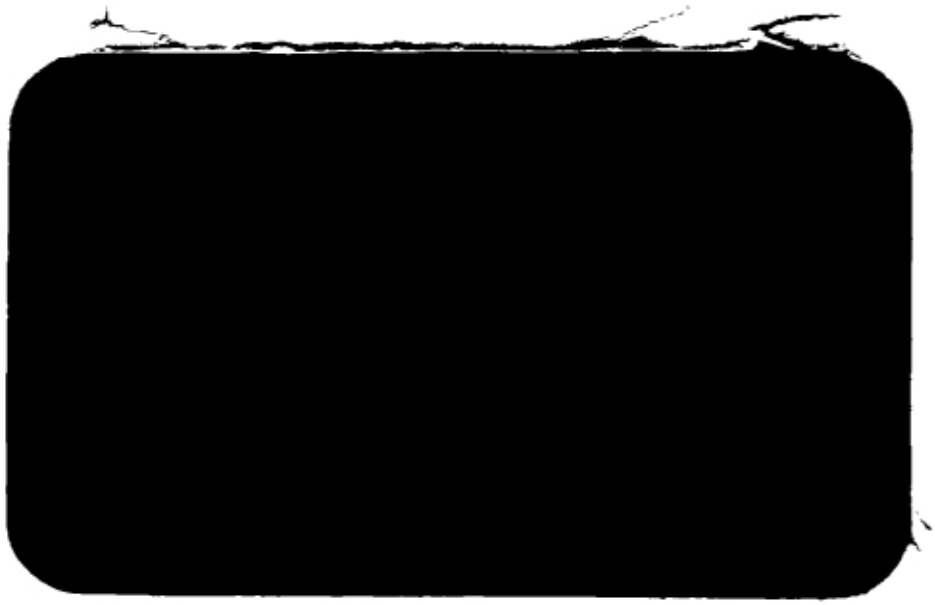

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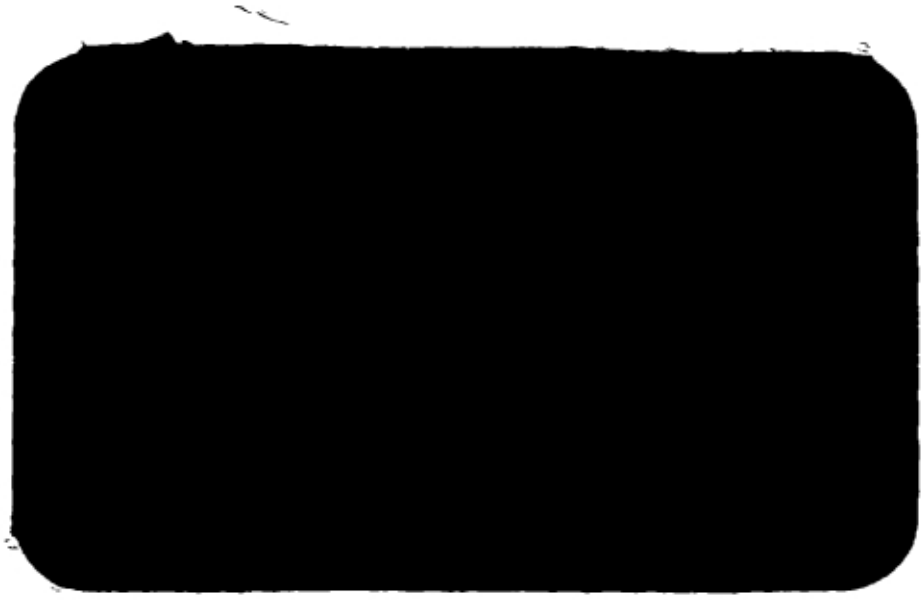

# WELL-DRILLING IN AFRICA - A STUDY OF DIFFERENT INVESTMENT FORMS AND PROJECT MANAGEMENT

A Master Thesis compiled in Zimbabwe and Kenya and at the Linköping Institute of Technology in Sweden by

Torbjörn C Arrland

Reg nr: LiTH - IPE - Ex - 1985:240

Instructor at the Institute:
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Linköping, December 1985.

| Linköping Institute of Technology<br>Department of Production Economics | Final project<br>LiTH-IPE-Ex-1985:240 |
|---|---|

By: Torbjörn C Arrland

Title: Well-drilling in Africa - A study of different investment forms and project management

Background:
The need for drinking water in some areas of the world must be emphasized more strongly. The United Nations has proclaimed this decade "The International Drinking and Water Supply and Sanitation Decade".

Purpose:
The purpose of my Master Thesis is to discover the most economically viable manner in which to conduct a project in well-drilling.
I hope that my comments and ranking order of the investment forms will be taken into consideration in future decisions by development and aid organizations.

Limitation:
The report deals with four different investment alternatives, both in theory and in practice. The latter is demonstrated by a description of the projects.
The main study deals with the economic facet, with an evaluation of several parameters to compare the total costs and the corresponding borehole output. This report does not examine geology, drilling methods and the technical specifications for drilling equipment.
The need for project management is emphasized but limited to a summary chapter. There are also descriptions of organizations and some comments on the rigs used.

Method:
My field-study in Zimbabwe and Kenya was conducted over a two month stay. I gathered information from interviews, reports, contracts and by estimation when examining the various projects.
The main comparison and academic analysis was done shortly after my return to Sweden. Evaluation of the costs has been carried out partly with the aid of computer.

Result:
The result is a ranking order of the four investment forms regarding total cost and borehole output. The report also points out a lot of facts and impressions resulting in a recommendation.

Avdelning, institution, fakultet:
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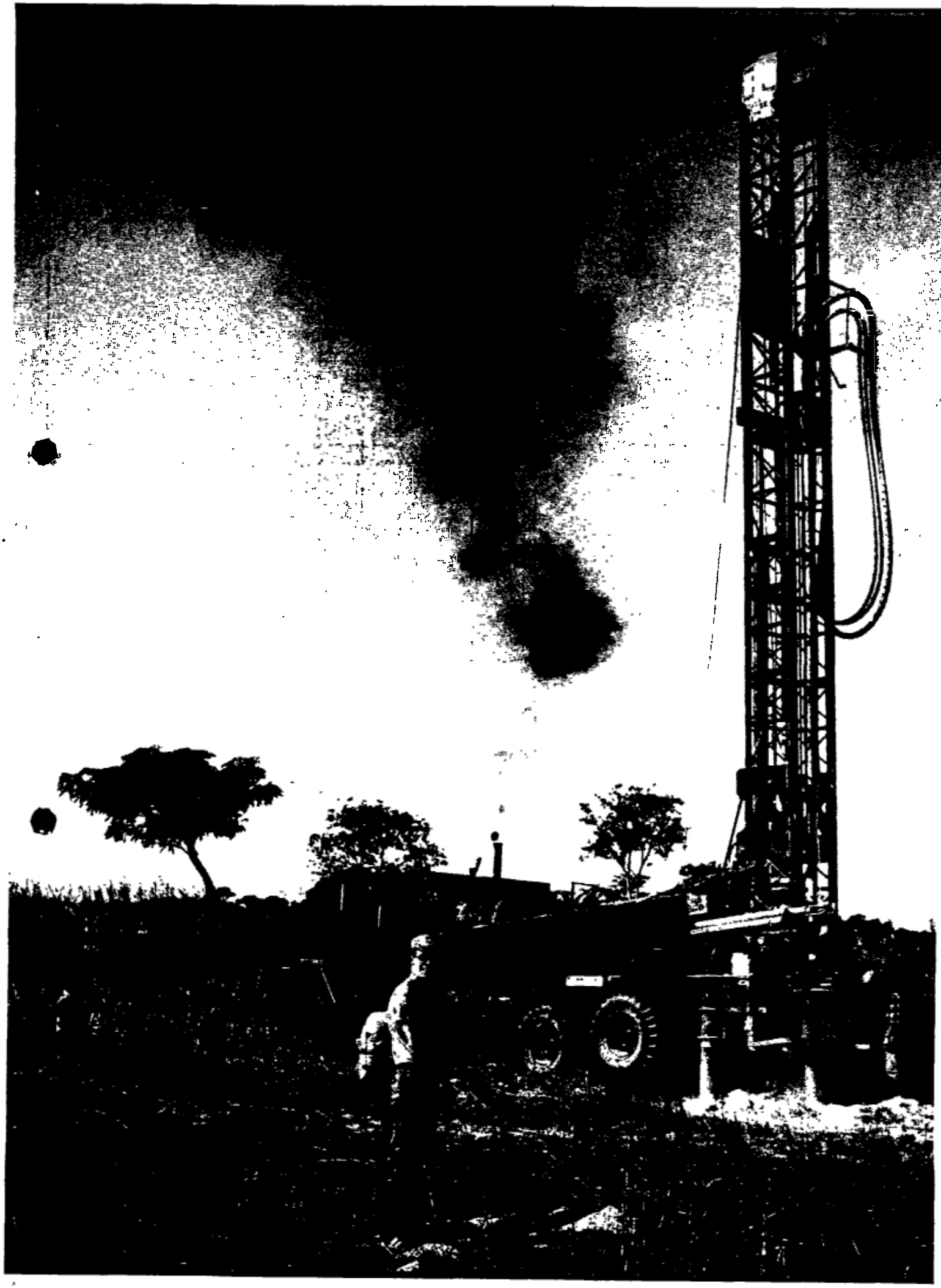
The need for a steady supply of clean water is very urgent in some rural areas of the world.
This report is a study of four investment alternatives.
During my stay in Zimbabwe and Kenya I collected the relevant facts and figures from actual projects. This fieldstudy is complemented by theories concerning aid money, forms of investment and project management.
Adequate organization and good project management is essential. Otherwise frequent breakdowns occur, the result of bad handling of drilling equipment.
This work concludes with an economic analysis of the projects in order to find the average total cost of one borehole.
The number of boreholes produced monthly per rig is also emphasized.
My report is written from the point of view of a development organization supporting a water project. The compilation of a ranking order of their various investment alternatives is something I recommend to the reader.

Keywords (8):
Well-drilling, Africa, investment forms, project management, water, borehole.

Bibliotekets anteckningar



PREFACE

This report is a Master Thesis performed by Torbjörn Arrland, School of Industrial and Management Engineering at the Linköping Institute of Technology in Sweden.

My degree project for a Master of Science was carried out in Zimbabwe and Kenya as a result of a scholarship I was awarded by the Swedish International Development Authority, SIDA. With a view to increasing the interest and knowledge of developing countries SIDA is sponsoring university students to perform a "Minor Research Task".

My friend Miss Anette Ohlsson, School of Mechanical Engineering in Linköping, was at the same time awarded a scholarship for a parallel study. I owe her many thanks for being a nice partner and a good support during our stay in Africa.

Anette's Master Thesis bears the title"Welldrilling Rigs in Africa - A Comparasive Study"and is a very interesting report which ought to be read in connection with mine. From now on the pronoun "I" will be used although it often ought to be "we", as Anette Ohlsson and I worked together on the same projects for most of the time.

My instructors were Dr Janerik Lundquist, Ass. Professor of Industrial Engineering at the Institute; Mr Lars Carlsson, Project Manager in Zimbabwe and Mr Christer Johansson, Managing Director in Kenya.

I am very grateful for the scholarship which has enabled me to do this interesting job, thus giving me a wider view and a better understanding of the problems of the developing countries. After what I have seen I sincerely hope that the United Nations' slogan for this decade, "Clean Water and Adequate Sanitations for All by 1990", will be as closely fulfilled as is possible.

The African countries are in many aspects very interesting. The first 14 pages of my appendix deal with politics, industry, transport and economy in Zimbabwe. See Appendix 1.

References in my report are marked after the section or figure in

question as follows: (Reference number, page of the source).

The abbreviation for the Zimbabwe Dollar is Z$ and for the Kenya Shilling it is KSh.

ACKNOWLEDGEMENTS

By way of my investigation I have made several new acquaintances and I want to thank everybody for help and cooperation.

I received information and guidance from the people below:
Mr Aage Krüger, Mr Finn Carlsen, Mr Peer Spone, Mr Ian Clifford, Mr Stig Lien, Mr Eric Braathen, Mr John Farr, Mr Dave Heywood, Mr Trevor Corrigan, Mr Don Ferreira, Mr John Birtwistle, Mr Anders Risberg, Mr Jim Holland, Mr A.S. Mpala, Mr Monjanjori, Mr Nhunhama, Mr Sharp, Mr R. Mutepfa, Mr Willy Hagström, Mr Johan Borgström and Mr Adam Amberg.

A special acknowledgement is addressed to Dr Janerik Lundquist, Mr John-Olof Johansson, Mr Hans Björnsson, Mr Lars Carlsson, Mr Ragnar Hurtig and Mr Christer Johansson.

Finally, I would like to acknowledge the excellent review of the entire manuscript by Miss Janet Bacon and also my thanks to my mother Barbro and sister Heléne who typed the report.

Linköping 1985.12.31

Torbjörn Arrland

Torbjörn C Arrland

TABLE OF CONTENTS

## 0 SUMMARY

My report is a study of the alternatives available for investing in equipment for well drilling in dried-up rural areas.

One of the best ways to ensure a permanent watersupply of clean water is to use the ground water resources, i.e. by drilling a borehole. This method is fast, has a high success rate of finding water and can be used almost anywhere.

I have chosen to study this from the point of view of a donor organization working in a developing country in great need of water. Consequently, this study starts with introductory theories concerning aid money, tender boards and the four forms of investment, namely total contract, management contract, purchasing and contractual leasing. For the economic analysis there is also a summary of rules of depreciation.

During my stay in Zimbabwe and Kenya I collected information from four projects, representing one investment alternative each. I consider it necessary to describe these projects very thoroughly as this gives the reader a better understanding of the problems.

It has been my intention to write an objective report with the most stringent choice of projects from the economical, organizational and technical point of view. Truckmounted rigs are employed in the total contract and light-weight rigs in the other projects.

During my stay in Africa, I came to realize more and more how the technical aspects of the equipment are of minor importance in comparison with the need for good workmanship. Adequate organization and project management have proved to be more important. Otherwise freqent breakdowns occur - the result of mishandling of the equipment.

The figures collected during my field study are to be found in my description of the various projects.

After compiling the costs in the analysis chapter I conclude with a ranking order. The recommendation is based on monthly borehole output per rig and the average total cost of one borehole.

# 1 MY STUDY AND ITS PURPOSE

My Master Thesis is a study in different ways to perform well drilling programmes and project management. The fieldstudy treats four theoretical investment forms, namely:

- Total contract
- Management contract
- Purchasing the equipment
- Contractual leasing

My fieldstudy in Africa lasted from June 29 till August 29 1985, with the first seven weeks in Zimbabwe and the last two in Kenya. In Zimbabwe I concentrated on three projects, each corresponding to one of the first three investment forms mentioned. In Kenya I visited a private contractor dealing with contracting and contractual leasing.

For this report I have evaluated the following parameters:

- Total cost
- Average cost per well
- Average borehole output per rig and month
- Depreciation
- Expenditures effecting my calculations like costs for:
    - drilling rig, compressor and accessories
    - support vehicles
    - spare parts for the machinery
    - service and maintenance
    - education etc.

I have also studied and written down some aspects of the organization, the effectivity and technical perspective of the project, as well as of the project management.

The final academic analysis and main comparison of the investment forms was done shortly after my return to Sweden at the Linköping Institute of Technology (1985).

The last section of my thesis presents the calculations exposing the most economic method of welldrilling. In other words, the purpose of my study is to answer the following question: How can people in developing countries obtain as many boreholes for drinking water as

possible for a fixed amount of aid money?

My wish is that the staff concerned with making decisions not only shall read these papers, but also imbibe my results.

## 1.1 A guide to my report

Start reading the "Summary" and the "Introductory Theory". Glance through the following chapters, my fieldstudy, which is a description of the projects themselves. Learn about "Project Management" and finally examine the concluding results of the "Analysis".

Or if you are more interested, look thouroughly at the projects and take part of the "Analysis", followed by the "Conclusion and Recommendation".

# 2 INTRODUCTORY THEORY

To faciliate the understanding of my report I have considered theoretical parts necessary in an opening chapter.

I start by discussing "Aid Money" and then continue with "Tender Board" and the different "Investment Forms".

"Depreciation Rules" of Zimbabwe are finally considered.

## 2.1 Aid money

The asquisition procedure of equipment is complexed. When the government has decided to drill for water under its own conduct the financial problem must be solved. Zimbabwe and Kenya are like other developing countries, extremely short of foreign currency. A request to various aid and development organizations in the world may be successful. Let us take a brief look in the ways in which aid money can be transferred.

### 2.1.1 Budget support

One method to sponsor deals is by budget support. The donor organization of an industrial country presents the government of a developing country with untied money. The receiver may spend its grant as it pleases within certain guidelines.

This procedure is nowadays very unusual since the donor government wants to support its own industry as well.

### 2.1.2 Project and programme support

If the donor country, for instance Sweden, wishes to control its grant, the project and programme support is a common method. So what is the difference between a project and a programme? Well, a project is just one part of a programme.

The following sequence occurs quarterly. Swedish crowns are transferred to the Financial Ministry of Zimbabwe from an account in the Swedish National bank. With the money now changed into local currency

the responsible ministry makes up a budget, which must be approved by SIDA, the Swedish Development organization. The monetary effects are then continuously reported to SIDA, whose personnel study the programme as it is being run.

### 2.1.3 Import support

The most common way to help a developing country nowadays is by import support, which concerns goods financed by the donor country. The goods are either tied to the donor's industry or untied; i.e. coming from another country. Alternatives arise, depending on who is to buy the equipment. Most frequently the donor asks the receiver to do so.

If SIDA or a corresponding orgainzation is the purchaser the procedure as a whole is related below:
The Ministry of Water applies to the Ministry of Finance for a well-drilling rig and then the local SIDA office is asked to finance it. A specification of the unit is distributed. After the central SIDA Procurement section is requested to buy the rig it sets up a tender board according to Swedish purchasing rules. Swedish and sometimes international companies are invited to bid. SIDA selects the most appropriate drilling rig. The company committed will be compensated for its goods either when the Procurement sector of SIDA has received copies of the shipping documents, or when the goods are finally delivered.

If the contract does not state otherwise, the receiving country is responsible for customs clearing and utilization of the goods. There is at last a representative at the local SIDA office checking that all duties of the receiver are being performed.

The country prefers international tender and purchasing:
Stipulated rules are followed. As mentioned before, one of the biggest problems for developing countries is lack of foreign currency, but the import support procedure is of great help. If, for example, a Swedish company happens to win the contract SIDA can sponsor the goods as a gift to the country.

A specification for an examination and evaluation is delivered. Before the purchase is confirmed, the following questions must be

positively answered:

- Has the tenderboard been correctly performed?
- Do the goods correspond to SIDA´s priority list?
- Can the purchase be defined as a relief action?
- Is it clear that there are no South-African interests in the company?

The Swedish company delivers as soon as possible. The Ministry of Finance in Zimbabwe, for example, has an account in one of the Swedish business banks where SIDA´s money is deposited. When the shipping documents are presented, the Ministry orders the bank to pay the company. Finally the goods arrive in the receiving country.

One example of what has just been described is the recent delivery of 38 Scania trucks to Zimbabwe´s railway department. Which was in need of modern rolling stock.

# Swedish trucks to aid rural drive

*Herald Reporter*

THE road motor service of the railways will be extended into communal areas to fight under · development, the Minister of Transport, Cde Herbert Ushewokunze, said yesterday.

He was speaking when he received 38 Scania trucks, worth $2,9 million, from the Swedish charge d'affaires, Mr Frederick Vahlquist at Willowvale Motor Industries in Harare where the trucks were assembled.

The trucks would allow more goods to be moved and allow the introduction of an important service into rural areas neglected by previous regimes, said the minister.

"With the support of Sweden, we shall realise our dream of developing the road motor service into the rural areas. This is a giant step by the railways," he said.

Cheap transport would now become available to those who needed it most, and not just the commercial farmers.

Cde Ushewokunze said the trucks were strong and ideal for rural work and their strength had been tested during the liberation war when "they became the workhorses in refugee and military camps".

Mr Vahlquist said: "An adequate and efficient transport system is a prerequisite for both growth and development in any country."

Most Zimbabweans lived in rural areas and it was essential for them to get their produce to the market on time. Sweden fully supported Zimbabwe's development endeavours and when his government heard Zimbabwe wanted to buy 38 trucks, it decided to give the trucks.

"It is my sincere hope that these 38 Scania trucks will be of good and long service and contribute to the further growth and development of Zimbabwe."

● Picture — Page 17

Figure 1. Import support. (Source: The Herald, 85.07.24, Harare)

Examples of import support to the private sector of Zimbabwe are contracts with Sandvik, SKF, John W. Searcy for Flygt and Atlas Copco.

Consequently it is possible for the Ministry of Finance to forward foreign currency indirectly from SIDA to the private sector in Zimbabwe. This all depends on the good will of the Ministry of Trade and Commerce.

The purchasing and specification contracts are sent to the local SIDA office and the goods will pass through Commercial Import Control before arriving at the private sector.

If the local SIDA officer agrees to the purchase, money is deposited in a Swedish business bank. When the private company in Zimbabwe has received the goods it is obliged to pay the equivalent amount to the Ministry of Finance within 15 days. After this, the Swedish bank is requested to pay the contractor in Sweden.

## 2.2 Tender board

If equipment is bought without import support an ordinary bidding procedure is established.

The government department or a parastatal department (more than 50% government owned but privately run) will invite several private companies to tender. Usually three to four manufacturers will compete and they submit their offers to the board. From the opening until the final decision is taken time varies.

If the EEC or the World bank is the buyer, the offers must be submitted to the committees of financing organizations. Due to "red tape" on the tender board it might take a year to pick the right contractor, although 60 days would be more adequate.

It is not always the lowest bidder who is selected. Companies with a good record often win the bidding. Negociations with the selected tenderer begin immediately after the decision has been taken.

Naturally the winning company quickly starts manufacturing and ordering from subcontractors so as to be able to deliver within the

contract period. Effects of legislation may influence the tender performance.

## 2.3 The investment forms

The welldrilling activities of my fieldstudy are related to projects close to the four investment forms as per definition. All projects are, however, more or less tailormade for their environments. For this reason I feel inclined to note some specific characteristics of the investment forms.

### 2.3.1 Total contract

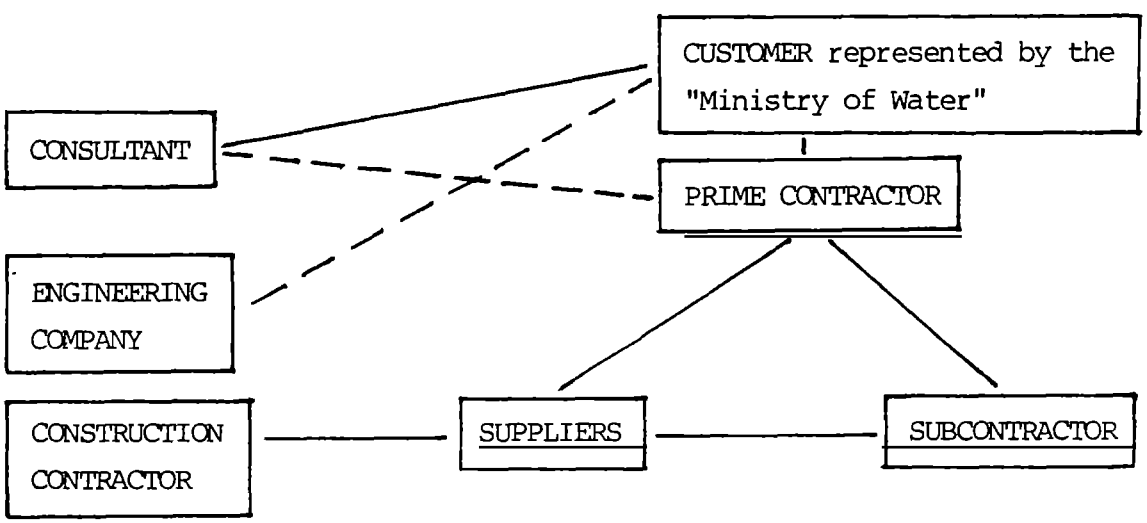



Figure 2. The total contract

Above is an outline of the general connections in a total contract.

The total contract for the welldrilling I studied in Zimbabwe is a composite of the contracts described below.

The organisation consists of, among others, a coordinator and representatives from the involved parties in committees all of whom are able to make powerful decisions.

A characteristic of total contracts is the impossibility in providing a sample of the result. The only way to check the established claims

is a final survey.

Consequently there are different methods to invite for tender, to remunerate and to design contracts.

You can compensate the contractor/contractors by:
- Agreeing on a fixed price in the contract.
- Current account; the contractor gets paid for his verified prime production cost plus a remuneration as fixed fees or in percent of the prime expense.
- An incitement agreement; depending on the final total cost. The remuneration is adjusted to the expenditure.

Closely related to total contracts are turn-key, general and shared contracts respectively.

Turn-key contract

To avoid split decisions the customer, often a government, prefers to make one comprehensive settlement with a single main contractor. The contract and an agreement of understanding is signed and the prime contractor becomes fully responsible for the realization of the project. Thus consultants and subcontractors are employed for the various assignments.

Turn-key contracts originate from large institutions' habit of buying and selling systems.

The customer solicits bids from prospective contractors, who after winning the contract, are responsible for bidding and assembling the subcomponents.

The contracts are named turn-key because the customer simply has to 'turn one key' in order to get everything started. In the so called "total contract" the "customer" is more involved in the project's realization, than in a turn-key contract.

General contract

In a less comprising contract the customer is responsible for the

prospecting. If he has no know-how himself a consultant is employed for the job.

The customer provides the general contractor with descriptions and plans for the programme. The responsibility for coordinating all distributors and accomplishing the project rests with the general contractor.

Shared contract

The customer engages several contractors for each different part of the project. A special contract and agreements with each contractor are established. In this manner the customer is responsible for the coordination of all participants in order to obtain the anticipated goals.

2.3.2 Management contract

The responsibility of a management contract is not very different from that of a total contract. Both comprise tangible and intangible assets such as machines, other equipment plus personnel and their know-how.

From a corporate point of view a management contract is a deal between at least two parties; for instance, a local company and a foreign one. The latter directs the activities and is responsible for education, training and many technical and administrative tasks.

Each specific contract has its limits concerning liability, contract time and remuneration for duties. Corporate management contracts are quite similar to agreements for licensing, franchising and joint ventures.

Two sorts of developing countries are appropriate for corporate management contracts:

- Primary production countries with resources like wood and iron ore eg. the African and Latinamerican countries.
- Developing countries lacking established industries but rich in hard currency eg. oil producing countries.

A management contract industrializes the country whilst at the same time developing education and training the workforce.

The contract I will be refering to employs a foreign company to supply management and know-how. The capital required is from a European government's developing organization. The company of my management contract fieldstudy not only provided personnel, but also drilling units.

In this way developing countries are helped to build themselves up and increase the level of expertise in water activities. The people receiving aid will 'learn-by-doing', or rather, 'learn-by-drilling'.

### 2.3.3 Purchasing

Another way in which drilling projects can be run is by the Ministry or or similar institution in a developing country purchasing its own equipment. Generally units are received from industrialized countries via aid money as import support. Well-drilling machinery run by a donor country is often handed over to the Ministry after the project's conclusion. Operation can be continued through other programmes.

"Government buying procedures fall into two types: The open bid and the negociated contract. Open-bid buying means that the government procuring office invites bids from qualified suppliers for carefully described items, generally awarding a contract to the lowest bidder. The supplier must consider whether it can meet the specifications and accept the terms. For commodities and standard items, such as fuel or school supplies, the specifications are not a hurdle. They can be a hurdle, however, for nonstandard items. The government procurement office is usually required to award to the lowest bidder on a winner-take-all basis. In some cases allowance is made for the supplier's superior product or reputation for completing contracts.

In negotiated-contract buying, the agency works with one or more companies and directly negotiates a contract with one of them covering the project and terms. This type of buying occurs primarily in connection with complex projects, often involving major research and development cost and risk and/or where there is a little effective competition." (Ref 7 , page 184)

"Government buyers are influenced by environmental, organizational, interpersonal and individual factors. A unique thing about government buying is that it is monitored closely by outside publics."

"Because spending decisions are subject to public review, government organizations get involved in considerable paper work. Elaborate forms must be filled out and signed before purchases are approved. The level of bureaucracy is high and marketers have to find ways to 'cut through the red tape'." (Ref 7, page 183)

### 2.3.4 Contractual leasing

I have called the last investment form contractual leasing since it is a combination of ordinary contracting and leasing i.e. a rental agreement.

The company uses the customer's drilling-unit or that of a third party for a lower charge per drilled meter than as per an ordinary contract.

This interesting form of contracting generates several advantages for both the customer and the contractor:

- The customer is not responsible for any practical problems concerning drilling.
- The contractor is provided with good equipment thus increasing the borehole output.
- Running service and maintenance obligations can be imposed upon the contractor, who is in turn interested in keeping the rig going.

During my stay in Africa I did not find any companies dealing with ordinary leasing contracts on drilling units. This is surprising since there exists advantage such as the possibility of tying a flexible contractor to the problems occuring during well drilling operations, probably resulting in a raised borehole output.

For a thorough explanation of leasing contracts I refer to literature on the subject. "Principles of Corporate Finance" by Brealy/Myers chapter 24, "Leasing", explains the financial part of the investment form. I quote the beginning of the summary about leasing from this book.

"A lease is just an extended rental agreement. The owner of the equipment (the lessor) allows the user (the lessee) to operate equipment in exchane for regular lease payments.

There is a wide variety of possible arrangements. Short-term, cancelable leases are known as operating leases: in these cases the lessor bears the risk of obsolescence. Long-term, noncancelable leases are called full payout, financial, or capital leases: in these cases the lessee bears the risk of obsolescence. Operating leases make sense when you want to use the equipment for only a short time or where the lessor has some control over the obsolescence rate. Financial leases are sources of financing for assets the firm wishes to acquire and use for an extended period.

Many vehicle or office equipment leases include insurance and maintenance. They are full-service leases. If the lessee is responsible for insurance and maintenance, the lease is a net lease.

Frequently the lessor acquires the asset directly from the manufacturer. This is a direct lease. Sometimes the lessor acquires the asset from the user and then leases it back to the user. This is sale and lease-back.

Most leases involve only the lessee and the lessor. But, if the asset is very costly, it may be convenient to arrange a leveraged lease, in which the cost of the leased asset is financed by issuing debt and equity claims against the asset and the future lease payments.

There are number of reasons that companies sometimes prefer to lease equipment rather than buying it. For example, there may be good tax reasons. If the operator cannot use the depreciation tax shield, it makes sense to sell the equipment to someone who can. Also, the lessor may be better able to bear the risk of obsolescence, or be in a better position to resell second-hand assets. The lessor may be able to offer a very good deal on maintenance. Finally, it may be much less costly in time and effort to arrange a simple lease contract on a standard item of equipment than to arrange a normal loan."
(Ref 4, page 561-562)

## 2.4 Depreciation rules

Experience in budgeting, finance and depreciation of equipment varies; however, it appears that the businesses involved in drilling in Zimbabwe and Kenya are fully aware of this.

In Zimbabwe, there are three different ways in which equipment can be phased out with regards to profit and loss:

### 2.4.1 The straight line method

Investments are written off each year according to a considered economic lifetime. Normally a rig depreciates within five years, i.e. the annual rate of depreciation is 20%.

The technical lifetime of a rig can be extended if it is handled and maintained properly.

### 2.4.2 The reduced balance method

The company is allowed to choose an appropriate percentage value to reduce the net book value. If 20% is selected for an investment of 100 Zimbabwe dollars(Z$), this value is thus reduced by 20 after the first year, to 80. After the following year the value is reduced by a further 20%, i.e. 80-16=64 and so on. Accordingly a paricular percentage value judged is for certain assets categorically. (Heavy equipment 25%, motor vehicles 20%, electronic data processors 20% and normal plant and equipment 20%.)

There is also a submethod called Special Initial Allowance, which is purely a taxation allowance. The whole investment (i.e. 100%) is depreciated after the first year if the object costs less than a certain amount; by way of example, a motor vehicle for a maximum of 15 000 Z$.

### 2.4.3 Revaluation method

Using this method, assets are constantly revalued according to price trends. Since most assets appreciate rather than the reverse, most companies find this procedure impractical. It is rarely used in

Zimbabwe.

2.4.4 Example: Plant of machinery

Item A: Purchased 1982 at 40 000 Z$
Item B: Purchased this year 1985 at 12 000 Z$

Depreciations: Straight line method - 20%
A: 8 000 Z$ B: 2 400 Z$
The total 10 400 Z$ is deducted from profit and loss account.

Taxation allowances:
A: Reducing balance method - 20%

| | | | |
|---|---|---|---|
| 1982: | 40 000 * 0,2 = 8 000 Z$ | | |
| 83: | 32 000 * 0,2 = 6 400 | | |
| 84: | 25 600 * 0,2 = 5 120 | | |
| 85: | 20 480 * 0,2 = 4 096 | ⇒ | 4 100 Z$ |

B: Special initial allowance - 100% 12 000 Z$

The total 16 100 Z$ is less taxable allowance.

Taxation: Corporate tax basic 45%
Extra premium 20% * 0,45 = 9%
Tax 54%

| | |
|---|---|
| Supposed profit July 30 1985: | 100 000 Z$ |
| Add back depreciation | +10 400 |
| | 110 400 |
| Less taxable allowances | -16 100 |
| Taxable profit | 94 300 |
| Tax payable (54%) | -54 922 |
| Profit after tax | 49 078 Z$ |

## 3 MY STUDY IN ZIMBABWE
## TOTAL CONTRACT

The first part of my study is about an "Emergency Drought Relief Programme". The sponsor is the Norwegian government and the receiver is the country of Zimbabwe. The funds for the total contract were provided in 1984. The project concerning 400 boreholes to be constructed and completed if not dry is called the Crash Borehole Programme - Mashonaland.

The first progress report says:
"It is the main objective of the Programme to accelerate provisions of clean and reliable water supplies to drought-stricken communities in communal areas of Mahonaland through rapid and intense borehole provision." (Ref 3, page 1)

The background is three years of drought in Zimbabwe, which affected the citizens while the commercial areas got their own water resources. To obtain the most suitable contractor an international tender was set up. Competing for the contract were seven tenderers, three local ones, three from Botswana and one from Zambia. Two of the Botswana drilling contractors were chosen and further examined. After a more exact evaluation of equipment and management abilities the contract was awarded Geotest (Pty) Ltd.

The country of Zimbabwe has through the Ministry of Energy and Water Resources and Development, MEWRF, been the "Employer" of the Crash Borehole Programme - Mashonaland. It was the MEWRD that issued the tender documents.

After negociations with Geotest's Managing Director, Mr John Farr, the contract was signed. To be able to complete a comprising program like this one, a consultant is necessary for the siting, i.e. the place, depth and design of the borehole. A Norwegian company, the Interconsult A/S Consulting Engineers, was requested to do the consultancy services. Except for the siting the "Engineer" has been responsible for supervising Geotest the "Contractor" when drilling and also assisting in performing a community participation plan.

For more facts about the institutions involved in water and sanitation

development in Zimbabwe see appendix 2, the MEWRD appendix 3 and the Interconsult A/S appendix 4.

## 3.1 Project organization and coordination

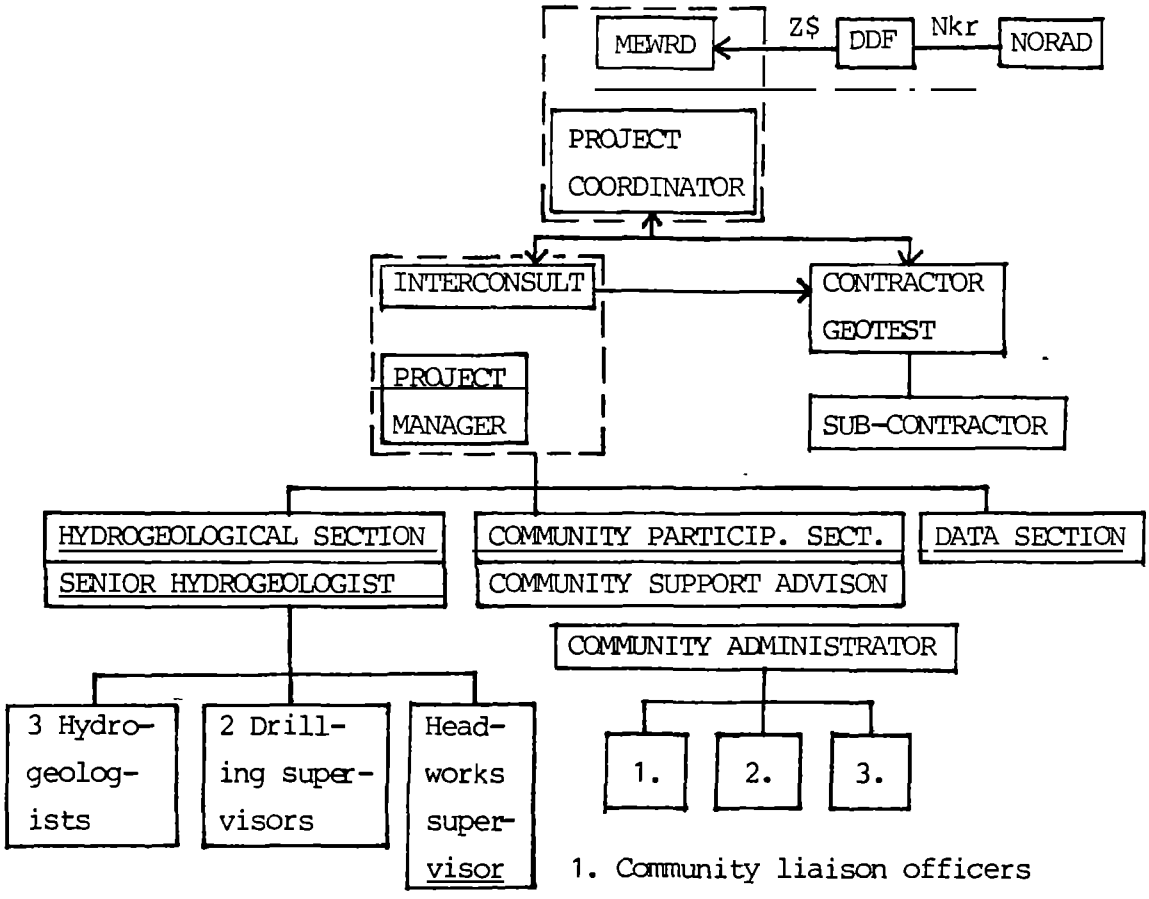
The Crash Programme involves the main parties namely the employer MEWRD, the engineer Interconsult A/S and the contractor Geotest Ltd. A very important part of the task is the coordination between the involved participants. Therefore MEWRD employed a project coordinator, Mr Aage Krüger, to establish a good working relationship primarily between the Interconsult A/S responsible for project management and the ministry. Apart from his overall responsibilities Mr Krüger is in charge of coordination meetings attended by MEWRD and Interconsult A/S, held every two weeks. Administrative matters discussed are minuted and kept in files. The project contractor usually also attends the site meetings with the major participants Interconsult and Geotest. The actual site work progress and contractual matters are discussed and recorded.

### 3.1.1 Organization chart

The organization chart shows the hierarchy of the operating organization. At the very top is the employer MEWRD sponsored by the Norwegian Development Organization NORAD. The funds were provided for District Development Fund, DDF, (Appendix 8) in Norwegian crowns by NORAD. Working as the project coordinator between the ministry and the Engineer Interconsult A/S is the preciously mentioned Mr Aage Krüger. The project manager is Mr Peer Spone, who is also manager of Interconsult in Zimbabwe.

Beneath the project manager are three main branches: The hydrogeological section, the community participation section and the data section.

Figure 3. Crash Programme Organization Chart




1. Community liaison officers
2. " training officer
3. " construction supervisors

There are four hydrogeologists occupied in the hydrogeological section, one senior and three men doing siting and surveying. Mr Ian Clifford, the senior hydrogeologist (who continued land analyses after Mr E. Marinelli's land analyses) has supervised all his own contracts.

There have furthermore been two drilling supervisors working full time. While drilling is going on, these men drive around in landcruisers checking the progress of the project. They decide the exact place and design of the borehole, how deep the contractor shall drill and if the yield corresponds to a wet or a dry hole. The supervisors can influence the payments to the contractor.

The Headworks' Supervisor is Mr Price, also working for Interconsult. He is directly responsible for head-works, construction, test pumping and pump installation.

The Community Participation section is divided into three activity branches directed by community liaison officers, a community training officer and construction supervisors respectively.

The Community Support Advisor, Mr Piers Cross, is the head of the participation plans. An administrator assists him in coordinating all action. The community officials are responsible for training pump attendants in maintenance and for organizing water committees.

Finally the community construction supervisors are aiding the participants in constructing washing slabs, fences etc.

All people in this section are working according to ideas of the Community Participation Plan. The main task is to educate local inhabitants for future maintenance of the boreholes' headworks. A one-day course is arranged and the follow-up of the community participation plan is also dealt with.

The data section is not in action during the crash programme. The engineer builds this unit for smoother handling of site records and files of future drilling prospects.

## 3.2 The proceeding work

### 3.2.1 Siting and Hydrogeological investigations

The whole program is to finish 400 boreholes within the contract period of about eight months. Hydrogeological studies take place at first and in this case they started August 1984, right after the Interconsult project team was established. This was exactly one month after the contract was signed between MEWRD and Interconsult and the tender documents were issued mid July.

The engineers' job in the consulting field concerning siting and community contacts is very important at this early stage. Detailed hydrogeological examination is necessary in creating successful boreholes. The following extract comes from the Progress report of August 1984 - March 1985, by the project's Senior Hydrogeologist Dr. E Martinelli, and concerns the geophysical investigations in the Crash programme:

"Geophysical Investigation

Geoelectrical techniques mainly using vertical electrial soundings (VES) with subordinate Electrical Traversing have been extensively applied in the siting operations. In some areas of dolerite instrusions, Magnetic Traverses have proven useful in locating dyke/country rock contacts. An average of 3-5 VES per locality have been run with maximum AB separation of 500 m.

The geoelectrical parameters used in the siting are those presented in Volume 2.2 Hydrogeology of the National Master Water Plan. When siting in hard rock aquifers the minimum thickness guideline of 15-25 m, depending upon the morphological/topographic conditions, has been used. The relatively high success ratio of approximately 87% is ascribed to the extensive use of those guidelines.

Because of the proven versatility of the electrical technique, electromagnetic traversing has been used only in very few instances." (Ref 3, page 9-10)

3.2.2 Coordination with District Development Fund, DDF.

Before drilling at the prospected sites could start a coordination meeting was held in order to finalize the list of sites.

Out of 740 sites the number was reduced to 500 which was enough to start the program. Further investigation resulted in a recommendation of 400 sites after meetings between MEWRD, DDF and Interconsult. At the end of the program and after additional siting the total number was 900 sites, of which 48% were recommended.

Minutes of the meeting held at Interconsult office 11th September 1984, appendix 5.

3.2.3 Drilling

Geotest was awarded the drilling contract by MEWRD mid October and it was signed Oct. 24 1984. Only three days later drilling operations and supervision started. There were two models of boreholes used, at first expected to be half design A and half design B. The latter is

produced if the ground has a tendency to collapse. The majority of boreholes turned out to be design A due to the presence of granite, gneiss and allied rocks in the ground. This fact resulted in cost savings of about 1 000 Z$ per hole design A. The two different boreholes design A and B are described in appendix 6. Form of tender, conditions of contract and schedule of charges - appendix 6.

From the very start two siting teams have been working full time on the Crash Programme. A third and fourth team were added after a proposal from the consultant to avoid the likelihood of the contractor catching up with the siting. As a result of this action the community's participating personnel's workload was reduced.

It is stated in the contract on Consulting services that on-site training of qualified zimbabwiens should be allowed. Two counterparts have therefore participated in siting operations and drilling supervision from January to February 1985. However, due to exceptionally bad weather conditions during this month the training could not be intense.

Because of the heavy rains during this period the contractor Geotest had problems. Since the rigs and trucks were stuck in the mud on the roads there was no chance on catching up with the schedule of 50 boreholes a month, so the contractor was consequently delayed by five to six weeks.

This slim contract was further aggravated by two weeks Christmas holiday etc.

### 3.2.4 Borehole output

The Crash Borehole Programme concerns 400 boreholes progressing at an estimated rate of 50 boreholes per month.

