia.) is locally available, but the quality of this pipe is often unacceptable. The MWCP has, therefore, resorted to importing g.i. pipe already some time ago. In more or less corrosive groundwaters even the best quality of g.i. pipe is not sufficient and ABS or PVC pipe will have to be used. ABS is not locally available; the availability of PVC is not always guaranteed (see under C.).

C. Well materials

Cement is produced in Tanzania in factories near Dar-es-Salaam (Wazo Hill) and Tanga, with the Mbeya factor nearing completion.. The maximum quantities required (see table 4.1.) remain below 2000 tonnes per annum, thus representing not more than 0.2 percent of the combined capacities of the two factories. Procurement of cement on behalf of wells implementation projects it not considered to be a task for a Shallow Wells Procurement Centre.

PVC pipe and screen are the most important well materials, cost-wise. It has been mentioned before (see para. 4.4.1.) that PVC can be produced by two Dar-es-Salaam based manufacturers, but that in practice a lack of raw materials is a severely restraining factor. In the past the quality of the produced PVC pipe has been such that it failed tests executed by the Netherlands testing institute for water supply articles, KIWA. Moreover the price of the local product did exceed the cost of the imported product (CIF Dar-es-Salaam) by 50 to over 100 percent (see fig. 4.7.). These factors combined have led to the fact that the Morogoro Wells Construction Project imports PVC pipe from abroad, as does, for instance, the Danida Steering Unit for Water Supply Project.

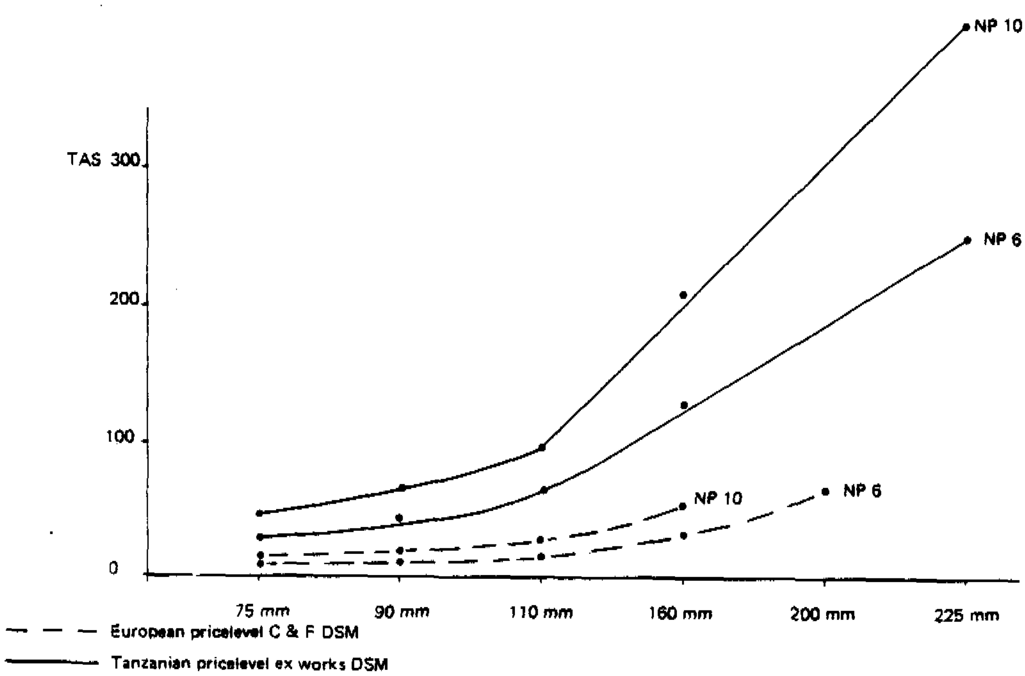
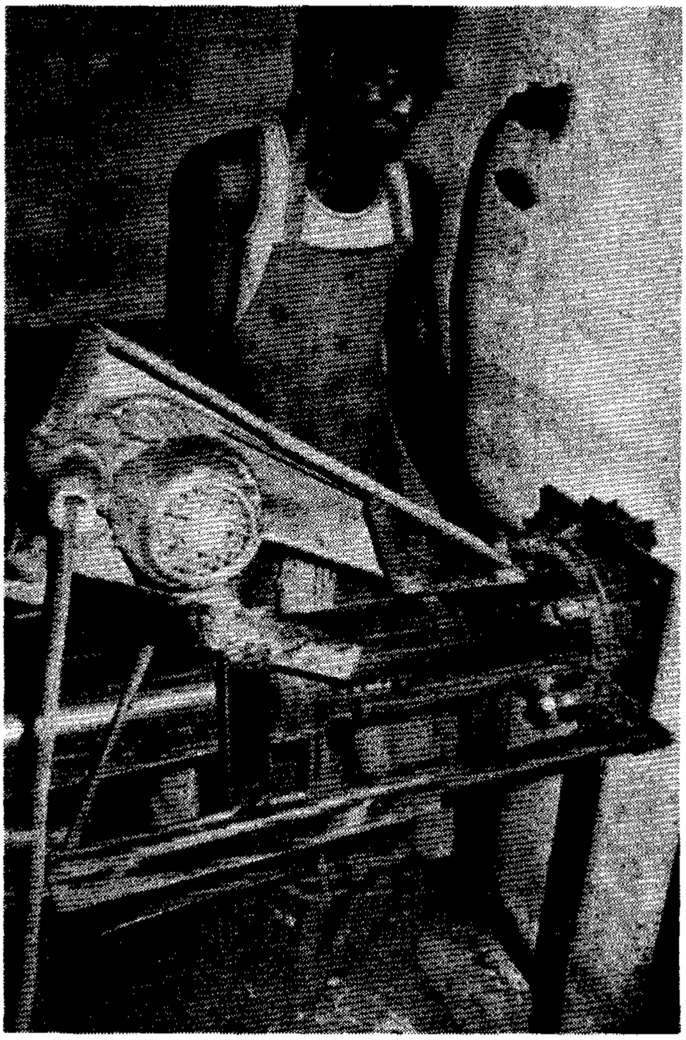


FIG. 4.7. PRICE LEVEL OF VARIOUS TYPES OF PLASTIC PIPES (Dec. 1980)

Slotted PVC pipes can not be obtained from either of the two local manufacturers. MAJI's Wazo Hill factory has the facility to make slots perpendicular to the pipe axis but, as mentioned before, the axially slotted pipe is preferred for reasons of material strength. Moreover the capacity of the Wazo Hill slotting machine is limited, and it is unclear to what extent - if any - this factory is allowed to supply non-MAJI, let alone private, customers. On the other hand, slotted PVC pipe may be imported at relatively low extra cost, and also the option exists to purchase a small slotting machine and slot plain PVC pipe locally. Sophisticated machinery, able of making a line of slots over the entire length of a pipe in one operation, is very expensive, but simpler machinery, making one or two slots at a time, can easily be put together locally.
An example of such a small slotting machine, used in Shinyanga, is shown on fig. 4.8.



4.8. PVC pipe slotting machine as used in Shinyanga

As far as the procurement of shallow well-related equipment and materials is concerned, the option of including plain and slotted (imported) PVC pipe may be included. On the other hand the option of removing the constraints that at present hamper local production of PVC pipes merits consideration also, albeit that it is rather outside the scope of this report.

D. Construction equipment for hand-bored wells

In paragraph 4.4.1. sub. B the items are listed that are currently being manufactured in Morogoro. Due to the limited staff of the workshop, priorities given to repairing existing equipment over producing new sets, and because of sometimes unexpectedly large orders, also a part of the equipment that can be made in Morogoro is frequently ordered from abroad.
Hexagonal coupling sets are relatively complicated to make and can be easier (and cheaper) imported; the specially hardened steel for cutting edges and teeth of bits and bailers also is not available in Tanzania, and because they are manufactured in much larger quantities it is much more attractive to order ready-made teeth and cutting edges from abroad, in order to weld them to the bits or bailers locally. Also chains, bolts, nuts, etc. are not made in Tanzania and can better be imported straight away, taking into account the necessary steel quality.

Casing pipes for hand-bored wells construction are partly imported and partly obtained locally.
Locally obtained pipe was received from MAJI stores in Dodoma, being redundant casing pipes from drilling rigs that had become obsolete. New square thread had to be cut on these pipes, for which the lathe at the Morogoro factory is not large enough. Wazo Hill has larger lathes, which would be able to do the job, but in spite of promises to make the casing pipe, the Wazo Hill factory has not proved able to turn out threaded casing sections in any quantity.

Therefore, and for as long as the available stock of large-diameter steel pipes (6" and 8") lasts, the MWCP reverted to the solution where pairs of threaded couplings are made in the Netherlands and shipped to Morogoro, where the required lengths of plain steel pipe are cut off and welded to these couplings.

Transportation being one of the main problems in a wells implementation project, it may prove worthwhile to economize on transportation by reducing the weight of the construction equipment. Since most of the weight is contributed by the steel casing of the HHD set, several ways have been tried to reduce this by using other materials. A promising solution which is used widely at the moment, is to have composite casing pipe sections, the threaded connector sections being made of tool steel, with the body of the casing section itself of ABS. Steel and ABS are connected with a threaded, and cemented, joint. Because ABS nor tool steel is available in Tanzania, with the abovementioned problems of cutting thread on larger-diameter pipes, the ABS-steel casing pipes are made in the Netherlands and shipped to Tanzania.

