# EVALUATION OF LABOUR-BASED TECHNIQUE FOR CONSTRUCTION OF SMALL EARTH DAMS IN NIGERIA

***BY***

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D E C L A R A T I O N

I hereby declare that this thesis has been composed by myself and that it is a record of my own research. It has not been accepted in any previous application for a higher degree.

All quotations are indicated and sources of information are specifically acknowledged by means of references.



OWOSENI, ADEYEMI BASHIR

1994

CERTIFICATION

This thesis entitled "EVALUATION OF LABOUR-BASED TECHNIQUE FOR CONSTRUCTION OF SMALL EARTH DAMS IN NIGERIA" by OWOSENI, ADEYEMI BASHIR meets the regulations governing the award of the degree of Master of Science (Structural Engineering) of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

Dedicated to the rural Community of Africa.

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ABSTRACT

This thesis evaluates the construction of small earth dams using the labour-based/light equipment supported technique. Actual cases of dam construction at three different locations in Nigeria have been used as case studies. Data from these projects were used to simulate likely construction costs using the labour-based technique and the traditional equipment-based technique. The results were used to compare the two techniques. Construction costs, duration of construction and employment generation were used as major indices for comparison.

Two innovavite approaches of method statement and the time and location chart were used to determine inputs needed under each construction technique. The methods were found to be appropriate in ensuring consistency work planning, a quality that hitherto had been the main drawback of the labour-based technique.

Under the labour-based technique, construction costs for the projects were N279.279.00, N4,670,573.00 and M6,198,125.00 while construction duration were 25 weeks, 30 weeks and 40 weeks respectively. The corresponding cost figures for the equipment-based technique were N585,152.00, H7,570,737.00 and N10,711,285.00 while construction duration were 7 weeks, 29 weeks and 39 weeks respectively. The simulated figures were found to be within 12% of actual construction costs. The labour-based technique was found to have about 40% reduction in the total construction cost and potentials for generating 10 times more employment than the equipment-based technique. Over 80% of such employment would acrue to unskilled workers who could come from the locality of construction site.

The results of this study have therefore shown that labour-based technique in comparison with equipment-based methods are cheaper, execution time compatible, quality of work comparable, it utilises local resources more extensively and boost the local economy through employment generation.

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## ABBREVIATIONS

| | | |
|---|---|---|
| SAP | - | Structural Adjustment Programme |
| CBN | - | Central Bank of Nigeria |
| LGA | - | Local Government Authority |
| DFRRI | - | Directorate of Food, Roads and Rural Infrastructures |
| ADP | - | Agricultural Development Programme |
| RBDA | - | River Basin Development Authority |
| OORBDA | - | Ogun-Oshun River Basin Development Authority |
| UNDP | - | United Nations Development Programme |
| ILO | - | International Labour Organization |
| NDE | - | National Directorate of Employment |
| SPWP | - | Special Public Works Programme |
| $Mm^3$ | - | Million Cubic Meter |
| NAFPP | - | National Accelerated Food Production Programme |
| OFN | - | Operation Feed the Nation |
| ITDG | - | Intermediate Technology Development Group |
| TRRL | - | Transport and Road Research Laboratory |
| TALC | - | Time and Location Chart |
| EL | - | Elevation |

NOTATIONS

| | | |
|---|---|---|
| USL | - | Unskilled Labour |
| GL or SL | - | Skilled Labour |
| CL | - | Cutlass |
| Fl | - | File |
| HR | - | Hand rammer |
| HP | - | Headpan |
| PAX | - | Pickaxe |
| RK | - | Rake |
| SH | - | Shovel |
| SP | - | Spade |
| WB | - | Wheel barrow |
| WC | - | Watering can |
| ED | - | Empty Drum |
| RO | - | Rope |
| CS | - | Chain saw |
| CD | - | Concrete dumper |
| CM | - | Concrete mixer |
| PR | - | Pedestrian roller |
| TR | - | Tractor trailer |
| TW | - | Trowel |
| WP | - | Water pump |
| WT | - | Water tanker |

| | | |
|---|---|---|
| TP | - | Tipper Lorry |
| BD | - | Bulldozer |
| EX | - | Excavator |
| GD | - | Grader |
| PL | - | Payloader |
| RL | - | Roller |

# CHAPTER 1: INTRODUCTION

## 1.1 PREAMBLE

An earth dam is a structure built with locally available materials (soils) to form a special embankment designed to impound water more or less permanently across a valley. The water impounded in dams is used for community water supply or provide an insurance against weather - induced fluctuation in crop cultivation thereby making our agriculture to be intensive and cost effective throughout the year. Small earth dams are common in Nigeria because of abundance of good construction materials. An earth dam is comparatively cheaper than any other type of dam, often suited where foundations are not rigid enough for masonry dams: Finally, the construction material- earth is easily handled either manually (i.e labour-based construction) or by machinery (equipment-based construction). The choice of construction technology is the consideration of this dissertation.

The current construction practice for small earth dam in Nigeria are geared towards the use of equipment-based method, which is a technique that makes extensive use of heavy construction equipment, such as bulldozers, excavators, gradders, payloader, rollers, dumper, tippers etc. for the entire range of construction activities. This method of construction is perceived to have productivities, cost and performance that are predictable. This assumptions is surrounded by an aura of technological progress. Hence, the use of equipment in construction was considered to be particularly

attractive and, in some cases, unavoidable. Nigeria as a developing country relies on this method for a number of reasons. These reasons include, the desire of Engineers and Politicians/Administrators to emulate the more advanced countries, the tendency among international consultants and contractors to favour construction methods with which they were familiar, and the biases inherent in the tied-aid stipulations of international and bilateral assistance agencies, the concern of the latter being to help exports from their own countries. A particularly important factor is the educational background of the technical leadership in Nigeria, which is often acquired in Engineering Schools that advocate the latest technological methods. This background has conditioned planners and engineers to favour the use of heavy equipment in all circumstances.

The labour-based construction method makes extensive use of unskilled surplus labour supported by light equipment and minimum use of capital equipment to build works at a speed, quality and cost which are equally comparable with other methods. It therefore means that the labour-based method will have the construction technology geared in favour of using more locally available resources but considerably lower foreign resource component. This method would have its immediate application feasible in an environment where the following circumstance prevail: There are many poor people, most of whom are under employed or unemployed; large numbers of infrastructural improvement are needed, some of which are small, technically simple; amd there is a shortage of foreign exchange with which to buy and operate machines

for construction. This method was unpopular in Nigeria because substitution of labourers for machines appeared to have negative connotations. Large numbers of labourers were needed to approach the output of a single piece of equipment, and they had to be housed, fed, trained and cared for. Doubts were entertained about the ability of unskilled workers to produce high-quality work. Thus a need for training them.

Besides, labourers were regarded to being undisciplined, unruly, unreliable and consequently, as requiring extensive supervision. In sum, the extensive use of labour was judged to increase the risk of higher costs, to bring about longer construction periods, and to produce results of dubious technical quality. These risks tended to make the public sectors in this country to reject/resist the use of unskilled labour in construction.

Reliance on equipment was shown to have some disadvantages, however, equipment-based operations entailed heavy expenditure of foreign exchange. These heavy/sophisticated construction machinery/equipment and their spare parts have to be imported, thus expending foreign exchange, which is scarce in Nigeria. Such costs might be an unavoidable burden for urgently needed high-technology projects. But for the construction of smaller scattered and technically less demanding rural projects, politicians and administrators began to look for ways to put local resources to work. If much of the work could be done by hand, the rural poor would not only receive the benefits of the finished product but would, in addition, secure much needed

income from its construction, considerable employment from its maintenance, and a sense of participation, civic pride and unity. A sustainable project is the end result which could be easily maintained with confidence and ease.

However, equipment-based and labour-based construction methods discussed above should not be evaluated as two diametrically opposed techniques. Rather, each of them constitute part of a spectrum of construction technologies available. All technologies employ some mix of human, animal and mechanical resources. Thus, the characterisation of a construction method as labour-based or equipment-based does not necessarily exclude other factors of production, but simply identifies the principal source of motive power used.

The Federal Government, in 1986, adopted a full scale structural adjustment programme (SAP) to reverse the country's economic distortions by aiming at a long term change in the effective use of available local resources. The collapse in world oil prices was biting further into the already diminished resources being made available for State and Local allocation for infrastructure development and maintenance, which included small earth dams. The State and Local Government Authorities responsible were suffering from a lack of investment and maintenance funding. The SAP initiated a series of foreign exchange auctions by Central Bank of Nigeria (CBN) which resulted in the ever declining official exchange rate for the local currency (Naira) thereby making the prices of foreign equipment and their spare parts almost prohibitive. Consequently, the Government had to focus on export expansion

and import substitution. Furthermore, the Federal Government recently opted for more extensive rural water development policies than those in the past. This has resulted in the establishment of the Directorate of Food, Roads and Rural Infrastructure (DFRRI), Agricultural Development Programme (ADP) and the various River Basin Authorities (RBDA).

There is another aspect of the National Economy which deserves high weightage in the National Policy formulation: The present high level of unemployment and under-employment in the country with apparent poverty is of prime concern to the Federal Government. One of the several initiatives taken by the Federal Government to deal with this problem was the establishment of the National Directorate of Employment (NDE) in November, 1986. The NDE is working on the identification of the scope for productive employment opportunities in all sectors of the economy. This prompted the Government in 1987 to request the United Nations Development Programme (UNDP) and the International Labour Organisation (ILO) to assist the NDE in the planning and implementation of the Labour-based/light equipment-supported public works programme in the country. The construction and maintenance of rural infrastructure has therefore been identified as one of the sectors which merits examining for generation of employment.

This approach conform with the view of Schumacher (1974) -

"If you want to go places, start from where you are
If you are poor, start with something cheap.

If you are uneducated, start with something re latively simple.
If you live in a poor environment, and poverty makes market small, start with something small.

> If you are unemployed, start using your labour power; because any productive use of it is better than letting it lie idle".

In other words, we must learn to recognise the boundaries of poverty. A project that does not fit, educationally and organisationally, into the environment, will be an economic failure and a cause of disruption.

In response to the Government's request, the UNDP/ILO fielded in 1987 a Multi-disciplinary Mission to Nigeria. The objective of the Mission was to assess the scope for productive employment opportunities in the construction, rehabilitation and maintenance of rural infrastructures. The Mission confirmed the bias in favour of using equipment in the construction, rehabilitation and maintenance of rural infrastructure works. Furthermore, the Mission concluded that while the Government is committed, the labour is available and the wages are competitive, there is a need to modify the present systems and procedures and develop appropriate managerial capacity, both in Government and the private sector, for the successful implementation of labour-based methods on a large scale. However, such development needs to be pursued with vigour combined with proper planning.

The policy makers in the country, which until then had made little or no use of labour-based construction methods, proposed to experiment with them. However, only limited knowledge was available on how to apply more labour efficiently in civil construction that were usually executed by machinery. No systematic investigation had yet been carried out on the comparative costs and results of using large number of workers to build civil works in Nigeria. This research effort, intends to undertake an extensive

comparative analysis (on both technical and financial terms) of the labour-based and equipment-based methods of construction for small earth dams in Nigeria.

## 1.2 CHOICE OF APPROPRIATE CONSTRUCTION TECHNOLOGY

Technology has an important role to play in the process of development. It has been claimed that the technology used should be appropriate to the socio-economic environment in which it operates. In view of the close relationship between technological choice and development, the question of the most appropriate technology for construction and maintenance of rural infrastructure works, in relation to resources available, has given rise recently to considerable interest in choice of technology all over the world.

Appropriate technology should recognise the potential of a particular community and enable it to develop in a gradual way. This development is based on local resources and progressively builds up the skills of the community. It is a complete system approach to development and is self-adaptive, dynamic and encourages self reliance.

An appropriate technology should satisfy the following criteria:-

- Employ local skills
- Employ local material resources
- Employ local financial resources
- Compatible with local culture and practices
- Satisfy local wishes and needs.

The search for appropriate technology by no means rules out using modern (or rediscovered) techniques or materials; it does not dismiss out of hand any option but seeks only to examine them

all in terms of a set of criteria with emphasis on ease of implementation by the project beneficiaries. The aims in applying Appropriate Technology should be:-

- To identify the bottlenecks, inefficiencies, sources of loss;
- To provide simple, cheap, appropriate/direct solutions;
- To arrange for a local source of supply and maintenance, preferably by a local manufacturer.

The above, if carefully followed, would facilitate judicious choice of technologies when related to the specific case study under consideration. The factors that can affect this choice may include technical and economic feasibility, quality, availability of labour, equipment, managerial capacity and the time required for construction. Thus, an appropriate technique for the construction of small earth dams is one that is both efficient and least costly.

## 1.3 PROBLEM STATEMENT

This project seeks to carry out a comparative analysis, vis-a-vis cost efficiency, time and quality of work achieved by the Equipment-based and the labour-based methods of construction of rural infrastructures in Nigeria. A specific case study of small earth dam projects is undertaken.

## 1.4 OBJECTIVES OF STUDY

The objectives of this research are to:

(1) Compare the labour-based and equipment-based construction techniques and identify the more appropriate one (i.e technically acceptable and financially justifiable) to the socio-economic conditions prevailing in the country now for the construction of earth dam.

(2) Formulate criteria which would serve as a guide in the selection of appropriate construction techniques for such rural infrastructures.

(3) Determine whether the initiation of labour-based method of construction in the country by the Federal Government is justifiable.

(4) Provide knowledge and awareness in labour-based methods of construction to attract patronage of the construction industry in Nigeria and hence develop the technique to its full potential.

## 1.5 LIMITATIONS

The high cost of data collection and time available has made the scope of the study to be based on three (3) dam sites located in three (3) different geographical zones of the Federation.

Dearth of published literature in the areas of appropriate technology in general and labour-based programme in particular, imposed serious limitations of the study. The scarcity in Nigeria of the few available literature in the labour-based technology also posed a limitation.

## 1.6 BASIC ASSUMPTIONS

The following assumption were made in carrying out the comparative analysis, of both the labour-based and equipment-based construction methods.

(i) Labour and equipment would be available for hire according to the construction plan and would not pose any major constraint during the construction period.

(ii) Costs of labour, handtools, materials and equipment-hire are according to market surveys undertaken during the last quarter (September to December of 1992) at Lagos, Abeokuta, Ibadan and Kaduna.

(iii) No provision is made for equipment break-down during the period of hire since timely replacement of break-down equipment is expected.

(iv) Handtools would be of good quality and 20% of the total cost would be sufficient for the provision of handles, maintenance as well as replacement in case of damages.

(v) Handtools will have no salvage value at the end of the construction period.

(vi) 5% of the total cost of equipment hire would be suffient for fuel, oil and lubrication of the equipment.

(vii) The foreign exchange rate and the associated costs are assumed to remain stable during the construction period.

## 1.7 BACKGROUND AND JUSTIFICATION OF STUDY

History attests to the scale, durability and technical sophistication of civil works constructed by labour-based methods. The pyramids of Egypt, the Great Wall of China, the Roman road and aqueduct systems, and the Inca irrigation networks are products of human ingenuity, labour and perseverance. The use of large numbers of labourers in civil-engineering works persisted well into the nineteenth and twentieth centuries: the trans-American railroad, the first autobahns (expressways) in Germany, and the gigantic Sarda Sahayak canal in India are examples of successful labour-based undertakings. It is only in relatively recent times that increasing labour costs and the consequent development of more powerful equipment in capital-abandonment of manual methods and to the increasing utilisation of high-output construction equipment.

In Africa and Nigeria in particular, human labour traditionally was used in all types of rural construction works before 1970. With the oil boom, the importance of labour in construction was placed down by the introduction of heavy machines for all types of construction works and even those with relatively simple technical

requirements like small earth dams. It has now become a tradition in Nigeria that in project designs, determination of completion time and project specification are all premised on the use of equipment. Furthermore, the registration of contractors is based on the size of plant holdings or the ability to secure the required items of equipment through the plant hiring services. Very often, the selection of contractor is based on his or her capability to mobilise a certain type and numbers of equipment units.

However, with the present socio-economic conditions characterised by massive labour unemployment, rising cost of machines, spare parts etc., due to shortage of foreign exchange and the worsening of the national economy due to global recession, emphasis addressing the potentials and capabilities of labour-based method of construction needs to be critically examined. Therefore the need to examine the relative desirability of the two options in an atmosphere of equal opportunity so that the labour-based method can also develop to its full potential. Moreover, there is widespread willingness at the National, State and Local Government levels for the use of manual labour in development activities.

# CHAPTER 2: REVIEW OF RELEVANT LITERATURE

## 2.1 INTRODUCTION

### 2.1.1 Specifications for Small Earth Dams

An earth dam is the most common type of structure because its construction involves the use of earth as construction materials, available in its natural state, at the construction sites, which can be easily handled requiring minimum processing. Besides, foundation requirements are less stringent than for other type of dams. Hence, earth dams are easier and cheaper to build than any other type of dams.

A small dam is one whose maximum heigh above the lowest point in the river/stream bed does not exceed 15m, and whose volume is not of such magnitude that significant economies can be obtained by utilising the more precise methods of designs usually reserved for large dams. A low dam cannot be considered small if its volume exceeds, say, 770,000m3 - USA Bureau of Reclamation (1977), Ogun -Oshun River Basin Development Authority Abeokuta - OORBDA (1984) States that small dams are considered to be associated with small streams and drainage areas of limited extent. Going by the most restrained definition, small dams include those structures with heights not exceeding 12m above stream bed level and having catchment areas of a few tens of square kilometres (sq.km).

For the purpose of this work, a small earth dam is one whose maximum height does not exceed 15m above the stream bed level. The spillway design for small earth dam entails estimating the maximum expected 10 years flood. Suitable dimensions of the spillway which would ensure that the design flood is evacuated

safely without overtopping the dam should be selected. UNDP/ILO W3 (1991).

## 2.2 CURRENT CONSTRUCTION PRACTICES

### 2.2.1 Review of the State of Art

The current construction practice for small earth dam in Nigeria involves the use of sophisticated construction equipment. This technique involves the utilisation of wide variety of heavy equipment units such as Bulldozer, Excavator, Grader, Payloader, Scraper, Crane, Trasit, Concrete mixer, Dumper, Water bowser, Tipper lorry and Dragline. Some of which are shown in Plates 2.1 - 2.6. These machines are used at different stages of construction activities including site clearing, excavation, loading, hauling spreading, watering and compaction. The equipment-based method gained popularity in the country because the petroleum boom provided fund for the purchase of heavy equipment for project execution, consequently many projects were simultaneously executed. The use of predominantly equipment-based technology was generally favoured then because it was believed that it would allow the development gap between Nigeria and developed countries to be closed quickly, since it used the latest technology which encourages its transfer. It was believed to have high productivity and considered appropriate for our practices and procedures.

Incidentally, the country did not develop the know-how and capacity to manufacture and maintain heavy construction equipment. The heavy equipment and its spare parts used for the construction of infrastructure projects are all imported from abroad. Now due to international indebtedness, stagnation in capital aid flow, dismantling of policies which had previously

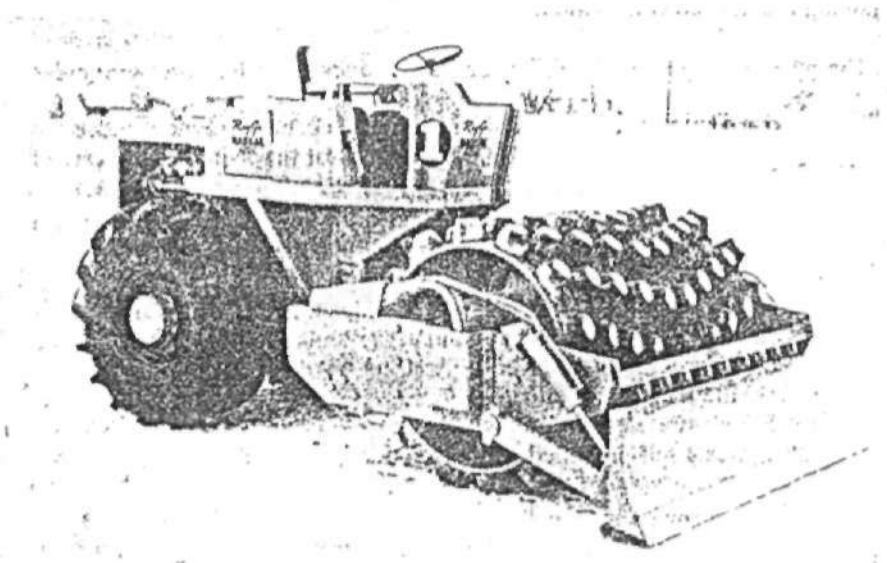


Plate 2.3 Self-propelled tamping roller and dozer. *(RayGo, Inc.)*

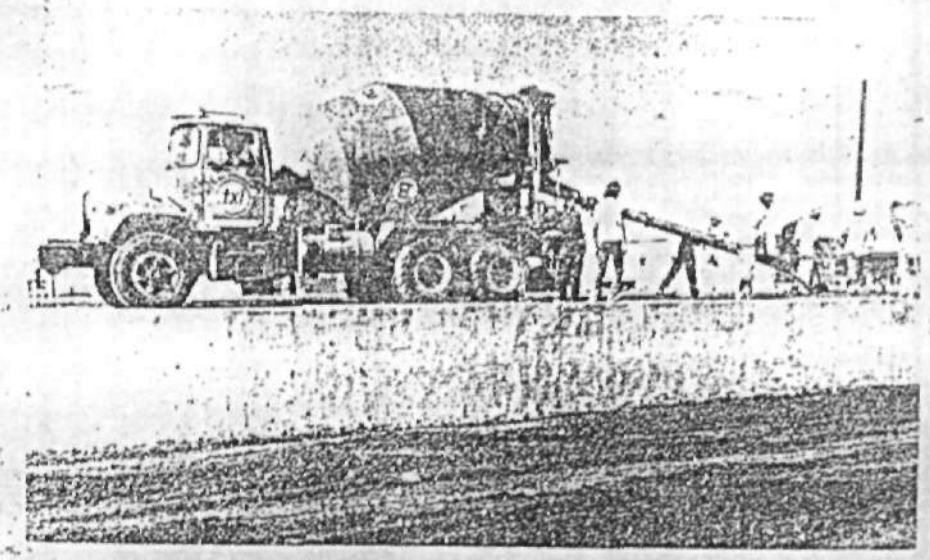


Plate 2.4: Transit mixer (8 cu yd).

over-valued the local currency, reduction in income accruing from the sale of petroleum and the subsequent adoption of the Structural Adjustment Programme (SAP), there is shrinkage of foreign exchanve in the country. Hussain et al (1990) observed that it has now become difficult to either replace the old worn-out equipment or import enough spares for their repairs. As a result, the use of those equipment units which are already available in the country are over-stretched, the consequence is that there is delay in the execution of all projects, particularly those under the rural development programme. The existing equipment-intensive approach to the development project has reduced firstly, the employment opportunities during the construction phase and secondly, the capacity of the beneficiaries to carry out regular maintenance and minor repair works, as they lack access to the use of heavy equipment.

### 2.2.2 Implications on Cosntruction Time

There are equally other important practical problems that frequently arise on projects in Nigeria using heavy machinery namely the prolongation of construction time. One such problem is that the productivity of these equipment usually fall short of expectations when compared with productivity level typically reached in the industrialised countries. The equipment availability rate and life, because of faulty maintenance, are poor compared to other situations. Some of the reasons given for this by the UNDP/ILO-SPWP (1989) are that the equipment are not adapted to the rigors of the terrain (not tropicalised)", lack of proper maintenance, little or no servicing from supplier following purchase, equipment are applied to other purpose than

planned and poorly trained equipment operators.

Expectedly, the situation now has generated considerable distress in the construction sector to the extent that the construction of smaller, more scattered and technically less demanding projects like small earth dams and other related (to dams) rural infrastructures such as supply of potable water and agricultural schemes are seriously affected. The extent to which predominant utilisation of heavy machinery for the construction of these projects had been able to close the developmental gap in Nigeria is manifested in the deplorable state of rural infrastructures.

2.2.3 Brief Performance Review of a Construction UNit

Eleven River Basin Development Authorities were established by the Federal Government of Nigeria in 1977 with a defined role of providing rural infrastructures including small earth dams in the economic development of the country. The whole country was thus divided into eleven units each representing the area of operation of a River Basin Development Authority, one of which is Ogun-Oshun River Basin Development Authority (OORBDA) Abeokuta which has jurisdiction over the area covered by the whole of Oshun, Oyo, Ogun and Lagos States having an estimated area of 66,264sq.km. The area is drained by two big rivers - Ogun and Oshun (after which it is named) - and a number of tributaries and smaller rivers, the most important among which are Oyan, Sasa, Ona, Ibu, Ofiki, Oni and Yewa rivers (OORBDA, 1990). Ogun-Oshun River Basin Development Authority Abeokuta procured some heavy equipment and started the construction of small earth dams within its jurisdiction in 1979.

Relevant construction data on some of the small earth dams constructed by OORBDA is summarised in Table 2.1. It is evident from the table that when the equipment acquired by OORBDA were new (i.e 1979 - 1984), all the earth dams it built were completed within a year. The only exception was Oke-Odan dam (No iv) which has a peculiar foundation problem that delayed the commencement of the embankment filling to 1984. Since 1985, the persistent picture is that of general scarcity of essential parts for the equipment stock it maintained and difficulty to procure from overseas due to scarce foreign exchange availability thereby causing delay (prolonged construction time) in the execution of small earth dams Nos. iv, vii & viii). It has been increasingly difficult for the Authority to complete dams under construction or embark on new ones despite the fact that the River Basin Development Authority has the technical potentials for dam construction. Inspite of large stock of heavy machinery, in all, the construction of six earth dams had been accomplished since inception (i.e 1977) of OORBDA. The experience of OORBDA, in terms of equipment-based construction technique is particularly relevant to this study.

Table 2.1: Data on OORBDA's Small Earth Dams

| S/No | Location | Capacity (Mm3) | Year Started | Year of Comple-tion | Remarks |
|---|---|---|---|---|---|
| i | Ofiki 1 | 0.6 | 1980 | 1981 | Irrigation & Fisheries |
| ii | Eniosa | 0.12 | 1980 | 1981 | -do- |
| iii | Lekan Are Abeokuta | 0.6 | 1982 | 1982 | Irrigation, potable water & Fisheries |
| iv | Oke-Odan | 7.5 | 1982 | - | Construction works in progress. |
| v | Ofiki II | 1.03 | 1983 | 1983 | Irrigation & Fisheries |
| vi | Sepeteri I | 2.1 | 1983 | 1984 | -do- |
| vii | Sepeteri II | 1.3 | 1984 | 1989 | 5years const-ruction period Now in use. |
| viii | Igbojaye | 5.6 | 1984 | - | Construction works in progress. |

Source: Ogun-Oshun River Basin Development Authority Abeokuta (Vol 4 1990).

## 2.3 ALTERNATIVE CONSTRUCTION TECHNOLOGY

### 2.3.1 Introduction

The growing scarcity of foreign exchange and massive increase in unemployment are two diversed phenomena presently affecting Nigeria. This means that the country is suffering from shortage of capital but she has abundant labour (human resource). High dependency on equipment-based technology for the construction of small earth dams will, unfortunately, worsen the present socio-economic conditions. In view of this, there is an urgent need to explore alternative construction technology that hinges on sustainable local resource based method. Moreover, the special report on employment policy in the second development decade, drawn up by the United Nations Administrative Committee on coordination considered that one of the better ways of finding a partial but rapid solution to the problems of poverty and unemployment is to institute what might be called "a major programme of minor works in rural areas/11/. Furthermore, the committee for Development Planning of the United Nations Economic and Social Council considered labour-based programme/12/ as a possible leading sector for the utilisation of local manpower in rural development.

### 2.3.2 Concept of Alternative Technology

Hussain (1992) stated that evidence available from different parts of the world suggests that the concept underlying labour-based programmes is an age-old one. In ancient times, the state called on the services of its unemployed population to participate

in public utility works or prestige projects. In most cases these were isolated activities which did not form part of any over-all policy designed to combat proverty or unemployment. More regularly, many clans, communities and traditional societies also require their members to perform statute labour for the common good and to safeguard their common heritage namely the land. Finally, industrialised countries, typically the United States of America, during the periods of economic depression, launched public works programmes, or compensatory employment programmes, to provide work for those who would otherwise be unable to find employment. What were described as "test" work relief programmes, were established in times of famine by British colonial administrators to provide temporary relief for the unemployed people of the colonies.

At the commencement of the present century in India, Ghandi stressed the importance of encouraging development in the rural areas by initiating the systematic study of village labour-intensive technology and a large number of village industrial units were also formed. In China, Mao and his colleagues in 1960 reversed the country's policy and shifted to decentralisation and the encouragement of self-sufficiency at the local level. They also introduced several rural infrastructural projects that absorbed unemployed labourers. This later policy is summed up by the well-known Mao quotation "Walking on two legs" Dunn (1978).

However, the idea of introducing unemployed labour as an investment factor to speed up the take-off of developing countries by launching infrastructure works, as well as to bring about a

more rapid and lasting reduction in the amount of poverty, under-employment and unemployment, only began to find its way into theory and practice in mid-fifties of this century. A number of countries initiated programmes aimed at mobilisation of surplus labour for implementation of infrastructure projects. By the mid-seventies, twenty (20) employment creating public works programmes had been successfully mounted. These, for example, include Morocco, Tunisia and Malagasy Republic, all in Africa and Brazil, Mexico and Peru in America; in Asia: China, India,Bangladesh, Indonesia and the Philippines.

Experience has therefore shown that labour can be successfully utilised as a major construction resource for the provision of infrastructures. The successful application of the labour-based technique in these countries did not only ensure that the much neglected infrastructures are resuscitated but also generated substantial amounts of employment in the locality, thereby encouraging self-reliance and sustainable method of construction.

2.3.3 Technological Choice

Technology used should be appropriate to the socio-economic environment in which it operates. It has been suggested that the most desirable technologies for developing countries are those requiring limited capital per worker and that its operations should be more labour-intensive. However, the world employment conference held in Geneva in 1976, concluded that the exclusive use of labour-intensive techniques will neither solve the problem of the developing countries nor reduce their dependance on

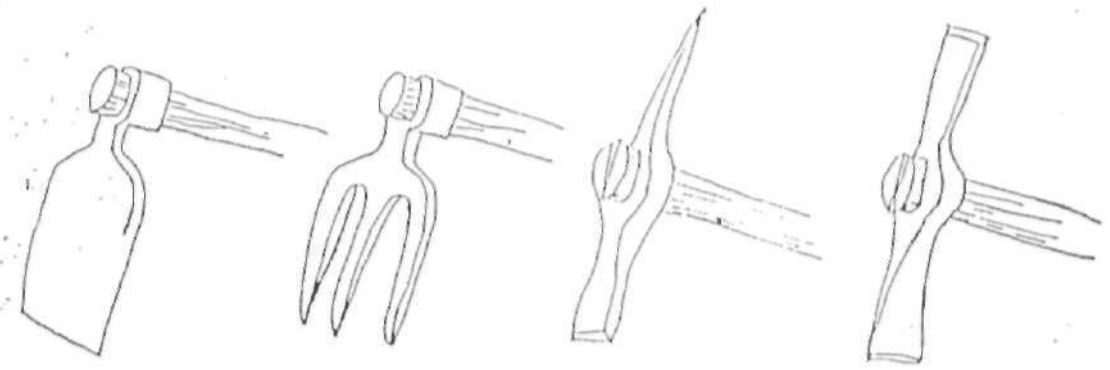
industrialised countries. Likewise, the exclusive use of capital intensive techniques will present the developing countries with serious problems of financial difficulties, lack of managerial staff and supervisory personnel. Thus, developing countries should arrive at a reasonable balance between labour-intensive and equipment-intensive techniques, with a view to relieving the fundamental aim of maximising growth and employment. The strategy of equilibrium between the various types of technologies should also take account of the desire to adopt advanced techniques, with a view to reducing the existing technological gap between countries (Hussain, 1978).

2.3.4 Labour-based/Light Equipment Supported Technique

The labour-based construction method is one that makes maximum use of unskilled labourers and minimum use of capital-intensive equipment to build work without sacrificing quality,time and cost. It is a method of construction that requires primarily the use of labour but supported by compatible light equipment. Indeed, availability of labour is the most important pre-requisite for labour-based construction but it should not however, be equated with "labour only" method of construction. Successful application of labour-based methods demands that the projects are designed appropriately, construction activities are well organised and adequately supervised, and that appropriate handtools and compatible light-equipment are used to produce the same result as heavy machines (such as Bulldozer, Excavator, Grader,etc) in equipment-based construction technique.

The handtools and light-equipment commonly used in labour-based/light equipment-supported construction have been inventoried by the UNDP/ILO/NDE Team in Nigeria as follows:-

Cutlass, File, Pickaxe, Hoe, shovel, Spade, Rake, Headpan, Wheel-barrow, Watering can, Hand rammer. Figures 2.1 - 2.8 and Plates 2.7 - 2.9 shows some of these handtools. The light equipment shown in plates 2.10 - 2,16 include pedestrian Roller (700kg - 1 ton), Tractor/Trailer, Chain saw, Water Pump, Hand operated water bowser, concrete mixer, Tractor-Drawn scrapper, Tractor-mounted Grader and Dozer.

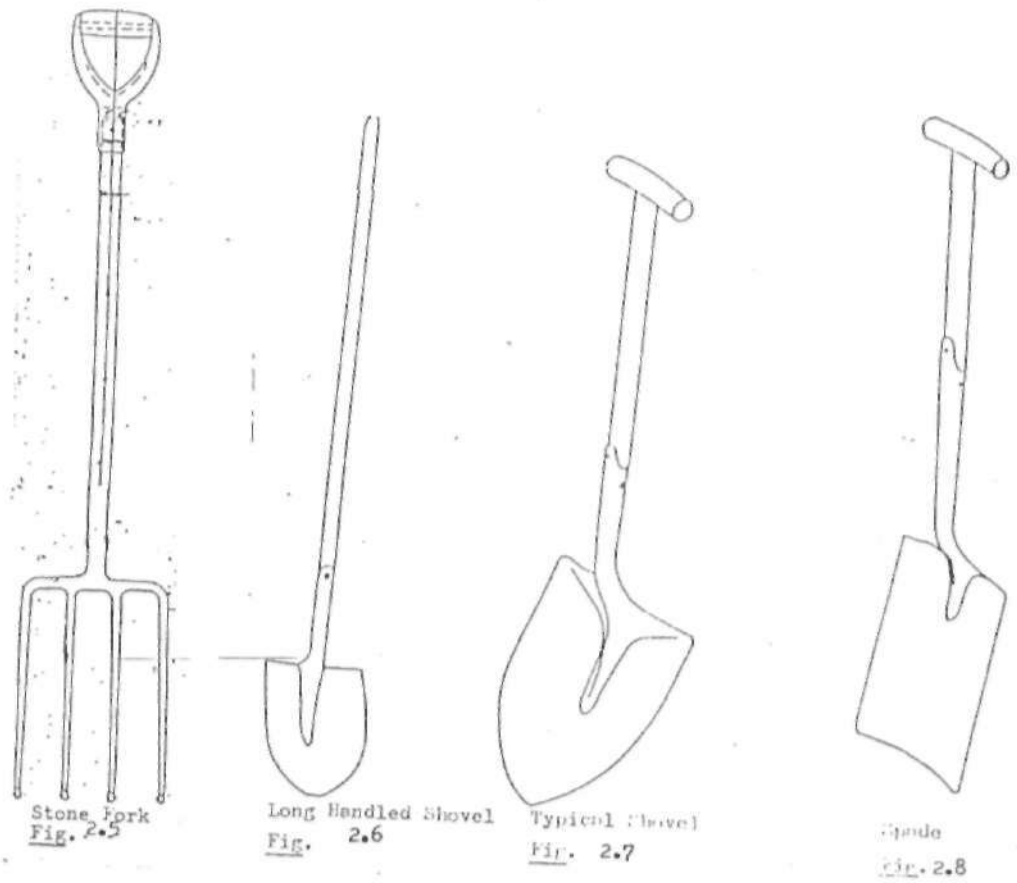


Hoe
Fig. 2.1

Forked hoe
Fig. 2.2

Pick-axe
Fig. 2.3

Mattock
Fig. 2.4



Stone Fork
Fig. 2.5

Long Handled Shovel
Fig. 2.6

Typical Shovel
Fig. 2.7

Spade
Fig. 2.8



Plate 2.5: Stumping and Grubbing



Plate 2.6: Spreading of Laterite on a road construction.