Progress has been at a rate of 4 to 80 boreholes per month. The extraordinary weater conditions at the start of the project resulted in a low borehole output. At the end of March only 131 boreholes had been drilled (93 behind the originally proposed schedule).

### 3.2.5 Control testing and wellhead construction

After the borehole is drilled, control testing is carried out. "The testing has been done on boreholes either possessing a blowing yield in excess of one liter per second or having a marginal yield. The testing comprised a constant test rate test followed by a water level recovery phase." (Ref 3)

The wellhead construction work is done by the Geotest subcontractor. The wellhead consists of slab, spillway, cattle trough, soakaway and pump installation.

### 3.2.6 Extension of contract time period

After negociations with the employer MEWRD the contractor managed to extend the period. If the project is completed by the end of August there will be no penalty for the delay.

The contractor's personnel is working seven days with 10-14 hours/day every week in order to finish in time. The working pace originally counted on was ten hours a day - 25 days per month - to achieve 50 holes drilled monthly.

## 3.3 Drilling supervision

The Engineer Interconsult A/S is through the Project Manager Mr Peer Spone responsible for the drilling supervision. When the programme started it was meant that both the project manager and the senior hydrogeologist should have enough time for supervising. It was quite an optimistic thought since many other important tasks turned up for the project manager, such as paper work, overall project management and liaison with the employer MEWRD and community liaison.

The Senior Hydrogeologist Mr Ian Clifford has been supervising full-time. Mr E. Martinelli before him dealt more with the siting of new boreholes.

To get continuous supervision of the operations two full time supervisors were employed. They travel by landcruiser between the different sites where the rigs are situated. When there is great progress

like in the second half of the program travelling takes much of their time, especially since the sites usually are quite distant from each other. All landcruisers are equipped with radiolinks for internal communication.

A headworks' supervisor was also employed.

The supervisors have a hard job since the contractor has stressed their working rate up to ten to twelve hours a day seven days a week.

## 3.4 Community Participation Plan

The Norwgian Development Organization NORAD has decided that the community where drilling is taking place should be involved in the planning, construction and maintenance of the boreholes. The goals of this rather expensive part of the programme are to:

"- Instill a sense of local ownership and accountability for the project.
- Facilitate better care of borehole headworks.
- Ensure that provision is culturally acceptable and locally appropriate.
- Establish a local system of project management.
- Establish a first tier maintenance capability." (Ref 3, page 16)

If the people living in the vicinity of the borehole fail to understand the necessity of right and proper utilization it will soon be ruined. Examples of sabotage on newly drilled holes due to quarrels about its location can be seen.

There are a lot of people involved on the programme.

### 3.4.1 Structure and personnel

"Within Interconsult A/S, the Community Participation Section reports to the Project Manager and works in close cooperation with both the drilling supervisors (supervising the work of the contractor) and the siting teams (undertaking hydrogeological/geophysical field studies).

The Community Participation Section consists of a Community Participation Co-ordinator, an assistant with special responsibilities for

developing the health educational materials and supervising training, and teams of direct-hire community liaison field workers. The direct-hire field workers work alongside existing Government extension workers: Local Government Promotion Officers (LGPO) and Community Development Officers (CDO) (in establishing local-level project management), and Health Assistants (HA) (in training committees and construction).

The section's community liaison field staff provide skilled community workers (five of whom have higher qualifications or considerable experience in community work) to supplement the work of existing extension workers to ensure that community liaison is keeping pace with the rate of technical implementation on this accelerated programme." (Ref 3, page 16)

The community participation section is responsible for liaising with local government authorities and beneficiary communities at a variety of stages in project implementation. The community liaison schedule is as follows:

- Meeting district administrators to inform and confirm sites. Siting
- Initial community contract
- A one-day course for committees at a local venue
- Drilling
- Pumpfitting
- Delivery of community construction materials and haulage of rocks
- and sand.
- Supervised community construction of fences and washing slab.
- An opening ceremony
- First follow up visit
- Second follow up visit

### 3.4.2 One day course

All five to six representatives from each local committee attend a one day course. Everything from committee functions, construction techniques, borehole and pump maintenance to health is discussed. A decision about the surrounding washing slab is also taken.

For the plan a lot of educational pamphlets have been printed and a

videofilm has been produced.

## 3.5 Contractor Geotest

To get a veritable knowledge of the contractor's position in a total contract like the Crash Programme, I have not only visited the camp and studied its activities, but have also talked to several persons in key positions. The name of the contractor is Geotest (Pty) Ltd. from Botswana. It is a fairly young company, the Managing Director of which is Mr John Farr whom I interviewed. He is a hydrogeologist but entered after seven years of work for the government the contract business. Out of a total experience of 15 years in the ground water industry he has now spent three years in this company.

Geotest was founded in Gaborone Botswana in mid 1982. It now operates many rigs, one borehole equipping-unit and one borehole testing-unit plus workshop support facilities, office establishment and ancillary transport. Geotest is altogether a Botswana company with no non-resident shareholders, directors, intercompany connections or parent companies. Its organization chart is shown below.

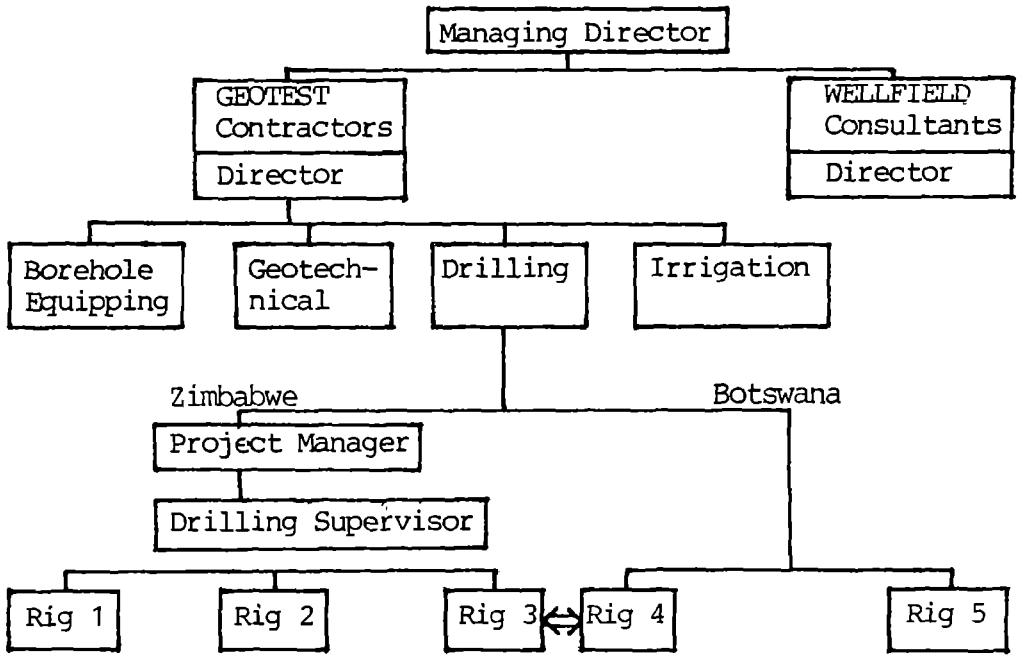



Figure 4. Geotest & Wellfield Consulting Services.

I have also talked to the project manager Mr Heywood and the drilling supervisor Mr Corrigan about their jobs. The drilling affair is strictly a field based operation, so most of the time they spend with their subordinates. The drilling supervisor must keep the rigs going and for the maintenance he has two assisting mechanics. He is futhermore part of the site management.

The project manager is responsible for the personnel, the logistics, liaison with the engineer and for the contract finances. It is a tough job that Mr Heywood has got. All the planning is done in the field although he sometimes has to leave for Harare, the capital of Zimbabwe, to solve practical problems. When the project started in October 1984 the manager Mr Farr thought another project manager was required in Harare but Mr Heywood assured it would be inefficient. He himself could rather do the whole job.

Professional (i.e. qualified geologist/hydrogeologist) personnel at management level has proved to be a great asset, in particular with request to relations with the client and the supervising engineer. Geotest as the contractor can then relate on fairly equal terms with the engineer and not be totally subordinate to him as would be the case with a contractor with no professional management staff.

The Geotest policy is to employ local personnel whenever it is possible. Africans are the most effective labour in the bush thus best suited for the drilling. Europeans would ask for luxurious camping facilities and higher income.

25 Zimbabweans were recruited as drill labour, drivers and kitchen personnel. Five skilled drillers were brought from Botswana by the company. Mr Farr says that good experience is the most important matter in drilling and it is only achieved on the job training. It is very possible to employ local (African) personnel, since a high level of academic achievement/schooling more usually associated with expatriotes (Europeans) is not necessary.

### 3.5.1 Teams

Geotest drillers belong to four teams, each of which consists of one driller, one driver, two rig labourers and one watchman. Each team

are supplied with a rig, a supply truck and a Landrover.

The four teams are supposed to work at an ideal working pace of six weeks duty followed by two weeks' leave. However, because of a very tight contract schedule this was not possible and rigs worked fairly continuously for six months.

## 3.6 Subcontractor

Geotest has engaged a local subcontractor for the construction of headworks and pump installations. The name is Geotechnical and Drilling Engineers (Pvt) Ltd and in June 1983 the company bought Pump and Water Reticulation (Pvt) Ltd, the largest borehole and reticulation firm in Zimbabwe.

The contractor's work always lies one to two weeks ahead of the construction of headworks and the bushpump installation. This means a lag of approx. 20 boreholes, which is accepted as a maximum delay for each completed borehole.

The contractor is responsible for the pump inspection and the subcontractor should, apart from the duties mentioned above, transport the community participation materials. Since the subcontractor from the very beginning seemed to possess merely worn-out equipment, Geotest lent out a truck and a radiolink to facilitate the communication. Radio communications between management and all field teams (drilling and equiping) is vital for an efficient operation. The link is hardly used, however, but the transport problem has decreased.

At first the yield testing was done by Geotest but after Jan. 1985 the subcontractor, Geotechnical and Drilling Engineers, was allowed to operate the testpumping.

## 3.7 Sundries from interviews with Mr John Farr

When comparing different investment forms it is not necessary to specify all parameters. Below I shall take up some interesting, brief facts about Geotest (Pty) Ltd: The company chose to invest in second-hand rigs by the name of Ingersoll-Rand TH60 for the Crash Programme. Appendix 8. These machines were used another four years before they

were reconditionned and delivered from Great Britain. The trucks, imported from South Africa, are at least four years old but in good shape.

Due to shortage of initial funds in the company and because of the price trend the best choice was to buy used equipment. Equipment used in contract see appendix 8.

### 3.7.1 Depreciations

The economic life duration of the rigs and trucks I could estimate by my experience from other projects. In Zimbabwe the result would be approx. five years for Ingersoll-Rand rigs and almost five years each for the trucks.

### 3.7.2 Wear and tear

Moving around is hard on equipment. In Botswana the wear and tear is much greater, however, than in Zimbabwe, Mr Farr explained. The conditions are extreme in the Kalahari desert, for example.

Drilling is difficult in the rainy season when the contractors really have to "bit into the clay".

### 3.7.3 Taxation

The company tax in Botswana is 35% on profit, but in Zimbabwe Geotest is exempt from tax since it is a nonresident company.

### 3.7.4 Legislation for drillers

In general the rules of the Government are very few and not enforced. In Botswana there are technical specifications, for instance a borehole act implying that primary holes have to be on a certain distance from each other. To be named a wet borehole a specific water quantity must be achieved. There are few rules for the working environment. Luckily Geotest has had no serious accidents during drilling although it is a rushed job.

### 3.7.5 Maintenance obligations

The obligations are to clean up the silted or in any other way not acceptable boreholes. Geotest is responsible for the maintenance up to three months after the holes are finished. If, nevertheless, a defect is found, the contract states that the maintenance period will be extended and retention money not released until the defect is corrected. Silted holes were cleaned by the TH60 rigs during a one month 'workover' period (during the last month of the contract - August 1985). Testpumping is undertaken before headworks and pump installation. All defect found during the period September to November have been headworks/pumpfaults and are being corrected by the subcontractor.

### 3.7.6 Logistics

In all well-drilling projects the logistics become complex when more than one rig is operating from the main camp. In the Crash programme this camp is moved up to 20 times to complete 400 boreholes. The number of moves in the course of a contract has increased because of alterations and uneven distribution of sites.

When the rigs are brought between 400 different locations diesel and other consumables, steel or plastic casing, must be supplied and sub-contractors be informed for their headworks' completion. If the new site for drilling is far away and on bad roads the transport may take three to four hours. Taken over the whole contract period the average is two and a half holes per day.

In order to understand the complexity of logistics a chart of the situation for drilling operations with three rigs is shown on the next page. Note that rigs and compressors are truck-mounted.

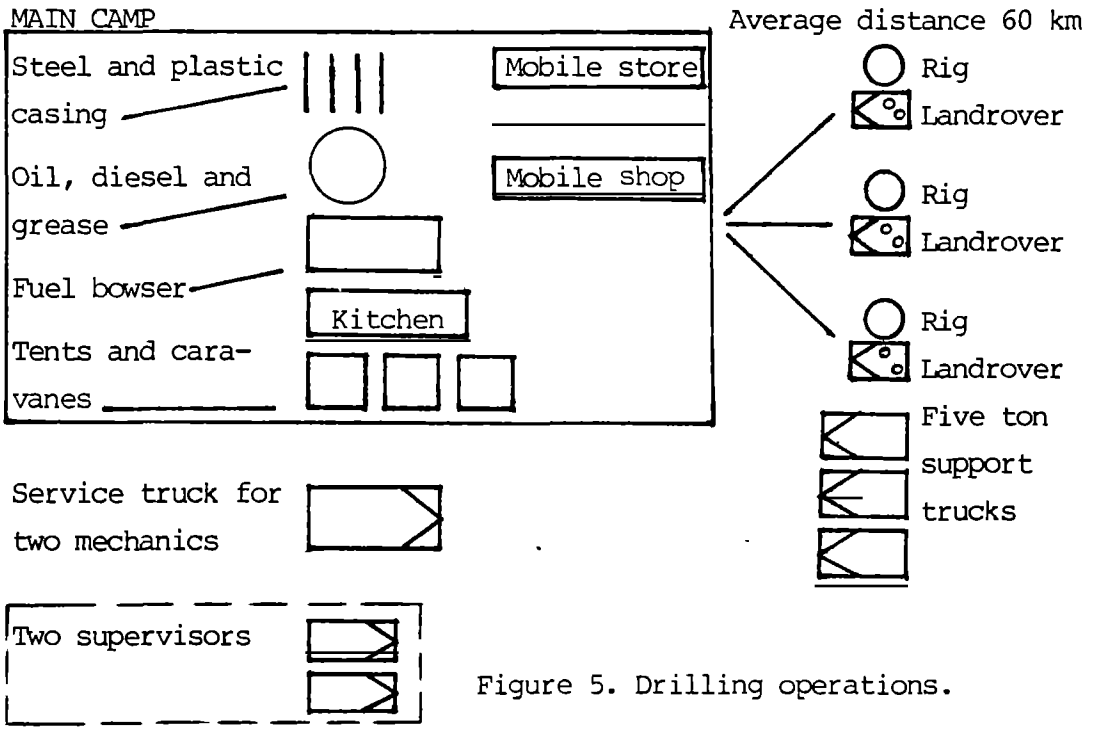



Figure 5. Drilling operations.

### 3.7.7 Ideal circumstances

Since logisitics seems to be quite difficult I want to point out perfect conditions. First of all if possible the main camp should always be moved while the rigs are drilling. Then no extra time would be spent on this action. Looking at the proceedings from drilling to testpumping I think it ought to take approximately seven days.

Timetable:

- Drilling 30-40 meters in four to five hours.
- Testpumping for five hours, followed by two hours' rest waiting for new water to come and finally two hours' testpumping. (Testpumping must be completed before the decision is made to install headworks and pump.)
- Headworks' construction is started and finished the third day.
- Then it takes three days for the concrete to harden.

## 3.8 Project economy

A long delay in the publication of the Crash Borehole Programme Final Report has forced me to base my comparison on the Progress Report August 1984 - March 1985 (Ref 3).

" ACTUAL COSTS

| | | | |
|---|---|---|---|
| **Contractural Services:** | | | |
| Request No. 1 | - ZW$ 92775,- | (16.1.85) | |
| Request No. 2 | - ZW$ 49411,- | (29.1.85) | |
| Request No. 3 | - ZW$ 56654,- | (15.2.85) | |
| Request No. 3A | - ZW$ 21224,- | (4.3.85) | |
| Request No. 4 | - ZW$ 152238,- | (29.3.85) | |
| Request No. 5 | - ZW$ 121000,-(3) | | ZW$ 493,302,- |
| **Consulting Services:** | | | |
| Remuneration exp. personnel : | ZW$ 381,402,- | (366150)(1) | |
| Remuneration local personnel : | ZW$ 32,825,- | (45600) | |
| Intern. travel & transport : | ZW$ 66,667,- | (66667)(2) | |
| Allowances : | ZW$ 129,000,- | (237490) | |
| Local travelling: | ZW$ 109,452,- | (124167) | |
| Rent & operation of equipment : | ZW$ 29,017,- | (42000) | |
| Other expenses : | ZW$ 41,656,- | (130000) | ZW$ 790,019,- |
| Project Management (estimate) | | | ZW$ 103,000,- |
| Materials from Employer (131 x ZW$900) | | | ZW$ 117,900,- |
| Value of work (31.3.85) | | | ZW$ 1,504,221,- |

Notes: (1) Number in parenthesis reflects figures from payment schedule, Contract consultancy services, Annex C.1.

(2) Prepaid lump sum figure.

(3) Estimated

The contractor has so far invoiced for a total of 99 boreholes at a total cost of $372302.- for 53 borehole Design A, 33 borehole Design B and 13 boreholes being unsuccessful.

Average cost of BH design "A" is $3588.-
Average cost of BH design "B" is $4277.-
Average cost of dry BH is $1340.-

In addition to above cost comes items such as:

Mobilization : $59.- per BH
Demobilisation : $33.- per BH
based on contract unit prices and an estimated 400 No. of boreholes.

For the time being we have not yet completed a breakdown and a summation of costs for each individual item included in the Bill of Quantities but will supply this shortly for discussion.

FORECAST

| | | | |
|---|---|---|---|
| At disposal | : | | ZW$ 4,670,000 |
| Contractural services | : ZW$ | 1,504,000 | |
| Consultancy services | : ZW$ | 1,614,000 | |
| Project management | : ZW$ | 155,000 | |
| Materials from Employer | : ZW$ | 360,000 | |
| Contingencies | : ZW$ | 467,000 | ZW$ 4,100,000 |
| Estimated amount available | : | | ZW$ 570,000 |

If above forecast materializes the ZW$ 570,000 will allow for an estimated distribution such as follows:

| | |
|---|---|
| Contractural services | ZW$ 209,000 |
| Consultancy services | ZW$ 224,000 (1) |
| Project management | ZW$ 22,000 |
| Materials from employer | ZW$ 50,000 |
| Contingencies | ZW$ 65,000 |
| | ZW$ 570,000 |

For this amount approximately 50 additional boreholes could be constructed.

(1) Includes community participation materials and services.

In above estimates the following assumptions are made:

- Contractural services; average ZW$3760 per BH
- Consulting services; as budgeted
- Project management; figures supplied by MEWRD
- Materials; ZW$900.- per BH
- Contingencies estimated as 10% of amount at disposal.

Estimated amount available (ZW$570 000.-) is distributed in same proportions as forcast.

An issue about headworks being constructed of screeded bricks or concrete have been argued with the contractors. If arbitration goes in favour of the contractor, the amount due the contractor should be a maximum of ZW$ 137 000." (Ref 3)

## 3.9 Future plans

When the Crash Programme is completed another project will go on till first of July 1986, and it will be sponsored by NORAD money. This program will be more integrated with water, sanitation, health etc. The overall costs are estimated to be 15 million Nkr and the prospecting will last for ten months, comprising 170 boreholes and an equal number of wells. Depending on weather conditions, 16-20 boreholes and as many wells are thus expected to be completed each month. (The maximum amount of holes drilled per month by the contractor of the Crash Programme was 80, mentioned as a comparison.)

Two teams working in shifts during eight months will choose 170-180 sites and have them prospected between first of August 1985 and first of March 1986. Heavy rain during this period may cause problems. When the siting is ready, one of the teams will go on supervising until June. Then the hydrogeologist will leave the second team in order to engage in different duties.

The drilling on this program will be done by MEWRD, who will be employing its own personnel on two rigs, namely Tone Top 200. These were donated by the Japanese Government. The drilling is expected to begin in September 1985 at the newly sited locations. Consequently, the siting in most areas will scarcely keep ahead of the drilling operation. To manage this situation one siter and one supervisor of each siting and each supervising team are employed.

The Ministry can handle the headwork construction and test pumping by using its own resources. All ministries, however, still suffer from the lack of competent personnel, personnel which left as the countries gained independence. There have also been losses to the private sector because contractors pay higher salaries.

To fill in the gaps at MEWRD, it seems that more expatriots must be employed. On a water project like the one described, a complete staff is almost necessary. The alternative is to use a consultant. Interconsult A/S will continue to work as such on future programmes.

## 4 DDF MANAGEMENT CONTRACT

This second part of my study concerns a very interesting form of contracting. In Sweden there is a company named WellDrill which was established in 1980. Its aim is to facilitate the development, production, marketing and sales of equipment and services tailor-made for the exploitation of groundwater resources in developing countries, especially in rural areas. For the project studied the company has recruited a staff qualified in various fields related to groundwater exploration and well drilling.

WellDrill System AB is a subsidiary of the Atlas Copco Group. The latter is a large well-known multinational Swedish company with vast resources and well developed marketing and sales network and offices in major cities around the world.

In Harare, Zimbabwe, there is an agency dealing with Atlas Copco equipment. I have been in contact with its Managing Director Mr Don Ferreira and also its Financial Manager Mr John Birtwistle.

Since its foundation, WellDrill aimed to assist its customers to achieve efficient utilization of equipment by providing a good service. In cooperation with the Zimbabwien DDF, which is part of the Ministry of Local Government and Town Planning furnished staff training, WellDrill management advice and controls project and drilling management.

Project manager Mr Lars Carlsson and the drilling superindtendant Mr Ragnar Hurtig have been working in Harare almost since the project's beginning. Now they are employed by the Norwegian Development Organization NORAD.

These people have been of great help to me in providing me with actual facts and documens.

Today the whole operation is financed by NORAD and it is DDF Water Division that is responsible for the well drilling and training programme. (Appendix 8)

A training centre 16 km outside Harare, the Hunyani DDF training

centre, has since the management programme started been built and is expanding. The architect is Mr Gordon Turner, who is also planning future constructions.

In Zimbabwe there are eight different training centres under the administration of DDF built through donations. All training has always been financed by aid money i.e. money which does not need to be paid back.

## 4.1 DDF: Background

Before independance in 1980, white farmers formed a self-supporting fund, the African Development Fund. It was run as a private company, dipped the big farmers' animals and reduced their taxes.

This fund was then under the same organization transformed to DDF, an establishment not aiming at profit and financed by donor money. Apart from water projecting, DDF deals with other development activities, like road and dam construction.

## 4.2 The organization of DDF Water Division

The District Development Fund is an organization closely related to the Ministry of Local Government and Town Planning. In the National Master Plan for Rural Water Supply and Sanitation the organizations are thoroughly examined. Appendix 8.

For my study I did not have time to look closely into these organizations. The chart on next page attempts to explain the close links between them.

4.2.1 Organization chart

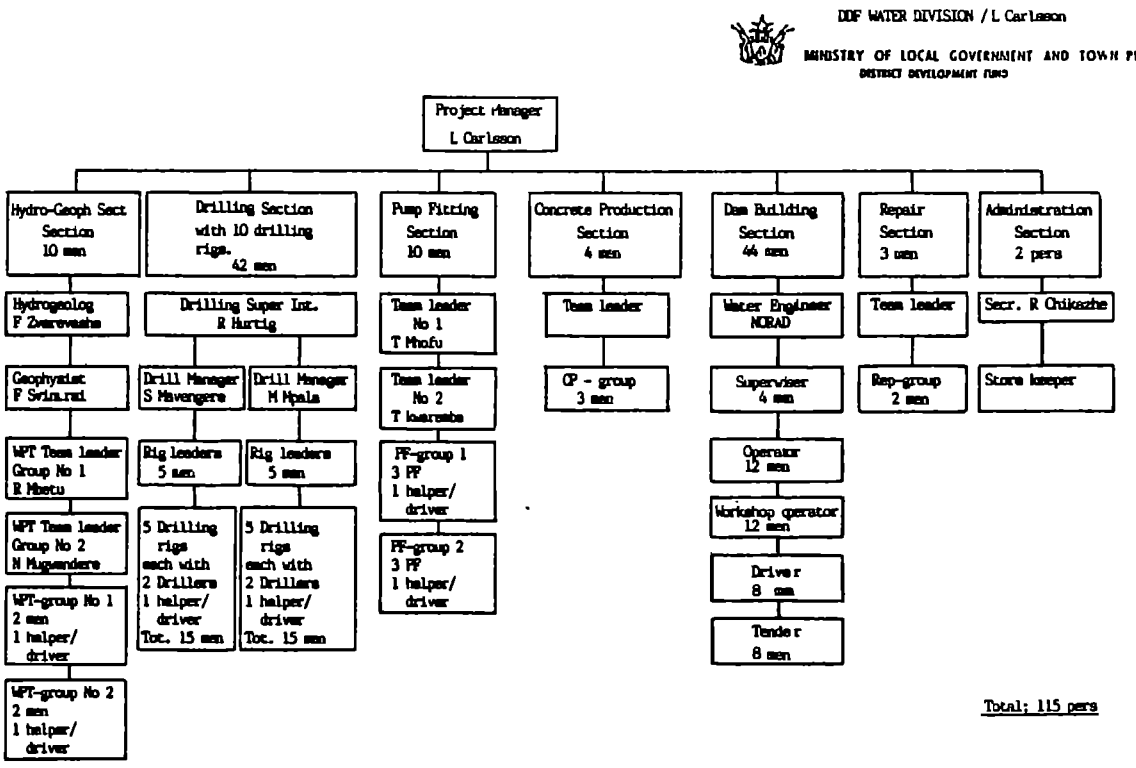



Figure 7. Organization of DDF Water Division 85.01.01.

The Water Division is split into seven sections:

The Hydro-Geophysist section consists of ten men. Two counterparts, taught by the hydrogeologist H. Timje and the geophysist A. Jämlid are the main persons. There are two water-prospecting teams. In future, yield and pump tests are to be carried out by a special group under the supervision of a hydrogeologist. The present procedure is quite primitive.

The drilling section has ten LWD 200 rigs operating. Appendix 9. Except for the Drilling Superindtendant there are two Drilling Managers, each with five rig leaders under their control. In order to get an efficient drilling performance and not an increased logistic problem, each rig is surrounded by a drilling team. An optimal operating team consists of one rig leader, two drillers and one assistant, who is also the driver.

When the rig is mounted on a truck each team should have a service car for smooth operations. Radiolinks between team and manager will be installed as soon as the money is available. Flexibility is increased

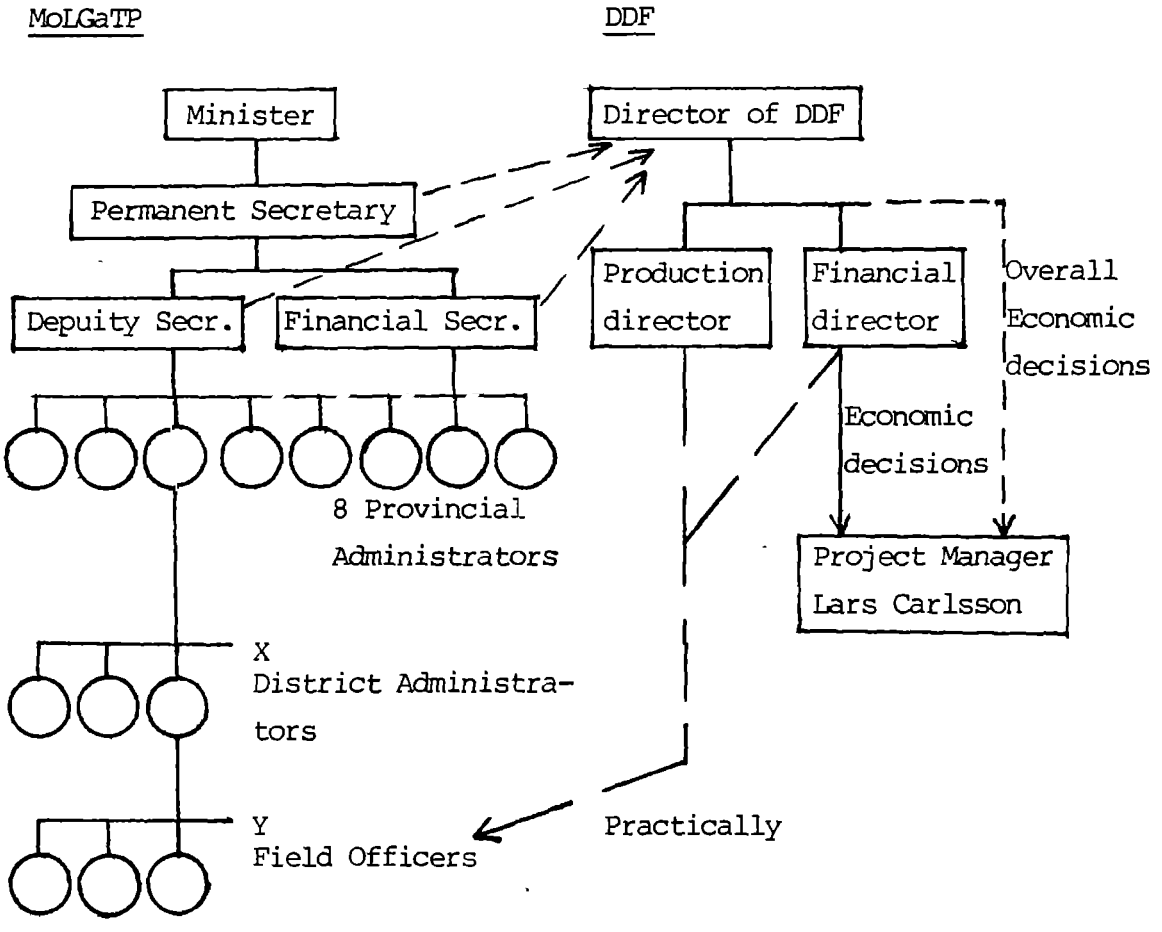



Figure 6. Chart of links between Ministry of Local Government and Town Planning and District Development Fund.

As these organizations are so complex and the drilling so widespread - over more or less the entire country - it is essential for personnel to be well directed. The total number of employees in DDF is approx. 3 500. Mr Lars Carlsson is the project manager under the direction of DDF.

If the job is going smoothly meetings are not held for all decisions.

One of the main tasks of expatriots in managing positions is to teach counterparts their jobs. Through these people and other local recruited staff the whole organization should remain stable when the expatriots contracts come to an end.

In this way it could be said that the managers are building a company within the bigger company, i.e. the DDF. A separate budget for the project manager is therefore recommended.

that way.

The pumpfitting section consists of two team leaders and two groups to make a total of ten men.

The concrete production section, dealing with the foundation of head-works, is a four man team.

The repair section is a very important part of the division. One mobile team in a Nissan Patrol is responsible for small repairs in the field. There is one team leader and two mechanics in a repro group doing this job. Bigger breakdowns must, as mentioned previously, be taken care of in a workshop.

In the administration sector there are only two people; a secretary and and a storekeeper. They will be accomodated in the Hunyany training center when completed. The store-keeper will be responsible for the new, bigger store. A card system and/or a computer will file the stored goods.

## 4.3 Costs and comments on my parameters

The facts I present below were obtained partly from several private interviews with the project manager, Mr Lars Carlsson, and partly from the report written by him about the District Development Fund, Zimbabwe. DDF Division.

The water division in Zimbabwe does not keep account and capital budgets according to the calendar year. The budget year runs from the first of July until the last day of June in the next year. The Ministry makes the situation even more complicated by closing the accounts two months before and two months after the beginning of the new budget year. The ministry seems to lack control of its available money. The drilling superintendant, Mr Ragnar Hurtig, is caused a lot of trouble and has therefore received a special account for running capital costs and investments on the well drilling project.

You may have noticed that apart from drilling wells, the water division also invests in the construction of dams. To obtain an appropriate evaluation of the management contract, I have excluded

the costs of these investments from my calculations.

### 4.3.1 Total cost

The project's total cost is financed by the Norwegian government. The entire sum is aid money which will therefore not have to be repaid.

The drilling project has during the budget year received 2 293 376 Z$ as expenditure forecast.

| | |
|---|---|
| Estimated cost of boreholes | 1 443 200 Z$ |
| " " of handpump installation | 850 176 Z$ |
| | 2 293 376 Z$ |

For this amount of money the plan was to make 656 boreholes in eight different districts. The actual number of boreholes produced was 371. Several reasons for this are as follows:

- There are only eight rigs in operation whereas the budget is calculated for all ten rigs.
- Some problems with the rigs.
- Sometimes training of local drilling managers does not work exactly as planned.
- Local circumstances and general problems in developing countries, such as shortage of oil.

The cost carried over for the dam and weir project is 1 584 015 Z$. Materials for training and education are bought with this money and are, as mentioned earlier, excluded from my calculations.

The resulting budget (after a few other adjustments) for water supply 1984-1985 will be:

| | |
|---|---|
| Drilling project expenses | 1 620 052 Z$ |
| Vehicles for drilling project | 138 000 |
| Buildings and equipment (50%) | 127 000 |
| Additional equipment | 151 678 |
| Staff salary | 239 355 |
| Experts' salary | 257 145 |
| | 2 533 230 Z$ |

The following figures come from the project report and should be

considered in order to account for the sums just mentioned:

Drilling project expenses

| | |
|---|---|
| - Petrol for trucks and cars<br>12 nos * 2 500 mil * 3 l * 1 Z$ +<br>12 nos * 2 500 mil * 2 l * 1 Z$ = | 150 000 |
| - Lubr. oil 10% of petrolc. +<br>Spare parts 10% of inv. cost = | 43 800 |
| - Casingtube 1 040 à 20 m à 21 Z$/m = | 436 800 |
| - Casing shoe 1 040 à 6 Z$ = | 6 240 |
| - Camping and staff equipment = | 48 800 |
| - Handpumps, local made 1 040 * 764,55 Z$ = | 776 412 |
| - Diesel and petrol for compressor and rigs<br>16 h * 100 hp * 165 gr * 1 040 hole: 0,82 * 0,5 Z$ = | 168 000 |
| -Lubr. oil for compressor 12% of dieselconsump. = | 20 000 |
| | 1 650 052 Z$ |

(Ref 5,page )

Vehicles for drilling project

| VEHICLES<br>Donor: NORWAY | | | |
|---|---|---|---|
| Vehicles for | Type | Cost incl. spares and tools | Expenditure forecast Z$ |
| Dr. Manager No 1 | Nissan Patrol | 9 000 | |
| Dr. Manager No 2 | Nissan Patrol | 9 000 | |
| DM - 1 Training leader | Nissan Patrol | 9 000 | |
| DM - 2 Training leader | Nissan Patrol | 9 000 | |
| Geophysist | Nissan Patrol | 9 000 | |
| Hydrogeologist | Nissan Patrol | 9 000 | |
| Rig No 9 | Nissan Diesel Truck 7 ton | 24 000 | |
| Rig No 10 | Nissan Diesel Truck 7 ton | 24 000 | |
| Transport | Nissan Diesel Truck 7 ton | 24 000 | |
| Inspection, 5 pers | Nissan Safari Diesel | 12 000 | 1984/1985<br>138 000 Z$ |

Figure 8.
(Ref 5, page 56)

## Buildings and equipment

From the sum of 240 000 Z$, 50% is omitted because these investments will approximately be 50-50 used by the drilling project and by the dam and weir project.

BUILDING AND EQUIPMENT
FOR DDF-WATER DIVISION
Donor: NORWAY

| Nos of buildings | Description | Cost | Expenditure forecast Z $ |
|---|---|---|---|
| 1 | Office | 87 000 | |
| 1 | Workshop | 33 000 | |
| 1 | Rigs & Compr. Garage | 18 000 | |
| 1 | Garage for light cars | 12 000 | |
| 1 | Garage for trucks | 19 000 | 1984/1985<br>169 000 Z$ |
| | EQUIPMENT | | |
| | Furnitures to office | 36 000 | |
| | Office equipment | 22 000 | |
| | Store equipment | 12 000 | |
| | Freight and insurance | 15 000 | 1984/1985<br>85 000 Z$ |

Total 254 000

Figure 9.
(Ref 5, page 55)

## Additional equipment

EQUIPMENT
Donor: NORWAY

| Nos or sets | Description | Cost Z $ | Expenditure forecast Z $ |
|---|---|---|---|
| 1 | Test pump set - el. or hydraulic driven - | 36 000 | |
| 1 | Reflecting telescope | 4 000 | |
| 1 | Computer type II 35 | 5 500 | |
| 1 | Water prospecting equipm | | |
| | 2 diesel generator set for charging of batteri etc. | 97 428 | |
| 6 | Welding plant for pump fitter team 1 - 2 . | 3 000 | |
| 4 | Tools, tool box, crane and work bench for pump fitter team 1 - 2 | 5 750 | 1984/1985<br>151 678 Z$ |

Figure 10.
(Ref 5, page 57)

## Staff salary

| | | Cost / year |
|---|---|---|
| Water Project Manager, paid by NORAD | | |
| Water Project Manager , under study | | 12 000 |
| Production Manager , paid by NORAD | | |
| Production Manager, under study | | 11 252 |
| Hydrogeologist | | 7 600 |
| Geophysist | | 7 600 |
| Water Prospecting Team No. 1 = 4 men | | |
| Water Prospecting Team No. 2 = 4 men | ( a'5 400 / man ) | 43 200 |
| Secretary | | 5 040 |
| Clark | | 2 880 |
| Purchasing | | 2 880 |
| Water engineer,hydrogeologist for dam construction, paid by NORAD | | |
| Storekeeper | | 2 448 |
| Pump Fitting Team No 1 = 4 men | | |
| Pump Fitting Team No 2 = 4 men | ( a' 2 592 / man ) | 20 739 |
| Drilling Manager No. 1 | | 5 276 |
| Drilling Manager No .2 | | 5 276 |
| Drillers 30 men | ( a' 2 736 / man ) | 82 080 |
| Drivers 12 men | ( a' 2 592 / man ) | 31 104 |
| | Total cost = | 239 355 |

Figure 11. Staff salary. (Ref 5, page 58)

## Experts' salary

The experts were paid by NORAD (257 145 Z$).

### 4.3.2 Some comments on staff salaries

The government in Zimbabwe has decided that wages for those in public services should not be raised at present. This freeze adversely affects the well drilling project. The men work 160 hours a month and the average salary is 1,65 Z$ per hour.

I, like many of the people involved in the project, believe that the salary system should be altered. Its efficiency is comparatively low. A drilling team accomplishes on average 9,9 meters per day. More motivation could be gained by offering bonuses per drilled meter or more time off after, say, a particularly well-performed job. I think a moving wage scale is preferable. Then, for example, a driver who

has a lot of responsibility could be motivated to work longer hours than the other drill labourers.

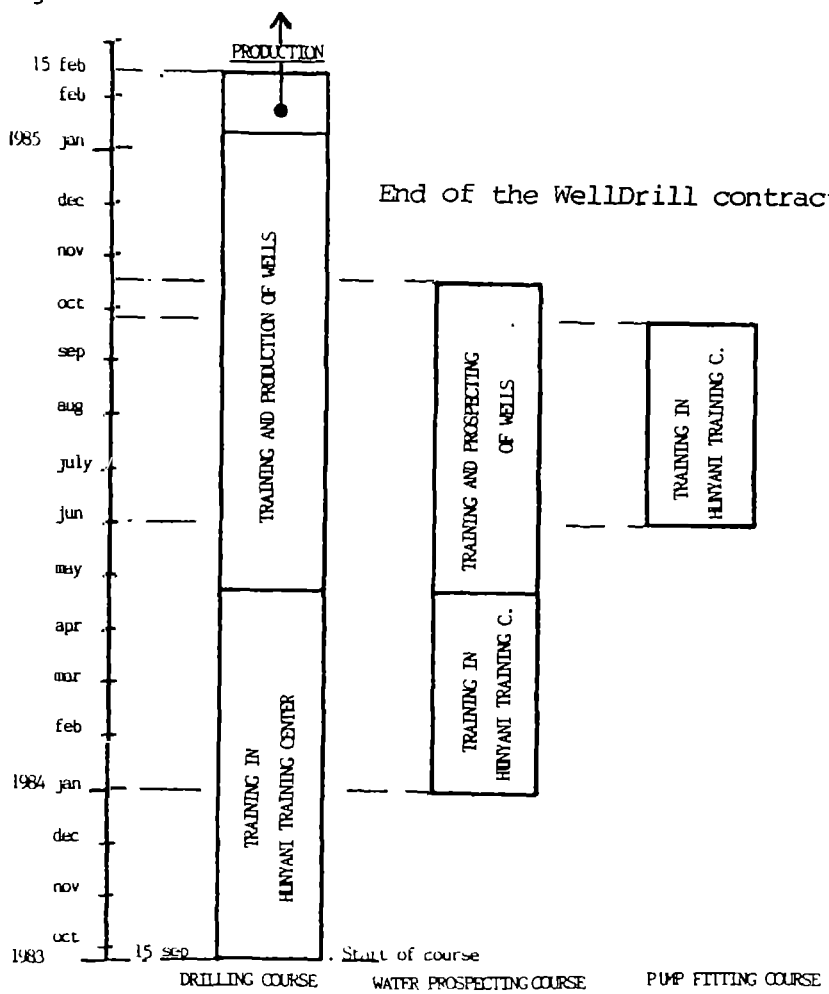
The aid organization has presented proposals similar to my own to the government of Zimbabwe. However, it is likely that the requests will interfere too much with the country's internal politics.

Another way of increasing efficiency is to cut down the number of staff. Every drilling team per rig consists of five to six men but can, under good conditions, be reduced to three, including a chauffeur. Action is being taken along those lines.

## 4.4 Education

Staff training is done partly at Hunyani training centre, and partly as the rig is in operation. The drilling, water prospecting and training for pump fitting at Hunyani were to begin with done in scheduled courses. Time periods as below used.

Figure 12. Drilling, Water Prospecting and Pump Fitting.Training (Ref 5, page 2)



The first course in drilling at the training centre lasted for more than six months. This long period was partly caused by lack of access to camping equipment and cars and trucks necessary for transport. These problems occured because of two factors:
- WellDrill was not sufficiently informed about how DDF functions.
- DDF did not have enough experience in this type of business.

The time normally required to train a team to work a rig is three to four weeks. Whether the unit is complex or simple the rig is operated by just a couple of levers on a control panel. From then on everything depends on the driller's ability and feeling for what is happening under the ground. To become a skilful driller takes anything from a month to a whole lifetime.

Costs during the education period depend on:
- Salary of supervisors and other instructors.
- Materials for training.

Increased wear and tear of the rigs and accessories due to the personnel's unfamiliarity with their work is noticeable.

## 4.5 Investments of equipment

The project report by Mr Carlsson presents a survey of the equipment invested in the project for drilling, water prospecting and in the pumpfitting section. See figure next page.

Today there are eight LWD operating units, and other equipment is quite intact after reinvestments.

## 4.6 Maintenance and service

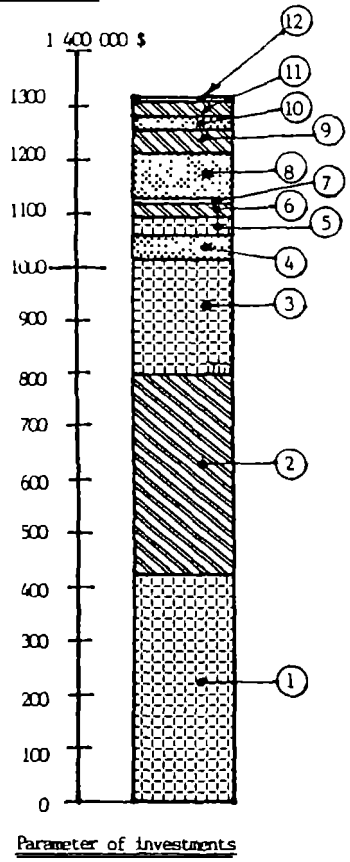
These outlays are not specified in any books but part of the total budget. There has been no reasons so far for keeping a record of the exact figures of these expenditures.