Although the production of hand-bored wells equipment is of minor importance, when compared to that of hand pumps or PVC pipe, experience shows that it is perfectly feasible to make this equipment, at any rate to a large extent, in Tanzania. Rather than embark on the local production of parts that have so far been imported, a first step might be to increase the output of locally produced HHD sets until all domestic requirements can be met. In case the Morogoro factory would be selected as the nucleus for a local production unit, such an increase in production capacity might be effectuated rather smoothly.

E. Construction equipment for hand-dug wells

As mentioned before, most small tools and equipment are available on the local market. The only piece of equipment that may have to be, and can be, constructed locally is the tripod.

F. Additional equipment

Paragraph 4.4.1. sub B mentions that most of this equipment either has to be imported, being of a too specialized nature or too small in number to be manufactured in Tanzania, or is normally available on the local market. Special items that can be made in Tanzania include: tripod with foot plate, measuring strip, water level meter, tool box, auger cleaner, casing retriever, gravel pack sieve, clay rammer, mould for well cover, cover plate, well cover hoist, pumprod hanger, cylinder plug spanner, etc.
All mentioned items are already being made at the Morogoro factory.

G. Survey equipment

In paragraph 4.4.1. sub A the items are listed that are made in Morogoro. As is the case with the construction equipment (see under D above) the restricted capacity of the workshop often makes it necessary to rely at least partly on imported survey equipment, whereas specific parts may have to be imported because of quality requirements (special steel quality required) or extremely low price levels abroad.
Cost-wise the procurement of survey equipment is even less important than that of HHD construction equipment. Nevertheless it is recommended to expand the capacity of the Morogoro Wells Construction Project's mechanical workshop to such an extent that all domestic requirements can be met.

4.4.3. Required set-up

It will be clear that the set-up of a local manufacturing organization for shallow well-related equipment depends entirely on the output level that is required. Earlier estimates have all been based on the anticipated production levels as shown in fgure 4.1. However, the sharp increase in the assumed production rate until 1985 renders all consumptions that go beyond a time span of one to two years highly speculative.

For the purpose of assessing the set-up that would be required for locally producing well-related equipment, the procurement volumes for the year 1982, as indicated in table 4.1, have been taken as the production capacity of the manufacturing organization. This means that a reasonably large output would be required, without being unrealistic when compared with actual present wells construction levels.

The procurement volume for 1982, exclusive of cement and PVC pipe, according to table 4.1 is as follows:

- survey equipment	:	23 lightweight sets
		13 heavyweight sets
- construction equipment	:	9 hand-digging sets
		11 hand-boring sets
		8 replacement sets
- hand pumps	:	1320 complete sets
		300 additional riser sets

With the exception of the additional riser sets, which can be imported directly, all other items could be manufactured locally, at least partly.

Table 4.3 gives an indication of the number of man-hours that would go into producing each of the various sets. The indication is valid for a well-trained organization, operating in Tanzania under expert supervision with direct access to high-quality raw materials and foreign exchange and for output levels as assumed for the year 1982 (see above) or higher. For very much higher output levels the indication is not necessarily correct, since in those cases other production methods (e.g. mass-production methods) might become more attractive.

The total number of man-hours required for the 1982 output level is indicated in table 4.4, as are the cost of the raw materials (prices ex-The Netherlands, price level October 1981), the cost of all raw materials plus the items that have been purchased as such without being used as raw material or half product, and the cost of all items, manufactured and purchased, ready for shipment from The Netherlands to Tanzania.

From table 4.4 it becomes clear once more that the hand pumps (pump heads SWN 80 + cylinder assemblies 3") are the most important product, accounting fore more than 50 percent of the total number of man-hours and of the total output (cost-wise).
Put differently, it suggests that all other items, required in a wide variety but in limited numbers, each from a relatively insignificant part of the total requirements.
Producing all these items might, therefore, increase the complexity of the local production organization out of all proportion when compared with the increase in production volume. For that reason two options will be investigated:

a. the local production of all items mentioned (see tables 4.3 and 4.4)
b. the local production of hand pumps only (based on SWN 80 pump head and 3" cylinder assembly).

Table 4.3 - <u>Breakdown of production in unit-operations</u> (man-hours per unit of product)

	sawing	turning	drilling	welding	cutting/ threading	grinding	forging	fitting/ bending	carpentry	painting/ packaging	total man-hours
leightweight survey set	4.6	11.7	1.1	19.5	5.7	2.8	7.8	1.1	-	11.7	66
heavyweight survey set	12.0	-	13.0	22.5	21.0	7.0	1.0	1.0	-	11.5	89
survey casing set	12.1	293.0	5.0	5.0	0.8	-	-	11.5	22.0	0.6	350
capacity control set	2.2	2.9	1.5	4.0	6.3	0.4	-	7.3	-	0.4	25
construction set (HHD)	15.6	4.2	11.0	71.6	0.3	28.8	6.5	-	-	12.0	150
construction casing set	25.0	146.0	3.0	7.0	-	10.0	1.0	38.0	-	-	230
additional construcion equipment	18.3	2.3	9.8	31.0	2.0	8.0	5.3	8.0	26.0	9.3	120
HHD replacement set	3.8	3.6	4.1	33.3	0.9	10.8	4.9	1.1	6.5	-	69
hand-digging set*)	7.2	2.3	4.5	20.5	-	5.0	3.0	2.0	-	7.0	51.5
pump head SWN 80	1.0	2.0	1.0	3.0	-	-	-	1.5	-	2.8	11.3
cylinder assembly 3"	0.5	2.0	-	0.5	-	-	-	1.0	-	-	4.0

*) In view of the very limited number of items that could be manufactured locally, most of which require expert knowledge, it is assumed that only the tripod and accessories will be considered for local production.

Table 4.4 - Total man-hours and costs for production/procurement (1982-level)

	number of units	total number of man-hours	cost per set (Dfl.) A**	B**	C**	total costs (Dfl.) A**	B**	C**
light weight survey set	23	1,518	1,379	2,184	3,008	31,717	50,232	69,184
heavyweight survey set	13	1,157	1,065	1,588	2,642	13,845	20,644	34,346
survey casing set	23	8,050	1,970	1,970	5,055	45,310	45,310	116,265
capacity control set	23	575	470	470	1,015	10,810	10,810	23,345
construction set (HHD)	11	1,650	2,613	2,918	5,667	28,743	32,098	62,337
construction casing set	11	2,530	5,900	6,320	9,945	64,900	69,520	109,395
additional construction equipment	11	1,320	1,272	6,930	10,197	13,992	76,230	112,167
HHD replacement set	8	552	1,155	5,063	6,668	9,240	40,504	53,344
hand-digging set*	9	464	495	2,605	3,846	4,455	23,445	34,614
pump head SWN 80	1,320	14,916	150	150	370	198,000	198,000	488,400
cylinder assembly 3"	1,320	5,280	138	138	225	182,160	182,160	297,000
total		38,012				603,172	748,953	1,400,397

* In view of the very limited number of items that could be manufactured locally, most of which require expert knowledge, it is assumed that only the tripod and accessories will be considered for local production.

** A. Cost (ex-Netherlands) of raw materials to be used in manufacturing only
B. Cost (ex-Netherlands) of raw materials to be used in manufacturing, plus remaining items that are purchased ready-made
C. Cost (ex-Netherlands) of manufactured products and ready-made products

Options A and B have been worked out in tables 4.5 and 4.6, respectively. These give a breakdown of the necessary equipment, its space requirements, cost (including transportation to the site, erection, connection to power supply etc.), depreciation period, consumption of small tools (drills, welding electrodes, cutting knives, etc.), power consumption and maintenance cost.
Also the wages and salaries of the staff have been included. These have been based on the following assumptions:

- numbers of staff involved in each unit process are based on the number of man-hours per unit operation (see table 4.3) and the average number of productive hours per staff member and per year
- the average number of productive man-hours per staff member and per year is calculated as follows:

. gross number of man-hours per year: 52 x 45	2,340 hours/year
. reduction for holidays, illness, special absence	340
number of hours present in the workshop	2,000 hours/year

  With an average efficiency of 70% this results in an average of 1,400 net productive hours per man and per year.

- salary levels (baed on the situation per second half of 1981) range from TAS 800/month to TAS 1500/month. In tables 4.5 and 4.6 an average salary level of Dfl 5,000 per year (or: approximately TAS 1250 per month) has been used
- no overhead cost, either for procuring of raw materials, or sale of end products, has been taken into account, since it is assumed that the manufcaturing workshop would be closely tied to the procurement organization
- management of the workshop, whether Tanzanian or expatriate, has not been included in tables 4.5 or 4.6

The cost figures in table 4.5 and 4.6 are all based on price levels valid for the second half of 1981. Annual costs are based, among other things, on straight-line depreciation without interest. Depreciation of buildings is based on an average lifetime of 20 years.