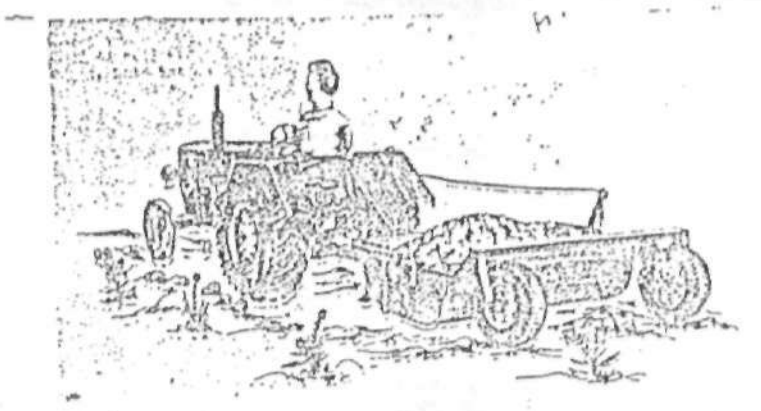


Plate 2.7 Tractor-drawn earth scraper

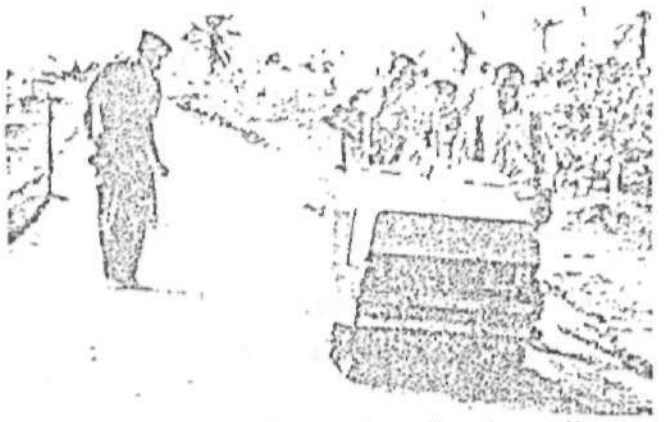


Plate 2.8 Pedestrian vibrating roller

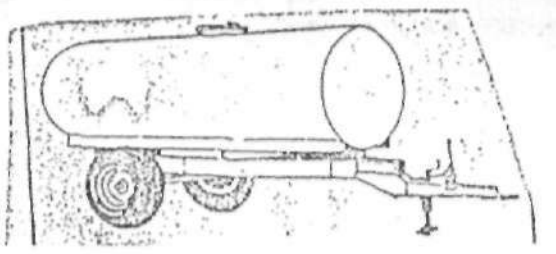


Plate 2.9 500 gallons Single Axle Waterbowser

The labour-based technique involves a thorough analysis of all the construction activities required on the project in order to decide which of them could be efficiently executed by labour, which would require the use/support of equipment to improve the quality of work and/or output (productivity) of labour and which should be executed by equipment only. The UNDP/ILO-SPWP (1989) report that the underlying strategy of this method is predicated on the social objective of boosting income through job creation and on the economic aim of optimising the use of local resources (labour, handtools, materials, know-how methods of organisation, institutions, firms, etc) in the implementation, operation and maintenance of infrastructures. The term "optimisation" rules out a radical interpretation of the principle; the idea is not to ban, at all costs, any outside contribution and to glorify an impracticable autarchy, but instead to make a thorough investigation of local potentials, extend the use of local resources to the extent that this is compatible with technical reliability and economic viability.

It is important to note that labour-based ocnstruction does not imply a lowering of engineering standards in any aspect. The required quality standards can be achieved by using the right tools with an appropriate level of engineering input and supervision. The method is, therefore, management intensive and requires a large number of lower level managerial staff to organise and supervise the labour force. Experience from the on-going UNDP/ILO/NDE Labour-based demonstration project at Epe, Lagos State in Nigeria has shown that local unskilled labour can be easily trained to perform the required activities

effectively. It therefore means that the labour-based method will have the construction technology geared in favour of using more locally available resources but considerably lower foreign resources component (Owoseni, 1989). The technique constitutes a significant shift in the allocation of fund and development resources, away from the needless promotion of technologies that make the rich richer, towards the development of technologies that can enable the rural and urban poor to earn a decent living.

## 2.4 ROLE OF INTERNATIONAL AGENCIES

In the summer of 1965, Dr E F Schumacher together with George McRobie and Mrs Julia Poter set up the Intermediate Technology Development Group Ltd (I.T.D.G.), a charitable trust. The objective was to promote the Appropriate Technology concept and assist in the collection and dissemination of data on simple low-cost technologies. This group of people had in common a variety of overseas experience; the conviction that "development" means first and foremost the development of people; and the knowledge that aid it. Development as currently practised was viewed as bypassing the majority of poor people in the developing countries.

Membership and support grew rapidly, and soon the Group had a nucleus of staff and had started work on filling the knowledge-gap, about self help technologies: technologies that are relatively small, simple, and capital-saving, and therefore more appropriate to the needs and resources of the majority of poor people in the rural and small-town areas of the developing countries.

These modest efforts started nearly twenty-eight years ago, have since grown into a world-wide network of people and organisations concerned with the development and application of Appropriate Technologies. There are now many groups engaged on such tasks as scaling down large-scale technology to bring it within the reach of rural people, upgrading traditional crafts to make them more productive and versatile as well as inventing new tools and equipment with which the poor can work themselves out of poverty. Today, this spearheading voluntary effort is being backed up by government and international support. Work programmes in Appropriate Technology are being build into the official aid programmes of the British, American, Netherlands, German, Scandinavian and a growing number of UN agencies.

The World Bank initially started research work in the application of labour-based construction programmes in 1971 as part of the study of labour and capital substitution in civil construction conducted by the Transportation and Water Department. In 1976, the World Bank research team shifted attention to design and execution of labour-based programmes in Kenya, Honduras, Chad, Lessotho and Benin Republic. The World Bank research and field experiences was put together in 1983 into a book entitled "Labour-based construction programmes: A practical guide for planning and management". Coukis (1983).

Following the recommendations of the international labour conference of 1964, the ILO formally initiate work on the labour-based works programme in 1974 in order to build the necessary technical capacity to be able to advise and assist the member countries.

The ILO therefore, embarked on the collection of data on the objectives, methodology and the lessons learned by those countries that had since early sixties launched rural works programmes. The analysis of the data resulted in a document entitled "Guidelines for the organisation of special labour-intensive works programme.

Since 1975, the Government of 22 countries have launched such programmes with the technical support of the ILO as executing agency and many of these (labour-based programme) are still being implemented. The United Nations Development Programme (UNDP) has contributed to the funding of many of these programmes. The UNDP and ILO are collaborating in the introduction of labour-based programme in Nigeria since 1987.

## 2.5 Results From Previous Comparative Analysis

A joint UNDP/ILO/NDE team in 1989 carried out a comparison of labour-based and equipment-based methods in terms of construction costs, local resources utilisation, employment generation and scope for encouraging grassroots participation in terms of construction as part of the demonstration project at Epe. The evidence (see Table 2.2) supports that a total of ₦12,538 is saved per kilometre of rural road if labour-based methods are used in place of equipment-based method. Thus, at market price construction cost can fall 7% (10.3% in the case of ADP costs) by shifting from equipment-based to labour-based methods. When economic efficiency (shadow) prices are used, the cost reduction resulting from this shift can be much higher.

Table 2.2 Comparison of construction costs of 1km of new road by alternatives methods (1989 prices)

| Item | Actual costs of labour-based construction at Epe | | Estimated average costs of equipment based construction | | ADB construction costs of new rural roads by equipment based method[3] |
|---|---|---|---|---|---|
| | Amount (₦) | % | Amount (₦) | % | |
| Labour | 106,437 | 65 | 5,466 | 3 | According to the World Bank, the cost of new rural roads constructed under ADP was $20,940 per km at 1987 prices with 60% of foreign costs, after allowing for a modest cost increase of 5% per annum this works at 1989 prices to $23,086 or ₦163,306 at $1 =₦7.94 |
| Handtools | 20,000 | 12 | 1,640 | 1 | |
| Materials | 7,000 | 4 | 7,000 | 4 | |
| Light Equipment | 31,050 | 19 | - | - | |
| Heavy Equipment[1] | - | - | 153,559 | 90 | |
| Supervision[2] | - | - | 4,340 | 2 | |
| Total | 164,487 | 100 | 172,005 | 100 | 163,306 |

Notes: 1/ Hiring charges of equipment including operator's wages

2/ Supervisory costs included as labour costs for labour-based method

3/ Source: "The Rural Road Question and Nigeria's Agricultural Development" MADIA Discussion Paper No. 10, Washington D.C. The World Bank, 1989.

The labour-based methods also maximise the use of local resources. The comparison betwen labour-based and equipment-based methods are incurred on locally available resources such as labour, handtools and construction materials. In contrast, equipment-based methods incur foreign costs to the extent of about 90% of total construction costs. The unit costs for the construction of similar rural feeder road under the World Bank-assisted Agricultural Development Projects (ADP) were obtained from the World Bank evaluation report which states that foreign costs amount to 85% of the total costs. The implications of these results are that the equipment-based approach is unlikely to maximise the effective use of available resources nor encourage self-reliance. A method that places such substatial reliance on imported items is not likely to be sustainable. In the same way, the scope for grassroots participation will be minimal. Thus, through the application of labour-based methods as much as ₦119,338 ($15,029.98) which would have been spent as foreign exchange payments per kilometre of new rural road is saved to create more jobs than the equipment-based alternative. Table 2.3 shows the employment generation patterns and it indicates that the labour-based methods generated 11,696 work days of employment per kilometre of the new rural roads whereas it was estimated that only 938 workdays of employment were generated under the equipment-based methods. This results in the creation of about 12 times more employment opportunities. Out of 11,696 workdays of employment generated per kilometre of the new rural road only 585 workdays accrue to skilled labour; as much as

Table 2.3: Employment generation in rural road construction under alternative technologies in Epe LGA.

| Item | Construction Methods | |
|---|---|---|
| | Labour-Based | Equipment-Based |
| Total cost (₦) | 164,487 | 177,025 |
| Wages (₦) | 106,437 | 8,834 |
| Employment Workdays | | |
| Unskilled labour | 11,111 workdays | 607 workdays |
| Skilled labour | 585 " | 331 " |
| Total labour | 11,696 " | 938 " |
| Cost per employment | 14 | 189 |

95% of the jobs accrue to local persons many of whom could be idle farmers, young school leavers and other rural dwellers. Thus, this approach is capable of improving the income profile as well as the knowledge and capacity situations of the local population: all these are important in the achievement of effective grassroots participation in the development process. There is evidence that similar results can be obtained when labour-based methods are applied to the construction of other types of rural infrastructures such as earth dams, erosion control works etc.

It is often stated that the labour-intensive methods may be able to compete in terms of cost, but can rarely attain the high rate of output possible with machinery, which is not always true. Costa et al (1977) says that in India, the time of construction of the Nagarjuna Sagar Dam built by labour-intensive methods compares well with the highly mechanised Bhakara Dam. On the Bhakara Dam it took seven years to complete the work involving 1.38 million units of 100 cu.ft (2.823m3) each, whereas in the case of Nagarjuna Sagar, it had been possible to achieve 1.9million units of 100 cu.ft (2.823m3) each in ten years.

Argentinian data from Costa et al (1977) research work shows that the capital-intensive equipment technique of low maintenance effort for a road can be the least expensive. Results obtained by using Bolivian data also show that the higher efforts of maintenance of roads by using equipment-intensive methods are the least expensive. These results of course cannot be generalised to other countries. In situations when labour unit prices are

much lower than unit prices for equipment, labour-intensive techniques can be more economical. Such would also be the case if the productivity rates of machinery were to decrease because of inadequate equipment maintenance, lack of experience on the part of the operator, scarcity of spare parts, mountainous terrain, or any other condition.

The irrigation canal from Changho river in China, 1,500km long, was completed in ten years by labour using only simple tools. The construction of the trans-American railway was completed by labour-intensive methods in ten years - an average range approaching 2km/day. To take another example the 266 miles' road from Seoul to Pusan in the Republic of Korea was built between 1968 and 1970 in 29 months using off-season labour or agricultural workers.

## 2.6 POTENTIAL FOR LABOUR-BASED TECHNOLOGY IN NIGERIA

### 2.6.1 Labour Availability

Availability of labour is the most important pre-requisite for a labour-based construction, so it must be established at the outset of the project. Labour availability is affected by the willingness to work on construction projects which depends on the amount of information available about the project, local attitudes to manual work; the severity of the infrastructure problems, local customs and tradition, the availability of alternative employment opportunities and the wage rates offered by the project. To determine the labour availability it is necessary to conduct a labour survey and estimate the labour surplus or deficit. These estimates are based on primary information regarding cultivation practices and labour calendars and labour

input per farm. Secondary data on labour utilisation for crop production obtained from similar agro-ecological setting can also be used - UNDP/ILO.CC13 (1991).

For the specific situation of Nigeria, the general picture is that in the months of October to March, there is substantial under - and unemployment although there are regional variations. In the report of Hussain et al (1990), approximately 35% of the total available labour force is unemployed during the period October - December, and in January - March the proportion rises to about 70%. The rains usually start during April/May annually and there is generally a surge in farming activities which completely absorbs the labour surplus in some areas. In April in particular, because of the over lapping of the various farm operations, labour bottlenecks result and there is extensive use of hired labour at considerably high wage rates. It is normal for the labour surplus to rise again from June but this may fall again as the final weeding operations in August/September overlap with the harvesting of maize and other crops.

In Northern Nigeria because of relatively large holdings, the harvesting of grains in November/December can bring about sizeable declines in the labour availability in those months. However, because of large household size and considerable unemployment, labour availability is generally high in the majority of the LGAs. Table 2.4 depicts the distribution of labour demand, supply and surplus availability by source and month as estimated in 1987/88. The table shows that labour would be available for ocnstruction throughout the year in Epe LGA of Lagos State except for the months of March and April during which land preparation

Table 2.4 Distribution of Labour demand, supply, and surplus availability by source and month of year in 1987, Epe LGA

| Source | Workdays of labour per month | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January | February | March | April | May | June | July | August | Sept. | October | November | December | |
| 1. Labour use/ Crop Labour per farm | 46.4 | 39.1 | 62.3 | 113.2 | 36.8 | 18.4 | 30.9 | 37.8 | - | - | 30.5 | 21.2 | 436.6 |
| 2. Crop Labour by farm Hholds | 101,375 | 87,115 | 136,804 | 250,210 | 81,960 | 40,993 | 68,845 | 84,218 | - | - | 67,954 | 47,334 | 972,744 |
| 3. Off-farm and domestic labour use by farm Households LGA | 191,051 | 191,051 | 191,051 | 191,051 | 191,051 | 191,051 | 191,051 | 191,051 | 191,051 | 191,051 | 191,051 | 191,051 | 2,292,612 |
| 4. Total Labour use by farm Households(2+3) | 284,430 | 278,166 | 328,855 | 443,261 | 272,041 | 232,046 | 259,896 | 275,269 | 191,051 | 191,051 | 259,005 | 238,385 | 3,265,356 |
| 5. Fishing Labour | 827,845 | 827,845 | 827,845 | 827,845 | 827,845 | 827,845 | 827,845 | 827,845 | 827,845 | 827,845 | 827,845 | 827,845 | 9,934,140 |
| 6. Other Labour use by fishing Households | 222,864 | 222,864 | 222,864 | 222,864 | 222,864 | 222,864 | 222,864 | 222,864 | 222,864 | 222,864 | 222,864 | 222,864 | 2,674,368 |
| 7. Total Labour use by Fishing Hholds (5+6) | 1,050,709 | 1,050,709 | 1,050,709 | 1,050,709 | 1,050,709 | 1,050,709 | 1,050,709 | 1,050,709 | 1,050,709 | 1050,709 | 1050,709 | 1,050,709 | 12,608,508 |
| 8. Labour use non-Agric. workers | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 | 649,967 |
| 9. Other Labour use non-agric. Households | 177,752 | 177,752 | 177,752 | 177,752 | 177,752 | 177,752 | 177,752 | 177,752 | 177,752 | 177,752 | 177,752 | 177,752 | 2,133,024 |
| 10. Total Labour use (4+7+8+9) | 2,172,858 | 2,156,594 | 2,208,283 | 2,321,689 | 2,151,469 | 2,110,474 | 2,138,324 | 2,153,697 | 2,069,479 | 2069,479 | 2137,433 | 2,116,713 | 25,906,492 |
| 11. Labour Surplus Labour supply by farm house-holds. | 262,003 | 262,003 | 262,003 | 262,003 | 262,003 | 262,003 | 262,003 | 262,003 | 262,003 | 262,003 | 262,003 | 262,003 | 3,144,036 |
| 12. Labour Supply by fishing households | 636,804 | 636,804 | 636,804 | 636,804 | 636,804 | 636,804 | 636,804 | 636,804 | 636,804 | 636,804 | 636,804 | 636,804 | 7,641,648 |
| 13. Labour Supply by formal sector workers | 25,999 | 25,999 | 25,999 | 25,999 | 25,999 | 25,999 | 25,999 | 25,999 | 25,999 | 25,999 | 25,999 | 25,999 | 311,988 |
| 14. Labour supply by informal Agric. workers | 711,039 | 711,039 | 711,039 | 711,039 | 711,039 | 711,039 | 711,039 | 711,039 | 711,039 | 711,039 | 711,039 | 711,039 | 8,532,468 |
| 15. Labour Supply by unemployed pers. | 568,572 | 568,572 | 568,572 | 568,572 | 568,572 | 568,572 | 568,572 | 568,572 | 568,572 | 568,572 | 568,572 | 568,572 | 6,822,864 |
| 16. Total labour Sup. (11+12+13+14+15) | 2,204,417 | 2,204,417 | 2,204,417 | 2,204,417 | 2,204,417 | 2,204,417 | 2,204,417 | 2,204,417 | 2,204,417 | 2204,417 | 2204,417 | 2,204,417 | 26,453,004 |
| 17. Labour Surplus (16 - 10) | 31,559 | 47,823 | (3,866) | (117,272) | 52,948 | 93,943 | 66,093 | 50,720 | 134,938 | 134,938 | 66,984 | 87,704 | |

Source: From Field Survey Results and Secondary data, 1988

Notes: 1. Represents labour input by farm and non-farm households and workers in Epe LGA in 1987
2. Represents labour supply by adult workers in farm and non-farm households workdays of labour in parentheses are deficits.

for farming takes place. Figures 2.9 - 2.12 shows the distribution of labour-surplus by month for four States of the Federation - Epe LGA - Lagos State, Obokun LGA - Oshun State, Uyo LGA - Akwa Ibom State and Alkaleri LGA - Bauchi State of the country. Labour Surplus (LS) is the difference between the total labour available/supply (LA) and the total labour used/demand (LU)(for farming, construction, etc) .

Arithmatically; LS = LA - LU.

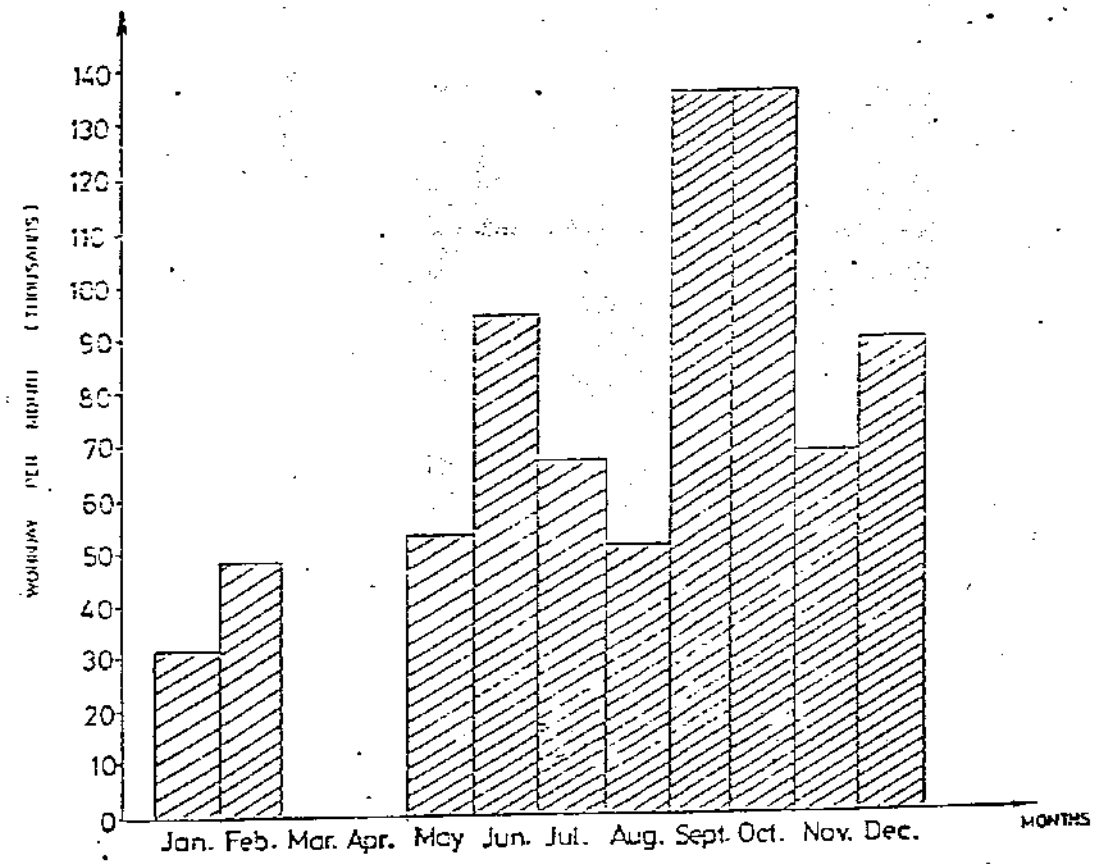



FIG : 2.9 LABOUR SURPLUS BY MONTH IN THE CATCHMENT AREA OF THE DEMONSTRATION PROJECT UNDP/ILO PROJECT ( NIR/87/025 )
EPE LGA LAGOS STATE (1987)

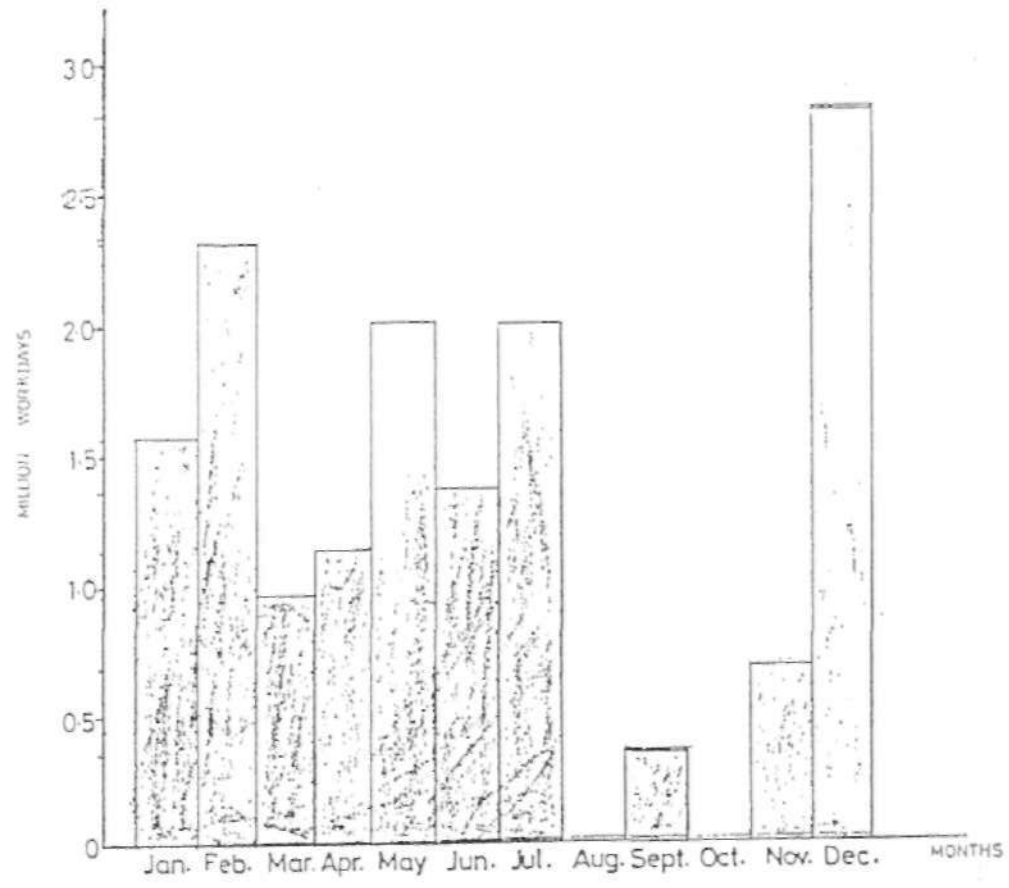



FIG 2.10 LABOUR SURPLUS BY MONTHS IN OBOKUN L.G.A. Oshun STATE 1987

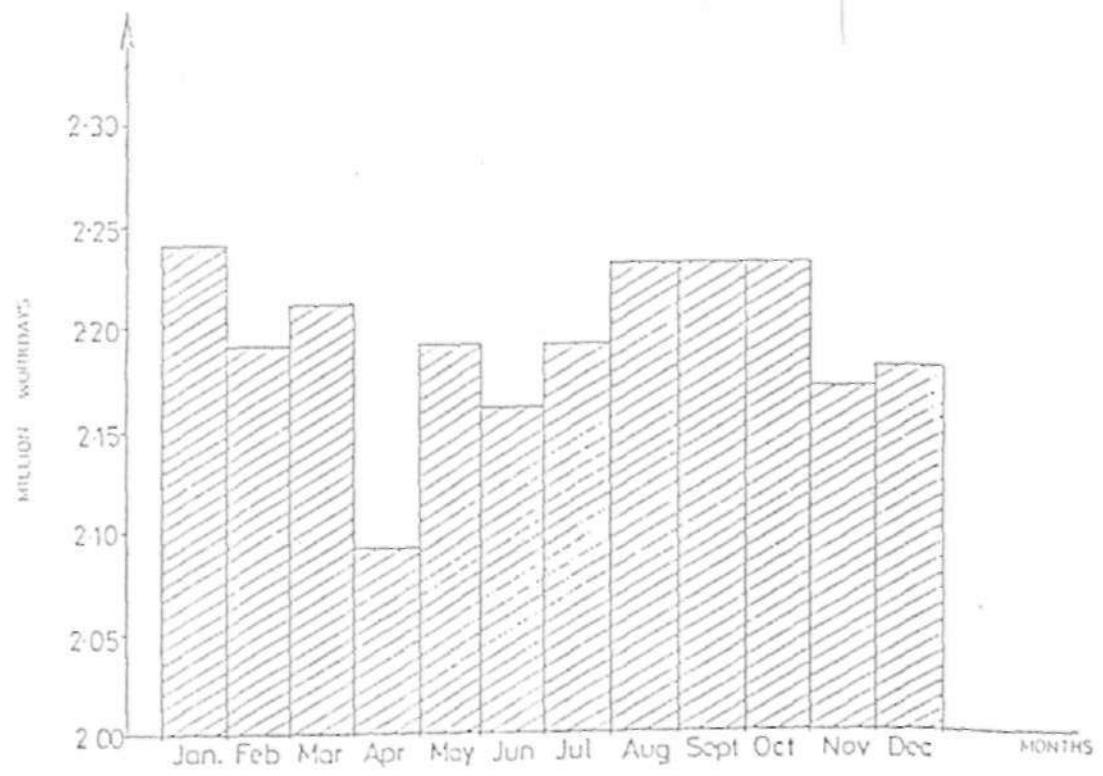



FIG 2.11 LABOUR SURPLUS BY MONTH IN UNO L.G.A. AKWA-IBOM STATE 1990

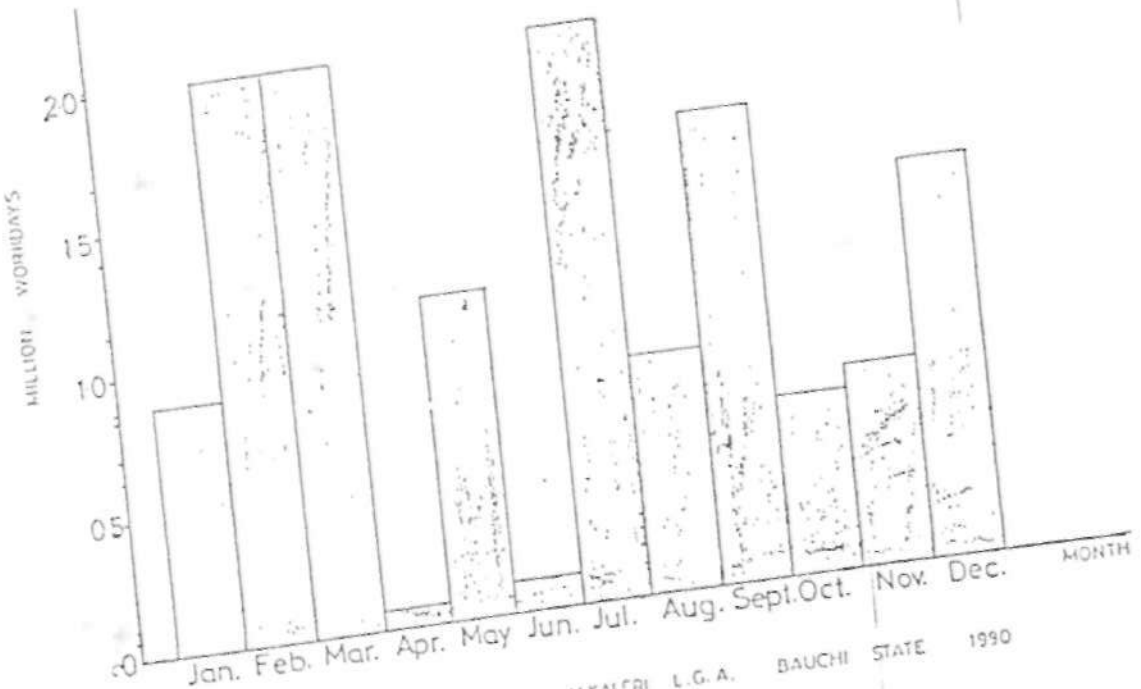



FIG2.12 LABOUR SURPLUS BY MONTH IN ALKALERI L.G.A. BAUCHI STATE 1990

In the Guardian Newspaper of 28th January, 1993, the Federal Office of Statistics released the following labour report for Nigeria -

(i) 2.9% urban workers are under-employed
(ii) 5.5% rural workers are under-used
(iii) 11.6% of urban and 29% of rural worked for less than 40 hours per week.

Two important components of labour availability viz: wages rates and willingness to work on construction projects, were assessed in the LGAs as part of the labour surveys. The results indicate that the level of rural wage rates at the relevant periods of the year will permit the cost effective application of the labour-based methods. Wage rates were found to be in range ₦15-₦20 during April/May 1987 because of the labour bottlenecks in those months which compels farmers to pay a premium on each unit of labour engaged. However, the wage rates gradually decline through the two to three weeding operations, and by the time harvesting of main season crops are underway from July, the wage rates have fallen to as low as ₦5 - ₦8 and generally remain at this level till the beginning of the rainy season.

In the case of willingness, the local people uniformly expressed intense eagerness to work on the construction projects during the dry season. The reason for this willingness was mainly to earn the extra cash, but the fact emerged in many communities that the rural infrastructure defects had caused the local people considerable distress and they see it as a duty to participate in solving the problems.

2.6.2 Handtools as a Factor

Good quality handtools of right design are essential for labour-based construction to be successful. Sufficient quantities at the right type of tools should be available on site before any labour is employed. Well shaped and fitted handles of good quality wood are extremely important as the productivity and life of the tool depend on the handle to a large extent. The common maintenance operation is to keep all tools clean at the end of each day's work and whenever it is necessary to clean at them in order to enhance their effectiveness during the day's work (UNDP/ILO. GC1, 1991).

The handtools required are easily availanle in the local markets/shops and consist of both locally manufactured and imported varieties. A wide variability was observed in the standards and specifications of the handtools available in the market. There is therefore a need to carefully select the handtools used to ensure that they would be able to efficiently perform the functions for which they were basically intended.

Since Nigeria now manufactures some of the handtools locally, the main area that needs to be addressed is the establishment of necessary standards and specifications for manufacturers so as to reduce the variability of the handtools available in the market. The specifications should be related to the type of work the handtools are required to perform. Existing medium and large scale manufactureres of handtools in Nigeria already have the necessary infrastructural facilities for large-scale production of handtools and are equipped to maintain standards as required. On the other hand, local blacksmiths and small scale manufacturers do not have facilities for large scale production of handtools will definitely

receive a boost when the production of flat steel comes on stream in the nation's steel factories (Hussain, 1992).

### 2.6.3 Light Equipment as a Factor

As stated earlier labour-based construction method primarily relies on the use of manual labour vut supported by light equipment. A construction equipment is considered as a light one when it has an output which is compatible to the output of the workers, it is easy to operate, easy to repair and maintain and should have relatively low initial cost.

The introduction of light equipment in construction would supplement the productivity of labour in many activities, for instance, matchets and axes are used for tree-felling but the use of chainsaw would increase the output of the activity. The use of light equipment augment the quality and output of construction. For instance, a certain level of compaction is required in the construction of a dam embankment. It is possible to use a hand rammer to achieve this level of compaction but the use of a pedestrian roller would ensure a more uniform compaction. In this case, the roller not only increases the productivity but also ensures the required quality of production. Whereas hand rammers are indispendsable handtools in confined workplaces achieving comparable or sometimes better compaction.

The use of light equipment play a significant role in situations where neither the use of labour is technically feasible nor the use of heavy equipment is economical. For instance, when a borrow-pit is about 300m away from dam site, then the use of light haulage equipment is more appropriate. Table 2.7 is a useful guide on choice of haulage mode.

Table 2.5: Appropriate Haulage Modes

| Haul Distance (m) | Recommended Haulage Mode |
|---|---|
| 0-5m | Shovelling |
| 5-50m | Headpand |
| 50-150m | Wheelbarrow |
| 150-1,000m | Single Axle Tractor(Agric.type) and Trailers. |
| 1000-8,000m | Other tractor and trailers |
| -8,000m | Tipper trucks. |

Source: Training Modules on Light Equipment for UNDP/ILO Project Module No. GC2.

As can be seen from the table, light equipment also have their limitations because if the borrow-pit is located beyond 8km, it is better to use tipper trucks. UNDP/ILO GC2 (1992).

The country currently has two assembling plants for agricultural tractors. One is located in Kano and it assembles Fiat tractors while the other located in Bauchi, assembles Steyr tractors. Plans are underway to commence the assembling of Mercedes Benz tractors by ANAMCO in Enugu. Apart from these companies, there are many local and multinational companies that import various types of agricultural tractors.

An increase in employment opportunities in other sectors of the economy, including agricultural sector, could reduce the level of labour surplus. In such a situation, the demand for use of light equipment in construction, rehabilitation and maintenance activities could be on the increase. This would stimulate interest in local production of light equipment. Apart from Fiat and Steyre, there are numerous small-scale producers of light equipment like concrete mixers, block moulding machines, etc. located in Aba, Onitsha, Nnewi, etc who can play some role in

the production of light equipment. There is also a lot of interest in the estblishment of foundries in various part of the country. The proliferation of foundries will encourage an increase in the local component of the tractors currently being assembled in Nigeria using the imported but completely knocked down (CKD) spare parts. This will ultimately lead to the manufacture rather than assembling of tractors in Nigeria (Hussain, 1992).

2.6.4 Manpower Situation as a Factor

There is no shortage of skilled manpower for the application of labour-based technique. There is a large pool of carpenters, bricklayers, masons and steel fixers. In addition, there is a lot of unemployed secondary school leavers. Under the on-going special Public Works Programme, the Federal Government, through the National Directorate of Employment (NDE), pays the salary of more than one thousand unemployed workers per month in each State of the country. These workers are graduates of tertiary institutions like NCE, HND, FTC and Bsc in Civil, Mechanical, Electrical and Agriculture Engineering, Geology, Architecture, Estate Management, Agricultural Science etc.

IN summary, the country is endowed with a large pool of technical manpower which need to be appropriately trained for the planning and effective implementation of the labour-based construction programmes. If this asset is carefully planned, the new technology can be mastered and effectively applied (Hussain, 1988).

## 2.7 CONSTRAINTS TO THE APPLICATION OF LABOUR-BASED TECHNOLOGY IN NIGERIA

The main constraints are that the existing systems and procedures in the country favours equipment-based approach. Also, there is a lack of appropriate construction managerial capacity both in Government and the private sector. Although the country has a good stock of effective managerial manpower in manufacturing, commerce and equipment-based construction activities, there is lack of know-how, at present, on the technical and managerial aspects of labour-based construction technique.

The systems and procedures prevailing in the country, as to the project designs, the completion time, and the specifications are all geared to the use of equipment. Again, the registration of contractors is based on the size of plant the prospective contractor can mobilise. Until the foreign exchange squeeze awakened contract-awarding agencies to the present market realities, contractors were selected on the basis of their equipment holdings. These days, they only need to show that they can obtain and use such equipment.

The contracting system for the execution of all types of civil engineering projects is well established in the country. There is a large number of contractors of various sizes - major, medium and small. Most medium to lage contractors (including foreign contractors based in the country) have their expertise in equipment-based methods, whereas, the small contractors rely entirely on work done manually with basic tools and their expertise is in relatively small scale building works. There is therefore, a serious gap of small and medium size contractors who have appropriate know-how for the application of labour-based technique.

The Structural Adjustment Programme (SAP) which is being implemented in the country, emphasises the need for moving towards self-sufficiency by effective utilisation of all available resources. Senior Government officials are convinced of the need for optimum use of available resources because they have attended some orientation seminars and workshops on labour-based techniques. These government officials (policy makers, planners and administrators) must know all the positive and negative aspects of the application of the labour-based method and also know the ways and means to create the right environment in which such approach can be applied to its full potential.

Nigeria has an abundance of engineers, that are educated and trained according to the curricula relevant to the problems of developed countries, hence, handicapped in their training when it comes to the consideration for the use of appropriate technologies to suit the environment in which they will have to work after leaving the School (Hussain et al, 1990).

There is no definite provision for maintenance of installed infrastructures because responsibilities for maintenance are usually not clearly defined. Furthermore, the maintenance aspect are often not considered at the time of project preparation and implementation. Consequently, it is not clear as to who should be expected to carry out routine and periodic maintenance of the infrastructures. The local community are always enthusiastic to participate in the operation and maintenance of infrastructures installed in their localities. But they lack the financial and technical capacbilities to sustain this enthusiasm.

There is an urgent need to spell out a strategy for maintenance aspect are often not considered at the time of project preparation and implementation. Consequently, it is not clear as to who should be expected to carry out routine and periodic maintenance of the infrastructures. The local community are always enthusiastic to participate in the operation and maintenance of infrastructures installed in their localities. But they lack the financial and technical capacbilities to sustain this enthusiasm.

There is an urgent need to spell out a strategy for maintenance. The strategy should be based on community participation and on a system which makes maximum use of locally available resources - human and physical. Such a strategy should take into account the necessary institutional arrangements for effective organisation of maintenance work as well as the financial and technical, including training requirements of such procedure.