Figure 13. Investment of equipment in drilling, water prospecting and pump fitting section.

(Ref 5, page 71)

Investments of equipment:

| | | | |
|---|---|---|---|
| 1 | 10 nos | Drilling rigs LWD | 425 000 $ |
| 2 | 10 nos | Compressors | 375 000 $ |
| 3 | 9 nos | Trucks 7 tons | 216 000 $ |
| 4 | 6 nos | Datsun 1800 | 45 000 $ |
| 5 | 3 nos | Nissan Patrol | 36 000 $ |
| 6 | 2 nos | Tractors | 24 000 $ |
| 7 | 2 nos | Bowser | 4 000 $ |
| 8 | 2 sets | Water prospecting equipment | 83 500 $ |
| 9 | 1 set | Camping equipment | 48 000 $ |
| 10 | - | Small investments | 24 000 $ |
| 11 | 2 nos | Truck 2 3/4 tons | 30 000 $ |
| 12 | 2 sets | Tools for pump fitters | 6 000 $ |
| | | Total investments: | 1,316 500 $ |

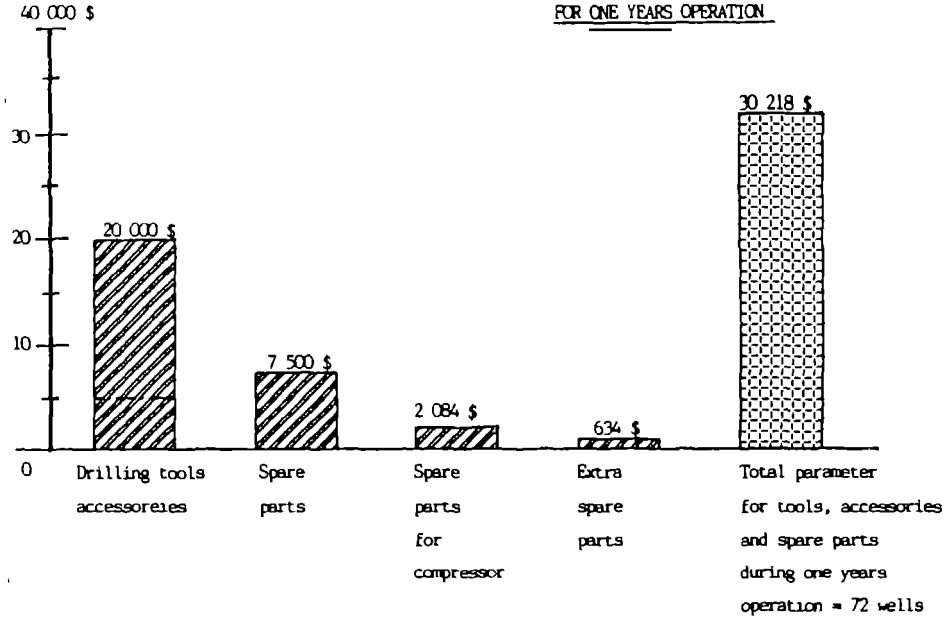



## 4.7 Spare parts

Consumption of drilling tools, accessories and spare parts during a one-year operation. Losses and other local circumstances generate uncertainty in these figures.

Figure 14. PARAMETERS OF TOOLS, ACCESSORIES, SPARE PARTS AND TOTAL PARAMETER FOR ONE YEARS OPERATION

(Ref 5, page 73)



### 4.7.1 Purchase of spare parts - comment

All spares which cannot be purchased in Zimbabwe are imported. If they were imported from the manufacturer instead of from an agent there would be potential for savings.

In case several companies are manufacturing the same product two or three tenderers are selected.

Finally the spare parts are sent by boat to Durban in South Africa and NORAD pays the invoice when shipping forms are delivered. Urgent orders are sent by air, which of course is more expensive.

## 4.8 Transport

Much time in a drilling project is spent on transportation between sites. Approxiamtely how much fuel is consumed is shown below. The amount of miles is directly furnished by the gauge of the vehicles. None of the figures include maintenance costs.

Figure 15. Transport cost for drilling rig.
(Only fuel for one 7 tons truck)
Continuation next page.
(Ref 5, page 74)

District.
Goromonzi
Wedza
km reading for trucks = rigs

| | | |
|---|---|---|
| Rig No 1 | 797 km | |
| Rig No 2 | 1097 | |
| Rig No 3 | 822 | |
| Rig No 4 | 1009 | Tot production of |
| Rig No 5 | 1271 | wells = 36 |
| Rig No 6 | 822 | |
| Rig No 7 | 986 | |
| Rig No 8 | 757 | |

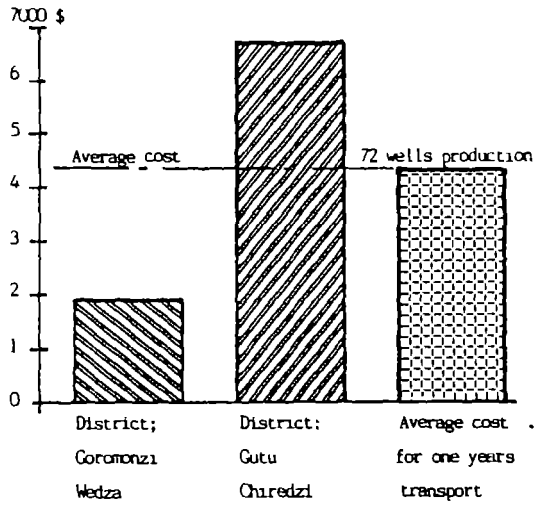
Tot km. 7558
Average dist/well. 7558 . 36 = 209,9 km
Average consumption / truck and 10 km = 2,5 L
Average consumption / well = 52,48 L
Average transp cost / well = 26,24 $
Max prod 72 wells/year and rig:
Tot fuel cost/ rig and year 1889,28 $

District
Gutu
Chiredzi
km reading for trucks = rigs

| | | |
|---|---|---|
| Rig No 1 | 2610 km | |
| Rig No 2 | 1800 | |
| Rig No 3 | 2270 | |
| Rig No 4 | 2340 | Tot production of |
| Rig No 5 | 1776 | wells = 26 |
| Rig No 6 | 2520 | |
| Rig No 7 | 1972 | |
| Rig No 8 | 2350 | |

Tot km: 19438
Average dist / well = 19438 : 26 = 747,6 km
Average consumption / truck and 10 km = 2,5 L
Average consumption /well = 186,9 L
Average transp cost / well = 93,45 $
Max prod 72 wells/year and rig:
Tot fuel cost / rig and year : 6728,40 $

Figure 16. Transport cost for drilling rig (Ref 5, page 74)
(Only fuel for one 7 tons truck)




Average cost / district for transport of drilling rig during one year operation:

a) $\frac{1889,28 + 6728,40}{2} = \underline{4308,84\ \$}$

Transp cost between wells:

b) $\frac{4308,84}{62} = \underline{69,50\ \$}$

Figure 17. Transport cost for Water Prospecters, Drilling Managers , Pump Fitters (Ref 5, page 76)
( Only fuel and petrol )

District.
Goromonzi
Wedza
Tot production of 36 wells

Hydro Section

km reading and consumption:

| | |
|---|---|
| Hydrogeologist | 2653 km / 265 lit |
| WPT-team No 1 | 1827 km / 487 lit |
| WPT-team 2 | 2280 km / 491 lit |
| Tot: | 6760 km / 1243 lit |

Average dist / well: 187,78 km

Average transp cost /well = 34,53 $

Pump Fitting Section

km reading and consumption:

| | |
|---|---|
| PFT No 1 | 1826 km / 376 lit |
| PFT No 2 | 1852 km / 442 lit |
| Tot: | 3678 km / 818 lit |

Average dist / well: 102,17 km

Average cost / well = 11,36 $

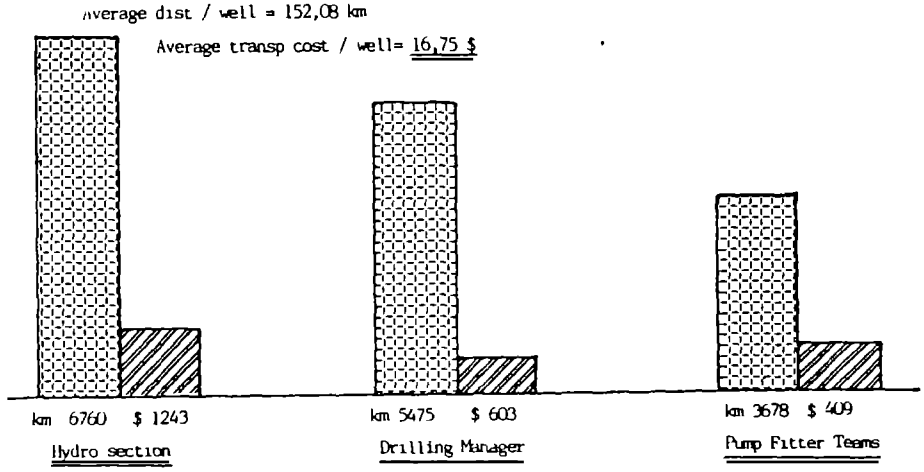
Drilling Managers

km reading and consumption:

| | |
|---|---|
| Drilling Manager No 1 | 2938 km/350 lit |
| Drilling Manager No 2 | 2537 km/253 lit |
| Tot: | 5475 km/603 lit |

Average dist / well = 152,08 km

Average transp cost / well= 16,75 $



## 4.9 Wear and tear on equipment

As mentioned earlier, this management contract has, since it started on the 15th September 1983, employed the WellDrill Systems AB LWD 200 drill rig (Appendix 9). The delivery included everything needed for the well drilling operation.

Until recently, the function of this equipment was quite satisfactory, although the right quantity and selection of spare parts was not supplied.

It was soon realized that the idea of drawing the light weight rig behind a tractor or jeep and pulling the compressor in the same way over long distances was a little bit too wishful thinking. DDF has therefore used trucks for this purpose.

Below are described some problems and breakdowns which occurred:

- The derricks' joints are weak and have been bent during drilling.
- The rear axis can sometimes not tolerate the pull-up power.
- Frequent replacement of the buttom bits partly due to the rig's light weight, make it 'jumpy'.
- The diesel pump is inefficient.
- The engine is too weak.
- Trouble with clay since the compressor is too weak to blow the bore-hole clean.
- The rig is unable to make holes deeper than ~80 m, due to a minor torque.
- A lot of down time because of broken trucks unable to pull the rigs.

To manipulate all these problems the DDF Water Division has a workshop in Mashwest just outside Harare. Since the capacity for the maintenance is slim, small private agencies must also be used. Consequently costs are increased.

Special conditions found in a developing country must be considered like:

- Bad roads, causing transport problems and extra damages to the equipment.
- Unskilled workmen's careless handling of the machinery, resulting

in breakdowns.
- Shortage of spare parts and fuel.

To solve some problems, drilling superintendant Mr Ragnar Hurtig and project manager Mr Lars Carlsson had the idea of mounting the LWD rig and the compressor on a Nissan Diesel seven ton truck. By rebuilding it into units obvious advantages are gained:
- It is easier to keep on the road and to move into the bush due to the unit being shorter.
- There is less fuel consumption.
- Having to keep a small number of spare parts in stock, e.g. only one dimension of wheels etc.
- Smaller maintenance outlay.

These advantages immediately result in:
- Higher speed between locations.
- Easier manoeuvrability into sites.
- Less visits to the shop for repairs.
- Higher drilling capacity.
- Easier planned logistics, thus creating more flexibility.

Mounting the rigs and compressor on a truck result, however, in bring about vibrations which the thin plate of the body cannot endure. The trucks are thus checked every three weeks.

## 4.10 Depreciations

The budget I studied in Harare was the first one of its kind at the DDF Water Division. It was compiled by Mr Carlsson for NORAD. The calculation was based on investments of drilling rigs and equipments from WellDrill Systems AB.

Since the ministry does not express any recommendations, Mr Carlsson decided to use straight depreciations at various times. This system of deducting the equipment seems reasonable to me, but the periods chosen are debatable.

The following schedule for each plant of machinery has been given the ministry's approval.

Investments of drilling rigs and equipments
from Well Drill Systems AB

| Pos | Nos | Description | Tot cost | Cost/rig | Depreciation | Cost/Unit |
|---|---|---|---|---|---|---|
| 1 | 10 Nos | LWD 200 Drill rigs as per attached technical specification | 425 000 $ | 42 500 $ | 5 Year | 8 500 $ |
| 2 | 10 Nos | Compressors Sullair HH 300 DP as per attached specification | 375 000 $ | 37 500 $ | 5 Year | 7 500 $ |
| 3 | 10 Nos | Drilling tools and accessories set as per attached specification | 450 000 $ | 45 000 $<br>(30 000 $)<br>(15 000 $) | 2 Year<br>3 Year | 15 000 $<br>5 000 $ |
| 4 | 10 Nos | Spare parts packages as per attached specifications | 75 000 $ | 7 500 $ | 1 Year | 7 500 $ |
| 5 | 10 Nos | Spare parts for the compressor as per technical specification | 41 667 $ | 4 167 $ | 2 Year | 2 084 $ |
| 6 | 2 Nos | Sets of extra spare parts as per attached specification | 12 667 $ | 1 267 $ | 2 Year | 634 $ |
| 7 | 2 Nos | Sets of water prospection equipment as per attached specification | 83 333 $ | 8 333 $ | 3 Year | 2 778 $ |
| | | Investments: | 1 462 667 $ | | Cost/Year: | 48 996 $ |

Figure 18. Depreciations. (Ref 5, page 70)

Since problems have occurred with the LVD 200 rigs, a deduction period of five years may seem too optimistic. After necessary technical modifications, however, it ought to be reasonable.

The spare-parts sets for rigs and compressors have, from my point of view, too short a depreciation age. Mr Carlsson´s opinion is that WellDrill lacked experience in fitting the spare parts, due to a new drill construction.

The sparepart sets which were available from September 1983 and should have had a life of 100 wells per rig lasted only for 208 holes during 16 months; until the end of the first contract.

## 4.11 Borehole output

The drilling manager Mr Ragnar Hurtig gave me the following schedule of the last six months production of boreholes in the project. The borehole output is during the period 01.01.85 - 06.30.85. The two

rigs missing (out of originally ten rigs) are standing still.

D.D.F. WATER DIVISION.
Production within six(6) months

| Rig nomber | Nomber of holes drilled | Total meters drilled | Average borehole depth | Odex | Total distance covered | Approximate distance/hole | Total diesel used | Average diesel per hole | | % succes |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 16 | 769 | 48,3 | 108 | 2174 | 136 | 4609 | 288 | | |
| 2 | 23 | 1221 | 51,5 | 177 | 1212 | 53,0 | 6294 | 267 | | |
| 3 | 14 | 721 | 53,2 | 100 | 1869 | 133,5 | 4866 | 348 | | |
| 4 | 29 | 1431 | 49,4 | 264 | 7366 | 254,0 | 8618 | 297 | | |
| 5 | 25 | 1287 | 51,5 | 260 | 1004 | 40,2 | 5741 | 412 | | |
| 6 | 17 | 908 | 53,4 | 317 | 3196 | 188,0 | 4896 | 288 | | |
| 7 | 18 | 867 | 48,2 | 162 | 2745 | 152,5 | 5661 | 314 | | |
| 8 | 21 | 1224 | 58,3 | 234 | 6400 | 304,8 | 6914 | 329 | | |
| | 163 | 8428 | 51,7 | 1622 | 25966 | 1593 | 48599 | 298,2 | | 83% |
| | two(2) days rest =848 | | per period for travelling = 96days | | | | | | | |
| | average meters drilled per day = 9,9m/day | | | | | | | | | |
| | diesel consamption | | | | = | 57,311/day | | | | |

Figure 19. Borehole output. (Source: Mr Ragnar Hurtig)

# 5 PURCHASING

This part of my study concerns the donation of four LWD drilling rigs, accessories and spare parts from SIDA to MEWRD, that is the Ministry of Energi and Water Resources and Development, in the beginning of 1983 by import support.

## 5.1 Background

When the ministry requested Swedish assistance in purchasing light weight air rigs there had been drought in Zimbabwe for two years. MEWRD then owned 20 slow but reliable cable tool rigs and two Japanese rotary rigs. Furthermore, private contractors with at times 31 rigs were working for the ministry.

250 boreholes were drilled annually, but the intention of the well drilling programme was to produce 3000 wells for domestic establishment in a period of two years, followed by a further 5000 holes drilled under the Rural Development Programme. The production didn't meet the demand!

With extra capacity MEWRD hoped to complete the project within ten years. For this reason, rotating drills driven by compressed air were obviously needed. These drills should be uncomplicated, easy to move and cheap to run.

The LWD, ie the Light Weight Drilling rig by WellDrill Systems AB exhibited in Bulawayo made the ministry very enthusiastic. Consequently, SIDA was asked to purchase five light air rigs in September 1982. (Appendix 9)

Invitations for bidding were prepared by SIDA in Sweden and three companies (Ahlsell VVS AB, Atlas Copco and WellDrill Systems AB) were asked on to the board.

Consultant Mr Willy Hagström considered the offers but there were still several questions to be answered: Mr Hagström wanted to know if the Zimbabwian Government was capable of drilling with the new rigs.

The procurement sector of SIDA sent Mr Per Olof Ahlberg to the country, and in the latter's report, "Duty trip to Zimbabwe to evaluate drilling equipment" he declares:

"Areas suitable for light air rigs

A light air rig is ideal for 4"-4½" hard rock holes. Depths of 80-100 m in such formation will meet little problems. However, the performance in soft formation is poor. Such a rig is also incapable of providing large boreholes. Consequently a light air rig shall operate in hard rock formation and provide small holes to limited depths. The rig can also be used to deepen percussion drilled holes into hard rock.
- Such suitable geological formations are found in the southeast, east and northeast of Zimbabwe where massive or gneissic granite is located.

The light air rigs must therefore operate in there areas. The average depths of the existing boreholes are 40-60 m and the average water rest level is 10-20 m, therefore the boreholes are suitable for hand pumps.

The MEWRD intends to initially make use of the Swedish rigs in the South East area of Matabeleland Province.

Drilling Programmes ...

Procurement procedures

It cannot be overemphasized how important a smooth procurement system is for purchasing of spare parts, oils, fuel, etc. If running to its optimum capacity, a light air rig would produce approximately 70 boreholes a year. This allows for time for the actual drilling activities, service, minor and major repairs, transport between sites and time off for drilling staff. Time for repairs must not be made too long. Spare parts must be available at short notice and it is therefore essential that the Government procurement system is smooth and efficient and that red tape does not impede with the drilling operations.

The Provincial Water Engineers (PWE) are responsible accounting officers. Fund allocated to PWE cover the costs for, among other things, drilling operations, equipping of boreholes and staff wages. If a spare part for a rig is not available at the PWE store, the manufacturer gets and order to supply the item. The order is usually given by telephone and later followed by a formal written request signed by PWE. The item is airfreighted to the province. Should it be necessary to import the spare part, the maximum time for such delivery is est-

imated at two weeks.

Diesel is currently supplied by Caltex, who has a three year contract with the Government. The MEWRD delivers diesel to the drilling sites in 200 litre drums. There has lately been a shortage of diesel in Zimbabwe, but it is hoped that this problem is only temporary. Caltex also supplies oil to the Government.

Compared with many other African countries, the Government procurement procedures in Zimbabwe appear to be fast and efficient. There procedures should not be a major problem when the drilling operation commences.

Personnel training and equipping of drilling teams

After independence Zimbabwe lost some of their most skilled people. A number of good, experienced drillers emigrated. Today, the MEWRD only has a few local drillers with experience from rotary drilling. As the drilling teams must change from percussion rigs to the more sophisticated rotary rigs, training is a crucial element.

In Matabeleland province, where the rigs are to be used initially, there is one senior drilling superindendent, who has the capability to supervise the drilling teams. Together with one driller/machanic from the manufacturer,it should be possible to train up three relatively good teams within three months. Even though the crew of the teams in no way can be fully trained after such a short period, they should be able to sufficiently handle the machines. The drilling superintendent will inspect the rig twice a week.

Each drilling team will consist of:

One senior driller
One assistant driller
One tractor driver
Two labourers

The following equipment is attached to each team:

One rig mounted on a trailer
One compressor
One tractor

One trailer loaded with crew huts, drilling bits, casing, test pumping equipment, water tank, personal belongings, etc.

The team is also supported by a lorry, which regularly provides fuel, food, etc. Test pumping is done with cylinder pumps.

The MEWRD said that it would be no problem to provide the required staff and equipment for the rigs.

Infrastructures

The MEWRD has one central drilling workshop in Harare. The workshop appeared to be clean and well equipped. There were a number of lathes and welding equipment. The workshop staff seemed to be competent. The workshop was not over-staffed, which usually is the case in many African countries. The provincial workshop for Mashonaland was also located in Harare. Even that workshop gave a good impression. The Central Store in Harare was also well managed and clean.

The provincial workshop for Matabeleland is in Bulawayo and it is said to be of the same standard as the workshops above. The Bulawayo workshop is equipped with lathe and welding equipment.

The workshops and the stores of the MEWRD are of high standard and from what could be seen, it should be possible to carry out even major repairs of rigs and vehicles. The impression as a whole was very satisfactory.

Equipping of boreholes

The MEWRD normally equips the successful boreholes immediately after they are drilled and test pumped. The PWE has a separate construction unit for that purpose. There will therefore not be any major gap in time between the drilling activities and the installation of pumps...

Service provided by the tenderers...

Conclusions and recommendations

From what was learnt during the short mission, the public sector of

Zimbabwe is extremely efficient compared with other African countries. The senior civil servants seemed to be competent and there was no difficult bureaucracy built in the system. Most of the responsibilities of the MEWRD are delegated from the headoffice in Harare to the provinces. The Provincial Water Engineers are the accounting officers in charge of funds for drilling operations and equipping of boreholes. The procurement procedures, which are crucial for the drilling operations, appear to be smooth and fast. The infrastructure, i.e. the workshops, stores and offices are also of high standard. A successfully drilled borehole is equipped immediately.

Considering the shortage of skilled personnel and the lack of previous experience from light air rigs, it would certainly be difficult to train and supervise five teams. A number of three rigs would be more appropriate.

The MEWRD intends to make use of the Swedish rigs in Matabeleland Province. One experienced drilling supervisor is stationed in Bulawayo, and he can efficiently supervise three drilling teams. It is therefore proposed that SIDA initially purchases three rigs for the MEWRD. Futhermore the crew of the three drilling teams are proposed to be trained for three months by one driller/mechanic provided by the manufacturer.

Three tenderers were invited to bid, Ahlsell VVS AB, Atlas Copco Int and WellDrill System AB. The tender invitation proforma was acceptable to the MEWRD, even though it was felt that the specifications were too detailed, as they were made to fit the WellDrill rig. The required performance, however, was correct and there is not need for retendering even though the tender period was extremely short. (Only one week).

The MEWRD emphasised that they do not accept a truck mounted rig. They did not either like the idea of Ahlsell VVS with a self-propelled trailer. Only sturdy trailers towed by tractors are suitable for the rough and hilly terrain. However, the rigs of all three tenderers are acceptable to MEWRD, should they be fitted on such trailers.

The tenders have been evaluated by Mr Willy Hagström and his evaluation is attached to this report. Mr Hagström found the Atlas Copco

rig most suitable and the findings of this mission strengthen that view.

As described in chapter 4, the service facilities of Atlas Copco are superior to what WellDrill Systems and Ahlsell VVS can offer. Atlas Copco's Aquadrill 461 can be mounted on a 4-wheeled trailer and will then meet the requirements of the MEWRD.

SIDA is therefore advised to purchase three rigs of the mark Aquadrill 461. The rigs shall be mounted on trailers. The specifications of the trailers shall be approved by the MEWRD in Harare before they are manufactured. SIDA shall therefore enter into negotiations with Atlas Copco for the supply of three trailer mounted rigs. Additional Aquadrill rigs can be purchased by SIDA when the MEWRD has convinced SIDA-DCO that the first three are properly used." (Ref. 1)

## 5.2 Tender evaluation

From the papers "Evaluation of Drilling Equipment for Zimbabwe" that Mr I W Hagström wrote for the Procurement section of SIDA I quote futermore;

"Enclosed is an evaluation of the Rigs for which Quotations have been received. (LWD-200, Aquadrill 461 and Borrmaster 500). It is obvious that aquadrill 461 of Atlas Copco is the best rig and most suitable for the purpose. The assessment includes considerations such as availability of spare parts and service, quality of compressor etc.

In the tender invitation (which is formulated to suit the LWD-200 rig), it says that the rig shall be trailermounted, which I consider to be wrong. A truck-mounted rig is better as a fast-drilling rig moves frequently. However, I would suggest that a Swedish truck is used. A Volvo or a Scania is probably cheaper than the suggested Mercedes truck. I do not think it is necessary with four wheel drive vehicle, so a simple truck would do, but it essential that spare parts and service are available in Zimbabwe. If not Volvo or Scania has any well established agent, maybe Bedford, Leyland or Izuzu can be purchased. However, the truck must have a diesel engine."

"I have been thinking of one thing: Is it really necessary to buy five

rigs? I would suggest that a maximum of three rigs are purchased and that the Ministry made sure that they are properly utilized. That is more economical than to have five rigs which are not used to their optimum capacity. Three rigs are of course much cheaper, not only in the initial capital cost, but also when it comes to supporting vehicles, tankers, huts, repair, radio, personnel etc. Also, the control is easier the fewer the rigs are."

"As far as the other rigs are concerned (LWD-200 and Borrmaster 500), I have for good reasons disqualified them. LWD-200 is too small and weak for the borehole depths required. Borrmaster 500 is, among others, too expensive. Besides, there will be problems with spare parts and service for both rigs in Zimbabwe, and this is crucial for such fast drilling and complicated rigs." (Ref. 1)

The "Tender Evaluation. Drilling Equipment for Zimbabwe. ZIM-IMPWAT-2310-01" at Procurment section of SIDA (1982-11-17) follows;

| | |
|---|---|
| Tenderer: | WellDrill System AB, Sweden |
| Rig: | LWD 200, top drive, trailer mounted, Swedish made |
| Compressor: | Sullar 300 HH DP, screw type, 175 PS1-300 CFM, trailer mounted, USA made |
| Price fob: | 4 212 000:- SEK for five units |
| Delivery time: | 2 months |

Remarks

"This is a very small rig which probably cannot drill to the depths required i.e. 120 m. Particularly it will be difficult to go through the layers with Odex 115 and casing which must be fitted at 30 m. This rig will then probably prove to be too small and weak. When you get stuck, which often happens, you need a more robust rig. The rig may be suitable if you have hard rock from top to bottom and you can also drill 4"-4½" diameter holes with a DTH hammer. It can also be suitable for more shallow holes at max 75 m. However, such good conditions are rare. The trailer, which the rig is mounted on, will

not stand the treatment given by the African roads. The compressor is also small for 120 m holes. The pressure (175 psi) is OK, but the air (300 CFM) is too small. There is no winch on the rig. The availability of spare parts and service in Zimbabwe, which is extremely important, is probably poor as it is a new mark. The rig is little known on the market. The other equipment (drilling tools and accessories) is of good quality and, most of it, except the DTH hammer and bits are Swedish made. The compressor is made in USA."

Tenderer: Atlas Copco Int, Sweden

Rig: Aquadrill 461, top drive, truck mounted, Swedish made

Compressor: Atlas Copco XR 210, screw type, 175 PSI-445 CFM, trailer mounted, Swedish made

Price fob: Alt I: 5 576 550:- SEK for five units
Alt II: 5 509 900:- SEK for five units

Delivery time: 2 months for 3 units then 1 month per unit

Remarks

"This is a robust and stable rig well suited for drilling to the required depths (120 m) with 4"-4½" diameter DHT hammer. Drilling through layers with ODEX 115 and casing, or directly with 6" hammerbit, to 30 m will cause no problem. The rig is truck mounted which is an advantage as it is a fast drilling rig which moves frequently (twice per week). You can load the drilling equipment on the truck (drilling pipes, casing, hammers, bits, tool boxes, tents etc). The compressor can be hooked and toved by the truck. The rig is equipped with a winch for casing, drilling pipes,bailing etc. The compressor is OK with 175 psi and 445 CFM, which is enough for the depths and diameters required in the tender documents. Atlas Copco is a well establishad company and spare parts and service should not be much of a problem. The equipment (drilling tools and accessories) is of good quality and Swedish made. The truck is made in Germany."

Tenderer: Ahlsell VVS AB, Sweden

Rig: Borrmaster 500, top drive, mounted on self-propelled trailer, Swedish made

Compressor: Atlas Copco XR 210, screw type, 175 psi-445 CFM, trailer mounted, Swedish made

Price: 6 909 350:- SEK for five units

Delivery time: 2 months

Remarks

"Borrmaster is well constructed and robust and there should be no problems to drill to the required depths (120 m) with a 4"-4½" diameter DTH hammer. Drilling is easy through the layers to 30 m with ODEX 115 with casing (or direct with 6"-6½" hammer bit). The rig is mounted on a self- propelled trailer, which probably is not suitable in this case. However, the rig can also be mounted on a simple trailer or truck. The rig has no airline lubricator, but it could be installed. The compressor XR 210 is OK. The rig is not considered suitable for Zimbabwe as there is likely to be problems with spare parts and service as the mark is not estblished in Zimbabwe. The equipment (drilling tools and accessories) is of good quality and most of it, except DTH hammer and bits, are Swedish made. The diesel engine on the rig is made in England."

When SIDA's procurement section had considered the tenderers offers they left the final decision to MEWRD in Harare. Briefly, MEWRD thought that the rigs should be:
- Light and easy to move
- Cheap to run
- Rapidly delivered

As said in my introduction, WellDrill System AB was entrusted with the task of delivering four light-weight rigs to MEWRD. Appendix 9.

## 5.3 My study

It was difficult to get started on my study of the four LWD 200 rigs which MEWRD received as import support from SIDA. The people at the Ministry of Energy and Water were very formal and requested clearance

from the Ministry of Foreign Affairs for my research. The SIDA office in Harare was of great help to me in this respect.

The LWD rigs mentioned are now employed under the guidance of two different Provincial Water Engineer Sections, subordinate to the Ministry of Water Development Enquires. MEWRD in Zimbabwe has divided the country into 5 provinces where water matters are concerned. Politically there are 8 provinces.

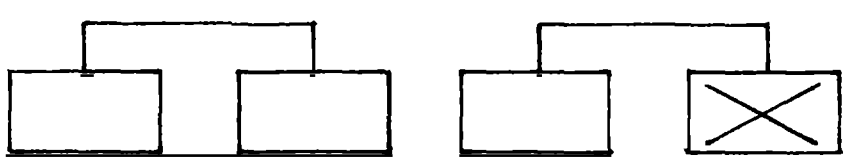
The five provinces are Mashonaland, Manicaland, Midlands, Masvingo and Matabeleland. The only Ministry provincial offices with drilling rigs are Mashonaland, Midlands and Matabeleland. Drilling in Manicaland is carried out by Mashonaland Province or by Head Office (which also operates a drilling unit). Masvingo uses a contractor.

The Ministry of Lands, Agriculture and Rural Settlement provides the MEWRD with its requirements for drilling in Resettlement Areas only. In communal lands it is the Ministry of Local Government, Rural and Urban Development that specifies where drilling is required. The communal lands are the opposite of the commercial areas and were established way back in the thirties. The Resettlement Areas were founded on earlier commercial farming areas after Independence.

The actual siting is performed by hydrogeologists. In Mashonaland and Manicaland, where I studied, it's done by three hydrogeologists from the provinces. Two of these three are expatriots.

In brief the groundwater section could be described as consisting of a drilling and a siting side operation in the provinces.

## 5.4 Team organisation



Two rigs are operating in Mashonaland under the supervision of Mr Nhunhama. The other two rigs, one of which is a replacement rig, are drilling in Matabeleland under the direction of Mr Von Straaten.

Both rigs operate constantly, not far from each other. They enter an

area only if a minimum of 10-15 boreholes can be produced.

On each rig there is a team consisting of four people: One foreman (the drill operator) and three drillers.

Only one driver works on the two teams in Mashonaland. When the rig and compressor are being moved from one location to another, the crew has to phone for this driver and his tractor. If just one more driver was available, the time-consuming process of conveying the equipment could be speeded up. For every move the driver has to go at least twice; once with the rig and once with the compressor. Often he must return a third time with a trailer for the accessories.

In order to leave the province office all equipment is loaded onto lorries and taken to the basecamp of the two teams. The staff stays overnight at the camp and there are four tents for each team (one cottage tent and three bed tents).

All wells completed are reported to headoffice.

## 5.5 Breakdowns

Real delays in the drilling schedule occur when the rig is breaking down for some reason. If this does happen the province office takes over the responsibility as soon as it has been informed. A truck is sent to bring the broken parts or the whole unit into town. The repairs are usually taken care of at the Atlas Copco agency in Harare. Occasionally broken parts are fixed by the ministry's own workshops. The one I visited employed one expatriot foreman and two semi-skilled mechanics for rig reparations.

The fact that Atlas Copco can quite easily apply for foreign currency (intended for spare parts) gives this firm the advantage of being able to repair most breakdowns. If spare parts are in stock the machinery will be fixed within one or two days, otherwise spare parts have to be imported, However, since Atlas Copco is also given priority in supplying the 10 LWD 200 rigs run by DDF the required parts are certainly handy.

However, Ministry personnel declares that self-running stores for

these goods would be preferable.

While the equipment is being repaired, which takes anything up to a month, the crew is often kept waiting in the camp.

Once, when the ministry received a rig in 1983, an agency was responsible for all maintenance.

Reliable sources explained to me that Atlas Copco gives a better service than the other agencies, especially concerning the Sullair Compressors. Since this equipment was not handled properly at first it will not last as long as is desirable. One reason I found out, was that instruction manuals were not available when the ministry got the compressors.

## 5.6 Central store

When the drilling teams need consumable supplies and locally-produced parts, they are supposed to go to the ministry's own central stores. Those things most frequently required are casing, welding and grinding discs. A statement of requisition is filled out by the supervisor. One simply takes the note to the store and is given what has been ordered. If an urgently-needed supply is out of stock the supervisor may go straight to retail or hardware shops and hopefully find the goods.

## 5.7 Bonus system

To motivate the crew some kind of bonus system is employed. Everybody gets a little extra per drilled meter. The salary of a drill operator is approx. 250 Z$ a month and that of the crew is 180 Z$. The bonus of eight cents per meter is rather low compared with those offered by private contractors. The normal working day is nine hours, five days a week.

## 5.8 Work progress

An intensive training program, run by WellDrill Systems AB on the first rig in Matabeleland, started as soon as the contract was signed in 1983. In this initial training programme under close supervision

of WellDrill personnel a number of local operators was trained.

### 5.8.1 Borehole output in Mashonaland Province

From May 1983 the following number of boreholes made by the two Mashonaland operated rigs are reported:

In Bendura twelve boreholes in four weeks and
in Masequa four boreholes in three weeks.

After this period and up to the middle of 1984 the Ministry of Energy, Water Resources and Development ran a training programme for the crew, given by the newly-trained drill operators. In this programme, which lasted for about one year, the following number of boreholes was drilled:

In Mashonaland - seven boreholes
In Bohera - 30 boreholes

The drilling continued with:
Twelve boreholes in Morewa within two months

The drilling then slowed down and stopped for 4-5 months. The two rigs drill preferably in areas where 10-15 sites can be found. MEWRD had to examine new areas.

From the beginning of 1985 the number of boreholes drilled is 37 in Hurungwe within six months.

### 5.8.2 Borehole output in Matabeleland Province

Time for my fieldstudy in Zimbabwe was running out. I did not have the chance to study the two LWD units operating in Matabeleland. Mr J.R. Holland at MEWRD promised to help me with the final pieces of information I needed. Below I quote the summary report that was sent to me after I was back in Sweden:

Reference : C/4/2/1
e.c. AM/1/A/106/18

Chief Hydrogeologist

24th October 1985

SUMMARY REPORT ON TWO SMALL DRILL LWD 200 DRILLING RIGS : MATABELELAND PROVINCE

Background

The above two drills were part of a group of four drilling rigs supplied to the Ministry under Swedish aid by SIDA. The rigs are trailer mounted, with separate Sullair air compressors. The two units were delivered to the Bulawayo office of the Ministry in April, 1983, and used for training of crews until June, 1983.

Production drilling began with the drills in July, 1983.

Borehole Output

Up to the end of 1983 a total of 7 boreholes were drilled in Hollins Block Resettlement scheme and 4 boreholes in Shobá (Beit bridge District). One of the drills and its compressor was destroyed in December, 1983 by dissidents.

Up to September, 1984 the remaining drilling rig drilled 2 boreholes at Jopempi Block (Beitbridge) 10 boreholes in Tsholotsho District before stopping due to lack of funds from DDF. It was then transferred to site investigation drilling at Mangwe and Mosa dam sites.

During the period January - September, 1985 the original rig and the new replacement unit have drilled a total of 48 boreholes (2 at Dombodema Resettlement Scheme, 21 for ARDA (at Gwaranyambe), 17 in Hlangabezi District and 8 for other Ministries).

Constraints

A number of serious constraints have limited the output of the drilling rigs. These are:

(i) Delays in movement due to the security situation, and hence the need for military escorts (who are not always available when required).

(ii) Logistical problems due to distances away from Bulawayo, particularly in maintaining supplies of fuel.

(iii) Limited capacity for siting of boreholes.

The LWD drills as supplied had a number of technical limitations:-

...

(i) The ODEX facility was not generally appropriate, as most drilling can be open-hole in hard-rock formations. A drawback was the tendency of the reamer bit to fail to retract, with the result that the drill-string unscrewed at some other point, resulting in long delays while fishing. Several ODEX bits were lost.

(ii) The pull-back capacity is low, so the handling of casing is difficult. Sometimes a cable-tool drill is required to pull out the casing in a dry hole.

(iii) The maximum hole size was limited to 5 inches.

Modifications to Equipment

In order to overcome the problems of the ODEX method, two Ingersoll-Rand DHD 16 A 6 inch DTH hammers and bits were acquired in October, 1983. This still meant that the maximum casing size that could be installed was 5 inch. More recently a special reamer has been manufactured for use with the LWD's so that the 6 inch diameter holes can be reamed out to 7½ inches, thus allowing 6 inch casing to be fitted. In this mode, the LWD's have been operated as rotary drills, using the compressor for clearing cuttings.

Comments on Performance

The original LWD 200 drilled 2200 metres in its first 18 months of operation, almost all of which was in hard rock formations. It has had very few breakdowns, and its performance is regarded as very good. Its drilling rate is high with a peak output of 3 site investigation holes of 4½ inches diameter drilled to 30 metres in a day. In one day it can drill a 50 metre borehole in very hard conditions that would take a jumper drill six to eight weeks to complete.

There have been few problems in operating the rigs, with only two fishing jobs required since the ODEX method was abandoned both of which were easily accomplished.

The remaining Sullair compressor is also reported to have had no major breakdowns in 1100 hours of operation. The most serious problems have been caused by dirty fuel.

Conclusion

The LWD-200's are highly regarded by the Ministry's Drill Superintendent in Matabeleland, and their efficiency has enabled the Ministry to reduce its drilling costs from $0.64 to between $0.25 to $0.30 per metre.

J.R. HOLLAND

JRH/tr

24th October, 1985

## 6 MY STUDY IN KENYA
## CONTRACTUAL LEASING

For the last part of my master thesis I visited Kenya in order to study how one of the private companies Instapump Limited administrates and operates its drilling.

This fourth part complements the Zimbabwean study at the same time as giving me a broader view. Instapump, apart from ordinary contracting, also deals with a special kind of contractual leasing which I have mainly studied.

In the "Africa Economic Digest" dated 29 March, 1985 was an article about this family company, which is run by Mr Christer Johansson.

Christer Johansson:
Have drill will travel

"Christer Johansson, a 37-year-old Swede who drills water boreholes in Kenya, is living proof that you don't have to be a multinational giant to do successfull business in Africa.

Seven years ago Johansson, a mechanical engineer, sold his ageing Alfa Romeo car for KSh 50 000 ($3 300) and begged and borrowed a further KSh 286 000 ($18 800). All this capital was sunk in buying a Nairobi agency selling water-pumps from his former employer, Atlas Copco Company of Sweden.

Today, Johansson's one-man business has an annual turnover of KSh 4 million ($263 000) and a capital replacement value of KSh 10 million ($660 000). Instapump operates six percussion drilling rigs, which will all work full-time this year, owns a fleet of eight heavy vehicles and ancillary equipment and has 54 local employees.

"We were already selling and installing submersible water pumps," says Johansson, a family man with an English wife, Sally, and two small children. "Round about the beginning of 1980, we decided to start drilling the boreholes as well. We just took it from there."

By last year, Johansson says, the pump agency business had become such

small beer and the import of spare parts so complicated that he sold it off to concentrate on drilling boreholes fulltime.

Part of Johansson's secret seems to be that he is prepared to go anywhere to drill a hole and that he follows the old business maxim: "No job too big or small." If a householder in the Nairobi area wants a borehole drilled in his "shamba," Johansson will happily do it for KSh 600 ($40) a metre.

But at the moment he is commuting daily, at the controls of his own Piper Colt aircraft, to the remote and aric northeastern Garissa district, where he is working on a KSh 1.5 million ($98 000) contract to drill 15 test boreholes for Norwegian development agency Norad.

Next on his order book is a scheme to drill 30 boreholes throughout Kenya, part of an experimental project run by the UK's Leicester university, and, possibly also in 1985, he hopes to begin work on 20 trial boreholes in the Mombasa region for a project financed jointly by the World Bank and Swedish aid agency SIDA. If the trial is a success, it could result in a commission to drill up to 800 boreholes to supply water to local people.

Johansson says the Mombasa contract is worth KSh 1.5 million($98 000) in immediate money. "But," he adds wistfully, "if it works out, it has a potential of KSh 4 million - 5 million ($260 000-330 000)."

## 6.1 General notes on drilling

Several factors affect what kind of rig should be used in Kenya. My conversations with Mr Johansson resulted in the following data.

Neither the air rig nor the cable-tool is the most suitable for general drilling. One has to consider:

- the ground conditions (overburden, weathered and hard rock);
- the roads and transportation facilities to the site;
- the supply possibilities of the team and the rig;
- time schedules for the borehole and drilling project;
- the staffing situation;
- the breakdown risk;
- borehole design

Economic factors must be taken in consideration when answering those questions. The investment costs in an air rig are much higher than with cable tools. The difference in drilling speed is striking. An air rig completes the borehole much faster but constant observation and flexibility is necessary.

An air rig with a compressor uses more consumable products and perhaps more spare parts then the cable-tool. The risk of losing expensive accessories for the air rig is quite large. A three meter string of drill-rods to an air rig costs about 4000 Kenya Shillings compared with 200 KSh for the same length of cable.

The actual bits and drillheads cost about the same but the costs of the connection between the rig and the working part is very different on a deep borehole. The driller's chances of getting stuck vary according to the ground.

Cable tools are preferred where deep wells are required. The borehole's diameter is limited when an air rig is employed. A small cable tool can be used for wells up to at least 12" and a Dando 800 up to 24" (inches).

The air rig, however, completes a programme much faster and is paid off therefore earlier. With a 2/3 in running costs the profit may cover the investment expense in less than two years.

Both air and cable tool rigs pose about the same transport and logistic problems but the air rig must be provided with a compressor.

More maintenance is required on the air unit, but in an emergency situation where water is needed rapidly it is still the best choice.

As long as salaries for the staff are comparably low the cable tool is okey, but if European wage levels are employed the air rig would be the only possible unit from an economic point of view.

## 6.2 The organization

Mr Christer Johansson, the managing director, is responsible for his companies, overall management and coordination of the drilling

activities.

For administrative work and contractual business he has a female assistant who deals with the paperwork for banking and filing.

The running costs and expenses are taken care of by two male assistants who administrate the payments of salaries and consumeries like fuel and diesel.

On the Instapump premises just outside Nairobi, where the Johanssons are living, there is also a small store with enough equipment for five mechanics, four welders and two electricians who work for the company. The store keeps casing, pipes, sand, cement, bentonite etc. Some spare parts and equipment such as pumps are stored in Nairobi.

To operate Instapump's own six cable tool rigs and the units in other contracts Mr Johansson has three drilling supervisors. One of them is, at the same time, service manager. Altogether 60 people are employed but Instapump is expanding because of additional contracting such as laying pipelines and building water tanks.

Mr Johansson says: An advantage is that we can provide a turn key project, which means that the water we have drilled for transported as per request from the source to the consumer in pipelines or tanks fabricated by my company.