The main parameters for the two options A and B can be summarized as follows:

Option A (local production of all items)

Number of personnel	:	29 (excl. management/ overhead)
Size of workshop	:	700 m^2
Investment costs	:	Dfl. 1,700,000
Annual running costs (without depreciation)	:	Dfl. 356,000
Total annual costs (with depreciation)	:	Dfl. 505,000

Option B (local production of hand pumps only)

Number of personnel	:	17 (excl. management/ overhead)
Size of workshop	:	430 m^2
Investment cost	:	Dfl. 860,000
Annual runing costs (without depreciation)	:	Dfl. 860,000
Total annual costs (with depreciation)	:	Dfl. 275,000

Table 4.5 - Investment and running costs for option A (production of all items locally)

no.	description	depre-ciation in years	required number	workshop space in m^2	investment costs in Dfl. basic outfit + tools	transport (Dfl. 2/kg)	installa-tion costs	annual costs in Dfl. deprecia-tion of invest-ment	tools	power consumption (at Dfl. 0.40/kWh)	mainte-nance	wages/ salaries
A.	Equipment											
1.	hacksaw 300 mm	5	3	75	36,000	18,000	3,000	11,400	6,000	1,500	1,500	15,000
2.	lathe 2.5 m	10	4	100	300,000	32,000	4,000	33,600	24,000	11,200	4,000	20,000
3.	lathe 1.5 m	10	6	120	300,000	40,000	6,000	34,600	36,000	13,500	6,000	30,000
4.	drill m.c. 4	10	1	15	15,000	6,000	1,000	2,200	2,000	2,300	1,000	5,000
5.	drill m.c. 3	10	1	15	10,000	4,000	1,000	1,500	2,000	1,700	1,000	5,000
6.	welding transformer 300A	5	5	125	20,000	5,000	2,500	5,500	22,500	11,200	2,500	25,000
7.	thread cutter ½"-2½"	5	1	15	10,000	1,000	500	1,100	2,000	300	100	2,500
8.	steel plate cutter 1.25 m	10	1	10	20,000	4,000	500	2,500	3,000	200	500	-
9.	bending machine 1.25 m	5	1	10	6,000	4,000	-	2,000	2,000	-	500	-
10.	cutter/puncher, hand	5	1	10	3,000	200	100	700	100	-	100	-
11.	grinder, hand, Ø 178 mm	3	3	-	3,000	100	200	1,100	3,000	4,000	200	-
12.	grinder, stationary, Ø 300 mm	5	1	5	1,500	100	400	400	250	600	100	-
13.	forge $1m^2$ surface	10	1	15	10,000	1,000	1,000	1,200	150	200	100	5,000
14.	carpentry set	10	1	15	4,000	1,000	-	500	1,000	100	-	5,000
15.	store outfit	10	1	100	15,000	2,000	3,000	2,000	-	100	-	10,000
16.	office equipment	10	1	25	10,000	2,000	1,000	1,300	2,000	200	-	28,000
17.	service/cleaning equip-ment	5	1	-	5,000	1,000	-	1,200	-	-	-	-
	sub-totals	-	-	665	768,500	121,400	24,200	102,800	106,000	47,100	17,500	150,500
	totals					914,100				423,900		
	miscellaneous/contin-gencies					85,900				46,100		
	grand totals					1,000,000				470,000		
B.	Buildings											
1.	665 m^2 x Dfl. 1000/m^2					655,000						
2.	Miscellaneous/contin-gencies					45,000						
	totals					700,000				35,000		
C.	GRAND TOTAL					1,700,000				505,000		

Table 4.6 - Investment and running costs for option B (production of hand pumps only)

no.	description	depreciation in years	required number	workshop space in m^2	investment costs in Dfl.: basic outfit + tools	investment costs in Dfl.: transport (Dfl. 2/kg)	investment costs in Dfl.: installation costs	annual costs in Dfl.: depreciation of investment	annual costs in Dfl.: tools	annual costs in Dfl.: power consumption (at Dfl. 04.0/kWh)	annual costs in Dfl.: maintenance	annual costs in Dfl.: wages/salaries
A.	Equipment											
1.	hacksaw 300 mm	5	2	50	24,000	12,000	2,000	7,600	4,000	1,000	1,000	10,000
2.	lathe 1.5 m	10	4	80	200,000	26,700	4,000	23,000	24,000	9,000	4,000	20,000
3.	drill m.c. 3	10	1	15	10,000	4,000	1,000	1,500	2,000	1,700	1,000	5,000
4.	welding transformer 300A	5	4	100	16,000	4,000	2,000	4,500	18,000	9,000	2,000	20,000
5.	thread cutter ½"-2½"	5	1	15	10,000	1,000	500	1,100	2,000	300	100	2,500
6.	steel plate cutter 1.25 m	10	1	10	20,000	4,000	500	2,500	3,000	200	500	-
7.	bending machine 1.25 m	5	1	10	6,000	4,000	-	2,000	2,000	-	500	-
8.	cutter/puncher, hand	5	1	10	3,000	200	100	700	100	-	100	-
9.	grinder, hand, Ø 178 mm	3	2	-	2,000	100	200	800	2,000	2,500	200	-
10.	grinder, stationary, Ø 300 mm	5	1	5	1,500	100	400	400	200	600	100	-
11.	store outfit	10	1	75	10,000	2,000	3,000	1,500	-	100	-	10,000
12.	office equipment	10	1	20	8,000	2,000	1,000	1,100	1,500	200	-	22,000
13.	service/cleaning equipment	5	1	-	4,000	1,000	-	1,000	-	-	-	-
	sub-totals	-	-	390	314,500	61,100	14,700	47,700	58,800	24,600	9,500	89,500
	totals					390,300				230,100		
	miscellaneous/contingencies					39,700				22,900		
	grand totals					430,000				253,000		
B.	Buildings											
1.	390 m^2 x Dfl. 1000/m^2					390,000						
2.	Miscellaneous/contingencies					40,000						
	totals					430,000				22,000		
C.	GRAND TOTAL					860,000				275,000		

4.4.4 Cost comparison (local production versus importation)

In table 4.7 a comparison is made between the annual cost (based on a production level as indicated for 1982 in fig. 4.1 and table 4.1) in case of local production versus importation of shallow-well related equipment. The same options A and B as mentioned in paragraph 4.4.3 are indicated.
Freight costs have not been included. These costs (freight of raw materials in case of local production; freight of the finished product in case of importation) are assumed to be more or less equal for both cases. At any rate the difference in freight costs will be within the margin of error of the total cost comparison.

Table 4.7 - Comparison of cost of locally produced versus imported items (all costs in Netherlands guilders)

no.	description	option A	option B
A.	depreciation of investments	149,000	74,500
B.	running costs per annum	356,000	200,500
C.	total annual costs (see tables 4.5 and 4.6)	505,000	275,000
D.	cost of materials (see table 4.4 under B)	749,000	380,200
E.	Total cost (local production,	1,254,000	655,200
F.	Total cost (importation, excluding freight	1,400,400	785,400
G.	financial advantage of local production	+ 146,400	+ 130,200

The following conclusions can be drawn from table 4.7:

a. on the basis of the - relatively rough - calculations as made in tables 4.5 and 4.6 there is a financial advantage of locally producing shallow well-related materials if:
   - no interest on investments is taken into account
   - no overhead or expatriate personnel is taken into account

b. the financial advantage is relatively larger for option B: investments as well as annual costs are roughly half those of option A, but the financial advantage is almost the same. (For option A the financial advantage amounts to 8.6 percent of total investments; for option B this is 15.1 percent)

c. in case interest on investments is taken into account, as annuities, the financial advantage will decrease with increasing interest rates. This is shown in table 4.8, for interest rates of 3, 5, 10 and 15 percent.

DHV - NSWP final report
(DRAFT)

method
1) [illegible] projects (SH + MR)
2) visit to [illegible]
3) discussion [illegible] with.
4) literature
NO [illegible] testing [illegible]

Problems
1) [illegible] projects not integrated into regional structure
2) no national [illegible]/control
3) different digging/constr. techniques
4) " handpumps - unstandardised parts
5) [illegible] adm. structure supply of [illegible] (pulleys, cement) etc
6) [illegible]
7) uncertain annual budgets
8) needs of CP not considered;
minimal CP on siting; [illegible], no [illegible] on [illegible] well + well [illegible]; unpaid attendant trained
9) no maint. by RWE. Depends on [illegible]
10) evaluation in production numbers + [illegible] efficiency.

ToR — nat. sh. wells programme

1) suitability? 1) SW not everywhere possible, but
2) SW suitable for 50 % of pop.; [illegible]; simple + known technology → rapid impl.

2) org. scale: 3) options a) national program, incl. SW
b) regional projects, incl. SW
c) national SW program
d) regional SW programmes.

3) maintenance: by village paid caretakers → policy decision
Agreement on maintenance resp + rules of use
depends on answering felt need for access + clean water
yet: || ease of access may be felt need more for women
|| and: many cases (Mwogno [illegible]) access is no problem

4) health impact: health benefits of RWS not perceived
add. changes for health impact [illegible].

5) proposed CEP procedure : p. 9-10.