In summary, Nigeria has a large pool of technical manpower which needs appropriate orientation and training in the planning and effective implementation of labour-based/light equipment-supported works programme.

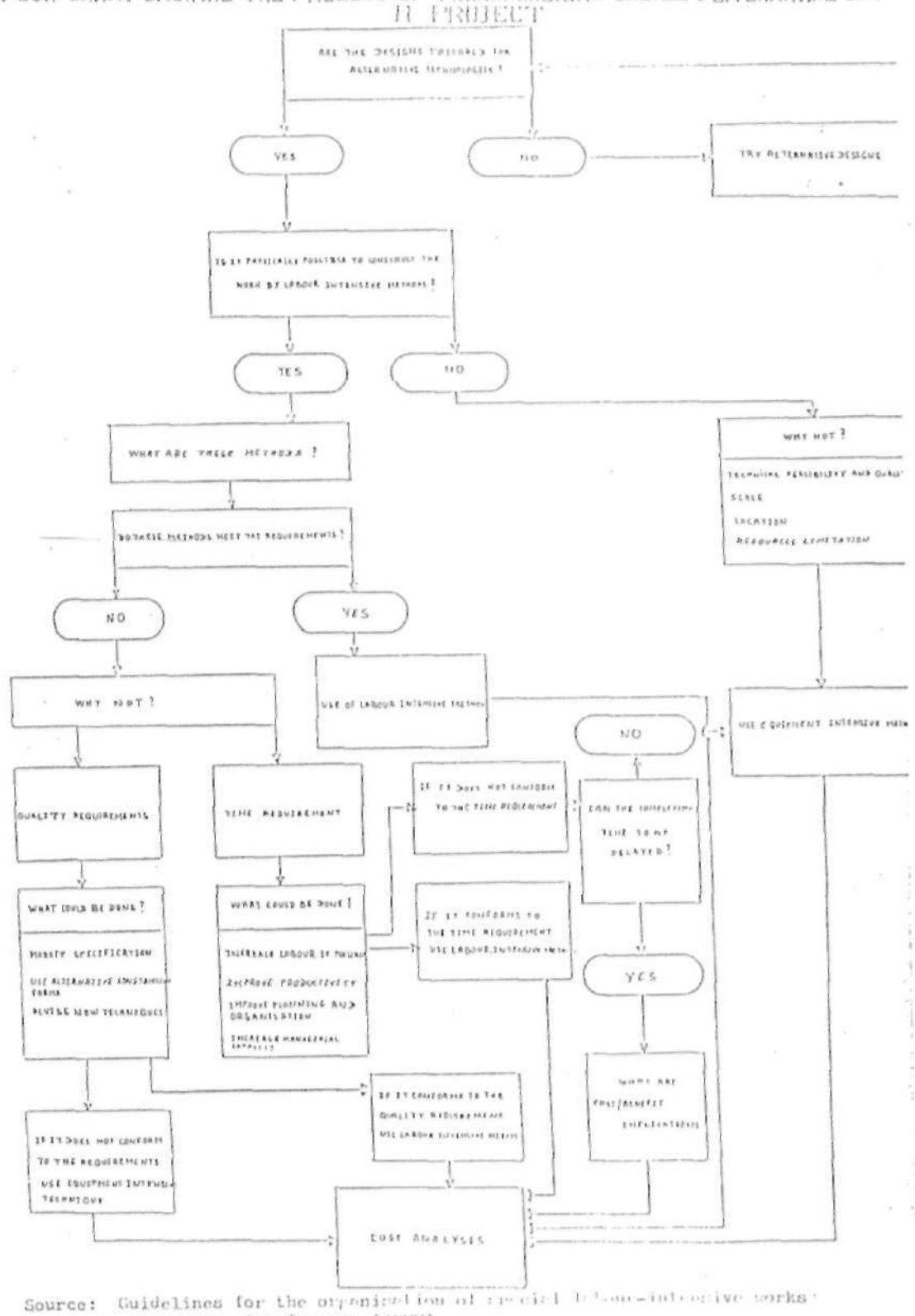
## 2.8 CRITERIA FOR CHOOSING CONSTRUCTION TECHNOLOGIES

### Introduction

In countries with a shortage of capital and availability of surplus labour, it is highly desirable that Engineers and Technicians investigate closely the possibility of utilising labour-intensive methods. Costa et al, (1977) has given the criteria for choosing the most appropriate technological methods for construction in developing countries and factors that affect the choice.

The first step in the choice of appropriate technology is to split the project into various possible tasks. The technological possibilities vary for different components of the same project. There are certain activities which clearly lend themselves to labour-intensive methods and the ideal case for labour-intensive public works programmes (LPWPs) is when labour-intensive methods are appropriate for all the activities in a project. But the use of light equipment is indiscpendsable to carry out a number of activities; and the various tasks which do not fall in either of these clear-cut categories can be carried out by manual labour as well as by equipment. Fig. 2.13 shows, diagrammatically, the process for the choice of technology.

FIG. 2.13. FLOW CHART SHOWING THE PROCESS OF TECHNOLOGICAL CHOICE FOR CARRYING OUT A PROJECT




Source: Guidelines for the organization of special labour-intensive works programmes ILO (Geneva (1977)
TECHNICAL PROBLEMS IN PROJECT : CHOICE AND DESIGN OF TECHNOLOGY

2.8.2 Factors affecting the choice of technology

Design - In the construction industry, the designers generally are not directly responsible for the construction process. It is at the design stage that the use of alternative construction techniques should be considered. In this way, the design process can be opened up to include the possibility of using alternative techniques and where necessary acceptable, it could be oriented towards one of these techniques.

In an attempt to consider the construction process as a separate entity, many analysis have ignored the fact that the design effectively constrains the construction methods adopted. There is no point in trying to use a method for which there is no room in the design of the scheme itself. The basic objective underlying the design procedure should be that the end product is a set of designs which can be costed in terms of various methods of construction at various technological levels.

Technical Feasibility and Quality - Where the specified quality requirements appear to indicate the need for mechanical equipment, it is necessary to question not only the need for mechanical equipment, but also the specification itself. The following questions should be posed and answered.

- Are the high quality standards specified really necessary?
- Could an alternative method of construction be substituted that is more appropriate to the greater use of labour and local materials, and still give satisfactory quality standards? Is it absolutely certain that there is not an alternative way of achieving the specified quality required other than by the conventional equipment - intensive methods?

Costs - Where it is technically feasible to construct a project by both methods, either equipment or labour-intensive, it is necessary ascertain which is economically and socially most advantageous.

To select the most advantageous method to the national economy in implementing a project, it is necessary to make a cost effectiveness analysis, i.e on cost comparison analysis, at market price and shadow price as well. The cost analysis at market price can be carried out relatively simply by comparing the construction and maintenance costs of alternative methods for each operation in the project and for the whole project. The shadow cost of project includes the costs due to time delays and quality differences and from which the secondary benefits, if any have to be deducted.

Construction Time - It is often thought that slowness is a disadvantage to the use of manual labour, particularly in large projects. It is possible to overcome this "slowness" by improved planning and organisation. If the productivity of the manual activity can be increased, then the same workforce can accomplish the same activity in less time. Time factor as a component of productivity can be substantially reduced.

There are various factors for which it is not possible to benefit from high productivity in capital-intensive works projects. The large amount of time consumed in planning for the equipment and awaiting deliveries or breakdown time may increase time schedules sufficiently to make it comparable to what obtains if the work is done by manual labour. Experience has also shown that not only can a very large workforce, well motivated and

organised, carry out work more cheaply than machines, but it can also proceed with the job at once, so that work can, in fact, be completed before heavy equipment can be delivered to the site.

Scale - During the construction stage, the larger the scale of the project, the greater will be the difficulty of organising and supervising it. The efficient control and use of a large labour force calls for good organisation and a high degree of managerial and supervisory skills which are not yet plentiful in developing countries.

On confined sites, such as in large earth dam construction or removal of over-burden in an open cast mining operation, there is a limit to the maximum amount of labour (and units of equipment for that matter) that can be efficiently deployed.

However, on unconstrained sties, like roads, railways and irrigation canals; etc., a large number of workers can be productively employed if properly supervised and organised. The work can be started at many points simultaneously and the overall completion time may not differ much as compared to mechanised methods.

Location - One of the main operational advantages of manual labour is its flexibility. Men can overcome or get round the obstacles which would impede machines, and can often work on sites which would need much prior clearing if machines were to be employed. When the projects are small and scattered the use of manual labour is more effective, often more economical, and sometimes the only feasible method. Such sites are less suited for the maximum use of equipment since for maximum effectiveness,

equipment needs to be concentrated.

Similarly, when the work sites are remote like most of the works in the rural areas, which are far from the main road system, if technically feasible, theobvious choice of construction is the labour-intensive methods. However, there are problems when the work site is away from the main sources of labour: It will normally be necessary to provide ancillary services, such as housing, medical care, transport, food supplies, etc. and this may sometimes put the equipment-intensive methods, if feasible, in a favourable position.

Resources - Finally, the availability of resources in terms of labour, plant, materials, managerial and supervisory, obviously have significant effect on the choice of technology. While availability of labour is the prerequisite for any labour-intensive operation, the non-availability of plant puts an emphasis on the need for a labour-intensive works programme. The material available, in terms of quality and quantity, also affects the choice of methods of construction. For instance, the use of earthen flood embankments along the river banks, may be due to the availability of suitable fill material for forming banks. The availability of managerial and supervisory capacity or lack of it also guides the choice of technology. In countries where the managerial experience is lacking in the field of labour-intensive construction there will be a natural reluctance to adopt labour-intensive works programmes, even if all other factors are favourable.

## 3.1 BACKGROUND INFORMATION

The research seeks to undertake a comparative study, vis-a-vis cost efficiency, construction time and quality of work achieved by both equipment-based and labour-based methods in the execution of three (3) small earth dams in Nigeria. These dams are of various heights and are located at Imokun village in Epe LGA, Lagos State, Batsari town in Batsari LGA, Katsina State and Oke-Odan village in Ado-Odo/Ota LGA, Ogun State. Fig. 3.1 shows the locations of the earth dam projects under study.

There are other types of dams (such as, concrete and Rock filled) whose sections and plans are similar to those of earth dams contained in this thesis. The salient features and brief description of the three small earth dams are given in subsequent subsections.

### 3.2.2 Imokun Irrigation Project

Imokun Irrigation Scheme is located at Imokun village in Epe Local Government Area of Lagos State along the Ololo stream.

The Ololo stream in Imokun is harnessed for irrigation. The stream takes its source from several perennial springs located at the foot of the hills within the enclave of the "Aaye" shrine. The dry season discharge of the stream is estimated as 12Ips (0.012m3/S). It is estimated that this discharge will irrigate 12 hectares of a mixed crop of vegetables and second season maize over an irrigation period of 12 hr/day.

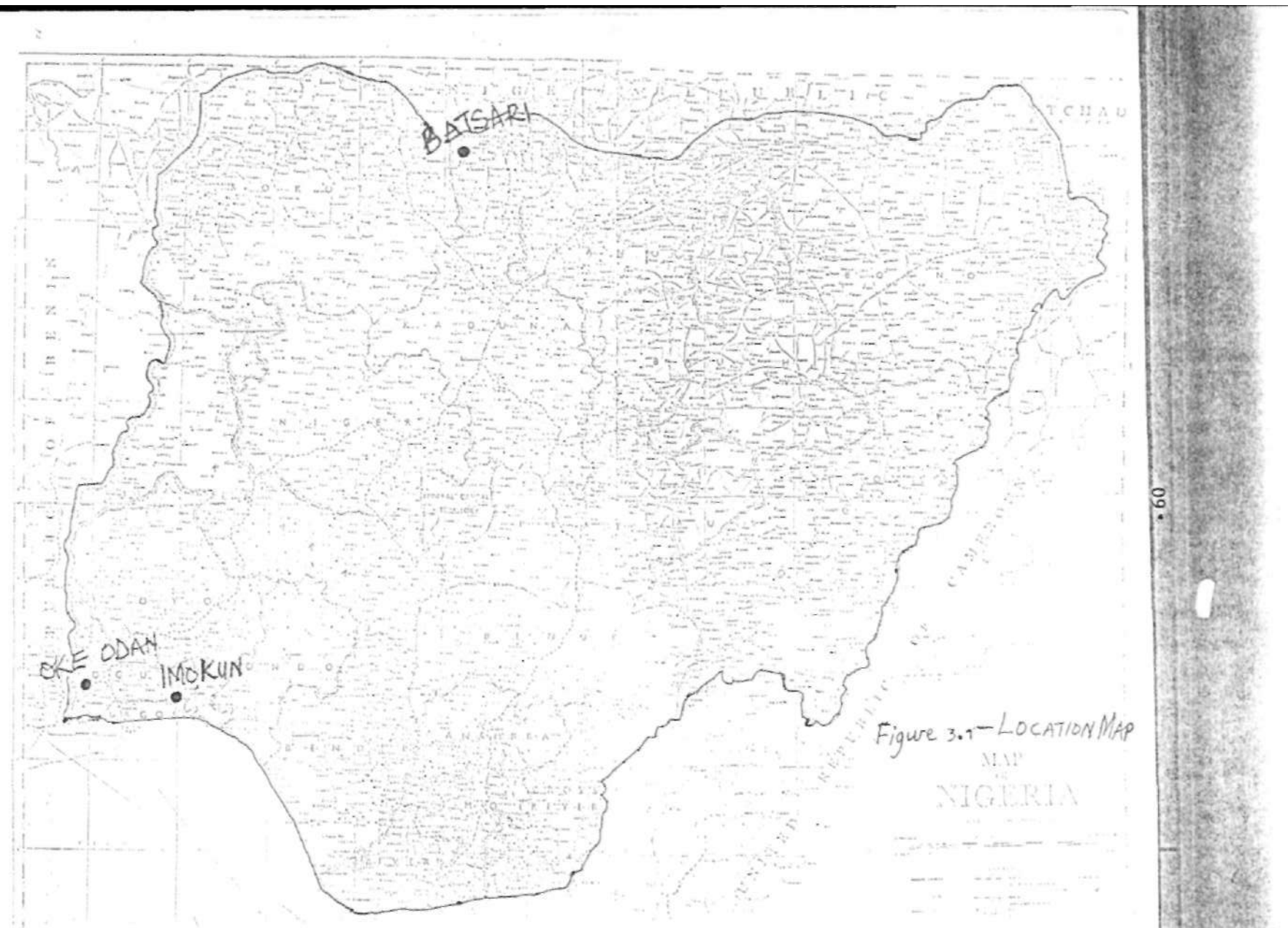



Figure 3.1 – LOCATION MAP

This case study examines two alternative options for the irrigation scheme; namely:

(a) Construction of an earth dam to raise the water level to the off take level of a canal.

(b) Pumping from the stream into the main canal.

The canal system under both options will be similar.

(a) Earth Dam Option

The dam option under Imokun Irrigation Scheme is currently under construction by UNDP/ILO under labour-based/light equipment supported construction methods. It has the following design characteristics:

| | | |
|---|---|---|
| Maximum height at stream bed | - | 5m |
| Upstream slope of embankment | - | 2:1 |
| Downstream slope | - | 1.5:1 |
| Width at crest | - | 1.5m |
| Length | - | 65m |
| Dead storage capacity | - | 1,600m3. |

The spillway consists of 2 parallel pipes located on the left flank of the dam. A scouring sluice is also provided. The site plan and cross section of the dam are shown in Figures 3.2 and 3.3.

The borrow pits for the embankment construction of the dam had been planned in such a way that these can be converted into fish ponds in due course.




Figure 3.2 Site Plan of Imokun Dam

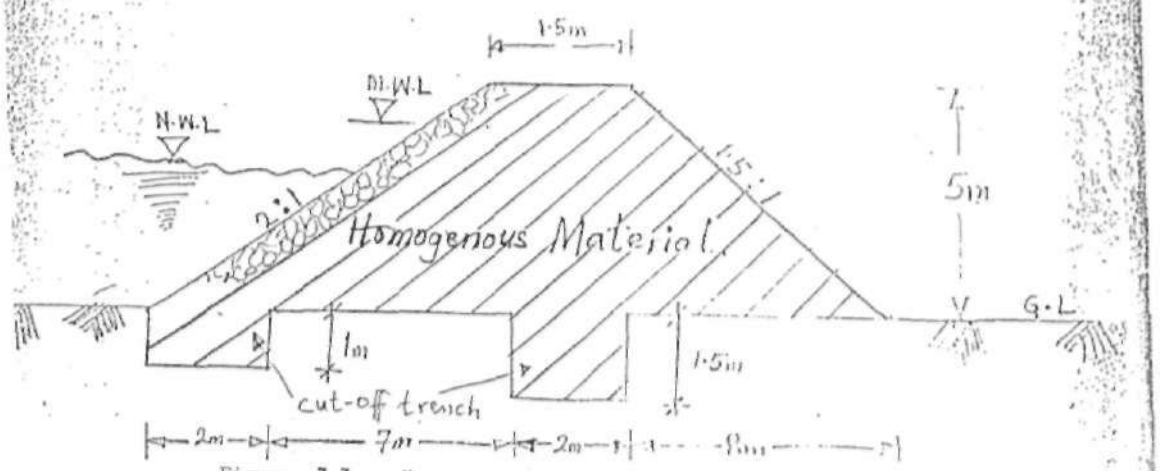



Figure 3.3 Cross Section of the Dam

The dam for the Imokun irrigation scheme was constructed by borrowing the embankment materials from borrow pits which are about 150m away from the dam axis. The recommended mode for this hauling distance is wheelbarrow but the use of wheelbarrow was not realistic because of swampy and water logged site conditions. The only mode for haulage was therefore the use of headpans, which has a productivity rate of 0.7m3/wd. The swampy and water-logged site conditions were also responsible for the inaccessibility of other light equipment, hence the use of several rows of hand rammers by labourers were successfully adopted for achieving the desired compaction.

(b) Pump Option Imokun Irrigation Scheme

The selected pump(s) has the following salient features -

(i) Type - Single state centrifugal pump, Lister TS1 water pump.

(ii) Power - The pump is powered by 8.78HP, Diesel Engine.

(iii) Operating Time - The pump is capable of operating eight (8) hours daily on continuous basis by pumping directly from a sump in the stream bed into the main canal.

(iv) Life Span - Service life of 5 years.

(v) Head - Is capable of operating up to a maximum head of 32m.

(vi) Number Required - Two (2) pumps will be required to meet the estimated discharge that will irrigate 12 hectares over a period of 12 hours/day.

Figure 3.4 shows the site plan of the Irrigation Scheme including the two (2) pumps.

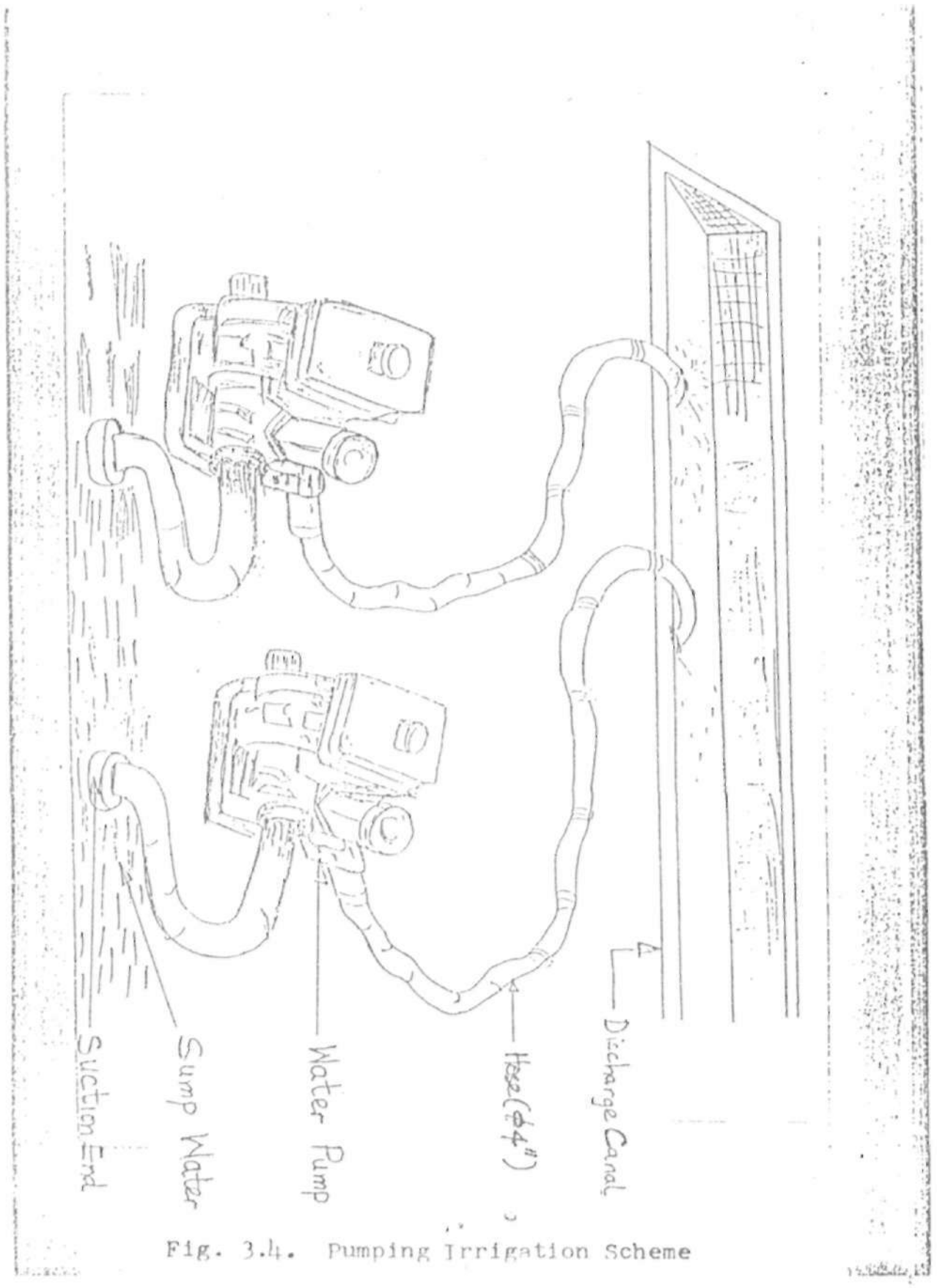



Fig. 3.4. Pumping Irrigation Scheme

The dam site for the Imokun Irrigation Scheme is confined and relatively narrow which combine to put the use of heavy construction machinery at unnecessary disadvantage. It was therefore decided to adopt the use of pump as an alternative to meet the water requirement for irrigation purposes. This option is designed to pump the same quantity of water into the canal as the spillway would have discharged in the labour-based construction.

3.1.2 Batsari and Oke-Odan Dams

The construction of Batsari and Oke-Odan small earth dams whose salient features are given below was conceptualised with the following two alternative approaches:

a) By using heavy equipment for all the constructional activities;

(b) By using the labour-based/light equipment-supported methods of construction.

Batsari Dam

The proposed earth dam is situated on a small seasonal tributary of the River Gada, north-west of Batsari town, Katsina State in order to impound sufficient water during the months of high river inflow which would meet the water supply needs of the town all the year round. Part of the design is that the selected dam site is to have a catchment area 34sq.km. The axis of the dam is underlain with silt and sandy clay which are to be excavated to a depth of impervious layer.

The dam, in addition to being of homogeneous earth fill on a horizontal impervious foundation, was to have the following salient features:

| | | |
|---|---|---|
| Maximum height of dam | - | 7.75m |
| Full Reservoir height | - | 7.25m |
| Upstream slope of the embankment | - | 1.3 |
| Downstream slope of the embankment | - | 1.2 |
| Width of crest | - | 5.00m |
| Length | - | 383.00m. |

The proposed dam sketches showing plan and cross-section is given in figure 3.5.

The proposed spillway is to be of reinforced concrete overflow weir having a designed flood discharge of 79m3/S and a maximum overflow height of 1.5m. It will be 6m long and located on the left flank of the dam. The discharge channel of the spillway is to be protected by mass concrete stilling basin and graded rip-rap.

3.1.3 Oke-Odan Dam

This earth dam is currently under construction. It is located on a tributary in a broad valley close to the confluence of the main Yewa River. The back flow of the main river has rendered the valley swampy throughout the year. The site for the dam was located by the Ogun-Oshun River Basin Development Authority for irrigation and domestic purposes. The river diversion was carried out so as to keep the construction area dry.

The dam comprised of an homogeneous earth fill on a horizontal impervious foundation. The salient features are as follows:-

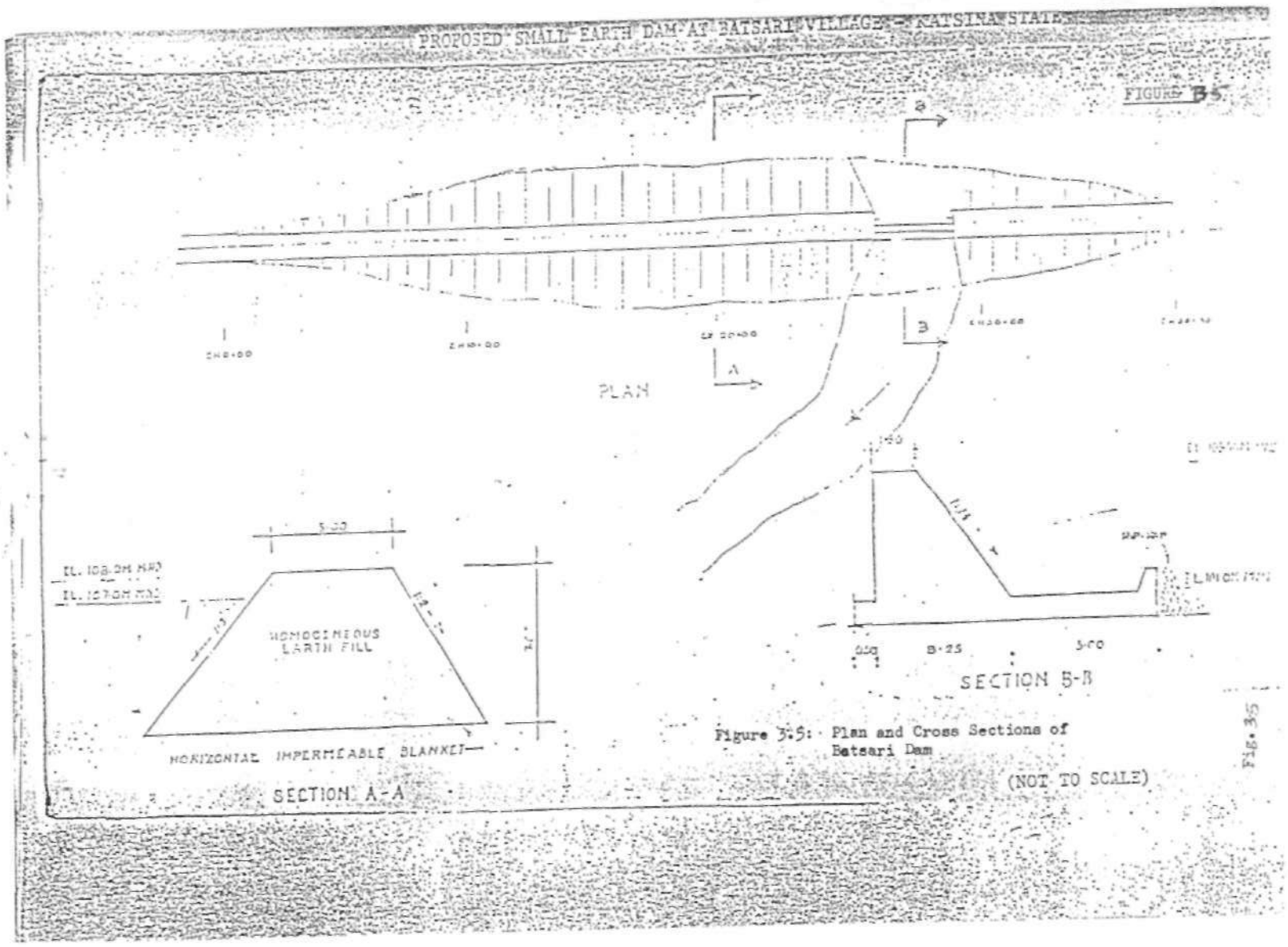



Figure 3.5: Plan and Cross Sections of Batsari Dam

| | | |
|---|---|---|
| Maximum height of dam | - | 11m |
| Full Reservoir height | - | 8m |
| Upstream slop | - | 3:1 |
| Downstream slope | - | 2½:1 |
| *Width of crest* | - | 8.00m |
| Length of dam | - | 520m |
| Catchment area | - | 40sq.km |
| Live Storage Capacity | - | 4.5Mm3 |
| Water supply Requirement | - | 1Mm3 |

The proposed spillway consisted of 8 parallel pipes (0.9m each) with a discharge capacity of 35m3/sec located on the left flank of the dam. An outlet structure to be located at the centre of the dam and beneath the embankment consisted of 2 parallel pipes of diameter 0.45m. Figure 3.6 shows the site plan of the dam while the longitudinal and cross section of the dam are shown in figure 3.7.

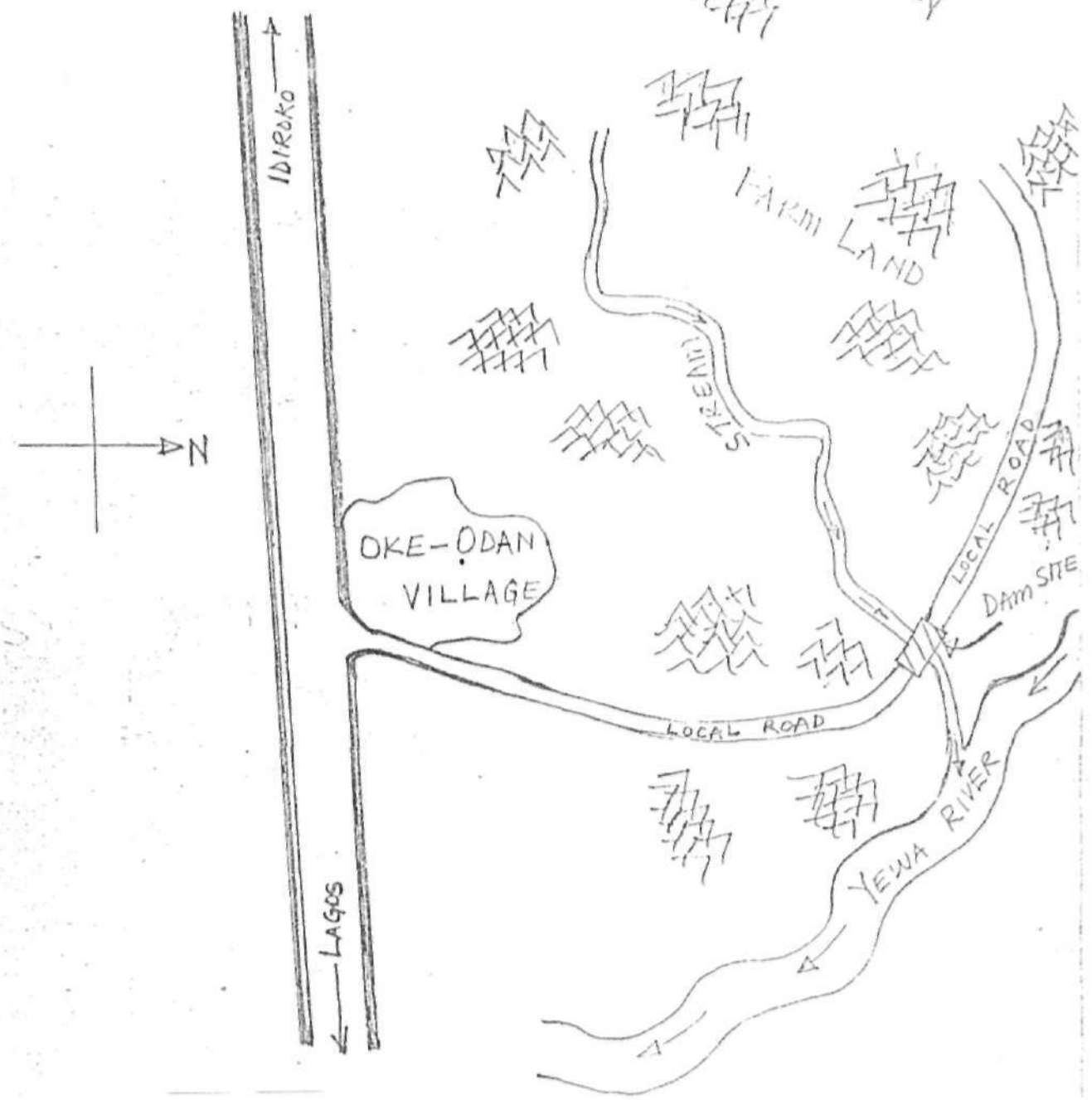



Figure 3.6 Site Plan Oke-Odan Dam
(The dam site in 4km from village)

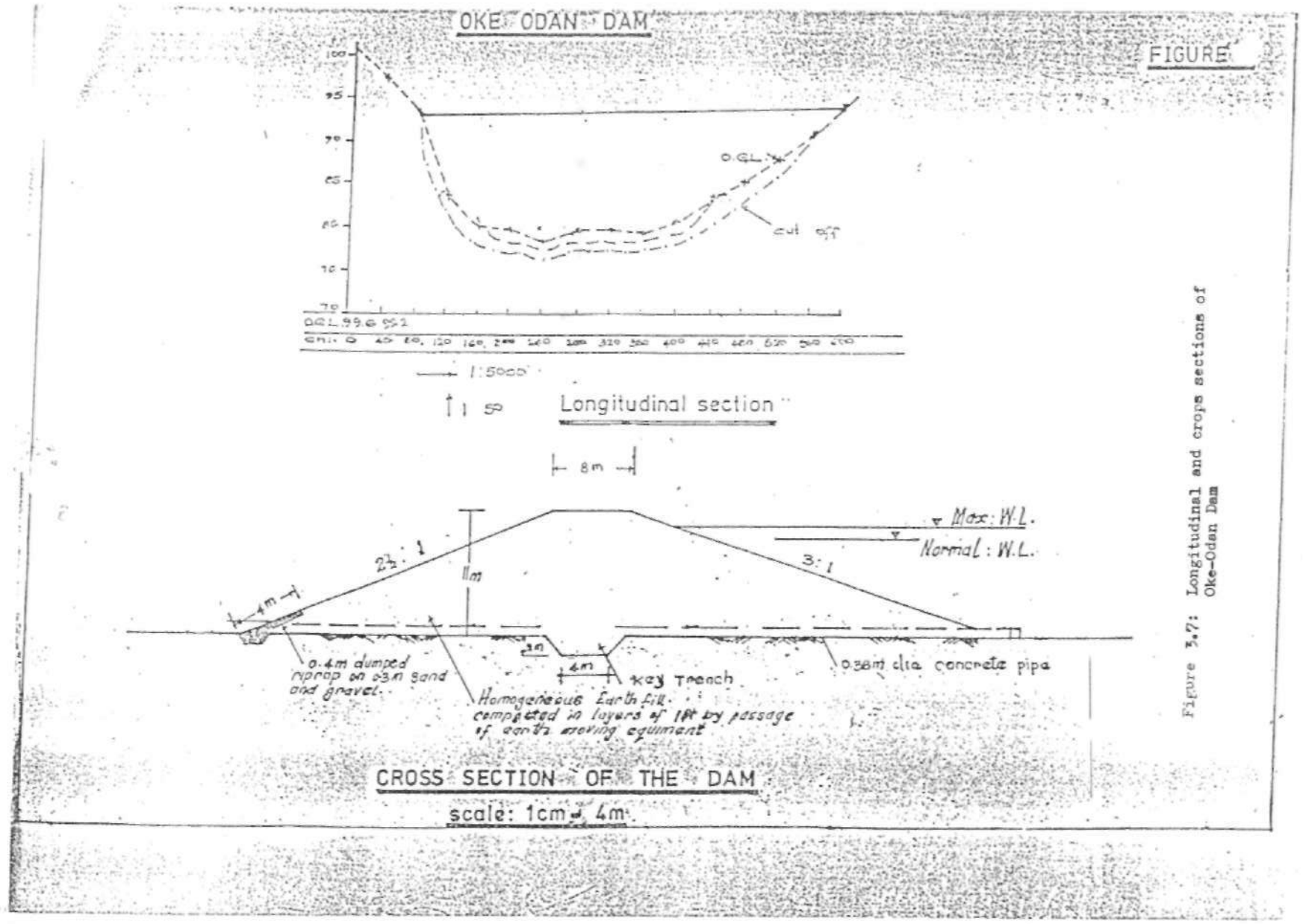



Figure 3.7: Longitudinal and cross sections of Oke-Odan Dam

## 3.2 CONCEPTUALISATION OF DESIGN

### 3.2.1 Introduction

The intention of this thesis is to make useful inference on the relative effectiveness of the labour-based technique in the construction of small earth dams as compared to the current practice of using equipment-based construction method.

The three (3) dam projects being considered are currently under construction and Table 3.1 gives the actual method of construction, the stages of completion reached up to date and the executing agencies.

Table 3.1: Status of dams under study

| S/NO | Dams | Actual Completion Stage | Actual Construction Method | Executing Agency |
|---|---|---|---|---|
| 1 | Imokun | 81% | Labour-based | UNDP/ILO/NDE |
| 2 | Batsari | 2% | Labour-based | UNDP/ILO/NDE |
| 3 | Oke-Odan | 48% | Equipment-based | OORBDA |

The dam designs were adopted as obtained from the executing agencies, no attempt was made to re-design or modify any of the dams. The focus of work done here is to evaluate the relative effectiveness of the two construction methodologies to each dam.

It is worth mentioning that the equipment-based construction method has been well developed to the extent that both the design and construction crew are versatile with it; whereas the same cannot be said of the labour-based construction technique for the project under the case studies. It therefore becomes necessary to give more details of labour-based technique; vis-a-vis construction sequence for earth dam construction, organisation of labour on sites, planning and organisation of the work itself.