## 6.3 Equipment

After starting from nil in 1979 the Instapump company is now furnished with a lot of equipment and accessories for drilling. The following machinery is used:

Six cable tool rigs
Two Krelius, both approx. 30 years old.
Two Dando 800, one of which is three years and the other ten years old.
Two Ruston 22 W Bucyres, 10 and 15 years old respectively.

Trucks
Four weighing 3 ton, two 5 ton, two 7 ton and two 10 ton each.

Other vehicles
Two Landcruiser Toyota
Two Willys Jeep
One Range Rover
One Peugeot pickup truck
One Suzuki pickup truck

Trailers, four smaller and two bigger ones.

Two caravans for the supervisors.

The company also possesses:
Two large generators; 60 kW and 40 kW respectively;
five small generators and five mobile welding units.

Testpumps

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| One 8 | inches | pump | for | 30 000 | (Imperial) | gallon | per hour |
| One 6 | " | " | " | 12 000 | " | " | " " |
| One 6 | " | " | " | 5 000 | " | " | " " |
| Two 4 | " | " | " | 1 000 | " | " | " " |

Camping equipment like tents and rondavels (unihuts in sections) and five mobile freshwater tanks for the drillers at site.

The replacement value of the Instapump Limited assets is 1985 over 16 million KSh (Kenya shillings).

### 6.3.1 Depreciation

The counting year in Kenya for private companies is not limited to certain nomths. Instapump Ltd asks a consultant to close the books when its new budget year starts July 1. As in Europe the annual report consists of an income statement, a balance sheet and notes to financial statements etc.

For the drilling rig, vehicles and other pieces of machinery the depreciation time is five years. The straightline method is used to write off the assets by 20% of the original value each year.

## 6.4 Drilling teams

As a private contractor, Instapump is very careful in choosing and then keeping all good personnel. Both when operating own rigs and when "selling knowledge" by drilling with a client's or a third part's rig, the structure of the team is nearly the same. There are three drilling supervisors as well as Mr Johansson himself, circulating between the rigs. If an extremely tough or important borehole is to be drilled, one supervisor usually stays there all the time. Mr Johansson's workload, since he is also the overall fieldmanager, is enormous. In the future, when the company has grown bigger and the drilling activities have stabilized to a level at which he can afford a highly qualified fieldmanager, he will employ such a man.

Recruiting of drilling personnel can sometimes be a problem. Many skilled (Instapump) employees are former workers of the Craelius East African Drilling Company. Unskilled staff start working as apprentices in a drilling team. A driller's education is practice, so to say.

To obtain high utilization and efficiency of the Instapump equipment a shift system is necessary. In each team a head man is responible for drilling and he is usually the driver as well. One shift may consist of four people going on an eight hours' (daytime) shift. Two shifts are most common and there are six men alternating. Half the crew works seven am to four pm with one hour's lunchbreak and the other half between four pm and midnight.

If the project is urgent, three shifts daily are employed. The team then consists of nine people with a nightshift working from midnight till early morning. Experience has shown that it is hard work effectively and make a straight borehole during the dark hours. Accidents can also occur easily.

The rigs are spread out over the country and there is normally a camp by each one. The men sleep in tents or rondavels, two by two except for the head man who has sleeping facilities of his own.

### 6.4.1 Salaries

The drilling superintendants, headmen, drilling labour and mechanics

employed by Instapump all have higher salaries than the government in Kenya recommends. Primarily, they are paid a stipulated amount plus additionally housing, travelling and hardship allowances. A drilling supervisor earns about 7000 KSh per month, a driller 1500-7000, a mechanic 3000-4000 and the lowestpaid 1000-1200 KSh a month.

To these fixed wages a bonus of approx. 10 KSh per drilled meter is added to everybody in the team. On average, three to four meters a day is completed. If the borehole is hard to drill and the contract time is slim the bonus may be multiplied by two. Higher bonusses may be given to qualified staff with heavy responsibilities.

## 6.5 Transport

Transport of equipment from one site to another is a delicate logistic problem. It is a timeconsuming procedure that has to be planned well.

Mr Johansson of Instapump Ltd. says that one or two trucks are always needed for transportation of the rig and accessories. Furthermore, trailers for pumps and at least two light vehicles for other equipment are needed. An air unit like WellDrills Light Weight Drilling rig, which is troller mounted, is pulled by one of the trucks. The compressor is usually taken on the same truck as the one pulling the LWD rig.

### 6.5.1 Supply

When on site the camp has to be supplied with different consumable products. The staff purchases fuel and diesel at the nearest service station. Pipes and casing are brought from Nairobi. If spare parts are lacking, a landcruiser or aeroplane is requested. The mechanics will go from the capital out to the rig when it is needed. At this stage the company is so busy that no time is available to take the units into service. What is done is merely the running maintenance on site. The stand-still cost for a cable tool rig is 3000-5000 KSh a day.

## 6.6 Projects

As the newspaper article noted, one of the secrets behind the success

of Instapump is that any job, small or big is taken. Mr Johansson's clients have come to realize that his company is serious. Lately he has been inquired about welldrilling projects comprising 300-500 boreholes. The projected need in Kenya over the next five years is approximately 10 000 wells.

### 6.6.1 Clients

Instapump has drilled for farmers, factories and large development organisations, for instance Dutch Aid, Korean Aid and the Norwegian NORAD. These organisations often involve the Ministry of Water Resources Development as one part of the project.

Many medium-sized jobs have been done for various Catholic missions. Mr Johansson declares that it is very rewarding to work with projects sponsored by different churches. In the long run it seems that they are the best ones to keep their wells in order. If the pump breaks down it will always be repaired.

Maintenance obligations have been performed by hardly any development organisation until now. It has finally become evident that maintenance is very, very important. Cleaning silted boreholes and repairing pumps is now among the main activities of SIDA's Water Branch in Kenya. In future, the trend will with luck be to drill no deeper than 80 m and to install handpumps, thus making maintenance easier.

### 6.6.2 Competing contractors

There are competitors to Instapump Ltd. on the Kenyan market.

Kenya Drilling Ltd., a parastatal company, more than 50% government-owned but run privately ought to considered as well as the Ministry of Water Resources Development supervising its own rigs.

The main private competing contractors are: Karlssons and Finne, Turn o Metal and finally Ingata Workshops.

### 6.6.3 Siting

If the client wants surveying to be part of the contract it is easily

arranged. Instapump has no hydrogeologists of its own but co-operates with a Dutch parastatal company for siting services.

This company also has the resources to evaluate the areal surveys apart from a skilled field staff. With help from computers and aerial photos the exact locations can be stated. The Ministry of Water Resources Development may provide siting services but it is usually very busy and lacking in adequate facilities for transportation.

## 6.7 Contractual leasing

Instapump Ltd. serves some clients possessing their own rig and the contracts make the company responsible for every procedure until the well is completed.

The reason why Mr Johansson originally introduced contracting like this was his company's meagre resources to buy its own rigs. The banks were not willing to give loans and the financial institutes had too high a rate of interest. The interest rate of a bank loan in Kenya Kenya is about 12% and private financial institutes apply an equivalent rate of 19-23%.

Mr Johansson consequently asked several development organizations if they would buy an imported rig which Instapump could lease.

The client's obligation is briefly the costs caused by custom and import regulations before the contractor borrows the rig.

Instapump will then charge the client per drilled meter as per contract but the price is 20-30% lower than in an ordinary contract.

The average cost of 500 KSh per drilled meter should cover administration, staffing, back-up vehicles, drilling consumeries plus a certain percentage of the profit.

## 6.8 One contractual leasing contract

For my study I have picked out a programme performed by Instapump for a Christian church in Kenya some years ago. In order to be as accurate as possible I am looking at nearly the same rig as in parts

two and three of my fieldstudy, namely the mark I model of the LWD drilling rig(1500kg)by WellDrill System AB in Sweden. The equipment was purchased and partly financed by NORAD.

One must take into consideration that each contract between a client and a contractor is unique. Since times change and contracts cover different agreements it is difficult to compare them with one other.

The prices presented below are from one of Instapump Ltd.'s early contracts:

"8 June 1982

Estimate for drilling of 30 boreholes in west Pokot for XXX, using XXX's own drilling rig.

| | |
|---|---|
| Initial mobilisation of rig from Nairobi to first site. | 56,350.00 |
| Moving to and setting up at each drill site when distance is not more than 30 km<br>KSh 3,000.00 per site, 30 sites | 90,000.00 |
| If the distance is more than 30 km to the next site a charge of KSh 25,00 per extra km will be charged. | |
| 30 holes drilling to 75 m at KSh 475.00 per metre, finished diameter 6"-4" | 1,068,750.00 |
| Estimated 6" casing using 18 m per hole, delivered to site and installed 30 holes at KSh 550.00 per meter | 297,000.00 |
| 24 hour testpump inclusive of installation and withdrawal of pumping gear and installing hand pump 30 holes - KSh 13,800.00 per hole. | 14,000.00 |
| | 1,926,100.00 |
| Establishment fee 7½% | 144,457.50 |
| | 2,070,557.50 |
| Contingency fee 10% | 207,055.75 |
| | 2,277,513.25 |

After our survey and due to the fact that drilling will be carried out with your own machinery but with our total management the price changes given above are now valid.

This estimate is valid for the commencement of work before 30 August 1982, as we are unable to predict the outcome of the Kenyan Budget, and we therefore retain the right to adjust these prices accordingly in case large changes are announced.

Prices of steel casing may be adjusted up or down depending on the market price at the time of purchase due to the availability of the local market at the time of signing the contract.

Terms of Payment - Down payment of KSh 350,000.00, then regularly against invoice within Thirty Days against work carried out.

Instapump Ltd."

6.8.1 The borehole output

The confirmation of order for the LWD rig, compressor, drilling tools, accessories and spare parts was signed in July 1982 at WellDrill in Sweden. The goods were sent to Kitale. NORAD and the client financed the investment and Instapump started operating in October 1982 in the Westpokot province of north-western Kenya.

For two years the company used the rig with good reslults. Because of disturbances in Uganda and Kenya there occasionally was a stand-still.

In total more than 40 boreholes have been drilled by this rig; the first 18 boreholes during the last three months of 1982 and another 15 boreholes from July 1983 till the end of October the same year.

The result of these periods is as follows: (Next page)

| Dates of Drilling | No days per hole | Place | Depth m | Casing m | Water struck m |
|---|---|---|---|---|---|
| 1982 | | | | | |
| 2.10. | 1 | 1 Kiesse I | 76 | 9 | 63.6; 70; 72 |
| 5.10.; 6.10. | 2 | 2 Kiesse II | 84 | 9 | 80 |
| 7,8.10. | 2 | 3 Nasal I | 126 | 12 | 70m trace |
| 14,15,16,18,19.10 | 5 | 4 Nasal II | 105 | 9 | trace 48; 78 |
| 21,22,23,24.10 | 4 | 5 Amakuriat I | 120 | 12 | trace 30; 36 |
| 25.10,1,2,3.11 | 4 | 6 Amakuriat II | 78 | 18.15 | 24; 27 |
| 8,9.11 | 2 | 7 Nauyapong III | 90 | 9 | 39 |
| 11,12,17.11 | 3 | 8 Sasak | 120 | 12 | 21 |
| 18,19,20.11 | 3 | 9 Otuko | 66 | 18 | 42 |
| 22,23.11 | 2 | 10 Kasitwt | 60 | 18 | 33 |
| 24,25.11 | 2 | 11 Kempur | 66 | 9 | 16.5 |
| 27.11 | 1 | 12 Locheremonyang | 60 | 6 | 30 |
| 29,30.11;1.12 | 3 | 13 Kases I | 102 | 9 | 81 |
| 2,3.12 | 2 | 14 Kases II | 51 | 12 | Hole 'dry' |
| 4,5.12 | 2 | 15 Omum | 69 | 6 | 48 |
| 7,8.12 | 2 | 16 Kales | 51 | 7.5 | 27 |
| 9,10.12 | 2 | 17 Parakapeleymoi | 60 | 7.3 | 15;36 |
| 11.12 | 1 | 18 Kauriyong | 36 | 6.5 | 15 |
| 1983 | | | | | |
| 2,4,5,6.7 | 4 | 19 Kiwawa III | 150 | 9 | trace 84 |
| 7,8,11,12.7 | 4 | 20 Kiawa IV | 96 | 12 | 57;75 |
| 13,14.7 | 2 | 21 Katuda | 63 | 8.6 | 36;57 |
| 18,19,20,21.7 | 4 | 22 Chelopoy I | 101 | 12 | trace 57 |
| 25,26.7 | 2 | 23 Chepkanagh | 60 | 15.4 | 30 |
| 8,9,10.8 | 3 | 24 Chelopoy II | 93 | 9 | trace 57 |
| 13,15.8 | 2 | 25 Natameri | 102 | 12.5 | 24;81 |
| 16,17,18.8 | 3 | 26 Losom I | 60 | 9.72 | 27;30 |
| 19,20.8 | 2 | 27 Losom II | 32 | 9 | |
| 23,24,25.8 | 3 | 28 Kemgeto | 90 | 18 | 57 trace |
| 28,29,30.8;1.10 | 4 | 29 Kesui II | 51 | 15 | 33 |
| 4,5.10 | 2 | 30 Kodera | 75 | 9 | 63.66 |
| 12.10 | 1 | 31 Kromti | 51 | 9 | 36;42 |
| 18.10. | 1 | 32 Lokicher | 45 | 12 | 12;42 |
| 22.10. | 1 | 33 Kitalakapel | 60 | 18 | 36 |

Figure 20. Borehole output. (Source: Mr Christer Johansson)

Drilling depths varied. The average was 78,9 m and 75,5 m respectively. The shallowest hole was 32 m and the deepest 150 m.

As soon as the client could afford new investments, additional drilling was done.

## 6.8.2 The cost of a borehole

In the estimate for the drilling of thirty boreholes from the contract the average depth of a borehole was estimated to be 75 m. The average cost of a borehole according to the contract was

$$\frac{2,277,513.00}{30} = 75,917.00 \text{ KSh}$$

The average depth of a borehole in the project turned out to be 75-80 metres.

In order to make a comparison between the other investment forms of my study, the investment cost of the drilling rig must be added (to the

yearly cost) before the calculation of the cost of an average bore-hole.

Mr Johansson showed me the following invoice for a 102 m deep bore-hole of the contract. The invoice presents the lump sums (LS) for all boreholes.

| Natemeri - Depth 102 m Yield 375 gph | | |
|---|---|---|
| Mobilisation and set up of equipment | LS | 3,000.00 |
| 102 m drilling | 475/- | 48,450.00 |
| 3 hrs and 15 minutes casing work | 250/- | 812.50 |
| 12.5 m casing 5" diameter | 550/- | 6,875.00 |
| Test pumping and installation | LS | 14,000.00 |
| One Uganda hand pump | LS | 7,000.00 |
| One cylinder and filter 2 1/4" | LS | 3,500.00 |
| Pipes supplied by client | | |
| Construction of trough | LS | 5,000.00 |
| | | 88,637.50 |

## 6.9 The LWD rig and the Sullair compressor

Mr Johansson declares that the troller-mounted LWD rig is excellent if it is handled properly. To drill 120-150 m deep boreholes demands great care. Theoretically, it is almost impossible to go that far down because of several factors:

- The pull-up capacity must be maximized to lift up the weight of all pipes.
- The cuttings are hard to get out of the hole even with foam or water.
- The pressure of the compressor is not enough for great depths.

The Sullair compressor was very reliable but the consumption of approx. 15 litres diesel an hour is too much according to the owner of Instapump. A smaller compressor would be much cheaper to run. With the diesel price at six - seven KSh a litre it is a fairly large expense, compared with a three kW generator running six hours on ten litres of petrol. The cost of this fuel is eight - nine KSh per litre.

### 6.9.1 Operating

The drilling with the LWD-unit was done by Instapump most of the time in two shifts with two men each. The organization was very simple: One man drilled and the other one supplied and assisted with drilling rods etc.

Oil and filters should be changed at the right time. This procedure is imparative to the reliability of an air rig and is performed by a maintenance crew of a further two men.

Testpumping is at last going on continuously (for 24 hours) and is done either by the people working on the machine or by a special team arriving at the site by truck.

## 7 PROJECT MANAGEMENT

Which are the most important elements of managing and how is a well-drilling project performed?

During my stay in Africa I came to realize more and more that for a successful welldrilling programme the project management must be handled in a proper way. This is necessary whether it is performed by a private company or a ministry. In consequence of my experiences in project management I would like to emphasize its importance by the following chapter:

What is management?

One might say that it is the process of efficient use and conservation of human resources and materials in reaching predetermined objectives; or that it is a group action toward the achievement of organizational goals and objectives; or that it is simply 'getting things done' through people executively skilled.

The elements of the management process are:
- Planning
- Directing, including organizing and staffing
- Controlling

To find the aims of the projects one can, generally speaking, apply several approaches. I believe the organizational approach is the most common in Zimbabwe and in Kenya. There is also the human relations´ approach. The two methods mentioned could be described as the "whip and carrot", respectively.

Without being racist one must comment that African labour is not inherently prone to serve the projects´ goals. Perhaps this laziness is caused by centuries of white exploitation. Motivation is necessary in order to get a job done quickly and well. Different culture is another reason. It takes time to catch up with the European way of solving technical problems etc.

The organization approach is based on authority from the top down through a hierarchy. Subordinates as drillers and drill labour are

often recruited locally. To obtain good results controlling is contin continuous which seems to be the only way at the moment.

"Scientific Management" states - "Organizational approach has developed accepted principles in general or specific terms which instruct managers what to do and sometimes when and how to do it."

The human relations approach with the carrot in form of a bonussystem is used by contractors and ministries in Zimbabwe and Kenya. The drillers get paid extra bonus per drilled meter. Efficiency is in the long run, however, more dependant on "team spirit", and on how the overall project-management is working.

When authority is at the base of the organization rather than the top and the projects' aims are mutually accepted, the approach is excellent.

All well drilling projects require skilful project managers and supervisors. Three major reasons, pictured below, show how the project managers' environment is so unique:

1. Competition for organizational resources
2. Task repetitiveness
3. Uncertainty

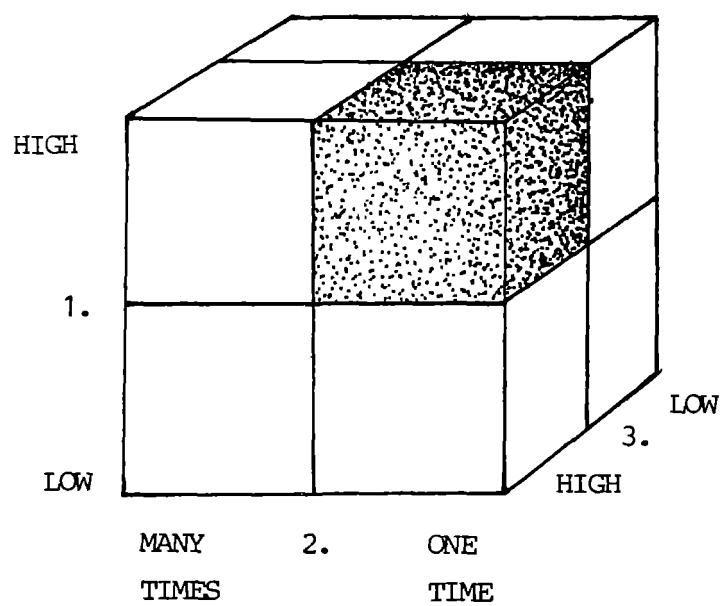



Figure 21. Project managers' environment. (Ref 2)

A project is defined according to the following four factors:
"A. Scope. A project involves a single, definable end-result, usually measured in terms of cost, schedule and performance requirements.

B. Unfailarity is generated because most activities are non-recurrent.

C. Complexity. Well-drilling programmes involve a large number of professional skills and more or less advanced technology. There are also several organizational interfaces between those concerned.

D. Finally, there is always a stake for everybody involved in the project. Failures might jeopardize and ruin a contractor and his organization." (Ref 2)

## 7.1 The elements of managing

The management's major elements may be defined as follows:
"1. PLANNING: Determining what needs to be done, by whom and by when, in order to fulfil one's assigned responsibility.

2. DIRECTING: Exercising leadership and human relations skills in implementation and carrying out approved plans through others in order to attain or exceed objectives.

3. CONTROLLING: Measuring progress toward objectives. Evaluating what needs to be done and then taking corrective action to achieve or exceed objectives." (Ref 8)

### 7.1.1 Planning

#### Forecast

A projection about what will happen and when must be made. Are problems with water large enough to warrant well-drilling in an area? How many drilling teams are necessary? Are air rigs or cable tool rigs required? Are the financing problems of drilling projects' expenditures possible to solve? Etc.

Objective

A well-drilling project has a quota to be achieved or exceeded; for example a number of sites or boreholes sited or drilled by the contractor or the ministry at the end of a period.

Programme

A project is only part of a well-drilling programme. A resettlement programme involves not only water development but very often that of sanitation, health etc.

A good management knowledge of the steering committee is imperative since it is responsible not only for the overall strategy to be followed, but also all major action to be taken in order to achieve the objectives.

The organization may be compound in various ways. A simple but effective plan is shown below.

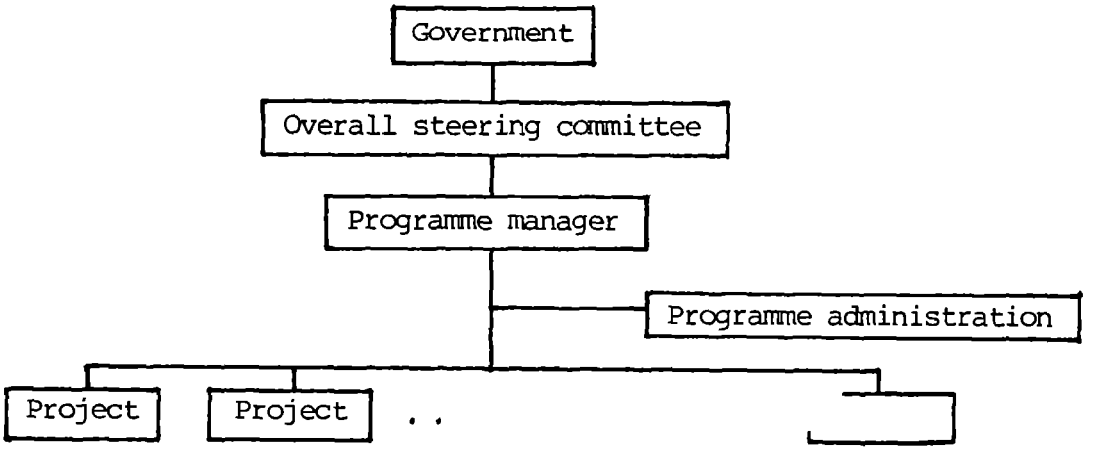



Figure 22. Programme organization.

Organization

What kind of organization is the most appropriate for well-drilling projects? The answer is probably the common, line organization charted below.

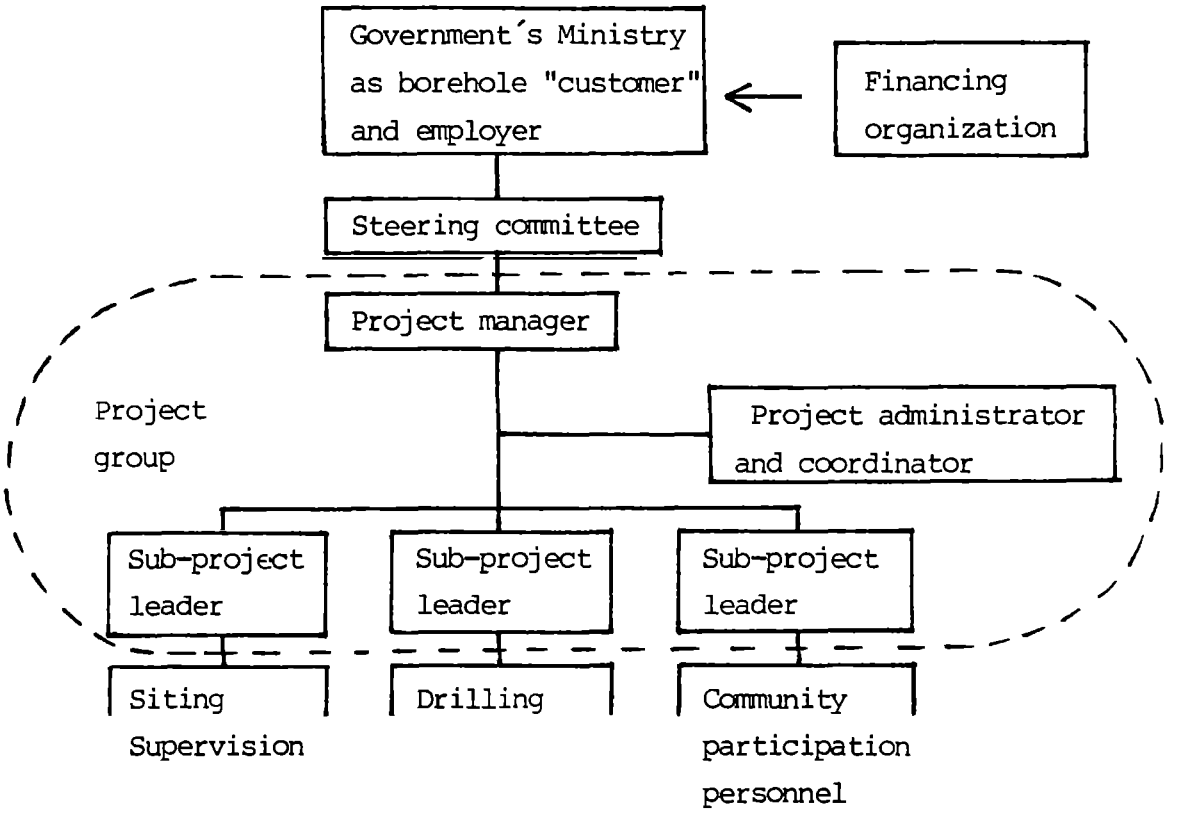



Figure 23. Project organization.

It is important for every project manager to know about the design of the number and kinds of positions along with the corresponding duties and responsibilities required to attain or exceed objectives.

The different function of the organization are related on the following pages.

The Steering Committee shall:
- describe and establish project goals
- establish time, cost and resource plans
- give priority to work assignment
- regularly ensure that project activities are following current plans
- take major project decisions, other decisions are delegated to the project manager.

The Project Group shall:
- in accordance with the steering committee's instructions perform the leading, planning, coordinating, follow-up and control of the project.

The group consists of:
- a project manager
- a project administrator and coordinator
- those responsible for sub-projects and activities.

The Project Manager is responsible for
- managing the project according to established plans and goals
- co-operation with external organizations, the steering committee, the project administrator and the coordinator
- information and guidance of project members, external organizations and the steering committee.

The Project Administrator and Coordinator has to
- develop and co-ordinate plans
- develop procedures for control, follow-up and reporting
- continuously follow up the project status
- keep plans updated
- analyze short and long-range effects of problems and disturbances
- replan
- prepare reports and assist in presentation of project status (time, cost and resources). (Ref 2)

Schedule

To avoid delays in a project's implementation as well as ensuring that its goals are reached, a schedule is necessary. The plan of action is to show when individual and/or group activities or accomplishments are started and/or completed.

The schedule ought to record all actions and deadlines so that the following notations at least will be clear:

- Preparation of the final project plan
- Selection of consultants and contractors
- Completion of different survey reports
- Borehole design reports
- Procurement of vehicles and equipment
- Institutional arrangements such as discussions and agreements:
  District administration and project implementation teams working and organizational relationships
  Management responsibilities
  Division of work between involved parts
- Personnel recruitment of an advisor, a coordinator , supervisors etc
- Training schemes for all new staff
- Project agreements:
  Negotiations
  Approvement and signing of project contracts and memorandum of understanding
  Exchange of agreement letters
- Development of continuous planning data such as technical implementation, cost calculations and information

Budget

Very important is budget planning when founding a project. All expenditures required to achieve the objectives must be evaluated. The budget must always be followed by a financing plan for various funds of the government and communities in the developing country, for those of the donor country through its development organization and for other volontary funds. Contingencies must also be taken in consideration.

From the drillers' point of view, the most important thing is to have enough time to do a good job, plus enough money to be able to use the best rigs, back-up facilities and materials for borehole constructions. The sad result will otherwise be silted-up wells that have to be re-constructed.

The developing organizations should preferably have more flexible budget years. Some projects are rushed because of the risk of with-

drawal of money.

An apparent but negative way of saving money is investing in cheap drilling-heads. A quality drilling head made of better steel lasts much longer and can drill 200-250 m (depending on the compressor) before it has to be sharpened. A cheap, poor-quality drilling head is more likely to break deep down in the very first borehole, resulting in other equipment losses and enormous costs due to the resulting standstills.

Financing

Today, many well-drilling projects are financed by aid money which does not have to be repaid. In future some programmes must no doubt be financed in alternative ways, if the water-supply situation is to improve rapidly.

As the trade balance in many donor countries today is negative, there is a tendency to "tie up" money. With this background one cannot exaggerate the difficulties developing countries have and the importance of good financing.

It is necessary to distinguish between three types of finance:
"CREDIT. The return on investment is limited to contractual terms.
RISK CAPITAL. The financing body faces risks of a commersial or political nature but anticipates that its share in returns of venture will compensate for the risk.
SUBSIDY CAPITAL. The expected financial returns do not compensate for the risks undertaken." (Ref 2)

There are several sources of credit:
- Private banks lending capital on market terms
- Official lenders such as import-export banks and
- Development banks and institutions such as the World Bank lending capital to lower interest but other terms.

For financial questions at issue I refer to literature on the subject.

Policy and procedure

To ensure a successful result to a water project, most policy decisions should be taken at the project's very beginning. The policy can be either a formal or an informal practice and serves as a general guide for decision-making and individual actions. Sometimes it is politically-based. It follows that the procedure is the detailed method of carrying out the policy decided on.

Standard

Some standard criteria are always chosen and when using these one can determine to what degree the individual or group performance is met. If it is decided that the people within a radius of two km from the handpump shall be supplied one has this standard. Another example is the yield corresponding to a wet borehole.

From the contractor's point of view there are different payments depending on the rate of success. A dry borehole is completed with headworks. If testpumping shows that water is present but not enough to warrant the title of wet hole it must be asked if it is worth the trouble and cost of putting a pump there. People in the area who need all the water they can get would certainly answer yes. It is a hard decision not to complete the well under these circumstances.

Finally, I think that some sort of standard certificate to designate a borehole as accurate is necessary, or else too many wells will silt up in the future because of rushed drilling.

Standardization

Technical standardization is one of the biggest problems the ministries are facing today. Donors from different countries are supporting their own industry. When the project is ready the rig is often left to the country and consequently the ministry ends up with a lot of rigs of varying brands. Since no standardization for rigs is statutory and money is lacking for spare parts it is difficult to keep the rigs drilling. If the development organizations could cooperate and support the countries with rigs of the same brand, drilling would be much more effective. Naturally spare parts must also be delivered

when local drilling is supported.

Frequent breakdowns of back-up vehicles can occur and cause disturbances, but the stumbling-block is always the rig.

Every possible effort to keep the rig drilling the whole shift is necessary. A medium-sized rig appears to be the best choice since it is quite cheap to run and a bit less complicated than a big, expensive unit.

### 7.1.2 Directing

#### Coordinating

On drilling programmes there are usually several parties; the employer, for instance the government of Zimbabwe through MEWRD, a consultant engineer and a drilling contractor. Communication between these parties is very important.

The project coordinator works under the employer (the ministry) and is responsible for the coordination meetings where practical problems are to be solved. Activities have to be carried out in relation to their importance and with a minimum of conflict.

In Zimbabwe there are local contractors as well as two ministries drilling for water. Ofter, simultaneous projects are going on and common meetings with steering committees and coordinators are held. Decisions are taken to avoid producing wells closer than two km from each other. On the other hand, some parties may reason that several small wells are better than a large central one in case of breakdown.

#### Supervising

The supervision from top to bottom of the organization in general is t to give day-to-day instruction, guidance and coaching to subordinates in implementing and carrying-out approved plans. For example, a Headwork Supervisor is responsible for the headworks and a Drilling Manager supervises the drillers and is in charge of the equipment. The Drilling Supervisor, often a hydrologist, is one of the main characters in a water project. His duties are as follows:

"- Drilling supervision, including making key decisions on borehole design, type, depth etc.
- Test pumping supervision
- Supervision of headworks construction
- Preparation of daily field reports
- Preparation of geological and hydrogeological logs
- Collection of test pumping data
- Collection of water quality samples." (Ref 3, page 21)

Staffing

The most responsible personnel on the total contract and management contracts I studied were European expatriots. In ministry-run drilling projects more Africans are found in these positions. The ministries in Zimbabwe have, since Independance in 1980, been short of skilled administrative personnel. Professional, qualified people had left the country. There are still vacant posts.

As the private sector pays their employees higher salaries than the ministries, the situation is not improving. There are right now many expatriot professionals operating in MEWRD, i.e. the Ministry of Energy Water Resources and Development. They are recruited to stay throughout donor governments' programmes.

The National Master Plan presents the following proposal for a temporary solution of some problems in the MEWRD of Zimbabwe.

"Establishment of a Management Unit

The Inception Report required an evaluation of the need to set up a budgeting unit, and for reasons of greater depth of expertise, better coordination and staff training the consultants support this concept (Section 7.3). However the Ministry's management problems go far beyond budgeting.

Recommendations

The Consultants recommend the establishment of a Management Unit of four people, to be appointed from inside and outside the Ministry. The vacant post of Principal Executive Officer (Economics) should be

the senior post in the Unit and this should be filled as a matter of urgency by a suitable candidate, who must have a professional qualification with preferably costing and management accounting experience.

We suggest that perhaps all, but certainly the senior posts in the unit should be on a time basis for three years, to ensure continuity and the retention of skills over a reasonable period.

A qualified and experienced management accountant should be seconded to the Unit for a minimum period of two years, to help establish the Unit and provide necessary expertise in the initial stages. The incumbent should also be required to undertake staff training, and should preferably have a knowledge of establishing computerised systems.

We recommend that the terms of reference for the Management Unit should be to:

- Undertake the preparation and monitoring of budgets in conjunction with the branches and provinces.
- Evaluate, establish and monitor financial and information systems relevant to the Ministry's needs.
- Initiate and carry out staff training.
- Act as management advisors to Ministry staff, particularly at provincial level.
- Provide specialists on a temporary basis for specific projects, e.g. computerised information systems.

While the Consultants are fully aware of current Government austerity measures, we believe that the establishment of the Management Unit (the equivalent of the Management Services Branch of most large companies) is a very high priority, and is likely to save its net cost in increased efficiency very quickly." (Ref 9)

Applicable to both the total and the management contract is the policy to recruit local drilling staff. The contractor of the Crash Programme presented employed most labour in Zimbabwe. The WellDrill Systems AB likewise trained and hired all field staff locally for the District Development Fund Water Division.

Training

The people in head positions, usually Europeans, are qualified professionals already educated for their work. A main policy is that the manager and the supervisor respectively shall teach a local counterpart to do his job when he leaves the country.

The counterparts of the Crash Programme have participated in siting and drilling supervision only lately. In the DDF training programme there are several counterparts, two of whom have taken over the charges of the Swedish hydrologist and geophysist who are leaving the programme.

The activities at the DDF Hunyani Training Center are presented in my study.

Delegating

Delegation of work is just as important in a water development project management as in any management situation. The point of assigning tasks, responsibility and authority is to make everyone use his abilities to the utmost.

I have found out that a trustable manager and an organization creating team spirit is necessary in order to get an effective progress rate.

Cultural traditions in Africa can sometimes cause problems. If an older man tells a younger man to do something he is expected to do so. A black foreman therefore have great difficulty in delegating work to older labourers.

Motivating

When working in developing countries expatriote staff can get into difficult situations. Just as the native-born staff they must be inspired and encouraged. Working under unfamiliar conditions is demanding. Directors and subordinates often need a tangible reward for achieving or exceeding the objectives. The most obvious recompense is the knowledge that welldrilling services create possibilities for life.

Counselling

Counselling concerns everything from discussing how somebody could do a better job, solving his personal problem, realizing his ambitions to asssisting the natives in Community Participation Plans. The counselling is important for the communities in order to understand the new situation with a watersupply that the inhabitants are responsible for.

The Crash Programme (described in my report) comprises a Community Participation Plan involving many people.

7.1.3 Controlling

The project control shall generate facts for decisions concerning the current project and future programmes.

If the big organizations had had better reporting and their personnel had been more open to positive and negative criticism maintenane obligations would have been understood earlier.

Measuring

The purpose of the project is very clear, namely to give rural inhabitants as many as possible watersupplies for a limited amount of money. It is necessary to make simple decisions through formal and informal progress reports about how objectives are approached.

The technical possibilities, time schedules and cost limits are restraints which influence the performance.

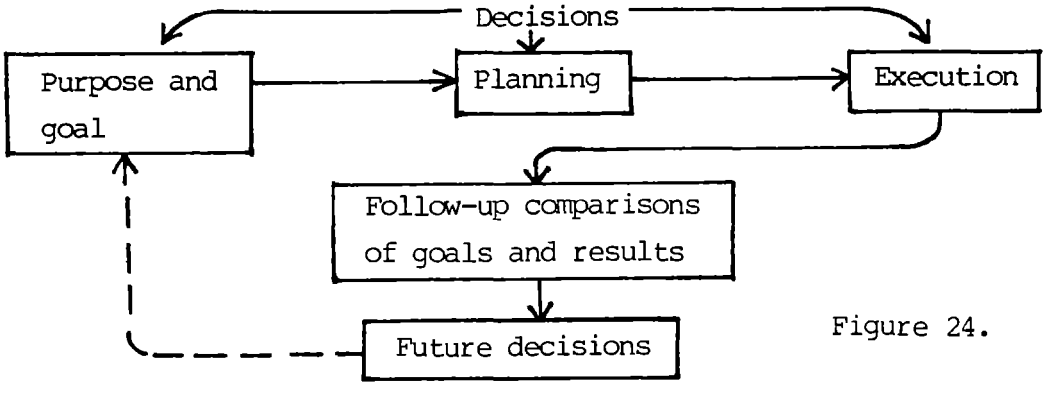



Figure 24.

Evaluation

To work in developing countries demands great flexibility. Determining deviation from a planned performance cannot be done in a traditional European way. Local factors are always present to affect the final result, which hopefully will not differ too much from the quota.

Generally, I think that the managers should push and bring up questions like the following to their subordinates more frequently:
- Is the project accomplishment as planned?
- Does the present project cost correspond to the planned expense?

Correcting

Development organizations must correct their efforts in certain respects in order to increase the number of wells within the budget.

Maintenance

The maintenance obligations of boreholes must be taken care of either by the citizens themselves of by a service team which is always available. I propose a community policy stating who is to attend to the wells.

## 7.2 Project life cycle and project management process

To sum up my project management chapter the idea of the following figure and keywords is borrowed from the material based on lectures by Mr Hans Björnsson, Chalmers Institute of Technology.

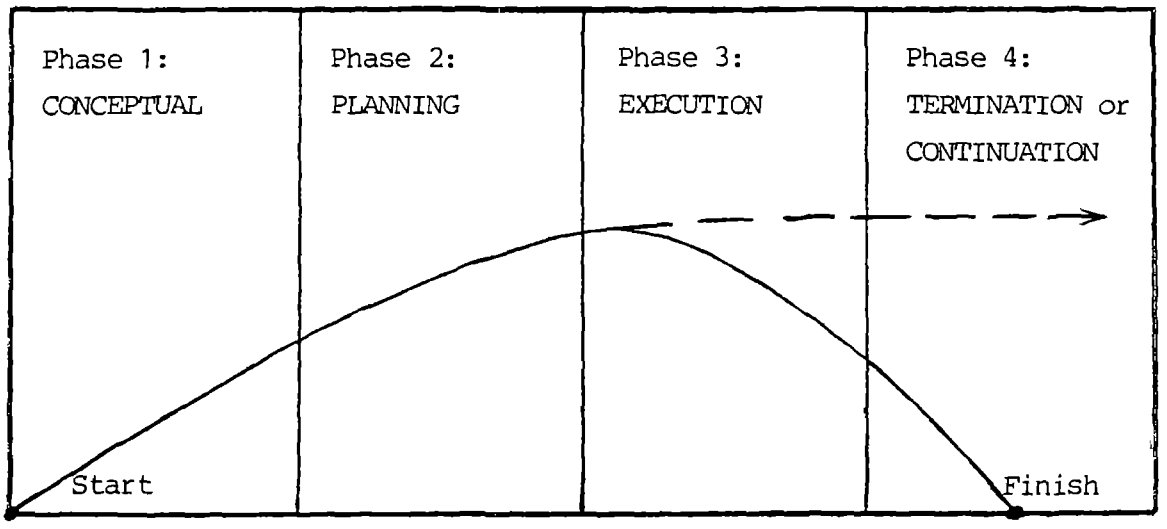



Figure 25. The project management process.

7.2.1 Important keywords

Phase 1:
- Identify needs & alternatives
- Establish feasibility
- Prepare proposals
- Basic budget & Schedule
- Identify project team

Phase 2:
- Implement schedules
- Studies & Analysis
- Design systems
- Obtein final approval for the project
- Start siting

Phase 3:
- Procurement of equipment
- Production of boreholes
- Testpumping
- Construction of headworks
- Verify performance
- Modify

Phase 4:
- Train counterparts
- Transfer responsibility
- Transfer materials
- Maintenance obligations
- Release resources
- Future plans

etc.

# 8 ANALYSIS

This last chapter of my report is an attempt to compare the different investment forms. The analysis has been performed in three stages namely:

- Compilation of the figures collected in Africa for handmade calculations and makeing up of borehole output schedule and comments.
- Net present value calculation and Monte Carlo Simulation by aid of computer to evaluate the management contract and the contractual leasing for a comparison.
- Comparison of the results.

My approach is, through this part, directed towards a donator such as a development organization or a big institution which is involved in water welldrilling. The aim is to obtain as much as possible for the money.

## 8.1 Borehole output

The need of drinking water in some areas of the countries I visited cannot be exaggerated. Fresh and clean water for year-round consumption may be provided from properly drilled boreholes constructed with headwork. Permanent water points are urgently required.

I have not included a comparison to the great variety of percussion rigs in my report. A properly handled air rig has the capacity to produce more boreholes in a certain period than a percussion rig can do. The latter is, however, in some respects a good alternative regarding ground conditions, technical aspects, supply of spare parts etc.

A natural way to begin a comparison of the different investment forms is therefore a schedule of borehole output per rig and month which follows:

| Investment form | Number of: Boreholes | Rigs | Period in months | Boreholes per rig and month |
|---|---|---|---|---|
| Total contract | 400[1] | 3-4[A] | 8,5 | $\frac{400}{4*8,5} = 11,8$ |
| Management contract | 208 | 10[B] | 12,5 | $\frac{208}{10*12,5} = 1,7$ |
| | 163[2] | 8 (10) | 6 | $\frac{163}{8*6} = 3,4$ |
| Import support | 102[3] | 2[B] | 24 | $\frac{102}{2*24} = 2,1$ |
| | 59[4] | 2[B] | 14,5 | $\frac{59}{2*14,5} = 2,0$ |
| | 12[4] | 1[B] | 8[5] | $\frac{12}{1*8} = 1,5$ |
| Contractual leasing | 18[6] | 1[C] | 3 | $\frac{18}{1*3} = 6,0$ |
| | 15[7] | 1[C] | 3[8] | $\frac{15}{1*3} = 5,0$ |

1) Average depth of boreholes: 42 m
2) Average depth of boreholes: 52 m
3) Boreholes drilled in Mashonaland province
4) Boreholes drilled in Matabeleland province
5) Drilling by one LWD-rig, waiting for the replacement rig
6) Average depth about 79 m ( Drilling in 1982 )
7) Average depth about 75 m ( Drilling in 1983 )
8) One month of external disturbances not included

A) Ingersoll-Rand TH 60 ( three pieces and one scorpion, which is a local truckmounted rig from Botswana ). Appendix 7.
B) WellDrill Systems AB LWD 200. Appendix 9.
C) WellDrill Systems AB LWD.

Figure 26. Boreholes per rig and month.

The figures in the schedule above hold an uncertainty caused by different environmental factors such as:

- External disturbances
- Different ground conditions (mud, rock eg.)
- Average depth of boreholes is greater in Kenya than in Zimbabwe

The figures from the table representing boreholes per rig and month are varying. Although they don't tell anything about the success rate (which is undistinguishable but similar to other projects) and the total water capacity of each well, they do reveal the efficiency of each system.