6) maint. org.
national procurement center — probably also include spares for transport, see App. 1, p. 2.
|
regional district stores
|
dir. maint. staff (+ stock of spares) + bike
|
village caretaker

2) Type of pump : sturdy pump requires importation. Suggested to be done through procurement centre. [illegible] has been purchased since now, shift to local assemblage provided enough demand, standardization of design and study of foreign exchange costs involved in locally obtainable (not imported) material and parts; and supervision + quality control (required) costs

2

Training : with teams at WRI
Caretakers by project impl. units at regional level

Role of Maji in CEP etc. : see p 14.
! Suggests that with greater resp. of Maji, [illegible] will have to pay salaries etc !

Other water uses : add. wells + cattle watering facilities in pastoralist societies + payment for add. services
• vegetable gardens discussed.

quality monitoring. Method — zonal labs + even more decentralisation for 24hr testing
— portable equipment for limited testing on fluoride, total solids, E. coli.
Esp. on fluoride more research needed in SW progr.

Org. chart for Nat. S.W. Programme.

Ch. II Shallow Wells Market (Potential of SW.)
[illegible] just rest already being served with PWS)
Arusha : max. 15 % (no groundwater data, [illegible] (10 %)
Coast : conflicting info. 1) : CBA Eng. Vancouver. [illegible] groundwater. (432.100 people)
2) WMP. 74 % of 355 villages use [illegible] with groundwater
of unserved pop, 25 % [illegible] with groundwater
(100 [illegible], 128.556 people, [illegible] SW.)
[illegible] included = WMP. [illegible]

Dodoma : est. 25-30 %, but not included
Iringa :
Kigoma :
Kilimanjaro : In Kole basin. No % given
Lindi : min. 50 % served thru SW.
Mara : 75-80 % potential; Plan:
Mwanza : 540 wells planned.
Lake :
Morogoro :
Morogoro North : 52 % in execution
" South : 80 % potential.
Mtwara : over 30 %
Mwan
Rukwa : ca. 800 wells planned. in R + K ? (= 24 %) or in Kwiz (= 61 % of pop.) ?
Ruvuma :
Shinyanga : 25 % of pop. served with SW in '80, potential 80 %. (2.325 wells).
Needed : 2200.
Singida : present use 63 %.
Tabora 75 % potential

OVERALL EST. 50 %

Size of NSWP : see table 2.1

Present rural pop : 15 m.
served : 5-6 million
functioning : 2-3 million
left to be served : 12 million } 18 m. 50% by SW → 9 m
pop. growth '91 : 5 million

Ch III Construction of SW.

Av. nr. of users : 300.
Total nr. of people to be served : 9 m.
Total nr. of wells needed till '91 : 30,000
→ ca. 3000 / yr.
or 150–200 yr/region.

Presently going on in : Sh., Mor, Lindi/Mtwara / Mwanza / Singida / Tabora / Tanga.

Nat. level — Recommended is Wood. Agency, with Techn. Word. Clee.
(started when visited Mtwara/Lindi. Report expected in March '78. see TOR.)
recom.: special unit under [illegible]
WMPCU as nucleus?

Tasks: see p. 5. compare with TOR!

Executive level:
- PS does not follow nat. project for regional SW activities, yet complains about lack of national info. (17 project info. offices in RWE office now appointed may help)
- Report recommends Regional impl. unit either as part of overall RWE or as separate well constr. team / project. (Mor, Lindi/Mtwara)
  1) Donor project with sep. funds + expat. staff. Only they showed max. output < independent: no bureaucracy, higher salaries, foreign exchange; linked to RWE: foreign exchange remains problem } no direct access to outside supply.
  2) Tz SW project under RWE
  3) Tz SW team as part of regional RWS programme.

Rm: suggest Tz. SW project under RWE but with one donor "advisor" for control and donor-organized + paid procurement centre to import pumps / spares, which is to be gradually replaced by local prod. pumps. (At same time procurement centre carrying Tz. "quality control officer to check quality of Tz-produced pumps).

Wellsiting — By trained RWE staff by (geo) hydrologist, with back-up if necessary from Principal Geologist Office, Dodoma

Well constr. — Suggested sub-contracting of constr. and possibly O+M to private or coop. enterprise. Gradual development from (1) donor-SW projects (2) train.[ing] staff at WRI + in the job (3) for integration in RWE or integrate well surveyors into RWE (4) prepare well constr. indep. operation. For latter, pilot project in Morogoro is suggested.

? impractical, integration: RWE!

Parastatal — Alternative is to replace RWE office + sep. donor projects by parastatal body for RWS (regional or national) (Water Supply Corporation). Constr. of SW either by well teams or by contractors.

Implementation — Survey independently as need more time + visit sites useful if constr. team are cut off by rains etc.

Procedures: see text.

Total (constr.) cost calculation (staff + well material and equipment + transport + offices) — initial: TAS 55; annual: TAS [illegible] (budget: TAS 200)

CQ. 4. Procurement of Mat. + Equipment

procurement + storage (at Maji Kurasini store) many problems, esp. foreign exchange problems + availability + expertise [illegible]
supply center for other projects.
surveying + of est. nr. of various types of mat + equipment see p. 15 —
HP is scaled Term. ca. 7000 / year needed.

Life curve : pumphead } 5 yrs. (in case of no maint.)
" rod
cylinder
riser : 3 yrs. " "

O+M central visits. → can be reduced to once/2 to 3 wees? when headed by [illegible]?

Procurement Org. : options are
a) gov. body
b) parastatal
c) independent (more or less) donor-sponsored project
d) coop. or local contractor.
↳ eg. RCT's (but no org. at national level + no spares ⊂ w knowledge) with access to much KVE a.o. gov. org. (with LHO's) and others (with TNS)
Gov. stores or Kurasini cannot supply to individuals.

Maint. org. see p. 29 !

Local prod. gradually possible
- pumphead 11.3 manhours. (sawing, turning, drilling, welding, fitting, painting)
- cylinder 4 " (" , " , — , " , " , —)

costs — Dfl. 150 (raw mat. + salary + transport + electric etc) to Dfl. 370 (ready imported) } no management
— Dfl. 128 to Dfl. 225 (") } costs incl.

From this table it is obvious that option B is much less vulnerable to the level of interest that might have to be paid on invested capital. It may be argued that most probably investments of this kind would be paid from grants of soft loans by donor agencies, so that interest rates may not be very high. On the other hand, such opportunities may not be available forever

Table 4.8. - Influence of interest payable on investments, on financial advantage of local production (all costs in Dfl)

Option	Description	interest rate payable on investements 3%	5%	10%	15%
A	Annuities of investements:	178,079	199,524	258,789	324,726
	Less: depreciation according to table 4.5. (incl. contigencies)	-113,980	-113,980	-113,980	-113,980
	Extra cost because of interest payable on investments:	64,099	84,544	144,809	210,746
	Financial advantage, after deduction of extra cost above:	+ 82,301	+ 60,856	+ 1,591	- 64,346
B	Annuities of investements:	92,995	104,465	136,339	171,858
	Less: depreciation according to table 4.5. (incl. contigencies)	- 54,447	- 54,447	- 54,447	- 54,447
	Extra cost because of interest payable on investments:	40,548	52,018	83,892	119,411
	Financial advantage, after deduction of extra cost above:	+ 89,652	+ 78,182	+ 46,308	+ 10,789

A solution that would still show a profit when interest would have to be paid, is thus clearly to be preferred.

A moderate overhead and management cost could be met from the financial advantage for both options, provided that no high interest rates would have to be paid. Paying highly qualified expatriate management personnel from the margins indicated in table 4.7.G (and table 4.8 in case interest will have toe be paid) will not normally be fiasible, though.
Payment of local management staff should be feasible, however, and as such the idea of locally producing shallow well-related equipment merits careful consideration.

Taking into account also earlier conclusions and recommendations, it is recommended that the competent Tanzanian authorities and the donor organizations involved, establish policy guidelines regarding local production of shallow well-related equipment and hand pumps.
It must be stressed that local production will only be feasible if firm commitments can be obtained from the on-going wells construction projects, regarding the required numbers of equipment and hand pumps. Also agreement about methods and models, on which to standardize construction, will have to be reached.
Moreover the local production of shallow well-related equipment and/or hand pumps will be viable only if:

- a good-quality product is guaranteed. This may require, at least initially, the employment of expatriate management staff
- the producing organization has direct access to high-quality raw materials. Most, if not all, of these will have to be imported, so that hard currency will have to be at the organization's disposal. It is for this reason that joint operation of the procurement and production organizations (see also paragraph 4.3.2) is recommended.

It is recommended to have a more detailed feasibility study carried out on locally manufacturing shallow well-related equipment and hand pumps as soon as the above-mentioned policy guidelines have been established and firm commitments regarding standardization of equipment and hand pumps have been obtained. In view of the tentative conclusions reached in this report and especially in the present paragraph, special attention should be given to investigate the possibilities of locally producing only the hand pumps. Producing also all other shallow well-related equipment has been shown to require much higher investment and recurrent costs, more personnel and, consequently, a larger management staff and overhead - thereby consuming more of the financial advantage shown in table 4.7 - without substantially increasing the initial value of that advantage, expressed as shillings (or guilders, etc.) per annum.