These are discussed in subsequent sections of this chapter.

## 3.3 BACKGROUND INFORMATION ON LABOUR-BASED CONSTRUCTION TECHNIQUES

### 3.3.1 Construction Sequence

The construction work for earth dam using the labour-based method was divided into seven (7) operations; each of which is sub-divided into activities. These operations (or activities) follows each other in a certain order or sequence. The construction sequence of operations assumed for these case studies are:-

(a) Bush clearing which is the first operation after the site selection; it entails the cutting and carting away of all grasses, shrubs and trees to prepare the site for the project.

(b) Stumping and grubbing operation is the removal of boulders as well as the removal/uprooting of trees and other vegetation from the cleared area of the dam site. If roots or stumps are left in the ground, they will eventually rot and create voids which can undermine the stability of the dam.

(c) Top soil removal - the top soil is one that usually contains decomposed organic matter which is not suitable for dam construction so it is removed, but if a suitable layer is found at the surface, no special measures are required again.

(d) Coffer dam/Diversion ditching operation (if necessary) - a temporary barrier (usually soil is used) is errected on the original river channel upstream of the construction area; a diversion ditch/structure is then constructed to carry the water flow downstream. In this way, the construction area stays dry.

(e) Foundation preparation operation - The following activities are undertaken at this stage: levelling of bumps, depressions, filling and compaction of holes (with good soil) resulting from stumping and grubbing activity (mentioned above). Since the top soil most have been removed, the foundation surface is loosened to improve the bond between it and the embankment. It should be noted, that the best foundation for earth dams is a thick layer of stable and impervious material.

(f) Spreading and compaction of fill/embankment materials - the embankment materials (usually clays or silty clays) is dumped and spread at the dam site to an even layer (150mm) for compaction. This process is repeated layer by layer until the final height is reached.

(g) Supporting/other constructional operation - This includes activities such as, errection of site store/office, recreation shed, supply of potable drinking water, spillway/drain construction, rip-raping, grassing of the embankment, etc.

3.3.2 Labour Recruitment and Payment System

Recruitment - The unskilled or casual labourers are recruited from the communities within the catchment area of the project. Most of the activities discussed under the labour-based construction sequence are carried out with surplus labour available at a time when agricultural and other productive activities within the project area have a slack period. Thus, construction activities are designed to provide workers, who otherwise would be idle, with employment opportunities within the project area. So far, in pursuing the labour-based construction technique, the system of recruitment adopted is fair and conforms to the local customs and traditions. This implies that the local leaders or Chiefs who command considerable influence over the people are approached for their advice and assistance in the recruitment exercise. Similarly, the recruitment of workers is also entrusted to existing grassroot organisations: community development, committees/unions women groups, cooperatives or labour contractor, etc. The workers are informed before they are recruited as to the type of project they will be working on an what their working conditions will be - so that they are fully aware of their duties and entitlements.

Method of Payment - At the UNDP/ILO/NDE labour-based Imokun Dam project at Epe, it was observed that the daily paid work system was being used and the daily wage rate of ₦10.50 was being paid as at December, 1992. This wage rate may appear low when compared with the prevailing market price but the strategy is to

attract only the surplus labour to the project so that the employed labourers in other sectors of the village economy (e.g agriculture, blacksmith etc.) will not be drawn. In the daily payment system, a worker is paid a fixed wage in return for working for a fixed number of hours. It is the opinion of the Researcher that this system breeds laziness, does not give room for competition among the workers and subsequently decreases the productivity of the work force. An alternative system of payment is the piece-work method which pays on the basis of work done. Both systems of payment are considered in this project. The daily rate of ₦10.50 was also considered rather low. In the piece work system the worker is paid an agreed sum per unit of output and the total daily output is left to the discretion and capacity of the worker. Based on the market survey (to be discussed in subsequent pages) of wage structure, a realistic wage rate of ₦25 to ₦30 per day for unskilled labour is adequate. These wage rates are used for this research purposes.

3.3.3 Orgnisation the Labour Force

The use of labour-based methods on projects of any size, implies the use of large labour forces. Organisation such large forces demands operation management skills significantly different from those needed for equipment-intensive operations. These skills include the leadership qualities necessary to manage large groups of human beings, control them and motivate them for higher productivity, over a long period of time. Lack of managerial skills creates doubts about the successful completion of projects carried out by labour-based methods, and motivates planners to look for equipment-based methods for which they can get expertise from the international market.

Management of the work force - It is vital to the success of a labour-based project utilising a mass of workers that relationship between the management and labour should be good at all times. This calls for efficiency and fair dealing by management and the establishment of open two-way communications. To establish this type of communication a committee comprising of representatives from management and workers can be formed. This committee is to be charged with the responsibility of discussing mutual problems in order to prevent suspicion. The labourers will be encouraged to maintain good relationship among themselves. As labourers from various tribal, regional and religious backgrounds may have strong feelings towards each other. Full regard of labourers social and cultural background should be allowed for and proper representation of all the major groups in the committee should be allowed so that the matter can best be kept under control. This, in fact, has been the practice where labour-based techniques of construction have been adopted.

Opeorational Logistics - For those sites covered in this project, having known the size of the work force for each of the project, part of data collection was to determine the field logistics (to be discussed later).

Recreation shed was erected at about 200m away from the dam sites for the relaxation of the workers during the break period. The local food vendors were attracted for sales of the food and other items. Provision of potable drinking water in tanks/drums at both the construction site and recreation shed, was ensured. First aid supplies was kept at the site for minor injuries, even though the LGA sick bay/hospital are within a reasonable distance.

Transportation for journey-to-work was not to be provided as most of the workers were recruited within self-commuting distances.

Productivity (PR) - Productivity is the rate at which a worker produces work output under a given set of inputs and site conditions. The average productivity data for the various activities in the construction sequence of small earth dams for labour-based methods were collected for this study. PR = QW ÷ T where QW = Quantity of Work achieved. T = Time taken to achieve the work.

The importance of productivity rate in this research cannot be over-emphasised because construction cannot be planned and target achieved in construction unless these rates are realistically established.

The productivity of the workforce is a major aspect in the acceptance or rejection of labour-intensive construction activity. An essential step towards better organisation for the workforce is an understanding of the factors which affect the productivity of labour. These factors include climate, standards of nutrition and health, level of supervision, organisation, payment methods, working methods, quality of tools and the standards of site management.

Motivation - Regardless of a worker's physical work capacity, it is essential to create an environment in which the worker is motivated to achieve optimum work capacity. This can be achieved by a responsible and sympathetic managerial leadership which develops confidence in the work force and the introduction of realistic incentives that ensure adequate reward for their hardwork.

In order to achieve a high or even level of productivity, the labourers are motivated/encouraged by their supervisors, as they (supervisors) identify themselves with the work force and share workers problems with understanding. Most of the workers are those who lived in the construction sites catchment area, this had proved to be the most powerful incentive because the workers are proud to be associated with the development of infrastructures in their own locality. Special rewards for good performance can additionally be granted to the most efficient and diligent gangs of the month such as wearing of a badge or a mark of distinction. All these, it is believed will increase the productivity, make planning of work simple and supervision easier.

### 3.3.4 Site Management

In the labour-based construction sequence earlier discussed, the labour force was divided into work groups of eight (8) to ten (10) workers under a headman. Each of these work groups (gang of labourers) is responsible for the execution of an activity. The size of the gang depends on the magnitude and complexity of the work/activity. Workers in the same group have the same type of work to do. The activity of each group follows the preceeding one as closely as possible because in some cases, the work undertaken by a group may be dependent on the other. Essentially, interference or overlapping of the groups are avoided in all cases.

The headman is responsible to a gang leader who is usually in charge of an operation such as stumping and grubbing or embankment formation etc. The gang leader has two (2) to three (3) headmen working under him, depending upon the number of activities

in his operation. Thus the gang for stumping and grubbing operation has 3 groups, one for stumping, one for grubbing and one for boulder removal. The gang leader maintains discipline and peomotes work output for a particular operation.

At a higher level of supervision of the group are foremen and under each foreman there are maximum of 3 to 4 gang leaders; that is, a foreman is responsible for a labour force of 80 - 120 workers. Foremen work under a work supervisor and smaller sites employing up to 250 workers is managed by a work supervisor as the head of the construction site.

In a very large site, where an activity is undertaken by 2 to 3 groups, a gang leader is in charge of an activity instead of operation. The work supervisors in turn, work under the supervision of the site engineer.

Fig. 3.9 and 3.10 show the site management organigram for these case studies. Each group worked on the same activity throughout the construction period so that the groups became more skilled and productive the longer they worked on the same type of job. In this way, maximum benefit is derived from the acquired skills.

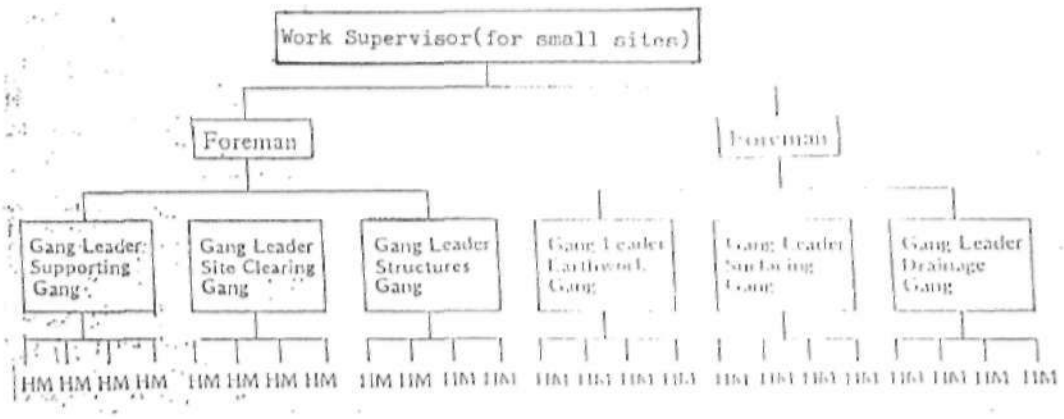



Figure 3.8 Site Management Organigram for small sites

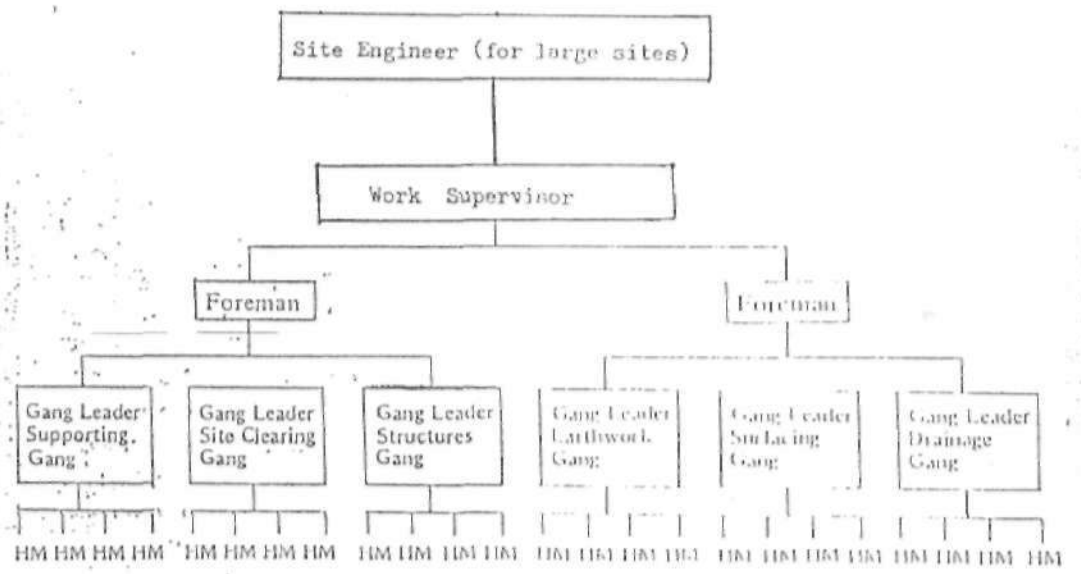



Figure 3.9 Site Management Organigram for large sites

3.3.5 Controlling the Work

A labour-based project should be a well-controlled engineering job in terms of quality and workmanship. Attention must be paid to optimising the productivity of labour-based methods, thereby reducing costs. This involves selecting not only the most effective working methods but also, once a particular method has been adopted, controlling the work task to achieve maximum efficiency of operations. The cost of the work (both unit and overall) is a major aspect of any construction project and it should be closely controlled.

Quality Control- The Supervisor or Site Engineers handling construction works have the competence to exercise the required quality control over the construction activities themselves and they also have access to materials testing laboratories. Some of the materials labouratories that have so far been used include Federal Ministry of Works and Yaba College of Technology Lagos, for Imokun Dam. Badafash Consulting Engineers, Lagos have been involved in the material testing of Oke-Odan Dam while Kaduna Polytechnic and Ahmadu Bello University Zaria are also available for Batsari Dam.

The main aspect of the quality control system which are being applied at the dam sites include (i) compliance with the method and sequence of working as specified (ii) carrying out the specific methods of testing.

(i) Compliance with the method and sequence of working as specified includes checking on excavation, formation of embankments, laying

of materials and compaction. In the case of excavation of borrow-pits, there is a restriction as to the depth of excavation (e.g. for Imokun Dam, the maximum depth of borrow-pits allowed is 2.5m because this will be converted into fish pond later while only 1m is allowed in the reservoir area of Oke-Odan so as to increase the dead storage capacity of the dam). In all the cases the open excavation allowed is 0.5 - 1m.

The embankment formation materials are laid in layers, for labour-based technique the thickness is 100m and 150mm for hand rammer and pedestrian roller respectively. The required strength/ standard of compactions is achieved by making between 3 - 5 passes of the 750kg hand-driven pedestrian roller on the land embankment materials.

ii) To ensure quality of construction and material, the regular test that were carried out included, determination of moisture content, grading analysis of soil and in situ density test. These tests guarantee that all the Site Engineers adhere strictly to all these quality tests/specifications and ensures same quality of work at the construction site of the small dams.

3.3.6 Work Planning

In preparing the work plan for a labour-based project, it is essential to have knowledge of the rate of output or productivity which can be achieved by a worker or a group of workers in executing a particular activity by a specified method. With the knowledge of the productivity rates it is possible to estimate with reasonable accuracy, the resources required (workers, hand-tools, materials and light equipment) to execute the activity

in a given time, or the time required to execute the activity given an inventory of resources available for the purpose.

A detailed work plan is prepared in two (2) stages, namely: (a) Preparation of method statement (b) preparation of time and location chart.

Method Statement- A method statement is a table that relates the quantity of work to be done under each activity/operation with the productivity rates as per working methodology and the resources required for the time taken to complete the particular activity/operation. A typical method statement sheet is as shown in Table 3.2.

The construction work is broken down into various activities/operations which are listed and quantified in the bill of quantities (BOQ). The method statement is normally prepared by taking the items from the bill of quantities, one by one. On any particular item/activity, a decision must be taken on how the work under the item should be executed, and the type of handtools or light equipment that is to be used. The total quantity (TQ) of the work (as contained in the BOQ) is divided by the known productivity rates (PR) for the selected method of execution. Thus, the number of work-days (wd) required to complete the work by the chosen method is determined; i.e TQ $\div$ PR = WD. If gangs of workers are already available for the job, then the work-days thus obtained should be divided by the gang size (ie, the number of workers in the gang GS) to obtain the number of days required (DR) to complete the job, WD $\div$ GS = DR. On the other hand, if the work-days is divided by the number of

METHOD STATEMENTS (LABOUR-BASED)
Kagara Dam Rafi LGA Niger State

Table 3.2 Typical Method Statement Sheet

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | LABOUR Time | MATERIALS Description | MATERIALS Qty | MATERIALS Unit | EQUIPMENT Type | EQUIPMENT Time | HAND TOOLS Type | HAND TOOLS Qty. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | BUSH CLEARING | 30800 | $m^2$ | Clear dam site and Reservoir Area of vegetation | $10m^2$/wd | 385 | 2GL 40USL | 10 days | Rope | 4 | No. | | | Cutlass 3F<br>Rake 1F<br>File 1F | | In each division use one (1) modified lacuwer (GL) as a highguard |
| 2.00 | FELLING OF TREES | 147 | No. | Fell trees from dam axis and Reservoir Area Cut to sizeable pieces | 30No./wd | 5 | | | | | | Chain Saw (2No) | 3days | | | |
| | | | | Carting away of fell trees | 1.5No/wd | 98 | 2GL 30USL | 2days | | | | | | Cutlass 60<br>File 10 | | |
| 3.00 | STUMPING AND GRUMBING | 99 | No. | Remove stump and grub along the dam axis | 1No./wd | 99 | 4GL 100USL | 1 day | | | | | | Pickaxe 60<br>Spade 40<br>Shovel 20 | | |
| 4.00 | TOP SOIL REMOVAL | 30000 | $m^2$ | Remove and cart away top soil and peat to depth of about 0.3m along the dam axis | $15m^2$/wd | 2000 | 7 GL 155 USL | 13 days | | | | | | Cutlass 60<br>Headpan 15<br>Pickaxe 60<br>Spade 30<br>Shovel 45<br>Headpan 70 | | |

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days required for completing the work we would obtain the number of workers required for the work; WD ÷ DR = GS. When the number of workers on the job is known, the exact number and type of handtools/light equipment required are determined. Thus, a complete method statement for the whole project (incorporating each item of work in the BOQ) can be prepared. The method statement is used by the Site Engineer, Work Supervisor and Foreman for the preparation of the weekly/daily work plans.

For the projects under consideration, this analysis made it easy to establish the sequence and phasing of operations with time required in days/weeks. In the preparation of the method statement factors that affect the phasing of operations are availability of labour, light equipment and materials.

The method statements for all the activities/operations involve in the case studies under consideration have been prepared in detail for both the labour-based and equipment-based methods of construction (in appendices 7 - 12).

Time and Location Chart (TALC)- A recent innovation in the planning of civil construction has been the use of time and location chart. This technique is used to simplify the planning process and present it in a way that is easily understood by non-technical staff in the field. The technique is more relevant to the construction of projects like dams, flood embankments, roads, canals and pipelines (drainage or water supply). It illustrates the main elements of a critical path network, without using the network diagram, and visually displays the location of critical operations along with the rest of the operations in a project. The diagram also shows the relationship in time

and location of one operation with another: thus, the dependence of one operation on another is shown in the same way as in a critical path network. The time and location study technique is a very useful instrument of planning and execution. On labour-based projects it provides a firm basis for the scheduling and planning of the work of large labour forces and therefore has a direct management application.

The chart is a graphical representation of the major constituents on the dame project in the following manner:-

(i) The plan of the dam is represented in a line diagram at the top of a drawing sheet. The location of all the structures and note-worthy features of the topography and vegetation of the adjoining lands are shown at the appropriate locations on the line diagram.

(ii) The longitudinal section of the dam is drawn under the plan and pictorially shows the volume of the embankment filling.

(iii) A time scale in weeks is drawn on the vertical axis, perpendicular to the diagram of the dam. Each operation in the construction sequence is represented on the diagram by a line. The locations of the starting point and ending point of each operation can be read off from the chainage scale on the line diagram and the times of commencement and ending from the vertical time scale. Each point on the line represents a location on the dam at which a particular operation is in progress at a particular time. The location and timing of the operation at the point may be read off from the chainage scale on the horizontal axis and the time scale on the vertical axis respectively.

(iv) The lines representing the various operations are then drawn one after the other in their normal sequence and lasting for the duration calculated in the method statement. The description of each operation together with the resources employed on it are written on top of each line.

(v) On the right hand side of the diagram a table of resources required on weekly basis is compiled for the project. The details of the types and numbers of all the resources (workers, handtools and light equipment required for the execution of the various operations in progress during each week is shown on this table.

Time and location chart clearly show the locations, dates of commencement, duration and completion of each operation as well as the resources required such as workers, handtools, materials and light equipment. It also shows the various activities in progress on a particular location at any particular time as also the timing of various activities on a particular location. Thus, it provides a sound basis for the execution of the project.

The Time and Location Chart is capacble of incorporating a lot of variations and the plan can be made as simple or as detailed as circumstances require. This is particularly important, as in labour-based construction where highly qualified technical personnel may find themselves supervising lower level supervisory staff of low educational background. From the Table of Resources, the engineer can prepare a precise plan for ordering the resources required on the deployed and used.

## 3.4 CONCEPTUAL ASPECTS OF EQUIPMENT-BASED CONSTRUCTION

### 3.4.1 Construction Sequence

In the Equipment-based methods of construction for small earth dam, the sequence adopted is similar to that of labour-based discussed earlier except that the first two (a & b) operations in the labour-based technology are carried out as a single operations. The construction sequence under equipment-based methods is as under:

(i) The Site Clearing operation (bush clearing, grubbing, tree and stump removal, boulder removal etc.,)

(ii) Top soil removal operation

(iii) Construction of coffer dam (if necessary)

(iv) Foundation preparation

(v) Embankment formation

(vi) Supporting or Ancillary works.

3.4.2 Construction Equipment and Logistics

The equipment-based construction is a technique that relies on the use of heavy construction equipment. Each of the operations itemised for the cases under consideration was accomplished by the use of one or more heavy equipment. Data was collected on the available plant hiring companies within the project area. Data was also collected on availability, hiring rates and transportation charges to the dam sites of construction equipment. Details are given in the next chapter. The construction machines were available for hire from plant hiring companies according to the construction plan. In case of breakdown there was immediate replacement of construction equipment.

The number/size of the construction machines used for an operation was dependent on the type, size and location of the construction site. The limitation posed to the number/units of equipment that can work efficiently at the same time in a confined (dam) construction sites was taken into consideration in the planning and construction stages of these case studies.

The equipment-based technique requires high level supervisory staff which is relatively low in numbers when compared with the

labour-based technology, where a maximum of two (2) supervisors worked under a Site Engineer who was the head of the construction crew for these case studies.

The local food vendors were attracted to the construction sites for sales of food and potable drinking water. First aid box was kept at the site for minor injuries while the LGA health centres were not very far being less than 4km from the construction sites.

### 3.4.3 Productivity

Productivity is the expected output of a machine per unit of time depending on some factors. The factors that affect the productivity rates of construction equipment are climatic conditions and terrain of the sites, equipment maintenance and the mode of the operator when the machine is being used.

The average productivity rates of heavy construction equipment for the various operations in the sequence of earth dams construction was collected and are further discussed in the next chapter.

### 3.4.4 Controlling and Planning the Work

The quality control of equipment-based technique is similar to the labour-based method earlier discussed. The only exception was the procedure followed in the embankment formation. The embankment materials are laid in layers with a thickness varying between 150mm - 200mm. The required standard of compaction of the embankment materials was attained in 2 - 3 passes by the twelve (12) tons ship-foot pneumatic tired or dead weight roller.

In planning the work under the equipment-based method of construction, the same procedure was followed based on method statements and time and location charts as for labour-based except that the productivity norms used were those of heavy equipment instead of labour or light-equipment.

# CHAPTER 4: DATA COLLECTION

## 4.1 INTRODUCTION

Several data sources were utilised for this study: data was gathered from field visits to various dam construction sites, offices of relevant agencies, and from available literatures, market surveys and plant hiring firms. Also, the data was collected at two different stages. The first data set which was on productivity rates was got between February - November 1992 and the second set, which was mainly on cost prices of tools and hiring charges of equipment was obtained in December, 1992.

## 4.2 PRODUCTIVITY DATA

Productivity data was obtained at dam construction sites, office record of related agencies, publications and personal experience. The earth dam construction sites visited include Imokun in Lagos State, Oke-Odan in Ogun State, Ede in Osun State, Officki and Sepeteri both in Oyo State. Data collection was by direct observation, verbal interviews of site workers and their supervisors. Additional information was also obtained from office records of Ogun-Osun River Basin Development Authority Abeokuta. The data from UNDP/ILO/NDE office at Lagos was also made available for this study. Some data was also obtained from publications of the World Bank, Transport and Road Research Laboratory (TRRL) and Yanney (1989). The productivity data collected from the above sources are given in Table 4.1 for aspect related to labour-based on technique and Table 4.2 for those relating to equipment-based technique.

Table 4.1: Productivity Indices for Activities relevant to labour-based construction technique

| S/No. | LABOUR-BASED ACTIVITY | PRODUCTIVITY RATE | | |
|---|---|---|---|---|
| | | IBOKUN | OKE-ODAN | BATSARI |
| 1. | Bush clearing (Thick vegetation) | $80m^2$/wd | $80m^2$/wd | $120m^2$/wd |
| 2. | Bush clearing (Light vegetation) | $120m^2$/wd | $120m^2$/wd | $150m^2$/wd |
| 3. | Felling of treds (Labour) | 2No/wd | 2No/wd | X |
| 4. | Felling of trees (Chain saw) | 30No/wd | 30No/wd | X |
| 5. | Carting away of felled trees | 1.5No/wd | 1.5No/wd | X |
| 6. | Stumping and Grubbing | 1No/wd or $12m^2$/wd | 1No/wd or $12m^2$/wd | X |
| 7. | Top soil removal (0.3m) | $15m^2$/wd | $15m^2$/wd | $12m^2$/wd |
| 8. | Excavation of Laterite | $3.5m^3$/wd | $3.5m^3$/wd | $2.5m^3$/wd |
| 9. | Loading of laterite | $4m^3$/wd | $4m^3$/wd | $3m^3$/wd |
| 10. | Hauling (Headpan) | | | |
| | dist. 50m | $2m^3$/wd | $2m^3$/wd | $2m^3$/wd |
| | dist. 80m | $0.7m^3$/wd | X | |
| 11. | Hauling (Wheel barrow) | X | $2.5m^3$/wd | $2.5m^3$/wd |
| 12. | Hauling (Tractor) dist. 1km | X | $78.4m^3$/wd | $78.4m^3$/wd |
| 13. | Spreading of laterite | $12m^3$/wd | $12m^3$/wd | $15m^3$/wd |
| 14. | Watering of laterite | 500Lit/wd | 500lit/wd | 500lit/wd |
| 15. | Compaction (Hand Rammer) | $3m^3$/wd | $3m^3$/wd | |
| 16. | Compaction (Pedestrian Roller) | X | $180m^3$/wd | $180m^3$/wd |
| 17. | Concreting (By Hand) | $1m^3$/wd | $1m^3$/wd | $1m^3$/wd |

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Table 4.1 (contd)

| S/No. | LABOUR-BASED ACTIVITY | PRODUCTIVITY RATE | | |
|---|---|---|---|---|
| | | IMOKUN | OKE-ODAN | BATSARI |
| 18. | Constructing (Mixer capacity $0.5m^3$) | X | $10m^3$/wd | $10m^3$/wd |
| 19. | Concreting (Mixer capacity $1.5m^3$) | X | $24m^3$/wd | $24m^3$/wd |
| 20. | Loading of concrete mixer | X | $2m^3$/wd | |
| 21. | Placement of concrete rings ($\phi$450mm) | 3No/wd | 5No/wd | X |
| 22. | Placement of concrete rings ($\phi$900mm) | X | 3No/wd | X |
| 23. | Erection and removal of formwork | $20m^2$/wd | $20m^2$/wd | $20m^2$/wd |
| 24. | Hauling and placing of rip rap (Hauling distance 100m) | $2m^2$/wd | $2m^2$/wd | $2m^2$/wd |
| 25. | Backfilling and compaction | $1.5m^3$/wd | $1.5m^3$/wd | |
| 26. | Blockwork (Laying) | 70No/wd | X | X |

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Table 4.2: Productivity indices for activities relevant to Equipment-based construction technique

| S/No. | Equipment-Based Activity | Type | Machine | Productivity Rate |
|---|---|---|---|---|
| 1. | Bush Clearing | Light Clearing<br>Medium "<br>Heavy " | Bulldozer D6<br>Bulldozer D8<br>Bulldozer D8 | 5,000m$^2$<br>5,000m$^2$<br>4,000m$^2$ |
| 2. | Top Soil Removal | 300mm thick<br>200mm thick | Bulldozer D8<br>Bulldozer D6 | 1,500m$^2$<br>1,500m$^2$ |
| 3. | Excavation | Open<br>Pit | Bulldozer D8<br>Excavator (Depending on bucket size) | 350m$^3$<br>80 - 200m$^3$ |
| 4. | Loading | | Payloader | 250m$^3$ |
| 5. | Spreading | | Spreader | 500m$^3$ |
| 6. | Compaction | | Roller | 500m$^3$ |

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## 4.3 Market Surveys

Market surveys were conducted in the month of December 1992. The selected markets where the surveys were carried out included Jankara Market in Lagos, Ogunpa in Ibadan, Sapon in Abeokuta and Central Market in Kaduna. These markets are the biggest and constitute the main city markets within the catchment areas of the case studies. The surveys were undertaken principally to ascertain the availability and prices of labour, handtools and construction materials. The average open market prices of these goods/services are summarised in Table 4.3.

## 4.4 Plant Hiring Rates

A survey of private companies and government agencies dealing in the hiring of light or heavy construction equipment in Lagos, Ibadan, Abeokuta and Kaduna were conducted. The main aim of carrying out the survey is to assess the availability and hiring rates of the machines. The survey covered a total of seven (7) private firms and two (2) government agencies. Two (2) private firms each at Lagos, Ibadan and Kaduna while the other one is at Abeokuta, of the 2 government agencies contacted - one each at Lagos and Abeokuta respectively. The survey revealed that it is better to use a tractor with at least two trailers for a hauling distance greater than 1km for maximum efficiency. All the private firms contacted said they will make any of the desired heavy equipment available according to the construction plan given only one week notice. There will also be a replacement within twelve hours of any broken down machine if a hiring agreement is signed with them. Such an agreement would entail tha all the equipment needed at the site are hired from a particular

Table 4.3 Cost Figures Obtained From Market Survey Conducted in December 1992

| S/No. | I T E M S | LAGOS ₦ | IBADAN ₦ | ABEOKUTA ₦ | KADUNA ₦ |
|---|---|---|---|---|---|
| 1. | LABOUR | | | | |
| | Unskilled Labour (per day) | 40 | 35 | 35 | 30 |
| | Skilled Labour ( " ) | 50-60 | 45 | 45 | 40 |
| 2. | HAND TOOLS | | | | |
| | Cutlass (CL) | 95 | 95 | 110 | 105 |
| | File (FL) | 50 | 55 | 60 | 60 |
| | Hand Rammer (HR) | 200 | 180 | - | 250 |
| | Headpan (HP) | 90 | 90 | 100 | 95 |
| | Pickaxe (PAX) | 180 | 180 | 195 | 200 |
| | Rake (RK) | 70 | 65 | 75 | 80 |
| | Shovel (SH) | 95 | 100 | 100 | 110 |
| | Spade (SP) | 90 | 100 | 105 | 100 |
| | Wheel barrow (WB) | 800 | 750 | 850 | 800 |
| | Watering Can (WC) | 90 | 90 | 95 | 95 |
| 3. | MATERIALS | | | | |
| | Cement (50kg each) | 100 | 100 | 100 | 100 |
| | Gravel (3.6m$^3$ each) | 750 | 650 | 600 | 700 |
| | Sand (3.6m$^3$ each) | 400 | 300 | 300 | 450 |
| | Corrugated Iron Sheet(Bundle) | 950 | 1050 | 1100 | 1200 |
| | Empty Drum (200 Lits each) | 200 | 160 | 220 | 220 |
| | Rope (30m) | 150 | 150 | 180 | 150 |
| | Measuring Tape (30m) | 200 | 180 | 220 | 200 |
| | Timber - 0.025mx0.305mx3.66m | 70 | 55 | 65 | 70 |
| | 0.05mx0.05mx3.66m | 20 | 15 | 18 | 25 |
| | 0.05mx0.05mx3.66m | 35 | 25 | 30 | 45 |
| | 0.05mx0.15mx3.66m | 45 | 35 | 40 | 55 |

Table 4.3 (contd)

| S/No. | I T E M S | LAGOS ₦ | IBADAN ₦ | ABEOKUTA ₦ | KADUNA ₦ |
|---|---|---|---|---|---|
| | Concrete Ring (ø450mm) | 200 | 160 | 160 | 200 |
| | Concrete Rings (ø900mm) | 250 | 200 | 200 | 280 |
| | Wire Nail (Bag) | 450 | 470 | 480 | 500 |
| | Roofing Nail (per pound = 0.454kg) | 15 | 18 | 20 | 20 |
| | Mild Steel (per ton) $\phi 12_{mm}$ | 8950 | 8800 | 9000 | 8800 |
| | Block (9") | 9.50 | 9.0 | 8.80 | 9.50 |
| 4. | LIGHT EQUIPMENT HIRING (per day) | | | | |
| | Concrete Mixer ($0.5m^3$) | 800 | 700 | 700 | 900 |
| | Concrete Mixer ($1.5m^3$) | 1100 | 950 | 1000 | 1250 |
| | Concrete Dumper | 1500 | 1200 | 1500 | 1800 |
| | Chain Saw | 500 | 350 | 400 | 450 |
| | Pedestrian Roller | 2000 | - | - | 2300 |
| | Tractor | 550 | 450 | 450 | 500 |
| | Trailer | 300 | 200 | 200 | 250 |
| | Water Pump | 500 | 400 | 400 | 600 |
| 5. | HEAVY EQUIPMENT HIRING (per day) | | | | |
| | Bulldozer | 6000 | 5800 | 5500 | 6000 |
| | Excavator | 5500 | 5000 | 5000 | 6000 |
| | Gradder | 4800 | 5000 | 4500 | 5000 |
| | Payloader | 4800 | 4500 | 4500 | 4800 |
| | Roller | 4500 | 4500 | 4000 | 4800 |
| | Tipper Lorry | 1800 | 1500 | 1500 | 1800 |
| | Water Tanker | 1800 | 1500 | 1800 | 2000 |
| | Low Loader | 8500 | 8000 | 8000 | 10000 |
| 6. | SUPERVISORY WORKERS (Average monthly salary including all allowances) | | | | |
| | Site Engineer | 4000 | 3500 | 3500 | 3500 |
| | Site Supervisor | 3500 | 2500 | 2500 | 2500 |
| | Work Foreman | 2000 | 1500 | 1500 | 1500 |

company whose mechanic will always be at the construction site for routine maintenance/services and prompt report of any signal or fault in any of the hired equipment so that a replacement can be planned before final breakdown. The average hiring rates based on the survey are compiled in Table 4.3 along with data obtained from market surveys.

## 4.5 Cost of Water Pump Acquisition

A quotation for the cost of purchase and installation of a suitable water pump was obtained from UTC, Ibadan (see Table 4.4). According to the UTC Irrigation Engineer and Field Operation Manager, the two selected water pump are capable of discharging the quantity of water required to irrigate 12 hectares of land over a period of 12 hours/day.

UTC Nigeria PLC
Ibadan.

FIELD OPERATIONS:
P. O. BOX 1381,
IBADAN.

United Nations Development
Programme,
International Labour Organisation,
Project Zonal Office,
12 - 14 Winjobi Street,
Off Old Ife Road,
P. O. Box 29115,
Ibadan.
Oyo State.

# Quotation

Table 4.4

RC: 6436 IBFO.92/EOF/DJA/056 22nd DECEMBER, 1992.

| Item | Description | Price |
|---|---|---|
| | QUOTATION FOR THE SUPPLY OF LISTER TS 1 WATER PUMP | |
| | TYPE: CX3 Single State Centrifugal Pumps. CX3 Lister (TS1 8.75 HP, Diesel Engine). | |
| | Price | ₦135,000.00 |
| | 4" Diameter Hose, Cost/Meter = ₦300.00/ Meter. | |
| | Frequency of Service:- 4 Times in a Year. | |
| | Estimate Cost of Service: - ₦1,600.00 /Service | |
| | Cost of Transportation to: | |
| | i. Epe Lagos State. ₦6,000.00 | |
| | ii. Oke-Odan -Ogun State ₦8,000.00 | |
| | iii. Batsari Dutsinma - Katsina State. ₦12,000.00 | |
| | iv. Abeokuta - Ogun State ₦8,000.00 | |
| | * Installation Cost: Subject to Site Inspection but Estimated at about 10% of the cost of Equipment. | |
| | *Please note that we shall only supply at the price ruling at the time of delivery. | |

E. O. FALADE
FIELD MANAGER.

Quotation is valid until (SEE OVER LEAF)

Terms of payment FULL PAYMENT WITH YOUR ORDER.

Delivery EX-STOCK.

Above quotation is subject to conditions of sale printed overleaf CO18/90

## CONDITIONS OF SALES

All quotations and contracts are subject to the laid down conditions (unless otherwise agreed in writing).

1. Acceptance of Orders
We reserve the right to accept or refuse any order.

2. Confirmation of Orders
Verbal orders and orders by cable, telegram, telephone or telex must always be confirmed in writing.

3. Prices
The Company's prices are based on current ex-works costs, ocean and inland freight rates, insurance rates, import duties, Government taxes and present rate of foreign exchange but in the event of any change in any of the foregoing between the date of this quotation and the date of delivery we reserve the right to adjust the prices accordingly.

4. Delivery
The delivery date stated in the quotation shall be open to revision. The Company shall employ all reasonable means to effect delivery within the time stated but cannot accept liability for loss or damage arising out of late delivery or non-fulfilment of contracts by reason of strikes, political strife, import licence, Government regulations, delay in transport not owned by the Company, or other matters outside the control of the Company.
Where breakages of materials occurred whilst in transit in the Company's own transport, delays caused by such breakages will be regarded as a matter outside the control of the Company. The liability of the Company in such cases is limited to replacing such articles free of charge and no allowance can be made for any consequential expenses incurred by the customer.
Material offered ex stock is subject to being unsold upon receipt or order.

5. Insurance
Insurance against loss, breakage and/or damage to goods conveyed from the Company's Store in vehicles provided by customers is the responsibility of the customer and will not be covered by the Company.

6. Claims
The customer shall be deemed to have accepted the goods as conforming to the offer/quotation if the customer does not notify in writing to the contrary within 14 days of delivery thereof.