Heavy truckmounted drilling rigs were used in the total contract. These rigs have been somewhat overdimensioned for the conditions in Zimbabwe. The work progress has been high.

The remaining contracts are using rigs from WellDrill Systems AB. The Kenyan contractor is operating on one of the first Light Weight Rigs. This model is even lighter than the 1700 kg LWD 200 rig. The efficiency of this contractual leasing rig is excellent while operating.

During the contract period of the management contract the borehole output was low. The last six months of production indicate a better efficiency. The output is still very low considering the fact that water is urgently required.

## 8.2 Purchasing

The four LWD 200 rigs donated by import support produce approximately two boreholes per month on an average, which is a bad result. The cost of producing boreholes must be closely related to the borehole output.

The expenditures for units operated in a management contract like the DDF and units operated by a Ministry are very similar.

The cash-flow based on the initial invoices of this particular import support donation are listed in appendix 10.

Considering my table and the foregoing reasoning it is quite clear that the Ministry run drilling units of my report do not produce wells at a satisfactory rate.

The import support investment alternative is not rated as one of the best.

## 8.3 Expenditure for the total contract

The expenditure for the Crash Borehole Programme will serve as a reference for futher comparisons.

The total expenditure on 131 boreholes, according to the Progress Report (Ref 3) is 1504221 Z$.
The average cost per borehole is therefore:

$\frac{1\ 504\ 221}{131}$ = 11 483 Z$

Capitalization: m: 85.04.01 - 85.09.01 = 1/2 year

$11\ 483 * (1+0{,}20)^{m} = 12\ 579$ Z$

(See 8.4.4 Capitalization)

Cost of one borehole in SEK:

12 579*5,93 = 74 590 SEK (See 8.4.6 Exchange rates)

Note of the high cut (52,5%) for consultation services (See 3.8 Project economy). Costs for community participation materials and services are included under the Consultation Services heading.

The community costs should be excluded in my comparison of the projects. Unfortunately it has not been possible to determine the share of this rather costy part of the programme. Conseqently the cost of each borehole used for my comparisons is lower than 74 590 SEK.

The total contract was completed in August 1985. When I later relate the average cost per well of the management contract and the contractual leasing my time reference is the first of September.

## 8.4 Net present value calculations

An advanced method for the evaluation of the cash flows related to the resulting two investment forms is needed. The net present value ( NPV ) concept supplemented by an annuity calculation is perhaps the most reliable method for a correct comparison of different investments with a time horizon.

The principle of the NPV concept is very simple. The future cash-flows ( outflows and inflows ) are normalized to a common point in time - in my calculations to the date of the first invoice - taking into account the "time value of money". A specified discount rate represensting the estimated "cost of capital" is used.

The interest rate is applied to the future cash flows to shrink them back to their equivalent rate: their present value.

Money invested today will in other words be worth more than an equal amount invested in the future.

The projects will be compared according to their net present values.

A NPV less than zero means that the aggregate present value of the cash outflows at the specified interest rate exceeds the aggregate present value of the cash inflows. The project does not pay for itself. The higher the NVP the better the investment.

All calculations are done with consideration of tax effects. An annuity factor is finally used to get the same estimated expenditure per year for all years of the projects' lifecycle.

See references for other facts of NPV concept.

The NPV calculations have been performed by aid of computer at the Linköping Institute of Technology in Sweden. I have written the programs for my NPV calculations to fit Execucom's Interactive Financial Planning Systems (IFPS). See reference 6.

IFPS enables me to evaluate the calculations by the "Monte Carlo Risk Analyses" facility.

"An integral part of the IFPS Modeling Language is the capability to perform risk analysis. Essentially, risk analysis provides a vehicle for assessing the impact of uncertainty. It also highlights the impact caused by variations in data or changes of underlying assumptions. Risk analysis has many benefits:

- Assesses the relative riskiness of an investment;
- Highlights areas of uncertainty;
- Measures the costs of reducing uncertainty; and
- Establishes better communications.

Although many meaningful and informative models may be run without risk analysis, it is possible to gain more insight into some problems by using the risk analysis capabilities of Monte Carlo simulation. Monte Carlo simulation is a technique that facilitates risk analysis. It collects statistics on multiple solutions computed using certain randomly generated values.

Specifically, Monte Carlo simulations are appropriate when it is either impossible or inadvisable to assign single-point estimates to certain variables. Thus, you may wish to run a simulation when available data reflects a high degree of uncertainty or when a number of alternatives exist. Major decisions and new situations often benefit from a Monte Carlo simulation. Typical applications occur during profit planning, pricing strategies, make-or-buy decisions, and cost estimations." (Ref 6)

A presentation of the calculations for the two projects' comparison follows. The base for figures may be found earlier in my report.
The base for figures may be found earlier in my report.

### 8.4.1 The calculation

The balance "cash out" gives an idea of the size of expenditures each year of the projects. The balance "add back" tells about the positive add back effects.

### 8.4.2 Freight and insurance

The estimated cost for freight and insurance is approximated as a triangular distribution with probable value of 8% of the investment expenditure (from the invoice). Lower bound is 5% and upper bound is 10%.

### 8.4.3 Depreciation and supplementary investments

This calculation is based on the straight line depreciation method with different economic lifecycles of the assets.

A replacement of the investment takes place the same year as the asset is fully written off.

Price trend on investments is taken into consideration.

### 8.4.4 Capitalisation

For the final comparison the cost per borehole of all three projects must be capitalized to the same decided point in time. I have chosen the first of September 1985.

The factor $( 1 + j )^m$ is used.
Where:
j = inflation rate
m = number of years

### 8.4.5 Annuity

The annuity factor is $\frac{i}{1-(1+i)^{-t}}$

Where:
i = Real interest rate
t = Economic life span of the projects = 5 years

A multiplication of the fifth year's capitalized NPV and the annuity factor results in an equal annual expenditure of the project. Finally dividing the annual expenditure by the borehole output per year of all rigs in the project the result will be the average cost per bore-

hole. The figure will be compared with the same figure of the total contract.

### 8.4.6 Exchange rates

When exchange rates are needed the values sketched in the diagram below are used.

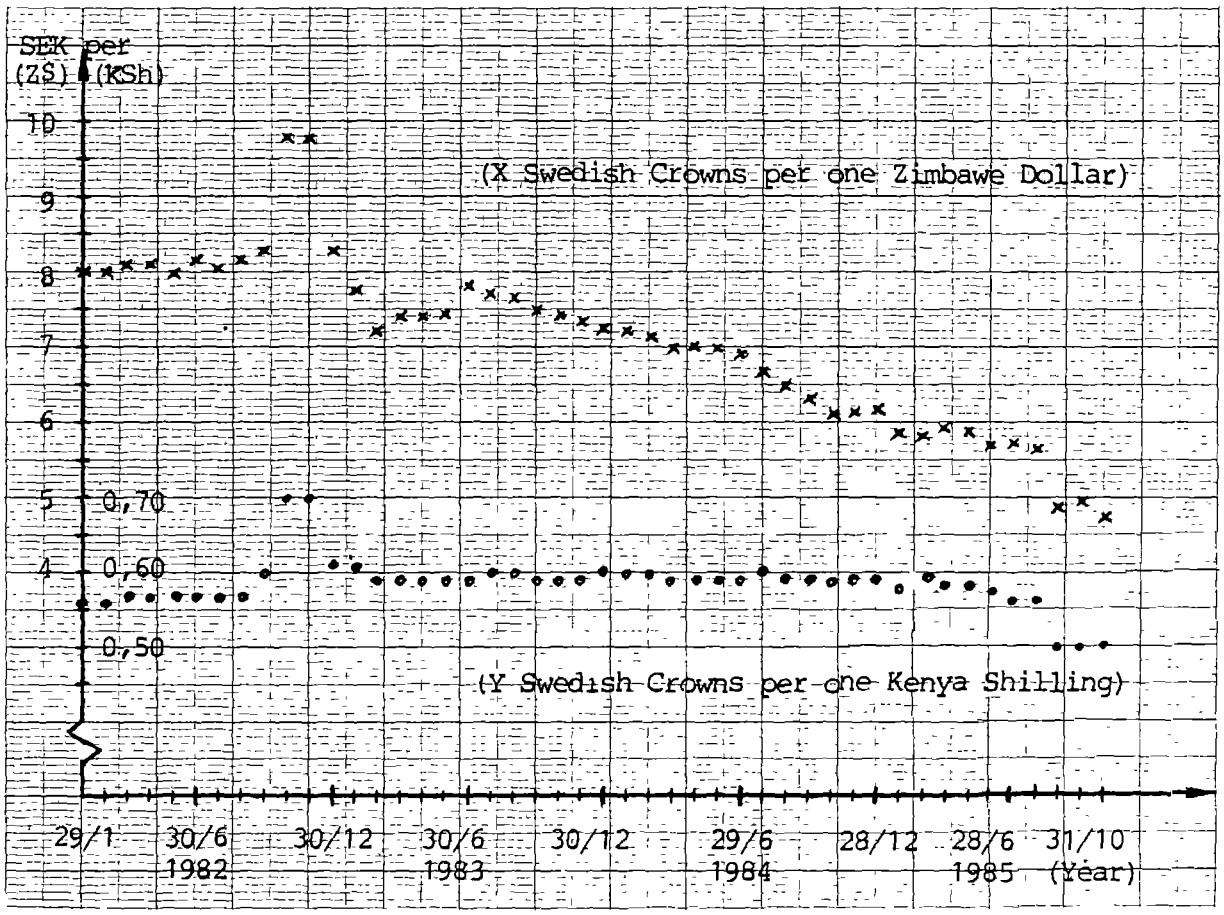



Figure 27. Exchange rates.
(Source: "Skandinaviska Enskilda Banken", Linköping)

## 8.5 The management contract

### 8.5.1 Interest rate

Estimations: Real interest rate = 5%
Inflation rate = 20%
Tax rate = 50%

$i_{nom}=(1+i_{real})*(1+\text{inflation rate}) - 1 = 0,26 \Rightarrow 26\%$

$i_{\text{nom after tax}}=(1-\text{tax rate})*i_{\text{nom before tax}} = 0,13$

Nominal interest rate is 13%.

### 8.5.2 Borehole output

The estimated borehole output from 1 January 1985 is 2*163 = 326 boreholes per year.

### 8.5.3 Initial investment

The management contract of WellDrill Systems, the District Development Fund for the government of Zimbabwe and Nowegian NORAD as sponsor made the following initial investments in equipment:

| | |
|---|---|
| Equipment | 1 316 500 Z$ |
| Drilling tools and accessories | 450 000 |
| Spare part packages | 75 000 |
| Spare parts for compressor | 41 667 |
| Extra sets of spare parts | + 12 667 |
| | 1 895 830 Z$ |

Freight:

$C_{low}$ = 0,05*1 895 830 = 94 790 Z$
$C_{average}$ = 0,08*1 895 830 = 151 670
$C_{high}$ = 0,10*1 895 830 = 189 580

### 8.5.4 Additional investment

| | |
|---|---|
| Vehicles for drilling project | 138 000 Z$ |
| Buildings (50%) | 127 000 |
| Camp and staff equipment | 48 800 |
| Additional equipment | +151 678 |
| | 492 560 Z$ |

Freigt:

$C_l$ = 0,05*338 478 = 16 920 Z$
$C_a$ = 0,08*338 478 = 27 088
$C_h$ = 0,10*338 478 = 33 850

### 8.5.5 Initial expenditures

Rental of buildings for administration is estimated to:
C = 200 000±100 000 Z$

Starting up salaries (main invoice):
C =435 330±10 000 Z$

8.5.6 Supplementary investment

Reinvestments of the consumaries takes place regularly.

The outlay is adjusted by the price trend on equipments which is estimated to be rising by 10% per year.

Three year drilling tools*, water prospecting equipment, camping equipment and small investments:
$I_3$=150 000+83 500+ 48 000+24 000 = 305 500 Z$

Two year drilling tools* and spare parts:
$I_2$=300 000+41 667+12 667 = 354 330 Z$

Spare parts*:
$I_1$= 75 000 Z$

*Prices at end of year 0.

8.5.7 Yearly cost

The yearly cost is assumed to be identical with the project expenses related to the budget for water supply 1984-1985.

Drilling project expenses:

| | | |
|---|---|---|
| Balance | 150 000+43 800+168 000+20 000 | = 381 000 Z$ |
| Casingtubes | 326*20*21 | = 136 920 |
| Casingshoes | 326*2 | = 1 956 |
| Hand pumps | 326*746,55 | = 243 375 |
| Staff salary | | = 239 355 |
| Experts' salary | | = 257 145 |
| Estimations: | | |
| Spare parts for vehicles | | 100 000 |
| Maintenance and service | | + 200 000 |
| | | 1 560 550 Z$ |

The probability distribution marginals are expected to be 300 000 Z$ to -100 000 Z$.

The yearly cost is adjusted by the rate of inflation (though the salaries are included).
Smaller faults in the real figures causing a slightly varying cost per year are negligible with a marginal of uncertainty.

### 8.5.8 Depreciations

The depreciation periods are the same as the ones used by DDF.

Rigs and compressors: 5 years

$$D_5 = \frac{800\ 000}{5} = 160\ 000\ Z\$ \text{ each year}$$

Trucks, cars, tractors, bowsers etc: 5 years.

$$D_1 = \frac{216'+45'+36'+24'+4'+30'}{5} = 71\ 000\ Z\$ \text{ each year}$$

Additional investment: 5 years

$$D_{add} = \frac{138'}{5} = 27\ 600\ Z\$$$

$$D_{2-5} = 71\ 000+27\ 600 = 98\ 600\ Z\$ \text{ each year}$$

Depreciations of investments with lifecycles of three, two and one year are adjusted to the expected price trend.

The depreciation of some additional equipment is added to the depreciation of three year drilling tools:

$$D_3 = \frac{48\ 800+151\ 678}{3} = 66\ 830\ Z\$ \text{ each year}$$

Buildings have an economic life cycle of approximately 40 years.
The depreciation per year would be very small. The small amount is neglected. The salvage value of the remaining accessories is instead adjusted positively.

### 8.5.9 Salvage values

Initial investments' salvage value is supposed to be within a triangular distribution, 5% as the most possible value, nil as lower and 10% as upper bound of the initial investment value.

Initial investment = 1 155 000 Z$

$S_1$= 0

$S_a$=0,05*1 155 000 = 57 750 Z$

$S_h$=0,10*1 155 000 =115 500 Z$

The values of the distribution are raised by the rate of inflation.

Remaining accessories are other assets remaining at the end of the fifth year. These are expected to have a salvage value represented by a uniform distribution from 300 000 Z$ to 600 000 Z$. Vehicles, buildings and supplementary investments not fully written off are included.

8.5.10 Graphical representation of the cash flow

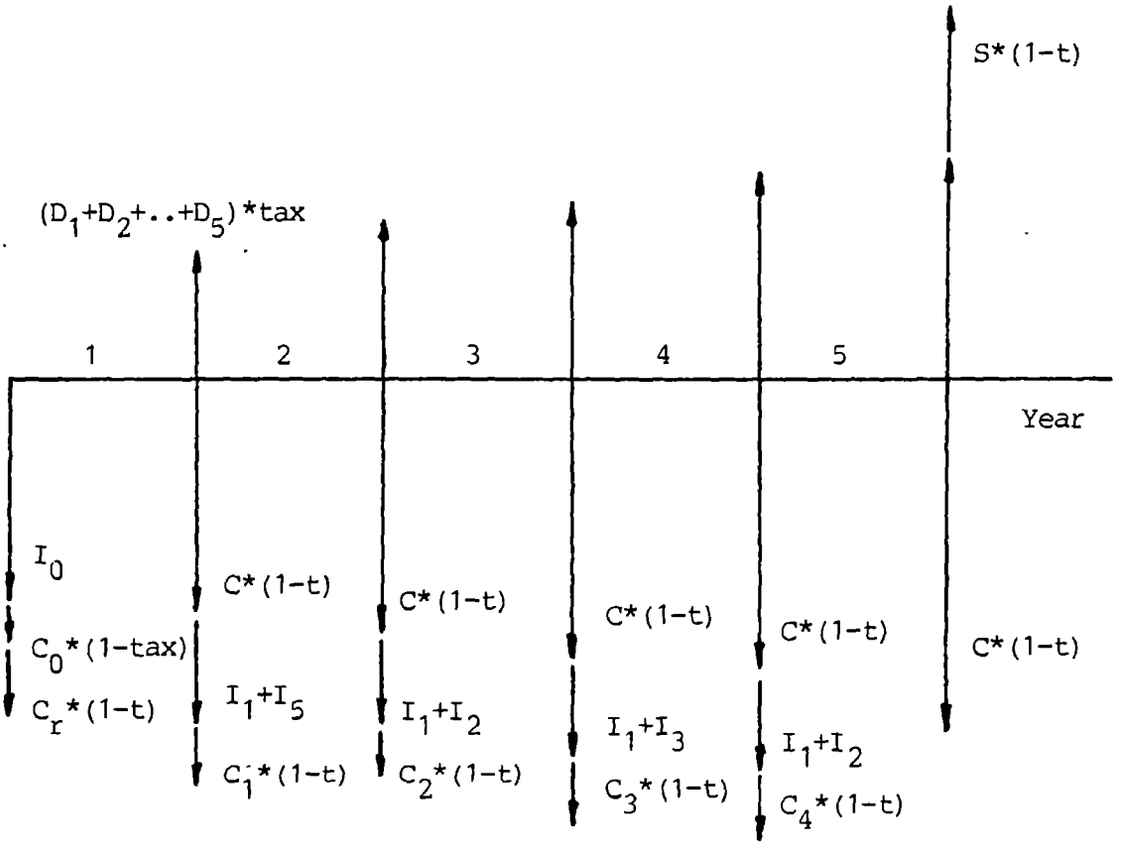



Figure 28. Management contract's cash flow.

The program written for the NPV calculation and the later simulation is listed in appendix 11.

The formula for execution of NPV is:

$$NPV=(-(I_0+C_0*(1-tax)+C_r*(1-t))+((D_1+D_2+..+D_5)*tax-(C*(1-t)+I_1+I_5+C_1*(1-t)))*\frac{1}{1+i}+...+X*\frac{1}{(1+i)^n}+(((D_1+D_2+..+D_5)*t+S*(1-t))-C*(1-t))*\frac{1}{(1+i)^5}$$

Where:

X = yearly cash flow

i = interest rate

n = actual year

t = tax rate

8.5.11 The NPV calculation by aid of computer

| | YEAR 0 | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 |
|---|---|---|---|---|---|---|
| MANAGEMENT CONTRACT | | | | | | |
| NET PRESENT VALUE CALCULATION AND ANALYSES USING MONTE CARLO SIMULATION | | | | | | |
| DATE OF FIRST INVOICE: 83.06.30 | | | | | | |
| CALCULATION IN ZIMBABWE DOLLAR | | | | | | |
| TAX RATE | .5000 | .5000 | .5000 | .5000 | .5000 | .5000 |
| INTEREST RATE | .1300 | .1300 | .1300 | .1300 | .1300 | .1300 |
| INFLATION RATE | .2000 | .2000 | .2000 | .2000 | .2000 | .2000 |
| PRICE TREND ON INVESTMENTS: | | | | | | |
| RATE | .1000 | .1000 | .1000 | .1000 | .1000 | .1000 |
| INITIAL INVESTMENT | 1895830 | 0 | 0 | 0 | 0 | 0 |
| ========== | | | | | | |
| INIT INV FREIGHT | 145347 | 0 | 0 | 0 | 0 | 0 |
| I I FR AFTER TAX | 72673 | 0 | 0 | 0 | 0 | 0 |
| ADDITIONAL INVESTMENT | 0 | 492560 | 0 | 0 | 0 | 0 |
| ========== | | | | | | |
| AD INV FREIGHT | 0 | 25950 | 0 | 0 | 0 | 0 |
| A I FR AFTER TAX | 0 | 12975 | 0 | 0 | 0 | 0 |
| INITIAL EXPENDITURES: | | | | | | |
| ========== | | | | | | |
| RENTAL OF BUILDINGS | 200000 | 0 | 0 | 0 | 0 | 0 |
| RENTAL AFTER TAX | 100000 | 0 | 0 | 0 | 0 | 0 |
| STARTING UP SALARIES | 0 | 441330 | 0 | 0 | 0 | 0 |
| START AFTER TAX | 0 | 220665 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| SUPPLEMENTARY INVESTMENTS: | | | | | | |
| THREE YEAR DRILL TOOLS | 0 | 0 | 0 | 406620 | 0 | 0 |
| THR Y DR T FREIGHT | 0 | 0 | 0 | 31174 | 0 | 0 |
| THR T FR AFTER TAX | 0 | 0 | 0 | 15587 | 0 | 0 |
| TWO YEAR DRILLING TOOLS | 0 | 0 | 428739 | 0 | 518775 | 0 |
| TWO Y DR T FREIGHT | 0 | 0 | 32870 | 0 | 39773 | 0 |
| TWO T FR AFTER TAX | 0 | 0 | 16435 | 0 | 19886 | 0 |
| SPARE PARTS | 0 | 82500 | 90750 | 99825 | 109807 | 0 |
| SP P FREIGHT | 0 | 6325 | 6957 | 7653 | 8419 | 0 |
| SP P FR AFTER TAX | 0 | 3163 | 3479 | 3827 | 4209 | 0 |
| OTHER EXPENDITURES: | | | | | | |
| YEARLY COST | 0 | 1627197 | 1952636 | 2343163 | 2811796 | 3374155 |
| YEARLY COST AFTER TAX | 0 | 813598 | 976318 | 1171582 | 1405898 | 1687078 |
| CASH OUT | 2241177 | 2675862 | 2511953 | 2888436 | 3488569 | 3374155 |
| DEPRECIATIONS: | | | | | | |
| RIG AND COMPRESSOR | 0 | 160000 | 160000 | 160000 | 160000 | 160000 |
| TAXSHIELD RIG COMP | 0 | 80000 | 80000 | 80000 | 80000 | 80000 |
| VEHICLES | 0 | 71000 | 98600 | 98600 | 98600 | 98600 |
| TAXSHIELD VEHICLES | 0 | 35500 | 49300 | 49300 | 49300 | 49300 |
| THREE YEAR DR TOOLS | 0 | 101830 | 168660 | 168660 | 204200 | 135540 |
| TAXSHIELD THREE YEAR DR | 0 | 50915 | 84330 | 84330 | 102100 | 67770 |
| TWO YEAR DR TOOLS | 0 | 177170 | 177170 | 214370 | 214370 | 259387 |
| TAXSHIELD TWO YEAR DR T | 0 | 88585 | 88585 | 107185 | 107185 | 129694 |
| SPARE PARTS | 0 | 75000 | 82500 | 90750 | 99825 | 109807 |
| TAXSHIELD SPARE PARTS | 0 | 37500 | 41250 | 45375 | 49912 | 54904 |
| SALVAGE VALUES: | | | | | | |
| INIT INVESTMENTS | 0 | 0 | 0 | 0 | 0 | 143700 |
| INIT INV AFTER TAX | 0 | 0 | 0 | 0 | 0 | 71850 |
| REMAINING ACCESSORIES | 0 | 0 | 0 | 0 | 0 | 450000 |
| REM ACC AFTER TAX | 0 | 0 | 0 | 0 | 0 | 225000 |
| ADD BACK | 0 | 292500 | 343465 | 366190 | 388497 | 678518 |
| CASH FLOW | 0 | -741763 | -632853 | -805392 | -1017401 | -1008560 |
| INVESTMENTS | 2068503 | 591198 | 539403 | 525859 | 652678 | 0 |
| NET PRESENT VALUE | -2068503 | -3172596 | -4033627 | -4892036 | -5844539 | -6328969 |

### 8.5.12 The cost of one borehole

Accumulated NPV = -6 328 969 Z$

Capitalization: m: 83.06.30 → 85.09.01 ⇒ 2 2/12 year

$-6\ 328\ 969*(1+0,20)^{m} = -9\ 394\ 904$ Z$

$$\text{Annuity} = -9\ 394\ 904* \frac{0,05}{1-(1+0,05)^{-5}} = -2\ 169\ 990 \text{ Z\$}$$

$$\text{Annuity/Number of boreholes drilled in one year} = \frac{-2\ 169\ 990}{326} = -6\ 660 \text{ Z\$}$$

Cost of one borehole in SEK:

6 660*7,80 = 51 920 SEK.

## 8.6 Contractual leasing

### 8.6.1 Interest rate

Estimations: Real interest rate = 5%

Inflation rate = 15%

Tax rate = 50%

$i_{nom} = (1+0,05)*(1+0,15)-1 = 0,208$ ⇒ 20,8%

$i_{nom \text{ after tax}} = (1-0,50)*0,208 = 0,104$

Nominal interest rate is 10,4%.

### 8.6.2 Borehole output

The expected borehole output for the three month periods of the last three years of the investment is 16 boreholes.

A theoretical output for the LWD rig could be 5*12=60 to 6*12=72 boreholes per year under the same conditions as the years 1982 and 1983. Although with a much higher cost per year! The supposed possibility will be considered when comparing my alternatives.

### 8.6.3 Initial investment

From the approach I have decided to use in the analysis, the investment expenditure is laid on the organization ordering drilling services from a smaller contractor. In my case the contractor is Instapump Ltd in Kenya.

$I = 693\ 700 * \frac{1}{0{,}57} = 1\ 217\ 020$ KSh.

The price in SEK is from the invoice of the drilling unit.

Freight:

$C_{low}$ =0,05*1 217 020 = 60 850
$C_{average}$ =0,08*1 217 020 = 97 360
$C_{high}$ =0,10*1 217 020 =121 700

### 8.6.4 Supplementary investment

Drilling tools* which are replaced every two years:

$I_2 = 247\ 000 * \frac{1}{0{,}57} = 433\ 330$ KSh

Spare parts*:

$I_1 = 60\ 000 * \frac{1}{0{,}57} = 105\ 260$ KSh

The price trend on investments is supposed to be 10%.

*Prices at end of year 0.

### 8.6.5 Siting

There is an uncertainty of the cost of siting. The siting services can be done by the "Client", the "Contractor" or by the Ministry of Water depending on circumstances.

The cost can not be exactely specified. Instead of overlooking the cost I have withened the bounds of the triangular distribution for the drilling cost later used.

### 8.6.6 Drilling cost

The "Estimate for drilling thirty boreholes in West Pokot" is very close to the real cost of drilling 30 boreholes. The average price per borehole was 75 917 KSh.

The 18 boreholes drilled in 1982: 18*75 917=1 366 510 KSh

The 15 boreholes drilled in 1983: 15*75 917=1 138 755 KSh

A triangular distribution is used. The bounds are ±50 000 KSh.

For the resulting three years of the projects' lifespan, I have supposed that the cost for borehole output corresponds to 16 boreholes in a three month period each year. The reason why the contractor in reality has not drilled at this rate is the client's scarce resources.

Year three to five:
(16*75 917)±200 000 = 1 214 670±200 000 KSh

The prices for the last three years are raised by the rate of inflation.

### 8.6.7 Depreciations

Rig and compressor: 5 years

$$D_5 = \frac{386\ 000}{5} * \frac{1}{0,57} = 135\ 440 \text{ KSh each year}$$

Drilling tools are depreciated in two years and replaced every two years.

Spare parts are depreciated in one year and replaced every year.

All prices are according to first invoice. The price trend on equipment is considered at reinvestments.

### 8.6.8 Salvage values

Rig and compressor:

$$S_l = 0$$

$$S_a = 0,05*386\ 000* \frac{1}{0,57} = 33\ 860 \text{ KSh}$$

$$S_h = 0,10*386\ 000* \frac{1}{0,57} = 67\ 720$$

Inflation rate is considered.

Remaining accessories:

A uniform distribution with a lower bound of 300 000 KSh and a upper bound of 600 000 KSh is used.

8.6.9 The NPV calculation by aid of computer

The programme written for this NPV calculation and later simulation is listed in appendix 11.

CONTRACTUAL LEASING

NET PRESENT VALUE CALCULATION AND ANALYSES USING
MONTE CARLO SIMULATION

DATE OF FIRST INVOICE: 82.07.06
CALCULATION IN KENYA SHILLING

| | YEAR 0 | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 |
|---|---|---|---|---|---|---|
| TAX RATE | .5000 | .5000 | .5000 | .5000 | .5000 | .5000 |
| INTEREST RATE | .1040 | .1040 | .1040 | .1040 | .1040 | .1040 |
| INFLATION RATE | .1500 | .1500 | .1500 | .1500 | .1500 | .1500 |
| PRICE TREND ON INVESTMENTS: | | | | | | |
| RATE | .1000 | .1000 | .1000 | .1000 | .1000 | .1000 |
| INITIAL INVESTMENT | 1217020 | 0 | 0 | 0 | 0 | 0 |
| INIT INV FREIGHT | 93303 | 0 | 0 | 0 | 0 | 0 |
| I I FR AFTER TAX | 46652 | 0 | 0 | 0 | 0 | 0 |
| SUPPLEMENTARY INVESTMENTS: | | | | | | |
| DRILLING TOOLS | 0 | 0 | 524329 | 0 | 634438 | 0 |
| DR T FREIGHT | 0 | 0 | 40199 | 0 | 48640 | 0 |
| D T FR AFTER TAX | 0 | 0 | 20099 | 0 | 24320 | 0 |
| SPARE PARTS | 0 | 115786 | 127365 | 140101 | 154111 | 0 |
| SP P FREIGHT | 0 | 8877 | 9765 | 10741 | 11815 | 0 |
| S P FR AFTER TAX | 0 | 4438 | 4882 | 5371 | 5908 | 0 |
| OTHER EXPENDITURES: | | | | | | |
| DRILLING COST | 0 | 1366510 | 1138760 | 1396871 | 1606401 | 1847361 |
| DRILLING COST AFTER TAX | 0 | 683255 | 569380 | 698435 | 803201 | 923681 |
| CASH OUT | 1310323 | 1491173 | 1840417 | 1547713 | 2455406 | 1847361 |

| | | | | | | |
|---|---|---|---|---|---|---|
| DEPRECIATIONS: | | | | | | |
| RIG AND COMPRESSOR | 0 | 135440 | 135440 | 135440 | 135440 | 135440 |
| TAXSHIELD RIG AND COMP | 0 | 67720 | 67720 | 67720 | 67720 | 67720 |
| DRILLING TOOLS | 0 | 216665 | 216665 | 262165 | 262165 | 317219 |
| TAXSHIELD DR TOOLS | 0 | 108333 | 108333 | 131082 | 131082 | 158610 |
| SPARE PARTS | 0 | 105260 | 115786 | 127365 | 140101 | 154111 |
| TAXSHIELD SP PARTS | 0 | 52630 | 57893 | 63682 | 70051 | 77056 |
| SALVAGE VALUES: | | | | | | |
| RIG AND COMPRESSOR | 0 | 0 | 0 | 0 | 0 | 68105 |
| RIG AND COMP AFTER TAX | 0 | 0 | 0 | 0 | 0 | 102157 |
| REMAINING ACCESSORIES | 0 | 0 | 0 | 0 | 0 | 450000 |
| REM ACC AFTER TAX | 0 | 0 | 0 | 0 | 0 | 675000 |
| ADD BACK | 0 | 228683 | 233946 | 262485 | 268853 | 1080542 |
| CASH FLOW | 0 | -454573 | -335435 | -435951 | -534348 | 156861 |
| INVESTMENTS | 1263672 | 120224 | 676675 | 145472 | 818777 | 0 |
| NET PRESENT VALUE | -1263672 | -1745533 | -2550011 | -2951591 | -3828586 | -3741950 |

8.6.10 The cost of one borehole

Accumulated NPV = -3 741 950 KSh

Capitalization: m: 82.07.06 - 85.09.01 = 3 1/12 year

$-3\ 741\ 950*(1+0,15)^{m} = -5\ 757\ 708$ KSh

$$\text{Annuity} = -5\ 757\ 708* \frac{0,05}{1-(1+0,05)^{-5}} = -1\ 329\ 890 \text{ KSh}$$

Annuity/Number of boreholes drilled in one year =

$$= \frac{-1\ 329\ 890}{16} = -83\ 120 \text{ KSh}$$

Cost of one borehole in SEK:

83 120*0,57 = 47 380 SEK.

## 8.7 Output of Monte Carlo Simulations

The programmes I have written for the NPV calculations contain probabilistic

variables.

The "Monte Carlo" simulation solves the models with the values from each distribution randomly generated for each iteration. Both simulations are done with 500 iterations each.

### 8.7.1 Frequency Table

"The values for this output are obtained by sorting all of the Monte Carlo iteration data values for a variable into ascending order and picking the appropriate percentile values. Thus, the 90% value is the value which had 10% of the data values smaller that it and 90% of the data values larger than it." (Ref. 6, page 14-14)

### 8.7.2 Sample Statistics Table

"For every variable the mean, standard deviation, skewness, and kurtosis values are printed. The standard deviation is a measure of uncertainty. The skewness is a measure of the symmetry of the data relative to the normal distribution. A positive number implies a distibution skewed to the left, zero means symmetric, and a negative number means that the distribution is skewed to the right.

The kurtosis is a measure of the "peakedness" of the data referenced to the slope of a normal distribution. (Three is the value for a normal distribution. A kurtosis value of greater than 3 indicates data that is more peaked than a normal distribution; a value less than 3 implies a flatter distribution curve.)

The table also contains the 10% and 90% confidence limits for the mean; that is, an 80% confidence interval for the mean." (Ref. 6, page 14-15)

### 8.7.3 Histogram

"Monte Carlo data values are plotted in graphic form. The height of each column of asterisks indicates the number of data values observed in that interval (determined from the vertical scale at the left). The numbers below the histogram are read vertically and indicate the horizontal axis values for every third column (interval). These numbers

represent the midpoint of an interval whose range is determined by the size of each interval. The start value (displayed on the bottom line) is the leftmost horizontal axis value. The stop value is the rightmost value. The size of each interval (also displayed on the bottom line) is the stop value minus start value divided by the number of intervals." (Ref. 6, page 14-15)

### 8.7.4 The Management Contract

The interesting tables and the histogram for column year 5 of net present value from my Monte Carlo simulation follow:

FREQUENCY TABLE

PROBABILITY OF VALUE BEING GREATER THAN INDICATED

| | 90 | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| NET PRESENT VALUE | | | | | | | | | | |
| YEAR 0 | -2099 | -2089 | -2081 | -2075 | -2071 | -2064 | -2058 | -2051 | -2039 | *1000 |
| YEAR 1 | -3231 | -3212 | -3196 | -3184 | -3173 | -3162 | -3152 | -3139 | -3123 | *1000 |
| YEAR 2 | -4148 | -4103 | -4079 | -4054 | -4028 | -4009 | -3991 | -3970 | -3948 | *1000 |
| YEAR 3 | -5060 | -4996 | -4965 | -4928 | -4880 | -4855 | -4822 | -4792 | -4763 | *1000 |
| YEAR 4 | -6080 | -5987 | -5941 | -5888 | -5830 | -5791 | -5744 | -5710 | -5669 | *1000 |
| YEAR 5 | -6633 | -6520 | -6447 | -6385 | -6315 | -6256 | -6199 | -6149 | -6103 | *1000 |

SAMPLE STATISTICS

| | MEAN | STD DEV | SKEWNESS | KURTOSIS | 10PC CONF MEAN | 90PC |
|---|---|---|---|---|---|---|
| NET PRESENT VALUE | | | | | | |
| YEAR 0 | -2069380 | 21998 | .2 | 2.7 | -2070639 | -2068121 |
| YEAR 1 | -3175318 | 40735 | -.3 | 2.7 | -3177649 | -3172986 |
| YEAR 2 | -4038493 | 74037 | -.4 | 2.3 | -4042731 | -4034255 |
| YEAR 3 | -4899085 | 111441 | -.4 | 2.3 | -4905464 | -4892706 |
| YEAR 4 | -5853836 | 151879 | -.4 | 2.2 | -5862530 | -5845142 |
| YEAR 5 | -6340877 | 197191 | -.4 | 2.3 | -6352165 | -6329589 |

```
    HISTOGRAM FOR COLUMN   YEAR 5 OF NET PRESENT VALUE
  57- 60                                        *
  53- 56                                        *
  49- 52                                        *
  45- 48                                        *
  41- 44                        *               *
  37- 40                        *           *   *
  33- 36                        *   *   * * * *
  29- 32                        * * * * * * * * *
  25- 28                  *     * * * * * * * * *
  21- 24                  *   * * * * * * * * * * *
  17- 20                * * * * * * * * * * * * * *
  13- 16          * * * * * * * * * * * * * * * *
   9- 12  *   * * * * * * * * * * * * * * * * * *
   5-  8  * * * * * * * * * * * * * * * * * * * *
   1-  4  * * * * * * * * * * * * * * * * * * * * *
          ---------------------------------------
          -     -     -     -     -     -     -
          6     6     6     6     6     6     6
          7     6     5     4     2     1     0
          9     6     3     0     7     4     2
          6     7     7     8     9     9     0
          4     1     8     5     2     9     6
          5     5     5     5     5     5     5
          0     0     0     0     0     0     0
START   -6818000  STOP   -5956000 SIZE OF INTERVAL   43100.00
```

## 8.7.5 Contractual Leasing

FREQUENCY TABLE

PROBABILITY OF VALUE BEING GREATER THAN INDICATED

| | 90 | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| NET PRESENT VALUE | | | | | | | | | | |
| YEAR 0 | -1272 | -1269 | -1268 | -1266 | -1265 | -1263 | -1261 | -1259 | -1255 | *1000 |
| YEAR 1 | -1759 | -1755 | -1752 | -1749 | -1745 | -1743 | -1740 | -1736 | -1731 | *1000 |
| YEAR 2 | -2568 | -2562 | -2558 | -2554 | -2550 | -2547 | -2543 | -2538 | -2533 | *1000 |
| YEAR 3 | -2997 | -2982 | -2969 | -2960 | -2950 | -2942 | -2932 | -2922 | -2909 | *1000 |
| YEAR 4 | -3915 | -3887 | -3861 | -3843 | -3823 | -3808 | -3790 | -3770 | -3744 | *1000 |
| YEAR 5 | -3900 | -3850 | -3811 | -3774 | -3745 | -3719 | -3682 | -3637 | -3581 | *1000 |

SAMPLE STATISTICS

| | MEAN | STD DEV | SKEWNESS | KURTOSIS | 10PC CONF MEAN | 90PC |
|---|---|---|---|---|---|---|
| NET PRESENT VALUE | | | | | | |
| YEAR 0 | -1263977 | 6128 | .3 | 2.5 | -1264327 | -1263626 |
| YEAR 1 | -1745670 | 10594 | .0 | 2.4 | -1746277 | -1745064 |
| YEAR 2 | -2550379 | 13765 | .1 | 2.7 | -2551167 | -2549591 |
| YEAR 3 | -2951310 | 34355 | -.1 | 2.8 | -2953276 | -2949343 |
| YEAR 4 | -3827641 | 65544 | -.1 | 2.5 | -3831393 | -3823889 |
| YEAR 5 | -3743710 | 120997 | .1 | 2.8 | -3750636 | -3736784 |

HISTOGRAM FOR COLUMN YEAR 5 OF NET PRESENT VALUE

```
66- 70                    *
61- 65                    *
56- 60                  * *
51- 55                  * *
46- 50                * * * *
41- 45              * * * * *
36- 40            * * * * * * * *
31- 35            * * * * * * * *
26- 30          * * * * * * * * *
21- 25          * * * * * * * * * * *
16- 20          * * * * * * * * * * *
11- 15        * * * * * * * * * * * * *
 6- 10      * * * * * * * * * * * * * *
 1-  5  * * * * * * * * * * * * * * * * * * *
        ---------------------------------------
        -     -     -     -     -     -     -
        4     3     3     3     3     3     3
        0     9     8     7     6     5     3
        6     5     4     3     2     0     9
        1     1     0     0     0     9     9
        6     2     8     4     0     6     2
        0     0     0     0     0     0     0
        0     0     0     0     0     0     0
START  -4080000  STOP  -3344000 SIZE OF INTERVAL  36800.00
```

## 8.7.6 Comparison between Management Contract and Contractual Leasing

The net present values from parts 8.5 and 8.6 were -6 328 696 Z$ and -3 741 950 KSh respectively. The mean net present values found in the "Sample Statistics Table" are similar to these above. They are -6 340 877 Z$ and -3 743 710 KSh.

The "Histograms" tell us that the intervals of the accumulated net present values are 43 100 Z$ and 36 800 KSh. The figures give an idea of the uncertainty in the calculations.

The probability of values from the "Frequency Tables" are, however, the figures I am going to base my conclusion on.

As the management contract seems to have a higher cost per borehole, the 10% value (-6 103 000 Z$) is chosen for the comparison. The 90% value (-3 900 000 KSh) is chosen for the contractual leasing.

If the average cost per borehole is calculated in the same manner as earlier, the costs will be 50 070 SEK and 49 380 SEK respectively.

The average cost per borehole is in other words approximately the same for both projects.

Contractual leasing is probably a better alternative than the management contract despite the small difference in cost per boreholes shown here. This conclusion is based on the follwing three facts:

- A higher output per rig and month.
- The rig of the actual contract could be more intensively used which would lower the cost of the initial investment if it is reated to a higher borehole output.
- The average depth of boreholes is much greater in Kenya than in Zimbabwe.

# 9 CONCLUSION AND RECOMMENDATION

The recommendation is primarily based on the average total cost of one borehole and the borehole output per rig and month. Some opinions based on interviews and from what I myself noted during the field study will also be taken into consideration.

The ranking order of the alternative investment forms will be:
1) Contractual leasing
2) Management contract
3) Total contract
4) Purchasing

Some comments on the ranking of the alternatives can be found in chapter eight, "Analysis", along with my calculations.

Personally, from what I saw in Africa, I think that the difference in efficiency between privately run projects (i.e. contractor or mission) and state run projects (i.e. governmental or big development organization) is even greater than the cost shows.

It appears that small organizations are superior in many aspects. A small organization has:
- more flexibility
- more personal responsibilities
- less bureaucracy
- better communication among its employees

than its "big brother".

The number of boreholes produced monthly per rig (Figure 26) gives an idea of the differences in work progress. The total contract and contractual leasing methods are superior to the two other alternatives in this respect. To achieve the same staff output in a Ministry the demand on the personnel responsible for the project management would be almost unhuman.

It is very hard to fulfil the necessary elements of managing, i.e. planning, directing and controlling, in the increased bureaucracy and under the very special conditions in a development country with problems like lack of:

- hard currency
- trained personnel
- spare parts
- transport facilities (which holds up supplies)

etc.

There are also the difficulties in choosing a good drilling unit operated by a big organization. Because of its complexity the air rig can be more easily handled if run privately since breakdowns can be taken care of directly by the contractor.

Percussion rigs, less complicated but very slow, seem to suit the bigger organization better.

From a technical aspect a medium-sized truck mounted air rig is considered the best choise for operation in rural areas.

In general the quality of new air rigs is not often the main problem in the developing countries. (An exception is the drillhead, which must be of the best quality if it is not to wear out too quickly and get stuck in the ground with a resulting standstill.) Again it all boils down to the structure of the organization. If the organization is not flexible enough, no rig can drill regularly.

The management contract is an interesting investment alternative if the low borehole output and a proportionately high initial investment are neglected. If the development organization can recruit good supervisors and if the water problem can be seen in alonger perspective this contract is a good alternative. The level of knowledge in the well drilling and management field will be raised and the receiving country will hopefully be able to undertake the drilling itself within a few years.

My recommendation to development and aid organizations in future projects is to engage private contractors for drilling. In the first instance local companies should be invited to tender and secondly other companies with good references.

Thirdly, a management contract can be used. Ministries should not be operative unities in any other respects than being engaged in community

participation plans and being responsible for the control of produced boreholes.

There should always be a coordinator elected by the development organization. The coordinator plots and controls the tasks of the contractors, the Ministries and other engaged parties, e.g. the consultants. The coordinator is also responsible for reporting back to the sponsor.

The geographical locations of the sites should not be affected by political factors.

A handpump is undoubtably the most reliable and least complicated pump. The depth of boreholes should not be too deep for a handpump.

Finally, before the project is ended a service organigation must be established. The organization assists the communities in maintaining the borehole's headworks and handpump.

REFERENCES AND OTHER LITERATURE

1. Ahlberg P.O., Duty Trip to Zimbabwe to Evaluate Drilling Equipment 22-26 November 1982, Industribyrån, SIDA.

Arnesdotter, I., Kompendium för juridik I, del 2, Industriell Ekonomi, EKI, Tekniska Högskolan Linköping 1985.