4.4.5. Choice of location

The selection of an organization or institution to be charged with the local production of shallow well-related equipment and/or hand pumps can be based on the following criteria:

a. advantageous geographical situation: good road and/or rail links to center of importation (harbour of Dar-es-Salaam, possibly also Tanga), and to ongoing wells construction projects primarily, but also to other regions.
   In view of the present state of the Tanzanian road and railway network, a location close to Dar-es-Salaam appears to be advantageous
b. availability of machinery and equipment, thereby reducing the amount of initial investments that would have to be made
c. availability of trained personnel. This narrows the possibilities down substantially.

Experience with the production of shallow well-related equipment and hand pumps in Tanzania is available only in Shinyanga and Morogoro, both projects having acted as a production and supply organization for such equipment

Experience gained during the execution of the Shinyanga and Morogoro wells construction projects tends to indicate that at present there is no Tanzanian organization that would be able to produce shallow well-related equipment and/or hand pumps commercially, and at short notice.
It appears logical, therefore, to confine oneself to those organizations that are already involved, to whatever extent, in the construction of shallow wells, when searching for possibilities of locally producing the items mentioned.
Taking into account the situation as it is, the following parties might be involved in local production:

- the Shinyanga Shallow Wells Project
- the Wazo Hill Workshop of MAJI
- the Morogoro Wells Construction Project

Historically, the Shinyanga Shallow Wells Project has been the first project to start manufacturing hand pumps (the "Shinyanga pump"), also for third parties. Since the direct Netherlands involvement in the project was drastically reduced (in 1978) and notwithstanding valiant efforts by the Tanzanian staff, the well-known problems that plague all Regional Water Engineers (lack of imported items, lack of funds, lack of trained staff, lack of spare parts, etc.) have severely reduced the output of this project.
Expertise of the staff is tied to the Shinyanga pump that, because of its maintenance requirements, has not been adopted by the other wells construction projects.
Also taking into account Shinyanga's geographical situation, which is clearly unfavourable, when compared with the other two, Shinyanga appears to be the least feasible centre for locally manufacturing the shallow well-related equipment and/or hand pumps.

The geographical disadvantage of Shinyanga does not apply to Maji's Wazo Hill workshop or, to a somewhat lesser extent, the Morogoro Wells Construction Project. Both can easily be reached from the port complex of Dar-es-Salaam, the difference in total driving time not exceeding 3 hours. As for the road connections to other parts of the country, the difference in total driving time is even less, or favouring Morogoro as a location.

As far as the available machinery is concerned, there is a distinct advantage for the Wazo Hill workshop, as can be derived from Appendix 3. The advantage may prove to be much smaller in practice, however, since most of this equipment is being used for other purposes: keeping MAJI's vehicles and mechanical equipment in running order.

Regarding the availability of trained personnel there is a distinct advantage for the workshop of the Morogoro Wells Construction Project. In practice this is the only project in Tanzania where shallow well-related equipment (including hand pump prototypes) is constructed and also supplied to third parties. Moreover, the travelling project members of MWCP are very much involved in the process of developing maintenance-"free" hand pumps and well-related equipment in general, and keeping up with latest developments regarding these subjects, all over the world.
The Wazo Hill workshop could have had the same function. In fact it was supposed to produce the hand pumps for the Shinyanga Shallow Wells Project at the very beginning of that project, and its inability, at that time, to produce these pumps led to the start of local manufacturing of the "Shinyanga pump". Also later it has been tried to produce hand pumps at Wazo Hill, without much success. A reason for the lack of success compared to the Morogoro workshop may be the much more difficult backstopping of the expatriate staff at Wazo Hill, but certainly also the fact that it will have to operate within the framework of the bureaucracy of the Ministry of Water and Energy. This has already led to grave difficulties regarding the availability of raw materials and to problems in the personnel sector. Recent experience with orders placed with the Wazo Hill workshop has not been very encouraging, orders not being followed up over periods of more than a year.

Finally, there might be the same type of problem in charging Maji's Wazo Hill workshop with the production of hand pumps and/or shallow well-related equipment that was mentioned before regarding the procurement of such items by a Maji department (see paragraph 4.3.2): because of the fact that the workshop is an integrated component of the Maji organization, it is not normally allowed - even if it would be able to do so, which is as yet doubtful - to produce items for third parties, which do not necessarily have to be government bodies, let alone be a part of the Ministry of Water and Energy itself.

Combining the above impressions and conclusions with the opinion as expressed by senior Maji officials that the Wazo Hill workshop's first and foremost task should be to keep the rolling stock and mechanical equipment of the Ministry operative by acting as a maintenance organization, and adding to that the security and personnel problems faced by the workshop (e.g. regular "disappearance" of more valuable spare parts), it becomes clear that selecting Maji's Wazo Hill workshop as a shallow well-related equipment production center is not an ideal solution either.

This leaves the option of transforming the Morogoro Wells Construction Project's workshop into the production centre for locally-made hand pumps and shallow well-related equipment or building up an entirely new organization.

The latter solution would have the advantage that an optimum location might be chosen, but, when compared to Morogoro with its tarmac road link to Dar-es-Salaam, to Dodoma (in the near future) and to Iringa, the advantage of selecting an other location may be rather limited. On the other hand the expertise of the Morogoro staff could be used, as well as the facilities available at the compound of the Morogoro Wells Contruction Project.
As it is envisaged that the regular production of shallow wells in the Morogoro Region will gradually be taken over by Tanzanian bodies, whether inside or outside the RWE's organization, the goals of the MWCP might be shifted towards acting more as a production organization:
This would tie in very well with the earlier made recommendation of having this project (or at least its procurement/supply department) act as the nucleus of a future National Shallow Wells Procurement Centre.

It is recommended, therefore, to charge the Morogoro Wells Construction Project with working out a detailed proposal for transforming its supply department and factory into components that could form the nucleus of a National Shallow Wells Procurement (and Production) Centre.
It is stressed once more, however, that creating such a body presupposes that measures regarding the selection of one or two standard pump types and standardization of construction methods and equipment, endorsed by the relevant Tanzanian authorities, have been taken, and that long-term availability of hard currency is guaranteed (by the donor organizations?).

4.5. Summary and recommendations

a. Procurement of materials and equipment for rural water supply in general, and also for shallow wells construction, is an essential element, accounting for more than 50% of annual costs in the rural water supply sector.
b. Established procurement procedures which, for rural water supply, are channelled through Maji (Kurasini stores), are less than satisfactory. Especially for the procurement of shallow well-related materials and hand pumps alternative solutions must be found. Reasons for this are, among other things, the bureaucratic framework in which a Maji supply organization will have to work, its lack of hard currency, and its inability to supply to third parties, especially in case these are non-government organizations or private persons/organizations.
c. The annual turnover of shallow well-related items is estimated (paragraph 4.2), based on the assumption that:
   - the 1991 target of providing each inhabitant of Tanzania with "ease of access" to clean water will have to be reached
   - a total of 30,000 shallow to medium-depth wells can and will be constructed before 1991
   - 90% of those wells can be made using HHD-equipment; the remainder by hand-digging methods.

d. The total turnover of materials and equipment required for those 30,000 wells amounts to approximately 375 million Tanzanian shillings, as follows:

- TAS 248 million : hand pumps
- TAS 65 million : well materials
- TAS 62 million : additional equipment and materials

e. It is clear, therefore, that hand pumps are the most important single item, accounting for not less than 50 to 78% of the total annual procurement (an average of 66% for the period up to 1991). It is for this reason that local production of shallow well-related items will be investigated for two options:

- option A : production of all shallow well-related items, including hand pumps
- option B : production of hand pumps only.

f. Both options have been worked out (paragraph 4.4.3) and costs compared with importation of end products from abroad (paragraph 4.4.4). For this comparison the production level as assumed to be required for the year 1982 has been taken, in order to have a reasonably high output level, without being unrealistically high when compared to actual wells production levels (1980/1981). The main results are as follows:

	option A	option B
number of personnel (excluding overhead/management)	29	17
size of workshop (m^2)	700	430
investment costs (Dfl.)	1,700,000	860,000
annual running costs (without depreciation) (Dfl.)	356,000	200,000
total annual costs (including depreciation) (Dfl.)	505,000	275,000
cost of materials (excluding freight) (Dfl.)	749,000	380,200
total costs (excluding freight) in case of local production (Dfl.)	1,254,000	655,200
total costs (excludingfreight) in case of importation (Dfl.)	1,400,400	785,400
financial advantage of local production (Dfl.)	146,400	130,200
ditto, in case of 3% interest on capital investment	82,301	89,652
ditto, in case of 5% interest on capital investment	60,856	78,182
ditto, in case of 10% interest on capital investment	1,591	46,308
ditto, in case of 15% interest on capital investment	- 64,346	10,789

g. According to the above data there is a financial advantage of locally producing shallow well-related items, provided that:
- the interest payable on capital investments is not too high
- no overhead of expatriate personnel needs to be taken into account

The first criterion might be met, since it might be assumed that setting up a local production organization would be financed with donor funds that are either grants or soft loans.
The second criterion would be more difficult to meet. Tanzanian management staff, the salaries for which could be paid from the indicated margins, is not readiliy available. A training programme would, therefore, have to be set up, most probably with expatriate involvement. It would be logical to assume, however, that the costs of such a programme should be considered separately.

h. It appears that the financial advantage of local production under option B (hand pumps only) is much less influenced by the interest that might have to be paid on capital investments.
Except for interest rates below 2% even the nominal value of the financial advantage is greater for option B, notwithstanding the fact that investments are only about half those of option A, that the number of staff involved is much smaller, and that the production process - being restricted to hand pumps - is much simpler, thus requiring much less management and overhead cost (which would have to be paid out of the financial advantage indicated).
It is recommended, therefore, to restrict local production, at any rate initially, to hand pumps. Also for these it might be advantageous not to embark on full production from the beginning, but to develop production in stages, starting with the assembling of readily imported components, and gradually increasing the use of locally produced components. The feasibility of such an approach would have to be investigated in greater detail, however, than is possible within the framework of the National Shallow Wells Programme, and might be checked in a pilot project.

i. A comparison of possible candidates for locally producing shallow well-related items has been made. Based on various criteria, such as:
- availability of trained staff
- availability of facilities and machinery
- geographical location; road and railway connections to other Regions
- organizational set-up
- possibilities to supply to third parties, including private parties/ persons.

the Morogoro Wells Construction Project's workshop appears to be the most suitable for locally producing the required items. Especially in case local production could be tied in with a National Shallow Wells Procurement Organization, the existing supply department and factory of the Morogoro Wells Construction Project could act as the nucleus for such a combined organization.