7. Modifications
Drawings, specifications, photographs and other illustrations, advertising matter and details in instruction books, catalogues and other publications supplied by the Company represent generally the goods specified but not necessarily the goods the subject of the offer/quotation and shall not form part of any contract based thereon nor shall the Company be responsible for any representations not specifically confirmed in writing to the individual customer.

8. Payment
Unless specific credit arrangements have been made in a particular case, all invoices are cash against presentation. All accounts are strictly net unless otherwise stated.
The Company shall be entitled to charge interest at the prevailing Bank lending rates on all overdue accounts, and expressly reserves the right to refuse to deliver to a customer at any time when the account of that customer is in debt whether in connection with that particular transaction or any other transaction.

9. Cancellation
The Company reserves the right to refuse cancellation. Where an order has been made and the Company has commenced the execution of the order, the Company shall not make a refund of any deposit paid by the customer.
The customer shall also be held liable for any loss not covered by the deposit. In the case of a credit customer, he/she shall be liable to pay for cost of goods produced upon his/her order.

10. Installation (Where applicable)
The customer shall prepare the premises where installation is to be carried out in accordance with the Company's specification and shall make the premises safe for the Company's workers, servants or agents. The Company shall not be held responsible for delay that may be due to bad layout or incomplete preparation of the premises. The Customer shall be responsible for the provision of all services (Electricity, water, lifting equipment etc) as requested in the quotation without charge to the Company.

11. Guarantees (where applicable)
The equipment supplied is guaranteed to be free of faulty workmanship and material for a period of..... from date of despatch.
Always refer to the manufacturer's warranty terms and conditions.
The Company undertakes at its option and at its expense to repair or replace the defective equipment or to refund any Purchase monies paid to it in respect of any equipment or portion thereof which during the guarantees period is found mechanically defective. This guarantee shall not be operative and enforceable (a) if the equipment is not operated strictly in accordance with the manufacturers instructions,
(b) in respect of any defect arising from accident, misuse or neglect, or (c) in respect of any other cause whatsoever beyond the Company's control.

for: UTC NIGERIA PLC.
FIELD OPERATIONS, IBADAN.

22ND DECEMBER, 1992 (Date)

Lagos

CO 19/86

## 4.6 Bill of Quantities (BOQ)

The bill of quantities (BOQ) for the work to be executed in each of the three dams under study was collected from the executing agencies. The BOQ for the two dams situated at Imokun in Lagos State and Batsari in Katsina State were collected from the UNDP/ILO office while that of Oke-Odan dam in Ogun State was obtained from the Abeokuta office of OORBDA. The BOQ collected for Imokun dam option is given in Table 4.5 and the pump option is given in Table 4.6. Table 4.7 gives the BOQ for Batsari while that of Oke-Odan is in Table 4.8.

Table 4.5: Bill of Quantities (Dam Option)
Imokun Dam Epe LGA Lagos State

| ITEM NO. | | DESCRIPTION OF WORK | QUANTITY | UNIT |
|---|---|---|---|---|
| | | DAM | | |
| 1.0 | | Clear dam site and reservoir area of vegetation (including borrow areas) | 1,900 | $m^2$ |
| 2.0 | | Fell trees from dam axis and reservoir area; cut to sizeable pieces and pack in downstream side at distance not exceeding 100m | 120 | No. |
| 3.0 | | Remove stumps and grub along dam axis | 50 | No. |
| 4.0 | | Remove top soil and peat to a depth of 200mm - 300mm along dam axis | 1,600 | $m^2$ |
| 5.0 | | Excavate cut-off trenches as directed, fill with suitable impervious material and compact adequately | 130 | $m^3$ |
| 6.0 | | Excavate and load suitable material from approved borrow areas, haul, deposit, spread, water and compact in 100mm layers and shape upstream and downstream slopes | 1,500 | $m^3$ |
| 7.00 | | Scouring Sluice | | |
| 7.01 | | Provide and place material for blinding (1:4:8), 150mm thick | 1.71 | $m^3$ |
| 7.02 | | Provide and place 2 rows of ∅ 450mm precast concrete rings | 22 | No. |
| 7.03 | | Provide and place formwork for the concrete surround | 20 | $m^2$ |
| 7.04 | | Provide concrete surround (1:3:6) | 4.91 | $m^3$ |

Table 4.5 (contd)

| ITEM NO. | | DESCRIPTION OF WORK | QUANTITY | UNIT |
|---|---|---|---|---|
| 8.00 | | Spillway | | |
| 8.01 | | Provide and place material for concrete blinding (1:4:8) | 0.68 | $m^3$ |
| 8.02 | | Provide and place 2 rows of ∅ 450mm precast culvert rings | 10 | No. |
| 8.03 | | Provide and place formwork for the concrete surround | 12 | $m^2$ |
| 8.04 | | Provide and place mass concrete surround (1:3:6) 150mm thick | 1.79 | $m^3$ |
| 9.00 | | Provide rock rip raps on upstream slope of dam (0.5m thick). | 76 | $m^3$ |



AHMADU BELLO UNIVERSITY

Table 4.6: Bill of Quantities (Pump Option)
Imokun Irrigation Scheme
Epe LGA Lagos State

| ITEM NO. | | DESCRIPTION OF WORK | QUANTITY | UNIT |
|---|---|---|---|---|
| | | PUMP AND ACCESSORIES | | |
| | | Water Pumps | 2 | No |
| | | 4" Diameter Hose | 200 | m |
| | | SUMP DETAILS | | |
| | | 2(10.2m x 10.2m x 2.5m) | | |
| | | Sump blockwork (9") | 1,995 | No. |
| | 0.004$m^3$ x 1995 | Motar for joining blocks | 8 | $m^3$ |
| | 4/0.2m x 0.2m x 10.2m | Reinforced concrete beams | 1.7 | $m^3$ |
| | 10/0.25x0.25 x 2.5 | Reinforced concrete columns | 1.6 | $m^3$ |
| | | Mild steel (Ø 12mm) | 33 | No |
| | (4x2)(10.2 x 2.5) x 0.015 | Plastering | 3.1 | $m^3$ |
| | 2(11 x 11 x 0.15) | Flooring concrete | 37 | $m^3$ |

Table 4.6 (contd)

| ITEM NO. | | DESCRIPTION OF WORK | QUANTITY | UNIT |
|---|---|---|---|---|
| | | ACCESS ROAD | | |
| 1. | 2km x 4m | Clearing of roadway | 8,000 | $m^2$ |
| | | PUMP HOUSE/STORE (5m x 5m) | | |
| 2. | 20mx0.68mx1m | Foundation Excavation | 13.6 | $m^3$ |
| 3. | 20mx0.68mx0.3m | Strip foundation concrete | 4.1 | $m^3$ |
| 4. | $\frac{2(20m)}{0.45m}$ | Foundation blocks (9") | 89 | No. |
| 5. | $0.004m^3$ x 89 | Motar for joining blocks | 0.40 | $m^3$ |
| 6. | 5m x 5m x 0.2m | Lateritic filling up to DPC | 5 | $m^3$ |
| 7. | 5.5mx5.5mx0.2m | Flooring concrete | 6.1 | $m^3$ |
| 8. | $4(\frac{2x5.5}{0.101})$ | Super structure blockwork (9") | 436 | No. |
| 9. | $0.004m^3$x436 | Motar for joining blocks | 1.8 | $m^3$ |
| | | ROOFING | | |
| 10. | $\frac{4(6)}{3.5}+1$ | Tie beams 2" x 6" x 12' | 8 | No. |
| 11. | $\frac{5.5}{3.5}$ x $\frac{5.5}{1.6}$ | Rafter 2" x 4" x 12' | 6 | No. |
| 12. | $\frac{5.5}{3.5}$ x $\frac{5.5}{0.8}$ | Purline 2" x 2" x 12' | 11 | No. |
| 13. | $\frac{6 \times 6m^2}{1.7x0.6m^2}$ | Corrugated iron sheet | 36 | No. |
| 14. | | Wire nails | 5 | Kg. |

Table 4.7: Bill of Quantities
Small Earth Dam at Batsari Town
Batsari LGA Katsina State

| ITEM NO. | | DESCRIPTION OF WORK | QUANTITY | UNIT |
|---|---|---|---|---|
| 1.00 | | Clear dam site of all bush, shrubs trees etc. (including reservoir area) | 28,210 | $m^3$ |
| 2.00 | | Strip top soil 300mm outside river bed | 6,000 | $m^3$ |
| 3.00 | | Excavate up to impervious layer for dam foundation and dispose-off the material | 7,663 | $m^3$ |
| 4.00 | | EMBANKMENT FORMATION | | |
| 4.01 | | Excavate approved impervious material from approved borrow areas or from river bed, haul excavated material not exceeding 500m, deposit, spread, compact as fill material for dam.embankment (All to 100% B.S. compaction in 150mm layer | 28,940 | $m^3$ |
| 4.02 | | Ditto item 4 but for haul distance of 2km | 19,294 | $m^3$ |
| 5.00 | | Provide and arrange stones or rip-rap for pitching embankment slopes. (0.5m thick on average) | 6,637 | $m^2$ |
| 6.00 | | SPILLWAY | | |
| 6.01 | | Provide mass concrete grade 10 (1:3:6) for blinding | 50 | $m^3$ |
| 6.02 | | Provide, place and remove after completion formwork for spillway surface | 343 | $m^2$ |
| 6.03 | | Supply and fix reinforcement for spillway | 9 | tonnes |
| 6.04 | | Provide reinforced concrete grade 25 (1:1½:3) in spillway | 670 | $m^3$ |
| 6.05 | | Provide and arrange rip-rap for discharge channel | 100 | $m^2$ |

Table 4.8: Bill of Quantities
Oke-Odan Earth Dam
Ado/Odo-Ota LGA Ogun State

| ITEM NO. | | DESCRIPTION OF WORK | QUANTITY | UNIT |
|---|---|---|---|---|
| 1.00 | | Clear dam site and reservoir area of vegetation | 30,800 | $m^2$ |
| 2.00 | | Fell trees from dam axis and reservoir area, cut to sizeable pieces and pack in downstream side at distance not exceeding 100m | 147 | No |
| 3.00 | | Remove stumps and grub along dam axis | 99 | No |
| 4.00 | | Remove top soil and peat to a depth of 0.3m along dam axis | 30,000 | $m^2$ |
| 5.00 | | Excavate cut-off (key) trench and re-fill with suitable impervious material. | 5,000 | $m^3$ |
| 6.00 | | OUTLET STRUCTURE | | |
| 6.01 | | Provide and place concrete surround (1:3:6) | 120 | $m^3$ |
| 6.02 | | Provide, place and remove after completion formwork for outlet surface | 260 | $m^2$ |
| 6.03 | | Provide and place 2 rows of ∅ 0.45m pre-cast concrete rings | 140 | No |
| 7.00 | | Excavate approved impervious material from the river bde/reservoir area, load, haul, deposite, spread and compact as fill material for dam embankment | 80,200 | $m^3$ |
| 8.00 | | SPILLWAY | | |
| 8.01 | | Provide and place blinding/mass concrete surround (1:3:6) | | |
| 8.02 | | Provide, place and remove after completion formwork for spillway surfaces | 150 | $m^2$ |
| 8.03 | | Provide and place 8 rows of ∅ 0.9m pre-cast concrete pipes | 200 | No |
| 9.00 | | Provide and arrange rip rap for pitching embankment slopes | 9,062 | $m^2$ |

# CHAPTER 5: COMPARATIVE ANALYSIS

## 5.1 PREAMBLE

This study is designed to evaluate the potentials of labour-based construction technique for small earth dams in Nigeria. Hence, the thrust of the work is to undertake a comparison of labour-based and equipment-based methods in terms of construction costs, duration and employment generation potential for the construction of three small earth dams whose main features were given in chapter 3. The colume of work involved in each case is highlighted in the Bill of Quantities given in chapter 4.

The volume of work so given was used as a basis to determine the various inputs (labour, handtools, materials and equipment) as well as the durations of different activities by applying the principles and procedures discussed in Work Planning in section 3.3.6. Details of inputs required as given in appendices 1 - 6. The unit rates and costs were then applied to determine the total costs of having any one option to construct the earth dams under consideration. The summary of costs for each option are given in Tables 5.1 to 5.6.

Table 5.1: Summary of needed inputs for Labour-Based construction of Imokun Dam. Epe LGA Lagos State

| ITEM | COSTS | | REMARKS |
|---|---|---|---|
| | Amount (₦) | % | |
| LABOUR | 202,860 | 72.64 | |
| HANDTOOLS | 13,062 | 4.68 | |
| MATERIALS | 20,134 | 7.21 | |
| LIGHT EQUIPMENT | 8,925 | 3.19 | |
| SUPERVISION | 34,298 | 12.28 | |
| TOTAL | 279,279 | 100 | |
| CONSTRUCTION DURATION | 25 weeks | | |

EMPLOYMENT GENERATION

(1) Unskilled 6,114 man-days

(2) Skilled 432 man-days

(3) Supervisory staff 360 man-days

Table 5.2: Summary of needed input for Equipment-Based (Pump Option) construction of Imokun Irrigation scheme

| ITEM | COSTS | | REMARKS |
|---|---|---|---|
| | Amount (₦) | % | |
| LABOUR | 6,945 | 1.19 | |
| HANDTOOLS | 2,938 | 0.50 | |
| MATERIALS | 100,421 | 17.16 | |
| PUMPS & EQUIPMENT | 466,200 | 79.67 | |
| SUPERVISION | 8,648 | 1.48 | |
| TOTAL | 585,152 | 100 | |
| CONSTRUCTION DURATION | 7 weeks | | |

EMPLOYMENT GENERATION

(1) Unskilled - 104 man-days

(2) Skilled - 85 man-days

(3) Supervisory staff - 60 man-days

Table 5.3: Summary of needed input for Labour-Based construction of Batsari Dam
Batsari LGA, Katsina State

| ITEM | COSTS | | REMARKS |
|---|---|---|---|
| | Amount (₦) | % | |
| LABOUR | 1,823,460 | 39.04 | |
| HANDTOOLS | 169,224 | 3.62 | |
| MATERIALS | 971,513 | 20.80 | |
| LIGHT EQUIP. HIRING | 1,637,352 | 35.06 | |
| SUPERVISION | 69,024 | 1.48 | |
| TOTAL | 4,670,573 | 100 | |
| CONSTRUCTION DURATION | 30 weeks | | |

EMPLOYMENT GENERATION

(1) Unskilled - 67,956 man-days

(2) Skilled - 3,114 man-days

(3) Supervisory staff 840 man-days

Table 5.4: Summary of needed input for Equipment-Based construction of Batsari Dam

| ITEM | COSTS | | REMARKS |
|---|---|---|---|
| | Amount (N) | % | |
| LABOUR | 169,350 | 2.24 | |
| HANDTOOLS | 22,691 | 0.30 | |
| MATERIALS | 969,728 | 12.81 | |
| EQUIPMENT HIRE | 6,334,010 | 83.66 | |
| SUPERVISION | 74,958 | 0.99 | |
| TOTAL | 7,570,737 | 100 | |
| CONSTRUCTION DURATION | 29 weeks | | |

EMPLOYMENT GENERATION

(1) Unskilled - 6,006 man-day

(2) Skilled - 480 man-day

(3) Supervisory staff - 960 man-day

Table 5.5: Summary of needed input for Labour-Based construction of Oke-Odan Dam Ado-Odo/Ota LGA Ogun State

| ITEM | COSTS | | REMARKS |
|---|---|---|---|
| | Amount (₦) | % | |
| LABOUR | 2,674,500 | 43.15 | |
| HANDTOOLS | 190,146 | 3.07 | |
| MATERIALS | 460,641 | 7.43 | |
| LIGHT EQUP. HIRING | 2,781,240 | 44.87 | |
| SUPERVISION | 91,598 | 1.48 | |
| TOTAL | 6,198,125 | 100 | |
| CONSTRUCTION DURATION | 40 weeks | | |

EMPLOYMENT GENERATION

(1) Unskilled - 83,646 man-days

(2) Skilled - 4,128 man-days

(3) Supervisory staff - 1,080 man-days

Table 5.6: Summary of needed input for Equipment-Based Construction of Oke-Odan Dam Ado-Odo/Ota LGA Ogun State

| ITEM | COSTS | | REMARKS |
|---|---|---|---|
| | Amount (₦) | % | |
| LABOUR | 156,120 | 1.46 | |
| HANDTOOLS | 10,356 | 0.10 | |
| MATERIALS | 452,661 | 4.22 | |
| EQUIPMENT HIRING | 9,986,095 | 93.23 | |
| SUPERVISION | 106,053 | 0.99 | |
| TOTAL | 10,711,285 | 100 | |
| CONSTRUCTION DURATION | 39 weeks | | |

EMPLOYMENT GENERATION

(1) Unskilled - 4,812 man-days

(2) Skilled - 294 man-days

(3) Supervisory staff - 1,350 man-days

5.2 IMOKUN IRRIGATION SCHEME

Tables 5.7 and 5.8 summarise the situations under the alternative construction methods. The evidence is that a total of ₦305,873 is saved in the dam option if labour-based method is used in place of the pump option. Thus, at open market prices, construction cost falls by about 52% by shifting from pump option to the dam option constructed by labour-based technique.

The comparison also revelas that 73% of the total construction cost under the labour-based option is incurred on labour whereas the pump option incurs foreign cost to the extent of about 80% of the total construction cost. In project evaluations for developing economies, shadow prices are normally applied for foreign inputs. If this is done, costs of the pump option will go up considerably.

The construction/installation duration puts the pump option at an advantage in terms of fast execution because only 7 weeks is required for installation while about 25 weeks is needed for the dam option to become operational.

The comparison further shows that the dam option could generate 6906 man-days of employment whereas it was estimated that only 249 man-days were generated under the pump option.

Table 5.7: *Construction costs and duration under alternative construction methods: Case of Imokun irrigation scheme*

| S/No | ITEM | LABOUR-BASED (Dam Option) | | Equipment-Based (Pump Option) | | REMARKS |
|---|---|---|---|---|---|---|
| | | *Amount(₦) | % | *Amount(₦) | % | |
| 1. | LABOUR | 202,860 | 72.64 | 6,945 | 1.19 | |
| 2. | HANDTOOLS | 13,062 | 4.68 | 2,938 | 0.50 | |
| 3. | MATERIALS | 20,134 | 7.21 | 100,421 | 17.16 | |
| 4. | LIGHT EQUIPMENT | 8,925 | 3.19 | - | - | |
| 5. | HEAVY EQUIPMENT | - | - | 466,200 | 79.67 | |
| 6. | SUPERVISION/OPERATOR | 34,298 | 12.28 | 8,648 | 1.48 | |
| | TOTAL AMOUNT | 279,279 | 100 | 585,152 | 100 | |
| | CONSTRUCTION DURATION | 25 WEEKS | | 7 WEEKS | | |

Table 5.8: Employment Generation Potentials Under Alternative Construction Methods: Case of Imokun Irrigation Scheme

| LABOUR DESCRIPTION | LABOUR-BASED (Man-days) | EQUIPMENT-BASED (Man-days) |
|---|---|---|
| Unskilled | 6,114 | 104 |
| Skilled | 432 | 85 |
| Supervisory | 360 | 60 |

*Cost comparison are based on December 1992 prices. The official Naira Exchange Rate then stood at $1=₦19.7597 or £1= ₦29.7680.

Thus a shift from pump to dam option results in creation of about 28 times more employment opportunities. Out of 6,905 man-days of employment generated in the dam option only 432 man-days accrue to skilled labour; as much as 89% of the jobs accrue to the local people.

The pump option, if implemented, can only pump for irrigation purposes whereas the dead storage water can be used for drinking and fishing in the dam option. The service life of the pump is only for 5 years whereas the dam has much more longer service life and can be utilised maximally through a 24-hour irrigation period without any additional expenditure being incurred.

5.3 Batsari Dam

Highlights of the two options for construction are summarised in Tables 5.9 and 5.10. From the analysis, the construction of this small earth dam will be completed in about 30 weeks by labour-based method and 29 weeks by the equipment-based.

The breakdown of the cost components shows that labour constitutes about 39% of the total cost by labour-based method and a negligible 2.2% by the equipment-based method. Furthermore, equipment hire acquisition constitutes the highest cost component; about 84% of the total cost, by equipment-based while it accounts for 35% by labour-based method. Adopting the labour-based option could result in a net saving of ₦2,900,256 thereby making construction cost to fall by about 38% as opposed to the equipment-based technique.

Table 5.9: Construction costs and duration under alternative construction methods: Case of Batsari Dam

| S/No | ITEM | LABOUR-BASED (Ism Option) | | Equipment-based (Imap Option) | | REMARKS |
|---|---|---|---|---|---|---|
| | | *Amount (₦) | % | *Amount (₦) | % | |
| 1. | LABOUR | 1,823,460 | 39.04 | 169,350 | 2.24 | |
| 2. | HANDTOOLS | 169,224 | 3.62 | 22,691 | 0.30 | |
| 3. | MATERIALS | 971,513 | 20.80 | 969,728 | 12.81 | |
| 4. | LIGHT EQUIPMENT | 1,637,352 | 35.06 | - | - | |
| 5. | HEAVY EQUIPMENT | - | - | 6,334,010 | 83.66 | |
| 6. | SUPERVISION/OPERATOR | 69,024 | 1.48 | 74,958 | 0.99 | |
| | TOTAL AMOUNT | 4,670,581 | 100 | 7,570,737 | 100 | |
| | CONSTRUCTION DURATION | 30 weeks | | 29 weeks | | |

Table 5.10: Employment Generation Potentials Under Alternative Construction Methods: Case of Batsari Dam

| LABOUR DESCRIPTION | LABOUR-BASED (Man-days) | EQUIPMENT-BASED (Man-days) |
|---|---|---|
| Unskilled | 67,956 | 6,006 |
| Skilled | 3,114 | 480 |
| Supervisory | 840 | 960 |

*Cost comparison are based on December 1987 prices. The official Naira Exchange Rate then stood at $1=₦19.7597 or £1= ₦29.7670.

The labour-based method provides 67,956 work days and 3,114 work days of unskilled and skilled labour respectively as compared to 6,006 work days unskilled labour and 480 work days for skilled labour in the equipment-based. In sum, it means that shift from equipment-based to labour-based will results in creation of about 10 times more employment opportunities.

5.4 Oke-Odan Dam

The main features of costs and employment generation potentials accruable from the two construction options are summarised in Tables 5.11 and 5.12 Table 5.11 reveals that a total of ₦4,513,160 is saved in the construction of the small dam if labour-based method is used in place of equipment-based method. Thus, at market prices, construction cost can fall 42% by shifting from equipment-based to labour-based methods.

The comparison between labour-based and equipment-based methods reveals that about 43% of the total construction costs under labour-based methods are incurred on labour. In contrast, equipment-based method incur foreign costs to the extent of about 93% of total construction costs. The implications of these results are that equipment-based is unlikely to maximise the effective use of available resources nor encourage self-reliance. A method that places substantial reliance on imported items is not likely to be sustainable. In the same way, the scope for grassroots participation will be minimal.

Table 5.11 Construction costs and duration under alternative construction methods: Case of Oke-Odan Dam

| S/No | ITEM | LABOUR-BASED (Dam Option) | | Equipment-Based (Pump Option) | | REM |
|---|---|---|---|---|---|---|
| | | *Amount(₦) | % | *Amount(₦) | % | |
| 1. | LABOUR | 2,674,500 | 43.15 | 156,120 | 1.46 | |
| 2. | HANDTOOLS | 190,146 | 3.07 | 10,356 | 0.1 | |
| 3. | MATERIALS | 460,641 | 7.43 | 452,661 | 4.22 | |
| 4. | LIGHT EQUIPMENT | 2,781,240 | 44.87 | - | - | |
| 5. | HEAVY EQUIPMENT | - | - | 9,986095 | 93.23 | |
| 6. | SUPERVISION/OPERATOR | 91,598 | 1.48 | 106,053 | 0.99 | |
| | TOTAL AMOUNT | 6,198,125 | 100 | 10,711,285 | 100 | |
| | CONSTRUCTION DURATION | 40 weeks | | 39 weeks | | |

Table 5.12: Employment Generation Potentials Under Alternative Construction Methods: Case of Oke-Odan Dam

| LABOUR DESCRIPTION | LABOUR-BASED (Man-days) | EQUIPMENT-BASED (Man-days) |
|---|---|---|
| Unskilled | 83,646 | 4,812 |
| Skilled | 4,128 | 294 |
| Supervisory | 1,080 | 1,350 |

*Cost comparison are based on December 1992 prices. The official Naira exchange rate then stood at $1=₦19.7597 or £1= ₦29.7030.

The analysis shows that the construction time for the small earth dam is 40 weeks using the labour-based approach whereas it will be 39 weeks for the equipment-based technique.

Table 5.12 shows that the labour-based methods would generate 88,854 man-days of employment while only 6,456 man-days of employment would be generated under the equipment-based method. Thus, a shift from equipment-based methods to labour-based methods results in the creation of about thirteen (13) times more employment opportunities. The labour-based method provides 83,646 man-days and 4,128 man-days of unskilled and skilled labour respectively as compared to 4,812 man-days of unskilled labour and 294 man-days of skilled labour in the equipment-based.

## 5.5 Validation of Analysis

It was stated earlier on that the earth dam projects under consideration are under construction. Specifically on Table 3.1. it was indicated that Imokun dam is actually being constructed with the labour-based method and Batsari dam is designed to be constructed with labour-based technique. The Oke-Odan dam is being constructed with the equipment-based method. As at data collection time, the stages of completion were that Imokun was 81% completed, Batsari 2% (Design data collection) completed while Oke-Odan was 48% completed. Based on available information from OORBDA Abeokuta, amount expended up to data collection time (December 1992) was ₦4,500,000 for Oke-Odan dam project

which covers machine repairs, construction materials, fuel, oil and lubricants while the expenditure for Imokun dam (option) was not available. This figure was projected against completion stage, the total projected construction cost given in Table 5.13 was obtained. The projected construction cost is given side by side with the construction cost estimated for the adopted construction method earlier discussed in this chapter. The percentage error in the estimation was computed and found to be 12.48% as given in the Table.

Table 5.13: Comparison of estimated construction cost with projected actual cost

| Project | Construction Method | Estimated total construction cost | Projected actual cost | % Estimated Error |
|---|---|---|---|---|
| Oke-Odan | Equipment-based | ₦10,711,285 | ₦9,375,000 | 12.48 |

Thus, %estimated error between the estimated cost and projected actual cost is 12.5% because the ₦4.5 million actual expenditure (for the 48% completion) that was used for the projected actual cost does not include machine/equipment hiring since OORBDA utilized own machine for the construction. Another possible source of error is that the expenditure incurred is between 1984 (when the actual dam construction started) and 1992 (when the research data collection was carried out) substantial inflation had been observed in the economy and if the present worth of the ₦4.5 million expended on the project was computed, it would exceed the figure used. On the basis of explanation offered, the error margin can be considered insignificant.

# CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

## 6.1 PREAMBLE

Technology has an important role to play in the process of development and it has been established that the technology used should be appropriate to the socio-economic environment in which it operates. The prevailing circumstances in Nigeria is characterised by massive underemployment and unemployment as well as shortage of foreign exchange for the importation of construction machines including their spare parts. There is, therefore, a need to make judicious choice of technologies. In view of the close relationship between technological choice and development, the labour-based and equipment-based methods of construction for small earth dams were subjected to technological appraisal so as to arrive at the most appropriate technique with a view to realising the fundamental aim of maximising growth and employment.

## 6.2 C O N C L U S I O N S

Based on the analysis of this study, an attempt towards identification of an appropriate construction technique for construction of small earth dams in Nigeria is made with the following conclusions:

(i) The construction time and quality of work achievable with the labour-based construction have been found to be comparable with those of equipment-based method.

(ii) The labour-based method of construction was found to be considerably cheaper than the equipment-based method.

(iii) Investment in labour-intensive construction of small earth dams will also boost the local economy through employment generation and extensive use of available local resources.

(iv) Labour-based technique is technically feasible and economically justifiable for the construction of small earth dams in Nigeria because the present socio-economic conditions are characterised by labour-surplus and scarce foreign exchange.

(v) The use of labour-based construction method was found to result in substantial foreign exchange savings.

It can also be inferred from the case studies highlighted that the labour-based approach will encourage self-reliance in construction and provide locally sustainable maintenance culture of infrastructures. The rural - urban drift of population can be checked through job creation which is facilitated by adapting the labour-based technique but it should be noted that indiscriminate use of labour for project execution could be as harmful to the economy as the indiscriminate use of equipment. The labour-based method of construction is normally supported by light equipment whose import and spares do not put excessive burden on foreign exchange. The savings of already scarce foreign exchange is therefore available for other more urgent and important needs. It opens up the opportunities for grass root participation in development activities and locally available unskilled labour can easily be trained to perform the work items effectively. Labour-based construction method can be employed for execution of projects either by "direct labour" or "contract" method of execution. With the adaption of this technology, minimum damage is done to the environment.

Specifically, three case studies were reviewed in this project to ascertain the relative desirability of labour-based and equipment-based techniques. The projects are located in

the Southwestern and Northcentral parts of the country with cultural and vegetational differences. The results, nonethless, give the same indications, namely: significant advantages are acruable by adopting labour-based construction techniques for small earth dams.

In the case of Batsari dam, located in the North-Central part of the country, about 38% reduction in total construction cost and 1,000% more jobs are achievable by adopting labour-based technique. The change in construction duration is a mere increase to 30 weeks from the estimated 29 weeks for equipment-based construction.

For Oke-Odan and Imokun dams, which are located in South-Western part of the country, similar results were also obtained. In terms of employment generation, Imokun provides 6906 man-days of employment by adopting the labour-based (dam-option) construction technique, whereas only 249 man-days were generated under the equipment-based (pump-option) method. The construction duration required is 25 weeks by using the labour-based method while 7 weeks is required for the equipment-based (pump-option).

Labour-based methods of construction of Oke-Odan dam generate 88,854 man-days of employment while 6,456 man-days of employment is generated under the equipment-based method. The change in construction duration is a mere increase to 40 weeks from the estimated 39 weeks for equipment-based construction technique.

The use of labour-based technique is, therefore, recommended for the construction of small earth dams in Nigeria. The conclusions of this study are equally applicable in the choice of an appropriate construction technique for other rural infrastructure works such as roads, water supply, sanitation schemes, storage facilities, soil conservation programmes, irrigation and flood control works etc. Hence, the justification for the initiation of the labour-based method of construction by the Nigeria Government.

Besides the significant findings related to the effectiveness of labour-based technique in this context, it is also instructive to note that reasonably scientific premises were used to quantify inputs for labour-based technique. The method statement and the Time and Location Chart are quite scientific and very useful in formalising labour-based construction technique. These approaches are innovative and should be improved further so as to further refine work planning under labour-based technique. Even at this satage, it is clear that with introduction of the method statement and the Time and Location Chart, arbitrainess and inconsistency of the labour-based technique of construction have been removed.

## 6.3 POLICY STATEMENT AND RECOMMENDATIONS

The current construction practices in Nigeria are greatly biased in facour of heavy construction equipment. In constrast, the labour-based method primarily utilises labour supported by compatible light equipment for construction. In view of the present socio-economic conditions in the country, characterised by shortage of capital and labour surplus, there is need to change our construction practice to a more sustainable local resource based method. There is, therefore, need to remove the existing biases and provide equal opportunity so that the labour-based methods can also develop to its full potential, hence the new National Construction Policy launched in May 1991 recognises the scope for using local resources. See appendix 13 for further details on the National Construction Policy.

Based on the findings from this study, the following recommendations are made:

1. Yhere is need to modify the existing system and procedures for the construction, rehabilitation and maintenance of rural infrastructures, which seems to favour equipment-based methods to the detriment of labour-based methods. These include financing, tendering procedures, role of small contractors, role of rural communities, recruitment of labour etc.

2. Each project needs to be subjected to a technological appraisal to identify which activities can be effectively carried out by labour-based methods and which need to be undertaken by equipment-based methods. This will allow a more rational approach to the choice of appropriate technology. The wide use of work planning, as applied in this study, will greatly facilitate the appraisal.

3. A shift towards more labour-based methods for execution of infrastructure works should be pursued with vigour (as contained in the new National Construction Policy of May 1991) but with proper construction planning. It is necessary to avoid hasty planning and implementation because this could lead to serious inefficiencies and result in poor quality of work.

4. The labour-based technology should not be seen or embarked upon merely as an employment creation scheme but as a method that constitute part of a spectrum of construction technologies available.

5. A strategy of gradual and carefully planned expansion of the on-going labour-based pilot programme of the Federal Government should be followed. The pace at which the institutional capacity can be built up should determine the rate of utilisation of locally available resources.

6. Government should formulate a policy that will mandate all Nigerian Universities and Polytechnics to include labour-based technology in Engineering curricula.

7. Efforts should be made to create greater awareness of the labour-based technique in Nigerian construction industry by organising seminars, courses, training programme etc., to practising Engineers, Contractors, Planners and Administrators/Politicians.

8. Labour-based projects should be given wide publicity by the Federal Government in all available print and electronic media until such a time that the general public are fully aware.

9. There is an urgent need to spell out a policy for maintenance of rural infrastructure. This policy should be based on community and local government participation and should clearly define their roles. Such a policy should take into account the necessary institutional arrangements for effective organisation of rehabilitation and maintenance of rural infrastructure works and its findings.

10. The manufacturing sector should be encouraged to fabricate appropriate light equipment handtools that are compatible to the labour-based/light equipment supported construction technique.

## 6.4 AREAS REQUIRING FURTHER RESEARCH

The following are the recommended areas of further research:

1. Development of appropriate technology under the labour-based construction technique for drainage structures.

2. Design and manufacturing of handtools appropriate for labour-based construction projects compatible to Nigerian traditions and environment.