Bergknut, P., och Elmgren, J., och Henzel, M., Investering i teori och praktik, Studentlitteratur, Lund 1981

2. Björnsson, H., Material based on lectures, Chalmers Institute of Technology, Göteborg 1985.

3. Borehole Programme - Mashonaland, Progress Report August 1984 - March 1985, Ministry of Energy Water Resources and Development, Interconsult A/S, Harare 1985.

4. Brealy, R., and Myers, S., Principles of Corporate Finance, Second Edition, McGraw-Hill, Inc., Auckland 1984.

5. District Development Fund, Zimbabwe, DDF Water Division, Project Report, Ministry of Local Government and Town Planning, Project Manager Lars Carlsson, Harare 1985.

Hjalte, K., och Jönsson, B., Resursfördelningsproblem, Liber Förlag, Stockholm 1982.

House, J. and M., and Salt, B., Zimbabwe A Handbook, Cannon Press, Harare 1983.

6. IFPS, USA's Manual Release 10,0, Execucom Systems Corporation, Texas 1984.

7. Kotler, P., Marketing Management: Analysis, Planning and Control, Fifth Edition, Prentice - Hall International, Inc., New Jersey 1984.

8. Loen, R. O., Chart from "Sales Managers Must Manage", Harvard Business Review May-June 1964.

Mabon, H., Organisationsläran- teori och praktik, Akademibok-handeln, Göteborgs Offset tryckeri AB, Stockholm 1980.

Republic of Zimbabwe, MEWRD, National Master Plan for Rural Water Supply and Sanitation:

Volume 3, Rural Water Supply Programme, Draft Copy, Interconsult A/S, NORAD, Harare 1985.

9. Volume 6, Management, Draft Copy, Interconsult A/S, NORAD, Harare 1985.

Söderman, S., (Red.), Exporthandboken, Sveriges Exportråd, Almquist & Wiksell, Uppsala 1984.

10. Zimbabwe Government, Contract No. DWD 33/84 Borehole Programme - Mashonaland, Ministry of Energy and Water Resources and Development, Harare 1984.

APPENDIX

Financial Times Wednesday August 21 1985 SECTION III

FINANCIAL TIMES

# ZIMBABWE SURVEY

**After five years of independence, the Government of Robert Mugabe has secured some notable achievements, but several economic challenges lie ahead and serious political divisions remain**

# Moving nearer a one-party state

BY MICHAEL HOLMAN, Africa Editor

EARLIER THIS month Mr Robert Mugabe, Zimbabwe's prime minister, took advantage of the most solemn occasion in the country's calendar to deliver what he called his final warning to his long time adversary, Mr Joshua Nkomo, leader of the Zapu opposition party.

Speaking at Heroes' Acre, an imposing memorial in the hills outside Harare to those who fell in the country's guerrilla war of independence and whose sacrifice is recalled every August 11, Mr Mugabe condemned the "armed banditry" in the Zapu stronghold of Matabeleland. It takes place, the Government believes, with the connivance and support of Mr Nkomo and his party.

Unless it ended immediately, Mr Mugabe pledged, the Government would have to take "very stern" measures.

The speech, preceded by raids on Mr Nkomo's homes in Harare and Bulawayo, arrests of three Zapu MPs and the confiscation of the Zapu leader's passport, appeared to signal what many observers had long believed likely: Mr Mugabe, set on a one-party state, is a short step away from banning Zapu and detaining Mr Nkomo and other senior officials.

## Inappropriate

To many observers it seemed an inappropriate occasion for such sentiments. Among those buried at Heroes' Acre are former stalwarts of Zapu, whose Zimbabwe African Peoples Revoluntionary Army (Zipra) played a major role in the defeat of white rule — albeit taking second place to the Zimbabwe African National Liberation Army (Zanla) of the ruling Zanu-PF Party.

It was an episode which illustrates the dichotomy in Mr Mugabe's nature. The same man marked the start of his period in office in 1980 with a statesmanlike address calling for reconciliation between races and parties. The appeal defused accumulated tensions left after some 80 years of white rule and a bitter seven-year guerrilla war to overthrow it which cost nearly 30,000 lives, the vast majority black Zimbabweans — many of them civilians.

These contrasting sides of his character — the reconciliation speech set against his remorseless pursuit of Zapu, or the adoption of a mixed economy while calling for socialist transformation — have made Mr Mugabe something of an enigma.

It is to his lasting credit that Zimbabwe emerged from its war to become a stable, relatively prosperous state. It was sufficiently tolerant to allow Mr Ian Smith, the UDI leader, a place in parliament. And it is a striking exception to Africa's woeful tale of coup and insurrection, economic mismanagement and a crippling drought from which Zimbabwe, thanks largely to government encouragement of peasant farmers and continued support of white commercial farmers, emerged comparatively unscathed.

The consequences of a ban on Zapu and arrests of senior officials are unpredictable. But there is the risk that it could provoke rather than end the dissident problem, which poses far less of a security threat than it did in 1983 and 1984. And the presence of young guerrillas in Matabeleland, angered by such a move, could prove fertile ground should South Africa, implicated in the past in dissident activity, wish to create trouble.

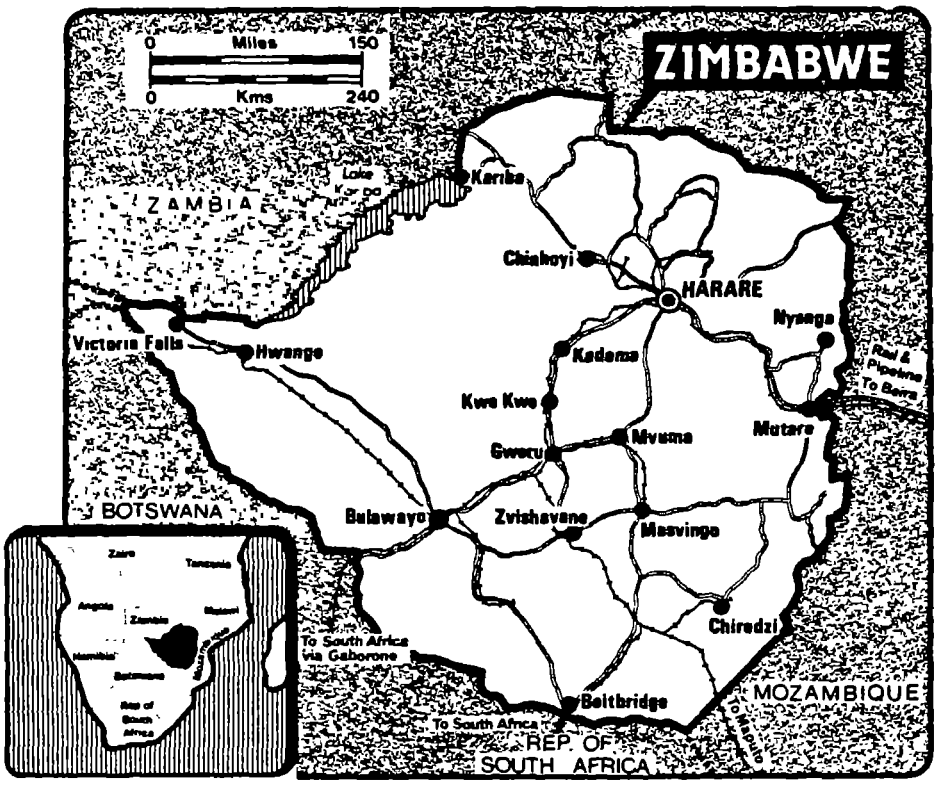
Tremendous strides have taken place for the country's 8m black majority in education, where primary enrolment has soared since UDI, in health services, and in rural developments including roads, clinics and new schools.

## Success

In the agricultural sector, the success of peasant farmers aside, the country's 4,300 mainly white commercial farmers acknowledge that life has seldom been better because of the end of the war, in which many played a dangerous and time-consuming front-line role. Government policies from the start also acknowledged the need for a realistic crop-pricing policy.

The rest of the white community, shrunk from a mid-1970s' peak of some 270,000 to fewer than 100,000, also continues to enjoy one of the highest living standards in the world.

Yet for all the considerable achievements, there are political and economic clouds on the horizon. The political issues were brought to a head at last month's first general election since independence. It was over-




whelmingly won by Zanu-PF, which secured 63 of the 80 black seats contested (and a further seat at a by-election) while Zapu took 15.

The outcome, while sweeping aside minority parties such as Bishop Abel Muzorewa's United African National Council, also confirmed the tribal arithmetic of Zimbabwe's politics: Zanu-PF won in the Shona-dominated provinces, while Zapu emerged secure in their stronghold of Matabeleland, reflecting the broad 80:20 ethnic breakdown.

The division, which goes back to the split in the nationalist movement in the early 1960s, needs to be carefully handled. Mr Mugabe, however, treated the outcome as a mandate for the one-party state he has long sought, and denounced yet again Zapu's alleged support of armed, anti-Government dissidents in Matabeleland. The result of some intemperate language was the ransacking of the homes of hundreds of opposition supporters by Zanu-PF women and youths, an alarming indication of the potential for factional violence.

The Prime Minister appears to have backed away from the other confrontation which the election outcome, and his reaction, seemed to herald. The success of the conservative alliance of Mr Ian Smith, the former Prime Minister, in winning 15 of the 20 entrenched white seats, was angrily interpreted by Mr Mugabe as a rejection of his reconciliation policy.

"Racist" whites, he warned, would be punished.

Mr Mugabe faces two critical challenges in foreign affairs. South Africa, apart from political links with dissidents, could present a serious problem should the republic carry out its threat to retaliate in the event of western economic sanctions by reviewing trade and transport links with black states. Zimbabwe would be in a severe predicament, for the republic is a major trading partner and the road and rail links to South African ports carry 85 per cent of the country's exports.

Apart from a fundamental distaste for doing business with South Africa it is this concern that is behind Mr Mugabe's growing involvement in the war between President Samora Machel of Mozambique and the anti-government Mozambique National Resistance.

## More assistance

The Mozambique port of Beira provides Zimbabwe's shortest road and rail route to the sea, as well as the loading point for the vital oil pipeline to the Zimbabwe border town of Mutare. Zimbabwe already has some 3,000 to 4,000 troops protecting this corridor, as well as the road link with Malawi running through Tete province.

As the war in Mozambique intensifies, so Mr Mugabe has promised to increase assistance to his old ally President Machel to as many as 30,000 troops if necessary. It could prove a major drain on the budget (defence already accounts for 14 per cent of spending) as well as draw Zimbabwe into a protracted war.

On the economic front the indicators appear encouraging at first. After three tough years of decline caused by drought and low commodity prices, Zimbabwe's real growth this year should reach 5 per cent.

But as the analysis of Zimbabwe's economy points out, 1985 real per capita incomes will be little different from 1965, at the time of the Unilateral Declaration of Independence. Even if there is a sustained period of 5 per cent real growth it will be at least a decade before real living standards measured in per capita income reach peak 1974 levels.

Government officials say there has been a less easily quantifiable improvement in living standards in such things as better education and health services.

Nevertheless the per capita figures are made even more worrying by the failure of the economy to keep up with the demand for jobs. In 1965 some 18 per cent of the population worked in the formal economy. today that has fallen to 12 per cent—partly because of a high population growth rate of about 3 to 3.5 per cent.

At the same time, the level of foreign investment attracted since independence has been disappointing, influenced by the Government's apparent ambivalence about the role of the private sector. It has yet to convince most foreign investors that its aim of creating a Marxist-Leninist state is compatible with a healthy investment climate.

There are several other worrying economic issues. Workers have found that although their wages have doubled in nominal terms since independence, inflation has left real purchasing power almost stagnant.

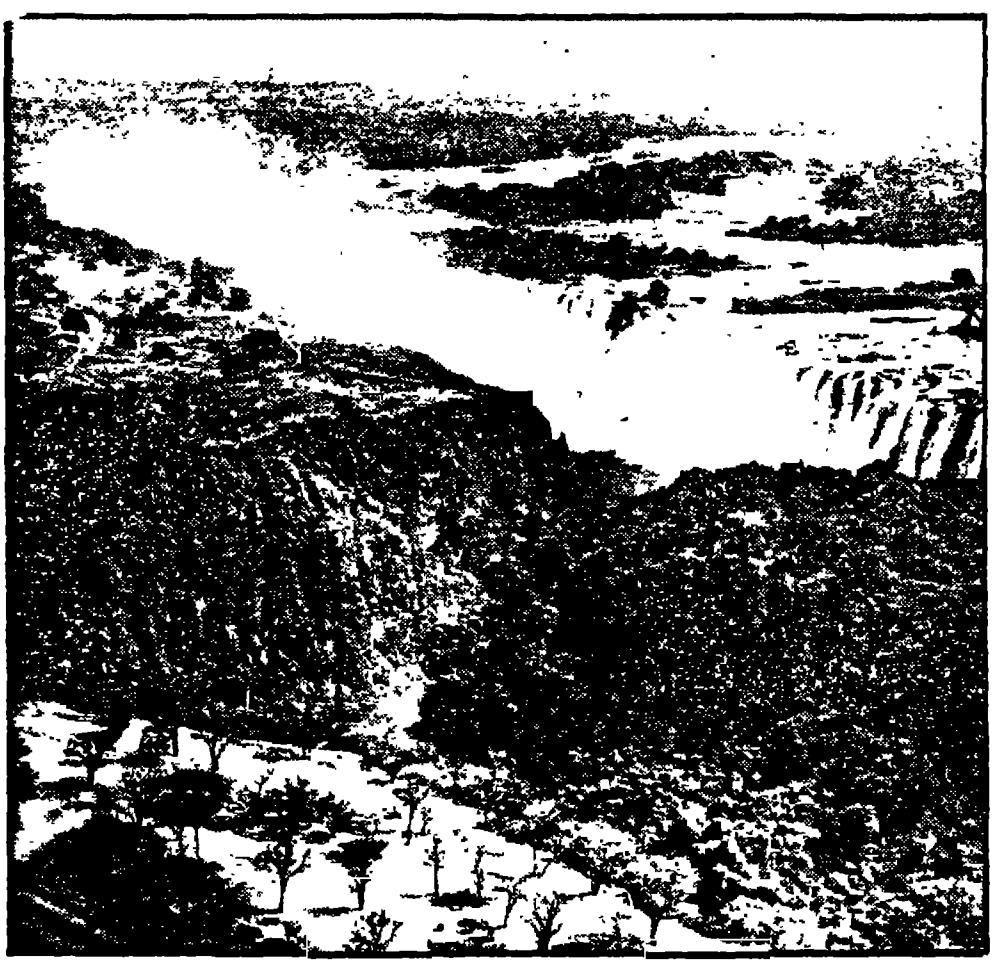
Subsidies in the 1985-6 Budget will also consume 11 per cent of spending, and the debt service ratio is about 26 per cent this year, giving further grounds for concern about medium-term prospects. These should be set against the encouraging growth in exports of maize, tobacco, cotton and other items, which has left the current account in the black this year for the first time since 1978.

It is the growing pressure on land, however, which most seriously threatens the country's long-term development. The much-vaunted land redistribution and resettlement programme, introduced after independence with substantial financial support from Britain, is inadequate. Only 32,000 families have been resettled from a target of 162,000 due to be moved over three years. In the meantime the backlog of unsatisfied demand has risen.

It is difficult to be precise but there could be 185,000 families—almost 1m people—either without land or in need of adequate arable or grazing land. Many areas are being steadily overworked, overgrazed and deforested, creating serious ecological problems for the future.

Mr Mugabe has much to deal with in the coming years, but it is not easy to predict the course he will adopt. Is he a sometimes irascible pragmatist, who may say things he later regrets, and then remedies? Or is he set at all costs on the creation of a one-party, Marxist-Leninist state.

This is a policy which could fan tribal tensions and undermine what today is, for all the problems, a relatively sound economy The answers to those questions will largely determine Zimbabwe's future.



**This aerial view shows the mile-wide Victoria Falls, one of the greatest tourist attractions in the world**

Financial Times Wednesday August 21 1985

Impressive performance on growth and inflation must be set against possible South African disruption and fiscal difficulties.

Export-led growth needed to break out of straitjacket.

## Economy

TONY HAWKINS

AFTER three years of stagnation and decline, the Zimbabwe economy will achieve real growth of at least 5 per cent in 1985, but prospects of a sustained improvement in living standards during the second half of the 1980s depend crucially on the course of events in neighbouring South Africa.

Even if the so-called "environmental variables" of the weather and world economic conditions turn out to be more favourable over the next five years than in the first half of the '80s — which is problematical to say the least — Zimbabwe's moderately-strong economic recovery could be aborted as South Africa both retaliates and defends itself against economic sanctions.

While the whole region would suffer to varying degrees, not so much from the imposition of economic sanctions but more from the likely South African counter-measures, Zimbabwe is particularly vulnerable. If Zimbabwe is to break out of the balance of payments straitjacket that has so severely constrained its economic performance since independence five years ago, it must enjoy a sustained period of export led growth.

**EMPLOYMENT AND POPULATION GROWTH**

| | Employment ('000s) | % of population |
|---|---|---|
| 1965 | 748 | 18 |
| 1970 | 853 | 17.5 |
| 1975 | 1,050 | 18.3 |
| 1979 | 984 | 14.6 |
| 1980 | 1,010 | 14.4 |
| 1981 | 1,038 | 14.3 |
| 1982 | 1,046 | 14.0 |
| 1983 | 1,030 | 13.3 |
| 1984 | 1,035 | 13.1 |

Zimbabwe's export dependence on South Africa is extremely high. An estimated 85 to 90 per cent of exports use the South African transport system and South Africa, as Zimbabwe's largest trading partner last year, purchased one fifth of total exports.

Zimbabwe's economic performance during the first five years of independence has been both impressive and disappointing. Impressive when set against that of sub-Saharan Africa as a whole to the extent that Zimbabwe stands out as a shining example of agricultural success, despite three successive drought seasons, but disappointing when viewed in terms of the admittedly-excessive expectations prevalent immediately after independence in 1980.

The disappointment has two quantitive and one qualitative aspect. On the quantitative side there is the sobering realisation that in 1985 real per capita incomes in Zimbabwe will be little different from their levels both when Ian Smith declared unilateral independence 20 years ago and when legal independence was granted in 1979. Indeed, even if Finance Minister Bernard Chidzero's plan for a sustained period of 5 per cent real growth is achieved—and many economists believe it to be on the optimistic side—it will be well into the 1990s before real living standards regain their peak historic 1974 levels.

Some more cautious projections suggest that these levels are unlikely to be regained before the end of the century, because with population growth estimated at 3 to 3½ per cent, incomes are unlikely to grow by much more than 1 per cent annually.

Linked with this is the concern, recently put by Dr Chidzero himself in his 1985 budget last month, over the deteriorating employment situation. In the past 20 years employment growth has lagged well behind the rate of labour-force expansion, with the result that while in 1965 some 18 per cent of the population had jobs in the formal economy, today the ratio is closer to 12 per cent.

Dr Chidzero's own figures show employment rising at a mere 7,000 new jobs annually since 1980 while an estimated 80,000 job-seekers have been joining the workforce each year.

Just how imperfect the Zimbabwe labour market has become is underlined by the experience of one prominent farmer who told me that he had to send lorries to the Harare area to pick up unemployed urban workers to help him hand-reap his cotton crop, because rural workers were simply unwilling to do it.

The large-scale cotton producers argue that—in a country of high and growing unemployment — the most serious constraint on output expansion is the reluctance of the workforce to pick cotton at economically-realistic piece rates.

The second disappointing aspect of quantitative performance has been the balance of payments, although this has improved radically in the past 18 months with rapid export growth raising hopes that the worst is now past.

Particularly disappointing on the balance of payments side has been Zimbabwe's failure to attract the levels of foreign direct investment so widely forecast in 1980, especially by Foreign Office mandarins.

Hopes that foreign investment will materialise on a significant scale now that the post-independence dust has settled and Zimbabwe has a five-year track record on which such investment decisions can be justified, may well be dashed by the spectre of a deteriorating regional economic situation created by the growing South African crisis.

On the qualitative side, there is the disappointment of the left-leaning radicals at Prime Minister Mugabe's failure to be sufficiently radical in implementing socialist economic doctrines, while on the other side of the political divide, business leaders fear that Zimbabwe may yet muff its golden opportunity to establish an efficiently-managed, mixed economy that would refute some at the World Bank, in the International Monetary Fund and in the West generally who appear to believe that African economies are destined only to failure.

**REAL INCOMES (1980 prices)**

| | GDP (Z$m) | GDP per head (Z$) |
|---|---|---|
| 1965 | 1,760 | 430 |
| 1974 | 3,140 | 555 |
| 1979 | 2,900 | 430 |
| 1980 | 3,226 | 455 |
| 1981 | 3,645 | 500 |
| 1982 | 3,645 | 483 |
| 1983 | 3,522 | 454 |
| 1984* | 3,565 | 438 |
| 1985* | 3,750 | 450 |

* Forecast.

The success both of agriculture, at peasant as well as commercial level, and more recently of manufactured exports, suggests that there is a good chance of Zimbabwe breaking free from the sub-Saharan mould, but this implies maintaining the delicate balance between radical socialism and business pragmatism achieved since 1980 by Mr Mugabe, primarily by talking socialist while acting pragmatically.

**BALANCE OF PAYMENTS (Z$m)**

| | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|
| **Exports** | 999 | 1,174 | 1,450 | 1,750 |
| **Imports** | 1,114 | 1,087 | 1,200 | 1,400 |
| **Trade Balance** | −115 | +87 | +250 | +350 |
| **Net Invisibles** | −415 | −545 | −350 | −300 |
| **Current Account** | −530 | −458 | −100 | +50 |
| **Capital Account** | +343 | +286 | +270 | n/a |
| **Overall Balance** | −187 | −172 | +170 | n/a |

There are three main dangers inherent in such a strategy. The first is that the rhetoric will acquire a momentum of its own eventually engulfing the private sector. Reflecting this momentum, a Zanu-PF official claimed at a political rally earlier this month that the time would soon come when no top post—even in the private sector—would be filled by individuals opposed to the ruling party.

The second danger, acknowleged implicity by Mr Chidzero in his budget address, is the danger of a crisis of unfulfilled expectations among school-leavers and the low-paid who, even though they have been the main targets of government social policies in respect of free primary education and health, minimum wage policies and controls on retrenchment, have seen some of these benefits severely eroded by inflation.

Thus, while average wages—excluding agriculture—virtually doubed in the five years from mid-1979 to mid-1984, so also did the price level with the result that average real wages barely changed. A major priority of the second Mugabe administration must be that of securing a significantly greater improvement in real incomes, wages and employment than in the first five years of independence.

Thirdly, there is the strategic danger—that of being "stuck in the middle" between radical socialism on the one hand and a mixed market economy on the other. The stuck-in-the-middle syndrome, familiar to business strategists, raises the spectre of two opposed sets of economic institutions, squabbling with one another rather than working harmoniously for the general good

The white-dominated — and largely foreign-inflenced, if not controlled—private sector is well aware of this danger and there has been refreshing evidence recently of a new preparedness to replace ideological confrontation with dialogue over the mechanics of economic co-existence.

Indeed, and this is a strongly positive development, on both sides of the public sector/private enterprise divide there is a new willingness to tackle bread-and-butter economic policy issues within the broad framework of the Mugabe Government's long-run socialist objectives. What remains to be seen is whether this pragmatism can weather some of the grass-roots pressures from within the ruling party for radical change.

In terms of economic performance, success depends substantially on continuing agricultural growth on the one hand, while maintaining the already-marked improvement in the balance of payments on the other. Although agriculture contributes no more than 14 per cent of GDP, even after a good season, there have been very few years in which there has been measurable growth in real GDP unless agriculture has performed reasonably well.

The handsome 26 per cent growth in real output in 1980/81 was primarily the result of a 12 per cent rise in agricultural production, and in the current year the projected 5 per cent growth rate will be associated with a forecast 20 per cent rebound in agricultural production after a superb rainy season.

The difference is that while in 1980/81 agricultural and industrial growth were mutually reinforcing, in 1985 agriculture is spearheading the recovery.

But Zimbabwe's ability to sustain satisfactory rates of growth for the rest of the decade hinge crucially on its balance of payments performance. The current account position deteriorated sharply from a deficit of Z$74m in 1979 to a current deficit of Z$533m in 1982.

It was at the end of 1982 that the over-valued Zimbabwe dollar was devalued by 20 per cent and the rate subsequently allowed to float further downwards.

At the same time, import quotas were cut and exchange controls tightened, resulting in a modest fall in the deficit to Z$454m in 1983.

Last year, however, there was a major improvement, only partly explained by the emergency exchange control measures imposed in March 1984 (and partially relaxed three months ago) and lower import allocations. Exports which stagnated during the 1980/82 period rose 17 5 per cent in 1983. With increased exports of tobacco, cotton, steel, gold and manufactured goods along with maize exports worth more than Z$40m exports are forecast to grow a further 20 per cent in value in 1985.

As a result, the current account deficit which fell to Z$100m last year will improve still further this year and is forecast to swing back into the black for the first time in seven years. The improved balance of payments position has allowed the Reserve Bank of Zimbabwe to reduce substantially its short-term foreign borrowings from Z$369m at the end of 1983 to only Z$141m last year.

Next year, however, the balance of payments position is likely to tighten, partly because the relaxation of last year's temporary ban on profit and dividend remittances will mean a higher invisibles deficit and partly because import allocations for the latter half of 1985 were recently increased by 30 per cent, reversing a four-year downtrend.

**EXPORTS**

| | Z$m | US$m |
|---|---|---|
| 1979 | 734 | 1,072 |
| 1980 | 929 | 1,473 |
| 1981 | 1,002 | 1,400 |
| 1982 | 999 | 1,087 |
| 1983 | 1,174 | 1,062 |
| 1984 | 1,450 | 1,200 |

Furthermore, export growth may well slacken in 1986 in response to slowing world economic growth and economic deterioration in South Africa, while debt-service payments as projected by the World Bank at the end of 1983 are estimated to have absorbed nearly 30 per cent of exports last year and the 1985 debt-service ratio is forecast to remain obstinately high at around 26 per cent.

These numbers underscore

the need for export-led growth if the import constraint that has stifled industrial growth and new investment is to be eased. While Zimbabwe does boast a much more diversified export base than the typical sub-Saharan economy, some of these exports—steel, asbestos, copper, nickel, cotton, sugar and even tobacco—either face fiercely competitive world market conditions or are into the mature phase of their industry life cycles, or both.

Exports of manufactures —excluding ferrochrome and steel—have doubled in the past three years though it will be difficult to maintain this momentum especially if South Africa takes counter-measures against economic sanctions that have adverse effects on the regional economy.

Inflation, which was a serious problem in 1982-83 reaching a peak of 20 per cent in 1983, fell to 16 per cent last year, declining further to dip below 10 per cent in the first half of this year. However, the signs are that a turning point in the cycle has been reached and price inflation will accelerate again in second half of 1985, reflecting higher food and fuel prices, the recent 5 to 15 per cent pay rise, a rash of official price approvals delayed by the elections and faster money supply growth over the next year. By mid-1986, the inflation rate is likely to be closer to 15 per cent than 10 per cent.

The use of price controls to slow inflation has taken its toll in the form of deterring investment. Dr Chidzero told parliament recently that total investment in Zimbabwe has fallen some 30 per cent short of the transitional development plan target of some $6bn. Investment peaked in 1982 at more than Z$1bn, but has since fallen an estimated 30 per cent in real terms.

The Mugabe Government's well-intentioned and justifiable income redistribution programmes have taken their toll, too — primarily in the shape of an obstinately large budget deficit which in the past three years has averaged more than 10 per cent of GDP. Indeed, in the past three years alone, the Government has borrowed more than Z$700m both at home and abroad to finance recurrent — as distinct from capital — public expenditure.

Some 45 per cent of budget spending in the current year is earmarked for education, defence and debt-service, thereby leaving the finance minister with precious little room for manoeuvre.

Public spending has increased its share of GDP from 38 per cent at independence to 45 per cent today and although the greater part of this expenditure growth has been funded from taxation, the size of the public sector deficit and borrowing requirement poses major problems not just in terms of existing policies but also because of future debt-service obligations.

Impressed though the IMF is likely to be with Zimbabwe's economic resilience in the face of drought, world recession and the South African crisis, and with the remarkable balance of payments turnround achieved in the past 18 months, there seems little doubt that the country's fiscal difficulties will raise problems when negotiations for a new IMF facility resume shortly.

Provided the combination of the world economic slowdown and the South African crisis does not jolt Zimbabwe's economic recovery off course, the near-term outlook is substantially more encouraging than seemed even remotely possible 18 months ago. Inflation has slowed, comfortable real growth is once again being achieved and the balance of payments is healthier than at any time for five years.

It is the longer-run scenario that is altogether less satisfactory given the rate of population growth and its age structure, allied with the need to break out of the balance of payments straitjacket that has constrained economic performance for a quarter of a century now.

These are the challenges that must be addressed in the new development programme currently being drawn up in Harare.

**MAIN EXPORTS IN 1984**

| | Z$m | % of total |
|---|---|---|
| Tobacco ..... | 275 | 19 |
| Gold ..... | 160 | 11 |
| Ferrochrome . | 155 | 10.7 |
| Cotton Lint... | 115 | 8 |
| Asbestos ..... | 74 | 5 |
| Nickel ..... | 62 | 4.3 |
| Sugar ..... | 56 | 3.9 |
| Steel ..... | 56 | 3.9 |
| Copper ..... | 43 | 3 |

Financial Times Wednesday August 21 1985

# Key role in funding state borrowings

## Banking

TONY HAWKINS

ZIMBABWE HAS the most sophisticated financial market infrastructure in the sub-Saharan region, after that of South Africa. The core of the system is made up by the central bank (the Reserve Bank of Zimbabwe) and the five commercial banks, with the dominant forces being Standard Chartered Bank which has the largest market share, and Barclays not far behind.

There are also two discount houses — something of a rarity in Africa — four merchant banks, five finance houses (largely hire-purchase operators), three building societies, and the post office savings bank.

In addition to this broad range of deposit-taking institutions. Zimbabwe possesses one of the most active stock exchanges in Africa, though of very marginal importance compared with the Johannesburg Stock Exchange. There are some 50 insurance companies and over 1,200 pension funds, many of them very small.

The public sector has long played an important money and capital market role, but this has grown since independence, both institutional and as a result of more active interventionist monetary policies. The Zimbabwe Government purchased a majority (nearly 60 per cent) controlling stake in the Zimbabwe Banking Corporation (Zimbank), in 1981, buying out the South African-based parent company, Nedbank.

### Investment

In addition, it is a joint-venture partner with the Bank of Credit and Commerce group in the only new commercial bank to be established in Zimbabwe in the past 20 years. The state recently launched the Zimbabwe Development Corporation, which will undertake mainly long-run financing for parastatals and has also established the state-owned Reinsurance Corporation — all of which points to a growing public-sector role in the field of financial institutions

On the investment side, the Government controls the Industrial Development Corporation and, most important of all in terms of loan policy, the Agricultural Finance Corporation which has played a vital role in expanding credit to the small farm sector.

The two British-owned banks — Standard Chartered and Barclays — dominate the commercial banking sector. Standard has 35 per cent of the total deposit base, with Barclays close behind with 33.5 per cent.

On the lending side, Standard Chartered runs well ahead with 38 per cent of the advances market, followed by Barclays with 31 per cent. Zimbank, with 17.6 per cent of advances, takes third place, and Grindlays and the Bank of Credit and Commerce (BCCZ), bring up the rear with 9 per cent and 4.4 per cent respectively.

The merchant banking market is shared out roughly evenly between the Merchant Bank of Central Africa, Ral Merchant Bank (controlled by the Anglo American Group) and Syfrets Merchant Bank, which is part of Zimbank. Standard Chartered Merchant Bank is the fourth participant, with about 22 per cent of the market, compared with the 25 to 26 per cent each of the other competitors.

The central bank has employed largely traditional monetary policies to restrain money supply growth, slow inflation and protect the balance of payments. Control of the money supply has not been easy, primarily because of the burgeoning public sector borrowing requirement necessary to finance a budget deficit, which exceeds 10 per cent of GDP, and the operations of the state-owned Agricultural Marketing Authority (AMA) whose total borrowings this year will approximate Z$1.2bn (US$720m).

### Lending

On top of that, central government will be in the market for a further Z$1.1bn and these two requirements between them pose serious problems, not just in terms of anti-inflationary policy but also in respect of the "crowding out" of private sector borrowings.

The money supply—broadly defined to include savings, and fixed deposits of commercial banks as well as demand deposits and currency in circulation—has more than doubled since 1979, with the public sector's share of commercial bank lending also doubling from 22 to 45 per cent over the period.

The rate of money supply growth has averaged 17 per cent annually since 1979, rising to 22 per cent last year, largely as a result of the government purchase of the pool of domestically-owned foreign securities.

By mid-1985 money supply growth was well under control at 12 per cent, but given the substantial financial needs of both the AMA and the Government, this is likely to accelerate again over the next nine months.

A more active interest-rate policy was signalled by the increase of bank rate from 4 5 per cent to 9 per cent in 1981, but since then the interest rate pattern has been largely stable, though short-run rates have fluctuated in response to liquidity pressures.

The three-month rate for negotiable certificates of deposit (NCDs) is perhaps the best indicator of market liquidity and this moved up from 3.5 per cent at independence to a peak of more than 15 per cent at the end of 1983, subsequently falling back to 9 per cent.

At present, lending rates—the prime overdraft rate is 13 per cent—exceed the inflation rate of just under 10 per cent, while deposit rates are only positive, in real terms, for deposits of 24 months and beyond.

But given the expectation of faster inflation it is likely that by early next year, the real return of long-term investments —such as government stock at 13.5 per cent—will once again be negative.

Desirable though positive real rates on savings might be in a country which does not save enough to fund the investment necessary to foster rapid job-creation, the authorities' room for manoeuvre is limited by the domestic debt-service burden resulting from local borrowings.

Financial Times Wednesday August 21 1985

Indeed, in the 1985 budget, interest charges on central government debt will absorb no less than 13.5 per cent of public spending and any upwards shift in the interest-rate pattern would only exacerbate an already severely-strained fiscal situation.

## Debt

Government borrowings have been growing at more than 20 per cent annually since independence with the result that the national debt/GDP ratio has risen from 58 per cent in 1979 to 64 per cent last year. The domestic capital market fulfils a key role in funding these borrowings with insurance companies and pension funds having subscribed for more than Z$500m of government stock issues since independence.

At the end of 1984, domestic debt accounted for just over 60 per cent of total government borrowings. The largest single holder of government stock is the Post Office Savings Bank with some Z$475m at the end of last year, followed closely by the insurance companies with Z$464m.

Pension funds, medical aid societies, financial institutions (excluding banks) and individuals account for a further Z$536m, while the banks themselves hold more than Z$350m. Both the extent and the spread of these holdings underscore the major role played by the domestic capital market in financing public spending.

# Strong comeback after fall

## Stock Exchange

TONY HAWKINS

**THE Zimbabwe Stock Exchange, which last year came perilously close to going under as broking firms closed and share prices plunged to 17-year lows, has mounted a strong comeback over the past year.**

**The exchange was already in the doldrums in March 1984 when dealings in the pool of external securities were suspended as a prelude to its acquisition. This raised serious doubts about the viability of the market, since in the preceding year turnover in the so-called externals had accounted for 83 per cent of the total.**

**It seemed inconceivable that the exchange could survive without this trade, especially as even then there were only two broking firms left in the market—one of which had signalled its intention to close because operations were no longer viable.**

**The exchange survived because of a combination of two forces. First, the Zimbabwe Exchange fell into line with those abroad in allowing corporate membership. This attracted the Anglo-American Group subsidiary Sagit Trust into the fold, ensuring that there were at least two dealing firms operating alongside 11 non-member institutions affiliated to the exchange.**

**Second, the compulsory acquisition of the external securities pool injected cash into the market, some of which was recycled into domestic equities and gilts. This coincided with economic recovery after two recession years, and the prolonged bear market came to an end in September 1984.**

**How severe the bear market had been was shown when the index of industrial share prices reached a low of 100.20 on September 12 1984, only two tenths of a percentage point above its base level of 1967.**

## Recovery

**At that stage market capitalisation was a mere Z$212m. This compares with a record high of 487 on the index in January 1981, meaning that the bear market lasted 3½ years, during which time the index plunged almost 80 per cent.**

**The recovery market took the index to a high of 262 in mid-1985, since when it has drifted gently lower to 247 in mid-August. The average yield on industrials is just over 10 per cent gross or 8 per cent net of tax. This is below both the inflation rate and short-term interest rates, suggesting that the market has reached a consolidation phase.**

**In the first full year of trading after the suspension of the externals, the value of turnover fell 52 per cent to Z$32.6m. More than two-thirds of this was in gilts, reflecting caution on the part of investors to hold equities given both the severity and the duration of the bear market.**

**The good news, however, is that corporate profitability is improving and higher dividends over the next year should maintain the firmer market tone.**

Financial Times Wednesday August 21 1985

Ambivalence over attracting new funds to an economy with a high level of foreign control

# Inflow dwarfed by loss of dividends, interest and profit

## Foreign Investment

TONY HAWKINS

BUSINESSMEN have long argued that one way of easing Zimbabwe's severe balance of payments constraint is through attraction of substantial foreign investment.

The post - independence record has not been an encouraging one, with reserve bank figures of private long-term capital flows showing a net inflow of some Z$40m in the first five years of independence. Over the same period, more than 10 times as much has left the country in profits, interest (on private sector debt) and dividends, raising serious doubts as to the foreign exchange benefits of foreign investment.

The benefits of direct investment stretch well beyond fund inflows and outflows, with technology transfer, access to skills, expertise and export markets being vitally important. The investment inflow to Zimbabwe has been disappointing — the Dandy Chewing Gum and Heinz investments by Denmark and the U.S. being the two most widely-quoted examples—and there have been joint venture and licensing agreements that have not caught the imagination.

Government policy towards foreign investment has blown hot and cold. Zimbabwe declined to sign the Overseas Private Investment Corporation agreement with the U.S., which is frequently a prerequisite for significant American participation in an economy. And although foreign investment guidelines were published in 1982, the Government has stopped short of agreeing to a fully-fledged investment code.

It argues that these involve making significant concessions to foreign investors that all too often fail to attract material amounts of the right type of investment.

There has also been some ambivalence over the desirability of attracting new foreign investment to an economy with an already-high level of foreign control.

How substantial that foreign control is has never been fully researched but an article in the Journal of Development Planning, by Mr Mudereri Kadhani, a former Zimbabwean treasury official, and Mr Reginald Green, an economist, developed some estimates of the ownership of the Zimbabwe capital stock.

They valued it as Z$19.2bn in 1983. Almost one-quarter was Government-owned and the balance owned by what they describe as "individual enterprises."

Foreign ownership accounted for about one quarter of the capital stock, far lower than some previous estimates which put the figure as high as 70 per cent.

### Choice

Once transport and power, private housing and public administration are excluded, the results show much higher foreign penetration.. Foreign investment is lowest in agriculture (19 per cent) and highest in mining (90 per cent), while in manufacturing it is just below 60 per cent.

If construction and services such as distribution and banking, are included the foreign-controlled share is about 45 per cent.

Whether this foreign control ratio is too high for the Government to wish to encourage additional investment is a matter of political choice. Internationally, however, there is little enthusiasm for direct investment anywhere in Africa and less so for investment in southern Africa, given the potential for economic disruption as the South African crisis worsens.

Financial Times Wednesday August 21 1985

# Worst seems over for whites

## Politics

MICHAEL HOLMAN

AS THE 100,000-strong crowd at Harare football ground at the end of June roared approval, an angry, grim-faced Robert Mugabe served what at the time seemed to be a clear threat that the bloc of 20 entrenched white seats in the country's 100-member parliament would be abolished despite constitutional constraints that should guarantee their presence at least until 1987.

His anger had been prompted by the success of Mr Ian Smith's Conservative Alliance, which, much to the surprise of many observers, had won 15 of the 20 white seats in the opening round of polling in the country's first general election since independence in 1980.

It was, said Mr Mugabe, a repudiation of his policy of reconciliation between races, and "racist" whites now faced very hard going. He ended his bitter attack on the white bloc, entrenched under the Lancaster House constitution drawn up under British chairmanship at the end of 1979, with the words: "We will not live with that indignity and insult very much longer. That dirty piece of paper (the constitution) will be cleansed."

A week later, speaking at a Press conference in the wake of the ruling Zanu-PF overwhelming success in the second round of polling for the 80 black seats, Mr Mugabe remained in an angry mood. He renewed his threat to remove the white seats, and said that he would also treat his massive victory as a mandate for a one party state—posing the prospect of a second constitutional crisis (for such a move would be illegal before 1990) and a confrontation with Mr Joshua Nkomo's Zapu.

The two episodes at the time seemed likely to change dramatically the face of Zimbabwe's politics. They may yet do so, but on the first issue at least the Prime Minister is treading cautiously, and indeed may be back-tracking.

His first step, however, confirmed some of the worst fears of the 100,000-strong white community. When the new Cabinet was announced shortly after the election, missing from the list of ministers was Mr Denis Norman, who had won wide respect for his handling of the agriculture portfolio—although a second white minister who had been returned as an independent, Mr Chris Andersen was retained as minister of the public services.

But in rejecting Mr Norman (whom Mr Mugabe thanked for his valuable services), the Prime Minister was making a point directed particularly at the white rural community and the 4,300 commercial farmers. Under the UDI era of the former Prime Minister, Mr Ian Smith, farmers had been stalwart supporters of the Rhodesian Front Party, and served in the front line of the guerrilla war.

Yet it was the same group that Mr Mugabe went out of his way to win over, acknowledging their key role in the economy. With Mr Norman putting their case for realistic crop prices, the majority of the hard-bitten white farmers declared that they had never had it so good.

The return, then of Mr Smith's Conservative Alliance candidates, the inheritors of the Rhodesian Front mantle, in several rural constituencies, as well as city seats, was understandably seen by Mr Mugabe as a particularly sharp rebuff.

### Worried

A jittery white community, feared worse was to come. While their fears could still be justified, the worst seems to be over.

Worried farmers were relieved early this month when no fewer than six Cabinet ministers attended the annual conference of the Commercial Farmers Union (predominantly white) and reassured the delegates that the Government recognised the importance of a successful commercial farming sector.

White fears have been further allayed by Mr Mugabe's comments both in public and in private. In Parliament earlier this month, in relaxed and joking mood, he implied that while his distaste for an entrenched racial block was as great as ever, the abolition of the 20 seats would take place within the constitution, ie not before late 1987.

His message in private, given to diplomats and others, is clearer and it now seems that the possible constitutional crisis, on this issue at least, has blown over.

The storm clouds are gathering, however, on the second issue: Mr Mugabe's often expressed determination to create a one-party state and frequent warnings that Mr Nkomo's Zapu will be banned. The two are not necessarily the same thing. To create a de jure one-party state before 1990 would contravene the entrenched provision in the Bill of Rights which guarantees freedom of political association and the Bill can be amended only with the support of all 100 MPs until 1990

Mr Mugabe could, however, draw on the range of emergency powers he inherited from Mr Smith (and which remain in force, being renewed every six months) and ban Zapu and any party that sprang up in its place.

There is growing evidence that this is what Mr Mugabe plans. Whether it will resolve the deep-rooted divisions between the country's Shona majority (about 80 per cent of the population) and the Ndebele balance is another matter.

Although some historians dispute the assertion, it is generally accepted that when the country's nationalist movement split in the early 1960s, the division was broadly along tribal lines, although both parties can point to members from the other tribe. Certainly the division was reflected in the general election results last month.

Zanu-PF won its 64 seats in the predominantly Shona provinces of Mashonaland East, West and Central, Midlands, Manicaland and Masvingo, while Zapu's 15 seats came from the Ndebele strongholds of Matabeleland North and South.

The United African National Council (UANC) of Bishop Abel Muzorewa, the former Prime Minister during the country's so-called internal settlement, lost the three seats it had held in the last parliament and was effectively wiped out.

The sole remaining seat was won by Rev Ndabaningi Sithole's Zanu party but it was the outcome of a favourite son vote rather than an indication of party political strength.

The vote itself almost reflected the tribal arithmetic—77 per cent of the 4m electorate secured by Zanu-PF and 19 per cent went to Zapu.

Strong a mandate as it was, Mr Mugabe appears set on further consolidating his power, basing his case in part on the argument that Zapu is responsible for the activity of armed anti-government dissidents in Matabeleland. The dissidents, most of whom are believed to be former members of the disbanded Zapu guerrilla army, have long been a thorn in the Government's side.