These units would then have to be separated from the wells construction units proper, and also the possibilities of direct involvement of other donor agencies might be contemplated in such a set-up.

j. The following recommendations are made:

1. Maji and/or P.M.O. should formulate a concrete policy of constructing shallow wells in Tanzania. This policy should, specifically, either take into account the Party's resolution regarding the supply of clean water to all Tanzanians by 1991, or formulate a clear alternative.
   The policy should also fix , per Region and per year, tangible goals in terms of numbers of shallow wells or other installations to be constructed, people to be supplied with water, etc.
   Such policy decisions would require the active cooperation of the donor agencies and coordination of their activities in the field of rural water supply, for which the Tanzanian Water Development Coordination Board would be the logical forum.
2. The Tanzanian authorties, together with the donor agencies, should establish standardization of hand pumps, methods and equipment to be used in rural water supply, and especally in the construction of shallow to medium-depth wells (preferably through a Technical Coordination Commitee, to be created).
3. Firm commitments from the ongoing wells construction projects must be obtained regarding the numbers of hand pumps and other shallow well-related items they would want to receive through a National Shallow Wells Procurement Centre (NSWPC) if such a body would be created.
4. Local production of hand pumps, and possibly also of other types of shallow well-related items should be started in Tanzania. Most probably a phased realisation of such a production organization would be preferable.
5. The existing supply and production departments of the Morogoro Wells Construction Project might form the nucleus of a National Shallow Wells Procurement Centre (including local production). In that case they should be separated from the MWCP proper, thereby also opening possibilities for other parties (e.g. donors) to participate in such a NSWPC. This participation might be in the shape of making staff available, or even putting in foreign currency or supplying certain raw materials that might be required for locally producing shallow well-related items. The value of the currency or materials input could then be booked against deliveries to parties or projects that are financed by that particular donor agency. The overall-effect of such an approach would be that those parties or projects receive their donor support at least partly in kind, rather than in cash, while the coordination of procurement is enhanced and the standardization of equipment and materials is promoted.

6. It is recommended to have the Morogoro Wells Construction Project work out detailed proposals for setting up a full-fledged procurement and production organization for shallow well-related equipment and hand pumps, taking into account the above-mentioned considerations.

DGIS/RW/MCJ/DGIS10-B

APPENDIX 1

RECOMMENDED EQUIPMENT FOR HANDDRILLED WELLS

(sizes in mm)

CASING SIZE / EQUIPMENT	(3") 90/76 — survey equipment	(4") 125/106 — survey equipment / construction equipment	(6") 165/150 — construction equipment	(8") 220/200 — construction equipment	(10") 275/250 — construction equipment
Tools					
Primary augers					
open clay auger	100	140	-	-	-
flight auger	-	-	180	230	300
riverside auger	100	140	180	230	300
Secondary auger					
open clay auger	70	100	-	-	-
flight auger	70	100	140	180	230
riverside auger	70	100	140	180	230
bailer	63	76	90	130	180
Drilling rod Φ	22	26	76	76	76
Tripod required	-	-	+	+	+
Max depth (m)	25	25	25	20	15
Materials:					
P.V.C.	-	80/74	90/84	110/103	160/150
pumpcylinder	-	62/50 (2")	75/63 (2½")	90/75 (3")	115/100 (4")

LIGHTWEIGHT conical thread connectors

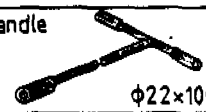
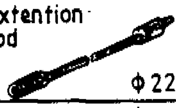
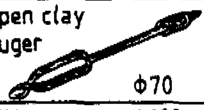
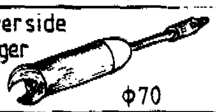
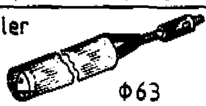
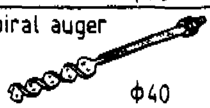
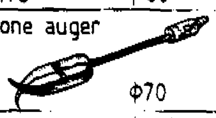
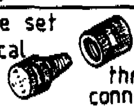
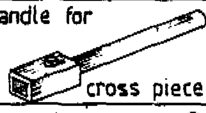
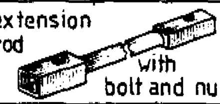
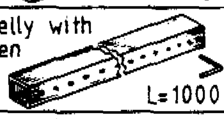
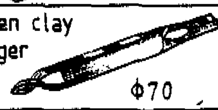
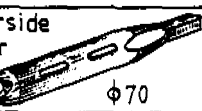
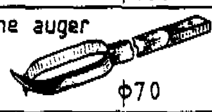
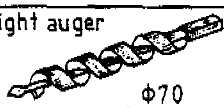
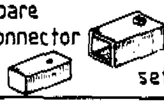
illustration description	nr.	price
handle  Φ22×1000		
ditto Φ26×1000		
extention rod  Φ22×1000		
ditto Φ26×1000		
open clay auger  Φ70		
ditto Φ100		
ditto Φ140		
riverside auger  Φ70		
ditto Φ100		
ditto Φ140		
spare bit for riverside auger  Φ70		
ditto Φ100		
ditto Φ140		
flight auger  Φ70		
ditto Φ100		
ditto Φ140		
bailer  Φ63		
ditto Φ76		
spare valve for bailer  Φ63		
ditto Φ76		
spiral auger  Φ40		
ditto Φ80		
stone auger  Φ70		
ditto Φ100		

illustration description	nr.	price
stone catcher  Φ70		
ditto Φ100		
ditto Φ140		
spare set conical  thread connector		

HEAVYWEIGHT square connectors

illustration description	nr.	price
cross piece 		
handle for  cross piece		
extension rod  with bolt and nut		
kelly with pen  L=1000		
open clay auger  Φ70		
ditto Φ100		
riverside auger  Φ70		
ditto Φ100		
spare bit for riverside auger  Φ70		
ditto Φ100		
stone auger  Φ70		
ditto Φ100		
flight auger  Φ70		
bolt+nut M12×50		
spare connector  set		

CASING ABS steel connectors

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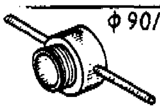
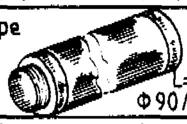
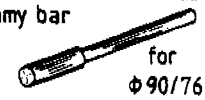
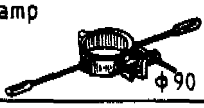
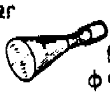
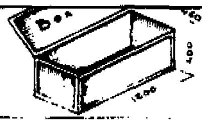
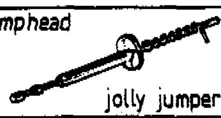
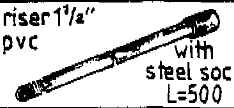
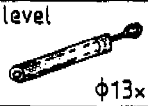
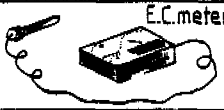
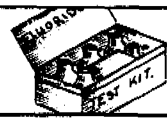
head  Φ 90/76		
ditto Φ125/106		
pipe  L=500 Φ 90/76		
ditto L=1000 Φ 90/76		
ditto L=1000 slotted Φ 90/76		
ditto L=500 Φ125/106		
ditto L=1000 Φ125/106		
ditto L=1000 slotted Φ125/106		
thread protector  Φ90/76 for female end		
ditto Φ125/106		
thread  protector for male end Φ90/76		
ditto Φ125/106		
shoe  Φ 90/76		
ditto Φ125/106		
tommy bar Φ12  for Φ 90/76		
ditto Φ12 Φ125/106		
clamp  Φ 90		
ditto Φ125		
retriever  for Φ 90/76		
ditto for Φ125/106		
		

CAPACITY AND QUALITY control set

illustration description	nr.	price
pumphead  jolly jumper		
riser 1½" pvc  with steel socket L=500		
ditto L=1000		
foot valve 		
bucket 20 ltr.		
water level meter  Φ13×200		
rope Φ 6×20m		
 E.C.meter		
timer, alarmclock		
compass		
		