3. An assessment and scope for participation of women in labour-based construction, rehabilitation and maintenance of rural infrastructures in Nigeria

4. Cost-benefit optimisation in labour intensive projects.

5. Financial and economic analysis of labour-based project.

6. An assessment of employment generation potential of labour-based construction technology in rural Nigeria.

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SCHEDULE OF RESOURCES AND COST ESTIMATES (LABOUR-BASED)

IMOKUN DAM EPE LGA LAGOS STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| 1. | LABOUR | | | | | |
| | Unskilled Labour (USL) | 6,114 | m-d | 30 | 183,420 | |
| | Skilled Labour (GL) | 432 | m-d | 45 | 19,440 | |
| | Total Labour | | | | 202,860 | 202,860 |
| 2. | HANDTOOLS | | | | | |
| | Cutlass (CL) | 15 | No. | 95 | 1,425 | |
| | File (Fl) | 3 | No. | 50 | 150 | |
| | Hand Rammer (HR) | 8 | No. | 200 | 1,600 | |
| | Headpan (HP) | 30 | No. | 90 | 2,700 | |
| | Pickaxe (PAX) | 10 | No. | 180 | 1,800 | |
| | Rake (RK) | 4 | No. | 70 | 280 | |
| | Shovel (SH) | 10 | No. | 95 | 950 | |
| | Spade (SP) | 6 | No. | 90 | 540 | |
| | Watering Can (WC) | 5 | No. | 90 | 450 | |
| | Basic Total | | | | 9,895 | |
| | Add 20% for Handles, Maintenance and replacement of damaged ones | | | | 1,979 | |
| | Sub Total | | | | 11,874 | |
| | Transportation of tools to the site (10%) | | | | 1,188 | |
| | Total Handtools | | | | 13,062 | 13,062 |
| 3. | MATERIALS | | | | | |
| | Cement (50kg each) | 42 | Bag | 100 | 4,200 | |
| | Gravel (3.6$m^3$ each) | 3 | Trip | 750 | 2,250 | |
| | Sand (3.6$m^3$ each) | 2 | Trip | 400 | 800 | |
| | Concrete Ring (Ø450mm) | 32 | No. | 200 | 6,400 | |
| | Empty Drum(200Lits.each) | 5 | No. | 200 | 1,000 | |
| | Rope (RO) | 4 | No. | 150 | 600 | |
| | Measuring Tape (30m) | 2 | No. | 200 | 400 | |
| | Timber 1"x12"x12' | 38 | No. | 70 | 2,660 | |
| | 2"x2"x12' | 29 | No. | 20 | 580 | |

SCHEDULE OF RESOURCES AND COST ESTIMATES (LABOUR-BASED)

IMOKUN DAM EPE LAGOS STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| | MATERIALS (contd) | | | | | |
| | Wire Nail 3" | 11 | Kg | 15 | 165 | |
| | 4" | 8 | Kg | 15 | 120 | |
| | Basic Total | | | | 19,175 | |
| | Transportation of materials to the site (5%) | | | | 959 | |
| | Total Materials | | | | 20,134 | 20,134 |
| 4. | LIGHT EQUIPMENT | | | | | |
| | Chain saw | 4 | w.d | 500 | 2,000 | |
| | Water Pump | 13 | w.d | 500 | 6,500 | |
| | Basic Total | | | | 8,500 | |
| | Add 5% for fuel, oil and lubrication | | | | 425 | |
| | Total Light Equipment | | | | 8,925 | 8,925 |
| | Total labour, handtools, materials and light equipment hire | | | | 244,981 | |
| | Add 14% for supervision | | | | 34,298 | |
| | Total | | | | 279,279 | 279,279 |
| | | | | | | ======= |

SCHEDULE OF RESOURCES AND COST ESTIMATES (PUMP OPTION)
IMOKUN IRRIGATION SCHEME EPE LGA LAGOS STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| 1. | LABOUR | | | | | |
| | Unskilled Labour (USL) | 104 | m-d | 30 | 3,120 | |
| | Skilled Labour (SL) | 85 | m-d | 45 | 3,825 | |
| | Total Labour | | | | 6,945 | 6,945 |
| 2. | HANDTOOLS | | | | | |
| | Headpan (HP) | 10 | No. | 90 | 900 | |
| | Pickaxe (PAX) | 3 | No. | 180 | 540 | |
| | Shovel (SH) | 5 | No. | 95 | 475 | |
| | Spade (SP) | 5 | No. | 90 | 450 | |
| | Sub Total | | | | 2,365 | |
| | Add 20% for handles, maintenance and replacement of damaged ones | | | | 473 | |
| | Transportation of tools to site | | | | 100 | |
| | Total Handtools | | | | 2,938 | 2,938 |
| 3. | MATERIALS | | | | | |
| | Blocks (9") | 2648 | No. | 9.50 | 25,156 | |
| | Cement (50kg each) | 438 | Bags | 100 | 43,800 | |
| | Gravel (3.6$m^3$ each) | 16 | Trips | 750 | 12,000 | |
| | Sand (3.6$m^3$ each) | 15 | Trip | 400 | 6,000 | |
| | Empty Drum (200Lit. each) | 2 | No. | 200 | 400 | |
| | Wire Nails | 6 | Kg | 18 | 108 | |
| | Roofing Nails | 5 | Kg | 33 | 165 | |
| | Corrugated Iron Sheet | 36 | No. | 50 | 1,800 | |
| | Timber - 2"x6"x12' | 8 | No. | 45 | 360 | |
| | 2"x4"x12' | 6 | No. | 35 | 210 | |
| | 2"x2"x12' | 81 | No. | 20 | 1,620 | |
| | 1"x12"x12' | 15 | No. | 70 | 1,050 | |
| | Mild Steel(Ø12mm) | 33 | No. | 90 | 2,970 | |
| | BASIC TOTAL | | | | 95,639 | |
| | Transportation of materials to site(5%) | | | | 4,762 | |
| | TOTAL MATERIALS | | | | 100,421 | 100,421 |

SCHEDULE OF RESOURCES AND COST ESTIMATES (PUMP OPTION)

IMOKUN IRRIGATION SCHEME EPE LGA LAGOS STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| 4. | PUMPS AND ACCESSORIES | | | | | |
| | 8.75HP Pump | 2 | No. | 135,000 | 270,000 | |
| | 4" Diameter Hose | 200 | m | 300 | 60,000 | |
| | Transportation of pumps, materials and labour | | | | 12,000 | |
| | Installation of Pump (including foundation, labour etc.) | | | | 27,000 | |
| | Total Pump | | | | 369,000 | 369,000 |
| 5. | EQUIPMENT HIRE | | | | | |
| | Bulldozer (D8) | 2 | w.d | 6,000 | 12,000 | |
| | Gradder (GR) | 1 | w.d | 4,800 | 4,800 | |
| | Excavator (EX) | 3 | w.d | 5,500 | 16,500 | |
| | Water Pump | 15 | w.d | 500 | 7,500 | |
| | Concrete Mixer | 4 | w.d | 800 | 3,200 | |
| | Basic Total | | | | 44,000 | |
| | Add 5% for fuel, oil and lubrication | | | | 2,200 | |
| | Transport for Equipment | 6 | Trips | 8,500 | 51,000 | |
| | Total Equipment Hire | | | | 97,200 | 97,200 |
| | Total Labour, Handtools, Materials, Pumps/ Accessories and Equipment hire | | | | 576,504 | |
| | Add 1.5% Supervision | | | | 8,648 | |
| | Total Amount | | | | 585,152 | 585,152 ======= |

SCHEDULE OF RESOURCES AND COST ESTIMATES (LABOUR-BASED)

BATSAKI DAM BATSARI LGA KATSINA STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| 1. | LABOUR | | | | | |
| | Unskilled Labour (USL) | 67,956 | m-d | 25 | 1,698,900 | |
| | Skilled Labour (GL) | 3,114 | m-d | 40 | 124,560 | |
| | Total Labour | | | | 1,823,460 | 1,823,460 |
| 2. | HANDTOOLS | | | | | |
| | Cutlass (CL) | 100 | No. | 105 | 10,500 | |
| | File (FI) | 20 | No. | 60 | 1,200 | |
| | Headpan (HP) | 140 | No. | 95 | 13,300 | |
| | Pickaxe (PAX) | 200 | No. | 200 | 40,000 | |
| | Rake (RK) | 50 | No. | 80 | 4,000 | |
| | Shovel (SH) | 170 | No. | 110 | 18,700 | |
| | Spade (SP) | 150 | No. | 100 | 15,000 | |
| | Wheel barrow (WB) | 20 | No. | 800 | 16,000 | |
| | Watering Can (WC) | 100 | No. | 95 | 9,500 | |
| | Basic Total | | | | 128,200 | |
| | Add 20% for Handles, Maintenance and replacement of damaged ones | | | | 25,640 | |
| | Sub Total | | | | 153,840 | |
| | Transportation of tools to the site (10%) | | | | 15,384 | |
| | Total Handtools | | | | 169,224 | 169,224 |
| 3. | MATERIALS | | | | | |
| | Cement (50kg each) | 6404 | Bags | 100 | 640,400 | |
| | Gravel (3.6$m^3$ each) | 200 | Trips | 650 | 130,000 | |
| | Sand (3.6$m^3$ each) | 100 | " | 400 | 40,000 | |
| | Empty Drum (200Lits ea) | 10 | No. | 220 | 2,200 | |
| | Rope (RO) | 4 | No. | 150 | 600 | |
| | Measruing Tape (30m) | 3 | No. | 200 | 600 | |
| | Mild Steel (Ø12mm) | 9 | Tons | 8800 | 79,200 | |

SCHEDULE OF RESOURCES AND COST ESTIMATES (LABOUR-BASED)

BATSARI DAM BATSARI LGA KATSINA STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (₦) | AMOUNT (₦) | TOTAL (₦) |
|---|---|---|---|---|---|---|
| 3. | MATERIALS (contd) | | | | | |
| | Timber 1"x12"x12' | 350 | No. | 70 | 24,500 | |
| | 2"x2"x12' | 200 | No. | 25 | 5,000 | |
| | Wire Nail 3" | 3.5 | Bag | 500 | 1,750 | |
| | 4" | 2 | " | 500 | 1,000 | |
| | Basic Total | | | | 925,250 | |
| | Transportation of materials to site(5%) | | | | 46,263 | |
| | Total Materials | | | | 971,513 | 971,513 |
| 4. | LIGHT EQUIPMENT HIRE | | | | | |
| | Concrete Mixer(CM) | 7 | w.d | 1250 | 8,750 | |
| | Pedestrian Roller (PR) | 360 | w.d | 2300 | 828,000 | |
| | Tractor | 720 | w.d | 500 | 300,000 | |
| | Trailer | 1440 | w.d | 250 | 360,000 | |
| | Water Pump (WP) | 36 | w.d | 600 | 21,000 | |
| | Water Tanker (WT) | 9 | w.d | 2000 | 18,000 | |
| | Basic Total | | | | 1,596,350 | |
| | Add 5% for fuel, oil and lubrication | | | | 79,818 | |
| | Transport for Equipment | 4 | Trips | 10000 | 40,000 | |
| | Transport for Mixer | 2 | " | 500 | 1,000 | |
| | Total Light Equip. Hire | | | | 1,637,352 | 1,637,352 |
| | Total Labour, Handtools, Materials and Light Equipment Hire | | | | 4,601,549 | |
| | Add 1.5% Supervision | | | | 69,024 | |
| | TOTAL AMOUNT | | | | 4,670,573 | 4,670,573 |

SCHEDULE OF RESOURCES AND COST ESTIMATES (EQUIPMENT-BASED)
BATSARI DAM BATSARI LGA KATSINA STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (₦) | AMOUNT (₦) | TOTAL (₦) |
|---|---|---|---|---|---|---|
| 1. | LABOUR | | | | | |
| | Unskilled Labour | 6006 | m-d | 25 | 150,150 | |
| | Skilled Labour | 480 | m-d | 40 | 19,200 | |
| | Total Labour | | | | 169,350 | 169,350 |
| 2. | HANDTOOLS | | | | | |
| | Cutlass | 8 | No. | 105 | 840 | |
| | Headpan | 140 | No. | 95 | 13,300 | |
| | Shovel | 10 | No. | 110 | 1,100 | |
| | Spade | 10 | No. | 100 | 1,000 | |
| | Watering Can | 10 | No. | 95 | 950 | |
| | Basic Total | | | | 17,190 | |
| | Add 20% for Handles, Maintenance and replacement of damaged ones | | | | 3,438 | |
| | Sub Total | | | | 20,628 | |
| | Transportation of tools to site (10%) | | | | 2,063 | |
| | Total Handtools | | | | 22,691 | 22,691 |
| 3. | MATERIALS | | | | | |
| | Cement (50kg each) | 6404 | Bags | 100 | 640,400 | |
| | Gravel (3.6m$^3$ each) | 200 | Trips | 650 | 130,000 | |
| | Sand (3.6m$^3$ each) | 100 | " | 400 | 40,000 | |
| | Empty Drums (200Lit ea.) | 5 | No. | 220 | 1,100 | |
| | Measuring Tape (30m) | 3 | No. | 200 | 600 | |
| | Mild Steel (Ø12mm) | 9 | Tons | 8800 | 79,200 | |
| | Timber 1"x12"x12' | 350 | No . | 70 | 24,500 | |
| | 2"x2"x12' | 200 | No. | 25 | 5,000 | |
| | Wire Nail 3" | 3.5 | Bags | 500 | 1,750 | |
| | 4" | 2 | Bags | 500 | 1,000 | |
| | Basic Total | | | | 923,550 | |
| | Transportation of materials to site (5%) | | | | 46,178 | |
| | Total Materials | | | | 969,728 | 969,728 |

SCHEDULE OF RESOURCES AND COST ESTIMATES (EQUIP-BASED)
BATSARI DAM BATSARI LGA KATSINA STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| 4. | EQUIPMENT HIRING | | | | | |
| | Bulldozer | 240 | w.d | 6,000 | 1,440,000 | |
| | Excavator | 42 | w.d | 6,000 | 252,000 | |
| | Gradder | 114 | w.d | 5,000 | 570,000 | |
| | Payloader | 270 | w.d | 4,800 | 1,296,000 | |
| | Roller | 114 | w.d | 4,800 | 547,200 | |
| | Concrete Dumper | 16 | w.d | 1,800 | 28,800 | |
| | Concrete Mixer | 32 | w.d | 1,250 | 40,000 | |
| | Tipper Lorry | 726 | w.d | 1,800 | 1,306,800 | |
| | Water Pump | 39 | w.d | 600 | 23,400 | |
| | Water Tanker | 126 | w.d | 2,000 | 252,000 | |
| | Basic Total | | | | 5,756,200 | |
| | Add 5% for fuel, oil and lubrication .. | | | | 287,810 | |
| | Transport for Equipment | 29 | Trips | 10,000 | 290,000 | |
| | Total Equip. Hire | | | | 6,334,010 | 6,334,010 |
| | Total Labour, Handtools, Materials and Equipment Hired | | | | 7,495,779 | |
| | Add 1% Supervision | | | | 74,958 | |
| | TOTAL AMOUNT | | | | 7,570,737 | 7,570,737 |

SCHEDULE OF RESOURCES AND COST ESTIMATES (LABOUR-BASED)
OKE-ODAN AIO-ODO/OTA LGA OGUN STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| 1. | LABOUR | | | | | |
| | Unskilled Labour (USL) | 83,646 | m-d | 30 | 2,509,380 | |
| | Skilled Labour (CL) | 4,128 | m-d | 40 | 165,120 | |
| | Total Labour | | | | 2,674,500 | 2,674,500 |
| 2. | HANDTOOLS | | | | | |
| | Cutlass (CL) | 60 | No. | 95 | 5,700 | |
| | File (Fl) | 10 | No. | 50 | 500 | |
| | Headpan (HP) | 270 | No. | 90 | 24,300 | |
| | Pickaxe (PAX) | 150 | No. | 180 | 27,000 | |
| | Rake (RK) | 30 | No. | 70 | 2,100 | |
| | Shovel (SH) | 160 | No. | 95 | 15,200 | |
| | Spade (SP) | 45 | No. | 90 | 4,050 | |
| | Wheel barrow (WB) | 68 | No. | 800 | 54,400 | |
| | Watering Can (WC) | 120 | No. | 90 | 10,800 | |
| | Basic Total | | | | 144,050 | |
| | Add 20% for Handles, Maintenance and replacement of damaged ones | | | | 28,810 | |
| | Sub Total | | | | 172,860 | |
| | Transportation of tools to the site (10%) | | | | 17,286 | |
| | Total Handtools | | | | 190,146 | 190,146 |
| 3. | MATERIALS | | | | | |
| | Cement (50kg each) | 2017 | Bags | 100 | 201,700 | |
| | Gravel (3.6m$^3$ each) | 124 | Trips | 700 | 86,800 | |
| | Sand (3.6m$^3$ each) | 62 | " | 450 | 27,900 | |
| | Concrete Rings(ø450mm) | 140 | No. | 200 | 28,000 | |
| | (ø900mm) | 200 | No. | 250 | 50,000 | |
| | Empty Drums(200Lit. ea) | 40 | No. | 200 | 8,000 | |
| | Rope (RO) | 4 | No. | 150 | 600 | |
| | Measuring Tape (30m) | 3 | No. | 200 | 600 | |

SCHEDULE OF RESOURCES AND COST ESTIMATES (LABOUR-BASED)

OKE-ODAN ADO-ODO/OTA LGA OGUN STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| 3. | MATERIALS (contd) | | | | | |
| | Timber 1"x12"x12' | 410 | No. | 65 | 26,650 | |
| | 2"x2"x12' | 270 | No. | 20 | 5,400 | |
| | Wire Nail 3" | 4.5 | Bags | 470 | 2,115 | |
| | 4" | 2 | " | 470 | 940 | |
| | Basic Total | | | | 438,705 | |
| | Transportation of materials to the site (5%) | | | | 21,936 | |
| | Total Materials | | | | 460,641 | 460,641 |
| 4. | LIGHT EQUIPMENT | | | | | |
| | Concrete Mixer($0.5m^3$) | 12 | w.d | 800 | 9,600 | |
| | Concrete Mixer ($1.5m^3$) | 12 | w.d | 1,100 | 13,200 | |
| | Chain Saw | 6 | w.d | 500 | 3,000 | |
| | Pedestrian Roller | 606 | w.d | 2,000 | 1,212,000 | |
| | Tractor | 1188 | w.d | 550 | 653,400 | |
| | Trailer | 2376 | w.d | 300 | 712,800 | |
| | Water Pump | 44 | w.d | 500 | 22,000 | |
| | Water Tanker | 6 | w.d | 1,800 | 10,800 | |
| | Basic Total | | | | 2,636,800 | |
| | Add 5% for fuel, oil and lubrication | | | | 131,840 | |
| | Transport for Equipment | 7 | Trips | 1,800 | 12,600 | |
| | Total Light Equipment Hire | | | | 2,781,240 | 2,781,240 |
| | Total Labour, Handtools, Materials and Light Equipment Hire | | | | 6,106,527 | |
| | Add 1.5% for Supervision | | | | 91,598 | |
| | TOTAL AMOUNT | | | | 6,198,125 | 6,198,125 |

SCHEDULE OF RESOURCES AND COST ESTIMATES (EQUIPMENT-BASED)
OKE-ODAN DAM AIO-OIO/OTA LGA OGUN STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (N) | AMOUNT (N) | TOTAL (N) |
|---|---|---|---|---|---|---|
| 1. | LABOUR | | | | | |
| | Unskilled Labour | 4812 | m-d | 30 | 144,360 | |
| | Skilled Labour | 294 | m-d | 40 | 11,760 | |
| | Total Labour | | | | 156,120 | 156,120 |
| 2. | HANDTOOLS | | | | | |
| | Cutlass | 11 | No. | 95 | 1,045 | |
| | Headpan | 50 | No. | 90 | 4,500 | |
| | Shovel | 10 | No. | 95 | 950 | |
| | Spade | 10 | No. | 90 | 900 | |
| | Watering Can | 5 | No. | 90 | 450 | |
| | Basic Total | | | | 7,845 | |
| | Add 20% for Handles, Maintenance and replacement of damaged ones | | | | 1,569 | |
| | Sub Total | | | | 9,414 | |
| | Transportation of tools to site (10%) | | | | 942 | |
| | Total Handtools | | | | 10,356 | 10,356 |
| 3. | MATERIALS | | | | | |
| | Cement (50kg each) | 2017 | Bags | 100 | 201,700 | |
| | Gravel (3.6$m^3$ each) | 124 | Trips | 700 | 86,800 | |
| | Sand (3.6$m^3$ each) | 62 | " | 450 | 27,900 | |
| | Concrete Rings (Ø450mm) | 140 | No. | 200 | 28,000 | |
| | (Ø900mm) | 200 | No. | 250 | 50,000 | |
| | Empty Drums (200Lit ea) | 5 | No. | 200 | 1,000 | |
| | Measuring Tape (30m) | 3 | No. | 200 | 600 | |
| | Timber 1"x12"x12' | 410 | No. | 65 | 26,650 | |
| | 2"x2"x12' | 270 | No. | 20 | 5,400 | |
| | Wire Nail 3" | 4.5 | Bags | 470 | 2,115 | |
| | 4" | 2 | " | 470 | 940 | |
| | Basic Total | | | | 431,105 | |
| | Transportation of materials to site (5%) | | | | 21,556 | |
| | Total Materials | | | | 452,661 | 452,661 |

SCHEDULE OF RESOURCES AND COST ESTIMATES(EQUIPMENT-BASED)

OKE-ODAN DAM AIO-OBO/OTA LGA OGUN STATE

| S/NO. | ITEM | QTY. | UNIT | RATE (₦) | AMOUNT (₦) | TOTAL (₦) |
|---|---|---|---|---|---|---|
| 4. | HIRED EQUIPMENT | | | | | |
| | Bulldozer | 408 | w.d | 6,000 | 2,448,000 | |
| | Excavator | 66 | w.d | 5,500 | 363,000 | |
| | Gradder | 204 | w.d | 4,800 | 979,200 | |
| | Payloader | 456 | w.d | 4,800 | 2,188,800 | |
| | Roller | 204 | w.d | 4,500 | 918,000 | |
| | Concrete Mixer | 18 | w.d | 1,100 | 19,800 | |
| | Tipper | 1074 | w.d | 1,800 | 1,932,200 | |
| | Water Pump | 20 | w.d | 500 | 10,000 | |
| | Concrete Dumper | 9 | w.d | 1,500 | 13,500 | |
| | Basic Total | | | | 9,283,900 | |
| | Add 5% for fuel, oil and lubrication | | | | 464,195 | |
| | Transport for Equipment | 28 | Trips | 8,500 | 238,000 | |
| | Total Hired Equipment | | | | 9,986,095 | 9,986,095 |
| | Total Labour, Handtools, Materials and Hired Equipment | | | | 10,605,232 | |
| | Add 1% Supervision | | | | 106,053 | |
| | TOTAL AMOUNT | | | | 10,711,285 | 10,711,285 |

METHOD STATEMENTS (LABOUR-BASED)
IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 1.00 | BUSH CLEARING | 1900 | $m^2$ | Clear and cart away vegetation from damsite, reservoir area and borrow pits | $80m^2$/ wd | 24 | 1GL 13USL | 2days | Rope | 4 | No. | | | Cutlass<br>Rake<br>File | 12<br>5<br>3 | In each activity use one (1) unskilled labourer (USL) as Night guard. |
| 2.00 | TREE FELLING | 120 | No. | Fell trees from dam axis and reservoir area, Cut to size-able pieces using chain saw | 30No./ wd | 4 | - | - | - | - | - | Chain saw | 4days | - | - | |
| 2.01 | | | | Carting away of fell trees | 1.5No./ wd | 80 | 1GL 13USL | 7days | | | | | | Cutlass<br>File | 15<br>3 | |
| 3.00 | STUMPING AND GRUBBING | 50 | No. | Remove stumps and grub along the dam axis | 1No./ wd | 50 | 1GL 13USL | 5days | | | | | | Pickaxe<br>Spade<br>Shovel<br>Cutlass<br>Headpan | 8<br>5<br>3<br>8<br>2 | |

METHOD STATEMENTS (LABOUR-BASED)
IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 4.00 | TOP SOIL REMOVAL | 1600 | $m^2$ | Remove top soil and peat to an average depth of 0.25m along the dam axis | $15m^2$/wd | 107 | 1GL<br>13USL | 9days | | | | | | Pickaxe<br>Shovel<br>Spade<br>Headpan | 5<br>5<br>3<br>8 | |
| 5.00 | CUT-OFF TRENCH | | | Excavate, load, Haul and Cart away cut-off trenchs of dam excluding the original River course ($5m^2$) | | | | | | | | | | | | The total volume of the cut-off excavated materials is $130m^3$ since no river diversion then the cut-off on the river course($1x1\frac{1}{2}.5x2$)+ ($1x1x2$) $m^3$ is excluded until the diversion is carried out. |
| 5.01 | | 125 | $m^3$ | Excavation | $3.5m^3$/wd | 36 | 1GL<br>3USL | 14days | Rope | 4 | No. | Water pump | 14 days | Pickaxe<br>Spade<br>Shovel<br>Headpan | 5<br>2<br>5<br>8 | |
| | | " | " | Loading | $4m^2$/wd | 32 | 3USL | " | | | | | | | | |
| | | " | " | Hauling | $2m^3$/wd | 63 | 5USL | " | | | | | | | | |

METHOD STATEMENTS (LABOUR-BASED)
IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 5.02 | | | | Fill the cut-off trench with materials obtained from borrow pits | | | | | | | | | | | | |
| | | 125 | $m^3$ | Excavation | $3.5m^3$/wd | 36 | 1GL<br>3USL | 14days | Rope | 4 | No. | | | Pickaxe<br>Spade<br>Shovel | 5<br>2<br>5 | |
| | | " | " | Loading | $4m^3$/wd | 32 | 3USL | " | | | | | | Headpan | 20 | |
| | | " | " | Hauling | $0.7m^3$/wd | 179 | 13USL | " | | | | | | | | Use one USL for root picking |
| | | " | " | Spreading | $12 m^3$/wd | 11 | 1GL<br>2USL | " | | | | | | | | |
| | | 12500 | Lits | Watering | 500Lit/wd | 25 | 2USL | " | Empty drum | 3 | No. | | | Space<br>Rake<br>Water-ing van | 2<br>3<br>3 | |
| | | 125 | $m^3$ | Compaction | $3m^3$/wd | 42 | 3USL | " | | | | | | Hand Rammer | 5 | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)
ENUGWU DAM, EFE LGA, LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 5.03 | REKAIMING CUT-OFF | | | Excavate and cartaway the remaining cut-off trench on the original River course | | | | | | | | | | | | | When the river diversion(through the scouring sluice ) is completed then the cut-off trench that falls on the original river course would be carried out. |
| | | 5 | $m^3$ | Excavation | $3.5m^3$/wd | 2 | 1GL 2USL | 1day | Rope | 4 | No. | | | Pickaxe<br>Spade<br>Shovel | 2<br>2<br>2 | | |
| | | " | " | Loading | $4m^3$/wd | 2 | 2USL | " | | | | Water Pump | 1day | Headpan | 5 | | |
| | | " | " | Hauling | $2m^3$/wd | 3 | 3USL | " | | | | | | | | | |
| .04 | | | | Fill the cut-off trench with materials from borrow-pits | | | | | | | | | | | | | |
| | | 5 | $m^3$ | Excavation | $3.5m^3$/wd | 2 | 1GL 2USL | 1day | | | | | | Pickaxe<br>Spade<br>Shovel<br>Headpan<br>Rake<br>Watering Can | 3<br>2<br>3<br>10<br>2<br>3 | | |



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METHOD STATEMENTS (LABOUR-BASED)
IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| | | 5 | $m^3$ | Loading | $4m^3$/wd | 2 | 2USL | 1day | | | | | | | | | |
| | | " | " | Hauling | $0.7m^3$/wd | 8 | 8USL | " | | | | | | | | | |
| | | " | " | Spreading | $12m^3$/wd | 0.5 | 1USL | " | | | | | | | | | |
| | | 500 | Lits | Watering | 500Lit | 1 | 1USL | " | Empty Drum | 1 | No. | | | | | | |
| | | 5 | $m^3$ | Compaction | $3m^3$/wd | 2 | 2USL | " | | | | | | | | | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | | |
| 6.00 | EMBANKMENT | | | Excavate, load, Haul, Spread, water and compact suitable materials from borrow-pit for the dam embankment. | | | | | | | | | | | | | The total embankmen material up to Elevation (EL) 101 is $700m^3$ including that of the origina river course.<br>It should be noted that the embankment up to EL101 on the original River Course whose dimension is $(\frac{1}{2}(2+2.9)x2)x17\ m^3$ = $84m^3$ |

METHOD STATEMENTS (LABOUR-BASED)
IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 6.010 | EMBANKMENT UP TO EL101 | 616 | $m^3$ | Excavation | $3.5m^3$/wd | 176 | 1GL 5USL | 37days | Rope | 4 | No. | | | Pickaxe | 6 | cannot be accomplished until River diversion is carried out. The scouring sluice is constructed at this (101) elevation. |
| | | " | " | Loading | $4m^3$/wd | 154 | 5USL | " | | | | | | Spade | 4 | |
| | | " | " | Hauling | $0.7m^3$/wd | 880 | 1GL 24USL | " | | | | | | Shovel | 6 | |
| | | " | " | Spreading | $12m^3$/wd | 52 | 1GL 3USL | " | | | | | | Headpan | 30 | |
| | | 61600 | Lts. | Watering | 500lit/wd | 124 | 4USL | " | Empty Drum | 5 | No. | | | Rake | 4 | |
| | | 616 | $m^3$ | Compaction | $3m^3$/wd | 206 | 6USL | " | | | | | | Watering Can | 5 | |
| | | | | Nightguard | | | 1USL | " | | | | | | Hand Rammer | 8 | |

Use one USL for root picking

1st layer

$20x17x0.10=34m^3$

$\frac{34m^3}{0.7x24} = \frac{34}{17} = 3days$

Last Layer

$44x11x0.10 = 49m^3$

$\frac{49m^3}{17} = 3days$

METHOD STATEMENTS (LABOUR-BASED)
IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 5.011 | COFFER DAM | | | Excavate, load, Haul, Spread, Water and compact materials from the Reservoir area for coffer dam on the original River course | | | | | | | | | | | | | To provide a dry working place for the construction of the Embankment (on the original River course) up to Elevation (EL)101. |
| | 6 | $m^3$ | Excavation | $3.5m^3$/wd | 2 | 1GL<br>2USL | 1day | | | | | | | Pickaxe<br>Spade<br>Shovel | 3<br>2<br>3 | | The dimension of the coffer dam$(4x0.5x3)m^3$ |
| | " | " | Loading | $4m^3$/wd | 2 | 2USL | " | | | | | | | Headpan<br>Rake | 5<br>2 | | |
| | " | " | Hauling | $2m^3$/wd | 3 | 3USL | " | | | | | | | watering Can | 3 | | |
| | " | " | Spreading | $12 m^3$/wd | 0.5 | 1USL | " | | | | | | | Hand Rammer | 3 | | |
| | 600 | Lts. | Watering | 500lit/wd | 2 | 2USL | " | | Empty Drum | 2 | No. | | | | | | |
| | 6 | $m^3$ | Compaction | $3m^3$/wd | 2 | 2USL | " | | | | | | | | | | |
| | | | Nightguard | | | 1USL | " | | | | | | | | | | |

150

150

METHOD STATEMENTS (LABOUR-BASED)

IMOKUN LAN EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 6.012 | EMBANKMENT UP TO EL101 | | | Embankment formation on the original River Course up to EL101. Obtain the material from borrow-pit | | | | | | | | | | | | The river is diverted through the scouring sluice. |
| | 84 | $m^3$ | Excavation | $3.5m^3$/wd | 24 | 1GL 5USL | 5days | Rope | 4 | No. | | | | Pickaxe | 6 | |
| | | | | | | | | | | | | | | Spade | 4 | |
| | | | | | | | | | | | | | | Shovel | 6 | |
| | | | | | | | | | | | | | | Headpan | 30 | |
| | " | " | Loading | $4m^3$/wd | 21 | 5USL | " | | | | | | | Rake | 4 | |
| | | | | | | | | | | | | | | Watering Can | 5 | |
| | " | " | Hauling | $0.7m^3$/wd | 120 | 1GL 24USL | " | | | | | | | Hand Hammer | 8 | |
| | " | " | Spreading | $12m^3$/wd | 7 | 1GL 3USL | " | | | | | | | | | One USL for root picking |
| | 8400 | Litres | Watering | 500Lit/wd | 17 | 4USL | " | Empty Drum | 5 | No | | | | | | |
| | 84 | $m^3$ | Compaction | $3m^3$/wd | 28 | 6USL | " | | | | | | | | | |
| | | | Nightguard | | | 1USL | " | | | | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)

ZINOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 6.020 | EMBANKMENT UP TO EL102.8 | | | Embankment formation up to elevation 102.8 | | | | | | | | | | | | Elevation 102.8 is for the construction of spillway. |
| | | 600 | $m^3$ | Excavation | $3.5m^3$/wd | 172 | 1GL 5USL | 36days | Rope | 4 | No. | | | Pickaxe | 6 | 1st Layer |
| | | | | | | | | | | | | | | Spade | 4 | $44x11x0.10=49m^3$ |
| | | " | " | Loading | $4m^3$/wd | 150 | 5USL | " | | | | | | Shovel | 6 | |
| | | | | | | | | | | | | | | Headpan | 30 | $\frac{49m^3}{0.7x24}$ = 3days |
| | | " | " | Hauling | $0.7m^3$/wd | 858 | 1GL 24USL | " | | | | | | Rake | 4 | |
| | | | | | | | | | | | | | | Watering Can | 5 | Last Layer |
| | | " | " | Spreading | $12m^3$/wd | 50 | 1GL 3USL | " | | | | | | Hand Rammer | 8 | $57x4x0.10=23m^3$ |
| | | 60000 | Lits | Watering | 500lit/wd | 120 | 4USL | " | Empty Drum | 5 | No. | | | | | $\frac{23}{0.7x24}$ = 2 days |
| | | 600 | $m^3$ | Compaction | $3m^3$/wd | 200 | 6USL | " | | | | | | | | One USL for root picking |
| | | | | Nightguard | | | 1USL | " | | | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)
INOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 6.030 | EMBANKMENT UP TO EL104 | | | Embankment formation to elevation 104 | | | | | | | | | | | | The final elevation of the dam is 104 |
| | | 200 | $m^3$ | Excavation | $3.5m^3$/wd | 58 | 1GL 5USL | 12days | Rope | 4 | No. | | | Pickaxe<br>Spade<br>Shovel | 6<br>4<br>6 | 1st Layer<br>$57x4x0.10=23m^3$ |
| | | " | " | Loading | $4m^3$/wd | 50 | 5USL | " | | | | | | Hescpan<br>Rake | 30<br>4 | $\frac{23}{0.7x24}$ = 2days |
| | | " | " | Hauling | $0.7m^3$/wd | 286 | 1GL 5USL | " | | | | | | Watering Can | 5 | |
| | | " | " | Spreading | $12m^3$/wd | 17 | 1GL 3USL | " | | | | | | Hand Rammer | 6 | Last layer<br>$65x1.5x0.10=10m^3$<br>$\frac{10m^3}{0.7x24}$ = 1 day |
| | | 20000 | Lits | Watering | 500lit/wd | 40 | 4USL | " | Empty Drum | 5 | No. | | | | | |
| | | 200 | $m^3$ | Compaction | $3m3$/wd | 67 | 6USL | " | | | | | | | | One USL for root picking |
| | | | | Nightguard | | | 1USL | " | | | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)
IMOKUN DAN EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 7.00 | SCOURING SLUICE | | | Provide scouring sluice at elevation (EL) 101 | | | | | | | | | | | | | |
| 7.01 | | 1.71 | $m^3$ | Provide and place blincing(1:4:8) Concrete of 0.15m thickness | $1m^3$/wd | 2 | 1GL 2USL | 1day | Cement<br>Sand<br>Gravel<br>Empty Drum | 6½<br>1/4<br>½<br>2 | Bags<br>Lorry<br>Lorry<br>No. | | | Shovel<br>Spade<br>Headpan<br>Watering Can | 2<br>2<br>3<br>2 | | |
| 7.02 | | 22 | No. | Provide and place two rows of Ø450mm x 1000mm precast concrete pipes | 5No./wd | 8 | 1GL 8USL | 1day | Concrete pipes(Ø450mm) | 22 | No. | | | | | | |
| 7.03 | | 20 | $m^2$ | Errect and remove formwork for the concrete surround | $20m^2$/wd | 1 | 1GL 1USL | 1day | Timber planks<br>1"x12"x12'<br>2"x2"x12'<br>4" Wire Nails<br>3" Wire Naile | 23<br>18<br>5<br>.7 | No.<br>No.<br>Kg<br>Kg | | | | | | |

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METHOD STATEMENTS (LABOUR-BASED)

IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 7.04 | | 4.91 | $m^3$ | Provide concrete surround(1:3:6) to the precast rings | $1m^2$/wd | 5 | 3GL<br>5USL | 1day | Cement<br>Sand<br>Gravel<br>Empty | 23<br>3/4<br>1 | Bags<br>Lorry<br>Lorry | | | Shovel<br>Spade<br>Headpan<br>watering | 2<br>2<br>3 | | |
| | | | | Night Guard | | | 1USL | 4days | Drum | 2 | No. | | | Can | 2 | | |
| 8.00 | SPILLWAY | | | Construct spillway at elevation(ZL) 102.8 | | | | | | | | | | | | | |
| 8.01 | | 0.68 | $m^3$ | Provide and place blinding (1:4:8)concrete of 0.15m thick | $1m^3$/wd | 1 | 1GL | 1day | Cement<br>Sand<br>Gravel | 3<br>0.15<br>0.3 | Bags | | | Shovel<br>Space<br>Headpan<br>Watering<br>Can | 2<br>2<br>3<br>2 | | |
| 8.02 | | 10 | No. | Provide and place 2 rows of Ø450 x 1000mm pre-cast concrete (10No.) | 3No/wd | 4 | 1GL<br>4USL | 1day | Concrete pipes (Ø450mm) | 10 | No. | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)
IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 8.03 | | 12 | $m^2$ | Errection and removal of formwork for the concrete surround | $20m^2$/wd | 1 | 1GL<br>1USL | 1day | Timber P<br>Planks -<br>1"x12"x12'<br>2"x2"x12'<br>4"Wire Nail<br>3" " " | <br><br>15<br>11<br>3<br>4 | <br><br>No.<br>No.<br>Kg.<br>Kg | | | | | | |
| 8.04 | | 1.79 | $m^3$ | Provide mass concrete surround (1:3:6) | $1m^3$/wd | 2 | 1GL<br>2USL | 1day | Cement<br>Sand<br>Gravel<br>Empty Drum | 8<br>0.25<br>0.5<br>2 | Bags<br>Lorry<br>"<br>No. | | | Shovel<br>Spade<br>Headpan<br>Watering Can | 2<br>2<br>3<br>2 | | |
| | | | | Nightguard | | | 1USL | 4days | | | | | | | | | |
| 9.00 | ROCK RIP RAP | | | Provide and place rock rip rap(0.2m thick) on the upstream slope of the dam. | | | | | | | | | | | | | |
| 9.01 | | 38 | $m^2$ | Hauling and placing of rip rap up to elevation (EL) 101 | $2m^2$/wd | 19 | 1GL<br>19USL | 1day | | | | | | Headpan | 25 | | |
| | | | | Nightguard | | | 1USL | 1day | | | | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)

IMOKUN DAM EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Description | Qty | Unit | Description | Output | Time | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | | | | | | | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 9.02 | | 20 | $m^2$ | Hauling and placing of rip rap up to EL102.8 | $2m^2$/wd | 10 | 1GL<br>1OUSL | 1day | | | | | | Headpan | 15 | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | |
| 9.03 | | 18 | $m^2$ | Hauling and placing of rip rap up to EL 104 | $2m^2$/wd | 9 | 1GL<br>1OUSL | | | | | | | Headpan | 15 | |
| | | | | Nightguard | | | 1USL | 1day | | | | | | | | |