Their motives unclear, their organisation limited, the dissidents have been responsible for

Financial Times Wednesday August 21 1985

numerous incidents of banditry in the province including attacks on white farmers. The most serious loss of life, however, has taken place in the course of brutal military retaliation, notably in 1983, in the course of which between 1,000 and 3,000 civilians died.

Although the situation has quietened, the Government is determined to stamp out the dissident activity altogether and remains convinced that the rebels are acting with the connivance and support of the Zapu leadership—hence Mr Mugabe's most recent threat to Mr Nkomo: eliminate the dissident activity yourselves or we will do it and eliminate Zapu in the process.

## Jockeying

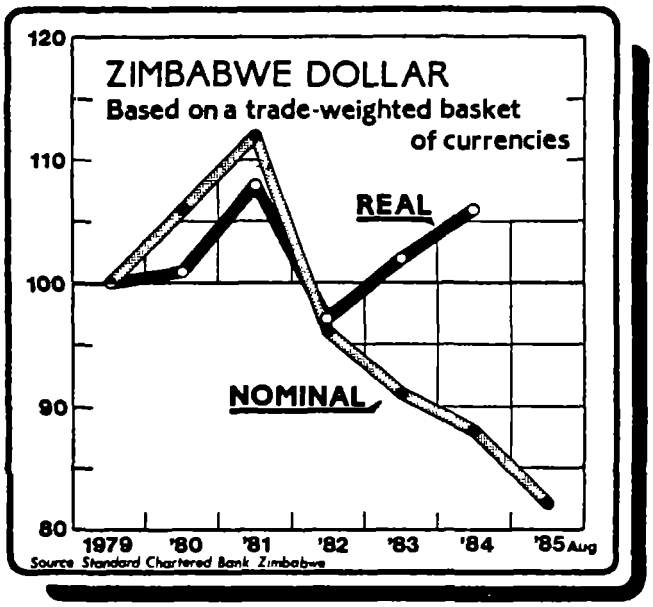
The eventual outcome—which could well trigger off further violence of the sort that marked the election result, when Zanu-PF women and youths evicted hundreds of opposition supporters from their homes in Harare and elsewhere—may well be the banning of Zapu. But in the meantime a process of attrition is under way, with arrests and harassment of Zapu officials, and Mr Nkomo, looking older and more tired by the day, a vulnerable and isolated figure.

In the meantime, a jockeying for power of a different sort—and far less easy to detect or follow—takes place within the ranks of Zanu-PF itself. One critical yardstick—although certainly not the only one—is the Cabinet and central committee line up according to membership of tribal groups within the Shonas as a whole: the Karanga (about 22 per cent of the population), Zezuru (18 per cent), Manyika (13 per cent), Korekore (12 per cent), Rozwi (9 per cent) and Ndau (3 per cent).

Leading the way is Mr Mugabe and the Zezurus who slightly outnumber the Karanga (most prominent of whom is Mr Simon Muzenda, the deputy Prime Minister, and Mr Emmerson Munangagwa, Minister of State for Security).

It is within and between these inner councils that the debate that will shape Zimbabwe's long-term policies is taking place: the pace at which Zimbabwe shifts from a mixed economy to Zanu-PF's declared aim of creating a Marxist-Leninist state, for example.

But for the short term at least, Zimbabwe's politics will continue to be dominated by the issue that is now over 20 years old: how do Zanu-PF and Zapu reconcile their differences?




# Real effective rate of exchange rises

**FOR THE past three years, Zimbabwe has been following a flexible exchange rate policy allowing its currency to depreciate gradually against those of its main trading partners. Since December 1982, the exchange rate of the Zimbabwe dollar has been determined on the basis of a trade-weighted basket of currencies. Before that, the exchange rate was set against a transactions-weighted basket of only six currencies.**

**The Reserve Bank of Zimbabwe does not publish details of the currencies that make up the basket nor of the weightings, but it is known that the effect of the change-over from a transactions-weighted basket was to reduce the impact of U.S. dollar movements very significantly while increasing the weight of a number of other currencies.**

**In the first three years of independence, the Zimbabwe dollar is estimated to have appreciated by about 18 per cent, but this was corrected when the currency was devalued by 20 per cent at the end of 1982 and then allowed to float down a further 5 per cent in the first half of 1983.**

**Standard Chartered Bank in Zimbabwe has attempted to track subsequent changes using a trade-weighted index covering some 75 per cent of exports and imports in 1980-1982.**

**This index shows the nominal exchange rate of the Zimbabwe dollar increasing sharply in the first three years of independence, but then falling steadily**

**Whether the exchange rate has depreciated far enough and fast enough depends, of course, on relative inflation rates. The Standard index does not cover real exchange rate movements beyond the end of 1984, but the graph does show that while the nominal rate fell markedly between 1981 and August 1985, the real effective exchange rate appears to have been rising in the two years from 1982 to 1984.**

**This reflected the fact that although the exchange rate was depreciating in nominal terms, it appeared not to be falling sufficiently rapidly to compensate for Zimbabwe's higher inflation rate, which saw prices rise more than 80 per cent 1980-84.**

**In the past six months, Zimbabwe's inflation has slowed significantly while the currency has depreciated—on the Standard Chartered index—by a further 7 per cent, suggesting that the real effective rate has started to fall. Clearly, this index cannot be precise because it is based on historic, rather than current, trade weightings**

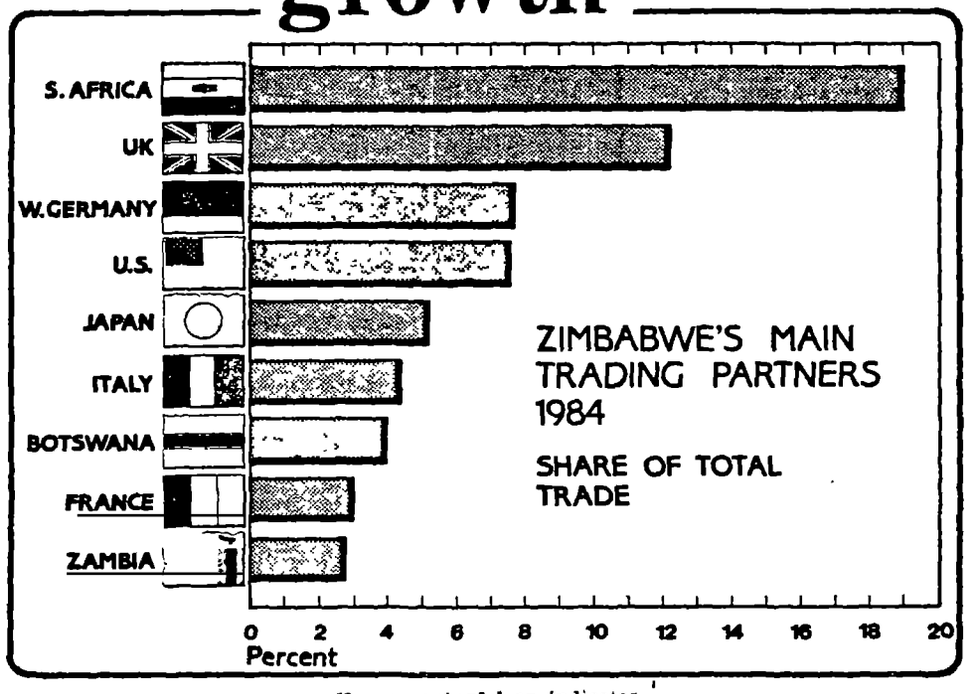
**Zimbabwe's inflation rate is expected to increase significantly over the next year.**

**Tony Hawkins**

Financial Times Wednesday August 21 1985

Manufacturing is able to meet the bulk of the country's needs and is the largest contributor to GDP

# Doubts over export growth




## Industry

TONY HAWKINS

ZIMBABWE ranks fourth in the sub-Saharan industrial league table behind South Africa, Nigeria and Ghana. United Nations data for 1981 show that South Africa was responsible for almost 54 per cent of the region's manufacturing value added, followed by Nigeria with only 12.5 per cent, Ghana with almost 8 per cent and Zimbabwe with 4.5 per cent.

These four African countries were the only ones, whose manufacturing value added exceeded U.S $1bn in 1981.

The relative insignificance of African industry is underlined by the fact that the sub-Saharan share of world industrial output was a mere 1.6 per cent, illustrating how much scope exists for development.

In spite of its modest contribution to African industrial output, manufacturing industry in Zimbabwe is the largest contributor to gross domestic product, accounting for 24 per cent in 1983, virtually the same as ten years previously.

How meaningful an indicator this is, has been a matter of debate. Economists argue that resource-intensive process industries like steel, ferrochrome, tobacco manufacture and cotton-ginning are more appropriately classified as mining or agriculturally-based.

### Strategic

But the importance of Zimbabwe's manufacturing sector is evident in its capacity to meet the bulk of the country's consumer requirements (direct imports of consumer goods account for less than 10 per cent of total imports) and its role as the second largest employer of labour, accounting for 16 per cent of the employed labour force compared with agriculture's 26 per cent. It also has an increasingly strategic importance as an exporter.

There has been a lively debate generating rather more heat than light whether manufacturing industry is a net user rather than a net provider of foreign exchange. Agriculture and mining see themselves as foreign currency earners, a high proportion of which is diverted to import-intensive industries. Agriculture, meanwhile, has to be satisfied with an inadequate and often-obsolete tractor fleet.

It is true that agriculture uses substantially less foreign currency than manufacturing, but the debate is unrewarding because the data base does not allow for meaningful conclusions. It is clear though, that the growth of manufacturing has been seriously constrained by reductions in import allocations since 1981. Also, partly as a result of incentives and partly in reaction to a depressed home market, industry has become more export-oriented.

Crude estimates suggest that manufacturing exports virtually doubled between 1980 and 1984 when volume of manufacturing production stagnated. The exports have been boosted by the 1982 currency devaluation and the government export incentive scheme, which will cost Z$18m (US$11m) this year.

But most importantly they have benefited by the World Bank's $70m export revolving fund, which last year provided more than Z$100m in foreign currency for imports to satisfy export customers.

An additional important factor has been the growth of exports to Zimbabwe's partner countries in the Preferential Trade Area. The major

Financial Times Wednesday August 21 1985

customers are Zambia, Botswana and Malawi. A survey by the Confederation of Zimbabwe Industries suggests that 34 per cent of industry's 1983 exports and 46 per cent last year went to this area.

Regulations of the PTA treaty pose a problem for some important Zimbabwean exporters, because they stipulate that 51 per cent of management in an exporting business must be by residents and that 51 per cent of equity must be held locally. The management requirement is no problem, but when the equity regulation is applied—Zimbabwe is covered by a grace period—industrialists believe PTA exports could decline because major exporting companies could not meet the provisions.

## Tiny surplus

In addition to PTA exports, some Zimbabwean clothing manufacturers have been breaking into West European and North American markets, though not on a large scale. Exports to South Africa (not purely manufacturers) increased 21 per cent last year, giving Zimbabwe a tiny trade surplus with the south for the first time.

Prior to the upturn of the last year, Zimbabwean manufacturers had faced a two-way squeeze of shrinking domestic demand and substantially-reduced import quotas. In the first six months of this year, import quotas to manufacturing industry were not much more than half their 1981 levels, excluding commodity aid import programmes and the special World Bank export fund.

The quotas, after adjusting for rising import prices and a depreciating exchange rate, even with the 30 per cent increase for the second half of 1985, are only about 40 per cent of 1981 levels. To this must be added commodity import programmes provided by western countries, primarily the UK and U S, which last year were worth an estimated Z$50m.

The domestic demand squeeze meant a 20 per cent fall in retail sales, adjusted for inflation, between 1981 and 1984. There has been a strong upturn this year, but domestic demand will not regain its 1981 levels until next year—and possibly not until 1987. The depressed domestic market contributed to the export efforts of industry.

Industrial production, which increased by 25 per cent in the first two years of independence, declined 8 per cent between 1981 and last year. However, output recovered strongly in the first four months of 1985, gaining more than 10 per cent over 1984.

This recovery rate is not going to be maintained through out the year, but forecasts point to annual industrial growth of at least 6 per cent, the first expansion in four years. But 1981 output levels are unlikely to be regained until next year.

Industry's problems focus around inadequate foreign currency allocations, and an ageing and often obsolete capital stock. The combination of price controls and labour-redundancy curbs have had a far-reaching impact on profitability and domesticdemand .

Most manufacturers have significant excess capacity but their ability to satisfy demand growth will continue to be severely constrained by the foreign currency bottleneck. In March this year, 71 per cent of industrialists responding to a business survey described inadequate import quotas as the critical constraint on production.

On the export front, South Africa's reaction to sanctions pressures will be crucial. The trade agreement between the two countries is immensely beneficial to Zimbabwe, but as Pretoria's difficulties proliferate, so it is likely to come under increased pressure from its own industry to terminate such preferences.

Heavy dependence on goodwill from South Africa

# Transport

TONY HAWKINS

**THE MOST serious potential threat to Zimbabwe's economy today is that of disruption of its transport routes as a result of counter-sanctions measures by Pretoria. Latest figures of Zimbabwe's transport dependence on the White South are not available, but 1983 statistics show that in that year no less than 93 per cent of Zimbabwe's imports and two-thirds of its exports used the two railway routes through South Africa.**

**In all, three-quarters of Zimbabwe's import and export traffic (excluding transit business) used the South African routes. The railway line via Bulawayo through Botswana to the South African ports was the more important of the two routes handling 1.4m tonnes or 40 per cent of total import and export traffic. The direct line to South Africa, via Beit Bridge handled a further 1.3m tonnes of 36 per cent of the total.**

**Of the balance, 235,000 tonnes represented trade with Zambia and the North using the railway across the Victoria Falls. Mozambique handled only 98,000 tonnes of imports but an important 490,000 tonnes of exports, making 17 per cent of the total. Mozambique traffic was in 1983 split between the line to Maputo which handled 380,000 tonnes of traffic—most bulk exports like sugar, steel and ferrochrome—and Beira with some 207,000 tonnes, mainly general goods, such as tobacco, tea, coffee, maize, etc.**

**For the past year, the Maputo line has—to all intents and purposes—been unusable because of the activities of the anti-Frelimo Mozambique resistance movement guerrillas in Southern Mozambique. Accordingly, Zimbabwe's reliance on South Africa has increased, although some traffic using the South African rail-**

ways has still been routed through the port of Maputo, but this link too has attracted guerrilla attacks.

Even with some increased use of the Beira line, it is estimated that at present upwards of 85 per cent and probably nearer to 90 per cent of Zimbabwe's import and export traffic relies either on the South African railways or ports or both.

If the transit traffic for Zambia and Zaire is added into the equation, the dependence is even greater. In 1983, transit traffic totalled 850,000 tonnes, almost all of which used the South African routes. If transit and Zimbabwean import/export traffic are taken together, then South Africa was, in 1983, handling more than 80 per cent of the region's traffic. Once the effective closure of the direct Maputo line is taken into account, it is likely that this proportion now exceeds 90 per cent.

## Sanctions threat

It is no wonder then that Southern African leaders, viewing the possible imposition of economic sanctions against South Africa, have raised the—surely impracticable—suggestion of a Berlin-style airlift to sustain Zimbabwe, Zambia, Zaire and Malawi, let alone such South African "dependencies" as Botswana, Lesotho and Swaziland.

An airlift simply is not a starter given the nature of the traffic—largely crops, fuels, metals, minerals and livestock. A more meaningful approach would be to invest in the defence and rehabilitation of the links through Mozambique and the ports of both Beira and Maputo, but that is not only an extremely expensive strategy but also a lengthy one, as well as being one that the South Africans could, if they so wished, frustrate by providing military support to the MNR in Mozambique.

Financial Times Wednesday August 21 1985

# Spending levels stay high

**Budget/Subsidies**

TONY HAWKINS

SINCE 1982 a tight budgetary position has seriously cramped the Mugabe Government's style. In the last three budgets, the deficit has averaged 10 per cent of GDP while the Government has been forced to borrow upwards of Z$700m merely to finance recurrent spending.

This in turn has resulted in increased reliance on borrowings, foreign as well as domestic, and even overdraft finance from the central bank, itself inherently inflationary.

The Government cannot be blamed for a failure to impose taxes. In the current fiscal year personal and consumption taxes are forecast to absorb more than 40 per cent of personal incomes and Mr Chidzero, the Finance Minister, has more than once conceded that tax levels are too high. The problem lies on the expenditure side, taking the form of excessive public consumption combined with inadequate public investment.

Some 44 per cent of budget spending is earmarked for three votes — education (16.7 per cent), defence (13.7 per cent) and debt-service (13.4 per cent). The Government is, to a great extent, locked into these appropriations, since there is virtually nothing it can do to achieve major savings.

Education spending is a source of grave concern since, barring a new political initiative, it will exceed 20 per cent of the budget by 1990. The same is true of debt-service, which has trebled in the last four years.

In spite of efforts to curb subsidies, these too have remained obstinately high, growing from Z$100m in 1980 to a forecast Z$377m this year. The 1985 Budget excludes Z$99m of subsidy payments being rolled over until next year, so the effective subsidy total for 1985-86, including interest charges on the roll-over amount, is not far short of Z$500m.

Good progress has been made in curbing food subsidies, which in real terms are lower now than three years ago, but there is a disturbing growth in the non-food area. The national railways and the Zimbabwe Iron and Steel Company will absorb Z$120m this year, while the airline and air freight company will make a further Z$30m. There are also relatively small amounts to the Tourism Corporation, the Mining Development Corporation, the state-owned news agency and Zimbabwe Broadcasting Corporation.

Big reductions in subsidies could transform the budgetary position, both by substantially reducing the Z$800m budget deficit this year and terminating the undesirable policy of borrowing to fund recurrent spending.

However, this is easier said than done given the desire within the Government to control inflation and to maintain output and employment in vital export sectors while subsidising both exports and food prices by financial support for the railways.

Republic of Zimbabwe, MEWRD, National Master Plan for Rural Water Supply and Sanitation: Volume 6, Management, Draft Copy, Interconsult A/S, NORAD, Harare 1985.

## 1.3 INSTITUTIONS INVOLVED IN WATER AND SANITATION DEVELOPMENT

Although the Ministry of Energy and Water Resources and Development is charged with responsibility for the 'formulation and administration of government policy on the development of water resources in Zimbabwe' and is the body responsible for the development of all water resources, there are in practice a number of agencies engaged in the development and provision of public water supplies. These include the following:

(i) Ministry of Energy and Water Resources and Development
(ii) Ministry of Health
(iii) Ministry of Local Government and Town Planning, and the District District Development Fund (DDF)
(iv) Ministry of Lands, Resettlement and Rural Development
(v) Ministry of Construction and Housing
(vi) Ministry of Agriculture
(vii) Local Authorities (eg Municiaplities, Town Councils, Rural Councils)
(viii) Private Organizations (eg Commercial Farmers, Mining and Industrial Companies)
(ix) A number of aid agencies, both official and private.

The vital coordinating role of the Ministry of Finance, Economic Planning and Development (MFEPD) must of course not be overlooked. This Ministry not only approves the funds for all Ministries' recurrent and capital expenditure - it also negotiates all aid projects and distributes donor finance.

MFEPD is responsible for compiling all national development plans and for coordinating the functions of the various Ministries in terms of development programmes. It thus plays an important role in ensuring that the Ministries involved do not duplicate programmes and also in channeling donor aid to the correct Ministry for the project concerned. Each Ministry submits its annual estimates and development programmes for consideration by MFEPD, which assesses these both in

the light of overall Government finance and donor assistance likely to be "available", as well as in accordance with Government priorities.

Hitherto MFEPD has operated only at National level but it is now the intention to appoint Economic Planning Officers in each of the eight Provencial Teams in preparing their development plans.

MFEPD is also reponsible for the Central Statistical Office (CSO) which compiles and publishes data on all aspects of the country's economic and social functioning. The CSO is available to assist other Ministries in developing surveys and questionnaires and in collating the results. Whenever necessary the CSO hires and trains enumerators to work in the field although the Office itself is established only at National level. As part of the National Census and subsequent sample household surveys, the CSO has collected information related to water supplies and sanitation.

Republic of Zimbabwe, MEWRD, National Master Plan for Rural Water Supply and Sanitation: Volume 6, Management, Draft Copy, Interconsult A/S, NORAD, Harare 1985.

## 2.0 ORGANISATION AND STRUCTURE OF MAIN AGENCIES

### 2.1 General

As is to be expected in a new Government with a development philosophy, the internal organisation of Ministries is continually changing and expanding and in consequence up to date composite organisational charts are not readily available. However, Ministries and Departments have explained their organisation's present structures but have emphasised that further changes are planned. (Some of these changes may well have been introduced before this Report is published).

### 2.2 Ministry of Energy and Water Resources and Development

#### 2.2.1 Head Office

The present organization of the water side of MEWRD head office is shown in Fig. 2-1.

The Ministry is headed by a Permanent Secretary who is a civil engineer and on the water side there are two Deputy Secretaries who are also civil engineers. These are known as the Deputy Secretary and the Deputy Secretary (Operations).

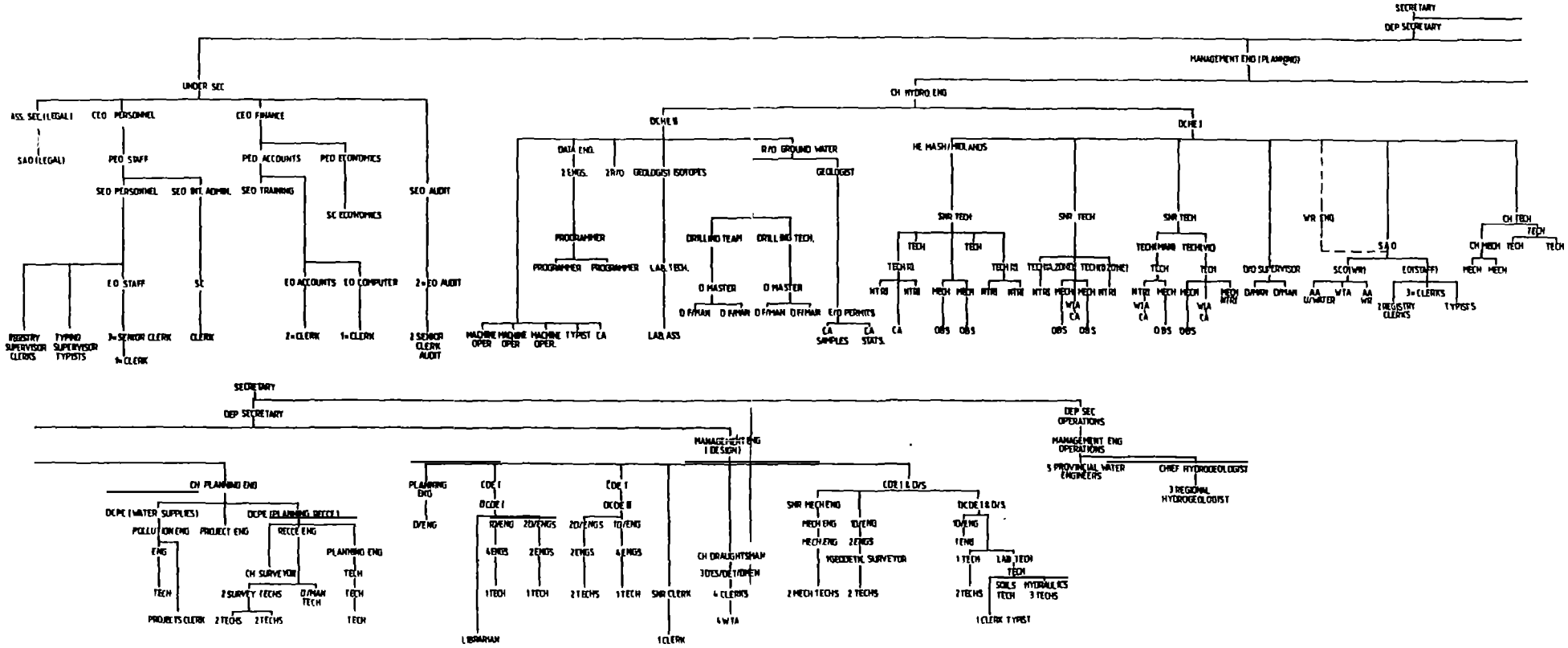
The Deputy Secretary has working to him the Under Secretary and two Management Engineers whose functions are as follows:

The Under Secretary is the Ministry's top administrative officer and is responsible for Administration and Finance with Chief Ecexutive Officers (CEO) in charge of each. Administration, as its name implies is responsible for general administration, personnel and establishment, procurement, registry and typing services, while Finance handles the Ministry's finances including operating the Working account, preparing estimates, internal audit and computer services. While the Deputy Secretary and even the Permanent Secretary may often be involved, the Under Secretary and his CEO's would usually be the Ministry's

FIGURE 2-1

MINISTRY OF ENERGY AND WATER RESOURCES DEVELOPMENT

ORGANISATION STRUCTURE OF MEWRD HEAD OFFICE



principal representative in dealings with the Treasury (part of FEPD) in respect of finance and estimates and the Public Service Commission in regard to establishment and personnel. Apart from his staff at Head Office, the Under Secretary has both administrative and financial staff at each Provincial Water Engineer's Office, who although responsible functionally to him are under the line control of the Provincial Water Engineer (PWE).

Also reporting to the Deputy Secretary is the Management Engineer (Planning) who is responsible for both Hydrology (which includes hydro-geology) and Planning. The Planning Branch is primarily though not solely, concerned with the development and use of the surface water resources of the eight major river systems into which the country has been divided for water resource planning purposes. The Branch also coordinates and controls planning for the provision, operation and expansion of domestic water supplies for Government and Government controlled institutions and small townships. It is also responsible for general administration of the Water Act in relation to the Minister's Water Rights, with particular reference to Pollution Control.

Finally, the Deputy Secretary also controls the Management Engineer (Design) who is responsible for designing all the Ministry's major projects, unless these are commissioned out, and for the design of all projects which the PWEs may be unable to undertake. There are three Chief Design Engineers, two of whom head Design Teams while the third is responsible for Investigations and Dam Safety and whose staff includes Mechanical Engineers and Technicians in addition to the Civil Engineers and Technicians to be found in all the professional branches of the Ministry.

Until 1981, the Deputy Secretary was also directly responsible for the PWEs. In that year however, an Operations Branch was created at Head Office consisting of a Management Engineer (Operations) who became responsible, under the Deputy Secretary, for the general supervison and coordination of all work carried out by the PWEs. With increasing emphasis on rural development, Operations also became responsible for general planning in this regard and in particular for the construction, negotiation and supervision of donor funded projects. Following the establishment of the National Action Committee (NAC) this responsibil-

ity also fell on Opartions which services NAC and provides it secretariat. No supporting establishment was created for the Operations Branch at Head Office but a number of posts were borrowed from other Branches in the Ministry. Subsequently, the post of Management Engineer (Operations) was upgraded to Deputy Secretary (Operations), thus making this officer directly responsible to the Permanent Secretary. The post of Management Engineer (Operations) then fell away while all other posts continued to be on loan. However in mid 1984 a new post of Management Engineer (Operations) was approved by the Public Service Commission, it having been found that the Permanent Secretary himself was able to give less time to the water side of the Ministry, and in particular to the Operations Branch, owing to his involvement with Energy.

It must be strongly emphasised that the description given above, as well as the organization chart, describe the authorised establishment. Throughout the Ministry, including the PWE establishments, over half the professional and technical posts are vacant. This of course is a major constraint in keeping the organizational structure intact and may many posts have to be combined in different parts of the structure at different times, and officers must undertake duties which properly belong to posts above, below and alongside them.

2.2.2 Provincial Offices

There are five Provincial Water Engineers (PWE) covering Mashonaland, Matabeleland, Midlands, Manicaland and Masvingo. Their duties are:

(1) Investigation, design and implementation of
   (a) Government conservation works within agreed levels of responsibility
   (b) Government irrigation schemes (to field edge)
   (c) Government water supplies
   (d) Water supplies for rural development and use in communal lands.

   Note If the PWE is unable to undertake a project for any reason then it is referred to the Design Branch at Head Office.

(2) Operation and maintenance of
   (a) Government conservation works
   (b) Government irrigation schemes
   (c) Rural village piped water supplies

(d) Government water supply stations.

(3) Geophysical surveys

(4) Drilling for ground water

(5) Water pollution control

(6) Reports to Water Court

(7) Engineering advisory and consulting services to

(a) other Government Ministries,

(b) parastatals in respect of water resources development and utilisation, and consequent involvement in design and construction of the requisite works, except major works, on an agreed division of responsibility,

(c) donor agencies.

(8) Provision on request, where possible, of engineering advisory and consulting services to local authorities, mines, farmers and other private sector bodies, including design and construction of works for evelopment of water supplies from both surface and underground sources in certain institutions.

(9) Maintenance of stores and workshop organisations in order to fulfil the relevant tasks enumerated above.

Each PWE office is headed by a senior Provincial Water Engineer who is assisted by a Deputy PWE, civil engineers, technicians, a geophysical officer, fitters and administrative and clerical staff. The establishment for Mahonaland and Matabeleland are identical in all but one respect and are somewhat larger than the other three. An organization chart for these two offices is given in Fig. 2-2.

The establishments for Manicaland, Masvingo and Midlands are again very similar and an organization chart for these three provinces is provided in Fig. 2-3.

Apart from the wide range of specialised equipmetn held by the PWEs and professional sections of the Ministry, each PWE has a number of drilling rigs at his disposal under the control of a drilling superintendent, some of which are owned by the Ministry and some by contractors working for the Ministry. Government drills in the charge of Drill Superintendents are in Mashonaland, Matabeleland and Midlands only. The Ministry's main workshop is in Harare attached to the PWE Mashonaland, and controlled by a Mechanical Engineer.

The detailed provincial structure recently announced by Government provides for eight provinces with Mashonaland consisting of Mashonaland East, Mashonaland Central and Mashonaland West, and Matabeleland of Matabeleland North and Matabeleland South, MEWRD has now been instructed to redistribute its establishments so as to comply with this provincial organization.

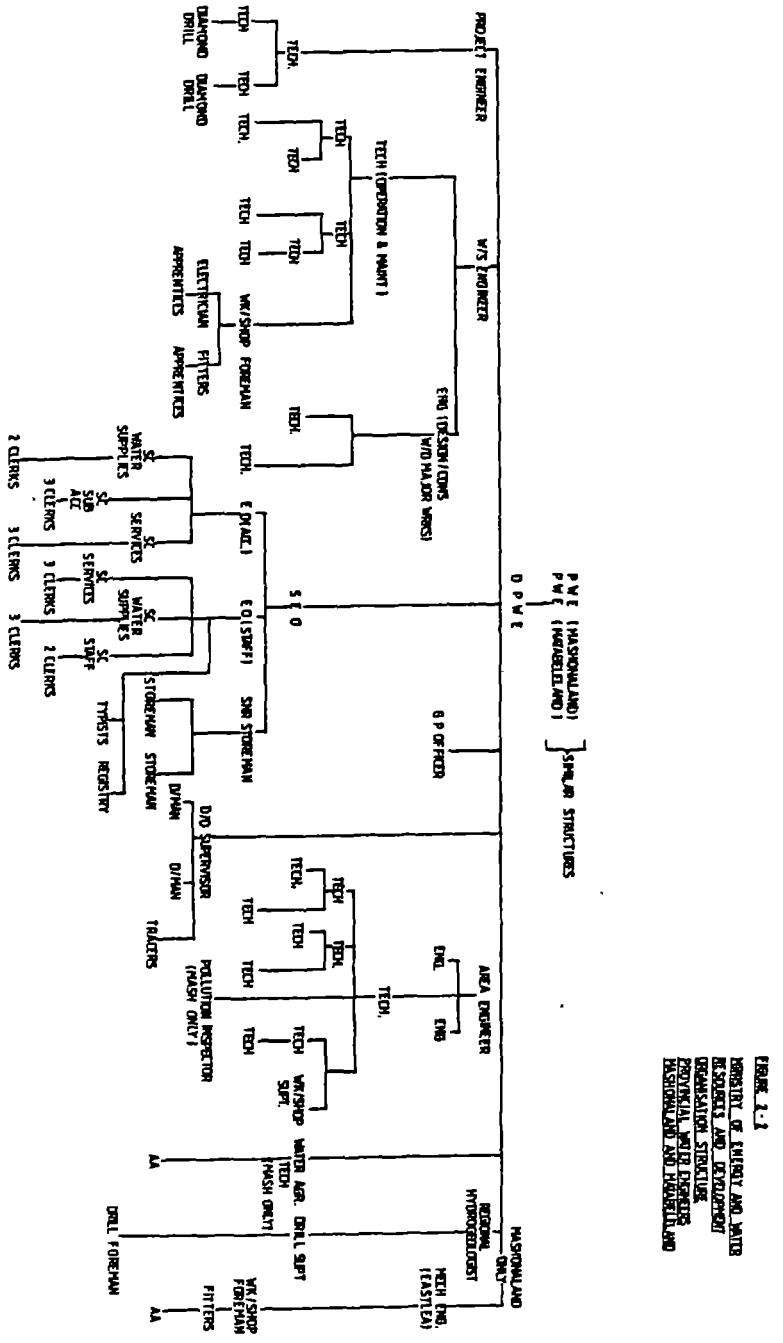



FIGURE 1.1
MINISTRY OF ENERGY AND WATER RESOURCES AND DEVELOPMENT
ORGANISATION STRUCTURE
PROVINCIAL WATER ENGINEERS
MASHONALAND AND MATABELELAND

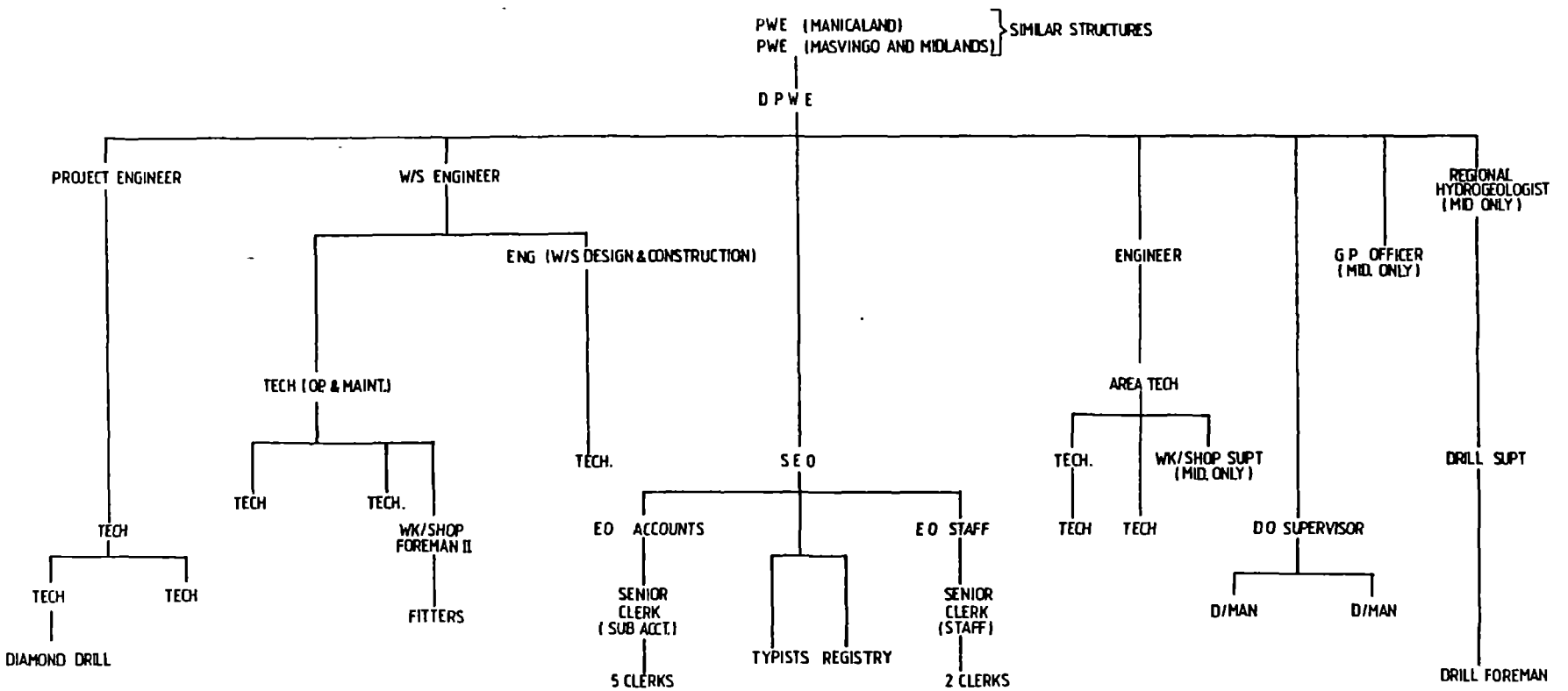
FIGURE 2-3

MINISTRY OF ENERGY AND WATER RESOURCES AND DEVELOPMENT

ORGANISATION STRUCTURE

PROVINCIAL WATER ENGINEERS

MANICALAND, MASVINGO AND MIDLANDS



Source: INTERCONSULT A/S.

# THE INTERCONSULT GROUP

## Introduction

Interconsult A/S is a Norwegian-based private company. As an independent consultant, Interconsult has no commercial, manufacturing, supplying or contracting interests. The statutes of the firm comply with the requirements of the International Federation of Consulting Engineers (FIDIC).

The firm was founded in 1977 as a amalgamation of well-known Norwegian consultants, and the Interconsult Group includes some of the oldest and most experienced engineering firms in Norway.

Interconsult offers an integrated range of planning, engineering and management services to governments, local authorities as well as various agencies and institutions. The Group is structured so that multi-disciplined teams can be composed from the relevant divisions to suit the particular requirements of a project. Our staff is also supported by advanced computing facilities, automatic drafting and cartography machines, modern laboratories etc. Ten of our engineers are also highly qualified divers.

The Group has served clients in forty different countries in Africa, America, Asia and Europe. Thus our international experience should meet the requirements of local conditions in most parts of the world. However, as we are a Norwegian-based company with our headquarters in Norway, the majority of our projects are within Norway. As is well-known, Norway is faced with extreme climatical and topographical conditions. Further, another characteristic of Norway is an infrastructure varying from the advanced industrial areas in South East Norway to the sparsely populated rural areas and isolated fishing villages in parts of Western and Northern Norway. Apart from international challenges, our planners and engineers are thus also regularly faced with projects at home which requiring a greater variety of experience and skills than perhaps in any other country.

MINUTES OF MEETING HELD AT INTERCONSULT OFFICES ON TUESDAY 11th SEPTEMBER 1984 AT 1430

| | | |
|---|---|---|
| PRESENT | Mr L Carlson | - D D F |
| | Mr F Carlsen | - Project Coordinator - MEWRD |
| | Mr P Spone | - Interconsult |
| | Mr G L Hubert | - Interconsult |
| | Mr I Clifford | - Interconsult |
| | Mr D Zuliani | - Interconsult |
| | Mr P Cross | - Interconsult |

The meeting was called to discuss and finalize the list of sites that would be considered for the provision of a borehole as part of the Crash Programme.

The list agreed in the meeting superceded:

a) the original list prepared and included with the Tender Documents, and

b) the modified list of 500 sites prepared by Interconsult on the basis of the original requests submitted by the District Administrators.

Mr Carlsen had previously handed over the final request for boreholes submitted by the District Administrators in Mashonaland. The final total of requests amounted to 727. Of these only 500 could be considered, thus allowing an excess of 20% over the planned 400 boreholes to be drilled.

A) To reduce the list to 500, it was agreed that :

1. no boreholes would be drilled in certain areas, as follows :
   - In the Zambezi Valley (Guruve, Centenary, and Mount Darwin Districts),
   - In Omay in the Kariba District,
   - In isolated communal areas where the request for boreholes was less than 10.

2. Requests for boreholes were reduced considerably where a large number had been requested compared to the original lists submitted by the District Administrators.

3. Mr Carlson produced a list of boreholes recently drilled by the DDF. This list was checked against the requests and 7 boreholes already drilled deleted.

4. Requests for boreholes where no Grid Reference was given were deleted.

The final list of 500 requests was agreed, as shown on the requests from the District Administrators attached to these minutes. These show which have been accepted and which rejected. Also attached is a schedule giving the maximum number for each communal land. The distribution of the sites per area is given on the attached map.

B) Mr Carlson stated that the DDF had funds for the drilling of 87 boreholes in Mashonaland. These would most probably be drilled in those communal lands excluded from the Crash Programme. If the DDF intended to drill in the same areas as the Crash Programme Mr Carlson undertook to advise Interconsult to avoid any duplication.

C) The agreed procedure for selecting which of the boreholes to be considered was actually drilled is as follows :

- It is assumed that the first locality given on the lists provided by the District Administrators is the priority.
- Boreholes will be drilled in 80% of the localities shown on on the lists as accepted, commencing at the priority borehole and working down the list.
- Once boreholes have been sited and drilled in the first 80% of the list, no further localities will be considered in that communal area.

D) Mr Carlson stated that the DDF would inform the District Administrators which of their requests had been accepted for consideration. The District Administrator would also be told that 80% of the requests accepted would be drilled.

E) It was agreed that the project would commence in Ngezi and Mhondoro areas. Mr Hubert confirmed that the air photography for these areas had already been purchased and siting work had begun.

F) Mr Carlson confirmed that it was the usual practice of the DDF to site boreholes within 1000 m of the locality where the borehole was required. If no site could be found within 2 km then the locality was abandoned. It was agreed that the Engineers would follow these guidelines.

Zimbabwe Government, CONTRACT No. 33/84,
BOREHOLE PROGRAMME - MASHONALAND.

GOVERNMENT OF ZIMBABWE

MINISTRY OF ENERGY AND WATER RESOURCES AND DEVELOPMENT

FORM OF TENDER

(note: The Appendix and Annexure A form part of the Tender)

Tender No. DED 33/84

Borehole Programme - Mashonaland

The Secretary,
Ministry of Energy and Water Resources and Development,
Private Bag 7712,
Causeway,
Harare

Dear Sir,

Having examined the Conditions of Contract and Specifications for the above Contract we offer to provide the services as shown in the Schedule of Charges attached hereto in conformity with the Conditions of Contract and Specifications, save as amended by the modifications set out in Annexure A attached hereto.

We undertake to complete the whole of the Works comprised in the Contract within the time stated in the Appendix hereto.

If our Tender is accepted, we will, when required and within the time stipulated, provide two good and sufficient Sureties or obtain the guarantee of a Bank or Insurance or other Registered Company (to be approved in either case by you) to be jointly and severally bound with us in the sum of two hundred thousand Zimbabwe dollars for the due performance of the Contract under the terms of a Deed of Suretyship

9/....

in the form annexed to the General Conditions of Contract. The Surety or Sureties we propose are :

BARCLAYS BANK (BOTSWANA) PTY LTD

MALL BRANCH P O BOX 41

GABORONE Botswana

We wish/do not wish* to exercise the option of providing a Surety or Guarantee in lieu of Retention Money in terms of Clause 62 (3). Unless and until a formal Agreement is prepared and executed, this Tender, together with the written acceptance thereof by yourselves or the Engineer acting on your behalf shall constitute a binding contract between us.

We understand that you are not bound to accept the lowest or any tender you may receive.

Appendix

| | Clause | |
|---|---|---|
| Amount of Deed of Suretyship.... | 10 | Z$ 200 000 |
| Time within which Sureties to be provided..... | 10 | Ten days |
| Duration of Deed of Suretyship. | 10 | Until issue of Final Certificate |
| Minimum Amount of Third Party Insurance..... | 23(2) | Z$ 100 000 in any one accident, the number of accidents being unlimited. |
| Time within which works are to be commenced..... | 41 | Twenty Eight days |
| Time for completion..... | 43 | Eight months |
| Amount of Penalty..... | 47 | In accordance with Clause 47 |
| Period of Maintenance..... | 49 | Three months |
| Percentage Retention..... | 62(1) | Ten per cent |
| Limit of Retention Money..... | 62(1) | Z$ 150 000 |

* Delete whichever is not applicable.

10/....

| | | |
|---|---|---|
| Time within which payment is to be made..... | 62(4) | 28 days |
| Period of Validity of Tender. | | Six weeks from date of closing |
| Number of drilling rigs to be supplied..... | | * 3 ..... air drills |
| | | * - ..... cable tool drills |

Signature J. C. FARR

Position Managing Director GEOTEST (PTY) LTD
P.O. BOX 1502 GABORONE

On behalf of and duly authorised by GEOTEST PTY LTD

Address P O Box 1502

GABORONE , Botswana

Date 8 August 1984

Witness T. M. McREIGAN

Address P O Box 1502 GABORONE

* To be completed by Tenderer.