ADDITIONAL TOOLS

spanner for  screw connector		
auger cleaner pipe wrench 24" adj. spanner 8" hammer 500gr. screwdriver 10mm. ditto 5mm. measuring tape 2m. file triangular 8" hacksaw frame 12" hacksaw blades 12"		
trolley 		

HAND DRILLING TOOLS
38mm hex connectors

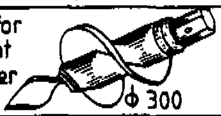
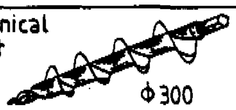
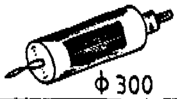
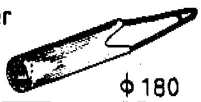
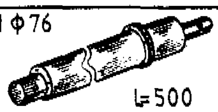
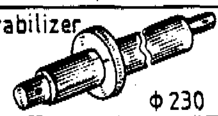
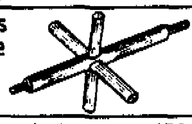
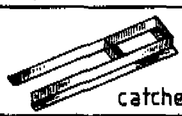
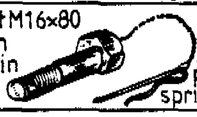
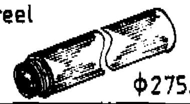
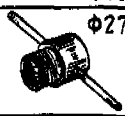
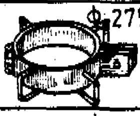
illustration description		nr.	price
bit for flight auger 	Φ 300		
ditto	Φ 230		
ditto	Φ 180		
ditto	Φ 140		
conical bit 	Φ 300		
ditto	Φ 230		
ditto	Φ 180		
ditto	Φ 140		
flight auger 	Φ 300		
ditto	Φ 230		
ditto	Φ 180		
ditto	Φ 140		
bucket auger 	Φ 300		
ditto	Φ 230		
ditto	Φ 180		
ditto	Φ 140		
river side auger 	Φ 300		
ditto	Φ 230		
ditto	Φ 180		
ditto	Φ 140		
bailer 	Φ 180		
ditto	Φ 130		
ditto	Φ 90		
rod Φ 76 	L=500		
ditto	L=1000		
ditto	L=1500		
ditto	L=2000		
ditto	L=3000		

illustration description		nr.	price
stabilizer 	Φ 230		
ditto	Φ 180		
ditto	Φ 140		
cross piece 			
handle Φ 2"	L=1250		
rod catcher 			
rod hanger 			
bolt M16×80 with chain and R spring 			
bolt/nut	M16×80		
spring washer	M16		
plain washer	M16		

CASING
for hand drilling

illustration description	nr.	price
A.B.S.steel conn.  L=1250 Φ275/250		
ditto Φ220/200		
ditto Φ165/150		
steel  Φ275/250		
ditto Φ220/200		
ditto Φ165/150		
thread protector female  Φ275/250		
ditto Φ220/200		
ditto Φ165/150		
thread protector male  Φ275/250		
ditto Φ220/200		
ditto Φ165/150		
head  Φ275/250		
ditto Φ220/200		
ditto Φ165/150		
shoe  Φ275/250		
ditto Φ220/200		
ditto Φ165/150		
tommy bar  Φ35 Φ275/250		
ditto Φ30 Φ220/200		
ditto Φ25 Φ165/150		
clamp  Φ275/250		
ditto Φ220		
ditto Φ165		
chainspanner Φ275		
ditto Φ220		
ditto Φ165		

ADDITIONAL EQUIPMENT
for hand drilling

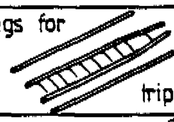
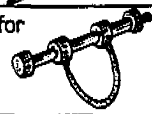
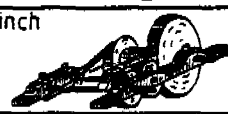
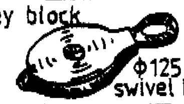
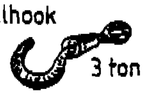
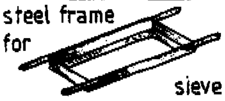
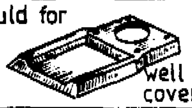
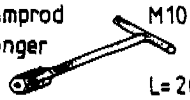
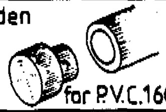
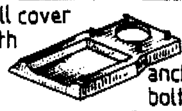
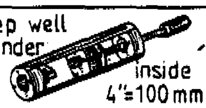
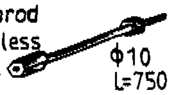
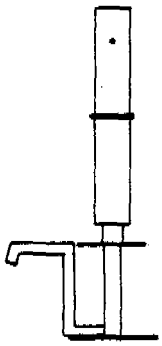
illustration description	nr.	price
legs for tripod 		
head for tripod 		
winch 		
footplate  400×400		
ditto 300×300		
pulley block with swivel hook  Φ125		
ditto with flapdoor		
swivelhook  3 ton		
O-shackl d=26 thimble for Φ10 clamps for Φ10 tool box 1200×400×460		
hand membrame pump 		
suction hose Φ2½ L=15m		
hose connector		
hose clamp		
measuring strip 		
water levelmeter  Φ12×200		
alarm clock shockproof		
spirit level shockproof		

illustration description	nr.	price
auger  cleaner		
casing  retriever Φ230		
ditto Φ180		
ditto Φ130		
jack, mech. 10 ton		
steel frame for  sieve		
sieve in wooden frame  opening Φ2mm		
ditto opening Φ5mm		
 clay rammer		
rods for rammer		
plunger for P.V.C.  Φ150		
ditto Φ117		
ditto Φ103		
ditto Φ84		
rods for plunger		
mould for  well cover		
cover plate 		
well cover hoist 		
pumprod hanger  M10 L=200		
ditto L=600		
spanner for  cylinder plug		
toolbox 600×350×350		
various tools		
for concrete work		
and pump installation		

WELL MATERIALS AND EQUIPMENT

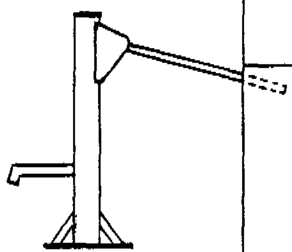
illustration description	nr.	price
wooden plug  for P.V.C. 160/150		
ditto for P.V.C. 125/117		
ditto for P.V.C. 110/103		
ditto for P.V.C. 90/84		
ditto for P.V.C. 80/74		
P.V.C. filter  L=3000 Φ160/150		
ditto Φ125/117		
ditto Φ110/103		
ditto Φ 90/84		
ditto Φ 80/74		
ditto plain Φ160/150		
ditto plain Φ110/103		
ditto plain Φ 90/84		
ditto plain Φ 80/74		
well cover with  anchor bolts		
bituminous foam seal		
deep well cylinder  inside 4"=100mm		
ditto (3") 75mm		
ditto (2½") 63mm		
ditto (2") 50mm		
washer, nylon, M10		
pumprod stainless steel  Φ10 L=750		
ditto L=1500		
ditto L=2000		
ditto L=3000		
ditto L=4000		
riser, 1½" G.I.P. with socket L=750		
ditto L=1500		
ditto L=2000		
ditto L=3000		
ditto L=4000		

PUMPHEADS



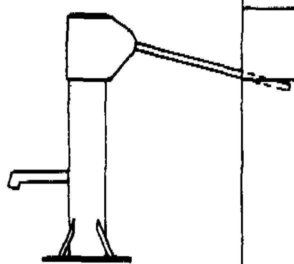
type: Kangaroo M2 (stroke length 350 mm)

cylinder Φ	max. lifting height	capacity/stroke
(4") 100 mm	5 m	2,7 lt
(3") 75 mm	8 m	1,5 lt
(2½") 63 mm	12 m	1,1 lt
(2") 50 mm	15 m	0,7 lt



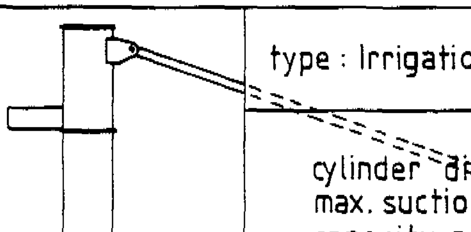
type: S.W.N. 80 (stroke length 160 mm)

cylinder Φ	max. lifting height	capacity/stroke
(4") 100 mm	10 m	1,2 lt
(3") 75 mm	15 m	0,7 lt
(2½") 63 mm	20 m	0,5 lt
(2") 50 mm	25 m	0,3 lt