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LABOUR-BASED
IMOKUN DAM EPE LGA LAGOS STATE

| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GL | US | CL | FI | BR | BP | PAX | MK | MO | SH | SP | WC | WP | CS | ED | | |
| 1 | 1) BUSH CLEARING | 1 | 13 | 12 | 3 | | | | 5 | 4 | | | | | | | | |
| | 2) TREE FELLING | 1 | 13 | 15 | 3 | | | | | | | | | | | | | |
| | TOTAL | 1 | 13 | 15 | 3 | | | | 5 | 4 | | | | | | | | |
| 2 | 1) TREE FELLING | 1 | 13 | 15 | 3 | | | | | | | | | | | | | |
| 3 | 1) TREE FELLING | 1 | 13 | 15 | 3 | | | | | | | | | | | | | |
| | 2) STUMPING | 1 | 13 | 8 | | | 2 | 8 | | | 3 | 5 | | | | 2 | | |
| | TOTAL | 1 | 13 | 15 | 3 | | 2 | 8 | | | 3 | 5 | | | | 2 | | |
| 4 | 1) STUMPING | 1 | 13 | 8 | | | 2 | 8 | | | 3 | 5 | | | | 2 | | |
| | 2) TOP SOIL REMOVAL | 1 | 13 | - | | | 8 | 5 | | | 5 | 3 | | | | | | |
| | TOTAL | 1 | 13 | 8 | | | 8 | 8 | | | 5 | 5 | | | | 2 | | |
| 5 | 1) TOP SOIL REMOVAL | 1 | 13 | | | | 8 | 5 | | | 5 | 3 | | | | | | |
| | 2) CUT OFF TRENCH | 3 | 38 | | | 5 | 28 | 10 | 3 | 4 | 10 | 6 | 3 | 1 | | 3 | | |
| | TOTAL | 3 | 38 | | | 5 | 28 | 10 | 3 | 4 | 10 | 6 | 3 | 1 | | 3 | | |
| 6 | 1) CUT-OFF TRENCH | 3 | 38 | | | 5 | 28 | 10 | 3 | 4 | 10 | 6 | 3 | 1 | | 3 | | |
| 7 | 1) CUT-OFF TRENCH | 3 | 38 | | | 5 | 28 | 10 | 3 | 4 | 10 | 6 | 3 | | | 3 | | |
| 8 | 1)EMBANKMENT UP TO EL101 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | | |
| 9 | " " | " | " | | | " | " | " | " | " | " | " | " | | | " | | |
| 10 | " " | " | " | | | " | " | " | " | " | " | " | " | | | " | | |
| 11 | " " | " | " | | | " | " | " | " | " | " | " | " | | | " | | |
| 12 | " " | " | " | | | " | " | " | " | " | " | " | " | | | " | | |
| 13 | " " | " | " | | | " | " | " | " | " | " | " | " | | | " | | |
| 14 | 1) EMBANKMENT UP TO EL101 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | | |
| | 2) SCOURING SLUICE | 6 | 17 | | | | 3 | | | | 2 | 2 | 2 | | | 2 | | |
| | TOTAL | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | | |
| 15 | 1) SCOURING SLUICE | 6 | 17 | | | | 3 | | | | 2 | 2 | 2 | | | 2 | | |
| | 2) RIP RAP UP TO EL101 | 1 | 20 | | | | 25 | | | | | | | | | | | |
| | 3) COFFER DAM | 1 | 13 | | | 3 | 5 | 3 | 2 | | 3 | 2 | 3 | | | 2 | | |
| | 4) CUT-OFF TRENCH(ORC) | 2 | 24 | | | 3 | 15 | 5 | 2 | 4 | 5 | 4 | 2 | 1 | | 1 | | |
| | TOTAL | 6 | 37 | | | 3 | 28 | 5 | 2 | 4 | 5 | 4 | 3 | 1 | | 2 | | |
| 16 | 1) EMBANKMENT UP TO EL101 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | | |
| | 2)EMBANKMENT UP TO EL102.8 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | | |
| | TOTAL | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | | |
| 17 | EMBANKMENT UP TO EL102.8 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | | |
| 18 | " " | " | " | | | " | " | " | " | " | " | " | " | | | " | | |

| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GI | USI | CI | FI | HR | HP | FAX | MX | RO | SH | SP | WC | WP | CS | ED | |
| 19 | EMBANKMENT UP TO EL102.8 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | |
| 20 | " " | " | " | | | " | " | " | " | " | " | " | " | | | " | |
| 21 | " " | " | " | | | " | " | " | " | " | " | " | " | | | " | |
| 22 | 1) EMBANKMENT UP TO EL102.8 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | |
| | 2) SPILLWAY | 4 | 8 | | | | 3 | | | | 2 | 2 | 2 | | | | |
| | TOTAL | 4 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | |
| 23 | 1) SPILLWAY | 4 | 8 | | | | 3 | | | | 2 | 2 | 2 | | | | |
| | 2) RIP RAP UP TO EL102.8 | 1 | 11 | | | | 15 | | | | | | | | | | |
| | 3) EMBANKMENT UP TO EL104 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | |
| | TOTAL | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | |
| 24 | EMBANKMENT UP TO EL104 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | |
| 25 | 1) EMBANKMENT UP TO EL104 | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | |
| | 2) RIP RAP UP TO EL104 | 1 | 11 | | | | 15 | | | | | | | | | | |
| | TOTAL | 3 | 48 | | | 8 | 30 | 6 | 4 | 4 | 6 | 4 | 5 | | | 5 | |

METHOD STATEMENTS (PUMP OPTION)
IMOKUN IRRIGATION SCHEME
EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Activity | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 1.0 | ACCESS ROAD | 8000 | $m^2$ | Clear bush and uproot trees to make the pump house accessible to man and vehicles | $500m^2$/wd | 2 | 1USL | 2days | | | | 108 | 2days | | | | |
| | | | | Grading of road | | | | | | | | 1GR | 1day | | | | |
| 2.0 | PUMP HOUSE | | | | | | | | | | | | | | | | |
| | | 13.6 | $m^3$ | Foundation Excavation | $3.5m^3$/wd | 4 | 2USL | 2days | | | | | | Pickaxe | 3 | | |
| | | | | | | | | | | | | | | Spade | 2 | | |
| | | 4.1 | $m^3$ | Foundation cone (1;3:6) | $1m^3$/wd | 5 | 2SL | 2days | WaterDrum | 2 | | | | Headpan | 4 | | |
| | | | | | | | 3USL | | Cement | 22 | Bags | | | Shovel | 4 | | |
| | | | | | | | | | Sand | 1 | Lorry | | | | | | |
| | | | | | | | | | Gravel | 1½ | " | | | | | | |

METHOD STATEMENTS (PUMP OPTION)
IMOKUN IRRIGATION SCHEME
EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Activity | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| | | 89 | No. | Laying of 9" blocks up to DPC level | 70No/wd | 2 | 2SL<br>2USL | 1day | 9" blocks<br>WaterDrum<br>Cement<br>Sand | 95<br>2<br>3<br>1/5 | No.<br>No.<br>Bags<br>Lorry | | | Headpan<br>Spade<br>Shovel | 3<br>2<br>1 | |
| | | 0.4 | $m^3$ | Motar (1:6) for joining the blocks | | | | | | | | | | Headpan | 3 | |
| | | 5 | $m^3$ | Lateritic filling up to DPC | $1.5m^3$/wd | 4 | 1GL<br>2USL | 2days | | | | | | Shovel | 3 | |
| | | 6.1 | $m^3$ | Floor concrete (1:2:4) | $1m^3$/wd | 7 | 4SL<br>3USL | 2days | WaterDrum<br>Cement<br>Sand<br>Gravel | 2<br>47<br>1<br>2 | No.<br>Bags<br>Lorry<br>" | | | Headpan<br>Spade<br>Shovel | 4<br>3<br>3 | |

METHOD STATEMENTS (PUMP OPTION)
IMOKUN IRRIGATION SCHEME
EPE LGA LAGOS STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Activity | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| | | 436 | No. | Super structure blockwork | 70No/wd | 7 | 4SL<br>4USL | 2days | 9" blocks<br>WaterDrum<br>Cement<br>Sand | 458<br>2<br>11<br>1 | No.<br>No.<br>Bag<br>Lorry | | | Headpan<br>Spade<br>Shovel | 5<br>3<br>2 | | |
| | | 1.8 | $m^3$ | Motar (1:6) for joining blocks | | | | | | | | | | | | | |
| 3.0 | ROOFING | | | Roofing of the pump house | | | 2SL<br>2USL | 1day | Timber<br>2"x6"x12'<br>2"x4"x12'<br>2"x2"x12'<br>Iron Sheet<br>Nails | 8<br>6<br>11<br>36<br>5 | No.<br>No.<br>No.<br>No.<br>Kg. | | | | | | |



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METHOD STATEMENTS (PUMP OPTION)
IMOKUN IRRIGATION SCHEME
EFE LGA LAGOS STATE

| No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Activity | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| .0 | SUMP | 520.2 | $m^3$ | Excavation of trench | $200m^3$/wd | 3 | 1USL | 3days | | | | 1EX Water Pump | 3days<br>3days | | | | |
| | | 1995 | No. | Sump blockwork | 70No/wd | 29 | 8SL<br>8USL | 4days | 9" blocks<br>WaterDrum<br>Cement<br>Sand | 2095<br>2<br>46<br>3 | No.<br>No.<br>Bag<br>Lorry | " | 4days | Headpan<br>Spade<br>Shovel | 10<br>5<br>5 | | |
| | | 8 | $m^3$ | Motar for blocks | | | | | | | | | | | | | |
| | | | | Construction of reinforced concrete beams and columns | | | | | | | | | | | | | |
| | | 15 | $m^2$ | Provide, place and remove after completion formwork | $20m^2$/wd | 1 | 1SL<br>1USL | 1day | Timber<br>1½"x12"x12'<br>2"x2"x12'<br>Wire Nails | 15<br>70<br>6 | No.<br>No.<br>Kg. | water Pump | 1day | | | | |



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METHOD STATEMENTS (PUMP OPTION)
IMOKUN IRRIGATION SCHEME
EPE LGA LAGOS STATE

| No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Activity | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| | | 33 | No. | Fixing of the reinforcement | | | 2SL<br>2USL | 1day | Mild Steel (Ø12mm) | 33 | No. | Water Pump | 1day | | | | |
| | | 3.3 | $m^3$ | Provide and place concrete(1:2:4) for beams and columns | $1m^3$/wd | 4 | 2SL<br>2USL | 2days | WaterDrum<br>Cement<br>Sand<br>Gravel | 2<br>24<br>½<br>1 | No.<br>Bags<br>Lorry<br>" | "<br><br><br> | 2days<br><br><br> | Headpan<br>Spade<br>Shovel | 4<br>2<br>2 | |
| | | 37 | $m^3$ | Casting of floor concretes (1:2:4) | $10m^3$/wd | 4 | 3SL | 4days | WaterDrum<br>Cement<br>Sand<br>Gravel | 2<br>267<br>6<br>11 | No.<br>Bags<br>Lorry<br>" | Mixer (1No)<br>Water Pump | 4days<br>" | Headpan<br>Spade<br>Shovel | 10<br>3<br>3 | |
| | | 37 | $m^3$ | Loading of mixer | $2m^3$/wd | 19 | 5USL | 4days | | | | | | | | | |
| | | 3.1 | $m^3$ | Plastering of block walls | $0.4m^3$/wd | 8 | 8SL<br>8USL | 1day | WaterDrum<br>Cement<br>Sand | 2<br>18<br>2 | No.<br>Bag<br>Lorry | | | | | | |

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Appendix 9

METHOD STATEMENTS (LABOUR-BASED)

BAKARI DAM LGA KATSINA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 1.00 | BUSH CLEARING | 28210 | $m^2$ | Clear Dam site (including reservoir area) of all bush, shrub, trees etc and cart-away | $120m^2$/wd | 236 | 6GL<br>120USL | 2days | Rope | 4 | No. | | | Cutlass<br>Rake<br>File | 100<br>50<br>20 | | Light vegetation so the productivity rate is high.<br>In each activity use one unskilled Labour as a Night-Guard |
| 2.00 | TOP SOIL REMOVAL | 6000 | $m^2$ | Strip top soil to depth of about 0.30m along the dam axis | $12m^2$/wd | 500 | 6GL<br>126USL | 4days | | | | | | Pickaxe<br>Spade<br>Shovel<br>Headpan | 50<br>20<br>30<br>65 | | |
| 3.00 | DAM FOUNDATION | 7663 | $m^3$ | Excavate up to the impervious layer for dam foundation and cart away | | | | | | | | | | | | | |
| | | | | Excavation | $2.5m^3$/wd | 3066 | 4GL<br>92USL | 34days | Rope | 4 | No. | 1WP | 34days | Pickaxe<br>Spade<br>Shovel | 100<br>20<br>85 | | |
| | | | | Loading | $3m^3$/wd | 2555 | 3GL<br>76USL | " | | | | | | Headpan<br>Wheel Barrow | 110<br>20 | | |
| | | | | Hauling | $2m^3$/wd | 2832 | 5GL<br>113USL | " | | | | | | | | | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)

BALOSSI DAM, LOW MATSIC STAGE

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | Time | MATERIALS: Description | Qty | Unit | EQUIPMENT: Type | Time | HAND TOOLS: Type | No. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.00 | EMBANKMENT FORMATION | 43234 | $m^3$ | Embankment Formation up to EL108 Obtain suitable material from borrow area | | | | | | | | | | | | |
| 4.01 | EMBANKMENT FORMATION | 28940 | $m^3$ | Embankment filling up to elevation 105.7 (centre).Obtain suitable material from the borrow area | | | | | | | | | | | | |
| | | | | Excavate | $2.5m^3$/wd | 11576 | 8GL 187USL | 62days | Rope | 4 | No. | | | Pickaxe<br>Spade<br>Shovel | 200<br>20<br>170 | The rate of excavation is lower compared to other dams because the activity was executed during the dry season and also in the North |
| | | | | Loading | $3m^3$/wd | 9647 | 6GL 156USL | " | | | | | | | | |
| | | | | Hauling | $78.4m^3$/wd | 370 | | | | | | Tractor (6No) | 62days | Spade<br>Rake<br>W.C. | 10<br>30<br>100 | Tractor trailer whose volume is $2.8m^3$ will make a total trip of 28 in 7 hrs. |
| | | | | Spreading | $15m^3$/wd | 1930 | 2GL 32USL | " | | | | | | | | Rate of spreading is higher because it is easier to spread. |
| | | 2894000 Lits | | Watering | 500lit/wd | 5788 | 4GL 94USL | " | | | | | | | | |

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METHOD STATEMENTS (LABOUR-BASED)

BATSARI DAM LGA KATSINA STATE

| DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| | | | Compaction | 180m³/wd | 161 | | | | | | Hand Roller (3No) | 62days | | | | 1st Layer<br>30x30x0.1= 90m³<br>$\frac{90}{7.4x6}$ = 0.2<br>Last Layer<br>226x12.25x0.1=277<br>$\frac{277}{76.4xc}$ = 1day |
| | | | Nightguard | | | 1USL | 62days | | | | | | | | | |
| Embankment to be placed on the right flank of the (Bank of the Village) | 6175 | m³ | Embankment filling up to EL??? obtain the material from borrow Area 2km away | | | | | | | | | | | | | |
| | | | Excavation | 1.5m³/wd | 2470 | 7GL<br>16USL | 15days | Rope | 4 | No. | | | Pickaxe | 10 | | |
| | | | | | | | | | | | | | Spade | 20 | | |
| | | | Loading | 3m³/wd | 2059 | 6GL<br>13SUSL | " | | | | | | Shovel | 150 | | |
| | | | Hauling | 70m³/wd | 89 | | | | | | Tractor (6No) | 15days | Spade | 10 | | For hauling dist. of 2km, the tractor (2.8m³) can make 25 trips. |
| | | | Spreading | 15m³/wd | 412 | 2GL<br>28USL | " | | | | | | Rake | 30 | | |
| | | | | | | | | | | | | | W.C. | 100 | | |



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METHOD STATEMENTS (LABOUR-BASED)

BATSARI DAM LGA KATSINA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| | | 617500 | Ltrs | Watering | 500lit/wd | 1235 | 4GL 8JUSL | 15days | | | | | | Watering Can | 100 | | |
| | | | | Compaction | 180m³/wd | 35 | | | | | | Hand Roller (5No) | 15days | | | | |
| | | | | Pitchguard | | | | | | | | | | | | | |
| 4.021 | EMBANKMENT TO EL 12.00M on the left flank of the spillway | 13119 | m³ | Embankment filling up to EL108. Obtain material from borrow area 2km away. | | | | | | | | | | | | 1st Layer | |
| | | | | Excavation | 2.5m³/wd | 5240 | 7GL 10SJUSL | 324days | Hope | - | No. | | | Pickaxe | 100 | 225x1.25x0.1=m³ | |
| | | | | | | | | | | | | | | Spade | 20 | | |
| | | | | Loading | 2m³/wd | 4370 | 6GL 10SJUSL | " | | | | | | Shovel | 150 | 225/70m³ = 1 day | |
| | | | | | | | | | | | | | | | | 2nd Layer | |
| | | | | Hauling | 70m³/wd | 188 | | | | | | Tractor (6No) | 32days | | | 282x5x0.1=141m³ | |
| | | | | Spreading | 15m³/wd | 875 | 2GL 28USL | " | | | | | | Spade | 10 | | |
| | | | | | | | | | | | | | | Shovel | 30 | 141/70x6 = 0.3 | |

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METHOD STATEMENTS (LABOUR-BASED)

BATSARI DAM LGA KATSINA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| | | 1311900 | Litre | Watering | 500lit/wd | 2624 | 4GL 83USL | 32days | | | | | | Watering Can | 100 | |
| | | | | Compaction | 160m³/wd | 73 | | | | | | Hand Roller (3No) | 32days | | | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | |
| | | | | Provide and place rip rap (0.3m thick) for pitching embankment slopes. | | | | | | | | | | | | |
| | | 3974 | m² | Haul and place rip rap up to EL108.7 | 2m²/wd | 1987 | 6GL 14USL | 14days | | | | | | Headpan | 120 | |
| | | 2663 | m² | Haul and place rip rap up to EL108 (both left and right flank) | 2m²/wd | 1332 | 5GL 12USL | 11days | | | | | | Headpan | 140 | The rip rap of the embankment on both sides of the spillway (i.e. EL108) was carried out together. The rip rap area is 2 (665+1798) m² |



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METHOD STATEMENTS (LABOUR-BASED)

B.OSARI DAM LOC. KATSINA SITE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 6.00 | SPILLWAY | | | Construct spillway at EL105.7 | | | | | | | | | | | | |
| | 50 | $m^3$ | Provide and place blinding concrete (1:3:6) | $1m^3$/wd | 50 | 1GSL<br>3OUSL | 2days | Empty-rum<br>Cement<br>Sand<br>Gravel | 10<br>264<br>8<br>16 | No.<br>Bags<br>Trips<br>" | 1.0 | 2days | Spade<br>Shovel<br>Headpan<br>Watering Can | 10<br>10<br>20<br>5 | | |
| | 343 | $m^2$ | Provide, place and remove after completion formwork | $20m^2$/wd | 18 | 9SL<br>5USL | 2days | Planks -<br>1"x12"x12'<br>2"x2"x12'<br>3"WireNail<br>4" " | 350<br>200<br>3.5<br>2 | No.<br>No.<br>Bags<br>" | | | | | | |
| | 9 | Tons | Supply and fix reinforcement | 0.3tons/ wd | 30 | 15SL<br>8USL | 2days | Mild Steel (Ø12mm) | 9 | tons | | | | | | |

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METHOD STATEMENTS (LABOUR-BASED)

BATSARI DAM LGA KATSINA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| | | 670 | $m^3$ | Provide and place reinforced concrete (1:1½:3) | $24m^3$/wd | 28 | 6SL<br>1USL | 7days | Empty Drum<br>Cement<br>Sand<br>Gravel | 10<br>6140<br>92<br>184 | No<br>Bags<br>Trips<br>" | 4CM<br>1LT | 7days | Spade | 10 | | |
| | | | | Loading of Mixer | $2m^3$/wd | 335 | 2SL<br>1USL | " | | | | | | Shovel<br>Watering Can<br>Hessyan<br>Wheel Barrow | 10<br>10<br>50<br>10 | | |
| | | | | Hauling of Concrete | $2m^3$/wd | 335 | 2USL<br>1USL | " | | | | | | | | | |
| | 100 | $m^2$ | Provide and arrange rip rap for discharge channel | $2m^2$/wd | 50 | 2SL<br>1USL | 7day | | | | | | | Hessyan | 10 | | |
| | | | Nightguard | | | 1USL | 14days | | | | | | | | | | |



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| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GL | UGL | CL | FI | HI | AX | LK | JO | H | T | B | G | T | T | CH | LD | PR | TR | |
| 1 | 1)BUSH CLEARING | 6 | 120 | 100 | 20 | | | 30 | 4 | | | | | | | | | | | |
| | 2)TOP SOIL REMOVAL | 6 | 120 | | | 65 | 50 | | | 30 | 20 | | | | | | | | | |
| | TOTAL | 6 | 120 | 100 | 20 | 65 | 50 | | 4 | 30 | 20 | | | | | | | | | |
| 2 | 1)TOP SOIL REMOVAL | 6 | 120 | | | 65 | 50 | | | 30 | 20 | | | | | | | | | |
| | 2)DAM FOUNDATION | 12 | 282 | | | 110 | 100 | | 4 | 85 | 20 | 20 | | 1 | | | | | | |
| | TOTAL | 12 | 282 | | | 110 | 100 | | 4 | 85 | 20 | 20 | | 1 | | | | | | |
| 3 | DAM FOUNDATION | 12 | 282 | | | 110 | 100 | | 4 | 85 | 20 | 20 | | 1 | | | | | | |
| 4 | " | 12 | 282 | | | 110 | 100 | | 4 | 85 | 20 | 20 | | 1 | | | | | | |
| 5 | " | " | " | | | " | " | | " | " | " | " | | " | | | | | | |
| 6 | " | " | " | | | " | " | | " | " | " | " | | " | | | | | | |
| 7 | " | " | " | | | " | " | | " | " | " | " | | " | | | | | | |
| 8 | EMBANKMENT EL105 | 20 | 470 | | | | 200 | 30 | 4 | 170 | 30 | | 100 | | | | | 3 | 6 | |
| 9 | " | 20 | 470 | | | | 200 | 30 | 4 | 170 | 30 | | 100 | | | | | 3 | 6 | |
| 10 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 11 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 12 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 13 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 14 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 15 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 16 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 17 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 18 | 1)EMBANKMENT EL105 | 20 | 470 | | | | 200 | 30 | 4 | 170 | 30 | | 100 | | | | | 3 | 6 | |
| | 2)RIP RAP EL105 | 6 | 143 | | | | 160 | | | | | | | | | | | | | |
| | 3)SPILLWAY | 15 | 97 | | | 60 | | | | 10 | 10 | 20 | 10 | | 1 | 4 | 10 | | | |
| | TOTAL | 21 | 470 | | | 60 | 200 | 30 | 4 | 170 | 30 | 20 | 100 | | 1 | 4 | 10 | 3 | 6 | |
| 19 | 1)RIP RAP EL105 | 6 | 143 | | | | 160 | | | | | | | | | | | | | |
| | 2)SPILLWAY | 15 | 97 | | | 60 | | | | 10 | 10 | 20 | 10 | | 1 | 4 | 10 | | | |
| | TOTAL | 21 | 240 | | | 60 | 160 | | | 20 | 20 | 20 | 10 | | 1 | 4 | 10 | | | |
| 20 | 1)RIP RAP EL105 | 6 | 143 | | | | 160 | | | | | | | | | | | | | |
| | 2)SPILLWAY | 15 | 97 | | | 60 | | | | 10 | 10 | 20 | 10 | | 1 | 4 | 10 | | | |
| | TOTAL | 21 | 240 | | | 60 | 160 | | | 20 | 20 | 20 | 10 | | 1 | 4 | 10 | | | |
| 21 | 1)RIP RAP EL105 | 6 | 143 | | | | 160 | | | | | | | | | | | | | |
| | 2) SPILLWAY | 15 | 97 | | | 60 | | | | 10 | 10 | 20 | 10 | | 1 | 4 | 10 | | | |
| | 3)EMBANKMENT EL10[illegible] | 19 | 415 | | | | 180 | 30 | 4 | 150 | 30 | | 100 | | | | | 3 | 6 | |

| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GL | US | CL | FI | BI | TAX | LK | SO | SH | CT | UR | LC | CI | T | CH | ED | PR | TR | |
| 21 | TOTAL | 21 | 415 | | | 60 | 180 | 30 | 4 | 150 | 30 | | 600 | | 1 | 4 | 10 | 3 | 6 | |
| 22 | EMBANK. EL108R | 19 | 415 | | | | 180 | 30 | 4 | 150 | 30 | | 600 | | | | | 3 | 6 | |
| 23 | 1)EMBANK. EL108R | 19 | 415 | | | | 180 | 30 | 4 | 150 | 30 | | 600 | | | | | 3 | 6 | |
| | 2)EMBANK. EL108L | 19 | 415 | | | | 180 | 30 | 4 | 150 | 30 | | 600 | | | | | 3 | 6 | |
| | TOTAL | 19 | 415 | | | | 180 | 30 | 4 | 150 | 30 | | 600 | | | | | 3 | 6 | |
| 24 | EMBANKMENT EL108L | 19 | 415 | | | | 180 | 30 | 4 | 150 | 30 | | 600 | | | | | 3 | 6 | |
| 25 | EMBANKMENT EL108L | 19 | 415 | | | | 180 | 30 | 4 | 150 | 30 | | 600 | | | | | 3 | 6 | |
| 26 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 27 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| 28 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | |
| | 1)EMBANK. EL108L | 19 | 415 | | | | 180 | 30 | 4 | 150 | 30 | | 600 | | | | | 3 | 6 | |
| 29 | 2)RIP RAP EL108 | 5 | 123 | | | 140 | | | | | | | | | | | | | | |
| | TOTAL | 19 | 415 | | | 140 | 180 | 30 | 4 | 150 | 30 | | 600 | | | | | 3 | 6 | |
| 30 | RIP RAP EL108 | 5 | 123 | | | 140 | | | | | | | | | | | | | | |

METHOD STATEMENTS (EQUIPMENT-BASED)
BAFSARI DAM LGA KATSINA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Ouzput | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 1.00 | BUSH CLEARING | 28210 | $m^2$ | Clear dam site and Reservoir area (of bush, fell all trees, stump and cart away) | 5000$m^2$/wd | 6 | 2USL | 6days | | | | 1D8 | 6days | Cutlass | 2 | Use one (1) unskilled labour (USL) as a Night Guard in each activity. |
| 2.00 | TOP SOIL REMOVAL | 6000 | $m^2$ | Remowe top soil to depth of 0.3m along the dam axis | | | | | | | | | | | | |
| | | | | Excavate/stock | 1500$m^2$/wd | 4 | 2USL | 4days | | | | 1D8 | 4days | Cutlass | 2 | |
| 3.00 | EXCAVATION IN DAM FOUNDATION | 7663 | $m^3$ | Excavate up to the impervious layer for dam founuation and cart away | | | | | | | | | | | | |
| | | | | Excavate | 200$m^3$/wd | 39 | 2USL | 39days | | | | 1WP<br>1EX<br>1PL | 39days<br>"<br>" | Cutlass | 3 | (7663+6000x0.3)$m^3$ = 9463$m^3$ includes the top soil stock pilled for carting away. |
| | | 9463 | $m^3$ | Loading | 250$m^3$/wd | 38 | 1USL | " | | | | 3TP | " | | | |
| | | " | " | Haul/Cartaway | 104$m^3$/wd | 91 | | " | | | | | | | | |



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METHOD STATEMENTS (EQUIPMENT BASED)

BATSARI L.G. LGA. KATSINA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 4.020 | EMBANKMENT UP TO EL108R (on the right flank of the spillway) | 6175 | $m^3$ | Embankment filling up to EL 108. Obtain the material from a borrow area 2km away | | | | | | | | | | | | |
| | | | | Excavation | $350m^3$/wd | 18 | 3USL | 13days | | | | 2D8 | 13days | | | |
| | | | | Loading | $250m^3$/wd | 25 | 2USL | " | | | | 2FL | " | Cutlass | 8 | |
| | | | | Hauling | $89m^3$/wd | 70 | | " | | | | 6TL | " | | | For hauling distance 2km away, the Tipper ($3.7m^3$) can make 24 trips. |
| | | | | Spreading | $500m^3$/wd | 13 | 1USL | " | | | | 1GR | " | | | |
| | | | | Watering and Compaction | $600m^3$/wd | 11 | 2USL | " | | | | 1WT 1RL | " | | | |
| 4.021 | EMBANKMENT UP TO EL108L (on the left flank of the spillway) | 13119 | $m^3$ | Embankment filling up to EL108. Obtain the material from a borrow area 2km away | | | | | | | | | | | | First Layer<br>$226 \times 12.25 \times 0.15 = 419m^3$<br>$\frac{419}{500}$ = 1day |
| | | 13119 | $m^3$ | Excavation | $350m^3$/wd | 38 | 3USL | 27days | | | | 2D8 | 27days | | | Last Layer<br>$282 \times 5 \times 0.15 = 212m^3$<br>$\frac{212}{500}$ = ½ day |
| | | | | Loading | $250m^3$/wd | 53 | 2USL | " | | | | 2FL | " | | | |
| | | | | Hauling | $89m^3$/wd | 148 | | " | | | | 6TP | " | | | |
| | | | | Spreading | $500m^3$/wd | 27 | 1USL | " | | | | 1GR | " | | | |
| | | | | Watering and Compaction | $600m^3$/wd | 22 | 2USL | " | | | | 1WT 1RL | " | | | |

METHOD STATEMENTS (EQUIPMENT-BASED)
BATSARI DAM LGA KATSINA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 4.00 | EMBANKMENT FORMATION | 48234 | $m^3$ | Embankment formation up to elevation (EL)108 obtain suitable material from borrowed area | | | | | | | | | | | | Elevation (EL) 105.7 is for the construction of an open spillway |
| 4.010 | EMBANKMENT UP TO EL 105.7 | 28940 | $m^3$ | Embankment filling up to EL 105.7. Material is obtained from a borrowed area with haulage distance less than 500m | | | | | | | | | | | | |
| | | | | Excavation | $350m^3$/wd | 83 | 3USL | 58days | | | | 2D8 | 58days | Cutlass | 8 | |
| | | | | Loading | $250m^3$/wd | 116 | 2USL | " | | | | 2FL | " | | | |
| | | | | Hauling | $104m^3$/wd | 279 | | " | | | | 5FL | " | | | |
| | | | | Spreading | $500m^3$/wd | 58 | 1USL | " | | | | 1GR | " | | | |
| | | | | Watering and Compaction | $600m^3$/wd | 49 | 2USL | " | | | | 1WT<br>1RL | " | | | |

Air Layer
$30 \times 30 \times 0.15 = 135m^3$
$\frac{135}{500} = 0.3$
Last layer
$226 \times 1.28 \times 0.15 = 416$
$\frac{416}{500} = 1.64$
For hauling distance less than 500m Tipper($3.7m^3$ can make 28 trips
Since the dam is an nomogeneous on (clay) use dead w or ship-foot Roller 12 tons pneumatic tired -Roller.


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METHOD STATEMENTS (EQUIPMENT-BASED).

BAESARI DAM LGA KATSINA STATE

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | Time | MATERIALS: Description | Qty | Unit | EQUIPMENT: Type | Time | HAND TOOLS: Type | No. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.00 | RIP RAP | | | Provide and place rip rap (0.5m thick) for pitching embankment slopes. | | | | | | | | | | | | |
| 5.01 | | 3974 | $m^2$ | Hauling of Rip rap up to EL 105.7 | | | | | | | | | | | | |
| | | | | Placing | $2m^2$/wd | 1987 | 4SL 28USL | 26days | | | | | | Headpan | 80 | |
| 5.02 | | 865 | $m^2$ | Hauling of Rip rap up to EL 108 on the right flank | | | | | | | | | | | | |
| | | | | Placing | $2m^2$/wd | 433 | 1SL 18USL | 27days | | | | | | Headpan | 20 | |
| 5.03 | | 1798 | $m^2$ | Hauling of Rip Rap up to EL 108 on the left flank | | | | | | | | | | | | |
| | | | | | $400m^2$/wd | 5 | 2USL | 5days | | | | 1FL | 5days | Cutlass | 2 | |
| | | | | Placing | $4m^2$/wd | 450 | 90USL 4SL | " | | | | | | | | |
| 6.00 | SPILLWAY | | | Construct spill way at elevation (EL) 105.7 | | | | | | | | | | | | |

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METHOD STATEMENTS (EQUIPMENT-BASED)

BATSARI DAM LGA KATSINA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 6.01 | | 50 | $m^3$ | Provide and place blinding concrete (1:3:6) | $24m^3$/wd | 3 | 3SL 1USL | 2days | Empty Drum<br>Cement<br>Sand<br>Gravel | 5<br>264<br>8<br>16 | No.<br>Bags<br>Trips<br>" | 1CD<br>2CM<br>1WT | 2days | Space<br>Shovel<br>Headpan<br>Watering Can | 5<br>8<br>20<br>4 | Mixer Capacity $1.5m^3$ |
| | | | | Loading of Mixer | $2m^3$/wd | 25 | 1SL 14USL | " | | | | | | | | |
| 6.02 | | 343 | $m^2$ | Provide, place and remove after completion form work | $20m^2$/wd | 18 | 9SL 5USL | 2days | Planks 1"x12"x12'<br>2"x2"x12'<br>3" Wire Nail<br>4" " | 350<br>200<br>3.5<br>2 | No.<br>No.<br>Bags<br>" | | | | | |
| 6.03 | | 9 | tons | Supply and fix reinforcement | 0.3tons/wd | 30 | 15SL 8USL | 2days | Mild Steel (Ø12mm) | 9 | tons | | | | | |
| 6.04 | | 670 | $m^3$ | Provide reinforced concrete (1:7½:3) | $2m^3$/wd | 28 | 8SL 1USL | 7days | Empty Drum<br>Cement<br>Sand<br>Gravel | 5<br>6140<br>92<br>184 | No.<br>Bags<br>Trips<br>" | 2CD<br>4CM<br>1WT | 7days | Space<br>Shovel<br>Headpan<br>Watering Can | 10<br>10<br>50<br>10 | |
| | | | | Loading of Mixer | $2m^3$/wd | 335 | 48USL | " | | | | | | | | |



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METHOD STATEMENTS (EQUIPMENT-BASED)

BATS.RI LGA LGA K.TSIWA STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 6.05 | | 100 | $m^2$ | Provide and arrange rip rap for the discharge channel | $m^2$/wd | 50 | 1SL<br>50USL | 1day | | | | | | Headpan | 60 | |
| | | | | Nightguard | | | 1USL | 14days | | | | | | | | |



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| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SL | USI | 08 | EX | GR | PL | RL | CD | CM | TP | WP | WT | CL | HP | SH | SP | WC | ED | | |
| 1 | BUSH CLEARING | | 2 | 1 | | | | | | | | | | 2 | | | | | | | |
| 2 | 1)BUSH CLEARING | | 2 | 1 | | | | | | | | | | 2 | | | | | | | |
| | 2)TOP SOIL REMOVAL | | 2 | 1 | | | | | | | | | | 2 | | | | | | | |
| | TOTAL | | 2 | 1 | | | | | | | | | | 2 | | | | | | | |
| 3 | DAM FOUNDATION | | 3 | | 1 | | 1 | | | | 3 | 1 | | 3 | | | | | | | |
| 4 | " | | 3 | | 1 | | 1 | | | | 3 | 1 | | 3 | | | | | | | |
| 5 | " | | " | | " | | " | | | | " | " | | " | | | | | | | |
| 6 | " | | " | | " | | " | | | | " | " | | " | | | | | | | |
| 7 | " | | " | | " | | " | | | | " | " | | " | | | | | | | |
| 8 | " | | 3 | | 1 | | 1 | | | | 3 | 1 | | 3 | | | | | | | |
| 9 | 1)DAM FOUNDATION | | 3 | | 1 | | 1 | | | | 3 | 1 | | 3 | | | | | | | |
| | 2)EMBANKMENT EL105.7 | | 8 | 2 | | 1 | 2 | 1 | | | 5 | | 1 | 8 | | | | | | | |
| | TOTAL | | 8 | 2 | 1 | 1 | 2 | 1 | | | 5 | 1 | 1 | 8 | | | | | | | |
| 10 | EMBANKMENT EL105.7 | | 8 | 2 | | 1 | 2 | 1 | | | 5 | | 1 | 8 | | | | | | | |
| 11 | " | | " | " | | " | " | " | | | " | | " | " | | | | | | | |
| 12 | " | | " | " | | " | " | " | | | " | | " | " | | | | | | | |
| 13 | " | | " | " | | " | " | " | | | " | | " | " | | | | | | | |
| 14 | " | | " | " | | " | " | " | | | " | | " | " | | | | | | | |
| 15 | " | | " | " | | " | " | " | | | " | | " | " | | | | | | | |
| 16 | " | | " | " | | " | " | " | | | " | | " | " | | | | | | | |
| 17 | " | | " | " | | " | " | " | | | " | | " | " | | | | | | | |
| 18 | " | | " | " | | " | " | " | | | " | | " | " | | | | | | | |
| 19 | 1)EMBANKMENT EL105.7 | | 8 | 2 | | 1 | 2 | 1 | | | 5 | | 1 | 8 | | | | | | | |
| | 2)SPILLWAY | 15 | 51 | | | | | | 2 | 4 | | | 1 | - | 60 | 10 | 10 | 10 | 5 | | |
| | 3)RIP RAP EL105.7 | 4 | 78 | | | | | | | | | | | | 80 | | | | | | |
| | TOTAL | 19 | 129 | 2 | | 1 | 2 | 1 | 2 | 4 | 5 | | 2 | 8 | 80 | 10 | 10 | 10 | 5 | | |
| 20 | 1)SPILLWAY | 15 | 51 | | | | | | 2 | 4 | | | 1 | | 60 | 10 | 10 | 10 | 5 | | |
| | 2)RIP RAP EL105.7 | 4 | 78 | | | | | | | | | | | | 80 | | | | | | |
| | TOTAL | 19 | 129 | | | | | | 2 | 4 | | | 1 | | 80 | 10 | 10 | 10 | 5 | | |
| 21 | 1)SPILLWAY | 15 | 51 | | | | | | 2 | 4 | | | 1 | | 60 | 10 | 10 | 10 | 5 | | |
| | 2)RIP RAP EL105.7 | 4 | 78 | | | | | | | | | | | | 80 | | | | | | |
| | 3)EMBANKMENT EL108 | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | | |
| | TOTAL | 19 | 129 | 2 | | 1 | 2 | 1 | 2 | 4 | 6 | | 1 | 8 | 140 | 10 | 10 | 10 | 5 | | |
| | | | | | | | | | | | | | | | | | | | | | |

| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SL | USE | 18 | EX | GR | PL | RL | CD | CM | TP | WP | WT | CL | HP | SH | SP | WC | ED | |
| 22 | 1)RIP RAP EL105.7 | 4 | 78 | | | | | | | | | | | | 80 | | | | | |
| | 2)EMBANKMENT EL108R | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| | TOTAL | 4 | 86 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | 80 | | | | | |
| 23 | 1)RIP RAP EL105.7 | 4 | 78 | | | | | | | | | | | | 80 | | | | | |
| | 2)EMBANKMENT EL108R | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| | TOTAL | 4 | 78 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| 24 | 1)RIP RAP EL105.7 | 4 | 78 | | | | | | | | | | | | 80 | | | | | |
| | 2)EMBANKMENT EL108R | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| | 3) " EL108L | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| | 4)RIP RAP EL108R | 1 | 18 | | | | | | | | | | | | 20 | | | | | |
| | TOTAL | 4 | 86 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | 80 | | | | | |
| 25 | 1)EMBANKMENT EL108L | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| | 2)RIP RAP EL108R | 1 | 18 | | | | | | | | | | | | 20 | | | | | |
| | TOTAL | 1 | 26 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | 20 | | | | | |
| 26 | 1)EMBANKMENT EL108L | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| | 2)RIP RAP EL108R | 1 | 18 | | | | | | | | | | | | 20 | | | | | |
| | TOTAL | 1 | 26 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | 20 | | | | | |
| 27 | 1)EMBANKMENT EL108L | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| | 2)RIP RAP EL108R | 1 | 18 | | | | | | | | | | | | 20 | | | | | |
| | TOTAL | 1 | 26 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | 20 | | | | | |
| 28 | 1)EMBANKMENT EL108L | | 8 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | | | | | | |
| | 2)RIP RAP EL108R | 1 | 18 | | | | | | | | | | | | 20 | | | | | |
| | 3)RIP RAP EL108L | 4 | 92 | | | | 1 | | | | | | | 2 | | | | | | |
| | TOTAL | 4 | 92 | 2 | | 1 | 2 | 1 | | | 6 | | 1 | 8 | 20 | | | | | |
| 29 | RIP RAP EL108L | 4 | 92 | | | | 1 | | | | | | | 2 | | | | | | |