## CONDITIONS OF CONTRACT

1.1 General Conditions

The General Conditions of Contract shall, in so far as they apply, be those published jointly by the then Rhodesian Institution of Engineers, the then Federation of Civil Engineering Contractors of Rhodesia, and then then Association of Consulting Engineers of Central Africa in the third edition of 1976, for works of Civil Engineering Construction.

The General Conditions of Contract are amended throughout as follows:-

(i) Wherever the phrase "Rhodesian Institution of Engineers" appears, substitute "Zimbabwe Institution of Engineers".

(ii) Wherever the phrase "Federation of Civil Engineering Contractors of Rhodesia" appears, substitute "Federation of Civil Engineering Contractors".

(iii) Wherever the phrase "Association of Consulting Engineers of Central Africa" appears, substitute "Zimbabwe Association of Consulting Engineers".

(iv) Wherever the word "Rhodesia" appears, substitute "Zimbabwe" and wherever the word "Rhodesian" occurs, substitute "Zimbabwean", other than as specified in (i) to (iii) above.

## SCHEDULE OF CHARGES

NOTES (i) Prices should not include customs duty, import duty or surtax.

| ITEM NO. | DESCRIPTION | UNIT | CHARGE |
|---|---|---|---|
| | Preliminary and General Items | | |
| 1.1 | Mobilization of all drilling rigs complete with associated equipment, stores, transport and personnel to Mashonaland Province, and estalishment of base camp(s). | Lump Sum. | 23580.00 |
| 1.2 | Demobilisation of all drilling rigs complete with associated equipment, stores, transport and personnel from Mashonaland Province to place of origin, and disestablishment of base camp(s). | Lump Sum. | 13250.00 |
| 1.3 | Movement of drilling rig complete with associated materials, equipment, stores and personnel to a drilling site, erection of machinery for drilling, provision of any temporary accommodation dismantling on completion ready for movement to next site, for distance of up to 20km. Include for equipment and personnel for wellhead completion and pump installations. | No. | 300.00 |
| 1.4 | Movement as 1.3 above, but where distance in excess of 20km. | Km. | 5.00 |

| ITEM NO. | DESCRIPTION | UNIT | CHARGE |
|---|---|---|---|
| 2. | Drilling and Associated Operations | | |
| | Design A | | |
| 2.1 | Drill borehole at 8 inch minimum diameter between ground level and 40 metres below ground level through any type of ground. Include for temporary casing, sampling and all routine operations. | m. | 38.00 |
| 2.1a | Ream borehole from 6 inch to 8 inch minimum diameter between ground level and 40 metres below ground level through any type of ground. | m. | 15.00 |
| 2.2 | Provide and install 6 inch steel casing between ground level and 40 metres below ground level. Include for construction of cement plug, cementing and waiting 2 hours. | m. | 48.00 |
| 2.3 | Drill 6 inch hole below 6 inch casing, including drilling out cement plug, to a maximum depth of 80 metres below ground level. Include for sampling and all routine operations. | m. | 35.00 |
| | Design B | | |
| 2.4 | Drill borehole at 6 inch minimum diameter between ground level and 40 metres below ground level through any type of ground. Include for temporary casing, sampling and all routine operations. | m. | 33.00 |

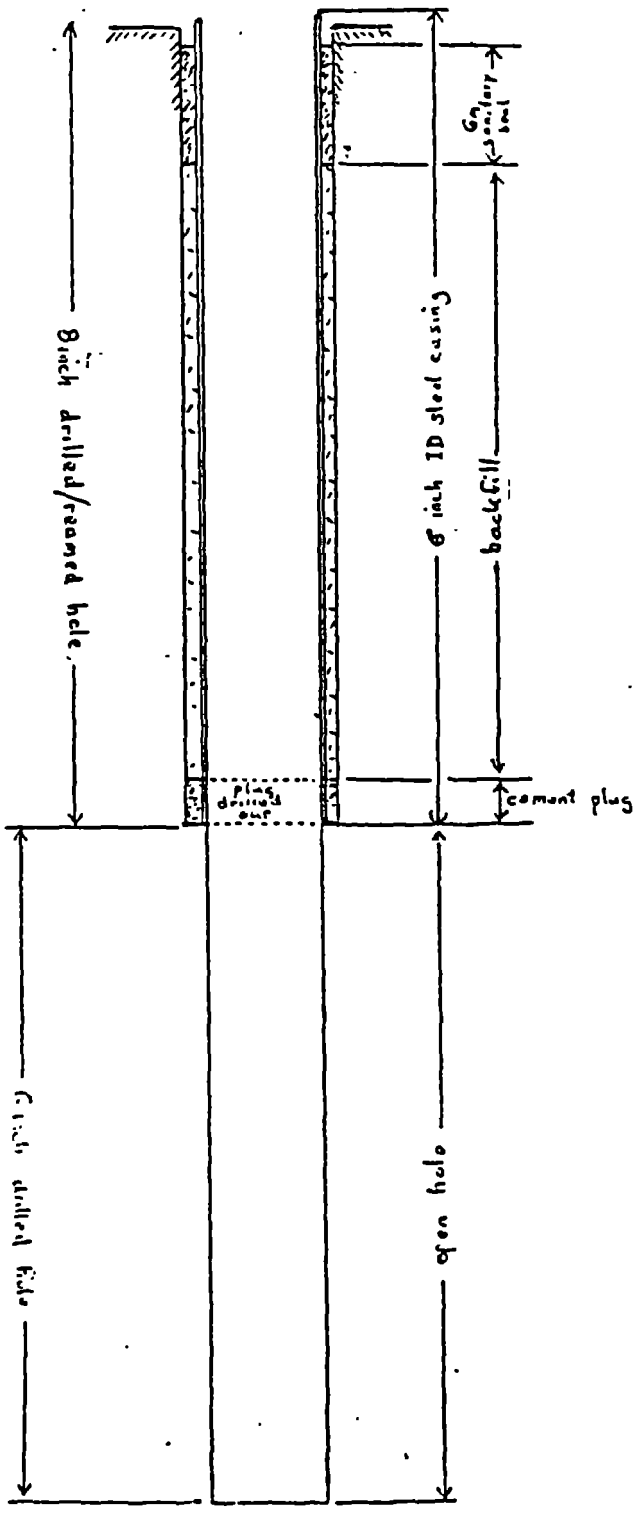
36/....

| ITEM NO. | DESCRIPTION | UNIT | CHARGE |
|---|---|---|---|
| 2.4a | Drill borehole at 6 inch minimum diameter between 40 metres below ground level and 80 metres below ground level. Include for tempoary casing, sampling and all routine operations. | m. | 35.00 |
| 2.5 | Provide and install 110mm Class 10 flush jointed PVC casing with all fittings at any depth between ground level and 40 metres below ground level. | m. | 18.00 |
| 2.5a | As above but install at any depth between 40 and 80 metres below ground level. | m. | 20.00 |
| 2.6 | Provide and install 110mm Class 10 flush jointed PVC screen with 0.6mm slots with all fittings at any depth between ground level and 40 metres below ground level. | m. | 28.00 |
| 2.6a | As above but install at any depth between 40 and 80 metres below ground level. | m. | 30.00 |
| 2.7 | Provide and install gravel pack in annular space at any depth between 7 and 40 metres below ground level. | m. | 7.00 |
| 2.8 | As above, but install at any depth between 40 and 80 metres below ground level. | m. | 9.00 |
| | <u>Design A and B</u> | | |
| 2.9 | Emplace backfill material in annular space at any depth. | m. | 4.00 |

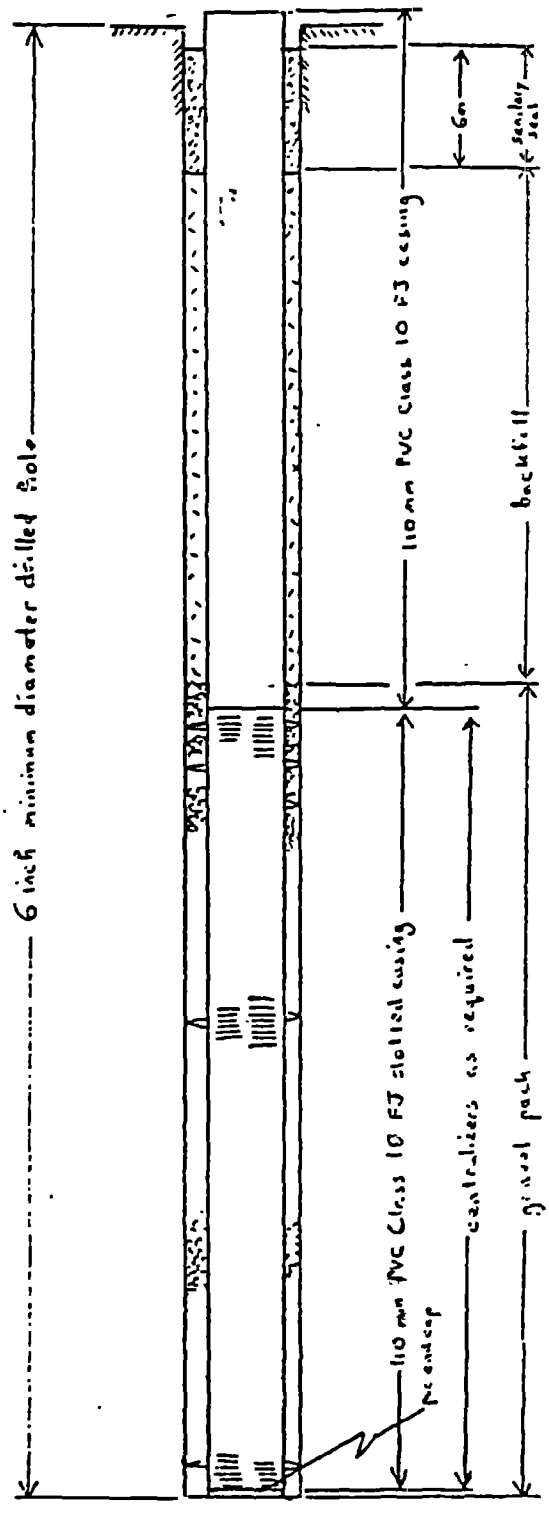
37/....

| ITEM NO. | DESCRIPTION | UNIT | CHARGE |
|---|---|---|---|
| 2.10 | Install grout sanitary seal in annulus between 1 metre and 7 metres below ground level. | No. | 25.00 |
| 2.11 | Develop borehole by any or all of following methods :<br>airlifting surging/pumping<br>mechanical surging<br>jetting<br>overpumping<br>Include for water level and discharge measurements. | hr. | 55.00 |
| 2.12 | Carry out pumping test. | hr. | 50.00 |
| 2.13 | Carry out water level recovery test. | hr. | 25.00 |
| 2.14 | Construct wellhead apron, drain, cattle trough and soakaway. | No. | 487.00 |
| 2.15 | Collect and Install Bush Pump. Include for 6 inch casing for pump mounting. | No. | 98.00 |
| 2.16 | Carry out any other operations using drilling rig, under direction by the Engineer or his Representative. | hr. | 100.00 |

BOREHOLE DESIGN A




BOREHOLE DESIGN B



TH-60 CYCLONE TOP-HEAD DRIVE WATER WELL DRILL

Source: INGERSOLL-RAND.

# It speeds up the job right from the word "Go"!

The less time you spend on the road, the more time you've got for drilling. And the less it costs you to get there and back, the more profit you'll make from your rig.

**Single-engine design speeds you on your way.** With the TH-60, the truck engine is the only one you need. Here's what this arrangement does for you.

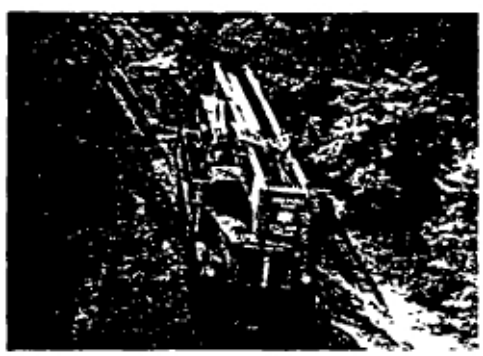
**1. More highway horsepower.** Some rigs have a hard time keeping up with a minimum highway speed. The TH-60 will make any speed the law allows under most highway conditions. Its 350 or 430-hp diesel has ample power to take you up steep grades and over rough off-road terrain, too.

**2. Less fuel consumption,** because single-engine design means a big saving in total rig weight.

**3. Better stability.** With the engine mounted low and less weight on the deck, you've got a lower center of gravity for greater sidehill stability.

**4. Lower noise.** The truck engine is up front, away from the drilling position and under the hood.

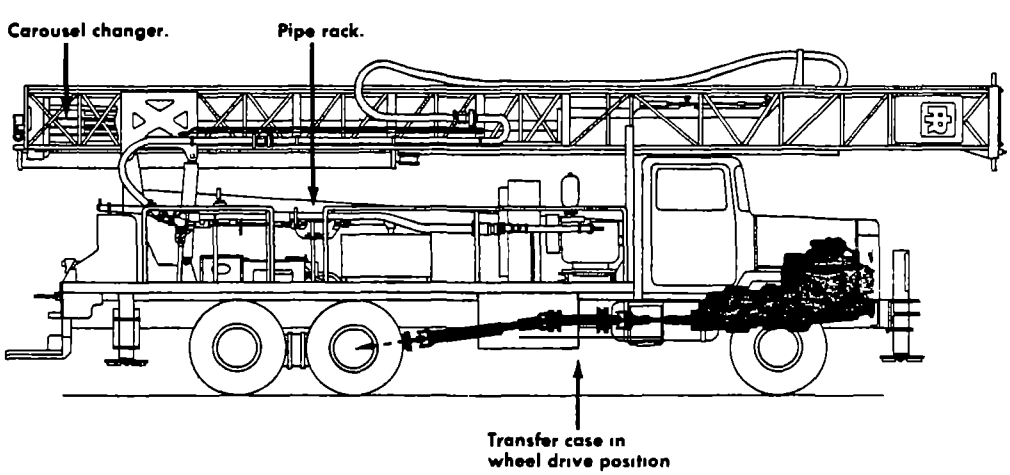
**5. Cleaner engine.** The farther the engine and filters are from the hole, the



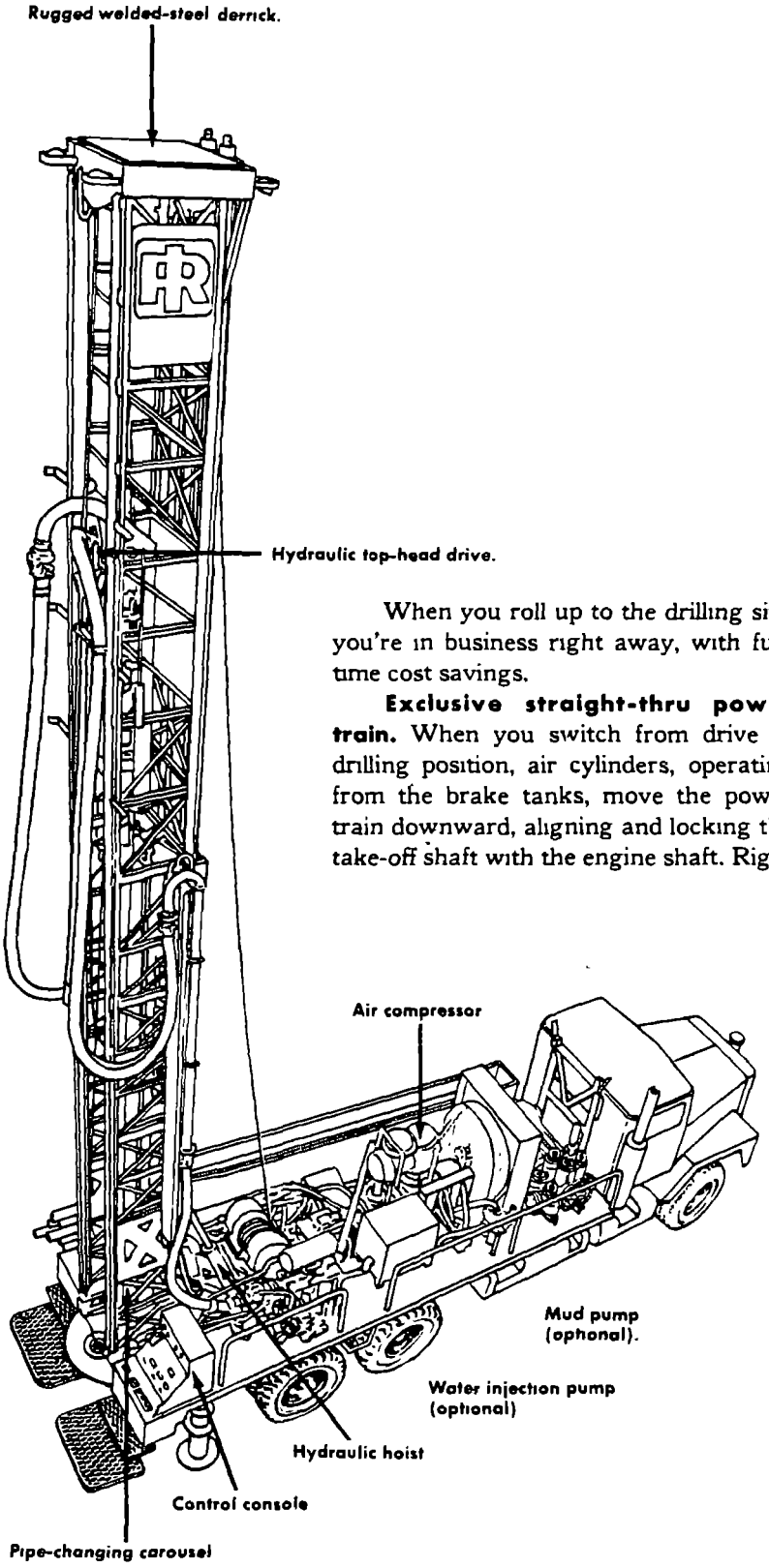
cleaner it will run. And our two-stage intake air cleaners with condition indicator help keep your engine breathing easy for top performance and economy.

**6. More deck space.** The TH-60 gives you plenty of deck room for drilling equipment including hoists, air compressor, mud pumps, water injection pumps or other auxiliaries.

**Generous pipe capacity.** With up to 400 ft. (120 m) of drill pipe on the rig including 7 or 9 lengths in the carousel changer, you can head for the job with enough pipe for most wells.




INGERSOLL-RAND




When you roll up to the drilling site, you're in business right away, with full-time cost savings.

**Exclusive straight-thru power train.** When you switch from drive to drilling position, air cylinders, operating from the brake tanks, move the power train downward, aligning and locking the take-off shaft with the engine shaft. Right

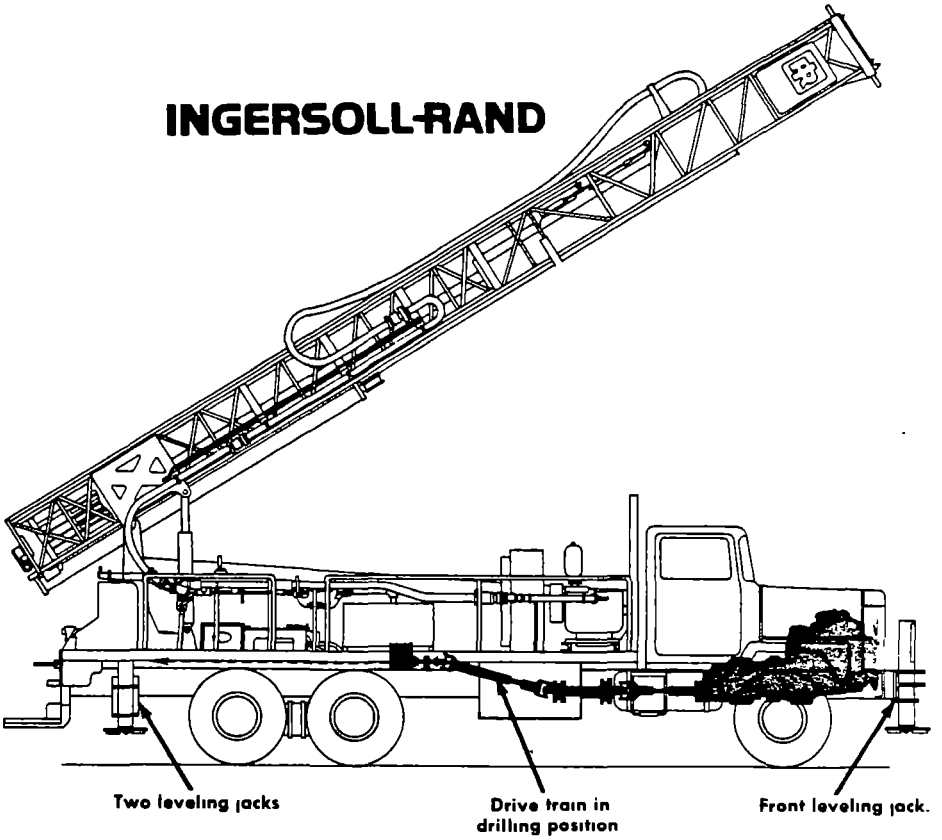
away all drilling systems are "go". Engine power is now being transmitted directly to the air compressor, gear case and hydraulic pumps. You get full horsepower for all drilling functions and save fuel whenever the rig is running.

**Three powerful hydraulic jacks** level the rig at the touch of the controls on the console. The jacks have hydraulic lock check valves that prevent creeping and eliminate the need for constant watching and adjustments.

**Raising the derrick** is done smoothly and rapidly by two hydraulic cylinders. It is held in drilling position by two large hold-down bolts at its base.

**Drillers' platforms,** of non-skid open steel mesh construction keep you up out of the mud or sand. Operating controls are always at the right height, no matter how much you have to raise the rig for leveling And the platform design lets us give you foot-pedal control for engine throttle, top breakout wrench and tophead retract latches.

That's all there is to it. And now you're ready to start drilling.



Zimbabwe Government, CONTRACT No. 33/84,
BOREHOLE PROGRAMME - MASHONALAND.
Letter from Geotest Ltd.

EQUIPMENT

The Contractor would propose to utilize the following major items of plant and equipment on the contract.

3 x Ingersoll Rand TH60 mobile air rigs. Each equipped with 250 psi 600 cfm air compressor, foam injection pump, 100 metres 4½ inch drill pipe, IR DHD 360 downhole hammers and all ancillary equipment. Each rig will carry one complete set of airlift testing and development equipment and will also be equipped with radio communications. Auxillary mud pumps are available if required.

3 x 5 ton Support Trucks (Bedford)
Each to be used to supply the drilling rigs with fuel, casing, cement, gravel etc.

5 x Light Support Vehicles (Landrover)
One each to accompany each rig plus one to be available for the Drilling Supervisor and one for the Camp Manager/ Mechanic. The latter two vehicles to be equipped with radio communications.

1 x 20 ton Mobile Camp/Workshop Truck
(Articulated 6 x6 Magirus Deutz). To be used as a mobile base to carry all spares, tools, workshop plant plus additional drill pipe, hammers etc. The Mobile Camp will be equipped with radio communications.

1 x 6000 litres Fuel Bowser Trailer.
To be used to deliver and store diesel at the mobile camp.

Republic of Zimbabwe, MEWRD, National Master Plan for Rural Water Supply and Sanitation: Volume 6, Management, Draft Copy, Interconsult A/S, NORAD, Harare 1985.

## 2.3 MINISTRY OF LOCAL GOVERNMENT AND TOWN PLANNING

### 2.3.1 Ministry

The Ministry of Local Government and Town Planning is not responsible for Government's entire provincial and district development structure, but it is convenient to deal with this at this point because at official level it is the Ministry's eight Provincial and fifty five District Administrators who chair the Provincial and District Development Committees.

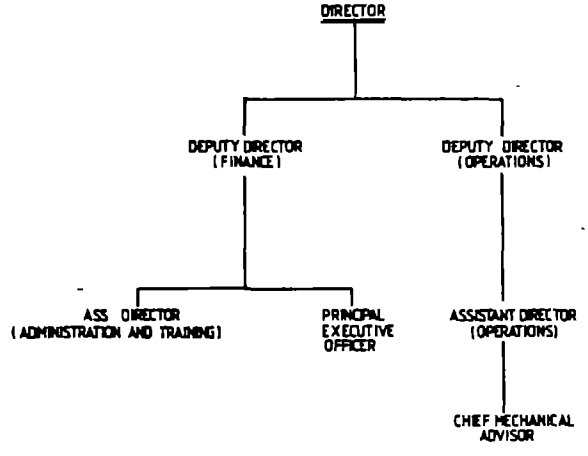
Government recently announced its plans for local administration and development planning and appointed eight Provincial Governors at Minister level who are responsible to the Prime Minister through the Minister of State (Political Affairs and Provincial Development Coordination) in the Prime Minister's office. Each Governor will coordinate ministry programmes and projects in their provinces but of course officials will continue to be responsible to their own Ministers in relation to the functions of those Ministries. The main purpose of the overall plan is to involve the local communities themselves much more effectively in the process of planning and effecting their own development and to bring about much closer coordination between Ministries at local level in order to achieve a more efficient use of ministerial and local inputs in the accomplishment of objectives.

In addition to the Provincial and District Administrators referred to in the above Committee structure, the Ministry also has a number of Local Government Promotion Officers stationed in Districts, but operating at ward and village level, who will be mainly responsible for encouraging the people to establish this local structure and who work with other Ministries in community development activities and encouraging community self-reliance.

## 2.3.2 District Development Fund (DDF)

The DDF does not have an establishment approved by the Public Service Commission since it determines its own staff requirements and recruits directly. The Director and his senior staff are civil servants, however, and in effect these officers constitute a "unit" within the Head Office of the Ministry of Local Government and Town Planning and are responsible to the Permanent Secretary of the Ministry. The "Unit" within the Ministry is headed by a Director and is organised as per Fig. 2-4.

FIGURE 2-4 ORGANISATIONAL STRUCTURE OF THE DISTRICT DEVELOPMENT FUND HEADQUARTERS

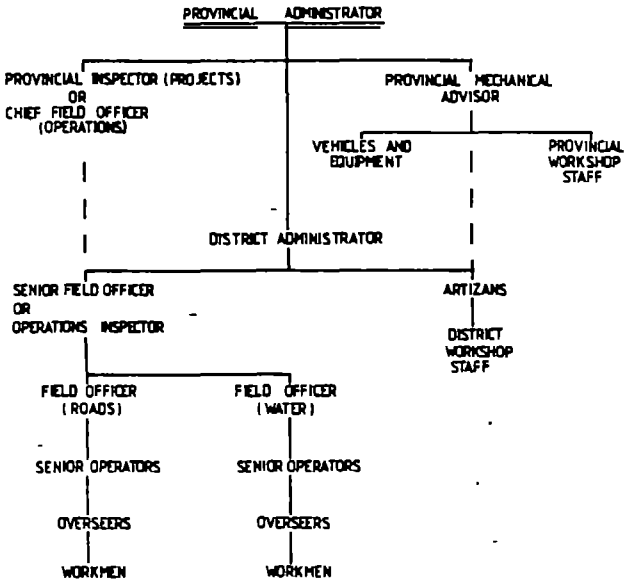



This Head Office establishment does not deal with directly, nor control, the DDF staff at Provincial and District level who are specifically under the control of the District Administrator and through him of the Provincial Administrator (formerly Under Secretary (Development)) who is directly responsible to the Head Office of the Ministry of Local Government and Town Planning.

Since staff can be recruited, trained and promoted as required and when available, there is no rigid organisational structure, and considerable variation between districts. However, the establishment of the DDF provides for a DDF team in every district with a workshop at the base camp. The team should be headed by a technically qualified Senior Field Officer (Operations Inspector) to check and advise on all work in the district which is carried out by DDF trained workers consisting of a Field Officer (Roads) and a Field Officer (Water), Senior Overseers, Operators, Overseers and Workmen.

The district workshop is run by a mechanic (called an artisan), with all major repairs going to the Provincial Workshop which is under the charge of a qualified Provincial Mechanical Adviser who is also responsible for the distribution of all vehicles and equipment. At Provincial level there should be a qualified Provincial Inspector (Projects) or Chief Field Officer (Operations), as well as a Provincial Accounts Clerk. This organisation is set out in chart form at Fig. 2-5.

FIGURE 2-5 DDF PROVINCIAL AND DISTRICT ORGANISATIONAL STRUCTURE



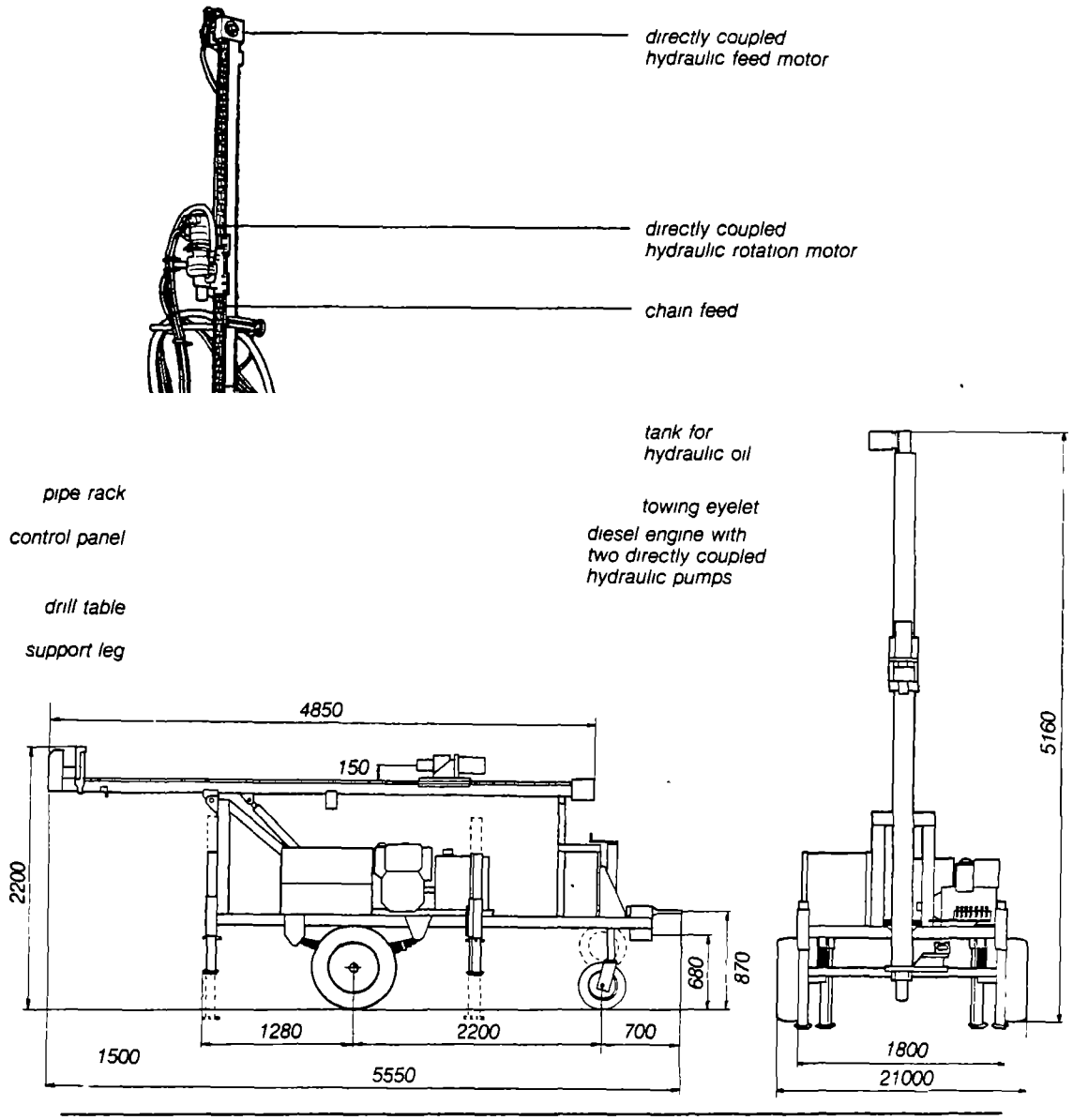

DDF is well supplied with transport and road building equipment and also has a number of dam scoops with which it constructs its own dams obtaining technical advice from MEWRD. The DDF also builds weirs, obtaining advice on sites from Agritex. Although DDF has normally supplied funds to MEWRD for drilling boreholes it has recently obtained drilling rigs itself through an aid donor. It has sought to obtain more and has recently completed the training of its own geophysical staff. DDF usually has the equipment and trained personnel to effect repairs to hand pumps, although this is not the case everywhere, and its funds are insufficient to undertake a regular maintenance programme.

In general, DDF is the only Government organisation with a country-wide network of workshops and trained operators at District level. It also has excellent communications through its radio and aircraft sections and road transport.

THE LIGHT WEIGHT DRILLING RIG

Model: LWD 200.

Source: WELLDRILL SYSTEMS AB.




TECHNICAL DATA

| | | | |
|---|---|---|---|
| Hole diameter | Rock 4 1/8"—4 1/2" (105—115 mm)<br>Overburden 6" (150 mm) | Mast | Torque 200 kpm<br>Lifting force 2500 kp<br>Feed force 600 kp<br>Feed/Hoist speed 0 3 m/s |
| Power unit | Diesel engine 7 4 kW (10 HP)<br>Hydraulic system 40 l/min, 175 bar<br>Rotation 12—40 rpm | Pneumatic system for DTH | 7—12 bar |
| | | Drilling capacity | 120 m under normal conditions |
| | | Weight | 1700 kg |

**WellDrill Systems AB**

Tagenevägen 21, S-425 90 Hisings Kärra, Sweden
Telephone 46-31 57 02 60 Telex 27329 WDRILL S

IMPORT SUPPORT INVOICES

Source: SIDA-office in Harare 1985.

THE FOUR LWD 200 RIGS

| Date of invoice/ Disburse date: | Amount disbursed: | Goods: |
|---|---|---|
| /82.11 | 17 856 SEK | Consultant Per Ahlberg |
| /83.02 | 3 000 | Consultant Per Ahlberg |
| 83.01.26/83.02 | 1 995 200 | Main invoice - 3 LWD 200+accessories |
| 83.02.26/83.02 | 143 143 | Ocean freight |
| 83.02.15/83.03 | 255 000 | 1 LWD 200 already in Zimbabwe |
| 83.01.24/83.02 | 158 000 | Provision of drilling supervisors for drilling programme during 9 weeks |
| 83.02.10/83.03 | 70 000 | Increased training programme 5 weeks |
| 83.02.25/83.03 | 675 000 | Sullair Compressors - 3 pcs |
| 83.02.25/83.03 | 75 000 | Spare part sets to compressors |
| 83.02.28/83.03 | 60 645 | Ocean freight |
| 83.03.02/83.04 | 2 700 | Drilling shoes for Odex drilling (10pcs) |
| 83.05.09/83.05 | 225 000 | 1 Compressor already in Zimbabwe |
| 83.05.25/83.06 | 25 000 | Spare part sets to compressor |

THE REPLACEMENT RIG

| | | |
|---|---|---|
| 84.02.22/84.03 | 1 088 500 | 1 LWD 200 inclusive freight. |

```
FILE      MODEL     MANAGE    12/11/85  43:45 18.7
1 *MANAGEMENT CONTRACT
2 *
3 *      NET PRESENT VALUE CALCULATION AND ANALYSES USING
4 *                  MONTE CARLO SIMULATION
5 *
6 *DATE OF FIRST INVOICE: 83.06.30
7 *CALCULATION IN ZIMBABWE DOLLAR
8 *
9 COLUMNS YEAR 0,YEAR 1, YEAR 2, YEAR 3, YEAR 4, YEAR 5
10 *
11 TAX RATE=0.50
12 INTEREST RATE= 0.13
13 INFLATION RATE=0.20
14 *PRICE TREND ON INVESTMENTS:
15 RATE=0.10
16 *
17 INITIAL INVESTMENT=1895830,0
18 *==================
19 INIT INV FREIGHT=TRIRAND(94790,151670,189580),0
20 I I FR AFTER TAX=(1-TAX RATE)*L19,0
21 *
22 ADDITIONAL INVESTMENT=0,492560,0
23 *====================
24 AD INV FREIGHT=0,TRIRAND(16920,27080,33850),0
25 A I FR AFTER TAX=0,(1-TAX RATE)*L24,0
26 *
27 *INITIAL EXPENDITURES:
28 *=====================
29 RENTAL OF BUILDINGS=TRIRAND(100000,200000,300000),0
30 RENTAL AFTER TAX=(1-TAX RATE)*L29
31 *
32 STARTING UP SALARIES=0,TRIRAND(425330,453330,445330),0
33 START AFTER TAX=(1-TAX RATE)*L32
34 *
35 *SUPPLEMENTARY INVESTMENTS:
36 *==========================
37 THREE YEAR DRILL TOOLS=0 FOR 3,(1+RATE)*(1+RATE)*(1+RATE)*305500,0
38 THR Y DR T FREIGHT=0 FOR 3,TRIRAND(0.05*L37,0.08*L37,0.10*L37),0
39 THR T FR AFTER TAX=(1-TAX RATE)*L38
40 *
41 TWO YEAR DRILLING TOOLS=0 FOR 2,(1+RATE)*(1+RATE)*354330,0,'
42                          (1+RATE)*(1+RATE)*(1+RATE)*(1+RATE)*354330,0
43 TWO Y DR T FREIGHT=0 FOR 2,TRIRAND(0.05*L41,0.08*L41,0.10*L41),0,'
44                              TRIRAND(0.05*L41,0.08*L41,0.10*L41),0
45 TWO T FR AFTER TAX=(1-TAX RATE)*L43
46 *
47 SPARE PARTS=0,75000*(1+RATE),PREVIOUS*(1+RATE) FOR 3,0
48 SP P FREIGHT=0,TRIRAND(0.05*L47,0.08*L47,0.10*L47),'
49                 TRIRAND(0.05*L47,0.08*L47,0.10*L47),'
50                 TRIRAND(0.05*L47,0.08*L47,0.10*L47),'
51                 TRIRAND(0.05*L47,0.08*L47,0.10*L47),0
51.5 SP P FR AFTER TAX=(1-TAX RATE)*L48
52 *
53 *OTHER EXPENDITURES:
54 *==================
55 YEARLY COST=0,TRIRAND(1460530,1560530,1860530),PREVIOUS*'
56             (1+INFLATION RATE)
57 YEARLY COST AFTER TAX=(1-TAX RATE)*L55
58 *
59 CASH OUT=L17+L19+L22+L24+L29+L32+L37+L38+L41+L43+L47+L48+L55
60 *--------
```

```
61 *DEPRECIATIONS:
62 *==============
63 RIG AND COMPRESSOR=0,160000
64 TAXSHIELD RIG COMP=TAX RATE*L63
64 *
65 VEHICLES=0,71000,98600
66 TAXSHIELD VEHICLES=TAX RATE*L65
67 *
68 THREE YEAR DR TOOLS=0,101830,168660,168660,68660+PREVIOUS L37/3,'
69                      PREVIOUS*1-68660
70 TAXSHIELD THREE YEAR DR T=TAX RATE*L68
71 *
72 TWO YEAR DR TOOLS=0,177170 FOR 2,PREVIOUS L41/2,PREVIOUS*1,'
73                    PREVIOUS L41/2
74 TAXSHIELD TWO YEAR DR T=TAX RATE*L72
75 *
76 SPARE PARTS=0,75000,PREVIOUS L47
77 TAXSHIELD SPARE PARTS=TAX RATE*L76
78 *
79 *SALVAGE VALUES:
80 *===============
81 INIT INVESTMENTS=0 FOR 5,(1+INFLATION RATE)*(1+INFLATION RATE)*'
82       (1+INFLATION RATE)*(1+INFLATION RATE)*(1+INFLATION RATE)*'
83       TRIRAND(0,57750,115500)
84 INIT INV AFTER TAX=(1-TAX RATE)*L81
85 *
86 REMAINING ACCESSORIES=0 FOR 5,UNIRAND(300000,600000)
87 REM ACC AFTER TAX=(1-TAX RATE)*L86
88 *
89 ADD BACK=L64+L66+L70+L74+L77+L84+L87
90 *++++++++
91 CASH FLOW=L89-L33-L57
92 *---------
93 INVESTMENTS=L17+L20+L22+L25+L30+L37+L39+L41+L45+L47+L51.5
94 *++++++++++
95 *
96 NET PRESENT VALUE=NPVC(CASH FLOW,INTEREST RATE,INVESTMENTS)
97 *=================
```

```
FILE      MODEL      CONTRA     12/09/85  54:10 54.1
1 *CONTRACTUAL LEASING
2 *
3 *      NET PRESENT VALUE CALCULATION AND ANALYSES USING
4 *                  MONTE CARLO SIMULATION
5 *
6 *DATE OF FIRST INVOICE: 82.07.06
7 *CALCULATION IN KENYA SHILLING
8 *
9 COLUMNS YEAR 0,YEAR 1, YEAR 2, YEAR 3, YEAR 4, YEAR 5
10 *
11 TAX RATE=0.50
12 INTEREST RATE= 0.104
13 INFLATION RATE=0.15
14 *PRICE TREND ON INVESTMENTS:
15 RATE=0.10
16 *
```

```
17 INITIAL INVESTMENT=1217020,0
18 *==================
19 INIT INV FREIGHT=TRIRAND(60850,97360,121700),0
19.5 I I FR AFTER TAX=(1-TAX RATE)*L19,0
20 *
21 *SUPPLEMENTARY INVESTMENTS:
22 *=========================
23 DRILLING TOOLS=0 FOR 2,433330*(1+RATE)*(1+RATE),0,433330*(1+RATE)*'
23.5              (1+RATE)*(1+RATE)*(1+RATE),0
24 DR T FREIGHT=0 FOR 2,TRIRAND(0.05*L23,0.08*L23,0.10*L23),0,'
24.2                    TRIRAND(0.05*L23,0.08*L23,0.10*L23),0
24.6 D T FR AFTER TAX=(1-TAX RATE)*L24
25 *
26 SPARE PARTS=0,(1+RATE)*105260,PREVIOUS*(1+RATE) FOR 3,0
27 SP P FREIGHT=0,TRIRAND(0.05*L26,0.08*L26,0.10*L26),'
27.1              TRIRAND(0.05*L26,0.08*L26,0.10*L26),'
27.2              TRIRAND(0.05*L26,0.08*L26,0.10*L26),'
27.3              TRIRAND(0.05*L26,0.08*L26,0.10*L26),0
27.5 S P FR AFTER TAX=(1-TAX RATE)*L27
28 *
29 *OTHER EXPENDITURES:
30 *====================
31 DRILLING COST=0,TRIRAND(1316510,1366510,1416510),TRIRAND(1088760,'
32               1138760,1188760),(1+INFLATION RATE)*TRIRAND(1014670,'
33               1214670,1414670),PREVIOUS*(1+INFLATION RATE)
34 DRILLING COST AFTER TAX=(1-TAX RATE)*L31
35 *
36 CASH OUT=L17+L19+L23+L24+L26+L27+L31
37 *--------
38 *
39 *DEPRECIATIONS:
40 *==============
41 RIG AND COMPRESSOR=0,135440
42 TAXSHIELD RIG AND COMP=TAX RATE*L41
43 *
44 DRILLING TOOLS=0,433330/2 FOR 2,PREVIOUS L23/2,PREVIOUS*1,PREVIOUS L23/2
45 TAXSHIELD DR TOOLS=TAX RATE*L44
46 *
47 SPARE PARTS=0,105260,PREVIOUS L26
48 TAXSHIELD SP PARTS=TAX RATE*L47
49 *
50 *SALVAGE VALUES:
51 *================
52 RIG AND COMPRESSOR=0 FOR 5,(1+INFLATION RATE)*(1+INFLATION RATE)*'
52.2       (1+INFLATION RATE)*(1+INFLATION RATE)*(1+INFLATION RATE)*'
52.4       TRIRAND(0,33860,67720)
53 RIG AND COMP AFTER TAX=(1+TAX RATE)*L52
54 *
55 REMAINING ACCESSORIES=0 FOR 5,UNIRAND(300000,600000)
56 REM ACC AFTER TAX=(1+TAX RATE)*L55
57 *
58 ADD BACK=L42+L45+L48+L53+L56
59 *++++++++
60 CASH FLOW=L58-L34
61 *---------
62 INVESTMENTS=L17+L19.5+L23+L24.6+L26+L27.5
63 *++++++++++
64 *
65 NET PRESENT VALUE=NPVC(CASH FLOW,INTEREST RATE,INVESTMENTS)
66 *==================
```