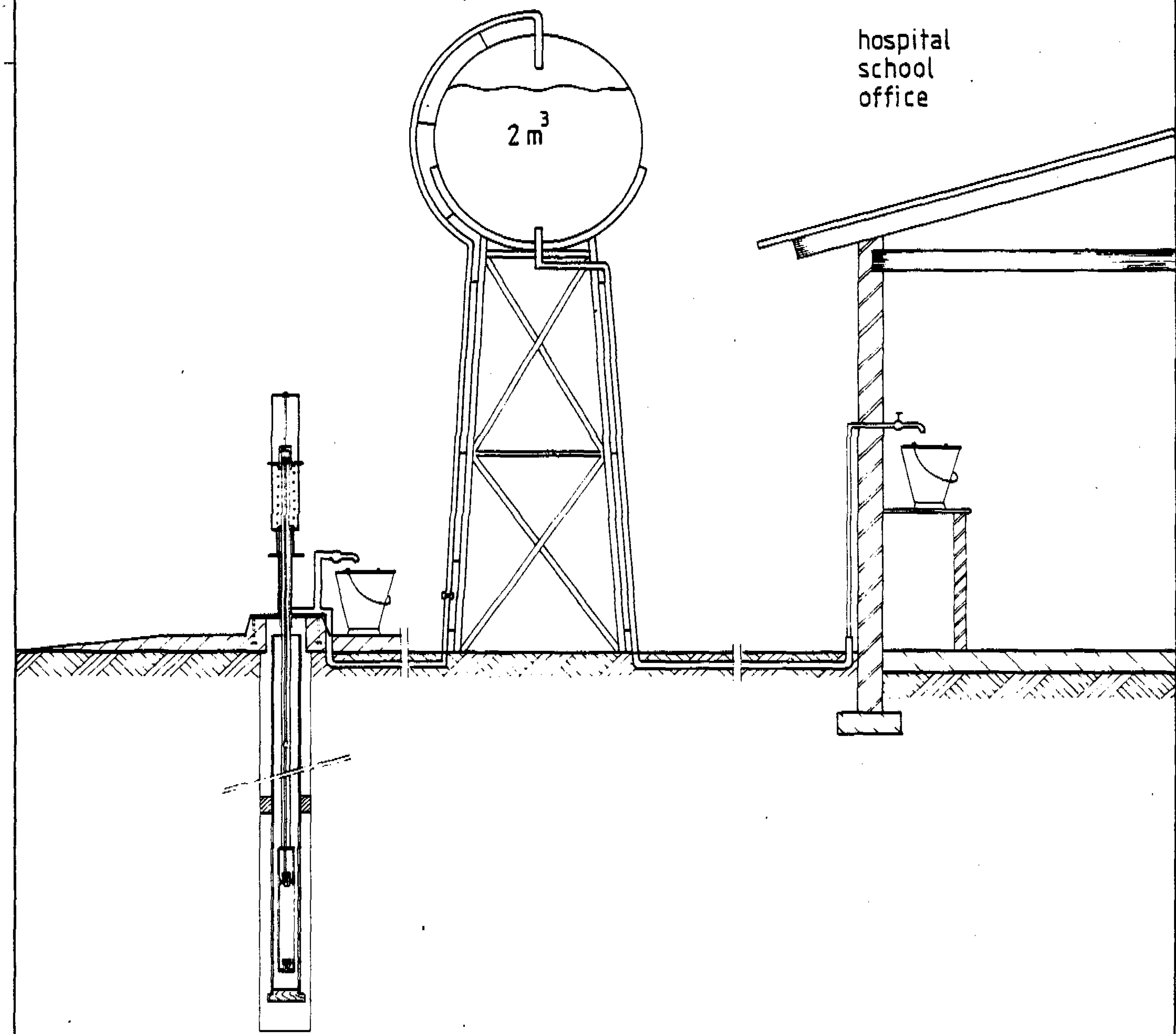
type: S.W.N. 81 (stroke length 160 mm)

cylinder Φ	max. lifting height	capacity/stroke
(4") 100 mm	20 m	1,2 lt
(3") 75 mm	30 m	0,7 lt
(2½") 63 mm	40 m	0,5 lt
(2") 50 mm	50 m	0,3 lt



type: Irrigation (stroke length 150 mm)

cylinder diameter 180 mm.
max. suction height ~ 7 m.
capacity per stroke 3,8 lt.


2 m³
hospital
school
office

APPENDIX 2

REGIONAL SECTIONS : PERSONNEL AND EQUIPMENT

	SPECIAL INVESTIGATIONS	B 30 S GROUP	GEO-WORKSHOP	PUMP-FACTORY	SPECIAL CONSTRUCTIONS	RECONSTR. WELLS	MAINTE-NANCE	LAB
TRANSPORT	1 Truck	1 Truck 1 *Pick-up*			1 Truck	1 Truck	1 Truck	1 Landrover
PERONNEL	1 Operator 2 Geo asst. 2 Handdriller 1 Driver	1 Operator 1 Assistant 1 Geo asst. 2 Driver	1 Metal worker 2 Assistent	6 Plumber 3 Welder	2 Well sinker 1 Driver	2 Well sinker 1 *Driver*	1 Plumber 1 Concrete wor. 1 Driver	1 Lab. worker 1 *Driver*
CAMPING EQUIPMENT	2 Tent 1 Tent (large) 1 Table + chair 3 Hurr. lamp 6 Bed	2 Tent 1 Tent (large) 1 Table + chair 3 Hurr. lamp 5 Bed			1 Tent 1 Tent (large) 1 Table + chair 2 Hurr. lamp 3 Bed	1 Tent 1 Tent (large) 1 Table + chair 2 Hurr. lamp 4 Bed	1 Tent (large) 1 Hurr. lamp 3 Bed	1 Tent 1 Hurr. lamp 2 Bed
MECHANICAL EQUIPMENT	1 Minute Man 1 Centr. pump 1 *Water bowser*	1 B 30 S 1 Water bowser		1 Lathe 2 *Drilling mach.* 1 Forge 2 Trafo	1 Centr. pump	1 Gentr. pump	1 *Centr. pump*	1 *Centr. pump*
TOOLS AND EQUIPMENT	2 Hand drill set 2 Casing set 1 Tripod + winch 1 *Test pump* 1 Tool box 1 *Set tools* 1 Access. for *Minute Man*	1 Tool box 1 *Maintenance material* 1 *Test pump*	Workshop tools and equipment	Workshop tools and equipment	1 Hand membr. pump 1 Tripod + winch 1 Wheelbarrow 2 Pick-axe (point 2 Pick-axe (jembe) 2 Shovel 2 Bucket 2 Hammer (2 lbs) 2 Hammer (5 lbs) 2 Trowel 2 Float 1 Plier 1 Pulley 1 Rope (20 m) 2 Cold chisel 2 Karai 1 Oil can 1 Tool box 1 Meas. tape 1 Hoe 1 Screwdriver 1 Handsaw 1 Panga 1 Axe 1 Jerrycan 2 Gravel sieve (1/4 and 1/2") 1 Hammer 1 Rope ladder 1 Ring mould 1 Block mould	See Special constructions	1 Tool box 2 Shovel 2 Pick-axe 2 Jembe 1 Bucket 1 Rope ladder 2 Spanner (5/8") 2 Pipe wrenche 1 Die 2" to 1/2" 1 Vice 1 Hacksaw 1 Handsaw 1 Wood drill 1 Trowel 1 Hammer 1 Cold store chisel 1 Cold steel chisel 1 File 1 *Meas. tape*	1 E-coli tester 1 Hach-kit 1 Fluor electr. 1 pH electr. 1 Reference electr. 1 E.C.-meter 1 Volt meter

APPENDIX 3

A. MACHINERY PRESENT AT THE MWCP MECHANICAL WORKSHOP

1. Sawing machine, capacity: Ø 250 mm; saw blade length: 18".
2. Pipe threading machine; capacity: Ø 2½".
3. Lathe; length between centers: 1250 mm; height of centers: 150 mm.
4. Drill press: 0.75 kW; capacity Ø 35 mm (in steel).
5. Welding transformer: 80-470 Amp. (2 units).
6. Welding transformer: 50-275 Amp. (2 units).
7. Autogenous welding set.
8. Shearing machine; capacity 10 mm steel plate.
9. Bending rolls; capacity 2-7 mm steel plate; net width: 1.20 m
10. Smithfires: 1 fixed and 2 mobile units.
11. Bench grinder, 2-wheel.

B. MACHINERY PRESENT AT THE MAJI WAZO HILL WORKSHOP

1. Sawing machine; capacity: 180 mm.
2. Pipe threading machine; capacity 6-8" dia. pipes.
3 Pipe threading machine; capacity max. 4" dia.
4. Lathe; length between centers: 1250 mm; height of centers: 190 mm.
5. Lathe; length between centers: 2000 mm; height of centers: 215 mm
6. Lathe; for very small work only.
7. Drill press; capacity Ø 50 mm (in steel).
8. Drill press; capacity Ø 25 mm (in steel).
9. Drilling machine; capacity Ø 25 mm (in steel).
10. Welding transformer (2 pcs.); max. 400 Amp., 40 V.
11. Hand shears; capacity 7 mm steel.
12. Pipe slotting machine; capacity 6"-10" PVC pipe.
13. Bench grinding machine; wheel dia. 400 mm
14. Hydraulic press; 40 ton.
15. Bending rolls; capacity: 2.5 mm steel; net width: 1020 mm.
16. Plate bending machine; capacity 2 mm steel; net width: 1020 mm
17. Light milling machine.
18. Light planing machine.
19. Electrical oven; int. dimensions: 20 x 20 x 40 cm; max. temp. 1100°C.
20. Air compressor; tank capacity: 500 litres; max. pressure: 12 atm.
21. Surface grinding machine for cylinder head and cylinder casing.
22. Crank shaft grinding machine.
23. Valve grinding machine; capacity: 6-15 mm valve stem dia.