METHOD STATEMENTS (LABOUR-BASED)
OKE-ODAN

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | LABOUR Time | MATERIALS Description | MATERIALS Qty | MATERIALS Unit | EQUIPMENT Type | EQUIPMENT Time | HAND TOOLS Type | HAND TOOLS No. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | BUSH CLEARING | 30800 | $m^2$ | Clear dam site and Reservoir Area of vegetation | $80m^2$/wd | 385 | 2GL 40USL | 10days | Rope | 4 | No. | | | Cutlass<br>Rake<br>File | 35<br>15<br>6 | In each activity use one (1) unskilled labourer (USL) as a Nightguard |
| 2.00 | FELLING OF TREES | 147 | No. | Fell trees from dam axis and Reservoir Area Cut to sizeable pieces | 30No./wd | 5 | | | | | | Chain Saw (2No) | 3days | | | |
| | | | | Carting away of fell trees | 1.5No/wd | 98 | 2GL 50USL | 2days | | | | | | Cutlass<br>File | 60<br>10 | |
| 3.00 | STUMPING AND GRUMBING | 99 | No. | Remove stump and grub along the dam axis | 1No./wd | 99 | 4GL 100USL | 1 day | | | | | | Pickaxe<br>Spade<br>Shovel<br>Cutlass<br>Headpan | 60<br>40<br>20<br>60<br>15 | |
| 4.00 | TOP SOIL REMOVAL | 30000 | $m^2$ | Remove and cart away top soil and peat to depth of about 0.3m along the dam axis | $15m^2$/wd | 2000 | 7 GL 155 USL | 13 days | | | | | | Pickaxe<br>Spade<br>Shovel<br>Headpan | 60<br>30<br>45<br>70 | |

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METHOD STATEMENTS (LABOUR-BASED)

OKE OJAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 5.00 | KEY TRENCH | 5000 | $m^3$ | Excavate key trench and fill with suitable material and compact properly | | | | | | | | | | | | | |
| | | | | Excavate | $3.5m^3$/wd | 1429 | 3GL 6SUSL | 22days | Rope | 4 | No. | water Pump (2½) | 22days | Pickaxe<br>Spade<br>Shovel | 50<br>15<br>20 | | 85% of the excavated material ($5000m^3$) is suitable for embankment formation so it is stock pile for re-use |
| 01 | | 750 | $m^3$ | Load, Haul and cart away the 15% unsuitable material($750m^3$) | | | | | | | | | | | | | |
| | | | | Loading | $4m^3$/wd | 188 | 1GL 9USL | 22days | | | | | | | | | |
| | | | | Haul/Cartaway | $2m^3$/wd | 375 | 18USL | | | | | | | Wheel Barrow<br>Headpan | 10<br>15 | | |

METHOD STATEMENTS (LABOUR-BASED)

OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 5.02 | | 5000 | $m^3$ | Excavate good material from borrow area, load, haul, spread, water and compact | | | | | | | | | | | | | |
| | | 5000 | $m^3$ | Excavation | $3.5m^3$/wd | 1429 | 3GL 65USL | 22days | Rope | 4 | No. | | | Pickaxe<br>Spade | 70<br>10 | | |
| | | " | " | Loading | $4m^3$/wd | 1250 | 2GL 57USL | 28days | | | | | | Shovel | 65 | | |
| | | " | " | Hauling | $78.4m^3$/wd | 64 | | | | | | 3 Tractors | 22days | | | | 2ach tractor ($2.8m^3$) would make 28 trips per day (i.e. 15mins/trip) A tractor has at two trailers. |
| | | " | " | Spreading | $12m^3$/wd | 417 | 1GL 19USL | 22days | | | | | | Shovel<br>Rake | 10<br>15 | | |
| | | 500000 | Lts | Watering | 500lit/wd | 1000 | 2GL 46USL | 22days | Empty drum | 25 | No. | | | Watering Can | 60 | | |
| | | 5000 | $m^3$ | Compaction | $180m^3$/wd | 28 | | | | | | Hand Rollers (2No.) | 22days | | | | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)
OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 6.00 | OUTLET STRUCTURE | | | Provide the outlet structure at the middle of the dam before the commencement of embankment formation | | | | | | | | | | | | | |
| 6.01 | | 120 | $m^3$ | Provide and place concrete for blinding and pipe surround(1:3:6) | $10m^3$/wd | 12 | 6GL | 3days | Empty Drum | 12 | No. | | | Spade | 5 | | Concrete Mixer capacity is $0.5m^3$ |
| | | | | | | | | | Cement | 605 | Bags | Con- | | Shovel | 10 | | |
| | | | | | | | | | Sand | 19 | Lorry | crete | | Headpan | 25 | | |
| | | | | | | | | | Gravel | 38 | " | Mixer (4No) | 3days | watering Can | 10 | | |
| | | | | Loading of Mixer | $2m^3$/wd | 50 | 2USL | " | | | | | | | | | |
| 6.02 | | 260 | $m^2$ | Errect and remove formwork for the structure | $20m^2$/wd | 13 | 4GL 4USL | 3days | Timber Flanks | | | | | | | | |
| | | | | | | | | | 1"x12"x12' | 260 | No. | | | | | | |
| | | | | | | | | | 2"x2"x12' | 200 | No. | | | | | | |
| | | | | | | | | | 3"Wire Nail | 2,5 | Bags | | | | | | |
| | | | | | | | | | 4" " | 1 | Bag | | | | | | |



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METHOD STATEMENTS (LABOUR-BASED)
OKE OLAN LGA OGUN STATE

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | LABOUR Time | MATERIALS Description | MATERIALS Qty | MATERIALS Unit | EQUIPMENT Type | EQUIPMENT Time | HAND TOOLS Type | HAND TOOLS No. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.03 | | 140 | No. | Provide and place 2 rows of Ø450mm pre-cast concrete pipe | 5No./wd | 28 | 1OUSL | 3days | Concrete Pipes (ØO.45m) | 140 | No. | | | | | |
| | | | | Nightguard | | | 1USL | 9days | | | | | | | | |
| 7.00 | EMBANKMENT FORMATION | 80200 | $m^3$ | Embankment formation up to elevation (EL) 90. Obtained suitable material from Reservoir area. | | | | | | | | | | | | |
| 7.010 | EMBANKMENT UP TO EL 87 | 46240 | $m^3$ | Embankment filling up to Elevation(EL) 87 ($41,990m^3$ from Reservoir Area and $4250m^3$ stock pilled material from key trench excavation) | | | | | | | | | | | | Elevation(EL) 87 is for the construction of spillway. |

METHOD STATEMENTS (LABOUR-BASED)

OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 7.011 | | 41990 | $m^3$ | Excavate load and haul material from the Reservoir area | | | | | | | | | | | | | |
| | | | | Excavation | $3.5m^3$/wd | 11998 | 7GL 134USL | 90days | Rope | 4 | No. | | | Pickaxe<br>Spade<br>Shovel | 150<br>20<br>130 | | |
| | | | | Loading | $4m^3$/wd | 10498 | 6GL 117USL | " | | | | | | | | | |
| | | | | Hauling | $78.4m^3$/wd | 536 | | | | | | 6 Tractors | 90days | | | Tractor trailer whose volume = $2.8m^3$ will make a total trip of 28 in 7 hours | |
| 7.012 | | 46240 | $m^3$ | Spread, water and compact both materials ($41,990m^3$ and $4,250m^3$) | | | | | | | | | | | | 1st Layer<br>$40x69x0.15=414m^3$ | |
| | | | | Spreading | $12m^3$/wd | 3854 | 20L 43USL | 90days | | | | | | Rake<br>Shovel | 30<br>30 | $\frac{414}{72.4} \times \frac{4}{47} = 1day$ | |
| | | 4624000 | Lits | Watering | 500Lit/wd | 9248 | 4GL 103USL | " | EmptyDrum | 40 | No. | | | Watering Can | | Last Layer<br>$375x25x0.15=1427$ | |
| | | 46240 | $m^3$ | Compaction | $180m^3$/wd | 257 | | | | | | Hand Roller (3No) | 90days | | | $\frac{1407}{471} = 3days$ | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | | |

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METHOD STATEMENTS (LABOUR-BASED)

OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | Time | MATERIALS: Description | Qty | Unit | EQUIPMENT: Type | Time | HAND TOOLS: Type | No. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.020 | EMBANKMENT UP TO EL90 | 33960 | $m^3$ | Embankment filling up to elecation (EL) 90. Obtain material from borrow-area | | | | | | | | | | | | |
| | | | | Excavation | $3.5m^3$/wd | 9703 | 7GL 134USL | 73days | Rope | 4 | No. | | | Pickaxe | 150 | |
| | | | | | | | | | | | | | | Space | 20 | |
| | | | | Loading | $4m^3$/wd | 8490 | 6GL 117USL | " | | | | | | Shovel | 130 | 1st Layer |
| | | | | | | | | | | | | | | | | 375x25x0.15=140 |
| | | | | Hauling | $78.4m^3$/wd | 434 | | " | | | | 6 Tractors | 73 days | | | $\frac{4407}{78.4xd}$ = 3 days |
| | | | | Spreading | $12m^3$/wd | 2830 | 2GL 39USL | " | | | | | | Rake | 30 | Last Layer |
| | | | | | | | | | | | | | | Shovel | 20 | 520xdx0.15=624 |
| | 3396000 | Lits | | Watering | 300Lit/wd | 6792 | 4GL 94USL | " | Empty drums | 4C | No. | | | Watering Can | 110 | $\frac{624}{78.4xd}$ = 2 days |
| | 33960 | $m^3$ | | Compaction | $160m^3$/wd | 189 | | " | | | | Hand Rollers 3Nos | 73days | | | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | |

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METHOD STATEMENTS (LABOUR-BASED)
OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT. | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 8.00 | SPILLWAY | | | Construct Spillway at elevation (EL) 87 | | | | | | | | | | | | | |
| 8.01 | | 280 | $m^3$ | Provide and place concrete for blinding and pipe surround (1:3:6) | $24m^3$/wd | 12 | 6GL | | Empty Drum | 12 | No. | Water Tanker (4NOS) | 3days | Spade | 10 | | The capacity of the concrete mixer is $1.5m^3$ |
| | | | | | | | | | Cement | 1412 | Bags | | | Shovel | 10 | | |
| | | | | | | | | | Sand | 43 | Trips | Concrete Mixer | " | Headpan | 20 | | |
| | | | | | | | | | Gravel | 86 | " | | | Watering Can | 8 | | |
| | | 280 | $m^2$ | Loading & Haul-ing | $3m^3$/wd | 280 | 94USL | 3days | | | | | | | | | |
| 8.02 | | 150 | $m^2$ | Erect and remove formwork for the structure | $20m^2$/wd | 8 | 4GL<br>2USL | 2days | Planks - 1"x12"x12' | 150 | No. | | | | | | |
| | | | | | | | | | 2"x2"x12' | 70 | No. | | | | | | |
| | | | | | | | | | 3" Wire Nail | 2 | Bags | | | | | | |
| | | | | | | | | | 4" " | 1 | Bag | | | | | | |
| 8.03 | | 200 | No. | Provide and place 3 rows of Ø0.9m Pre-cast concrete Rings | 3No./wd | 67 | 1GL<br>17USL | 4days | Concrete Pipes (Ø 0.9m) | 200 | No. | | | | | | |
| | | | | Nightguard. | | | 1USL | 9days | | | | | | | | | |

METHOD STATEMENTS (LABOUR-BASED)

OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | LABOUR Time | MATERIALS Description | MATERIALS Qty | MATERIALS Unit | EQUIPMENT Type | EQUIPMENT Time | HAND TOOLS Type | HAND TOOLS No. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.00 | RIP RAP | | | Provide and place rip rap for pitching embankment slopes | | | | | | | | | | | | |
| 9.01 | | 5225 | $m^2$ | Hauling/placing of rip rap up to elecation(EL) 87 | $2m^2$/wd | 2613 | 11GL<br>291USL | 9days | | | | | | Headpan<br>Wheel Barrow | 250<br>60 | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | |
| 9.02 | | 3837 | | Hauling/placing of rip rap up to EL90 | $2m^2$/wd | 1919 | 10GL<br>240USL | 8days | | | | | | Headpan<br>Wheel Barrow | 200<br>60 | |
| | | | | Nightguard | | | 1USL | " | | | | | | | | |



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LABOUR-BASED
OKE-ODAN DAM
OGUN STATE

| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GL | USL | CI | FI | HP | PAS | RK | HO | SH | GP | LB | LC | SF | CH 1 | H 2 | CS | LD | PR | TR |
| 1 | BUSH CLEARING | 2 | 40 | 35 | 6 | | | 15 | 4 | | | | | | | | | | | |
| 2 | BUSH CLEARING | 2 | 40 | 35 | 6 | | | 15 | 4 | | | | | | | | | | | |
| 3 | a)FELLING OF TREES | 2 | 50 | 60 | 10 | | | | | | | | | | | | 2 | | | |
| | b)STUMPING | 4 | 100 | 60 | | 15 | 60 | | | 20 | 40 | | | | | | | | | |
| | c)TOP SOIL REMOVAL | 7 | 155 | | | 70 | 60 | | | 45 | 30 | | | | | | | | | |
| | TOTAL | 7 | 155 | 60 | 10 | 70 | 60 | | | 45 | 40 | | | | | | 2 | | | |
| 4 | TOP SOIL REMOVAL | 7 | 155 | | | 70 | 60 | | | 45 | 30 | | | | | | | | | |
| 5 | 1)TOP SOIL REMOVAL | 7 | 155 | | | 70 | 60 | | | 45 | 30 | | | | | | | | | |
| | 2)KEY TRENCH | 12 | 280 | | | 15 | 120 | 15 | | 110 | 40 | 10 | 30 | 2 | | | | | 2 | 3 |
| | TOTAL | 12 | 280 | | | 70 | 120 | 15 | | 110 | 40 | 10 | 30 | 2 | | | | | 2 | 3 |
| 6 | KEY TRENCH | 12 | 280 | | | 15 | 120 | 15 | | 110 | 40 | 10 | 30 | 2 | | | | | 2 | 3 |
| 7 | KEY TRENCH | 12 | 280 | | | 15 | 120 | 15 | | 110 | 40 | 10 | 30 | 2 | | | | | 2 | 3 |
| 8 | 1)KEY TRENCH | 12 | 280 | | | 15 | 120 | 15 | | 110 | 40 | 10 | 30 | 2 | | | | | 2 | 3 |
| | 2)OUTLET STRUCTURE | 10 | 35 | | | 25 | | | | 10 | 15 | | 10 | | 4 | -- | | | | |
| | TOTAL | 22 | 315 | | | 40 | 120 | 15 | | 120 | 45 | 10 | 70 | 2 | 4 | | | | 2 | 3 |
| 9 | 1)KEY TRENCH | 12 | 280 | | | 15 | 120 | 15 | | 110 | 40 | 10 | 30 | 2 | | | | | 2 | 3 |
| | 2)OUTLET STRUCTURE | 10 | 35 | | | 25 | | | | 10 | 5 | | 10 | | 4 | | | | | |
| | 3)ENBANKMENT EL87 | 19 | 398 | | | | 150 | 30 | 4 | 160 | 20 | | 120 | | | | | 40 | 3 | 6 |
| | TOTAL | 22 | 398 | | | 40 | 150 | 30 | 4 | 160 | 45 | 10 | 120 | 2 | 4 | | | 40 | 3 | 6 |
| 10 | EMBANKMENT EL87 | 19 | 398 | | | | 150 | 30 | 4 | 160 | 20 | | 120 | | | | | 40 | 3 | 6 |
| 11 | " | 19 | 398 | | | | 150 | 30 | 4 | 160 | 20 | | 120 | | | | | 40 | 3 | 6 |
| 12 | " | 19 | 398 | | | | 150 | 30 | 4 | 160 | 20 | | 120 | | | | | 40 | 3 | 6 |
| 13 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 14 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 15 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 16 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 17 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 18 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 19 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 20 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 21 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 22 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 23 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 24 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |

LABOUR-BASED
OKE-ODAN DAM
OGUN STATE

| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GL | USL | CL | FL | BP | PAX | RK | BO | SH | SP | WB | WC | WP | CH | EM | CS | ED | PR | TR |
| 25 | 1)EMBANKMENT EL87 | 19 | 398 | | | | 150 | 30 | 4 | 160 | 20 | | 120 | | | | | 40 | 3 | 6 |
| | 2)RIP RAP EL87 | 11 | 291 | | | 250 | | | | | | 60 | | | | | | | | |
| | 3)SPILLWAY | 13 | 68 | | | 20 | | | | 10 | 10 | 8 | | | | | | | | |
| | TOTAL | 24 | 398 | | | 270 | 150 | 30 | 4 | 60 | 20 | 68 | | | | | | 40 | 3 | 6 |
| 26 | 1)RIP RAP EL87 | 11 | 291 | | | 250 | | | | | | 60 | | | | | | | | |
| | 2) SPILLWAY | 13 | 68 | | | 20 | | | | 10 | 10 | 8 | | | | 4 | | | | |
| | 3)EMBANKMENT EL90 | 19 | 385 | | | | 150 | 30 | 4 | 150 | 20 | | 110 | | | | | 40 | 3 | 6 |
| | TOTAL | 24 | 385 | | | 270 | 150 | 30 | 4 | 150 | 20 | 68 | 110 | | | 4 | | 40 | 3 | 6 |
| 27 | EMBANKMENT EL90 | 19 | 385 | | | | 150 | 30 | 4 | 150 | 20 | | 110 | | | | | 40 | 3 | 6 |
| 28 | " | 19 | 385 | | | | 150 | 30 | 4 | 150 | 20 | | 110 | | | | | 40 | 3 | 6 |
| 29 | " | 19 | 385 | | | | 150 | 30 | 4 | 150 | 20 | | 110 | | | | | 40 | 3 | 6 |
| 30 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 31 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 32 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 33 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 34 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 35 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 36 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 37 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 38 | " | " | " | | | | " | " | " | " | " | | " | | | | | " | " | " |
| 39 | 1)EMBANKMENT EL90 | 19 | 385 | | | | 150 | 30 | 4 | 150 | 20 | | 110 | | | | | 40 | 3 | 6 |
| | 2)RIP RAP EL90 | 10 | 240 | | | 200 | | | | | | 60 | | | | | | | | |
| | TOTAL | 19 | 385 | | | 200 | 150 | 30 | 4 | 150 | 20 | 60 | 110 | | | | | 40 | 3 | 6 |
| 40 | RIP RAP EL90 | 10 | 240 | | | 200 | | | | | | 60 | | | | | | | | |

Appendix 12

METHOD STATEMENTS (EQUIPMENT-BASED)

OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 1.00 | BUSH CLEARING | 30800 | $m^2$ | Clear dam site and reservoir area (of bush, fell all trees, stump and cart away) | 5000$m^2$/wd | 7 | 2USL | 7days | | | | 1D8 | 7days | Cutlass | 2 | Use one (1) unskilled labour (USL)for Nightguard in each activity |
| 2.00 | TOP SOIL REMOVAL | 30000 | $m^2$ | Remove top soil/ peat to depth C.2m along the dam axis | | | | | | | | | | | | |
| | | | | Excavate/Stock | 1500$m^2$/wd | 20 | 2USL | 20days | | | | 1D8 | 20days | Cutlass | 3 | |
| | | 9000 | $m^3$ | Loading | 250$m^3$/wd | 36 | 1USL | " | | | | 2PL | " | | | Tipper (Vol=3.7$m^3$ is expected to make a total of 28 trips per day |
| | | | | Haul/Cartaway | 104$m^3$/wd | 87 | | " | | | | 5TP | " | | | |
| 3.00 | KEY TRENCH | 5000 | $m^3$ | Excavate key trench and fill with suitable material and then compact properly | | | | | | | | | | | | Stock pill for re-use 85% of the excavation material (4250$m^3$) as this is suitable for the embankment formation. |
| | | | | | | | | | | | | 1WP | 20days | | | |
| | | | | Excavation | 200m3/wd | 25 | 3USL | | | | | 2EX | " | Cutlass | 3 | |



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METHOD STATEMENTS (EQUIPMENT-BASED)
OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| | | 750 | $m^3$ | Load, Haul and cart away the 15% ($750m^3$) unsuitable material from key trench excavation | | | | | | | | | | | | | |
| | | | | Loading | $250m^3$/wd | 3 | 1USL | 20days | | | | 1PL | 20days | Cutlass | 1 | | |
| | | | | Haul/Cartaway | $104m^3$/wd | 8 | | " | | | | 1TP | " | | | | Tipper(Vol=$3.7m^3$) is expected to make a total of 28 trips per day |
| | | 5000 | $m^3$ | Excavate good material from the borrow area for the key trench | | | | | | | | | | | | | |
| | | | | Excavation | $350m^3$/wd | 15 | 1USL | 20days | | | | 1D8 | 20days | Cutlass | 5 | | |
| | | | | Loading | $250m^3$/wd | 20 | 1USL | " | | | | 1PL | " | | | | |
| | | | | Hauling | $104m^3$/wd | 49 | | | | | | 3TP | " | | | | |
| | | | | Spreading | $500m^3$/wd | 10 | 1USL | " | | | | 1GR | " | | | | Since the dam is an homogenious one (clay) use dead weight or ship-foot Roller i.e. 12tons pneumatic-tired Roller. |
| | | | | Watering and Compaction | $600m^3$/wd | 9 | 2USL | " | | | | 1WT<br>1RL | " | | | | |

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METHOD STATEMENTS (EQUIPMENT-BASED)

OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | LABOUR Time | MATERIALS: Description | Qty | Unit | EQUIPMENT: Type | EQUIPMENT: Time | HAND TOOLS: Type | HAND TOOLS: No. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.00 | OUTLET STRUCTURE | | | Provide the outlet structure at the middle of the dam before the commencement of embankment formation | | | | | | | | | | | | |
| 4.01 | Provide and place concrete for blinding and pipe surround(1:3:6) | 120 | $m^3$ | | $24m^3$/wd | 5 | 4GL<br>1USL<br>1SL | 3days | Empty Drum<br>Cement<br>Sand<br>Gravel | 5<br>605<br>19<br>38 | No.<br>Bags<br>lorry<br>" | CU<br>-7No.<br>Mixer<br>(2No)<br>1WT | 3days<br><br>" | Cutlass<br>Spade<br>Shovel<br>Headpan<br>watering<br>Can | 2<br>5<br>10<br>25<br><br>5 | |
| | Loading of Mixer | | | | $2m^3$/wd | 60 | 20USL | " | | | | | | | | |
| 4.02 | Errect and remove formwork for the structure | 260 | $m^2$ | | $20m^2$/wd | 13 | 4GL<br>4USL | " | Planks 1"x12"x12'<br>2"x2"x12'<br>3" wire Nail<br>4" " | 260<br>200<br>2.5<br>1 | No.<br>No.<br>Bags<br>Bag | | | | | |
| 4.03 | Provide and place 2 rows of Ø450mm pre-cast concrete pipe | 140 | No. | | 50No/wd | 3 | | " | Concrete pipes(Ø45m) | 140 | No. | 1EX | " | | | |
| | Nightguard | | | | | | 1LSL | 9days | | | | | | | | |



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METHOD STATEMENTS (EQUIPMENT-BASED)

OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK: Description | Qty | Unit | METHOD OF CONSTRUCTION: Description | Output | Time | SCHEDULE OF RESOURCES REQUIRED: LABOUR Type | LABOUR Time | MATERIALS Description | MATERIALS Qty | MATERIALS Unit | EQUIPMENT Type | EQUIPMENT Time | HAND TOOLS Type | HAND TOOLS No. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.00 | EMBANKMENT FORMATION | 80200 | $m^3$ | Embankment formation up to elevation (EL)90 Obtain suitable material from Reservoir Area. | | | | | | | | | | | | |
| 7.01 | EMBANKMENT UP TO EL87 | 46240 | $m^3$ | Embankment filling up to EL87 ($41990m^3$ from Reservoir Area and $4250m^3$ stock pilled material from key trench excavation) | | | | | | | | | | | | Elevation (EL)87 is for the construction of spillway<br>1st layer<br>$4\times69\times0.15=414m^3$<br>$\frac{414}{300}$ = 1 day<br>Last layer<br>$375\times25\times0.15=1407m^3$<br>$\frac{1407}{300}$ = 5days |
| 7.011 | | 41990 | $m^3$ | Excavate, Load, and haul material from reservoir area | | | | | | | | | | | | |
| | | | | Excavate | $350m^3$/wk | 120 | 3USL | 93days | | | | 2EE | 93days | | | |
| | | | | Loading | $250m^3$/wk | 168 | 1USL | " | | | | 2EL | " | Cutlass | 4 | |
| | | | | Hauling | $104m^3$/wk | 404 | | | | | | 5EP | " | | | |



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METHOD STATEMENTS (EQUIPMENT-BASED)

OKE ODAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 7.012 | | 46240 | $m^3$ | Spread, Water and Compact both materials (41990 and 4250 $m^3$) | | | | | | | | | | | | |
| | | | | Spreading | $500m^3$/wd | 93 | 1USL | 93days | | | | 1GR | 93days | | | Since the dam is an homoge-nous one (clay) use dead weight or ship-foot roller |
| | | | | Watering and Compaction | $600m^2$/wd | 78 | 2USL | " | | | | 1WT<br>1RL | "<br>" | Cutlass | 3 | |
| 7.020 | EMBANKMENT UP TO EL90 | 33960 | $m^3$ | Embankment filling up to elevation(EL)90 Obtain the material from borrow area | | | | | | | | | | | | 1st Layer<br>375x25x0.15=1407 $m^3$<br>$\frac{1407}{500}$ = 3 days |
| | | | | Excavation | $350m^3$/wd | 98 | 3USL | 68days | | | | 2DB | 68days | | | Last Layer |
| | | | | Loading | $250m^3$/wd | 136 | 2USL | " | | | | 2FL | " | Cutlass | 8 | 520x8x0.15=624$m^3$ |
| | | | | Hauling | $92m^3$/wd | 370 | | " | | | | 6TP | " | | | $\frac{624}{500}$ = 2 days |
| | | | | Spreading | $500m^3$/wd | 68 | 1USL | " | | | | 1GR | " | | | |
| | | | | Watering and Compaction | $600m^3$/wd | 57 | 2USL | " | | | | 1WT<br>1RL | | | | |



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METHOD STATEMENTS (EQUIPMENT-BASED)

ORE CAMP LOW LEVEL STAGE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | |
| 8.00 | SPILLWAY | | | Construct Spillway at elevation(EL)87 | | | | | | | | | | | | |
| 8.01 | | 260 | $m^3$ | Provide and place concrete for blinding and pipe surround (1:3:6) | $24m^3$/wd | 12 | 1USL<br>5GL | 3days | Empty drum<br>Cement<br>Sand<br>Gravel | 5<br>1412<br>43<br>86 | No.<br>Bags<br>Lorry<br>" | 2CD<br>1WT<br>Con-crete Mixer (4No) | 3days<br>" | Cutlass<br>Spade<br>Shovel<br>Headpan<br>Watering Can | 2<br>10<br>10<br>50<br>5 | |
| | | | | Loading of Mixer | $2m^3$/wd | 140 | 48USL<br>1SL | " | | | | | | | | |
| 8.02 | | 150 | $m^2$ | Errect and remove formwork for the structure | $20m^3$/wd | 8 | 4GL<br>2USL | 2days | Planks - 1"x12"x12'<br>2"x2"x12'<br>3"WireNail<br>4" " | 150<br>70<br>2<br>1 | No.<br>No.<br>Bags<br>Bag | | | | | |
| 8.03 | | 200 | No. | Provide and place 8 rows of Ø0.9m Pre-cast concrete Rings | 50No./wd | 4 | | 4days | Concrete Pipes(Ø0.9m) | 200 | No. | 1EX | 4days | | | |
| | | | | Nightguard | | | 1USL | 9days | | | | | | | | |

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METHOD STATEMENTS (EQUIPMENT-BASED)
OKE OLAN LGA OGUN STATE

| S/No. | DETAILS OF WORK | | | METHOD OF CONSTRUCTION | | | SCHEDULE OF RESOURCES REQUIRED | | | | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | LABOUR | | MATERIALS | | | EQUIPMENT | | HAND TOOLS | | | |
| | Description | Qty | Unit | Description | Output | Time | Type | Time | Description | Qty | Unit | Type | Time | Type | No. | | |
| 9.00 | RIP RAP | | | Provide and place Rip Rap for pitching embankment slopes | | | | | | | | | | | | | |
| 9.01 | | 5225 | $m^2$ | Hauling of rip rap up to EL87 | 400 $m^2$/wd | 14 | 3USL | 7 days | | | | 2PL | 7 days | Cutlass | 3 | | |
| | | | | Placing | $4m^2$/wd | 1307 | 4GL 94USL | " | | | | | | | | | |
| 9.02 | | 3837 | $m^2$ | Hauling of rip rap up to EL90 | 400 $m^2$/wd | 10 | 3USL | 5 days | | | | 2PL | 5 days | Cutlass | 3 | | |
| | | | | Placing | $4m^2$/wd | 960 | 4GL 96USL | " | | | | | | | | | |

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EQUIPMENT - BASED
OKE-ODAN DAM
OGUN STATE

| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SL | USL | D8 | EX | GR | PL | RL | CM | TP | WP | WT | CL | HP | SH | SP | WC | ED | CD | |
| 1 | BUSH CLEARING | | 2 | 1 | | | | | | | | | 2 | | | | | | | |
| 2 | 1)BUSH CLEARING | | 2 | 1 | | | | | | | | | 2 | | | | | | | |
| | 2)TOP SOIL REMOVAL | | 3 | 1 | | | 2 | | | | | | 3 | | | | | | | |
| | TOTAL | | 3 | 1 | | | 2 | | | | | | 3 | | | | | | | |
| 3 | TOP SOIL REMOVAL | | 3 | 1 | | | 2 | | | | | | 3 | | | | | | | |
| 4 | TOP SOIL REMOVAL | | 3 | 1 | | | 2 | | | | | | 3 | | | | | | | |
| 5 | 1)TOP SOIL REMOVAL | | 3 | 1 | | | 2 | | | | | | 3 | | | | | | | |
| | 2)KEY TRENCH | | 9 | 1 | 2 | 1 | 2 | 1 | | 4 | 1 | 1 | 9 | | | | | | | |
| | TOTAL | | 9 | 1 | 2 | 1 | 2 | 1 | | 4 | 1 | 1 | 9 | | | | | | | |
| 6 | KEY TRENCH | | 9 | 1 | 2 | 1 | 2 | 1 | | 4 | 1 | 1 | 9 | | | | | | | |
| 7 | 1)KEY TRENCH | | 9 | 1 | 2 | 1 | 2 | 1 | | 4 | 1 | 1 | 9 | | | | | | | |
| | 2)OUTLET STRUCTURE | 5 | 21 | | 1 | | | | 2 | | | 1 | 2 | 25 | 10 | 5 | 5 | 5 | 1 | |
| | TOTAL | 5 | 30 | 1 | 2 | 1 | 2 | 1 | 2 | 4 | 1 | 2 | 11 | 25 | 10 | 5 | 5 | 5 | 1 | |
| 8 | 1)KEY TRENCH | | 9 | 1 | 2 | 1 | 2 | 1 | | 4 | 1 | 1 | 9 | | | | | | | |
| | 2)OUTLET STRUCTURE | 5 | 21 | | 1 | | | | 2 | | | 1 | 2 | 25 | 10 | 5 | 5 | 5 | 1 | |
| | TOTAL | 5 | 30 | 1 | 2 | 1 | 2 | 1 | 2 | 4 | 1 | 2 | 11 | 25 | 10 | 5 | 5 | 5 | 1 | |
| 9 | 1)KEY TRENCH | | | | 2 | 1 | 2 | 1 | | 4 | 1 | 1 | 9 | | | | | | | |
| | 2)OUTLET STRUCTURE | 5 | 21 | | 1 | | | | 2 | | | 1 | 2 | 25 | 10 | 5 | 5 | 5 | 1 | |
| | 3)EMBANKMENT EL87 | | 7 | 2 | | 1 | 2 | 1 | | 5 | | 1 | 7 | | | | | | | |
| | TOTAL | 5 | 30 | 2 | 1 | 1 | 2 | 1 | 2 | 5 | 1 | 2 | 11 | 25 | 10 | 5 | 5 | 5 | 1 | |
| 10 | EMBANKMENT EL87 | | 7 | 2 | | 1 | 2 | 1 | | 5 | | 1 | 7 | | | | | | | |
| 11 | EMBANKMENT EL87 | | 7 | 2 | | 1 | 2 | 1 | | 5 | | 1 | 7 | | | | | | | |
| 12 | " " | | 7 | 2 | | 1 | 2 | 1 | | 5 | | 1 | 7 | | | | | | | |
| 13 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 14 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 15 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 16 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 17 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 18 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 19 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 20 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 21 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 22 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 23 | " " | | " | " | | " | " | " | | " | | " | " | | | | | | | |

EQUIPMENT - BASED
OKE-ODAN
OGUN STATE

| WEEK | ACTIVITY | SCHEDULE OF RESOURCES | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SL | US | LB | EX | GR | FL | RL | CM | TP | WP | WT | CL | BP | GR | SP | WC | ED | CD | |
| 24 | EMBANKMENT EL87 | | 7 | 2 | | 1 | 2 | 1 | | 5 | | 1 | 7 | | | | | | | |
| 25 | 1)EMBANKMENT EL87 | | 7 | 2 | | 1 | 2 | 1 | | 5 | | 1 | 7 | | | | | | | |
| | 2)SPILL WAY | 9 | 49 | | 1 | | | | 4 | | | 1 | 2 | 50 | 10 | 10 | 5 | 5 | 2 | |
| | 3)RIP RAP EL87 | 4 | 97 | | | | 2 | | | | | | 3 | | | | | | | |
| | TOTAL | 13 | 146 | 2 | 1 | 1 | 2 | 1 | 4 | 5 | | 2 | 9 | 50 | 10 | 10 | 5 | 5 | 2 | |
| 26 | 1) SPILLWAY | 9 | 49 | | 1 | | | | 4 | | | 1 | 2 | 50 | 10 | 10 | 5 | 5 | 2 | |
| | 2) RIP RAP EL87 | 4 | 97 | | | | 2 | | | | | | 3 | | | | | | | |
| | 3) EMBANKMENT EL90 | | 8 | 2 | | 1 | 2 | 1 | | 6 | | 1 | 8 | | | | | | | |
| | TOTAL | 13 | 146 | 2 | 1 | 1 | 2 | 1 | 4 | 6 | | 1 | 8 | 50 | 10 | 10 | 5 | 5 | 2 | |
| 27 | EMBANKMENT EL90 | | 8 | 2 | | 1 | 2 | 1 | | 6 | | 1 | 8 | | | | | | | |
| 28 | EMBANKMENT EL90 | | 8 | 2 | | 1 | 2 | 1 | | 6 | | 1 | 8 | | | | | | | |
| 29 | " | | 8 | 2 | | 1 | 2 | 1 | | 6 | | 1 | 8 | | | | | | | |
| 30 | " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 31 | " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 32 | " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 33 | " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 34 | " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 35 | " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 36 | " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 37 | " | | " | " | | " | " | " | | " | | " | " | | | | | | | |
| 38 | 1) EMBANKMENT EL90 | | 8 | 2 | | 1 | 2 | 1 | | 6 | | 1 | 8 | | | | | | | |
| | 2) RIP RAP EL90 | 4 | 99 | | | | 2 | | | | | | 3 | | | | | | | |
| | TOTAL | 4 | 99 | 2 | | 1 | 2 | 1 | | 6 | | 1 | 8 | | | | | | | |
| 39 | RIP RAP | 4 | 99 | | | | 2 | | | | | | 3 | | | | | | | |

# NATIONAL CONSTRUCTION POLICY

FEDERAL REPUBLIC OF NIGERIA

MAY 1991

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# CHAPTER FIVE

## 5.0 CONSTRUCTION TECHNOLOGY

### 5.1 Goal

To encourage the adoption of appropriate construction technology responsive to the technological conditions of the country.

### 5.2 Objectives

(i) Utilise the abundant labour in the country.

(ii) Reduce the foreign exchange needed for the importation of capital intensive equipment and foreign personnel.

(iii) Encourage the development of indigenous method of construction.

(iv) Reduce the cost of construction

(v) Enhance self-reliance in the construction industry and the acquisition of technical know-how by Nigerians.

### 5.3 Strategies

(i) As far as possible, projects shall be parcelled out into smaller manageable units which can be executed by many indigenous contractors.

(ii) Both the formal and informal sectors shall be mobilised by promoting the use of appropriate technology through:

(a) the development of appropriate equipment, tools and skills.

(b) Exhibitions and Awards.

(c) Training Workshops and technical extension services.

(iii) A comprehensive national productivity indices must be developed for the construction industry.